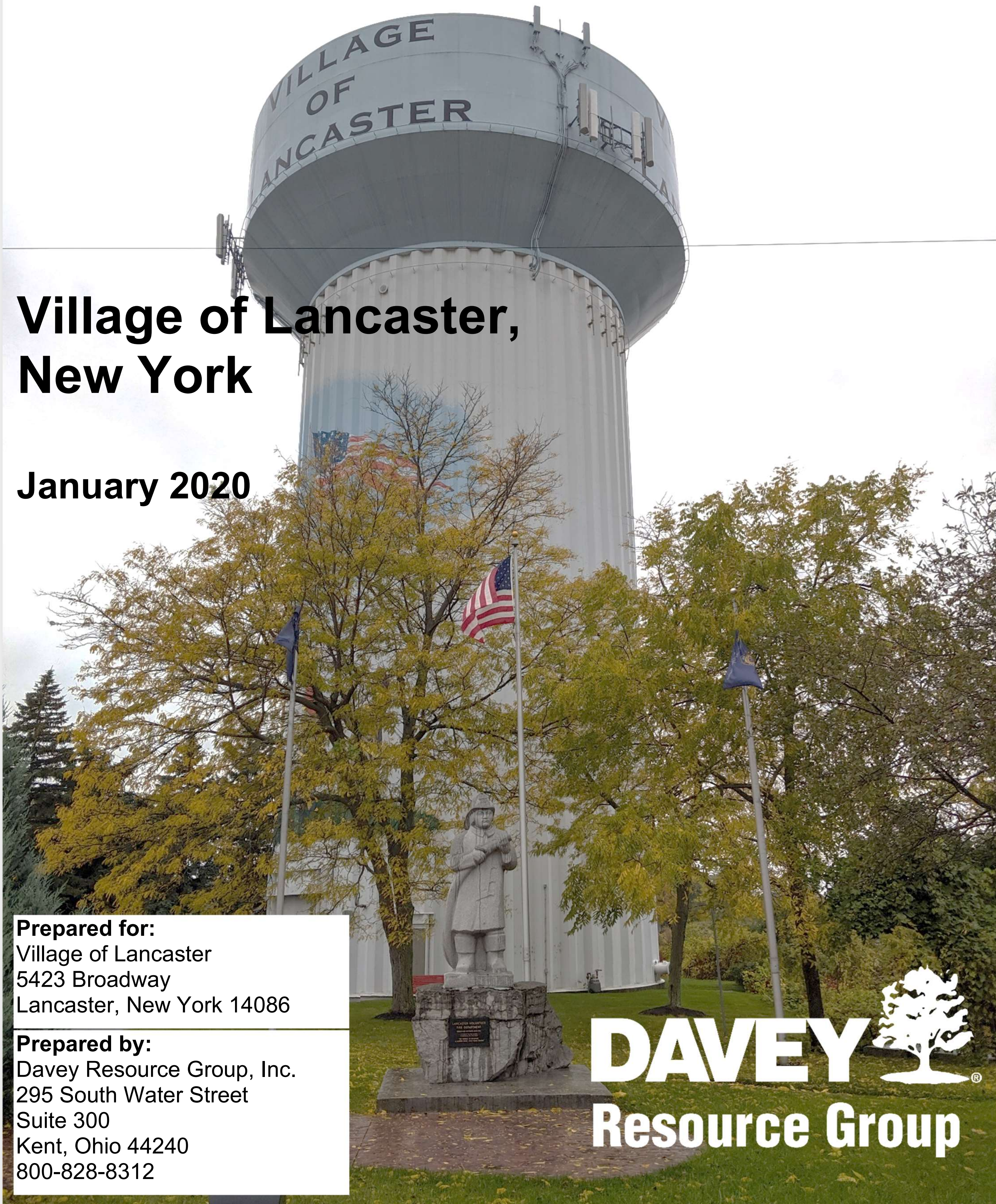
TREE MANAGEMENT PLAN



Village of Lancaster, New York

January 2020

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MISSION STATEMENT

Incorporated in 1849, The Village of Lancaster is the third oldest incorporated village in Erie County and strives to enhance and promote an excellent quality of life for its citizens. The vision to support and preserve the Village urban forest and improve the management of public trees was a fundamental inspiration for this project. Implementation of the recommendations and accomplishment of the goals identified in this project will ensure canopy continuity, which will reduce stormwater runoff and improve aesthetic value, air quality, and public health. The Village is committed to sustaining and enhancing the benefits trees provide to the community by developing and following this strategic Community Forest Management Plan.

ACKNOWLEDGMENTS

Lancaster's vision to promote and preserve the urban forest and improve the management of public trees was a fundamental inspiration for this project. This vision will ensure canopy continuity, which will reduce stormwater runoff and improve aesthetic value, air quality, and public health.

Lancaster is thankful for the grant funding it received from the New York State Department of Environmental Conservation (NYSDEC). The Lancaster Tree Inventory and Management Plan was financially supported by a 2019 NYSDEC Urban and Community Forestry grant. The funding is made available through New York State's Environmental Protection Fund, providing crucial assistance for communities to help develop and implement comprehensive projects to create healthy forests and enhance quality of life for residents.

The Village also recognizes the support of its Mayor and Village council:

EXECUTIVE SUMMARY

This plan was developed for the Village of Lancaster by Davey Resource Group (DRG) with a focus on addressing short-term and long-term maintenance needs for their inventoried public trees. A tree inventory is utilized to gain an understanding of the needs of an existing urban forest and to project a recommended maintenance schedule for tree care.

State of the Existing Urban Forest

The 2019 inventory included trees, stumps, and planting sites along public street rights-of-way (ROW). A total of 5,278 sites were recorded during the inventory which included: 3,960 trees, 16 stumps, and 1,302 vacant planting sites. The following key points were found from the analysis of the tree inventory data:

- One species, *Acer platanoides* (Norway maple), comprises a large percentage of the inventory (50%). *Tilia cordata* (littleleaf linden) was found in abundance (13%).
- The diameter size class distribution of the inventoried tree population has a greater number of established sized trees than young, maturing, or mature trees.
- The overall condition of the inventoried tree population is rated Fair. The majority of defects noted were either weakly attached branches or codominant stems (46%).
- Overhead utilities interfering with street trees occur among 10% of the population.
- Granulate ambrosia beetle (*Xylosandrus crassiusculus*) and Asian longhorned beetle (*Anoplophora glabripennis*) are the largest pest concerns for the inventory.
- The inventoried trees have an estimated structural value of $6.01 million.
- Total carbon storage of the inventory was estimated to be 2,050 tons, valued at $349K.
- Trees provide approximately $24K in the following annual benefits:
    - *Air quality*: 1,660 pounds of pollutants removed, valued at $14.6K per year.
    - *Net total carbon sequestered:* 27 tons, valued at $4.7K per year.
    - *Stormwater attenuation:* 75K ft^3, valued at $5K per year.

Tree Maintenance and Planting Needs

Trees provide many environmental and economic benefits that justify the time and money invested in planting and maintenance. Recommended maintenance needs include: Tree Removal, Stump Removal, Routine Pruning, Young Tree Training, Routine Pruning, and New Tree Plantings. Maintenance should be prioritized by addressing trees with the highest risk first. A low amount of High Risk categorized trees were recorded in the inventory; these trees should be removed or pruned immediately to promote public safety. Low and Moderate Risk trees should be addressed after all elevated risk tree maintenance has been completed. Trees should be planted to mitigate removals and create canopy.

Lancaster's urban forest will benefit greatly from a three-year young tree training cycle and a five-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 future costly problems. Based on inventory data, at least 120 young trees should be structurally pruned each year during the young tree training cycle, and approximately 230 trees should be cleaned each year during the routine pruning cycle.

Planting trees is necessary to increase canopy cover. However, there must be enough plantings to accommodate trees that have been removed or lost to natural mortality (1–3% per year) or other threats. Other threats include construction, invasive pests, or impacts from weather events such as drought, flooding, ice, snow, storms, and wind). DRG recommends planting at least 260 trees of a variety of species each year to offset these losses, increase canopy, maximize benefits, and fill in the vacant planting sites noted in the inventory.

Tree planting should focus on replacing trees recommended for removal and 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. Various tree species should be planted; however, the planting of *Acer* spp. (maple species) should be limited until the species distribution normalizes.

Urban Forest Program Needs

Adequate funding will be needed for the Village 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 five-year program is approximately $175K. This total will decrease to approximately $150K in Year 5 of the program. Overall, the bulk of the budget is in new tree plantings as the trees in the inventory appeared to be well maintained. The first year is the most expensive as all the higher risk items are alleviated first. After high-priority work has been completed, the urban forestry program will mostly involve proactive maintenance, which is generally less costly. Tree planting estimates were derived from the amount of inventoried vacant planting spaces and filling those voids within the time frame of five years. Municipal budgets will determine if this is feasible. The primary focus should be risk reduction followed by tree plantings.

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 Village infrastructure. Keeping the inventory up-to-date using TreeKeeper® or similar software is crucial for making informed management decisions and projecting accurate maintenance budgets.

Lancaster has many opportunities to improve its urban forest. Planned tree planting after risk reduction is a systematic approach to tree maintenance which 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.

The highlights of the management program including cost and workload estimates by program year are described below.

FY 2020

$174,952

- 8 High Risk Removals
- 39 Moderate and Low Risk Removals
- 5 High Risk Prunes
- 16 Stump Removals
- Routine Pruning Cycle: 234 Trees
- Young Tree Training Cycle: 121 Trees
- 230 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2021

$158,943

- 45 Moderate and Low Risk Removals
- Routine Pruning Cycle: 234 Trees
- Young Tree Training Cycle: 121 Trees
- 230 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2022

$154,917

- 17 Moderate and Low Risk Removals
- Rountine Pruning Cycle: 234 Trees
- Young Tree Training Cycle: 121 Trees
- 230 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2023

$151,570

- 10 Moderate and Low Risk Removals
- Routine Pruning Cycle: 234 Trees
- Young Tree Training Cycle: 131 Trees
- 230 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY2024

$151,628

- 23 Low Risk Removals
- Routine Pruning Cycle: 234 Trees
- Young Tree Training Cycle: 121 Trees
- 230 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

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INTRODUCTION

The Village of Lancaster is home to more than 10,000 full-time residents who enjoy the beauty and benefits of their urban forest. The Village's forestry program manages and maintains trees stumps, and planting sites in specified parks, public facilities, and along the street rights-of-way (ROW).

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.

In October 2019, The Village worked with DRG to inventory trees and develop a management plan. This plan considers the diversity, distribution, and general condition of the inventoried trees, but also provides a prioritized system for managing public trees. The following tasks were completed:

- Inventory of trees, stumps, and planting sites along the street ROW and within public parks as designated by the 38.5 street miles within the Village. The inventory area includes residential neighborhoods, small Village-wide parks, business districts, an industrial park, and two National Historic Districts.
- Analysis of the tree inventory data, including the current state of the urban forest and tree public benefits.
- Development of a plan that prioritizes the recommended tree maintenance.

This plan is divided into four sections:

- *Section 1: Tree Inventory Analysis* summarizes the tree inventory data and presents trends, results, and observations.
- *Section 2: Benefits of the Urban Forest* summarizes the economic, environmental, and social benefits that trees provide to the community. This section presents statistics of an i-Tree Streets benefits analysis conducted for Lancaster.
- *Section 3: Tree Management Program* utilizes the inventory data to develop a prioritized maintenance schedule and projected budget for the recommended tree maintenance over a five-year period.
- *Section 4: Community Tree Board and Public Outreach* summary of tree board fundamentals and nuances of public outreach.

SECTION 1: TREE INVENTORY ANALYSIS

In October 2019, DRG arborists assessed and inventoried trees, stumps, and planting sites along the street ROW, specified parks, and public facilities. A total of 5,278 sites were collected during the inventory which included: 3,960 trees, 16 stumps, and 1,302 planting sites. Of the 3,960 sites collected, all were collected along the street ROW. Figure 1 provides a breakdown of the number and type of sites inventoried. See Appendix A for more information on data collection and site location methodology.

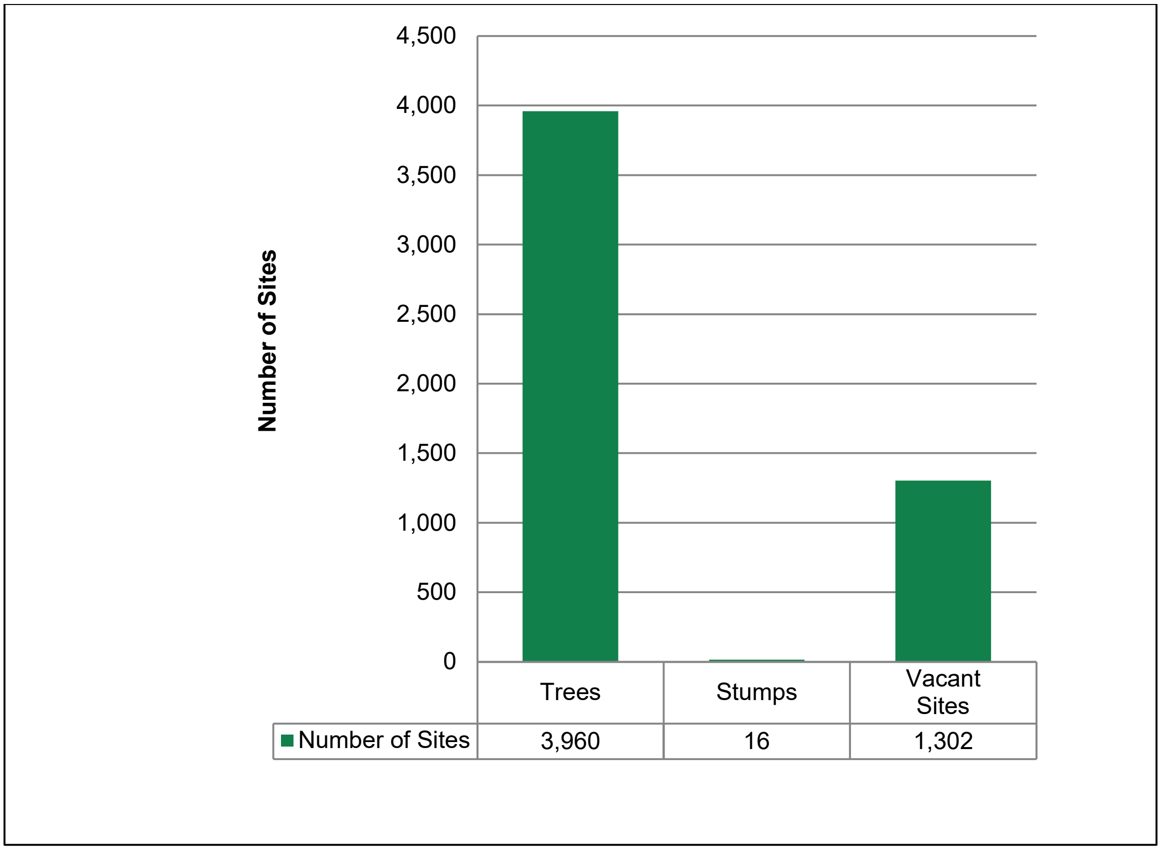


Figure 1. Sites collected during the 2019 inventory

Assessment of Tree Inventory Data

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

- *Species Diversity*, the variety of species in a specific population, affects the 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*, the statistical distribution of a given tree population's diameter-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.

Photograph 1. *DRG's 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.*

- *Condition and Defects*, 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.
- *Stocking Level* is the proportion of existing street trees compared to the total number of potential street trees (number of inventoried trees plus the number of potential planting spaces); stocking level can help determine tree planting needs and budgets.
- *Infrastructure Conflicts* indicates the observed existence of tree growth conflicting with overhead powerlines. Storm readiness involves awareness of potential infrastructure damage due to power line conflicts.
- *Growing Space Type and Size* is inventory data analysis that provides insight into past existing growing conditions; observations such as maximum grow space will affect future tree selections.
- *Further Inspection* indicates whether a particular tree requires additional inspection, such as a Level III risk inspection in accordance with *American National Standards Institute (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.
- *Potential Threats from Pests* includes potential disease and insect targets found during the inventory. Disease and pest readiness are essential to ensuring the health and continuity of public trees.

Species Diversity

Species diversity affects maintenance costs, planting goals, canopy continuity, and the 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, which is a biodiversity concern. Emerald Ash Borer (EAB, *Agrilus planipennis*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are non-native insect pests that attack some of the most prevalent urban shade trees and certain agricultural trees throughout the country. More discussion regarding potential pests are included later in this section.

The composition of a tree population should follow the 10-20-30 Rule for species diversity: 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%.

Findings

The ROW tree population in the Village had 38 genera and 64 species represented in the October 2019 inventory. Figure 2 uses the 10% Rule to compare the percentages of the most common species identified during the inventory. Norway maple far exceeded the recommended 10% maximum for a single species in a population, comprising 50% of the inventoried tree population. Littleleaf linden and silver maple are around the 10% threshold for a single species. Crimson King Norway maples are identified by their rich, dark purple to maroon leaves. This genetic variation creates an attractive option for communities interested in adding color to their tree palate and is readily available through the nursery marketplace.

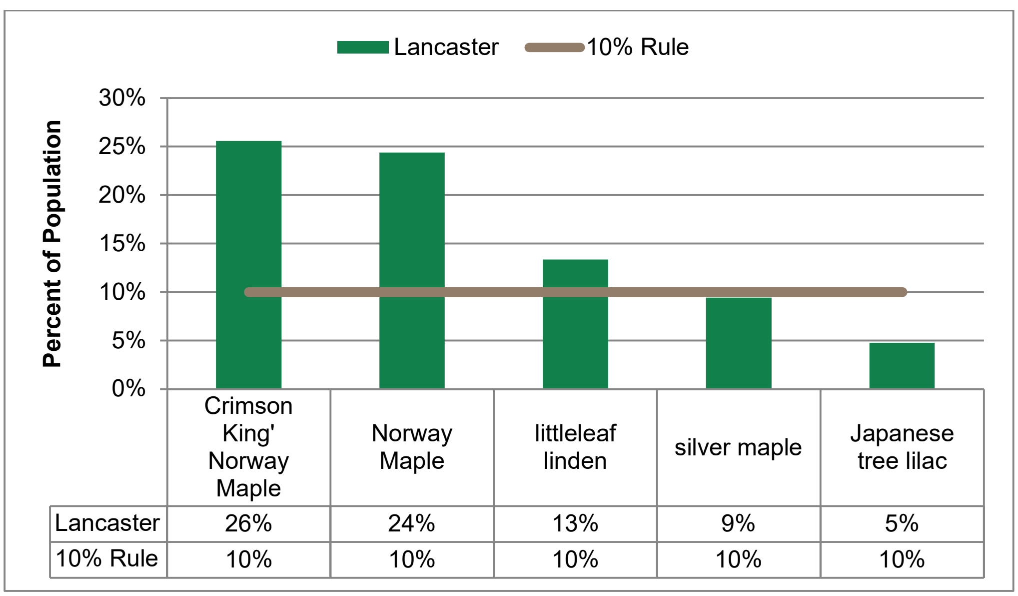


Figure 2. Five most abundant species of the inventoried population compared to the 10% Rule.

Figure 3 shows the 20% Rule compared to the percentages of the most common genera identified during the inventory. The *Acer* genus far exceeded the recommended 20% maximum for a single genus in a population, comprising 67% of the inventoried tree population. The *Tilia* genus is approaching the 20% threshold.

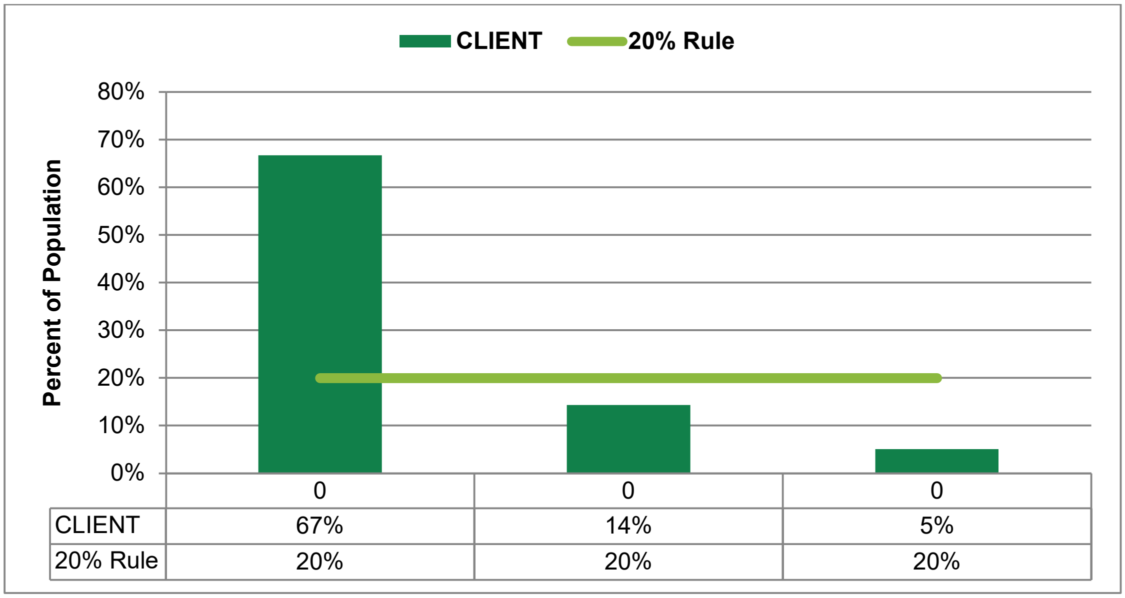


Figure 3. Most abundant genera of the inventoried population compared to the 20% Rule.

Discussion

Acer platanoides (Norway maple) dominate the streets and parks. This is a biodiversity concern because their abundance in the landscape creates the beginnings of a monoculture. Continued diversity of tree species is an important objective that will ensure Lancaster's urban forest is sustainable and resilient to future invasive pest infestations.

Considering the large quantity of Norway maple in the Village's population, along with their susceptibility to Asian longhorned beetle, granulate ambrosia beetle, Xm ambrosia beetle, and spotted lanternfly, the planting of Norway maple should cease. Consider increasing the diversity of tree species in order to minimize the potential for loss in the event that these pests threaten Lancaster's urban tree population. See Appendix C 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 practices and needs.

The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 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 the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while a smaller fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). A tree population with an ideal distribution would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees.

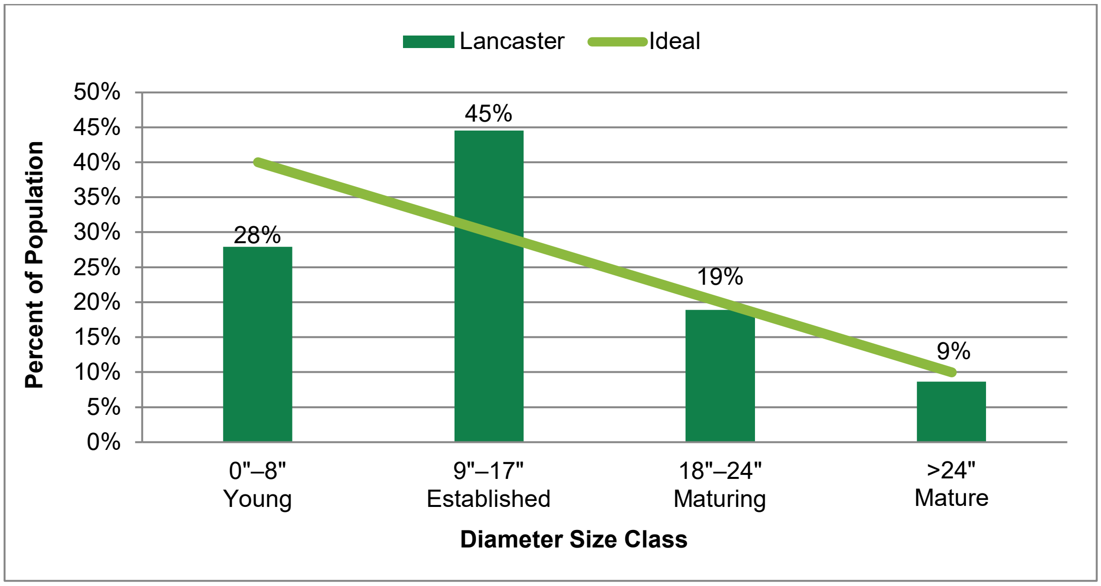


Figure 4. Comparison of diameter size class distribution for inventoried trees to the ideal distribution.

Findings

Figure 4 compares Lancaster's diameter size class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Lancaster's distribution trends toward the ideal; young trees fall under the ideal by 12%, while established trees exceed the ideal.

Discussion

Although Lancaster's tree population trends toward the ideal, there are more established trees compared to young trees. DRG recommends that Lancaster support a strong planting and maintenance program to ensure that young, healthy trees are in place to ensure canopy continuity and to replace older declining trees. The Village must promote tree preservation and proactive tree care to ensure the long-term survival of older trees. See Appendix B for more information on risk assessment and priority maintenance. Additionally, tree planting and tree care will allow the distribution to normalize over time. See Appendix C for a recommended tree species list for planting. See Appendix D for a tree planting guide.

Planting trees is necessary to increase canopy cover and replace trees lost to natural mortality (1%–3% per year) and other threats. Other threats include 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.

Condition and Defects

DRG assessed the condition of individual trees based on methods defined by the International Society of Arboriculture (ISA). Several factors were considered for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. The condition of each inventoried tree was rated Good, Fair, Poor, or Dead. The general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory. Defects were also noted as needed for each tree inspected (Table 1).

Comparing the condition of the inventoried tree population to 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 (9–17 inches DBH), maturing (18–24 inches DBH), and mature (greater than 24 inches DBH).

Figures 5 and 6 illustrate the general health and distribution of young, established, mature, and maturing trees relative to their condition.

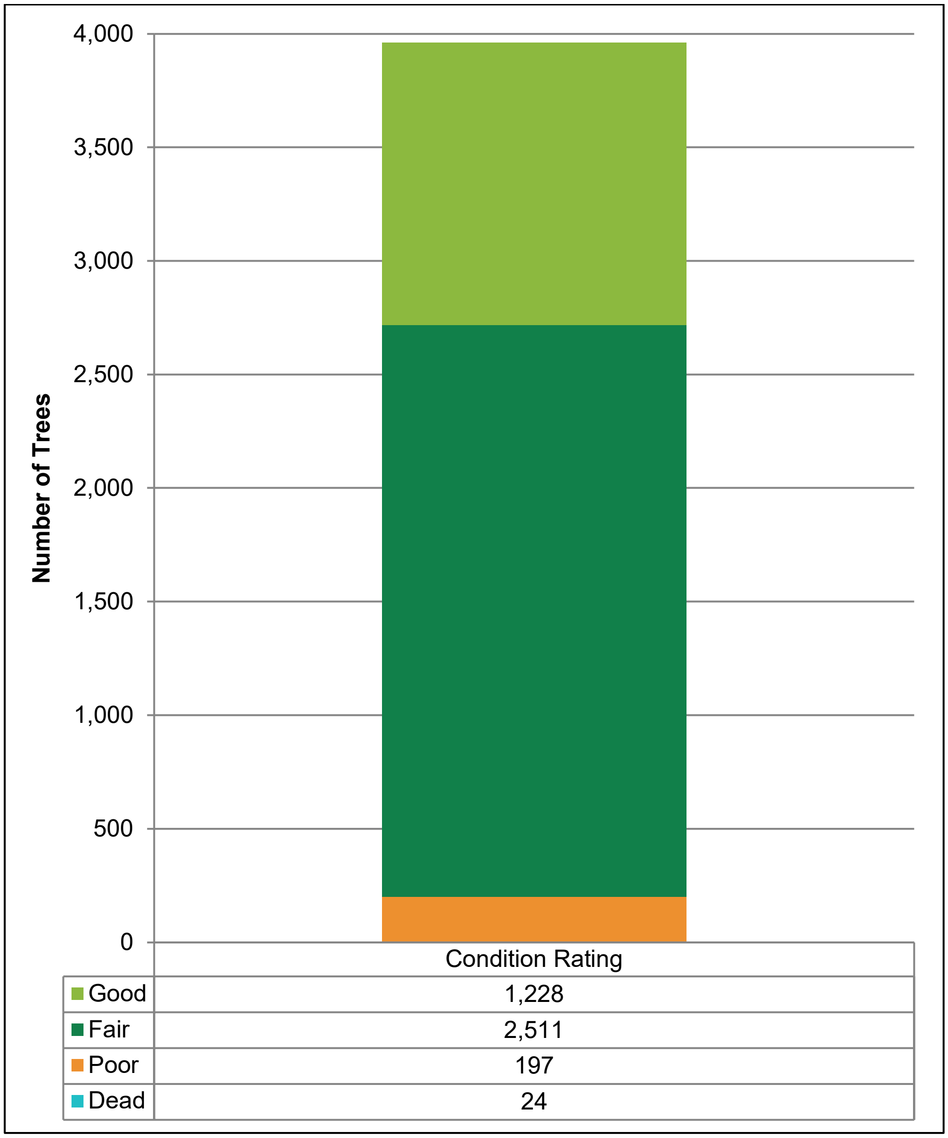


Figure 5. Conditions of inventoried trees.

Findings

Most of the inventoried trees were recorded to be in Fair or Good condition, 63% and 31%, respectively (Figure 5). Based on these data, the general health of the overall inventoried tree population is rated Fair. Figure 6 illustrates that most of the trees within each relative age class were rated Fair.

Of the defects discovered, the most common concerns were weakly attached branches and codominant stems.

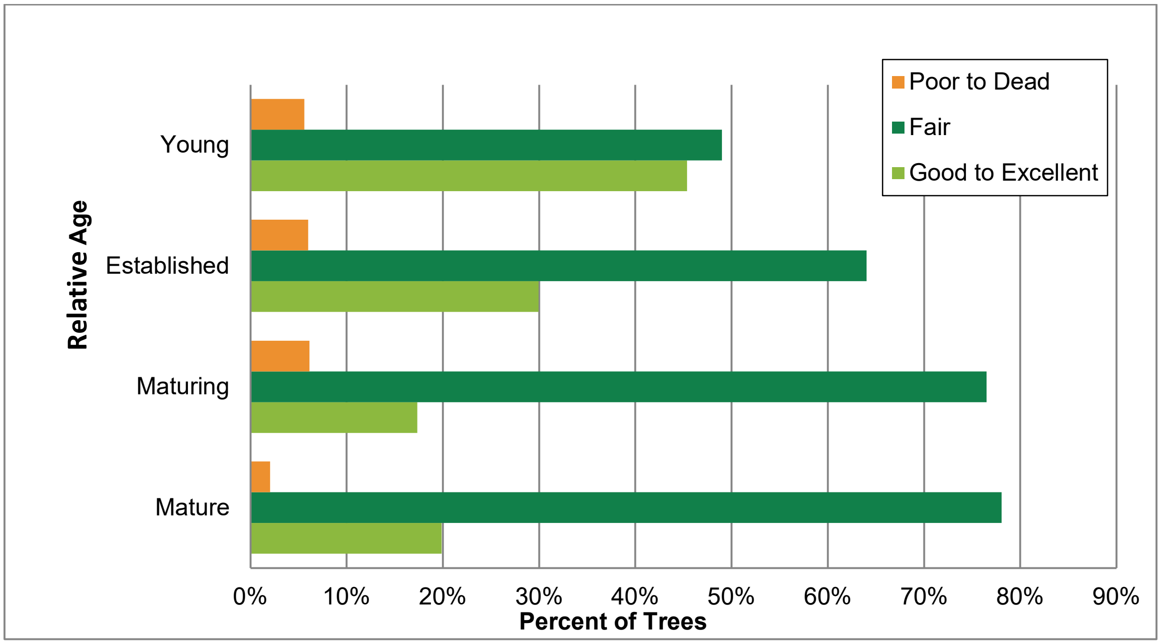


Figure 6. Tree condition by relative age during the 2019 inventory.

Table 1. Defects of Trees Noted During Inventory

Defects Noted	Number of Trees
Weakly attached branches and codominant stems	1,856
Dead and dying parts	715
Missing or decayed wood	623
Tree architecture	110
Cracks	108
Other	106
Root problems	46
Broken and/or hanging branches	32
None Noted	1,682
Grand Total	**5,278**

Discussion

Lancaster's inventoried tree population was rated as Fair in overall condition. However, following established maintenance guidelines based on condition rating and defects can improve the condition of these trees.

- Dead trees should be removed because of their failed health. Stumps can negatively affect the aesthetic of the community; be sure to include stump removal when removing the dead trees.
- Younger trees rated in Fair or Poor condition may benefit from improvements in structure that may improve their health over time. Pruning should follow *ANSI A300 (Part 1)* (ANSI 2008).

- 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. Tree removal may be necessary.
- The defect information in the inventory can enable staff to identify which trees may need future work. Using a tracking program which is geographically referenced can offer a pathway to successful workload management.
- Proper tree care practices are needed for the long-term general health of the urban forest. Many of the newly planted trees were improperly mulched or had staking hardware attached to them long after they should have been removed. 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.

Stocking Level

Stocking is a traditional forestry term used to measure the density and distribution of trees. For an urban/community forest, stocking level is used to estimate the total number of sites along the street ROW that could contain trees. Park trees and public property trees are excluded from this measurement as it evaluates street trees only.

Stocking level is the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. For example, a street ROW tree inventory of 1,000 total sites with 750 existing trees and 250 planting sites would have a stocking level of 75%.

For an urban area, DRG recommends that the street ROW stocking level be at least 90% so that no more than 10% of the potential planting sites along the street ROW are vacant.

Findings

The inventory found 1,302 planting sites. Of the inventoried sites, 126 were potential planting sites for large-size trees (8-foot-wide and greater); 444 were potential sites for medium-size trees (6- to 7-foot-wide growing space sizes); and 732 were potential sites for small-size trees (4- to 5-foot-wide growing space sizes).

Based upon the inventory findings of 1,302 planting sites and the Tree Management Program time frame of 5 years, it is estimated 260 trees should be planted to fill the vacant sites within 5 years. The current stocking level is 66%. To each the recommended level of 90% within 5 years, 260 trees per year will need to be planted. The upcoming budget table in Section 3 provides cost estimates. Tree planting plans can be constrained by funding, if a 10-year plan was adopted, the new trees needed to be installed would reduce to approximately 130 per year.

Discussion

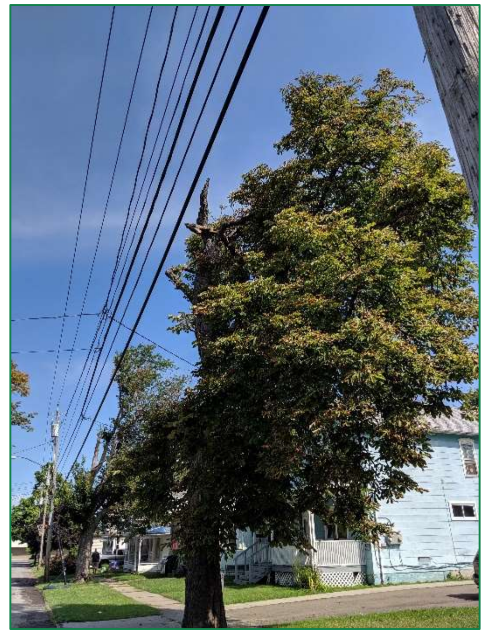
Inadequate tree planting and maintenance budgets, along with tree mortality, will result in lower stocking levels. Working to attain a fully stocked street ROW is important to promote canopy continuity and environmental sustainability. The Village should consider improving its street ROW population's stocking level of 75% to the recommendation of 90% or better. This includes creating a plan for new tree planting, care, and maintenance for the Village's street trees.

The Village of Lancaster estimates that it plants 30 trees per year. With a current total of 1,302 planting sites along the street ROW, it would take approximately 27 years for the Village to reach the recommended stocking level of 90%. If budgets allow, DRG recommends that Lancaster increase the annual number of trees planted to 260. Exceeding this recommendation will better prepare for impending threats and increase the benefits provided by the urban forest. Appendix C is a list of Suggested Tree and Plant Species.

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 pose risks to public health and safety and to tree health. 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.



Photograph 2. *Trees pruned near powerlines require more maintenance, often have an unsightly aesthetic, and may pose a threat to public safety.*

Findings

There were 503 trees noted as Present and Conflicting with overhead utilities. Of this number, 2 were noted as Dead, 15 for Poor, and 373 in Fair condition (Table 2). Dead trees should be a priority for removal, and the Poor rated trees should be evaluated for potential removal.

Table 2. Trees Noted to be Conflicting with Infrastructure

Conflict	Type	Number of Trees	Percent
Overhead Utilities	Present and Conflicting	503	9.53%
	Present and Not Conflicting	1,902	36.04%
	Not Present	2,873	54.43%
Total		**5,278**	**100%**

Discussion

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). DRG's 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, and large-growing trees outside 40 feet will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines. Follow the Arbor Day Foundation mantra, "Right Tree in the Right Place." Consider overhead utility lines when planting trees.

When planting around hardscape, 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 4–5 feet, medium-growing trees 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. Larger trees in smaller spaces can cause issues such as sidewalk damage and other streetscape design facets. In the long run, too large of a tree for a planting site is more costly to mitigate in the future.

Growing Space Type and Size

Information about the type and size of the growing space for each tree was recorded. Growing space size was recorded as the minimum width of the growing space needed for root development. Growing space types are 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/Parkway—located between the street curb and the public sidewalk.
- Unmaintained/Natural Area—located in areas that do not appear to be regularly maintained.
- Well/Pit—at grade level and surrounded by sidewalk.

Findings

Most of the inventoried sites were in tree lawns that range between 4 and 12 feet wide (93%), with the greatest percentage in 4- to 8-foot tree lawns (59%). Suggested vacant planting sites are mostly tree lawns (97%). Table 3 provides a list of grow space types and number of sites found during the inventory.

Table 3. Grow Space Types and Sizes Noted in the 2019 Inventory

Grow Space Type / Size	Number of Sites
Island	**4**
12'+	4
Median	**12**
12'+	4
4-8'	2
8-12'	6
Natural Area	**6**
12'+	6
Open/Restricted	**44**
12'+	38
4-8'	5
8-12'	1
Open/Unrestricted	**216**
0-4'	1
12'+	193
4-8'	3
8-12'	19
Tree Lawn/Parkway	**4,963**
0-4'	55
12'+	104
4-8'	3,156
8-12'	1,648
Well/Pit	**33**
0-4'	32
4-8'	1
Grand Total	**5,278**

Discussion

To prolong the useful life of street trees and achieve the maximum ecological benefit for each site, small-growing tree species should be planted in tree lawns 4–5 feet wide, medium-size tree species in tree lawns 6–7 feet wide, and large-growing tree species in tree lawns at least 8 feet wide. 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. See Appendix D for the Tree Planting Guide.

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, Village staff should investigate as soon as possible to determine corrective actions.

Findings

The inventory revealed 18 trees requiring a Level III assessment, and 20 trees recommended for insect/disease monitoring. Table 4 provides a breakdown of any sites which were recommended for further inspections and type.

Table 4. Inspection Type Recommended as Noted in Further Inspection

Inspection Type	Sites
Insect/disease monitoring	20
Level III assessment	18
Multi-year annual	391
None Noted	4,849
Grand Total	**5,278**

Discussion

An ISA Certified Arborist should perform additional inspections of the 429 trees recommended for further inspection. 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. Be sure to update the inventory database and remove the stump promptly if tree removal is deemed necessary. A Level III inspection should be performed if the tree defect of note is not directly observable from the ground or without the use of extraordinary measures. This methodology will provide a more detailed information regarding individual tree parts, defects, targets, or site conditions. This assessment can take many forms and may employ one or more of the following measures—aerial inspection, assessment of internal decay, root excavation, and evaluation most commonly.

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 street and park trees. Appendix E provides information about some of the current potential threats to Lancaster's trees and includes websites where more detailed information can be found.

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 New York (see Figure 7). It is important to note that the figure only presents data collected from the inventory. Many more trees throughout Lancaster, including those on public and private property, may be susceptible to these invasive pests.

Findings

Spotted Laternfly (*Lycorma delicatula*), Granulate ambrosia beetle (*Xylosandrus crassiusculus*), Asian longhorned beetle (*Anoplophora glabripennis*) are known threats to a large percentage of the inventoried street trees (71%, 70%, and 64%, respectively). These pests were not detected in Lancaster, but if they were detected, the Village could see losses in its tree population.

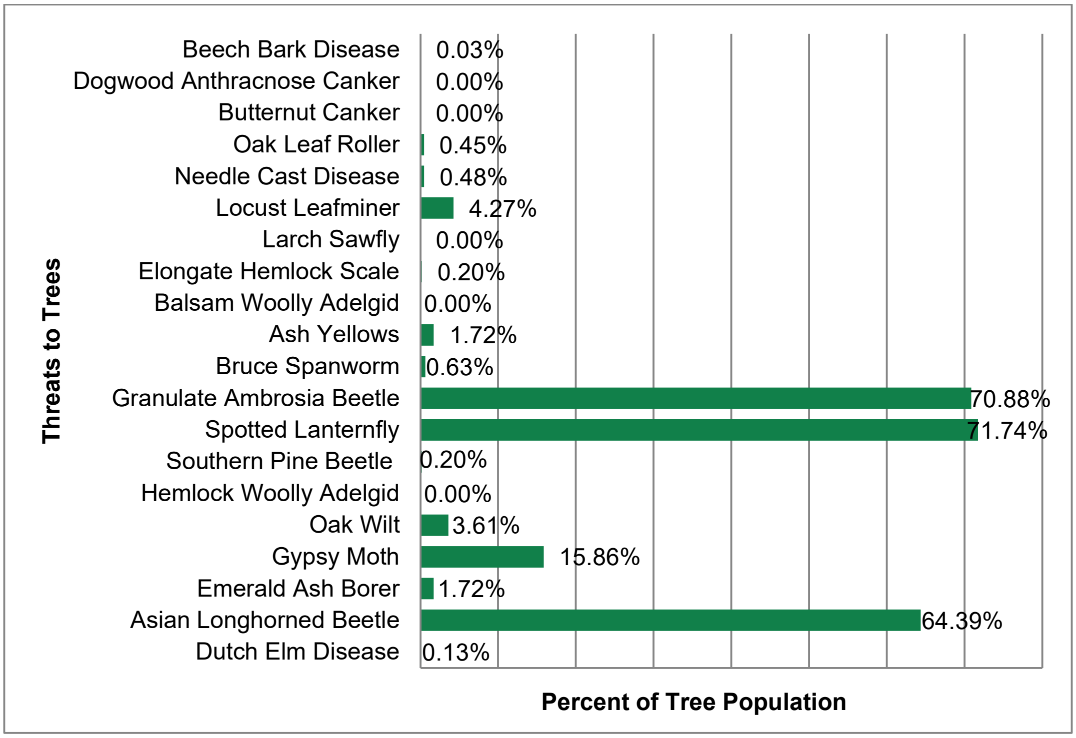


Figure 7. Potential impact of insect and disease threats recorded during the 2019 inventory.

Discussion

Lancaster should be aware of the signs and symptoms of potential infestations. municipal officials should be prepared to act if a significant threat is observed in its tree population or a nearby community. A municipal urban forestry integrated pest management plan should be established, based upon identifying and monitoring threats, cost/benefit analysis, correct treatment, recordkeeping, and evaluating results. Public education and input should be a foundation of the plan. Appendix E is provided for consideration of review for pests and diseases which affect the trees of the region.

SECTION 2: BENEFITS OF THE URBAN FOREST

There is a growing understanding and validation of the importance of trees to a community. Scientists and researchers have studied the effects of trees on air quality, stormwater runoff, human behavior, and crime rates. Trees are demonstrably beneficial and positively affect human and public health. The benefits trees provide are commonly divided into three categories—economic, environmental, and social.

The benefit of utilizing i-Tree Eco is that it provides a better understanding of the structure and function of trees as a resource. It also provides municipalities the means to advocate for the necessary funding to manage trees appropriately.

i-Tree Eco Analysis

Both the structural and functional benefits of trees can be assessed when utilizing i-Tree Eco. The functional benefits of trees are associated with their ability to provide pollution reduction and ecosystem services through sequestration. Pollution removed from the Village includes carbon (C), ozone (O_3), nitrogen dioxide (NO_2), particulate matter up to the tenth of a micron (PM_{10}), and sulfur dioxide (SO_2). These services are also quantifiable within i-Tree through a process that utilizes tree growth algorithms which are part of a tree benefits model. The Village currently receives $24,311 annually in ecosystem services from the trees recorded in the 2019 inventory data set (Figure 8).

Lancaster's trees benefit the community in the following ways:

- The net air quality improvement provided by the inventoried tree population is valued at approximately $14,600 per year with the removal of 1,660 pounds of pollutants annually, for an average net benefit of $3.69 per tree.
- Provides a total carbon storage benefit worth roughly $349,000, with total carbon storage of 2,050 tons.
- Annual carbon sequestration for the inventoried trees is 27.43 tons per year, which accounts for an estimated annual value of $4.68 thousand.
- Oxygen produced by the sample tree population amounts to 73.14 tons annually.
- Attenuation of 75.04 thousand cubic feet of stormwater per year. The total annual value of this benefit is $5.02 thousand.
- Total structural value of $6.01 million for the inventoried trees.

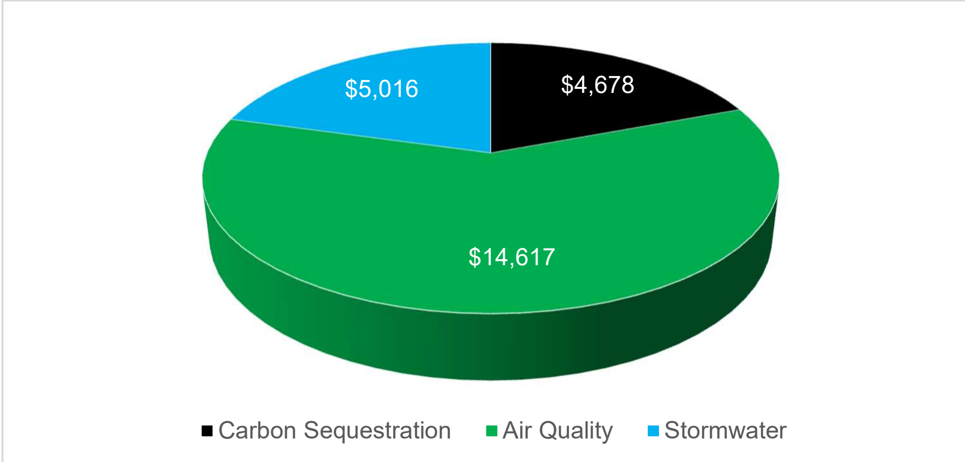


Figure 8. Annual ecosystem benefits for the inventoried trees.

Economic Benefits

Lancaster's inventoried trees have been quantified utilizing the i-Tree Eco software suite and the assessment provides economic benefits. i-Tree Eco can be utilized with a complete inventory to simplify the quantification process. When prudent location in the landscape is matched with healthy, high-quality tree species, the economic benefits can be readily quantified utilizing the Council of Tree and Landscape Appraiser's methodology within the i-Tree Eco tool. The monetary values of trees are based on four characteristics, which are condition, location, species, and trunk area. This information has been complemented with United States Forest Service (USFS) software programs like i-Tree Eco to provide benefit-based assessments of what trees are worth on an economic level (McPherson 2007) and (Nowak *et al.* 2008).

Trees improve air quality. During photosynthesis, trees remove carbon dioxide (CO_2) from the atmosphere to form carbohydrates that are used in plant structure/function and return oxygen (O_2) back to the atmosphere as a byproduct. Trees, therefore, act as a carbon sink- a natural reservoir that stores carbon from the atmosphere. Urban forests cleanse the air by intercepting and slowing particulate materials and by absorbing pollutant gases on their leaf surfaces. Pollutants partially controlled by trees include nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), CO_2, ozone (O_3), and small particulates less than 10 microns in size (PM_{10}). Trees can reduce air pollution by up to 60% (Coder 1996), and Children who live in communities with an abundance of trees have lower rates of asthma (Lovasi et al. 2008).

Planting trees in strategic areas can augment the function of existing stormwater infrastructure by increasing its capacity and delaying onsets of peak flows and improving water quality. Because trees act as mini-reservoirs, planting trees can reduce the long-term costs to manage runoff. Leafy tree canopies catch precipitation before it reaches the ground, allowing some water to gently drip and the rest to evaporate. This lessens the initial impact of storms and reduces runoff and erosion. For every 5% of tree cover added to a community, stormwater runoff is reduced by approximately 2% (Coder 1996). Research by the U.S. Department of Agriculture (USDA) Forest Service indicates that 100 mature tree crowns intercept about 100,000 gallons of rainfall per year, reducing runoff and providing cleaner water (USDA Forest Service 2003(a)). A typical community forest of 10,000 trees will retain approximately 10 million gallons of rainwater per year (USDA Forest Service 2003(b)).

Social Benefits

Research has shown that trees can lead to reduced crime rates, decreased amounts of human stress, and shorter lengths of hospital stays. Kuo and Sullivan (2001(a)) studied apartment buildings in Chicago and found that buildings with high levels of greenery had 52% fewer crimes than those without any trees, and buildings with medium amounts of greenery had 42% fewer crimes.

Trees create a sense of serenity and add to the overall landscape athletics of a location. Ulrich (1984, 1986) found that hospital patients who were recovering from surgery and had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall.

Functional Benefits

The functional benefits of trees are associated with their ability to provide pollution reduction and ecosystem services through sequestration. Pollution removed from the Village from the sample trees includes carbon (C), ozone (O_3), nitrogen dioxide (NO_2), particulate matter up to the tenth of a micron (PM_{10}), and sulfur dioxide (SO_2). These services are also quantifiable within i-Tree through a process that utilizes tree growth algorithms which are part of a tree benefits model. The inventoried trees provide numerous functional benefits to the community. These cumulative benefits can be valued at an annual average of approximately $89 per tree for trees surveyed. Trees help reduce local carbon dioxide levels, improve air quality, and mitigate stormwater runoff.

Structural Benefits

The most straightforward way to establish a monetary value for a forest is by establishing a structural value. This value represents the amount it would cost to replace all the trees in of the inventory performed. Structural value provides an approximation of the investment in planning, resources, and time which has produced the establishment and maintenance of the existing inventory. The inventory performed has a total structural value of $14,380,468 based on the i-Tree Eco valuation algorithm. Table 5 shows the functional and structural benefits of the top species from the tree inventory, as gathered from i-Tree Eco. Tables 6 through 8 provide the highest dollar values per tree in the inventory for each ecological benefit.

Table 5. Top 30 Highest Structural Valued Species of the Inventory

Species	Tree Count	Carbon Storage (ton)	Carbon Storage ($)	Gross Carbon (ton/yr)	Gross Carbon ($/yr)	Avoided Runoff (ft³/yr)	Avoided Runoff ($/yr)	Pollution Removal (ton/yr)	Pollution Removal($/yr)	Structural Value ($)
Norway maple	966	501.54	$85,538.83	7.25	$1,236.14	21,995.88	$1,470.33	0.24	$4,284.75	$1,454,295.37
Littleleaf linden	529	199.87	$34,087.67	3.08	$526.00	10,325.51	$690.22	0.11	$2,011.39	$1,225,640.29
Silver maple	373	658.37	$112,285.17	5.10	$870.05	13,642.82	$911.97	0.15	$2,657.59	$1,057,947.08
Crimson king Norway maple	1,012	302.13	$51,528.78	5.87	$1,001.68	17,096.80	$1,142.85	0.19	$3,330.42	$993,268.51
hedge maple	94	62.14	$10,597.82	0.85	$144.14	2,484.21	$166.06	0.03	$483.92	$153,910.71
red maple	140	37.42	$6,382.12	0.60	$102.25	1,399.96	$93.58	0.02	$272.71	$129,044.51
honeylocust	82	37.23	$6,349.18	0.59	$101.22	548.49	$36.66	0.01	$106.85	$126,776.66
Japanese tree lilac	189	19.26	$3,284.46	0.66	$112.11	327.04	$21.86	0.00	$63.71	$119,120.79
apple species	125	23.41	$3,992.57	0.52	$89.35	778.39	$52.03	0.01	$151.63	$95,209.51
American basswood	37	13.72	$2,339.46	0.23	$38.67	877.37	$58.65	0.01	$170.91	$88,518.86
Callery pear	109	21.98	$3,748.09	0.46	$79.21	553.06	$36.97	0.01	$107.74	$85,318.30

sugar maple	24	27.78	$4,737.59	0.28	$48.10	534.58	$35.73	0.01	$104.13	$72,619.07
American sycamore	12	23.03	$3,927.68	0.27	$46.89	639.58	$42.75	0.01	$124.59	$67,594.10
black walnut	17	24.71	$4,214.63	0.27	$46.87	818.43	$54.71	0.01	$159.43	$64,245.77
horse chestnut	21	23.05	$3,930.48	0.27	$45.70	641.96	$42.91	0.01	$125.05	$46,618.88
white ash	36	10.26	$1,750.34	0.21	$35.50	416.03	$27.81	0.00	$81.04	$36,536.31
northern red oak	11	9.49	$1,618.72	0.12	$19.94	196.43	$13.13	0.00	$38.26	$30,390.33
blue spruce	11	4.34	$739.48	0.06	$10.75	179.30	$11.99	0.00	$34.93	$18,408.76
green ash	26	4.35	$742.36	0.05	$8.60	184.33	$12.32	0.00	$35.91	$17,277.87
plum species	13	5.43	$926.55	0.09	$15.71	138.90	$9.28	0.00	$27.06	$13,606.98
London plane	4	4.66	$794.54	0.05	$8.71	124.61	$8.33	0.00	$24.27	$12,064.83
Norway spruce	7	2.46	$420.36	0.03	$5.53	124.15	$8.30	0.00	$24.19	$11,403.70
pin oak	4	3.88	$662.03	0.04	$6.63	48.28	$3.23	0.00	$9.40	$9,050.37
northern catalpa	3	4.63	$789.40	0.04	$6.98	51.07	$3.41	0.00	$9.95	$8,437.65
eastern hophornbeam	10	0.95	$161.41	0.04	$6.07	88.68	$5.93	0.00	$17.28	$7,343.25
common lilac	11	1.28	$217.63	0.04	$6.71	24.06	$1.61	0.00	$4.69	$7,186.64
columnar maple	10	1.09	$186.64	0.04	$6.77	108.37	$7.24	0.00	$21.11	$6,417.00
black maple	4	1.87	$319.36	0.03	$4.92	85.04	$5.68	0.00	$16.57	$6,274.45
boxelder	2	5.44	$927.87	0.05	$8.22	70.51	$4.71	0.00	$13.74	$4,506.32
slippery elm	3	1.96	$334.20	0.02	$3.63	58.31	$3.90	0.00	$11.36	$4,452.81
eastern cottonwood	3	3.61	$616.12	0.04	$7.11	119.03	$7.96	0.00	$23.19	$4,030.97
red pine	3	0.98	$166.45	0.01	$2.44	26.87	$1.80	0.00	$5.23	$3,935.92
ginkgo	3	1.05	$178.27	0.02	$3.66	40.11	$2.68	0.00	$7.81	$3,589.50
Scots pine	3	0.25	$41.83	0.01	$1.28	19.13	$1.28	0.00	$3.73	$2,834.87
Total	**3,959**	**2,047.64**	**$349,227.40**	**27.43**	**$4,677.67**	**75,035.24**	**$5,015.79**	**0.83**	**$14,616.71**	**$6,009,556.27**

Table 6. Top 15 Highest Valued Trees for Pollution Removal

Species	Tree Count	Pollution Removal (ton/yr)	Pollution Removal($/yr)	Pollution $ per Tree
American sycamore	12	0.01	$124.59	$10.38
black walnut	17	0.01	$159.43	$9.38
eastern cottonwood	3	0.00	$23.19	$7.73
silver maple	373	0.15	$2,657.59	$7.12
boxelder	2	0.00	$13.74	$6.87
London plane	4	0.00	$24.27	$6.07
European beech	1	0.00	$5.98	$5.98
horse chestnut	21	0.01	$125.05	$5.95
hedge maple	94	0.03	$483.92	$5.15
American basswood	37	0.01	$170.91	$4.62
Norway maple	966	0.24	$4,284.75	$4.44
sugar maple	24	0.01	$104.13	$4.34
black maple	4	0.00	$16.57	$4.14
swamp white oak	1	0.00	$3.94	$3.94
littleleaf linden	529	0.11	$2,011.39	$3.80

Table 7. Top 15 Highest Valued Trees for Annual Carbon Storage

Species	Tree Count	Gross Carbon (ton/yr)	Gross Carbon ($/yr)	Carbon $/y/Tree
boxelder	2	0.05	$8.22	$4.11
American sycamore	12	0.27	$46.89	$3.91
black walnut	17	0.27	$46.87	$2.76
eastern cottonwood	3	0.04	$7.11	$2.37
silver maple	373	5.10	$870.05	$2.33
northern catalpa	3	0.04	$6.98	$2.33
London plane	4	0.05	$8.71	$2.18
horse chestnut	21	0.27	$45.70	$2.18
sugar maple	24	0.28	$48.10	$2.00
swamp white oak	1	0.01	$1.96	$1.96
northern red oak	11	0.12	$19.94	$1.81
pin oak	4	0.04	$6.63	$1.66
hedge maple	94	0.85	$144.14	$1.53
black locust	1	0.01	$1.39	$1.39
paper birch	1	0.01	$1.30	$1.30
Norway maple	966	7.25	$1,236.14	$1.28
honeylocust	82	0.59	$101.22	$1.23
black maple	4	0.03	$4.92	$1.23
Siberian elm	1	0.01	$1.23	$1.23
European hornbeam	1	0.01	$1.22	$1.22

Table 8. Top 15 Highest Valued Tree species for Stormwater Runoff Control

Species	Tree Count	Avoided Runoff (ft^3/yr)	Avoided Runoff ($/yr)	Runoff $ per Tree
American sycamore	12	639.58	$42.75	$3.56
black walnut	17	818.43	$54.71	$3.22
eastern cottonwood	3	119.03	$7.96	$2.65
silver maple	373	13,642.82	$911.97	$2.44
boxelder	2	70.51	$4.71	$2.36
London plane	4	124.61	$8.33	$2.08
European beech	1	30.72	$2.05	$2.05
horse chestnut	21	641.96	$42.91	$2.04
hedge maple	94	2,484.21	$166.06	$1.77
American basswood	37	877.37	$58.65	$1.59
Norway maple	966	21,995.88	$1,470.33	$1.52
sugar maple	24	534.58	$35.73	$1.49
black maple	4	85.04	$5.68	$1.42
swamp white oak	1	20.21	$1.35	$1.35
littleleaf linden	529	10,325.51	$690.22	$1.30

SECTION 3: TREE MANAGEMENT PROGRAM

This five-year tree management program based on tree inventory data was developed to uphold Lancaster's comprehensive vision for preserving its urban forest. The program was designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. Tree planting and public outreach are important parts of the program as well.

While implementing a tree care program is an ongoing process, tree work must always be prioritized to reduce public safety risks. DRG recommends completing the work identified during the inventory based on the assigned risk rating; however, routinely monitoring the tree population is essential so that newly discovered Extreme or High Risk trees can be identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work (especially for Extreme or High Risk trees) must sometimes take precedence to ensure that risk is expediently managed.

In this plan, the recommended tree maintenance work was divided into either priority or proactive maintenance. Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of High and Extreme Risk. Proactive tree maintenance includes pruning of trees with an assessed risk of Moderate or Low Risk and trees that are young. Tree planting, inspections, and community outreach are also considered proactive maintenance.

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 individual trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care. Within a 5 year program, $1/5^{th}$ of the trees should be inspected each year.

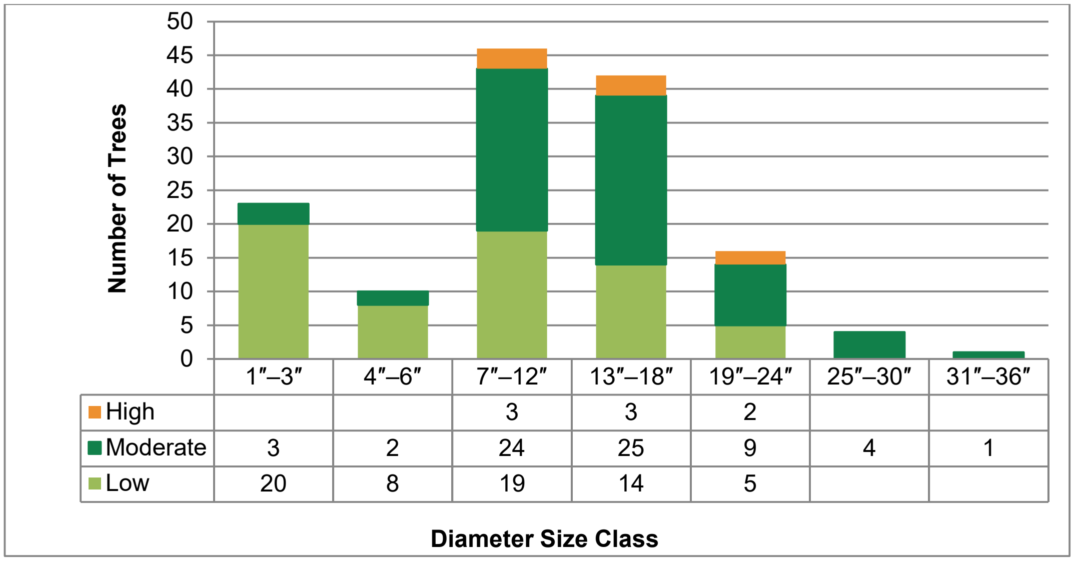
Trees along the street ROW should be regularly inspected and attended to as needed based on the inspection findings. When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate. Use appropriate computer management software such as TreeKeeper® to update inventory data and work records. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases.

Priority Tree and Stump Removal

Although tree removal is usually considered a last resort and may sometimes create a reaction from the community, there are circumstances in which removal is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. It is recommended that trees 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 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.

Findings



	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″
High			3	3	2		
Moderate	3	2	24	25	9	4	1
Low	20	8	19	14	5		

Figure 9. Tree removals by risk rating and diameter size class.

A total of 142 trees were recommended for removal. There were 8 High Risk trees, 68 Moderate Risk trees, and 66 Low Risk trees that are recommended for removal. These trees should be removed based on their assigned risk and size. Larger trees with greatest risk are the initial priority. As the larger sized, higher risk trees are removed, removal work should continue into the lesser sized and lower risk removals.

The inventory identified 16 stumps recommended for removal. The stumps ranged from 9 inches to 28 inches in diameter. Stumps are aesthetically unpleasing and depending on the morphology, can create a public tripping hazard. Stump removals should occur when convenient, and after removal, the residual site should be added to the potential planting site inventory. Further research into why the original tree failed could aid in the next tree selection choice.

Discussion

Proactive tree maintenance that actively mitigates elevated risk situations will promote public safety. Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that should be removed before creating a more costly scenario in the future. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category. All Low Risk trees should be removed when convenient and after all High and Moderate Risk removals have been completed.

There were 8 trees under the High Risk category which were selected for removal. Of these 8 trees, 6 had Dead and Dying Parts and 2 had Missing or Decayed Wood as the main defect noted. Unless already stated for removal, other trees noted as having Missing or Decayed Wood (623 trees) or Dead and Dying Parts (715 trees) should be inspected on a regular basis.

Updating the tree inventory data can streamline workload management and lend insight into setting accurate budgets and staffing levels. Inventory updates should be made electronically and can be implemented using TreeKeeper® or similar computer software.

Priority Tree Pruning

Extreme and High Risk pruning generally requires cleaning the canopy of both small and large trees to remove defects such as dead 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.

Findings

There were only 5 High Risk trees noted for Priority Pruning. Two trees were identified as 10 to 24 inches DBH range; 2 in the 25 to 30 inches range, and 1 in the 37 to 42 inches range.

Photograph 3. *Pruning trees in a proactively can aid in reducing risk from future weather events and increasing aesthetic appeal of the trees.*

Discussion

The inventory identified 5 High Risk trees. This pruning should be performed immediately based on assigned risk and may be performed concurrently with other High Risk removals and pruning. Moderate and Low Risk trees recommended for pruning are included in the routine pruning cycle after all the higher risk trees are addressed.

Proactive Pruning Cycles

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. It is recommended that pruning cycles begin after all High Risk trees are corrected through removal or pruning. However, due to the long-term benefits of pruning cycles, a schedule should be implemented as soon as possible.

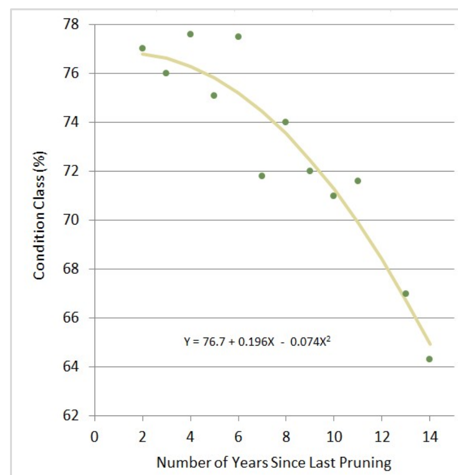


Figure 10. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981).

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 cycle. Figure 10 represents the decline of tree condition over time that corresponds with longer pruning intervals.

The recommended number of trees in the pruning cycles should be modified over time 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, the stump ground out, and eliminated from the RP Cycle. The new site should be added to the potential site inventory.

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 documented a decline in tree health as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, the average tree condition was rated 10% lower than when trees 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 response to urgent situations is the standard. Research has shown that a proactive program that includes a RP 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.

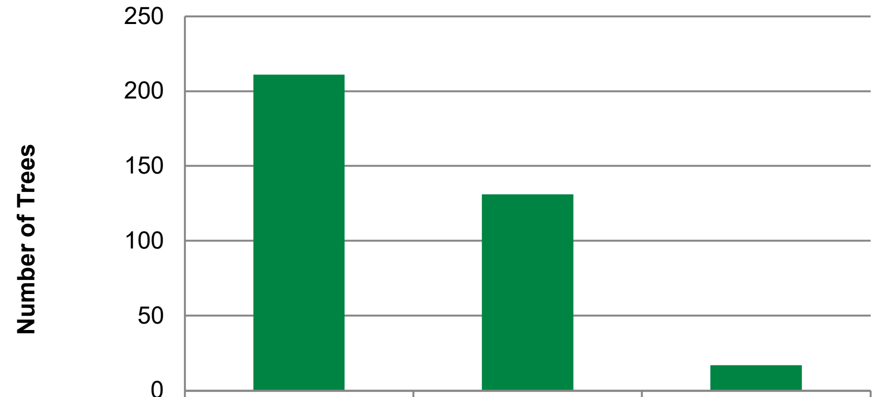
Young Tree Training Cycle

Trees included in the YTT Cycle are generally less than 8 inches but can include trees up to 12 inches DBH. These younger trees sometimes have branch structures that can lead to potential problems as the tree ages. Potential structural problems include 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, increasing risk and creating potential liability. YTT Pruning is performed to improve tree form or structure. The recommended length of a YTT Cycle is 3 years, because young trees tend to grow at faster rates (on average) than more mature trees.

The YTT Cycle differs from the RP Cycle in that these trees generally can be pruned from the ground with a pole pruner or pruning shear. The objective is to increase structural integrity by pruning for one dominant leader. 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.

Findings

A total of 359 young trees were identified during the inventory which were recommended for the YTT Cycle. The majority of those trees were very young and in the 1 to 3 inches DBH bracket.



	1-3"	4-6"	7-12"
Young Tree Training	211	131	17

Figure 11. Trees recommended for the YTT Cycle by diameter size class.

Discussion

DRG recommends that Lancaster implement a three-year YTT Cycle to begin after all High Risk trees are removed or pruned. Since the number of existing young trees is relatively small, and the benefit of beginning the YTT Cycle is substantial, DRG recommends that an average of 120 trees be structurally pruned each year over 3 years, beginning in Year One of the management program. If trees are planted, they will need to enter the YTT Cycle after establishment, typically a few years after planting.

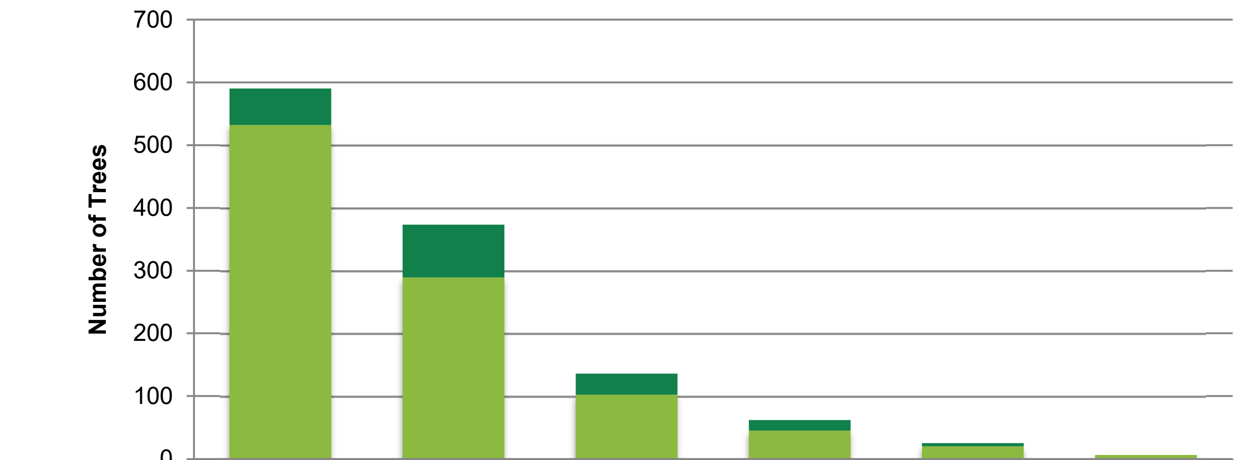
In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. The Village should strive to prune approximately one-third of its young trees each year.

Routine Pruning Cycle

The RP Cycle includes established, maturing, and mature trees (mostly greater than 13 inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, routine pruning can reduce reactive maintenance, minimize instances of elevated risk, and provide the basis for a more defensible risk management program. Included in this cycle are Moderate and Low Risk trees that require pruning and pose some risk but have a smaller size of defect and/or less potential for target impact. The defects found within these trees can usually be remediated during the RP Cycle.

The length of the RP Cycle is based on the size of the tree population and what was assumed to be a reasonable number of trees for a program to prune per year. Generally, the RP Cycle recommended for a tree population is five years but may extend to seven years if the population is large.

Findings



Risk Rating	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Moderate	58	84	34	17	5	0
Low	532	289	102	45	20	6

Diameter Size Class

Figure 12. Trees recommended for the RP Cycle by diameter size class.

Recommendations

DRG recommends that the Village establish a five-year RP Cycle in which approximately one-fifth of the tree population is to be pruned each year. The 2019 tree inventory identified 1,192 trees that should be pruned over a five-year RP Cycle. An average of 238 trees should be pruned each year over the course of the five-year cycle. DRG recommends that the RP Cycle begin in Year One of this plan, after all High Risk trees are pruned or removed. Figure 12 shows that a variety of tree sizes will require pruning; however, most of the trees that require routine pruning were smaller than 19 inches DBH.

Maintenance Schedule and Budget

Utilizing data from the 2019 Village of Lancaster tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year. DRG made budget projections using industry knowledge and public bid tabulations. A summary of the maintenance schedule is presented below, and a complete table of estimated costs for a five-year tree management program follows (Table 9).

The schedule provides a framework for completing the inventory maintenance recommendations over the next five years. Following this schedule can shift tree care activities from an on-demand system to a more proactive tree care program. The planting efforts are a larger portion of the budget overall. The estimate of new tree plantings was based upon the vacant sites discovered during the inventory and filling those sites over the five-year program to maximize the benefits of the urban forest. Budget constraints will determine the actual amount to be planted; however, the focus should be on existing higher risk maintenance concerns first. Ideally, a tree management plan involves infill of existing vacant sites with new plantings as well as maintenance. To reduce the annual cost, tree plantings can be considered for a 10-year schedule (130 new trees/year).

The Village's five-year tree maintenance budget is estimated at $174,952 for the first year of implementation. After the higher risk tree maintenance concerns are addressed, the annual estimates reduce to $151,628 in year five. These annual costs include approximately $125,000 in new tree plantings and associated maintenance. At a minimum, annual budget funds are needed to ensure that High Risk trees are remediated and that crucial YTT and RP Cycles can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

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. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. For more information concerning storm readiness, see Appendix F which provides Storm Response Categories for the Urban Forest.

Table 9. Estimated Costs for Five-Year Urban Forestry Management Program

Estimated Costs for Each Activity			Year One / 2020		Year Two / 2021		Year Three / 2022		Year Four / 2023		Year Five / 2024		5-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Severe and High Risk Removals	1-3"	$28											
	4-6"	$58											
	7-12"	$138	3	$413									$413
	13-18"	$314	3	$941									$941
	19-24"	$605	2	$1,210									$1,210
	25-30"	$825											
	31-36"	$1,045											
	37-42"	$1,485											
	43"+	$2,035											
Activity Total(s)			**8**	**$2,563**									**$2,563**
Moderate and Low Risk Removals	1-3"	$28									23	$633	$633
	4-6"	$58							10	$575			$575
	7-12"	$138			35	$4,813	8	$1,100					$5,913
	13-18"	$314	20	$6,270	10	$3,135	9	$2,822					$12,227
	19-24"	$605	14	$8,470									$8,470
	25-30"	$825	4	$3,300									$3,300
	31-36"	$1,045	1	$1,045									$1,045
	37-42"	$1,485											
	43"+	$2,035											
Activity Total(s)			**39**	**$19,085**	**45**	**$7,948**	**17**	**$3,922**	**10**	**$575**	**23**	**$633**	**$32,162**
Stump Removals	1-3"	$18											
	4-6"	$28											
	7-12"	$44	7	$308									$308
	13-18"	$72	2	$143									$143
	19-24"	$94	5	$468									$468
	25-30"	$110	2	$220									$220
	31-36"	$138											
	37-42"	$160											
	43"+	$182											
Activity Total(s)			**16**	**$1,139**									**$1,139**
High Risk Pruning	1-3"	$20											
	4-6"	$30											
	7-12"	$75											
	13-18"	$120											
	19-24"	$170	2	$340									$340
	25-30"	$225	2	$450									$450
	31-36"	$305											
	37-42"	$380	1	$380									$380
	43"+	$590											
Activity Total(s)			**5**	**$1,170**									**$1,170**
Routine Pruning (5-year cycle)	1-3"	$20											
	4-6"	$30											
	7-12"	$75											
	13-18"	$120	118	$14,160	118	$14,160	118	$14,160	118	$14,160	118	$14,160	$70,800
	19-24"	$170	75	$12,750	75	$12,750	75	$12,750	75	$12,750	75	$12,750	$63,750
	25-30"	$225	27	$6,075	27	$6,075	27	$6,075	27	$6,075	27	$6,075	$30,375
	31-36"	$305	12	$3,660	12	$3,660	12	$3,660	12	$3,660	12	$3,660	$18,300
	37-42"	$380	2	$760	2	$760	2	$760	2	$760	2	$760	$3,800
	43"+	$590											
Activity Total(s)			**234**	**$37,405**	**234**	**$37,405**	**234**	**$37,405**	**234**	**$37,405**	**234**	**$37,405**	**$187,025**
Young Tree Training Pruning (3-year cycle)	1-3"	$20	71	$1,420	71	$1,420	71	$1,420	71	$1,420	71	$1,420	$7,100
	4-8"	$30	44	$1,320	44	$1,320	44	$1,320	44	$1,320	44	$1,320	$6,600
	7-12"	$75	6	$450	6	$450	6	$450	6	$450	6	$450	$2,250
Activity Total(s)			**121**	**$3,190**	**121**	**$3,190**	**121**	**$3,190**	**121**	**$3,190**	**121**	**$3,190**	**$15,950**
Replacement Tree Planting	Purchasing	$170	230	$39,100	230	$39,100	230	$39,100	230	$39,100	230	$39,100	$195,500
	Planting	$110	230	$25,300	230	$25,300	230	$25,300	230	$25,300	230	$25,300	$126,500
Activity Total(s)			**460**	**$64,400**	**460**	**$64,400**	**460**	**$64,400**	**460**	**$64,400**	**460**	**$64,400**	**$322,000**
Replacement Young Tree Maintenance	Mulching	$100	230	$23,000	230	$23,000	230	$23,000	230	$23,000	230	$23,000	$115,000
	Watering	$100	230	$23,000	230	$23,000	230	$23,000	230	$23,000	230	$23,000	$115,000
Activity Total(s)			**460**	**$46,000**	**460**	**$46,000**	**460**	**$46,000**	**460**	**$46,000**	**460**	$46,000	**$230,000**
Activity Grand Total			**883**		**860**		**832**		**825**		**838**		
Cost Grand Total				**$174,952**		**$158,943**		**$154,917**		**$151,570**		**$151,628**	**$792,008**

SECTION 4: COMMUNITY TREE BOARD AND PUBLIC OUTREACH

Volunteers and partnerships with community organizations are fundamental components of a successful tree management program. One way to garner support and public input is through a tree board. The most recent publication of *Municipal Tree Care and Management in the United States* identified 65% of the 644 municipalities surveyed had community volunteers involved in their urban forestry program.

All municipalities with a population over 1 million had some form of volunteer involvement, and as the population decreased, so did the percentage of volunteers. Sixty one percent of the cities with similar demographics to the Village had some form of volunteer tree-related activity. Forty eight percent of municipalities had a volunteer tree board that helped their community carry out tree management activities. The largest portion of the volunteers help with tree planting and watering (85%), while a smaller percentage (18%) serve as policy/management advisors.

A community tree board is a selected group of citizens intended to serve as an advisory board that supports tree management in the municipality. Typically, the municipal administrator or his/her designee will delegate or contract responsibility for care and oversight of public trees to a professional forester, arborist, citizen led Tree Advisory Committee, or a combination of these options.

Tree Advisory Committee

Tree Advisory Committees will typically meet the following requirements:

A. **Creation:** The municipal council, with support of the Mayor, has the authority to create a Tree Advisory Committee for the municipality. Committee members should reflect the diverse citizen interests of the municipality and may include homeowners, tree professionals, business owners, and municipal staff.

B. **Duties:** The Tree Advisory Committee shall be an advisory committee to the Public Works Department (or comparable municipal unit) concerning tree related topics in the municipality.

C. **Compensation:** Members of the Tree Advisory Committee shall serve without compensation.

D. **Structure:** The Tree Advisory Committee may set rules of procedure for its meeting as it deems appropriate. The Village Public Works Director (or comparable municipal designee) will be the staff liaison to the board. Members serve at the discretion of the Mayor and municipal council.

Means of Public Outreach

The data collected and analyzed to develop this plan provide significant information about the tree population and can be utilized to guide the proactive management of that resource. 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, preservation initiative, and budgetary concerns.
- 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 citizens about threats to urban trees (such as granulate ambrosia beetle, emerald ash borer, and gypsy moth).

Lancaster's data are instrumental in helping to provide tangible and meaningful outreach about the urban forest. There are various avenues for outreach. Maps can be created and posted on websites, in parks, or in business areas. Public service announcements can be developed. Articles can be written and programs about trees and the benefits they provide can be developed. Arbor Day and Earth Day celebrations can become community traditions. The data can also be used to engage existing volunteer groups to host tree plantings and maintenance events.

Educational contests can be created to increase awareness of the importance of trees. One proven way of engaging the public is through a tree-centered photography contest. In one example, a city selected photo from a contest and used them in their Urban Forest Master Plan. Winning photos were also publicly displayed at city hall and public libraries.

Hanging signs from trees will highlight the contributions trees make to the community (Photograph 4). Trees provide oxygen we need to breathe, shade to cool our neighborhoods, and canopies to aid in stormwater control. Using the free software of the i-Tree suite of tools (itreetools.org) helps educate the citizens. The i-Tree MyTree tool allows users to look at the individual benefits for any tree of their choosing.

Photograph 4. *An 11"x 17" weatherproof vinyl tree tag form used to publicly display per tree benefits.*

CONCLUSIONS

Every hour of every day, public trees in Lancaster are supporting and improving the quality of life. 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 (Photograph 5).

Photograph 5. *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.*

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, physical components of trees, severe weather events, and the expectation that these issues will be resolved immediately is a considerable challenge.

The Village must carefully consider these challenges to fully understand the needs of maintaining an urban forest. Now equipped with the knowledge and wherewithal to address the needs of the Village's trees, Lancaster is well positioned to thrive. If the management program is successfully implemented, the health of Lancaster's trees and will be maintained for years to come.

Inventory and Plan Updates

DRG recommends that the inventory and management plan be updated using an appropriate computer software program so that the Village can sustain its program and accurately project future program and budget needs:

- 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 Village 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 using TreeKeeper®, or similar software, as work is performed. Add new tree work to the schedule when work is identified through inspections or a citizen call process.
- Re-inventory the street ROW, and update all data fields in five years, or a portion of the population (1/5) every year over the course of five years.
- Revise the *Tree Management Plan* after five years when the re-inventory has been completed.

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GLOSSARY

aboveground utilities (data field): Shows the presence or absence of overhead utilities at the tree site. Overhead utilities defined as the primary electricity transmission lines.

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.

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.

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.

block side (data field): Address information for a site that includes the *on street*, *from street*, and *to street*. The *on street* is the street on which the site is actually located. The *from street* is the cross street from which one moves away when heading in the direction of traffic flow. The *to street* is the cross street from which one moves toward when heading in the direction of traffic flow.

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.

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**.

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).

Espalier (Secondary Maintenance Need): Type of pruning that combines supporting and training branches to orient a plant in one plane.

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**.

IPED (data field): Invasive pest detection protocol; a standardized method for evaluating a tree for possible insect or disease.

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.

location rating (data field): Describes/rates the position of a tree based on existing land use of the site, the functional and aesthetic contributions of the tree to the site, and surrounding structures or landscapes. Categories for location value include: Excellent, Good, Fair, and Poor. The location rating, along with species, size, and condition ratings, is used in determining a tree's value.

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. Municipality-wide 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.

None (Secondary Maintenance Need): Used to show that no secondary maintenance is recommended for the tree. Usually a vacant planting site or stump will have a secondary maintenance need of *none*.

notes (data field): Describes additional pertinent information.

observations (data field): When conditions with a specific tree warrant recognition, it was described in this data field. Observations include cavity decay, grate guard, improperly installed, improperly mulched, improperly pruned, mechanical damage, memorial tree, nutrient deficiency, pest problem, poor location, poor root system, poor structure, remove hardware, serious decline, and signs of stress.

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.

Palm Prune (Primary Maintenance Need): Routine horticultural pruning to remove any dead, dying, or broken fronds.

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.

Pollard (Secondary Maintenance Need): Pruning method in which tree branches are initially headed and then reduced on a regular basis without disturbing the callus knob.

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.

Raise (Secondary Maintenance Need): Signifies a maintenance need for a tree. Raising the crown is characterized by pruning to remove low branches that interfere with sight and/or traffic. It is based on *ANSI A300 (Part 1)*.

Reduce (Secondary Maintenance Need): Signifies a maintenance need for a tree. Reducing the crown is characterized by selective pruning to decrease height and/or spread of the crown in order to provide clearance for electric utilities and lighting.

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.

Restore (Secondary Maintenance Need): Signifies a maintenance need for a tree. Restoring is selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.

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): The risk assessment is a point-based assessment of each tree by an arborist using a protocol based on the U.S. Forest Service Community Tree Risk Rating System. In the field, the probability of tree or tree part failure is assigned 1–4 points (identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions), the size of the defective tree part is assigned 1–3 points (rates the size of the part most likely to fail), the probability of target impact by the tree or tree part is assigned 1–3 points (rates the use and occupancy of the area that would be struck by the defective part), and other risk factors are assigned 0–2 points (used if professional judgment suggests the need to increase the risk rating). The data from the risk assessment is used to calculate the risk rating that is ultimately assigned to the tree.

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.

Secondary Maintenance Need (data field): Recommended maintenance for a tree, which may be risk oriented, such as raising the crown for clearance, but generally was geared toward improving the structure of the tree and enhancing aesthetics.

side value (data field): Each site is assigned a side value to aid in locating the site. Side values include: *front*, *side to*, *side away*, *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 to* is the name of the street the arborist is walking toward as data are being collected. The *side from* is the name of the street the arborist is walking away from while collecting data. *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.

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.

Thin (Secondary Maintenance Need): Signifies a maintenance need for a tree. Thinning the crown is the selective removal of water sprouts, epicormic branches, and live branches to reduce density.

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.

Utility (Secondary Maintenance Need): Selective pruning to prevent the loss of service, comply with mandated clearance laws, prevent damage to equipment, avoid access impairment, and uphold the intended usage of the facility/utility space.

Vista Prune (Secondary Maintenance Need): Pruning to enhance a specific view without jeopardizing the health of the tree.

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.

APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

DRG collected tree inventory data using a system that utilizes a customized program loaded onto pen-based field computers equipped with geographic information system (GIS) and global positioning system (GPS) receivers. The knowledge and professional judgment of DRG's arborists ensure the high quality of inventory data.

Data fields are defined in the glossary of the management plan. At each site, the following data fields were collected:

• Address	• Notes
• Condition	• Overhead Utilities
• Date of Inventory	• Primary Maintenance
• Defects	• Residual Risk
• Further Inspection	• Risk Rating
• Growspace	• Species
• Multi-stem	• Tree Size*

* measured in inches in diameter at 4.5 feet above ground (or diameter at breast height [DBH])

Maintenance needs are based on *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture [ISA] 2011).

The data collected were provided in an ESRI® shapefile, Access™ database, and Microsoft Excel™ spreadsheet on a CD-ROM that accompanies this plan.

Site Location Methods

Equipment and Base Maps

Inventory arborists use CF-19 Panasonic Toughbook® unit(s) with integral GPS receiver(s).

Base map layers were loaded onto these unit(s) to help locate sites during the inventory. The table below lists the base map layers, utilized along with source and format information for each layer.

Base Map Layers Utilized for Inventory

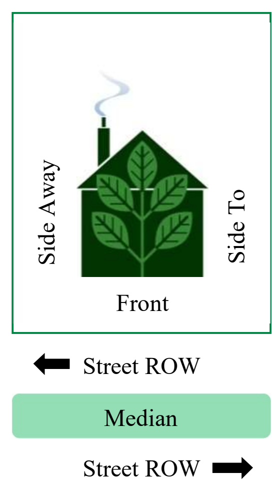
Imagery/Data Source	Date	Projection
Shapefiles NY GIS Clearinghouse -*- Parcel Data County GIS	2018-2019	NAD 1983 StatePlane New York West; Feet
1ft Aerial Imagery NY GIS Clearinghouse	2016	NAD 1983 StatePlane New York West; Feet

Street ROW Site Location

Individual street ROW sites (trees, stumps, or planting sites) were located using a methodology that identifies sites by *address number*, *street name, side, site number*, or *block side*. This methodology was developed by DRG to help ensure consistent assignment of location.

Address Number and Street Name

The *address number* was recorded based on visual observation by the arborist at the time of the inventory (the address number was posted on a building at the inventoried site). Where there was no posted address number on a building, or where the site was located by a vacant lot with no GIS parcel addressing data available, the arborist used his/her best judgment to assign an address number based on opposite or adjacent addresses. An “X” was then added to the number in the database to indicate that it was assigned (for example, “37X Choice Avenue”).



Side values for street ROW sites.

Sites in medians or islands were assigned an address number using the address on the right side of the street in the direction of collection closest to the site. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was assigned its own address.

The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.

Side Value and Site Number

Each site was assigned a *side value* and *site number*. Side values include *front*, *side to*, *side away*, *median* (includes islands), or *rear* based on the site's location in relation to the lot's street frontage (Figure 1). The *front side* is the side that faces the address street. *Side to* is the name of the street the arborist walks toward as data are being collected. *Side from* is the name of the street the arborist walks away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

All sites at an address are assigned a *site number*. Site 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 was a two-way street; therefore, some site numbers will oppose traffic.

A separate site number sequence is used for each side value of the address (*front*, *side to*, *side away*, *median*, or *rear*). For example, trees at the front of an address may have site numbers from 1 through 999; if trees are located on the *side to*, *side away*, *median*, or *rear* of that same address, each side will also be numbered consecutively beginning with the number 1.

Block Side

Block side information for a site includes the *on street*, *from street*, and *to street*.

- The *on street* is the street on which the site is located. The *on street* may not match the address street. A site may be physically located on a street that is different from its street address (i.e., a site located on a side street).
- The *from street* is the first cross street encountered when proceeding along the street in the direction of traffic flow.
- The *to street* is the second cross street encountered when moving in the direction of traffic flow.

Park and/or Public Space Site Location

Park and/or public space site locations were collected using the same methodology as street ROW sites; however, the *on street*, *from street*, and *to street* would be the park and/or public space's name (not street names).

Site Location Examples

The tree trimming crew in the truck traveling westbound on E. Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address/Street Name: 226 E. Mac Arthur Street

Side: Side To

Site Number: 1

On Street: Davis Street

From Street: Taft Street

To Street: E. Mac Arthur Street

The tree site circled in red signifies the crew's target site. Because the tree is located on the side of the lot, the *on* street is Davis Street, even though it is addressed as 226 East Mac Arthur Street. Moving with the flow of traffic, the *from* street is Taft Street, and the *to* street is East Mac Arthur Street.

Location information collected for inventoried trees at Corner Lots A and B.

<u>Corner Lot A</u>

Address/Street Name: 205 Hoover St.
Side/Site Number: Side To / 1
On Street: Taft St.
From Street: E Mac Arthur St.
To Street: Hoover St.

Address/Street Name: 205 Hoover St.
Side/Site Number: Side To / 2
On Street: Taft St.
From Street: E Mac Arthur St.
To Street: Hoover St.

Address/Street Name: 205 Hoover St.
Side/Site Number: Side To / 3
On Street: Taft St.
From Street: 19th St.
To Street: Hoover St.

Address/Street Name: 205 Hoover St.
Side/Site Number: Front / 1
On Street: Hoover St.
From Street: Taft St.
To Street: Davis St.

<u>Corner Lot B</u>

Address/Street Name: 226 E Mac Arthur St.
Side/Site Number: Side To / 1
On Street: Davis St.
From Street: Hoover St.
To Street: E Mac Arthur St.

Address/Street Name: 226 E Mac Arthur St.
Side/Site Number: Front / 1
On Street: E Mac Arthur St.
From Street: Davis St.
To Street: Taft St.

Address/Street Name: 226 E Mac Arthur St.
Side/Site Number: Front / 2
On Street: E Mac Arthur St.
From Street: Davis St.
To Street: Taft St.

APPENDIX B
RISK ASSESSMENT/PRIORITY AND PROACTIVE MMAINTENANCE

Risk Assessment

Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, DRG performed a Level 2 qualitative risk assessment for each tree and assigned a risk rating based on the *ANSI A300* (Part 9), and the companion publication *Best Management Practices: Tree Risk Assessment* (ISA 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.

- **Likelihood of Failure**—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.
  - Improbable—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
  - Possible—Failure could occur but is unlikely during normal weather conditions within the specified time period.
  - Probable—Failure may be expected under normal weather conditions within the specified time period.
- **Likelihood of Impacting a Target**—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls toward the target.
  - Very low—The chance of the failed tree or branch impacting the target is remote.
    - Rarely used sites
    - Examples include rarely used trails or trailheads
    - Instances where target areas provide protection
  - Low—It is not likely that the failed tree or branch will impact the target.
    - Occasional use area fully exposed to tree
    - Frequently used area partially exposed to tree
    - Constant use area that is well protected
  - Medium—The failed tree or branch may or may not impact the target.
    - Frequently used areas that are partially exposed to the tree on one side
    - Constantly occupied area partially protected from the tree
  - High—The failed tree or branch will most likely impact the target.
    - Fixed target is fully exposed to the tree or tree part

- **Categorizing Likelihood of Tree Failure Impacting a Target**—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- **Consequence of Failure**—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.
    - Negligible—Consequences involve low value damage and do not involve personal injury.
        - Small branch striking a fence
        - Medium-sized branch striking a shrub bed
        - Large tree part striking structure and causing monetary damage
        - Disruption of power to landscape lights
    - Minor—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.
        - Small branch striking a house roof from a high height
        - Medium-sized branch striking a deck from a moderate height
        - Large tree part striking a structure, causing moderate monetary damage
        - Short-term disruption of power at service drop to house
        - Temporary disruption of traffic on neighborhood street
    - Significant—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.
        - Medium-sized part striking a vehicle from a moderate or high height
        - Large tree part striking a structure resulting in high monetary damage
        - Disruption of distribution of primary or secondary voltage power lines, including individual services and street-lighting circuits
        - Disruption of traffic on a secondary street
    - Severe—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.
        - Injury to a person that may result in hospitalization
        - Medium-sized part striking an occupied vehicle
        - Large tree part striking an occupied house
        - Serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Trees have the potential to fail in more than one way and can affect multiple targets.

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

- None—Used for planting and stump sites only.
- Low—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.
- Moderate—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.
- High—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.
- Extreme—The Extreme Risk category applies in situations where tree failure is imminent and 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 to avoid injury to people.

Trees with elevated (Extreme or High) risk levels are usually recommended for removal or pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. DRG recommends only removal or pruning to alleviate risk. But in special situations, such as a memorial tree or a tree in a historic area, Manchester may decide that cabling, bracing, or moving the target may be the best option for reducing risk.

Determination of acceptable risk ultimately lies with city managers. Since there are inherent risks associated with trees, the location of a tree is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enables tree work to be assigned priority based on observed risk. Once prioritized, tree work can be systematically addressed to eliminate the greatest risk and liability first (Stamen 2011).

Risk is a graduated scale that measures potential tree related hazardous conditions. A tree is considered hazardous when its potential risks exceed an acceptable level. Managing trees for risk reduction provides many benefits, including:

- Lower frequency and severity of accidents, damage, and injury
- Less expenditure for claims and legal expenses
- Healthier, long-lived trees
- Fewer tree removals over time
- Lower tree maintenance costs over time

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be found and addressed before they escalate.

In this plan, all tree removals and Extreme and High Risk prunes are included in the priority maintenance program.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Tree work is typically performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest, as every tree in the inventoried population is regularly visited, assessed, and maintained. DRG recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

APPENDIX C
SUGGESTED TREE AND PLANT SPECIES

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 6 on the USDA Plant Hardiness Zone Map. Avoid invasive species and chose native varieties were possible.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	Red Sunset®
Acer saccharum	sugar maple	'Legacy'
*Aesculus flava**	yellow buckeye	
*Betula alleghaniensis**	yellow birch	
*Betula lenta**	sweet birch	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Carya illinoensis**	pecan	
*Carya lacinata**	shellbark hickory	
*Carya ovata**	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata	sugar hackberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	Katsura tree	'Aureum'
*Diospyros virginiana**	common persimmon	
*Fagus grandifolia**	American beech	
*Fagus sylvatica**	European beech	(Numerous exist)
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Shademaster'
Gymnocladus dioica	Kentucky coffeetree	Prairie Titan®
*Juglans nigra**	black walnut	
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	'Rotundiloba'
*Liriodendron tulipifera**	tuliptree	'Fastigiatum'
*Magnolia acuminata**	cucumbertree magnolia	(Numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
*Platanus occidentalis**	American sycamore	
Platanus × acerifolia	London planetree	'Yarwood'
Quercus alba	white oak	

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus imbricaria	shingle oak	
Quercus phellos	willow oak	
Quercus robur	English oak	Heritage®
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	Shumard oak	
Styphnolobium japonicum	Japanese pagodatree	'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia americana	American linden	'Redmond'
Tilia cordata	littleleaf linden	'Greenspire'
Tilia × euchlora	Crimean linden	
Tilia tomentosa	silver linden	'Sterling'
Ulmus parvifolia	Chinese elm	Allée®
Zelkova serrata	Japanese zelkova	'Green Vase'
Note: * denotes species that are **not** recommended for use as street trees.		

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Alnus cordata	Italian alder	
*Asimina triloba**	pawpaw	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Pistacia chinensis	Chinese pistache	
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Sassafras albidum**	sassafras	
Note: * denotes species that are **not** recommended for use as street trees.		

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	trident maple	Streetwise®
Acer campestre	hedge maple	Queen Elizabeth™
Acer cappadocicum	coliseum maple	'Aureum'
Acer ginnala	amur maple	Red Rhapsody™
Acer griseum	paperbark maple	
Acer nigrum	black maple	
*Acer pensylvanicum**	striped maple	
Acer triflorum	three-flower maple	
*Aesculus pavia**	red buckeye	
Amelanchier arborea	downy serviceberry	(Numerous exist)
Amelanchier laevis	Allegheny serviceberry	
*Carpinus caroliniana**	American hornbeam	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus virginicus	white fringetree	
Cornus alternifolia	pagoda dogwood	
Cornus kousa	Kousa dogwood	(Numerous exist)
Cornus mas	corneliancherry dogwood	'Spring Sun'
Corylus avellana	European filbert	'Contorta'
*Cotinus coggygria**	common smoketree	'Flame'
*Cotinus obovata**	American smoketree	
*Crataegus phaenopyrum**	Washington hawthorn	Princeton Sentry™
Crataegus viridis	green hawthorn	'Winter King'
*Franklinia alatamaha**	Franklinia	
*Halesia tetraptera**	Carolina silverbell	'Arnold Pink'
Laburnum × watereri	goldenchain tree	
Maackia amurensis	amur maackia	
*Magnolia × soulangiana**	saucer magnolia	'Alexandrina'
*Magnolia stellata**	star magnolia	'Centennial'
*Magnolia tripetala**	umbrella magnolia	
*Magnolia virginiana**	sweetbay magnolia	Moonglow®
Malus spp.	flowering crabapple	(Disease resistant only)
Oxydendrum arboreum	sourwood	'Mt. Charm'
Prunus subhirtella	Higan cherry	'Pendula'
Prunus virginiana	common chokecherry	'Schubert'
*Staphylea trifolia**	American bladdernut	
Stewartia ovata	mountain stewartia	
*Styrax japonicus**	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Note: * denotes species that are **not** recommended for use as street trees.

Coniferous and Evergreen Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea	balsam fir	
Abies concolor	white fir	'Violacea'
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
× *Cupressocyparis leylandii*	Leyland cypress	
Ilex opaca	American holly	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Psedotsuga menziesii	Douglas-fir	
Thuja plicata	western arborvitae	(Numerous exist)
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides	atlantic whitecedar	(Numerous exist)
Juniperus virginiana	eastern redcedar	
Pinus bungeana	lacebark pine	
Pinus flexilis	limber pine	
Pinus parviflora	Japanese white pine	
Thuja occidentalis	eastern arborvitae	(Numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Ilex × attenuata	Foster's holly	
Pinus aristata	bristlecone pine	
Pinus mugo mugo	mugo pine	

Dirr's Hardy Trees and Shrubs (Dirr 2013) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1988) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade. Also consider Dirr's new book, *The Tree Book – Superior Selection for Landscapes, Streetscapes, and Gardens*, with Keith Warren from 2019. The USDA's i-Tree suite of tools has a species selection component: i-Tree Species tool can be found https://species.itreetools.org/

For restoration purposes, there are several seed companies which sell custom or pre-designed mixes. One such company to review is Ernst Seeds https://www.ernstseed.com/.

Herbaceous Perennials for Native Restoration

Scientific Name	Common Name
Elymus riparius	riverbank wild rye
Elymus candensis	nodding wild rye
Elymus virginicus	Virginia wild rye
Andropogon geradii	big bluestem
Scripus atrovirens	dark green bulrush
Carex crinite	fringed sedge
Carex frankii	Frank's sedge
Glyceria grandis	American manna grass
Scripus cyperinus	woolgrass
Aster umbellatus	flat topped white aster
Hibiscus mosheutos	Crimson-eyed rose mallow
Actionmeris alternifolia	wingstem
Asclepias incarnata	swamp milkweed
Eupatorium perfoliatum	common boneset
Verbena hastata	Blue Vervain
Eupatorium fistulosum	hollow Joe Pye
Mimulus ringens	monkey flower
Lobelia cardinalis	Cardinal flower

Woody shrubs for native restoration

Scientific Name	Common Name
Aronia melanocarpa	black chokecherry
Cephalanthus occidentalis	buttonbush
Cornus amomum	silky dogwood
Cornus sericea	red-osier dogwood
Physocarpus opulifolius	ninebark
Salix discolor	pussy willow
Sambucus canadensis	elderberry
Ilex verticillate	winterberry
Rosa palustris	swamp rose

DRG's Premium Obligate Wetland Mix for restoration

Scientific Name	Common Name
Acornus americanus	sweetflag
Alisma subcordatum	water plantain
Cephalanthus occidentalis	buttonbush
Iris versicolor	blueflag
Nuphar advena	yellow pond lily
Peltandra virginica	arrow arum
Pontederia cordata	pickerelweed
Rosa palustris	swamp rose
Sagittaria latifolia	arrowhead
Schoenoplectus tabernaemontani	softstem bulrush
Sparganium americanum	American burreed
Sparganium eurycarpum	broadfruit burreed
Hibiscus moscheutos	swamp rose mallow

APPENDIX D
TREE PLANTING GUIDE

Tree Planting

Planting trees is a valuable task as long as tree species are carefully selected and correctly planted. When trees are planted, they are planted selectively and with purpose. Without proactive planning and follow-up tree care, a newly planted tree may become a future problem instead of a benefit to the community.

When planting trees, it is important to be cognizant of the following:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations (i.e., confined spaces, overhead wires, and/or soil type).
- Select the species or cultivar best suited for the site conditions.
- Examine trees before buying them and buy for quality.

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species is more beneficial and can save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. This reduces time and money spent to mitigate pest- or disease-related problems. A wide variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand drought, ice, flooding, strong storms, and wind.

Tree species should be selected for their durability and low-maintenance characteristics. These attributes are highly dependent on site characteristics below ground (soil texture, soil structure, drainage, soil pH, nutrients, road salt, and root spacing). Matching a species to its favored soil conditions is the most important task when planning for a low-maintenance landscape. Plants that are well matched to their environmental site conditions are much more likely to resist pathogens and insect pests and will, therefore, require less maintenance overall.

The Right Tree in the Right Place is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Some grow tall, some grow wide, and some have extensive root systems. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. Equally important to selecting the right tree is choosing the right spot to plant it. Blocking an unsightly view or creating some shade may be a priority, but it is important to consider how a tree may impact existing utility lines as it grows taller, wider, and deeper. If the tree's canopy, at maturity, will reach overhead lines, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as *Acer saccharinum* (silver maple) have weak wood and typically drop many small branches during a growing season. Others, such as *Liquidambar styraciflua* (American sweetgum), drop high volumes of fruit. In certain species, such as *Ginkgo biloba* (ginkgo), female trees produce large odorous fruit; male ginkgo trees, however, do not produce fruit. Furthermore, a few species of trees, including *Crataegus* spp. (hawthorn) and *Gleditsia triacanthos* (honeylocust), may have substantial thorns. These species should be avoided in high-traffic areas.

Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring, and deciduous trees that display bright colors in autumn can add a great deal of appeal to surrounding landscapes.

Tips for Planting Trees

To ensure a successful tree planting effort, the following measures should be taken:

- Handle trees with care. Trees are living organisms and are perishable. Protect trees from damage during transport and when loading and unloading. Use care not to break branches, and do not lift trees by the trunk.
- If trees are stored prior to planting, keep the roots moist.
- Dig the planting hole according to the climate. Generally, the planting hole is two to three times wider and not quite as deep as the root ball. The root flair is at or just above ground level.
- Fill the hole with native soil unless it is undesirable, in which case soil amendments should be added as appropriate for local conditions. Gently tamp and add water during filling to reduce large air pockets and ensure a consistent medium of soil, oxygen, and water.
- Stake the tree as necessary to prevent it from shifting too much in the wind.
- Add a thin layer (1–2 inches) of mulch to help prevent weeds and keep the soil moist around the tree. Do not allow mulch to touch the trunk.
- There is no substitute for purchasing high-quality trees. All trees should be inspected to ensure that they meet the size and proportion guidelines set out in the American Standard for Nursery Stock (ANSI Z60.1). Some of the characteristics of healthy nursery trees include free of bark injuries and wounds, healthy root systems, balanced branch distribution, proper taper, and good vigor.
- Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how often trees should be irrigated based on time of planting, drought status, species selection, and site condition.
- Mulch should be applied to the grow space around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the grow space is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk or be piled up around the tree.

Newly Planted and Young Tree Maintenance

Caring for trees is just as important as planting them. Once a tree is planted, it must receive maintenance for several years.

Watering

Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how often trees should be irrigated based on time of planting, drought status, species selection, and site condition.

Mulching

Mulch can be applied to the grow space around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the grow space is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk or be piled up around the tree.

Lifelong Tree Care

After the tree is established, it will require routine tree care, which includes inspections, routine pruning, watering, plant health care, and integrated pest management as needed.

The municipality should employ qualified arborists to provide most of the routine tree care. An arborist can determine the type of pruning necessary to maintain or improve the health, appearance, and safety of trees. These techniques may include: eliminating branches that rub against each other; removing limbs that interfere with wires and buildings or that obstruct streets, sidewalks, or signage; removing dead, damaged, or weak limbs that pose a hazard or may lead to decay; removing diseased or insect-infested limbs; creating better structure to reduce wind resistance and minimize the potential for storm damage; and removing branches—or thinning—to increase light penetration.

An arborist can help decide whether a tree should be removed and, if so, to what extent removal is needed. Additionally, an arborist can perform—and provide advice on—tree maintenance when disasters such as storms or droughts occur. Storm-damaged trees can often be dangerous to remove or trim. An arborist can assist in advising or performing the job in a safe manner while reducing further risk of damage to property. The arborist can also help with cabling or bracing for added support to branches with weak attachment, aeration to improve root growth, and installation of lightning protection systems.

Plant health care, a preventive maintenance process that keeps trees in good health, helps a tree better defend itself against insects, disease, and site problems. Arborists can help determine proper plant health so that the municipal tree population will remain healthy and provide benefits to the community for as long as possible.

Educating the community on basic tree care is a good way to promote the urban forestry program and encourage tree planting on private property. Encourage citizens to water trees on the ROW adjacent to their homes and to reach out to the urban forestry staff if they notice any changes in the trees, such as signs or symptoms of pests, early fall foliage, or new mechanical or vehicle damage.

APPENDIX E
INVASIVE PESTS AND DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in cleanup costs. Keeping these pests and diseases out of the country is the number one priority of the United States Department of Agriculture's (USDA) Animal and Plant Inspection Service (APHIS).

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

Once they arrive, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.

APHIS, Plant Health, Plant Pest Program Information
- www.aphis.usda.gov/plant_health/plant_pest_info

The University of Georgia, Center for Invasive Species and Ecosystem Health
- www.bugwood.org

USDA National Agricultural Library
- www.invasivespeciesinfo.gov/microbes

USDA Northeastern Areas Forest Service, Forest Health Protection
- www.na.fs.fed.us/fhp

Asian Longhorned Beetle

Adult Asian longhorned beetle

Photograph courtesy of New Bedford Guide 2011

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

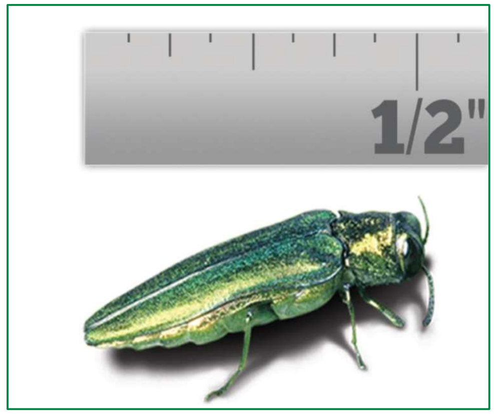
ALB is a serious threat to a large number of America's hardwood tree species. Like EAB, this invasive pest arrived from Asia within the last few decades. However, unlike EAB, ALB targets many common species (maple, birch, horse chestnut, poplar, willow, elm, and ash) and is, for the most part, untreatable.

Because it is untreatable, if found, the USDA institutes an immediate removal of 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. The management of ALB is under state and federal regulations. 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 is early detection, which requires vigilant monitoring. This is why educating the public and Village staff is so important.

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: *Acer negundo* (box elder); *A. platanoides* (Norway maple); *A. rubrum* (red maple); *A. saccharinum* (silver maple); *A. saccharum* (sugar maple); *Aesculus glabra* (buckeye); *A. hippocastanum* (horsechestnut); *Betula* (birch); *Platanus* × *acerifolia* (London planetree); *Salix* (willow); and *Ulmus* (elm).

Emerald Ash Borer

Emerald ash borer *(EAB) (Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002. The EAB-preferred host tree species are in the genus *Fraxinus* (ash).



Close-up of the emerald ash borer
Photograph courtesy of APHIS (2011)

Emerald ash borer (*Agrilus planipennis*) is a small insect native to Asia. In North America, the borer is an invasive species that is highly destructive to ash trees in its introduced range. The potential damage of EAB rivals that of chestnut blight and Dutch elm disease. Chestnut blight is a fungus that was introduced in North America around 1900 and by 1940 it wiped out most of the mature American chestnut population. Dutch elm disease is a fungus spread by the elm bark beetle. Since its discovery in the United States in 1928, it has killed millions of elm trees. EAB is thought to have been introduced into the United States and Canada in the 1990s but was not positively identified in North America until 2002 in Canton, Michigan. It has now been confirmed in 14 states and has killed at least 50 to 100 million ash trees so far and threatens another 7.5 billion ash trees throughout North America. The EAB is a serious pest and is known to attack all native ash trees, including black, blue, green and white ash. The state is committed to early detection and thoughtful management of this pest.

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

EAB adults grow to 5/8 inch in length (Photo courtesy of www.wisconsin.gov).

EAB larvae (Photo courtesy of www.emeraldashborer.info).

Gypsy Moth

The gypsy moth (GM) *(Lymantria dispar)* is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.

Close-up of male (darker brown) and female (whitish color) European gypsy moths

Photograph courtesy of APHIS (2011b)

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, saw-toothed patterns on their wings. Although they have wings, the female GM cannot fly.

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

Granulate Ambrosia Beetle

Adult granulate ambrosia beetle

Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark-brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some shrubs (azalea, rhododendron) but not conifer. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crapemyrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoinensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Xm Ambrosia Beetle

The Xm ambrosia beetle (*Xylosandrus mutilatus*), is native to Asia and was first detected in the United States in 1999 in traps near Starkville, Mississippi. By 2002, the beetle spread throughout Missouri and quickly became well established in Florida. The species also has been found in Alabama, northern Georgia, and Texas. In addition to its prevalence in the southeastern United States, the Xm ambrosia beetle is currently found in China, India, Indonesia, Japan, Korea, Malaya, Myanmar, Papua New Guinea, Sri Lanka, Taiwan, and Thailand.

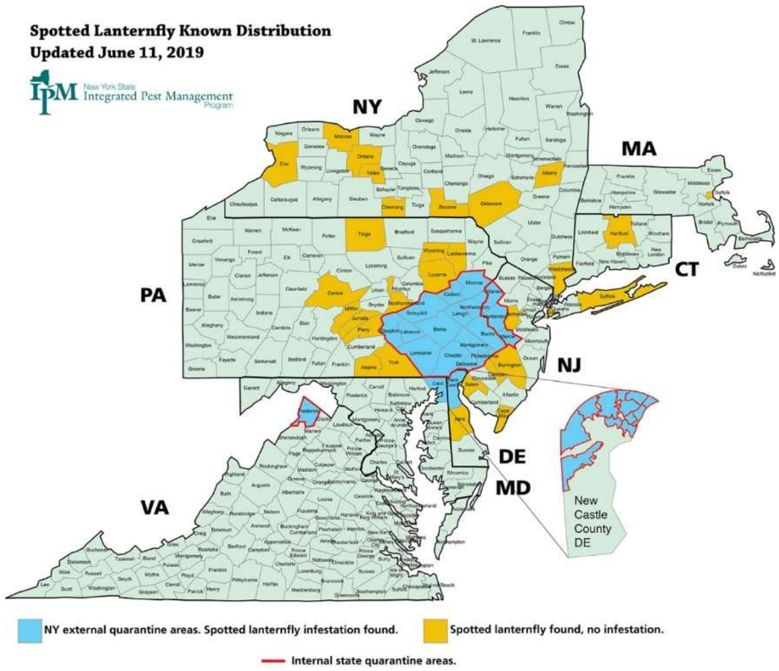
Xm ambrosia beetle
Photograph courtesy of Michael C. Thomas, Florida Department of Agriculture and Consumer Services (Rabaglia et al 2003)

This species generally targets weakened and dead trees. Since the beetle attacks small-diameter material, it may be commonly transported in nursery stock. Female adults are prone to dispersal by air currents and can travel 1–3 miles in pursuit of potential hosts. This active capability results in a broad host range and high probability of reproduction. The species is larger than any other species of *Xylosandrus* (greater than 3 millimeters) in the U.S. and is easily recognized by its steep declivity and dark brown to black elytra (hard casings protecting the wings). Larvae are white and C-shaped with an amber colored head capsule.

Known hosts in the U.S. include: *Acer* (maple); *Albizia* (silktree); *Benzoin* (northern spicebush); *Camellia* (camellia); *Carpinus laxiflora* (looseflower hornbeam); *Castanae* (sweet chestnut); *Cinnamomum camphora* (camphor tree); *Cornus* (dogwood); *Cryptomeria japonica* (Japanese cedar); *Fagus crenata* (Japanese beech); *Lindera erythrocarpa* (spicebush); *Machilus thurnbergii* (Japanese persea); *Ormosia hosiei* (ormosia); *Osmanthus fragrans* (sweet osmanthus); *Parabezion praecox*; *Platycarpa*; and *Sweitenia macrophylla* (mahogany).

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, and Virginia.



Spotted Lanternfly Detections in New England as of June 2019. Map by New York State Integrated Pest Management Program https://nysipm.cornell.edu/environment/invasive-species-exotic-pests/spotted-lanternfly/spotted-lanternfly-ipm/introduction-native-range-and-current-range-us/

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. The spotted lanternfly will lay its eggs on plant surfaces, firewood, cars, and other non-host material, which can easily be transported. It can alos be transported along rail lines, whereas Lancaster has an active rail line. An adult SLF was found in Buffalo in the last several months. Lancaster's residents should be educated about the spotted lanternfly, because early dection can help prevent an infestation.

Spotted laternfly prefers the host tree-of-heaven, 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 science of the spotted laternfly is still unfolding, removing tree-of-heaven may help slow its spread.

Hemlock Woolly Adelgid

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, Virginia.

Hemlock woolly adelgids on a branch

Photograph courtesy of USDA Forest Service (2011a)

In their native range, populations of HWA cause little damage to the hemlock trees, as they feed on natural enemies and possible tree resistance has evolved with this insect. In eastern North America and in the absence of natural control elements, HWA attacks both *Tsuga canadensis* (eastern or Canadian hemlock) and *T. caroliniana* (Carolina hemlock), often damaging and killing them within a few years of becoming infested.

The HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

Sirex Woodwasp

Sirex woodwasp (*Sirex noctillio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Close-up of female Sirex Woodwasp

Photograph courtesy of USDA (2005)

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the three to six months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Southern Pine Beetle

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern United States. It attacks and kills all species of southern yellow pines including *P. strobus* (eastern white pine). Trees are killed when beetles construct winding, S-shaped egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport food throughout the tree. Furthermore, the beetles carry blue staining fungi on their bodies that clog the water conductive tissues (wood), which transport water within the tree. Signs of attack on the outside of the tree are pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Adult southern pine beetles

Photograph courtesy of Forest Encyclopedia Network (2012)

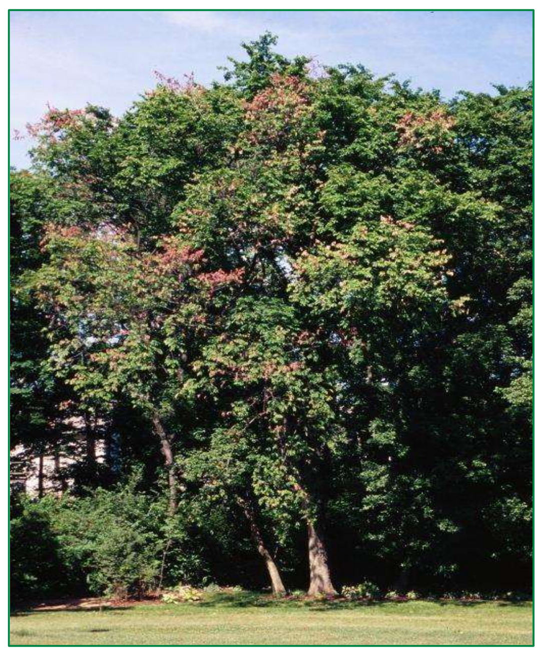
Adult SPBs reach an ultimate length of only 1/8 inch, similar in size to a grain of rice. They are short-legged, cylindrical, and brown to black in color. Eggs are small, oval-shaped, shiny, opaque, and pearly white.

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Illinois, and annually kills many of the remaining and newly planted elms. The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.

There are two closely-related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elms by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus)*.

The species most affected by DED is the *Ulmus americana* (American elm).



Branch death, or flagging, at multiple locations in the crown of a diseased elm

Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

Oak Wilt

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Oak wilt symptoms on red and white oak leaves

Photograph courtesy of USDA Forest Service (2011a)

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oaks and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oaks, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

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APPENDIX F
STORM RESPONSE CATEGORIES FOR THE URBAN FOREST

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 responses are offered for Village consideration and adoption as part of an official emergency response plan.

Class I – Minor Storm Event

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

Damage reports and service requests are made to the government department directly by citizens and from staff inspections. Damage is corrected, and debris is disposed by municipal staff and contractors on site or following customary procedures.

Generally, Class I storms require no outside assistance for parks or streets personnel, and only limited (if any) assistance from contractors or others. Storm damage remediation and cleanup are achieved by municipal staff and/or contractors, requires no additional funding or special equipment, and is completed quickly.

Class I – Storm Mitigation Procedures

- Municipal urban forestry staff receive calls/reports from citizens and partnering agencies.
- Municipal urban forestry staff inspect and determine appropriate mitigation; utility company is called as required.
- Municipal urban forestry staff and/or contractors immediately resolve damage and dispose of debris.
- Municipal urban forestry staff perform a final inspection, complete a work order, and/or otherwise note the occurrence in the tree inventory database.

Class II – Large Storm Event

Class II storms are those that are long in duration or are severe enough to cause widespread damage. 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.

Class II storms exceed the normal staff and resources of the municipality and/or contractors alone. Damage mitigation for these storms will usually require the assistance of outside contractors and from other government departments. The assistance will come in the forms of additional staff and equipment, communication assistance, public safety measures, electrical hazard reduction, and customer service.

Class II Storm Mitigation Procedures

- Municipal urban forestry staff assess damage and immediately communicate with police and fire to determine the extent of the damage.
- The informal Emergency Operations Center should be convened to receive calls/reports and to coordinate mitigation response.
- Municipal urban forestry staff inspect damage, determine mitigation levels and needs, and set work priorities.
- Municipal urban forestry staff designate personnel and equipment resources under the guidance of the EOC leader.
- Municipal urban forestry staff and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Municipal urban forestry staff make final inspection and update the tree inventory database.
- Debris is processed appropriately.
- Municipal urban forestry staff should communicate with the citizens about its response activities and status using the Village's website and social media platforms.

Class III – Catastrophic Storm Event

Class III storms will be rare but can occur. Generally, these will result from snowstorms 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 municipality officials. Other local, state, and federal emergency management agencies will become involved, as well as department of transportations, and natural gas and electric utility providers. It will become necessary to identify municipal funding 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 for evacuation and/or access to hospitals, shelters, police, fire and rescue stations, and other facilities providing vital public services.

The second priority of streets and highways to be cleared of debris are those that provide access to components of the public and private utility systems that are vital to the restoration of essential utility services, such as electrical power stations and substations, municipal water and sanitary sewer pumping stations, and communication stations and towers. The last priority of roadways to be cleared are residential streets and alleys/access ways.

<u>No debris is intended to be removed during the initial emergency road-clearing operations.</u> Rather, debris is to be moved to the side of the roadway that will allow for a minimum of one lane of traffic in each direction and not create conflict with future utility restoration efforts by others.

Class III - Storm Mitigation Procedures

- Municipal urban forestry staff assesses damage and immediately communicates with the EOC and the designated municipal staff leader to determine the extent of the damage. County and State Emergency Management agencies may also be in the communication channels.
- Municipal urban forestry staff secures additional regional tree debris disposal site(s) as needed.
- Municipal urban forestry staff inspects tree related damage, determines mitigation levels and needs, and sets work priorities.
- Municipal, county, DOT and other agencies combine sufficient and appropriate personnel and equipment resources under the guidance of the municipality to mitigate tree related situations.
- Municipality, allied agencies, and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Municipal urban forestry staff make final inspection and update the tree inventory database.
- Debris is processed appropriately.
- Municipal urban forestry staff assist EOC team members and municipal leaders with completion of required state and Federal Emergency Management Agency (FEMA) forms.
- Municipal urban forestry staff should communicate with the citizens about its response activities and status, and advice for the treatment of private trees that have been damaged using the municipal website, and social media platforms.

Partners

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

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

1. **Utility Agencies**
   Electric distribution lines are the responsibility of the corresponding utility and are a key partner during a storm emergency. Only electrical provider staff are qualified to work around energized lines. They have the resources to mobilize quick and appropriate responses to emergency situations involving trees and utilities. During a widespread storm event, the municipality will likely also need to communicate and coordinate with the county public utility service agency or the state power agency. Where whole trees or limbs are down or resting on energized lines, rescue and cleanup efforts cannot proceed until power lines have been addressed by the trained personnel of these agencies. Prioritization of where utility agencies respond first generally are: three-phase aerial electric lines; single-phase aerial electric lines; secondary electric lines; and then service (or residential) drops.

2. **State Department of Transportations (DOTs)**

   DOTs are responsible for the safety and maintenance of interstate and state routes within and around municipalities. During a storm emergency, they can respond with staff and equipment to clear such rights-of-way and assist with municipal streets if authorized. The DOT will likely have a priority clearing routes which may affect debris staging or removal patterns for the municipality. Check with the local district DOT authority to reflect upon their responsibilities and the municipal expectations for each storm category.

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 the municipality. During an emergency, the municipality 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 New York**

   When the response efforts appear to be beyond the capability of the municipality or the county, the state can normally provide the next level of assistance by declaring a state of emergency. The New York Department of Homeland Security's Division of Emergency Response and Recovery aids local emergency response leaders for major or complex emergencies or disasters. The division also assists 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. The division typically evaluates the disaster situation and provides advice to the governor on the availability of state resources to assist local efforts.

   The Department of Homeland Security's website, http://www.dhses.ny.gov/, offers a toolbox of information to assist with the process of requesting aid and making claims for reimbursement. It offers several guide sheets and forms that provide excellent information about the application process and how to maintain adequate records of debris cleanup costs and contracting procedures.

5. **Federal Government**

   The U.S. Army Corps of Engineers may be able to respond for up to 10 days without a Presidential Declaration; the Federal Highway Administration may provide grant assistance to New York 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 Lancaster 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 Lancaster for debris removal costs if a federal disaster is declared. FEMA will also reimburse municipalities 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.

FEMA will also reimburse municipalities 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.

FEMA Funding Programs

Following is a summary of key federal disaster aid programs that were offered by FEMA and administered by the state in 2014 when under a presidential disaster declaration:

- Payment of not 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 nonprofit 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).