DAVEY Resource Group

October 2021

STANDARD INVENTORY ANALYSIS AND MANAGEMENT PLAN

City of Jersey City, New Jersey

Prepared for:

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ACKNOWLEDGMENTS

This project supports Jersey City's vision to promote and enhance community well-being through public tree conservation and improved forestry management practices. This *Standard Inventory Analysis and Management Plan* offers expertise in preserving and expanding urban canopy so the environmental, economic, and social benefits it provides continue for generations.

This plan was made possible through municipal operating funds and the support of the following:

Mayor Steven M, Fulop

Jersey City Municipal Council

Forester Edward O'Malley

Jersey City Office of Sustainability

City Jersey City Division of Parks and Forestry

Jersey City Shade Tree Committee

Montclair State University Institute for Sustainable Studies

NJCU

Five-year Tree Resource Maintenance Schedule

EXECUTIVE SUMMARY

Standard Inventory Analysis and Management Plan focuses on quantifying the benefits provided by the inventoried tree resource and addressing its maintenance needs. Davey Resource Group (DRG) completed a tree inventory for Jersey City during the months of November and December of 2020 and January, June and July of 2021, building on inventory work conducted by students[1] from New Jersey City University (NJCU) in August of 2018. A total of 12,916 sites were collected as part of the inventory effort (Figure 1), which covered a significant but partial inventory of the City's trees.

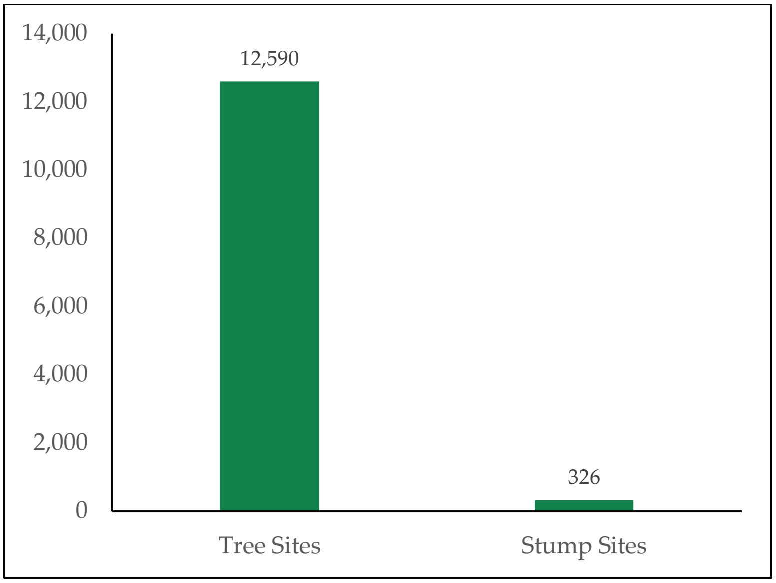


Figure 1. Number of inventoried sites by location and type.

DRG analyzed the inventory data to understand the structure of the city's inventoried tree resource. DRG also estimated the economic values of the various environmental benefits provided by this public tree resource by analyzing inventory data with i-Tree Eco and recommended a prioritized management program for future tree care. Jersey City's inventoried tree population provides benefits with an estimated total value of $122,336 annually. The city's annual tree maintenance budget[2] is $514,867 making Jersey City's return on investment almost 24% annually. The functions of Jersey City's

[1] Jersey City's Office of Sustainability initiated this project with students from New Jersey City University (NJCU) supervised by city employees and collegiate professors. In the spring of 2020, this initiate was continued using student Green Teams procured by Montclair State University. These students were able to map thousands of trees and built an interactive dashboard to display their results.

2 From New Jersey Urban and Community Forestry Program Annual Accomplishment Report dated February 3, 2021.

inventoried tree population throughout its trees' lifetimes are worth an estimated $19.1 million. Supporting and funding proactive maintenance of the public tree resource is a sound long-term investment that will reduce tree management costs over time.

High priority tree removal and pruning is costly, accounting for the larger budget in the Year 1 of the five-year schedule, as shown in Table 1. After high priority work has been completed, budgets are expected to decrease and stabilize as tree management transitions from reactive to proactive maintenance. This also reduces the number of new elevated risk trees over time by preventing deteriorating conditions of trees with initially minor defects.

Table 1. Estimated costs for five-year tree management program.

Maintenance Type			Year 1		Year 2		Year 3		Year 4		Year 5		**Five-Year Cost**
	Activity	Ave. Cost/ Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
PRIORITY MAINTENANCE	High Risk Removals	$1,661	49	$69,260	0	$0	0	$0	0	$0	0	$0	$69,260
	High Risk Pruning	$247	44	$12,920	0	$0	0	$0	0	$0	0	$0	$12,920
	Total Cost		**$82,180**		$0		$0		$0		$0		**$82,180**
PROACTIVE MAINTENANCE	Moderate/ Low Risk Removals	$1,661	60	$136,140	199	$184,575	121	$174,530	313	$55,120	0	$0	$550,365
	Removals due to Natural Mortality (1%)	$1,661	124	$100,157	122	$99,155	121	$98,163	120	$97,182	119	$96,210	$490,867
	Stump Removals	$239	248	$33,375	0	$0	0	$0	0	$0	0	$0	$33,375
	Young Tree Training (3-year cycle)	$90	1,077	$48,465	1,077	$48,465	1,077	$48,465	1,077	$48,465	1,077	$48,465	$242,325
	Routine Pruning (5-year cycle)	$306	952	$188,785	952	$188,785	952	$188,785	952	$188,785	952	$188,785	$943,925
	Further Inspection	$165	500	$58,645	0	$0	0	$0	0	$0	0	$0	$58,645
	Total Cost		**$565,567**		**$520,980**		**$509,943**		**$389,552**		**$333,460**		**$2,319,502**
PLANTING	Procurement, installation, 2-year maintenance guarantee	$1,200	274	$328,380	270	$324,496	269	$323,027	268	$321,573	267	$320,133	$1,617,610
	Total Cost		**$328,380**		**$324,496**		**$323,027**		**$321,573**		**$320,133**		**$1,617,610**
Maintenance Cost Grand Total			**$976,127**		**$845,476**		**$832,971**		**$711,125**		**$653,593**		**$4,019,291**

Recommended Maintenance Types

Tree Removal

Trees designated for removal have defects that cannot be cost-effectively or practically corrected. Most of the trees in this category have a large percentage of dead crown.

Total = 742 trees
High Priority = 49 trees
Moderate Priority = 259 trees
Low Priority = 434 trees
Stumps = 248

Priority Pruning

Priority pruning removes defects such as Dead and Dying Parts or Broken and/or Hanging Branches. Pruning the defected branch(es) can lower risk associated with the tree while promoting healthy growth.

Total = 44 trees

Routine Pruning Cycle

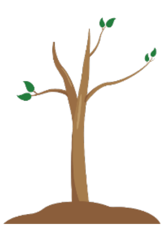
Over time, routine pruning of Low and Moderate Risk trees can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program.

Total = 4,758 trees
Number in cycle each year = at least 952 trees

New Tree Planting

Planting new trees in areas that have poor canopy continuity or sparse canopy is important to ensure that tree benefits are distributed evenly across the city.

Total replacement plantings due to removal = 742 trees
Total replacement plantings due to natural mortality = 606 trees
Total new plantings = 1,348 trees



Young Tree Training Cycle

Younger trees can have branch structures that lead to potential problems as the tree ages, requiring training to ensure healthy growth. Training is completed from the ground with a pole pruner or pruning shear.

Total = 5,385 trees
Number in cycle each year = at least 1,077 trees

Routine Tree Inspection

Routine inspections are essential to uncovering potential problems with trees and should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees.

Total = 12,444 existing trees + 1,348 new trees
Number in assessment cycle each year = 2,758 trees

INTRODUCTION

Jersey City is home to 292,449 residents (U.S. Census Bureau 2020) who benefit from the public trees in their community. The city's urban forestry program manages all trees, stumps, and planting sites along the street rights-of-way (ROW) and throughout public parks. Jersey City's staff in the Office of Sustainability and Business Administration and the Division of Parks Maintenance have shown continued commitment to developing a thriving public tree resource.

Urban forestry program budgets are funded by the Jersey City's Municipal Operating Fund. Jersey City has a shade tree committee and a tree ordinance, celebrates Arbor Day, and spends more than $2.00 per capita on tree maintenance. Jersey City also organizes an "Adopt-A-Tree" program in which homeowners can request a tree be planted in front of their home.

Jersey City has one ISA Certified Arborist and will soon be able to set goals and perform proactive maintenance using this *Standard Inventory Analysis and Management Plan*. The city's urban forestry program is well on its way to creating a sustainable and resilient public tree resource, and it is important to stay on track by consistently renewing program funding and routinely updating the tree inventory.

RECOMMENDED APPROACH TO TREE MANAGEMENT

An effective approach to tree resource management follows a proactive and systematic program that sets clear and realistic goals, prescribes future action, and periodically measures progress. A robust urban forestry program establishes tree maintenance priorities and utilizes modern tools, such as a tree inventory accompanied by TreeKeeper® or other asset management software.

In 2021, Jersey City worked with DRG to inventory its public trees and develop this management plan. Consisting of three sections, this plan considers the diversity, distribution, and condition of the inventoried tree population and provides a prioritized system for managing the city's public tree resource.

- *Section 1: Structure and Composition of the Public Tree Resource* summarizes the inventory data with trends representing the current state of the tree resource.
- *Section 2: Functions and Benefits of the Public Tree Resource* summarizes the estimated value of benefits provided to the community by public trees' various functions.
- *Section 3: Recommended Management of the Public Tree Resource* details a prioritized management program and provides an estimated budget for recommended maintenance activities over a five-year period.

Section 1:

Structure and Composition

of the Public Tree Resource

SECTION 1: STRUCTURE AND COMPOSITION OF THE PUBLIC TREE RESOURCE

DRG completed a tree inventory for Jersey City during the months of November and December of 2020 and January, June, and July of 2021, collecting data on trees and stumps along the street right-of-way, and continuing the inventory work started by students from New Jersey City University (NJCU) in August of 2018. DRG analyzed the inventory data from both efforts to understand the structure of the city's inventoried tree resource. In total, 12,916 sites were inventoried - 9,980 sites (77%) were collected by DRG and the remaining 2,936 (23%) were collected by the students – a significant but partial inventory of the City's trees. Figure 2 breaks down the total sites inventoried by type and inventory source. See Appendix A for details about DRG's methodology for collecting site data.

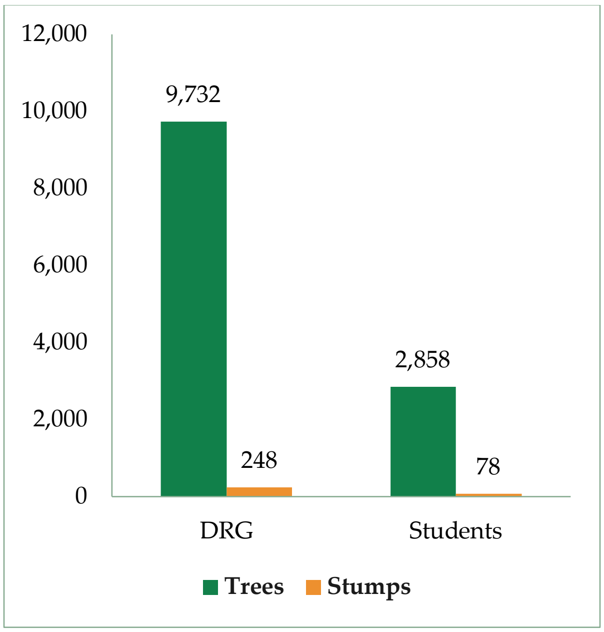


Figure 2. Number of inventoried sites by type and inventory source. *Includes DRG and student data, excludes sites with DBH <1.

SPECIES, GENUS, AND FAMILY DISTRIBUTION

The 10-20-30 rule is a common standard for tree population distribution, in which a single species should compose no more than 10% of the tree population, a single genus no more than 20%, and a single family no more than 30% (Santamour 1990).

Figure 3 shows Jersey City's distribution of the most abundant tree species inventoried compared to the 10% species threshold. London planetree (*Platanus hybrida)* is the most abundant species, comprising 21% of the population, which is significantly higher than the 10% threshold. Jersey City should not plant London planetrees or any other sycamore/ planetree species until this distribution becomes more ideal.

Callery pear (*Pyrus calleryana,* 12%) and cherry (P*runus*, 11%) trees also exceed the 10% threshold, though not as dramatically as the London planetree. These trees should be avoided in plantings until the species distribution becomes more ideal. Red maple (*acer rubrum*, 9%) and thornless honeylocust (*Gleditsia triacanthos inermis*, 8%) are both close but do not yet exceed the 10% threshold.

	London planetree	Callery pear	cherry spp	red maple	thornless honeylocust
Jersey City	21%	12%	11%	9%	8%
10% Rule	10%	10%	10%	10%	10%

Figure 3. Species distribution of inventoried trees. *Includes DRG and student data, excludes sites with DBH <1, stumps, and dead trees.

Species distribution alone does not completely represent tree population diversity. Genus distribution is an important consideration because some pests, such as emerald ash borer (EAB, *Agrilus planipennis*), target a single genus as its host. Some pests also target a single family as its host, such as the bacterium *Erwinia amylovora*, commonly known as fireblight. Fireblight only affects plants in the rose family (*Rosaceae*), such as serviceberry, hawthorn, apple/ crabapple, hawthorn, cherry, and pear.

Figure 4 shows the Jersey City's distribution of the most abundant tree genera inventoried. Sycamore/ planetree comprise 22% of the inventoried population, just over the 20% threshold. In general, Jersey City should avoid planting sycamore or planetrees until this distribution becomes more ideal. The remaining four of the top five most abundant genera are well under the 20% threshold and should remain on species planting lists.

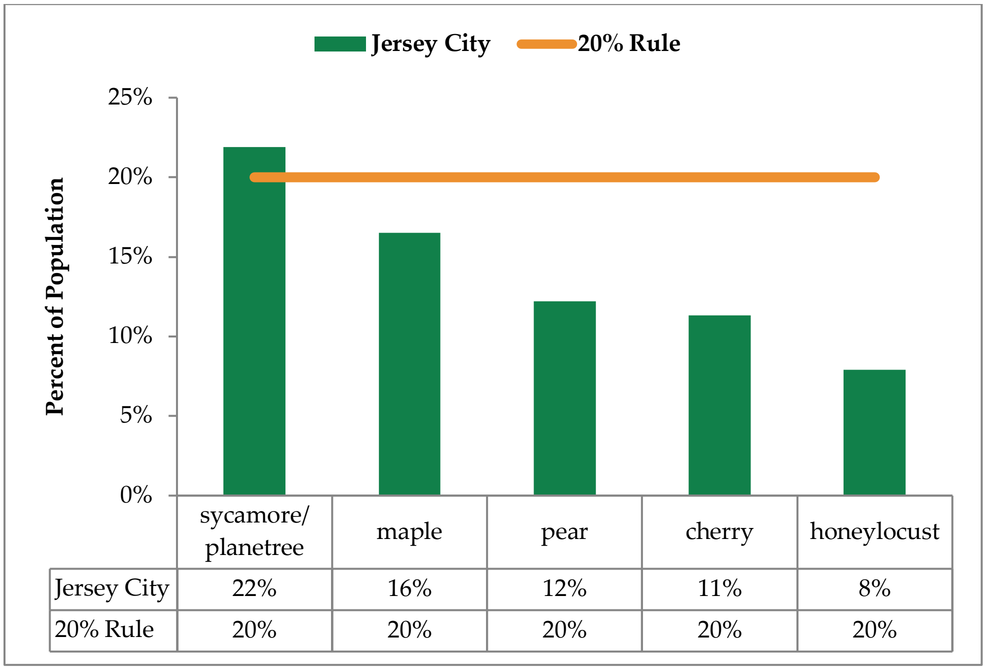


Figure 4. Genus distribution of inventoried trees. *Includes DRG and student data, excludes sites with DBH <1, stumps, and dead trees.

Figure 5 shows the Jersey City's distribution of the most abundant tree families inventoried compared to the 30% threshold. While Platanaceae (22%) is nearing the threshold, it is still relatively far away. The remaining four of the top five most abundant families are even farther from the threshold and make up a healthy distribution.

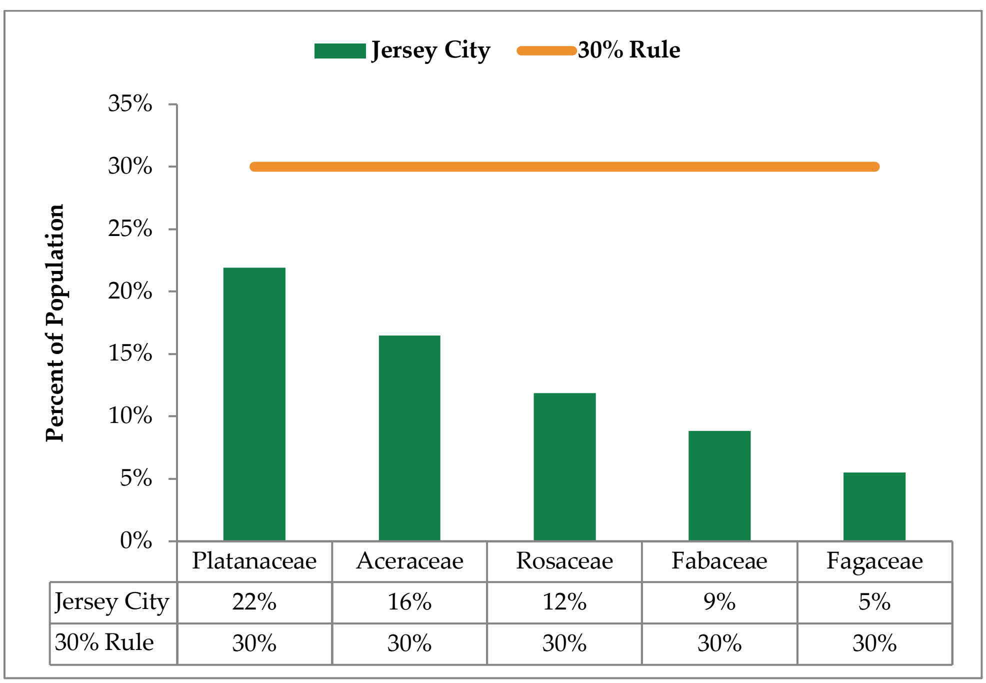


Figure 5. Family distribution of inventoried trees. *Includes DRG and student data. Excludes sites with DBH <1, stumps, and dead trees.

PEST SUSCEPTIBILITY

Early diagnosis of disease and infestation is essential to ensuring the health and longevity of Jersey City's public tree resource. See Appendix B for some information about the pests listed below and websites where additional information can be found.

Figure 6 shows the percent of inventoried trees susceptible to some of the known pests in and around New Jersey. It is important to remember that this figure only represents data collected during the inventory. Many more trees throughout Jersey City, especially those on private property, may be susceptible to hosting these invasive pests. Spotted lanternfly (SLF, *Lycorma delicatula*)] and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are potential threats to a large percentage of the inventoried tree resource, 58% and 43%, respectively, followed closely by European Gypsy moth (30%).

Ash trees in an urban forest killed by emerald ash borer.

USDA Forest Service (2017)

Case Study: RESILIENCE THROUGH DIVERSITY

The Dutch elm disease epidemic of the 1930s provides a key historical lesson on the importance of diversity (Karnosky 1979). The disease killed millions of American elm trees, leaving behind enormous gaps in the urban canopy of many Midwestern and Northeastern communities. In the aftermath, ash trees became popular replacements and were heavily planted along city streets. History repeated itself in 2002 with the introduction of the emerald ash borer into America. This invasive beetle devastated ash tree populations across the Midwest. Other invasive pests spreading across the country threaten urban forests, so it's vital that we learn from history and plant a wider variety of tree genera to develop a resilient public tree resource.

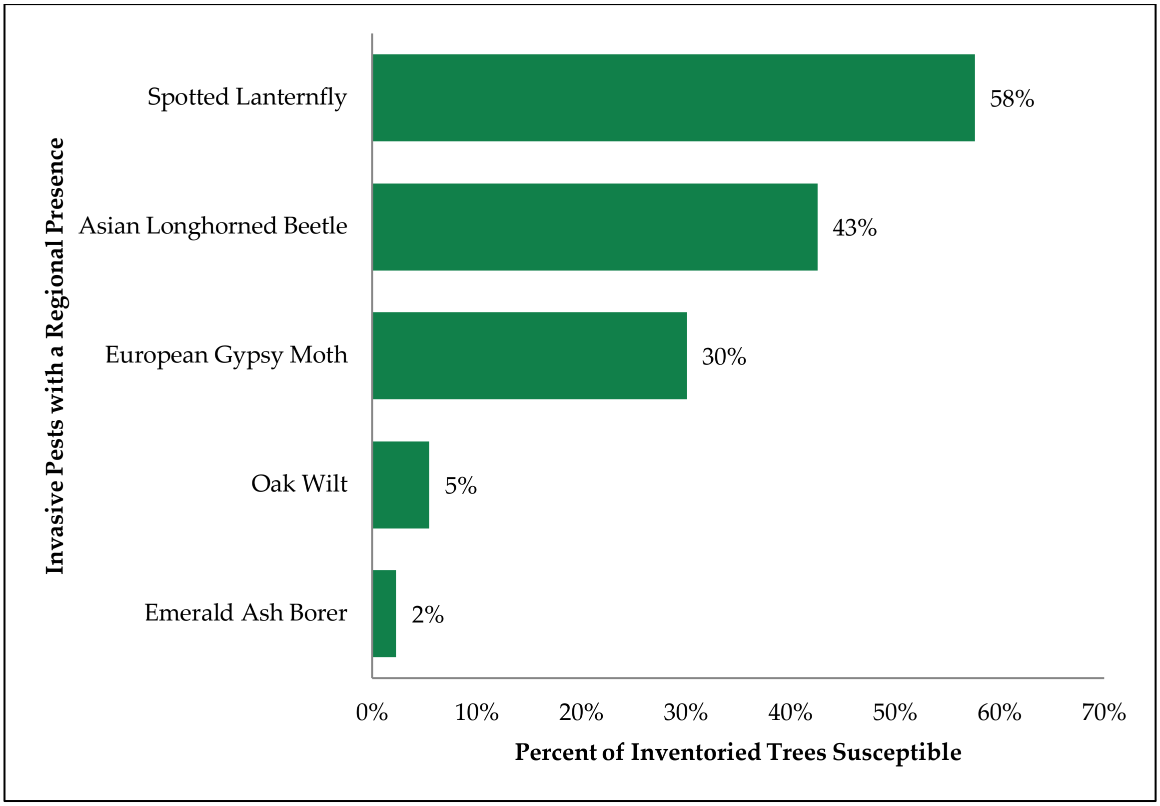


Figure 6. Tree resource susceptibility to invasive pests that have a regional presence. *Includes DRG and student data. Excludes sites with DBH <1, stumps, and dead trees

Pest Susceptibility Recommendations

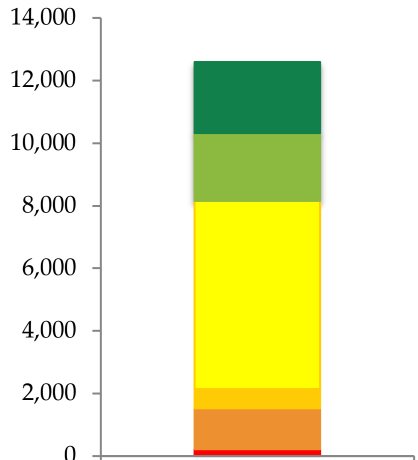
Increasing species diversity is a critical goal that will help Jersey City's tree resource be resilient in the event of future pest invasions. While it might be prudent for the city to limit planting species in the Platanaceae family to prevent it from approaching the 30% threshold, efforts to improve diversity at the genus and species level are a better use of short-term resources until more research is done on family diversity as a mechanism for promoting system resilience.

Additionally, the overabundance of maples (Aceraceae) in Jersey City's population is a management concern, creating unnecessary risk in the event of an invasive pest outbreak. This abundance not only represents more tree resource to lose but it also represents more habitat for pests, such as SLF or ALB, making it easier for them to spread.

CONDITION

Several factors affecting condition 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 by an arborist as Good, Good/Fair, Fair, Fair/Poor, Poor, or Dead. The general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory.

Figure 7 shows most of the inventoried trees were recorded in Good, Good/Fair or Fair condition, 18%, 17%, and 48%, respectively. Based on these data, the general health of the inventoried tree population is rated as Fair. Jersey has a low percentage of trees in Fair/Poor, Poor, and Dead condition, so the general health of the city's tree resource is approaching good.



Good	2,271
Good/Fair	2,170
Fair	5,999
Fair/Poor	617
Poor	1,308
Dead	225

Figure 7. Condition of inventoried trees. *Includes DRG and student data. Excludes sites with DBH <1, and stumps.

Condition Recommendations

- Dead trees and trees in Poor condition should be removed as soon as possible - the health of these trees is unlikely to recover even with increased care and present a risk.
- Younger trees rated in Fair or Poor condition may benefit from structural pruning to improve their health over time. Pruning should follow *ANSI A300 (Part 1)* guidelines.
- 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 likely require corrective pruning and intensive plant health care to improve their vigor and should be monitored for worsening conditions.

RELATIVE AGE DISTRIBUTION

A tree population's relative age distribution assigns age classes to size classes of inventoried trees, offering insight into the maintenance needs of the tree resource. The inventoried trees are grouped into the following relative age classes:

- Young trees (0–8 inches diameter at breast height (DBH[3]))
- Established trees (9–17 inches DBH)
- Maturing trees (18–24 inches DBH)
- Mature trees (greater than 24 inches DBH)

These size classes were chosen so that the inventoried tree resource can be compared to the ideal relative age distribution, which holds that the largest proportion of the inventoried tree population (approximately 40%) should be young trees, while a smallest proportion (approximately 10%) should be mature trees (Richards 1983). Since tree species have different lifespans and mature at different diameters, actual tree age cannot be determined from diameter size class alone, yet size classifications can be extrapolated into relative age classes.

Figure 8 compares Jersey City's relative age distribution of the inventoried tree population to the ideal. The city's inventoried tree resource is starting to trend towards the ideal; however, young (43%), established (32%), and mature (11%) trees exceed the ideal, while maturing trees (14%) fall short by 6%.

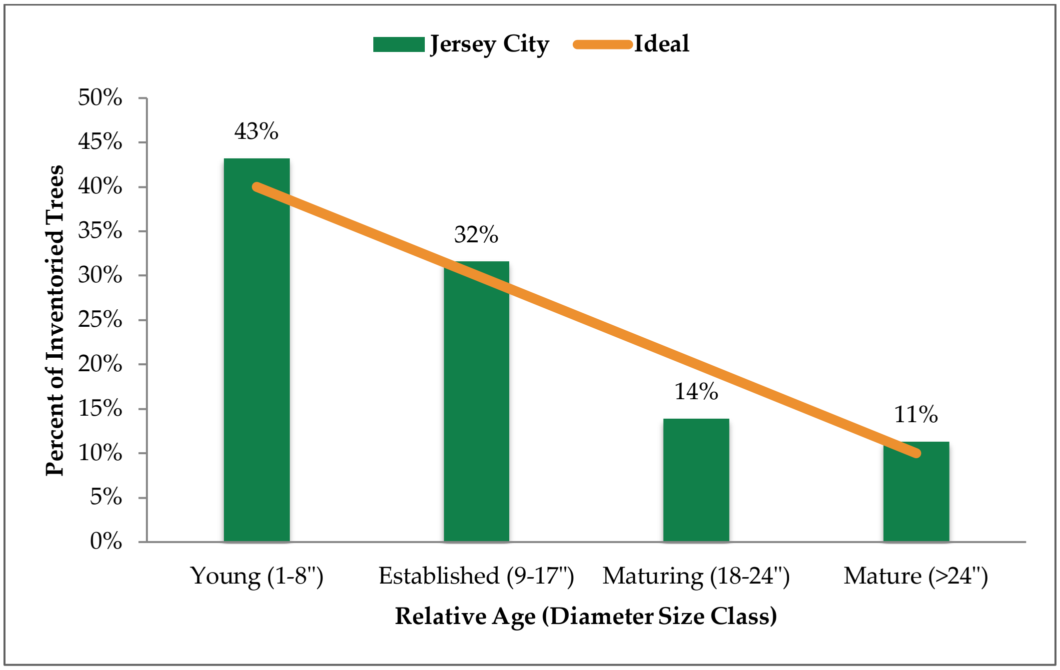


Figure 8. Relative age distribution of inventoried trees. *Includes DRG and student data. Excludes sites with DBH <1, and stumps.

Figure 9 compares the condition of the inventoried tree resource with its relative age distribution, providing insight into the inventoried population's stability. 78% of mature trees and 76% of maturing trees are rated in Fair condition or better, which is important because these larger trees would have a more damaging impact in the event of failure. 81% of established trees and 88% of young trees are rated in Fair condition or better, so it is important to provide the maintenance they need to remain healthy as

[3] Measured at 4.5 feet from the ground.

they age and grow, which will reduce the proportion of mature and maturing trees in Poor condition or worse.

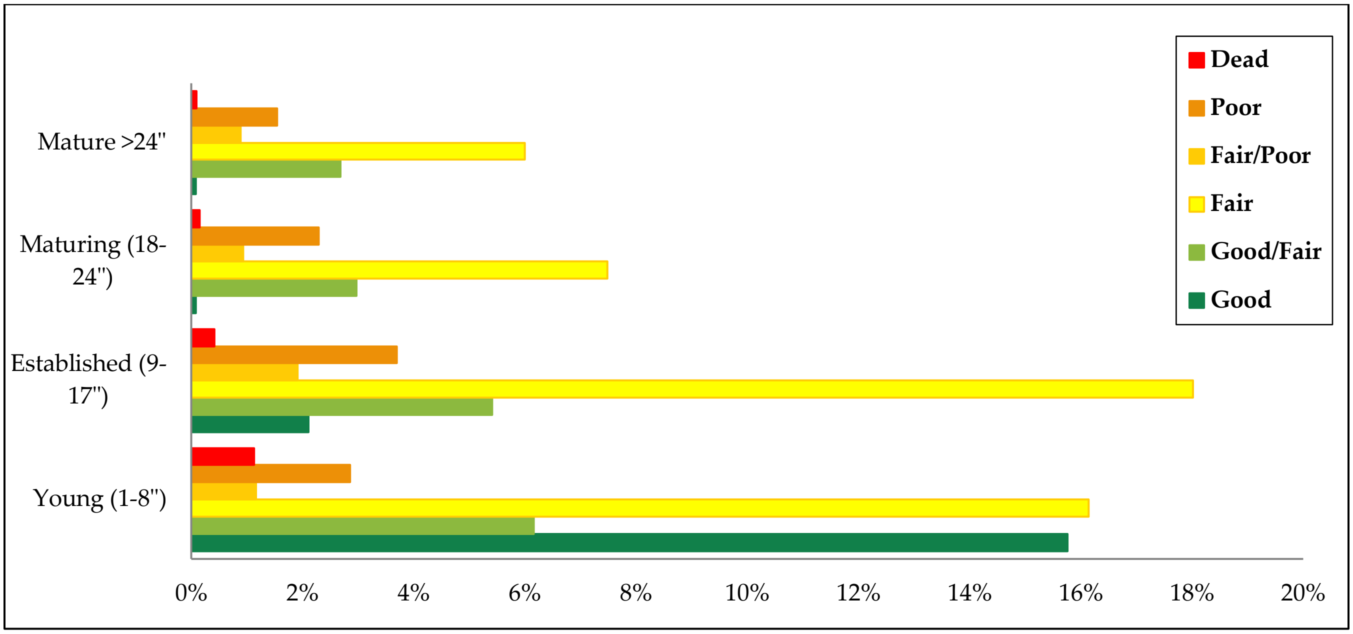


Figure 9. Condition of inventoried trees by relative age class. *Includes DRG and student data. Excludes sites with DBH <1, and stumps.

Relative Age Recommendations

While Jersey City has an abundance of young and established trees and a smaller proportion of maturing and mature trees, the city has a low percentage of trees in Poor condition, indicating that young and established trees have the potential of reaching maturity if they are well maintained. DRG recommends that Jersey City implement a robust maintenance program, to conserve the condition of young trees as they age so they replace removed trees and fill canopy gaps in maturity. The city should also focus on tree preservation and proactive care, to protect mature and maturing trees from unnecessary removal and to prevent them from succumbing to treatable defects. Prioritizing proactive maintenance above tree planting will shift the relative age distribution towards the ideal over time.

DEFECT OBSERVATIONS

For each tree inventoried, DRG assessed conditions that indicated the presence of structural defects and recorded the most significant condition. Defects were limited to the following categories:

- Broken and/or hanging branches
- Cracks
- Dead and dying parts
- Missing or decayed wood
- Root problems
- Tree architecture
- Weakly attached branches and codominant stems
- Other[4]

Defects	# of Street Trees	% of Street Trees
Dead and Dying Parts	2,971	31%
Other	1,109	11%
Missing or Decayed Wood	938	10%
Weakly Attached Branches and Codominant Stems	794	8%
Tree Architecture	541	6%
Root Problems	511	5%
Broken and/ or Hanging Branches	436	4%
Cracks	50	1%
None	2,630	27%
Total	**9,723**	**100%**

Table 2. Tree defect categories recorded by DRG during the inventory. *Includes DRG data, excludes defects "None," "Not Assigned" and all student data.

The two defects most frequently recorded by DRG were "Dead and Dying Parts" and "Other" at 40% and 15% of trees, respectively (Table 1). Of the 2,971 trees with "Dead and Dying Parts", 237 were recommended for removal. Of the 1,109 trees with the defect "Other", 22 were recommended for removal. The next most common defects recorded were "Missing or Decayed Wood" and "Weakly Attached Branch Unions and Codominant Stems" at 13% and 11% respectively.

Defect Observation Recommendations

When considering the defect recorded for each tree, there are two important qualifiers to keep in mind. First, the categories are broadly inclusive. For example, the "Dead and Dying Parts" category can include trees with just one or two smaller diameter dead limbs as well as trees found with large-diameter dead

[4] Examples of defects assigned to "Other" include trees that were observed to be improperly pruned, utility pruned, have a foliage disorder, or have sustained mechanical damage.

limbs or entire sections of dead canopy. Therefore, inferences on overall tree condition or risk rating cannot be derived solely from the presence or absence of a defect recorded during the inventory. Second, an inventoried tree may have multiple defects; the Jersey City inventory recorded only the most significant defect observed for each tree. These two qualifiers are important to keep in mind when considering urban forest management planning and the prioritization of maintenance or monitoring activities.

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, utility wires, and pipes, which could pose risk to public safety. "Overhead Utilities" – the presence of overhead utility lines above a tree or planting – was the existing or possible conflict recorded during the inventory. This data is important to consider when planning pruning activities and selecting tree species for planting.

Table 2 shows the total number of street trees recorded with utilities present. The majority of those (61%) did not have overhead utilities present during the time of the inventory. There were 3,853 street trees with utilities directly above, or passing through, or within 10' of the tree canopy.

Overhead Utilities	# of Street Trees	% of Street Trees
Not Present	6,127	61%
Present	3,853	39%
Total	**9,980**	**100%**

Table 3. Status of overhead utilities. *Includes DRG data, excludes overhead utilities "Not Assigned" and all student data.

Infrastructure Conflict Recommendations

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.

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.

GROWING SPACE

DRG collected information about the growing space type for all sites inventoried. Growing space types are categorized as follows:

- *Median/ Island*—located between opposing lanes of traffic. Includes traditional medians as well as traffic islands or the center of traffic circles.

- *Open/ Unrestricted*—open sites with unrestricted growing space on at least three sides. Primarily used for sites located behind sidewalk in lawns.
- *Tree Lawn*—located between the street curb and the public sidewalk. These spaces are 20′ in length or longer.
- *Well/Pit*—at grade level and completely surrounded by sidewalk.
- *Natural area* —areas that do not appear to be regularly maintained. Included unmaintained strips between houses, wooded lots, and wooded areas of parks.

As recorded by DRG, most (89%) trees along the street ROW were located in Well/ Pits. The next most common growing space type was Tree Lawns (10%). Median/ Islands, Open/ Unrestricted, Other, and Natural Area space types made up a very small portion of the growing space types observed in the inventory.

Growing Space Type	# of Street Trees	% of Street Trees
Well/ Pit	8,871	89%
Tree Lawn	952	10%
Median/ Island	88	1%
Open/ Unrestricted	40	0.4%
Other	27	0.3%
Natural Area	2	0.02%
Total	**9,980**	**100%**

Table 4. Growing space type. *Includes DRG data, excludes grow space type "Not Assigned" and all student data.

Growing Space Recommendations

To prolong the useful life of street trees, 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.

Section 2:

Functions and Benefits

of the Public Tree Resource

SECTION 2: FUNCTIONS AND BENEFITS OF THE PUBLIC TREE RESOURCE

Trees occupy a vital role in the urban environment by providing of a wide array of economic, environmental, and social benefits, which far exceed the investments in planting, maintaining, and removals. Trees reduce air pollution, improve public health outcomes, reduce stormwater runoff, sequester and store carbon, reduce energy use, and increase property value. Using advanced analytics, such as i-Tree Eco and other models in the i-Tree software suite, understanding the importance of trees to a community continues to expand by providing tools to estimate monetary values of the various benefits provided by a public tree resource.

Environmental Benefits

- Trees decrease energy consumption and moderate local climates by providing shade and acting as windbreaks.
- Trees act as mini reservoirs, helping to slow and reduce the amount of stormwater runoff that reaches storm drains, rivers, and lakes. One hundred mature tree crowns intercept roughly 100,000 gallons of rainfall per year (U.S. Forest Service 2003a).
- Trees help reduce noise levels, cleanse atmospheric pollutants, produce oxygen, and absorb carbon dioxide.
- Trees can reduce street-level air pollution by up to 60% (Coder 1996). Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.
- Trees stabilize soil and provide a habitat for wildlife.

Economic Benefits

- Trees in a yard or neighborhood increase residential property values by an average of 7%.
- Commercial property rental rates are 7% higher when trees are on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).
- On average, consumers will pay about 11% more for goods in landscaped areas, with this figure being as high as 50% for convenience goods (Wolf 1998b, Wolf 1999, and Wolf 2003).
- Consumers also feel that the quality of products is better in business districts surrounded by trees than those considered barren (Wolf 1998b).
- The quality of landscaping along the routes leading to business districts had a positive influence on consumers' perceptions of the area (Wolf 2000).

Social Benefits

- Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).
- Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001b).
- Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).
- Hospital patients recovering from surgery who 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 (Ulrich 1984, 1986).

I-TREE ECO ANALYSIS

i-Tree Eco utilizes tree inventory data along with local air pollution and meteorological data to quantify the functional benefits of a community's tree resource. By framing trees and their benefits in a way that everyone can understand – dollars saved per year – i-Tree Eco helps a community to understand trees as both a natural resource and an economic investment. Knowledge of the composition, functions, and monetary value of trees helps to inform planning and management decisions, assists in understanding the impact of those decisions on human health and environmental quality, and aids communities in advocating for the necessary funding to manage their vested interest in the public tree resource appropriately.

ANNUAL RETURN ON INVESTMENT FROM THE PUBLIC TREE RESOURCE

The i-Tree Eco analysis of Jersey City's inventoried trees quantified the functional benefits of three critical ecosystem services that they provide: air pollution removal, carbon sequestration, and avoided surface runoff. The city's annual tree maintenance budget is $$514,867 making Jersey City's return on investment almost 24% annually.

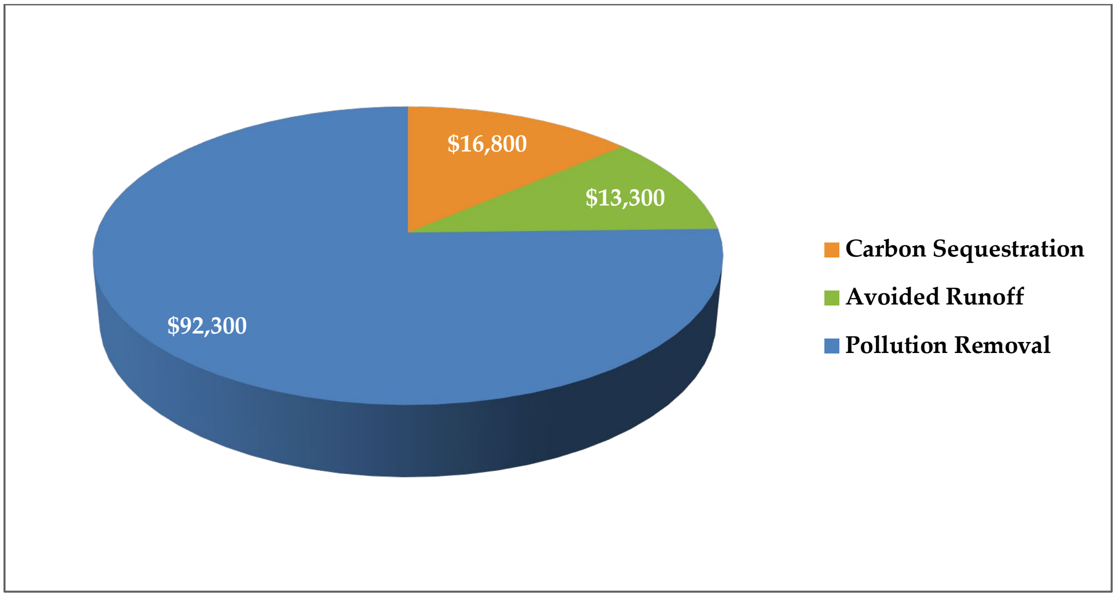


Figure 10. Estimated value of the benefits provided by inventoried trees. *Includes DRG and student data, Excludes all trees with DBH <1, stumps, and species "Unknown tree."

Urban environments have unique challenges that make the estimated $122,400 of functional benefits (Figure 10) provided by Jersey City's inventoried tree population an essential asset to the city.

Carbon dioxide (CO_2) impacts people, property, and the environment as the primary greenhouse gas driving climate change, valuing the 196,620 lbs (see Table 5). sequestered by Jersey City's tree resource at an estimated $16,800 annually. Avoiding stormwater runoff reduces the risk of flooding and combined sewer overflow, both of which impact people, property, and the environment, valuing the 7,018,700 gal of runoff avoided with Jersey City's tree resource at an estimated $13,300, annually. Finally, compared to rural landscapes, urban landscapes are characterized by high emissions in a relatively small area, valuing the 5,560 lbs. of airborne pollutants removed by Jersey City's tree resource at an estimated $92,300, annually.

The replacement value of the city's inventoried tree population is estimated to be $ 19,100,000. In Jersey City, only ten species account for almost half of the public tree resource and half of the functional benefits it provides. If any of these species were lost to invasive pests, disease, or other threats, the loss would have significant costs. It is critical to promote species diversity with future plantings to minimize susceptibility to potential threats, and to plant large-statured broadleaf tree species wherever possible to maximize potential environmental and economic benefits. See Appendix C for a tree species list recommended by DRG.

Most Common Trees Collected During Inventory		Number Trees on the ROW	Percent of Total Trees	Benefits Provided by Street Trees				
				Stormwater Intercepted	Avoided Runoff	CO_2 Sequestered	CO_2 Stored	Air Pollution Removed
Common Name	Botanical Name		%	gal / yr	gal / yr	lbs / yr	lbs	lbs / yr
London plane	*Platanus hybrida*	2,677	21.5%	3,640,367	772,144	96,600	5,618,360	2,980
Callery pear	*Pyrus calleryana*	1,527	12.3%	447,503	94,918	25,140	1,268,280	360
cherry spp	*Prunus species*	1,328	10.7%	210,839	44,720	3,220	399,940	160
red maple	*Acer rubrum*	1,168	9.4%	375,571	79,661	14,760	399,740	300
thornless honeylocust	*Gleditsia triacanthos inermis*	979	7.9%	421,045	89,306	10,600	829,080	340
littleleaf linden	*Tilia cordata*	582	4.7%	177,769	37,706	6,140	231,600	140
Japanese zelkova	*Zelkova serrata*	533	4.3%	215,553	45,720	2,680	149,160	180
Freeman maple	*Acer x freemanii*	332	2.7%	97,202	20,617	3,820	158,940	80
ginkgo	*Ginkgo biloba*	321	2.6%	81,714	17,332	960	44,700	60
pin oak	*Quercus palustris*	297	2.4%	365,410	77,506	4,020	509,360	280
Norway maple	*Acer platanoides*	293	2.4%	150,575	31,938	4,400	273,340	120
Japanese tree lilac	*Syringa reticulata*	209	1.7%	4,412	936	1,020	20,360	0
green ash	*Fraxinus pennsylvanica*	177	1.4%	95,101	20,172	2,060	83,200	80
pagoda tree	*Styphnolobium japonicum*	161	1.3%	57,388	12,172	2,920	147,800	40
white ash	*Fraxinus americana*	107	0.9%	44,804	9,503	1,440	60,200	40
Northern red oak	*Quercus rubra*	99	0.8%	52,939	11,229	1,280	72,060	40
silver maple	*Acer saccharinum*	96	0.8%	96,019	20,366	2,400	181,340	80
American elm	*Ulmus americana*	95	0.8%	37,308	7,913	1,420	86,580	20
sawtooth oak	*Quercus acutissima*	93	0.7%	63,677	13,506	1,980	108,020	60
other street trees	69 genera and ~140 species	1,370	11.0%	383,501	81,343	9,760	517,760	200
ROW Total		**12,444**	**100%**	**7,018,700**	**1,488,709**	**196,620**	**11,159,820**	**5,560**

Table 5. Summary of benefits provided by inventoried trees ranked by species importance value. *Includes DRG and student data, Excludes all trees with DBH <1, stumps, and species "Unknown tree."

SEQUESTERING AND STORING CARBON

Trees are carbon sinks, which are the opposite of carbon sources. While carbon is emitted from cars and smokestacks, carbon is absorbed into trees during photosynthesis and stored in their tissue as they grow. The i-Tree Eco model estimates both the carbon sequestered each year and total carbon stored. Jersey City's inventoried trees have stored 11,159,820 lbs. of carbon, which is all the carbon each tree has amassed throughout their lifetimes and is valued at $952,000. London planetree (*palatanus hybrida)* and Callery pear (*Pyrus calleryana*) store the most carbon: 5,618,360 lbs. and 1,268,280 lbs., respectively. Both species also sequester the most carbon annually: 96,600 lbs. and 25,140 lbs., respectively.

CONTROLLING STORMWATER

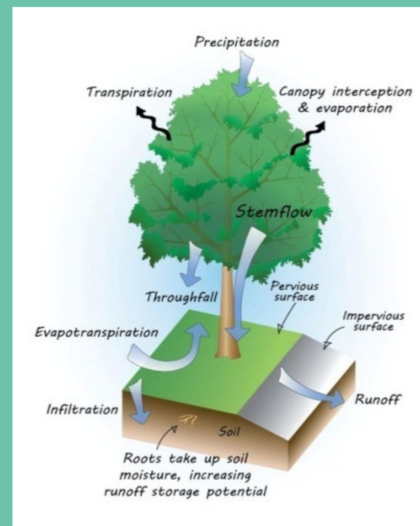
Trees intercept rainfall with their leaves and branches, helping lower stormwater management costs by avoiding runoff. The inventoried trees in Jersey City avoid 7,018,700 gallons of runoff annually. Avoided runoff accounts for 30% of the annual functional benefits provided by Jersey City's public tree resource.

Of all species inventoried, London planetree (*Platanus hybrida*) contributed the most annual stormwater benefits. The London planetree population (21.5% of inventoried trees) avoided 772,144 gallons of runoff. On a per-tree basis, large trees with leafy canopies provide the most functional benefits. Callery pear (*Pyrus calleryana*) and cherry species (*prunus*) comprised 12.3% and 10.7% of the inventoried tree resource, respectively. Callery Pear avoided 94,918 gallons of runoff, twice as much as cherry species did, despite only having only a slightly larger population size. This illustrates how large-statured trees with wide canopies provide significantly greater benefits.

IMPROVING AIR QUALITY

The inventoried tree population annually removes 5,560 lbs. of air pollutants, including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter ($PM_{2.5}$). The i-Tree Eco model estimated the value of this benefit at $92,263, which is 30% of the value of all annual benefits. As shown in Figure [11], a small reduction

CANOPY FUNCTIONS



Trees provide many functions and benefits all at once simply by existing, such as:

- Catching rainfall in their crown so it drips to the ground with less of an impact or flows down their trunk.
- Helping stormwater soak into the ground by slowing down runoff.
- Creating more pore space in the soil with their roots, helping stormwater to move through the ground.
- Cooling the surrounding landscape by casting shade with their canopy and releasing water from their leaves.
- Catching airborne pollutants on

of $PM_{2.5}$ is the more valuable than any of the other pollutants removed. The trees that provided the highest annual air quality benefits were London planetree (*Platanus hybrida*) and Callery pear (*Pyrus calleryana*) which removed 2,880 lbs. of pollutants per tree per year and 360 lbs. of pollutants per tree per year, respectively.

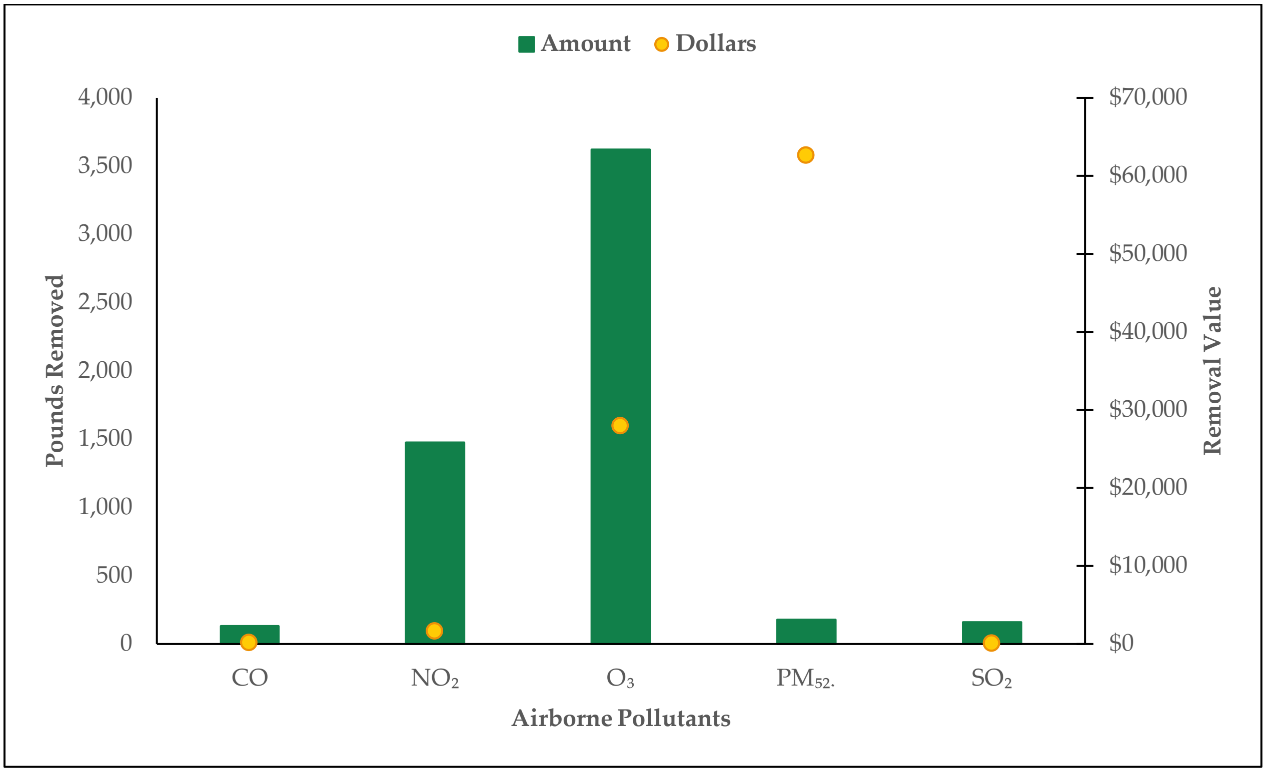


Figure 11. Estimated value of removing airborne pollution by weight and type.
*Includes DRG and student data, Excludes all trees with DBH <1, stumps, and species "Unknown tree."

Section 3:

Recommended Management

of the Public Tree Resource

SECTION 3: RECOMMENDED MANAGEMENT OF THE PUBLIC TREE RESOURCE

During the inventory, both a risk rating and a recommended maintenance activity were assigned to each tree. DRG recommends prioritizing and completing each tree's recommended maintenance activity based on the assigned risk rating. This five-year tree management program takes a multi-faceted and proactive approach to tree resource management.

High Priority	• All High Priority tree removals and pruning should be completed as soon as possible - these trees have significant defects that will become severe over time.
Moderate Priority	• Moderate Priority tree removals and pruning should only start after most High Priority tree maintenance has been completed, and should be performed concurrently.
Low Priority	• Low Priority tree maintenance should be performed after all High and Moderate Priority maintenance has been completed.
Stump Removal	• Stump removals should be performed either when a tree is removed or before a planting season begins, so planting sites are vacant for replacement trees.
Routine Inspection	• Routine Inspection from a drive-by perspective is important for detecting major defects before they worsen, and a walk-by perspective is important for updating inventory data.
Young Tree Training	• Young Tree Training Cycles improve tree structure so defects do not worsen and become more costly to correct as they grow, and should begin as soon as possible.
Routine Pruning	• Routine Pruning Cycles correct defects before they worsen, which is crucial for maintaining the overall condition of the inventoried tree resource over the long-term.
Replace Trees	• Removed trees should be replaced so there is no net loss of the tree resource, which should enter the Young Tree Training Cycle immediately.
Tree Planting	• Planting new trees is important for increasing population size and urban canopy, but can wait until higher priority maintenance is complete or at least in progress.

RISK MANAGEMENT AND RECOMMENDED MAINTENANCE

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. DRG recommends that trees be removed when corrective pruning will not adequately mitigate risk or when correcting problems would be cost-prohibitive. DRG recommends that tree maintenance activities are prioritized and completed based on the risk rating that was assigned to each tree during the inventory. The following section describes recommended maintenance for each risk rating category.

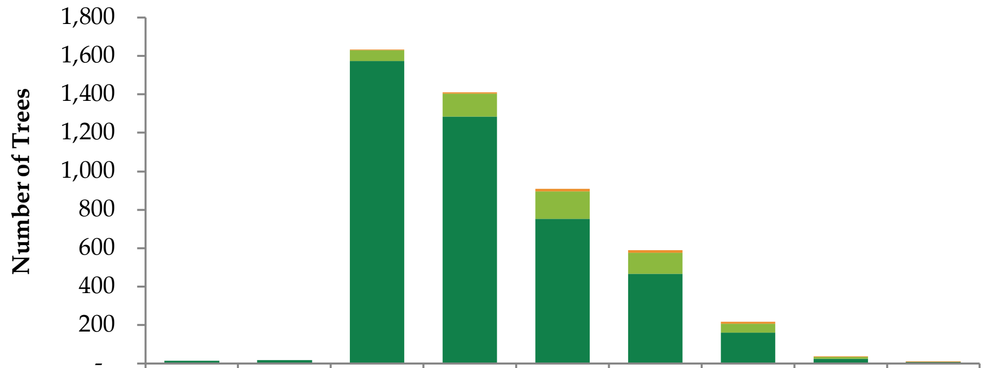
Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased and nuisance trees also warrant removal. Even though large short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety. The following sections briefly summarize the recommended removals identified by DRG during the inventory.

The ANSI A300 standard for tree risk assessment outlines three levels of risk assessment. Each level is built on the one before it. The lowest level is designed to be a cost-effective approach to quickly identifying tree risk concerns; whereas, the highest level is intended to provide in-depth information to decide about a tree. These levels are:

- **Level 1** inspection is defined as a Limited Visual assessment, which is often conducted as a walk through or windshield survey designed to identify obvious defects or specified conditions.
- **Level 2** inspection is defined as a Basic assessment and is a detailed, 360-degree visual inspection of a tree and its surrounding site, and a synthesis of the information collected.
- **Level 3** inspection is an Advanced assessment and is performed to provide detailed information about specific tree parts, defects, targets, or site conditions. A level 3 inspection may use specialized tools or require the input of an expert.

PRIORITY MAINTENANCE

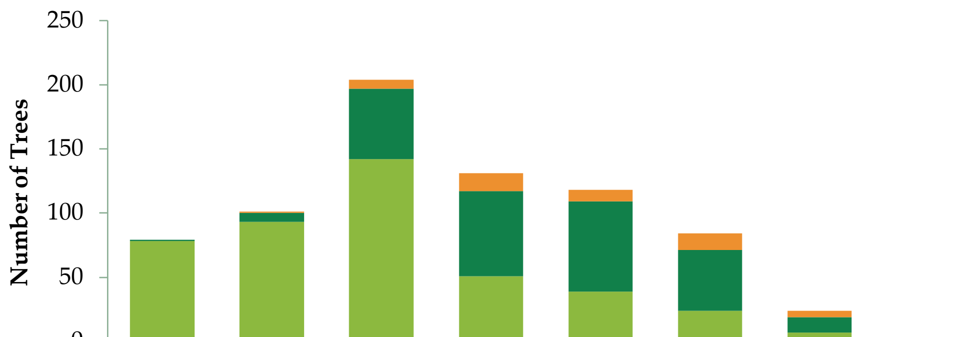
Figures 12 and 13 present tree pruning and tree removals by risk rating and diameter size class, respectively. Pruning or removing High Risk trees should be prioritized and completed as soon as possible. In general, maintenance activities should be completed first for the largest diameter trees (>25”) that pose the greatest risk. Once addressed, recommended tree maintenance activities should be completed for smaller diameter trees (<25”) that pose the greatest risk. Addressing High Risk trees in a timely and proactive manner often requires significant resources to be secured and allocated. However, peforming this work expediently will mitigate risk, improve public safety, and reduce long-term costs.



	1-3"	4-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43"+
High	0	0	2	5	12	12	10	2	1
Moderate	0	0	57	120	142	109	47	9	0
Low	13	19	1,573	1,286	754	468	160	26	7

Diameter Size Class

Figure 12. DRG recommended pruning by size class and risk rating.
*Includes DRG data, excludes sites <1 DBH, stumps, all student data, and
sites collected by Edward O'Malley.



	1-3"	4-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"
High	0	1	7	14	9	13	5	0
Moderate	1	7	55	66	70	47	12	1
Low	78	93	142	51	39	24	7	0

Diameter Size Class

Figure 13. DRG recommended removals by size class and risk rating.
*Includes DRG data, excludes sites <1 DBH, stumps, all student data, and
sites collected by Edward O'Malley.

High Priority Pruning Recommendations

Trees with High Risk ratings should be pruned immediately. This generally requires removing defects such as dead and dying parts, broken and/or hanging branches, and missing or decayed wood that may be present in tree crowns, even when most of the tree is sound. In these cases, when pruning the defected branch(es) can correct the problem, risk associated with the tree is reduced while promoting healthy growth.

DRG identified no Extreme risk trees in this inventory but did identify 44 High Risk trees recommended for pruning. The diameter size classes for trees with recommended high-priority pruning ranged between 7-12 inches DBH and 43+ inches DBH. This maintenance should be performed immediately based on assigned risk rating and may be performed concurrently with other Extreme and High Risk removals.

High Priority Removal Recommendations

Trees with High Risk ratings recommended for removal should be removed immediately. DRG did not identify any Extreme Risk trees but did identify 49 High Risk trees recommended for removal in this inventory. The diameter size classes for High Risk trees ranged between 4-6 inches DBH and 31-36 inches DBH.

DRG recommends that trees be removed when pruning will not correct their defects, eliminate the risks that their defects cause, or when corrective pruning would be cost-prohibitive. These trees should be removed immediately based on their risk rating and size class.

PROACTIVE MAINTENANCE

ROUTINE 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. Ideally, the arborist will be ISA Certified and also hold the ISA Tree Risk Assessment Qualification credential.

Routine Inspection Recommendations

All trees along the street ROW should be regularly inspected and attended to as needed. When trees require additional or new work, they should be added to the maintenance schedule. The budget should also be updated to reflect the additional work. Utilize computer management software such as TreeKeeper® to make updates, edits, and keep a log of work records. In addition to locating trees with unidentified defects, inspections also present an opportunity to look for signs and symptoms of pests and diseases. Jersey City has a large population of trees that are susceptible to pests and diseases, including ash, maple, and oak.

DRG recommends that Jersey City perform routine inspections of inventoried trees by windshield survey (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* annually and after all severe weather events, to identify defects with heightened risk, signs of pest activity, and symptoms of disease. When trees need additional maintenance or dead from national attrition[5], they should be added to the work schedule immediately. Use asset management software such as TreeKeeper® to update inventory data and schedule work records.

MODERATE AND LOW RISK REMOVALS

Removing Moderate and Low Risk trees is generally the next priority for maintenance activities. For efficiency, Moderate and Low Risk removals may also be addressed when removing adjacent higher risk trees. DRG recommends implementing proactive maintenance programs incrementally over time as the backlog of risk is reduced.

Moderate Risk Removal Recommendations

DRG identified 259 Moderate Risk trees recommended for removal. Most Moderate Risk trees recommended for removal were smaller than 31 inches DBH. If corrective pruning cannot correct a tree's defects and/or adequately mitigate risk, then the tree should be removed. A total of 13 Moderate Risk trees 31 inches DBH and larger were recommended for removal. These trees should be removed as soon as possible after all High Risk removals and pruning have been completed.

Low Priority Removal Recommendations

DRG identified 434 Low Risk trees recommended for removal. Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects 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. If pruning cannot correct a tree's defects and/or adequately mitigate risk, then the tree should be removed. All Low Risk trees should be removed when convenient after all higher risk pruning and removals have been completed and may be performed concurrently with routine pruning.

YOUNG TREE TRAINING CYCLE

Trees included in the Young Tree Training cycle are generally less than 6 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 its risk rating and creating potential liability.

[5] The assumed natural mortality rate for trees in Jersey City is 1% annually.

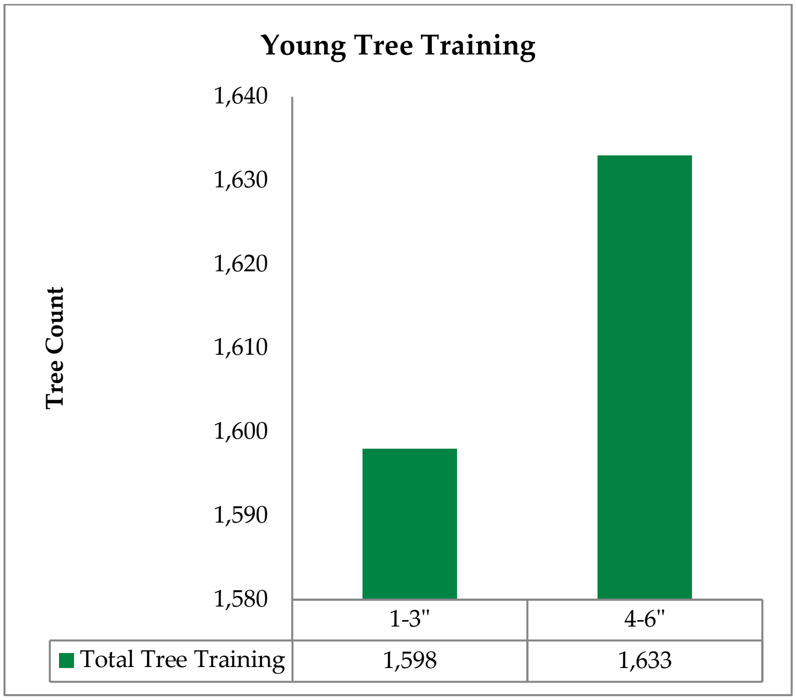


Figure 14. DRG's Three-year Young Tree Training cycle by size class.
*Includes DRG data, excludes sites <1 DBH, stumps, all student data, and sites collected by Edward O'Malley.

The recommended length of a Young Tree Training cycle is three years because young trees tend to grow at faster rates than mature trees.

The Young Tree Training cycle differs from the Routine Pruning cycle in that the Young Tree Training cycle generally only includes trees that can be pruned from the ground with a pole pruner or pruning shear.

Young Tree Training Cycle Recommendations

DRG recommends that Jersey City implement a three-year Young Tree Training cycle beginning after the completion of all High Risk Recommended Maintenance activities. During the inventory, 3,231 trees less than or equal to 6 inches DBH were inventoried and recommended for young tree training. Because Jersey City has so many young trees, the Young Tree Training cycle is vital for the future condition of the inventoried tree population. DRG recommends that an average of 1,077 trees be trained with structural pruning each year over three years beginning in Year One of the management program.

When new trees are planted, they should enter the Young Tree Training cycle after establishment, typically within 2–3 years after planting. In future years, the number of trees in the Young Tree Training cycle will be based on tree planting efforts and growth rates of young trees. The city should strive to training prune approximately one-third of its young trees each year.

ROUTINE PRUNING CYCLE

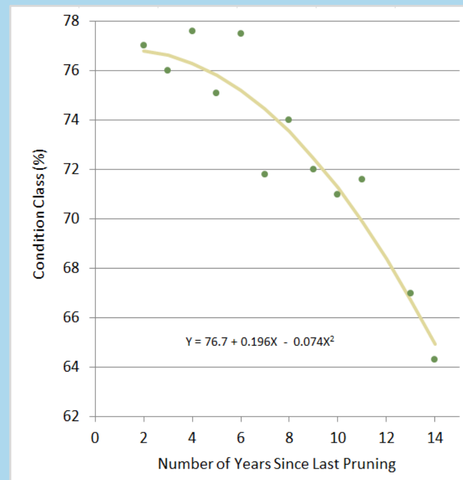
The Routine Pruning cycle includes all Moderate and Low Risk trees, larger than 6" DBH that received a "Prune", "Discretionary Prune", or "None" maintenance recommendation. These trees pose some risk but have a smaller defect size and/or a lower probability of impacting a target. Over time, routine pruning can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program.

Based on Miller and Sylvester's research, DRG recommends five-year Routine Pruning cycles to maintain the condition of the inventoried tree resource. However, not all municipalities are able to remain proactive with a five-year cycle based on budgetary constraints, the size of the public tree resource, or both. In these cases, extending the length of the Routine Pruning cycle is an option; however, it is in the municipality's best interest to not approach or exceed a 10-year pruning cycle. This is the point in which tree condition deteriorates significantly without regular pruning, because once-minor defects have worsened, reducing tree health and potentially increasing risk (Miller and Sylvester 1981).

Routine Pruning Cycle Recommendations

Jersey City's inventory found 4,758 trees that should be included in the routine pruning cycle. DRG recommends that the city establish a five-

PROACTIVE PRUNING



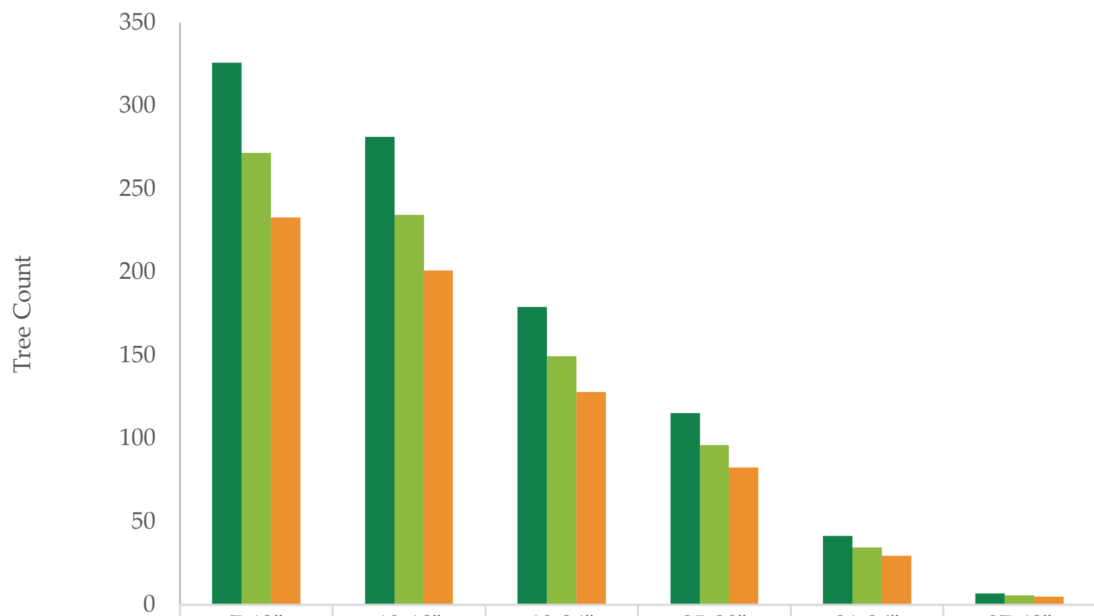
Miller and Sylvester studied the pruning frequency of 40,000 street trees in Milwaukee, Wisconsin. Trees that had not been pruned for more than 10 years had an average condition rating 10% lower than trees that had been pruned in the previous several years. Their research suggests that a five-year pruning cycle is optimal for urban trees.

Routine pruning cycles help detect and correct most defects before they reach higher risk levels. DRG recommends that pruning cycles begin after all Extreme and High Risk tree maintenance has been completed.

DRG recommends two pruning cycles: a Young Tree Training cycle and a Routine Pruning cycle. Newly planted trees will enter the Young Tree Training cycle once they become established and will move into the Routine Pruning cycle when they reach maturity. A tree should be removed and eliminated from the Routine Pruning cycle when it outlives its usefulness.

year Routine Pruning cycle with approximately 952 trees pruned each year. If this is not feasible for Jersey City, a six-year Routine Pruning cycle with approximately 793 trees pruned each year, or a seven-year Routine Pruning cycle with approximately 680 trees pruned each year, is acceptable considering the inventoried tree population's size. DRG recommends that the Routine Pruning cycle begins in Year One of the proposed five-year program, after all High Risk Recommended Maintenance is complete.

Approximately 38% of the inventoried tree population would benefit from routine pruning as of the time of the inventory. Figure 15 shows that a variety of size classes are recommended for pruning, most of which are smaller than 7-18 inches DBH.



	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"
5-year cycle	326	281	179	115	41	7
6-year cycle	272	234	149	96	35	6
7-year cycle	233	201	128	82	30	5

Figure 15. DRG Routine Prune cycle by size class. *Includes DRG data, excludes sites <1 DBH, stumps, all student data, and sites collected by Edward O'Malley.

FURTHER INSPECTION

Trees were marked for Further Inspection when it required additional and/or future inspections to assess and/or monitor conditions that may cause it to become a risk to people, property, or other trees. The inventory identified 500 requiring one of three inspection types. Further Inspections are beyond the scope of a standard tree inventory, and can be one of the following:

a. Multi-year Annual Inspection (e.g., a healthy tree that has been impacted by recent construction, weather, or other damage).

b. Level 3 Risk Assessment (e.g., a tree with a defect requiring additional or specialized equipment for investigation).

c. Insect/Disease Monitoring (e.g., a tree that appears to have an emerging insect or disease problem).

d. No further inspection required.

A Level 3 inspection was recommended for trees in which a defect was observed during the inventory and it warranted a closer inspection by a TRAQ arborist. These trees were inspected utilizing an aerial bucket to provide the inspector access to the canopy of the tree in which most of the defects are located. Trees with a Further Inspection requirement should be assessed by an ISA certified arborist as soon as possible, because the longer serious defects are left unaddressed, the greater a risk that a tree becomes. For the same reason, the management that the arborist recommends should be performed as soon as possible to minimize risk.

Further Inspection Recommendations

The inventory found 98 trees recommended for an advanced Level 3 risk assessment, 211 trees recommended for multi-year annual inspections, and 191 trees noted for insect and disease monitoring. Unless already designated for removal, the 938 trees noted as having "Missing or Decayed Wood" and the 228 trees noted as having "cavity" or "decay" should be inspected on a regular basis. Corrective action should be taken as soon as possible unless it will not adequately eliminate the defect, in which case tree removal is likely to be the safest and most cost-effective management.

TREE PLANTING AND STUMP REMOVAL

Planting new trees in areas where there is sparse canopy is the most important. It is also important to plant more trees in areas with poor canopy continuity or gaps in existing canopy. While the Jersey City as a whole receives value from the ecosystem services provided by the public tree resource, those benefits usually are not distributed evenly across the city.

"Right Tree in the Right Place" is a mantra for tree planting used by many professional arborists and utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. 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 and hardscape as it grows taller, wider, and deeper. If the tree at maturity will reach overhead lines, or conflict with sidewalks and curbs, it is best to choose another tree or a different location.

Tree Planting and Stump Removal Recommendations

Creating larger growing sites for trees in the municipal ROW can be the single most beneficial management practice to improve the survival rate of planted and developing trees. Increasing planting space can also reduce the amount of tree-related infrastructure conflicts, as the trees will be planted further from curbs and sidewalks. Depending on the site, there are several methods available to create and/or increase the growing space for newly planted trees:

- Install or enlarge tree wells/pits in existing sidewalks of sufficient width. Ideally, the minimum growing space of a small-sized tree is 32 square feet. Where Jersey City has sidewalks of a sufficient width and length, the city could install tree pits with enough space remaining for the sidewalk to still comply with American Disability Act (ADA) standards.
- Planting trees 4 feet behind a curb without a sidewalk, or 4 feet behind an existing sidewalk, can be a low-cost alternative to more construction intensive methods. This can result in less damage to the sidewalk and give tree roots room to grow into the open soil.
- Re-routing the sidewalk around an area to create designated large tree sites is a relatively cost-effective method to increase growing spaces. This method can also be applied to existing large tree sites, where tree roots have already come in conflict with the sidewalk.
- A landscape bump-out/curb extension is a vegetative area that protrudes into the parking lane of a street, to provide a growing space for plants or trees. These spaces can be used quite effectively by municipalities to beautify a streetscape, provide greater storm water retention, along with the added benefit of slowing car speeds at the bump-out location.

The inventory identified 248 stumps recommended for removal, with a wide range of sizes from 1" to 44" in diameter. Stump removals should occur when convenient and be included regular planting plans if the site would be feasible for planting after the stump is removed. For this reason, it is most convenient to remove all stumps in areas with scheduled tree planting work, so all feasible sites in an area are stocked at once.

A list of suggested tree species is provided in Appendix C. These tree species are specifically selected for the climate of Jersey City. This list is not exhaustive but can be used as a guideline for species that meet community objectives and to enhance any existing list of approved species.

MAINTENANCE SCHEDULE AND BUDGET

Utilizing the 2021 Jersey City tree inventory data, an annual maintenance schedule was developed detailing the recommended tasks to complete each year. DRG made budget projections using industry knowledge and public bid tabulations. A complete table of estimated costs for Jersey City's five-year tree management program follows.

This schedule provides a framework for completing the recommended inventoried tree maintenance over the next five years. Following this schedule can shift tree maintenance activities from being reactive to a more proactive tree care program.

To implement the maintenance schedule, Jersey City's tree maintenance budget should be:

- No less than $977,000 for the first year of implementation
- No less than $1,679,000 for the second and third years
- No less than $1,365,000 for the final two years of the maintenance schedule

Annual budget funds are needed to ensure that High Risk trees are expediently managed and that the vital Young Tree Training and Routine Pruning cycles can begin as soon as possible. If routing efficiencies and/or contract specifications allow more tree work to be completed in a given year, or if this maintenance schedule requires adjustment to meet budgetary or other needs, then it should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. If maintenance needs change, then budgets, staffing, and equipment should be adjusted to meet the new demand.

Maintenance Type	Activity	Ave. Cost/ Tree	Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
			# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
PRIORITY MAINTENANCE	High Risk Removals	$1,661	49	$69,260	0	$0	0	$0	0	$0	0	$0	$69,260
	High Risk Pruning	$247	44	$12,920	0	$0	0	$0	0	$0	0	$0	$12,920
	Total Cost		**$82,180**		$0		$0		$0		$0		**$82,180**
PROACTIVE MAINTENANCE	Moderate and Low Risk Removals	$1,661	60	$136,140	199	$184,575	121	$174,530	313	$55,120	0	$0	$550,365
	Removals due to Natural Mortality (1%)	$1,661	124	$100,157	122	$99,155	121	$98,163	120	$97,182	119	$96,210	$490,867
	Stump Removals	$239	248	$33,375	0	$0	0	$0	0	$0	0	$0	$33,375
	Young Tree Training (3-year cycle)	$90	1,077	$48,465	1,077	$48,465	1,077	$48,465	1,077	$48,465	1,077	$48,465	$242,325
	Routine Pruning (5-year cycle)	$306	952	$188,785	952	$188,785	952	$188,785	952	$188,785	952	$188,785	$943,925
	Further Inspection	$165	500	$58,645	0	$0	0	$0	0	$0	0	$0	$58,645
	Total Cost		**$565,567**		**$520,980**		**$509,943**		**$389,552**		**$333,460**		**$2,319,502**
PLANTING	Procurement, installation, 2-year maintenance guarantee	$1,200	274	$328,380	270	$324,496	269	$323,027	268	$321,573	267	$320,133	$1,617,610
	Total Cost		**$328,380**		**$324,496**		**$323,027**		**$321,573**		**$320,133**		**$1,617,610**
Maintenance Cost Grand Total			**$976,127**		**$845,476**		**$832,971**		**$711,125**		**$653,593**		**$4,019,291**

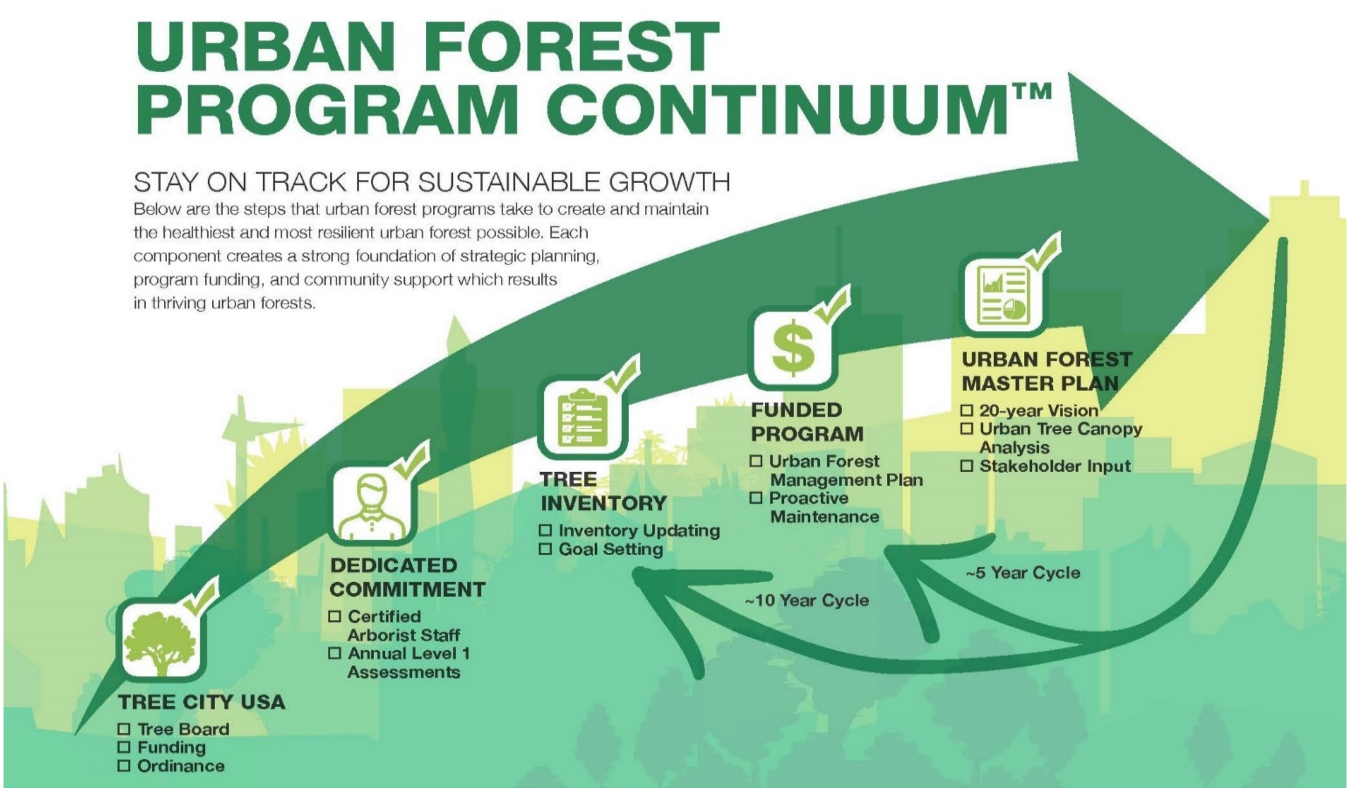
Table 6. Estimated budget for recommended five-year tree resource management program.

CONCLUSION

When properly maintained, the valuable benefits trees provide over their lifetime far exceed the time and money invested in planting, pruning, and inevitably removing them. The 12,444 public trees inventoried provide $122,336 in estimated annual economic value, which is almost 24% of the city's annual tree maintenance budget of $514,867. Successfully implementing the five-year program may increase Jersey City's ROI over time, or at least maintain it over the years.

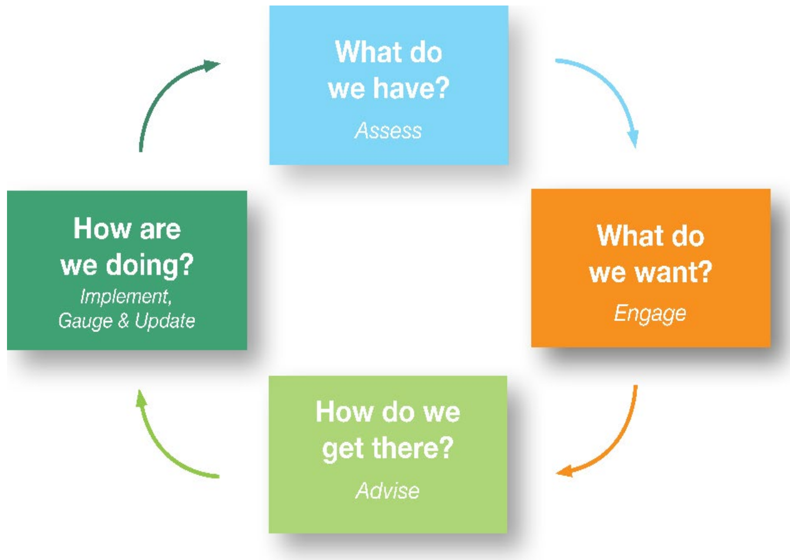
The program is ambitious and is a challenge to complete in five years but becomes easier after all high priority tree maintenance is completed. This *Standard Inventory Analysis and Management Plan* could potentially help the city advocate for an increased urban forestry budget to fund the recommended maintenance activities. Getting started is the most difficult part because of the expensive maintenance in the first year, which represents the transition from reactive maintenance to proactive maintenance. Significant investment early on can reduce tree maintenance costs over time.

As the urban forest grows, the benefits enjoyed by Jersey City and its residents will increase as well. Inventoried trees are only a fraction of the total trees in Jersey City when including private property, which is why it is important to also incentivize private landowners to care for their trees and to plant new ones. The city's urban forestry program is well on its way to creating a sustainable and resilient public tree resource, and can stay on track by setting goals, updating inventory data to check progress, and setting more ambitious goals once they are reached.



EVALUATING AND UPDATING THIS PLAN

This *Standard Inventory Analysis and Management Plan* provides management priorities for the next five years, and it is important to update the tree inventory using TreeKeeper® as work is completed, so the software can provide updated species distribution and benefit estimates. This empowers Jersey City to self-assess the city's progress over time and set goals to strive toward by following the adaptive management cycle. Below are some ways of implementing the steps of this cycle:



- Prepare planting plans well enough in advance to schedule and complete stump removal in the designated area, and to select species best suited to the available sites.
- Annually comparing the number of trees planted to the number of trees removed and the number of vacant planting sites remaining, then adjusting future planting plans accordingly.
- Annually comparing the species distribution of the inventoried tree resource with the previous year after completing planting plans to monitor recommended changes in abundance.
- Schedule and assign high-priority tree work so it can be completed as soon as possible instead of reactively addressing new lower priority work requests as they are received.
- Include data collection such as measuring DBH and assessing condition into standard procedure for tree work and routine inspections, so changes over time can be monitored.

Davey Resource Group recommends the following next steps to complete the inventory and management plan process:

- Inventory the remaining area of the city in order to complete Jersey City's street tree population data set.
- Audit and update the data collected by the NJCU students, to complete the data set and align it with the data collected by DRG arborists.
- Update this Standard Inventory Analysis and Management Plan once all data has been collected to reflect the complete data set of Jersey City's street tree population.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

DATA COLLECTION METHODS

DRG collects tree inventory data using their proprietary GIS software, called Rover, loaded onto pen-based field computers. At each site, the following data fields were collected:

- Address
- Comments
- Condition
- Date of Inventory
- Maintenance Recommendation
- Multi-stem Tree
- Notes
- Relative Location
- Size*
- Species and Identification Confidence Level
- Utility Interference
- X and Y Coordinates

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

The knowledge, experience, and professional judgment of DRG's arborists ensure the high quality of inventory data.

SITE LOCATION METHODS

Equipment and Base Maps

Inventory arborists use FZ-G1 Panasonic Toughpad® units with internal GPS receivers. Geographic information system (GIS) map layers are loaded onto these units to help locate sites during the inventory. This table lists these base map layers, along with each layer's source and format information.

Data Source	Data Year	Projection
Shapefile Big Rapids, MI Information Technology Department	2019-2020	NAD 1983 State Plane Michigan South, FT
Aerial Imagery Big Rapids, MI Information Technology Department	2014	NAD 1983 State Plane Michigan South, FT

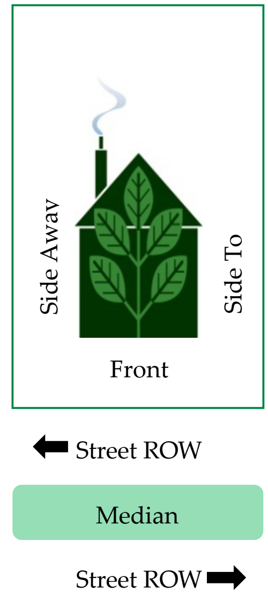
STREET ROW SITE LOCATION

Individual street ROW sites were located using a methodology that identifies sites by *address number*, *street name*, *side*, and *on street*. This methodology was used to help ensure consistent assignment of location.

Address Number and Street Name

Where there was no GIS parcel addressing data available for sites located adjacent to a vacant lot, or adjacent to an occupied lot without a posted address number, the arborist used their best judgment to assign an address number based on nearby addresses. An "X" was then added to the number in the database to indicate that it was assigned, for example, "37X Choice Avenue."

Sites in medians were assigned an address number by the arborist in Rover using parcel and streets geographical data. Each segment was numbered with an assigned address that was interpolated from addresses facing that median and addressed on that same street as the median. If there were multiple medians between cross streets, each segment was assigned its own address. The *street name* assigned to a site was determined by street centerline information.



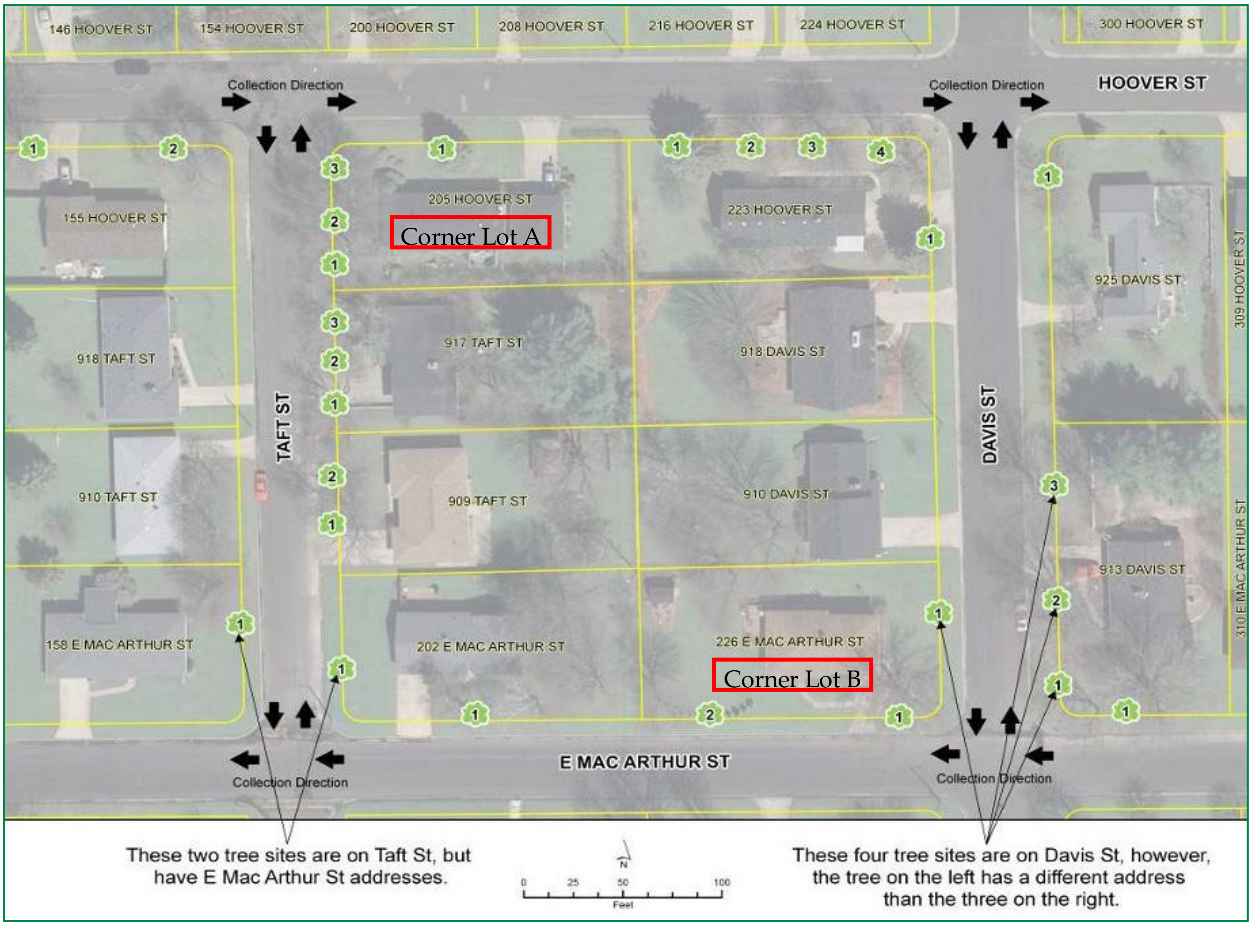
Side Value

Each site was assigned a *side value*, including *front*, *side*, *median*, or *rear* based on the site's location in relation to the lot's street frontage. The *front* is the side facing the address street. *Side* is either side of the lot that is between the front and rear. *Median* indicates a median or island surrounded by pavement. The *rear* is the side of the lot opposite of the address street.

PARK AND PUBLIC SPACE SITE LOCATION

Park and/or public space site locations were collected using the same methodology as street ROW sites, however nearly all of them have the "Assigned Address" field set to 'X' and have the "Park Name" data field filled.

Site Location Example



<u>Corner Lot A</u>

Address/Street Name: 205 Hoover St.
Side: Side
On Street: Taft St.

Address/Street Name: 205 Hoover St.
Side: Side
On Street: Taft St.

Address/Street Name: 205 Hoover St.
Side: Side
On Street: Taft St.

Address/Street Name: 205 Hoover St.
Side: Front
On Street: Hoover St.

<u>Corner Lot B</u>

Address/Street Name: 226 E Mac Arthur St.
Side: Side
On Street: Davis St.

Address/Street Name: 226 E Mac Arthur St.
Side: Front
On Street: E Mac Arthur St.

Address/Street Name: 226 E Mac Arthur St.
Side: Front
On Street: E Mac Arthur St.

APPENDIX B
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 USDA's Animal and Plant Inspection Service (APHIS).

Updated pest range maps can be found at: https://www.nrs.fs.fed.us/tools/afpe/maps/ and updated pest information can be found at: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/Pest-Tracker

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, invasive 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

SPOTTED LANTERNFLY

The spotted lanternfly (SLF, *Lycorma delicatula*) is native to China and was first detected in Pennsylvania in September 2014. SLF feeds on a wide range of fruit, ornamental, and woody trees, with tree-of-heaven being one of its preferred hosts. SLF is a hitchhiker and can be spread long distances by people who move infested material or items containing egg masses.

Pinned spotted lanternfly.

Photograph courtesy of PA Dept of Agriculture

If allowed to spread in the United States, this pest could seriously impact the country's grape, orchard, and logging industries. Be sure to inspect for the pest. Egg masses, juveniles, and adults can be on trees and plants, as well as on bricks, stone, metal, and other smooth surfaces. Also thoroughly check vehicles, trailers, and even the clothes you are wearing to prevent accidently moving SLF.

Pinned spotted lanternfly nymph with wingspan open.

Photograph courtesy of USDA APHIS

Symptoms of SLF are plants oozing or weeping with a fermented odor, buildup of a sticky fluid called honeydew on the plant or on the ground underneath them, and sooty mold growing on plants. The following trees are susceptible to SLF: almonds, apples, apricots, cherries, maples, nectarines, oaks, peaches, pines, plums, poplars, sycamores, walnuts, and willows, as well as grape vines and hop plants.

ASIAN LONGHORNED BEETLE

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.

Adult Asian longhorned beetle.

Photograph courtesy of New Bedford Guide (2011)

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).

EUROPEAN 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 USDA APHIS (2019)

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).

EMERALD ASH BORER

Close-up of an emerald ash borer.

Photograph courtesy of USDA APHIS (2020)

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.

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.

The EAB-preferred host tree species are in the genus *Fraxinus* (ash).

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APPENDIX C
i-TREE STREETS METHOLOGY

i-Tree Streets regionalizes the calculations of its output by incorporating detailed reference city project information for 16 climate zones across the United States. Big Rapids falls within the Midwest Climate Zone. Sample inventory data from Minneapolis represent the basis for the Midwest Reference City Project for the Midwest Community Tree Guidelines. The basis for the benefit modeling in this study compares the inventory data from Big Rapids to the results of Midwest Reference City Project to obtain an estimation of the annual benefits provided by Big Rapids' tree resource.

Growth rate modeling information was used to perform computer-simulated growth of the existing tree population for one year and account for the associated annual benefits. This "snapshot" analysis assumed that no trees were added to or removed from the existing population. Calculations of carbon dioxide (CO_2) released due to decompositions of wood from removed trees did consider average annual mortality. This approach directly connects benefits with tree-size variables such as diameter at breast height (DBH) and leaf-surface area. Many benefits of trees are related to processes that involve interactions between leaves and the atmosphere (e.g., interception, transpiration, photosynthesis); therefore, benefits increase as tree canopy cover and leaf surface area increase.

For each of the modeled benefits, an annual resource unit was determined on a per-tree basis. Resource units are measured as megawatt-hours of electricity saved per tree; therms of natural gas conserved per tree, pounds of atmospheric CO_2 reduced per tree; pounds of nitrogen dioxide (NO_2), particulate matter (PM_{10}), and volatile organic compounds (VOCs) reduced per tree; cubic feet of stormwater runoff reduced per tree; and square feet of leaf area added per tree to increase property values.

Prices were assigned to each resource unit using economic indicators of society's willingness to pay for the environmental benefits trees provide. Estimates of benefits are initial approximations as some benefits are difficult to quantify (e.g., impacts on psychological health, crime, and violence). In addition, limited knowledge about the physical processes at work and their interactions make estimates imprecise (e.g., fate of air pollutants trapped by trees and then washed to the ground by rainfall). Therefore, this method of quantification provides first-order approximations. It is meant to be a general accounting of the benefits produced by urban trees—an accounting with an accepted degree of uncertainty that can, nonetheless, provide science-based platform for decision-making.

A detailed description of how the default benefit prices are derived, refer to the *City of Minneapolis, Minnesota Municipal Tree Resource Analysis* (McPherson *et al.* 2005) and the *Midwest Community Tree Guide: Benefits, Costs, and Strategic Planning* (McPherson *et al.* 2009). i-Tree Streets' default values from the Midwest Climate Zone were used for air quality and stormwater benefit prices and local values were used for energy usage, aesthetics, and other benefits.

Benefit Prices Used by i-Tree Streets in the Analysis of Big Rapids' Tree Inventory

Benefits	Price	Unit	Source
Electricity	$0.00759	$/Kwh	Xcelenergy 2004
Natural Gas	$0.0098	$/Therm	Centerpoint Energy
CO_2	$0.0075	$/lb	US EPA 2003
PM_{10}	$2.84	$/lb	US EPA 2003
NO_2	$3.34	$/lb	US EPA 2003
O_3	$3.34	$/lb	US EPA 2003
SO_2	$2.06	$/lb	US EPA 2003
VOCs	$3.75	$/lb	Ottinger and others
Stormwater Interception	$0.0046	$/gallon	McPherson & Xiao
Aesthetic Value	$218,000	Average Midwest Housing Price	TreeKeeper®

Using these prices, the magnitude of the benefits provided by the public tree resource was calculated based on the science of i-Tree Streets using DRG's TreeKeeper® inventory management software. For a detailed description of how the magnitudes of benefit prices are calculated, refer to the *Midwest Community Tree Guide: Benefits, Costs, and Strategic Planning* (McPherson *et al*. 2009).

APPENDIX D
SUGGESTED TREE SPECIES
FOR USDA HARDINESS ZONE 7

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 7 on the USDA Plant Hardiness Zone Map.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer x freemanii	Freeman maple	
Acer rubrum	red maple	(Numerous exist)
*Aesculus flava**	yellow buckeye	
*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	
Catalpa speciosa	northern catalpa	
Celtis laevigata	sugar hackberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	katsuratree	'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	
*Juglans cinerea**	butternut	
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	
Quercus coccinea	scarlet oak	
Quercus lobata	valley oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus robur	English oak	Heritage® , Fastigiata
Quercus rubra	northern red oak	
Quercus shumardii	Shumard oak	
Quercus virginiana	live 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 X	Hybrid Elm	'Pioneer', 'Princeton'
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 pistachio	

Populus tremuloides	quaking aspen	
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Salix babylonica**	weeping willow	
*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 palmatum	Japanese maple	(Numerous exist)
*Aesculus pavia**	red buckeye	
Amelanchier arborea	downy serviceberry	(Numerous exist)
Amelanchier laevis	Allegheny serviceberry	
Asimina triloba	pawpaw	
*Carpinus caroliniana**	American hornbeam	
Cercis canadensis	eastern redbud	'Forest Pansy'
Cornus alternifolia	pagoda dogwood	
Cornus florida	flowering dogwood	(Numerous exist)
Cornus kousa	Kousa dogwood	(Numerous exist)
*Cornus mas**	corneliancherry dogwood	'Spring Sun'
*Corylus avellane**	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	
Lagerstroemia spp.	crapemyrtle	(Numerous exist)
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'

*Salix caprea**	pussywillow	
*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 deodara	deodar cedar	
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
× *Cupressocyparis leylandii*	Leyland cypress	
Cupressus arizonica	Arizona cypress	
Ilex opaca	American holly	
Picea abies	Norway spruce	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Picea punges	Colorado blue spruce	
Pinus contorta	lodgepole pine	
Pinus densiflora	Japanese red pine	
Pinus nigra	Austrian pine	
*Pinus ponderosa**	ponderosa pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Pseudotsuga menziesii	Douglas-fir	
*Sequoiadendron giganteum**	giant sequoia	
Thuja occidentalis	American arborvitae	(Numerous exist)
Thuja plicata	western arborvitae	(Numerous exist)
Tsuga canadensis	eastern hemlock	

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

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) as well as the Arbor Day Foundation website (arborday.org) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on Davey Resource Group, Inc.'s experience. Tree availability will vary based on availability in the nursery trade.