March 2021

TREE INVENTORY & SUMMARY REPORT

City of Farmington, Michigan

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INTRODUCTION

An effective approach to tree resource management follows a proactive and systematic urban forestry 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 March 2021, the City of Farmington worked with DRG to inventory its public tree resource and develop this *Tree Inventory and Summary Report*. In two parts this report considers the diversity, distribution, and condition of the inventoried tree population and provides recommendations for managing this public tree resource.

- *Part 1: Structure and Composition of the Public Tree Resource* shows trends representing the current state of the inventoried population.
- *Part 2: Recommended Management of the Public Tree Resource* uses risk assessment findings to prioritize tree maintenance activities.

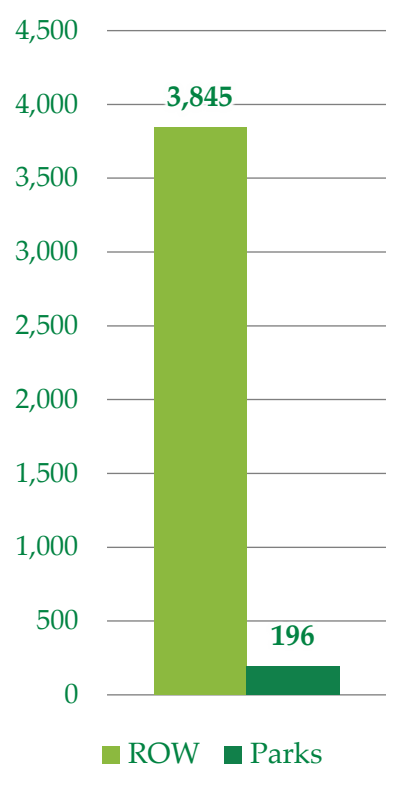


Figure 1. Tree data collected in street ROW and public parks.

In March 2021, DRG arborists collected site data on all trees in the street right-of-way (ROW) and certain public parks for a tree inventory contracted by the City of Farmington. The City of Farmington had 3 public parks with trees: Warner Home, Women's Park, Veterans Memorial Park, and Oakwood Cemetery. Figure 1 breaks down all trees inventoried into ROW sites and parks sites. Of the total 4,041 trees inventoried, 95% were collected in the ROW and the remaining 5% were collected in parks. See Appendix A for details about DRG's methodology for collecting site data.

PART 1: STRUCTURE AND COMPOSITION OF THE PUBLIC TREE RESOURCE

Species, Genus, and Family Distribution

Increasing species and genus diversity is a crucial priority that improves the public tree population's resilience to pests and disease. The 10-20-30 rule is a common standard for the species, genus, and family distribution of a tree population, in which a single species should not represent more than 10% of the population, a single genus no more than 20%, and a single family no more than 30% (Santamour 1990). Even when the 10-20-30 standard is met, it is important for planting plans to prioritize diversity. Rather than continuing to plant abundant trees until they reach the 10-20-30 threshold, it is more beneficial to plant species that represent a smaller proportion of the population.

Figure 2 shows the distribution of the most abundant species in Farmington's tree population compared to Santamour's 10% threshold. Norway maple (*Acer platanoides*, 22%) is the most abundant species followed closely by silver maple (*Acer saccharinum*, 17%), both significantly exceeding the recommended threshold. Honey locust (*Gleditsia triacanthos inermis*, 9%), Red maple (*Acer rubrum*, 8%), and sugar maple (*Acer saccharum*, 5%) are below it.

Figure 2. Species distribution of Farmington's public tree resource.

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 is vital that we learn from history and plant a wider variety of tree genera to develop a resilient public tree resource.

Urban ash tree with emergence hole from emerald ash borer.

Figure 3 shows the distribution of the most abundant genera in Farmington's tree population compared to Santamour's 20% threshold. The only genus with a proportion greater than 20% is maple (*Acer*, 53%), but it is drastically above the recommended threshold. This is a management concern because it risks greater losses in the event of a spotted lanternfly (SLF, *Lycorma delicatula*) or Asian longhorned beetle (ALB, *Anoplophora glabripennis*) invasion while also providing habitat and making it easier to spread. While other genera besides maple are susceptible to both pests, they represent a much smaller proportion of the public tree resource. Maples are a preferred host of ALB, so having a large maple population makes the public tree resource more susceptible to infestation and widespread losses.

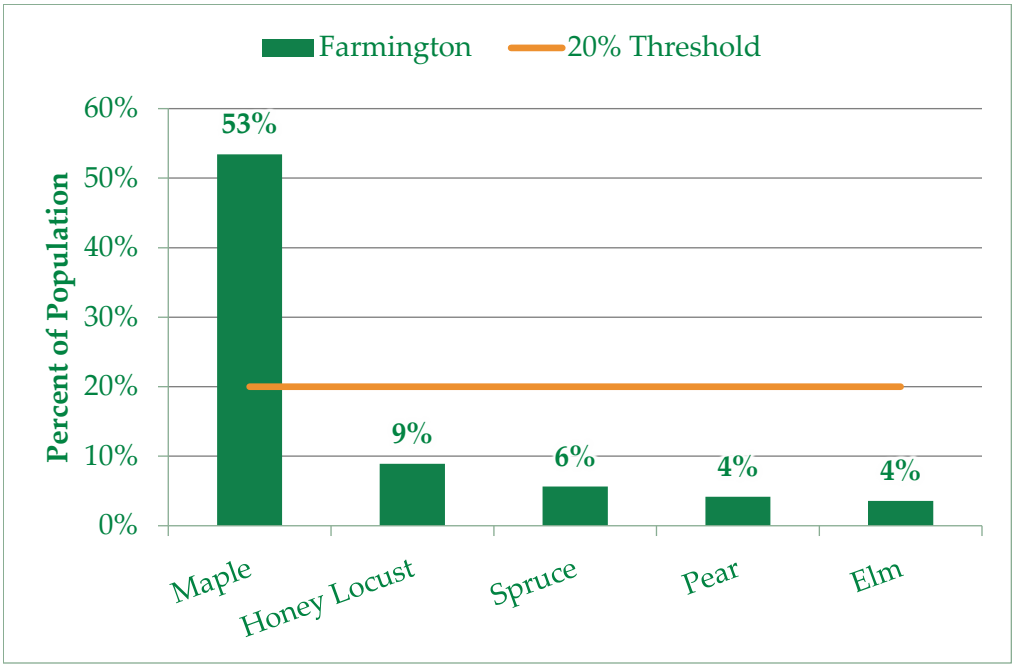


Figure 3. Genus distribution of Farmington's public tree resource.

Figure 4 shows the distribution of the most abundant families inventoried in Farmington's tree population compared to Santamour's 30% threshold. The overabundance of maple significantly influences the family distribution, causing the soapberry family (*Sapindaceae*, 54%) to represent more than half of the population. The legume/pea family (*Fabaceae*, 10%) is abundant, but not enough to be concerning. Table 1 lists all inventoried genera represented by the families shown on the chart.

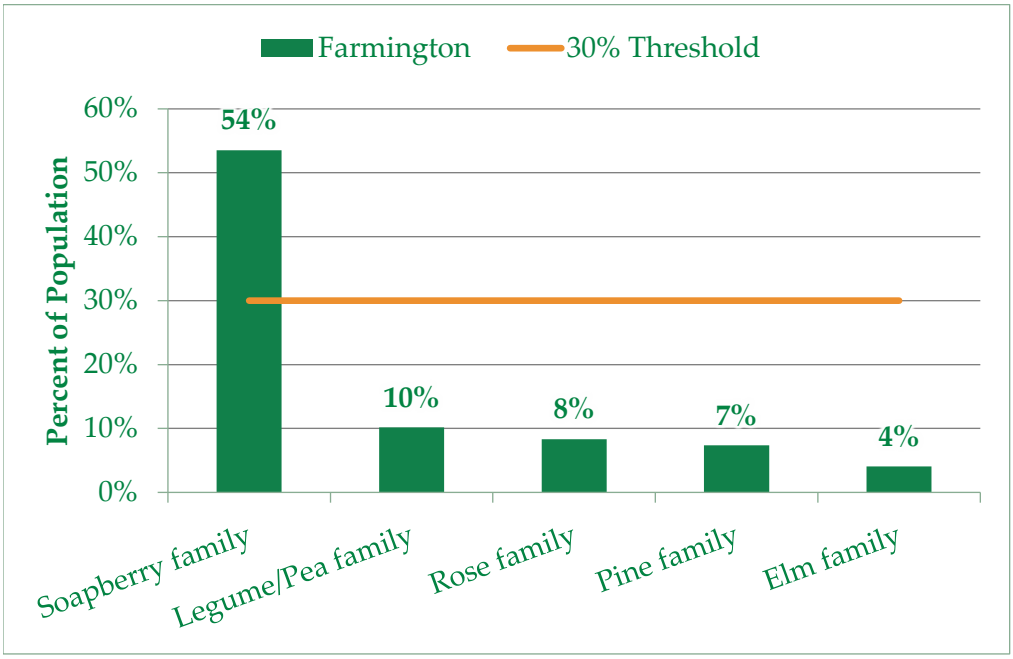


Figure 4. Family distribution of Farmington's public tree resource.

Family	Genus	Common Name
Soapberry Family (*Sapindaceae*)	*Acer*	maple
	Aesculus	horsechestnut/buckeye
Rose Family (*Rosaceae*)	*Amelanchier*	serviceberry
	Crataegus	hawthorn
	Malus	apple
	Prunus	cherry
	Pyrus	pear
Legume/pea Family (*Fabaceae*)	*Gleditsia*	honey locust
	Robinia	black locust
	Cercis	redbuds
	Cladrastis	yellowood
Pine Family (*Pinaceae*)	*Abies*	fir
	Larix	larch
	Picea	spruce
	Pinus	pine
	Tsuga	hemlock
	Pseudotsuga	Douglas fir
Elm Family (Ulm*aceae*)	*Ulmus*	elms
	Zelkova	zelkova serrata

Table 1. Reference list of tree genera in the most abundant families collected.

PEST SUSCEPTIBILITY

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

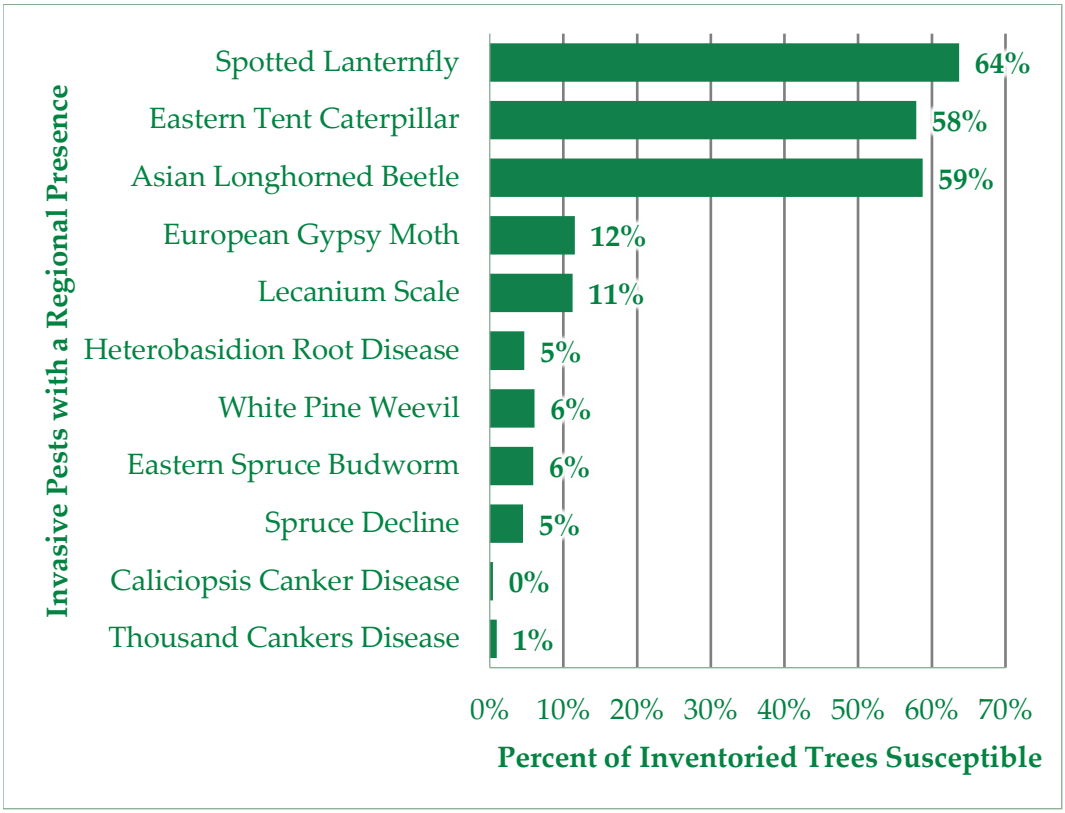


Figure 5. Tree susceptibility to pests and diseases with a regional presence.

Figure 5 shows the proportion of inventoried trees susceptible to some of the known pests in and around Michigan. It is important to remember that this figure only represents data collected during the inventory; there are many trees in Farmington's private properties and natural areas that can spread pests and disease. The inventoried tree population is most susceptible to SLF, eastern tent caterpillar (ETC, *Malacosoma americanum*), and ALB because maples are hosts to all three and are more than half of the population. ETC is a native species with fluctuating population levels only cause outbreaks once every several years; however, SLF and ALB are aggressive invasive pests that could cause massive losses to Farmington's public tree resource if either becomes established in Michigan.

While SLF also has several hosts, it does not cause tree mortality as directly as ALB because it feeds on tree sap rather than boring into wood. Sap has more sugar than can be readily digested by SLF, so its excrement is referred to as "honeydew" because it still has sugar content, attracting other insects to the infested tree as well as providing growth substrate to sooty molds. Sap-sucking and pest attraction cause stress that makes it difficult for a tree to withstand other environmental stress over time, which can lead to worsening condition or death. Currently, SLF has been found in Virginia, Pennsylvania, New York, New Jersey, Maryland, and Delaware (USDA APHIS 2020).

ALB has been found in Ohio, South Carolina, New York, and Massachusetts (USDA APHIS 2020). While ALB has not yet been detected in Michigan there are active populations in southern Ohio, and like emerald ash borer (EAB, *Agrilus planipennis*) it can be transported in firewood (Michigan.gov 2020). While ash (*Fraxinus*) trees are the only host of EAB, several tree genera are preferred hosts of ALB, such as horsechestnut/buckeye (*Aesculus*), birch (*Betula*), willow (*Salix*), and elm (*Ulmus*) (USDA APHIS 2020). Hopefully neighboring states will continue to quarantine ALB and other invasive pests, but planting species representing smaller proportions of the public tree resource is a proactive approach to avoid losses on the scale of EAB.

CONDITION DISTRIBUTION

Several factors affecting condition were considered for each tree, including branch structure, trunk, canopy, foliage condition, root condition, and the presence of pests. The condition of each inventoried tree was rated by an ISA certified arborist as Good, Fair, Poor, or Dead. The general health of the tree population is characterized by the most prevalent condition rating assigned during the inventory. Figure 6 shows that Farmington's public tree resource is generally in Fair condition (68%). 13% of trees are in Good condition, 19% are in Poor condition, and less than 1% are Dead.

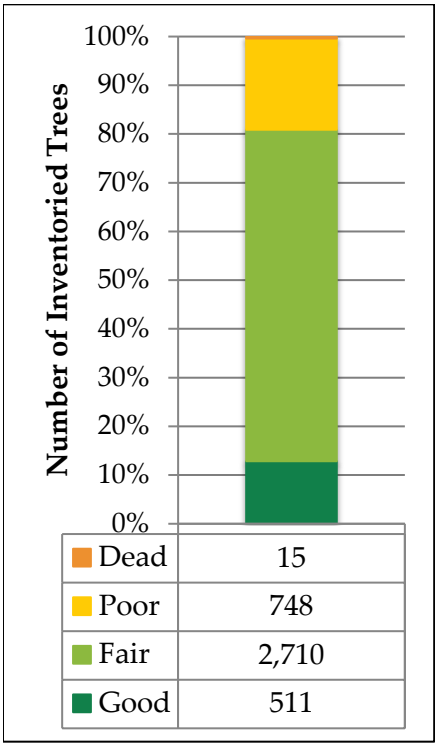


Figure 6. Condition distribution of Farmington's public tree resource.

Condition Recommendations

Poor branch attachment that could be easily pruned from the ground before the tree grows larger.

Poor branch attachment that would have been easier to correct when the tree was smaller.

Tree condition should be improved by training younger trees by pruning structural defects before they grow too tall to reach from the ground. This prevents poorly attached branches from growing large enough to cause damage in event of failure during storm or otherwise. All pruning should follow *ANSI A300 (Part 1)* guidelines (American National Standards Institute, 2017).

SIZE DISTRIBUTION

Richards' ideal size distribution for a tree population is that the largest proportion (approximately 40%) should be young trees while the smallest proportion (approximately 10%) should be mature trees (Richards 1983). Farmington's public tree resource is comprised by 35% young trees (1-10" in diameter), 55% established trees (11-30" in diameter), and 10% mature trees (31"+ in diameter). It is more important to spend resources maintaining the condition of existing trees than it is to plant any new trees.

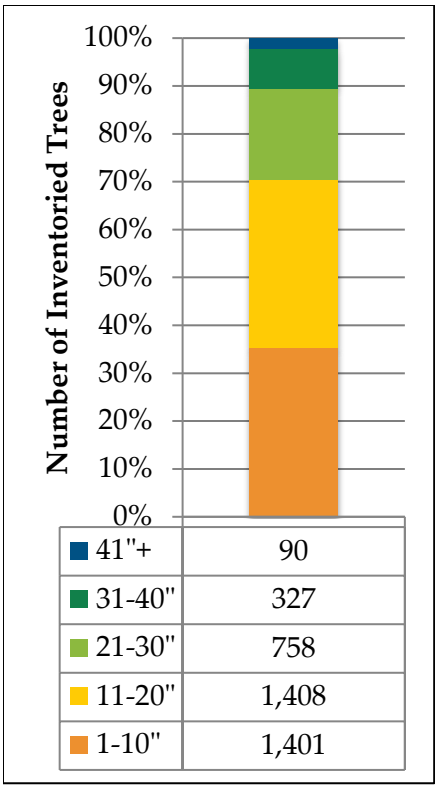


Figure 7. Size distribution of Farmington's public tree resource.

CONDITION BY SIZE CLASS

Figure 8 cross-analyzes the condition of Farmington's tree population with its size distribution. There are significantly more Poor & Dead trees smaller than 20 inches DBH (11%) than there are Poor & Dead trees larger than 20 inches DBH (7%). The proportion of young trees (1-10" DBH) in Good condition (10%) is five times the proportion of established trees (11-20" DBH) rated Good condition (2%). This indicates that a significant number of trees have declining condition by the time they become established, which emphasizes the importance of training young trees. Less than 1% of Farmington's public tree resource consists of mature and maturing trees in Good condition, emphasizing the importance of routine tree care so their health is maintained as they age.

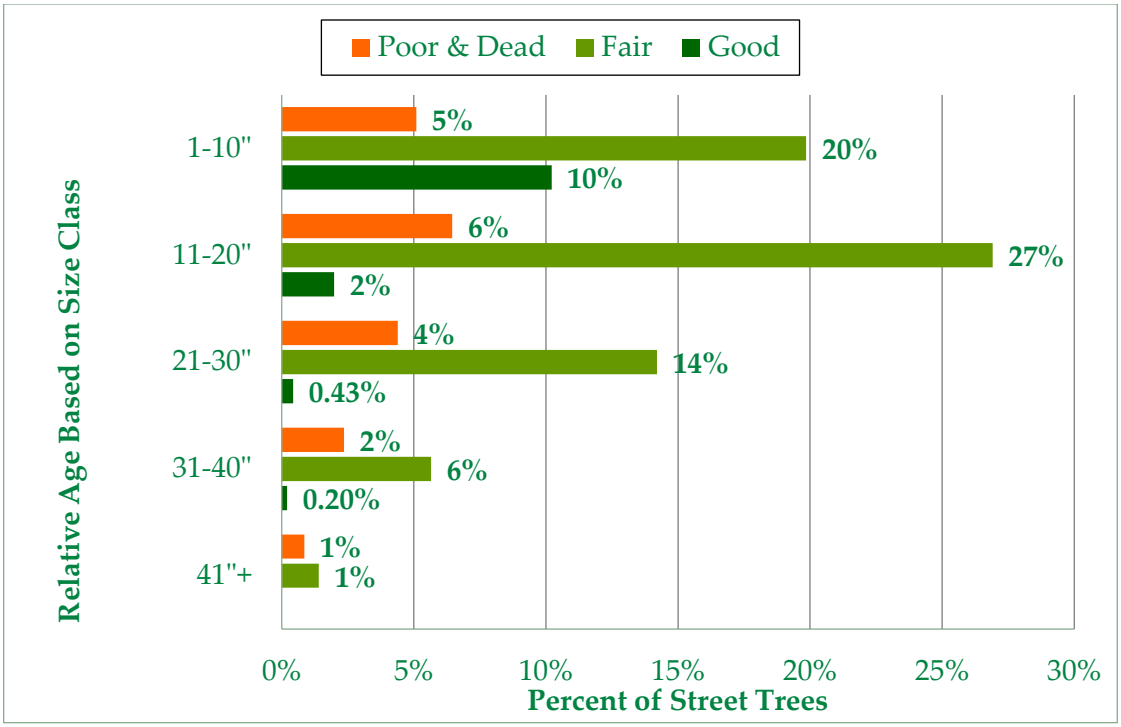


Figure 8. Condition by size class of Farmington's public tree resource.

OVERHEAD UTILITIES

The presence of overhead electrical distribution lines above a site was noted. It is important to consider these data when planning pruning or removal activities and when selecting tree species for planting. Table 2 shows 310 trees (8%) that have overhead utilities conflicting with their crown and 267 trees (7%) that have overhead utilities present but not conflicting with their crown. Of those trees, only 107 (19%) are small or medium growing species while 454 (81%) are large growing species. Remaining 16 sites are stumps that are underneath utilities.

Overhead Utilities	Number of Public Trees	Percent of Public Trees
Present and Conflicting	310	8%
Present and Not Conflicting	267	7%
Not Present	3,464	86%
TOTAL	**4,041**	**100%**

Table 2. Overhead utility conflicts between trees and electrical distribution lines.

Overhead Utilities Recommendations

To minimize future conflicts with overhead utility lines, DRG recommends planting only small-growing species within 20 feet of overhead utilities, medium-growing species within 20–40 feet, and large-growing trees outside 40 feet. This prevents the health impacts of unnecessary pruning and reduces the costs of maintaining trees near overhead utilities.

PART 2: 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 advises prioritizing the recommended maintenance activities for all trees with a High or Moderate risk rating.

Tree removal is often unpopular among residents and should be considered a last resort, but there are conditions when it is the most cost-effective management option for mitigating risk. There are also conditions that are preventable by young tree training and routine pruning, which correct defects before they worsen and increase the risk of tree failure. DRG recommends removals when corrective pruning or plant health care will not adequately mitigate risk or would be cost-prohibitive.

PRIMARY MAINTENANCE: REMOVE

Removal Recommendations

DRG advises removing all High Risk trees as soon as possible because tree defects can worsen over time and increase their risk. Shown in Figure 9, the inventory identified a total of 37 High Risk trees recommended for removal. DRG recommends removing the 31 High Risk trees above 20 inches DBH before addressing smaller High risk trees and any Moderate Risk trees and eventually Low Risk trees above 20 inches DBH. Using TreeKeeper® to locate target trees, plan scheduled work, and keep records of completed work will improve the ease and efficiency of tree management.

This Moderate Risk removal could have been prevented if these poorly-attached branches with included bark were corrected during routine training when the tree was young. This crack has formed along the seam of included bark as the tree matured, causing the trunk to become hollow over time and start splitting.

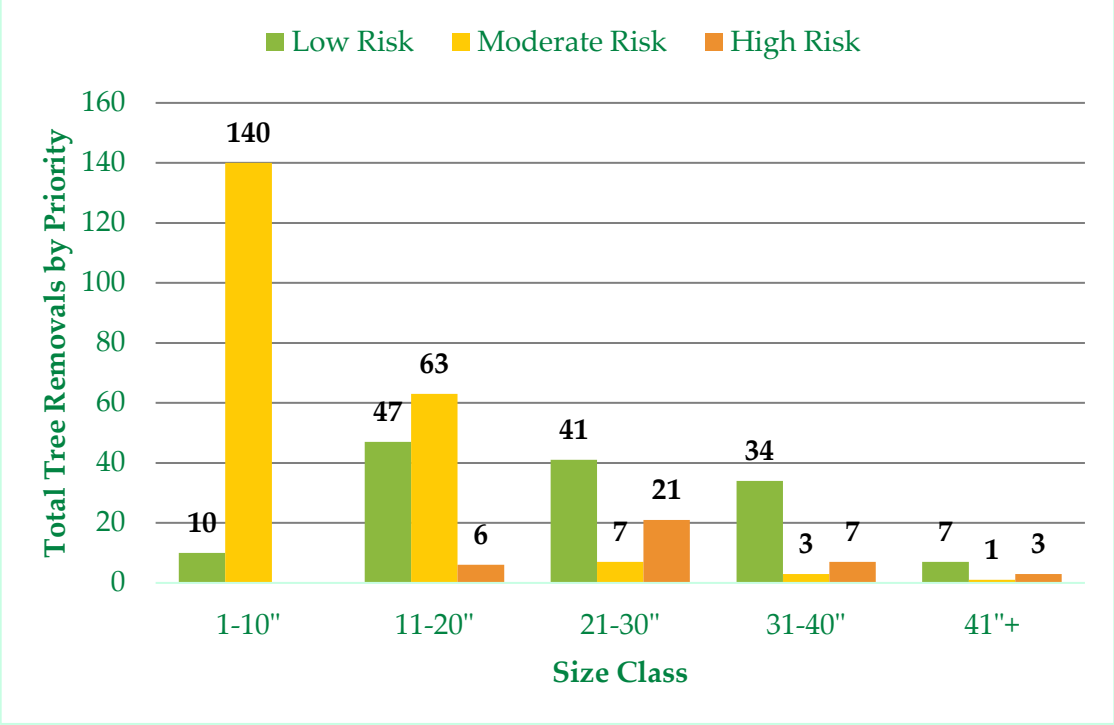


Figure 9. Recommended removals prioritized by risk rating and size class.

PRIMARY MAINTENANCE: PRUNE

Pruning Recommendations

DRG advises pruning all High Risk trees as soon as possible because tree defects can worsen over time and increase their risk. The best approach would be pruning the 14 High Risk trees immediately, then pruning the 78 Moderate Risk trees greater than 30 inches DBH after. This high priority pruning should happen concurrently with high priority removals. Continue addressing the largest trees with the highest risk rating until all remaining trees have a Low Risk rating. Low Risk trees with the 'Prune' recommendation for Primary Maintenance are a higher priority than trees with the 'Discretionary' recommendation because all trees with 'Prune' have deadwood greater than 2 inches in diameter. For this reason, Low Risk trees with a 'Prune' recommendation will still have a Significant consequence in the event of failure and impact.

DRG also advises pruning higher in the canopy of your street trees. It was observed during the inventory that more recent pruning appeared to be done in the lower canopy leaving the large dead limbs in the upper canopy. These large dead limbs in the upper canopy pose a higher risk and consequence if they were to fail making them a higher priority for pruning than the lower canopy limbs.

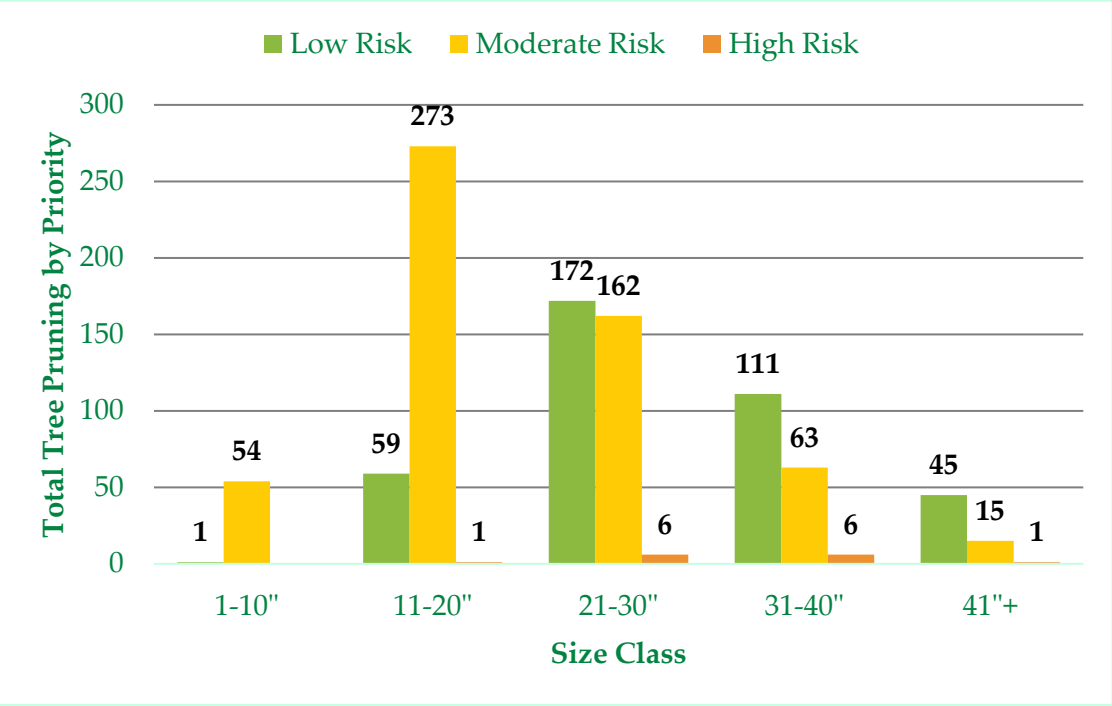


Figure 10. Recommended pruning prioritized by risk rating and sized class.

FURTHER INSPECTION

In the ANSI A300 system, there are 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-by or drive-by 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.

The inventory that was done in March would be considered Level 2 Inspections on all of the inventoried sites. Further Inspection data field indicates whether a tree requires additional future inspections to assess and/or monitor conditions that may cause it to become a risk to people, property, or other trees. Further Inspections are beyond the scope of a standard tree inventory, and can be one of the following:

a. Annul Inspection (Trees showing increased decline that should be monitored on a yearly basis)

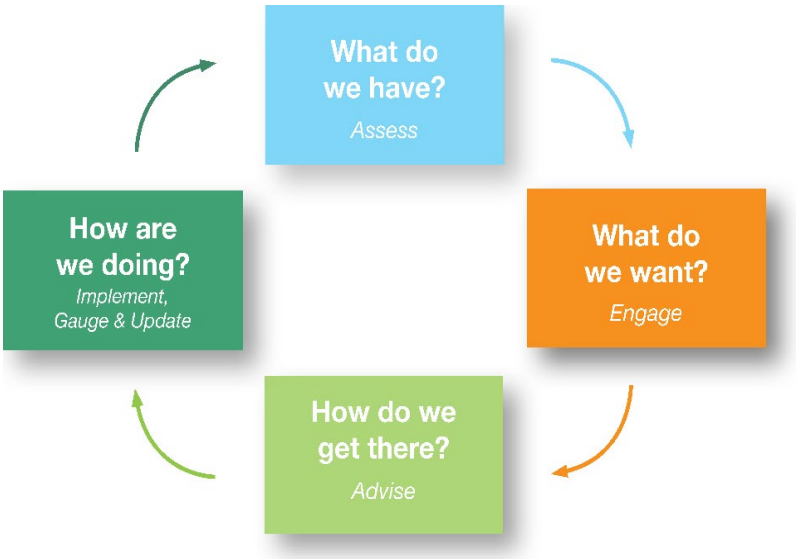
b. Recent Damage (e.g., a healthy tree that has been impacted by recent construction, weather, or other damage).
c. Advanced (Level 3) Risk Assessment (e.g., a tree with a defect requiring additional or specialized equipment for investigation).
d. Insect/Disease Monitoring (e.g., a tree that appears to have an emerging insect or disease problem).
e. No further inspection required.

A Level 3 inspection was recommended for trees in which a defect was observed during the inventory and it warranted advanced assessment by a TRAQ qualified arborist. 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.

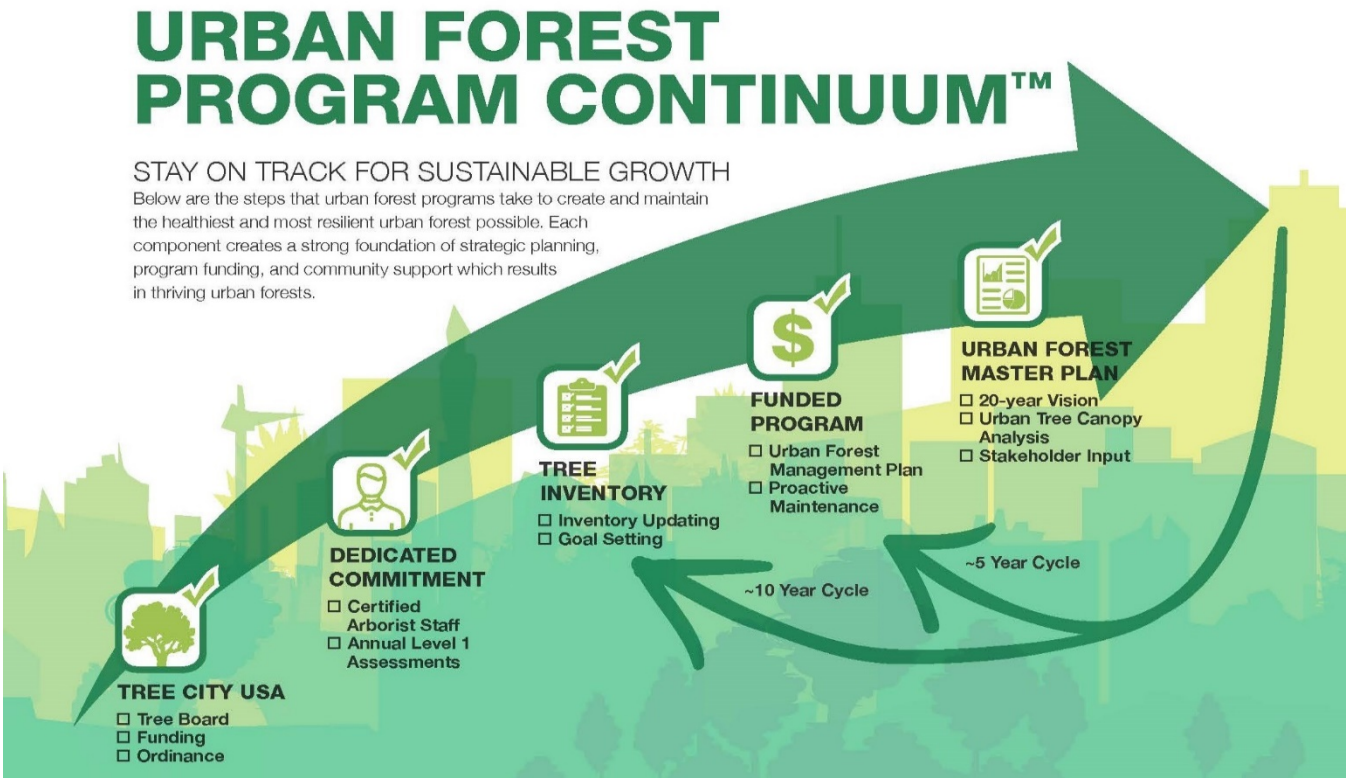
Further Inspection Recommendations

The inventory found 99 trees with recommended 'Annual Inspection', 21 trees with recommended 'Advanced Risk Assessment', 16 trees with recommended 'Insect/disease Monitoring', and 2 tree with a recommended 'Recent Damage Inspection'. DRG advises conducting the Advanced Risk Assessments as soon as possible, because trees with this recommendation are in such a condition that they have unknown factors in their risk rating. 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 mitigation strategy.

CONCLUSION



This *Tree Inventory and Summary Report* can help advocate for an increased urban forestry budget to fund the recommended maintenance activities. As the urban forest grows, the benefits enjoyed by the City of Farmington and its residents will increase as well. Inventoried trees are only a fraction of the total trees in Farmington when including private property and natural areas, which is why it is important to also incentivize landowners to care for their trees and to plant less abundant species. It is important to update the tree inventory using TreeKeeper® as tree maintenance activities are completed so the software can provide updated species distribution and benefit estimates. Make data collection, such as measuring DBH and assessing condition, and data entry into TreeKeeper® the standard procedure for all tree work and routine inspections so changes over time can be monitored. This empowers Farmington to self-assess the City's progress over time and set goals to strive toward by following the adaptive management cycle.



REFERENCES

American National Standards Institute. 2017. *ANSI A300 (Part 1): Tree, Shrub, and Other Woody Plant Management—Standard Practices (Pruning)*. Tree Care Industry Association, Inc.

———. 2011. *ANSI A300 (Part 9): Tree, Shrub, and Other Woody Plant Management Standard Practices (Tree Risk Assessment a. Tree Failure).* Tree Care Industry Association, Inc.

Coder, K. D. 1996. Identified Benefits of Community Trees and Forests. University of Georgia Cooperative Extension Service: Forest Resources Unit. Publication FOR96-39. Retrieved from https://nfs.unl.edu/documents/communityforestry/coderbenefitsofcommtrees.pdf

Culley, T.M. & Hardiman, N.A. 2007. The Beginning of a New Invasive Plant: A History of the Ornamental Callery Pear in the United States. *BioScience*, 57(11): 956-964.

Evans, E. 2012. Americans are Planting Trees of Strength. North Carolina State University College of Agriculture & Life Sciences: Department of Horticultural Science. http://www.treesofstrength.org/benefits.htm

Heisler, G. M. 1986. Energy Savings with Trees. *Journal of Arboriculture* 12(5):113–125. Retrieved from https://www.nrs.fs.fed.us/pubs/jrnl/1986/nrs_1986_heisler_002.pdf

Karnosky, D. F. 1979. Dutch Elm Disease: A Review of the History, Environmental Implications, Control, and Research Needs. *Environmental Conservation* 6(4): 311–322.

Kuo, F. E., & Sullivan, W. C. 2001a. Environment and Crime in the Inner City: Does Vegetation Reduce Crime? *Environment and Behavior* 33(3): 343–367. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.644.9399&rep=rep1&type=pdf

———. 2001b. Aggression and Violence in the Inner City: Effects of Environment via Mental Fatigue. *Environment and Behavior* 33(4): 543–571. Retrieved from https://pdfs.semanticscholar.org/9ca8/a34eee31d42ac2235aa6d0b9b6e7a5f32386.pdf

Lovasi, G. S., Quinn, J. W., Neckerman, K. M., Perzanowski M., Rundle, A. 2008. Children living in areas with more street trees have lower prevalence of asthma. *Journal of Epidemiology and Community Health* 62(7): 647-649. Retrieved from https://www.researchgate.net/publication/5401459_Children_living_in_areas_with_more_trees_have_lower_prevalence_of_asthma

McPherson, E. G., Rowntree, R. A. 1989. Using Structural Measures to Compare Twenty-Two U.S. Street Tree Populations. *Landscape Journal* 8(1): 13–23. Retrieved from https://www.fs.fed.us/psw/topics/urban_forestry/products/1/psw_cufr745_structuralmeasures.pdf

Michigan Department of Natural Resources. 2020. Black Locust (*Robinia pseudoacacia*). Retrieved from https://www.michigan.gov/invasives/0,5664,7-324-68002_71240_73851-379779--,00.html

Michigan.gov. 2020. Asian Longhorned Beetle. *Michigan Invasive Species*. Retrieved from https://www.michigan.gov/invasives/0,5664,7-324-68002_71241-367887--,00.html

Miller, R. W., & Sylvester, W.A. 1981. An Economic Evaluation of the Pruning cycle. *Journal of Arboriculture* 7(4): 109–112. Retrieved from http://webcache.googleusercontent.com/search?q=cache:VENBQXq9EmcJ:joa.isa-arbor.com/request.asp%3FJournalID%3D1%26ArticleID%3D1724%26Type%3D2+&cd=2&hl=en&ct=clnk&gl=us

Nowak, D. J., Greenfield, E. J., Hoehn, R. E., & Lapoint, E. 2013. Carbon storage and sequestration by trees in urban and community areas of the United States. *Environmental Pollution* 178: 229-236. Retrieved from https://www.fs.fed.us/nrs/pubs/jrnl/2013/nrs_2013_nowak_001.pdf

Richards, N. A. 1983. Diversity and Stability in a Street Tree Population. *Urban Ecology* 7(2): 159–171.

Santamour, F.S. 1990. Trees for Urban Planting: Diversity Uniformity, and Common Sense. *U.S. National Arboretum: Agricultural Research Service*. Retrieved from https://pdfs.semanticscholar.org/26a2/4c5361ce6d6e618a9fa307c4a34a3169e309.pdf?_ga=2.266051527.959145428.1587418896-558533249.1587418896

Ulrich, R. 1984. View through Window May Influence Recovery from Surgery. *Science* 224: 420–422. Retrieved from https://pdfs.semanticscholar.org/43df/b42bc2f7b212eb288d2e7be289d251f15bfd.pdf

———. 1986. Human Responses to Vegetation and Landscapes. *Landscape and Urban Planning* 13: 29–44. Retrieved from https://www.researchgate.net/profile/Roger_Ulrich4/publication/254315158_Visual_Landscapes_and_Psychological_Well-Being/links/0c96053a3fe7796728000000/Visual-Landscapes-and-Psychological-Well-Being.pdf

Ulrich R.S., R.F. Simmons, B.D. Losito, E. Fiority, M.A. Miles and M. Zeison. 1991. Stress Recovery During Exposure to Natural and Urban Environments. *Journal of Environmental Psychology* 11(3): 201-230.

USDA Forest Service. 2003a. Benefits of Urban Trees—Urban and Community Forestry: Improving Our Quality of Life. *Southern Region Forestry Report* R8-FR 71. Retrieved from http://www.sci-links.com/files/Benefits_of_Urban_Trees.pdf

———. 2003b. Is all your rain going down the drain? Look to Bioretainment—trees are a solution. *Center for Urban Forest Research: Pacific Southwest Research Station*. Retrieved from https://www.fs.fed.us/psw/topics/urban_forestry/products/cufr_392_rain_down_the_drain.pdf

———. 2020. Forest Health Highlights. Retrieved from https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/monitoring-forest-highlights.shtml

USDA APHIS. 2020. Pest Tracker. https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/Pest-Tracker

———. 2015. Asian Longhorned Beetle: Annotated Host List. Retrieved from https://www.aphis.usda.gov/plant_health/plant_pest_info/asian_lhb/downloads/hostlist.pdf

Wolf, K. L. 1998a. Urban Nature Benefits: Psycho-Social Dimensions of People and Plants. *University of Washington: College of Forest Resources* Human Dimensions of the Urban Forest Fact Sheet #1. Retrieved from https://www.naturewithin.info/UF/PsychBens-FS1.pdf

———. 1998b. Trees in Business Districts: Positive Effects on Consumer Behavior! *University of Washington: College of Forest Resources* Human Dimensions of the Urban Forest Fact Sheet #5. Retrieved from https://www.naturewithin.info/CityBiz/Biz3Ps-FS5.pdf

———. 1999. Grow for the Gold: Trees in Business Districts. *Washington State DNR: Community Forestry Program* Number 14. Retrieved from https://www.naturewithin.info/CityBiz/TreeLink.PDF

———. 2000. Community Image: Roadside Settings and Public Perceptions. *University of Washington: College of Forest Resources* Human Dimensions of the Urban Forest Factsheet #10. Retrieved from https://www.naturewithin.info/Roadside/Rsd-Community-FS10.pdf

———. 2003. Social Aspects of Urban Forestry: Public Response to the Urban Forest in Inner-City Business Districts. *Journal of Arboriculture* 29(3): 117–126. Retrieved from https://www.naturewithin.info/CityBiz/JofA_Biz.pdf

———. 2007. City Trees and Property Values. *Arborist News* 16(4): 34-36. Retrieved from https://www.naturewithin.info/Policy/Hedonics.pdf

———. 2009. Trees & Urban Streets: Research on Traffic Safety & Livable Communities. *University of Washington, Seattle USDA Forest Service: Pacific Northwest Research Station*. Retrieved from http://www.naturewithin.info/urban.html

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.

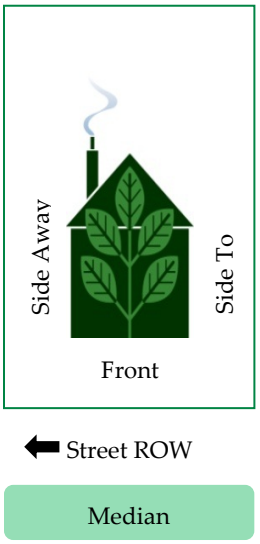
STREET ROW SITE LOCATION

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

Corner Lot A

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.

Corner Lot B

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.

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.

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.

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: almond, apple, apricot, cherry, maple, nectarine, oak, peach, pine, plum, poplar, sycamore, walnut, and willow, as well as grape vine and hop plants.

Pinned spotted lanternfly.

Photograph courtesy of PA Dept of Agriculture

Pinned spotted lanternfly nymph with wingspan open.

Photograph courtesy of USDA APHIS

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: box elder (*Acer negundo*); Norway maple *(A. platanoides*); red maple *(A. rubrum*); silver maple (*A. saccharinum*); sugar maple (*A. saccharum*); buckeye (*Aesculus glabra*); horsechestnut (*A. hippocastanum*); birch (*Betula*); London planetree (*Platanus* × *acerifolia*); willow (*Salix)*; and elm (*Ulmus*).

EASTERN TENT CATERPILLAR

Eastern tent caterpiller (*Malacosoma americanum*) was first observed in the United States in 1646. In spring, caterpillars make nests in the forks and crotches of tree branches. Caterpillars do not feed within the nest; they leave the nest to feed up to 3 feet from nest, and return to rest and take shelter in wet weather. Large infestations may occur at 8- to 10-year intervals. Egg masses overwinter on twigs. Trees are rarely killed by eastern tent caterpillar, but health is compromised that year and aesthetic value is decreased.

Easter tent caterpiller have a wide range of hosts, including apple (*Malus*) and cherry (*Prunus*).

Eastern tent caterpillar nest.

Photograph courtesy of Prairie Haven (2008)

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.

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.

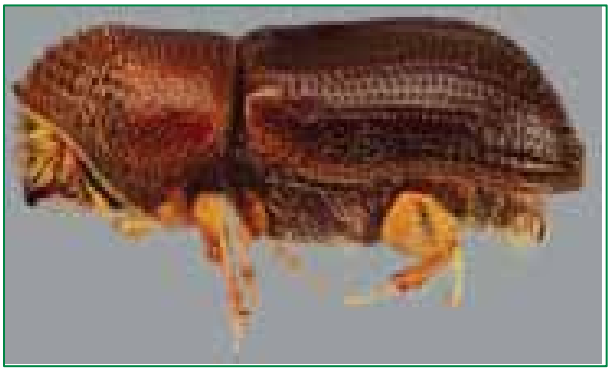
Close-up of male (darker brown) and female (whitish color) European gypsy moths.

Photograph courtesy of USDA APHIS (2019)

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: birch (*Betula*); cedar (*Juniperus*); larch (*Larix*); aspen, cottonwood, poplar (*Populus*); oak (*Quercus*); and willow (*Salix*).

THOUSAND CANKERS DISEASE

A complex disease referred to as Thousand cankers disease (TCD) was first observed in Colorado in 2008 and is now thought to have existed in Colorado as early as 2003. TCD is considered to be native to the United States and is attributed to numerous cankers developing in association with insect galleries.



Side view of a walnut twig beetle.

Photograph courtesy of the USFS (2011)

TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two decades, and coupled with the *Geosmithia morbida* fungus, *Juglans* (walnut) mortality has manifested in Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Washington. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. This is the first report east of the 100th meridian, raising concerns that large native populations of black walnut (*J. nigra*) in the eastern United States may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnut.

OAK WILT

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

Oak wilt symptoms on red and white oak leaves.

Photograph courtesy of the USFS (2011a)

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

HEMLOCK WOOLY ADELGID

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

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

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

Hemlock woolly adelgids on a branch.

Photograph courtesy of Connecticut Agricultural Experiment Station, Bugwood.org (2011)

EMERALD ASH BORER

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

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).

*Close-up of an emerald ash bore**r.***

Photograph courtesy of USDA APHIS (2020)

REFERENCES

Connecticut Agricultural Experiment Station, Bugwood.org. 2011. *Hemlock woolly adelgid* (Adelges tsugae). Retrieved from https://www.invasive.org/browse/detail.cfm?imgnum=3225077

Cranshaw, W. 2004. *Garden Insects of North America: The Ultimate Guide to Backyard Bugs* (pp. 114, 118). Princeton University Press.

DiOrio, A. 2011. *Volunteers Needed for Asian Longhorned Beetle Survey.* New Bedford Guide. Retrieved from http://www.newbedfordguide.com/volunteers-needed-for-asian- longhorned-beetle-survey/2011/03/30

Indiana Department of Natural Resources. 2019. *Sudden Oak Death*. Entomology and Plant Pathology. Retrieved from http://www.in.gov/dnr/entomolo/4532.htm

Miller, F. 2016. *2016 Illinois Forest Health Highlights*. The Morton Arboretum. Retrieved from http://www.mortonarb.org/files/2016-FHH-Final-Version-12-28-16-Submitted.pdf

University of Georgia. *Invasive Species*. Center for Invasive Species and Ecosystem Health. Retrieved from www.bugwood.org

USDA Animal and Plant Health Inspection Service. 2019. *Hungry Pests: Your Move Gypsy Moth Free.* Retrieved from https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/thethreat/gypsy-moth-free

USDA Animal and Plant Health Inspection Service. 2019. *Pest Alert: Spotted Lantern Fly* (Lycorma delicatula). Retrieved from https://www.aphis.usda.gov/publications/plant_health/alert-spotted-lanternfly.pdf

USDA Animal and Plant Health Inspection Service. 2020. *Plant Pests and Diseases: Emerald Ash Borer.* Retrieved from https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/emerald-ash-borer/emerald-ash-borer

USDA Forest Service. 2013. *Pest Alert: Thousand Cankers Disease*. Northeastern Area State and Private Forestry, NA–PR–02–10. Retrieved from https://www.fs.usda.gov/naspf/sites/default/files/thousand_cankers_disease_print_res.pdf

APPENDIX C: SUGGESTED TREE SPECIES FOR USDA HARDINESS ZONE 6

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

DECIDUOUS TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	Red Sunset®
Acer saccharum	sugar maple	'Legacy'
*Aesculus flava**	yellow buckeye	
*Betula alleghaniensis**	yellow birch	
*Betula lenta**	sweet birch	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Carya illinoensis**	pecan	
*Carya lacinata**	shellbark hickory	
*Carya ovata**	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata	sugar hackberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	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	
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	'Rotundiloba'
*Liriodendron tulipifera**	tuliptree	'Fastigiatum'
*Magnolia acuminata**	cucumbertree magnolia	(Numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
*Platanus occidentalis**	American sycamore	
Platanus × acerifolia	London planetree	'Yarwood'
Quercus alba	white oak	

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

Article I. cientific Name	Common Name	Cultivar
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus imbricaria	shingle oak	
Quercus phellos	willow oak	
Quercus robur	English oak	Heritage®
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	Shumard oak	
Styphnolobium japonicum	Japanese pagodatree	'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia americana	American linden	'Redmond'
Tilia cordata	littleleaf linden	'Greenspire'
Tilia × euchlora	Crimean linden	
Tilia tomentosa	silver linden	'Sterling'
Ulmus parvifolia	Chinese elm	Allée®
Zelkova serrata	Japanese zelkova	'Green Vase'

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Alnus cordata	Italian alder	
*Asimina triloba**	pawpaw	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Pistacia chinensis	Chinese pistache	
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Sassafras albidum**	sassafras	

Small Trees: 15 to 30 Feet in Height at Maturity

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

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

CONIFEROUS AND EVERGREEN TREES

Large Trees: Greater than 45 Feet in Height at Maturity

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

Medium Trees: 31 to 45 Feet in Height at Maturity

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

Small Trees: 15 to 30 Feet in Height at Maturity

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

Dirr's Hardy Trees and Shrubs (Dirr 2013) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1988) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade.