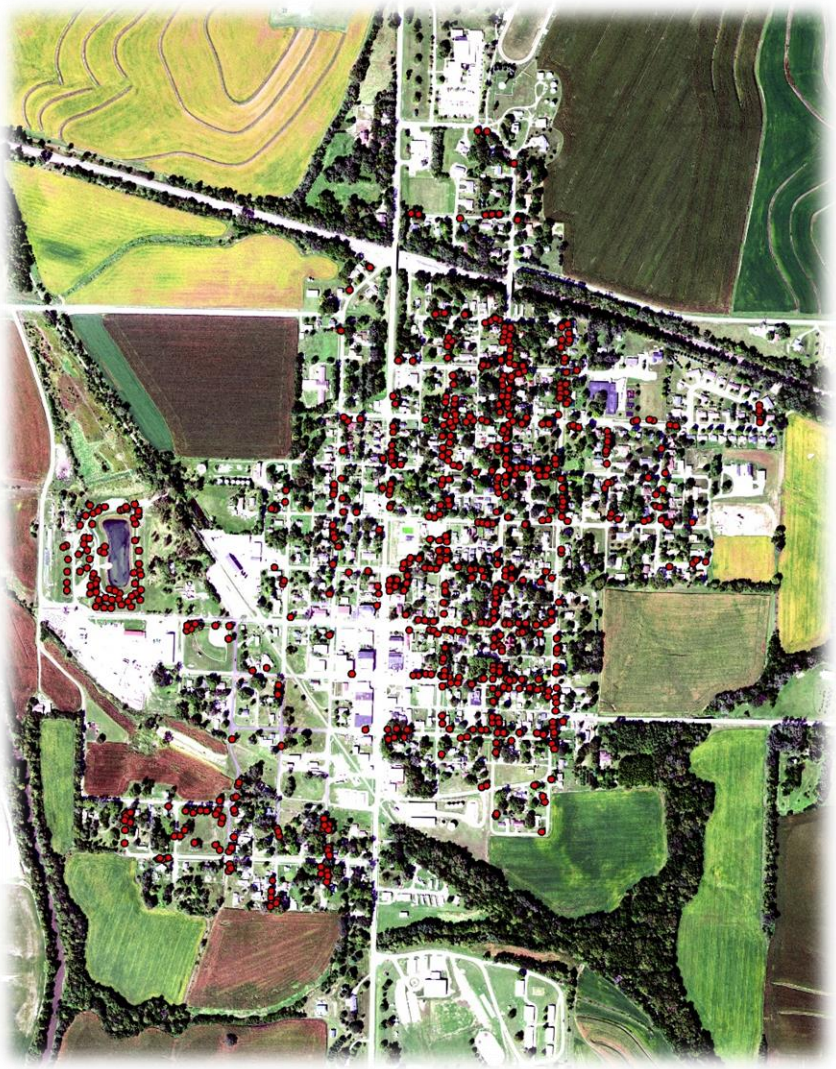
2022 Urban Forest Management Plan for the city of Malvern



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Executive Summary

Overview

This plan was developed to assist the City of Malvern with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 12% of Malvern's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2022, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 638 trees inventoried.

- Malvern's trees provide $139,275 of benefits annually, an average of $218.30 per tree
- There are over 45 species of trees
- The top three genera are: Maple 36%, Ash 12%, and Oak 12%
- 25% of trees are in need of some type of management
- 61 trees are recommended for removal

Recommendations

The core recommendations are detailed in the Recommendations Section. The Emerald Ash Borer Plan includes management recommendations as well. Below are some key recommendations.

- Of the 61 trees needing removal, 10 trees of critical concern and are over 24 inches in diameter at 4.5 ft and should be addressed immediately (these trees were classified as critical concern) *City ownership of the trees recommended for removal should be verified prior to any removal*
- 69 of the 78 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation
- All trees should be pruned on a routine schedule- one third of the city every other year in a 6 year cycle
- Plant a diverse mix of native trees that does not include: ash, maple, cottonwood, poplar, willow, or non-native invasive trees (Bartlett Pear, Norway Maple, Amur Cork tree, Princess Tree, Siberian elm, etc).
- Check ash trees with a visual survey yearly
- With the current budget it could take almost 9 years just to remove all trees recommended for removal, in addition to all ash trees. Suggestion: request a budget increase to $25,000 annually to cover potential EAB losses and normal tree losses and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Malvern with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of that money spent on tree removal. With the recovery from Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal or treatment and replacement planting. With proper planning and management of the current canopy in Malvern, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Malvern's infrastructure and one of the greatest assets to the community. The benefits of trees are immense. Trees provide the community with improved air quality, stormwater runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and create a desirable place to live, to name just a few benefits. It is essential that these benefits be maintained for the people of Malvern and future generations through good urban forestry management.

Good urban forestry management involves setting goals and developing management strategies to achieve these goals. An essential part of developing management strategies is a comprehensive public tree inventory. The inventory supplies information that will be used for maintenance, removal schedules, tree planting and budgeting. Basing actions on this information will help meet Malvern's urban forestry goals.

Inventory

In 2022, a tree inventory was conducted that included city owned trees in right of ways and in parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

The programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms associated with EAB were noted for all ash trees. The signs and symptoms noted were canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

The data collected for the 678 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban Forestry Management as part of the i-Tree suite. The following are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Malvern's trees reduce energy related costs by approximately $34,395 annually (Appendix A, Table 1). These savings are both in Electricity (164.6 MWh) and in Natural Gas (22,347.4 Therms).

Annual Stormwater Benefits

Malvern's trees intercept about 1,997,154 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $54,123 of benefits to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Malvern, it is estimated that trees remove 2,112.6 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $5,887 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere. In Malvern, trees sequester about 476,983 lbs of carbon a year with an associated value of $3,577 (Appendix A, Table 5). In addition, the trees store 7,927,358 lbs of carbon, with a yearly benefit of $59,455 (Appendix A, Table 4).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Malvern receives $39,521 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Malvern's trees provide $139,275 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 678 trees in Malvern provide approximately $218 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Malvern has over 45 different tree species along city streets and parks. There are more than 24 genera (close relatives) of trees within Malvern (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Genus	Number of Trees	Percent of Total
Maple *(Acer)*	229	35.9%
Ash *(Fraxinus)*	78	12.2%
Oak *(Quercus)*	77	12.1%
Apple *(Malus)*	54	8.4%
Basswood/Linden *(Tilia)*	31	4.9%
Spruce *(Picea)*	30	4.7%
Elm *(Ulmus)*	22	3.4%
Pear *(Pyrus)*	15	2.3%
Honeylocust *(Gleditsia)*	11	1.7%
Hackberry *(Celtis)*	10	1.6%
Cedar *(Thuja)*	9	1.4%
Sycamore *(Platanus)*	9	1.4%
Conifer-Evergreen	9	1.4%
Walnut *(Juglans)*	8	1.2%
Broadleaf-Evergreen	8	1.2%
Redbud *(Cercis)*	6	0.9%
Birch *(Betula)*	5	0.7%
Cherry/Plum *(Prunus)*	5	0.7%
Broadleaf-Deciduous	5	0.7%
Pine *(Pinus)*	5	0.7%
Tulip Tree *(Liriodendron)*	3	0.4%
Gingko	2	0.3%
Magnolia	2	0.3%
Mulberry *(Morus)*	2	0.3%
Cottonwood *(Populus)*	1	0.15%
Tree Lilac *(Syringa)*	1	0.15%
Juniper *(Juniperus)*	1	0.15

Age Class

Most of Malvern's trees (41%) are between 24 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Malvern's size curve is on the larger side, indicating an older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Malvern indicate that 97% of the trees are in good or fair health, with only 3% of the trees having foliage in poor health or dead/dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 87% of Malvern's trees are in good or fair health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 13% of the population.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy.

Crown Cleaning	77	12.1%
Tree Removal	61	9.6%
Tree Reduction	16	2.5%
Tree Raising	3	0.4%
Staking/Training	1	0.16%

Canopy Cover

The total canopy cover, including both private and public trees is 18.4% (or 141.25 total acres, as calculated in 2010). The canopy cover on city own properties included in this Malvern inventory includes approximately 19.85 acres (Appendix A, Figure 4). New plantings and replacement plantings will be critical for just maintaining the current canopy cover. While there are no programs to assist with tree removals, there are many programs available to assist communities with replacing public and private trees.

Land Use and Location

The majority of Malvern's city and park trees are found in planting strips in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use	
Single family residential	83.07%
Park/Vacant Lot	16.3%
Multifamily Residential	0.47%
Industrial/Large Commercial	0.16%

Location	
Planting Strip	58.46%
Other maintained locations	41.54%

Changes in Forest Structure Since plan in 2015: Emerald Ash borer hit South Central and Southwest Iowa with a vengeance, staring around 2015 (two years before the first inventory was collected in 2017). The increase in tree removals has to do with natural tree aging (and

age-related structural risks), and also the tree decline and death associated with Emerald Ash Borer infestations. For instance, in 2015, 22% of the ash trees showed signs of EAB, and now 88% of the ash trees are showing symptoms of insect infestation.

Recommendations

Risk Management

Hazardous trees can be a significant threat to both people and property. Trees that are dead or dying, or that have large issues such as trunk cracks longer than 18 inches should be removed. Broken branches and branches that interfere with motorist's vision of pedestrians, vehicles, traffic signs and signals, etc should be removed.

Hazardous trees

Malvern has 11 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figures 4 and 5). It is recommended to start with the large diameter critical concern trees first. There are 10 critical concern trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the six-year maintenance plan at the end of this section. There are 30 other trees (noted as mature tree immediate) that need to be looked at for removal, 8 trees in need of crown raising, and 8 trees in need of canopy reduction within the next 3 years. Within 3 to 5 years, there are an additional 17 trees in need of potential removal, and 3 trees in need of cleaning. In general, trees classified as critical concern should be addressed ASAP. Trees noted as mature tree immediate will need to be addressed within 3 years, and mature tree routine trees will need to be looked at within 5 years. Trees classified as "young tree immediate" are less than 15 feet tall and need to be addressed within 1-3 years. Trees listed as "young tree routine" should be looked at within 3-5 years. Young trees are not included in the estimated removal costs, as their size will make removals much less expensive, especially if the trees could be removed using city labor.

Poor tree species

After the recommended removals, cleanings, raisings, and reductions have been made, remaining trees indicated as having poor leaf or wood health should be revisited and evaluated for any new needs at that time (Appendix B, Figure 3). *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are five main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Staking/training is a notation for small trees that need to be staked, protected, or correctively pruned due to some kind of damaging agent.

Planting

Planting over the next 6 years should be implemented to replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six-year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Malvern.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with maple (36%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood (except in parks or natural areas), poplar, box elder, Siberian elm, willow or black walnut (or other trees with large seeds for right of way use), as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Budget and Emerald Ash Borer Plan

There are 78 ash trees that may require removal over the next five years, and 61 trees are slated for critical concern removal, immediate mature tree removal, mature tree routine removals, and young tree routine removal. If you take out the 3 young tree routine removals (these trees are less than 15 feet tall), there are only 58 removals. Of the 78 ash trees, 19 are already accounted for in the 61 removals. This leaves 59 potential ash removals, and the 58 other “mature” tree removals, for a potential total of 117 removals. If a tree service performs all the removals (and the removal work is not done by city staff), the cost to the city could be as much as $140,400 over the next 6 years (117 mature trees x $1,200 per tree). If city staff cannot remove trees, it is recommended that you solicit bids from tree services, in hope to get a quantity discount. The current tree budget is $16,000/year. This means, the removals would have to be spread out over 8.8 years unless the budget is increased. If the tree budget is increased to $25,000/year (at least in the short term), the ash and other tree removals could be covered within 6 years’ time.

Six Year Maintenance Plan (if budget increased to $25,000)

FY 2023

Removal: 11 critical concern trees and at least 9 remaining mature tree immediate removals over 18” in diameter.

Planting and Replacement: 20 removals x 1.2 = up to 24 trees replaced
Routine Trimming: Perform mature tree immediate reductions, crown raisings, and up to 25 mature tree immediate crown cleanings (if possible)
Ongoing visual survey for signs and symptoms of EAB

FY 2024

Removal: Remove an additional 20 trees slated for mature tree immediate removal
Planting and Replacement: Replant at least 24 trees
Routine trimming: Perform crown cleaning (pruning) on another 25 trees indicated for mature tree immediate crown cleaning.
Visual Survey for signs and symptoms of EAB

FY 2025

Removal: Remove the 1 remaining mature tree immediate tree, and also the 17 mature tree routine trees. Remove 3 young tree immediate trees. Remove 2 ash trees that are showing severe symptoms of EAB.
Planting and Replacement: replant 24 trees
Routine trimming: Prune remaining 24 trees indicated for mature tree immediate "cleaning."
Visual Survey for signs and symptoms of EAB

FY 2026

Removal: Remove an additional 20 ash trees that are showing severe symptoms of EAB
Planting and Replacement: Replant 24 trees
Routine trimming: Complete crown cleaning on 3 remaining trees classified as "mature tree routine crown cleaning."
Visual Survey for signs and symptoms of EAB

FY 2027

Removal: Remove an additional 20 ash trees that are showing severe symptoms of EAB
Planting and Replacement: replant 24 trees
Visual Survey for signs and symptoms of EAB

FY 2028

Removal: Remove the final 17 ash trees (if dead or showing severe symptoms)
Planting and Replacement: replant 24 trees
Routine Trimming: Consider implementing routine trimming of 1/3 of the city trees every 2 years in FY 2029.
Visual Survey for signs and symptoms of EAB

Ash Tree Removal

Tree removal will be prioritized for dead, dying, and hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). *City ownership of the tree recommended for removal should be verified prior to any removal*

Treatment of Ash Trees
Chemical treatment can be effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/ .

EAB Quarantines
The Federal EAB quarantine was eliminated in 2021. Iowa has a Statewide quarantine, which means the following regulated articles may be transported throughout all of Iowa's counties. It is recommended, however, that the following regulated articles are retained to local, non-infested portions of the state if possible. It is also recommended that the following regulated articles do not move across state lines (as many states to the West do not have state-wide EAB infestations).

A regulated article under the USDA's previous quarantine included any of the following items:

- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

Wood Disposal
A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that movement out-of-state should not occur. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? For more information on wood utilization or disposal, contact your District Forester, and for EAB and its distribution in Iowa, please visit: http://iowatreepests.com/eab_home.html.

Canopy Replacement
As budget (or financial assistance grants) permit, all removed trees should be replaced. All trees should meet the restrictions in city ordinance 151.02 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Siberian elm, evergreen, willow or black walnut.

Postponed Work
While finances, staffing and equipment are focused on the management of hazardous trees and symptomatic ash, usual tree maintenance requests may be delayed.

Monitoring
It is recommended that ash trees be checked with a visual survey every year for tree death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Private Ash Trees

It is strongly recommended that private property owners start removing symptomatic ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 151.06 states "If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property."

Tree Replacement and Prolonging Tree Life

If all ash trees die, in combination with all trees recommended for removal, Malvern may lose as many as 120 trees. It is recommended that trees be replaced at a rate of 1.2 x the number of trees removed (which would equal 144 trees). While removal expenses are not covered by grants, tree planting activities are often covered by grants for landowners and communities. Utility Company grants are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. Ash trees selected for ongoing treatments should be in excellent health, good structural form, and have more than 75% of their canopy intact. Actively dying trees with less than 75% of their canopy intact are not good candidates for injection treatment and should be considered for eventual removal. This is an alternative to the straight removal of ash trees.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Malvern

Annual Energy Benefits of Public Trees

12/2/2022

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	40.2	3,055	5,282.5	5,177	8,232	(N/A)	18.2	23.9	70.96
Green ash	20.0	1,515	2,668.3	2,615	4,130	(N/A)	11.1	12.0	58.17
Norway maple	16.9	1,286	2,441.5	2,393	3,678	(N/A)	9.7	10.7	59.33
Apple	4.5	343	696.8	683	1,025	(N/A)	8.5	3.0	18.99
Pin oak	17.9	1,356	2,386.5	2,339	3,695	(N/A)	7.4	10.7	78.61
Sugar maple	9.8	745	1,322.7	1,296	2,042	(N/A)	5.0	5.9	63.80
American basswood	7.0	531	1,006.8	987	1,517	(N/A)	4.1	4.4	58.36
Blue spruce	2.8	211	376.0	369	579	(N/A)	3.6	1.7	25.18
Siberian elm	6.8	515	902.9	885	1,399	(N/A)	2.8	4.1	77.75
Bur oak	3.9	292	512.6	502	795	(N/A)	2.7	2.3	46.75
Callery pear	1.9	142	286.6	281	423	(N/A)	2.4	1.2	28.22
Maple	2.5	188	343.1	336	524	(N/A)	1.7	1.5	47.63
Honeylocust	3.6	273	470.1	461	733	(N/A)	1.7	2.1	66.66
Northern red oak	1.8	136	246.6	242	378	(N/A)	1.6	1.1	37.76
Northern hackberry	3.4	257	480.1	470	728	(N/A)	1.6	2.1	72.76
American sycamore	2.6	195	361.1	354	549	(N/A)	1.4	1.6	60.99
Northern white cedar	0.4	28	56.4	55	83	(N/A)	1.4	0.2	9.22
Black walnut	2.1	162	290.0	284	446	(N/A)	1.3	1.3	55.79
Conifer Evergreen Medium	0.9	67	118.1	116	183	(N/A)	1.1	0.5	26.16
Spruce	0.9	70	107.5	105	175	(N/A)	1.1	0.5	25.04
White ash	3.0	225	352.1	345	570	(N/A)	1.1	1.7	81.39
Red maple	1.5	116	216.0	212	328	(N/A)	0.9	1.0	54.67
Eastern redbud	0.3	23	50.1	49	72	(N/A)	0.9	0.2	12.06
Cherry plum	0.4	27	58.5	57	84	(N/A)	0.8	0.2	16.85
Birch	1.2	90	172.9	169	259	(N/A)	0.8	0.8	51.89
Littleleaf linden	1.3	95	173.6	170	265	(N/A)	0.8	0.8	53.09
Eastern white pine	0.9	67	118.1	116	183	(N/A)	0.8	0.5	36.63
Broadleaf Evergreen Small	0.0	4	8.6	8	12	(N/A)	0.6	0.0	3.00
Broadleaf Evergreen Mediur	0.5	37	54.1	53	90	(N/A)	0.6	0.3	22.62
Broadleaf Deciduous Small	0.2	17	38.5	38	55	(N/A)	0.5	0.2	18.19
Elm	0.8	63	113.1	111	174	(N/A)	0.5	0.5	57.90
Swamp white oak	0.7	54	88.5	87	140	(N/A)	0.5	0.4	46.78
Tulip tree	0.3	25	47.8	47	72	(N/A)	0.5	0.2	24.07
Ginkgo	0.5	36	64.0	63	99	(N/A)	0.3	0.3	49.28
Southern magnolia	0.7	56	93.9	92	148	(N/A)	0.3	0.4	73.91
White mulberry	0.2	16	28.5	28	44	(N/A)	0.3	0.1	21.77
Broadleaf Deciduous Large	0.9	66	116.8	114	181	(N/A)	0.3	0.5	90.32
Eastern cottonwood	0.2	18	27.0	26	44	(N/A)	0.2	0.1	44.23
Conifer Evergreen Small	0.0	4	7.9	8	11	(N/A)	0.2	0.0	11.47
Amur maple	0.1	6	12.8	13	18	(N/A)	0.2	0.1	18.19
Eastern red cedar	0.1	8	16.4	16	25	(N/A)	0.2	0.1	24.57
Conifer Evergreen Large	0.2	14	24.6	24	38	(N/A)	0.2	0.1	38.17
Black maple	0.3	22	39.9	39	61	(N/A)	0.2	0.2	60.68
American elm	0.5	40	67.0	66	106	(N/A)	0.2	0.3	105.59
Lilac	0.0	0	0.6	1	1	(N/A)	0.2	0.0	0.87
Total	164.6	12,495	22,347.4	21,900	34,395	(N/A)	100.0	100.0	53.91

Table 2: Annual Storm Water Benefits

Malvern

Annual Stormwater Benefits of Public Trees

12/2/2022

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	620,417	16,813	(N/A)	18.2	31.1	144.94
Green ash	212,707	5,764	(N/A)	11.1	10.7	81.19
Norway maple	171,100	4,637	(N/A)	9.7	8.6	74.79
Apple	19,298	523	(N/A)	8.5	1.0	9.68
Pin oak	225,292	6,105	(N/A)	7.4	11.3	129.90
Sugar maple	121,110	3,282	(N/A)	5.0	6.1	102.56
American basswood	80,645	2,185	(N/A)	4.1	4.0	84.06
Blue spruce	41,475	1,124	(N/A)	3.6	2.1	48.87
Siberian elm	79,445	2,153	(N/A)	2.8	4.0	119.61
Bur oak	39,229	1,063	(N/A)	2.7	2.0	62.54
Callery pear	13,537	367	(N/A)	2.4	0.7	24.46
Maple	22,935	622	(N/A)	1.7	1.1	56.50
Honeylocust	40,788	1,105	(N/A)	1.7	2.0	100.49
Northern red oak	16,632	451	(N/A)	1.6	0.8	45.07
Northern hackberry	35,109	951	(N/A)	1.6	1.8	95.15
American sycamore	33,070	896	(N/A)	1.4	1.7	99.58
Northern white cedar	6,307	171	(N/A)	1.4	0.3	18.99
Black walnut	23,013	624	(N/A)	1.3	1.2	77.96
Conifer Evergreen Medium	12,938	351	(N/A)	1.1	0.6	50.09
Spruce	12,201	331	(N/A)	1.1	0.6	47.23
White ash	37,572	1,018	(N/A)	1.1	1.9	145.46
Red maple	14,960	405	(N/A)	0.9	0.7	67.57
Eastern redbud	1,530	41	(N/A)	0.9	0.1	6.91
Cherry plum	1,718	47	(N/A)	0.8	0.1	9.31
Birch	10,718	290	(N/A)	0.8	0.5	58.09
Littleleaf linden	13,751	373	(N/A)	0.8	0.7	74.53
Eastern white pine	21,388	580	(N/A)	0.8	1.1	115.92
Broadleaf Evergreen Small	149	4	(N/A)	0.6	0.0	1.01
Broadleaf Evergreen Medium	3,663	99	(N/A)	0.6	0.2	24.82
Broadleaf Deciduous Small	793	22	(N/A)	0.5	0.0	7.17
Elm	12,747	345	(N/A)	0.5	0.6	115.15
Swamp white oak	4,227	115	(N/A)	0.5	0.2	38.19
Tulip tree	3,979	108	(N/A)	0.5	0.2	35.94
Ginkgo	3,715	101	(N/A)	0.3	0.2	50.33
Southern magnolia	9,480	257	(N/A)	0.3	0.5	128.45
White mulberry	735	20	(N/A)	0.3	0.0	9.96
Broadleaf Deciduous Large	12,729	345	(N/A)	0.3	0.6	172.48
Eastern cottonwood	1,466	40	(N/A)	0.2	0.1	39.72
Conifer Evergreen Small	659	18	(N/A)	0.2	0.0	17.86
Amur maple	264	7	(N/A)	0.2	0.0	7.17
Eastern red cedar	1,635	44	(N/A)	0.2	0.1	44.30
Conifer Evergreen Large	4,605	125	(N/A)	0.2	0.2	124.79
Black maple	2,867	78	(N/A)	0.2	0.1	77.70
American elm	4,551	123	(N/A)	0.2	0.2	123.33
Lilac	7	0	(N/A)	0.2	0.0	0.20
Citywide total	1,997,154	54,123	(N/A)	100.0	100.0	84.83

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Table 3: Annual Air Quality Benefits

Malvern

Annual Air Quality Benefits of Public Trees

12/2/2022

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($) Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2							
Silver maple	112.5	19.1	54.6	5.0	605	189.6	27.8	26.5	182.0	1,186	-57.5	-215	559.6	1,576 (N/A)	18.2	13.58
Green ash	26.3	4.2	12.6	1.2	140	94.8	13.8	13.2	90.5	592	0.0	0	256.6	732 (N/A)	11.1	10.31
Norway maple	36.7	6.3	17.8	1.6	198	82.1	11.9	11.3	76.9	509	-8.5	-32	236.2	675 (N/A)	9.7	10.88
Apple	5.7	0.9	2.7	0.3	30	22.2	3.2	3.0	20.4	137	0.0	0	58.5	167 (N/A)	8.5	3.10
Pin oak	42.5	7.4	21.4	1.9	231	84.7	12.4	11.8	80.9	529	-77.7	-291	185.3	469 (N/A)	7.4	9.98
Sugar maple	16.8	2.9	8.2	0.7	90	46.6	6.8	6.5	44.5	291	-13.0	-49	120.0	333 (N/A)	5.0	10.39
American basswood	11.2	1.9	5.5	0.5	61	33.9	4.9	4.7	31.7	210	-9.5	-36	84.8	235 (N/A)	4.1	9.03
Blue spruce	5.9	1.2	4.9	0.7	39	13.2	1.9	1.8	12.6	82	-15.5	-58	26.7	63 (N/A)	3.6	2.75
Siberian elm	14.7	2.5	7.0	0.6	79	32.1	4.7	4.5	30.7	201	0.0	0	96.8	279 (N/A)	2.8	15.52
Bur oak	4.6	0.7	2.2	0.2	25	18.3	2.7	2.5	17.5	114	0.0	0	48.7	139 (N/A)	2.7	8.16
Callery pear	2.1	0.4	1.2	0.1	12	9.2	1.3	1.3	8.5	57	-0.6	-2	23.5	67 (N/A)	2.4	4.44
Maple	5.7	1.0	2.6	0.3	30	11.8	1.7	1.6	11.2	74	-1.9	-7	34.1	97 (N/A)	1.7	8.81
Honeylocust	8.0	1.3	3.6	0.4	42	16.9	2.5	2.4	16.3	106	-6.3	-24	45.0	125 (N/A)	1.7	11.32
Northern red oak	3.4	0.6	1.7	0.2	18	8.6	1.2	1.2	8.1	53	-4.8	-18	20.1	54 (N/A)	1.6	5.35
Northern hackberry	5.8	1.0	2.9	0.3	31	16.3	2.4	2.3	15.4	101	0.0	0	46.2	133 (N/A)	1.6	13.27
American sycamore	4.4	0.7	2.1	0.2	23	12.3	1.8	1.7	11.6	77	0.0	0	34.9	100 (N/A)	1.4	11.13
Northern white cedar	0.6	0.1	0.6	0.1	4	1.8	0.3	0.2	1.7	11	-3.3	-12	2.0	3 (N/A)	1.4	0.32
Black walnut	2.8	0.4	1.3	0.1	15	10.2	1.5	1.4	9.7	63	0.0	0	27.4	78 (N/A)	1.3	9.77
Conifer Evergreen Medium	1.9	0.4	1.5	0.2	12	4.2	0.6	0.6	4.0	26	-4.8	-18	8.6	21 (N/A)	1.1	2.94
Spruce	1.4	0.3	1.2	0.2	9	4.2	0.6	0.6	4.2	27	-4.7	-17	7.9	18 (N/A)	1.1	2.62
White ash	7.9	1.3	3.5	0.4	41	13.6	2.0	1.9	13.4	86	0.0	0	43.9	127 (N/A)	1.1	18.17
Red maple	3.8	0.7	1.8	0.2	20	7.4	1.1	1.0	6.9	46	-1.2	-5	21.5	61 (N/A)	0.9	10.22
Eastern redbud	0.5	0.1	0.2	0.0	3	1.5	0.2	0.2	1.4	9	0.0	0	4.2	12 (N/A)	0.9	1.99
Cherry plum	0.5	0.1	0.2	0.0	3	1.8	0.3	0.2	1.6	11	0.0	0	4.8	14 (N/A)	0.8	2.73
Birch	2.1	0.4	1.1	0.1	11	5.8	0.8	0.8	5.4	36	-0.5	-2	15.9	45 (N/A)	0.8	9.06
Littleleaf linden	2.5	0.4	1.2	0.1	13	6.0	0.9	0.8	5.7	37	-1.2	-4	16.5	46 (N/A)	0.8	9.29
Eastern white pine	2.6	0.5	2.1	0.3	17	4.2	0.6	0.6	4.0	26	-12.8	-48	2.1	-5 (N/A)	0.8	-0.97
Broadleaf Evergreen Small	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.6	2 (N/A)	0.6	0.39
Broadleaf Evergreen Medium	0.2	0.0	0.3	0.0	2	2.2	0.3	0.3	2.2	14	-1.0	-4	4.6	12 (N/A)	0.6	2.98
Broadleaf Deciduous Small	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.0	7	0.0	0	2.7	8 (N/A)	0.5	2.55
Elm	2.0	0.3	0.9	0.1	10	4.0	0.6	0.5	3.8	25	0.0	0	12.0	35 (N/A)	0.5	11.61
Swamp white oak	0.7	0.1	0.3	0.0	4	3.3	0.5	0.5	3.2	21	-0.2	-1	8.4	24 (N/A)	0.5	7.92
Tulip tree	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	13 (N/A)	0.5	4.21
Ginkgo	1.1	0.2	0.5	0.0	6	2.2	0.3	0.3	2.1	14	-0.3	-1	6.5	19 (N/A)	0.3	9.29
Southern magnolia	1.5	0.3	1.3	0.2	10	3.4	0.5	0.5	3.3	21	-2.7	-10	8.3	21 (N/A)	0.3	10.71
White mulberry	0.2	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	0.0	0	2.6	7 (N/A)	0.3	3.63
Broadleaf Deciduous Large	2.4	0.4	1.0	0.1	12	4.1	0.6	0.6	4.0	26	0.0	0	13.2	38 (N/A)	0.3	19.13
Eastern cottonwood	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	0.0	0	2.6	7 (N/A)	0.2	7.42
Conifer Evergreen Small	0.1	0.0	0.1	0.0	0	0.2	0.0	0.0	0.2	1	-0.3	-1	0.3	1 (N/A)	0.2	0.62
Amur maple	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.2	2.55
Eastern red cedar	0.3	0.1	0.3	0.0	2	0.5	0.1	0.1	0.5	3	-0.9	-3	1.0	2 (N/A)	0.2	2.19
Conifer Evergreen Large	0.6	0.1	0.4	0.1	4	0.9	0.1	0.1	0.8	5	-2.9	-11	0.3	-2 (N/A)	0.2	-1.58
Black maple	0.7	0.1	0.3	0.0	4	1.4	0.2	0.2	1.3	8	-0.2	-1	4.0	12 (N/A)	0.2	11.54
American elm	1.5	0.3	0.7	0.1	8	2.5	0.4	0.3	2.4	15	0.0	0	8.1	23 (N/A)	0.2	23.47
Lilac	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	0.2	0.11
Citywide total	345.0	58.8	172.3	16.5	1,872	783.6	114.2	108.9	745.6	4,886	-232.3	-871	2,112.6	5,887 (N/A)	100.0	9.23

Table 4 – Annual Carbon Storage by Trees by Species

Malvern

Stored CO2 Benefits of Public Trees

12/2/2022

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	2,585,875	19,394	(N/A)	18.2	32.6	167.19
Green ash	862,169	6,466	(N/A)	11.1	10.9	91.07
Norway maple	605,855	4,544	(N/A)	9.7	7.6	73.29
Apple	91,405	686	(N/A)	8.5	1.2	12.70
Pin oak	1,140,757	8,556	(N/A)	7.4	14.4	182.04
Sugar maple	483,413	3,626	(N/A)	5.0	6.1	113.30
American basswood	418,699	3,140	(N/A)	4.1	5.3	120.78
Blue spruce	42,850	321	(N/A)	3.6	0.5	13.97
Siberian elm	355,039	2,663	(N/A)	2.8	4.5	147.93
Bur oak	150,979	1,132	(N/A)	2.7	1.9	66.61
Callery pear	36,890	277	(N/A)	2.4	0.5	18.44
Maple	61,459	461	(N/A)	1.7	0.8	41.90
Honeylocust	103,144	774	(N/A)	1.7	1.3	70.33
Northern red oak	71,405	536	(N/A)	1.6	0.9	53.55
Northern hackberry	89,252	669	(N/A)	1.6	1.1	66.94
American sycamore	145,112	1,088	(N/A)	1.4	1.8	120.93
Northern white cedar	7,796	58	(N/A)	1.4	0.1	6.50
Black walnut	89,248	669	(N/A)	1.3	1.1	83.67
Conifer Evergreen M	13,855	104	(N/A)	1.1	0.2	14.84
Spruce	10,364	78	(N/A)	1.1	0.1	11.10
White ash	116,719	875	(N/A)	1.1	1.5	125.06
Red maple	40,827	306	(N/A)	0.9	0.5	51.03
Eastern redbud	7,870	59	(N/A)	0.9	0.1	9.84
Cherry plum	8,586	64	(N/A)	0.8	0.1	12.88
Birch	34,896	262	(N/A)	0.8	0.4	52.34
Littleleaf linden	52,907	397	(N/A)	0.8	0.7	79.36
Eastern white pine	33,304	250	(N/A)	0.8	0.4	49.96
Broadleaf Evergreen S	219	2	(N/A)	0.6	0.0	0.41
Broadleaf Evergreen !	3,707	28	(N/A)	0.6	0.0	6.95
Broadleaf Deciduous	2,724	20	(N/A)	0.5	0.0	6.81
Elm	65,214	489	(N/A)	0.5	0.8	163.03
Swamp white oak	10,872	82	(N/A)	0.5	0.1	27.18
Tulip tree	15,797	118	(N/A)	0.5	0.2	39.49
Ginkgo	15,601	117	(N/A)	0.3	0.2	58.50
Southern magnolia	16,648	125	(N/A)	0.3	0.2	62.43
White mulberry	3,215	24	(N/A)	0.3	0.0	12.06
Broadleaf Deciduous	81,925	614	(N/A)	0.3	1.0	307.22
Eastern cottonwood	3,672	28	(N/A)	0.2	0.0	27.54
Conifer Evergreen Sn	277	2	(N/A)	0.2	0.0	2.08
Amur maple	908	7	(N/A)	0.2	0.0	6.81
Eastern red cedar	1,102	8	(N/A)	0.2	0.0	8.27
Conifer Evergreen La	7,490	56	(N/A)	0.2	0.1	56.18
Black maple	7,945	60	(N/A)	0.2	0.1	59.59
American elm	29,353	220	(N/A)	0.2	0.4	220.15
Lilac	14	0	(N/A)	0.2	0.0	0.10
Citywide total	7,927,358	59,455	(N/A)	100.0	100.0	93.19

The value of stored carbon dioxide is calculated as the total amount of carbon dioxide sequestered annually over the life of each tree, summed for the population. This value should not be added to the Replacement Value or double-counting of the carbon dioxide storage benefit will occur.

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Table 5: Annual Carbon Sequestered

Malvern

Annual CO Benefits of Public Trees

12/2/2022

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	180,703	1,355	-12,412	-459	-97	67,512	506	235,344	1,765	(N/A)	18.2	33.0	15.22
Green ash	45,727	343	-4,138	-203	-33	33,492	251	74,878	562	(N/A)	11.1	10.5	7.91
Norway maple	17,664	132	-2,908	-187	-23	28,414	213	42,984	322	(N/A)	9.7	6.0	5.20
Apple	6,646	50	-439	-66	-4	7,569	57	13,710	103	(N/A)	8.5	1.9	1.90
Pin oak	93,331	700	-5,476	-197	-43	29,969	225	117,627	882	(N/A)	7.4	16.5	18.77
Sugar maple	23,615	177	-2,320	-108	-18	16,474	124	37,660	282	(N/A)	5.0	5.3	8.83
American basswood	23,939	180	-2,010	-83	-16	11,727	88	33,573	252	(N/A)	4.1	4.7	9.68
Blue spruce	2,559	19	-206	-51	-2	4,657	35	6,959	52	(N/A)	3.6	1.0	2.27
Siberian elm	13,436	101	-1,704	-74	-13	11,373	85	23,031	173	(N/A)	2.8	3.2	9.60
Bur oak	8,819	66	-725	-40	-6	6,462	48	14,517	109	(N/A)	2.7	2.0	6.40
Callery pear	3,476	26	-177	-20	-1	3,147	24	6,425	48	(N/A)	2.4	0.9	3.21
Maple	1,740	13	-295	-24	-2	4,148	31	5,569	42	(N/A)	1.7	0.8	3.80
Honeylocust	7,006	53	-495	-28	-4	6,023	45	12,506	94	(N/A)	1.7	1.8	8.53
Northern red oak	1,996	15	-343	-22	-3	3,004	23	4,635	35	(N/A)	1.6	0.6	3.48
Northern hackberry	4,389	33	-428	-33	-3	5,683	43	9,610	72	(N/A)	1.6	1.3	7.21
American sycamore	6,367	48	-697	-28	-5	4,309	32	9,951	75	(N/A)	1.4	1.4	8.29
Northern white cedar	400	3	-37	-8	0	613	5	968	7	(N/A)	1.4	0.1	0.81
Black walnut	5,155	39	-428	-22	-3	3,583	27	8,287	62	(N/A)	1.3	1.2	7.77
Conifer Evergreen Mediun	793	6	-67	-16	-1	1,490	11	2,201	17	(N/A)	1.1	0.3	2.36
Spruce	881	7	-50	-14	0	1,545	12	2,362	18	(N/A)	1.1	0.3	2.53
White ash	7,463	56	-560	-25	-4	4,964	37	11,842	89	(N/A)	1.1	1.7	12.69
Red maple	2,935	22	-196	-15	-2	2,570	19	5,295	40	(N/A)	0.9	0.7	6.62
Eastern redbud	656	5	-38	-5	0	513	4	1,126	8	(N/A)	0.9	0.2	1.41
Cherry plum	724	5	-41	-5	0	594	4	1,271	10	(N/A)	0.8	0.2	1.91
Birch	1,920	14	-167	-12	-1	1,989	15	3,730	28	(N/A)	0.8	0.5	5.59
Littleleaf linden	4,383	33	-254	-14	-2	2,107	16	6,222	47	(N/A)	0.8	0.9	9.33
Eastern white pine	956	7	-160	-18	-1	1,490	11	2,268	17	(N/A)	0.8	0.3	3.40
Broadleaf Evergreen Small	40	0	-1	-1	0	80	1	118	1	(N/A)	0.6	0.0	0.22
Broadleaf Evergreen Medi	288	2	-18	-4	0	827	6	1,094	8	(N/A)	0.6	0.2	2.05
Broadleaf Deciduous Smal	342	3	-13	-4	0	372	3	697	5	(N/A)	0.5	0.1	1.74
Elm	1,874	14	-313	-10	-2	1,389	10	2,940	22	(N/A)	0.5	0.4	7.35
Swamp white oak	1,158	9	-52	-6	0	1,185	9	2,285	17	(N/A)	0.5	0.3	5.71
Tulip tree	862	6	-76	-4	-1	561	4	1,343	10	(N/A)	0.5	0.2	3.36
Ginkgo	638	5	-75	-7	-1	792	6	1,348	10	(N/A)	0.3	0.2	5.06
Southern magnolia	840	6	-80	-7	-1	1,234	9	1,987	15	(N/A)	0.3	0.3	7.45
White mulberry	306	2	-15	-3	0	346	3	633	5	(N/A)	0.3	0.1	2.37
Broadleaf Deciduous Larg	1,438	11	-393	-10	-3	1,463	11	2,498	19	(N/A)	0.3	0.4	9.37
Eastern cottonwood	445	3	-18	-2	0	393	3	819	6	(N/A)	0.2	0.1	6.14
Conifer Evergreen Small	40	0	-1	-1	0	82	1	119	1	(N/A)	0.2	0.0	0.89
Amur maple	114	1	-4	-1	0	124	1	232	2	(N/A)	0.2	0.0	1.74
Eastern red cedar	0	0	-5	-2	0	187	1	180	1	(N/A)	0.2	0.0	1.35
Conifer Evergreen Large	256	2	-36	-4	0	311	2	528	4	(N/A)	0.2	0.1	3.96
Black maple	0	0	-38	-3	0	477	4	436	3	(N/A)	0.2	0.1	3.27
American elm	655	5	-141	-5	-1	883	7	1,392	10	(N/A)	0.2	0.2	10.44
Lilac	9	0	0	0	0	6	0	14	0	(N/A)	0.2	0.0	0.10
Citywide total	476,983	3,577	-38,053	-1,850	-299	276,134	2,071	713,214	5,349	(N/A)	100.0	100.0	8.38

Table 6: Annual Social and Aesthetic Benefits

Malvern

Annual Aesthetic/Other Benefits of Public Trees

12/2/2022

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	13,492	(N/A)	18.2	34.1	116.31
Green ash	3,829	(N/A)	11.1	9.7	53.93
Norway maple	1,653	(N/A)	9.7	4.2	26.66
Apple	378	(N/A)	8.5	1.0	7.00
Pin oak	6,797	(N/A)	7.4	17.2	144.61
Sugar maple	2,379	(N/A)	5.0	6.0	74.34
American basswood	1,685	(N/A)	4.1	4.3	64.79
Blue spruce	477	(N/A)	3.6	1.2	20.75
Siberian elm	867	(N/A)	2.8	2.2	48.19
Bur oak	784	(N/A)	2.7	2.0	46.11
Callery pear	381	(N/A)	2.4	1.0	25.42
Maple	235	(N/A)	1.7	0.6	21.34
Honeylocust	1,690	(N/A)	1.7	4.3	153.65
Northern red oak	161	(N/A)	1.6	0.4	16.10
Northern hackberry	572	(N/A)	1.6	1.4	57.18
American sycamore	487	(N/A)	1.4	1.2	54.08
Northern white cedar	81	(N/A)	1.4	0.2	8.99
Black walnut	428	(N/A)	1.3	1.1	53.44
Conifer Evergreen Medium	150	(N/A)	1.1	0.4	21.36
Spruce	241	(N/A)	1.1	0.6	34.43
White ash	749	(N/A)	1.1	1.9	107.06
Red maple	357	(N/A)	0.9	0.9	59.51
Eastern redbud	37	(N/A)	0.9	0.1	6.23
Cherry plum	42	(N/A)	0.8	0.1	8.33
Birch	183	(N/A)	0.8	0.5	36.59
Littleleaf linden	428	(N/A)	0.8	1.1	85.65
Eastern white pine	126	(N/A)	0.8	0.3	25.17
Broadleaf Evergreen Small	2	(N/A)	0.6	0.0	0.62
Broadleaf Evergreen Medium	70	(N/A)	0.6	0.2	17.49
Broadleaf Deciduous Small	19	(N/A)	0.5	0.0	6.40
Elm	130	(N/A)	0.5	0.3	43.40
Swamp white oak	117	(N/A)	0.5	0.3	39.16
Tulip tree	76	(N/A)	0.5	0.2	25.37
Ginkgo	46	(N/A)	0.3	0.1	22.94
Southern magnolia	77	(N/A)	0.3	0.2	38.47
White mulberry	18	(N/A)	0.3	0.0	8.77
Broadleaf Deciduous Large	95	(N/A)	0.3	0.2	47.59
Eastern cottonwood	46	(N/A)	0.2	0.1	45.86
Conifer Evergreen Small	21	(N/A)	0.2	0.1	21.34
Amur maple	6	(N/A)	0.2	0.0	6.40
Eastern red cedar	0	(N/A)	0.2	0.0	0.00
Conifer Evergreen Large	26	(N/A)	0.2	0.1	26.25
Black maple	0	(N/A)	0.2	0.0	0.00
American elm	82	(N/A)	0.2	0.2	82.32
Lilac	0	(N/A)	0.2	0.0	0.03
Citywide total	39,521	(N/A)	100.0	100.0	61.95

Table 7: Summary of Benefits in Dollars

Malvern

Total Annual Benefits of Public Trees by Species ($)

12/2/2022

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	8,232	1,765	1,576	16,813	13,492	41,878	(N/A)	30.1
Green ash	4,130	562	732	5,764	3,829	15,018	(N/A)	10.8
Norway maple	3,678	322	675	4,637	1,653	10,965	(N/A)	7.9
Apple	1,025	103	167	523	378	2,197	(N/A)	1.6
Pin oak	3,695	882	469	6,105	6,797	17,948	(N/A)	12.9
Sugar maple	2,042	282	333	3,282	2,379	8,318	(N/A)	6.0
American basswood	1,517	252	235	2,185	1,685	5,874	(N/A)	4.2
Blue spruce	579	52	63	1,124	477	2,296	(N/A)	1.6
Siberian elm	1,399	173	279	2,153	867	4,872	(N/A)	3.5
Bur oak	795	109	139	1,063	784	2,889	(N/A)	2.1
Callery pear	423	48	67	367	381	1,286	(N/A)	0.9
Maple	524	42	97	622	235	1,519	(N/A)	1.1
Honeylocust	733	94	125	1,105	1,690	3,747	(N/A)	2.7
Northern red oak	378	35	54	451	161	1,078	(N/A)	0.8
Northern hackberry	728	72	133	951	572	2,456	(N/A)	1.8
American sycamore	549	75	100	896	487	2,107	(N/A)	1.5
Northern white cedar	83	7	3	171	81	345	(N/A)	0.2
Black walnut	446	62	78	624	428	1,638	(N/A)	1.2
Conifer Evergreen Medi	183	17	21	351	150	720	(N/A)	0.5
Spruce	175	18	18	331	241	783	(N/A)	0.6
White ash	570	89	127	1,018	749	2,553	(N/A)	1.8
Red maple	328	40	61	405	357	1,192	(N/A)	0.9
Eastern redbud	72	8	12	41	37	172	(N/A)	0.1
Cherry plum	84	10	14	47	42	196	(N/A)	0.1
Birch	259	28	45	290	183	806	(N/A)	0.6
Littleleaf linden	265	47	46	373	428	1,160	(N/A)	0.8
Eastern white pine	183	17	-5	580	126	901	(N/A)	0.6
Broadleaf Evergreen Sm	12	1	2	4	2	21	(N/A)	0.0
Broadleaf Evergreen Me	90	8	12	99	70	280	(N/A)	0.2
Broadleaf Deciduous Sm	55	5	8	22	19	108	(N/A)	0.1
Elm	174	22	35	345	130	706	(N/A)	0.5
Swamp white oak	140	17	24	115	117	413	(N/A)	0.3
Tulip tree	72	10	13	108	76	279	(N/A)	0.2
Ginkgo	99	10	19	101	46	274	(N/A)	0.2
Southern magnolia	148	15	21	257	77	518	(N/A)	0.4
White mulberry	44	5	7	20	18	93	(N/A)	0.1
Broadleaf Deciduous La	181	19	38	345	95	678	(N/A)	0.5
Eastern cottonwood	44	6	7	40	46	143	(N/A)	0.1
Conifer Evergreen Small	11	1	1	18	21	52	(N/A)	0.0
Amur maple	18	2	3	7	6	36	(N/A)	0.0
Eastern red cedar	25	1	2	44	0	72	(N/A)	0.1
Conifer Evergreen Large	38	4	-2	125	26	192	(N/A)	0.1
Black maple	61	3	12	78	0	153	(N/A)	0.1
American elm	106	10	23	123	82	345	(N/A)	0.2
Lilac	1	0	0	0	0	1	(N/A)	0.0
Citywide Total	34,395	5,349	5,887	54,123	39,521	139,275	(N/A)	100.0

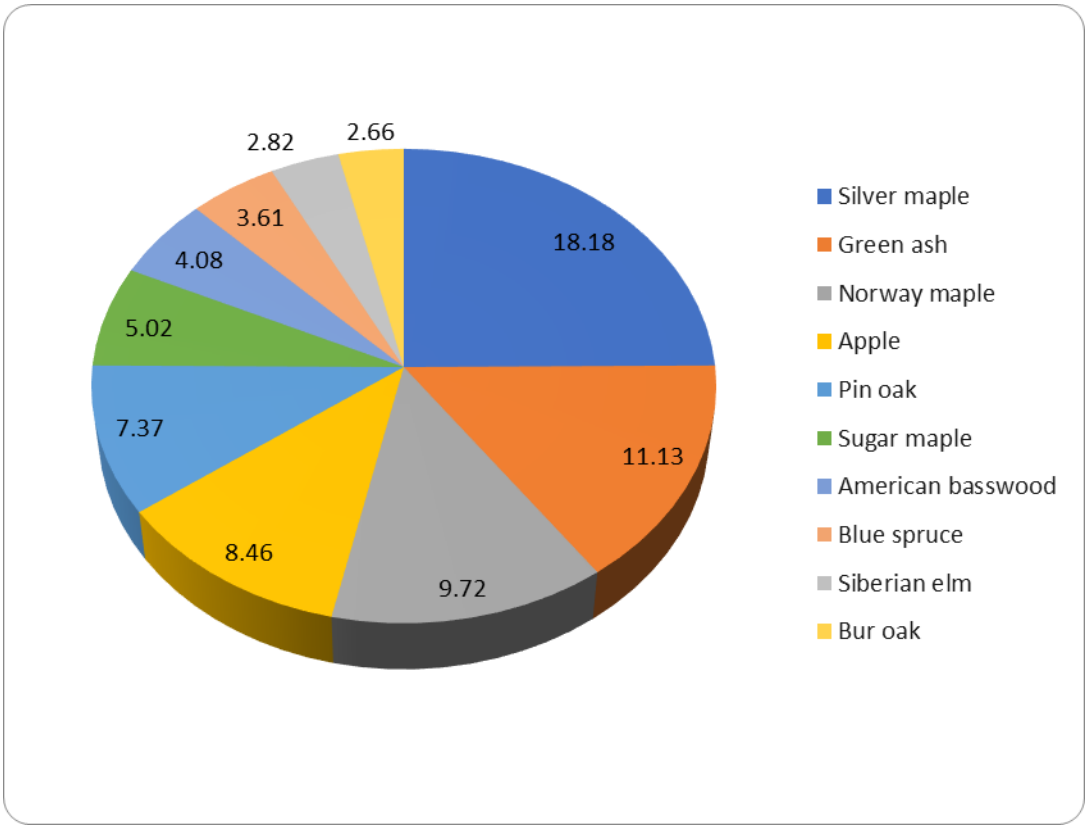

Figure 1: Species Distribution

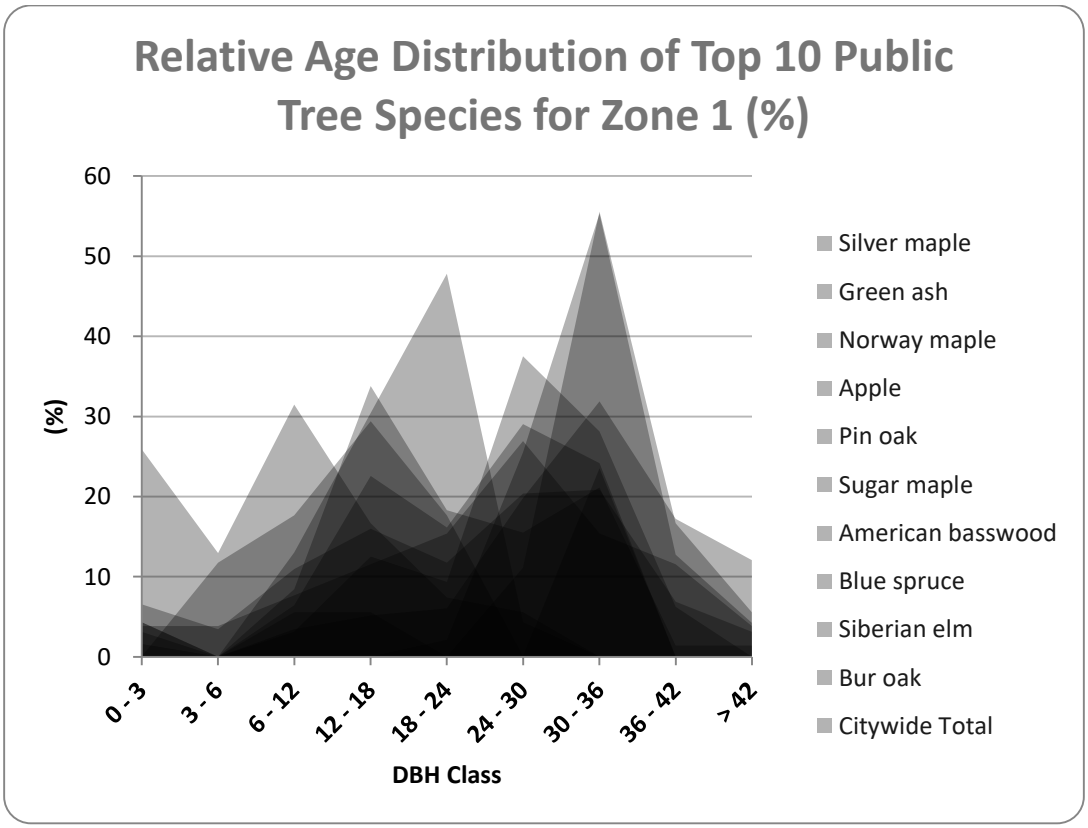

Figure 2: Relative Age Distribution by Species

Figure 3: Average Foliar Condition of Trees

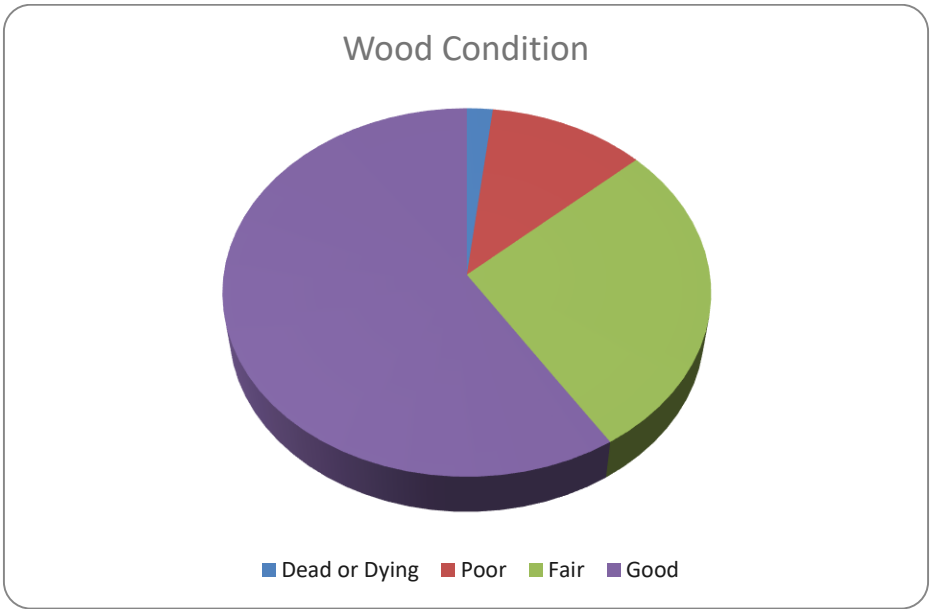

Figure 4: Average Wood Condition of Trees

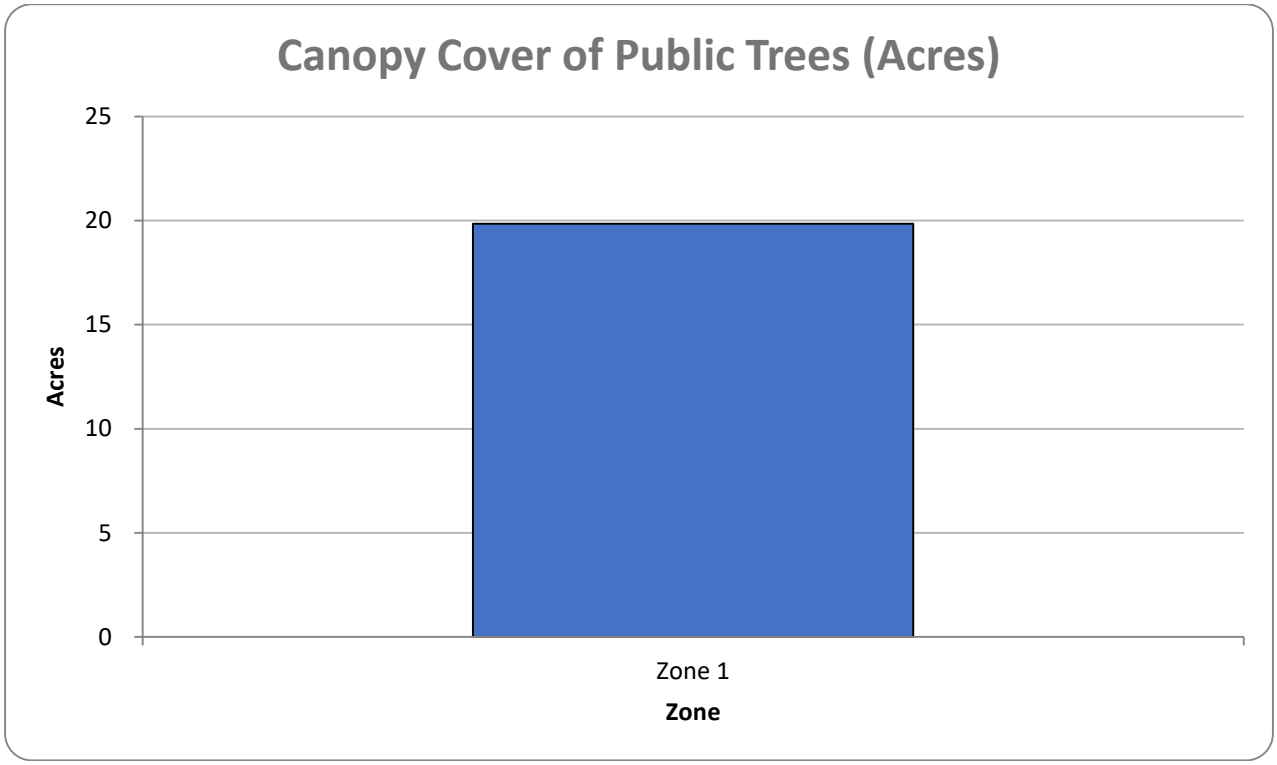

Figure 5: Canopy Coverage of City Managed Trees (19.85 acres)

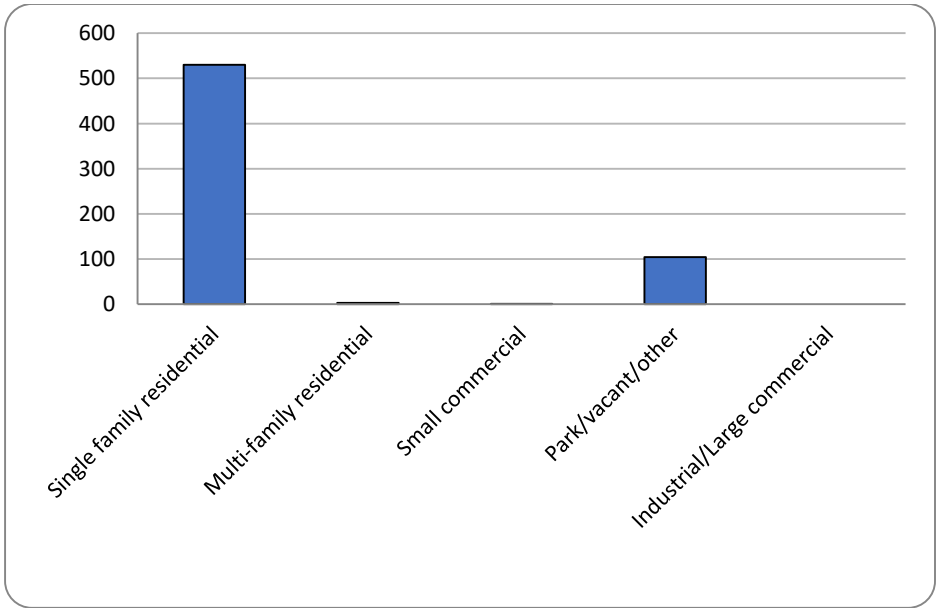

Figure 6: Land Use of City Managed Trees by Zone

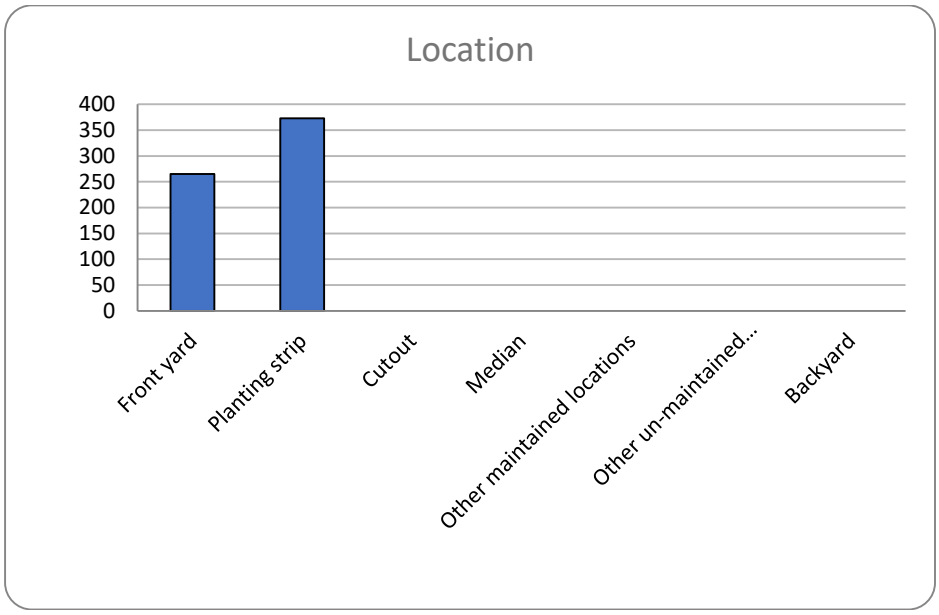

Figure 7: Location of City Managed Trees

Appendix B: Arc GIS Mapping

Figure 1: Location of Malvern's Ash Trees

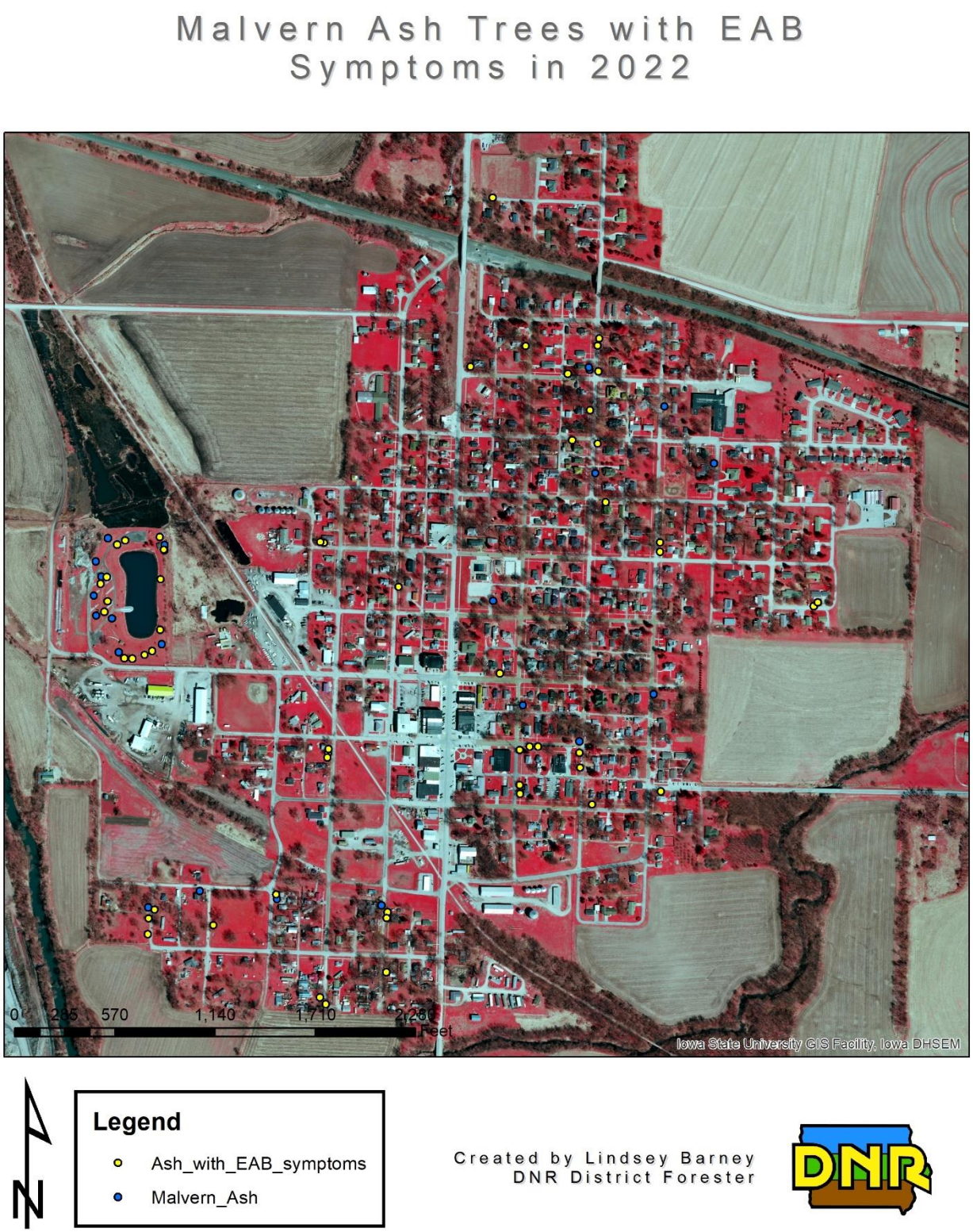

Figure 2: Malvern's Ash trees with EAB Symptoms (bark cracks, flecking, dieback, and/or epicormic sprouts)

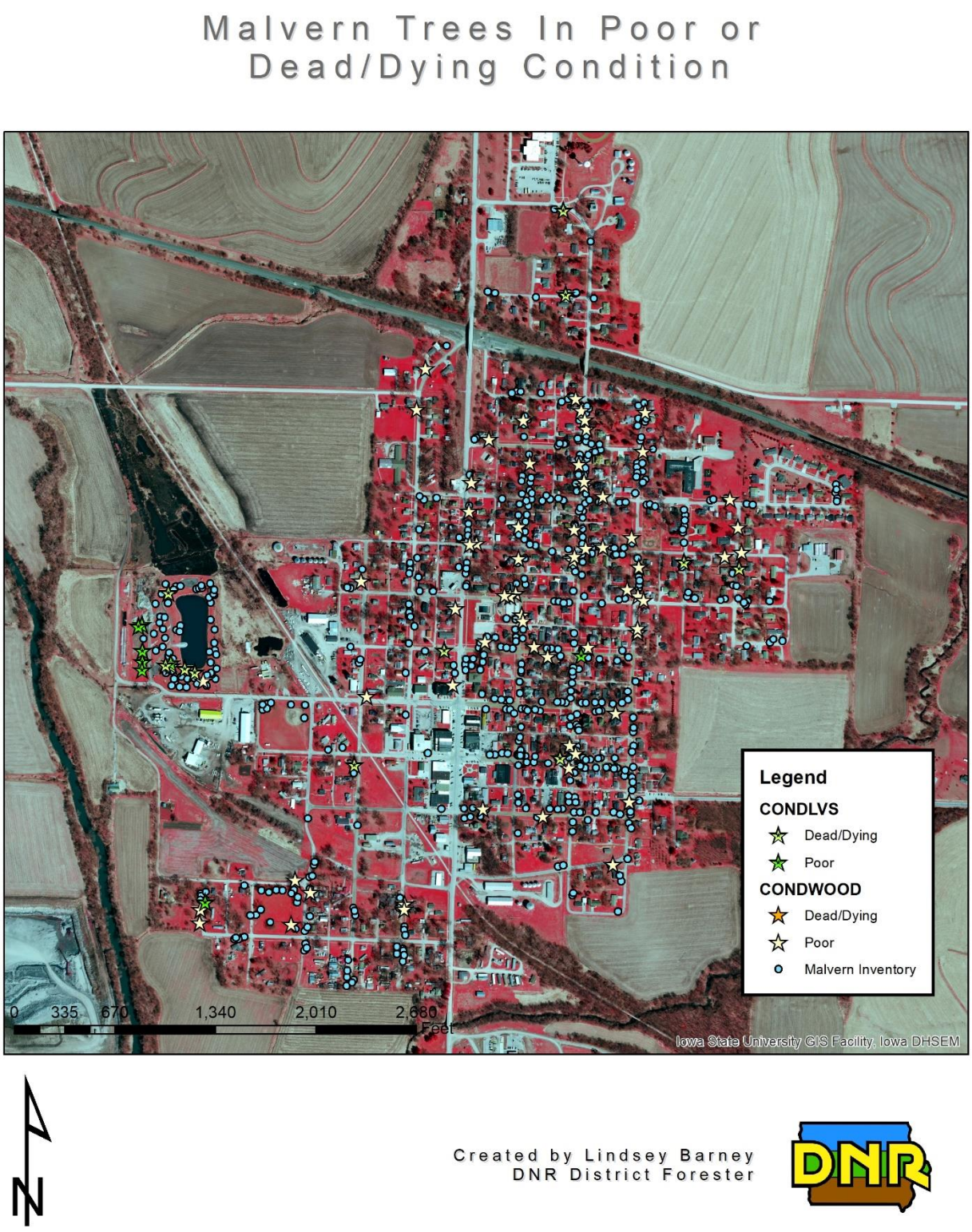

Figure 3: Distribution of trees in poor or dead/dying leaf or wood condition

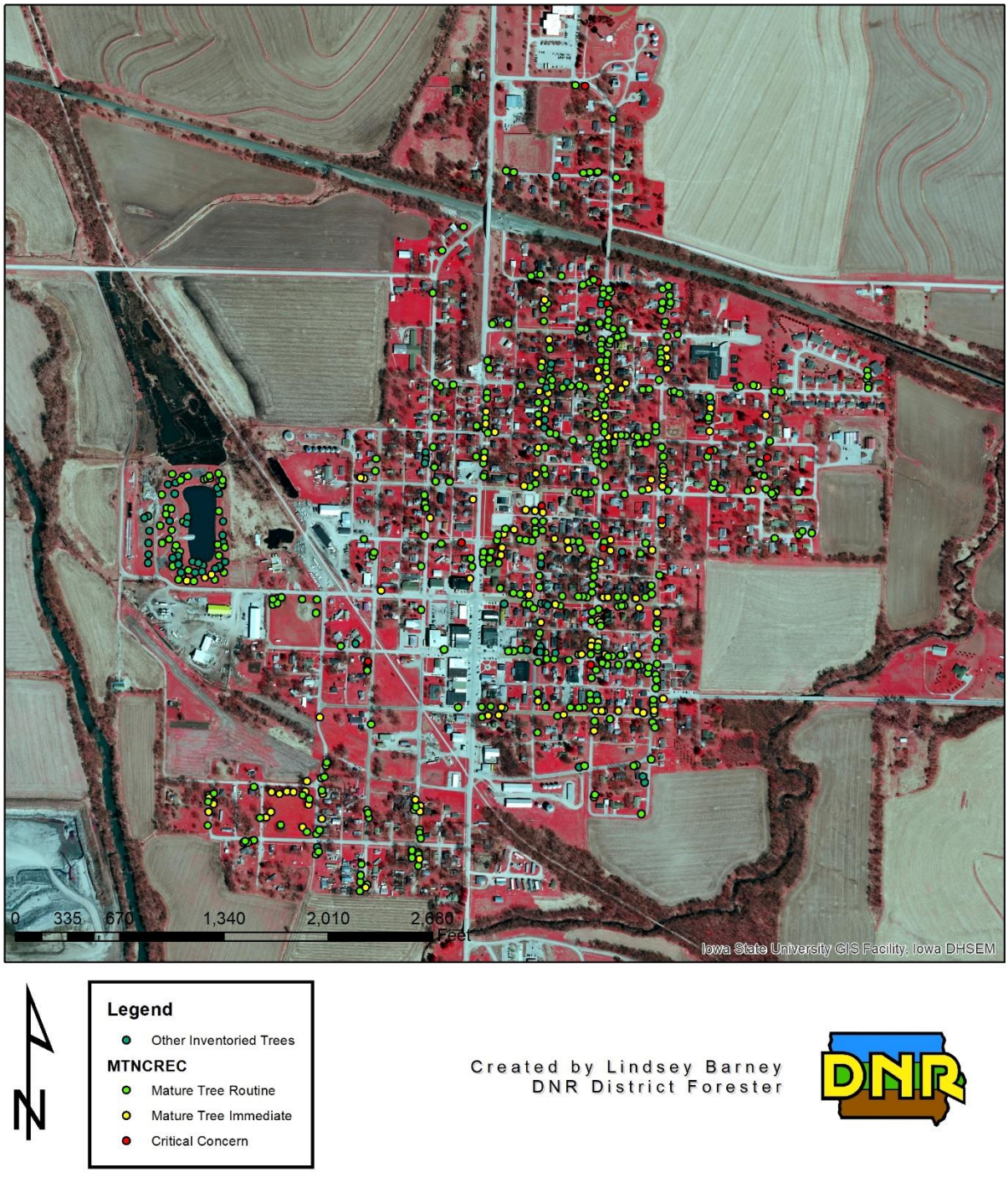

Figure 4: Malvern Trees by Maintenance Priority

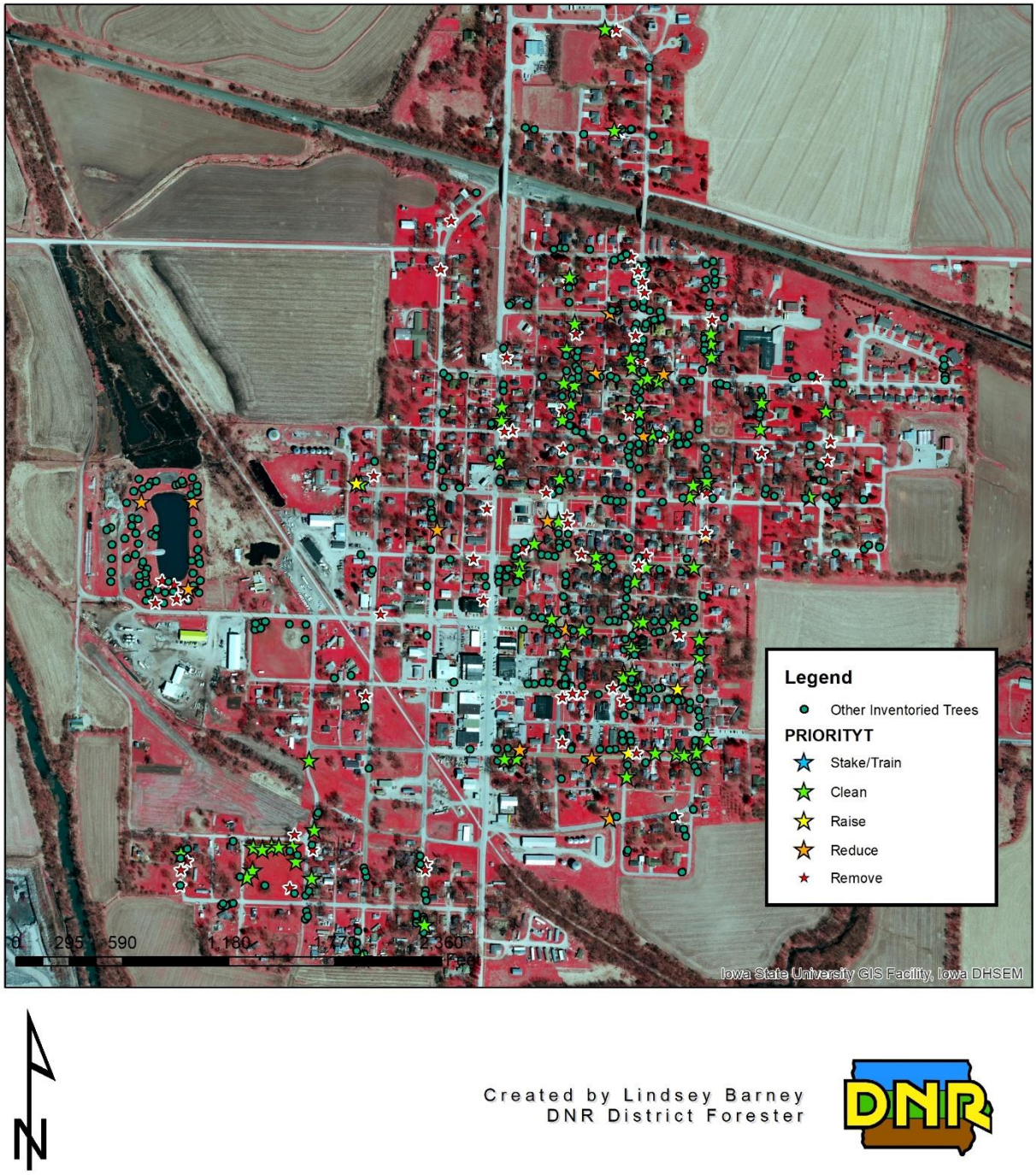

Figure 5: Malvern Trees by Maintenance Task ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Malvern Tree Ordinances

The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

Federal law prohibits employment discrimination on the basis of race, color, age, religion, national origin, sex or disability. State law prohibits employment discrimination on the basis of race, color, creed, age, sex, sexual orientation, gender identity, national origin, religion, pregnancy, or disability. State law also prohibits public accommodation (such as access to services or physical facilities) discrimination on the basis of race, color, creed, religion, sex, sexual orientation, gender identity, religion, national origin, or disability. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please contact the Iowa Civil Rights Commission, 1-800-457-4416, or write to the Iowa Department of Natural Resources, Wallace State Office Bldg., 502 E 9th St, Des Moines IA 50319.

If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-725-8200.