Harlan, IA

2019 URBAN FOREST MANAGEMENT PLAN

IOWA DEPARTMENT OF NATURAL RESOURCES

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Executive Summary

Overview

This plan was developed to assist the City of Harlan in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like 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 except mountain ash. There is a strong possibility that 20% of Harlan's city-owned trees will die once EAB becomes established in the community, unless local leaders begin preventative treatment. 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 2019, JEO conducted a tree inventory 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 1,618 trees inventoried.

- Harlan's trees provide $371,995 of benefits annually, an average of $229.91 per tree
- There are over 27 species of trees
- The top three genera are: Maple 45%, Ash 17%, and Oak 15%
- 4% of trees need some type of management
- 18 trees should be removed

Recommendations

We detail our core recommendations in the Recommendations Section. In the Emerald Ash Borer Plan, we include management recommendations. Below are some key recommendations.

- Out of the 18 trees needing removal, 15 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately. *City ownership of the trees recommended for removal should be verified prior to any removal*
- 8 of the 325 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.
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Check ash trees yearly with a visual survey.
- With the current budget it could take 23 years to remove ash. We suggest that city officials request a budget increase to $15,000 annually and apply for grants to plant replacement trees.

Introduction

This plan was developed to assist Harlan with managing, budgeting, and future planning of their urban forest. Across the state, forestry budgets continue to decrease as a higher percentage of the budgets are devoted to tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal, treatment, and replacement planting. With proper planning and management of the current canopy in Harlan, these costs can be spread out over the years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important part of Harlan's infrastructure and one of the city's greatest assets. The benefits of trees are immense. Trees improve air quality, intercept stormwater runoff, conserve energy, lower traffic speeds, increase property values, reduce crime, improve mental health, and create a desirable place to live, to name just a few. Good urban forestry management will maintain these important benefits for the people of Harlan and future generations.

Urban forestry management sets goals and develops management strategies to achieve them. To develop management strategies, a comprehensive public tree inventory must be conducted. The inventory informs maintenance, removal schedules, tree planting, and budgeting. Aligning management actions with the tree inventory results will help meet Harlan's urban forestry goals.

Inventory

In 2019, JEO conducted a tree inventory that included 100% of the city-owned trees on both streets and parks. The team collected tree data 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 data collectors' programming 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, for all ash trees, the team notes signs and symptoms associated with EAB including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

JEO entered the data collected for the 1,618 city trees into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. Below are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Harlan's trees reduce energy-related costs by approximately $95,511 annually (Appendix A, Table 1). These savings are both in electricity (456.2 MWh) and in natural gas (62,129.4 Therms).

Annual Stormwater Benefits

Harlan's trees intercept about 5,700,918 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $154,495 in benefit 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 lessens emissions of volatile organic matter (ozone). In Harlan, it is estimated that trees remove 6,185.4 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 $17,497 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Harlan, trees sequester about 1,055,018 lbs of carbon per year with an associated value of $7,913 (Appendix A, Table 5). In addition, the trees store 22,565,512 lbs of carbon, with a yearly benefit of $169,241 (Appendix A, Table 4).

Annual Aesthetics Benefits

The social benefits of trees are hard to capture. The i-Tree 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. Harlan receives $91,691 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, Harlan's trees provide $371,995 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,618 trees in Harlan provide approximately $229.91 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Harlan has over 28 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	576	35.5%
Ash	325	20%
Oak	186	11.5%
Broadleaf Deciduous Medium	99	6%
Pear	67	4%
Hackberry	59	4%
Linden/Basswood	57	3.5%
Evergreen Large	44	3%
Walnut	43	3%
Spruce	27	1.5%
Locust	25	1%
Broadleaf Deciduous Small	24	1%
Cottonwood	14	<1%
Pine	12	<1%
Birch	11	<1%
Sycamore	10	<1%
Apple (Crab)	8	<1%
Elm	8	<1%
Broadleaf Evergreen Medium	6	<1%
Kentucky Coffeetree	4	<1%
Catalpa	3	<1%
Boxelder	3	<1%
Ohio buckeye	2	<1%
Hickory	2	<1%
Tulip tree	2	<1%
Ginkgo	1	<1%

Age Class

Most of Harlan's trees (38%) are between 24 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Harlan's size curve is on the larger side, indicating an average to older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Harlan indicate that 84.5% of the trees are in good health, with only 1% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 78% of Harlan's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Two and a half percent of the tree population's wood condition is in poor health, dead, or dying. This 2.5% is an estimate of trees that need management follow up.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3).

Crown Raising	0	0%
Crown Cleaning	1	<1%
Tree Staking	1	<1%
Crown Reduction	5	<1%
Tree Removal	18	1%
Treat Pest/Disease	57	3.5%

Land Use and Location

The majority of Harlan's city and park trees are 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	74%
Industrial/Large commercial	26%
Park/vacant/other	0%
Small commercial	0%

Recommendations

Risk Management

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

Hazardous trees

Harlan has 18 trees suggested for immediate removal. These trees in addition to other trees needing maintenance can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). We recommend starting with the large-diameter, critical concern trees first. There are 15 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Work Schedule and Budget at the end of this section. After all the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 40 trees with maintenance needs.

Poor tree species

After removing the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 18 removals, 7 are ash trees. There are a total of 325 ash trees, and 310 of those have signs and symptoms that have been associated with EAB. In addition, there are 8 trees that are in poor health. *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 four 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 removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend that all trees be pruned on a routine schedule every five to seven years. Please refer to the Six Year Maintenance Plan for further information.

Planting

Most of the planting over the next five years will replace the trees that are removed. We recommend planting 1.2 trees for every tree removed, since survival rates will not be 100%. 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 Harlan.

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 (35.5%) (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, poplar, box elder, Chinese elm, evergreen, willow or black walnut, 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. We recommend 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.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized by first removing dead, dying, hazardous trees (Appendix B, Figure 4). Next will be all ash in poor condition that display EAB signs and symptoms (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 an effective tool for communities to spread removal costs out over several years while allowing trees to continue providing benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles.

A regulated article under the USDA's quarantine includes 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)

In addition, any other article, product, or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB once a quarantine is in effect for your county.

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. 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? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be normally disposed of if your county is not part of a quarantine.

Canopy Replacement
As budget permits, all removed trees will be replaced. All trees will 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, Chinese elm, evergreen, willow or black walnut.

Postponed Work
While finances, staffing, and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genera other than ash will be prioritized by hazardous or emergency situations only.

Monitoring
It is recommended that ash trees be checked with a visual survey every year for tree death and for EAB signs and symptoms including 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 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."

Proposed Work Schedule and Budget

Budget Allowance of $10,000/Year – (Based off Reported Yearly Forestry Budget)

YEAR 1	**ESTIMATED COSTS**
Remove 13 trees recommended for immediate removal	$9,100
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 2	
Remove 1 tree recommended for immediate removal	$700
Plant 5 trees in open locations	$750
Prune 1/3 of City Owned Trees	$8,100
Visual Survey of EAB Signs/Symptoms	

YEAR 3

Remove 4 trees recommended for immediate removal	$2,800
Remove 9 ash trees in poor condition	$6,300
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Remove 1 ash tree in poor condition	$700
Plant 5 trees in open locations	$750
Prune 1/3 of City Owned Trees	$8,100
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 13 ash trees in poor condition	$9,100
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 1 ash tree in poor condition	$700
Plant 5 trees in open locations	$750
Prune 1/3 of City Owned Trees	$8,100
Visual Survey of EAB Signs/Symptoms	

Estimated costs based on average costs of $700/tree for removal, $150/tree for planting and maintenance, and $15/tree for pruning.

**To remove all ash trees within 6 years alone, the budget would need to be $38,000 a year. If the budget were increased to $15,000 a year all ash could be removed in 15 years.

Proposed Work Schedule with Increased Budget

Budget Allowance of $15,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	**ESTIMATED COSTS**
Remove 18 trees recommended for immediate removal	$12,600
Remove 2 ash trees in poor condition	$1,400
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 2

Remove 8 ash trees in poor condition	$5,600
Plant 5 trees in open locations	$750
Prune 1/3 of City Owned Trees	$8,100
Visual Survey of EAB Signs/Symptoms	

YEAR 3

Remove 20 ash trees in poor condition	$14,000
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Remove 8 ash trees in poor condition	$5,600
Plant 5 trees in open locations	$750
Prune 1/3 of City Owned Trees	$8,100
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 20 ash trees in poor condition	$8,400
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 8 ash trees	$5,600
Plant 5 trees in open locations	$750
Prune 1/3 of City Owned Trees	$8,100
Visual Survey of EAB Signs/Symptoms	

Purposed Budget Increase

EAB could potentially kill all ash trees in Harlan within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to $38,000 a year. If the budget were increased to $15,000 per year all ash could be removed within 15 years. Additionally, we recommend that Harlan apply for grants to fund replacement trees. 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 considered by many communities is treating 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 removal all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20

inches and at $15 per inch, about 4 trees could be treated per year (every other year treatment). Eight trees would be selected for treatment, and Harlan would still need to find $221,900 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $4,500 a year for treatment and leave $5,500 for removal. These are alternatives to straight removal of ash trees. However, whether the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Harlan. We suggest considering an increased budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

4/14/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	92.3	7,004	12,097.2	11,855	18,859	(N/A)	16.1	19.7	72.54
Green ash	60.0	4,553	8,250.3	8,085	12,638	(N/A)	11.6	13.2	67.58
White ash	53.1	4,030	6,462.5	6,333	10,364	(N/A)	8.5	10.9	75.10
Norway maple	35.8	2,718	5,246.8	5,142	7,859	(N/A)	8.2	8.2	59.09
Northern pin oak	35.8	2,720	5,283.8	5,178	7,898	(N/A)	7.0	8.3	69.89
Broadleaf Deciduous Mec	18.4	1,399	2,661.3	2,608	4,007	(N/A)	6.1	4.2	40.47
Red maple	13.2	1,000	1,781.6	1,746	2,746	(N/A)	5.0	2.9	33.91
Sugar maple	24.5	1,863	3,263.1	3,198	5,061	(N/A)	5.0	5.3	62.48
Pear	7.5	567	1,162.3	1,139	1,707	(N/A)	4.1	1.8	25.47
Northern hackberry	23.1	1,755	3,254.4	3,189	4,945	(N/A)	3.6	5.2	83.81
American basswood	12.4	938	1,775.1	1,740	2,678	(N/A)	2.8	2.8	58.22
Northern red oak	8.9	674	1,234.3	1,210	1,884	(N/A)	2.8	2.0	40.95
Black walnut	17.3	1,311	2,362.9	2,316	3,627	(N/A)	2.7	3.8	84.34
Conifer Evergreen Large	6.2	471	773.9	758	1,230	(N/A)	2.6	1.3	29.28
Honeylocust	7.2	547	942.9	924	1,472	(N/A)	1.5	1.5	61.32
Black maple	5.8	438	804.7	789	1,227	(N/A)	1.3	1.3	58.41
Norway spruce	2.1	163	268.8	263	426	(N/A)	0.9	0.4	28.42
River birch	1.4	109	217.2	213	322	(N/A)	0.7	0.3	29.24
Cottonwood	4.7	355	626.6	614	969	(N/A)	0.7	1.0	88.05
Littleleaf linden	2.0	148	268.0	263	411	(N/A)	0.7	0.4	37.35
American sycamore	4.4	331	583.6	572	903	(N/A)	0.6	0.9	90.25
Eastern white pine	1.7	127	221.4	217	344	(N/A)	0.6	0.4	38.17
Broadleaf Deciduous Sma	0.5	35	72.6	71	106	(N/A)	0.6	0.1	11.79
Blue spruce	1.4	107	193.8	190	297	(N/A)	0.6	0.3	32.96
White oak	0.8	64	118.0	116	179	(N/A)	0.6	0.2	19.93
Apple	0.4	33	75.5	74	107	(N/A)	0.5	0.1	13.40
Bur oak	0.9	71	129.5	127	197	(N/A)	0.5	0.2	24.69
Swamp white oak	0.7	56	110.1	108	164	(N/A)	0.5	0.2	20.47
Chinese elm	2.9	224	398.4	390	614	(N/A)	0.4	0.6	87.75
Common chokecherry	0.6	49	105.5	103	152	(N/A)	0.4	0.2	25.38
Southern magnolia	0.7	50	90.6	89	138	(N/A)	0.3	0.1	27.69
Eastern redbud	0.2	15	33.3	33	47	(N/A)	0.2	0.0	11.80
Kentucky coffeetree	0.8	58	95.8	94	152	(N/A)	0.2	0.2	37.90
Boxelder	0.7	54	96.4	94	149	(N/A)	0.2	0.2	49.63
Northern catalpa	0.6	47	88.7	87	134	(N/A)	0.2	0.1	44.68
Eastern cottonwood	1.0	77	134.3	132	208	(N/A)	0.2	0.2	69.42
Black spruce	0.3	25	44.9	44	69	(N/A)	0.2	0.1	22.99
Austrian pine	0.5	38	69.8	68	106	(N/A)	0.2	0.1	35.47
Ohio buckeye	0.6	44	87.0	85	130	(N/A)	0.1	0.1	64.76
Broadleaf Evergreen Larg	0.5	38	56.8	56	94	(N/A)	0.1	0.1	46.87
Hickory	0.7	49	91.8	90	139	(N/A)	0.1	0.1	69.67
Tulip tree	0.7	50	93.7	92	142	(N/A)	0.1	0.1	70.91
Mountain ash	0.4	28	49.3	48	76	(N/A)	0.1	0.1	38.13
American elm	0.6	45	71.2	70	114	(N/A)	0.1	0.1	114.45
Scarlet oak	0.4	33	59.0	58	91	(N/A)	0.1	0.1	91.02
Black cherry	0.2	15	31.6	31	46	(N/A)	0.1	0.0	46.14
Pin oak	0.4	33	56.2	55	88	(N/A)	0.1	0.1	87.97
Black locust	0.3	24	47.4	46	71	(N/A)	0.1	0.1	70.84
Ginkgo	0.1	5	9.9	10	15	(N/A)	0.1	0.0	14.72
Broadleaf Evergreen Med	0.1	6	12.7	12	19	(N/A)	0.1	0.0	18.82
Alder	0.2	15	31.6	31	46	(N/A)	0.1	0.0	46.14
White mulberry	0.2	15	31.6	31	46	(N/A)	0.1	0.0	46.14
Total	456.2	34,625	62,129.4	60,887	95,511	(N/A)	100.0	100.0	59.03

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

4/14/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,449,529	39,282	(N/A)	16.1	25.4	151.09
Green ash	761,005	20,623	(N/A)	11.6	13.3	110.28
White ash	650,215	17,621	(N/A)	8.5	11.4	127.69
Norway maple	380,935	10,323	(N/A)	8.2	6.7	77.62
Northern pin oak	416,197	11,279	(N/A)	7.0	7.3	99.81
Broadleaf Deciduous Medi	144,906	3,927	(N/A)	6.1	2.5	39.67
Red maple	106,034	2,874	(N/A)	5.0	1.9	35.48
Sugar maple	317,476	8,604	(N/A)	5.0	5.6	106.22
Pear	34,929	947	(N/A)	4.1	0.6	14.13
Northern hackberry	256,400	6,948	(N/A)	3.6	4.5	117.77
American basswood	137,315	3,721	(N/A)	2.8	2.4	80.90
Northern red oak	91,404	2,477	(N/A)	2.8	1.6	53.85
Black walnut	259,277	7,026	(N/A)	2.7	4.5	163.40
Conifer Evergreen Large	114,653	3,107	(N/A)	2.6	2.0	73.98
Honeylocust	73,499	1,992	(N/A)	1.5	1.3	82.99
Black maple	56,702	1,537	(N/A)	1.3	1.0	73.17
Norway spruce	39,945	1,083	(N/A)	0.9	0.7	72.17
River birch	13,748	373	(N/A)	0.7	0.2	33.87
Cottonwood	66,243	1,795	(N/A)	0.7	1.2	163.20
Littleleaf linden	16,896	458	(N/A)	0.7	0.3	41.63
American sycamore	65,596	1,778	(N/A)	0.6	1.2	177.77
Eastern white pine	41,442	1,123	(N/A)	0.6	0.7	124.79
Broadleaf Deciduous Smal	1,620	44	(N/A)	0.6	0.0	4.88
Blue spruce	23,716	643	(N/A)	0.6	0.4	71.41
White oak	9,258	251	(N/A)	0.6	0.2	27.88
Apple	1,528	41	(N/A)	0.5	0.0	5.18
Bur oak	10,746	291	(N/A)	0.5	0.2	36.40
Swamp white oak	4,091	111	(N/A)	0.5	0.1	13.86
Chinese elm	43,880	1,189	(N/A)	0.4	0.8	169.88
Common chokecherry	3,210	87	(N/A)	0.4	0.1	14.50
Southern magnolia	6,926	188	(N/A)	0.3	0.1	37.54
Eastern redbud	666	18	(N/A)	0.2	0.0	4.51
Kentucky coffeetree	5,693	154	(N/A)	0.2	0.1	38.57
Boxelder	7,635	207	(N/A)	0.2	0.1	68.97
Northern catalpa	6,705	182	(N/A)	0.2	0.1	60.57
Eastern cottonwood	12,447	337	(N/A)	0.2	0.2	112.43
Black spruce	4,612	125	(N/A)	0.2	0.1	41.66
Austrian pine	8,774	238	(N/A)	0.2	0.2	79.26
Ohio buckeye	6,244	169	(N/A)	0.1	0.1	84.60
Broadleaf Evergreen Large	5,055	137	(N/A)	0.1	0.1	68.49
Hickory	8,081	219	(N/A)	0.1	0.1	109.50
Tulip tree	7,886	214	(N/A)	0.1	0.1	106.85
Mountain ash	1,333	36	(N/A)	0.1	0.0	18.06
American elm	4,551	123	(N/A)	0.1	0.1	123.33
Scarlet oak	7,239	196	(N/A)	0.1	0.1	196.17
Black cherry	1,174	32	(N/A)	0.1	0.0	31.82
Pin oak	6,412	174	(N/A)	0.1	0.1	173.76
Black locust	3,764	102	(N/A)	0.1	0.1	102.01
Ginkgo	301	8	(N/A)	0.1	0.0	8.17
Broadleaf Evergreen Medit	677	18	(N/A)	0.1	0.0	18.34
Alder	1,174	32	(N/A)	0.1	0.0	31.82
White mulberry	1,174	32	(N/A)	0.1	0.0	31.82
Citywide total	5,700,918	154,495	(N/A)	100.0	100.0	95.49

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

4/14/2020

Species	Deposition (lb) O_3	NO_2	PM_{10}	SO_2	Total Depos. ($)	Avoided (lb) NO_2	PM_{10}	VOC	SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg $/tree
Silver maple	266.9	45.2	129.1	11.8	1,434	434.5	63.6	60.8	417.4	2,720	-137.6	-516	1,291.8	3,637	(N/A)	16.1	13.99
Green ash	106.5	17.0	49.1	4.8	562	286.8	41.7	39.8	271.8	1,785	0.0	0	817.5	2,347	(N/A)	11.6	12.55
White ash	127.9	20.4	57.4	5.7	670	246.0	36.3	34.8	240.4	1,550	0.0	0	769.0	2,221	(N/A)	8.5	16.09
Norway maple	83.5	14.4	40.3	3.7	449	174.3	25.1	23.9	162.4	1,078	-19.1	-72	508.6	1,455	(N/A)	8.2	10.94
Northern pin oak	95.2	16.4	45.5	4.2	510	174.7	25.2	24.0	162.6	1,080	-21.5	-80	526.2	1,510	(N/A)	7.0	13.36
Broadleaf Deciduous Medi	26.0	4.5	13.3	1.2	142	89.4	12.9	12.3	83.6	554	-6.4	-24	236.8	672	(N/A)	6.1	6.78
Red maple	24.3	4.1	11.5	1.1	130	62.6	9.1	8.7	59.7	391	-8.3	-31	173.0	490	(N/A)	5.0	6.05
Sugar maple	46.8	8.0	22.5	2.1	251	116.2	17.0	16.2	111.2	726	-36.3	-136	303.7	841	(N/A)	5.0	10.39
Pear	11.1	1.8	5.2	0.5	59	36.9	5.3	5.0	33.9	227	-0.1	0	99.6	285	(N/A)	4.1	4.26
Northern hackberry	45.1	7.8	22.2	2.0	244	111.4	16.2	15.4	104.9	692	0.0	0	324.9	936	(N/A)	3.6	15.86
American basswood	18.8	3.2	9.2	0.8	101	59.9	8.7	8.2	56.1	371	-16.0	-60	148.9	412	(N/A)	2.8	8.97
Northern red oak	19.4	3.4	9.4	0.9	105	42.5	6.2	5.9	40.2	264	-28.0	-105	99.9	264	(N/A)	2.8	5.74
Black walnut	40.1	6.4	17.9	1.8	210	82.5	12.0	11.4	78.3	514	0.0	0	250.4	724	(N/A)	2.7	16.83
Conifer Evergreen Large	13.6	2.7	11.0	1.7	89	28.9	4.3	4.1	28.1	182	-60.9	-228	33.5	43	(N/A)	2.6	1.02
Honeylocust	14.1	2.3	6.5	0.6	75	34.0	5.0	4.8	32.7	213	-10.7	-40	89.2	247	(N/A)	1.5	10.29
Black maple	14.6	2.5	6.7	0.6	78	27.6	4.0	3.8	26.1	172	-4.8	-18	81.3	232	(N/A)	1.3	11.03
Norway spruce	4.7	0.9	3.8	0.6	31	10.0	1.5	1.4	9.7	63	-21.0	-79	11.7	15	(N/A)	0.9	1.02
River birch	2.8	0.5	1.4	0.1	15	7.0	1.0	1.0	6.5	43	-0.7	-2	19.6	56	(N/A)	0.7	5.10
Cottonwood	12.6	2.0	5.5	0.6	66	22.2	3.2	3.1	21.2	138	0.0	0	70.4	204	(N/A)	0.7	18.56
Littleleaf linden	2.6	0.4	1.3	0.1	14	9.3	1.4	1.3	8.9	58	-1.3	-5	24.1	67	(N/A)	0.7	6.14
American sycamore	11.9	1.9	5.2	0.5	62	20.7	3.0	2.9	19.7	129	0.0	0	65.9	191	(N/A)	0.6	19.12
Eastern white pine	5.1	1.0	4.0	0.6	33	7.9	1.2	1.1	7.6	49	-25.8	-97	2.7	-14	(N/A)	0.6	-1.58
Broadleaf Deciduous Smal	0.4	0.1	0.2	0.0	2	2.3	0.3	0.3	2.1	14	0.0	0	5.6	16	(N/A)	0.6	1.77
Blue spruce	4.1	0.8	3.3	0.5	27	6.7	1.0	0.9	6.4	42	-9.2	-34	14.5	34	(N/A)	0.6	3.78
White oak	1.1	0.2	0.5	0.0	6	4.0	0.6	0.6	3.8	25	0.0	0	10.8	31	(N/A)	0.6	3.43
Apple	0.2	0.0	0.1	0.0	1	2.2	0.3	0.3	2.0	14	0.0	0	5.2	15	(N/A)	0.5	1.86
Bur oak	1.3	0.2	0.6	0.1	7	4.5	0.6	0.6	4.2	28	0.0	0	12.2	35	(N/A)	0.5	4.34
Swamp white oak	0.5	0.1	0.3	0.0	3	3.6	0.5	0.5	3.3	22	-0.1	-1	8.7	24	(N/A)	0.5	3.04
Chinese elm	7.6	1.2	3.3	0.3	40	14.0	2.0	2.0	13.4	88	0.0	0	43.9	127	(N/A)	0.4	18.15
Common chokecherry	1.0	0.2	0.5	0.0	5	3.2	0.5	0.4	2.9	20	0.0	0	8.7	25	(N/A)	0.4	4.17
Southern magnolia	0.8	0.2	0.8	0.1	6	3.1	0.5	0.4	2.9	19	-1.9	-7	6.9	18	(N/A)	0.3	3.61
Eastern redbud	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	0.0	0	2.3	7	(N/A)	0.2	1.63
Kentucky coffeetree	0.5	0.1	0.3	0.0	3	3.6	0.5	0.5	3.4	22	0.0	0	8.9	25	(N/A)	0.2	6.26
Boxelder	1.0	0.2	0.5	0.0	5	3.4	0.5	0.5	3.2	21	-0.4	-2	8.9	25	(N/A)	0.2	8.33
Northern catalpa	0.8	0.1	0.4	0.0	4	3.0	0.4	0.4	2.8	19	0.0	0	8.0	23	(N/A)	0.2	7.56
Eastern cottonwood	1.7	0.3	0.8	0.1	9	4.8	0.7	0.7	4.6	30	0.0	0	13.6	39	(N/A)	0.2	12.95
Black spruce	0.6	0.1	0.5	0.1	4	1.6	0.2	0.2	1.5	10	-1.7	-6	3.1	8	(N/A)	0.2	2.51
Austrian pine	1.6	0.3	1.3	0.2	10	2.4	0.3	0.3	2.3	15	-3.4	-13	5.3	12	(N/A)	0.2	4.16
Ohio buckeye	1.4	0.2	0.7	0.1	7	2.9	0.4	0.4	2.6	18	-0.3	-1	8.3	24	(N/A)	0.1	11.87
Broadleaf Evergreen Large	0.4	0.1	0.4	0.1	3	2.3	0.3	0.3	2.3	15	-2.1	-8	4.1	10	(N/A)	0.1	4.77
Hickory	1.1	0.2	0.5	0.0	6	3.1	0.5	0.4	2.9	19	0.0	0	8.7	25	(N/A)	0.1	12.53
Tulip tree	1.0	0.2	0.5	0.0	5	3.2	0.5	0.4	3.0	20	0.0	0	8.7	25	(N/A)	0.1	12.48
Mountain ash	0.4	0.1	0.2	0.0	2	1.7	0.3	0.2	1.7	11	0.0	0	4.6	13	(N/A)	0.1	6.56
American elm	2.2	0.4	1.0	0.1	12	2.7	0.4	0.4	2.7	17	0.0	0	9.9	29	(N/A)	0.1	28.89
Scarlet oak	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.1	19.04
Black cherry	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.1	8.35
Pin oak	1.3	0.2	0.7	0.1	7	2.0	0.3	0.3	2.0	13	-2.4	-9	4.5	11	(N/A)	0.1	10.96
Black locust	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14	(N/A)	0.1	13.58
Ginkgo	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2	(N/A)	0.1	2.12
Broadleaf Evergreen Medi	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	-0.2	-1	0.8	2	(N/A)	0.1	2.10
Alder	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.1	8.35
White mulberry	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.1	8.35
Citywide total	1,028.0	172.9	497.1	48.2	5,522	2,174.0	316.8	302.1	2,066.5	13,551	-420.2	-1,576	6,185.4	17,497	(N/A)	100.0	10.81

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

4/14/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	6,294,180	47,206	(N/A)	16.1	27.9	181.56
Green ash	3,521,171	26,409	(N/A)	11.6	15.6	141.22
White ash	1,975,848	14,819	(N/A)	8.5	8.8	107.38
Norway maple	1,378,485	10,339	(N/A)	8.2	6.1	77.73
Northern pin oak	1,572,830	11,796	(N/A)	7.0	7.0	104.39
Broadleaf Deciduou	435,310	3,265	(N/A)	6.1	1.9	32.98
Red maple	267,887	2,009	(N/A)	5.0	1.2	24.80
Sugar maple	1,382,247	10,367	(N/A)	5.0	6.1	127.99
Pear	175,972	1,320	(N/A)	4.1	0.8	19.70
Northern hackberry	712,483	5,344	(N/A)	3.6	3.2	90.57
American basswoo	699,795	5,248	(N/A)	2.8	3.1	114.10
Northern red oak	426,924	3,202	(N/A)	2.8	1.9	69.61
Black walnut	1,343,092	10,073	(N/A)	2.7	6.0	234.26
Conifer Evergreen I	152,789	1,146	(N/A)	2.6	0.7	27.28
Honeylocust	180,084	1,351	(N/A)	1.5	0.8	56.28
Black maple	155,685	1,168	(N/A)	1.3	0.7	55.60
Norway spruce	52,367	393	(N/A)	0.9	0.2	26.18
River birch	46,459	348	(N/A)	0.7	0.2	31.68
Cottonwood	435,097	3,263	(N/A)	0.7	1.9	296.66
Littleleaf linden	56,509	424	(N/A)	0.7	0.3	38.53
American sycamore	409,363	3,070	(N/A)	0.6	1.8	307.02
Eastern white pine	67,413	506	(N/A)	0.6	0.3	56.18
Broadleaf Deciduou	6,158	46	(N/A)	0.6	0.0	5.13
Blue spruce	35,802	269	(N/A)	0.6	0.2	29.83
White oak	36,028	270	(N/A)	0.6	0.2	30.02
Apple	5,073	38	(N/A)	0.5	0.0	4.76
Bur oak	43,504	326	(N/A)	0.5	0.2	40.79
Swamp white oak	8,481	64	(N/A)	0.5	0.0	7.95
Chinese elm	258,140	1,936	(N/A)	0.4	1.1	276.58
Common chokeche	16,387	123	(N/A)	0.4	0.1	20.48
Southern magnolia	9,849	74	(N/A)	0.3	0.0	14.77
Eastern redbud	2,171	16	(N/A)	0.2	0.0	4.07
Kentucky coffeetre	15,987	120	(N/A)	0.2	0.1	29.98
Boxelder	32,184	241	(N/A)	0.2	0.1	80.46
Northern catalpa	24,416	183	(N/A)	0.2	0.1	61.04
Eastern cottonwood	55,558	417	(N/A)	0.2	0.2	138.90
Black spruce	4,064	30	(N/A)	0.2	0.0	10.16
Austrian pine	14,680	110	(N/A)	0.2	0.1	36.70
Ohio buckeye	22,225	167	(N/A)	0.1	0.1	83.35
Broadleaf Evergree	7,190	54	(N/A)	0.1	0.0	26.96
Hickory	34,401	258	(N/A)	0.1	0.2	129.00
Tulip tree	31,546	237	(N/A)	0.1	0.1	118.30
Mountain ash	6,074	46	(N/A)	0.1	0.0	22.78
American elm	41,265	309	(N/A)	0.1	0.2	309.48
Scarlet oak	39,259	294	(N/A)	0.1	0.2	294.44
Black cherry	6,743	51	(N/A)	0.1	0.0	50.57
Pin oak	37,616	282	(N/A)	0.1	0.2	282.12
Black locust	14,280	107	(N/A)	0.1	0.1	107.10
Ginkgo	474	4	(N/A)	0.1	0.0	3.56
Broadleaf Evergree	484	4	(N/A)	0.1	0.0	3.63
Alder	6,743	51	(N/A)	0.1	0.0	50.57
White mulberry	6,743	51	(N/A)	0.1	0.0	50.57
Citywide total	22,565,512	169,241	(N/A)	100.0	100.0	104.60

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees

4/14/2020

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	427,318	3,205	-30,216	-1,070	-235	154,792	1,161	550,824	4,131	(N/A)	16.1	32.3	15.89
Green ash	139,098	1,043	-16,902	-650	-132	100,610	755	222,156	1,666	(N/A)	11.6	13.0	8.91
White ash	127,259	954	-9,485	-449	-75	89,070	668	206,395	1,548	(N/A)	8.5	12.1	11.22
Norway maple	32,337	243	-6,620	-413	-53	60,059	450	85,362	640	(N/A)	8.2	5.0	4.81
Northern pin oak	8,497	64	-7,550	-461	-60	60,112	451	60,598	454	(N/A)	7.0	3.6	4.02
Broadleaf Deciduous Me	28,677	215	-2,093	-191	-17	30,911	232	57,305	430	(N/A)	6.1	3.4	4.34
Red maple	23,684	178	-1,286	-126	-11	22,110	166	44,382	333	(N/A)	5.0	2.6	4.11
Sugar maple	62,089	466	-6,637	-277	-52	41,173	309	96,348	723	(N/A)	5.0	5.6	8.92
Pear	11,138	84	-845	-110	-7	12,540	94	22,724	170	(N/A)	4.1	1.3	2.54
Northern hackberry	31,623	237	-3,420	-229	-27	38,794	291	66,769	501	(N/A)	3.6	3.9	8.49
American basswood	40,638	305	-3,359	-144	-26	20,740	156	57,874	434	(N/A)	2.8	3.4	9.44
Northern red oak	4,823	36	-2,049	-116	-16	14,893	112	17,552	132	(N/A)	2.8	1.0	2.86
Black walnut	38,230	287	-6,447	-195	-50	28,972	217	60,560	454	(N/A)	2.7	3.5	10.56
Conifer Evergreen Large	3,022	23	-733	-124	-6	10,420	78	12,584	94	(N/A)	2.6	0.7	2.25
Honeylocust	14,380	108	-865	-56	-7	12,099	91	25,558	192	(N/A)	1.5	1.5	7.99
Black maple	2,495	19	-747	-55	-6	9,679	73	11,372	85	(N/A)	1.3	0.7	4.06
Norway spruce	1,202	9	-251	-43	-2	3,601	27	4,508	34	(N/A)	0.9	0.3	2.25
River birch	1,927	14	-226	-17	-2	2,406	18	4,090	31	(N/A)	0.7	0.2	2.79
Cottonwood	7,363	55	-2,088	-54	-16	7,834	59	13,055	98	(N/A)	0.7	0.8	8.90
Littleleaf linden	4,931	37	-272	-23	-2	3,276	25	7,912	59	(N/A)	0.7	0.5	5.39
American sycamore	7,428	56	-1,965	-51	-15	7,307	55	12,719	95	(N/A)	0.6	0.7	9.54
Eastern white pine	1,536	12	-324	-35	-3	2,799	21	3,977	30	(N/A)	0.6	0.2	3.31
Broadleaf Deciduous Sm	711	5	-30	-7	0	772	6	1,446	11	(N/A)	0.6	0.1	1.21
Blue spruce	1,327	10	-172	-28	-2	2,357	18	3,485	26	(N/A)	0.6	0.2	2.90
White oak	2,058	15	-173	-11	-1	1,409	11	3,284	25	(N/A)	0.6	0.2	2.74
Apple	683	5	-24	-8	0	732	5	1,384	10	(N/A)	0.5	0.1	1.30
Bur oak	2,325	17	-209	-12	-2	1,560	12	3,664	27	(N/A)	0.5	0.2	3.44
Swamp white oak	1,478	11	-42	-8	0	1,235	9	2,663	20	(N/A)	0.5	0.2	2.50
Chinese elm	5,558	42	-1,239	-34	-10	4,947	37	9,232	69	(N/A)	0.4	0.5	9.89
Common chokecherry	858	6	-79	-10	-1	1,079	8	1,848	14	(N/A)	0.4	0.1	2.31
Southern magnolia	605	5	-47	-8	0	1,098	8	1,648	12	(N/A)	0.3	0.1	2.47
Eastern redbud	304	2	-10	-4	0	323	2	612	5	(N/A)	0.2	0.0	1.15
Kentucky coffeetree	1,625	12	-77	-7	-1	1,276	10	2,816	21	(N/A)	0.2	0.2	5.28
Boxelder	2,495	19	-154	-9	-1	1,202	9	3,533	27	(N/A)	0.2	0.2	8.83
Northern catalpa	1,591	12	-117	-7	-1	1,042	8	2,509	19	(N/A)	0.2	0.1	6.27
Eastern cottonwood	2,365	18	-267	-11	-2	1,693	13	3,780	28	(N/A)	0.2	0.2	9.45
Black spruce	276	2	-20	-6	0	552	4	803	6	(N/A)	0.2	0.0	2.01
Austrian pine	377	3	-70	-11	-1	840	6	1,136	9	(N/A)	0.2	0.1	2.84
Ohio buckeye	840	6	-107	-6	-1	979	7	1,706	13	(N/A)	0.1	0.1	6.40
Broadleaf Evergreen Lar	837	6	-35	-4	0	843	6	1,641	12	(N/A)	0.1	0.1	6.15
Hickory	1,619	12	-165	-7	-1	1,091	8	2,539	19	(N/A)	0.1	0.1	9.52
Tulip tree	1,714	13	-151	-7	-1	1,105	8	2,660	20	(N/A)	0.1	0.2	9.97
Mountain ash	535	4	-29	-4	0	617	5	1,119	8	(N/A)	0.1	0.1	4.20
American elm	724	5	-198	-6	-2	987	7	1,507	11	(N/A)	0.1	0.1	11.31
Scarlet oak	912	7	-188	-5	-1	734	6	1,453	11	(N/A)	0.1	0.1	10.90
Black cherry	478	4	-32	-3	0	335	3	778	6	(N/A)	0.1	0.0	5.84
Pin oak	2,912	22	-181	-5	-1	728	5	3,454	26	(N/A)	0.1	0.2	25.90
Black locust	0	0	-69	-4	-1	539	4	466	3	(N/A)	0.1	0.0	3.49
Ginkgo	58	0	-2	-1	0	111	1	165	1	(N/A)	0.1	0.0	1.24
Broadleaf Evergreen Me	56	0	-2	-1	0	141	1	194	1	(N/A)	0.1	0.0	1.45
Alder	0	0	-32	-4	0	335	3	299	2	(N/A)	0.1	0.0	2.24
White mulberry	0	0	-32	-4	0	335	3	299	2	(N/A)	0.1	0.0	2.24
Citywide total	1,055,018	7,913	-108,335	-5,128	-851	765,193	5,739	1,706,747	12,801	(N/A)	100.0	100.0	7.91

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

4/14/2020

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	31,520	(N/A)	16.1	34.4	121.23
Green ash	10,648	(N/A)	11.6	11.6	56.94
White ash	13,372	(N/A)	8.5	14.6	96.90
Norway maple	3,003	(N/A)	8.2	3.3	22.58
Northern pin oak	746	(N/A)	7.0	0.8	6.60
Broadleaf Deciduous Medi	2,965	(N/A)	6.1	3.2	29.95
Red maple	3,148	(N/A)	5.0	3.4	38.86
Sugar maple	6,122	(N/A)	5.0	6.7	75.59
Pear	650	(N/A)	4.1	0.7	9.70
Northern hackberry	3,861	(N/A)	3.6	4.2	65.44
American basswood	2,888	(N/A)	2.8	3.2	62.79
Northern red oak	417	(N/A)	2.8	0.5	9.06
Black walnut	2,606	(N/A)	2.7	2.8	60.59
Conifer Evergreen Large	836	(N/A)	2.6	0.9	19.91
Honeylocust	3,307	(N/A)	1.5	3.6	137.81
Black maple	314	(N/A)	1.3	0.3	14.95
Norway spruce	327	(N/A)	0.9	0.4	21.82
River birch	201	(N/A)	0.7	0.2	18.26
Cottonwood	501	(N/A)	0.7	0.5	45.58
Littleleaf linden	538	(N/A)	0.7	0.6	48.89
American sycamore	488	(N/A)	0.6	0.5	48.81
Eastern white pine	158	(N/A)	0.6	0.2	17.50
Broadleaf Deciduous Smal	39	(N/A)	0.6	0.0	4.32
Blue spruce	129	(N/A)	0.6	0.1	14.36
White oak	213	(N/A)	0.6	0.2	23.65
Apple	38	(N/A)	0.5	0.0	4.77
Bur oak	225	(N/A)	0.5	0.2	28.12
Swamp white oak	173	(N/A)	0.5	0.2	21.57
Chinese elm	373	(N/A)	0.4	0.4	53.23
Common chokecherry	50	(N/A)	0.4	0.1	8.34
Southern magnolia	114	(N/A)	0.3	0.1	22.74
Eastern redbud	17	(N/A)	0.2	0.0	4.23
Kentucky coffeetree	164	(N/A)	0.2	0.2	41.03
Boxelder	170	(N/A)	0.2	0.2	56.74
Northern catalpa	138	(N/A)	0.2	0.2	46.00
Eastern cottonwood	179	(N/A)	0.2	0.2	59.68
Black spruce	66	(N/A)	0.2	0.1	22.09
Austrian pine	26	(N/A)	0.2	0.0	8.54
Ohio buckeye	75	(N/A)	0.1	0.1	37.26
Broadleaf Evergreen Large	194	(N/A)	0.1	0.2	97.24
Hickory	124	(N/A)	0.1	0.1	62.14
Tulip tree	131	(N/A)	0.1	0.1	65.59
Mountain ash	31	(N/A)	0.1	0.0	15.48
American elm	87	(N/A)	0.1	0.1	86.69
Scarlet oak	58	(N/A)	0.1	0.1	58.34
Black cherry	29	(N/A)	0.1	0.0	28.80
Pin oak	206	(N/A)	0.1	0.2	205.74
Black locust	0	(N/A)	0.1	0.0	0.00
Ginkgo	7	(N/A)	0.1	0.0	6.77
Broadleaf Evergreen Medit	22	(N/A)	0.1	0.0	21.93
Alder	0	(N/A)	0.1	0.0	0.00
White mulberry	0	(N/A)	0.1	0.0	0.00
Citywide total	91,691	(N/A)	100.0	100.0	56.67

Table 7: Summary of Benefits in Dollars

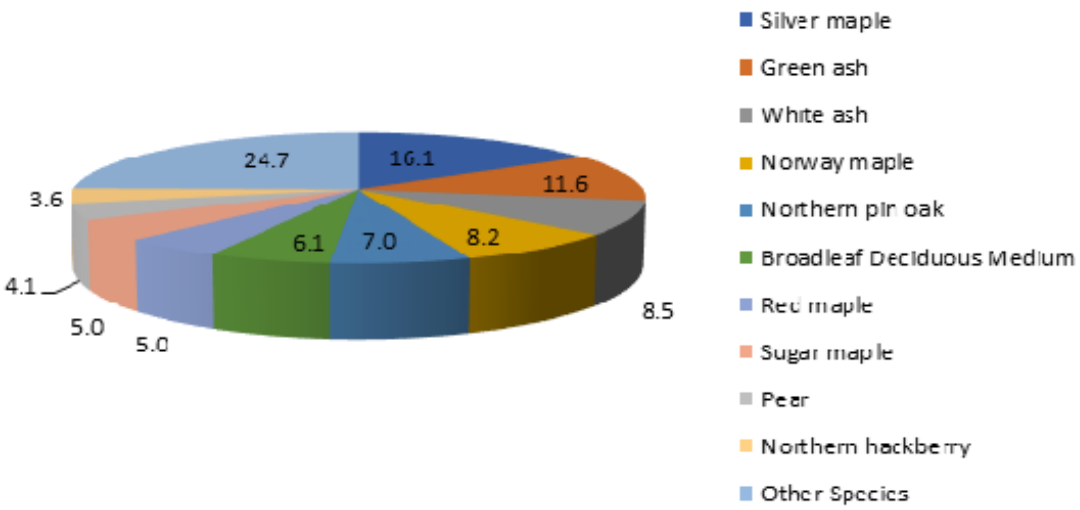
Annual Benefits of Public Trees by Species ($/tree)

4/14/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Silver maple	72.54	15.89	13.99	151.09	121.23	374.73	(N/A)
Green ash	67.58	8.91	12.55	110.28	56.94	256.27	(N/A)
White ash	75.10	11.22	16.09	127.69	96.90	327.00	(N/A)
Norway maple	59.09	4.81	10.94	77.62	22.58	175.04	(N/A)
Northern pin oak	69.89	4.02	13.36	99.81	6.60	193.69	(N/A)
Broadleaf Deciduou	40.47	4.34	6.78	39.67	29.95	121.21	(N/A)
Red maple	33.91	4.11	6.05	35.48	38.86	118.40	(N/A)
Sugar maple	62.48	8.92	10.39	106.22	75.59	263.59	(N/A)
Pear	25.47	2.54	4.26	14.13	9.70	56.11	(N/A)
Northern hackberry	83.81	8.49	15.86	117.77	65.44	291.37	(N/A)
American basswood	58.22	9.44	8.97	80.90	62.79	220.31	(N/A)
Northern red oak	40.95	2.86	5.74	53.85	9.06	112.46	(N/A)
Black walnut	84.34	10.56	16.83	163.40	60.59	335.73	(N/A)
Conifer Evergreen L	29.28	2.25	1.02	73.98	19.91	126.43	(N/A)
Honeylocust	61.32	7.99	10.29	82.99	137.81	300.39	(N/A)
Black maple	58.41	4.06	11.03	73.17	14.95	161.62	(N/A)
Norway spruce	28.42	2.25	1.02	72.17	21.82	125.68	(N/A)
River birch	29.24	2.79	5.10	33.87	18.26	89.25	(N/A)
Cottonwood	88.05	8.90	18.56	163.20	45.58	324.29	(N/A)
Littleleaf linden	37.35	5.39	6.14	41.63	48.89	139.39	(N/A)
American sycamore	90.25	9.54	19.12	177.77	48.81	345.49	(N/A)
Eastern white pine	38.17	3.31	-1.58	124.79	17.50	182.20	(N/A)
Broadleaf Deciduou	11.79	1.21	1.77	4.88	4.32	23.97	(N/A)
Blue spruce	32.96	2.90	3.78	71.41	14.36	125.41	(N/A)
White oak	19.93	2.74	3.43	27.88	23.65	77.63	(N/A)
Apple	13.40	1.30	1.86	5.18	4.77	26.50	(N/A)
Bur oak	24.69	3.44	4.34	36.40	28.12	96.98	(N/A)
Swamp white oak	20.47	2.50	3.04	13.86	21.57	61.43	(N/A)
Chinese elm	87.75	9.89	18.15	169.88	53.23	338.90	(N/A)
Common chokecher	25.38	2.31	4.17	14.50	8.34	54.70	(N/A)
Southern magnolia	27.69	2.47	3.61	37.54	22.74	94.06	(N/A)
Eastern redbud	11.80	1.15	1.63	4.51	4.23	23.32	(N/A)
Kentucky coffeetree	37.90	5.28	6.26	38.57	41.03	129.05	(N/A)
Boxelder	49.63	8.83	8.33	68.97	56.74	192.51	(N/A)
Northern catalpa	44.68	6.27	7.56	60.57	46.00	165.09	(N/A)
Eastern cottonwood	69.42	9.45	12.95	112.43	59.68	263.94	(N/A)
Black spruce	22.99	2.01	2.51	41.66	22.09	91.26	(N/A)
Austrian pine	35.47	2.84	4.16	79.26	8.54	130.26	(N/A)
Ohio buckeye	64.76	6.40	11.87	84.60	37.26	204.89	(N/A)
Broadleaf Evergreen	46.87	6.15	4.77	68.49	97.24	223.53	(N/A)
Hickory	69.67	9.52	12.53	109.50	62.14	263.36	(N/A)
Tulip tree	70.91	9.97	12.48	106.85	65.59	265.81	(N/A)
Mountain ash	38.13	4.20	6.56	18.06	15.48	82.43	(N/A)
American elm	114.45	11.31	28.89	123.33	86.69	364.67	(N/A)
Scarlet oak	91.02	10.90	19.04	196.17	58.34	375.47	(N/A)
Black cherry	46.14	5.84	8.35	31.82	28.80	120.94	(N/A)
Pin oak	87.97	25.90	10.96	173.76	205.74	504.33	(N/A)
Black locust	70.84	3.49	13.58	102.01	0.00	189.93	(N/A)
Ginkgo	14.72	1.24	2.12	8.17	6.77	33.03	(N/A)
Broadleaf Evergreen	18.82	1.45	2.10	18.34	21.93	62.64	(N/A)
Alder	46.14	2.24	8.35	31.82	0.00	88.55	(N/A)
White mulberry	46.14	2.24	8.35	31.82	0.00	88.55	(N/A)
Citywide Total	59.03	7.91	10.81	95.49	56.67	229.91	(N/A)

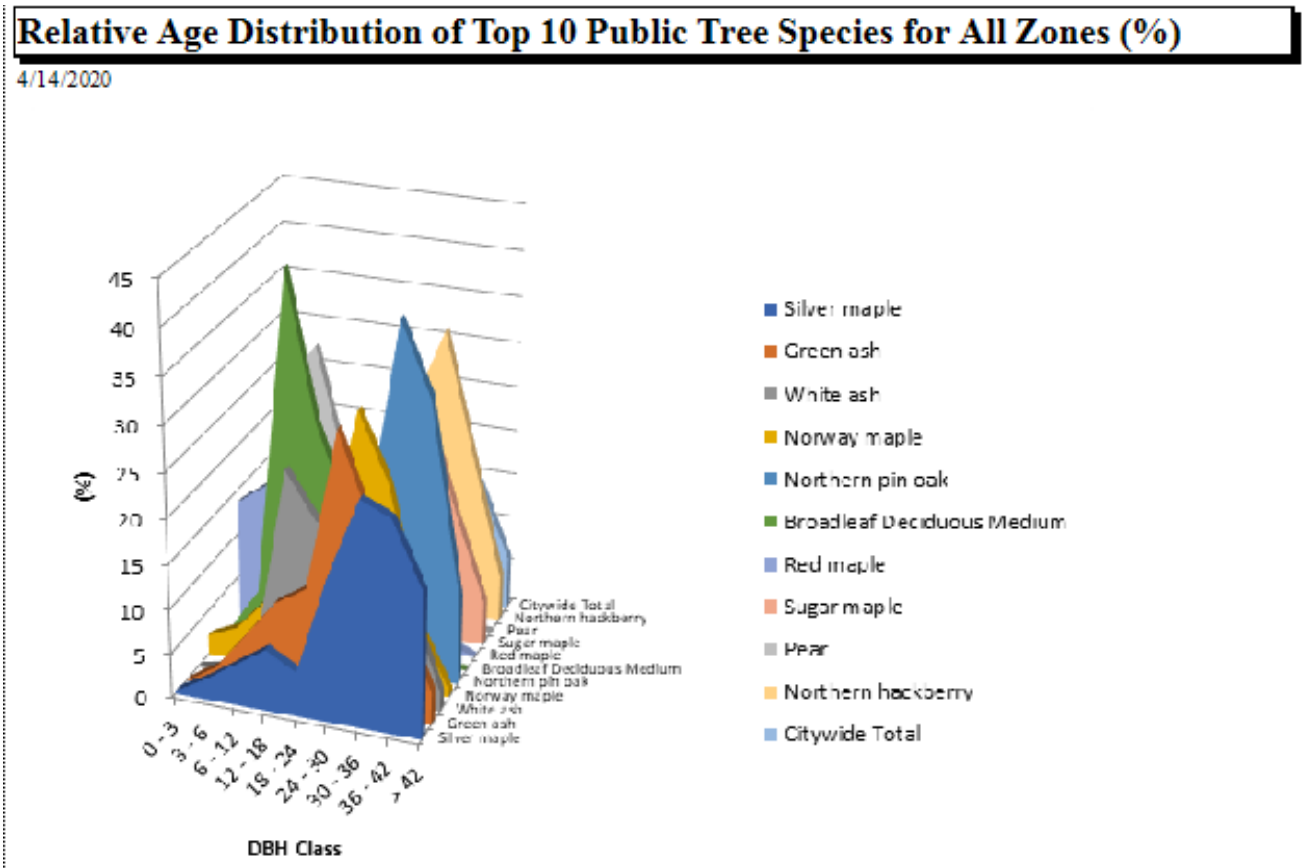
Species Distribution of Public Trees

4/14/2020



Species	Percent
Silver maple	16.1
Green ash	11.6
White ash	8.5
Norway maple	8.2
Northern pin oak	7.0
Broadleaf Deciduous Me	6.1
Red maple	5.0
Sugar maple	5.0
Pear	4.1
Northern hackberry	3.6
Other Species	24.7
Total	100.0

Figure 1: Species Distribution



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Silver maple	0.38	2.31	4.62	6.92	5.00	16.15	25.00	23.46	16.15
Green ash	0.00	2.14	6.42	10.70	12.83	30.48	21.39	12.30	3.74
White ash	0.00	0.72	3.62	23.91	18.84	18.84	20.29	11.59	2.17
Norway maple	2.26	3.76	7.52	10.53	15.04	30.08	22.56	7.52	0.75
Northern pin oak	0.00	0.00	0.88	1.77	0.88	16.81	38.94	30.97	9.73
Broadleaf Deciduous I	0.00	5.05	41.41	25.25	16.16	5.05	7.07	0.00	0.00
Red maple	13.58	16.05	22.22	18.52	17.28	8.64	2.47	1.23	0.00
Sugar maple	2.47	3.70	6.17	13.58	12.35	16.05	25.93	14.81	4.94
Pear	1.49	25.37	29.85	16.42	16.42	8.96	1.49	0.00	0.00
Northern hackberry	1.69	0.00	3.39	5.08	10.17	23.73	32.20	18.64	5.08
Citywide Total	1.92	5.32	10.57	13.35	11.25	17.49	20.15	14.09	5.87

Figure 2: Relative Age Class

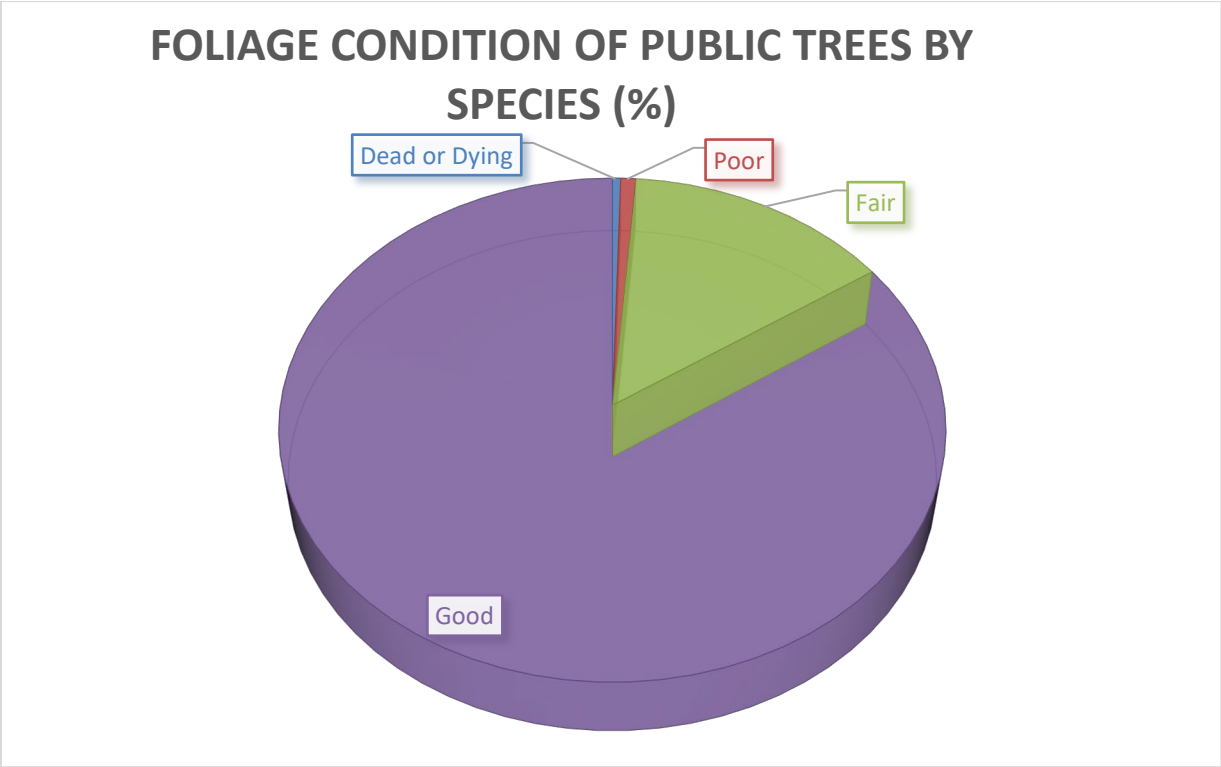


Figure 3: Foliage Condition

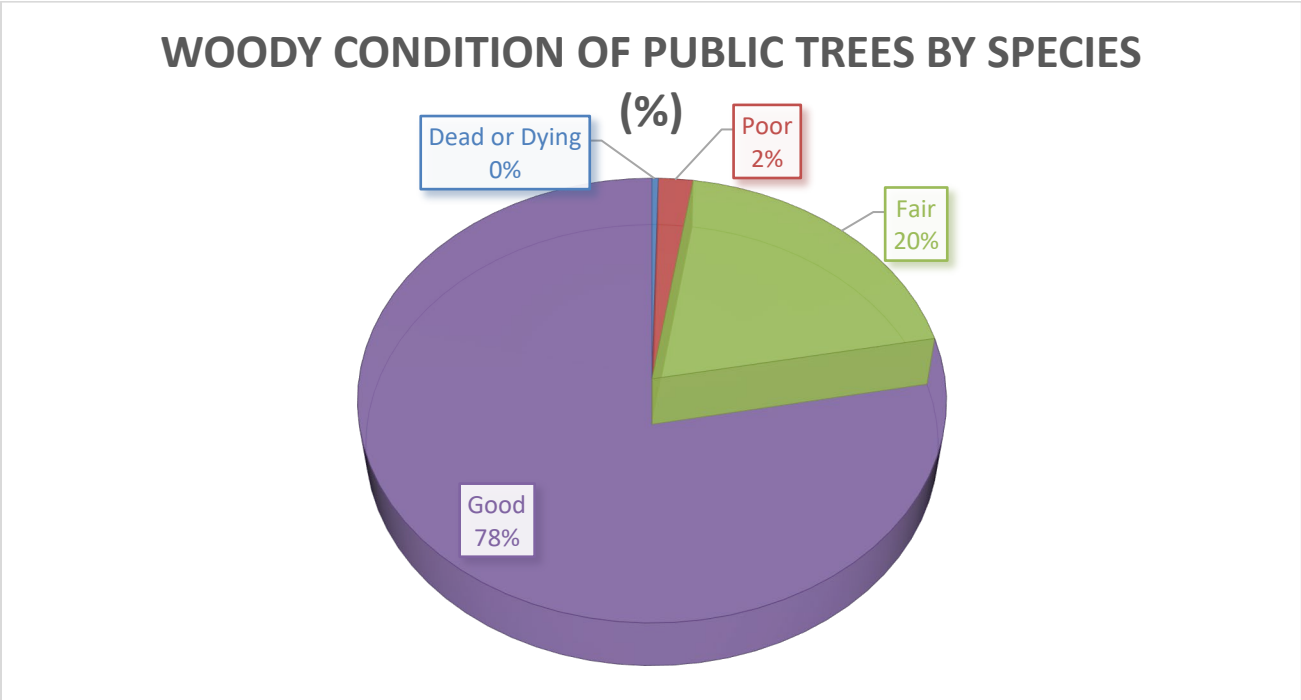
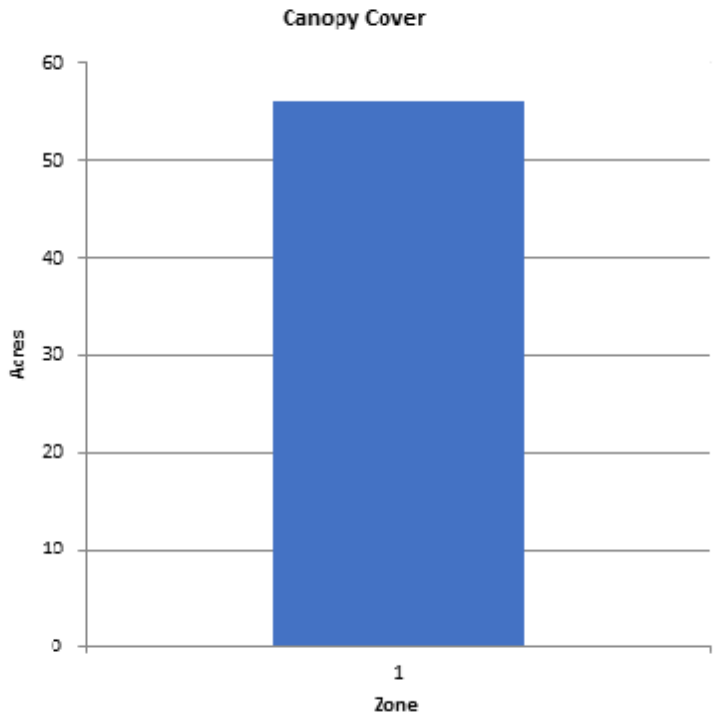


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

4/14/2020



Zone	Acres	% of Total Canopy Cover
1	56	100.0
Citywide total	56	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide Total	0	0	56	0.00	0.00

Figure 5: Canopy Cover in Acres

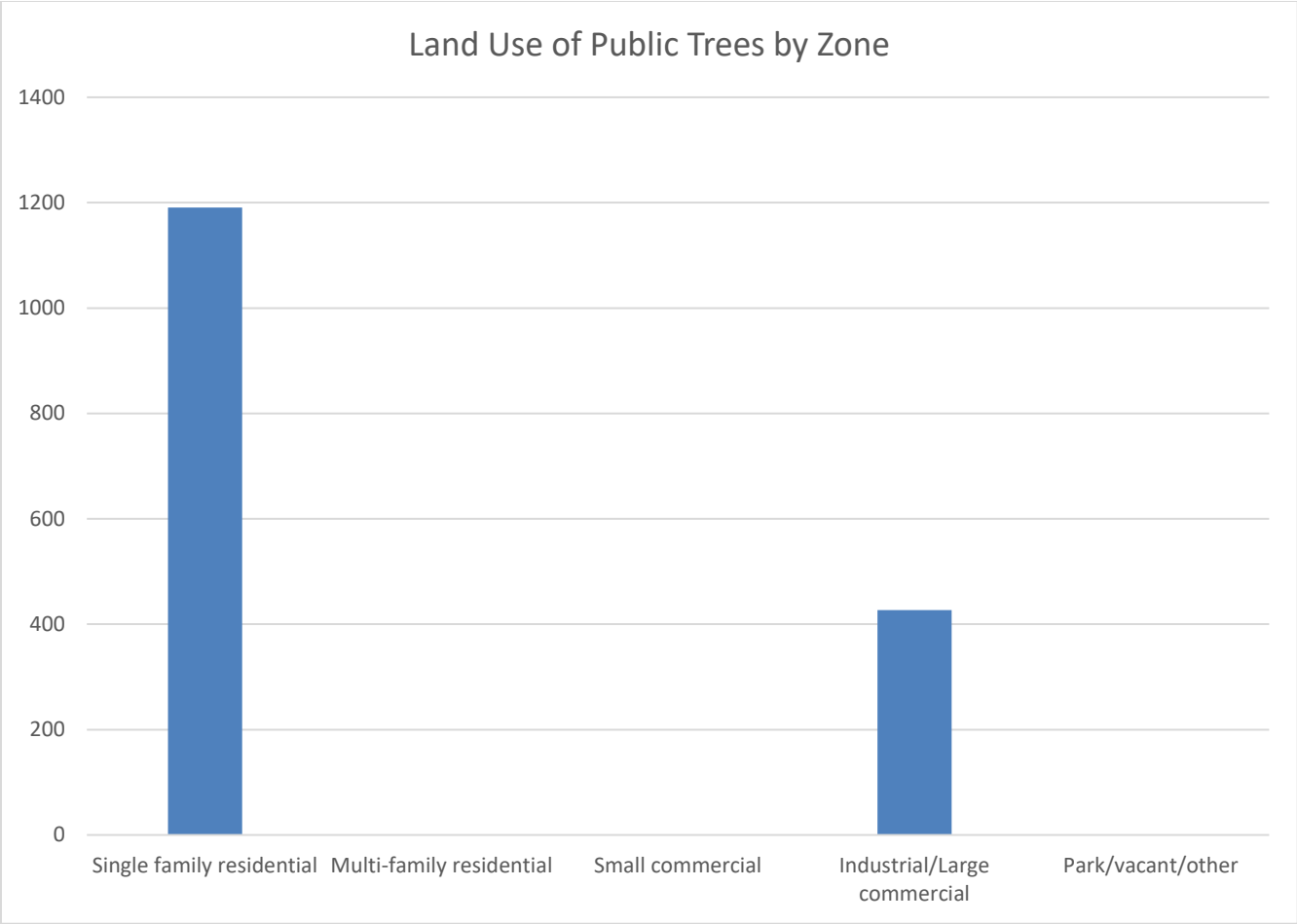


Figure 6: Land Use of city/park trees

Appendix B: ArcGIS Mapping

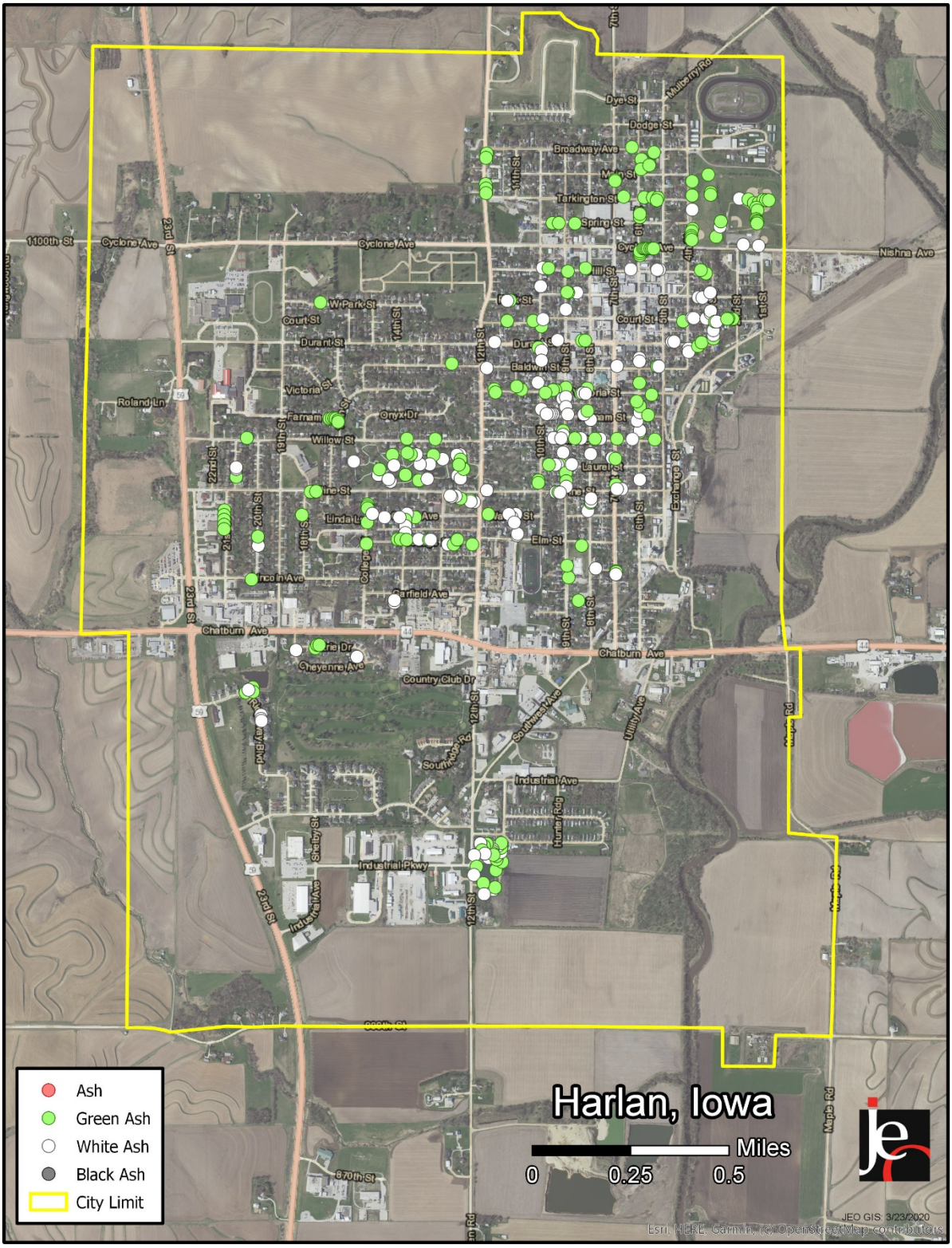


Figure 1: Location of Ash Trees

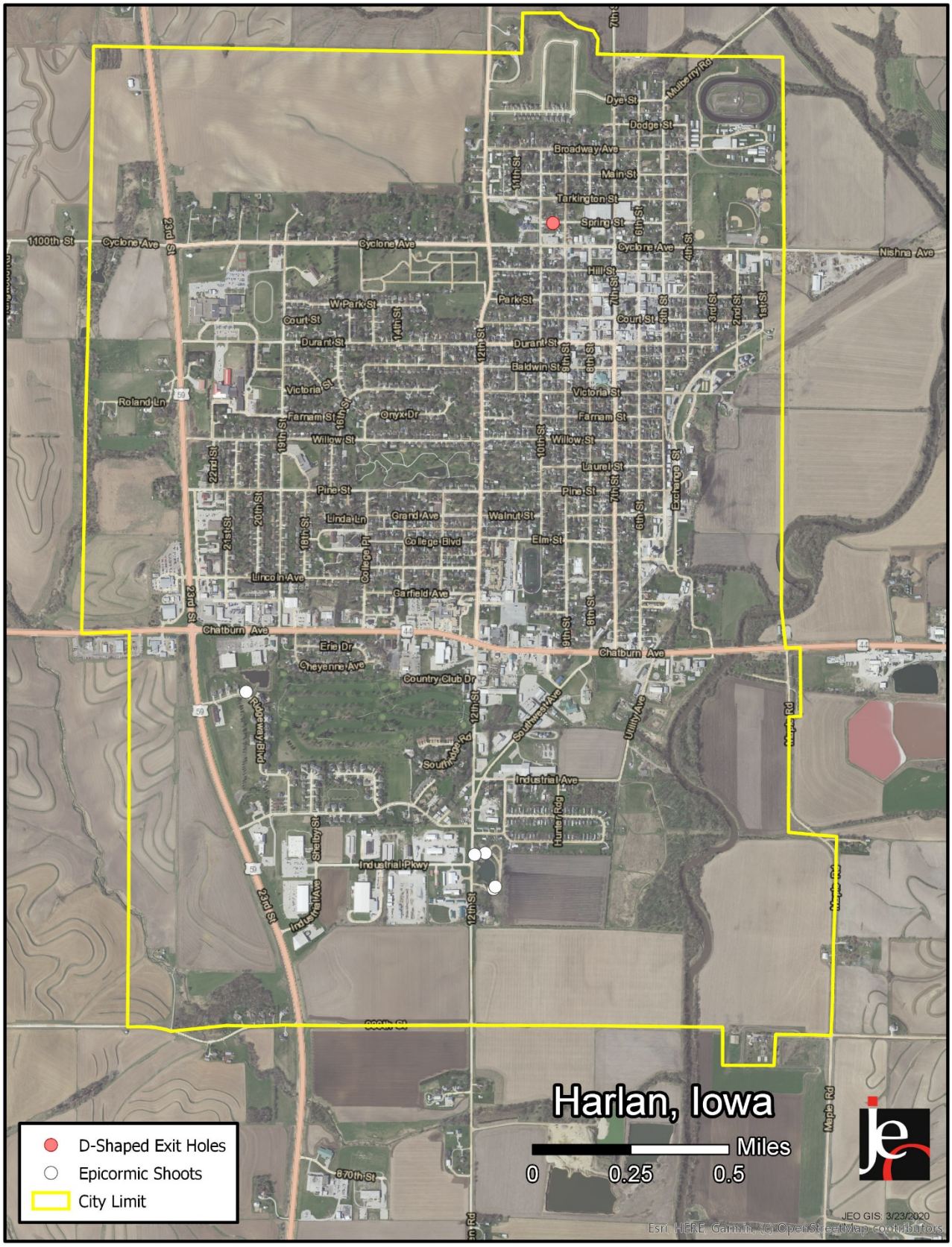


Figure 2: Location of EAB symptoms

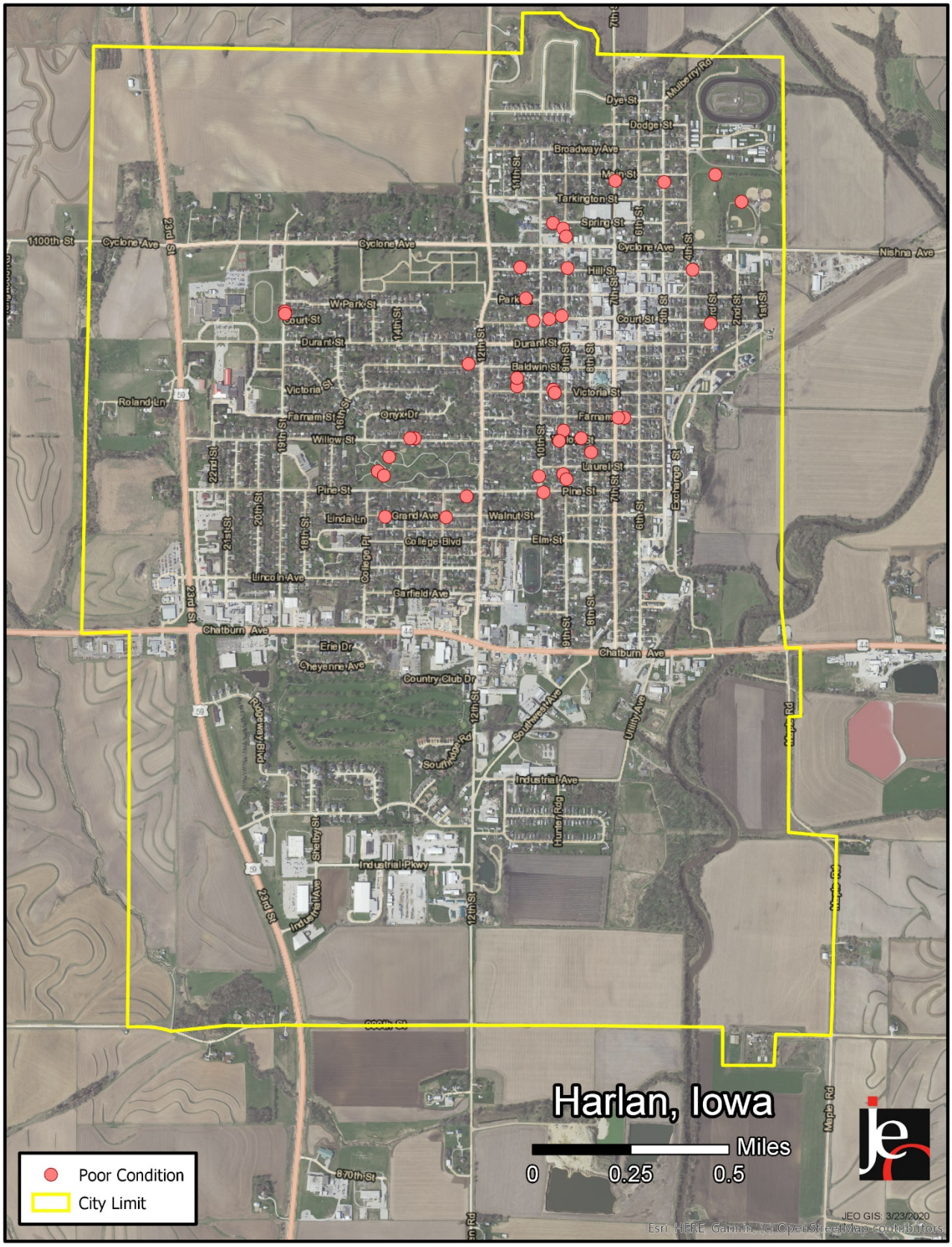


Figure 3: Location of Poor Condition Trees

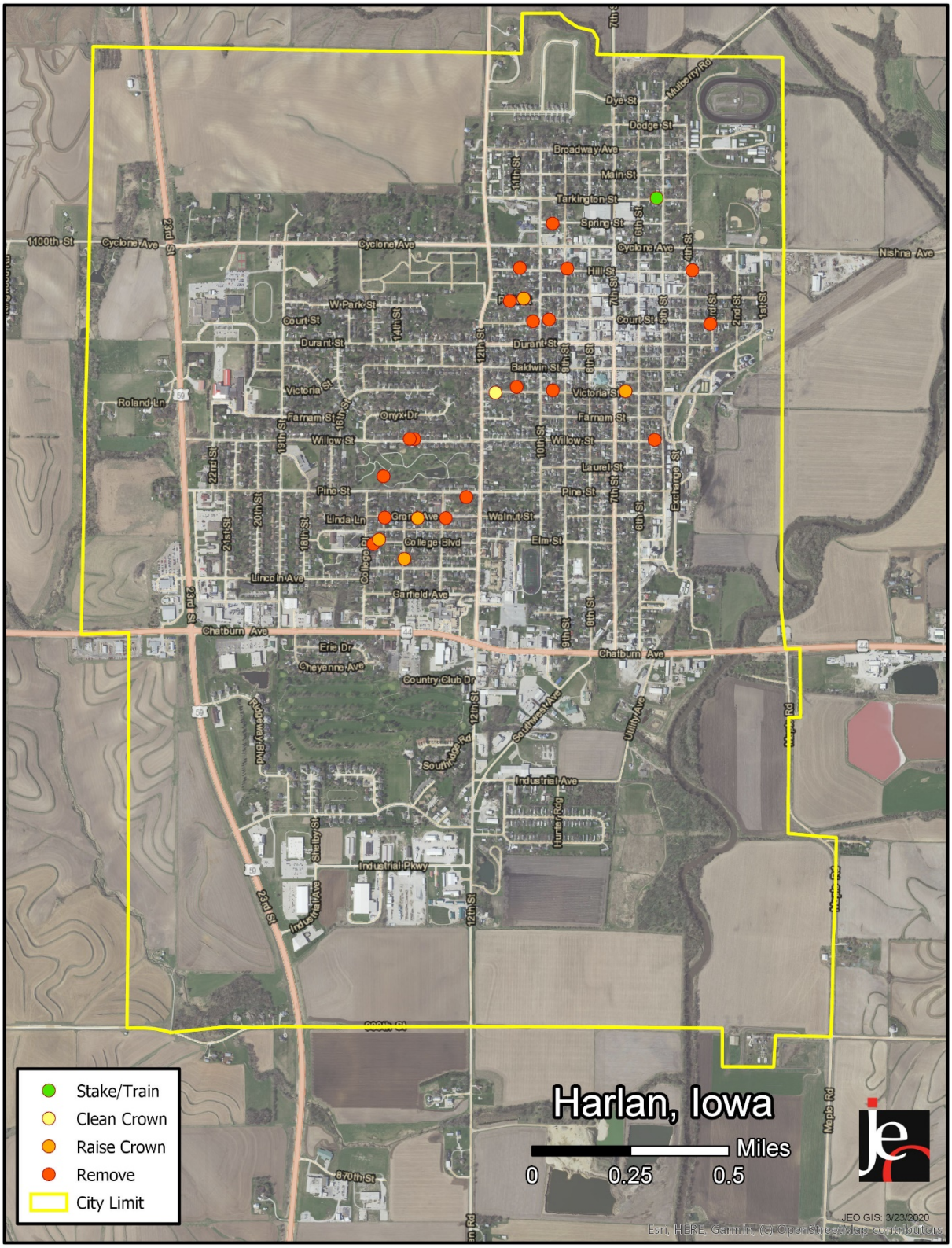


Figure 4: Location of Trees with Recommended Maintenance ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Harlan Tree Ordinances

CHAPTER 151
TREES

151.01 DEFINITION.
For use in this chapter, "parking" means that part of the street, avenue or highway in the City not covered by sidewalk and lying between the lot line and the curb line; or, on unpaved streets, that part of the street, avenue or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

151.02 PLANTING RESTRICTIONS.
No tree shall be planted in any parking or street except in accordance with the following:
1. Alignment. All trees planted in any street shall be planted in the parking midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.
2. Spacing. Trees shall not be planted on any parking which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.
3. Prohibited Trees. No person shall plant in any street any fruit bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

151.03 DUTY TO TRIM TREES.
The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax.

151.04 TRIMMING TREES TO BE SUPERVISED.
Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

151.05 DISEASE CONTROL.
Any dead, diseased or damaged tree or shrub which may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

151.06 INSPECTION AND REMOVAL.
The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:
1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be

corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.
2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that 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 fourteen (14) days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.

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.