Griswold, 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 Griswold 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 15% of Griswold'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 860 trees inventoried.

- Griswold's trees provide $158,820 of benefits annually, an average of $185 per tree
- There are over 52 species of trees
- The top three genera are: Maple 27%, Ash 15%, and Oak 14%
- 32% of trees need some type of management
- 43 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 43 trees needing removal, 7 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*
- 2 of the 127 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 43 years to remove ash. We suggest that city officials request a budget increase to $5,000 annually and apply for grants to plant replacement trees.

Introduction

This plan was developed to assist Griswold 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 Griswold, 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 Griswold'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 Griswold 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 Griswold'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 860 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. Fin

Annual Benefits

Annual Energy Benefits
Trees conserve energy by shading buildings and blocking winds. Griswold's trees reduce energy-related costs by approximately $40,900 annually (Appendix A, Table 1). These savings are both in electricity (195 MWh) and in natural gas (26,634.9 Therms).

Annual Stormwater Benefits
Griswold's trees intercept about 2,174,897 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $58,940 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 Griswold, it is estimated that trees remove 2,482 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 $6,786 (Appendix A, Table 3).

Annual Carbon Benefits
Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Griswold, trees sequester about 507,831 lbs of carbon per year with an associated value of $3,809 (Appendix A, Table 5). In addition, the trees store 8,173,602 lbs of carbon, with a yearly benefit of $61,302 (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. Griswold receives $46,243 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, Griswold's trees provide $158,820 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 860 trees in Griswold provide approximately $185 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Griswold has over 52 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	235	2%
Ash	127	15%
Oak	117	14%
Apple	82	10%
Walnut	43	5%
Spruce	38	4%
Elm	31	4%
Hackberry	29	3%
Pine	26	3%
Basswood/Linden	22	3%
Sycamore	15	2%
Locust	13	2%
Redbud	13	2%
Pear	8	1%
Birch	4	<1%
Ginkgo	3	<1%
Magnolia	3	<1%
Catalpa	2	<1%
Kentucky Coffeetree	1	<1%
Aspen	1	<1%
Hickory	1	<1%
Tulip Tree	1	<1%
Willow	1	<1%
Boxelder	1	<1%
Cherry	1	<1%
Cedar	1	<1%
Other Evergreen	55	6%
Other Deciduous	7	<1%

Age Class

Most of Griswold's trees (35%) are between 6 and 18 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. Griswold's size curve is on the smaller side, indicating a younger 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 Griswold indicate that 60% of the trees are in good health, with only 4% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 62% of Griswold's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Seven percent of the tree population's wood condition is in poor health, dead, or dying. This 7% 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 Cleaning	208	24%
Tree Removal	43	5%
Tree Staking	5	1%
Crown Raising	2	<1%
Crown Reduction	1	<1%

Land Use and Location

The majority of Griswold'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	65%
Industrial/Large commercial	33%
Park/vacant/other	2%
Small commercial	<1%
Multifamily residential	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

Griswold has 43 trees that need immediate removal. These trees 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 4 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Proposed 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 259 trees with maintenance needs.

<u>Poor tree species</u>
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 43 removals, 13 are ash trees. There are a total of 127 ash trees, and 2 of those have signs and symptoms that have been associated with EAB. In addition, there are 11 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 Proposed Work Schedule and Budget 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 Griswold.

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 (27%) (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 6-10-2 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 6-10-2 (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 6-10-2 (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 6-10-6 states "The Council shall inspect or cause to be inspected any trees or shrubs in the city reported or suspected to be infected with or damaged by any disease or insect or disease pests, and such trees and shrubs shall be subject to removal as follows:

1. Removal from 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, and that danger to other trees within the city is imminent, the Council shall immediately cause such condition to be corrected by treatment or removal so as to destroy or prevent as fully as possible the spread of the disease or the insect or disease pests. 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. Removal from private property. If it is determined with reasonable certainty that any such condition exists on private property and that the danger to other trees within the city is imminent, the Council shall immediately 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 nuisance to be removed and the cost assessed against the property. (Code of Iowa, Sec. 364.12[3b &h])

Should the City remove a tree or shrub from private property, in addition to the cost to remove the tree or shrub, the property owner shall also be responsible for any costs associated with removing a stump."

Proposed Work Schedule and Budget

Budget Allowance of $2,072/Year – (Based off $2/Capita Calculation Due to no City Reporting)

YEAR 1	ESTIMATED COSTS
Remove 2 trees recommended for immediate removal	$1,400
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 2

Remove 2 trees recommended for immediate removal	$1,400
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 3

Remove 2 trees recommended for immediate removal	$1,400
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Remove 2 trees recommended for immediate removal	$1,400
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 2 trees recommended for immediate removal	$1,400
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 2 trees recommended for immediate removal	$1,400
Plant 4 trees in open locations	$600
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 $14,850 a year. If the budget were increased to $5,000 a year all ash could be removed in 18 years.

Proposed Work Schedule with Increased Budget

Budget Allowance of $5,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1   ESTIMATED COSTS

Remove 6 trees recommended for immediate removal	$4,200
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 2

Plant 4 trees in open locations	$600
Prune 1/3 of City Owned Trees	$4,305
Visual Survey of EAB Signs/Symptoms	

YEAR 3

Remove 6 trees recommended for immediate removal	$4,200
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Plant 4 trees in open locations	$600
Prune 1/3 of City Owned Trees	$4,305
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 6 trees recommended for immediate removal	$4,200
Plant 5 trees in open locations	$750
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Plant 4 trees in open locations	$600
Prune 1/3 of City Owned Trees	$4,305
Visual Survey of EAB Signs/Symptoms	

Purposed Budget Increase

EAB could potentially kill all ash trees in Griswold within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to $14,850 a year. If the budget were increased to $5,000 per year all ash could be removed within 18 years. Additionally, we recommend that Griswold 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 Griswold would still need to find $83,300 for removal of the remaining ash. Alternatively, if there are 12 treatable trees, it would cost approximately $3,600 a year

for treatment and leave $1,400 for removal under the proposed budget increase. 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 Griswold. 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
4/23/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	28.5	2,164	3,738.5	3,664	5,828	(N/A)	10.9	14.2	62.00
Green ash	26.3	1,995	3,598.5	3,527	5,521	(N/A)	10.2	13.5	62.74
Apple	8.5	643	1,288.0	1,262	1,905	(N/A)	9.5	4.7	23.24
Pin oak	25.4	1,927	3,449.5	3,380	5,308	(N/A)	8.8	13.0	69.84
Norway maple	14.6	1,108	2,105.0	2,063	3,171	(N/A)	6.6	7.8	55.63
Black walnut	11.5	873	1,552.6	1,522	2,395	(N/A)	5.0	5.9	55.69
Red maple	4.8	365	665.0	652	1,017	(N/A)	4.7	2.5	25.42
Ash	3.0	227	439.8	431	658	(N/A)	4.1	1.6	18.81
Sugar maple	9.1	691	1,224.4	1,200	1,890	(N/A)	4.1	4.6	54.01
Conifer Evergreen Large	4.3	330	518.2	508	838	(N/A)	3.8	2.0	25.39
Northern hackberry	11.1	842	1,565.4	1,534	2,376	(N/A)	3.4	5.8	81.92
Siberian elm	10.3	785	1,384.2	1,357	2,142	(N/A)	3.1	5.2	79.32
Northern red oak	3.5	268	482.8	473	742	(N/A)	2.7	1.8	32.24
American sycamore	6.2	469	840.3	823	1,293	(N/A)	1.7	3.2	86.19
American basswood	4.0	303	588.3	577	879	(N/A)	1.6	2.2	62.82
Red pine	1.9	147	240.4	236	382	(N/A)	1.6	0.9	27.30
Honeylocust	4.6	348	601.0	589	937	(N/A)	1.5	2.3	72.09
Eastern redbud	0.9	65	126.4	124	189	(N/A)	1.5	0.5	14.51
Blue spruce	0.9	69	126.3	124	193	(N/A)	1.4	0.5	16.07
Eastern white pine	1.5	116	180.9	177	294	(N/A)	1.3	0.7	26.69
Norway spruce	1.4	106	171.5	168	274	(N/A)	1.2	0.7	27.44
Littleleaf linden	1.4	105	194.4	190	295	(N/A)	0.9	0.7	36.93
Swamp white oak	0.9	69	136.8	134	203	(N/A)	0.9	0.5	25.32
Pear	0.7	50	99.2	97	147	(N/A)	0.9	0.4	18.38
Spruce	0.7	50	90.9	89	139	(N/A)	0.9	0.3	17.33
Black spruce	0.2	18	38.8	38	56	(N/A)	0.9	0.1	6.94
Maple	0.9	72	127.8	125	197	(N/A)	0.7	0.5	32.83
Oak	0.1	7	12.0	12	19	(N/A)	0.6	0.0	3.75
Broadleaf Deciduous Sma	0.1	7	15.2	15	22	(N/A)	0.5	0.1	5.40
White ash	0.5	41	68.4	67	108	(N/A)	0.5	0.3	27.11
River birch	0.4	27	56.7	56	82	(N/A)	0.5	0.2	20.60
Northern pin oak	0.9	67	124.3	122	188	(N/A)	0.3	0.5	62.82
Ginkgo	0.2	13	19.8	19	33	(N/A)	0.3	0.1	10.87
Southern magnolia	0.7	52	83.8	82	134	(N/A)	0.3	0.3	44.67
Broadleaf Deciduous Larg	0.7	54	100.5	99	153	(N/A)	0.2	0.4	76.46
Amur maple	0.3	20	37.5	37	56	(N/A)	0.2	0.1	28.16
Bur oak	0.5	36	54.0	53	88	(N/A)	0.2	0.2	44.23
Northern catalpa	0.8	59	107.4	105	164	(N/A)	0.2	0.4	82.02
Elm	0.8	63	112.7	110	173	(N/A)	0.2	0.4	86.52
Black maple	0.3	22	39.9	39	61	(N/A)	0.1	0.1	60.68
Conifer Evergreen Small	0.1	8	16.4	16	25	(N/A)	0.1	0.1	24.57
Conifer Evergreen Mediu	0.1	5	10.2	10	15	(N/A)	0.1	0.0	14.80
Kentucky coffeetree	0.3	25	46.9	46	71	(N/A)	0.1	0.2	70.91
Black cherry	0.0	2	3.8	4	5	(N/A)	0.1	0.0	5.40
Broadleaf Deciduous Med	0.0	0	0.8	1	1	(N/A)	0.1	0.0	1.10
American elm	0.1	6	11.7	11	18	(N/A)	0.1	0.0	17.66
Boxelder	0.2	17	30.8	30	47	(N/A)	0.1	0.1	46.76
Eastern red cedar	0.0	4	7.9	8	11	(N/A)	0.1	0.0	11.47
Hickory	0.2	18	27.0	26	44	(N/A)	0.1	0.1	44.23
Willow	0.1	8	16.9	17	24	(N/A)	0.1	0.1	24.47
Quaking aspen	0.1	7	13.7	13	21	(N/A)	0.1	0.1	20.64
Tulip tree	0.2	18	27.0	26	44	(N/A)	0.1	0.1	44.23
Scotch pine	0.1	10	14.6	14	24	(N/A)	0.1	0.1	24.14
Total	195.0	14,798	26,634.9	26,102	40,900	(N/A)	100.0	100.0	47.56

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

4/23/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	402,796	10,916	(N/A)	10.9	18.5	116.13
Green ash	316,492	8,577	(N/A)	10.2	14.6	97.47
Apple	35,760	969	(N/A)	9.5	1.6	11.82
Pin oak	282,883	7,666	(N/A)	8.8	13.0	100.87
Norway maple	136,584	3,701	(N/A)	6.6	6.3	64.94
Black walnut	108,767	2,948	(N/A)	5.0	5.0	68.55
Red maple	37,307	1,011	(N/A)	4.7	1.7	25.28
Ash	16,159	438	(N/A)	4.1	0.7	12.51
Sugar maple	104,142	2,822	(N/A)	4.1	4.8	80.64
Conifer Evergreen Large	61,481	1,666	(N/A)	3.8	2.8	50.49
Northern hackberry	115,383	3,127	(N/A)	3.4	5.3	107.82
Siberian elm	120,539	3,267	(N/A)	3.1	5.5	120.99
Northern red oak	32,618	884	(N/A)	2.7	1.5	38.43
American sycamore	93,445	2,532	(N/A)	1.7	4.3	168.82
American basswood	45,996	1,246	(N/A)	1.6	2.1	89.03
Red pine	31,555	855	(N/A)	1.6	1.5	61.08
Honeylocust	55,563	1,506	(N/A)	1.5	2.6	115.83
Eastern redbud	3,029	82	(N/A)	1.5	0.1	6.31
Blue spruce	10,724	291	(N/A)	1.4	0.5	24.22
Eastern white pine	23,057	625	(N/A)	1.3	1.1	56.80
Norway spruce	22,744	616	(N/A)	1.2	1.0	61.64
Littleleaf linden	13,388	363	(N/A)	0.9	0.6	45.35
Swamp white oak	5,088	138	(N/A)	0.9	0.2	17.23
Pear	2,333	63	(N/A)	0.9	0.1	7.90
Spruce	8,641	234	(N/A)	0.9	0.4	29.27
Black spruce	2,052	56	(N/A)	0.9	0.1	6.95
Maple	7,986	216	(N/A)	0.7	0.4	36.07
Oak	551	15	(N/A)	0.6	0.0	2.98
Broadleaf Deciduous Small	275	7	(N/A)	0.5	0.0	1.86
White ash	3,504	95	(N/A)	0.5	0.2	23.74
River birch	1,921	52	(N/A)	0.5	0.1	13.01
Northern pin oak	8,938	242	(N/A)	0.3	0.4	80.74
Ginkgo	732	20	(N/A)	0.3	0.0	6.61
Southern magnolia	7,192	195	(N/A)	0.3	0.3	64.97
Broadleaf Deciduous Large	9,433	256	(N/A)	0.2	0.4	127.82
Amur maple	931	25	(N/A)	0.2	0.0	12.62
Bur oak	2,931	79	(N/A)	0.2	0.1	39.72
Northern catalpa	10,981	298	(N/A)	0.2	0.5	148.79
Elm	12,729	345	(N/A)	0.2	0.6	172.48
Black maple	2,867	78	(N/A)	0.1	0.1	77.70
Conifer Evergreen Small	1,635	44	(N/A)	0.1	0.1	44.30
Conifer Evergreen Medium	755	20	(N/A)	0.1	0.0	20.47
Kentucky coffeetree	3,943	107	(N/A)	0.1	0.2	106.85
Black cherry	69	2	(N/A)	0.1	0.0	1.86
Broadleaf Deciduous Medit	12	0	(N/A)	0.1	0.0	0.33
American elm	432	12	(N/A)	0.1	0.0	11.72
Boxelder	2,233	61	(N/A)	0.1	0.1	60.52
Eastern red cedar	659	18	(N/A)	0.1	0.0	17.86
Hickory	1,466	40	(N/A)	0.1	0.1	39.72
Willow	586	16	(N/A)	0.1	0.0	15.88
Quaking aspen	608	16	(N/A)	0.1	0.0	16.47
Tulip tree	1,466	40	(N/A)	0.1	0.1	39.72
Scotch pine	1,539	42	(N/A)	0.1	0.1	41.70
Citywide total	2,174,897	58,940	(N/A)	100.0	100.0	68.53

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

Species	Deposition (lb) O₃	NO₂	PM₁₀	SO₂	Total Depos ($)	Avoided (lb) NO₂	PM₁₀	VOC	SO₂	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($) Standard Error	% of Total Trees	Avg $/tree
Silver maple	68.6	11.6	33.8	3.0	370	154.3	19.7	18.8	129.0	841	-56.2	-156	382.7	1,075 (N/A)	10.9	11.44
Green ash	42.4	6.8	19.8	1.9	224	125.5	18.3	17.4	119.1	782	0.0	0	351.2	1,006 (N/A)	10.2	11.43
Apple	10.6	1.8	5.1	0.5	57	41.6	6.0	5.7	38.4	256	-0.1	0	109.5	313 (N/A)	9.5	3.81
Pin oak	49.3	8.6	25.3	2.2	270	120.9	17.6	16.8	115.0	754	-91.6	-344	264.2	680 (N/A)	8.8	8.95
Norway maple	27.9	4.8	13.7	1.2	151	70.8	10.2	9.7	66.2	438	-6.5	-24	198.0	564 (N/A)	6.6	9.90
Black walnut	11.6	1.9	5.9	0.5	63	54.7	8.0	7.6	52.2	342	0.0	0	142.3	404 (N/A)	5.0	9.40
Red maple	8.2	1.4	3.9	0.4	44	23.0	3.3	3.2	21.8	143	-2.8	-11	62.4	177 (N/A)	4.7	4.41
Ash	1.8	0.3	1.1	0.1	10	14.6	2.1	2.0	13.6	90	-0.6	-2	35.0	98 (N/A)	4.1	2.81
Sugar maple	14.0	2.4	6.9	0.6	76	43.2	6.3	6.0	41.2	270	-10.9	-41	109.7	304 (N/A)	4.1	8.69
Conifer Evergreen Large	6.9	1.4	5.8	0.8	46	20.0	3.0	2.8	19.7	127	-24.9	-94	35.6	79 (N/A)	3.8	2.40
Northern hackberry	20.3	3.5	10.1	0.9	110	53.4	7.7	7.4	50.3	332	0.0	0	153.6	442 (N/A)	3.4	15.23
Siberian elm	22.2	3.8	10.6	1.0	119	49.1	7.2	6.8	46.9	306	0.0	0	147.4	425 (N/A)	3.1	15.74
Northern red oak	6.7	1.1	3.3	0.3	36	16.8	2.5	2.3	16.0	105	-9.5	-36	39.5	105 (N/A)	2.7	4.58
American sycamore	15.1	2.4	6.7	0.7	79	29.5	4.3	4.1	28.0	184	0.0	0	90.9	263 (N/A)	1.7	17.53
American basswood	6.3	1.1	3.1	0.3	34	19.5	2.8	2.7	18.1	120	-5.3	-20	48.4	134 (N/A)	1.6	9.58
Red pine	3.6	0.7	3.0	0.4	24	9.0	1.3	1.3	8.7	57	-13.5	-50	14.6	30 (N/A)	1.6	2.13
Honeylocust	11.0	1.8	5.0	0.5	58	21.6	3.2	3.0	20.8	135	-8.7	-33	58.1	161 (N/A)	1.5	12.35
Eastern redbud	0.8	0.1	0.4	0.0	4	4.2	0.6	0.6	3.9	26	0.0	0	10.5	30 (N/A)	1.5	2.30
Blue spruce	1.2	0.2	1.0	0.1	8	4.3	0.6	0.6	4.1	27	-3.6	-13	8.7	21 (N/A)	1.4	1.79
Eastern white pine	2.7	0.5	2.2	0.3	18	7.0	1.0	1.0	6.9	45	-10.6	-40	11.1	22 (N/A)	1.3	2.02
Norway spruce	2.6	0.5	2.2	0.3	17	6.5	1.0	0.9	6.3	41	-10.3	-39	10.1	20 (N/A)	1.2	1.97
Littleleaf linden	2.2	0.4	1.1	0.1	12	6.7	1.0	0.9	6.3	41	-1.1	-4	17.6	49 (N/A)	0.9	6.17
Swamp white oak	0.6	0.1	0.4	0.0	3	4.4	0.6	0.6	4.1	27	-0.2	-1	10.6	30 (N/A)	0.9	3.74
Pear	0.6	0.1	0.3	0.0	3	3.2	0.5	0.4	3.0	20	0.0	0	8.1	23 (N/A)	0.9	2.86
Spruce	0.9	0.2	0.8	0.1	6	3.1	0.5	0.4	3.0	19	-3.2	-12	5.8	14 (N/A)	0.9	1.69
Black spruce	0.1	0.0	0.2	0.0	1	1.2	0.2	0.2	1.0	7	-0.5	-2	2.3	6 (N/A)	0.9	0.75
Maple	1.9	0.3	0.9	0.1	10	4.5	0.7	0.6	4.3	28	-0.6	-2	12.6	36 (N/A)	0.7	5.96
Oak	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3 (N/A)	0.6	0.56
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3 (N/A)	0.5	0.71
White ash	0.2	0.0	0.1	0.0	1	2.5	0.4	0.4	2.5	16	0.0	0	6.1	17 (N/A)	0.5	4.26
River birch	0.2	0.0	0.1	0.0	1	1.8	0.3	0.2	1.6	11	-0.1	0	4.1	12 (N/A)	0.5	2.90
Northern pin oak	1.9	0.3	0.9	0.1	10	4.2	0.6	0.6	4.0	26	-0.4	-2	12.3	35 (N/A)	0.3	11.69
Ginkgo	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.8	5	0.0	0	2.0	6 (N/A)	0.3	1.86
Southern magnolia	0.9	0.2	0.8	0.1	6	3.2	0.5	0.4	3.1	20	-2.0	-8	7.1	18 (N/A)	0.3	6.10
Broadleaf Deciduous Large	1.3	0.2	0.6	0.1	7	3.4	0.5	0.5	3.2	21	0.0	0	9.8	28 (N/A)	0.2	14.09
Amur maple	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.2	9 (N/A)	0.2	4.55
Bur oak	0.2	0.0	0.1	0.0	1	2.1	0.3	0.3	2.1	14	0.0	0	5.3	15 (N/A)	0.2	7.42
Northern catalpa	1.6	0.3	0.7	0.1	8	3.7	0.5	0.5	3.5	23	0.0	0	10.9	31 (N/A)	0.2	15.71
Elm	2.0	0.3	0.9	0.1	10	3.9	0.6	0.5	3.7	25	0.0	0	12.0	35 (N/A)	0.2	17.37
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)	0.1	11.54
Conifer Evergreen Small	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)	0.1	2.19
Conifer Evergreen Medium	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	2 (N/A)	0.1	1.53
Kentucky coffeetree	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12 (N/A)	0.1	12.48
Black cherry	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.1	0.71
Broadleaf Deciduous Med	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)	0.1	0.14
American elm	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	2	0.0	0	0.9	3 (N/A)	0.1	2.54
Boxelder	0.3	0.0	0.1	0.0	1	1.0	0.2	0.1	1.0	7	-0.1	0	2.7	8 (N/A)	0.1	7.54
Eastern red cedar	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)	0.1	0.62
Hickory	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)	0.1	7.42
Willow	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3 (N/A)	0.1	3.47
Quaking aspen	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3 (N/A)	0.1	2.99
Tulip tree	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)	0.1	7.42
Scotch pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3 (N/A)	0.1	2.82
Citywide total	351.0	59.7	178.4	17.2	1,914	929.8	135.4	129.1	883.3	5,794	-245.8	-922	2,438.2	6,786 (N/A)	100.0	7.89

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees
4/23/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,574,130	11,806	(N/A)	10.9	19.3	125.60
Green ash	1,392,432	10,443	(N/A)	10.2	17.0	118.67
Apple	169,036	1,268	(N/A)	9.5	2.1	15.46
Pin oak	1,277,356	9,580	(N/A)	8.8	15.6	126.05
Norway maple	457,756	3,433	(N/A)	6.6	5.6	60.23
Black walnut	372,250	2,792	(N/A)	5.0	4.6	64.93
Red maple	91,864	689	(N/A)	4.7	1.1	17.22
Ash	33,497	251	(N/A)	4.1	0.4	7.18
Sugar maple	402,673	3,020	(N/A)	4.1	4.9	86.29
Conifer Evergreen I	57,059	428	(N/A)	3.8	0.7	12.97
Northern hackberry	317,738	2,383	(N/A)	3.4	3.9	82.17
Siberian elm	536,600	4,024	(N/A)	3.1	6.6	149.06
Northern red oak	140,365	1,053	(N/A)	2.7	1.7	45.77
American sycamore	511,632	3,837	(N/A)	1.7	6.3	255.82
American basswood	229,411	1,721	(N/A)	1.6	2.8	122.90
Red pine	31,591	237	(N/A)	1.6	0.4	16.92
Honeylocust	142,677	1,070	(N/A)	1.5	1.7	82.31
Eastern redbud	12,424	93	(N/A)	1.5	0.2	7.17
Blue spruce	6,022	45	(N/A)	1.4	0.1	3.76
Eastern white pine	25,513	191	(N/A)	1.3	0.3	17.40
Norway spruce	24,540	184	(N/A)	1.2	0.3	18.40
Littleleaf linden	48,122	361	(N/A)	0.9	0.6	45.11
Swamp white oak	10,447	78	(N/A)	0.9	0.1	9.79
Pear	9,331	70	(N/A)	0.9	0.1	8.75
Spruce	6,748	51	(N/A)	0.9	0.1	6.33
Black spruce	343	3	(N/A)	0.9	0.0	0.32
Maple	20,649	155	(N/A)	0.7	0.3	25.81
Oak	581	4	(N/A)	0.6	0.0	0.87
Broadleaf Deciduou	711	5	(N/A)	0.5	0.0	1.33
White ash	6,775	51	(N/A)	0.5	0.1	12.70
River birch	3,520	26	(N/A)	0.5	0.0	6.60
Northern pin oak	32,184	241	(N/A)	0.3	0.4	80.46
Ginkgo	1,796	13	(N/A)	0.3	0.0	4.49
Southern magnolia	10,658	80	(N/A)	0.3	0.1	26.65
Broadleaf Deciduou	41,716	313	(N/A)	0.2	0.5	156.43
Amur maple	3,945	30	(N/A)	0.2	0.0	14.79
Bur oak	7,344	55	(N/A)	0.2	0.1	27.54
Northern catalpa	51,886	389	(N/A)	0.2	0.6	194.57
Elm	65,202	489	(N/A)	0.2	0.8	244.51
Black maple	7,945	60	(N/A)	0.1	0.1	59.59
Conifer Evergreen S	1,102	8	(N/A)	0.1	0.0	8.27
Conifer Evergreen M	284	2	(N/A)	0.1	0.0	2.13
Kentucky coffeetree	15,773	118	(N/A)	0.1	0.2	118.30
Black cherry	178	1	(N/A)	0.1	0.0	1.33
Broadleaf Deciduou	17	0	(N/A)	0.1	0.0	0.13
American elm	908	7	(N/A)	0.1	0.0	6.81
Boxelder	7,945	60	(N/A)	0.1	0.1	59.59
Eastern red cedar	277	2	(N/A)	0.1	0.0	2.08
Hickory	3,672	28	(N/A)	0.1	0.0	27.54
Willow	1,101	8	(N/A)	0.1	0.0	8.26
Quaking aspen	1,035	8	(N/A)	0.1	0.0	7.76
Tulip tree	3,672	28	(N/A)	0.1	0.0	27.54
Scotch pine	1,170	9	(N/A)	0.1	0.0	8.78
Citywide total	8,173,602	61,302	(N/A)	100.0	100.0	71.28

Table 5: Annual Carbon Sequestered

Annual CO$_2$ Benefits of Public Trees

4/23/2020

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	117,326	880	-7,558	-315	-59	47,834	359	157,288	1,180 (N/A)	10.9	19.8	12.55
Green ash	61,881	464	-6,684	-280	-52	44,085	331	99,002	743 (N/A)	10.2	12.5	8.44
Apple	13,442	101	-812	-117	-7	14,213	107	26,726	200 (N/A)	9.5	3.4	2.44
Pin oak	119,361	895	-6,131	-269	-48	42,589	319	155,549	1,167 (N/A)	8.8	19.6	15.35
Norway maple	22,525	169	-2,199	-148	-18	24,485	184	44,663	335 (N/A)	6.6	5.6	5.88
Black walnut	27,067	203	-1,787	-113	-14	19,300	145	44,466	333 (N/A)	5.0	5.6	7.76
Red maple	7,743	58	-441	-49	-4	8,071	61	15,324	115 (N/A)	4.7	1.9	2.87
Ash	6,081	46	-175	-33	-2	5,024	38	10,898	82 (N/A)	4.1	1.4	2.34
Sugar maple	20,754	156	-1,936	-99	-15	15,261	114	33,979	255 (N/A)	4.1	4.3	7.28
Conifer Evergreen Large	4,322	32	-274	-70	-3	7,296	55	11,274	85 (N/A)	3.8	1.4	2.56
Northern hackberry	14,738	111	-1,525	-108	-12	18,597	139	31,702	238 (N/A)	3.4	4.0	8.20
Siberian elm	20,360	153	-2,576	-113	-20	17,350	130	35,022	263 (N/A)	3.1	4.4	9.73
Northern red oak	3,889	29	-674	-45	-5	5,931	44	9,101	68 (N/A)	2.7	1.1	2.97
American sycamore	12,848	96	-2,456	-71	-19	10,373	78	20,695	155 (N/A)	1.7	2.6	10.35
American basswood	13,343	100	-1,101	-48	-9	6,695	50	18,889	142 (N/A)	1.6	2.4	10.12
Red pine	2,120	16	-152	-33	-1	3,240	24	5,176	39 (N/A)	1.6	0.7	2.77
Honeylocust	13,210	99	-685	-35	-5	7,693	58	20,183	151 (N/A)	1.5	2.5	11.64
Eastern redbud	1,293	10	-60	-12	-1	1,432	11	2,653	20 (N/A)	1.5	0.3	1.53
Blue spruce	592	4	-29	-15	0	1,527	11	2,075	16 (N/A)	1.4	0.3	1.30
Eastern white pine	1,552	12	-122	-25	-1	2,570	19	3,975	30 (N/A)	1.3	0.5	2.71
Norway spruce	1,511	11	-118	-23	-1	2,349	18	3,719	28 (N/A)	1.2	0.5	2.79
Littleleaf linden	3,442	26	-232	-17	-2	2,320	17	5,513	41 (N/A)	0.9	0.7	5.17
Swamp white oak	1,825	14	-51	-10	0	1,515	11	3,280	25 (N/A)	0.9	0.4	3.07
Pear	991	7	-45	-9	0	1,101	8	2,038	15 (N/A)	0.9	0.3	1.91
Spruce	647	5	-32	-12	0	1,095	8	1,697	13 (N/A)	0.9	0.2	1.59
Black spruce	96	1	-2	-5	0	387	3	477	4 (N/A)	0.9	0.1	0.45
Maple	654	5	-99	-9	-1	1,584	12	2,130	16 (N/A)	0.7	0.3	2.66
Oak	228	2	-3	-2	0	155	1	377	3 (N/A)	0.6	0.0	0.57
Broadleaf Deciduous Sn	152	1	-3	-2	0	149	1	295	2 (N/A)	0.5	0.0	0.55
White ash	1,040	8	-33	-5	0	915	7	1,917	14 (N/A)	0.5	0.2	3.60
River birch	767	6	-18	-4	0	592	4	1,338	10 (N/A)	0.5	0.2	2.51
Northern pin oak	1,126	8	-154	-9	-1	1,472	11	2,435	18 (N/A)	0.3	0.3	6.09
Ginkgo	139	1	-9	-2	0	293	2	420	3 (N/A)	0.3	0.1	1.05
Southern magnolia	619	5	-51	-7	0	1,146	9	1,707	13 (N/A)	0.3	0.2	4.27
Broadleaf Deciduous La	1,816	14	-200	-8	-2	1,202	9	2,811	21 (N/A)	0.2	0.4	10.54
Amur maple	382	3	-19	-3	0	433	3	792	6 (N/A)	0.2	0.1	2.97
Bur oak	891	7	-35	-4	0	786	6	1,637	12 (N/A)	0.2	0.2	6.14
Northern catalpa	1,919	14	-249	-9	-2	1,300	10	2,962	22 (N/A)	0.2	0.4	11.11
Elm	1,872	14	-313	-9	-2	1,384	10	2,934	22 (N/A)	0.2	0.4	11.00
Black maple	0	0	-38	-3	0	477	4	436	3 (N/A)	0.1	0.1	3.27
Conifer Evergreen Small	43	0	-5	-2	0	187	1	222	2 (N/A)	0.1	0.0	1.67
Conifer Evergreen Medi	39	0	-1	-1	0	106	1	142	1 (N/A)	0.1	0.0	1.07
Kentucky coffeetree	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	0.1	0.2	9.97
Black cherry	38	0	-1	-1	0	37	0	74	1 (N/A)	0.1	0.0	0.55
Broadleaf Deciduous Me	5	0	0	0	0	7	0	12	0 (N/A)	0.1	0.0	0.09
American elm	111	1	-4	-1	0	137	1	242	2 (N/A)	0.1	0.0	1.82
Boxelder	694	5	-38	-3	0	366	3	1,020	8 (N/A)	0.1	0.1	7.65
Eastern red cedar	40	0	-1	-1	0	82	1	119	1 (N/A)	0.1	0.0	0.89
Hickory	445	3	-18	-2	0	393	3	819	6 (N/A)	0.1	0.1	6.14
Willow	224	2	-5	-1	0	176	1	393	3 (N/A)	0.1	0.0	2.95
Quaking aspen	209	2	-5	-1	0	159	1	361	3 (N/A)	0.1	0.0	2.71
Tulip tree	445	3	-18	-2	0	393	3	819	6 (N/A)	0.1	0.1	6.14
Scotch pine	116	1	-6	-2	0	216	2	324	2 (N/A)	0.1	0.0	2.43
Citywide total	507,831	3,809	-39,257	-2,172	-311	327,032	2,453	793,434	5,951 (N/A)	100.0	100.0	6.92

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

4/23/2020

| Species	Total ($) Error	Standard	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	9,255 (N/A)		10.9	20.0	98.46
Green ash	4,875 (N/A)		10.2	10.5	55.40
Apple	779 (N/A)		9.5	1.7	9.50
Pin oak	9,172 (N/A)		8.8	19.8	120.69
Norway maple	2,103 (N/A)		6.6	4.5	36.90
Black walnut	2,369 (N/A)		5.0	5.1	55.09
Red maple	1,079 (N/A)		4.7	2.3	26.99
Ash	716 (N/A)		4.1	1.5	20.45
Sugar maple	2,145 (N/A)		4.1	4.6	61.29
Conifer Evergreen Large	1,132 (N/A)		3.8	2.4	34.31
Northern hackberry	1,848 (N/A)		3.4	4.0	63.73
Siberian elm	1,320 (N/A)		3.1	2.9	48.89
Northern red oak	319 (N/A)		2.7	0.7	13.86
American sycamore	864 (N/A)		1.7	1.9	57.63
American basswood	964 (N/A)		1.6	2.1	68.83
Red pine	556 (N/A)		1.6	1.2	39.70
Honeylocust	3,306 (N/A)		1.5	7.1	254.32
Eastern redbud	72 (N/A)		1.5	0.2	5.54
Blue spruce	243 (N/A)		1.4	0.5	20.27
Eastern white pine	343 (N/A)		1.3	0.7	31.21
Norway spruce	361 (N/A)		1.2	0.8	36.14
Littleleaf linden	371 (N/A)		0.9	0.8	46.33
Swamp white oak	209 (N/A)		0.9	0.5	26.17
Pear	56 (N/A)		0.9	0.1	7.04
Spruce	180 (N/A)		0.9	0.4	22.53
Black spruce	99 (N/A)		0.9	0.2	12.31
Maple	96 (N/A)		0.7	0.2	15.97
Oak	55 (N/A)		0.6	0.1	10.94
Broadleaf Deciduous Small	8 (N/A)		0.5	0.0	2.06
White ash	164 (N/A)		0.5	0.4	41.00
River birch	92 (N/A)		0.5	0.2	22.89
Northern pin oak	102 (N/A)		0.3	0.2	34.03
Ginkgo	13 (N/A)		0.3	0.0	4.27
Southern magnolia	95 (N/A)		0.3	0.2	31.79
Broadleaf Deciduous Large	132 (N/A)		0.2	0.3	66.10
Amur maple	22 (N/A)		0.2	0.0	10.94
Bur oak	92 (N/A)		0.2	0.2	45.86
Northern catalpa	133 (N/A)		0.2	0.3	66.60
Elm	125 (N/A)		0.2	0.3	62.47
Black maple	0 (N/A)		0.1	0.0	0.00
Conifer Evergreen Small	14 (N/A)		0.1	0.0	13.68
Conifer Evergreen Medium	21 (N/A)		0.1	0.0	21.08
Kentucky coffeetree	66 (N/A)		0.1	0.1	65.59
Black cherry	2 (N/A)		0.1	0.0	2.06
Broadleaf Deciduous Medium	3 (N/A)		0.1	0.0	2.74
American elm	20 (N/A)		0.1	0.0	19.89
Boxelder	52 (N/A)		0.1	0.1	51.63
Eastern red cedar	21 (N/A)		0.1	0.0	21.34
Hickory	46 (N/A)		0.1	0.1	45.86
Willow	26 (N/A)		0.1	0.1	26.22
Quaking aspen	29 (N/A)		0.1	0.1	28.56
Tulip tree	46 (N/A)		0.1	0.1	45.86
Scotch pine	32 (N/A)		0.1	0.1	32.32
Citywide total	46,243 (N/A)		100.0	100.0	53.77

Table 7: Summary of Benefits in Dollars

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

4/23/2020

Species	Energy	CO₂	Air Quality	Stormwater	Aesthetic/Other	Total ($) Standard Error
Silver maple	62.00	12.55	11.44	116.13	98.46	300.58 (N/A)
Green ash	62.74	8.44	11.43	97.47	55.40	235.48 (N/A)
Apple	23.24	2.44	3.81	11.82	9.50	50.81 (N/A)
Pin oak	69.84	15.35	8.95	100.87	120.69	315.70 (N/A)
Norway maple	55.63	5.88	9.90	64.94	36.90	173.24 (N/A)
Black walnut	55.69	7.76	9.40	68.55	55.09	196.48 (N/A)
Red maple	25.42	2.87	4.41	25.28	26.99	84.97 (N/A)
Ash	18.81	2.34	2.81	12.51	20.45	56.92 (N/A)
Sugar maple	54.01	7.28	8.69	80.64	61.29	211.91 (N/A)
Conifer Evergreen L:	25.39	2.56	2.40	50.49	34.31	115.15 (N/A)
Northern hackberry	81.92	8.20	15.23	107.82	63.73	276.90 (N/A)
Siberian elm	79.32	9.73	15.74	120.99	48.89	274.66 (N/A)
Northern red oak	32.24	2.97	4.58	38.43	13.86	92.08 (N/A)
American sycamore	86.19	10.35	17.53	168.82	57.63	340.52 (N/A)
American basswood	62.82	10.12	9.58	89.03	68.83	240.38 (N/A)
Red pine	27.30	2.77	2.13	61.08	39.70	132.99 (N/A)
Honeylocust	72.09	11.64	12.35	115.83	254.32	466.23 (N/A)
Eastern redbud	14.51	1.53	2.30	6.31	5.54	30.19 (N/A)
Blue spruce	16.07	1.30	1.79	24.22	20.27	63.65 (N/A)
Eastern white pine	26.69	2.71	2.02	56.80	31.21	119.44 (N/A)
Norway spruce	27.44	2.79	1.97	61.64	36.14	129.97 (N/A)
Littleleaf linden	36.93	5.17	6.17	45.35	46.33	139.95 (N/A)
Swamp white oak	25.32	3.07	3.74	17.23	26.17	75.55 (N/A)
Pear	18.38	1.91	2.86	7.90	7.04	38.10 (N/A)
Spruce	17.33	1.59	1.69	29.27	22.53	72.42 (N/A)
Black spruce	6.94	0.45	0.75	6.95	12.31	27.41 (N/A)
Maple	32.83	2.66	5.96	36.07	15.97	93.48 (N/A)
Oak	3.75	0.57	0.56	2.98	10.94	18.80 (N/A)
Broadleaf Deciduous	5.40	0.55	0.71	1.86	2.06	10.58 (N/A)
White ash	27.11	3.60	4.26	23.74	41.00	99.70 (N/A)
River birch	20.60	2.51	2.90	13.01	22.89	61.91 (N/A)
Northern pin oak	62.82	6.09	11.69	80.74	34.03	195.36 (N/A)
Ginkgo	10.87	1.05	1.86	6.61	4.27	24.66 (N/A)
Southern magnolia	44.67	4.27	6.10	64.97	31.79	151.81 (N/A)
Broadleaf Deciduous	76.46	10.54	14.09	127.82	66.10	295.02 (N/A)
Amur maple	28.16	2.97	4.55	12.62	10.94	59.24 (N/A)
Bur oak	44.23	6.14	7.42	39.72	45.86	143.36 (N/A)
Northern catalpa	82.02	11.11	15.71	148.79	66.60	324.23 (N/A)
Elm	86.52	11.00	17.37	172.48	62.47	349.85 (N/A)
Black maple	60.68	3.27	11.54	77.70	0.00	153.19 (N/A)
Conifer Evergreen S:	24.57	1.67	2.19	44.30	13.68	86.40 (N/A)
Conifer Evergreen M	14.80	1.07	1.53	20.47	21.08	58.96 (N/A)
Kentucky coffeetree	70.91	9.97	12.48	106.85	65.59	265.81 (N/A)
Black cherry	5.40	0.55	0.71	1.86	2.06	10.58 (N/A)
Broadleaf Deciduous	1.10	0.09	0.14	0.33	2.74	4.40 (N/A)
American elm	17.66	1.82	2.54	11.72	19.89	53.63 (N/A)
Boxelder	46.76	7.65	7.54	60.52	51.63	174.10 (N/A)
Eastern red cedar	11.47	0.89	0.62	17.86	21.34	52.19 (N/A)
Hickory	44.23	6.14	7.42	39.72	45.86	143.36 (N/A)
Willow	24.47	2.95	3.47	15.88	26.22	72.99 (N/A)
Quaking aspen	20.64	2.71	2.99	16.47	28.56	71.37 (N/A)
Tulip tree	44.23	6.14	7.42	39.72	45.86	143.36 (N/A)
Scotch pine	24.14	2.43	2.82	41.70	32.32	103.40 (N/A)
Citywide Total	47.56	6.92	7.89	68.53	53.77	184.67 (N/A)
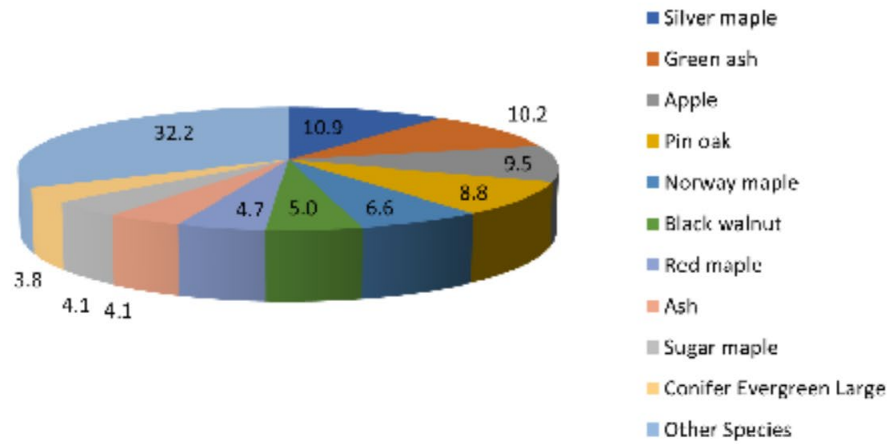
Species	Percent
Silver maple	10.9
Green ash	10.2
Apple	9.5
Pin oak	8.8
Norway maple	6.6
Black walnut	5.0
Red maple	4.7
Ash	4.1
Sugar maple	4.1
Conifer Evergreen Large	3.8
Other Species	32.2
Total	100.0

Figure 1: Species Distribution

## Relative Age Distribution of Top 10 Public Tree Species for All Zones (%)

4/23/2020
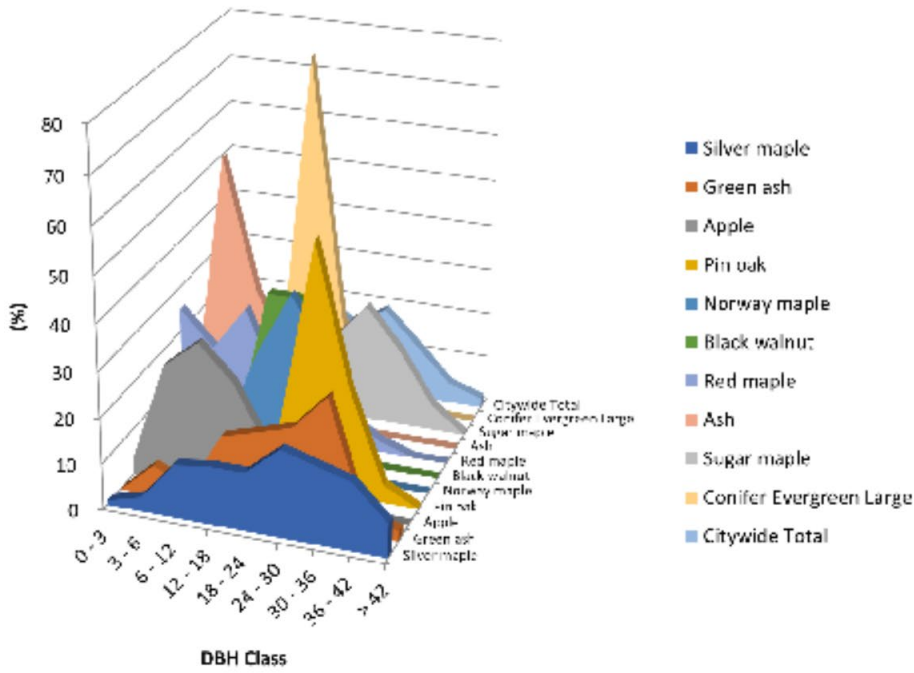
	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Silver maple	1.06	3.19	11.70	12.77	12.77	19.15	17.02	14.89	7.45
Green ash	0.00	6.82	3.41	15.91	18.18	20.45	28.41	4.55	2.27
Apple	3.66	25.61	31.71	24.39	10.98	3.66	0.00	0.00	0.00
Pin oak	0.00	1.32	1.32	2.63	13.16	53.95	23.68	3.95	0.00
Norway maple	0.00	3.51	5.26	24.56	38.60	28.07	0.00	0.00	0.00
Black walnut	0.00	0.00	2.33	34.88	34.88	27.91	0.00	0.00	0.00
Red maple	25.00	17.50	27.50	10.00	10.00	7.50	2.50	0.00	0.00
Ash	0.00	57.14	28.57	14.29	0.00	0.00	0.00	0.00	0.00
Sugar maple	0.00	11.43	8.57	14.29	17.14	25.71	17.14	5.71	0.00
Conifer Evergreen La	0.00	0.00	3.03	75.76	18.18	3.03	0.00	0.00	0.00
Citywide Total	2.91	11.86	12.79	19.88	14.77	19.30	11.98	4.53	1.98

Figure 2: Relative Age Class

Functional (Foliage) Condition of Public Trees by Species (%)

2% 3%

34%

60%

- Dead/Dying - Poor - Fair - Good
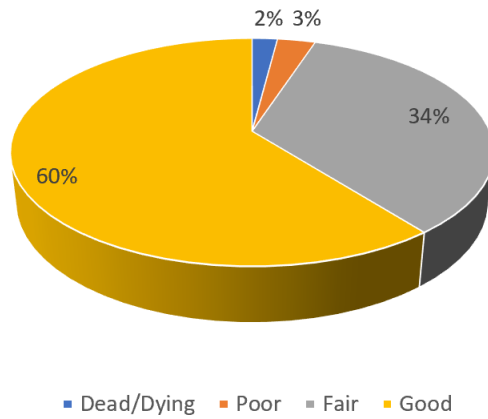
Figure 3: Foliage Condition

Functional (Foliage) Condition of Public Trees by Species (%)

2%

5%

31%

62%

- Dead/Dying - Poor - Fair - Good
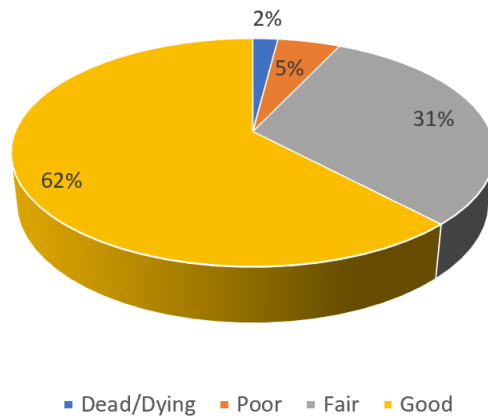
Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

4/23/2020
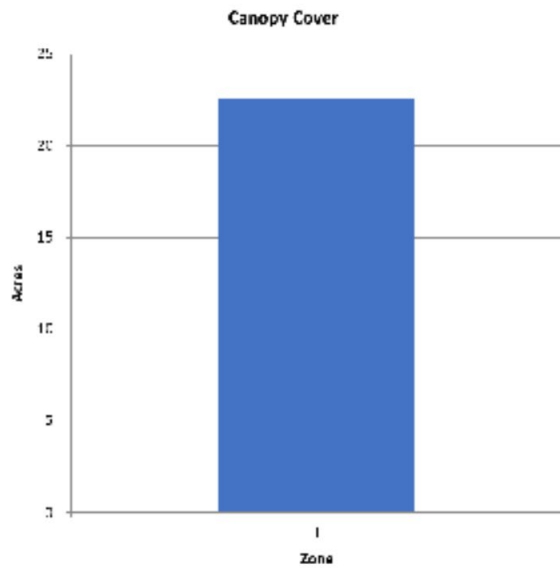
Canopy Cover

Zone	Acres	% of Total Canopy Cover
1	23	100.0
Citywide total	23	100.0

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

■ 1 ■ Citywide total
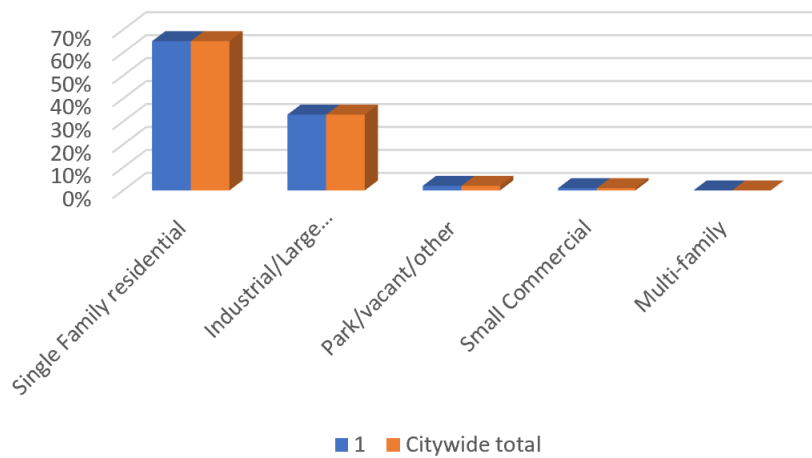
Figure 6: Land Use of city/park trees

Appendix B: ArcGIS Mapping
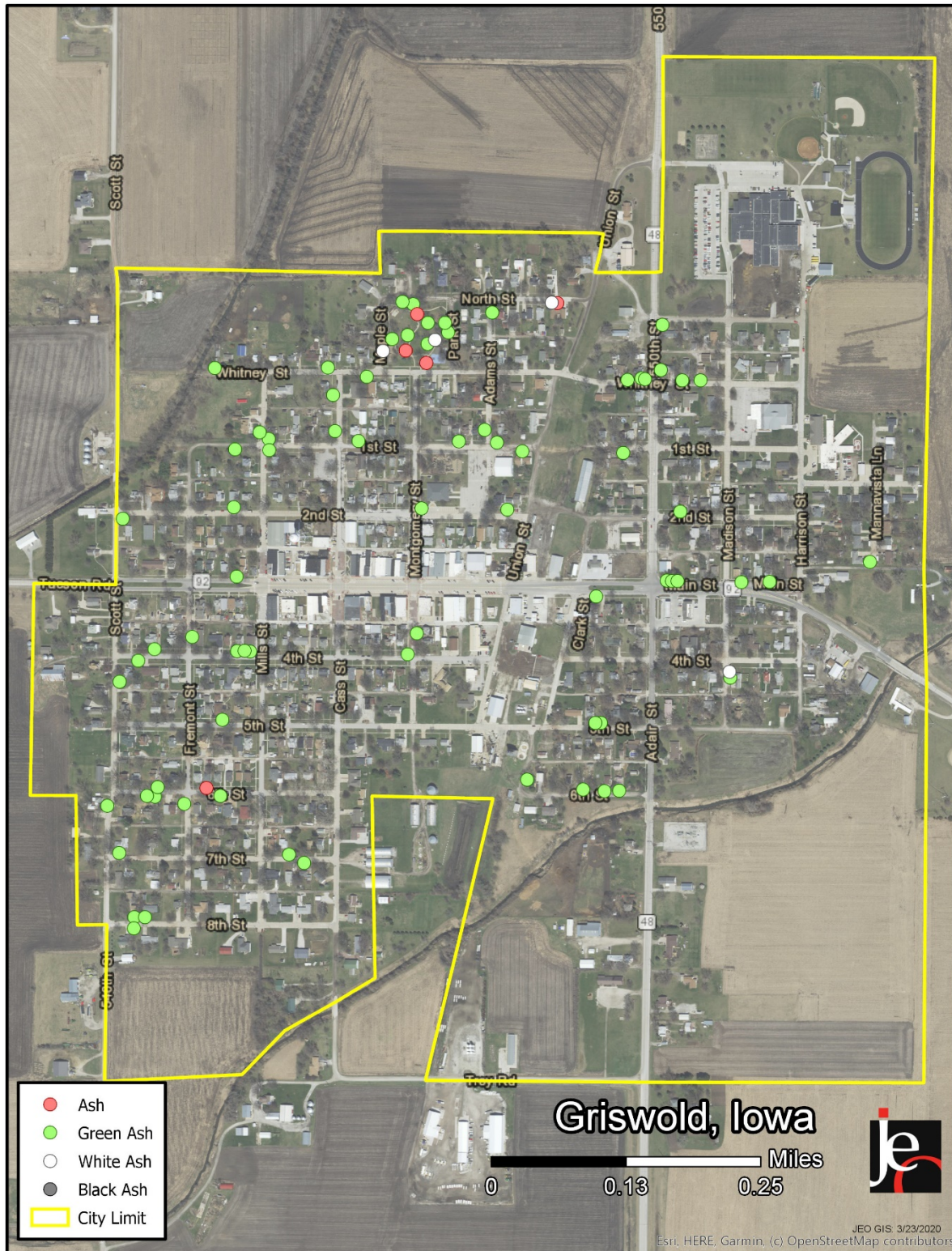
Figure 1: Location of Ash Trees
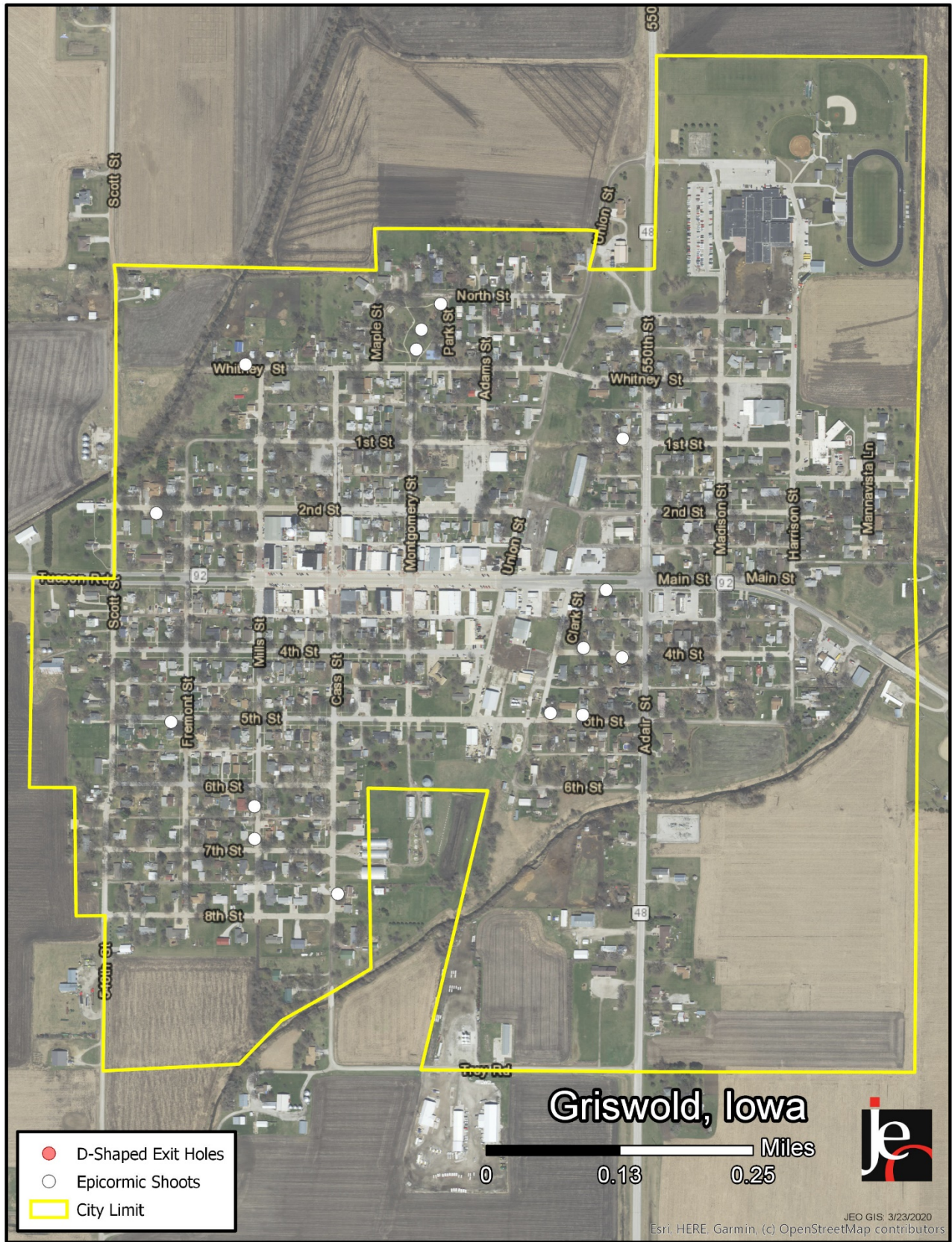
Figure 2: Location of EAB symptoms

Figure 3: Location of Poor Condition Trees
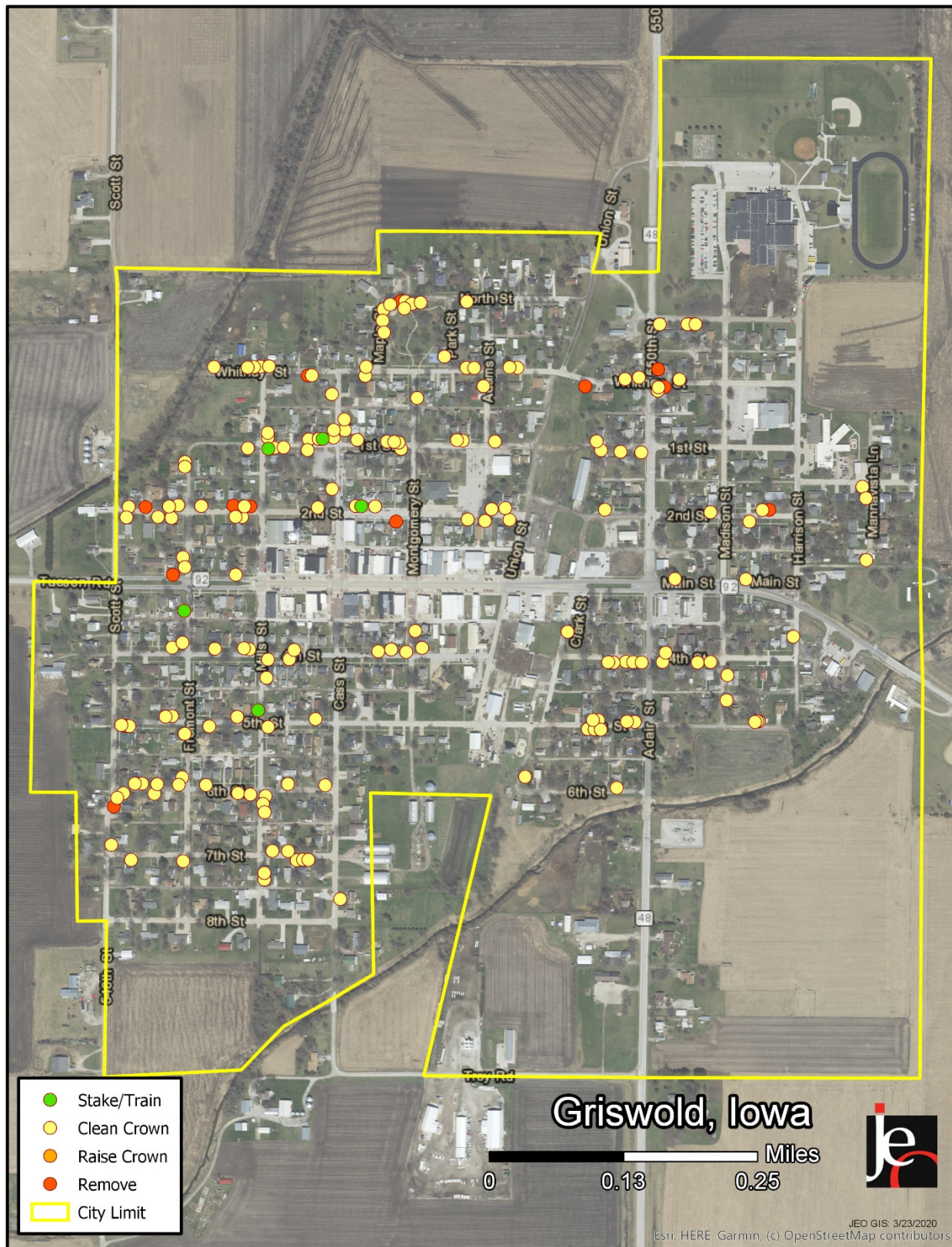
Figure 4: Location of Trees with Recommended Maintenance *City ownership of the trees recommended for removal should be verified prior to any removal*

Appendix C: Griswold Tree Ordinances

6-10-1 Definition
6-10-2 Planting Restrictions
6-10-3 Duty to Trim Trees
6-10-4 Trimming Tress to be Supervised
6-10-5 Disease Control 6-10-6 Inspection and Removal

6-10-1 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 street, that part of the street, avenue or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

6-10-2 PLANTING RESTRICTIONS.
No person shall plant a tree in any parking or street without first obtaining a permit from the Clerk at least five days prior to such planting. Any trees planted in the parking or street shall be planted in accordance with the following:
1. 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. 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. 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.

6-10-3 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. (Code of Iowa, Sec. 364.12[2c, d & e])

6-10-4 TRIMMING TREES TO BE SUPERVISED.
Except as allowed in Section 6-10-3, 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.

6-10-5 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 a nuisance.

6-10-6 INSPECTION AND REMOVAL.

The Council shall inspect or cause to be inspected any trees or shrubs in the city reported or suspected to be infected with or damaged by any disease or insect or disease pests, and such trees and shrubs shall be subject to removal as follows:

1. Removal from 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, and that danger to other trees within the city is imminent, the Council shall immediately cause such condition to be corrected by treatment or removal so as to destroy or prevent as fully as possible the spread of the disease or the insect or disease pests. 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. Removal from private property. If it is determined with reasonable certainty that any such condition exists on private property and that the danger to other trees within the city is imminent, the Council shall immediately 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 nuisance to be removed and the cost assessed against the property. (Code of Iowa, Sec. 364.12[3b &h])

Should the City remove a tree or shrub from private property, in addition to the cost to remove the tree or shrub, the property owner shall also be responsible for any costs associated with removing a stump

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.