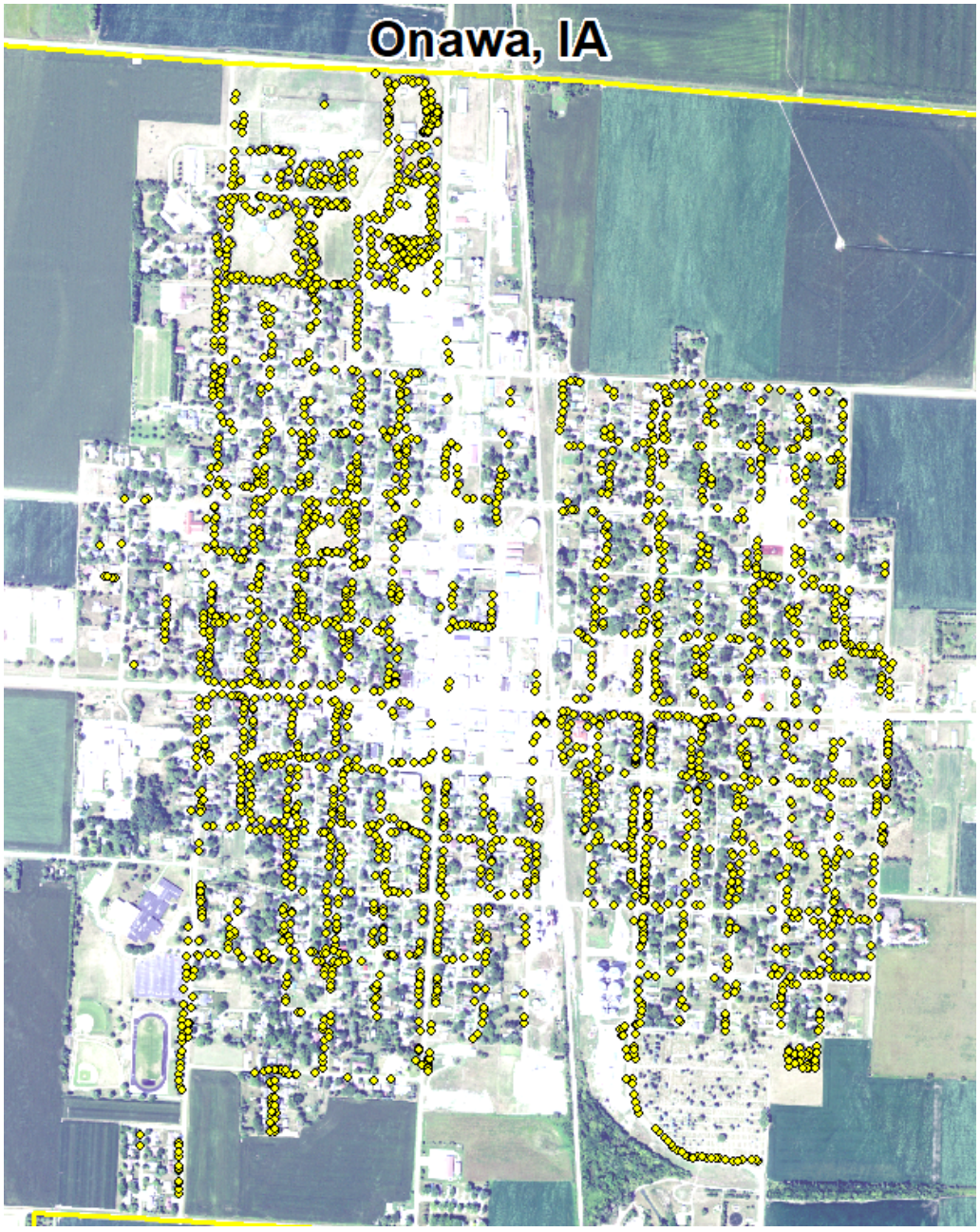
2023 Urban Forest Management Plan



For Onawa, Iowa

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Executive Summary

Overview

This plan was developed to assist the City of Onawa with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 25% of Onawa's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2021, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 2708 trees inventoried.

- Onawa's trees provide $488,777 of benefits annually, an average of $180 a tree
- There are over 36 species of trees
- The top three genera are: Maple 31%, Ash 25%, and Spruce 7%
- 7% of trees are in need of some type of management
- 126 trees are recommended for removal

Recommendations

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

- Of the 126 trees needing removal, 10 critical concern 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*
- 71 of the 670 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 with a visual survey yearly
- With the current budget it could take 19 years to remove ash – Suggestion: request a budget increase to at least $60,000 annually and apply for grants to plant replacement trees

Introduction

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

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

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

Inventory

In 2021, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

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

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

Inventory Results

The data collected for the 2708 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. The following are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Onawa's trees reduce energy related costs by approximately $128,403 annually (Appendix A, Table 1). These savings are both in Electricity (615.7 MWh) and in Natural Gas (83,337.8 Therms).

Annual Stormwater Benefits

Onawa's trees intercept about 6,634,563 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $179,797 of benefits to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Onawa, it is estimated that trees remove 7,905 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 $22,207 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Onawa, trees sequester about 2,347,846 lbs of carbon a year with an associated value of $17,609 (Appendix A, Table 5). In addition, the trees store 22,966,592 lbs of carbon, with a yearly benefit of $172,249 (Appendix A, Table 4).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Onawa receives $140,761 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, Onawa's trees provide $488,777 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 2708 trees in Onawa provide approximately $180 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Onawa has over 36 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	841	31%
Ash	670	25%
Spruce	203	7%
Locust	172	6%
Hackberry	150	6%
Oak	129	5%
Apple	103	4%
Linden/Basswood	102	4%
Pear	32	1%
Cedar	31	1%
Siberian elm	28	1%
Birch	25	1%
Elm	24	1%
Pine	24	1%
Walnut	18	1%
Kentucky Coffee Tree	14	1%
Catalpa	11	<1%
Cherry	11	<1%
Mulberry	11	<1%
Redbud	10	<1%
Poplar	8	<1%
Cottonwood	8	<1%
Gingko	8	<1%

Willow	6	<1%
Sycamore	5	<1%
Lilac	4	<1%
Hop hornbeam	3	<1%
Mountain ash	2	<1%
Alder	2	<1%
Chestnut	2	<1%
Dogwood	2	<1%
Magnolia	2	<1%
Buckeye	1	<1%
Apsen	1	<1%
Other Broadleaf	39	1%
Other Evergreen	5	<1%

Age Class

Most of Onawa's trees (57%) are between 6 and 24 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Onawa's size curve indicates a moderately young stand, though only 11% of trees are in the <6" DBH size classes.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Onawa indicate that 95% 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, 93% of Onawa's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 3% of the population. This 8% 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).

Tree Removal	126	5%
Crown Cleaning	25	1%
Tree Staking	21	1%
Crown Reduction	9	<1%
Crown Raising	4	<1%

Canopy Cover

The total canopy with both private and public trees is 9%, or 284 acres. The canopy cover on city owned properties included in the Onawa inventory includes approximately 69 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3% in 30 years on all lands. To achieve this goal it is estimated that 243 trees need to be planted annually on public and/or private lands.

Land Use and Location

The majority of Onawa'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	71%
Industrial/Large commercial	23%
Park/vacant/other	3%
Multifamily residential	2%
Small commercial	1%
Location	
Front yard	56%
Planting strip	44%
Cutout (surrounded by pavement)	<1%

Changes in Forest Structure Since 2014 Plan

Notable changes from the 2014 Onawa Management Plan include:

- 121 fewer trees inventoried
- A 3% decrease of trees with good or fair wood condition/health
- 62 more trees recommended for removal (64 in 2014, 126 in 2023)
- No change in total canopy cover percentage on all lands (9%). This number is expected to drop notably as ash trees die or are removed due to EAB.

Recommendations

Risk Management

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

Hazardous trees

Onawa has 12 critical concern trees that need immediate removal and 3 critical concern trees that need cleaned or reduced. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There are 10 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the six year maintenance plan at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 170 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 126 removals, 79 are ash trees. There are a total of 670 ash trees, and 71 of those have signs and symptoms that have been associated with EAB. 12 of the ash trees are in poor health. In addition, there are 48 trees of other species 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 is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six year maintenance plan for further information.

Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Onawa.

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 (31%) (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. It is recommended that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Proposed Work Schedule, Budget, and Emerald Ash Borer Plan

Six Year Maintenance Plan with <u>No Additional Funding</u>
Current Budget $40,000/year, Total $240,000 over 6 years

FY 2023 - Total: $39,900

Removal: 12 critical concern trees, 22 mature tree immediate noted for removal, 3 young tree immediate that are dead/dying, **$33,300**
Planting and Replacement: 37 x 1.2 (recommended replacement rate) = 44 trees, **$4,400**
Tree Pruning & Maintenance: Clean/reduce 3 critical concern, Clean/reduce 18 mature tree immediate, stake/train 1 young tree immediate = **$2,200**
Visual Survey for signs and symptoms of EAB

FY 2024 - Total: $39,400

Removal: 35 trees noted for removal, **$31,500**
Planting and Replacement: 42 trees, **$4,200**
Tree Pruning & Maintenance: Clean/raise/reduce 17 mature tree routine, Stake/train 20 young tree routine, **$3,700**
Routine trimming: As needed
Visual Survey for signs and symptoms of EAB

FY 2025 - Total: $39,800

Removal: 39 trees noted for removal, **$35,100**
Planting and Replacement: 47 trees, **$4,700**
Tree Pruning & Maintenance: As needed, ⅓ of city trees should be pruned every other year
Visual Survey for signs and symptoms of EAB

FY 2026 - Total: $37,700

Removal: Remaining 15 trees currently noted for removal AND 22 ash trees, **$33,300**
Planting and Replacement: 44 trees, **$4,400**
Tree Pruning & Maintenance, Routine trimming: As needed
Visual Survey for signs and symptoms of EAB

FY 2027 - Total: $37,700

Removal: 37 ash trees, **$33,300**
Planting and Replacement: 44 trees, **$4,400**
Tree Pruning & Maintenance: As needed, prune ⅓ of city trees
Visual Survey for signs and symptoms of EAB

FY 2028 - Total: $37,700

Removal: 37 ash trees, **$33,300**
Planting and Replacement: **44 trees, $4,400**
Tree Pruning & Maintenance, Routine trimming: As needed
Visual Survey for signs and symptoms of EAB

**Amounts given are based on an estimate of $900/tree for removals, $100/tree for planting and maintenance, and $100/tree for pruning and maintenance

Reduction of ash over 6 years: Approximately 175 ash trees removed (approximately 25% of ash). It will take approximately 19 years to remove and replace all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.

To remove and replace all ash trees within 6 years, the budget would need to be increased to $124,000 a year. If the budget were increased to $80,000 a year all ash could be removed/replaced in just under 10 years, and if increased to $60,000 a year the work could be completed in approximately 12 years.

Ash Tree Removal

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

Treatment of Ash Trees

Chemical treatment can be an effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide 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 disposed of as you normally would 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 the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Private Ash Trees

It is strongly recommended that private property owners start removing 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 Budget Increase

EAB could potentially kill all ash trees in Onawa within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $124,000 a year. Additionally, it is recommended that Onawa 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 being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. This is an alternative to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing

with ash trees when EAB is found in Onawa. It is suggested to consider increasing the budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefit

Onawa

Annual Energy Benefits of Public Trees

3/24/2022

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	148.0	11,233	19,309.8	18,924	30,156	(N/A)	18.0	23.5	61.92
Ash	86.6	6,573	12,231.9	11,987	18,561	(N/A)	12.7	14.5	53.80
Green ash	69.8	5,300	9,376.8	9,189	14,489	(N/A)	9.2	11.3	58.42
Norway maple	34.7	2,636	4,856.9	4,760	7,395	(N/A)	6.6	5.8	41.09
Honeylocust	48.0	3,646	6,254.5	6,129	9,776	(N/A)	6.2	7.6	58.54
Blue spruce	17.4	1,321	2,327.7	2,281	3,602	(N/A)	5.6	2.8	23.85
Northern hackberry	46.8	3,553	6,617.3	6,485	10,038	(N/A)	5.5	7.8	66.92
Apple	11.4	867	1,727.1	1,693	2,559	(N/A)	3.8	2.0	24.85
White ash	18.9	1,435	2,261.5	2,216	3,651	(N/A)	2.8	2.8	47.42
Red maple	10.1	763	1,340.4	1,314	2,077	(N/A)	2.6	1.6	29.25
Sugar maple	16.2	1,228	2,115.9	2,074	3,301	(N/A)	2.4	2.6	50.79
Northern red oak	11.3	856	1,492.1	1,462	2,319	(N/A)	2.4	1.8	35.67
Littleleaf linden	13.0	986	1,864.3	1,827	2,813	(N/A)	2.1	2.2	50.24
American basswood	11.5	872	1,672.5	1,639	2,511	(N/A)	1.7	2.0	54.58
Amur maple	3.7	284	568.8	557	841	(N/A)	1.4	0.7	22.74
Bur oak	5.5	420	694.9	681	1,101	(N/A)	1.3	0.9	31.47
Callery pear	4.2	317	601.9	590	907	(N/A)	1.1	0.7	30.24
Siberian elm	7.5	566	996.2	976	1,542	(N/A)	1.0	1.2	55.08
Eastern red cedar	2.8	210	412.4	404	615	(N/A)	1.0	0.5	21.95
Spruce	0.5	36	60.5	59	96	(N/A)	1.0	0.1	3.41
Norway spruce	2.6	198	339.5	333	531	(N/A)	0.9	0.4	22.13
Elm	4.6	350	574.9	563	914	(N/A)	0.7	0.7	45.69
Black walnut	4.5	339	630.9	618	958	(N/A)	0.7	0.7	53.21
Broadleaf Deciduous Small	0.5	37	84.7	83	120	(N/A)	0.6	0.1	7.52
River birch	2.2	165	311.4	305	470	(N/A)	0.6	0.4	31.36
Swamp white oak	1.1	84	169.2	166	249	(N/A)	0.6	0.2	16.63
Austrian pine	2.2	166	296.1	290	456	(N/A)	0.6	0.4	30.39
Broadleaf Deciduous Mediu	1.5	114	223.8	219	333	(N/A)	0.5	0.3	23.78
Kentucky coffeetree	1.5	114	192.0	188	302	(N/A)	0.5	0.2	21.56
Catalpa	3.7	281	487.8	478	759	(N/A)	0.4	0.6	68.96
White mulberry	0.8	57	109.1	107	164	(N/A)	0.4	0.1	16.42
Eastern redbud	0.7	57	119.6	117	174	(N/A)	0.4	0.1	17.41
Paper birch	0.7	50	87.5	86	135	(N/A)	0.4	0.1	13.52
Kwanzan cherry	1.2	88	168.8	165	253	(N/A)	0.3	0.2	31.66
Black poplar	3.3	254	442.8	434	688	(N/A)	0.3	0.5	85.95
Ginkgo	1.7	130	224.3	220	350	(N/A)	0.3	0.3	43.71
Broadleaf Deciduous Large	2.4	185	338.9	332	517	(N/A)	0.3	0.4	64.68
Eastern white pine	1.0	77	121.9	119	197	(N/A)	0.3	0.2	24.57
White oak	1.4	108	175.8	172	280	(N/A)	0.3	0.2	40.03
Willow	0.7	54	104.3	102	157	(N/A)	0.2	0.1	26.10
Black locust	1.5	113	221.4	217	330	(N/A)	0.2	0.3	65.98
Cottonwood	1.8	135	241.6	237	372	(N/A)	0.2	0.3	74.45
American sycamore	0.5	38	67.3	66	104	(N/A)	0.2	0.1	20.79
Northern pin oak	1.1	84	166.9	164	248	(N/A)	0.2	0.2	49.60
Conifer Evergreen Large	0.4	34	53.4	52	86	(N/A)	0.1	0.1	21.50
Lilac	0.0	2	5.7	6	8	(N/A)	0.1	0.0	2.00
American elm	1.1	84	133.7	131	215	(N/A)	0.1	0.2	53.75
Mountain ash	0.2	17	38.5	38	55	(N/A)	0.1	0.0	18.19
Eastern cottonwood	0.2	17	31.1	31	47	(N/A)	0.1	0.0	15.70
Northern white cedar	0.1	8	17.4	17	25	(N/A)	0.1	0.0	8.26
Eastern hophornbeam	0.5	36	76.1	75	110	(N/A)	0.1	0.1	36.82
American chestnut	0.2	14	27.5	27	41	(N/A)	0.1	0.0	20.64
Southern magnolia	0.4	29	49.8	49	78	(N/A)	0.1	0.1	38.93
Oak	0.8	59	107.4	105	164	(N/A)	0.1	0.1	82.02
Cherry plum	0.0	2	4.4	4	6	(N/A)	0.1	0.0	3.13
Alder	0.1	11	25.7	25	36	(N/A)	0.1	0.0	18.19

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Dogwood	0.0	1	1.2	1	2 (N/A)	0.1	0.0	0.87
Pear	0.0	1	1.2	1	2 (N/A)	0.1	0.0	0.87
Scotch pine	0.1	4	9.5	9	14 (N/A)	0.0	0.0	13.58
Japanese maple	0.0	2	3.8	4	5 (N/A)	0.0	0.0	5.40
Ohio buckeye	0.1	8	16.9	17	24 (N/A)	0.0	0.0	24.47
Quaking aspen	0.0	2	3.7	4	6 (N/A)	0.0	0.0	5.82
Common chokecherry	0.1	6	12.8	13	18 (N/A)	0.0	0.0	18.19
Conifer Evergreen Small	0.0	1	2.5	2	4 (N/A)	0.0	0.0	3.62
Mulberry	0.2	15	31.6	31	46 (N/A)	0.0	0.0	46.14
Total	615.7	46,732	83,337.8	81,671	128,403 (N/A)	100.0	100.0	47.43

Table 2: Annual Stormwater Benefits

Onawa

Annual Stormwater Benefits of Public Trees

3/24/2022

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	2,157,378	58,465	(N/A)	18.0	32.5	120.05
Ash	780,079	21,140	(N/A)	12.7	11.8	61.28
Green ash	744,769	20,183	(N/A)	9.2	11.2	81.38
Norway maple	263,426	7,139	(N/A)	6.6	4.0	39.66
Honeylocust	511,143	13,852	(N/A)	6.2	7.7	82.95
Blue spruce	245,181	6,644	(N/A)	5.6	3.7	44.00
Northern hackberry	425,417	11,529	(N/A)	5.5	6.4	76.86
Apple	48,711	1,320	(N/A)	3.8	0.7	12.82
White ash	157,031	4,256	(N/A)	2.8	2.4	55.27
Red maple	64,005	1,735	(N/A)	2.6	1.0	24.43
Sugar maple	142,670	3,866	(N/A)	2.4	2.2	59.48
Northern red oak	93,679	2,539	(N/A)	2.4	1.4	39.06
Littleleaf linden	147,396	3,994	(N/A)	2.1	2.2	71.33
American basswood	140,363	3,804	(N/A)	1.7	2.1	82.69
Amur maple	13,425	364	(N/A)	1.4	0.2	9.83
Bur oak	45,421	1,231	(N/A)	1.3	0.7	35.17
Callery pear	28,785	780	(N/A)	1.1	0.4	26.00
Siberian elm	78,686	2,132	(N/A)	1.0	1.2	76.16
Eastern red cedar	40,415	1,095	(N/A)	1.0	0.6	39.12
Spruce	5,834	158	(N/A)	1.0	0.1	5.65
Norway spruce	40,115	1,087	(N/A)	0.9	0.6	45.30
Elm	43,747	1,186	(N/A)	0.7	0.7	59.28
Black walnut	53,972	1,463	(N/A)	0.7	0.8	81.26
Broadleaf Deciduous Small	1,625	44	(N/A)	0.6	0.0	2.75
River birch	14,448	392	(N/A)	0.6	0.2	26.10
Swamp white oak	6,048	164	(N/A)	0.6	0.1	10.93
Austrian pine	34,954	947	(N/A)	0.6	0.5	63.15
Broadleaf Deciduous Medium	8,429	228	(N/A)	0.5	0.1	16.32
Kentucky coffeetree	12,451	337	(N/A)	0.5	0.2	24.10
Catalpa	47,136	1,277	(N/A)	0.4	0.7	116.13
White mulberry	2,688	73	(N/A)	0.4	0.0	7.29
Eastern redbud	3,112	84	(N/A)	0.4	0.0	8.43
Paper birch	4,140	112	(N/A)	0.4	0.1	11.22
Kwanzan cherry	4,634	126	(N/A)	0.3	0.1	15.70
Black poplar	50,390	1,366	(N/A)	0.3	0.8	170.69
Ginkgo	11,962	324	(N/A)	0.3	0.2	40.52
Broadleaf Deciduous Large	28,501	772	(N/A)	0.3	0.4	96.55
Eastern white pine	14,432	391	(N/A)	0.3	0.2	48.89
White oak	11,978	325	(N/A)	0.3	0.2	46.37
Willow	5,085	138	(N/A)	0.2	0.1	22.97
Black locust	16,252	440	(N/A)	0.2	0.2	88.08
Cottonwood	26,268	712	(N/A)	0.2	0.4	142.37
American sycamore	7,618	206	(N/A)	0.2	0.1	41.29
Northern pin oak	11,214	304	(N/A)	0.2	0.2	60.78
Conifer Evergreen Large	5,211	141	(N/A)	0.1	0.1	35.31
Lilac	91	2	(N/A)	0.1	0.0	0.62
American elm	7,765	210	(N/A)	0.1	0.1	52.61
Mountain ash	793	22	(N/A)	0.1	0.0	7.17
Eastern cottonwood	1,387	38	(N/A)	0.1	0.0	12.53
Northern white cedar	1,021	28	(N/A)	0.1	0.0	9.22
Eastern hophornbeam	2,613	71	(N/A)	0.1	0.0	23.60
American chestnut	1,216	33	(N/A)	0.1	0.0	16.47
Southern magnolia	4,796	130	(N/A)	0.1	0.1	64.99
Oak	10,981	298	(N/A)	0.1	0.2	148.79
Cherry plum	76	2	(N/A)	0.1	0.0	1.03
Alder	529	14	(N/A)	0.1	0.0	7.17
Dogwood	15	0	(N/A)	0.1	0.0	0.20
Pear	15	0	(N/A)	0.1	0.0	0.20
Scotch pine	596	16	(N/A)	0.0	0.0	16.14
Japanese maple	69	2	(N/A)	0.0	0.0	1.86
Ohio buckeye	586	16	(N/A)	0.0	0.0	15.88
Quaking aspen	172	5	(N/A)	0.0	0.0	4.65
Common chokecherry	264	7	(N/A)	0.0	0.0	7.17
Conifer Evergreen Small	183	5	(N/A)	0.0	0.0	4.97
Mulberry	1,174	32	(N/A)	0.0	0.0	31.82
Citywide total	6,634,563	179,797	(N/A)	100.0	100.0	66.42

Table 3: Annual Air Quality Benefits

Onawa

Annual Air Quality Benefits of Public Trees

3/24/2022

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($) Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2							
Silver maple	378.5	64.2	185.3	16.8	2,039	696.2	102.0	97.4	669.4	4,359	-197.2	-739	2,012.5	5,659 (N/A)	18.0	11.62
Ash	157.6	27.2	77.7	7.0	852	417.6	60.5	57.7	393.0	2,592	-37.1	-139	1,161.1	3,305 (N/A)	12.7	9.58
Green ash	90.2	14.4	43.5	4.0	481	331.8	48.4	46.2	316.5	2,071	0.0	0	895.1	2,552 (N/A)	9.2	10.29
Norway maple	47.0	8.1	24.1	2.1	257	167.0	24.2	23.1	157.6	1,038	-11.6	-44	441.6	1,251 (N/A)	6.6	6.95
Honeylocust	98.7	16.3	45.2	4.5	521	226.0	33.1	31.6	217.5	1,415	-77.1	-289	595.7	1,648 (N/A)	6.2	9.87
Blue spruce	33.8	6.7	28.0	4.1	223	82.3	12.0	11.5	78.8	515	-90.0	-337	167.3	400 (N/A)	5.6	2.65
Northern hackberry	64.1	11.1	33.1	2.9	351	225.7	32.7	31.2	212.3	1,401	0.0	0	613.1	1,752 (N/A)	5.5	11.68
Apple	14.8	2.4	7.0	0.7	79	56.0	8.0	7.6	51.8	345	-0.1	0	148.3	424 (N/A)	3.8	4.11
White ash	17.3	2.8	8.9	0.8	94	87.3	12.9	12.4	85.6	551	0.0	0	227.9	645 (N/A)	2.8	8.37
Red maple	11.7	2.0	5.9	0.5	63	47.6	7.0	6.6	45.5	297	-4.4	-17	122.4	344 (N/A)	2.6	4.85
Sugar maple	16.7	2.8	8.9	0.7	92	76.3	11.2	10.7	73.3	478	-13.5	-51	187.0	519 (N/A)	2.4	7.98
Northern red oak	18.6	3.2	9.2	0.8	101	53.3	7.8	7.4	51.1	334	-26.2	-98	125.4	336 (N/A)	2.4	5.17
Littleleaf linden	26.6	4.6	12.9	1.2	143	62.9	9.1	8.7	59.0	390	-12.6	-47	172.4	486 (N/A)	2.1	8.68
American basswood	20.1	3.4	9.7	0.9	108	55.8	8.1	7.7	52.1	345	-16.8	-63	140.9	390 (N/A)	1.7	8.48
Amur maple	3.3	0.5	1.7	0.2	18	18.4	2.6	2.5	17.0	113	0.0	0	46.1	131 (N/A)	1.4	3.54
Bur oak	4.5	0.7	2.4	0.2	25	25.9	3.8	3.6	25.1	163	0.0	0	66.3	187 (N/A)	1.3	5.35
Callery pear	4.6	0.8	2.4	0.2	25	20.3	2.9	2.8	19.0	126	-1.2	-4	51.8	146 (N/A)	1.1	4.88
Siberian elm	13.2	2.3	6.5	0.6	71	35.4	5.2	4.9	33.8	221	0.0	0	101.7	292 (N/A)	1.0	10.43
Eastern red cedar	8.2	1.6	6.5	1.0	53	13.5	1.9	1.8	12.6	83	-22.3	-83	24.8	53 (N/A)	1.0	1.89
Spruce	0.5	0.1	0.5	0.1	4	2.2	0.3	0.3	2.2	14	-2.1	-8	4.1	10 (N/A)	1.0	0.35
Norway spruce	4.5	0.9	3.8	0.6	30	12.3	1.8	1.7	11.8	77	-18.2	-68	19.2	39 (N/A)	0.9	1.61
Elm	5.6	0.9	2.7	0.3	30	21.5	3.2	3.0	20.9	135	0.0	0	58.1	165 (N/A)	0.7	8.27
Black walnut	6.9	1.1	3.3	0.3	37	21.5	3.1	3.0	20.3	134	0.0	0	59.5	170 (N/A)	0.7	9.46
Broadleaf Deciduous Small	0.2	0.0	0.1	0.0	1	2.5	0.4	0.3	2.2	15	0.0	0	5.8	16 (N/A)	0.6	1.02
River birch	2.2	0.4	1.2	0.1	12	10.5	1.5	1.5	9.9	65	-0.6	-2	26.7	75 (N/A)	0.6	5.02
Swamp white oak	0.6	0.1	0.4	0.0	4	5.4	0.8	0.7	5.0	33	-0.2	-1	12.9	36 (N/A)	0.6	2.42
Austrian pine	5.8	1.2	4.7	0.7	38	10.4	1.5	1.4	9.9	65	-13.4	-50	22.2	53 (N/A)	0.6	3.50
Broadleaf Deciduous Medium	1.0	0.2	0.6	0.0	6	7.3	1.1	1.0	6.8	45	-0.3	-1	17.6	50 (N/A)	0.5	3.54
Kentucky coffeetree	1.2	0.2	0.6	0.1	7	7.0	1.0	1.0	6.8	44	0.0	0	17.9	51 (N/A)	0.5	3.62
Catalpa	7.6	1.2	3.4	0.3	40	17.5	2.6	2.4	16.8	109	0.0	0	51.8	149 (N/A)	0.4	13.55
White mulberry	0.7	0.1	0.4	0.0	4	3.7	0.5	0.5	3.4	23	0.0	0	9.3	26 (N/A)	0.4	2.65
Eastern redbud	0.8	0.1	0.4	0.0	4	3.7	0.5	0.5	3.4	23	0.0	0	9.6	27 (N/A)	0.4	2.73
Paper birch	0.2	0.0	0.2	0.0	1	3.1	0.5	0.4	3.0	19	0.0	0	7.3	21 (N/A)	0.4	2.06
Kwanzan cherry	1.4	0.2	0.7	0.1	7	5.6	0.8	0.8	5.2	35	0.0	0	14.8	42 (N/A)	0.3	5.28
Black poplar	8.7	1.4	3.8	0.4	45	15.8	2.3	2.2	15.1	99	0.0	0	49.8	144 (N/A)	0.3	18.05
Ginkgo	3.3	0.6	1.6	0.1	18	8.1	1.2	1.1	7.7	50	-1.0	-4	22.7	64 (N/A)	0.3	8.03
Broadleaf Deciduous Large	3.6	0.6	1.7	0.2	19	11.7	1.7	1.6	11.1	73	0.0	0	32.2	92 (N/A)	0.3	11.50
Eastern white pine	1.6	0.3	1.4	0.2	11	4.7	0.7	0.7	4.6	30	-6.3	-24	7.9	17 (N/A)	0.3	2.10
White oak	1.3	0.2	0.6	0.1	7	6.6	1.0	0.9	6.4	42	0.0	0	17.1	48 (N/A)	0.3	6.92
Willow	0.8	0.1	0.4	0.0	5	3.5	0.5	0.5	3.2	22	-0.2	-1	8.9	25 (N/A)	0.2	4.21
Black locust	3.6	0.6	1.7	0.2	19	7.3	1.0	1.0	6.7	45	-0.8	-3	21.3	61 (N/A)	0.2	12.21
Cottonwood	4.4	0.7	2.0	0.2	23	8.5	1.2	1.2	8.1	53	0.0	0	26.3	76 (N/A)	0.2	15.22
American sycamore	1.2	0.2	0.5	0.1	6	2.4	0.3	0.3	2.3	15	0.0	0	7.2	21 (N/A)	0.2	4.19
Northern pin oak	2.3	0.4	1.1	0.1	13	5.5	0.8	0.7	5.0	34	-0.5	-2	15.5	44 (N/A)	0.2	8.84
Conifer Evergreen Large	0.6	0.1	0.5	0.1	4	2.0	0.3	0.3	2.0	13	-1.8	-7	4.1	10 (N/A)	0.1	2.48
Lilac	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.1	1	0.0	0	0.4	1 (N/A)	0.1	0.26
American elm	1.7	0.3	0.8	0.1	9	5.1	0.8	0.7	5.0	32	0.0	0	14.5	41 (N/A)	0.1	10.34
Mountain ash	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.0	7	0.0	0	2.7	8 (N/A)	0.1	2.55
Eastern cottonwood	0.1	0.0	0.0	0.0	0	1.1	0.2	0.1	1.0	7	0.0	0	2.4	7 (N/A)	0.1	2.29
Northern white cedar	0.1	0.0	0.1	0.0	1	0.5	0.1	0.1	0.5	3	-0.3	-1	1.0	3 (N/A)	0.1	0.86
Eastern hophornbeam	0.9	0.2	0.4	0.0	5	2.4	0.3	0.3	2.1	14	0.0	0	6.7	19 (N/A)	0.1	6.41
American chestnut	0.0	0.0	0.0	0.0	0	0.9	0.1	0.1	0.9	6	0.0	0	2.1	6 (N/A)	0.1	2.99
Southern magnolia	0.7	0.1	0.7	0.1	5	1.8	0.3	0.3	1.7	11	-1.3	-5	4.3	11 (N/A)	0.1	5.59
Oak	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)	0.1	15.71
Cherry plum	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	0.41
Alder	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.7	5	0.0	0	1.8	5 (N/A)	0.1	2.55
Dogwood	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	0.1	0.11
Pear	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	0.1	0.11
Scotch pine	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	1 (N/A)	0.0	1.48
Japanese maple	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)	0.0	0.71
Ohio buckeye	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)	0.0	3.47
Quaking aspen	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)	0.0	0.87
Common chokecherry	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.0	2.55
Conifer Evergreen Small	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	-0.1	0	0.1	0 (N/A)	0.0	0.20
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)	0.0	8.35
Citywide total	1,105.9	188.1	560.4	53.7	6,024	2,929.8	427.2	407.5	2,789.7	18,274	-557.4	-2,090	7,904.7	22,207 (N/A)	100.0	8.20

Table 4: Annual Carbon Stored

Onawa

Stored CO2 Benefits of Public Trees

3/24/2022

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	8,718,329	65,387	(N/A)	18.0	38.0	134.27
Ash	2,601,410	19,511	(N/A)	12.7	11.3	56.55
Green ash	2,945,121	22,088	(N/A)	9.2	12.8	89.07
Norway maple	782,671	5,870	(N/A)	6.6	3.4	32.61
Honeylocust	1,274,310	9,557	(N/A)	6.2	5.5	57.23
Blue spruce	234,695	1,760	(N/A)	5.6	1.0	11.66
Northern hackberry	954,861	7,161	(N/A)	5.5	4.2	47.74
Apple	233,326	1,750	(N/A)	3.8	1.0	16.99
White ash	394,310	2,957	(N/A)	2.8	1.7	38.41
Red maple	138,472	1,039	(N/A)	2.6	0.6	14.63
Sugar maple	471,454	3,536	(N/A)	2.4	2.1	54.40
Northern red oak	374,860	2,811	(N/A)	2.4	1.6	43.25
Littleleaf linden	564,716	4,235	(N/A)	2.1	2.5	75.63
American basswood	748,727	5,615	(N/A)	1.7	3.3	122.08
Amur maple	54,094	406	(N/A)	1.4	0.2	10.96
Bur oak	153,513	1,151	(N/A)	1.3	0.7	32.90
Callery pear	77,618	582	(N/A)	1.1	0.3	19.40
Siberian elm	324,669	2,435	(N/A)	1.0	1.4	86.96
Eastern red cedar	26,499	199	(N/A)	1.0	0.1	7.10
Spruce	3,573	27	(N/A)	1.0	0.0	0.96
Norway spruce	42,950	322	(N/A)	0.9	0.2	13.42
Elm	190,991	1,432	(N/A)	0.7	0.8	71.62
Black walnut	225,834	1,694	(N/A)	0.7	1.0	94.10
Broadleaf Deciduous	4,871	37	(N/A)	0.6	0.0	2.28
River birch	37,445	281	(N/A)	0.6	0.2	18.72
Swamp white oak	12,052	90	(N/A)	0.6	0.1	6.03
Austrian pine	49,227	369	(N/A)	0.6	0.2	24.61
Broadleaf Deciduous	17,608	132	(N/A)	0.5	0.1	9.43
Kentucky coffeetree	40,841	306	(N/A)	0.5	0.2	21.88
Catalpa	256,875	1,927	(N/A)	0.4	1.1	175.14
White mulberry	11,324	85	(N/A)	0.4	0.0	8.49
Eastern redbud	13,959	105	(N/A)	0.4	0.1	10.47
Paper birch	8,044	60	(N/A)	0.4	0.0	6.03
Kwanzan cherry	21,615	162	(N/A)	0.3	0.1	20.26
Black poplar	298,613	2,240	(N/A)	0.3	1.3	279.95
Ginkgo	46,778	351	(N/A)	0.3	0.2	43.85
Broadleaf Deciduous	118,477	889	(N/A)	0.3	0.5	111.07
Eastern white pine	14,768	111	(N/A)	0.3	0.1	13.85
White oak	41,677	313	(N/A)	0.3	0.2	44.65
Willow	13,804	104	(N/A)	0.2	0.1	17.26
Black locust	58,731	440	(N/A)	0.2	0.3	88.10
Cottonwood	151,306	1,135	(N/A)	0.2	0.7	226.96
American sycamore	39,654	297	(N/A)	0.2	0.2	59.48
Northern pin oak	38,133	286	(N/A)	0.2	0.2	57.20
Conifer Evergreen La	3,767	28	(N/A)	0.1	0.0	7.06
Lilac	219	2	(N/A)	0.1	0.0	0.41
American elm	36,335	273	(N/A)	0.1	0.2	68.13
Mountain ash	2,724	20	(N/A)	0.1	0.0	6.81
Eastern cottonwood	2,255	17	(N/A)	0.1	0.0	5.64
Northern white cedar	333	2	(N/A)	0.1	0.0	0.83
Eastern hophornbeam	14,393	108	(N/A)	0.1	0.1	35.98
American chestnut	2,069	16	(N/A)	0.1	0.0	7.76
Southern magnolia	8,327	62	(N/A)	0.1	0.0	31.23
Oak	51,886	389	(N/A)	0.1	0.2	194.57
Cherry plum	192	1	(N/A)	0.1	0.0	0.72
Alder	1,816	14	(N/A)	0.1	0.0	6.81
Dogwood	28	0	(N/A)	0.1	0.0	0.10
Pear	28	0	(N/A)	0.1	0.0	0.10
Scotch pine	257	2	(N/A)	0.0	0.0	1.93
Japanese maple	178	1	(N/A)	0.0	0.0	1.33
Ohio buckeye	1,101	8	(N/A)	0.0	0.0	8.26
Quaking aspen	185	1	(N/A)	0.0	0.0	1.39
Common chokecherry	908	7	(N/A)	0.0	0.0	6.81
Conifer Evergreen Sn	43	0	(N/A)	0.0	0.0	0.32
Mulberry	6,743	51	(N/A)	0.0	0.0	50.57
Citywide total	22,966,592	172,249	(N/A)	100.0	100.0	63.63

Table 5: Annual Carbon Sequestered

Onawa

Annual CO Benefits of Public Trees

3/24/2022

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	630,576	4,729	-41,865	-1,652	-326	248,239	1,862	835,298	6,265 (N/A)	18.0	35.6	12.86
Ash	112,471	844	-12,490	-896	-100	145,269	1,090	244,354	1,833 (N/A)	12.7	10.4	5.31
Green ash	162,143	1,216	-14,137	-710	-111	117,127	878	264,423	1,983 (N/A)	9.2	11.3	8.00
Norway maple	57,338	430	-3,768	-339	-31	58,245	437	111,477	836 (N/A)	6.6	4.7	4.64
Honeylocust	81,422	611	-6,121	-366	-49	80,580	604	155,515	1,166 (N/A)	6.2	6.6	6.98
Blue spruce	14,632	110	-1,127	-308	-11	29,192	219	42,389	318 (N/A)	5.6	1.8	2.11
Northern hackberry	56,226	422	-4,584	-431	-38	78,511	589	129,722	973 (N/A)	5.5	5.5	6.49
Apple	18,711	140	-1,120	-154	-10	19,158	144	36,596	274 (N/A)	3.8	1.6	2.66
White ash	43,076	323	-1,894	-156	-15	31,707	238	72,734	546 (N/A)	2.8	3.1	7.08
Red maple	17,741	133	-665	-94	-6	16,860	126	33,843	254 (N/A)	2.6	1.4	3.57
Sugar maple	30,340	228	-2,264	-160	-18	27,136	204	55,052	413 (N/A)	2.4	2.3	6.35
Northern red oak	13,966	105	-1,800	-133	-14	18,924	142	30,958	232 (N/A)	2.4	1.3	3.57
Littleleaf linden	28,840	216	-2,712	-168	-22	21,796	163	47,756	358 (N/A)	2.1	2.0	6.40
American basswood	41,841	314	-3,594	-140	-28	19,261	144	57,369	430 (N/A)	1.7	2.4	9.35
Amur maple	5,601	42	-260	-50	-2	6,274	47	11,565	87 (N/A)	1.4	0.5	2.34
Bur oak	11,389	85	-737	-55	-6	9,290	70	19,887	149 (N/A)	1.3	0.8	4.26
Callery pear	7,568	57	-376	-42	-3	7,014	53	14,163	106 (N/A)	1.1	0.6	3.54
Siberian elm	13,990	105	-1,560	-81	-12	12,507	94	24,857	186 (N/A)	1.0	1.1	6.66
Eastern red cedar	473	4	-127	-50	-1	4,652	35	4,947	37 (N/A)	1.0	0.2	1.33
Spruce	435	3	-17	-11	0	801	6	1,208	9 (N/A)	1.0	0.1	0.32
Norway spruce	2,481	19	-206	-46	-2	4,384	33	6,613	50 (N/A)	0.9	0.3	2.07
Elm	8,984	67	-917	-46	-7	7,742	58	15,764	118 (N/A)	0.7	0.7	5.91
Black walnut	11,038	83	-1,084	-50	-9	7,502	56	17,406	131 (N/A)	0.7	0.7	7.25
Broadleaf Deciduous Smal	806	6	-23	-11	0	824	6	1,596	12 (N/A)	0.6	0.1	0.75
River birch	4,024	30	-181	-22	-2	3,651	27	7,473	56 (N/A)	0.6	0.3	3.74
Swamp white oak	2,262	17	-60	-13	-1	1,848	14	4,038	30 (N/A)	0.6	0.2	2.02
Austrian pine	1,827	14	-236	-43	-2	3,662	27	5,210	39 (N/A)	0.6	0.2	2.60
Broadleaf Deciduous Medi	2,984	22	-86	-16	-1	2,509	19	5,391	40 (N/A)	0.5	0.2	2.89
Kentucky coffeetree	3,226	24	-196	-17	-2	2,513	19	5,526	41 (N/A)	0.5	0.2	2.96
Catalpa	7,150	54	-1,233	-40	-10	6,200	46	12,077	91 (N/A)	0.4	0.5	8.23
White mulberry	1,133	8	-54	-10	0	1,265	9	2,333	17 (N/A)	0.4	0.1	1.75
Eastern redbud	1,324	10	-67	-11	-1	1,257	9	2,503	19 (N/A)	0.4	0.1	1.88
Paper birch	1,365	10	-39	-8	0	1,094	8	2,412	18 (N/A)	0.4	0.1	1.81
Kwanzan cherry	1,891	14	-104	-14	-1	1,941	15	3,714	28 (N/A)	0.3	0.2	3.48
Black poplar	6,011	45	-1,433	-38	-11	5,606	42	10,146	76 (N/A)	0.3	0.4	9.51
Ginkgo	813	6	-225	-24	-2	2,870	22	3,434	26 (N/A)	0.3	0.1	3.22
Broadleaf Deciduous Large	5,813	44	-569	-26	-4	4,095	31	9,313	70 (N/A)	0.3	0.4	8.73
Eastern white pine	1,002	8	-71	-16	-1	1,704	13	2,619	20 (N/A)	0.3	0.1	2.46
White oak	2,952	22	-200	-13	-2	2,385	18	5,123	38 (N/A)	0.3	0.2	5.49
Willow	1,315	10	-66	-7	-1	1,201	9	2,442	18 (N/A)	0.2	0.1	3.05
Black locust	1,310	10	-282	-18	-2	2,496	19	3,506	26 (N/A)	0.2	0.1	5.26
Cottonwood	3,369	25	-726	-21	-6	2,993	22	5,614	42 (N/A)	0.2	0.2	8.42
American sycamore	1,066	8	-190	-7	-1	840	6	1,709	13 (N/A)	0.2	0.1	2.56
Northern pin oak	1,785	13	-183	-12	-1	1,866	14	3,456	26 (N/A)	0.2	0.1	5.18
Conifer Evergreen Large	399	3	-18	-7	0	744	6	1,118	8 (N/A)	0.1	0.0	2.10
Lilac	64	0	-1	-1	0	54	0	116	1 (N/A)	0.1	0.0	0.22
American elm	1,209	9	-174	-10	-1	1,856	14	2,880	22 (N/A)	0.1	0.1	5.40
Mountain ash	342	3	-13	-4	0	372	3	697	5 (N/A)	0.1	0.0	1.74
Eastern cottonwood	492	4	-11	-3	0	366	3	844	6 (N/A)	0.1	0.0	2.11
Northern white cedar	89	1	-2	-2	0	170	1	255	2 (N/A)	0.1	0.0	0.64
Eastern hophornbeam	1,071	8	-69	-7	-1	794	6	1,789	13 (N/A)	0.1	0.1	4.47
American chestnut	418	3	-10	-2	0	318	2	723	5 (N/A)	0.1	0.0	2.71
Southern magnolia	421	3	-40	-4	0	643	5	1,020	8 (N/A)	0.1	0.0	3.83
Oak	1,919	14	-249	-9	-2	1,300	10	2,962	22 (N/A)	0.1	0.1	11.11
Cherry plum	47	0	-1	-1	0	43	0	88	1 (N/A)	0.1	0.0	0.33
Alder	228	2	-9	-2	0	248	2	465	3 (N/A)	0.1	0.0	1.74
Dogwood	17	0	0	0	0	11	0	28	0 (N/A)	0.1	0.0	0.10
Pear	17	0	0	0	0	11	0	28	0 (N/A)	0.1	0.0	0.10
Scotch pine	53	0	-1	-1	0	94	1	145	1 (N/A)	0.0	0.0	1.08
Japanese maple	38	0	-1	-1	0	37	0	74	1 (N/A)	0.0	0.0	0.55
Ohio buckeye	224	2	-5	-1	0	176	1	393	3 (N/A)	0.0	0.0	2.95
Quaking aspen	74	1	-1	-1	0	49	0	121	1 (N/A)	0.0	0.0	0.91
Common chokecherry	114	1	-4	-1	0	124	1	232	2 (N/A)	0.0	0.0	1.74
Conifer Evergreen Small	13	0	0	-1	0	26	0	39	0 (N/A)	0.0	0.0	0.29
Mulberry	0	0	-32	-4	0	335	3	299	2 (N/A)	0.0	0.0	2.24
Citywide total	1,431,957	10,740	-110,291	-6,583	-877	1,032,763	7,746	2,347,846	17,609 (N/A)	100.0	100.0	6.50

Table 6: Annual Social and Aesthetic Benefits

Onawa

Annual Aesthetic/Other Benefits of Public Trees

3/24/2022

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	48,667	(N/A)	18.0	34.6	99.93
Ash	10,857	(N/A)	12.7	7.7	31.47
Green ash	13,567	(N/A)	9.2	9.6	54.70
Norway maple	5,808	(N/A)	6.6	4.1	32.27
Honeylocust	19,551	(N/A)	6.2	13.9	117.07
Blue spruce	3,255	(N/A)	5.6	2.3	21.56
Northern hackberry	7,848	(N/A)	5.5	5.6	52.32
Apple	1,086	(N/A)	3.8	0.8	10.54
White ash	5,269	(N/A)	2.8	3.7	68.43
Red maple	2,646	(N/A)	2.6	1.9	37.26
Sugar maple	3,380	(N/A)	2.4	2.4	52.00
Northern red oak	1,151	(N/A)	2.4	0.8	17.71
Littleleaf linden	2,918	(N/A)	2.1	2.1	52.12
American basswood	2,915	(N/A)	1.7	2.1	63.37
Amur maple	319	(N/A)	1.4	0.2	8.63
Bur oak	1,190	(N/A)	1.3	0.8	33.99
Callery pear	809	(N/A)	1.1	0.6	26.97
Siberian elm	1,055	(N/A)	1.0	0.7	37.67
Eastern red cedar	195	(N/A)	1.0	0.1	6.95
Spruce	241	(N/A)	1.0	0.2	8.61
Norway spruce	600	(N/A)	0.9	0.4	25.00
Elm	840	(N/A)	0.7	0.6	41.98
Black walnut	903	(N/A)	0.7	0.6	50.16
Broadleaf Deciduous Small	44	(N/A)	0.6	0.0	2.75
River birch	429	(N/A)	0.6	0.3	28.57
Swamp white oak	272	(N/A)	0.6	0.2	18.15
Austrian pine	239	(N/A)	0.6	0.2	15.92
Broadleaf Deciduous Medium	343	(N/A)	0.5	0.2	24.49
Kentucky coffeetree	365	(N/A)	0.5	0.3	26.04
Catalpa	547	(N/A)	0.4	0.4	49.73
White mulberry	63	(N/A)	0.4	0.0	6.35
Eastern redbud	76	(N/A)	0.4	0.1	7.61
Paper birch	196	(N/A)	0.4	0.1	19.59
Kwanzan cherry	110	(N/A)	0.3	0.1	13.74
Black poplar	403	(N/A)	0.3	0.3	50.37
Ginkgo	65	(N/A)	0.3	0.0	8.07
Broadleaf Deciduous Large	467	(N/A)	0.3	0.3	58.39
Eastern white pine	236	(N/A)	0.3	0.2	29.45
White oak	284	(N/A)	0.3	0.2	40.55
Willow	140	(N/A)	0.2	0.1	23.35
Black locust	118	(N/A)	0.2	0.1	23.51
Cottonwood	239	(N/A)	0.2	0.2	47.88
American sycamore	98	(N/A)	0.2	0.1	19.67
Northern pin oak	163	(N/A)	0.2	0.1	32.67
Conifer Evergreen Large	112	(N/A)	0.1	0.1	28.09
Lilac	2	(N/A)	0.1	0.0	0.54
American elm	176	(N/A)	0.1	0.1	43.95
Mountain ash	19	(N/A)	0.1	0.0	6.40
Eastern cottonwood	72	(N/A)	0.1	0.1	23.95
Northern white cedar	29	(N/A)	0.1	0.0	9.70
Eastern hophornbeam	64	(N/A)	0.1	0.0	21.33
American chestnut	57	(N/A)	0.1	0.0	28.56
Southern magnolia	38	(N/A)	0.1	0.0	19.24
Oak	133	(N/A)	0.1	0.1	66.60
Cherry plum	2	(N/A)	0.1	0.0	1.05
Alder	13	(N/A)	0.1	0.0	6.40
Dogwood	0	(N/A)	0.1	0.0	0.03
Pear	0	(N/A)	0.1	0.0	0.03
Scotch pine	15	(N/A)	0.0	0.0	15.42
Japanese maple	2	(N/A)	0.0	0.0	2.06
Ohio buckeye	26	(N/A)	0.0	0.0	26.22
Quaking aspen	15	(N/A)	0.0	0.0	14.73
Common chokecherry	6	(N/A)	0.0	0.0	6.40
Conifer Evergreen Small	13	(N/A)	0.0	0.0	13.37
Mulberry	0	(N/A)	0.0	0.0	0.00
Citywide total	140,761	(N/A)	100.0	100.0	52.00

Table 7: Summary of Benefits in Dollars

Onawa

Total Annual Benefits of Public Trees by Species ($)

3/24/2022

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	30,156	6,265	5,659	58,465	48,667	149,211	(N/A)	30.5
Ash	18,561	1,833	3,305	21,140	10,857	55,695	(N/A)	11.4
Green ash	14,489	1,983	2,552	20,183	13,567	52,775	(N/A)	10.8
Norway maple	7,395	836	1,251	7,139	5,808	22,429	(N/A)	4.6
Honeylocust	9,776	1,166	1,648	13,852	19,551	45,993	(N/A)	9.4
Blue spruce	3,602	318	400	6,644	3,255	14,220	(N/A)	2.9
Northern hackberry	10,038	973	1,752	11,529	7,848	32,140	(N/A)	6.6
Apple	2,559	274	424	1,320	1,086	5,663	(N/A)	1.2
White ash	3,651	546	645	4,256	5,269	14,366	(N/A)	2.9
Red maple	2,077	254	344	1,735	2,646	7,055	(N/A)	1.4
Sugar maple	3,301	413	519	3,866	3,380	11,479	(N/A)	2.3
Northern red oak	2,319	232	336	2,539	1,151	6,577	(N/A)	1.3
Littleleaf linden	2,813	358	486	3,994	2,918	10,570	(N/A)	2.2
American basswood	2,511	430	390	3,804	2,915	10,050	(N/A)	2.1
Amur maple	841	87	131	364	319	1,742	(N/A)	0.4
Bur oak	1,101	149	187	1,231	1,190	3,858	(N/A)	0.8
Callery pear	907	106	146	780	809	2,749	(N/A)	0.6
Siberian elm	1,542	186	292	2,132	1,055	5,208	(N/A)	1.1
Eastern red cedar	615	37	53	1,095	195	1,994	(N/A)	0.4
Spruce	96	9	10	158	241	513	(N/A)	0.1
Norway spruce	531	50	39	1,087	600	2,307	(N/A)	0.5
Elm	914	118	165	1,186	840	3,223	(N/A)	0.7
Black walnut	958	131	170	1,463	903	3,624	(N/A)	0.7
Broadleaf Deciduous Sn	120	12	16	44	44	236	(N/A)	0.0
River birch	470	56	75	392	429	1,422	(N/A)	0.3
Swamp white oak	249	30	36	164	272	752	(N/A)	0.2
Austrian pine	456	39	53	947	239	1,734	(N/A)	0.4
Broadleaf Deciduous M	333	40	50	228	343	994	(N/A)	0.2
Kentucky coffeetree	302	41	51	337	365	1,096	(N/A)	0.2
Catalpa	759	91	149	1,277	547	2,823	(N/A)	0.6
White mulberry	164	17	26	73	63	345	(N/A)	0.1
Eastern redbud	174	19	27	84	76	381	(N/A)	0.1
Paper birch	135	18	21	112	196	482	(N/A)	0.1
Kwanzan cherry	253	28	42	126	110	559	(N/A)	0.1
Black poplar	688	76	144	1,366	403	2,677	(N/A)	0.5
Ginkgo	350	26	64	324	65	828	(N/A)	0.2
Broadleaf Deciduous La	517	70	92	772	467	1,919	(N/A)	0.4
Eastern white pine	197	20	17	391	236	860	(N/A)	0.2
White oak	280	38	48	325	284	976	(N/A)	0.2
Willow	157	18	25	138	140	478	(N/A)	0.1
Black locust	330	26	61	440	118	975	(N/A)	0.2
Cottonwood	372	42	76	712	239	1,442	(N/A)	0.3
American sycamore	104	13	21	206	98	443	(N/A)	0.1
Northern pin oak	248	26	44	304	163	785	(N/A)	0.2
Conifer Evergreen Larg	86	8	10	141	112	358	(N/A)	0.1
Lilac	8	1	1	2	2	15	(N/A)	0.0
American elm	215	22	41	210	176	664	(N/A)	0.1
Mountain ash	55	5	8	22	19	108	(N/A)	0.0
Eastern cottonwood	47	6	7	38	72	170	(N/A)	0.0
Northern white cedar	25	2	3	28	29	86	(N/A)	0.0
Eastern hophornbeam	110	13	19	71	64	278	(N/A)	0.1
American chestnut	41	5	6	33	57	143	(N/A)	0.0
Southern magnolia	78	8	11	130	38	265	(N/A)	0.1
Oak	164	22	31	298	133	648	(N/A)	0.1
Cherry plum	6	1	1	2	2	12	(N/A)	0.0
Alder	36	3	5	14	13	72	(N/A)	0.0
Dogwood	2	0	0	0	0	3	(N/A)	0.0
Pear	2	0	0	0	0	3	(N/A)	0.0
Scotch pine	14	1	1	16	15	48	(N/A)	0.0
Japanese maple	5	1	1	2	2	11	(N/A)	0.0
Ohio buckeye	24	3	3	16	26	73	(N/A)	0.0
Quaking aspen	6	1	1	5	15	27	(N/A)	0.0
Common chokecherry	18	2	3	7	6	36	(N/A)	0.0
Conifer Evergreen Smal	4	0	0	5	13	22	(N/A)	0.0
Mulberry	46	2	8	32	0	89	(N/A)	0.0
Citywide Total	128,403	17,609	22,207	179,797	140,761	488,777	(N/A)	100.0

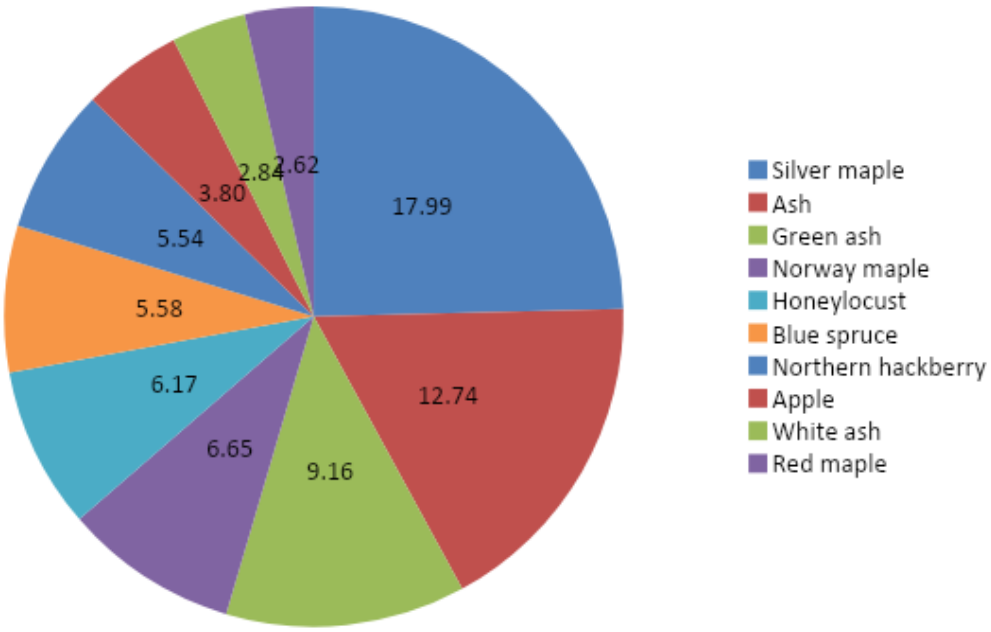

Figure 1: Species Distribution

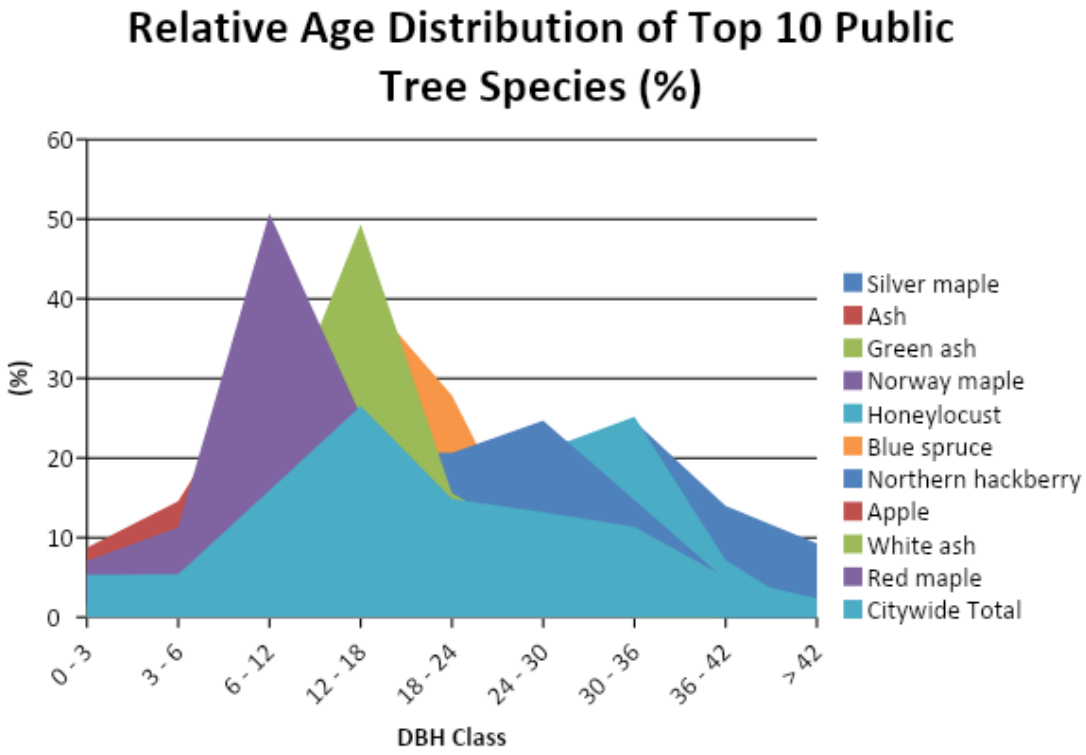

Figure 2: Relative Age Class

Figure 3: Foliage Condition

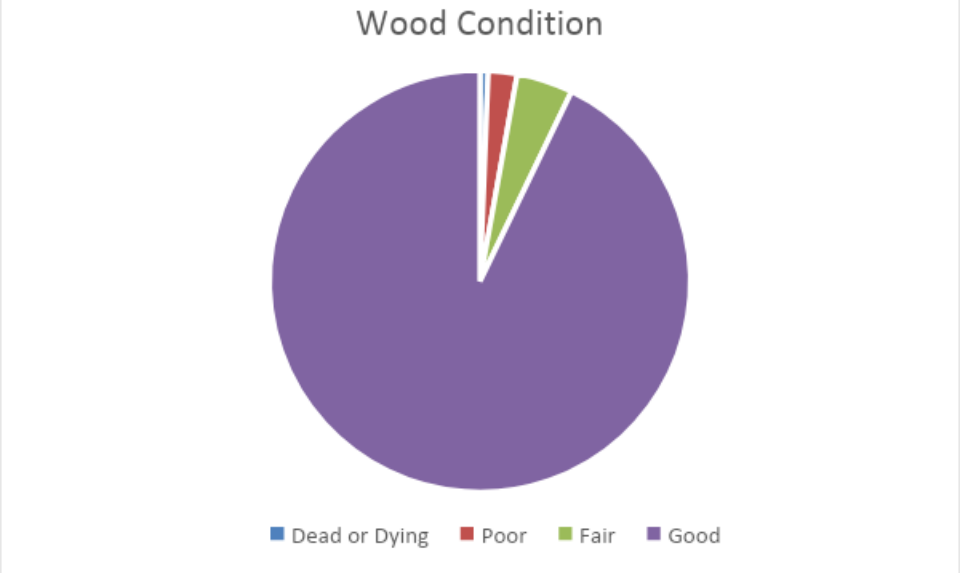

Figure 4: Wood Condition

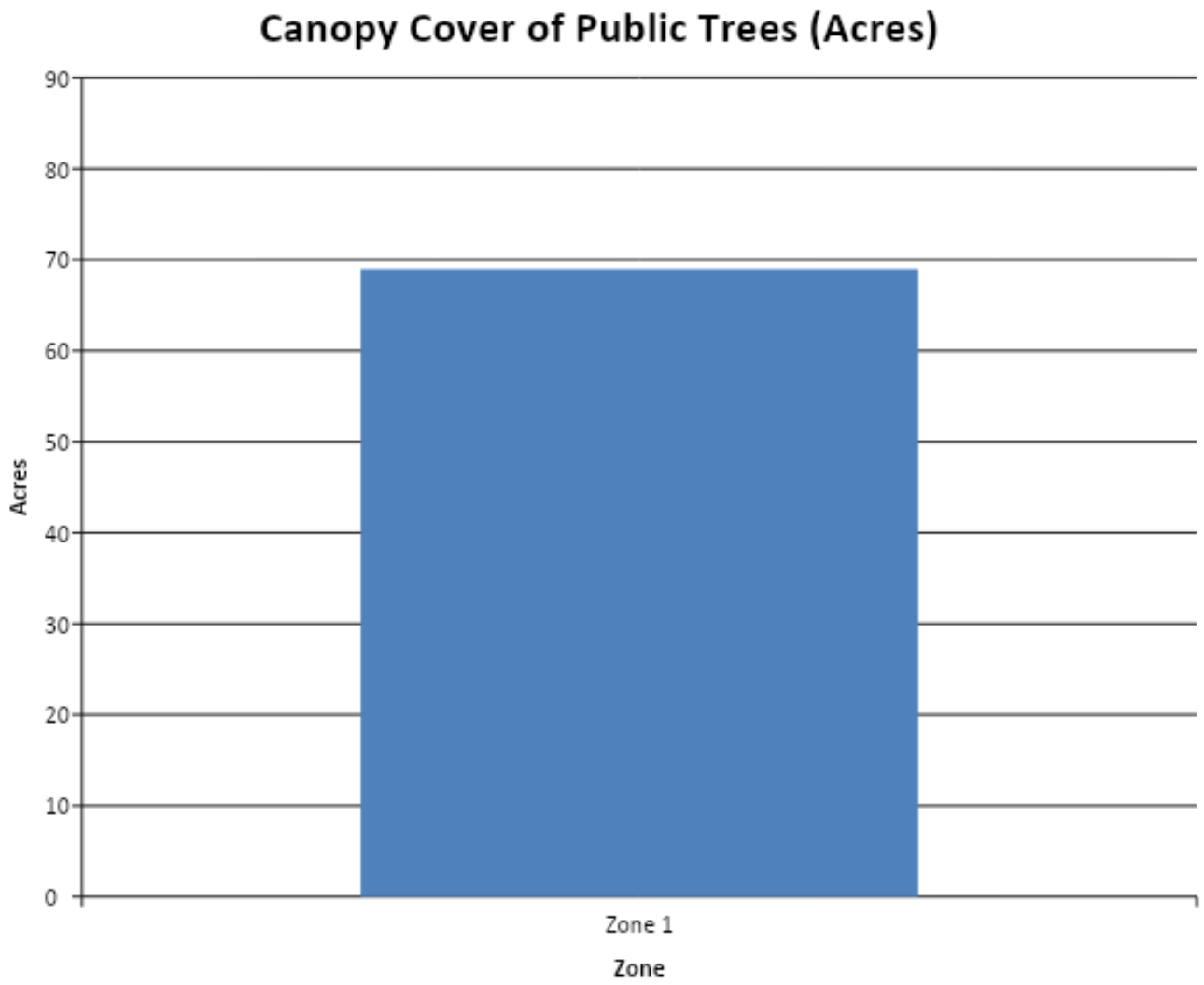

Figure 5: Canopy Cover in Acres

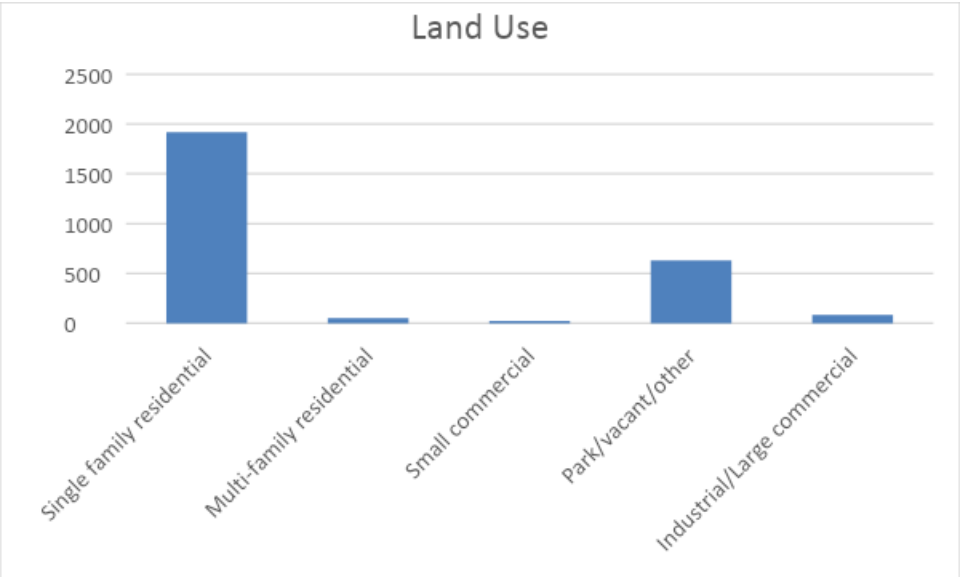

Figure 6: Land Use of city/park trees

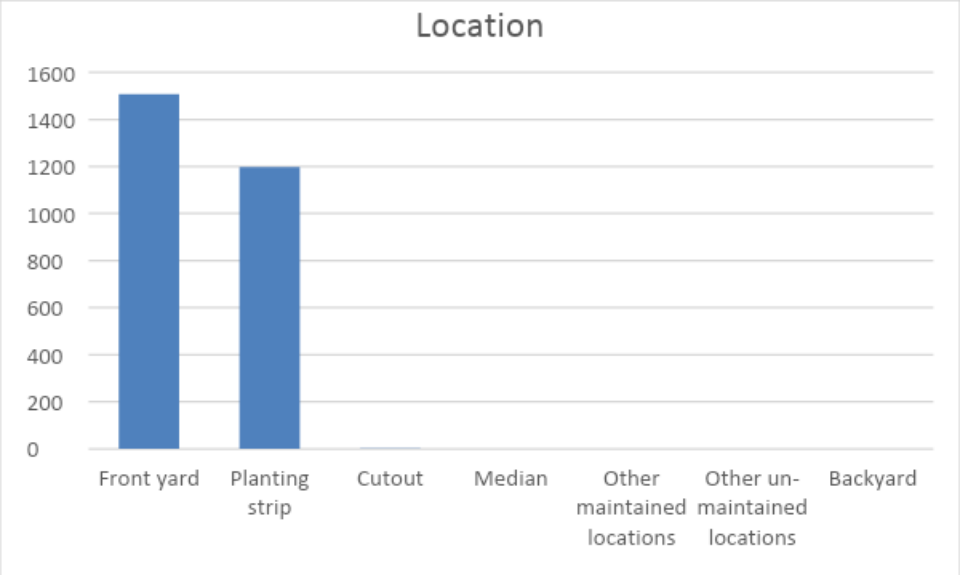

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

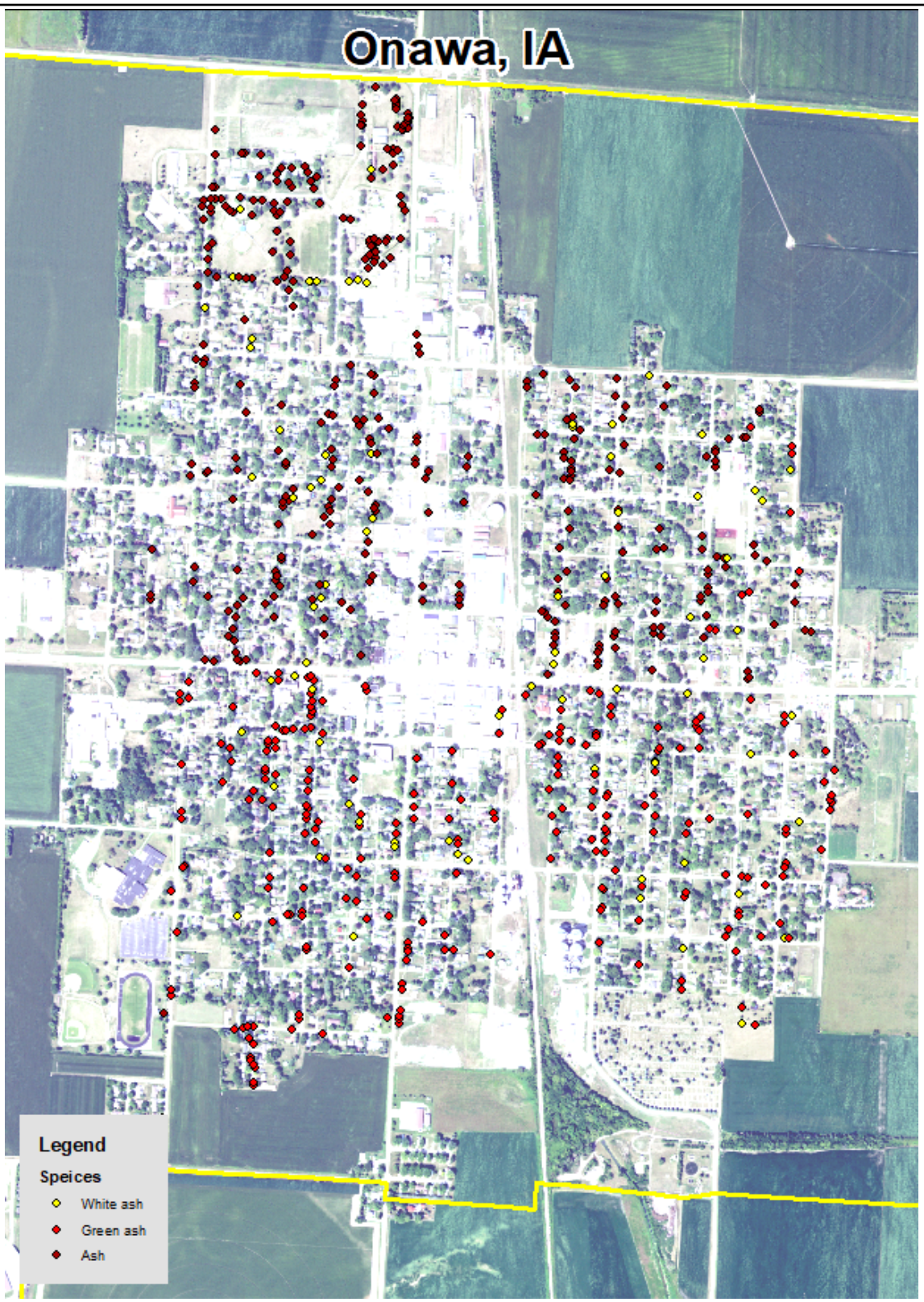

Figure 1: Location of Ash Trees

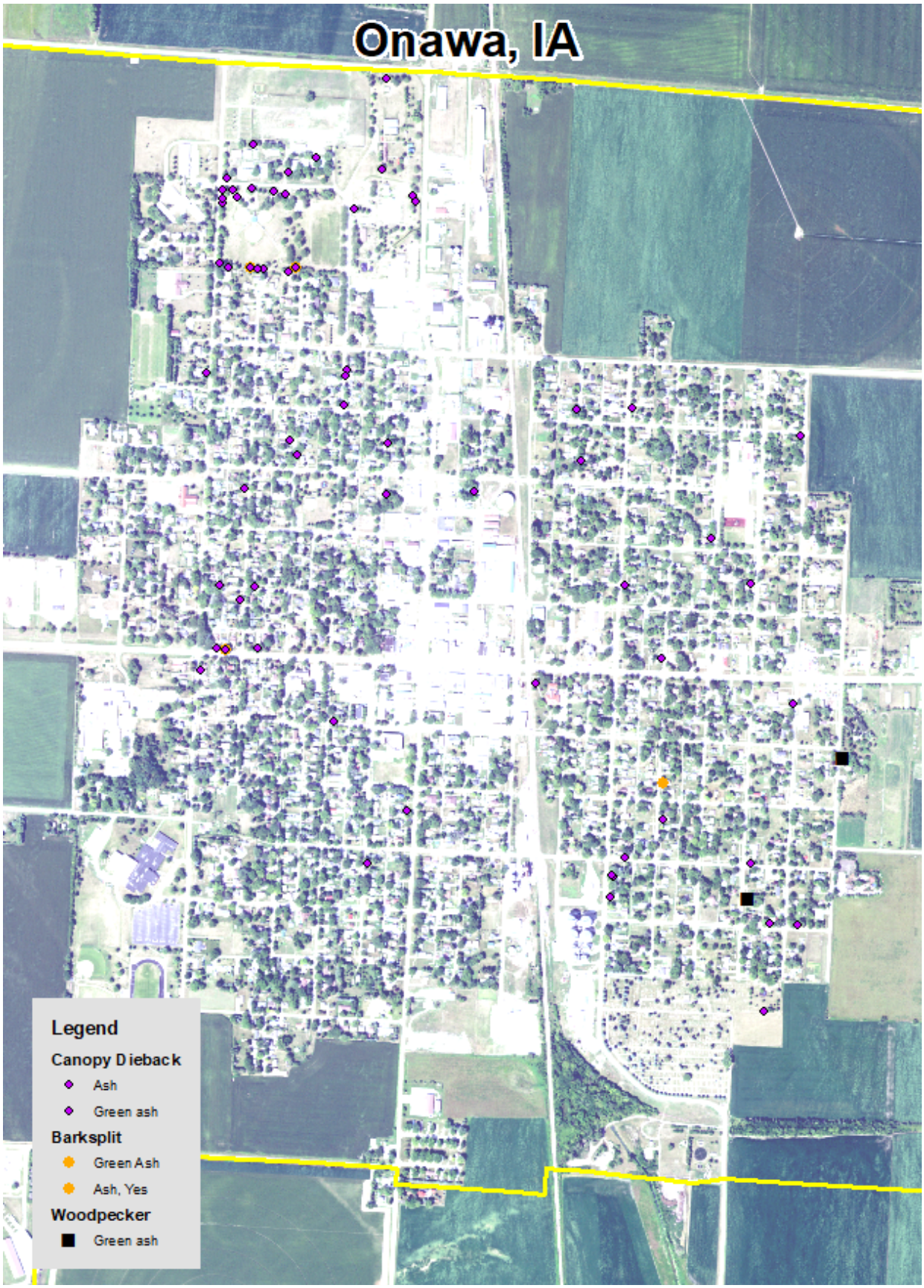

Figure 2: Location of EAB symptoms

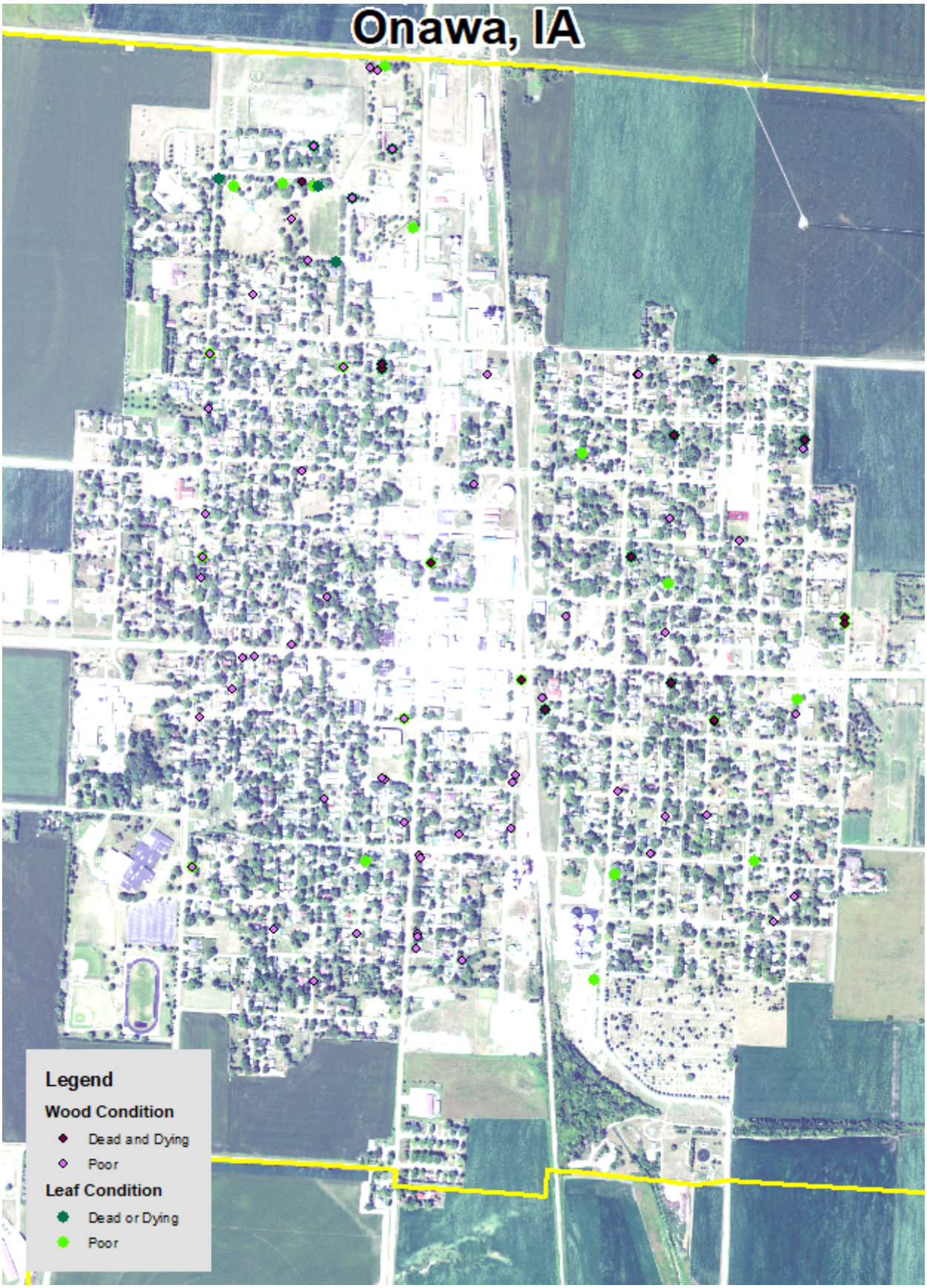

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

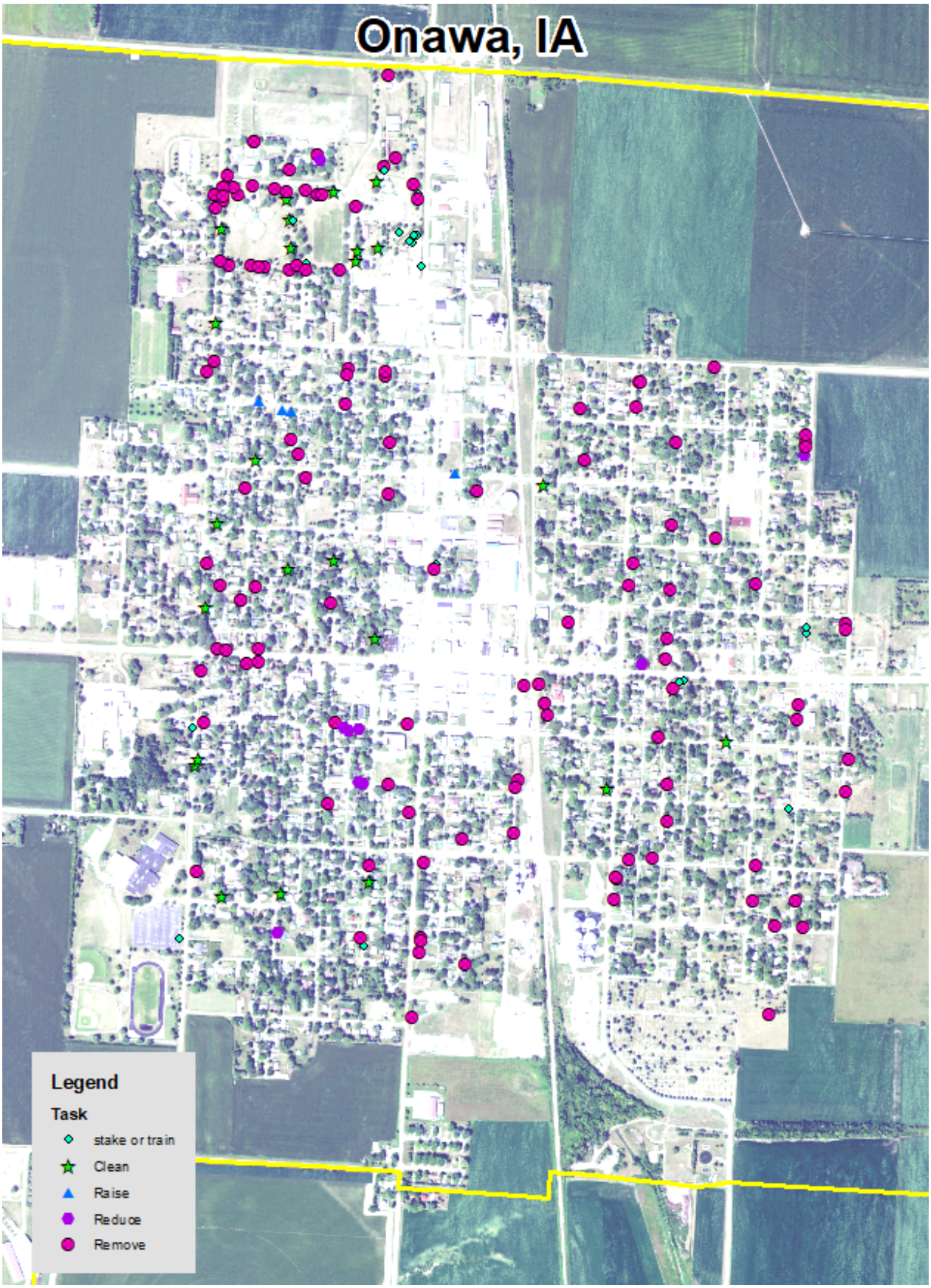

Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Onawa 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 that 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. Volunteer trees are prohibited and are defined as any tree that was not specifically planted on the property and all trees that grow out of a fence line, hedges, and around foundations and alleyways. The duty to cut and remove prohibited trees is the same as provided under Section 147.01.

(Subsection 3 – Ord. 491 – Aug. 18 Supp.)

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, or by any means available to the City. ***(Ord. 491 – Aug. 18 Supp.)***

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

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.

Current
12-16-19

151.05 DISEASE CONTROL. Any dead, diseased, or damaged tree or shrub that 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 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.

(Code of Iowa, Sec. 364.12[3b & h])

[The next page is 881]

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.