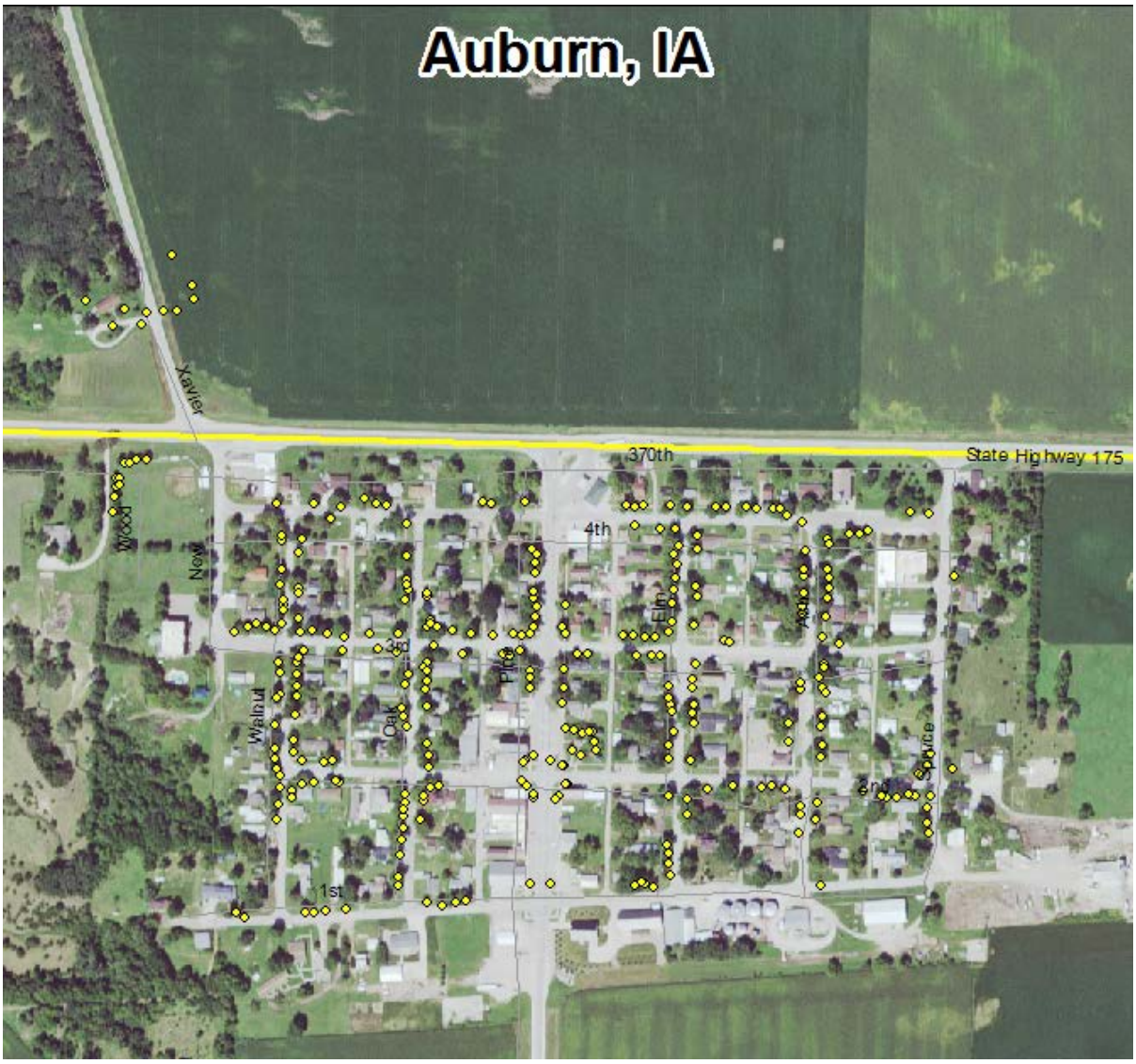
Auburn, IA



2017 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Auburn 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 10% of Auburn'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 2016, 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 318 trees inventoried.

- Auburn's trees provide $59,735 of benefits annually, an average of $188 a tree
- There are over 26 species of trees
- The top three genera are: Maple 42%, Hackberry 21% and Ash 10%,
- 6% of trees are in need of some type of management
- 7 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 7 trees needing removal 2 must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 9 of the 31 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 or evergreens
- Check ash trees with a visual survey yearly
- With the current budget it could take 7.6 years to remove ash – Suggestion: request a budget increase to $550 annually and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Auburn 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 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 and replacement planting. With proper planning and management of the current canopy in Auburn, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Auburn'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 Auburn 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 Auburn's urban forestry goals.

Inventory

In 2016, 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 318 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. Auburn's trees reduce energy related costs by approximately $16,434 annually (Appendix A, Table 1). These savings are both in Electricity (78.2 MWh) and in Natural Gas (10,716.0 Therms).

Annual Stormwater Benefits

Auburn's trees intercept about 830,301 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $22,501 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 mater (ozone). In Auburn, it is estimated that trees remove 1,022.4 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $2,892 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Auburn, trees sequester about 281,381 lbs of carbon a year with an associated value of $2,110 (Appendix A, Table 4). In addition, the trees store 2,723,005 lbs of carbon, with a yearly benefit of $20,423 (Appendix A, Table 5).

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. Auburn receives $15,797 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, Auburn's trees provide $59,735 of benefits annually. Benefits of individual trees vary based on size, species, health and

location, but on average each of the 318 trees in Auburn provide approximately $188 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Auburn has over 26 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	132	42%
Hackberry	68	21%
Ash	31	10%
Apple (crabapple)	29	9%
Lilac	16	5%
Linden	9	3%
Honey locust	7	2%
Walnut	7	2%
Spruce	6	2%
Oak	4	1%
Cherry	2	1%
White Cedar	2	1%
Black locust	1	<1%
Cottonwood	1	<1%
Elm	1	<1%
Ohio Buckeye	1	<1%
Other	1	<1%

Age Class

Most of Auburn's trees (41%) are between 6 and 18 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. Auburn'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 overall health of the urban forest. The foliage condition results for Auburn indicate that 88% of the trees are in good health, with only 2% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). On the contrary, 44% of Auburn'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 9% of the population. This 9% 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	9	3%
Tree Removal	7	2%
Crown Raising	4	1%

Canopy Cover

The total canopy with both private and public trees is 16%, 51 acres. The canopy cover included in the Auburn inventory includes approximately 9 acres (Appendix A, Figure 4). The Statewide Canopy goal is 3%, in 30 years. To achieve this goal it is estimated that 23 trees need to be planted annually.

Land Use and Location

The majority of Auburn'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	85%
Park/vacant/other	10%
Small commercial	5%

Location	
Planting strip	69%
Front yard	31%

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

Auburn has 2 critical concern trees that need immediate removal and one critical concern pruning. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). 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 17 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). There are a total of 31 ash trees, and 9 of those have signs and symptoms that have been associated with EAB. In addition, there are 2 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 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 Auburn.

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 (42%) (Appendix A, Figure 1). Maples and Hackberry should not be planted until these percentages 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 or evergreens in 6-13-2of the ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 6-13-2 (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.

Six Year Maintenance Plan with <u>No Additional Funding</u>

Year 1

Removal: 5 largest critical concern trees
Planting and Replacement: 6 trees (plus seedlings on public or private lands)
Young Tree Pruning & Maintenance: 1 critical, 1 immediate and 2 others
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 2 marked for removal and 3 removal of any new critical concern tree, an ash in poor health or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 6 trees
Young Tree Pruning & Maintenance: 4 trees
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 5 trees - removal of any new critical concern trees, ash in poor health or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 6 trees
Young Tree Pruning & Maintenance: 4 trees
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 5 trees - removal of any new critical concern trees, ash in poor health or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 6 trees
Young Tree Pruning & Maintenance: 4 trees
Visual Survey for signs and symptoms of EAB

Year 5

Removal: 5 trees - removal of any new critical concern trees, ash in poor health or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 6 trees
Young Tree Pruning & Maintenance: 4 trees
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 5 trees - removal of any new critical concern trees, ash in poor health or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 6 trees
Young Tree Pruning & Maintenance: 4 trees
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 23 ash trees removed (approximately 74% of ash). It will take approximately 7.6 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.
** To remove all ash trees within 6 years, the budget would need to be increased to $5,543 a year.

Emerald Ash Borer Plan

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 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 6-13-2 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, hackberry, cottonwood, poplar, box elder, Chinese elm or evergreens.

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 treatment is not in use.

Budget

Current Budget
$5,000 Budget

Removal: $4,000
Planting: $600
Routine trimming & Maintenance: $400

*Reduction of ash over 6 years: Approximately 23 ash trees removed (approximately 74% of ash). It will take approximately 7.6 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.
** To remove all ash trees within 6 years, the budget would need to be increased to $5,543 a year.

Purposed Budget Increase

EAB could potentially kill all ash trees in Auburn within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $5,543 a year. Additionally, it is recommended that Auburn 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. 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). This would be 8 trees selected for treatment $1,200, and Auburn would still need to find $18,400 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $2,250 a year for treatment and leave $12,800 for removal. These are alternatives 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 if EAB is found in Auburn. 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 Benefits

Auburn

Annual Energy Benefits of Public Trees

2/9/2017

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	24.0	1,819	3,396.3	3,328	5,147	(N/A)	21.4	31.3	75.69
Norway maple	13.5	1,027	1,876.3	1,839	2,866	(N/A)	19.5	17.4	46.22
Silver maple	16.7	1,267	2,190.7	2,147	3,414	(N/A)	16.0	20.8	66.95
Green ash	8.1	617	1,069.7	1,048	1,665	(N/A)	9.7	10.1	53.72
Apple	2.9	220	457.4	448	668	(N/A)	9.1	4.1	23.04
Japanese tree lilac	0.1	4	10.0	10	14	(N/A)	5.0	0.1	0.87
Maple	1.7	128	210.3	206	334	(N/A)	3.1	2.0	33.42
Black walnut	2.1	159	288.7	283	442	(N/A)	2.2	2.7	63.09
Honeylocust	2.1	163	280.6	275	438	(N/A)	2.2	2.7	62.55
American basswood	1.4	106	185.3	182	288	(N/A)	1.9	1.8	48.01
Sugar maple	1.1	87	149.6	147	234	(N/A)	1.6	1.4	46.72
Red maple	0.3	23	36.8	36	59	(N/A)	1.3	0.4	14.71
Blue spruce	0.3	24	40.6	40	64	(N/A)	0.9	0.4	21.27
Littleleaf linden	0.6	43	78.3	77	120	(N/A)	0.9	0.7	39.88
Norway spruce	0.4	28	49.2	48	76	(N/A)	0.6	0.5	38.17
Northern red oak	0.5	34	59.7	59	93	(N/A)	0.6	0.6	46.47
Swamp white oak	0.3	26	46.3	45	71	(N/A)	0.6	0.4	35.62
Northern white cedar	0.4	28	49.2	48	76	(N/A)	0.6	0.5	38.17
Conifer Evergreen Large	0.1	10	14.6	14	24	(N/A)	0.3	0.1	24.14
Black locust	0.3	24	47.4	46	71	(N/A)	0.3	0.4	70.84
Black cherry	0.2	15	31.6	31	46	(N/A)	0.3	0.3	46.14
Eastern cottonwood	0.4	29	53.7	53	82	(N/A)	0.3	0.5	82.02
Black spruce	0.1	11	19.5	19	30	(N/A)	0.3	0.2	29.65
Elm	0.4	29	53.7	53	82	(N/A)	0.3	0.5	82.02
Ohio buckeye	0.1	8	16.9	17	24	(N/A)	0.3	0.1	24.47
Cherry plum	0.0	2	3.8	4	5	(N/A)	0.3	0.0	5.40
Total	78.2	5,932	10,716.0	10,502	16,434	(N/A)	100.0	100.0	51.68

Table 2: Annual Stormwater Benefits

Auburn

Annual Stormwater Benefits of Public Trees

2/9/2017

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	246,144	6,671	(N/A)	21.4	29.6	98.10
Norway maple	107,846	2,923	(N/A)	19.5	13.0	47.14
Silver maple	246,743	6,687	(N/A)	16.0	29.7	131.11
Green ash	80,436	2,180	(N/A)	9.7	9.7	70.32
Apple	11,760	319	(N/A)	9.1	1.4	10.99
Japanese tree lilac	119	3	(N/A)	5.0	0.0	0.20
Maple	10,170	276	(N/A)	3.1	1.2	27.56
Black walnut	24,883	674	(N/A)	2.2	3.0	96.33
Honeylocust	26,349	714	(N/A)	2.2	3.2	102.01
American basswood	10,172	276	(N/A)	1.9	1.2	45.94
Sugar maple	9,543	259	(N/A)	1.6	1.1	51.72
Red maple	1,764	48	(N/A)	1.3	0.2	11.95
Blue spruce	3,844	104	(N/A)	0.9	0.5	34.72
Littleleaf linden	5,464	148	(N/A)	0.9	0.7	49.36
Norway spruce	9,209	250	(N/A)	0.6	1.1	124.79
Northern red oak	4,224	114	(N/A)	0.6	0.5	57.23
Swamp white oak	1,995	54	(N/A)	0.6	0.2	27.03
Northern white cedar	9,209	250	(N/A)	0.6	1.1	124.79
Conifer Evergreen Large	1,539	42	(N/A)	0.3	0.2	41.70
Black locust	3,764	102	(N/A)	0.3	0.5	102.01
Black cherry	1,174	32	(N/A)	0.3	0.1	31.82
Eastern cottonwood	5,491	149	(N/A)	0.3	0.7	148.79
Black spruce	2,312	63	(N/A)	0.3	0.3	62.66
Elm	5,491	149	(N/A)	0.3	0.7	148.79
Ohio buckeye	586	16	(N/A)	0.3	0.1	15.88
Cherry plum	69	2	(N/A)	0.3	0.0	1.86
Citywide total	830,301	22,501	(N/A)	100.0	100.0	70.76

Table 3: Annual Air Quality Benefits

Auburn

Annual Air Quality Benefits of Public Trees

2/9/2017

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								
Northern hackberry	42.3	7.3	21.1	1.9	230	115.6	16.8	16.0	108.7	718	0.0	0	329.6	947	(N/A)	21.4	13.93
Norway maple	20.2	3.5	10.2	0.9	110	65.0	9.4	9.0	61.4	404	-4.9	-18	174.7	496	(N/A)	19.5	7.99
Silver maple	42.8	7.3	20.9	1.9	230	78.6	11.5	11.0	75.5	492	-21.7	-81	227.8	641	(N/A)	16.0	12.57
Green ash	9.3	1.5	4.6	0.4	50	38.4	5.6	5.4	36.9	240	0.0	0	102.1	290	(N/A)	9.7	9.37
Apple	3.2	0.5	1.6	0.1	17	14.4	2.1	1.9	13.1	88	0.0	0	36.9	105	(N/A)	9.1	3.63
Japanese tree lilac	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.2	2	0.0	0	0.6	2	(N/A)	5.0	0.11
Maple	1.9	0.3	0.9	0.1	10	7.9	1.2	1.1	7.6	49	-0.7	-3	20.3	57	(N/A)	3.1	5.69
Black walnut	3.2	0.5	1.5	0.1	17	10.0	1.5	1.4	9.5	62	0.0	0	27.7	79	(N/A)	2.2	11.32
Honeylocust	5.2	0.9	2.4	0.2	28	10.1	1.5	1.4	9.7	63	-4.2	-16	27.2	75	(N/A)	2.2	10.74
American basswood	1.0	0.2	0.6	0.0	6	6.7	1.0	0.9	6.4	42	-1.0	-4	15.8	44	(N/A)	1.9	7.27
Sugar maple	1.1	0.2	0.6	0.0	6	5.4	0.8	0.8	5.2	34	-0.9	-3	13.2	36	(N/A)	1.6	7.30
Red maple	0.3	0.1	0.2	0.0	2	1.4	0.2	0.2	1.4	9	-0.1	0	3.6	10	(N/A)	1.3	2.53
Blue spruce	0.5	0.1	0.4	0.1	3	1.5	0.2	0.2	1.4	9	-1.3	-5	3.0	7	(N/A)	0.9	2.44
Littleleaf linden	0.9	0.2	0.5	0.0	5	2.7	0.4	0.4	2.6	17	-0.4	-2	7.2	20	(N/A)	0.9	6.73
Norway spruce	1.1	0.2	0.9	0.1	7	1.8	0.3	0.2	1.7	11	-5.7	-21	0.6	-3	(N/A)	0.6	-1.58
Northern red oak	0.9	0.2	0.4	0.0	5	2.1	0.3	0.3	2.1	13	-1.3	-5	5.1	13	(N/A)	0.6	6.72
Swamp white oak	0.3	0.0	0.2	0.0	2	1.6	0.2	0.2	1.5	10	-0.1	0	4.0	11	(N/A)	0.6	5.69
Northern white cedar	1.1	0.2	0.9	0.1	7	1.8	0.3	0.2	1.7	11	-5.7	-21	0.6	-3	(N/A)	0.6	-1.58
Conifer Evergreen Large	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)	0.3	2.82
Black locust	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14	(N/A)	0.3	13.58
Black cherry	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.3	8.35
Eastern cottonwood	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16	(N/A)	0.3	15.71
Black spruce	0.4	0.1	0.3	0.0	2	0.7	0.1	0.1	0.6	4	-0.9	-3	1.3	3	(N/A)	0.3	3.10
Elm	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16	(N/A)	0.3	15.71
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)	0.3	3.47
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)	0.3	0.71
Citywide total	138.8	23.7	69.6	6.4	753	373.4	54.3	51.8	354.2	2,325	-49.8	-187	1,022.4	2,892	(N/A)	100.0	9.09

Table 4: Annual Carbon Stored

Auburn

Stored CO2 Benefits of Public Trees

2/9/2017

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	662,590	4,969	(N/A)	21.4	24.3	73.08
Norway maple	336,729	2,525	(N/A)	19.5	12.4	40.73
Silver maple	944,992	7,087	(N/A)	16.0	34.7	138.97
Green ash	306,391	2,298	(N/A)	9.7	11.3	74.13
Apple	52,126	391	(N/A)	9.1	1.9	13.48
Japanese tree lilac	221	2	(N/A)	5.0	0.0	0.10
Maple	21,860	164	(N/A)	3.1	0.8	16.39
Black walnut	103,911	779	(N/A)	2.2	3.8	111.33
Honeylocust	67,981	510	(N/A)	2.2	2.5	72.84
American basswood	37,837	284	(N/A)	1.9	1.4	47.30
Sugar maple	30,574	229	(N/A)	1.6	1.1	45.86
Red maple	3,876	29	(N/A)	1.3	0.1	7.27
Blue spruce	2,521	19	(N/A)	0.9	0.1	6.30
Littleleaf linden	19,859	149	(N/A)	0.9	0.7	49.65
Norway spruce	14,981	112	(N/A)	0.6	0.6	56.18
Northern red oak	18,834	141	(N/A)	0.6	0.7	70.63
Swamp white oak	4,725	35	(N/A)	0.6	0.2	17.72
Northern white cedar	14,981	112	(N/A)	0.6	0.6	56.18
Conifer Evergreen La	1,170	9	(N/A)	0.3	0.0	8.78
Black locust	14,280	107	(N/A)	0.3	0.5	107.10
Black cherry	6,743	51	(N/A)	0.3	0.2	50.57
Eastern cottonwood	25,943	195	(N/A)	0.3	1.0	194.57
Black spruce	2,661	20	(N/A)	0.3	0.1	19.96
Elm	25,943	195	(N/A)	0.3	1.0	194.57
Ohio buckeye	1,101	8	(N/A)	0.3	0.0	8.26
Cherry plum	178	1	(N/A)	0.3	0.0	1.33
Citywide total	2,723,005	20,423	(N/A)	100.0	100.0	64.22

Table 5: Annual Carbon Sequestered

Auburn

Annual CO Benefits of Public Trees

2/9/2017

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
Northern hackberry	31,142	234	-3,180	-233	-26	40,196	301	67,924	509	(N/A)	21.4	24.1	7.49
Norway maple	19,325	145	-1,617	-134	-13	22,700	170	40,274	302	(N/A)	19.5	14.3	4.87
Silver maple	70,000	525	-4,537	-186	-35	28,007	210	93,284	700	(N/A)	16.0	33.2	13.72
Green ash	18,110	136	-1,471	-81	-12	13,638	102	30,197	226	(N/A)	9.7	10.7	7.31
Apple	3,472	26	-250	-43	-2	4,862	36	8,041	60	(N/A)	9.1	2.9	2.08
Japanese tree lilac	139	1	-2	-3	0	90	1	224	2	(N/A)	5.0	0.1	0.10
Maple	2,989	22	-105	-14	-1	2,832	21	5,702	43	(N/A)	3.1	2.0	4.28
Black walnut	5,144	39	-499	-22	-4	3,508	26	8,131	61	(N/A)	2.2	2.9	8.71
Honeylocust	2,433	18	-326	-17	-3	3,600	27	5,690	43	(N/A)	2.2	2.0	6.10
American basswood	2,786	21	-182	-14	-1	2,352	18	4,942	37	(N/A)	1.9	1.8	6.18
Sugar maple	2,067	16	-147	-11	-1	1,923	14	3,832	29	(N/A)	1.6	1.4	5.75
Red maple	528	4	-19	-3	0	505	4	1,011	8	(N/A)	1.3	0.4	1.90
Blue spruce	220	2	-12	-5	0	532	4	735	6	(N/A)	0.9	0.3	1.84
Littleleaf linden	1,856	14	-95	-7	-1	948	7	2,702	20	(N/A)	0.9	1.0	6.75
Norway spruce	256	2	-72	-9	-1	622	5	797	6	(N/A)	0.6	0.3	2.99
Northern red oak	281	2	-90	-5	-1	761	6	946	7	(N/A)	0.6	0.3	3.55
Swamp white oak	610	5	-23	-3	0	571	4	1,155	9	(N/A)	0.6	0.4	4.33
Northern white cedar	0	0	-72	-9	-1	622	5	541	4	(N/A)	0.6	0.2	2.03
Conifer Evergreen Large	116	1	-6	-2	0	216	2	324	2	(N/A)	0.3	0.1	2.43
Black locust	370	3	-69	-4	-1	539	4	837	6	(N/A)	0.3	0.3	6.27
Black cherry	0	0	-32	-4	0	335	3	299	2	(N/A)	0.3	0.1	2.24
Eastern cottonwood	960	7	-125	-4	-1	650	5	1,481	11	(N/A)	0.3	0.5	11.11
Black spruce	147	1	-13	-3	0	233	2	364	3	(N/A)	0.3	0.1	2.73
Elm	960	7	-125	-4	-1	650	5	1,481	11	(N/A)	0.3	0.5	11.11
Ohio buckeye	224	2	-5	-1	0	176	1	393	3	(N/A)	0.3	0.1	2.95
Cherry plum	38	0	-1	-1	0	37	0	74	1	(N/A)	0.3	0.0	0.55
Citywide total	164,172	1,231	-13,073	-821	-104	131,103	983	281,381	2,110	(N/A)	100.0	100.0	6.64

Table 6: Annual Social and Aesthetic Benefits

Auburn

Annual Aesthetic/Other Benefits of Public Trees

2/9/2017

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	4,025	(N/A)	21.4	25.5	59.19
Norway maple	1,953	(N/A)	19.5	12.4	31.50
Silver maple	5,444	(N/A)	16.0	34.5	106.75
Green ash	1,591	(N/A)	9.7	10.1	51.32
Apple	197	(N/A)	9.1	1.2	6.79
Japanese tree lilac	1	(N/A)	5.0	0.0	0.03
Maple	434	(N/A)	3.1	2.7	43.35
Black walnut	404	(N/A)	2.2	2.6	57.77
Honeylocust	584	(N/A)	2.2	3.7	83.41
American basswood	232	(N/A)	1.9	1.5	38.68
Sugar maple	235	(N/A)	1.6	1.5	47.08
Red maple	73	(N/A)	1.3	0.5	18.31
Blue spruce	72	(N/A)	0.9	0.5	23.85
Littleleaf linden	192	(N/A)	0.9	1.2	64.11
Norway spruce	26	(N/A)	0.6	0.2	13.13
Northern red oak	24	(N/A)	0.6	0.2	12.04
Swamp white oak	65	(N/A)	0.6	0.4	32.69
Northern white cedar	0	(N/A)	0.6	0.0	0.00
Conifer Evergreen Large	32	(N/A)	0.3	0.2	32.32
Black locust	31	(N/A)	0.3	0.2	31.46
Black cherry	0	(N/A)	0.3	0.0	0.00
Eastern cottonwood	67	(N/A)	0.3	0.4	66.60
Black spruce	20	(N/A)	0.3	0.1	19.97
Elm	67	(N/A)	0.3	0.4	66.60
Ohio buckeye	26	(N/A)	0.3	0.2	26.22
Cherry plum	2	(N/A)	0.3	0.0	2.06
Citywide total	15,797	(N/A)	100.0	100.0	49.68

Table 7: Summary of Benefits in Dollars

Auburn

Total Annual Benefits of Public Trees by Species ($)

2/9/2017

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Northern hackberry	5,147	509	947	6,671	4,025	17,299	(N/A)	29.0
Norway maple	2,866	302	496	2,923	1,953	8,539	(N/A)	14.3
Silver maple	3,414	700	641	6,687	5,444	16,886	(N/A)	28.3
Green ash	1,665	226	290	2,180	1,591	5,953	(N/A)	10.0
Apple	668	60	105	319	197	1,349	(N/A)	2.3
Japanese tree lilac	14	2	2	3	1	21	(N/A)	0.0
Maple	334	43	57	276	434	1,143	(N/A)	1.9
Black walnut	442	61	79	674	404	1,661	(N/A)	2.8
Honeylocust	438	43	75	714	584	1,854	(N/A)	3.1
American basswood	288	37	44	276	232	877	(N/A)	1.5
Sugar maple	234	29	36	259	235	793	(N/A)	1.3
Red maple	59	8	10	48	73	198	(N/A)	0.3
Blue spruce	64	6	7	104	72	252	(N/A)	0.4
Littleleaf linden	120	20	20	148	192	500	(N/A)	0.8
Norway spruce	76	6	-3	250	26	355	(N/A)	0.6
Northern red oak	93	7	13	114	24	252	(N/A)	0.4
Swamp white oak	71	9	11	54	65	211	(N/A)	0.4
Northern white cedar	76	4	-3	250	0	327	(N/A)	0.5
Conifer Evergreen Large	24	2	3	42	32	103	(N/A)	0.2
Black locust	71	6	14	102	31	224	(N/A)	0.4
Black cherry	46	2	8	32	0	89	(N/A)	0.1
Eastern cottonwood	82	11	16	149	67	324	(N/A)	0.5
Black spruce	30	3	3	63	20	118	(N/A)	0.2
Elm	82	11	16	149	67	324	(N/A)	0.5
Ohio buckeye	24	3	3	16	26	73	(N/A)	0.1
Cherry plum	5	1	1	2	2	11	(N/A)	0.0
Citywide Total	16,434	2,110	2,892	22,501	15,797	59,735	(N/A)	100.0

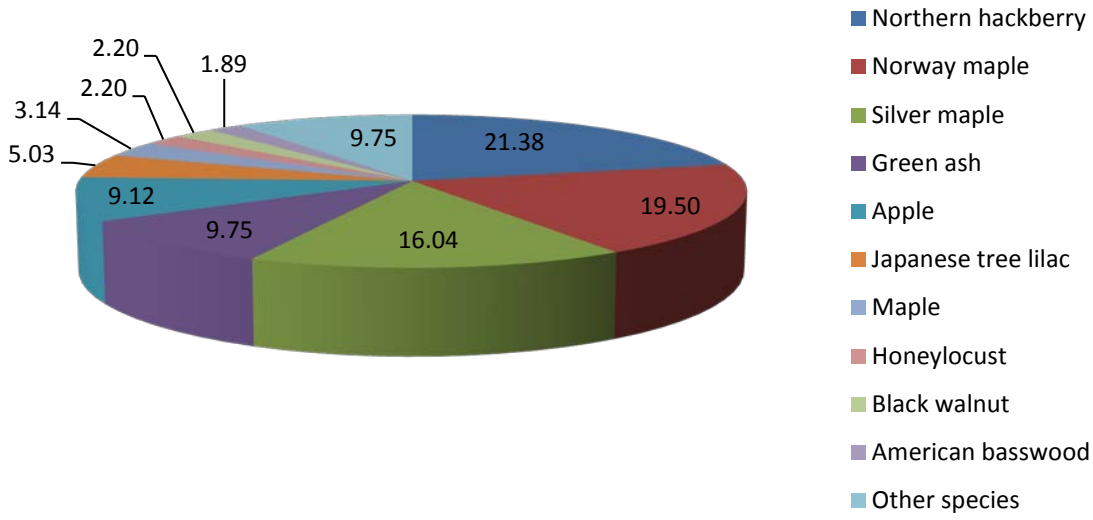

Figure 1: Species Distribution

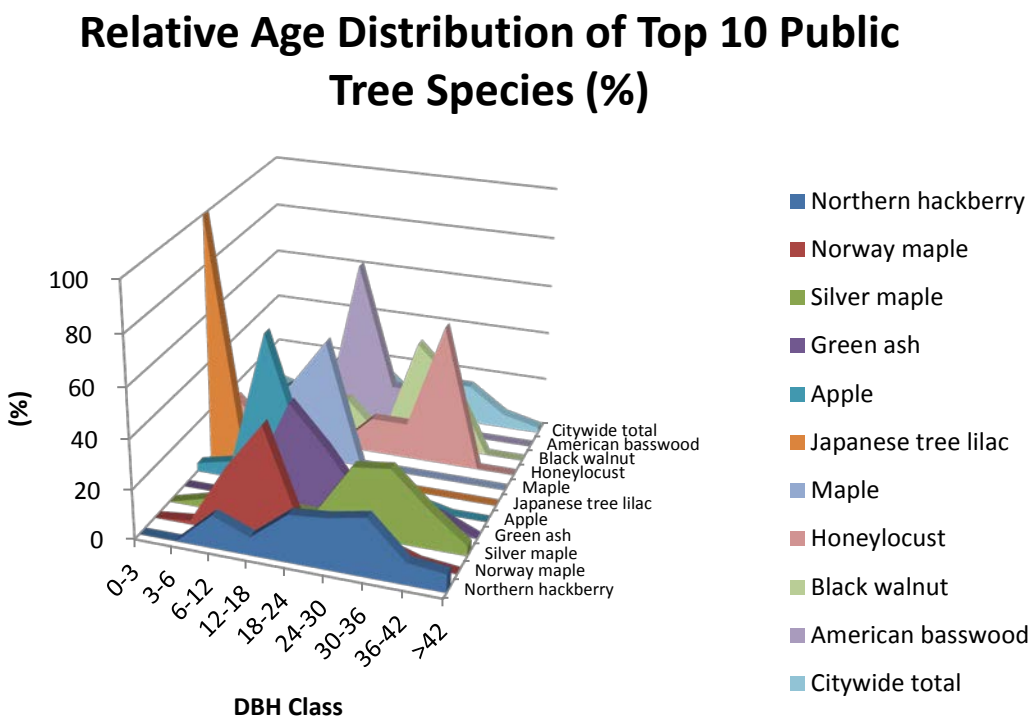

Figure 2: Relative Age Class

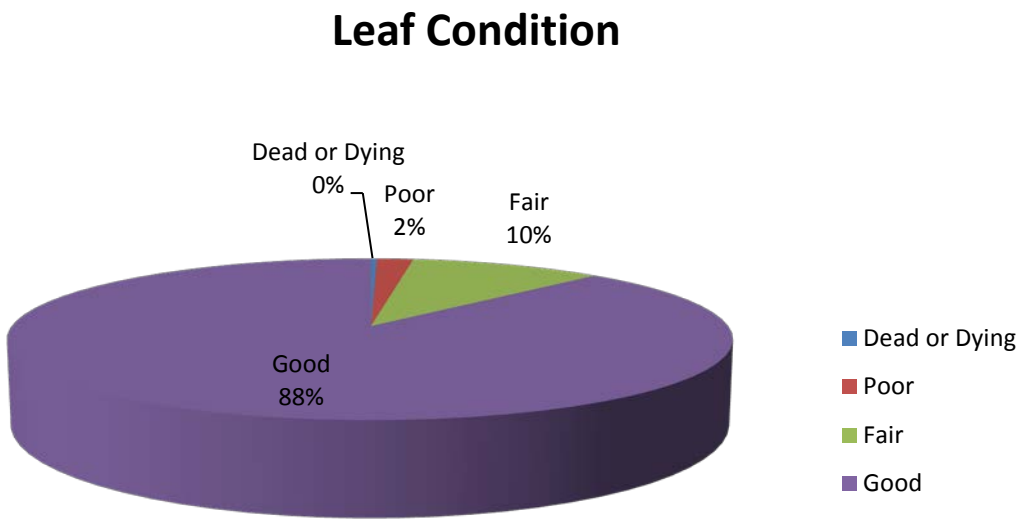

Figure 3: Foliage Condition

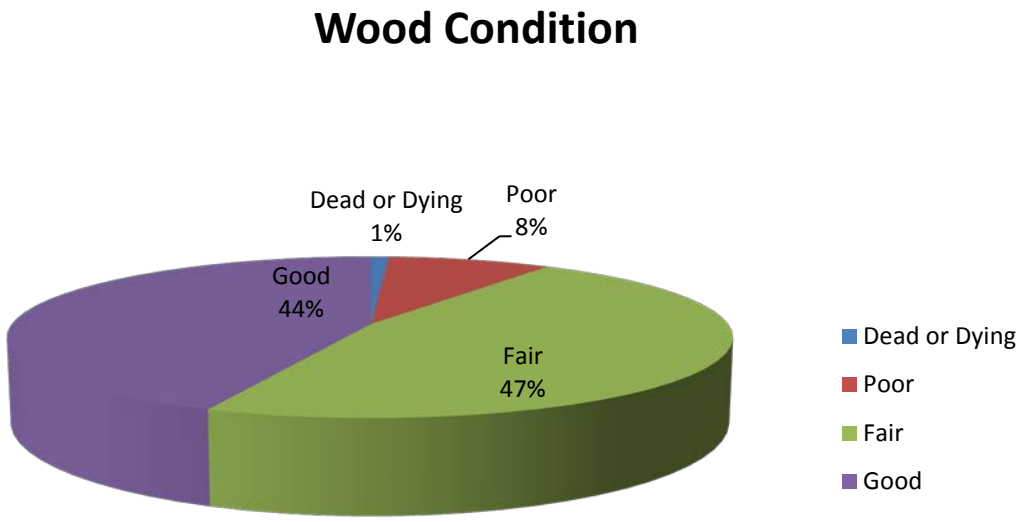

Figure 4: Wood Condition

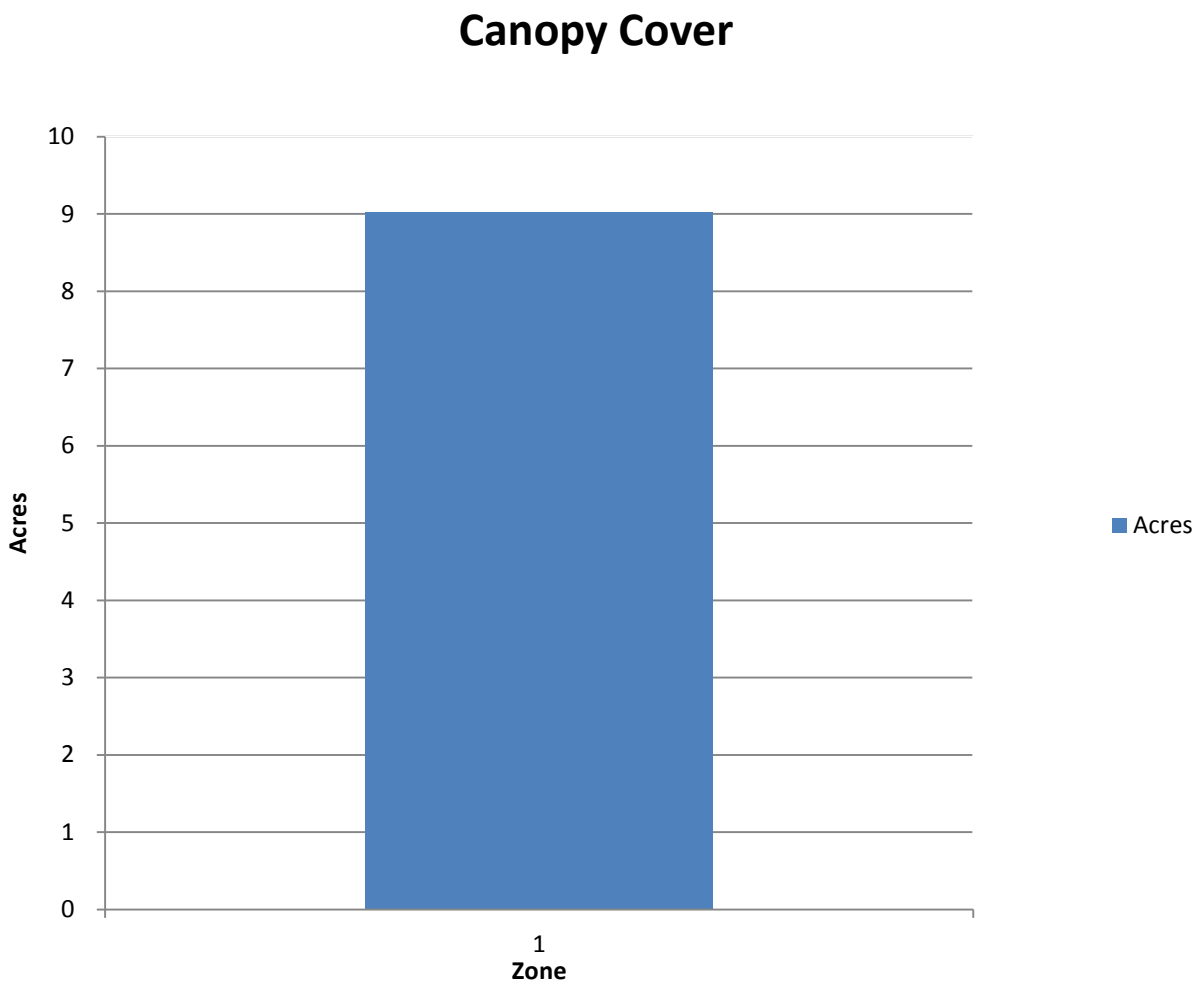

Figure 5: Canopy Cover in Acres

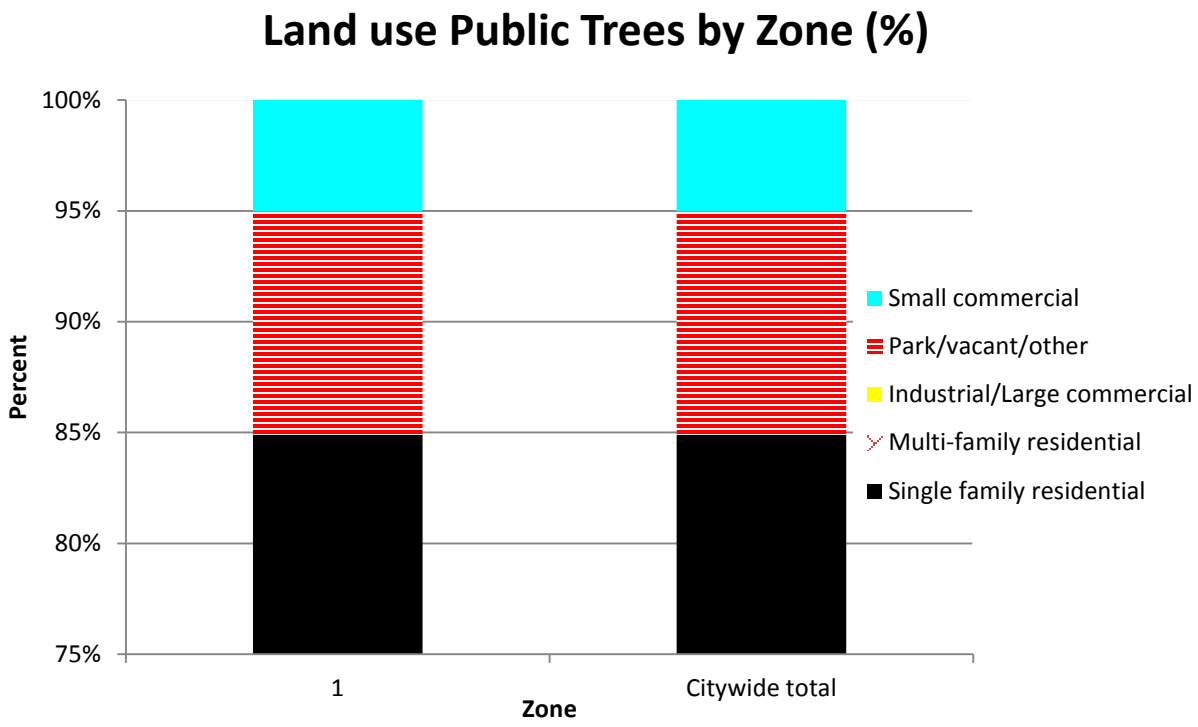

Figure 6: Land Use of city/park trees

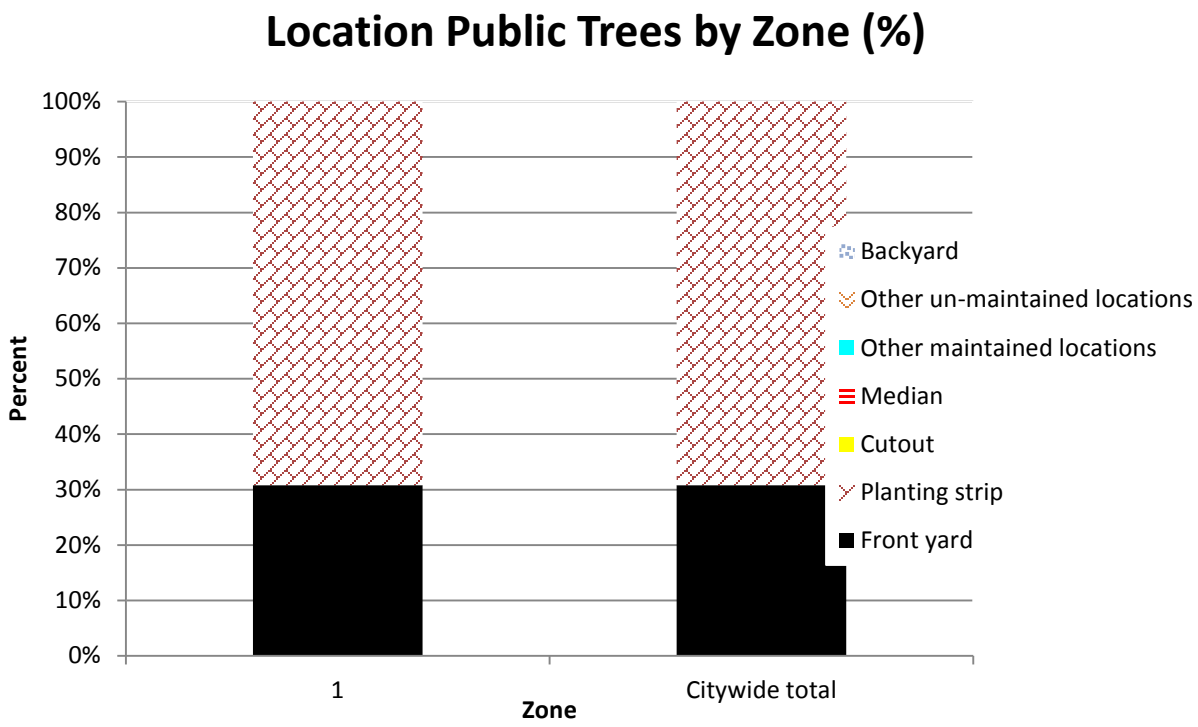

Figure 7: Location of city/park trees

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: Auburn Tree Ordinances

TITLE VI PHYSICAL ENVIRONMENT

CHAPTER 13 TREES

6-13-1 DEFINITION. The term "parking" shall refer to that part of the street, avenue, or highway in the city that is unpaved 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.

6-13-2 PLANTING RESTRICTIONS. No tree shall be planted in any parking or street right of way except in accordance with the following:

1. Alignment. All trees hereafter planted in any parking or street right of way 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 the parking if it 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 to street intersections (property lines extended) and ten (10) feet to 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, or evergreens.

6-13-3 TRIMMING TREES. The owner of the adjacent property shall keep the trees on, or overhanging any street or alley, trimmed so that all the branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. Any tree trimming conducted in a street or public place shall be supervised by the City. If the adjacent property owner fails to trim the trees, the City may serve notice on the adjacent 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 adjacent property for collection in the same manner as a property tax.

(Code of Iowa, Sec. 364.12(2))

6-13-4 REMOVAL OF TREES. The Superintendent shall remove, on the order of the Council, any tree on the streets of the city which interfere with the making of improvements or with travel thereon. He or she shall additionally remove any trees on the street, not on private property, which have become diseased, or which constitute a danger to the public, or

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