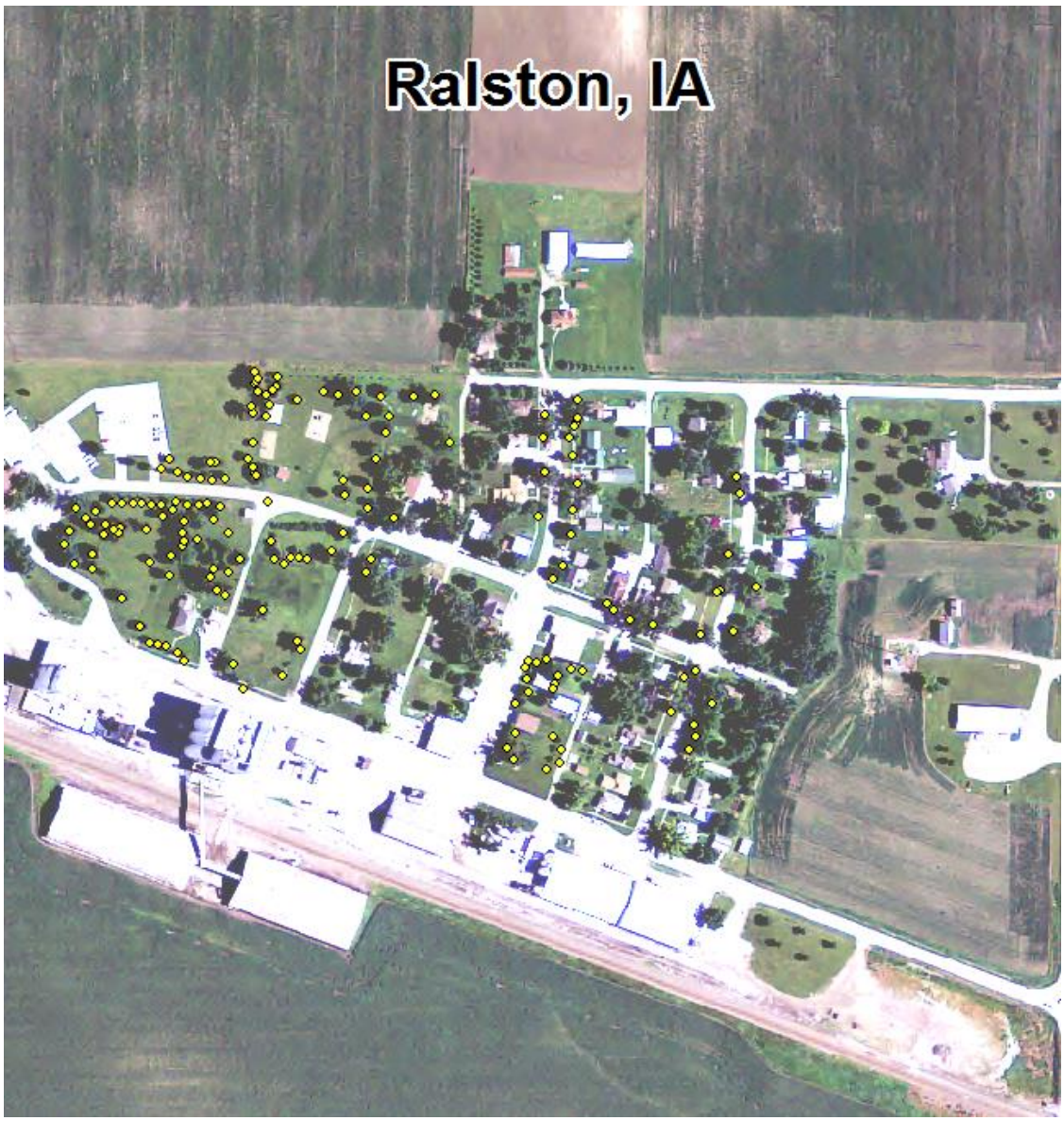
Ralston, IA



2016 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Ralston 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 17% of Ralston'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 2015, 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 166 trees inventoried.

- Ralston's trees provide $21,467 of benefits annually, an average of $129 a tree
- There are over 21 species of trees
- The top three genera are: Spruce 19%, Maple 19%, and Apple (crab) 18%
- 42% of trees are in need of some type of management
- 2 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.

- 9 of the 29 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 20 years to remove ash – Suggestion: request a budget increase and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Ralston 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 Ralston, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2015, 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 166 city trees was entered into the USDA Forest service program i-Tree STREETS, 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. Ralston's trees reduce energy related costs by approximately $5,703 annually (Appendix A, Table 1). These savings are both in Electricity (27 MWh) and in Natural Gas 3,729.9 Therms).

Annual Stormwater Benefits

Ralston's trees intercept about 301,758 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $8,178 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 Ralston, it is estimated that trees remove 322 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 $882 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Ralston, trees sequester about 49,951 lbs of carbon a year with an associated value of $375 (Appendix A, Table 4). In addition, the trees store 899,483lbs of carbon, with a yearly benefit of $6,746 (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. Ralston receives $6,329 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, Ralston's trees provide $21,467 of benefits annually. Benefits of individual trees vary based on size, species, health and

location, but on average each of the 166 trees in Ralston provide approximately $129 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Ralston has over 21 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Spruce	32	19%
Maple	31	19%
Apple (crab)	30	18%
Ash	29	17%
Pine	14	8%
Other	8	5%
Mulberry	5	3%
Honeylocust	3	2%
Oak	3	2%
Linden	3	2%
Hackberry	2	1%
Cedar	2	1%
Ginkgo	1	1%
Walnut	1	1%
Pear	1	1%
Coffeetree	1	1%

Age Class

Most of Ralston's trees (53%) 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. Ralston'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 Ralston indicate that 80% of the trees are in good health, with only 17% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 91% of Ralston'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 2% of the population. This 2% 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	55	33%
Crown Raising	13	7%
Tree Staking	2	1%
Tree Removal	2	1%

Canopy Cover

The total canopy with both private and public trees is 1%, 14 acres. The canopy cover included in the Ralston inventory includes approximately 3 acres (Appendix A, Figure 4).

Land Use and Location

The majority of Ralston'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	21%
Park/vacant/other	79%

Location	
Front yard	77%
Planting strip	23%

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

Ralston has 1 of the critical concern trees needs removal. 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 is 1 tree that needs to be removed 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 70 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). Neither of the 2 removal are ash trees. There are a total of 29 ash trees, and 9 of those have signs and symptoms that have been associated with EAB. In addition, there is one ash tree 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 Ralston.

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 spruce (19%), maple (19%) and Crabapple (18%) (Appendix A, Figure 1). These trees 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.

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 AND ESTIMATED COSTS

YEAR 1	**ESTIMATED COSTS**
Remove 1 critical concern and 1 immediate recommended	$1,400
Plant 3 trees in open locations	$450
Inspect ash trees for signs of Emerald Ash Borer	

YEAR 2	
Removal: 1 any new critical concern tree or ash in poor health	$700
*Or saving for ash tree treatment and/or future ash removal	
Plant 2 trees in open locations	$300
Prune 1/3 of city owned trees	$800
Inspect ash trees for signs of Emerald Ash Borer	

YEAR 3	
Removal: 2 trees - removal of any new critical concern trees or ash in poor health	$1,400
*Or saving for ash tree treatment and/or future ash removal	
Planting and Replacement: 6 trees to be planted in open locations and locations from previous removals	$450
Visual Survey for signs and symptoms of EAB	

YEAR 4	
Removal: 1 any new critical concern tree or ash in poor health	$700
*Or saving for ash tree treatment and/or future ash removal	
Plant 2 trees in open locations	$300
Prune 1/3 of city owned trees	$800
Inspect ash trees for signs of Emerald Ash Borer	

YEAR 5	
Removal: 2 trees - removal of any new critical concern trees or ash in poor health	$1,400
*Or saving for ash tree treatment and/or future ash removal	
Planting and Replacement: 6 trees to be planted in open locations and locations from previous removals	$450
Visual Survey for signs and symptoms of EAB	

YEAR 6

Removal: 1 any new critical concern tree or ash in poor health	$700
*Or saving for ash tree treatment and/or future ash removal	
Plant 2 trees in open locations	$300
Prune 1/3 of city owned trees	$800
Inspect ash trees for signs of Emerald Ash Borer	

*Reduction of ash over 6 years: Approximately 6 ash trees removed (approximately 20% of ash). It will take approximately 20 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 $4,108 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.

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.

Budget

Purposed Budget Increase

EAB could potentially kill all ash trees in Ralston within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $4,108 a year. If the budget were increased to $10,000 a year all ash could be removed within 13 years. Additionally, it is recommended that Ralston 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, and Ralston would still need to find $17,850 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $2,250 a year for treatment and leave $11,900 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 Ralston. 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

Ralston

Annual Energy Benefits of Public Trees

2/1/2016

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	1.6	124	276.2	271	395	(N/A)	18.0	6.9	13.16
Green ash	8.4	639	1,152.2	1,129	1,768	(N/A)	17.4	31.0	60.98
Blue spruce	1.5	112	203.1	199	311	(N/A)	10.8	5.4	17.26
Norway maple	2.4	185	360.8	354	539	(N/A)	9.6	9.5	33.69
Eastern white pine	1.6	122	194.5	191	313	(N/A)	8.4	5.5	22.33
Norway spruce	1.6	120	206.7	203	323	(N/A)	6.6	5.7	29.32
Silver maple	3.0	225	392.7	385	610	(N/A)	6.0	10.7	61.00
Conifer Evergreen Large	1.1	84	137.4	135	218	(N/A)	4.8	3.8	27.30
Mulberry	1.0	75	151.2	148	223	(N/A)	3.0	3.9	44.54
Spruce	0.3	26	42.7	42	67	(N/A)	2.4	1.2	16.86
Honeylocust	1.0	74	132.1	129	204	(N/A)	1.8	3.6	67.95
Northern red oak	0.2	15	29.5	29	44	(N/A)	1.8	0.8	14.63
Littleleaf linden	0.4	27	48.9	48	75	(N/A)	1.8	1.3	25.07
Red maple	0.3	25	49.5	49	74	(N/A)	1.8	1.3	24.58
Eastern red cedar	0.2	17	32.9	32	49	(N/A)	1.2	0.9	24.57
Northern hackberry	1.0	77	135.7	133	210	(N/A)	1.2	3.7	104.85
Sugar maple	0.4	32	59.0	58	90	(N/A)	1.2	1.6	44.87
Cottonwood	0.5	37	63.1	62	99	(N/A)	0.6	1.7	98.63
Black walnut	0.3	20	38.1	37	57	(N/A)	0.6	1.0	57.32
Ginkgo	0.1	5	9.9	10	15	(N/A)	0.6	0.3	14.72
Kentucky coffeetree	0.1	7	13.7	13	21	(N/A)	0.6	0.4	20.64
Total	27.0	2,048	3,729.9	3,655	5,703	(N/A)	100.0	100.0	34.15

Table 2: Annual Stormwater Benefits

Ralston

Annual Stormwater Benefits of Public Trees

2/1/2016

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	5,730	155	(N/A)	18.0	1.9	5.18
Green ash	95,892	2,599	(N/A)	17.4	31.8	89.61
Blue spruce	18,173	492	(N/A)	10.8	6.0	27.36
Norway maple	16,916	458	(N/A)	9.6	5.6	28.65
Eastern white pine	20,142	546	(N/A)	8.4	6.7	38.99
Norway spruce	29,800	808	(N/A)	6.6	9.9	73.42
Silver maple	40,862	1,107	(N/A)	6.0	13.5	110.74
Conifer Evergreen Large	18,031	489	(N/A)	4.8	6.0	61.08
Mulberry	5,363	145	(N/A)	3.0	1.8	29.07
Spruce	3,886	105	(N/A)	2.4	1.3	26.32
Honeylocust	10,495	284	(N/A)	1.8	3.5	94.81
Northern red oak	1,076	29	(N/A)	1.8	0.4	9.72
Littleleaf linden	2,181	59	(N/A)	1.8	0.7	19.70
Red maple	1,876	51	(N/A)	1.8	0.6	16.95
Eastern red cedar	3,269	89	(N/A)	1.2	1.1	44.30
Northern hackberry	12,986	352	(N/A)	1.2	4.3	175.96
Sugar maple	4,342	118	(N/A)	1.2	1.4	58.84
Cottonwood	7,239	196	(N/A)	0.6	2.4	196.17
Black walnut	2,591	70	(N/A)	0.6	0.9	70.21
Ginkgo	301	8	(N/A)	0.6	0.1	8.17
Kentucky coffeetree	608	16	(N/A)	0.6	0.2	16.47
Citywide total	301,758	8,178	(N/A)	100.0	100.0	48.97

Table 3: Annual Air Quality Benefits

Ralston

Annual Air Quality Benefits of Public Trees

2/1/2016

Species	Deposition (lb) O_3	NO_2	PM_{10}	SO_2	Total Depos. ($)	Avoided (lb) NO_2	PM_{10}	VOC	SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
Apple	1.0	0.2	0.6	0.0	6	8.3	1.2	1.1	7.4	50	0.0	0	19.7	56	(N/A)	18.0	1.86
Green ash	12.1	1.9	5.7	0.5	64	40.2	5.9	5.6	38.2	250	0.0	0	110.1	315	(N/A)	17.4	10.85
Blue spruce	2.1	0.4	1.8	0.3	14	7.0	1.0	1.0	6.7	44	-6.2	-23	14.0	34	(N/A)	10.8	1.91
Norway maple	2.6	0.5	1.4	0.1	15	11.9	1.7	1.6	11.1	74	-0.7	-3	30.3	86	(N/A)	9.6	5.35
Eastern white pine	2.2	0.4	1.9	0.3	15	7.4	1.1	1.1	7.3	47	-7.3	-27	14.3	34	(N/A)	8.4	2.43
Norway spruce	3.4	0.7	2.8	0.4	23	7.4	1.1	1.0	7.2	47	-13.5	-51	10.6	19	(N/A)	6.6	1.70
Silver maple	6.9	1.2	3.4	0.3	37	14.0	2.0	2.0	13.4	88	-3.7	-14	39.5	111	(N/A)	6.0	11.10
Conifer Evergreen Large	2.1	0.4	1.7	0.3	14	5.1	0.8	0.7	5.0	32	-7.7	-29	8.3	17	(N/A)	4.8	2.13
Mulberry	1.9	0.3	0.9	0.1	10	4.8	0.7	0.7	4.4	30	0.0	0	13.9	40	(N/A)	3.0	7.99
Spruce	0.4	0.1	0.4	0.0	3	1.6	0.2	0.2	1.5	10	-1.3	-5	3.1	8	(N/A)	2.4	1.92
Honeylocust	2.0	0.3	0.9	0.1	11	4.7	0.7	0.6	4.4	29	-1.5	-6	12.3	34	(N/A)	1.8	11.36
Northern red oak	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	-0.2	-1	2.2	6	(N/A)	1.8	2.00
Littleleaf linden	0.2	0.0	0.1	0.0	1	1.7	0.3	0.2	1.6	11	-0.1	-1	4.1	12	(N/A)	1.8	3.84
Red maple	0.2	0.0	0.1	0.0	1	1.6	0.2	0.2	1.5	10	-0.1	0	3.9	11	(N/A)	1.8	3.64
Eastern red cedar	0.7	0.1	0.5	0.1	4	1.1	0.2	0.1	1.0	7	-1.8	-7	2.0	4	(N/A)	1.2	2.19
Northern hackberry	2.9	0.5	1.4	0.1	16	4.8	0.7	0.7	4.6	30	0.0	0	15.7	46	(N/A)	1.2	22.76
Sugar maple	0.5	0.1	0.3	0.0	3	2.0	0.3	0.3	1.9	13	-0.4	-2	5.0	14	(N/A)	1.2	6.93
Cottonwood	1.6	0.3	0.7	0.1	8	2.3	0.3	0.3	2.2	14	0.0	0	7.7	23	(N/A)	0.6	22.55
Black walnut	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.3	9	(N/A)	0.6	9.34
Ginkgo	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2	(N/A)	0.6	2.12
Kentucky coffeetree	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3	(N/A)	0.6	2.99
Citywide total	43.4	7.5	25.0	2.8	247	129.0	18.8	17.9	122.2	803	-44.7	-168	321.9	882	(N/A)	100.0	5.28

Table 4: Annual Carbon Stored

Ralston

Stored CO2 Benefits of Public Trees

2/1/2016

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	19,711	148	(N/A)	18.0	2.2	4.93
Green ash	394,071	2,956	(N/A)	17.4	43.8	101.92
Blue spruce	11,732	88	(N/A)	10.8	1.3	4.89
Norway maple	45,205	339	(N/A)	9.6	5.0	21.19
Eastern white pine	15,815	119	(N/A)	8.4	1.8	8.47
Norway spruce	32,425	243	(N/A)	6.6	3.6	22.11
Silver maple	160,111	1,201	(N/A)	6.0	17.8	120.08
Conifer Evergreen La	18,052	135	(N/A)	4.8	2.0	16.92
Mulberry	30,008	225	(N/A)	3.0	3.3	45.01
Spruce	2,635	20	(N/A)	2.4	0.3	4.94
Honeylocust	25,730	193	(N/A)	1.8	2.9	64.33
Northern red oak	2,062	15	(N/A)	1.8	0.2	5.15
Littleleaf linden	5,644	42	(N/A)	1.8	0.6	14.11
Red maple	3,302	25	(N/A)	1.8	0.4	8.26
Eastern red cedar	2,204	17	(N/A)	1.2	0.2	8.27
Northern hackberry	49,445	371	(N/A)	1.2	5.5	185.42
Sugar maple	15,381	115	(N/A)	1.2	1.7	57.68
Cottonwood	55,982	420	(N/A)	0.6	6.2	419.86
Black walnut	8,458	63	(N/A)	0.6	0.9	63.43
Ginkgo	474	4	(N/A)	0.6	0.1	3.56
Kentucky coffeetree	1,035	8	(N/A)	0.6	0.1	7.76
Citywide total	899,483	6,746	(N/A)	100.0	100.0	40.40

Table 5: Annual Carbon Sequestered

Ralston

Annual CO2 Benefits of Public Trees

2/1/2016

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
Apple	2,554	19	-95	-28	0	0	0	2,431	18	(N/A)	18.0	4.9	0.61
Green ash	19,940	150	-1,892	-88	-1	0	0	17,961	135	(N/A)	17.4	36.0	4.65
Blue spruce	1,026	8	-56	-25	0	0	0	945	7	(N/A)	10.8	1.9	0.39
Norway maple	4,461	33	-217	-25	0	0	0	4,219	32	(N/A)	9.6	8.4	1.98
Eastern white pine	1,501	11	-76	-26	0	0	0	1,399	10	(N/A)	8.4	2.8	0.75
Norway spruce	1,917	14	-156	-28	0	0	0	1,733	13	(N/A)	6.6	3.5	1.18
Silver maple	12,070	91	-769	-33	0	0	0	11,268	85	(N/A)	6.0	22.6	8.45
Conifer Evergreen Large	1,212	9	-87	-19	0	0	0	1,106	8	(N/A)	4.8	2.2	1.04
Mulberry	746	6	-144	-15	0	0	0	587	4	(N/A)	3.0	1.2	0.88
Spruce	302	2	-13	-6	0	0	0	283	2	(N/A)	2.4	0.6	0.53
Honeylocust	3,359	25	-124	-8	0	0	0	3,227	24	(N/A)	1.8	6.5	8.07
Northern red oak	300	2	-10	-3	0	0	0	287	2	(N/A)	1.8	0.6	0.72
Littleleaf linden	961	7	-27	-4	0	0	0	929	7	(N/A)	1.8	1.9	2.32
Red maple	496	4	-16	-4	0	0	0	476	4	(N/A)	1.8	1.0	1.19
Eastern red cedar	0	0	-11	-4	0	0	0	-14	0	(N/A)	1.2	0.0	-0.05
Northern hackberry	1,454	11	-237	-11	0	0	0	1,206	9	(N/A)	1.2	2.4	4.52
Sugar maple	907	7	-74	-5	0	0	0	829	6	(N/A)	1.2	1.7	3.11
Cottonwood	479	4	-269	-6	0	0	0	204	2	(N/A)	0.6	0.4	1.53
Black walnut	660	5	-41	-3	0	0	0	616	5	(N/A)	0.6	1.2	4.62
Ginkgo	58	0	-2	-1	0	0	0	54	0	(N/A)	0.6	0.1	0.41
Kentucky coffeetree	209	2	-5	-1	0	0	0	203	2	(N/A)	0.6	0.4	1.52
Citywide total	54,610	410	-4,318	-341	-3	0	0	49,951	375	(N/A)	100.0	100.0	2.24

Table 6: Annual Social and Aesthetic Benefits

Ralston

Annual Aesthetic/Other Benefits of Public Trees

2/1/2016

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	143	(N/A)	18.0	2.3	4.75
Green ash	1,621	(N/A)	17.4	25.6	55.89
Blue spruce	370	(N/A)	10.8	5.8	20.54
Norway maple	480	(N/A)	9.6	7.6	30.03
Eastern white pine	417	(N/A)	8.4	6.6	29.75
Norway spruce	488	(N/A)	6.6	7.7	44.40
Silver maple	964	(N/A)	6.0	15.2	96.37
Conifer Evergreen Large	318	(N/A)	4.8	5.0	39.70
Mulberry	44	(N/A)	3.0	0.7	8.86
Spruce	87	(N/A)	2.4	1.4	21.72
Honeylocust	778	(N/A)	1.8	12.3	259.37
Northern red oak	34	(N/A)	1.8	0.5	11.34
Littleleaf linden	117	(N/A)	1.8	1.9	39.16
Red maple	90	(N/A)	1.8	1.4	29.84
Eastern red cedar	0	(N/A)	1.2	0.0	0.00
Northern hackberry	160	(N/A)	1.2	2.5	79.83
Sugar maple	98	(N/A)	1.2	1.5	48.87
Cottonwood	29	(N/A)	0.6	0.5	28.57
Black walnut	58	(N/A)	0.6	0.9	57.69
Ginkgo	7	(N/A)	0.6	0.1	6.77
Kentucky coffeetree	29	(N/A)	0.6	0.5	28.56
Citywide total	6,329	(N/A)	100.0	100.0	37.90

Table 7: Summary of Benefits in Dollars

Ralston

Total Annual Benefits of Public Trees by Species ($)

2/1/2016

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Apple	395	18	56	155	143	767	(N/A)	3.6
Green ash	1,768	135	315	2,599	1,621	6,437	(N/A)	30.0
Blue spruce	311	7	34	492	370	1,214	(N/A)	5.7
Norway maple	539	32	86	458	480	1,595	(N/A)	7.4
Eastern white pine	313	10	34	546	417	1,319	(N/A)	6.1
Norway spruce	323	13	19	808	488	1,650	(N/A)	7.7
Silver maple	610	85	111	1,107	964	2,877	(N/A)	13.4
Conifer Evergreen Large	218	8	17	489	318	1,050	(N/A)	4.9
Mulberry	223	4	40	145	44	457	(N/A)	2.1
Spruce	67	2	8	105	87	269	(N/A)	1.3
Honeylocust	204	24	34	284	778	1,325	(N/A)	6.2
Northern red oak	44	2	6	29	34	115	(N/A)	0.5
Littleleaf linden	75	7	12	59	117	270	(N/A)	1.3
Red maple	74	4	11	51	90	229	(N/A)	1.1
Eastern red cedar	49	0	4	89	0	142	(N/A)	0.7
Northern hackberry	210	9	46	352	160	776	(N/A)	3.6
Sugar maple	90	6	14	118	98	325	(N/A)	1.5
Cottonwood	99	2	23	196	29	347	(N/A)	1.6
Black walnut	57	5	9	70	58	199	(N/A)	0.9
Ginkgo	15	0	2	8	7	32	(N/A)	0.1
Kentucky coffeetree	21	2	3	16	29	70	(N/A)	0.3
Citywide Total	5,703	375	882	8,178	6,329	21,467	(N/A)	100.0

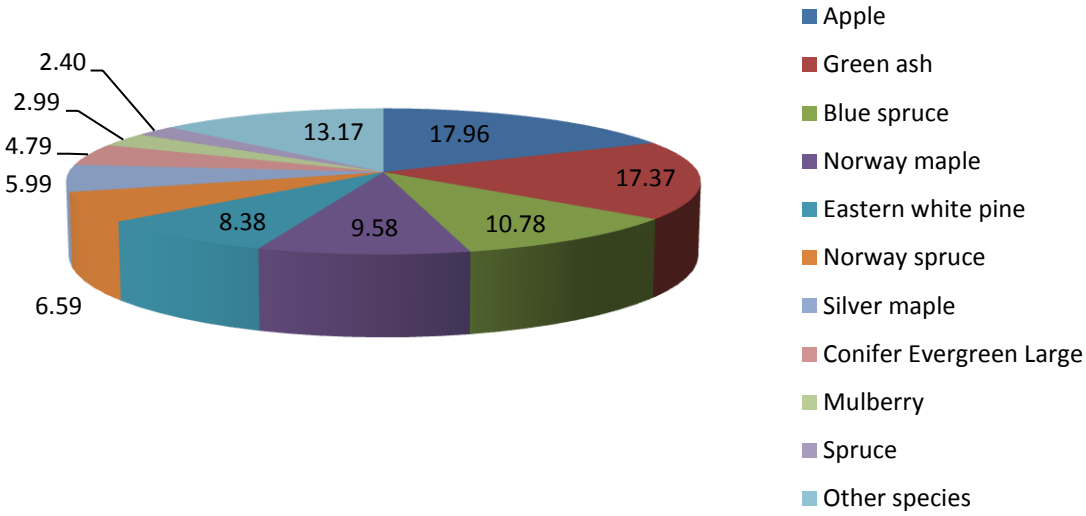

Figure 1: Species Distribution

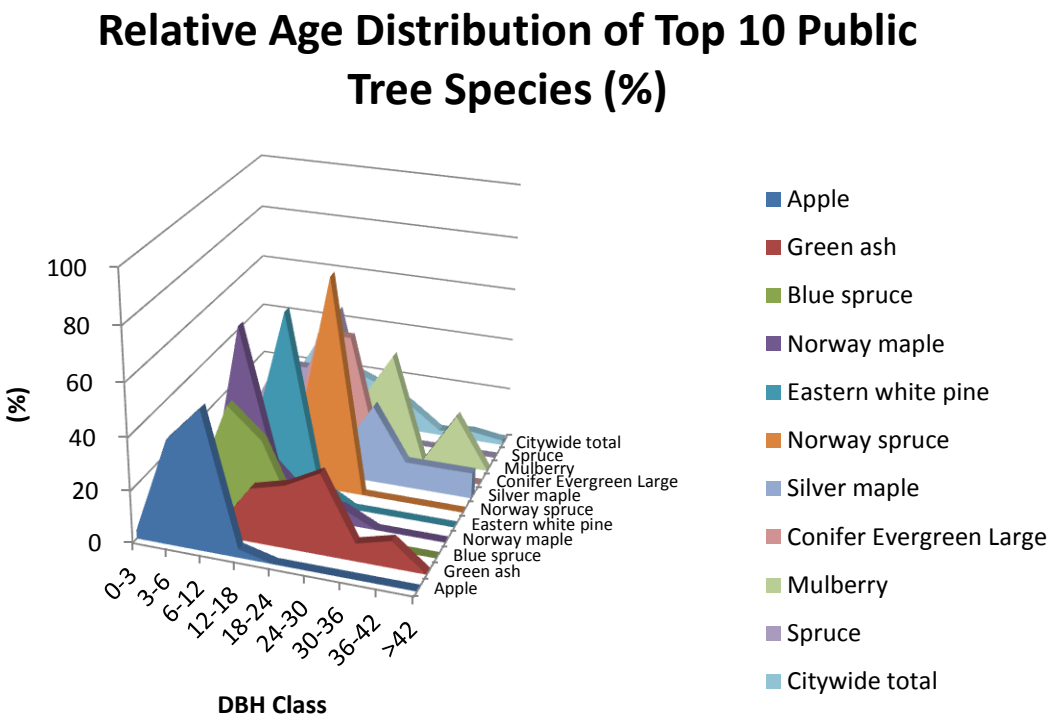

Figure 2: Relative Age Class

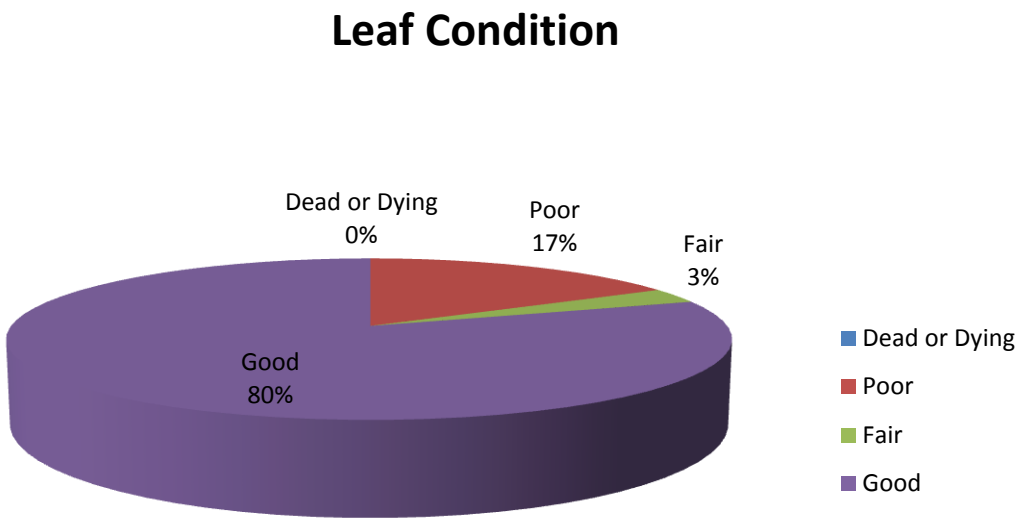

Figure 3: Foliage Condition

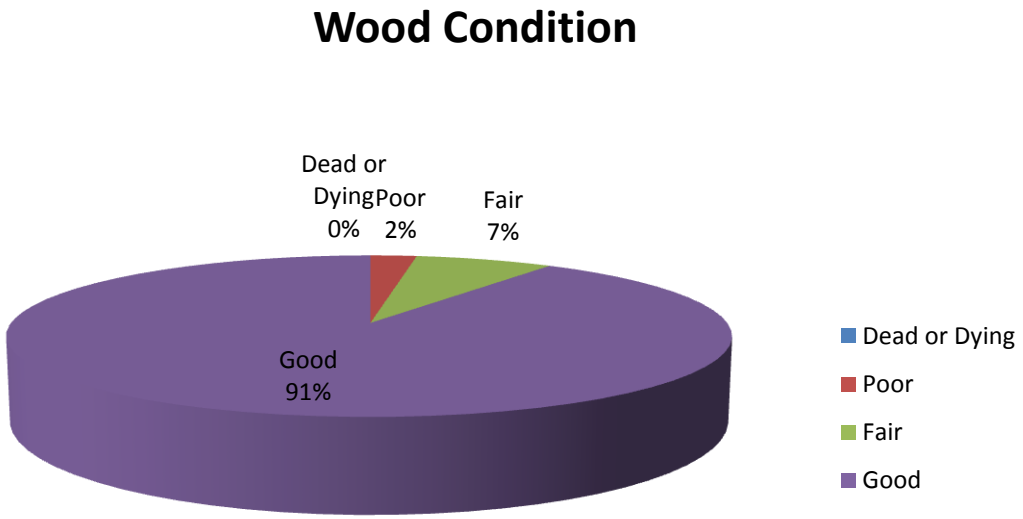

Figure 4: Wood Condition

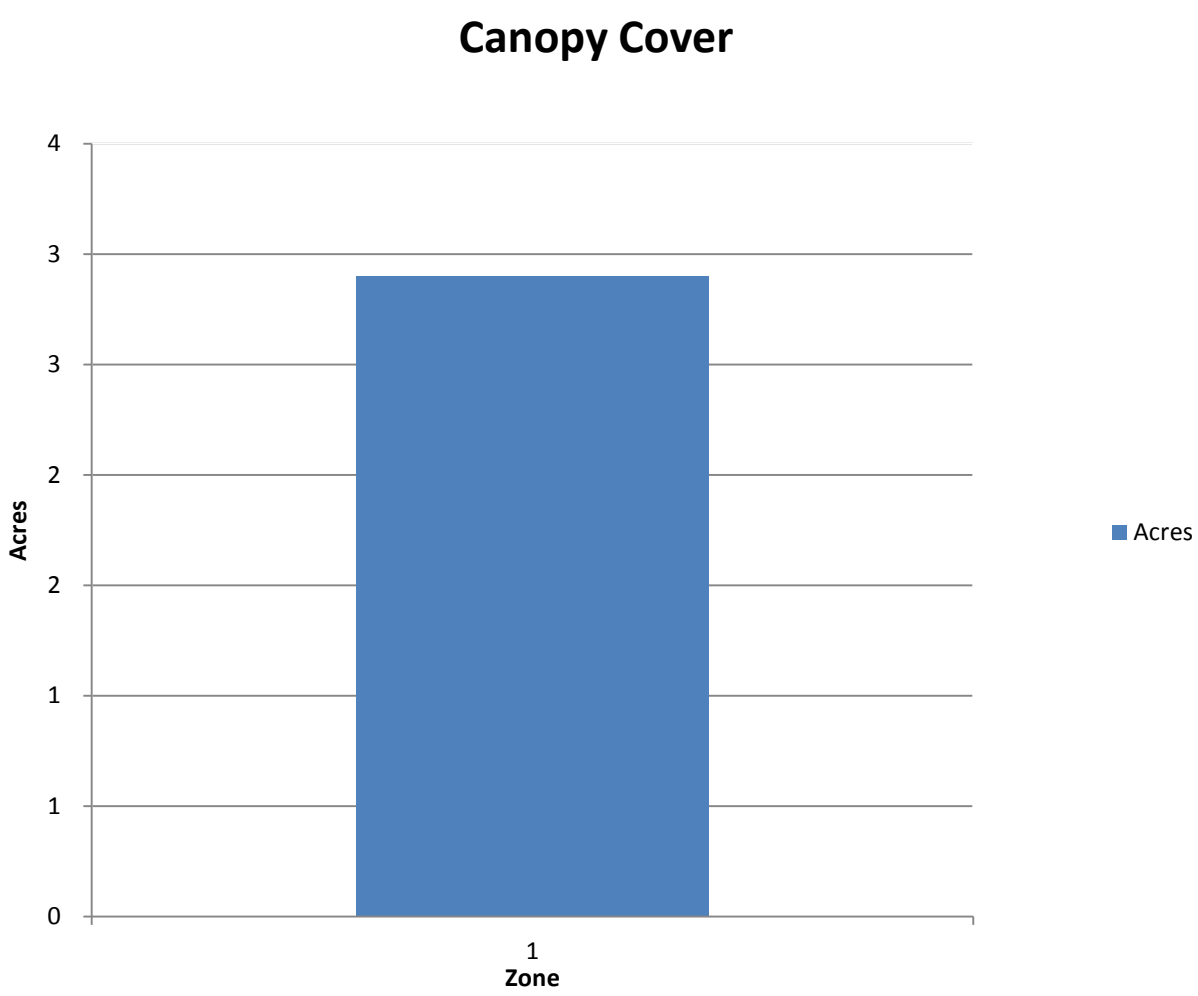

Figure 5: Canopy Cover in Acres

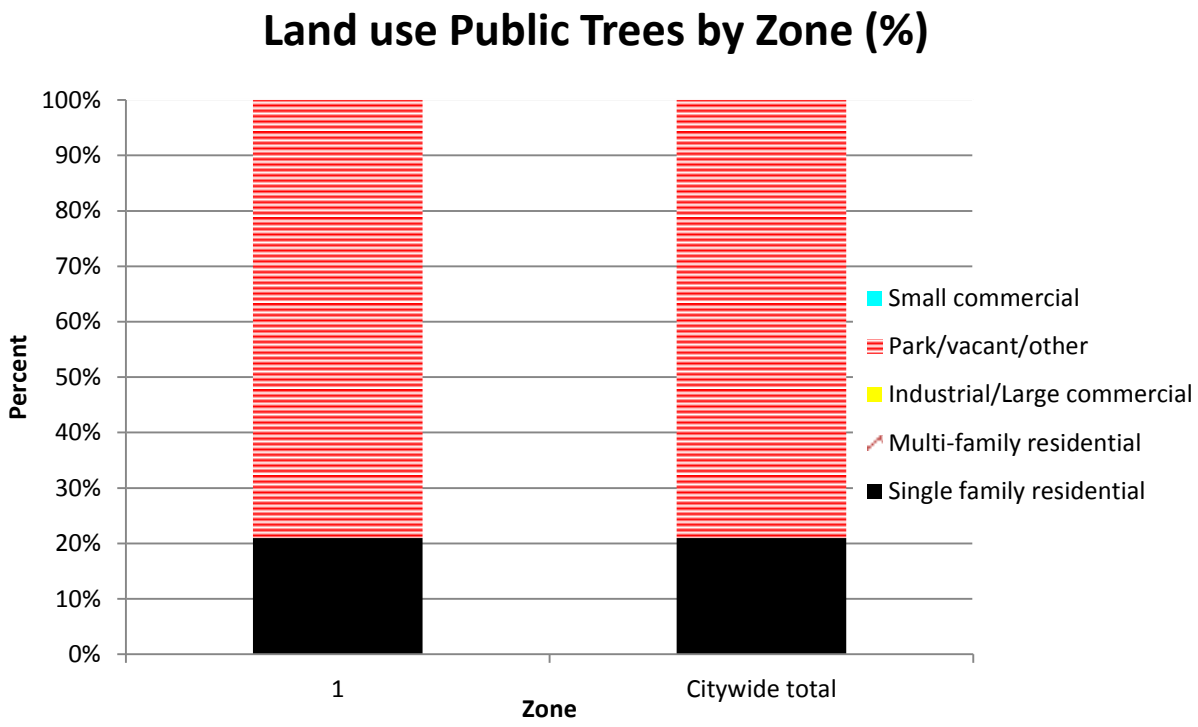

Figure 6: Land Use of city/park trees

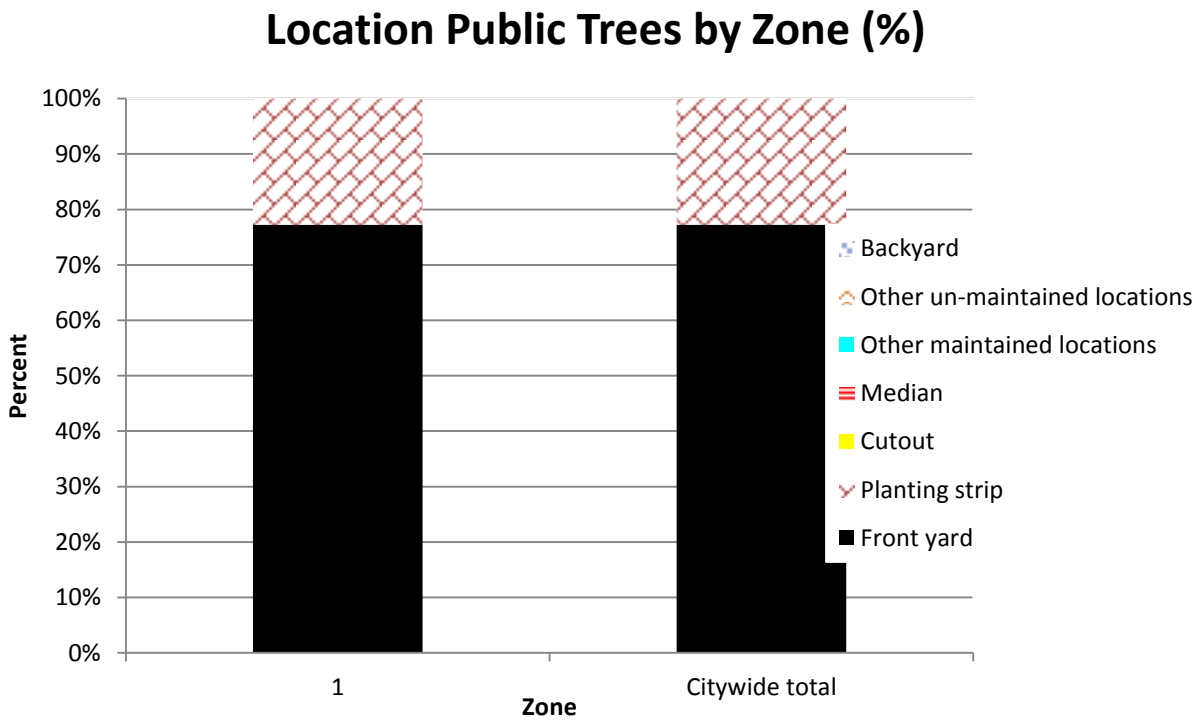

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees

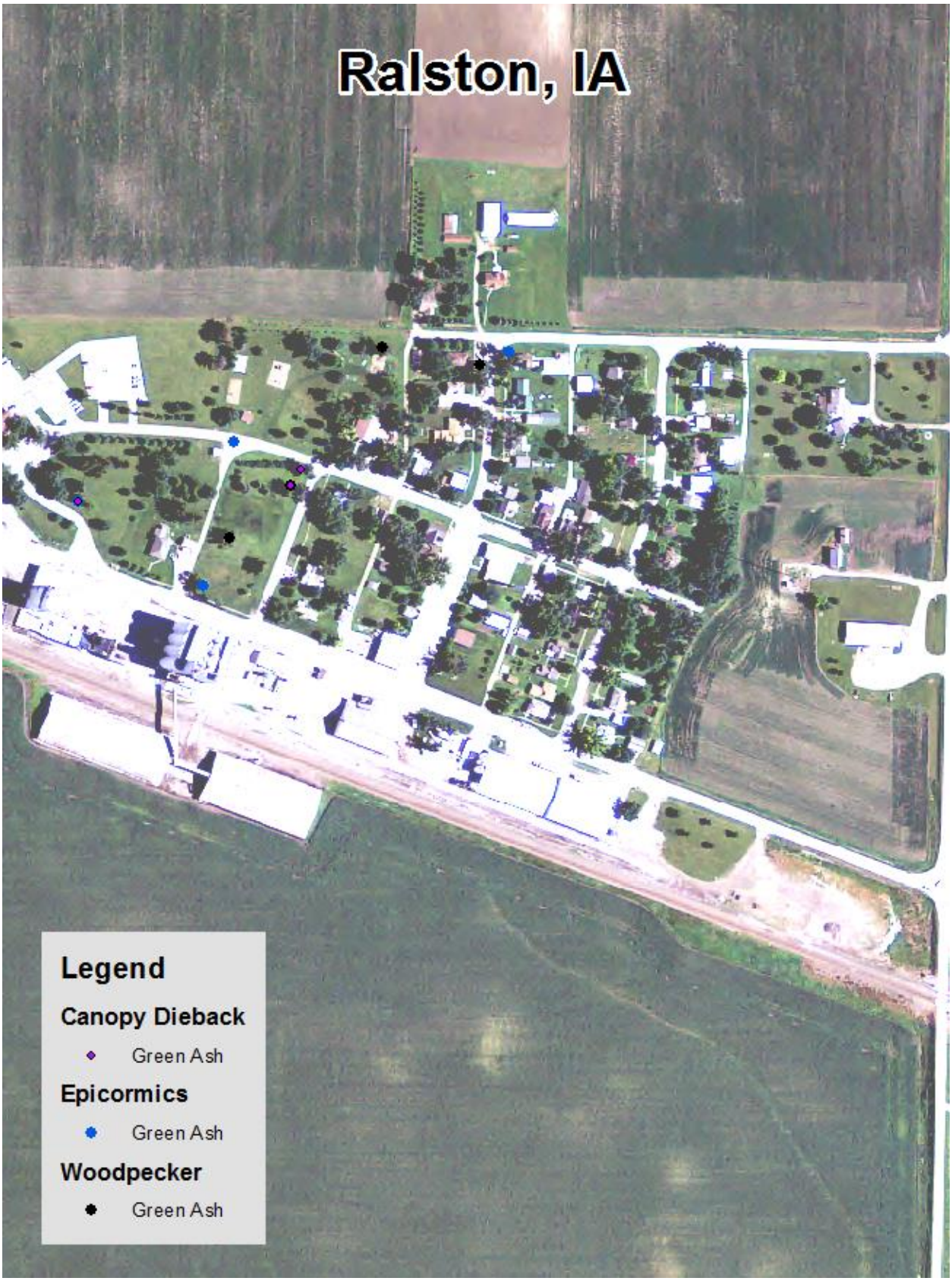

Figure 2: Location of EAB symptoms

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

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