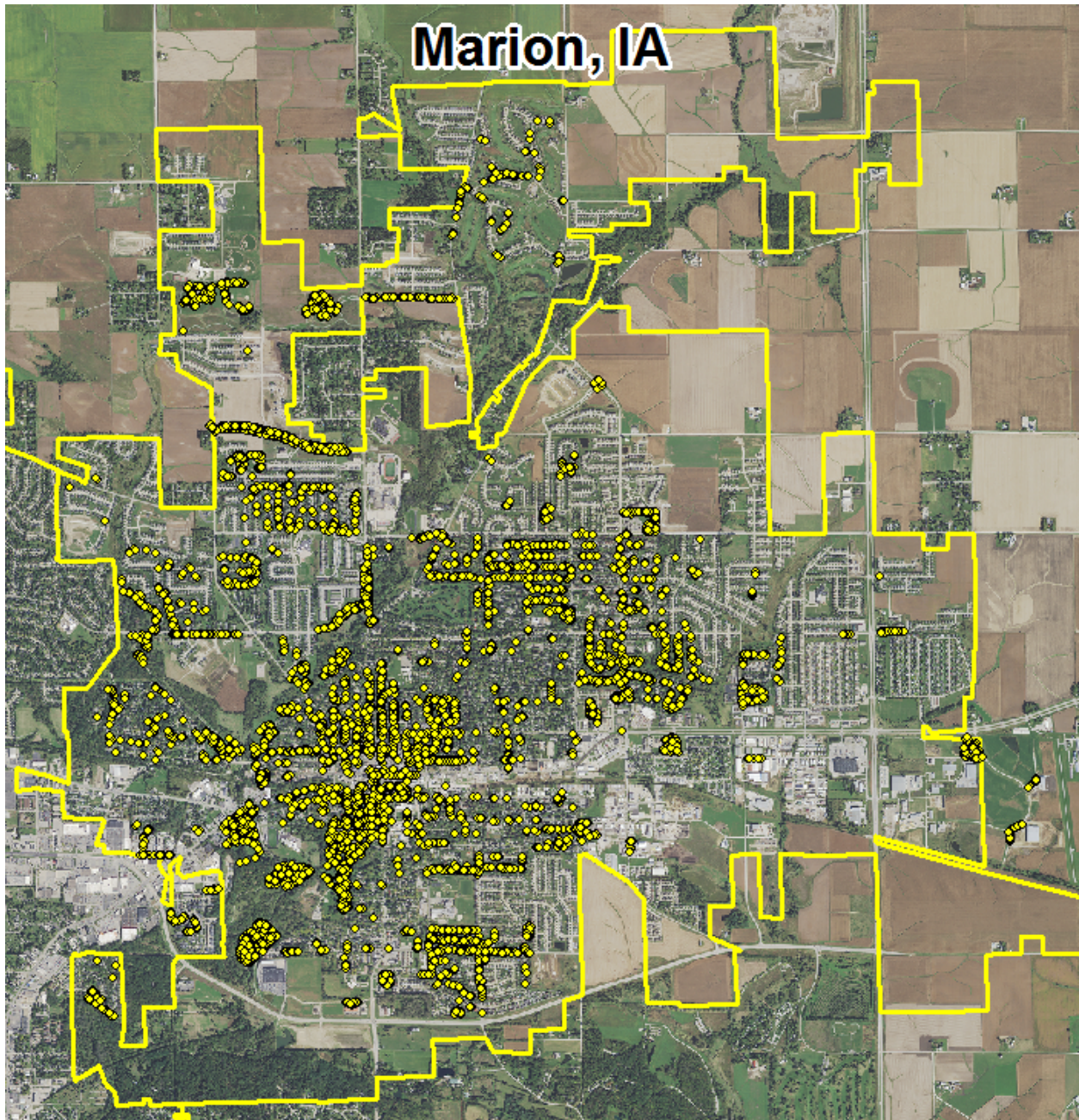


# Marion, IA



2017 Urban Forest Management Plan  
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# Executive Summary

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## Overview

This plan was developed to assist the City of Marion 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 16% of Marion'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 5,872 trees inventoried.

- Marion's trees provide \$668,977 of benefits annually, an average of \$114 a tree
- There are over 87 species of trees
- The top three genera are: Maple 27%, Ash 16%, and Oak 11%
- 52% of trees are in need of some type of management
- 246 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 246 trees needing removal, 24 must be addressed immediately *\*City ownership of the trees recommended for removal should be verified prior to any removal\**
- 88 of the 956 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 and maple
- Check ash trees with a visual survey yearly
- With the current budget it could take 14 years to remove ash – Suggestion: request a budget increase to and apply for grants to plant replacement trees

## Introduction

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

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

## Inventory

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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

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The data collected for the 5,872 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. Marion's trees reduce energy related costs by approximately \$189,802 annually (Appendix A, Table 1). These savings are both in Electricity (902.3 MWh) and in Natural Gas (189,802 Therms).

#### **Annual Stormwater Benefits**

Marion's trees intercept about 8,277,265 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$224,314 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 Marion, it is estimated that trees remove 11,412.2 lbs of air pollution (ozone (O<sub>3</sub>), particulate matter less than 10 microns (PM<sub>10</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and sulfur dioxide (SO<sub>2</sub>)) per year with a net value of \$32,088 (Appendix A, Table 3).

#### **Annual Carbon Benefits**

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Marion, trees sequester about 23,381 lbs of carbon a year with an associated value of \$3,117,497 (Appendix A, Table 4). In addition, the trees store 26,101,185 lbs of carbon, with a yearly benefit of \$195,759 (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. Marion receives \$199,391 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, Marion's trees provide \$668,977 of benefits annually. Benefits of individual trees vary based on size, species, health and



location, but on average each of the 5,872 trees in Marion provide approximately \$114 annually (Appendix A, Table 7).

## **Forest Structure**

### **Species Distribution**

Marion has over 87 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	1599	27%
Ash	956	16%
Oak	559	10%
Other	332	6%
Honeylocust	315	5%
Apple (crabapple)	250	4%
Spruce	188	3%
Elm	179	3%
Linden	173	3%
Hackberry	141	2%
Pear	129	2%
Pine	109	2%
Cottonwood/poplar	104	2%
Kentucky Coffeetree	96	2%
Sycamore	72	1%
Tulip tree	71	1%
Walnut	70	1%
Cherry	63	1%
Birch	58	1%
Hickory	54	1%
White Cedar	44	1%
Catalpa	42	1%
Ohio Buckeye	40	1%
Mulberry	39	1%
Lilac	33	1%
Ginkgo	28	<1%
Red bud	23	<1%
Magnolia	19	<1%
Red Cedar	17	<1%
Black locust	16	<1%
Dogwood	11	<1%
Willow	10	<1%
Alder	9	<1%

Yellowwood	8	<1%
Chestnut	6	<1%
Hophornbeam	5	<1%
Hemlock	3	<1%
Sweetgum	1	<1%

### Age Class

Most of Marion's trees (72%) are between less than 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. Marion'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 Marion indicate that 87% of the trees are in good health, with only 3% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 87% of Marion'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 5% of the population. This 5% is an estimate of trees that need management follow up.

### Management Needs

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

Crown Raising	1,294	22%
Crown Cleaning	1,244	21%
Tree Staking	251	4%
Tree Removal	246	4%
Crown Reduction	26	<1%
Treat Pest	19	<1%

### Canopy Cover

The total canopy with both private and public trees is 19%, 1989 acres. The canopy cover included in the Marion inventory includes approximately 94 acres (Appendix A, Figure 4). The City's Canopy goal is 3%, in 30 years. To achieve this goal it is estimated that 750 trees need to be planted annually on public and private land beyond replacement trees.

### Land Use and Location

The majority of Marion's city and park trees are in planting strips in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.



### Land Use

Single family residential	65%
Park/vacant/other	33%
Industrial/Large commercial	1%
Small commercial	<1%
Multifamily residential	<1%

### Location

Planting strip	65%
Front yard	35%
Cutout (surrounded by pavement)	<1%
Median	<1%

## Recommendations

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### **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

Marion has 24 critical concern trees that need immediate 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. 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 3,046 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 246 removals, 49 are ash trees. There are a total of 956 ash trees, and 88 of those have signs and symptoms that have been associated with EAB. In addition, there are 48 ash 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 Marion.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with maple (27%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. All trees planted must meet the permitting process outlined in city ordinance 152.05 (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 No Additional Funding**

### **Year 1**

- Removal: 24 concern trees and 58 other trees
- Planting and Replacement: 98 trees to be planted in open locations
- Pruning & Maintenance: 460 trees
- Visual Survey for signs and symptoms of EAB

### **Year 2**

- Removal: 82 trees
- Planting and Replacement: 98 trees in open locations from year one removals
- Pruning & Maintenance: 460 trees
- Visual Survey for signs and symptoms of EAB

### **Year 3**

- Removal: 82 trees
- Planting and Replacement: 98 trees in open locations from year one removals
- Pruning & Maintenance: 460 trees
- Visual Survey for signs and symptoms of EAB

### **Year 4**

Removal: Removal of any new critical concern trees and ash in poor health

\*Or saving for ash tree treatment and/or future ash removal

Planting and Replacement: 98 trees in open locations

Pruning & Maintenance: 460 Trees

Visual Survey for signs and symptoms of EAB

#### Year 5

Removal: Removal of any new critical concern trees and ash in poor health

\*Or saving for ash tree treatment and/or future ash removal

Planting and Replacement: 98 trees in open locations

Pruning & Maintenance: 460 Trees

Visual Survey for signs and symptoms of EAB

#### Year 6

Removal: Removal of any new critical concern trees and ash in poor health

\*Or saving for ash tree treatment and/or future ash removal

Planting and Replacement: 98 trees in open locations

Pruning & Maintenance: 460 Trees

Visual Survey for signs and symptoms of EAB

\*Reduction of ash over 6 years: Approximately 49 to 295 ash trees removed if they are not treated (approximately 30% of ash). It will take approximately 14 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 \$211,240 a year.

## Emerald Ash Borer Plan

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### 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](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 planted must meet the permitting process outlined in city ordinance 152.05 (Appendix C). The new plantings will be a diverse mix and will not include

### **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 being used as the tree might become hazardous. City Code 152.06 states “If it becomes necessary to trim trees or shrubs on private property, the City Forester shall declare the tree or shrub a nuisance.”

## Budget

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### Current Budget

**Total \$110,000**

Removal: \$65,600

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$9,800

Pruning & Maintenance: \$34,600

\*Reduction of ash over 6 years: Approximately 49 to 295 ash trees removed if they are not treated (approximately 30% of ash). It will take approximately 14 years to remove all ash with the current budget.

### Purposed Budget Increase

EAB could potentially kill all ash trees in Marion within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to \$211,240 a year. Additionally, it is recommended that Marion 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 40 trees could be treated per year (every other year treatment). This would be 80 trees selected for treatment for \$12,000 a year, and Marion would still need to find \$700,800 for removal. Alternatively, if there are 200 treatable trees, it would cost approximately \$30,000 a year for treatment and leave \$604,800 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. 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

Marion

### Annual Energy Benefits of Public Trees

2/6/2017

Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Maple	166.4	12,632	22,277.7	21,832	34,464	(N/A)	14.4	18.2	40.88
Ash	173.4	13,164	24,663.0	24,170	37,334	(N/A)	13.5	19.7	47.14
Silver maple	106.1	8,054	14,042.7	13,762	21,816	(N/A)	6.7	11.5	55.51
Honeylocust	69.0	5,237	9,067.8	8,886	14,123	(N/A)	5.4	7.4	44.84
Apple	12.7	963	2,017.3	1,977	2,940	(N/A)	4.3	1.5	11.76
Broadleaf Deciduous Small	4.3	326	729.8	715	1,041	(N/A)	3.1	0.5	5.78
Northern red oak	19.6	1,489	2,720.0	2,666	4,154	(N/A)	3.0	2.2	23.60
Red maple	21.8	1,654	2,869.5	2,812	4,466	(N/A)	2.7	2.4	27.91
Swamp white oak	8.7	657	1,248.9	1,224	1,881	(N/A)	2.5	1.0	12.88
Northern hackberry	19.2	1,454	2,716.5	2,662	4,116	(N/A)	2.4	2.2	29.19
Blue spruce	9.1	687	1,270.9	1,245	1,933	(N/A)	2.2	1.0	14.87
Green ash	27.9	2,115	3,762.1	3,687	5,802	(N/A)	1.9	3.1	51.35
Elm	4.3	327	585.3	574	900	(N/A)	1.8	0.5	8.41
Kentucky coffeetree	5.6	422	713.2	699	1,121	(N/A)	1.6	0.6	11.68
Littleleaf linden	11.6	880	1,562.3	1,531	2,411	(N/A)	1.6	1.3	25.12
Cottonwood	23.1	1,753	3,142.4	3,080	4,832	(N/A)	1.5	2.5	53.69
Pear	2.8	213	443.5	435	647	(N/A)	1.4	0.3	8.09
American basswood	11.5	869	1,639.0	1,606	2,476	(N/A)	1.2	1.3	34.38
American sycamore	11.1	844	1,461.2	1,432	2,276	(N/A)	1.2	1.2	31.61
Tulip tree	2.4	178	318.4	312	491	(N/A)	1.2	0.3	6.91
Northern pin oak	19.3	1,464	2,793.6	2,738	4,202	(N/A)	1.2	2.2	59.18
Black walnut	19.2	1,454	2,643.5	2,591	4,045	(N/A)	1.2	2.1	57.78
Sugar maple	12.5	948	1,618.3	1,586	2,534	(N/A)	1.2	1.3	36.73
Eastern white pine	7.4	560	939.5	921	1,481	(N/A)	1.2	0.8	21.78
Bur oak	11.0	831	1,496.8	1,467	2,298	(N/A)	1.1	1.2	37.07
Oak	4.8	364	638.6	626	990	(N/A)	1.0	0.5	17.36
Hickory	7.1	541	975.9	956	1,498	(N/A)	0.9	0.8	27.74
Broadleaf Deciduous Medium	3.1	232	466.7	457	689	(N/A)	0.9	0.4	13.01
Black cherry	5.4	410	852.4	835	1,246	(N/A)	0.9	0.7	23.96
Norway maple	8.6	652	1,219.8	1,195	1,848	(N/A)	0.9	1.0	36.96
Callery pear	4.2	322	607.9	596	918	(N/A)	0.8	0.5	18.73
White ash	10.7	810	1,291.9	1,266	2,076	(N/A)	0.8	1.1	43.25
White oak	13.2	1,006	1,768.4	1,733	2,739	(N/A)	0.7	1.4	62.24
Northern white cedar	2.1	161	306.1	300	461	(N/A)	0.7	0.2	10.49
Amur maple	3.0	226	451.1	442	668	(N/A)	0.7	0.4	15.90
Ohio buckeye	1.6	123	262.3	257	380	(N/A)	0.7	0.2	9.50
Chinese elm	6.1	466	820.9	804	1,271	(N/A)	0.7	0.7	32.58
Mulberry	4.4	337	688.1	674	1,011	(N/A)	0.7	0.5	25.93
Birch	5.0	378	715.1	701	1,079	(N/A)	0.6	0.6	29.96
Conifer Evergreen Large	2.4	185	319.8	313	499	(N/A)	0.6	0.3	13.85
Boxelder	6.6	505	875.8	858	1,363	(N/A)	0.5	0.7	42.59
American elm	1.7	126	207.9	204	330	(N/A)	0.5	0.2	10.31
Austrian pine	2.7	206	375.8	368	574	(N/A)	0.5	0.3	19.79
Ginkgo	0.8	63	115.8	113	177	(N/A)	0.5	0.1	6.32
Broadleaf Deciduous Large	1.0	76	138.4	136	211	(N/A)	0.5	0.1	7.83
Lilac	0.3	24	53.0	52	76	(N/A)	0.4	0.0	3.04
Catalpa	1.5	115	202.3	198	313	(N/A)	0.4	0.2	12.52
Eastern redbud	0.9	67	152.8	150	217	(N/A)	0.4	0.1	9.42
Black spruce	0.6	49	108.2	106	155	(N/A)	0.4	0.1	7.05
River birch	1.3	101	188.8	185	286	(N/A)	0.4	0.2	13.61
Southern magnolia	0.6	44	85.1	83	127	(N/A)	0.3	0.1	7.07
Spruce	0.4	33	60.9	60	93	(N/A)	0.3	0.0	5.17
Norway spruce	2.2	165	276.5	271	436	(N/A)	0.3	0.2	24.21
Conifer Evergreen Medium	0.7	55	113.9	112	167	(N/A)	0.3	0.1	9.81
Eastern red cedar	1.6	120	234.6	230	350	(N/A)	0.3	0.2	20.56
Northern catalpa	1.8	137	233.2	229	366	(N/A)	0.3	0.2	21.52

Black locust	3.6	275	513.8	504	779 (N/A)	0.3	0.4	48.67
Willow	2.7	206	402.4	394	600 (N/A)	0.2	0.3	60.02
Conifer Evergreen Small	0.0	3	6.7	7	9 (N/A)	0.2	0.0	0.93
Quaking aspen	0.8	57	107.9	106	163 (N/A)	0.2	0.1	18.13
Alder	0.5	41	94.2	92	134 (N/A)	0.2	0.1	14.85
Black maple	2.1	160	272.9	267	427 (N/A)	0.2	0.2	47.44
Red pine	0.5	37	68.1	67	103 (N/A)	0.2	0.1	11.50
Dogwood	0.0	3	8.2	8	11 (N/A)	0.1	0.0	1.43
Yellowwood	0.1	5	11.7	11	17 (N/A)	0.1	0.0	2.09
Japanese tree lilac	0.0	2	5.0	5	7 (N/A)	0.1	0.0	0.87
American chestnut	0.0	3	6.0	6	9 (N/A)	0.1	0.0	1.52
Eastern hophornbeam	0.4	32	67.0	66	98 (N/A)	0.1	0.1	19.62
Black poplar	1.2	89	135.0	132	221 (N/A)	0.1	0.1	44.23
Basswood	0.3	24	45.3	44	68 (N/A)	0.1	0.0	13.68
Plum	0.0	1	3.1	3	4 (N/A)	0.1	0.0	0.87
Broadleaf Evergreen Small	0.1	4	10.1	10	14 (N/A)	0.1	0.0	2.82
Cherry plum	0.1	6	14.7	14	21 (N/A)	0.1	0.0	5.20
Black ash	0.6	44	75.8	74	118 (N/A)	0.1	0.1	39.34
Broadleaf Evergreen Medium	0.0	3	8.5	8	12 (N/A)	0.1	0.0	3.94
Eastern hemlock	0.6	42	73.8	72	115 (N/A)	0.1	0.1	38.17
Pin oak	0.8	59	103.0	101	160 (N/A)	0.1	0.1	53.21
Flowering dogwood	0.1	5	11.4	11	16 (N/A)	0.1	0.0	5.40
Scotch pine	0.3	23	40.1	39	62 (N/A)	0.1	0.0	20.62
Kwanzan cherry	0.0	1	1.2	1	2 (N/A)	0.0	0.0	0.87
Broadleaf Evergreen Large	0.4	29	56.3	55	84 (N/A)	0.0	0.0	42.23
Siberian elm	0.5	38	62.2	61	98 (N/A)	0.0	0.1	98.48
Japanese maple	0.1	6	12.8	13	18 (N/A)	0.0	0.0	18.19
Sweetbay	0.1	4	9.2	9	13 (N/A)	0.0	0.0	13.40
Sweetgum	0.0	0	0.5	0	1 (N/A)	0.0	0.0	0.66
Paper birch	0.1	7	13.7	13	21 (N/A)	0.0	0.0	20.64
Total	902.3	68,486	123,791.7	121,316	189,802 (N/A)	100.0	100.0	32.32

Table 2: Annual Stormwater Benefits

## Marion

## Annual Stormwater Benefits of Public Trees

2/6/2017

Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Maple	1,381,803	37,447	(N/A)	14.4	16.7	44.42
Ash	1,473,790	39,940	(N/A)	13.5	17.8	50.43
Silver maple	1,283,291	34,777	(N/A)	6.7	15.5	88.49
Honeylocust	612,617	16,602	(N/A)	5.4	7.4	52.70
Apple	47,381	1,284	(N/A)	4.3	0.6	5.14
Broadleaf Deciduous Small	14,964	406	(N/A)	3.1	0.2	2.25
Northern red oak	173,924	4,713	(N/A)	3.0	2.1	26.78
Red maple	150,620	4,082	(N/A)	2.7	1.8	25.51
Swamp white oak	48,023	1,301	(N/A)	2.5	0.6	8.91
Northern hackberry	151,826	4,114	(N/A)	2.4	1.8	29.18
Blue spruce	111,590	3,024	(N/A)	2.2	1.3	23.26
Green ash	268,895	7,287	(N/A)	1.9	3.2	64.49
Elm	37,723	1,022	(N/A)	1.8	0.5	9.55
Kentucky coffeetree	35,078	951	(N/A)	1.6	0.4	9.90
Littleleaf linden	76,908	2,084	(N/A)	1.6	0.9	21.71
Cottonwood	260,327	7,055	(N/A)	1.5	3.1	78.39
Pear	9,704	263	(N/A)	1.4	0.1	3.29
American basswood	125,206	3,393	(N/A)	1.2	1.5	47.13
American sycamore	126,249	3,421	(N/A)	1.2	1.5	47.52
Tulip tree	15,777	428	(N/A)	1.2	0.2	6.02
Northern pin oak	194,309	5,266	(N/A)	1.2	2.3	74.17
Black walnut	207,370	5,620	(N/A)	1.2	2.5	80.28
Sugar maple	113,637	3,080	(N/A)	1.2	1.4	44.63
Eastern white pine	117,996	3,198	(N/A)	1.2	1.4	47.02
Bur oak	131,995	3,577	(N/A)	1.1	1.6	57.69
Oak	50,739	1,375	(N/A)	1.0	0.6	24.12
Hickory	63,751	1,728	(N/A)	0.9	0.8	31.99
Broadleaf Deciduous Medium	17,933	486	(N/A)	0.9	0.2	9.17
Black cherry	23,467	636	(N/A)	0.9	0.3	12.23
Norway maple	65,059	1,763	(N/A)	0.9	0.8	35.26
Callery pear	23,977	650	(N/A)	0.8	0.3	13.26
White ash	95,816	2,597	(N/A)	0.8	1.2	54.10
White oak	184,604	5,003	(N/A)	0.7	2.2	113.70
Northern white cedar	24,953	676	(N/A)	0.7	0.3	15.37
Amur maple	10,590	287	(N/A)	0.7	0.1	6.83
Ohio buckeye	8,304	225	(N/A)	0.7	0.1	5.63
Chinese elm	49,602	1,344	(N/A)	0.7	0.6	34.47
Mulberry	19,572	530	(N/A)	0.7	0.2	13.60
Birch	32,511	881	(N/A)	0.6	0.4	24.47
Conifer Evergreen Large	37,028	1,003	(N/A)	0.6	0.4	27.87
Boxelder	63,132	1,711	(N/A)	0.5	0.8	53.46
American elm	10,212	277	(N/A)	0.5	0.1	8.65
Austrian pine	37,245	1,009	(N/A)	0.5	0.4	34.80
Ginkgo	4,407	119	(N/A)	0.5	0.1	4.27
Broadleaf Deciduous Large	6,368	173	(N/A)	0.5	0.1	6.39
Lilac	1,475	40	(N/A)	0.4	0.0	1.60
Catalpa	11,334	307	(N/A)	0.4	0.1	12.29
Eastern redbud	3,036	82	(N/A)	0.4	0.0	3.58
Black spruce	6,266	170	(N/A)	0.4	0.1	7.72

River birch	7,099	192 (N/A)	0.4	0.1	9.16
Southern magnolia	3,452	94 (N/A)	0.3	0.0	5.20
Spruce	5,115	139 (N/A)	0.3	0.1	7.70
Norway spruce	40,269	1,091 (N/A)	0.3	0.5	60.63
Conifer Evergreen Medium	7,987	216 (N/A)	0.3	0.1	12.73
Eastern red cedar	22,934	622 (N/A)	0.3	0.3	36.56
Northern catalpa	13,277	360 (N/A)	0.3	0.2	21.17
Black locust	32,630	884 (N/A)	0.3	0.4	55.27
Willow	30,863	836 (N/A)	0.2	0.4	83.64
Conifer Evergreen Small	245	7 (N/A)	0.2	0.0	0.66
Quaking aspen	7,556	205 (N/A)	0.2	0.1	22.75
Alder	1,928	52 (N/A)	0.2	0.0	5.80
Black maple	16,267	441 (N/A)	0.2	0.2	48.98
Red pine	5,332	144 (N/A)	0.2	0.1	16.06
Dogwood	121	3 (N/A)	0.1	0.0	0.41
Yellowwood	248	7 (N/A)	0.1	0.0	0.84
Japanese tree lilac	60	2 (N/A)	0.1	0.0	0.20
American chestnut	261	7 (N/A)	0.1	0.0	1.18
Eastern hophornbeam	1,529	41 (N/A)	0.1	0.0	8.29
Black poplar	7,328	199 (N/A)	0.1	0.1	39.72
Basswood	2,013	55 (N/A)	0.1	0.0	10.91
Plum	37	1 (N/A)	0.1	0.0	0.20
Broadleaf Evergreen Small	172	5 (N/A)	0.1	0.0	0.93
Cherry plum	287	8 (N/A)	0.1	0.0	1.94
Black ash	3,404	92 (N/A)	0.1	0.0	30.75
Broadleaf Evergreen Medium	169	5 (N/A)	0.1	0.0	1.53
Eastern hemlock	13,814	374 (N/A)	0.1	0.2	124.79
Pin oak	10,015	271 (N/A)	0.1	0.1	90.47
Flowering dogwood	206	6 (N/A)	0.1	0.0	1.86
Scotch pine	5,987	162 (N/A)	0.1	0.1	54.08
Kwanzan cherry	15	0 (N/A)	0.0	0.0	0.20
Broadleaf Evergreen Large	5,727	155 (N/A)	0.0	0.1	77.61
Siberian elm	7,351	199 (N/A)	0.0	0.1	199.22
Japanese maple	264	7 (N/A)	0.0	0.0	7.17
Sweetbay	289	8 (N/A)	0.0	0.0	7.83
Sweetgum	18	0 (N/A)	0.0	0.0	0.48
Paper birch	608	16 (N/A)	0.0	0.0	16.47
Citywide total	8,277,265	224,314 (N/A)	100.0	100.0	38.19

**Table 3: Annual Air Quality Benefits**

Marion

**Annual Air Quality Benefits of Public Trees**

2/6/2017

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 <sub>3</sub>	NO <sub>2</sub>	PM <sub>10</sub>	SO <sub>2</sub>		NO <sub>2</sub>	PM <sub>10</sub>	VOC	SO <sub>2</sub>								
Maple	326.1	55.6	152.8	14.4	1,738	789.1	115.3	110.0	753.9	4,929	-110.1	-413	2,207.1	6,254 (N/A)		14.4	7.42
Ash	284.6	49.1	142.2	12.6	1,544	837.9	121.4	115.6	787.0	5,198	-68.2	-256	2,282.1	6,486 (N/A)		13.5	8.19
Silver maple	196.5	33.3	99.9	8.7	1,069	501.2	73.3	70.0	480.3	3,134	-109.9	-412	1,353.3	3,791 (N/A)		6.7	9.65
Honeylocust	113.2	18.7	52.9	5.1	601	325.5	47.7	45.5	312.4	2,037	-83.1	-312	837.8	2,326 (N/A)		5.4	7.38
Apple	10.9	1.8	5.6	0.5	59	63.0	9.0	8.5	57.5	387	-0.1	0	156.8	446 (N/A)		4.3	1.78
Broadleaf Deciduous Small	2.6	0.4	1.5	0.1	15	21.7	3.1	2.9	19.4	132	0.0	0	51.8	147 (N/A)		3.1	0.82
Northern red oak	34.8	6.0	17.3	1.5	188	93.8	13.6	13.0	88.9	584	-49.6	-186	219.3	586 (N/A)		3.0	3.33
Red maple	30.6	5.2	14.9	1.4	165	102.9	15.1	14.4	98.7	644	-11.0	-41	272.2	768 (N/A)		2.7	4.80
Swamp white oak	5.8	1.0	3.5	0.3	33	42.0	6.1	5.8	39.3	260	-1.7	-6	102.0	287 (N/A)		2.5	1.97
Northern hackberry	21.9	3.8	11.7	1.0	121	92.5	13.4	12.8	86.9	574	0.0	0	243.9	695 (N/A)		2.4	4.93
Blue spruce	12.7	2.5	11.3	1.6	86	43.4	6.3	6.0	41.0	270	-38.1	-143	86.6	213 (N/A)		2.2	1.64
Green ash	29.3	4.7	14.7	1.3	158	132.6	19.3	18.4	126.3	827	0.0	0	346.8	985 (N/A)		1.9	8.72
Elm	4.0	0.6	2.1	0.2	22	20.5	3.0	2.8	19.5	128	0.0	0	52.7	149 (N/A)		1.8	1.40
Kentucky coffeetree	2.0	0.3	1.4	0.1	12	26.1	3.8	3.7	25.2	164	0.0	0	62.6	175 (N/A)		1.6	1.83
Littleleaf linden	9.3	1.6	5.2	0.4	52	55.3	8.1	7.7	52.7	345	-5.2	-19	135.0	377 (N/A)		1.6	3.93
Cottonwood	34.6	5.5	16.3	1.5	184	110.1	16.0	15.3	104.6	686	0.0	0	304.0	870 (N/A)		1.5	9.66
Pear	2.0	0.3	1.1	0.1	11	13.9	2.0	1.9	12.7	85	0.0	0	34.0	97 (N/A)		1.4	1.21
American basswood	17.1	2.9	8.4	0.8	92	55.4	8.0	7.6	52.0	344	-14.5	-54	137.6	381 (N/A)		1.2	5.29
American sycamore	18.7	3.0	8.7	0.8	99	52.5	7.7	7.3	50.4	329	0.0	0	149.1	427 (N/A)		1.2	5.94
Tulip tree	0.9	0.1	0.6	0.0	5	11.2	1.6	1.6	10.7	70	0.0	0	26.7	75 (N/A)		1.2	1.06
Northern pin oak	41.5	7.2	20.1	1.8	223	93.6	13.5	12.9	87.5	580	-9.6	-36	268.6	767 (N/A)		1.2	10.80
Black walnut	24.7	3.9	11.9	1.1	132	91.7	13.3	12.7	86.8	570	0.0	0	246.2	702 (N/A)		1.2	10.03
Sugar maple	13.8	2.3	7.2	0.6	76	58.8	8.6	8.2	56.6	368	-11.1	-42	145.0	402 (N/A)		1.2	5.83
Eastern white pine	13.4	2.6	11.2	1.6	89	34.5	5.1	4.9	33.4	217	-54.9	-206	51.8	100 (N/A)		1.2	1.46
Bur oak	19.3	3.1	8.9	0.9	102	52.3	7.6	7.3	49.6	326	0.0	0	148.9	427 (N/A)		1.1	6.89
Oak	6.6	1.1	3.2	0.3	35	22.7	3.3	3.2	21.7	142	0.0	0	62.0	177 (N/A)		1.0	3.10
Hickory	6.2	1.0	3.3	0.3	34	34.0	5.0	4.7	32.3	212	0.0	0	86.8	246 (N/A)		0.9	4.56
Broadleaf Deciduous Medium	2.2	0.4	1.3	0.1	12	15.1	2.2	2.1	13.9	93	-0.6	-2	36.5	103 (N/A)		0.9	1.94
Black cherry	6.8	1.1	3.3	0.3	36	26.8	3.8	3.6	24.5	164	0.0	0	70.2	201 (N/A)		0.9	3.86
Norway maple	11.5	2.0	5.9	0.5	63	41.5	6.0	5.7	39.0	258	-2.9	-11	109.3	310 (N/A)		0.9	6.19
Callery pear	3.0	0.5	1.8	0.1	17	20.5	3.0	2.8	19.2	127	-0.9	-3	50.1	141 (N/A)		0.8	2.88
White ash	13.1	2.1	6.4	0.6	70	49.4	7.3	7.0	48.3	311	0.0	0	134.2	382 (N/A)		0.8	7.95
White oak	33.2	5.3	14.7	1.5	173	62.9	9.2	8.8	60.0	393	0.0	0	195.5	566 (N/A)		0.7	12.86
Northern white cedar	2.3	0.5	2.2	0.3	16	10.3	1.5	1.4	9.6	64	-8.3	-31	19.7	49 (N/A)		0.7	1.10
Amur maple	2.6	0.4	1.3	0.1	14	14.6	2.1	2.0	13.5	90	0.0	0	36.6	104 (N/A)		0.7	2.47

Ohio buckeye	0.7	0.1	0.5	0.0	4	8.1	1.2	1.1	7.4	50	-0.3	-1	18.8	53 (N/A)	0.7	1.32
Chinese elm	4.4	0.7	2.4	0.2	24	29.1	4.3	4.1	27.8	182	0.0	0	73.0	206 (N/A)	0.7	5.29
Mulberry	5.9	1.0	2.8	0.3	32	21.9	3.1	3.0	20.1	135	0.0	0	58.1	166 (N/A)	0.7	4.26
Birch	4.8	0.8	2.6	0.2	27	24.1	3.5	3.3	22.6	149	-1.3	-5	60.8	172 (N/A)	0.6	4.77
Conifer Evergreen Large	4.1	0.8	3.5	0.5	27	11.5	1.7	1.6	11.1	72	-16.2	-61	18.4	38 (N/A)	0.6	1.06
Boxelder	7.7	1.2	3.7	0.3	41	31.4	4.6	4.4	30.1	196	-3.3	-12	80.2	225 (N/A)	0.5	7.04
American elm	0.5	0.1	0.4	0.0	3	7.7	1.1	1.1	7.5	49	0.0	0	18.5	52 (N/A)	0.5	1.62
Austrian pine	5.0	1.0	4.2	0.6	33	12.9	1.9	1.8	12.3	81	-13.4	-50	26.4	64 (N/A)	0.5	2.20
Ginkgo	0.8	0.1	0.4	0.0	5	4.0	0.6	0.6	3.8	25	-0.3	-1	10.1	28 (N/A)	0.5	1.01
Broadleaf Deciduous Large	0.3	0.0	0.2	0.0	2	4.8	0.7	0.7	4.5	30	0.0	0	11.2	32 (N/A)	0.5	1.17
Lilac	0.4	0.1	0.2	0.0	2	1.6	0.2	0.2	1.4	10	0.0	0	4.2	12 (N/A)	0.4	0.48
Catalpa	0.8	0.1	0.5	0.0	5	7.2	1.0	1.0	6.8	45	0.0	0	17.6	50 (N/A)	0.4	1.98
Eastern redbud	0.4	0.1	0.3	0.0	3	4.5	0.6	0.6	4.0	27	0.0	0	10.5	30 (N/A)	0.4	1.30
Black spruce	0.4	0.1	0.5	0.1	3	3.3	0.5	0.4	2.9	20	-1.7	-6	6.4	17 (N/A)	0.4	0.76
River birch	0.8	0.1	0.5	0.0	5	6.4	0.9	0.9	6.0	40	-0.3	-1	15.5	44 (N/A)	0.4	2.08
Southern magnolia	0.1	0.0	0.3	0.0	1	2.8	0.4	0.4	2.6	17	-0.8	-3	5.9	16 (N/A)	0.3	0.88
Spruce	0.4	0.1	0.4	0.1	3	2.1	0.3	0.3	2.0	13	-1.7	-6	4.0	10 (N/A)	0.3	0.54
Norway spruce	4.7	0.9	3.8	0.6	31	10.2	1.5	1.4	9.8	64	-20.5	-77	12.5	18 (N/A)	0.3	1.00
Conifer Evergreen Medium	0.7	0.1	0.7	0.1	5	3.6	0.5	0.5	3.3	22	-2.5	-9	7.1	18 (N/A)	0.3	1.05
Eastern red cedar	4.6	0.9	3.7	0.6	30	7.7	1.1	1.1	7.1	47	-12.6	-47	14.1	30 (N/A)	0.3	1.77
Northern catalpa	1.1	0.2	0.6	0.0	6	8.5	1.2	1.2	8.2	53	0.0	0	21.0	59 (N/A)	0.3	3.49
Black locust	6.6	1.1	3.2	0.3	36	17.5	2.5	2.4	16.4	109	-1.5	-6	48.6	138 (N/A)	0.3	8.64
Willow	7.0	1.2	3.3	0.3	37	13.2	1.9	1.8	12.3	82	-1.6	-6	39.5	113 (N/A)	0.2	11.33
Conifer Evergreen Small	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	-0.1	0	0.3	1 (N/A)	0.2	0.09
Quaking aspen	0.8	0.1	0.4	0.0	4	3.6	0.5	0.5	3.4	23	0.0	0	9.5	27 (N/A)	0.2	2.99
Alder	0.3	0.1	0.2	0.0	2	2.8	0.4	0.4	2.5	17	0.0	0	6.6	19 (N/A)	0.2	2.07
Black maple	3.7	0.6	1.7	0.2	20	9.9	1.5	1.4	9.5	62	-1.3	-5	27.2	77 (N/A)	0.2	8.55
Red pine	0.5	0.1	0.5	0.1	3	2.3	0.3	0.3	2.2	14	-1.7	-6	4.6	11 (N/A)	0.2	1.26
Dogwood	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	1 (N/A)	0.1	0.18
Yellowwood	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2 (N/A)	0.1	0.27
Japanese tree lilac	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	0.11
American chestnut	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	1 (N/A)	0.1	0.21
Eastern hophornbeam	0.3	0.1	0.2	0.0	2	2.1	0.3	0.3	1.9	13	0.0	0	5.2	15 (N/A)	0.1	2.98
Black poplar	0.5	0.1	0.3	0.0	3	5.4	0.8	0.8	5.3	34	0.0	0	13.2	37 (N/A)	0.1	7.42
Basswood	0.1	0.0	0.1	0.0	0	1.5	0.2	0.2	1.4	9	0.0	0	3.5	10 (N/A)	0.1	1.99
Plum	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.2	1 (N/A)	0.1	0.11
Broadleaf Evergreen Small	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.6	2 (N/A)	0.1	0.37
Cherry plum	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3 (N/A)	0.1	0.72
Black ash	0.5	0.1	0.3	0.0	3	2.7	0.4	0.4	2.6	17	-0.1	-1	6.9	19 (N/A)	0.1	6.43
Broadleaf Evergreen Medium	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	1 (N/A)	0.1	0.47
Eastern hemlock	1.7	0.3	1.3	0.2	11	2.6	0.4	0.4	2.5	16	-8.6	-32	0.9	-5 (N/A)	0.1	-1.58
Pin oak	1.9	0.3	1.0	0.1	10	3.7	0.5	0.5	3.5	23	-3.5	-13	8.0	20 (N/A)	0.1	6.72
Flowering dogwood	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2 (N/A)	0.1	0.71
Scotch pine	0.7	0.1	0.6	0.1	5	1.4	0.2	0.2	1.3	9	-2.8	-10	1.9	3 (N/A)	0.1	0.98
Kwanzan cherry	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)	0.0	0.11
Broadleaf Evergreen Large	0.7	0.1	0.6	0.1	5	1.9	0.3	0.3	1.7	12	-2.5	-9	3.1	7 (N/A)	0.0	3.37
Siberian elm	1.7	0.3	0.8	0.1	9	2.3	0.3	0.3	2.2	15	0.0	0	8.0	23 (N/A)	0.0	23.37
Japanese maple	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
Sweetbay	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.7	2 (N/A)	0.0	2.06
Sweetgum	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	0.0	0.08
Paper birch	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)	0.0	2.99
Citywide total	1,433.5	243.5	722.0	67.9	7,792	4,309.1	627.3	598.1	4,089.3	26,841	-678.5	-2,544	11,412.2	32,088 (N/A)	100.0	5.46



Table 4: Annual Carbon Stored

## Marion

## Stored CO2 Benefits of Public Trees

2/6/2017

Species	Total Stored CO2 (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Maple	3,553,309	26,650	(N/A)	14.4	13.6	31.61
Ash	4,711,636	35,337	(N/A)	13.5	18.1	44.62
Silver maple	4,415,848	33,119	(N/A)	6.7	16.9	84.27
Honeylocust	1,433,243	10,749	(N/A)	5.4	5.5	34.12
Apple	191,031	1,433	(N/A)	4.3	0.7	5.73
Broadleaf Deciduous	52,291	392	(N/A)	3.1	0.2	2.18
Northern red oak	727,791	5,458	(N/A)	3.0	2.8	31.01
Red maple	349,640	2,622	(N/A)	2.7	1.3	16.39
Swamp white oak	105,425	791	(N/A)	2.5	0.4	5.42
Northern hackberry	332,296	2,492	(N/A)	2.4	1.3	17.68
Blue spruce	72,577	544	(N/A)	2.2	0.3	4.19
Green ash	951,077	7,133	(N/A)	1.9	3.6	63.12
Elm	138,707	1,040	(N/A)	1.8	0.5	9.72
Kentucky coffeetree	72,639	545	(N/A)	1.6	0.3	5.67
Littleleaf linden	216,866	1,626	(N/A)	1.6	0.8	16.94
Cottonwood	1,152,414	8,643	(N/A)	1.5	4.4	96.03
Pear	36,337	273	(N/A)	1.4	0.1	3.41
American basswood	635,442	4,766	(N/A)	1.2	2.4	66.19
American sycamore	636,762	4,776	(N/A)	1.2	2.4	66.33
Tulip tree	32,418	243	(N/A)	1.2	0.1	3.42
Northern pin oak	682,242	5,117	(N/A)	1.2	2.6	72.07
Black walnut	795,967	5,970	(N/A)	1.2	3.0	85.28
Sugar maple	401,751	3,013	(N/A)	1.2	1.5	43.67
Eastern white pine	131,045	983	(N/A)	1.2	0.5	14.45
Bur oak	652,303	4,892	(N/A)	1.1	2.5	78.91
Oak	223,449	1,676	(N/A)	1.0	0.9	29.40
Hickory	210,211	1,577	(N/A)	0.9	0.8	29.20
Broadleaf Deciduous	39,555	297	(N/A)	0.9	0.2	5.60
Black cherry	110,589	829	(N/A)	0.9	0.4	15.95
Norway maple	192,188	1,441	(N/A)	0.9	0.7	28.83
Callery pear	53,127	398	(N/A)	0.8	0.2	8.13
White ash	251,705	1,888	(N/A)	0.8	1.0	39.33
White oak	1,144,188	8,581	(N/A)	0.7	4.4	195.03
Northern white cedar	15,575	117	(N/A)	0.7	0.1	2.65
Amur maple	42,513	319	(N/A)	0.7	0.2	7.59
Ohio buckeye	14,612	110	(N/A)	0.7	0.1	2.74
Chinese elm	149,209	1,119	(N/A)	0.7	0.6	28.69
Mulberry	94,576	709	(N/A)	0.7	0.4	18.19
Birch	82,732	620	(N/A)	0.6	0.3	17.24
Conifer Evergreen La	37,411	281	(N/A)	0.6	0.1	7.79
Boxelder	231,340	1,735	(N/A)	0.5	0.9	54.22
American elm	22,026	165	(N/A)	0.5	0.1	5.16
Austrian pine	35,027	263	(N/A)	0.5	0.1	9.06
Ginkgo	11,861	89	(N/A)	0.5	0.0	3.18
Broadleaf Deciduous	11,491	86	(N/A)	0.5	0.0	3.19
Lilac	7,402	56	(N/A)	0.4	0.0	2.22
Catalpa	28,795	216	(N/A)	0.4	0.1	8.64
Eastern redbud	9,840	74	(N/A)	0.4	0.0	3.21
Black spruce	1,505	11	(N/A)	0.4	0.0	0.51
River birch	15,360	115	(N/A)	0.4	0.1	5.49
Southern magnolia	2,453	18	(N/A)	0.3	0.0	1.02
Spruce	2,924	22	(N/A)	0.3	0.0	1.22
Norway spruce	50,618	380	(N/A)	0.3	0.2	21.09
Conifer Evergreen M	3,130	23	(N/A)	0.3	0.0	1.38
Eastern red cedar	14,967	112	(N/A)	0.3	0.1	6.60



Northern catalpa	36,064	270 (N/A)	0.3	0.1	15.91
Black locust	108,157	811 (N/A)	0.3	0.4	50.70
Willow	115,560	867 (N/A)	0.2	0.4	86.67
Conifer Evergreen Sn	25	0 (N/A)	0.2	0.0	0.02
Quaking aspen	25,685	193 (N/A)	0.2	0.1	21.40
Alder	6,547	49 (N/A)	0.2	0.0	5.46
Black maple	40,534	304 (N/A)	0.2	0.2	33.78
Red pine	3,045	23 (N/A)	0.2	0.0	2.54
Dogwood	274	2 (N/A)	0.1	0.0	0.26
Yellowwood	336	3 (N/A)	0.1	0.0	0.32
Japanese tree lilac	110	1 (N/A)	0.1	0.0	0.10
American chestnut	246	2 (N/A)	0.1	0.0	0.31
Eastern hophornbeam	5,939	45 (N/A)	0.1	0.0	8.91
Black poplar	18,359	138 (N/A)	0.1	0.1	27.54
Basswood	3,301	25 (N/A)	0.1	0.0	4.95
Plum	69	1 (N/A)	0.1	0.0	0.10
Broadleaf Evergreen l	233	2 (N/A)	0.1	0.0	0.35
Cherry plum	949	7 (N/A)	0.1	0.0	1.78
Black ash	8,349	63 (N/A)	0.1	0.0	20.87
Broadleaf Evergreen l	9	0 (N/A)	0.1	0.0	0.02
Eastern hemlock	22,471	169 (N/A)	0.1	0.1	56.18
Pin oak	52,867	397 (N/A)	0.1	0.2	132.17
Flowering dogwood	533	4 (N/A)	0.1	0.0	1.33
Scotch pine	6,688	50 (N/A)	0.1	0.0	16.72
Kwanzan cherry	28	0 (N/A)	0.0	0.0	0.10
Broadleaf Evergreen l	9,243	69 (N/A)	0.0	0.0	34.66
Siberian elm	41,265	309 (N/A)	0.0	0.2	309.48
Japanese maple	908	7 (N/A)	0.0	0.0	6.81
Sweetbay	908	7 (N/A)	0.0	0.0	6.81
Sweetgum	12	0 (N/A)	0.0	0.0	0.09
Paper birch	1,035	8 (N/A)	0.0	0.0	7.76
Citywide total	26,101,185	195,759 (N/A)	100.0	100.0	33.33

**Table 5: Annual Carbon Sequestered**

Marion

**Annual CO<sub>2</sub> Benefits of Public Trees**

2/6/2017

Species	Sequestered (lb)	Sequestered (\$)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released (\$)	Avoided (lb)	Avoided (\$)	Net Total (lb)	Total Standard (\$)	% of Total Trees	% of Total \$	Avg. \$/tree
Maple	227,388	1,705	-17,060	-1,538	-139	279,170	2,094	487,960	3,660 (N/A)	14.4	15.7	4.34
Ash	261,351	1,960	-22,647	-1,758	-183	290,931	2,182	527,876	3,959 (N/A)	13.5	16.9	5.00
Silver maple	380,075	2,851	-21,207	-1,103	-167	177,991	1,335	535,757	4,018 (N/A)	6.7	17.2	10.22
Honeylocust	151,895	1,139	-6,906	-554	-56	115,734	868	260,169	1,951 (N/A)	5.4	8.3	6.19
Apple	20,984	157	-919	-210	-8	21,288	160	41,144	309 (N/A)	4.3	1.3	1.23
Broadleaf Deciduous Small	7,256	54	-256	-89	-3	7,199	54	14,111	106 (N/A)	3.1	0.5	0.59
Northern red oak	23,824	179	-3,496	-253	-28	32,900	247	52,975	397 (N/A)	3.0	1.7	2.26
Red maple	43,404	326	-1,680	-203	-14	36,553	274	78,074	586 (N/A)	2.7	2.5	3.66
Swamp white oak	16,399	123	-525	-99	-5	14,520	109	30,296	227 (N/A)	2.5	1.0	1.56
Northern hackberry	20,007	150	-1,602	-187	-13	32,133	241	50,351	378 (N/A)	2.4	1.6	2.68
Blue spruce	6,294	47	-349	-158	-4	15,186	114	20,974	157 (N/A)	2.2	0.7	1.21
Green ash	65,158	489	-4,565	-281	-36	46,745	351	107,057	803 (N/A)	1.9	3.4	7.11
Elm	9,225	69	-668	-64	-5	7,219	54	15,712	118 (N/A)	1.8	0.5	1.10
Kentucky coffeetree	11,337	85	-351	-67	-3	9,333	70	20,252	152 (N/A)	1.6	0.6	1.58
Littleleaf linden	31,923	239	-1,048	-137	-9	19,453	146	50,191	376 (N/A)	1.6	1.6	3.92
Cottonwood	51,409	386	-5,532	-247	-43	38,731	290	84,361	633 (N/A)	1.5	2.7	7.03
Pear	4,429	33	-176	-48	-2	4,700	35	8,904	67 (N/A)	1.4	0.3	0.83
American basswood	36,847	276	-3,051	-139	-24	19,213	144	52,870	397 (N/A)	1.2	1.7	5.51
American sycamore	21,985	165	-3,057	-125	-24	18,652	140	37,454	281 (N/A)	1.2	1.2	3.90
Tulip tree	5,019	38	-157	-36	-1	3,945	30	8,771	66 (N/A)	1.2	0.3	0.93
Northern pin oak	26,233	197	-3,276	-202	-26	32,359	243	55,114	413 (N/A)	1.2	1.8	5.82
Black walnut	46,755	351	-3,821	-199	-30	32,134	241	74,869	562 (N/A)	1.2	2.4	8.02
Sugar maple	24,108	181	-1,934	-129	-15	20,954	157	43,000	322 (N/A)	1.2	1.4	4.67
Eastern white pine	7,612	57	-629	-129	-6	12,382	93	19,236	144 (N/A)	1.2	0.6	2.12
Bur oak	22,896	172	-3,132	-125	-24	18,373	138	38,013	285 (N/A)	1.1	1.2	4.60
Oak	10,075	76	-1,074	-58	-8	8,039	60	16,982	127 (N/A)	1.0	0.5	2.23
Hickory	16,310	122	-1,009	-81	-8	11,964	90	27,185	204 (N/A)	0.9	0.9	3.78
Broadleaf Deciduous Medium	6,007	45	-193	-36	-2	5,128	38	10,906	82 (N/A)	0.9	0.3	1.54
Black cherry	7,853	59	-531	-79	-5	9,067	68	16,311	122 (N/A)	0.9	0.5	2.35
Norway maple	14,536	109	-926	-85	-8	14,416	108	27,941	210 (N/A)	0.9	0.9	4.19
Callery pear	8,037	60	-261	-45	-2	7,111	53	14,843	111 (N/A)	0.8	0.5	2.27
White ash	18,185	136	-1,209	-96	-10	17,898	134	34,778	261 (N/A)	0.8	1.1	5.43

White oak	22,404	168	-5,492	-153	-42	22,224	167	38,982	292 (N/A)	0.7	1.3	6.64
Northern white cedar	1,970	15	-75	-41	-1	3,566	27	5,420	41 (N/A)	0.7	0.2	0.92
Amur maple	4,507	34	-205	-42	-2	4,992	37	9,253	69 (N/A)	0.7	0.3	1.65
Ohio buckeye	3,523	26	-78	-22	-1	2,716	20	6,138	46 (N/A)	0.7	0.2	1.15
Chinese elm	13,505	101	-716	-65	-6	10,302	77	23,026	173 (N/A)	0.7	0.7	4.43
Mulberry	6,668	50	-454	-63	-4	7,448	56	13,599	102 (N/A)	0.7	0.4	2.62
Birch	9,245	69	-399	-50	-3	8,351	63	17,147	129 (N/A)	0.6	0.6	3.57
Conifer Evergreen Large	2,550	19	-180	-44	-2	4,093	31	6,419	48 (N/A)	0.6	0.2	1.34
Boxelder	19,816	149	-1,110	-78	-9	11,151	84	29,778	223 (N/A)	0.5	1.0	6.98
American elm	2,403	18	-118	-26	-1	2,791	21	5,050	38 (N/A)	0.5	0.2	1.18
Austrian pine	2,201	17	-168	-49	-2	4,546	34	6,530	49 (N/A)	0.5	0.2	1.69
Ginkgo	834	6	-57	-16	-1	1,401	11	2,162	16 (N/A)	0.5	0.1	0.58
Broadleaf Deciduous Large	2,099	16	-56	-15	-1	1,676	13	3,705	28 (N/A)	0.5	0.1	1.03
Lilac	745	6	-36	-8	0	533	4	1,233	9 (N/A)	0.4	0.0	0.37
Catalpa	3,384	25	-139	-19	-1	2,534	19	5,760	43 (N/A)	0.4	0.2	1.73
Eastern redbud	1,410	11	-47	-17	0	1,480	11	2,826	21 (N/A)	0.4	0.1	0.92
Black spruce	304	2	-7	-13	0	1,086	8	1,369	10 (N/A)	0.4	0.0	0.47
River birch	2,594	19	-81	-15	-1	2,225	17	4,723	35 (N/A)	0.4	0.2	1.69
Southern magnolia	237	2	-12	-7	0	971	7	1,189	9 (N/A)	0.3	0.0	0.50
Spruce	400	3	-14	-9	0	739	6	1,115	8 (N/A)	0.3	0.0	0.46
Norway spruce	2,530	19	-243	-38	-2	3,641	27	5,890	44 (N/A)	0.3	0.2	2.45
Conifer Evergreen Medium	412	3	-15	-14	0	1,220	9	1,603	12 (N/A)	0.3	0.1	0.71
Eastern red cedar	406	3	-72	-29	-1	2,646	20	2,951	22 (N/A)	0.3	0.1	1.30
Northern catalpa	3,844	29	-173	-19	-1	3,037	23	6,688	50 (N/A)	0.3	0.2	2.95
Black locust	5,154	39	-519	-37	-4	6,080	46	10,678	80 (N/A)	0.3	0.3	5.01
Willow	690	5	-555	-35	-4	4,549	34	4,648	35 (N/A)	0.2	0.1	3.49
Conifer Evergreen Small	6	0	0	-2	0	61	0	65	0 (N/A)	0.2	0.0	0.05
Quaking aspen	1,884	14	-123	-9	-1	1,267	10	3,019	23 (N/A)	0.2	0.1	2.52
Alder	844	6	-31	-9	0	912	7	1,715	13 (N/A)	0.2	0.1	1.43
Black maple	4,110	31	-195	-18	-2	3,525	26	7,423	56 (N/A)	0.2	0.2	6.19
Red pine	426	3	-15	-9	0	811	6	1,213	9 (N/A)	0.2	0.0	1.01
Dogwood	99	1	-2	-2	0	76	1	172	1 (N/A)	0.1	0.0	0.16
Yellowwood	134	1	-3	-2	0	115	1	244	2 (N/A)	0.1	0.0	0.23
Japanese tree lilac	69	1	-1	-2	0	45	0	112	1 (N/A)	0.1	0.0	0.10
American chestnut	87	1	-1	-2	0	71	1	155	1 (N/A)	0.1	0.0	0.19
Eastern hophornbeam	647	5	-29	-6	0	718	5	1,331	10 (N/A)	0.1	0.0	2.00
Black poplar	2,227	17	-88	-10	-1	1,964	15	4,093	31 (N/A)	0.1	0.1	6.14
Basswood	703	5	-16	-4	0	529	4	1,212	9 (N/A)	0.1	0.0	1.82
Plum	43	0	-1	-1	0	28	0	70	1 (N/A)	0.1	0.0	0.10
Broadleaf Evergreen Small	45	0	-1	-1	0	93	1	135	1 (N/A)	0.1	0.0	0.20
Cherry plum	140	1	-5	-2	0	141	1	274	2 (N/A)	0.1	0.0	0.51
Black ash	996	7	-40	-5	0	966	7	1,917	14 (N/A)	0.1	0.1	4.79
Broadleaf Evergreen Medium	4	0	0	-1	0	77	1	80	1 (N/A)	0.1	0.0	0.20
Eastern hemlock	768	6	-108	-11	-1	933	7	1,583	12 (N/A)	0.1	0.1	3.96
Pin oak	4,414	33	-254	-9	-2	1,297	10	5,448	41 (N/A)	0.1	0.2	13.62
Flowering dogwood	114	1	-3	-2	0	112	1	221	2 (N/A)	0.1	0.0	0.55
Scotch pine	378	3	-32	-6	0	499	4	839	6 (N/A)	0.1	0.0	2.10
Kwanzan cherry	17	0	0	0	0	11	0	28	0 (N/A)	0.0	0.0	0.10
Broadleaf Evergreen Large	851	6	-44	-4	0	647	5	1,450	11 (N/A)	0.0	0.0	5.44
Siberian elm	983	7	-198	-6	-2	829	6	1,608	12 (N/A)	0.0	0.1	12.06
Japanese maple	114	1	-4	-1	0	124	1	232	2 (N/A)	0.0	0.0	1.74
Sweetbay	81	1	-4	-1	0	98	1	174	1 (N/A)	0.0	0.0	1.30
Sweetgum	3	0	0	0	0	4	0	7	0 (N/A)	0.0	0.0	0.05
Paper birch	209	2	-5	-1	0	159	1	361	3 (N/A)	0.0	0.0	2.71
Citywide total	1,739,049	13,043	-125,473	-9,609	-1,013	1,513,530	11,351	3,117,497	23,381 (N/A)	100.0	100.0	3.98

Table 6: Annual Social and Aesthetic Benefits

Marion

Annual Aesthetic/Other Benefits of Public Trees

2/6/2017

Species	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Maple	30,375	(N/A)	14.4	15.2	36.03
Ash	25,747	(N/A)	13.5	12.9	32.51
Silver maple	32,303	(N/A)	6.7	16.2	82.20
Honeylocust	34,075	(N/A)	5.4	17.1	108.17
Apple	1,173	(N/A)	4.3	0.6	4.69
Broadleaf Deciduous Small	359	(N/A)	3.1	0.2	2.00
Northern red oak	2,040	(N/A)	3.0	1.0	11.59
Red maple	6,026	(N/A)	2.7	3.0	37.67
Swamp white oak	2,006	(N/A)	2.5	1.0	13.74
Northern hackberry	3,448	(N/A)	2.4	1.7	24.45
Blue spruce	2,362	(N/A)	2.2	1.2	18.17
Green ash	5,780	(N/A)	1.9	2.9	51.15
Elm	1,421	(N/A)	1.8	0.7	13.28
Kentucky coffeetree	1,655	(N/A)	1.6	0.8	17.24
Littleleaf linden	3,750	(N/A)	1.6	1.9	39.06
Cottonwood	4,364	(N/A)	1.5	2.2	48.49
Pear	232	(N/A)	1.4	0.1	2.90
American basswood	2,687	(N/A)	1.2	1.3	37.32
American sycamore	2,044	(N/A)	1.2	1.0	28.38
Tulip tree	885	(N/A)	1.2	0.4	12.46
Northern pin oak	2,398	(N/A)	1.2	1.2	33.77
Black walnut	3,874	(N/A)	1.2	1.9	55.35
Sugar maple	2,651	(N/A)	1.2	1.3	38.42
Eastern white pine	1,758	(N/A)	1.2	0.9	25.85
Bur oak	2,022	(N/A)	1.1	1.0	32.61
Oak	1,106	(N/A)	1.0	0.6	19.41
Hickory	1,743	(N/A)	0.9	0.9	32.27
Broadleaf Deciduous Medium	738	(N/A)	0.9	0.4	13.92
Black cherry	453	(N/A)	0.9	0.2	8.71
Norway maple	1,495	(N/A)	0.9	0.7	29.90
Callery pear	932	(N/A)	0.8	0.5	19.02
White ash	2,445	(N/A)	0.8	1.2	50.94
White oak	1,649	(N/A)	0.7	0.8	37.49
Northern white cedar	628	(N/A)	0.7	0.3	14.27
Amur maple	252	(N/A)	0.7	0.1	6.00
Ohio buckeye	469	(N/A)	0.7	0.2	11.73
Chinese elm	1,442	(N/A)	0.7	0.7	36.98
Mulberry	387	(N/A)	0.7	0.2	9.92
Birch	994	(N/A)	0.6	0.5	27.61
Conifer Evergreen Large	680	(N/A)	0.6	0.3	18.89
Boxelder	1,519	(N/A)	0.5	0.8	47.46
American elm	360	(N/A)	0.5	0.2	11.26
Austrian pine	568	(N/A)	0.5	0.3	19.60
Ginkgo	80	(N/A)	0.5	0.0	2.87
Broadleaf Deciduous Large	365	(N/A)	0.5	0.2	13.51
Lilac	34	(N/A)	0.4	0.0	1.35
Catalpa	454	(N/A)	0.4	0.2	18.15
Eastern redbud	76	(N/A)	0.4	0.0	3.32

Black spruce	268 (N/A)	0.4	0.1	12.19
River birch	315 (N/A)	0.4	0.2	15.01
Southern magnolia	67 (N/A)	0.3	0.0	3.70
Spruce	177 (N/A)	0.3	0.1	9.84
Norway spruce	520 (N/A)	0.3	0.3	28.89
Conifer Evergreen Medium	253 (N/A)	0.3	0.1	14.88
Eastern red cedar	165 (N/A)	0.3	0.1	9.72
Northern catalpa	448 (N/A)	0.3	0.2	26.33
Black locust	494 (N/A)	0.3	0.2	30.88
Willow	71 (N/A)	0.2	0.0	7.06
Conifer Evergreen Small	43 (N/A)	0.2	0.0	4.27
Quaking aspen	202 (N/A)	0.2	0.1	22.48
Alder	47 (N/A)	0.2	0.0	5.21
Black maple	541 (N/A)	0.2	0.3	60.15
Red pine	130 (N/A)	0.2	0.1	14.41
Dogwood	2 (N/A)	0.1	0.0	0.29
Yellowwood	32 (N/A)	0.1	0.0	4.00
Japanese tree lilac	0 (N/A)	0.1	0.0	0.03
American chestnut	41 (N/A)	0.1	0.0	6.84
Eastern hophornbeam	37 (N/A)	0.1	0.0	7.35
Black poplar	229 (N/A)	0.1	0.1	45.86
Basswood	106 (N/A)	0.1	0.1	21.13
Plum	0 (N/A)	0.1	0.0	0.03
Broadleaf Evergreen Small	3 (N/A)	0.1	0.0	0.60
Cherry plum	7 (N/A)	0.1	0.0	1.63
Black ash	105 (N/A)	0.1	0.1	34.85
Broadleaf Evergreen Medium	0 (N/A)	0.1	0.0	0.01
Eastern hemlock	79 (N/A)	0.1	0.0	26.25
Pin oak	323 (N/A)	0.1	0.2	107.62
Flowering dogwood	6 (N/A)	0.1	0.0	2.06
Scotch pine	100 (N/A)	0.1	0.1	33.31
Kwanzan cherry	0 (N/A)	0.0	0.0	0.03
Broadleaf Evergreen Large	179 (N/A)	0.0	0.1	89.36
Siberian elm	54 (N/A)	0.0	0.0	54.03
Japanese maple	6 (N/A)	0.0	0.0	6.40
Sweetbay	4 (N/A)	0.0	0.0	4.38
Sweetgum	5 (N/A)	0.0	0.0	5.26
Paper birch	29 (N/A)	0.0	0.0	28.56
Citywide total	199,391 (N/A)	100.0	100.0	33.95

Table 7: Summary of Benefits in Dollars

## Marion

## Total Annual Benefits of Public Trees by Species (\$)

2/6/2017

Species	Energy	CO <sub>2</sub>	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Maple	34,464	3,660	6,254	37,447	30,375	112,200	(N/A)	16.8
Ash	37,334	3,959	6,486	39,940	25,747	113,466	(N/A)	17.0
Silver maple	21,816	4,018	3,791	34,777	32,303	96,706	(N/A)	14.5
Honeylocust	14,123	1,951	2,326	16,602	34,075	69,077	(N/A)	10.3
Apple	2,940	309	446	1,284	1,173	6,152	(N/A)	0.9
Broadleaf Deciduous Sm	1,041	106	147	406	359	2,059	(N/A)	0.3
Northern red oak	4,154	397	586	4,713	2,040	11,892	(N/A)	1.8
Red maple	4,466	586	768	4,082	6,026	15,928	(N/A)	2.4
Swamp white oak	1,881	227	287	1,301	2,006	5,703	(N/A)	0.9
Northern hackberry	4,116	378	695	4,114	3,448	12,751	(N/A)	1.9
Blue spruce	1,933	157	213	3,024	2,362	7,689	(N/A)	1.1
Green ash	5,802	803	985	7,287	5,780	20,658	(N/A)	3.1
Elm	900	118	149	1,022	1,421	3,611	(N/A)	0.5
Kentucky coffeetree	1,121	152	175	951	1,655	4,054	(N/A)	0.6
Littleleaf linden	2,411	376	377	2,084	3,750	8,999	(N/A)	1.3
Cottonwood	4,832	633	870	7,055	4,364	17,754	(N/A)	2.7
Pear	647	67	97	263	232	1,305	(N/A)	0.2
American basswood	2,476	397	381	3,393	2,687	9,333	(N/A)	1.4
American sycamore	2,276	281	427	3,421	2,044	8,449	(N/A)	1.3
Tulip tree	491	66	75	428	885	1,944	(N/A)	0.3
Northern pin oak	4,202	413	767	5,266	2,398	13,046	(N/A)	2.0
Black walnut	4,045	562	702	5,620	3,874	14,802	(N/A)	2.2
Sugar maple	2,534	322	402	3,080	2,651	8,989	(N/A)	1.3
Eastern white pine	1,481	144	100	3,198	1,758	6,680	(N/A)	1.0
Bur oak	2,298	285	427	3,577	2,022	8,610	(N/A)	1.3
Oak	990	127	177	1,375	1,106	3,775	(N/A)	0.6
Hickory	1,498	204	246	1,728	1,743	5,418	(N/A)	0.8
Broadleaf Deciduous M	689	82	103	486	738	2,098	(N/A)	0.3
Black cherry	1,246	122	201	636	453	2,658	(N/A)	0.4
Norway maple	1,848	210	310	1,763	1,495	5,625	(N/A)	0.8
Callery pear	918	111	141	650	932	2,752	(N/A)	0.4
White ash	2,076	261	382	2,597	2,445	7,760	(N/A)	1.2
White oak	2,739	292	566	5,003	1,649	10,249	(N/A)	1.5
Northern white cedar	461	41	49	676	628	1,855	(N/A)	0.3
Amur maple	668	69	104	287	252	1,380	(N/A)	0.2
Ohio buckeye	380	46	53	225	469	1,173	(N/A)	0.2
Chinese elm	1,271	173	206	1,344	1,442	4,436	(N/A)	0.7
Mulberry	1,011	102	166	530	387	2,197	(N/A)	0.3
Birch	1,079	129	172	881	994	3,254	(N/A)	0.5
Conifer Evergreen Large	499	48	38	1,003	680	2,268	(N/A)	0.3
Boxelder	1,363	223	225	1,711	1,519	5,041	(N/A)	0.8
American elm	330	38	52	277	360	1,057	(N/A)	0.2
Austrian pine	574	49	64	1,009	568	2,264	(N/A)	0.3
Ginkgo	177	16	28	119	80	421	(N/A)	0.1
Broadleaf Deciduous La	211	28	32	173	365	808	(N/A)	0.1
Lilac	76	9	12	40	34	171	(N/A)	0.0
Catalpa	313	43	50	307	454	1,167	(N/A)	0.2
Eastern redbud	217	21	30	82	76	426	(N/A)	0.1

Black spruce	155	10	17	170	268	620 (N/A)	0.1
River birch	286	35	44	192	315	872 (N/A)	0.1
Southern magnolia	127	9	16	94	67	312 (N/A)	0.0
Spruce	93	8	10	139	177	427 (N/A)	0.1
Norway spruce	436	44	18	1,091	520	2,109 (N/A)	0.3
Conifer Evergreen Medi	167	12	18	216	253	666 (N/A)	0.1
Eastern red cedar	350	22	30	622	165	1,189 (N/A)	0.2
Northern catalpa	366	50	59	360	448	1,283 (N/A)	0.2
Black locust	779	80	138	884	494	2,375 (N/A)	0.4
Willow	600	35	113	836	71	1,655 (N/A)	0.2
Conifer Evergreen Smal	9	0	1	7	43	60 (N/A)	0.0
Quaking aspen	163	23	27	205	202	620 (N/A)	0.1
Alder	134	13	19	52	47	264 (N/A)	0.0
Black maple	427	56	77	441	541	1,542 (N/A)	0.2
Red pine	103	9	11	144	130	398 (N/A)	0.1
Dogwood	11	1	1	3	2	20 (N/A)	0.0
Yellowwood	17	2	2	7	32	59 (N/A)	0.0
Japanese tree lilac	7	1	1	2	0	11 (N/A)	0.0
American chestnut	9	1	1	7	41	60 (N/A)	0.0
Eastern hophornbeam	98	10	15	41	37	201 (N/A)	0.0
Black poplar	221	31	37	199	229	717 (N/A)	0.1
Basswood	68	9	10	55	106	248 (N/A)	0.0
Plum	4	1	1	1	0	7 (N/A)	0.0
Broadleaf Evergreen Sm	14	1	2	5	3	25 (N/A)	0.0
Cherry plum	21	2	3	8	7	40 (N/A)	0.0
Black ash	118	14	19	92	105	348 (N/A)	0.1
Broadleaf Evergreen Me	12	1	1	5	0	18 (N/A)	0.0
Eastern hemlock	115	12	-5	374	79	575 (N/A)	0.1
Pin oak	160	41	20	271	323	815 (N/A)	0.1
Flowering dogwood	16	2	2	6	6	32 (N/A)	0.0
Scotch pine	62	6	3	162	100	333 (N/A)	0.0
Kwanzan cherry	2	0	0	0	0	3 (N/A)	0.0
Broadleaf Evergreen Lau	84	11	7	155	179	436 (N/A)	0.1
Siberian elm	98	12	23	199	54	387 (N/A)	0.1
Japanese maple	18	2	3	7	6	36 (N/A)	0.0
Sweetbay	13	1	2	8	4	29 (N/A)	0.0
Sweetgum	1	0	0	0	5	7 (N/A)	0.0
Paper birch	21	3	3	16	29	71 (N/A)	0.0
Citywide Total	189,802	23,381	32,088	224,314	199,391	668,977 (N/A)	100.0



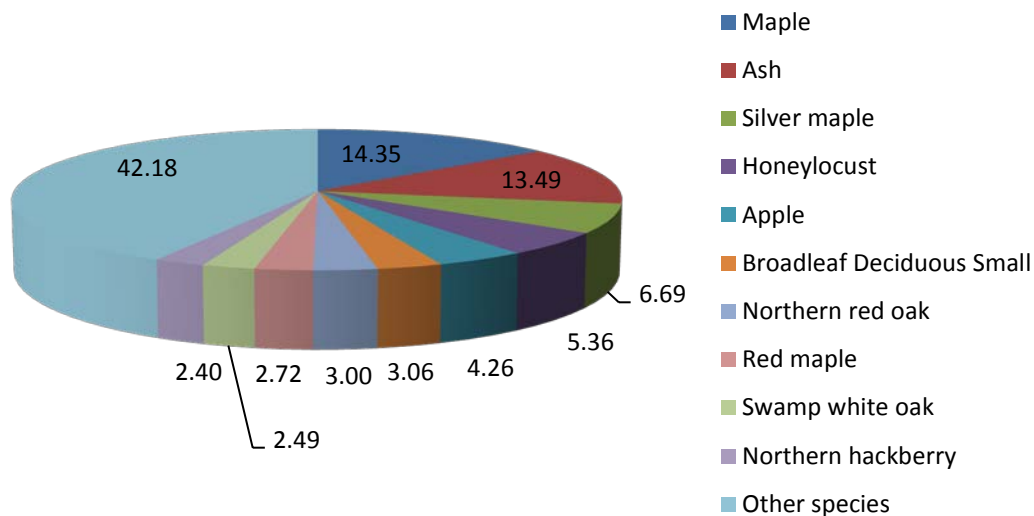


Figure 1: Species Distribution

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

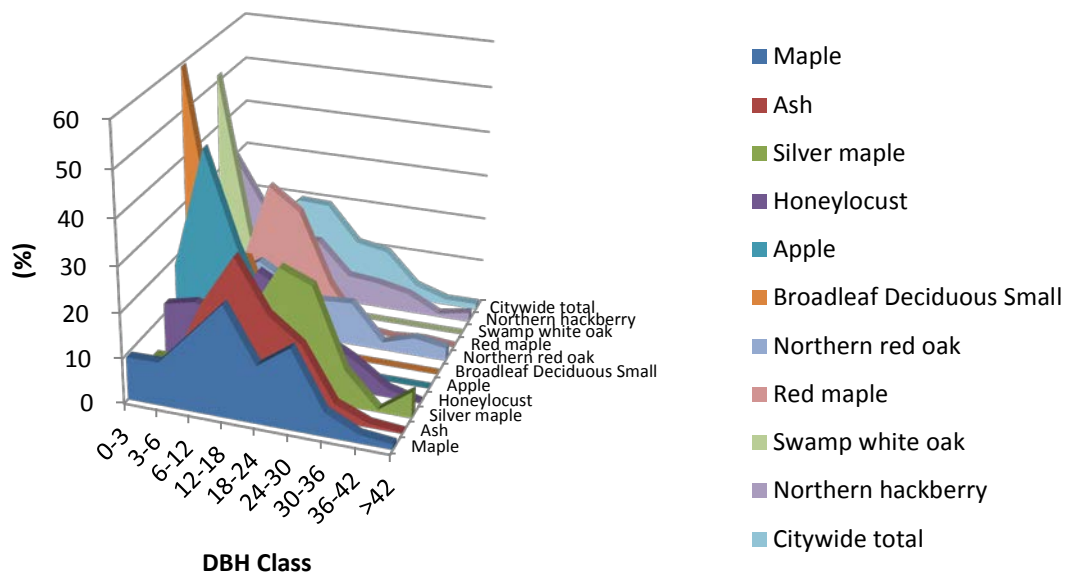


Figure 2: Relative Age Class

## Leaf Condition

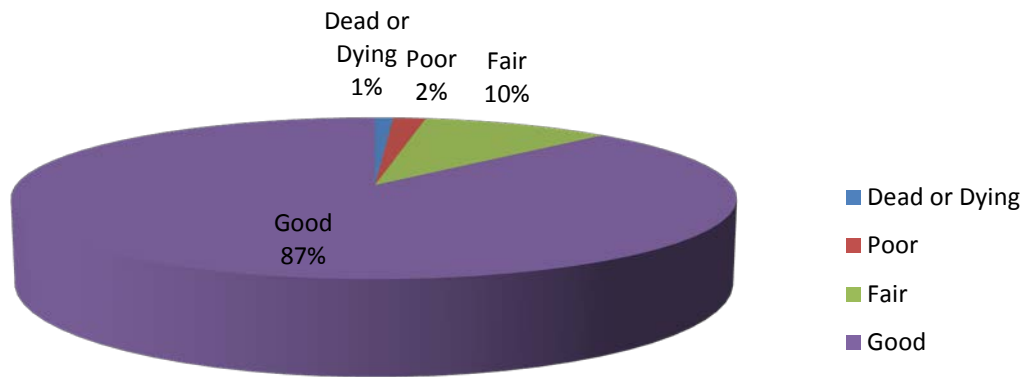


Figure 3: Foliage Condition

## Wood Condition

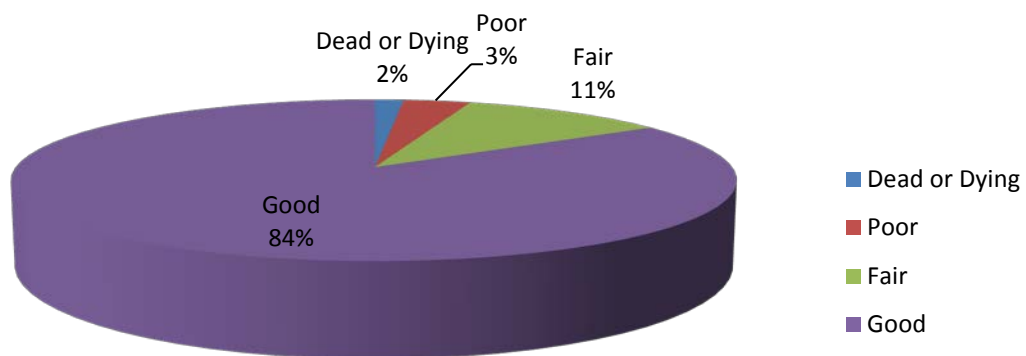
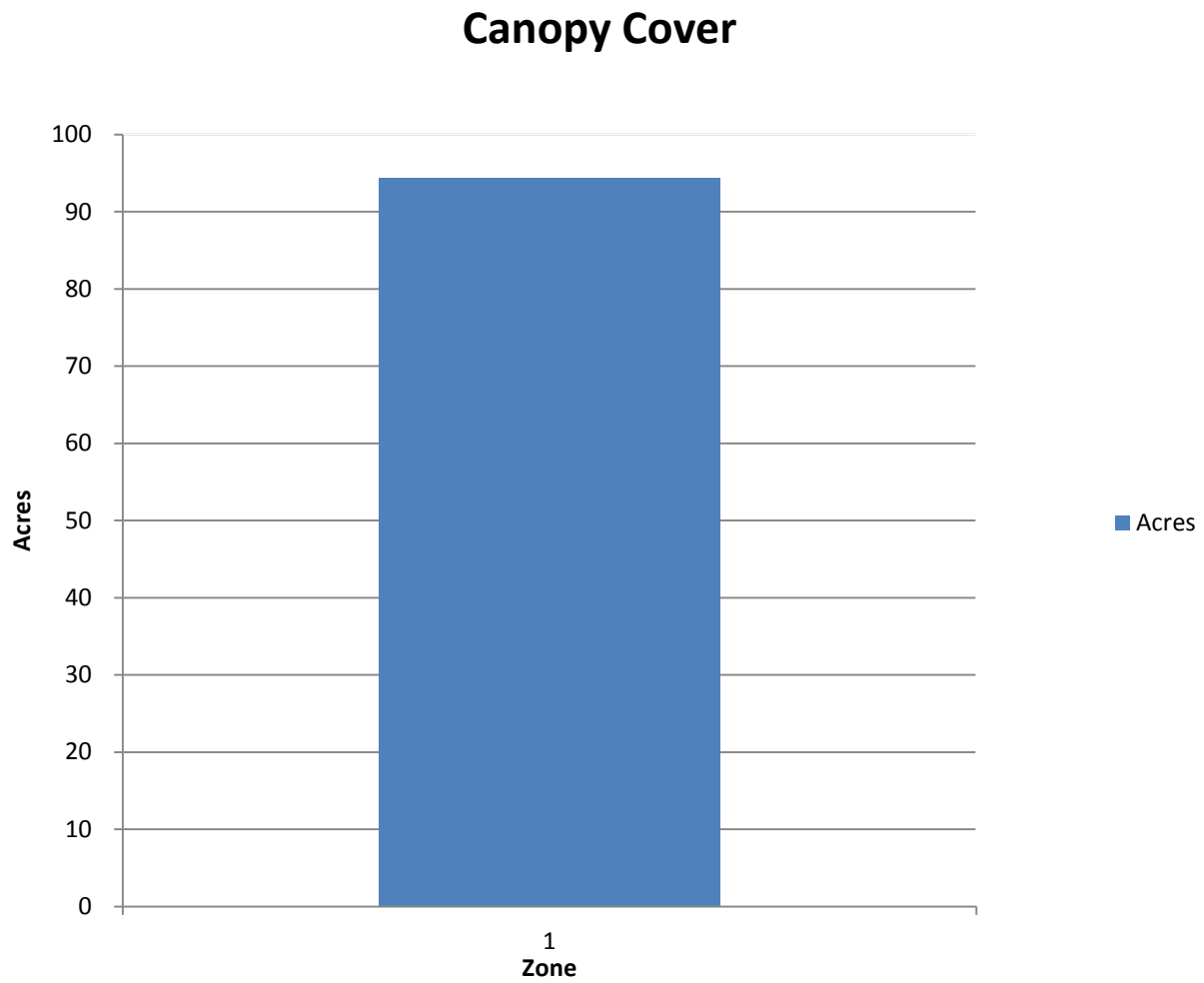


Figure 4: Wood Condition



**Figure 5: Canopy Cover in Acres**

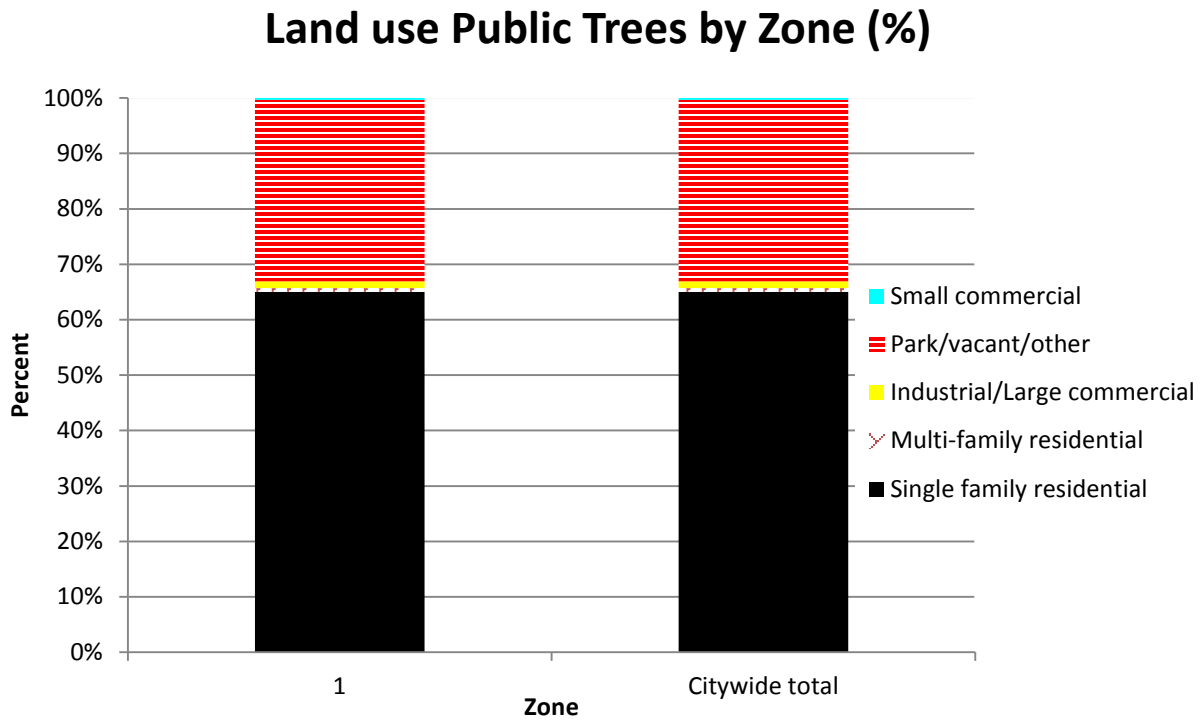


Figure 6: Land Use of city/park trees

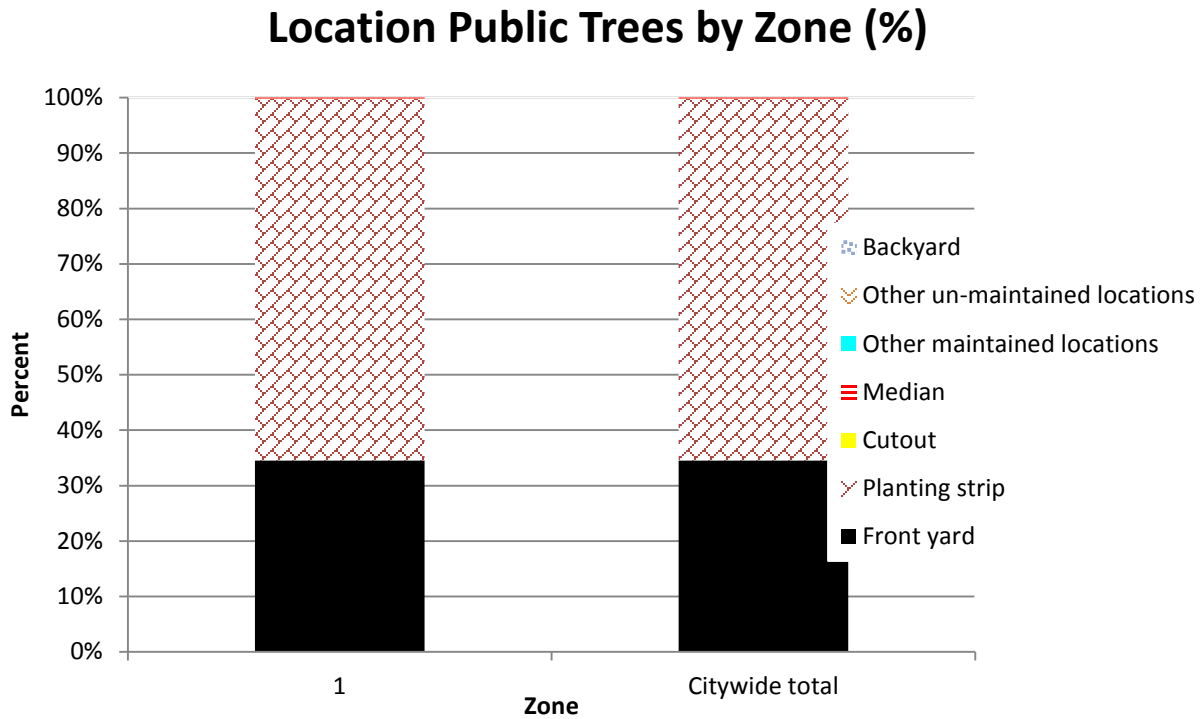


Figure 7: Location of city/park trees

## Appendix B: ArcGIS Mapping



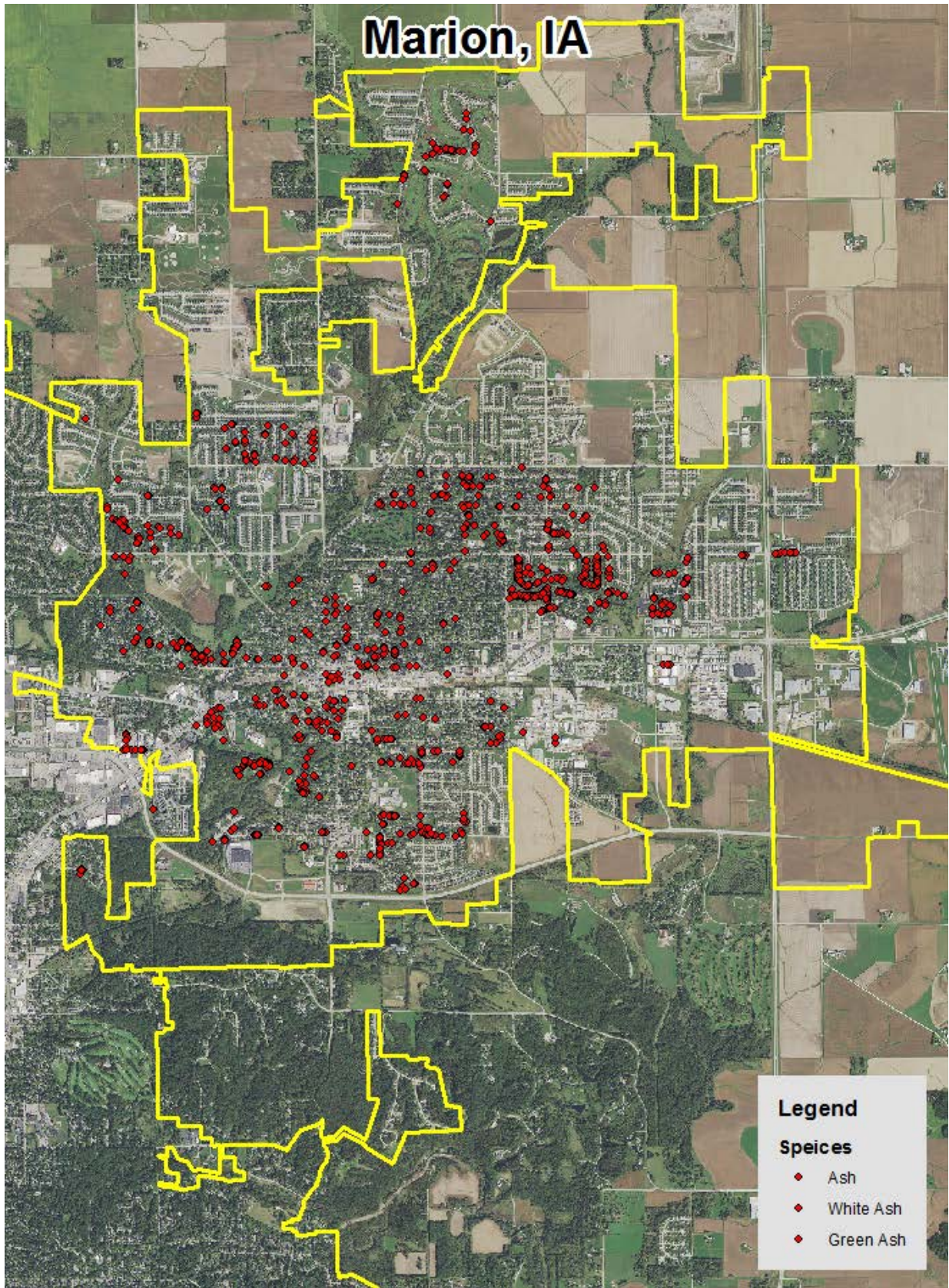


Figure 1: Location of Ash Trees



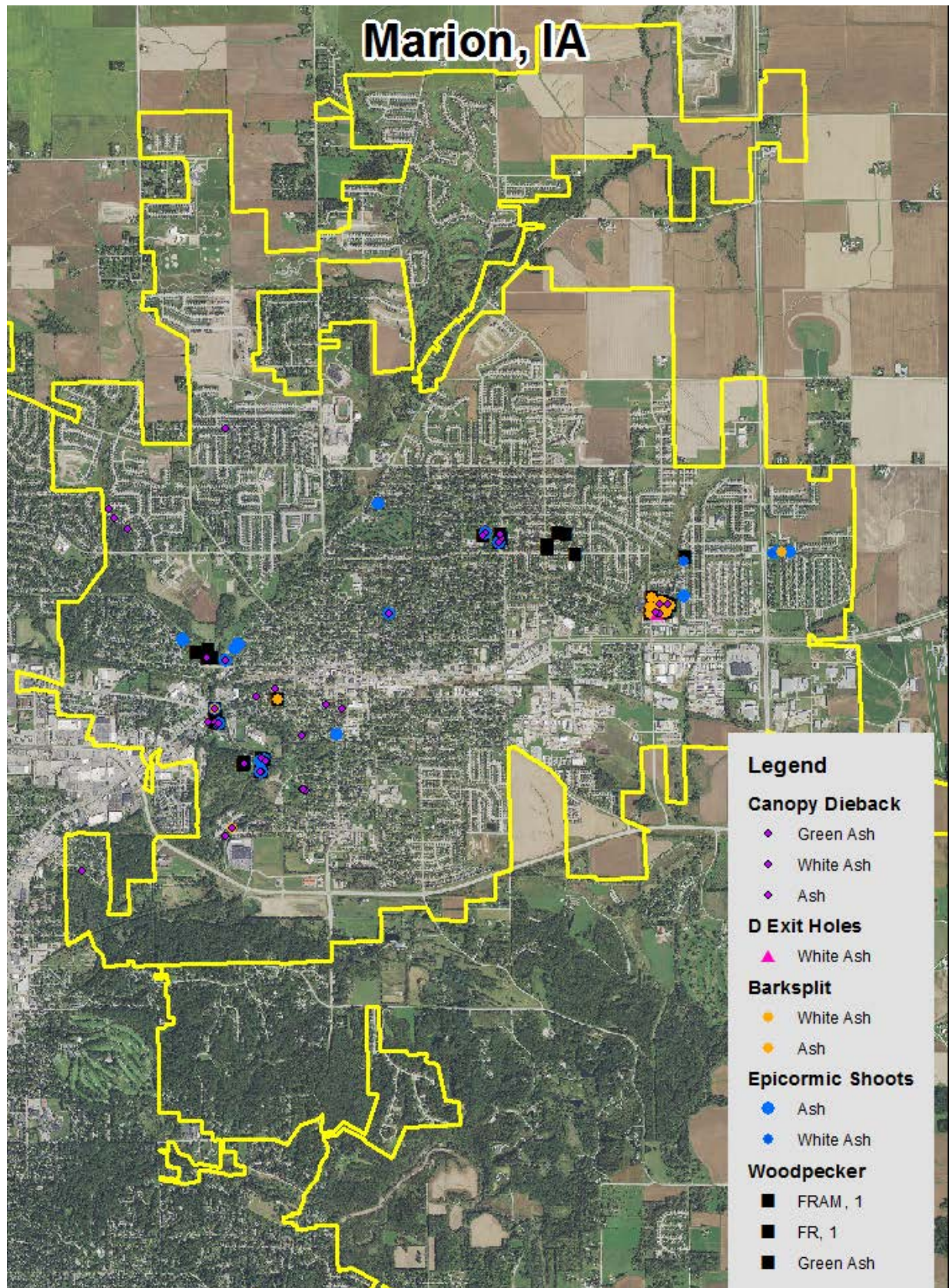


Figure 2: Location of EAB symptoms



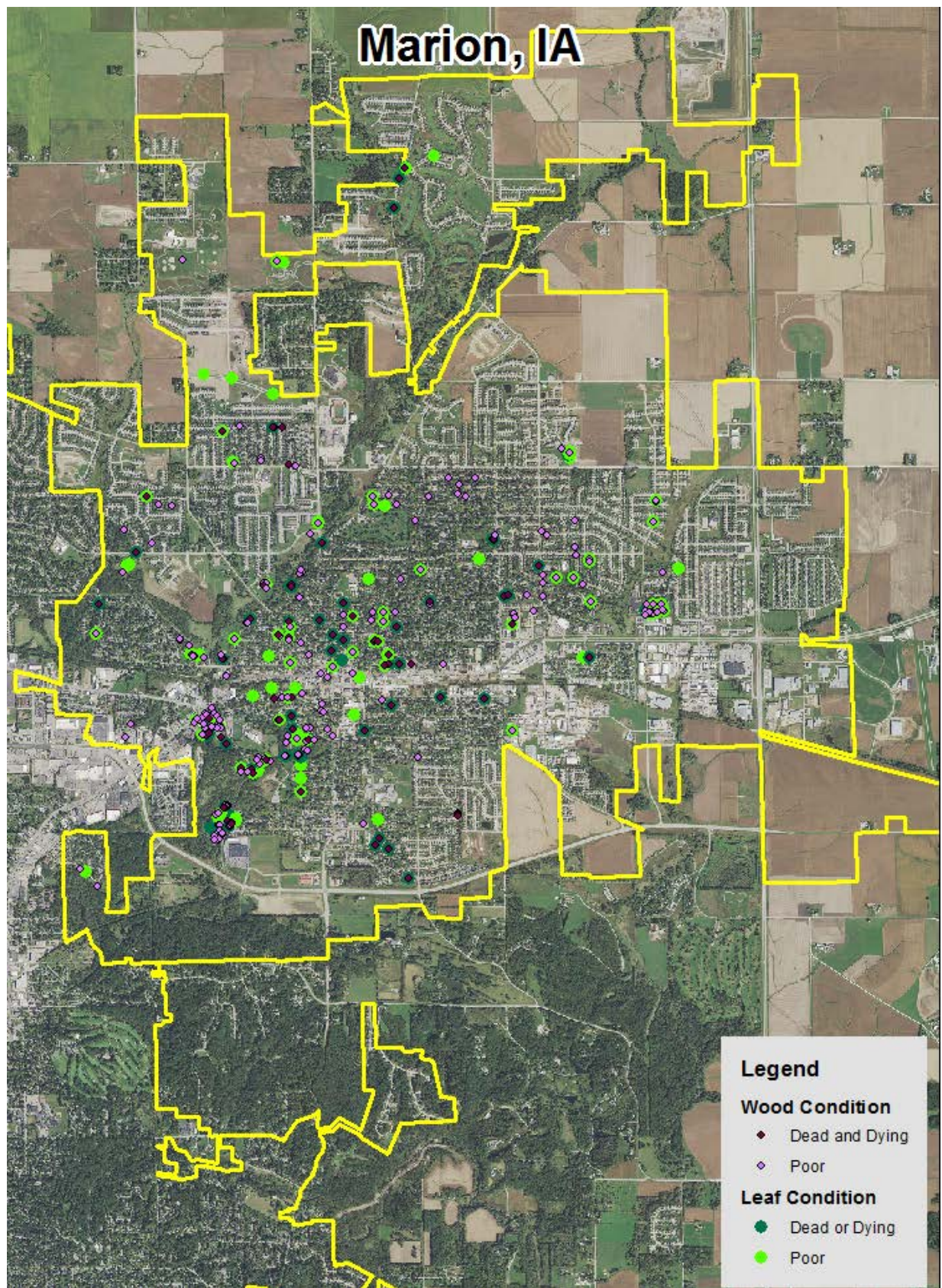


Figure 3: Location of Poor Condition Trees



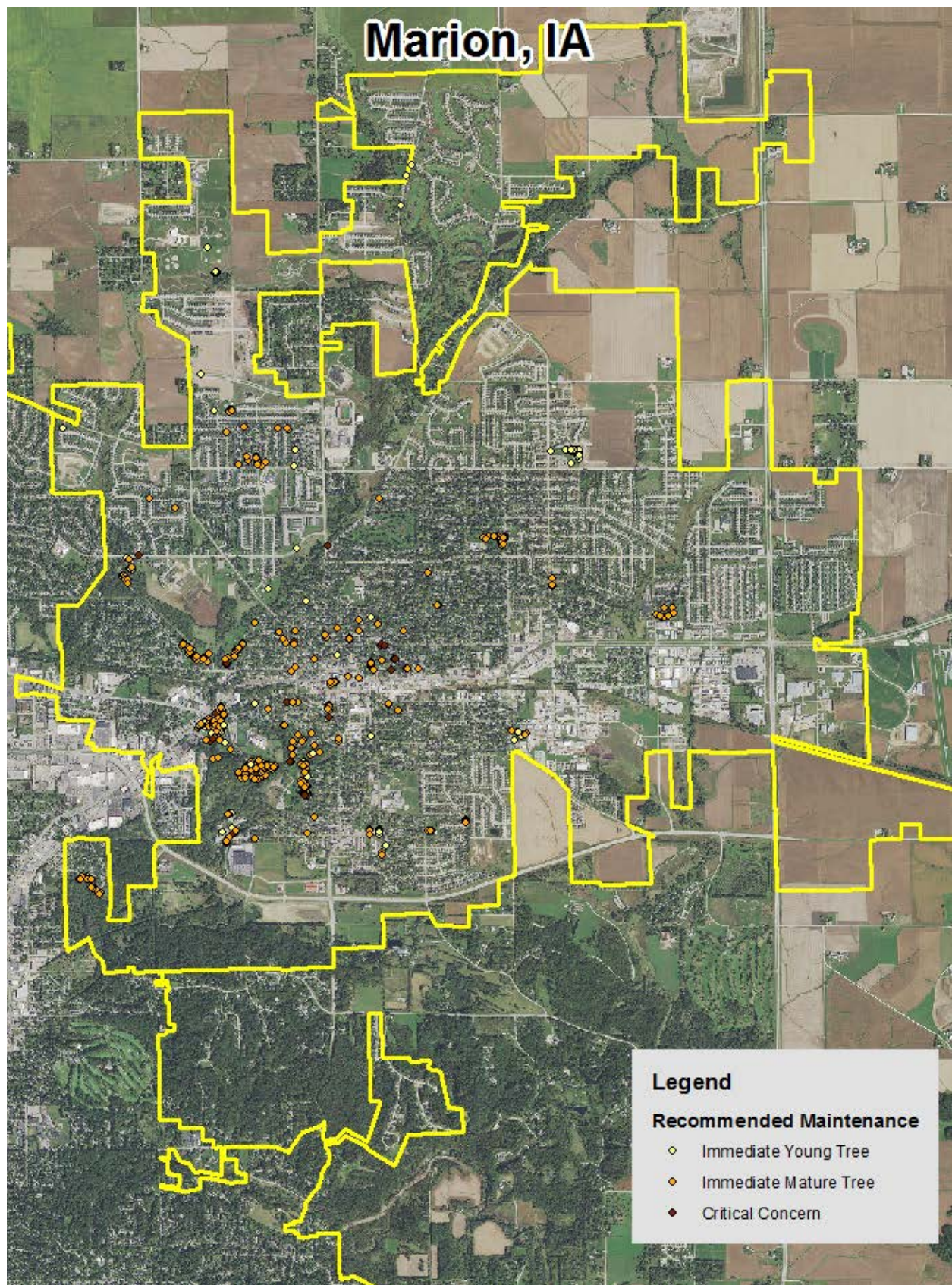
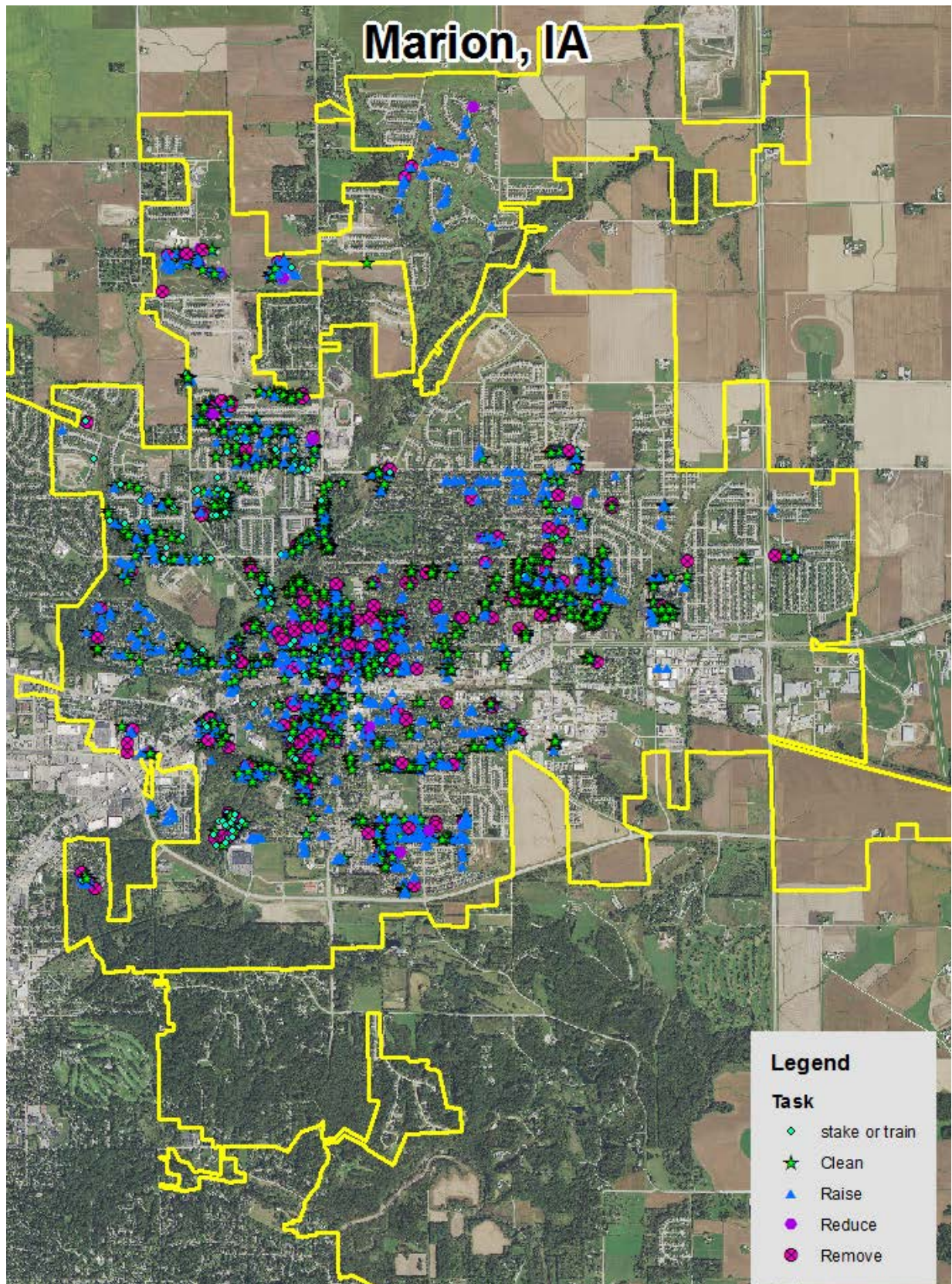


Figure 4: Location of Trees with Recommended Maintenance





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



## Appendix C: Marion Tree Ordinances

### CHAPTER 152

#### TREES

152.01 Definition	152.05 Trees on Public Property
152.02 Tree Board	152.06 Trees on Private Property
152.03 City Forester	152.07 Enforcement
152.04 Arboricultural Specifications and Standards of Practice	

**152.01 DEFINITION.** For use in this chapter, the following terms are defined:

1. “City Arboricultural Specifications and Standards of Practice” means the document containing the detailed performance standards and specifications to be used in carrying out the provisions of this chapter.
2. “Contractor” means any person, business or organization who receives compensation for the performance of work done.
3. “Park” means all public parks having individual names and maintained by the City.
4. “Parking” means that part of the right-of-way in the City not covered by sidewalk, between the lot line and the curb line. On unpaved streets, it is that portion between the lot line and portion usually traveled by vehicular traffic.
5. “Private tree” means any and all trees growing on private property.
6. “Property owner” means a person owning private property in the City, as shown by the County Auditor’s Plat of the City.
7. “Public property” means any and all property located within the confines of the City and owned by the City or held in the name of the City by any of the departments, commissions or agencies within the City government.
8. “Public tree” means any and all trees growing on public property including but not limited to street right-of-ways.
9. “Right-of-way” means a parcel of land intended to be occupied for streets, sidewalks, utilities and other public purposes.
10. “Shrubs” means woody vegetation usually growing with multiple stems and a height less than ten (10) feet.

11. "Street trees" means any and all trees growing on the parking including but not limited to street right-of-ways.

*(Ord. 08-06 – Aug. 08 Supp.)*

12. "Topping" means heading, stubbing, rounding, tipping, or "dehorning," which means the drastic removal of large branches, severely cutting back limbs to stubs larger than three inches in diameter within the tree's crown to such a degree so as to remove the normal canopy and disfigure the tree.

13. "Trees" mean woody vegetation usually growing with a single stem and a height over 10 feet.

14. "Tree Board" means the duly established board responsible to study, investigate, counsel and develop a written plan for the care, preservation, trimming, planting, replanting, removal or disposition of trees and shrubs within the City.

#### **152.02 TREE BOARD.**

1. Establishment. There is established a seven member Tree Board. The Board shall be appointed by the Mayor and confirmed by the City Council. The Mayor in appointing the initial Board shall appoint four members to four year terms and three members to three year terms. After the initial appointments, all subsequent appointments shall be for four years. The Board shall determine its officers, bylaws and meeting schedule.

*(Ord. 08-06 – Aug. 08 Supp.)*

2. Duties. The Tree Board shall have the following duties:

A. Study, investigate, counsel, develop, update annually and administer a written plan for carrying out the purposes of this chapter.

B. Present their plan to the Council. Upon the Council's acceptance and approval of the plan, the plan shall constitute the official tree plan for the City.

C. The Tree Board may draft and recommend to the Council amendments to the Zoning Ordinance, Subdivision Ordinance and other chapters of this Code of Ordinances, so as to require additional planting of street trees and/or privately owned trees, or both, in association with property development or redevelopment in the City.

D. The Tree Board may draft and recommend to the City Manager changes to staff procedures, so as to make them consistent with the intent of this chapter. These procedures may

include, but are not limited to, tree trimming and excavation procedures of the City.

E. The Tree Board shall act as the final step in an appeals process regarding disputes between the City Forester and citizens.

3. Responsibilities. The Tree Board shall:

A. File with the Clerk for public inspection copies of the minutes and other action taken by the Tree Board within fourteen (14) days of the date on which the action was taken.

*(Ord. 08-06 – Aug. 08 Supp.)*

B. Utilize the central staff and auxiliary services of the City administration and refrain from duplicating them or from establishing incompatible procedures.

**152.03 CITY FORESTER.**

1. Establishment. There is established the position of City Forester, who shall be the Director of the Marion Parks and Recreation Department. The City Forester shall serve as an ex-officio member of the Tree Board.

*(Ord. 08-06 – Aug. 08 Supp.)*

2. Authority. The City Forester shall have the authority and jurisdiction of regulating and planting, maintenance and removal of trees on publicly owned property to ensure safety or preserve or enhance the aesthetics of these public sites. The City Forester shall have the authority to supervise, inspect, or both, all work done under a permit issued in accordance with terms of this chapter. The City Forester shall have the authority to formulate and publish a master tree plan with the advice, hearing and approval of the Tree Board. The City Forester has the general authority to do all of the following:

A. Direct, manage, supervise and control the planting, removal, maintenance and protection of all trees and shrubs on public areas;

B. Guard all trees and shrubs within the City to prevent the spread of disease or pests;

C. Eliminate dangerous tree and shrub conditions within the City that may affect the life, health or safety of persons or property.

**152.04 ARBORICULTURAL SPECIFICATIONS AND STANDARDS OF PRACTICE.**

1. Establishment. There is hereby established an Arboricultural Specifications and Standards of Practice document of and for the City. This document shall include but shall not be limited to: species of street trees allowed and banned; the spacing between street trees and distances from fixed objects; proximity of street trees to utility lines; and topping.
2. Authority. The performance standards and specifications contained within the City Arboricultural Specifications and Standards of Practice shall be considered a part of this chapter and made subject to all its provisions.

**152.05 TREES ON PUBLIC PROPERTY.**

1. Conditions Under Which Trees Allowed. From and after July 1, 2010, no person, except City personnel, agents for City purposes, or authorized tree permit holders shall plant any tree or shrub upon any City owned property, including property dedicated or used for right-of-way purposes. Only trees from the City of Marion Approved Street Trees List may be planted in the public right-of-way. *(Ord. 10-15 – Aug. 10 Supp.)*
2. Insurance. The City Forester shall have the authority to require any permit holder to show adequate insurance coverage to cover potential damages that occur during the execution of the work. In the case of the property owner doing the work, proof of homeowner personal liability insurance may be required. If the property owner has hired another person or contractor to do the work, the contractor shall provide the City with a certificate of insurance. The certificates shall show the following minimum required limits of coverage of Commercial General Liability Insurance with limits of not less than \$500,000 per occurrence and Worker's Compensation insurance coverage at statutory limits on any and all employees.
3. Public Utilities. A public utility may be issued a permit to treat, trim or remove any tree or shrub on any street or other public place. The work shall be limited to the actual necessities of the service of the company in the area specified on the permit. This work shall be done in accordance with the Arboricultural Specifications and Standards of Practice as established for the City. The City Forester may assign an inspector to supervise the provisions of the permit. The cost of the service shall be charged to the public utility. In the event severe weather has caused a tree to damage utility lines, the utility company, the City, or their agents may trim or remove trees necessary to repair the damaged



utility lines without first obtaining a permit. A permit should be obtained before any additional trimming not required for repair of the utility line is done.

4. Maintenance. The maintenance of all street trees or shrubs shall be the responsibility of the City Forester. Street trees may be trimmed and maintained to allow free passage of pedestrians and vehicular travel and so they will not obstruct or shade street lights, traffic lights, signs or any traffic control devices or the view of any street intersection. Such detailed information is contained in the City's Arboricultural Specifications and Standards of Practice. If in the opinion of the City Forester trimming of a street tree is necessary, the adjacent property owner shall be notified and in the event the adjacent property owner disagrees with the Forester's decision, an appeal may be filed. Whenever the City Forester is notified or becomes aware of a dead or broken branch or limb in any street tree or a dead street tree which is in imminent danger of falling and thereby injuring any individual or causing property damage, the offending branch, limb or tree shall be considered a hazard and may be removed. Subsequent trimming of the tree which contained the dead or broken branch or limb should occur after notification of the adjacent property owner.

5. Removal. If in the opinion of the City Forester removal of a street tree becomes necessary, the adjacent property owner shall be notified. In the event the adjacent property owner requests the removal of a street tree or shrub and the City Forester does not consider the removal necessary, the property owner may appeal the City Forester's decision to the Tree Board.

6. Traffic Control. In the event the planting, maintenance or removal of any tree requires equipment or material to be located on or fall onto the street right-of-way, the permit holder shall provide for traffic control. All traffic control shall conform to the requirements and specifications of the current edition the Manual of Uniform Traffic Control Devices (MUTCD). In all cases the disruption of smooth traffic flow shall be kept to a minimum. Additional warning devices or precautionary measures may be necessary to control pedestrian traffic.

7. Protection. No person shall intentionally damage, cut, carve, attach any rope, wire, nails, advertising posters or other contrivance to any street tree; allow any gaseous, liquid, chemical or solid substance harmful to such trees to come in contact with them, or set fire or permit fire to burn when such fire or the heat will injure any portion of any tree.

8. **Permit.** No person except the City or person hired by the City shall spray, fertilize, preserve, prune, remove, cut above or below ground or otherwise disturb any tree on City property without first filing an application and obtaining a permit from the City Forester. The person receiving the permit shall abide by the Arboricultural Specifications and Standards of Practice as adopted by the City.

9. **Permits.** The Tree Board may issue a permit for the planting of a tree in the public right-of-way when: (1) The proper permit fee has been paid in full to the City; (2) The proposed site has been reviewed and approved by the City Forester; and (3) Species and planting technique have been reviewed and found to meet City standards.

*(Ord. 10-15 – Aug. 10 Supp.)*

10. **Establishment of Fees.** The City Council shall adopt by resolution a permit fee for the issuance of a tree permit. Said fees may be amended by resolution at the discretion of the City Council.

11. The Tree Board of the City shall adopt a City of Marion Approved Street Trees List by 7/1/2010.

*(Ord. 10-15 – Aug. 10 Supp.)*

12. **Establishment of Urban Forest Utility.** An urban forest utility is hereby established to provide for the collection and use of public tree management fees, tree permit fees and other fees as applicable for use to maintain trees on City owned property and provide for the disposal or re-use of tree-related materials.

13. **Public Tree Management Fees.** The City Council shall, by resolution, set fees for the management of trees on City owned property. This includes the initial establishment of fees and subsequent changes to the fees as deemed necessary by the City Council.

*(Ord. 10-16 – Aug. 10 Supp.)*

#### **152.06 TREES ON PRIVATE PROPERTY.**

1. **Maintenance.** The property owner is responsible for the maintenance and care of any tree located on private property. Certain regulations apply to trees whose branches, limbs, roots or other parts extend into or over the street right-of-way. The property owner is responsible for ensuring private trees are trimmed to sufficient height to allow free passage of pedestrians and vehicular travel and so they will not obstruct or shade street lights, traffic lights, signs or any traffic control devices or the view of any street intersection. Detailed information is contained in the City's Arboricultural Specifications and Standards of Practice. If it becomes necessary to trim trees or shrubs on

private property to comply with this chapter, the City Forester shall declare the tree or shrub a nuisance. Whenever the City Forester is notified or becomes aware of a dead or diseased tree or broken or dead branch or limb in any private tree which is in imminent danger of falling and thereby injuring any individual or causing property damage to adjacent property, the City Forester may declare the tree, branch or limb a hazard and order the property owner to remove the hazard in an expedient manner. If the property owner fails to remove the hazard, the City Forester may cause the hazard to be removed. For purposes of removing the hazard, City crews or City agents shall be allowed on private property. Attempts should be made to notify the property owner before entering onto private property. (Ord. 08-06 – Aug. 08 Supp.)

2. Traffic Control. In the event the planting, maintenance or removal of any private tree requires equipment or material to be located on or fall onto the street right-of-way, the homeowner or the homeowner's agent shall provide for traffic control. All traffic control shall conform to the requirements and specifications of the current edition of the Manual of Uniform Traffic Control Devices (MUTCD). In all cases the disruption of smooth traffic flow shall be kept to a minimum. Additional warning devices or precautionary measures may be necessary to control pedestrian traffic.

#### 152.07 ENFORCEMENT.

1. Appeals. Any person who receives an order from the City Forester and objects to all or part of the order may, within ten (10) days of the receipt of the order, notify the City Forester and City Tree Board in writing of the nature of the objection and request a hearing on the order thereon. The hearing shall be held within thirty (30) days of notice to the appellant. Within ten (10) days the Chair of the Tree Board shall notify the appellant and City Forester of the final decision.
2. Interference. No person shall hinder, prevent, delay or otherwise interfere with the City Forester or any assistants in the execution or enforcement of this chapter.
3. Violation. If, as a result of a violation of any provision of this chapter, the injury, mutilation or death of a tree, shrub or other plant located on City-owned property is caused, the cost of repair or replacement of the tree, shrub or other plant shall be borne by the party in violation. The value of shrubs shall be determined in accordance with the latest revision of *A Guide to the Professional Evaluation of*

*Landscape Trees, Specimen Shrubs and Evergreens* as published by the  
International Society of Arboriculture.

CODE OF ORDINANCES, MARION, IOWA  
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