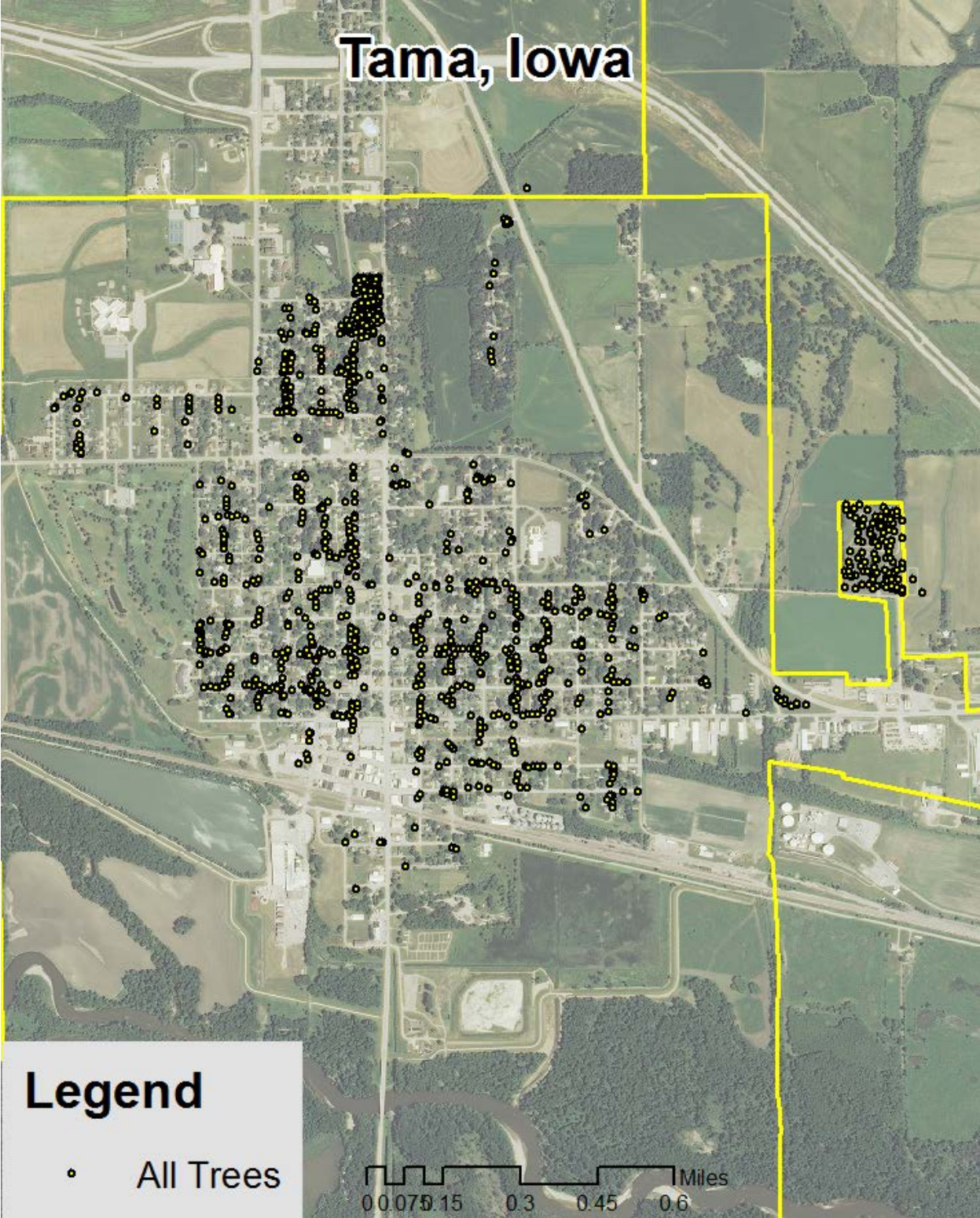


# Tama, IA



2016 Urban Forest Management Plan  
Prepared by Matt Brewer  
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Trees inventoried in Summer 2015



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# Executive Summary

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## Overview

This plan was developed to assist the City of Tama 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 14% of Tama'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 by Matt Brewer, Iowa DNR, 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 1,070 trees inventoried.

- Tama's trees provide \$247,901 of benefits annually, an average of \$232 a tree
- There are over 52 species of trees
- The top three genera are: Maple 32%, Oak 16%, and Ash 14%
- 18% of trees are in need of some type of management
- 29 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 29 trees needing removal, 25 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately [\\*City ownership of the trees recommended for removal should be verified prior to any removal\\*](#)
- 54 of the 150 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 are consistent with the *Approved Street Tree List* and do not include ash or maple
- Check ash trees with a visual survey yearly
- Budget impacts from ash removal – Suggestion: request a budget increase to at least \$10,500-\$22,500 a year and apply for grants to plant replacement trees

## Introduction

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

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

## Inventory

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In 2015, a tree inventory was conducted by Matt Brewer, Iowa DNR, 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 1,070 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. Tama's trees reduce energy related costs by approximately \$62,463 annually (Appendix A, Table 1). These savings are both in Electricity (297.1 MWh) and in Natural Gas (40,726.2 Therms).

#### **Annual Stormwater Benefits**

Tama's trees intercept about 3,860,921 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$104,631 of benefits to the city.

#### **Annual Air Quality Benefits**

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Tama, it is estimated that trees remove 3,808.7 lbs of air pollution (ozone (O<sub>3</sub>), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and sulfur dioxide (SO<sub>2</sub>)) per year with a net value of \$10,599 (Appendix A, Table 3).

#### **Annual Carbon Benefits**

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Tama, trees sequester about 738,187 lbs of carbon a year with an associated value of \$5,536 (Appendix A, Table 4). In addition, the trees store 15,212,862 lbs of carbon, with a yearly benefit of \$114,096 (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. Tama receives \$61,508 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, Tama's trees provide \$247,901 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,070 trees in Tama provides approximately \$232 annually (Appendix A, Table 7).

## **Forest Structure**

### **Species Distribution**

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

|                        |     |     |
|------------------------|-----|-----|
| Maple                  | 344 | 32% |
| Oak                    | 171 | 16% |
| Ash                    | 150 | 14% |
| Spruce                 | 65  | 6%  |
| Hackberry              | 47  | 4%  |
| Northern White Cedar   | 37  | 3%  |
| Elm                    | 35  | 3%  |
| Apple/Crabapple        | 31  | 3%  |
| Pine                   | 31  | 3%  |
| Eastern Red Cedar      | 20  | 2%  |
| Hickory                | 17  | 2%  |
| Honeylocust            | 14  | 1%  |
| Linden/Basswood        | 14  | 1%  |
| Aspen/Cottonwood       | 13  | 1%  |
| Black Walnut           | 12  | 1%  |
| Pear                   | 12  | 1%  |
| Willow                 | 12  | 1%  |
| Mulberry               | 6   | 1%  |
| Catalpa                | 5   | <1% |
| Ohio Buckeye           | 4   | <1% |
| American Sycamore      | 4   | <1% |
| American Chestnut      | 3   | <1% |
| Ginkgo                 | 3   | <1% |
| Cherry/Plum            | 3   | <1% |
| Mountain Ash           | 3   | <1% |
| Lilac                  | 2   | <1% |
| Birch                  | 1   | <1% |
| Eastern Redbud         | 1   | <1% |
| Dogwood                | 1   | <1% |
| Magnolia               | 1   | <1% |
| Other Small Deciduous  | 6   | 1%  |
| Other Medium Deciduous | 1   | <1% |
| Other Large Evergreen  | 1   | <1% |

## Age Class

Over half of Tama’s trees (61%) are between 18 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that a large number of trees are in the smallest size categories (a downward slope) to prepare for natural mortality and to maintain canopy cover. Tama will have an aging tree population as this 61% matures, and should consider new plantings (currently only 6% are under 6 inches in diameter) to develop the next generation of trees.

## 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 Tama indicate that 80% of the trees are in good health, with only 4% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Additionally, 45% of Tama’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 19% of the population. This 19% 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 | 146 | 14% |
| Tree Removal   | 29  | 3%  |
| Tree Staking   | 7   | <1% |

## Canopy Cover

The total canopy with both private and public trees is 31% (678 acres). The canopy cover included in the Tama inventory includes approximately 36 acres (Appendix A, Figure 4).

## Land Use and Location

The majority of Tama’s city and park trees are in yard settings 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 | 75% |
| Park/vacant/other         | 23% |
| Small commercial          | 1%  |
| Multifamily residential   | <1% |

### Location

|                            |     |
|----------------------------|-----|
| Front yard                 | 55% |
| Planting strip             | 45% |
| Other maintained locations | <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

Tama has 15 critical concern trees, 11 of which need immediate removal and 4 that need immediate cleaning. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There are 15 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the six year maintenance plan at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 182 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 29 removals, 8 are ash trees. There are a total of 150 ash trees, and 54 of those have signs and symptoms that have been associated with EAB. In addition, there are 25 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.

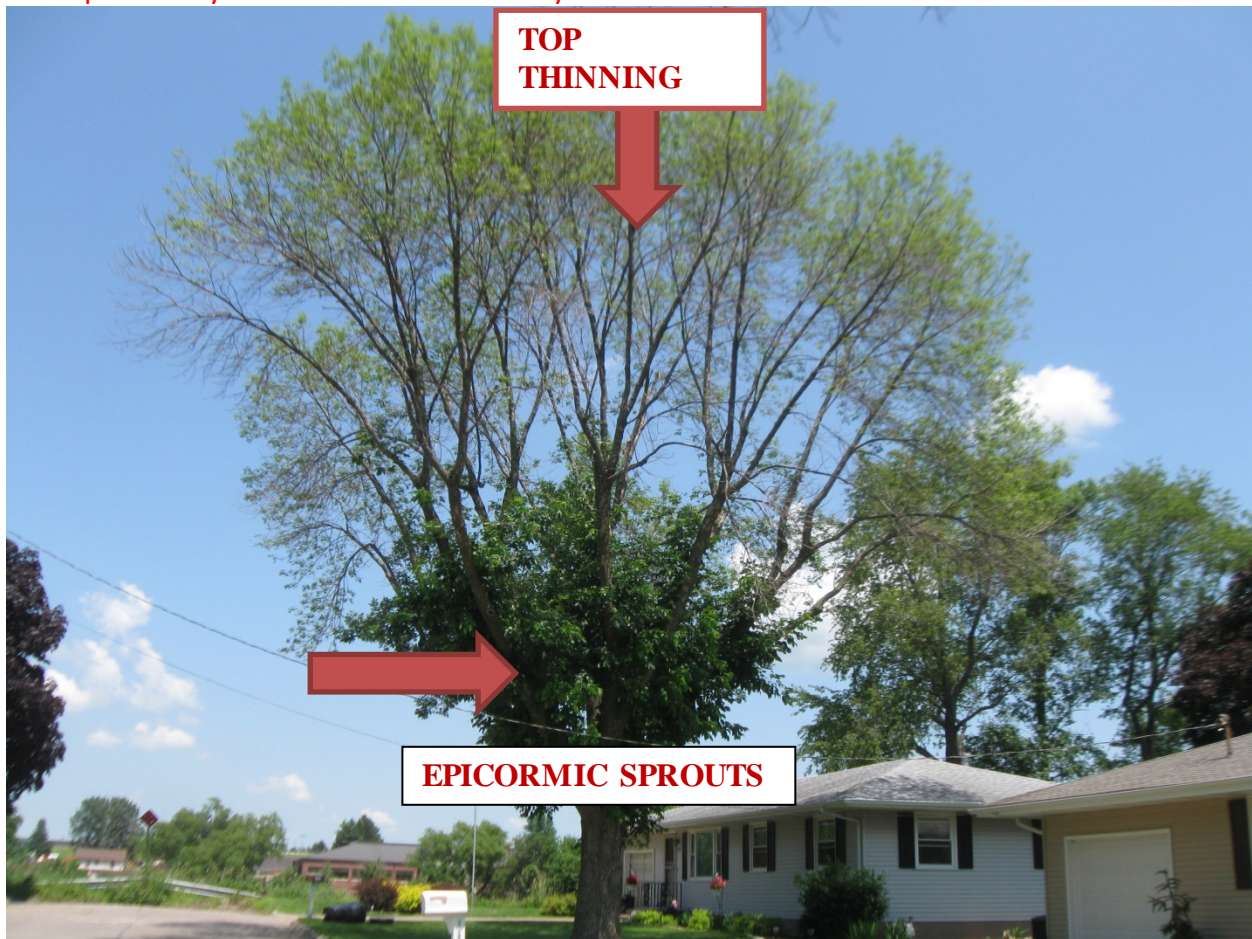
## Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant at least 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 or greater number of trees helps ensure continuation of the benefits of the existing forest in Tama.

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 10% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 5-10% of the total urban forest. Presently, the forest is heavily planted with maple (32%) (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. Tree species that may be planted can be found on the *Approved Street Tree List*, as outlined in section 6-2.0103 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 6-2.0103 (Appendix C).

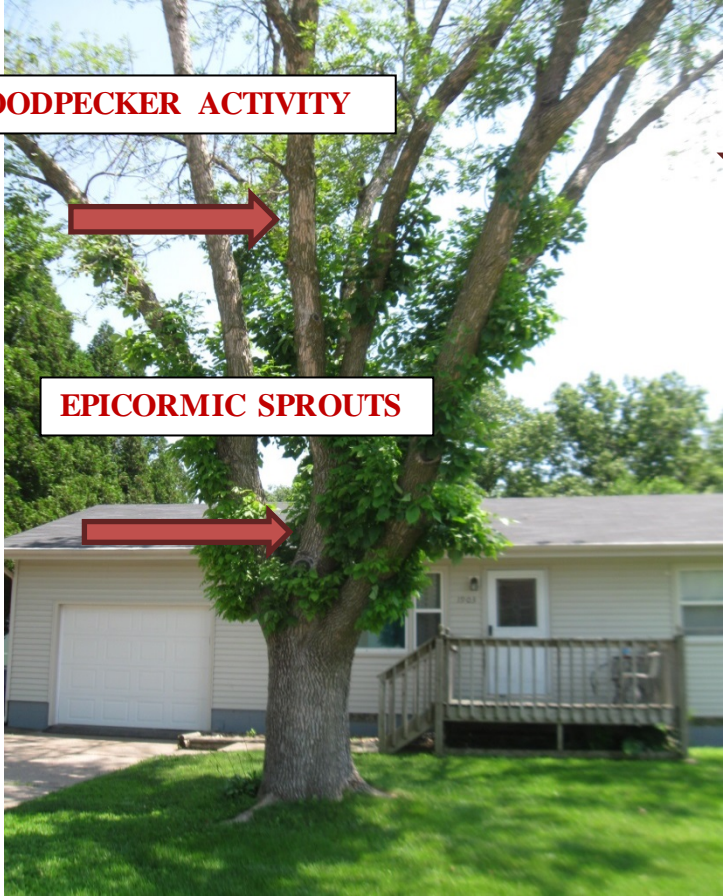
### **Continual Monitoring For EAB**

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 (See examples below). **Once EAB arrives in Tama, it could potentially kill all ash within 4 to 10 years of its arrival.**

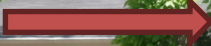


**EAB infested tree in Muscatine with top thinning and many new green epicormic sprouts**

**WOODPECKER ACTIVITY**



**EPICORMIC SPROUTS**



**WOODPECKER ACTIVITY**



**D-SHAPED EXIT HOLE**



**EAB infested tree in Muscatine with sprouting, wood pecker activity, and D-shaped exit holes**



# 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 an effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit <http://extension.entm.purdue.edu/treecomputer/>

## EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles.

A regulated article under the USDA's quarantine includes any of the following items:

- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

In addition, any other article, product or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB once a quarantine is in effect.

## 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? The entire state of Iowa is under quarantine, so regulated articles may not be moved into non-quarantined states. For more information, please visit <http://www.emeraldashborer.info/>.

## **Canopy Replacement**

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance 6-2.0103 (Appendix C). The new plantings will be a diverse mix, consistent with the *Approved Street Tree List*, and will not include ash or maple.

## **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. City Code 6-2.0205 states "If the superintendent upon inspection or examination, in person or by some qualified person acting for him, shall determine with reasonable certainty that any condition as herein defined exists in or upon private premises and that the danger to other elm trees within the city is imminent, he shall immediately notify by certified mail the owner, occupant or person in charge of such property, to correct such condition within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within fourteen (14) days of receipt thereof, the council may cause the nuisance to be removed and the cost assessed against the property as provided in Article 2, Chapter 2, of Title III."

## Six Year Maintenance Plan and Cost Estimates

### Year 1 (FY 2016)

|   |                 |
|---|-----------------|
| Remove 11 critical concern trees that need immediate attention  | \$9,900         |
| Maintain 4 critical concern trees that need immediate attention (cleaning)  | \$1,200         |
| Remove 4 trees (marked for removal)   | \$3,600         |
| Plant and Maintain 20 trees in open locations (pursue grants)   | \$2,000         |
| Ash tree treatment (if elected), 72 trees in good condition, average 24–30”<br>-\$15 per inch, treated every two years, see note<br>*Or saving for future ash removal | avg. \$405/tree |
| Visual Survey for signs and symptoms of EAB   |                 |

### Year 2 (FY 2017)

|  |          |
|--|----------|
| Remove 14 trees (marked for removal)                                       | \$12,600 |
| Plant and Maintain 20 trees in open locations (pursue grants)              | \$2,000  |
| Ash tree treatment (if elected) or saving for future ash removal           |          |
| Routine trimming: Contract to trim 1/3 of the city trees (~\$300 per tree) |          |
| Visual Survey for signs and symptoms of EAB                                |          |

### Year 3 (FY 2018)

|  |            |
|--|------------|
| Remove any new critical concern trees and ash in poor health     | \$900/tree |
| Plant and Maintain 20 trees in open locations (pursue grants)    | \$2,000    |
| Ash tree treatment (if elected) or saving for future ash removal |            |
| Visual Survey for signs and symptoms of EAB                      |            |

### Year 4 (FY 2019)

|  |            |
|--|------------|
| Remove any new critical concern trees and ash in poor health               | \$900/tree |
| Plant and Maintain 20 trees in open locations (pursue grants)              | \$2,000    |
| Ash tree treatment (if elected) or saving for future ash removal           |            |
| Routine trimming: Contract to trim 1/3 of the city trees (~\$300 per tree) |            |
| Visual Survey for signs and symptoms of EAB                                |            |

### Year 5 (FY 2020)

|  |            |
|--|------------|
| Remove any new critical concern trees and ash in poor health     | \$900/tree |
| Plant and Maintain 20 trees in open locations (pursue grants)    | \$2,000    |
| Ash tree treatment (if elected) or saving for future ash removal |            |
| Visual Survey for signs and symptoms of EAB                      |            |



## Year 6 (FY 2021)

|  |            |
|--|------------|
| Remove any new critical concern trees and ash in poor health               | \$900/tree |
| Plant and Maintain 20 trees in open locations (pursue grants)              | \$2,000    |
| Ash tree treatment (if elected) or saving for future ash removal           |            |
| Routine trimming: Contract to trim 1/3 of the city trees (~\$300 per tree) |            |
| Visual Survey for signs and symptoms of EAB                                |            |

\*Reduction of ash in poor health will reduce exposure to Emerald Ash Borer over time. EAB could potentially kill all ash within 4-15 years of its arrival.

\*\*Assuming a cost of \$900 per tree for removal, the budget would need to be increased to \$22,500 a year to remove all ash trees within 6 years.

\*\*\*Suggest a future (post ash removal and replacement) budget of at least \$2 per capita (population 2,877). Currently, this amount would cover about 25% of what would be needed to remove EAB infested trees over a six year period. Suggest setting aside additional funds to prepare for the expected arrival of EAB. Planting would be at least partially dependent on receiving grant funds annually.

### Proposed Budget Increase

EAB could potentially kill all ash trees in Tama within 4-15 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to \$22,500 a year. If the budget were increased to \$10,500 a year all ash could be removed within 13 years. Additionally, it is recommended that Tama 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 an example, if the average ash diameter is 20 inches and treatment costs \$15 per inch, then treating 10 trees would cost about \$3,000 (every other year treatment). This would be 10 trees selected for treatment, and Tama would still need to find \$900 per tree for removal. Alternatively, if there are 15 treatable trees, it would cost approximately \$4,500 every two years for treatment and leave five less trees for removal (for at least two more years). 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 Tama. 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

| Annual Energy Benefits of Public Trees |                         |                  |                            |                  |            |                |                  |               |              |
|--|-------------------------|------------------|----------------------------|------------------|------------|----------------|------------------|---------------|--------------|
| 2/2/2016                               |                         |                  |                            |                  |            |                |                  |               |              |
| Species                                | Total Electricity (MWh) | Electricity (\$) | Total Natural Gas (Therms) | Natural Gas (\$) | Total (\$) | Standard Error | % of Total Trees | % of Total \$ | Avg. \$/tree |
| Green ash                              | 47.2                    | 3,586            | 6,569.3                    | 6,438            | 10,024     | (N/A)          | 13.4             | 16.0          | 70.10        |
| Silver maple                           | 47.8                    | 3,625            | 6,282.7                    | 6,157            | 9,782      | (N/A)          | 12.0             | 15.7          | 76.42        |
| Bur oak                                | 38.7                    | 2,934            | 5,333.7                    | 5,227            | 8,161      | (N/A)          | 11.4             | 13.1          | 66.89        |
| Sugar maple                            | 31.6                    | 2,398            | 4,255.2                    | 4,170            | 6,568      | (N/A)          | 9.1              | 10.5          | 67.71        |
| Norway maple                           | 24.1                    | 1,830            | 3,513.9                    | 3,444            | 5,274      | (N/A)          | 8.3              | 8.4           | 59.26        |
| Northern hackberry                     | 19.2                    | 1,455            | 2,665.0                    | 2,612            | 4,066      | (N/A)          | 4.4              | 6.5           | 86.52        |
| Spruce                                 | 6.2                     | 471              | 816.3                      | 800              | 1,271      | (N/A)          | 3.7              | 2.0           | 31.78        |
| Northern white cedar                   | 4.7                     | 355              | 605.9                      | 594              | 948        | (N/A)          | 3.5              | 1.5           | 25.63        |
| Pin oak                                | 10.7                    | 815              | 1,428.4                    | 1,400            | 2,214      | (N/A)          | 3.0              | 3.5           | 69.20        |
| Apple                                  | 3.0                     | 227              | 452.1                      | 443              | 670        | (N/A)          | 2.9              | 1.1           | 21.62        |
| Siberian elm                           | 6.3                     | 477              | 852.2                      | 835              | 1,312      | (N/A)          | 2.7              | 2.1           | 45.26        |
| Eastern white pine                     | 4.5                     | 339              | 594.3                      | 582              | 922        | (N/A)          | 2.3              | 1.5           | 36.87        |
| Blue spruce                            | 1.8                     | 136              | 254.8                      | 250              | 385        | (N/A)          | 2.3              | 0.6           | 15.41        |
| Eastern red cedar                      | 1.8                     | 135              | 265.0                      | 260              | 394        | (N/A)          | 1.9              | 0.6           | 19.72        |
| Hickory                                | 4.2                     | 322              | 538.5                      | 528              | 849        | (N/A)          | 1.6              | 1.4           | 49.95        |
| Red maple                              | 3.9                     | 292              | 504.7                      | 495              | 787        | (N/A)          | 1.4              | 1.3           | 52.47        |
| Honeylocust                            | 4.6                     | 350              | 604.3                      | 592              | 942        | (N/A)          | 1.3              | 1.5           | 67.27        |
| Black walnut                           | 3.6                     | 271              | 504.3                      | 494              | 766        | (N/A)          | 1.1              | 1.2           | 63.79        |
| Pear                                   | 1.5                     | 110              | 220.1                      | 216              | 326        | (N/A)          | 1.1              | 0.5           | 27.17        |
| Cottonwood                             | 4.8                     | 367              | 656.0                      | 643              | 1,010      | (N/A)          | 1.1              | 1.6           | 84.19        |
| Willow                                 | 2.8                     | 214              | 409.7                      | 402              | 615        | (N/A)          | 1.1              | 1.0           | 51.26        |
| American basswood                      | 3.4                     | 255              | 485.8                      | 476              | 731        | (N/A)          | 1.0              | 1.2           | 66.43        |
| Northern red oak                       | 1.7                     | 132              | 235.4                      | 231              | 363        | (N/A)          | 1.0              | 0.6           | 32.96        |
| Maple                                  | 0.9                     | 66               | 113.3                      | 111              | 177        | (N/A)          | 0.9              | 0.3           | 17.68        |
| White ash                              | 2.0                     | 152              | 267.0                      | 262              | 414        | (N/A)          | 0.7              | 0.7           | 59.11        |
| Mulberry                               | 1.1                     | 81               | 170.9                      | 168              | 249        | (N/A)          | 0.6              | 0.4           | 41.48        |
| Broadleaf Deciduous Small              | 0.3                     | 23               | 52.6                       | 52               | 75         | (N/A)          | 0.6              | 0.1           | 12.42        |
| Elm                                    | 1.9                     | 141              | 249.3                      | 244              | 385        | (N/A)          | 0.6              | 0.6           | 64.14        |
| Red pine                               | 1.0                     | 76               | 132.9                      | 130              | 206        | (N/A)          | 0.6              | 0.3           | 34.32        |
| Catalpa                                | 1.7                     | 132              | 239.0                      | 234              | 367        | (N/A)          | 0.5              | 0.6           | 73.34        |
| Boxelder                               | 0.9                     | 68               | 121.8                      | 119              | 187        | (N/A)          | 0.4              | 0.3           | 46.82        |
| American sycamore                      | 1.6                     | 121              | 217.3                      | 213              | 334        | (N/A)          | 0.4              | 0.5           | 83.39        |
| Ohio buckeye                           | 1.3                     | 97               | 189.7                      | 186              | 283        | (N/A)          | 0.4              | 0.5           | 70.84        |
| Mountain ash                           | 0.5                     | 35               | 69.1                       | 68               | 102        | (N/A)          | 0.3              | 0.2           | 34.15        |
| White oak                              | 1.0                     | 72               | 127.5                      | 125              | 197        | (N/A)          | 0.3              | 0.3           | 65.72        |
| Ginkgo                                 | 0.6                     | 45               | 77.4                       | 76               | 121        | (N/A)          | 0.3              | 0.2           | 40.38        |
| Littleleaf linden                      | 0.9                     | 65               | 125.7                      | 123              | 188        | (N/A)          | 0.3              | 0.3           | 62.69        |
| American chestnut                      | 0.7                     | 54               | 94.4                       | 93               | 147        | (N/A)          | 0.3              | 0.2           | 48.96        |
| Plum                                   | 0.4                     | 28               | 49.3                       | 48               | 76         | (N/A)          | 0.2              | 0.1           | 38.13        |
| Oak                                    | 0.6                     | 45               | 85.0                       | 83               | 128        | (N/A)          | 0.2              | 0.2           | 64.12        |
| Lilac                                  | 0.1                     | 6                | 12.8                       | 13               | 18         | (N/A)          | 0.1              | 0.0           | 18.19        |
| Amur maple                             | 0.2                     | 14               | 24.7                       | 24               | 38         | (N/A)          | 0.1              | 0.1           | 38.13        |
| Eastern redbud                         | 0.1                     | 6                | 12.8                       | 13               | 18         | (N/A)          | 0.1              | 0.0           | 18.19        |
| River birch                            | 0.3                     | 24               | 47.4                       | 46               | 71         | (N/A)          | 0.1              | 0.1           | 70.84        |
| Sweetbay                               | 0.2                     | 17               | 28.2                       | 28               | 44         | (N/A)          | 0.1              | 0.1           | 44.11        |
| Dogwood                                | 0.1                     | 6                | 12.8                       | 13               | 18         | (N/A)          | 0.1              | 0.0           | 18.19        |
| Black cherry                           | 0.2                     | 15               | 31.6                       | 31               | 46         | (N/A)          | 0.1              | 0.1           | 46.14        |
| Swamp white oak                        | 0.0                     | 3                | 6.2                        | 6                | 9          | (N/A)          | 0.1              | 0.0           | 8.99         |
| Conifer Evergreen Large                | 0.1                     | 10               | 14.6                       | 14               | 24         | (N/A)          | 0.1              | 0.0           | 24.14        |
| Broadleaf Deciduous Medium             | 0.3                     | 24               | 47.4                       | 46               | 71         | (N/A)          | 0.1              | 0.1           | 70.84        |
| Eastern cottonwood                     | 0.4                     | 29               | 53.7                       | 53               | 82         | (N/A)          | 0.1              | 0.1           | 82.02        |
| Japanese tree lilac                    | 0.0                     | 2                | 3.8                        | 4                | 5          | (N/A)          | 0.1              | 0.0           | 5.40         |
| Total                                  | 297.1                   | 22,551           | 40,726.2                   | 39,912           | 62,463     | (N/A)          | 100.0            | 100.0         | 58.38        |

**Table 2: Annual Stormwater Benefits**

**Annual Stormwater Benefits of Public Trees**

2/2/2016

| Species                    | Total rainfall interception (Gal) | Total (\$) | Standard Error | % of Total Trees | % of Total \$ | Avg. \$/tree |
|----------------------------|-----------------------------------|------------|----------------|------------------|---------------|--------------|
| Green ash                  | 599,803                           | 16,255     | (N/A)          | 13.4             | 15.5          | 113.67       |
| Silver maple               | 752,298                           | 20,387     | (N/A)          | 12.0             | 19.5          | 159.28       |
| Bur oak                    | 490,919                           | 13,304     | (N/A)          | 11.4             | 12.7          | 109.05       |
| Sugar maple                | 411,857                           | 11,161     | (N/A)          | 9.1              | 10.7          | 115.07       |
| Norway maple               | 252,455                           | 6,842      | (N/A)          | 8.3              | 6.5           | 76.87        |
| Northern hackberry         | 210,760                           | 5,712      | (N/A)          | 4.4              | 5.5           | 121.52       |
| Spruce                     | 139,895                           | 3,791      | (N/A)          | 3.7              | 3.6           | 94.78        |
| Northern white cedar       | 92,390                            | 2,504      | (N/A)          | 3.5              | 2.4           | 67.67        |
| Pin oak                    | 130,028                           | 3,524      | (N/A)          | 3.0              | 3.4           | 110.12       |
| Apple                      | 12,063                            | 327        | (N/A)          | 2.9              | 0.3           | 10.55        |
| Siberian elm               | 68,949                            | 1,869      | (N/A)          | 2.7              | 1.8           | 64.43        |
| Eastern white pine         | 110,724                           | 3,001      | (N/A)          | 2.3              | 2.9           | 120.03       |
| Blue spruce                | 21,746                            | 589        | (N/A)          | 2.3              | 0.6           | 23.57        |
| Eastern red cedar          | 25,728                            | 697        | (N/A)          | 1.9              | 0.7           | 34.86        |
| Hickory                    | 37,134                            | 1,006      | (N/A)          | 1.6              | 1.0           | 59.20        |
| Red maple                  | 32,696                            | 886        | (N/A)          | 1.4              | 0.8           | 59.07        |
| Honeylocust                | 55,692                            | 1,509      | (N/A)          | 1.3              | 1.4           | 107.80       |
| Black walnut               | 44,332                            | 1,201      | (N/A)          | 1.1              | 1.1           | 100.12       |
| Pear                       | 5,692                             | 154        | (N/A)          | 1.1              | 0.1           | 12.85        |
| Cottonwood                 | 68,829                            | 1,865      | (N/A)          | 1.1              | 1.8           | 155.44       |
| Willow                     | 27,783                            | 753        | (N/A)          | 1.1              | 0.7           | 62.74        |
| American basswood          | 38,852                            | 1,053      | (N/A)          | 1.0              | 1.0           | 95.72        |
| Northern red oak           | 13,962                            | 378        | (N/A)          | 1.0              | 0.4           | 34.40        |
| Maple                      | 5,142                             | 139        | (N/A)          | 0.9              | 0.1           | 13.93        |
| White ash                  | 23,126                            | 627        | (N/A)          | 0.7              | 0.6           | 89.53        |
| Mulberry                   | 6,135                             | 166        | (N/A)          | 0.6              | 0.2           | 27.71        |
| Broadleaf Deciduous Small  | 1,073                             | 29         | (N/A)          | 0.6              | 0.0           | 4.85         |
| Elm                        | 22,884                            | 620        | (N/A)          | 0.6              | 0.6           | 103.36       |
| Red pine                   | 22,722                            | 616        | (N/A)          | 0.6              | 0.6           | 102.63       |
| Catalpa                    | 26,067                            | 706        | (N/A)          | 0.5              | 0.7           | 141.28       |
| Boxelder                   | 9,012                             | 244        | (N/A)          | 0.4              | 0.2           | 61.06        |
| American sycamore          | 22,163                            | 601        | (N/A)          | 0.4              | 0.6           | 150.15       |
| Ohio buckeye               | 15,057                            | 408        | (N/A)          | 0.4              | 0.4           | 102.01       |
| Mountain ash               | 2,105                             | 57         | (N/A)          | 0.3              | 0.1           | 19.02        |
| White oak                  | 10,899                            | 295        | (N/A)          | 0.3              | 0.3           | 98.45        |
| Ginkgo                     | 3,815                             | 103        | (N/A)          | 0.3              | 0.1           | 34.46        |
| Littleleaf linden          | 11,232                            | 304        | (N/A)          | 0.3              | 0.3           | 101.46       |
| American chestnut          | 7,564                             | 205        | (N/A)          | 0.3              | 0.2           | 68.33        |
| Plum                       | 1,333                             | 36         | (N/A)          | 0.2              | 0.0           | 18.06        |
| Oak                        | 6,534                             | 177        | (N/A)          | 0.2              | 0.2           | 88.53        |
| Lilac                      | 264                               | 7          | (N/A)          | 0.1              | 0.0           | 7.17         |
| Amur maple                 | 667                               | 18         | (N/A)          | 0.1              | 0.0           | 18.06        |
| Eastern redbud             | 264                               | 7          | (N/A)          | 0.1              | 0.0           | 7.17         |
| River birch                | 3,764                             | 102        | (N/A)          | 0.1              | 0.1           | 102.01       |
| Sweetbay                   | 2,052                             | 56         | (N/A)          | 0.1              | 0.1           | 55.60        |
| Dogwood                    | 264                               | 7          | (N/A)          | 0.1              | 0.0           | 7.17         |
| Black cherry               | 1,174                             | 32         | (N/A)          | 0.1              | 0.0           | 31.82        |
| Swamp white oak            | 163                               | 4          | (N/A)          | 0.1              | 0.0           | 4.41         |
| Conifer Evergreen Large    | 1,539                             | 42         | (N/A)          | 0.1              | 0.0           | 41.70        |
| Broadleaf Deciduous Medium | 3,764                             | 102        | (N/A)          | 0.1              | 0.1           | 102.01       |
| Eastern cottonwood         | 5,491                             | 149        | (N/A)          | 0.1              | 0.1           | 148.79       |
| Japanese tree lilac        | 69                                | 2          | (N/A)          | 0.1              | 0.0           | 1.86         |
| Citywide total             | 3,860,921                         | 104,631    | (N/A)          | 100.0            | 100.0         | 97.79        |

**Table 3: Annual Air Quality Benefits**

**Annual Air Quality Benefits of Public Trees**

2/2/2016

| Species                    | Deposition (lb) |                 |                  |                 | Total Depos. (\$) | Avoided (lb)    |                  |       |                 | Total Avoided (\$) | BVOC Emissions (lb) | BVOC Emissions (\$) | Total (lb) | Total Standard (\$) | 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> |                    |                     |                     |            |                     |                |                  |              |
| Green ash                  | 82.0            | 13.1            | 37.9             | 3.7             | 433               | 226.5           | 32.9             | 31.4  | 214.1           | 1,409              | 0.0                 | 0                   | 641.6      | 1,842               | (N/A)          | 13.4             | 12.88        |
| Silver maple               | 141.6           | 24.0            | 68.3             | 6.3             | 760               | 225.1           | 33.0             | 31.5  | 216.0           | 1,408              | -73.1               | -274                | 672.7      | 1,894               | (N/A)          | 12.0             | 14.80        |
| Bur oak                    | 67.8            | 10.9            | 31.3             | 3.0             | 358               | 185.0           | 26.9             | 25.6  | 175.2           | 1,151              | 0.0                 | 0                   | 525.7      | 1,509               | (N/A)          | 11.4             | 12.37        |
| Sugar maple                | 58.5            | 10.0            | 28.2             | 2.6             | 314               | 150.0           | 21.9             | 20.9  | 143.1           | 936                | -45.2               | -169                | 390.0      | 1,081               | (N/A)          | 9.1              | 11.14        |
| Norway maple               | 55.0            | 9.5             | 26.6             | 2.4             | 296               | 117.2           | 16.9             | 16.1  | 109.4           | 725                | -12.6               | -47                 | 340.5      | 974                 | (N/A)          | 8.3              | 10.94        |
| Northern hackberry         | 37.8            | 6.5             | 18.6             | 1.7             | 204               | 92.0            | 13.4             | 12.7  | 86.9            | 572                | 0.0                 | 0                   | 269.7      | 777                 | (N/A)          | 4.4              | 16.52        |
| Spruce                     | 17.0            | 3.4             | 13.5             | 2.1             | 110               | 29.3            | 4.3              | 4.1   | 28.1            | 183                | -81.4               | -305                | 20.3       | -11                 | (N/A)          | 3.7              | -0.29        |
| Northern white cedar       | 10.9            | 2.2             | 8.8              | 1.3             | 72                | 22.0            | 3.2              | 3.1   | 21.2            | 138                | -50.2               | -188                | 22.5       | 21                  | (N/A)          | 3.5              | 0.56         |
| Pin oak                    | 24.1            | 4.2             | 12.2             | 1.1             | 132               | 50.8            | 7.4              | 7.1   | 48.6            | 318                | -44.4               | -166                | 111.2      | 283                 | (N/A)          | 3.0              | 8.84         |
| Apple                      | 3.4             | 0.6             | 1.7              | 0.2             | 18                | 14.7            | 2.1              | 2.0   | 13.6            | 90                 | 0.0                 | 0                   | 38.2       | 109                 | (N/A)          | 2.9              | 3.51         |
| Siberian elm               | 11.7            | 2.0             | 5.7              | 0.5             | 63                | 29.9            | 4.4              | 4.2   | 28.5            | 187                | 0.0                 | 0                   | 86.7       | 249                 | (N/A)          | 2.7              | 8.60         |
| Eastern white pine         | 13.6            | 2.7             | 10.8             | 1.7             | 89                | 21.1            | 3.1              | 3.0   | 20.3            | 132                | -68.8               | -258                | 7.4        | -37                 | (N/A)          | 2.3              | -1.49        |
| Blue spruce                | 2.4             | 0.5             | 2.2              | 0.3             | 16                | 8.6             | 1.2              | 1.2   | 8.1             | 53                 | -7.3                | -27                 | 17.1       | 42                  | (N/A)          | 2.3              | 1.69         |
| Eastern red cedar          | 5.1             | 1.0             | 4.0              | 0.6             | 33                | 8.6             | 1.2              | 1.2   | 8.0             | 53                 | -14.1               | -53                 | 15.7       | 33                  | (N/A)          | 1.9              | 1.67         |
| Hickory                    | 3.9             | 0.6             | 2.0              | 0.2             | 21                | 19.9            | 2.9              | 2.8   | 19.2            | 125                | 0.0                 | 0                   | 51.5       | 146                 | (N/A)          | 1.6              | 8.58         |
| Red maple                  | 7.9             | 1.4             | 3.7              | 0.4             | 42                | 18.2            | 2.7              | 2.5   | 17.5            | 114                | -2.7                | -10                 | 51.5       | 146                 | (N/A)          | 1.4              | 9.73         |
| Honeylocust                | 11.0            | 1.8             | 5.0              | 0.5             | 58                | 21.7            | 3.2              | 3.0   | 20.8            | 136                | -8.8                | -33                 | 58.3       | 161                 | (N/A)          | 1.3              | 11.48        |
| Black walnut               | 5.8             | 0.9             | 2.7              | 0.3             | 31                | 17.2            | 2.5              | 2.4   | 16.2            | 107                | 0.0                 | 0                   | 48.0       | 138                 | (N/A)          | 1.1              | 11.46        |
| Pear                       | 1.6             | 0.3             | 0.8              | 0.1             | 8                 | 7.1             | 1.0              | 1.0   | 6.6             | 44                 | 0.0                 | 0                   | 18.4       | 52                  | (N/A)          | 1.1              | 4.37         |
| Cottonwood                 | 12.0            | 1.9             | 5.3              | 0.5             | 63                | 23.1            | 3.4              | 3.2   | 21.9            | 144                | 0.0                 | 0                   | 71.3       | 206                 | (N/A)          | 1.1              | 17.21        |
| Willow                     | 5.9             | 1.0             | 2.9              | 0.3             | 32                | 13.7            | 2.0              | 1.9   | 12.8            | 85                 | -1.4                | -5                  | 38.9       | 111                 | (N/A)          | 1.1              | 9.26         |
| American basswood          | 5.4             | 0.9             | 2.6              | 0.2             | 29                | 16.3            | 2.4              | 2.2   | 15.2            | 101                | -4.6                | -17                 | 40.7       | 113                 | (N/A)          | 1.0              | 10.25        |
| Northern red oak           | 2.7             | 0.5             | 1.4              | 0.1             | 15                | 8.3             | 1.2              | 1.1   | 7.9             | 52                 | -3.8                | -14                 | 19.3       | 52                  | (N/A)          | 1.0              | 4.72         |
| Maple                      | 0.9             | 0.1             | 0.5              | 0.0             | 5                 | 4.1             | 0.6              | 0.6   | 3.9             | 26                 | -0.3                | -1                  | 10.4       | 29                  | (N/A)          | 0.9              | 2.91         |
| White ash                  | 3.5             | 0.6             | 1.6              | 0.2             | 19                | 9.5             | 1.4              | 1.3   | 9.1             | 59                 | 0.0                 | 0                   | 27.1       | 78                  | (N/A)          | 0.7              | 11.12        |
| Mulberry                   | 2.2             | 0.4             | 1.0              | 0.1             | 12                | 5.3             | 0.8              | 0.7   | 4.9             | 33                 | 0.0                 | 0                   | 15.3       | 44                  | (N/A)          | 0.6              | 7.38         |
| Broadleaf Deciduous Small  | 0.2             | 0.0             | 0.1              | 0.0             | 1                 | 1.5             | 0.2              | 0.2   | 1.4             | 9                  | 0.0                 | 0                   | 3.7        | 10                  | (N/A)          | 0.6              | 1.73         |
| Elm                        | 3.6             | 0.6             | 1.6              | 0.2             | 19                | 8.8             | 1.3              | 1.2   | 8.4             | 55                 | 0.0                 | 0                   | 25.6       | 74                  | (N/A)          | 0.6              | 12.29        |
| Red pine                   | 2.7             | 0.5             | 2.2              | 0.3             | 18                | 4.7             | 0.7              | 0.7   | 4.5             | 29                 | -12.7               | -48                 | 3.7        | 0                   | (N/A)          | 0.6              | -0.06        |
| Catalpa                    | 3.9             | 0.6             | 1.8              | 0.2             | 21                | 8.3             | 1.2              | 1.2   | 7.9             | 52                 | 0.0                 | 0                   | 25.1       | 72                  | (N/A)          | 0.5              | 14.50        |
| Boxelder                   | 1.1             | 0.2             | 0.5              | 0.1             | 6                 | 4.3             | 0.6              | 0.6   | 4.1             | 27                 | -0.5                | -2                  | 10.9       | 31                  | (N/A)          | 0.4              | 7.69         |
| American sycamore          | 3.7             | 0.6             | 1.6              | 0.2             | 19                | 7.6             | 1.1              | 1.1   | 7.2             | 47                 | 0.0                 | 0                   | 23.0       | 66                  | (N/A)          | 0.4              | 16.61        |
| Ohio buckeye               | 3.5             | 0.6             | 1.6              | 0.2             | 19                | 6.3             | 0.9              | 0.9   | 5.8             | 39                 | -0.8                | -3                  | 18.9       | 54                  | (N/A)          | 0.4              | 13.58        |
| Mountain ash               | 0.7             | 0.1             | 0.3              | 0.0             | 4                 | 2.2             | 0.3              | 0.3   | 2.1             | 14                 | 0.0                 | 0                   | 6.1        | 17                  | (N/A)          | 0.3              | 5.82         |
| White oak                  | 1.4             | 0.2             | 0.7              | 0.1             | 7                 | 4.5             | 0.7              | 0.6   | 4.3             | 28                 | 0.0                 | 0                   | 12.5       | 36                  | (N/A)          | 0.3              | 11.87        |
| Ginkgo                     | 1.0             | 0.2             | 0.5              | 0.0             | 5                 | 2.8             | 0.4              | 0.4   | 2.7             | 18                 | -0.3                | -1                  | 7.7        | 22                  | (N/A)          | 0.3              | 7.22         |
| Littleleaf linden          | 2.2             | 0.4             | 1.0              | 0.1             | 12                | 4.2             | 0.6              | 0.6   | 3.9             | 26                 | -1.0                | -4                  | 11.9       | 34                  | (N/A)          | 0.3              | 11.21        |
| American chestnut          | 0.9             | 0.1             | 0.4              | 0.0             | 5                 | 3.4             | 0.5              | 0.5   | 3.2             | 21                 | 0.0                 | 0                   | 9.2        | 26                  | (N/A)          | 0.3              | 8.71         |
| Plum                       | 0.4             | 0.1             | 0.2              | 0.0             | 2                 | 1.7             | 0.3              | 0.2   | 1.7             | 11                 | 0.0                 | 0                   | 4.6        | 13                  | (N/A)          | 0.2              | 6.56         |
| Oak                        | 0.8             | 0.1             | 0.4              | 0.0             | 4                 | 2.9             | 0.4              | 0.4   | 2.7             | 18                 | 0.0                 | 0                   | 7.6        | 22                  | (N/A)          | 0.2              | 10.91        |
| Lilac                      | 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)          | 0.1              | 2.55         |
| Amur maple                 | 0.2             | 0.0             | 0.1              | 0.0             | 1                 | 0.9             | 0.1              | 0.1   | 0.8             | 5                  | 0.0                 | 0                   | 2.3        | 7                   | (N/A)          | 0.1              | 6.56         |
| Eastern redbud             | 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)          | 0.1              | 2.55         |
| River birch                | 0.9             | 0.1             | 0.4              | 0.0             | 5                 | 1.6             | 0.2              | 0.2   | 1.5             | 10                 | -0.2                | -1                  | 4.7        | 14                  | (N/A)          | 0.1              | 13.58        |
| Sweetbay                   | 0.7             | 0.1             | 0.5              | 0.1             | 4                 | 1.0             | 0.1              | 0.1   | 1.0             | 6                  | 0.0                 | 0                   | 3.7        | 11                  | (N/A)          | 0.1              | 10.84        |
| Dogwood                    | 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)          | 0.1              | 2.55         |
| Black cherry               | 0.4             | 0.1             | 0.2              | 0.0             | 2                 | 1.0             | 0.1              | 0.1   | 0.9             | 6                  | 0.0                 | 0                   | 2.9        | 8                   | (N/A)          | 0.1              | 8.35         |
| Swamp white oak            | 0.0             | 0.0             | 0.0              | 0.0             | 0                 | 0.2             | 0.0              | 0.0   | 0.2             | 1                  | 0.0                 | 0                   | 0.4        | 1                   | (N/A)          | 0.1              | 1.21         |
| Conifer Evergreen Large    | 0.2             | 0.0             | 0.1              | 0.0             | 1                 | 0.6             | 0.1              | 0.1   | 0.6             | 4                  | -0.5                | -2                  | 1.2        | 3                   | (N/A)          | 0.1              | 2.82         |
| Broadleaf Deciduous Medium | 0.9             | 0.1             | 0.4              | 0.0             | 5                 | 1.6             | 0.2              | 0.2   | 1.5             | 10                 | -0.2                | -1                  | 4.7        | 14                  | (N/A)          | 0.1              | 13.58        |
| Eastern cottonwood         | 0.8             | 0.1             | 0.4              | 0.0             | 4                 | 1.9             | 0.3              | 0.3   | 1.8             | 12                 | 0.0                 | 0                   | 5.5        | 16                  | (N/A)          | 0.1              | 15.71        |
| 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              | 0.71         |
| Citywide total             | 623.9           | 105.9           | 314.4            | 31.9            | 3,396             | 1,418.2         | 206.5            | 196.8 | 1,346.0         | 8,834              | -434.9              | -1,631              | 3,808.7    | 10,599              | (N/A)          | 100.0            | 9.91         |

Table 4: Annual Carbon Stored

| <b>Stored CO2 Benefits of Public Trees</b> |                           |               |                   |                     |                  |                 |
|--|---------------------------|---------------|-------------------|---------------------|------------------|-----------------|
| 2/2/2016                                   |                           |               |                   |                     |                  |                 |
| Species                                    | Total Stored<br>CO2 (lbs) | Total<br>(\$) | Standard<br>Error | % of Total<br>Trees | % of<br>Total \$ | Avg.<br>\$/tree |
| Green ash                                  | 2,685,147                 | 20,139        | (N/A)             | 13.4                | 17.7             | 140.83          |
| Silver maple                               | 3,365,111                 | 25,238        | (N/A)             | 12.0                | 22.1             | 197.17          |
| Bur oak                                    | 2,229,858                 | 16,724        | (N/A)             | 11.4                | 14.7             | 137.08          |
| Sugar maple                                | 1,693,154                 | 12,699        | (N/A)             | 9.1                 | 11.1             | 130.91          |
| Norway maple                               | 908,363                   | 6,813         | (N/A)             | 8.3                 | 6.0              | 76.55           |
| Northern hackberry                         | 601,282                   | 4,510         | (N/A)             | 4.4                 | 4.0              | 95.95           |
| Spruce                                     | 209,317                   | 1,570         | (N/A)             | 3.7                 | 1.4              | 39.25           |
| Northern white cedar                       | 126,352                   | 948           | (N/A)             | 3.5                 | 0.8              | 25.61           |
| Pin oak                                    | 649,617                   | 4,872         | (N/A)             | 3.0                 | 4.3              | 152.25          |
| Apple                                      | 55,054                    | 413           | (N/A)             | 2.9                 | 0.4              | 13.32           |
| Siberian elm                               | 284,232                   | 2,132         | (N/A)             | 2.7                 | 1.9              | 73.51           |
| Eastern white pine                         | 179,805                   | 1,349         | (N/A)             | 2.3                 | 1.2              | 53.94           |
| Blue spruce                                | 12,957                    | 97            | (N/A)             | 2.3                 | 0.1              | 3.89            |
| Eastern red cedar                          | 16,583                    | 124           | (N/A)             | 1.9                 | 0.1              | 6.22            |
| Hickory                                    | 127,822                   | 959           | (N/A)             | 1.6                 | 0.8              | 56.39           |
| Red maple                                  | 85,526                    | 641           | (N/A)             | 1.4                 | 0.6              | 42.76           |
| Honeylocust                                | 143,252                   | 1,074         | (N/A)             | 1.3                 | 0.9              | 76.74           |
| Black walnut                               | 188,993                   | 1,417         | (N/A)             | 1.1                 | 1.2              | 118.12          |
| Pear                                       | 25,247                    | 189           | (N/A)             | 1.1                 | 0.2              | 15.78           |
| Cottonwood                                 | 409,818                   | 3,074         | (N/A)             | 1.1                 | 2.7              | 256.14          |
| Willow                                     | 96,758                    | 726           | (N/A)             | 1.1                 | 0.6              | 60.47           |
| American basswood                          | 199,101                   | 1,493         | (N/A)             | 1.0                 | 1.3              | 135.75          |
| Northern red oak                           | 53,766                    | 403           | (N/A)             | 1.0                 | 0.4              | 36.66           |
| Maple                                      | 10,635                    | 80            | (N/A)             | 0.9                 | 0.1              | 7.98            |
| White ash                                  | 65,454                    | 491           | (N/A)             | 0.7                 | 0.4              | 70.13           |
| Mulberry                                   | 34,621                    | 260           | (N/A)             | 0.6                 | 0.2              | 43.28           |
| Broadleaf Deciduous                        | 3,659                     | 27            | (N/A)             | 0.6                 | 0.0              | 4.57            |
| Elm  | 121,032                   | 908           | (N/A)             | 0.6                 | 0.8              | 151.29          |
| Red pine                                   | 32,499                    | 244           | (N/A)             | 0.6                 | 0.2              | 40.62           |
| Catalpa                                    | 131,438                   | 986           | (N/A)             | 0.5                 | 0.9              | 197.16          |
| Boxelder                                   | 33,795                    | 253           | (N/A)             | 0.4                 | 0.2              | 63.37           |
| American sycamore                          | 123,641                   | 927           | (N/A)             | 0.4                 | 0.8              | 231.83          |
| Ohio buckeye                               | 57,121                    | 428           | (N/A)             | 0.4                 | 0.4              | 107.10          |
| Mountain ash                               | 10,688                    | 80            | (N/A)             | 0.3                 | 0.1              | 26.72           |
| White oak                                  | 45,388                    | 340           | (N/A)             | 0.3                 | 0.3              | 113.47          |
| Ginkgo                                     | 13,790                    | 103           | (N/A)             | 0.3                 | 0.1              | 34.48           |
| Littleleaf linden                          | 45,717                    | 343           | (N/A)             | 0.3                 | 0.3              | 114.29          |
| American chestnut                          | 30,650                    | 230           | (N/A)             | 0.3                 | 0.2              | 76.62           |
| Plum                                       | 6,074                     | 46            | (N/A)             | 0.2                 | 0.0              | 22.78           |
| Oak  | 24,230                    | 182           | (N/A)             | 0.2                 | 0.2              | 90.86           |
| Lilac                                      | 908                       | 7             | (N/A)             | 0.1                 | 0.0              | 6.81            |
| Amur maple                                 | 3,037                     | 23            | (N/A)             | 0.1                 | 0.0              | 22.78           |
| Eastern redbud                             | 908                       | 7             | (N/A)             | 0.1                 | 0.0              | 6.81            |
| River birch                                | 14,280                    | 107           | (N/A)             | 0.1                 | 0.1              | 107.10          |
| Sweetbay                                   | 6,743                     | 51            | (N/A)             | 0.1                 | 0.0              | 50.57           |
| Dogwood                                    | 908                       | 7             | (N/A)             | 0.1                 | 0.0              | 6.81            |
| Black cherry                               | 6,743                     | 51            | (N/A)             | 0.1                 | 0.0              | 50.57           |
| Swamp white oak                            | 218                       | 2             | (N/A)             | 0.1                 | 0.0              | 1.64            |
| Conifer Evergreen La                       | 1,170                     | 9             | (N/A)             | 0.1                 | 0.0              | 8.78            |
| Broadleaf Deciduous                        | 14,280                    | 107           | (N/A)             | 0.1                 | 0.1              | 107.10          |
| Eastern cottonwood                         | 25,943                    | 195           | (N/A)             | 0.1                 | 0.2              | 194.57          |
| Japanese tree lilac                        | 178                       | 1             | (N/A)             | 0.1                 | 0.0              | 1.33            |
| Citywide total                             | 15,212,862                | 114,096       | (N/A)             | 100.0               | 100.0            | 106.63          |



**Table 5: Annual Carbon Sequestered**

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

2/2/2016

| Species                  | Sequestered (lb) | Sequestered (\$) | Decomposition Release (lb) | Maintenance Release (lb) | Total Released (\$) | Avoided (lb) | Avoided (\$) | Net Total (lb) | Total Standard (\$) | Standard Error | % of Total Trees | % of Total \$ | Avg. \$/tree |
|--------------------------|------------------|------------------|----------------------------|--------------------------|---------------------|--------------|--------------|----------------|---------------------|----------------|------------------|---------------|--------------|
| Green ash                | 114,120          | 856              | -12,889                    | -511                     | -100                | 79,249       | 594          | 179,970        | 1,350               | (N/A)          | 13.4             | 15.5          | 9.44         |
| Silver maple             | 226,408          | 1,698            | -16,153                    | -558                     | -125                | 80,114       | 601          | 289,812        | 2,174               | (N/A)          | 12.0             | 25.0          | 16.98        |
| Bur oak                  | 91,597           | 687              | -10,704                    | -418                     | -83                 | 64,839       | 486          | 145,315        | 1,090               | (N/A)          | 11.4             | 12.5          | 8.93         |
| Sugar maple              | 79,009           | 593              | -8,127                     | -354                     | -64                 | 52,991       | 397          | 123,518        | 926                 | (N/A)          | 9.1              | 10.6          | 9.55         |
| Norway maple             | 25,136           | 189              | -4,361                     | -269                     | -35                 | 40,446       | 303          | 60,952         | 457                 | (N/A)          | 8.3              | 5.3           | 5.14         |
| Northern hackberry       | 25,939           | 195              | -2,886                     | -188                     | -23                 | 32,147       | 241          | 55,011         | 413                 | (N/A)          | 4.4              | 4.7           | 8.78         |
| Spruce                   | 5,296            | 40               | -1,005                     | -125                     | -8                  | 10,414       | 78           | 14,581         | 109                 | (N/A)          | 3.7              | 1.3           | 2.73         |
| Northern white cedar     | 3,313            | 25               | -606                       | -96                      | -5                  | 7,836        | 59           | 10,447         | 78                  | (N/A)          | 3.5              | 0.9           | 2.12         |
| Pin oak                  | 56,578           | 424              | -3,118                     | -117                     | -24                 | 18,003       | 135          | 71,346         | 535                 | (N/A)          | 3.0              | 6.2           | 16.72        |
| Apple                    | 4,558            | 34               | -264                       | -41                      | -2                  | 5,023        | 38           | 9,274          | 70                  | (N/A)          | 2.9              | 0.8           | 2.24         |
| Siberian elm             | 12,332           | 92               | -1,370                     | -72                      | -11                 | 10,548       | 79           | 21,439         | 161                 | (N/A)          | 2.7              | 1.8           | 5.54         |
| Eastern white pine       | 1,554            | 12               | -863                       | -107                     | -7                  | 7,501        | 56           | 8,085          | 61                  | (N/A)          | 2.3              | 0.7           | 2.43         |
| Blue spruce              | 1,206            | 9                | -62                        | -31                      | -1                  | 2,998        | 22           | 4,111          | 31                  | (N/A)          | 2.3              | 0.4           | 1.23         |
| Eastern red cedar        | 302              | 2                | -80                        | -33                      | -1                  | 2,976        | 22           | 3,166          | 24                  | (N/A)          | 1.9              | 0.3           | 1.19         |
| Hickory                  | 9,258            | 69               | -614                       | -40                      | -5                  | 7,105        | 53           | 15,710         | 118                 | (N/A)          | 1.6              | 1.4           | 6.93         |
| Red maple                | 5,708            | 43               | -411                       | -34                      | -3                  | 6,461        | 48           | 11,725         | 88                  | (N/A)          | 1.4              | 1.0           | 5.86         |
| Honeylocust              | 4,311            | 32               | -688                       | -35                      | -5                  | 7,724        | 58           | 11,312         | 85                  | (N/A)          | 1.3              | 1.0           | 6.06         |
| Black walnut             | 8,853            | 66               | -907                       | -39                      | -7                  | 5,996        | 45           | 13,902         | 104                 | (N/A)          | 1.1              | 1.2           | 8.69         |
| Pear                     | 1,868            | 14               | -121                       | -20                      | -1                  | 2,438        | 18           | 4,165          | 31                  | (N/A)          | 1.1              | 0.4           | 2.60         |
| Cottonwood               | 8,945            | 67               | -1,967                     | -55                      | -15                 | 8,119        | 61           | 15,041         | 113                 | (N/A)          | 1.1              | 1.3           | 9.40         |
| Willow                   | 2,535            | 19               | -464                       | -33                      | -4                  | 4,722        | 35           | 6,760          | 51                  | (N/A)          | 1.1              | 0.6           | 4.22         |
| American basswood        | 11,491           | 86               | -956                       | -39                      | -7                  | 5,627        | 42           | 16,123         | 121                 | (N/A)          | 1.0              | 1.4           | 10.99        |
| Northern red oak         | 2,240            | 17               | -258                       | -21                      | -2                  | 2,914        | 22           | 4,875          | 37                  | (N/A)          | 1.0              | 0.4           | 3.32         |
| Maple                    | 1,476            | 11               | -51                        | -8                       | 0                   | 1,452        | 11           | 2,869          | 22                  | (N/A)          | 0.9              | 0.2           | 2.15         |
| White ash                | 5,883            | 44               | -315                       | -18                      | -2                  | 3,361        | 25           | 8,911          | 67                  | (N/A)          | 0.7              | 0.8           | 9.55         |
| Mulberry                 | 592              | 4                | -166                       | -18                      | -1                  | 1,798        | 13           | 2,206          | 17                  | (N/A)          | 0.6              | 0.2           | 2.76         |
| Broadleaf Deciduous Smal | 473              | 4                | -18                        | -5                       | 0                   | 508          | 4            | 958            | 7                   | (N/A)          | 0.6              | 0.1           | 1.20         |
| Elm                      | 3,712            | 28               | -581                       | -20                      | -5                  | 3,106        | 23           | 6,217          | 47                  | (N/A)          | 0.6              | 0.5           | 7.77         |
| Red pine                 | 1,074            | 8                | -156                       | -20                      | -1                  | 1,672        | 13           | 2,571          | 19                  | (N/A)          | 0.6              | 0.2           | 3.21         |
| Catalpa                  | 3,952            | 30               | -631                       | -20                      | -5                  | 2,927        | 22           | 6,229          | 47                  | (N/A)          | 0.5              | 0.5           | 9.34         |
| Boxelder                 | 2,845            | 21               | -162                       | -11                      | -1                  | 1,501        | 11           | 4,174          | 31                  | (N/A)          | 0.4              | 0.4           | 7.83         |
| American sycamore        | 3,255            | 24               | -593                       | -18                      | -5                  | 2,665        | 20           | 5,309          | 40                  | (N/A)          | 0.4              | 0.5           | 9.95         |
| Ohio buckeye             | 1,110            | 8                | -274                       | -15                      | -2                  | 2,154        | 16           | 2,975          | 22                  | (N/A)          | 0.4              | 0.3           | 5.58         |
| Mountain ash             | 860              | 6                | -51                        | -6                       | 0                   | 767          | 6            | 1,570          | 12                  | (N/A)          | 0.3              | 0.1           | 3.93         |
| White oak                | 2,262            | 17               | -218                       | -10                      | -2                  | 1,595        | 12           | 3,629          | 27                  | (N/A)          | 0.3              | 0.3           | 9.07         |
| Ginkgo                   | 360              | 3                | -66                        | -8                       | -1                  | 1,000        | 7            | 1,285          | 10                  | (N/A)          | 0.3              | 0.1           | 3.21         |
| Littleleaf linden        | 1,118            | 8                | -219                       | -12                      | -2                  | 1,433        | 11           | 2,320          | 17                  | (N/A)          | 0.3              | 0.2           | 5.80         |
| American chestnut        | 1,614            | 12               | -147                       | -7                       | -1                  | 1,202        | 9            | 2,661          | 20                  | (N/A)          | 0.3              | 0.2           | 6.65         |
| Plum                     | 535              | 4                | -29                        | -4                       | 0                   | 617          | 5            | 1,119          | 8                   | (N/A)          | 0.2              | 0.1           | 4.20         |
| Oak                      | 1,517            | 11               | -116                       | -6                       | -1                  | 994          | 7            | 2,388          | 18                  | (N/A)          | 0.2              | 0.2           | 8.95         |
| Lilac                    | 114              | 1                | -4                         | -1                       | 0                   | 124          | 1            | 232            | 2                   | (N/A)          | 0.1              | 0.0           | 1.74         |
| Amur maple               | 268              | 2                | -15                        | -2                       | 0                   | 308          | 2            | 560            | 4                   | (N/A)          | 0.1              | 0.0           | 4.20         |
| Eastern redbud           | 114              | 1                | -4                         | -1                       | 0                   | 124          | 1            | 232            | 2                   | (N/A)          | 0.1              | 0.0           | 1.74         |
| River birch              | 0                | 0                | -69                        | -4                       | -1                  | 539          | 4            | 466            | 3                   | (N/A)          | 0.1              | 0.0           | 3.49         |
| Sweetbay                 | 325              | 2                | -32                        | -2                       | 0                   | 365          | 3            | 656            | 5                   | (N/A)          | 0.1              | 0.1           | 4.92         |
| Dogwood                  | 114              | 1                | -4                         | -1                       | 0                   | 124          | 1            | 232            | 2                   | (N/A)          | 0.1              | 0.0           | 1.74         |
| Black cherry             | 478              | 4                | -32                        | -3                       | 0                   | 335          | 3            | 778            | 6                   | (N/A)          | 0.1              | 0.1           | 5.84         |
| Swamp white oak          | 96               | 1                | -2                         | -1                       | 0                   | 65           | 0            | 158            | 1                   | (N/A)          | 0.1              | 0.0           | 1.18         |
| Conifer Evergreen Large  | 116              | 1                | -6                         | -2                       | 0                   | 216          | 2            | 324            | 2                   | (N/A)          | 0.1              | 0.0           | 2.43         |
| Broadleaf Deciduous Medi | 370              | 3                | -69                        | -4                       | -1                  | 539          | 4            | 837            | 6                   | (N/A)          | 0.1              | 0.1           | 6.27         |
| Eastern cottonwood       | 960              | 7                | -125                       | -4                       | -1                  | 650          | 5            | 1,481          | 11                  | (N/A)          | 0.1              | 0.1           | 11.11        |
| Japanese tree lilac      | 38               | 0                | -1                         | -1                       | 0                   | 37           | 0            | 74             | 1                   | (N/A)          | 0.1              | 0.0           | 0.55         |
| Citywide total           | 738,187          | 5,536            | -73,031                    | -3,467                   | -574                | 498,372      | 3,738        | 1,160,062      | 8,700               | (N/A)          | 100.0            | 100.0         | 8.13         |

**Table 6: Annual Social and Aesthetic Benefits**

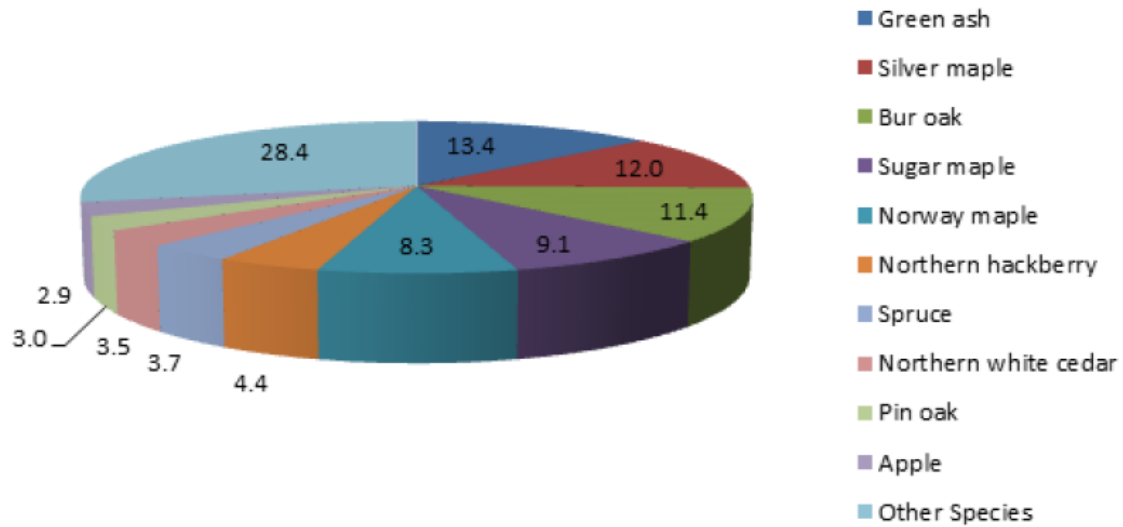
| <b>Annual Aesthetic/Other Benefits of Public Trees</b> |            |                |                  |               |              |
|--|------------|----------------|------------------|---------------|--------------|
| 2/2/2016   |            |                |                  |               |              |
| Species  | Total (\$) | Standard Error | % of Total Trees | % of Total \$ | Avg. \$/tree |
| Green ash  | 8,626      | (N/A)          | 13.4             | 14.0          | 60.32        |
| Silver maple   | 16,377     | (N/A)          | 12.0             | 26.6          | 127.94       |
| Bur oak  | 6,963      | (N/A)          | 11.4             | 11.3          | 57.07        |
| Sugar maple  | 7,865      | (N/A)          | 9.1              | 12.8          | 81.08        |
| Norway maple   | 2,323      | (N/A)          | 8.3              | 3.8           | 26.11        |
| Northern hackberry                                     | 3,159      | (N/A)          | 4.4              | 5.1           | 67.22        |
| Spruce   | 866        | (N/A)          | 3.7              | 1.4           | 21.66        |
| Northern white cedar                                   | 734        | (N/A)          | 3.5              | 1.2           | 19.83        |
| Pin oak  | 4,193      | (N/A)          | 3.0              | 6.8           | 131.04       |
| Apple  | 262        | (N/A)          | 2.9              | 0.4           | 8.45         |
| Siberian elm   | 961        | (N/A)          | 2.7              | 1.6           | 33.14        |
| Eastern white pine                                     | 164        | (N/A)          | 2.3              | 0.3           | 6.58         |
| Blue spruce  | 484        | (N/A)          | 2.3              | 0.8           | 19.35        |
| Eastern red cedar                                      | 144        | (N/A)          | 1.9              | 0.2           | 7.20         |
| Hickory  | 845        | (N/A)          | 1.6              | 1.4           | 49.68        |
| Red maple  | 730        | (N/A)          | 1.4              | 1.2           | 48.66        |
| Honeylocust  | 1,035      | (N/A)          | 1.3              | 1.7           | 73.96        |
| Black walnut   | 692        | (N/A)          | 1.1              | 1.1           | 57.67        |
| Pear   | 107        | (N/A)          | 1.1              | 0.2           | 8.90         |
| Cottonwood   | 621        | (N/A)          | 1.1              | 1.0           | 51.75        |
| Willow   | 251        | (N/A)          | 1.1              | 0.4           | 20.92        |
| American basswood                                      | 808        | (N/A)          | 1.0              | 1.3           | 73.42        |
| Northern red oak                                       | 196        | (N/A)          | 1.0              | 0.3           | 17.79        |
| Maple  | 221        | (N/A)          | 0.9              | 0.4           | 22.15        |
| White ash  | 628        | (N/A)          | 0.7              | 1.0           | 89.71        |
| Mulberry   | 35         | (N/A)          | 0.6              | 0.1           | 5.87         |
| Broadleaf/Deciduous Small                              | 26         | (N/A)          | 0.6              | 0.0           | 4.28         |
| Elm  | 294        | (N/A)          | 0.6              | 0.5           | 48.98        |
| Red pine   | 194        | (N/A)          | 0.6              | 0.3           | 32.29        |
| Catalpa  | 278        | (N/A)          | 0.5              | 0.5           | 55.69        |
| Boxelder   | 208        | (N/A)          | 0.4              | 0.3           | 52.01        |
| American sycamore                                      | 227        | (N/A)          | 0.4              | 0.4           | 56.84        |
| Ohio buckeye   | 94         | (N/A)          | 0.4              | 0.2           | 23.60        |
| Mountain ash   | 51         | (N/A)          | 0.3              | 0.1           | 16.89        |
| White oak  | 178        | (N/A)          | 0.3              | 0.3           | 59.35        |
| Ginkgo   | 30         | (N/A)          | 0.3              | 0.0           | 9.85         |
| Littleleaf linden                                      | 106        | (N/A)          | 0.3              | 0.2           | 35.34        |
| American chestnut                                      | 141        | (N/A)          | 0.3              | 0.2           | 47.00        |
| Plum   | 31         | (N/A)          | 0.2              | 0.1           | 15.48        |
| Oak  | 123        | (N/A)          | 0.2              | 0.2           | 61.64        |
| Lilac  | 6          | (N/A)          | 0.1              | 0.0           | 6.40         |
| Amur maple   | 15         | (N/A)          | 0.1              | 0.0           | 15.48        |
| Eastern redbud   | 6          | (N/A)          | 0.1              | 0.0           | 6.40         |
| River birch  | 0          | (N/A)          | 0.1              | 0.0           | 0.00         |
| Sweetbay   | 27         | (N/A)          | 0.1              | 0.0           | 27.26        |
| Dogwood  | 6          | (N/A)          | 0.1              | 0.0           | 6.40         |
| Black cherry   | 29         | (N/A)          | 0.1              | 0.0           | 28.80        |
| Swamp white oak  | 13         | (N/A)          | 0.1              | 0.0           | 12.89        |
| Conifer Evergreen Large                                | 32         | (N/A)          | 0.1              | 0.1           | 32.32        |
| Broadleaf/Deciduous Medium                             | 31         | (N/A)          | 0.1              | 0.1           | 31.46        |
| Eastern cottonwood                                     | 67         | (N/A)          | 0.1              | 0.1           | 66.60        |
| Japanese tree lilac                                    | 2          | (N/A)          | 0.1              | 0.0           | 2.06         |
| Citywide total   | 61,508     | (N/A)          | 100.0            | 100.0         | 57.48        |

**Table 7: Summary of Benefits in Dollars**

| <b>Total Annual Benefits of Public Trees by Species (\$)</b> |               |                 |               |                |                 |                |                |               |
|--|---------------|-----------------|---------------|----------------|-----------------|----------------|----------------|---------------|
| 2/2/2016   |               |                 |               |                |                 |                |                |               |
| Species  | Energy        | CO <sub>2</sub> | Air Quality   | Stormwater     | Aesthetic/Other | Total (\$)     | Standard Error | % of Total \$ |
| Green ash  | 10,024        | 1,350           | 1,842         | 16,255         | 8,626           | 38,096         | (N/A)          | 15.4          |
| Silver maple   | 9,782         | 2,174           | 1,894         | 20,387         | 16,377          | 50,614         | (N/A)          | 20.4          |
| Bur oak  | 8,161         | 1,090           | 1,509         | 13,304         | 6,963           | 31,027         | (N/A)          | 12.5          |
| Sugar maple  | 6,568         | 926             | 1,081         | 11,161         | 7,865           | 27,602         | (N/A)          | 11.1          |
| Norway maple   | 5,274         | 457             | 974           | 6,842          | 2,323           | 15,870         | (N/A)          | 6.4           |
| Northern hackberry   | 4,066         | 413             | 777           | 5,712          | 3,159           | 14,126         | (N/A)          | 5.7           |
| Spruce   | 1,271         | 109             | -11           | 3,791          | 866             | 6,026          | (N/A)          | 2.4           |
| Northern white cedar   | 948           | 78              | 21            | 2,504          | 734             | 4,285          | (N/A)          | 1.7           |
| Pin oak  | 2,214         | 535             | 283           | 3,524          | 4,193           | 10,749         | (N/A)          | 4.3           |
| Apple  | 670           | 70              | 109           | 327            | 262             | 1,438          | (N/A)          | 0.6           |
| Siberian elm   | 1,312         | 161             | 249           | 1,869          | 961             | 4,552          | (N/A)          | 1.8           |
| Eastern white pine   | 922           | 61              | -37           | 3,001          | 164             | 4,110          | (N/A)          | 1.7           |
| Blue spruce  | 385           | 31              | 42            | 589            | 484             | 1,531          | (N/A)          | 0.6           |
| Eastern red cedar  | 394           | 24              | 33            | 697            | 144             | 1,293          | (N/A)          | 0.5           |
| Hickory  | 849           | 118             | 146           | 1,006          | 845             | 2,964          | (N/A)          | 1.2           |
| Red maple  | 787           | 88              | 146           | 886            | 730             | 2,637          | (N/A)          | 1.1           |
| Honeylocust  | 942           | 85              | 161           | 1,509          | 1,035           | 3,732          | (N/A)          | 1.5           |
| Black walnut   | 766           | 104             | 138           | 1,201          | 692             | 2,901          | (N/A)          | 1.2           |
| Pear   | 326           | 31              | 52            | 154            | 107             | 671            | (N/A)          | 0.3           |
| Cottonwood   | 1,010         | 113             | 206           | 1,865          | 621             | 3,816          | (N/A)          | 1.5           |
| Willow   | 615           | 51              | 111           | 753            | 251             | 1,781          | (N/A)          | 0.7           |
| American basswood  | 731           | 121             | 113           | 1,053          | 808             | 2,825          | (N/A)          | 1.1           |
| Northern red oak   | 363           | 37              | 52            | 378            | 196             | 1,025          | (N/A)          | 0.4           |
| Maple  | 177           | 22              | 29            | 139            | 221             | 588            | (N/A)          | 0.2           |
| White ash  | 414           | 67              | 78            | 627            | 628             | 1,813          | (N/A)          | 0.7           |
| Mulberry   | 249           | 17              | 44            | 166            | 35              | 511            | (N/A)          | 0.2           |
| Broadleaf Deciduous Sp                                       | 75            | 7               | 10            | 29             | 26              | 147            | (N/A)          | 0.1           |
| Elm  | 385           | 47              | 74            | 620            | 294             | 1,419          | (N/A)          | 0.6           |
| Red pine   | 206           | 19              | 0             | 616            | 194             | 1,034          | (N/A)          | 0.4           |
| Catalpa  | 367           | 47              | 72            | 706            | 278             | 1,471          | (N/A)          | 0.6           |
| Boxelder   | 187           | 31              | 31            | 244            | 208             | 702            | (N/A)          | 0.3           |
| American sycamore  | 334           | 40              | 66            | 601            | 227             | 1,268          | (N/A)          | 0.5           |
| Ohio buckeye   | 283           | 22              | 54            | 408            | 94              | 862            | (N/A)          | 0.3           |
| Mountain ash   | 102           | 12              | 17            | 57             | 51              | 239            | (N/A)          | 0.1           |
| White oak  | 197           | 27              | 36            | 295            | 178             | 733            | (N/A)          | 0.3           |
| Ginkgo   | 121           | 10              | 22            | 103            | 30              | 285            | (N/A)          | 0.1           |
| Littleleaf linden  | 188           | 17              | 34            | 304            | 106             | 649            | (N/A)          | 0.3           |
| American chestnut  | 147           | 20              | 26            | 205            | 141             | 539            | (N/A)          | 0.2           |
| Plum   | 76            | 8               | 13            | 36             | 31              | 165            | (N/A)          | 0.1           |
| Oak  | 128           | 18              | 22            | 177            | 123             | 468            | (N/A)          | 0.2           |
| Lilac  | 18            | 2               | 3             | 7              | 6               | 36             | (N/A)          | 0.0           |
| Amur maple   | 38            | 4               | 7             | 18             | 15              | 82             | (N/A)          | 0.0           |
| Eastern redbud   | 18            | 2               | 3             | 7              | 6               | 36             | (N/A)          | 0.0           |
| River birch  | 71            | 3               | 14            | 102            | 0               | 190            | (N/A)          | 0.1           |
| Sweetbay   | 44            | 5               | 11            | 56             | 27              | 143            | (N/A)          | 0.1           |
| Dogwood  | 18            | 2               | 3             | 7              | 6               | 36             | (N/A)          | 0.0           |
| Black cherry   | 46            | 6               | 8             | 32             | 29              | 121            | (N/A)          | 0.0           |
| Swamp white oak  | 9             | 1               | 1             | 4              | 13              | 29             | (N/A)          | 0.0           |
| Conifer Evergreen Large                                      | 24            | 2               | 3             | 42             | 32              | 103            | (N/A)          | 0.0           |
| Broadleaf Deciduous Me                                       | 71            | 6               | 14            | 102            | 31              | 224            | (N/A)          | 0.1           |
| Eastern cottonwood   | 82            | 11              | 16            | 149            | 67              | 324            | (N/A)          | 0.1           |
| Japanese tree lilac  | 5             | 1               | 1             | 2              | 2               | 11             | (N/A)          | 0.0           |
| <b>Citywide Total</b>  | <b>62,463</b> | <b>8,700</b>    | <b>10,599</b> | <b>104,631</b> | <b>61,508</b>   | <b>247,901</b> | <b>(N/A)</b>   | <b>100.0</b>  |

# Species Distribution of Public Trees

2/2/2016

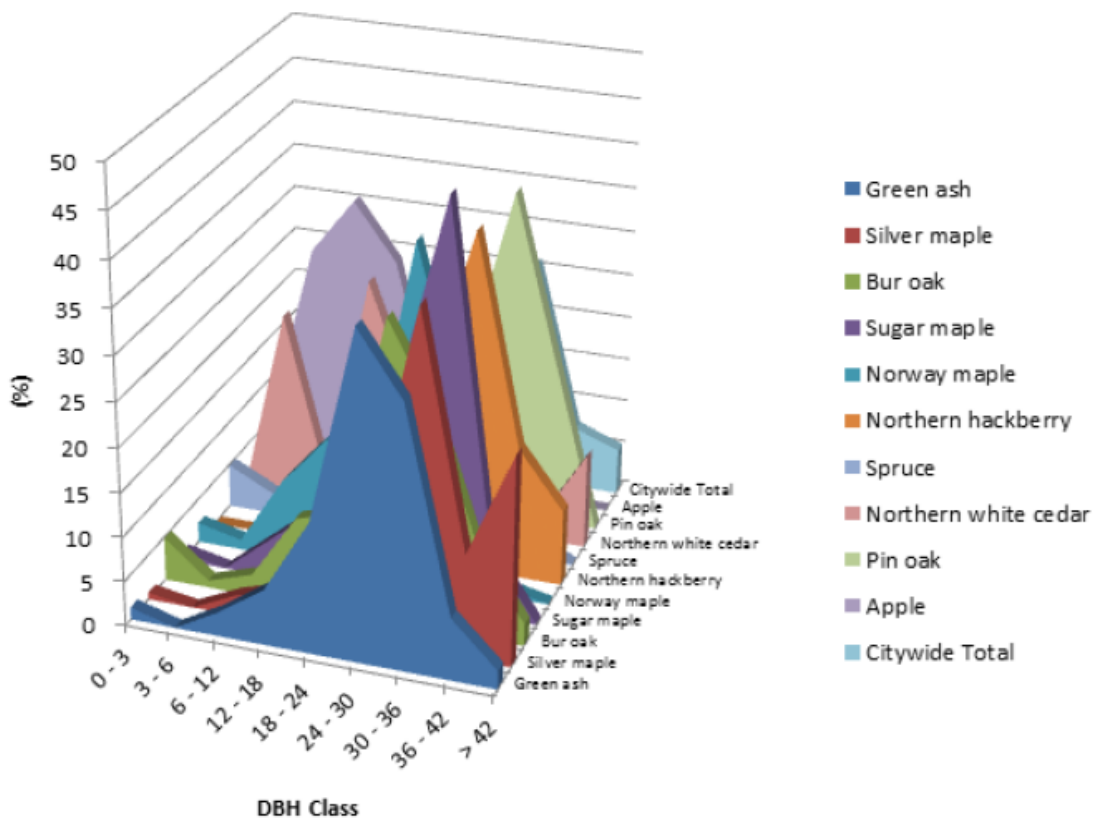


| Species              | Percent |
|----------------------|---------|
| Green ash            | 13.4    |
| Silver maple         | 12.0    |
| Bur oak              | 11.4    |
| Sugar maple          | 9.1     |
| Norway maple         | 8.3     |
| Northern hackberry   | 4.4     |
| Spruce               | 3.7     |
| Northern white cedar | 3.5     |
| Pin oak              | 3.0     |
| Apple                | 2.9     |
| Other Species        | 28.4    |
| Total                | 100.0   |

Figure 1: Species Distribution

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

2/2/2016



| Species              | DBH class (in) |       |       |       |       |       |       |       |       |
|----------------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                      | 0-3            | 3-6   | 6-12  | 12-18 | 18-24 | 24-30 | 30-36 | 36-42 | > 42  |
| Green ash            | 1.40           | 0.00  | 2.80  | 6.29  | 14.69 | 36.36 | 29.37 | 6.99  | 2.10  |
| Silver maple         | 0.78           | 0.00  | 2.34  | 3.91  | 4.69  | 15.63 | 37.50 | 11.72 | 23.44 |
| Bur oak              | 4.92           | 0.82  | 2.46  | 9.84  | 11.48 | 33.61 | 24.59 | 9.84  | 2.46  |
| Sugar maple          | 1.03           | 0.00  | 4.12  | 8.25  | 8.25  | 25.77 | 45.36 | 7.22  | 0.00  |
| Norway maple         | 2.25           | 1.12  | 8.99  | 14.61 | 13.48 | 38.20 | 20.22 | 1.12  | 0.00  |
| Northern hackberry   | 0.00           | 0.00  | 0.00  | 12.77 | 4.26  | 21.28 | 38.30 | 14.89 | 8.51  |
| Spruce               | 5.00           | 2.50  | 2.50  | 12.50 | 17.50 | 32.50 | 25.00 | 2.50  | 0.00  |
| Northern white cedar | 0.00           | 21.62 | 2.70  | 27.03 | 13.51 | 10.81 | 10.81 | 2.70  | 10.81 |
| Pin oak              | 3.13           | 3.13  | 3.13  | 6.25  | 9.38  | 18.75 | 37.50 | 18.75 | 0.00  |
| Apple                | 6.45           | 25.81 | 32.26 | 25.81 | 6.45  | 3.23  | 0.00  | 0.00  | 0.00  |
| Citywide Total       | 2.62           | 3.83  | 8.41  | 11.68 | 10.47 | 24.77 | 25.89 | 7.10  | 5.23  |

Figure 2: Relative Age Class

### Citywide total

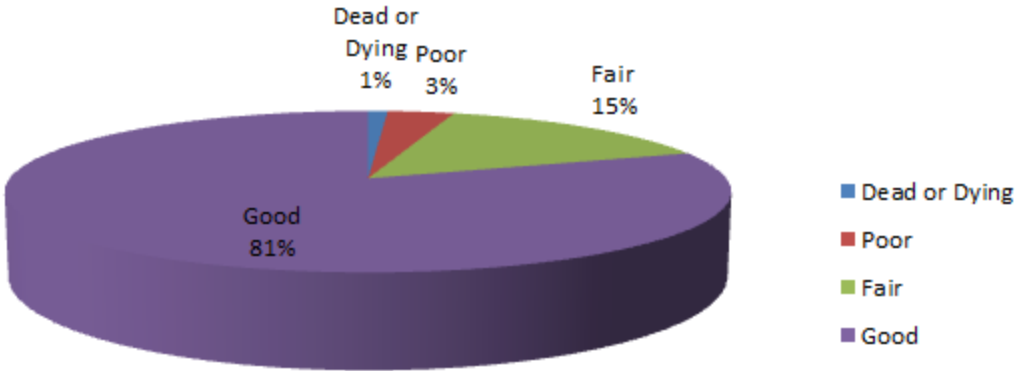


Figure 3: Foliage Condition

### Citywide total

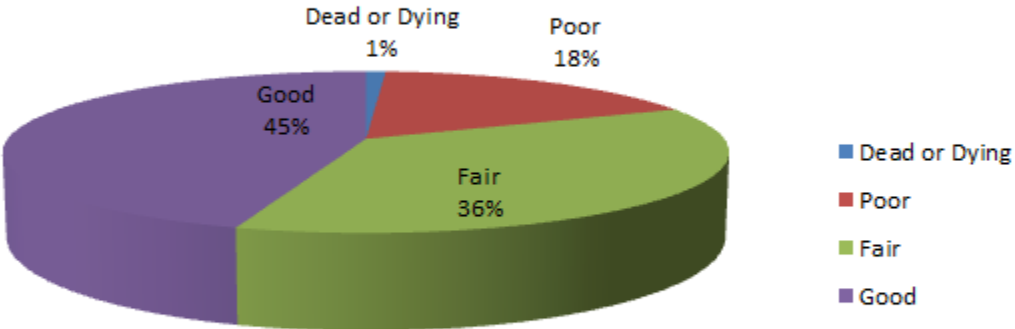
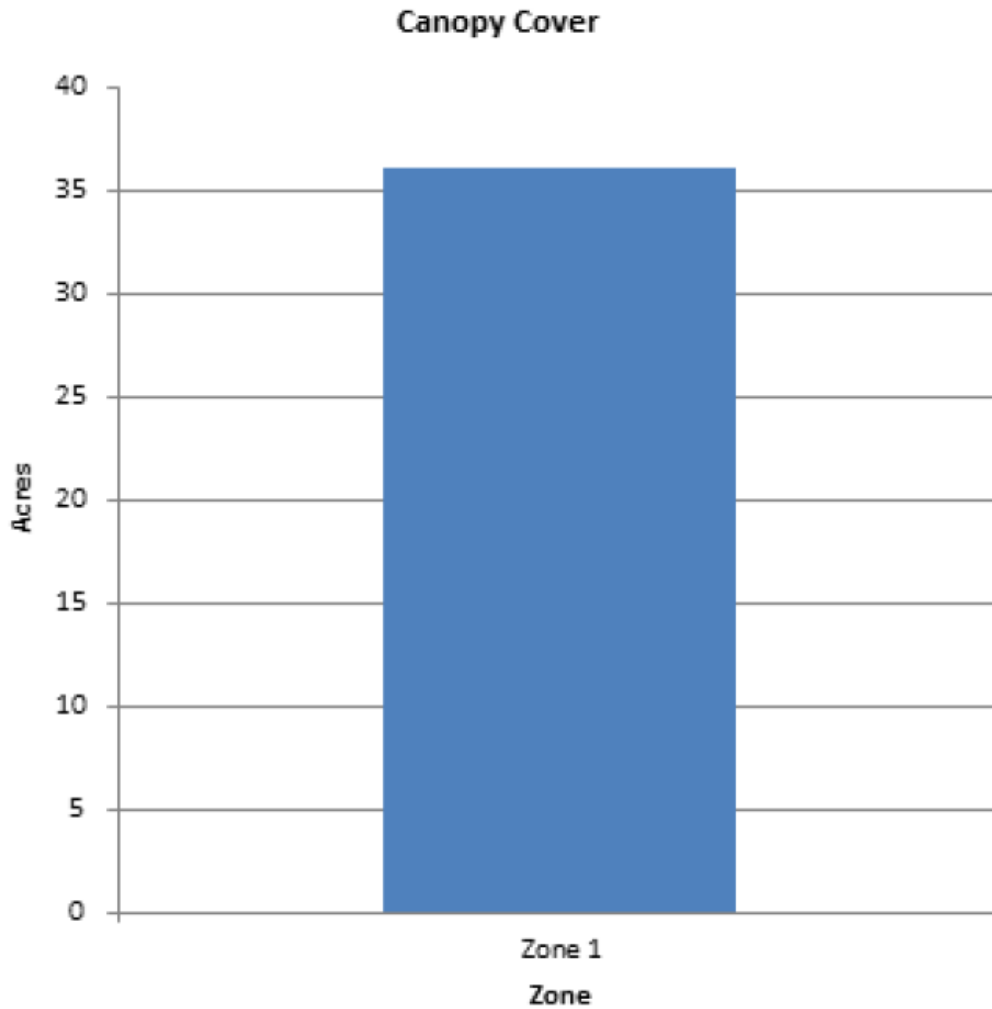


Figure 4: Wood Condition



# Canopy Cover of Public Trees (Acres)

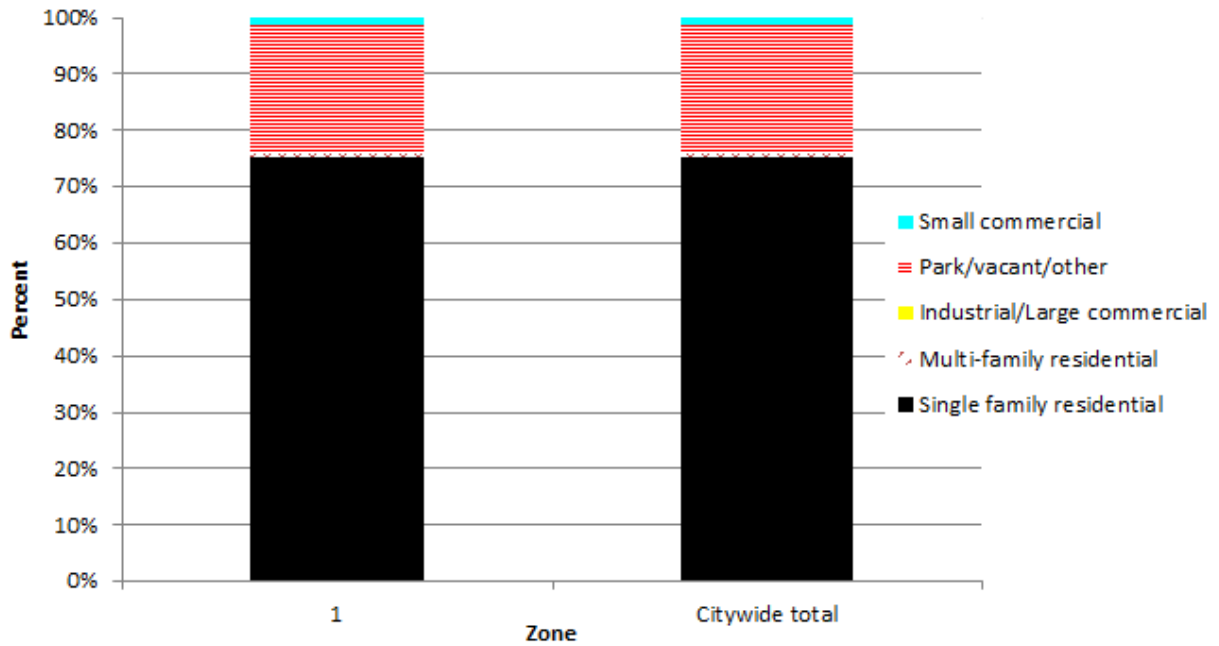
2/2/2016



| Zone           | Acres | % of Total Canopy Cover |
|----------------|-------|-------------------------|
| Zone 1         | 36    | 100.0                   |
| Citywide total | 36    | 100.0                   |

Figure 5: Canopy Cover in Acres

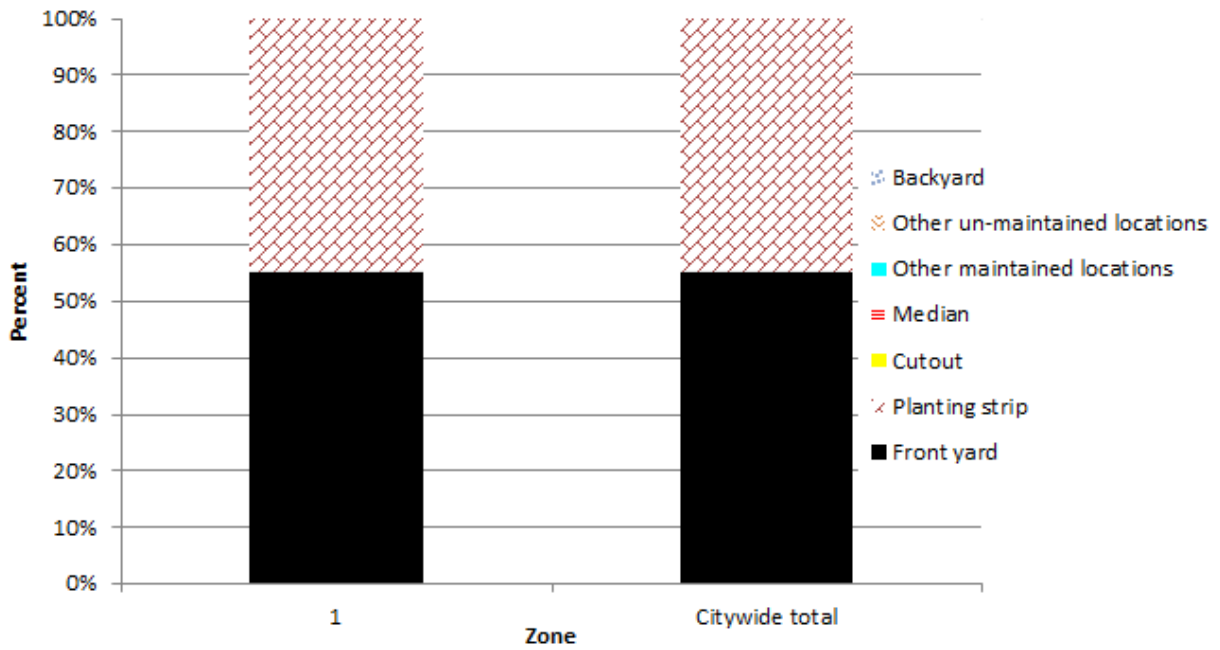
### Land use Public Trees by Zone (%)



| Zone           | Single family residential | Multi-family residential | Industrial/Large commercial | Park/vacant/other | Small commercial |
|----------------|---------------------------|--------------------------|-----------------------------|-------------------|------------------|
| 1              | 75.14                     | 0.75                     | 0.00                        | 22.90             | 1.21             |
| Citywide total | 75.14                     | 0.75                     | 0.00                        | 22.90             | 1.21             |

Figure 6: Land Use of city/park trees

## Location Public Trees by Zone (%)



| Zone           | Front yard | Planting strip | Cutout | Median | Other maintained locations | Other un-maintained locations | Backyard |
|----------------|------------|----------------|--------|--------|----------------------------|-------------------------------|----------|
| 1              | 54.95      | 44.95          | 0.00   | 0.09   | 0.00                       | 0.00                          | 0.00     |
| Citywide total | 54.95      | 44.95          | 0.00   | 0.09   | 0.00                       | 0.00                          | 0.00     |

Figure 7: Location of city/park trees

## Appendix B: ArcGIS Mapping

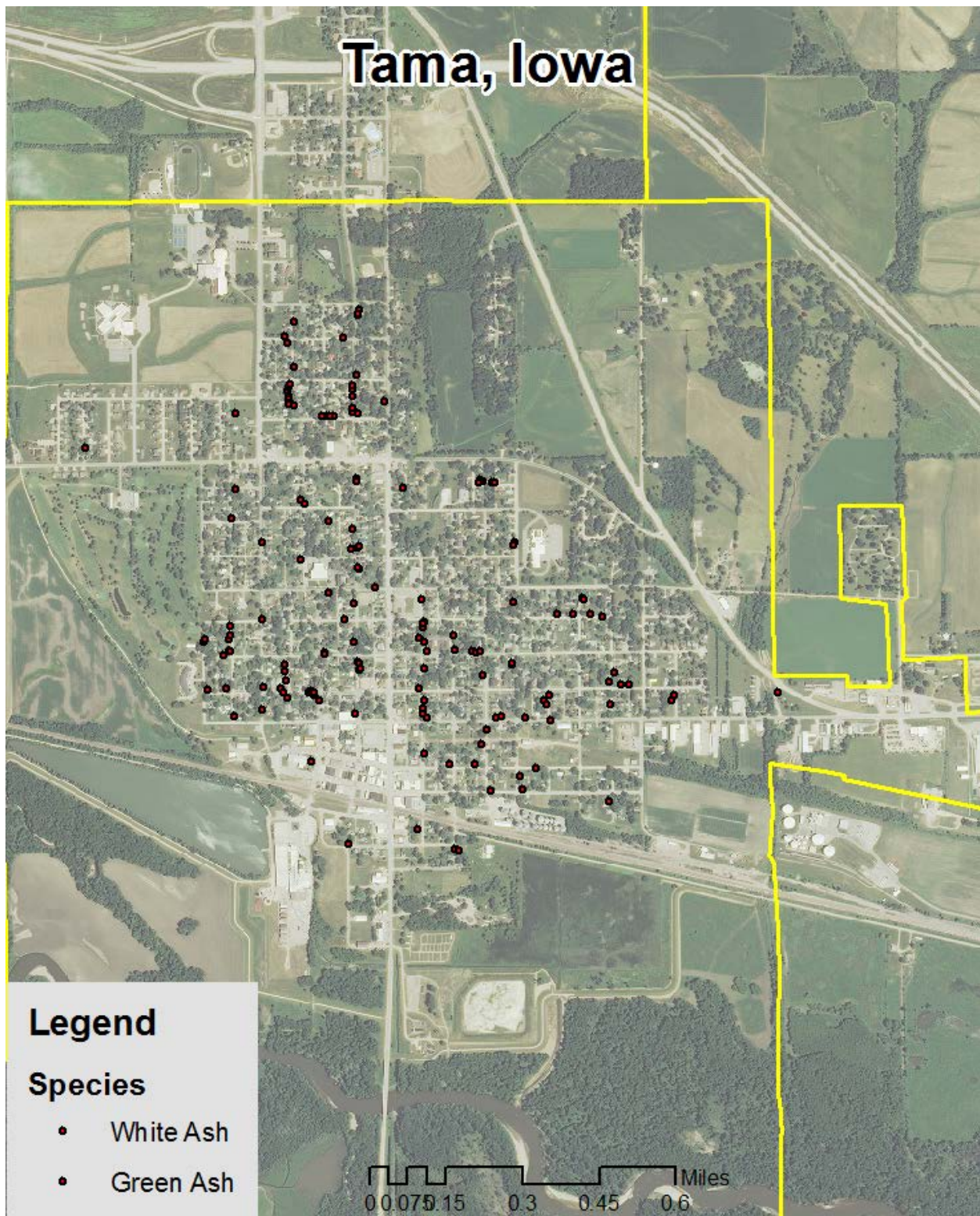


Figure 1: Location of Ash Trees



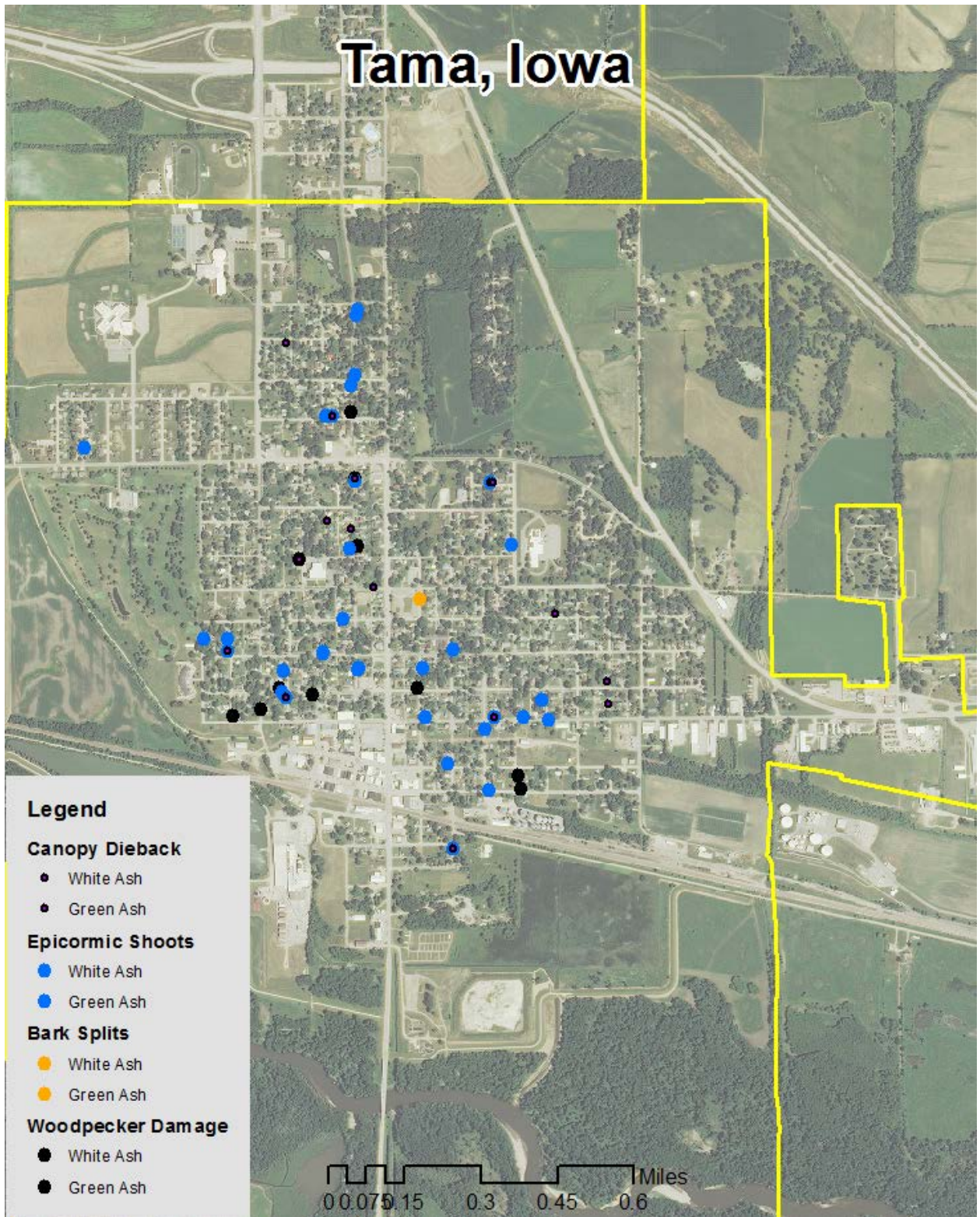


Figure 2: Location of EAB symptoms



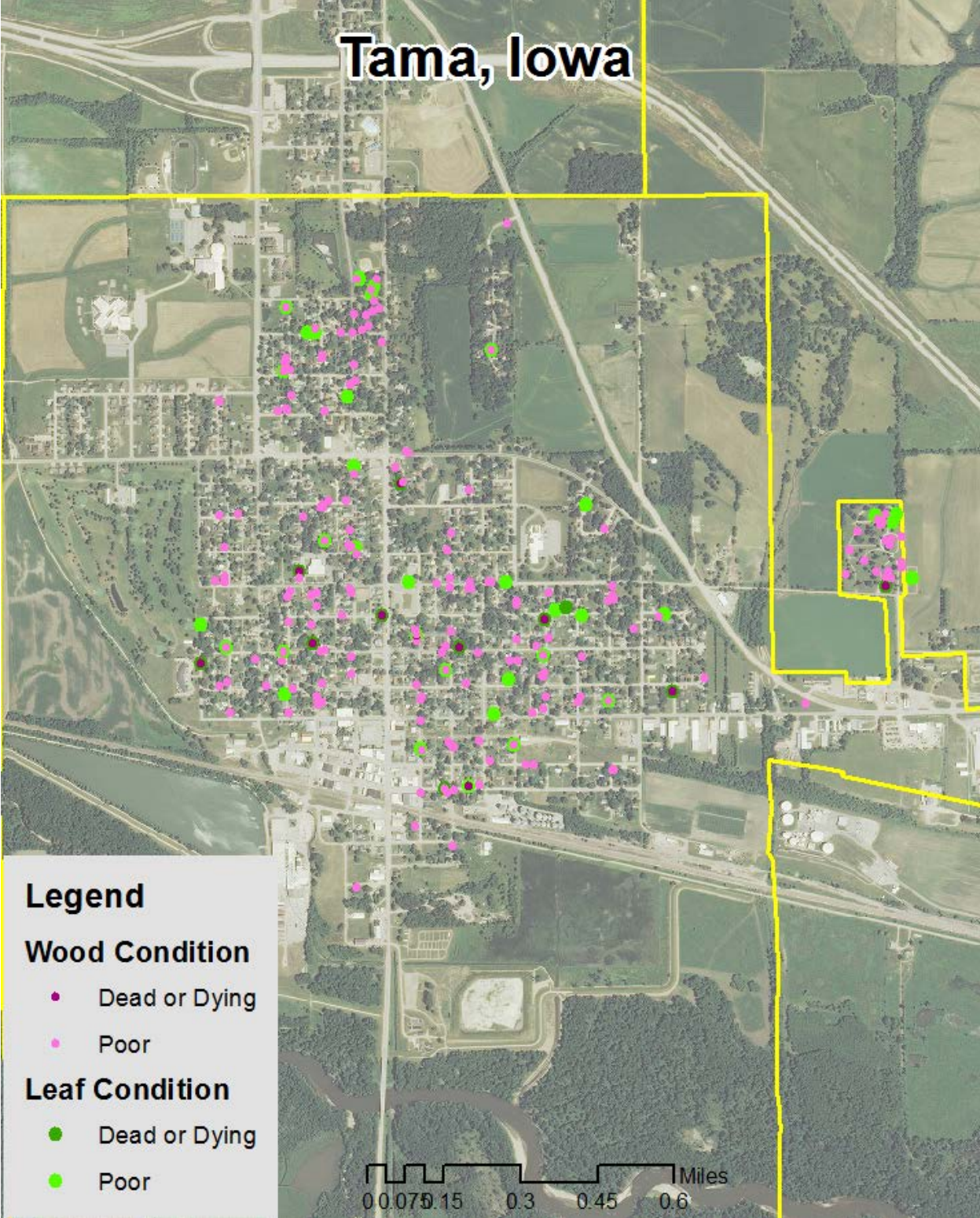


Figure 3: Location of Poor Condition Trees



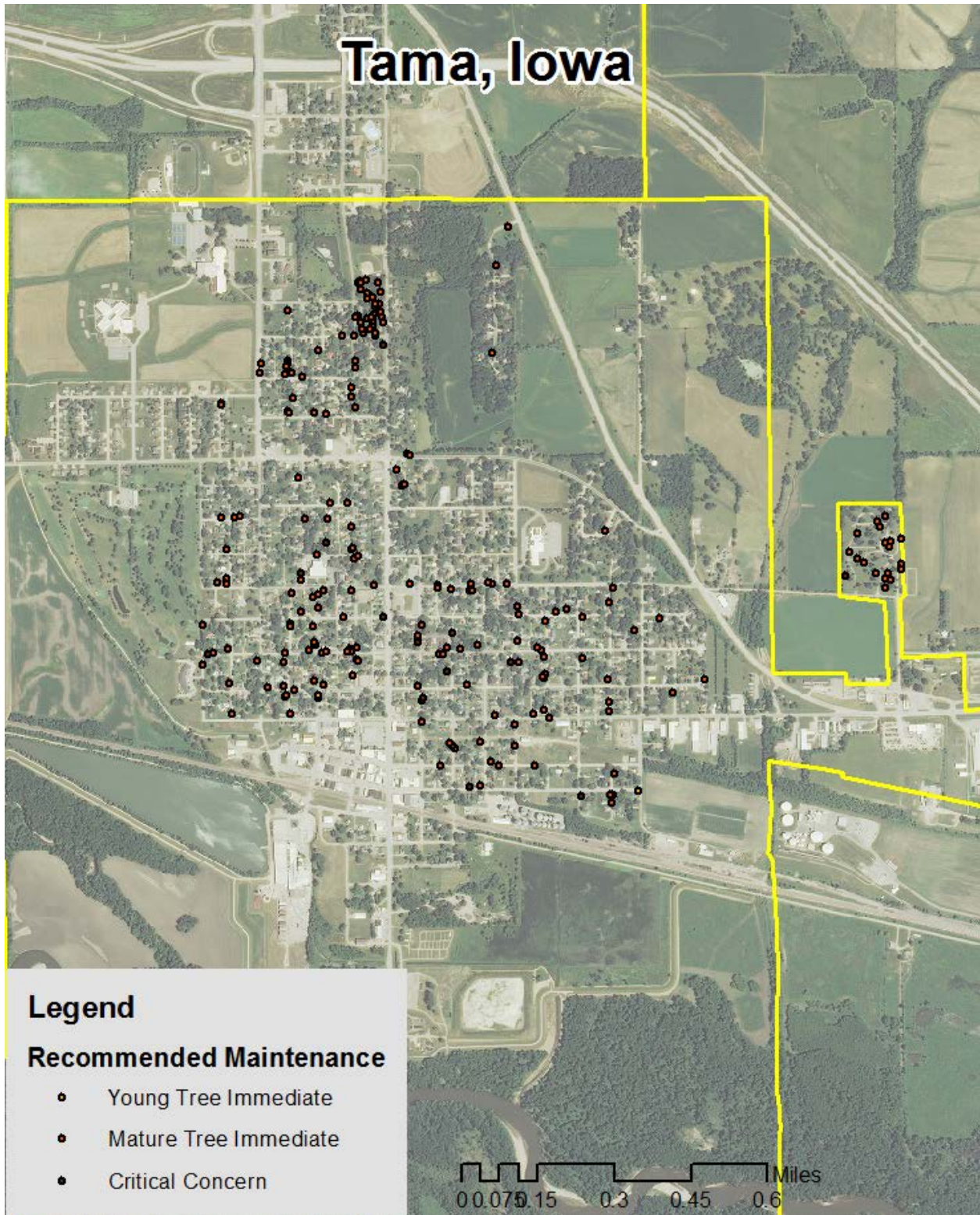


Figure 4: Location of Trees with Recommended Maintenance



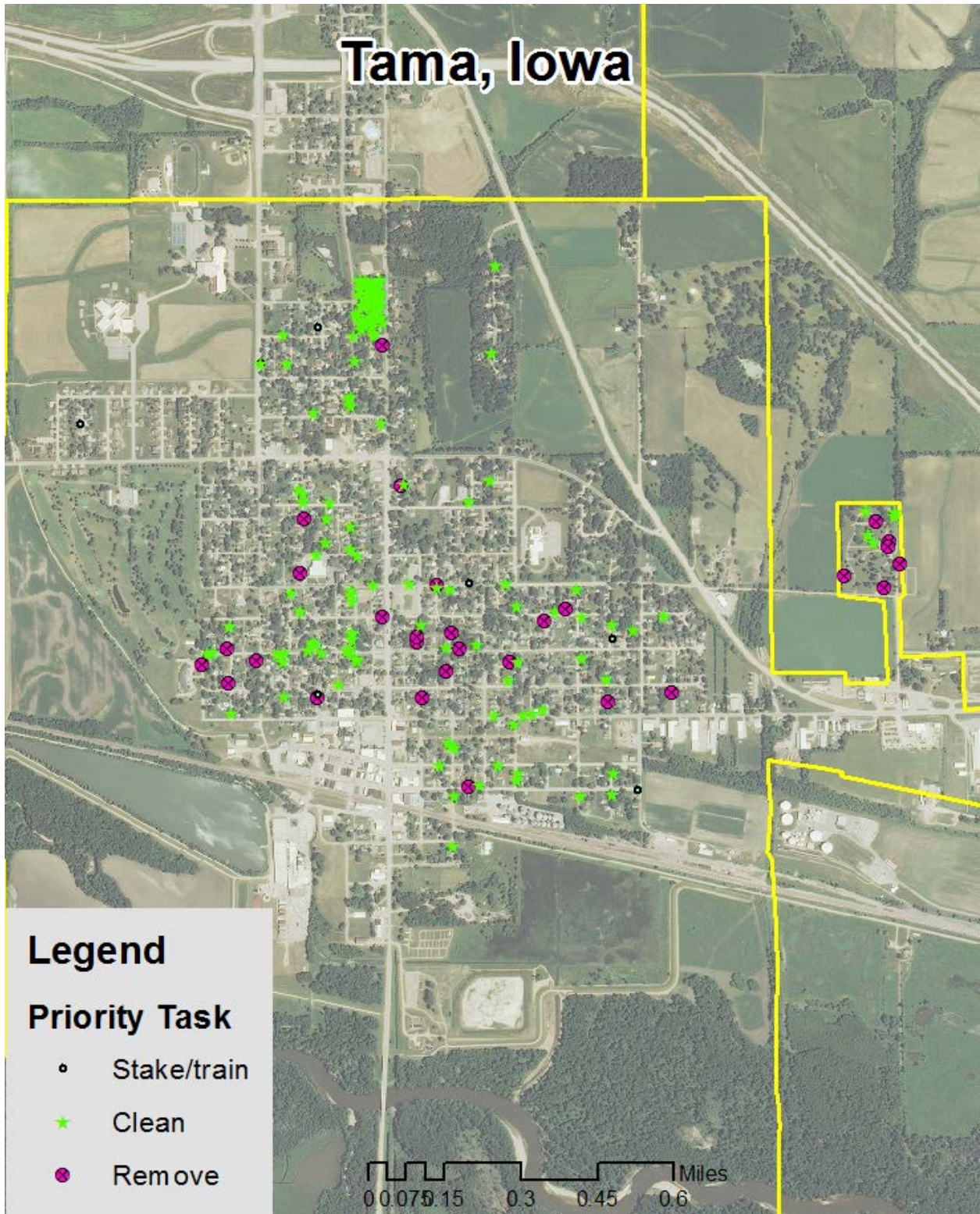


Figure 5: Maintenance Tasks \*City ownership of the trees recommended for removal should be verified prior to any removal\*

## Appendix C: Tama Tree Ordinances

### TITLE VI - COMMUNITY DEVELOPMENT AND ENVIRONMENT CHAPTER 2 - TREES

#### ARTICLE 1 GENERAL PROVISIONS

6-2.0101 PURPOSE. The purpose of this ordinance is to enhance the appearance of the City and to promote the public health, safety and well being by regulating the planting, care and removal of trees, shrubs and bushes.

6-2.0102 DEFINITIONS. For use in this Chapter, the following terms are defined:

2. "Parking": shall mean that part of the street, avenue or highway in the City not covered by sidewalk and lying between the lot line and the curb line; or, on unpaved streets, that part of the street, avenue or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic .

6-2.0103 PLANTING RESTRICTIONS. No tree, shrub bush or other woody vegetation shall be planted in or upon the parking except in accordance with the following:

1. The owner of the adjacent real estate shall have made application for a permit on a form provided by the City Clerk and paid such fee as the City Council may from time to time fix and establish by resolution.
2. As a condition of the issuance of said permit the owner of the adjacent real estate and such other persons as the City may require shall agree in writing at their expense, to trim and maintain said trees, shrubs, bushes or woody vegetation and to remove the same as the City may require or deem necessary with said agreement to be a perpetual covenant running with said abutting real estate, binding upon successive owners thereof and with the same to be filed of record in the office of the Tama County Recorder.

Title VI, Page 13

3. Any tree, shrub, bush or other woody vegetation shall be of such type and planted in such a manner and in such locations as the City may prescribe.
4. The issuance or denial of a permit shall be in the sole discretion of the City of Tama.

6-2.0104 DUTY TO TRIM TREES. The owner or agent of the abutting real estate shall keep trees, shrubs, bushes or woody vegetation on or overhanging the streets or sidewalks trimmed so as not to obstruct traffic and visibility and so that all branches will be at least fifteen (15) feet above the surface of the street and at least eight (8) feet above the surface of the sidewalks.

6-2.0105 REMOVAL OF DEAD OR DISEASED TREES. The City may in its discretion, require the removal, at the owners expense, of dead or diseased trees on private property.

6-2.0106 PUBLIC TREE CARE. The City may, in its discretion, plant, prune, maintain, trim, remove or cause to be removed, any tree, shrub, bush or other woody vegetation in or upon the parking as it deems necessary to maintain the public safety, health and well-being and/or preserve or enhance the symmetry and beauty of the parking in particular and the City in general.

6-2.0107 It shall be unlawful for any person to cut or trim any tree situated in or upon the parking unless the City's prior consent is obtained and unless said work is done under the supervision of the City.

6-2.0108 Failure of any property owner to perform any duty or obligation imposed upon them by this Article shall be deemed a violation of the City Code and in, addition to all other remedies available to it, the City may, in its discretion, and in the manner proscribed by Section 364.12(3)(b) of the Code of Iowa, perform the required action and assess the costs against the property for collection in the same manner as a property tax.

There being present the following Council members: \_\_\_\_\_  
Bearden, Metz, McAdoo, Hill, Smith \_\_\_\_\_ and  
the following Council members absent: \_\_\_\_\_. It was  
moved by Metz and seconded by McAdoo that the  
following Resolution be adopted:

RESOLUTION NO. 11-00

BE IT RESOLVED by the Council of the City of Tama, Iowa:

1. In accordance with Section 6-2.0103 of the City Code of Tama,  
Iowa, the following species of trees may be planted in the parking  
subject to compliance with all other provisions of the City Code:

a. Large trees:

Black Maple  
Norway Maple  
Red Maple  
Sugar Maple  
Freeman Maple  
River Birch (single stem only)  
Hackberry  
White Ash  
Gingko (male form only)  
Thornless Honeylocust  
Kentucky Coffeetree  
Cucumbertree Magnolia  
Sycamore  
Black Cherry  
White Oak  
Swamp White Oak  
Red Oak  
Shingle Oak  
Bur Oak  
Chinkapin Oak  
English Oak  
Black Oak  
Basswood  
Little Leaf Linden  
Redmond Linden

b. Small trees:

Amur Maple  
Tatarian Maple  
Ruby Red Horsechestnut  
Serviceberry  
European Hornbeam  
American Hornbeam  
Eastern Redbud  
Yellowwood

Pagoda Dogwood  
Thornless Cockspur Hawthorn  
Washington Hawthorn  
Winter King Hawthorn  
Hophornbeam  
Amur Corktree  
Amur Cherry  
Mayday Tree  
Japanese Pagoda Tree  
Japanese Tree Lilac

2. In accordance with Section 6-2.0103 of the City Code of Tama, Iowa, every application for a planting permit shall be accompanied by a permit fee in the amount of \$25.00.

A roll call was taken and the following Council members voted "aye": McAdoo, Hill, Smith, Bearden, Metz and the following council members voted "nay": \_\_\_\_\_ That the vote being called and the results thereof tabulated, the Mayor declared the resolution duly adopted.

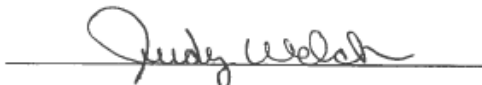
Dated this 5th day of June, 2000.

CITY OF TAMA, IOWA



Richard Gibson, Mayor

ATTEST:



Judy Welch, City Clerk

(SEAL)



TITLE VI - COMMUNITY DEVELOPMENT AND ENVIRONMENT  
CHAPTER 2 - TREES

ARTICLE 2  
DUTCH ELM DISEASE CONTROL

6-2.0201 TREES SUBJECT TO REMOVAL. The council having determined that the health of the elm trees within the city is threatened by a fatal disease known as the Dutch Elm Disease hereby declares the following shall be removed:

1. Living or Standing Trees. Any living or standing elm tree or part thereof infected with the Dutch Elm Disease fungus or which harbors any of the elm bark beetles, that is *scolytus multistriatus* (eichb.) or *hylurgopinus rufipes* (marsh.).

2. Dead Trees. Any dead elm tree or part thereof including logs, branches, stumps, firewood or other elm material from which the bark has not been removed and burned or sprayed with an effective elm bark beetle destroying insecticide.

6-2.0202 DUTY TO REMOVE. No person, firm or corporation shall permit any tree or material as defined in Section 1 of this article to remain on the premises owned, controlled or occupied by him within the city.

6-2.0203 INSPECTION. The superintendent shall inspect or cause to be inspected all premises and places within the city to determine whether any condition as defined in Section 1 of this article exists thereon, and shall also inspect or cause to be inspected any elm trees reported or suspected to be infected with the Dutch Elm Disease or any elm bark bearing material reported or suspected to be infected with the elm bark beetles.

6-2.0204 REMOVAL FROM CITY PROPERTY. If the superintendent upon inspection or examination, in person or by some qualified person acting for him, shall determine that any condition as herein defined exists in or upon any public street, alley, park or in any public place, including the strip between the

curb and the lot line of private property, within the city and that the danger of other elm trees within the city is imminent, he shall immediately cause it to be removed and burned or otherwise correct the same in such manner as to destroy or prevent as fully as possible the spread of Dutch Elm Disease or the insect pests or vectors known to carry such disease fungus.

6-2.0205 REMOVAL FROM PRIVATE PROPERTY. If the superintendent upon inspection or examination, in person or by some qualified person acting for him, shall determine with reasonable certainty that any condition as herein defined exists in or upon private premises and that the danger to other elm trees within the city is imminent, he shall immediately notify by certified mail the owner, occupant or person in charge of such property, to correct such condition within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within fourteen (14) days of receipt thereof, the council may cause the nuisance to be removed and the cost assessed against the property as provided in Article 2, Chapter 2, of Title III.

If the superintendent is unable to determine with reasonable certainty whether or not a tree in or upon private premises is infected with Dutch Elm Disease, he is authorized to remove or cut specimens from said tree, and obtain a diagnosis of such specimens.

**The State of Iowa is an Equal Opportunity Employer and provider of ADA services.**

Federal law prohibits employment discrimination on the basis of race, color, age, religion, national origin, sex or disability. State law prohibits employment discrimination on the basis of race, color, creed, age, sex, sexual orientation, gender identity, national origin, religion, pregnancy, or disability. State law also prohibits public accommodation (such as access to services or physical facilities) discrimination on the basis of race, color, creed, religion, sex, sexual orientation, gender identity, religion, national origin, or disability. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please contact the Iowa Civil Rights Commission, 1-800-457-4416, or write to the Iowa Department of Natural Resources, Wallace State Office Bldg., 502 E. 9<sup>th</sup> St., Des Moines, IA 50319.

If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-725-8200.