# Community Tree Management Plan For Union, IA

Prepared by the Iowa DNR
Urban and Community Forestry Program
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# Executive Summary

**Overview**

This plan was developed to assist the City of Union with managing its public tree population, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management of this resource is critical to fully reaping these rewards. Management is especially important considering the serious threats posed by forest pests such as the Emerald Ash Borer (EAB), Gypsy Moth, Asian Long-Horned Beetle, and others. With proper planning and management, the costs of removing dead and dying trees can be spread out over time, mitigating the financial burden as well as public safety issues.

**Inventory and Results**

In June 2018, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete survey of street and park trees. Below are some key findings of the 165 trees inventoried.

- Union's trees provide $32,215 of benefits annually, at an average of $195 a tree
- There are at least 24 different species of trees in Union
- The top three genus are: Maple 65%, Ash 8%, and Walnut 4%
- 71 trees (43% of the population) are in need of some type of maintenance (trimming, removal, etc.):
    - 2 trees are "critical concerns" that should be addressed immediately for safety reasons
    - 28 trees are recommended for removal either for safety or tree health reasons. Ideally these would be promptly replaced by new trees

**Recommendations**

The core recommendations are detailed in the *Recommendations* section. Some key ones include:

- Address the 28 trees recommended for removal according to their priority level: 2 are "critical concern" trees which need to be addressed immediately; 5 should be removed in the next 1-3 years; and 16 sometime in the next 6 years *City ownership of the trees recommended for removal should be verified prior to any removal*
- Begin planting new trees using a diverse mix of species wherever space is available and replacing existing trees that are in poor health to diversify the tree population and buffer against catastrophic tree pests such as EAB
- Schedule maintenance (trimming, etc.) for the other 48 trees identified by the inventory

# Introduction

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

Trees are an important component of any community'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 Union and future generations through good urban forest management.

Good urban forest 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 Union maximize the benefits and minimize the costs of the tree canopy.

# Inventory

In June 2018, a tree inventory was conducted of municipally-owned trees on both streets and parks. Tree locations were recorded using a handheld Global Positioning System (GPS) receiver with an accuracy of 3 meters, which can be used as an active GIS data layer. Because the inventory is a digital document the data can be edited and 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 was 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, all ash trees were inspected for signs and symptoms of EAB. The signs and symptoms noted were canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

# Inventory Results

The data collected for the 165 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

## ***Annual Benefits***

### Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Union's trees reduce energy related costs by approximately $8,701 annually (Appendix A, Table 1). These savings are both in Electricity (41.4 MWh) and in Natural Gas (5,675 Therms).

### Annual Stormwater Benefits

Union's trees intercept about 471,024 gallons of rainfall or snowmelt a year (Appendix A, Table 2). This interception provides $12,765 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 Union, it is estimated that trees remove 535 lbs of air pollution (ozone ($O_3$), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide ($NO_2$), and sulfur dioxide ($SO_2$)) per year with a net value of $1,496 (Appendix A, Table 3).

### Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Union, trees sequester about 86,525 lbs of carbon each year with an associated value of $649 (Appendix A, Table 5). This equates to 1,782,702 lbs of carbon being stored in Union's trees with total benefit of $13,370 (Appendix A, Table 4).

### Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Union receives $8,151 in annual social benefits from trees (Appendix A, Table 6).

### Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Union's trees provide $32,215 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 165 trees in Union provide approximately $195 annually (Appendix A, Table 7).

## ***Forest Structure***

### Species Distribution

Union has over 24 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

| | | |
|---|---|---|
| Maple | 107 | 65% |
| Ash | 13 | 8% |
| Walnut | 7 | 4% |
| Crabapple | 7 | 4% |
| All others | < 6 ea. | < 4% ea. |

### Size Class

Most of Union's trees (64%) are over 18 inches in diameter at 4.5 ft (Appendix A, Figure 2). Just 8% of the trees are 6" in diameter or less. This indicates an imbalance in the city's tree population and suggests that as the larger, older trees decline and are removed, there is a lack of younger trees being planted to replace them. Having too many large trees and too few young ones increases the risk for catastrophic storm damage and a long "lag period" following major damage.

### Condition: Wood and Foliage Health

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The survey results for Union indicate that 86% of the trees are in either good or fair health, while 14% of the trees are either in poor health or are considered dead or dying (Appendix A, Figures 3 & 4 and Appendix B, Figure 3).

The 14% of trees classified as poor, dead, or dying represent opportunity costs to the city where time and space are being sacrificed. Trees in poor health should be promptly removed and replaced with new, healthy trees to diversify and improve the overall health and resiliency of Union's urban tree population.

### Canopy Cover

The amount of tree canopy cover over Union is approximately 5 acres (Appendix A, Figure 5). According to the U.S. Census, Union occupies 352 acres of land. Thus the canopy cover on city land is about 1%.

### Land Use and Location

The majority of Union's city and park trees are in planting strips in single family residential neighborhoods (Appendix A, Figures 6 & 7).

### Management Needs

The following table outlines specific management needs of the street and park trees that were identified during the survey. (Appendix B, Figures 4 & 5).

| Maintenance Type Needed | # of Trees | Pct. of Tree Population |
|---|---|---|
| Crown Cleaning | 32 | 19% |
| Crown Reduction | 6 | 4% |
| Tree Removal | 23 | 14% |
| Crown Raising | 5 | 3% |
| Tree Staking/Training | 5 | 3% |
| Pest/Disease Treatment | 0 | 0% |

*Definitions: "Crown cleaning"* removes dead, diseased, and broken limbs. *"Crown reduction"* involves shortening or removing individual limbs to avoid interference with nearby structures, utility wires, traffic flow, or other branches. "*Removal"* implies that the entire tree needs to be removed either for safety or tree health purposes. *"Raising"* removes lower branches from the tree trunk to eliminate obstructions or clearance issues. *"Staking/training"* refers to corrective staking or pruning on very young saplings to help develop proper form and prevent future problems. "*Pest/Disease Treatment"* would imply treating very high value or important landscape trees with preventative pesticides to protect their health.

# Recommendations

**Risk Management**

Hazardous trees and branches 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 immediately.

Hazardous trees & branches: Critical concerns

Union has 2 "critical concern" trees that need immediate attention: both are potentially hazardous trees that are recommended for removal. Refer to the maps in Figure 4 of Appendix B to view the locations of these trees.

**Immediate Needs (defer up to 3 years)**

After both of the critical concern trees are addressed, there should be follow-up on the trees marked as needing "immediate" maintenance attention, meaning within the next three years. There are a total of 13 trees with these needs (Figure 4 of Appendix B).

**Routine Maintenance (defer up to 6 years)**

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. It is generally recommended that all trees be inspected for pruning needs every five to ten years. This would equate to pruning roughly 20 trees per year in Union.

After addressing the critical concern and immediate need trees in the city, there are 56 trees recommended for "routine" maintenance within the next six years (Appendix B, Figures 5). Of

this number, 40 need trimming and 16 are recommended for removal & replacement with something new.

**Planting**

Theoretically, the city should be planting (and removing) about 5-10 trees every 5 years in order to sustain the current tree population and to spread the trees equally out among different ages (size classes). This assumes the typical lifespan of a tree in Union to be 80-140 years; if the trees are not living that long, or if the goal is to *increase* the tree population, the target will be higher (15-20 trees/yr). Most of the planting over the next 10-15 years can be done to replace the trees that are removed. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Union.

It is important to plant a diverse mix of differing *species* in the urban forest to maintain canopy health, since most insects and diseases target a single genus of trees (e.g., ash, maple, oak).

Current diversity recommendations advise that:

- No single species should comprise more than 10% of the total tree population in the community (e.g. silver maple, sugar maple, white oak, bur oak)
- No single genus should comprise more than 20% of the total tree population

Presently, Union's urban forest is heavily planted with the genus Maple, at 65% (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid for various reasons include: cottonwood, poplar, boxelder, Chinese elm, evergreens, willow, or black walnut, and any others identified in the city tree code.

A list containing generally acceptable and recommended trees for planting in Iowa is provided with this plan (Appendix D). Ensure each individual planting is tailored for the environmental conditions, available space, and other factors.

**Continual Monitoring**

Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that all ash trees which are showing any signs or symptoms of EAB be checked annually with a visual survey for tree death and for additional symptoms (canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage). All other ash trees in the city which aren't exhibiting these symptoms should still be routinely monitored as time allows.

# Proposed Work Schedule & Estimated Costs

The trees in Union represent an important part of its overall infrastructure and quality of life for its residents. By budgeting for routine maintenance, replacement, and removals now, the city can be proactive and preventative rather than reactive when unexpected storms or tree pests arrive.

The following is a proposed 6-year work plan that would address the highest priority issues at this time. Estimated costs are based on $700/tree average for removal, $25/tree average for trimming*, and $150/tree average for planting. *Individual homeowners are presumed to be responsible for light trimming and staking/training of young trees in the City right-of-way.
For new tree plantings & replacements, it is recommended that Union apply for grants. 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.

| Year 1 | Estimated Costs |
|---|---|
| Removals: 7 of the 23 recommended trees | $4900 |
| Planting and replacements: 10 new trees | $1500 |
| Trimming: 23 of the 43 recommended trees | $575 |
| Staking & training: 5 of 5 recommended trees | |
| **Year 2** | |
| Removals: 8 of the 23 recommended trees | $5600 |
| Trimming: 20 of the 43 recommended trees | $500 |
| **Year 3** | |
| Removals: 8 of the 23 recommended trees | $5600 |
| **Year 6** | |
| Planting and replacements: 10 new trees | $1500 |
| Monitor for pruning needs: 20 trees | $500 |
| **Annually thereafter** | |
| Removals: 5-10 trees/5 years avg. focusing on poor condition trees | $7000 |
| Planting and replacements: 5-10 trees/5 years avg. | $1500 |
| Routine trimming: 20 trees/year on average | $500 |
| Routine monitoring for EAB symptoms | |

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All data and information used for this report may be obtained by contacting the Iowa DNR Forestry Bureau.

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# *Appendix A: i-Tree Data*

## Table 1: Annual Energy Benefits

**Union**

**Annual Energy Benefits of Public Trees**

1/10/2019

| Species | Total Electricity (MWh) | Electricity ($) | Total Natural Gas (Therms) | Natural Gas ($) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|
| Sugar maple | 12.1 | 918 | 1,618.8 | 1,586 | 2,505 | (N/A) | 28.5 | 28.8 | 53.29 |
| Black maple | 5.9 | 449 | 818.2 | 802 | 1,251 | (N/A) | 12.7 | 14.4 | 59.57 |
| Norway maple | 4.9 | 372 | 687.7 | 674 | 1,046 | (N/A) | 11.5 | 12.0 | 55.07 |
| Silver maple | 5.6 | 428 | 753.5 | 738 | 1,167 | (N/A) | 9.1 | 13.4 | 77.79 |
| Ash | 3.4 | 261 | 490.6 | 481 | 742 | (N/A) | 7.9 | 8.5 | 57.06 |
| Black walnut | 1.5 | 117 | 211.9 | 208 | 324 | (N/A) | 4.2 | 3.7 | 46.35 |
| Apple | 0.7 | 52 | 104.5 | 102 | 154 | (N/A) | 4.2 | 1.8 | 22.06 |
| Spruce | 0.7 | 55 | 97.7 | 96 | 150 | (N/A) | 3.6 | 1.7 | 25.07 |
| Northern hackberry | 1.0 | 79 | 152.9 | 150 | 229 | (N/A) | 2.4 | 2.6 | 57.19 |
| Red maple | 0.9 | 71 | 126.4 | 124 | 195 | (N/A) | 2.4 | 2.2 | 48.72 |
| Norway spruce | 0.4 | 29 | 53.8 | 53 | 82 | (N/A) | 1.8 | 0.9 | 27.41 |
| Eastern red cedar | 0.3 | 25 | 49.3 | 48 | 74 | (N/A) | 1.8 | 0.8 | 24.57 |
| Pin oak | 0.6 | 46 | 84.4 | 83 | 129 | (N/A) | 1.2 | 1.5 | 64.44 |
| Littleleaf linden | 0.4 | 30 | 47.9 | 47 | 77 | (N/A) | 1.2 | 0.9 | 38.70 |
| American sycamore | 0.7 | 57 | 101.2 | 99 | 156 | (N/A) | 1.2 | 1.8 | 77.98 |
| Honeylocust | 0.6 | 47 | 84.6 | 83 | 130 | (N/A) | 1.2 | 1.5 | 64.79 |
| American elm | 0.0 | 1 | 1.9 | 2 | 3 | (N/A) | 0.6 | 0.0 | 3.29 |
| Kentucky coffeetree | 0.3 | 25 | 46.9 | 46 | 71 | (N/A) | 0.6 | 0.8 | 70.91 |
| White ash | 0.3 | 23 | 43.0 | 42 | 66 | (N/A) | 0.6 | 0.8 | 65.60 |
| Mulberry | 0.0 | 0 | 0.6 | 1 | 1 | (N/A) | 0.6 | 0.0 | 0.87 |
| Amur maple | 0.2 | 14 | 24.7 | 24 | 38 | (N/A) | 0.6 | 0.4 | 38.13 |
| Black cherry | 0.0 | 0 | 0.6 | 1 | 1 | (N/A) | 0.6 | 0.0 | 0.87 |
| Callery pear | 0.1 | 8 | 16.9 | 17 | 24 | (N/A) | 0.6 | 0.3 | 24.47 |
| American basswood | 0.4 | 30 | 56.8 | 56 | 86 | (N/A) | 0.6 | 1.0 | 86.12 |
| Total | 41.4 | 3,140 | 5,674.8 | 5,561 | 8,701 | (N/A) | 100.0 | 100.0 | 52.74 |

## Table 2: Annual Stormwater Benefits

**Union**

**Annual Stormwater Benefits of Public Trees**

1/10/2019

| Species | Total rainfall interception (Gal) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|
| Sugar maple | 142,029 | 3,849 | (N/A) | 28.5 | 30.2 | 81.89 |
| Black maple | 57,680 | 1,563 | (N/A) | 12.7 | 12.2 | 74.44 |
| Norway maple | 43,077 | 1,167 | (N/A) | 11.5 | 9.1 | 61.44 |
| Silver maple | 89,704 | 2,431 | (N/A) | 9.1 | 19.0 | 162.07 |
| Ash | 32,482 | 880 | (N/A) | 7.9 | 6.9 | 67.71 |
| Black walnut | 20,669 | 560 | (N/A) | 4.2 | 4.4 | 80.02 |
| Apple | 2,460 | 67 | (N/A) | 4.2 | 0.5 | 9.52 |
| Spruce | 13,273 | 360 | (N/A) | 3.6 | 2.8 | 59.95 |
| Northern hackberry | 9,838 | 267 | (N/A) | 2.4 | 2.1 | 66.66 |
| Red maple | 7,963 | 216 | (N/A) | 2.4 | 1.7 | 53.95 |
| Norway spruce | 8,169 | 221 | (N/A) | 1.8 | 1.7 | 73.80 |
| Eastern red cedar | 4,904 | 133 | (N/A) | 1.8 | 1.0 | 44.30 |
| Pin oak | 5,987 | 162 | (N/A) | 1.2 | 1.3 | 81.13 |
| Littleleaf linden | 2,519 | 68 | (N/A) | 1.2 | 0.5 | 34.14 |
| American sycamore | 9,830 | 266 | (N/A) | 1.2 | 2.1 | 133.19 |
| Honeylocust | 5,810 | 157 | (N/A) | 1.2 | 1.2 | 78.73 |
| American elm | 98 | 3 | (N/A) | 0.6 | 0.0 | 2.65 |
| Kentucky coffeetree | 3,943 | 107 | (N/A) | 0.6 | 0.8 | 106.85 |
| White ash | 3,225 | 87 | (N/A) | 0.6 | 0.7 | 87.40 |
| Mulberry | 7 | 0 | (N/A) | 0.6 | 0.0 | 0.20 |
| Amur maple | 667 | 18 | (N/A) | 0.6 | 0.1 | 18.06 |
| Black cherry | 7 | 0 | (N/A) | 0.6 | 0.0 | 0.20 |
| Callery pear | 586 | 16 | (N/A) | 0.6 | 0.1 | 15.88 |
| American basswood | 6,096 | 165 | (N/A) | 0.6 | 1.3 | 165.21 |
| Citywide total | 471,024 | 12,765 | (N/A) | 100.0 | 100.0 | 77.36 |

## Table 3: Annual Air Quality Benefits

**Union**

**Annual Air Quality Benefits of Public Trees**

1/10/2019

| Species | Deposition (lb) | | | | Total Depos. ($) | Avoided (lb) | | | | Total Avoided ($) | BVOC Emissions (lb) | BVOC Emissions ($) | Total (lb) | Total ($) | Standard Error | % of Total Trees | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $O_3$ | $NO_2$ | $PM_{10}$ | $SO_2$ | | $NO_2$ | $PM_{10}$ | VOC | $SO_2$ | | | | | | | | |
| Sugar maple | 20.1 | 3.4 | 9.9 | 0.9 | 109 | 57.4 | 8.4 | 8.0 | 54.8 | 358 | -15.7 | -59 | 147.1 | 408 | (N/A) | 28.5 | 8.68 |
| Black maple | 14.9 | 2.5 | 6.8 | 0.7 | 79 | 28.3 | 4.1 | 3.9 | 26.8 | 176 | -4.8 | -18 | 83.2 | 237 | (N/A) | 12.7 | 11.27 |
| Norway maple | 8.6 | 1.5 | 4.2 | 0.4 | 46 | 23.6 | 3.4 | 3.3 | 22.3 | 147 | -2.0 | -8 | 65.2 | 186 | (N/A) | 11.5 | 9.76 |
| Silver maple | 16.8 | 2.9 | 8.1 | 0.7 | 90 | 26.7 | 3.9 | 3.7 | 25.5 | 167 | -8.9 | -33 | 79.6 | 224 | (N/A) | 9.1 | 14.93 |
| Ash | 6.7 | 1.2 | 3.3 | 0.3 | 36 | 16.6 | 2.4 | 2.3 | 15.6 | 103 | -1.6 | -6 | 46.8 | 134 | (N/A) | 7.9 | 10.27 |
| Black walnut | 3.4 | 0.5 | 1.5 | 0.2 | 18 | 7.4 | 1.1 | 1.0 | 7.0 | 46 | 0.0 | 0 | 22.0 | 63 | (N/A) | 4.2 | 9.07 |
| Apple | 0.6 | 0.1 | 0.3 | 0.0 | 3 | 3.4 | 0.5 | 0.5 | 3.1 | 21 | 0.0 | 0 | 8.5 | 24 | (N/A) | 4.2 | 3.43 |
| Spruce | 1.5 | 0.3 | 1.3 | 0.2 | 10 | 3.4 | 0.5 | 0.5 | 3.3 | 21 | -6.5 | -24 | 4.4 | 7 | (N/A) | 3.6 | 1.18 |
| Northern hackberry | 1.5 | 0.3 | 0.8 | 0.1 | 8 | 5.1 | 0.7 | 0.7 | 4.7 | 31 | 0.0 | 0 | 13.8 | 39 | (N/A) | 2.4 | 9.86 |
| Red maple | 1.9 | 0.3 | 0.9 | 0.1 | 10 | 4.4 | 0.6 | 0.6 | 4.2 | 28 | -0.6 | -2 | 12.5 | 35 | (N/A) | 2.4 | 8.87 |
| Norway spruce | 1.0 | 0.2 | 0.8 | 0.1 | 6 | 1.9 | 0.3 | 0.3 | 1.8 | 12 | -4.4 | -17 | 1.8 | 1 | (N/A) | 1.8 | 0.45 |
| Eastern red cedar | 1.0 | 0.2 | 0.8 | 0.1 | 7 | 1.6 | 0.2 | 0.2 | 1.5 | 10 | -2.7 | -10 | 3.1 | 7 | (N/A) | 1.8 | 2.19 |
| Pin oak | 0.9 | 0.2 | 0.5 | 0.0 | 5 | 2.9 | 0.4 | 0.4 | 2.8 | 18 | -1.8 | -7 | 6.3 | 17 | (N/A) | 1.2 | 8.29 |
| Littleleaf linden | 0.3 | 0.1 | 0.2 | 0.0 | 2 | 1.9 | 0.3 | 0.3 | 1.8 | 12 | -0.2 | -1 | 4.6 | 13 | (N/A) | 1.2 | 6.42 |
| American sycamore | 1.9 | 0.3 | 0.8 | 0.1 | 10 | 3.6 | 0.5 | 0.5 | 3.4 | 22 | 0.0 | 0 | 11.0 | 32 | (N/A) | 1.2 | 15.94 |
| Honeylocust | 1.1 | 0.2 | 0.5 | 0.0 | 6 | 2.9 | 0.4 | 0.4 | 2.8 | 18 | -0.8 | -3 | 7.6 | 21 | (N/A) | 1.2 | 10.61 |
| American elm | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0.0 | 0.1 | 1 | 0.0 | 0 | 0.2 | 1 | (N/A) | 0.6 | 0.53 |
| Kentucky coffeetree | 0.5 | 0.1 | 0.2 | 0.0 | 3 | 1.6 | 0.2 | 0.2 | 1.5 | 10 | 0.0 | 0 | 4.4 | 12 | (N/A) | 0.6 | 12.48 |
| White ash | 0.4 | 0.1 | 0.2 | 0.0 | 2 | 1.5 | 0.2 | 0.2 | 1.4 | 9 | 0.0 | 0 | 3.9 | 11 | (N/A) | 0.6 | 11.18 |
| Mulberry | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | (N/A) | 0.6 | 0.11 |
| 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) | 0.6 | 6.56 |
| Black cherry | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | (N/A) | 0.6 | 0.11 |
| Callery pear | 0.1 | 0.0 | 0.0 | 0.0 | 0 | 0.5 | 0.1 | 0.1 | 0.5 | 3 | 0.0 | 0 | 1.2 | 3 | (N/A) | 0.6 | 3.47 |
| American basswood | 1.0 | 0.2 | 0.5 | 0.0 | 5 | 1.9 | 0.3 | 0.3 | 1.8 | 12 | -0.8 | -3 | 5.2 | 14 | (N/A) | 0.6 | 14.28 |
| Citywide total | 84.4 | 14.4 | 41.7 | 4.0 | 457 | 197.5 | 28.8 | 27.4 | 187.4 | 1,230 | -50.8 | -191 | 534.7 | 1,496 | (N/A) | 100.0 | 9.07 |

## Table 4: Annual Carbon Stored

**Union**

**Stored CO2 Benefits of Public Trees**

1/10/2019

| Species | Total Stored CO2 (lbs) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|
| Sugar maple | 588,750 | 4,416 | (N/A) | 28.5 | 33.0 | 93.95 |
| Black maple | 158,209 | 1,187 | (N/A) | 12.7 | 8.9 | 56.50 |
| Norway maple | 141,221 | 1,059 | (N/A) | 11.5 | 7.9 | 55.75 |
| Silver maple | 412,260 | 3,092 | (N/A) | 9.1 | 23.1 | 206.13 |
| Ash | 110,834 | 831 | (N/A) | 7.9 | 6.2 | 63.94 |
| Black walnut | 113,507 | 851 | (N/A) | 4.2 | 6.4 | 121.61 |
| Apple | 9,884 | 74 | (N/A) | 4.2 | 0.6 | 10.59 |
| Spruce | 15,859 | 119 | (N/A) | 3.6 | 0.9 | 19.82 |
| Northern hackberry | 22,406 | 168 | (N/A) | 2.4 | 1.3 | 42.01 |
| Red maple | 20,615 | 155 | (N/A) | 2.4 | 1.2 | 38.65 |
| Norway spruce | 11,090 | 83 | (N/A) | 1.8 | 0.6 | 27.72 |
| Eastern red cedar | 3,306 | 25 | (N/A) | 1.8 | 0.2 | 8.27 |
| Pin oak | 23,457 | 176 | (N/A) | 1.2 | 1.3 | 87.96 |
| Littleleaf linden | 7,190 | 54 | (N/A) | 1.2 | 0.4 | 26.96 |
| American sycamore | 64,440 | 483 | (N/A) | 1.2 | 3.6 | 241.65 |
| Honeylocust | 13,485 | 101 | (N/A) | 1.2 | 0.8 | 50.57 |
| American elm | 178 | 1 | (N/A) | 0.6 | 0.0 | 1.33 |
| Kentucky coffeetree | 15,773 | 118 | (N/A) | 0.6 | 0.9 | 118.30 |
| White ash | 8,458 | 63 | (N/A) | 0.6 | 0.5 | 63.43 |
| Mulberry | 14 | 0 | (N/A) | 0.6 | 0.0 | 0.10 |
| Amur maple | 3,037 | 23 | (N/A) | 0.6 | 0.2 | 22.78 |
| Black cherry | 14 | 0 | (N/A) | 0.6 | 0.0 | 0.10 |
| Callery pear | 1,101 | 8 | (N/A) | 0.6 | 0.1 | 8.26 |
| American basswood | 37,616 | 282 | (N/A) | 0.6 | 2.1 | 282.12 |
| Citywide total | 1,782,702 | 13,370 | (N/A) | 100.0 | 100.0 | 81.03 |

## Table 5: Annual Carbon Sequestered

**Union**

**Annual CO Benefits of Public Trees**

1/10/2019

| Species | Sequestered (lb) | Sequestered ($) | Decomposition Release (lb) | Maintenance Release (lb) | Total Released ($) | Avoided (lb) | Avoided ($) | Net Total (lb) | Total Standard ($) Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sugar maple | 28,643 | 215 | -2,826 | -133 | -22 | 20,290 | 152 | 45,973 | 345 (N/A) | 28.5 | 31.3 | 7.34 |
| Black maple | 966 | 7 | -759 | -56 | -6 | 9,924 | 74 | 10,075 | 76 (N/A) | 12.7 | 6.9 | 3.60 |
| Norway maple | 6,401 | 48 | -678 | -50 | -5 | 8,229 | 62 | 13,902 | 104 (N/A) | 11.5 | 9.5 | 5.49 |
| Silver maple | 27,226 | 204 | -1,979 | -67 | -15 | 9,467 | 71 | 34,648 | 260 (N/A) | 9.1 | 23.6 | 17.32 |
| Ash | 3,548 | 27 | -532 | -38 | -4 | 5,769 | 43 | 8,747 | 66 (N/A) | 7.9 | 6.0 | 5.05 |
| Black walnut | 3,160 | 24 | -545 | -18 | -4 | 2,581 | 19 | 5,178 | 39 (N/A) | 4.2 | 3.5 | 5.55 |
| Apple | 1,029 | 8 | -47 | -9 | 0 | 1,151 | 9 | 2,123 | 16 (N/A) | 4.2 | 1.4 | 2.27 |
| Spruce | 852 | 6 | -76 | -13 | -1 | 1,209 | 9 | 1,971 | 15 (N/A) | 3.6 | 1.3 | 2.46 |
| Northern hackberry | 1,273 | 10 | -108 | -10 | -1 | 1,744 | 13 | 2,899 | 22 (N/A) | 2.4 | 2.0 | 5.44 |
| Red maple | 2,495 | 19 | -99 | -9 | -1 | 1,570 | 12 | 3,958 | 30 (N/A) | 2.4 | 2.7 | 7.42 |
| Norway spruce | 240 | 2 | -53 | -9 | 0 | 652 | 5 | 830 | 6 (N/A) | 1.8 | 0.6 | 2.07 |
| Eastern red cedar | 86 | 1 | -16 | -6 | 0 | 561 | 4 | 625 | 5 (N/A) | 1.8 | 0.4 | 1.56 |
| Pin oak | 2,371 | 18 | -113 | -6 | -1 | 1,020 | 8 | 3,272 | 25 (N/A) | 1.2 | 2.2 | 12.27 |
| Littleleaf linden | 1,029 | 8 | -35 | -4 | 0 | 674 | 5 | 1,664 | 12 (N/A) | 1.2 | 1.1 | 6.24 |
| American sycamore | 1,139 | 9 | -309 | -9 | -2 | 1,254 | 9 | 2,075 | 16 (N/A) | 1.2 | 1.4 | 7.78 |
| Honeylocust | 1,873 | 14 | -65 | -5 | -1 | 1,030 | 8 | 2,833 | 21 (N/A) | 1.2 | 1.9 | 10.62 |
| American elm | 45 | 0 | -1 | -1 | 0 | 31 | 0 | 73 | 1 (N/A) | 0.6 | 0.1 | 0.55 |
| Kentucky coffeetree | 857 | 6 | -76 | -4 | -1 | 552 | 4 | 1,330 | 10 (N/A) | 0.6 | 0.9 | 9.97 |
| White ash | 845 | 6 | -41 | -3 | 0 | 518 | 4 | 1,320 | 10 (N/A) | 0.6 | 0.9 | 9.90 |
| Mulberry | 9 | 0 | 0 | 0 | 0 | 6 | 0 | 14 | 0 (N/A) | 0.6 | 0.0 | 0.10 |
| Amur maple | 268 | 2 | -15 | -2 | 0 | 308 | 2 | 560 | 4 (N/A) | 0.6 | 0.4 | 4.20 |
| Black cherry | 9 | 0 | 0 | 0 | 0 | 6 | 0 | 14 | 0 (N/A) | 0.6 | 0.0 | 0.10 |
| Callery pear | 224 | 2 | -5 | -1 | 0 | 176 | 1 | 393 | 3 (N/A) | 0.6 | 0.3 | 2.95 |
| American basswood | 1,940 | 15 | -181 | -5 | -1 | 673 | 5 | 2,428 | 18 (N/A) | 0.6 | 1.7 | 18.21 |
| Citywide total | 86,525 | 649 | -8,558 | -457 | -68 | 69,394 | 520 | 146,904 | 1,102 (N/A) | 100.0 | 100.0 | 6.68 |

## Table 6: Annual Social and Aesthetic Benefits

**Union**

**Annual Aesthetic/Other Benefits of Public Trees**

1/10/2019

| Species | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|
| Sugar maple | 2,896 | (N/A) | 28.5 | 35.5 | 61.61 |
| Black maple | 132 | (N/A) | 12.7 | 1.6 | 6.28 |
| Norway maple | 618 | (N/A) | 11.5 | 7.6 | 32.51 |
| Silver maple | 1,971 | (N/A) | 9.1 | 24.2 | 131.38 |
| Ash | 343 | (N/A) | 7.9 | 4.2 | 26.42 |
| Black walnut | 242 | (N/A) | 4.2 | 3.0 | 34.59 |
| Apple | 59 | (N/A) | 4.2 | 0.7 | 8.38 |
| Spruce | 184 | (N/A) | 3.6 | 2.3 | 30.60 |
| Northern hackberry | 185 | (N/A) | 2.4 | 2.3 | 46.18 |
| Red maple | 314 | (N/A) | 2.4 | 3.9 | 78.47 |
| Norway spruce | 63 | (N/A) | 1.8 | 0.8 | 20.84 |
| Eastern red cedar | 27 | (N/A) | 1.8 | 0.3 | 9.12 |
| Pin oak | 199 | (N/A) | 1.2 | 2.4 | 99.74 |
| Littleleaf linden | 110 | (N/A) | 1.2 | 1.4 | 55.09 |
| American sycamore | 86 | (N/A) | 1.2 | 1.1 | 43.13 |
| Honeylocust | 389 | (N/A) | 1.2 | 4.8 | 194.60 |
| American elm | 5 | (N/A) | 0.6 | 0.1 | 5.36 |
| Kentucky coffeetree | 66 | (N/A) | 0.6 | 0.8 | 65.59 |
| White ash | 101 | (N/A) | 0.6 | 1.2 | 101.35 |
| Mulberry | 0 | (N/A) | 0.6 | 0.0 | 0.03 |
| Amur maple | 15 | (N/A) | 0.6 | 0.2 | 15.48 |
| Black cherry | 0 | (N/A) | 0.6 | 0.0 | 0.03 |
| Callery pear | 26 | (N/A) | 0.6 | 0.3 | 26.22 |
| American basswood | 119 | (N/A) | 0.6 | 1.5 | 119.43 |
| Citywide total | 8,151 | (N/A) | 100.0 | 100.0 | 49.40 |

## Table 7: Summary of Benefits in Dollars

**Union**

**Total Annual Benefits of Public Trees by Species ($)**

1/10/2019

| Species | Energy | $CO_2$ | Air Quality | Stormwater | Aesthetic/Other | Total ($) | Standard Error | % of Total $ |
|---|---|---|---|---|---|---|---|---|
| Sugar maple | 2,505 | 345 | 408 | 3,849 | 2,896 | 10,002 | (N/A) | 31.0 |
| Black maple | 1,251 | 76 | 237 | 1,563 | 132 | 3,258 | (N/A) | 10.1 |
| Norway maple | 1,046 | 104 | 186 | 1,167 | 618 | 3,121 | (N/A) | 9.7 |
| Silver maple | 1,167 | 260 | 224 | 2,431 | 1,971 | 6,052 | (N/A) | 18.8 |
| Ash | 742 | 66 | 134 | 880 | 343 | 2,165 | (N/A) | 6.7 |
| Black walnut | 324 | 39 | 63 | 560 | 242 | 1,229 | (N/A) | 3.8 |
| Apple | 154 | 16 | 24 | 67 | 59 | 320 | (N/A) | 1.0 |
| Spruce | 150 | 15 | 7 | 360 | 184 | 716 | (N/A) | 2.2 |
| Northern hackberry | 229 | 22 | 39 | 267 | 185 | 741 | (N/A) | 2.3 |
| Red maple | 195 | 30 | 35 | 216 | 314 | 790 | (N/A) | 2.5 |
| Norway spruce | 82 | 6 | 1 | 221 | 63 | 374 | (N/A) | 1.2 |
| Eastern red cedar | 74 | 5 | 7 | 133 | 27 | 245 | (N/A) | 0.8 |
| Pin oak | 129 | 25 | 17 | 162 | 199 | 532 | (N/A) | 1.7 |
| Littleleaf linden | 77 | 12 | 13 | 68 | 110 | 281 | (N/A) | 0.9 |
| American sycamore | 156 | 16 | 32 | 266 | 86 | 556 | (N/A) | 1.7 |
| Honeylocust | 130 | 21 | 21 | 157 | 389 | 719 | (N/A) | 2.2 |
| American elm | 3 | 1 | 1 | 3 | 5 | 12 | (N/A) | 0.0 |
| Kentucky coffeetree | 71 | 10 | 12 | 107 | 66 | 266 | (N/A) | 0.8 |
| White ash | 66 | 10 | 11 | 87 | 101 | 275 | (N/A) | 0.9 |
| Mulberry | 1 | 0 | 0 | 0 | 0 | 1 | (N/A) | 0.0 |
| Amur maple | 38 | 4 | 7 | 18 | 15 | 82 | (N/A) | 0.3 |
| Black cherry | 1 | 0 | 0 | 0 | 0 | 1 | (N/A) | 0.0 |
| Callery pear | 24 | 3 | 3 | 16 | 26 | 73 | (N/A) | 0.2 |
| American basswood | 86 | 18 | 14 | 165 | 119 | 403 | (N/A) | 1.3 |
| Citywide Total | 8,701 | 1,102 | 1,496 | 12,765 | 8,151 | 32,215 | (N/A) | 100.0 |

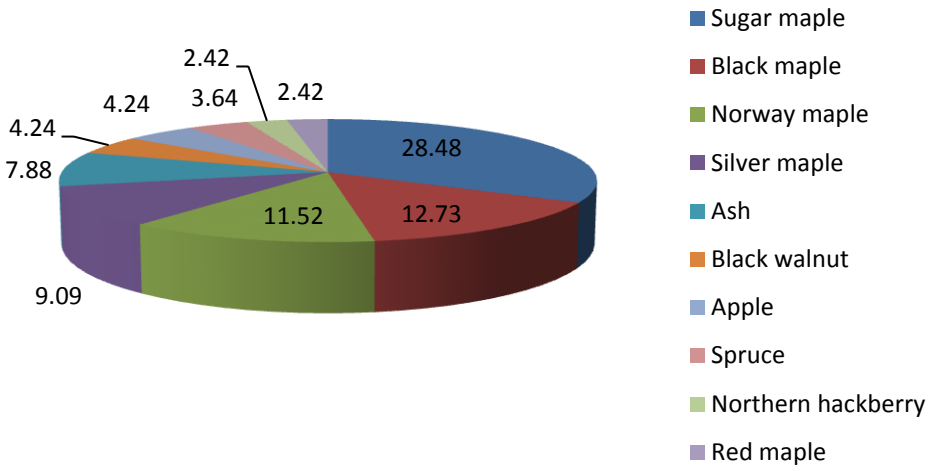


**Figure 1: Species Distribution**

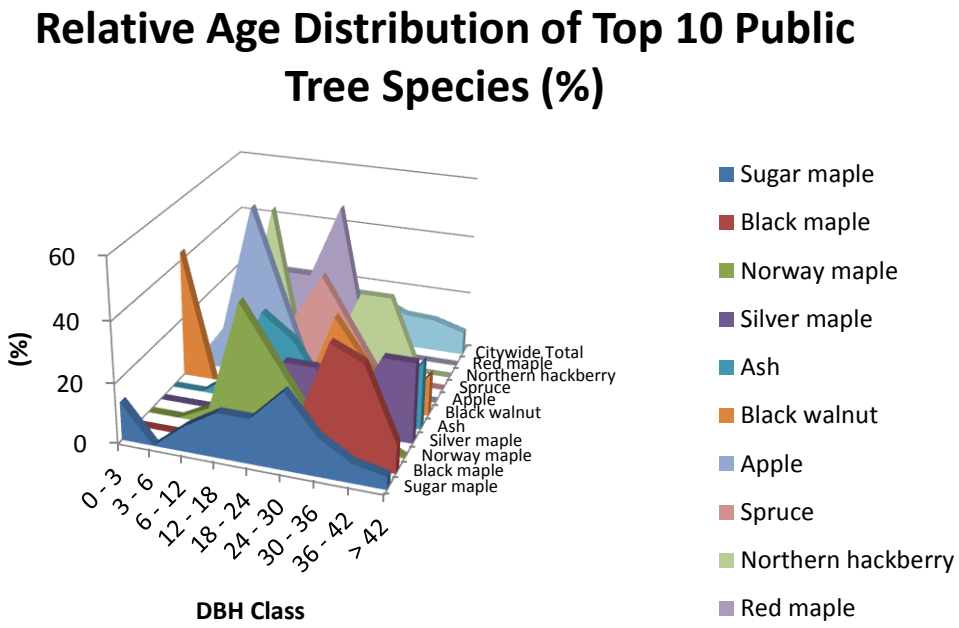


**Figure 2: Relative Age Class**

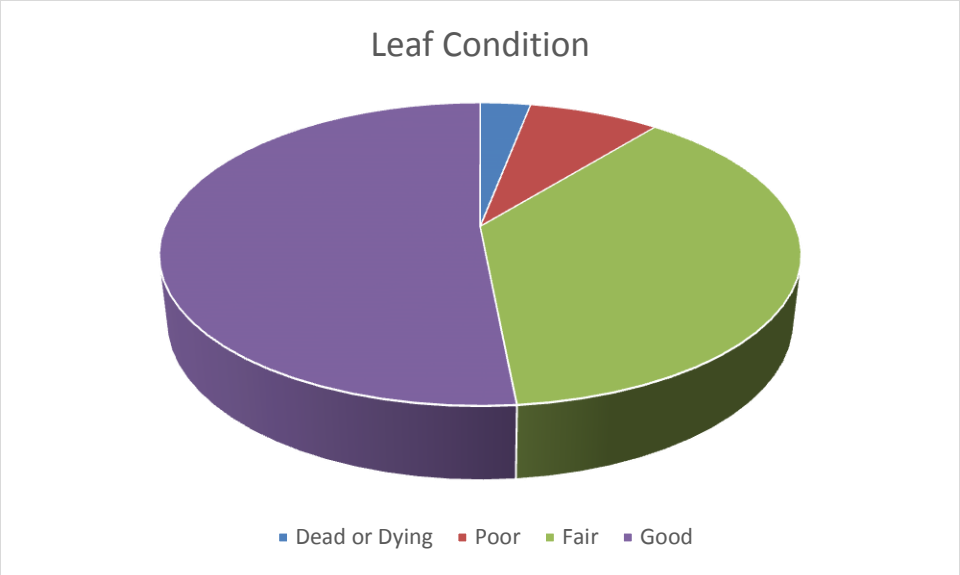


**Figure 3: Foliage Condition**

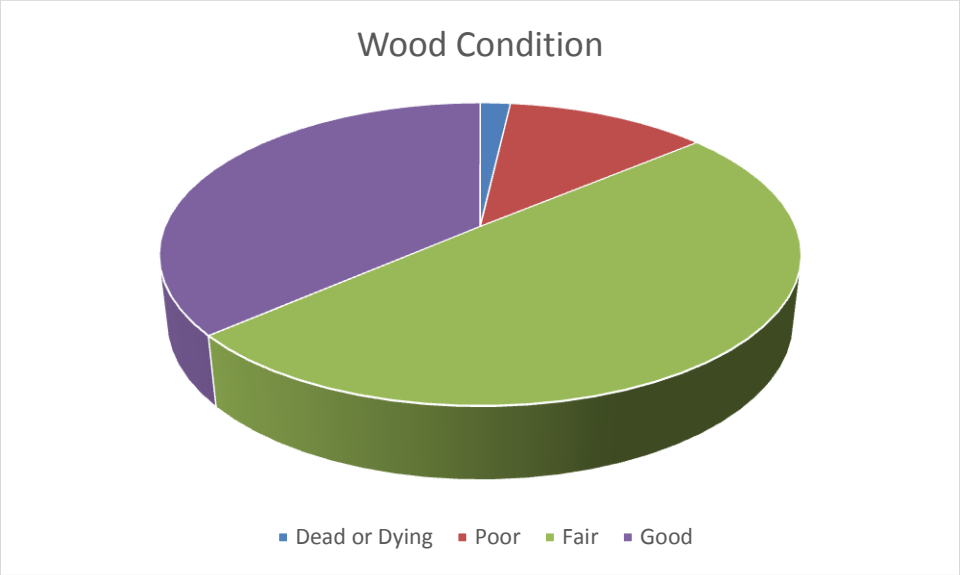


**Figure 4: Wood Condition**

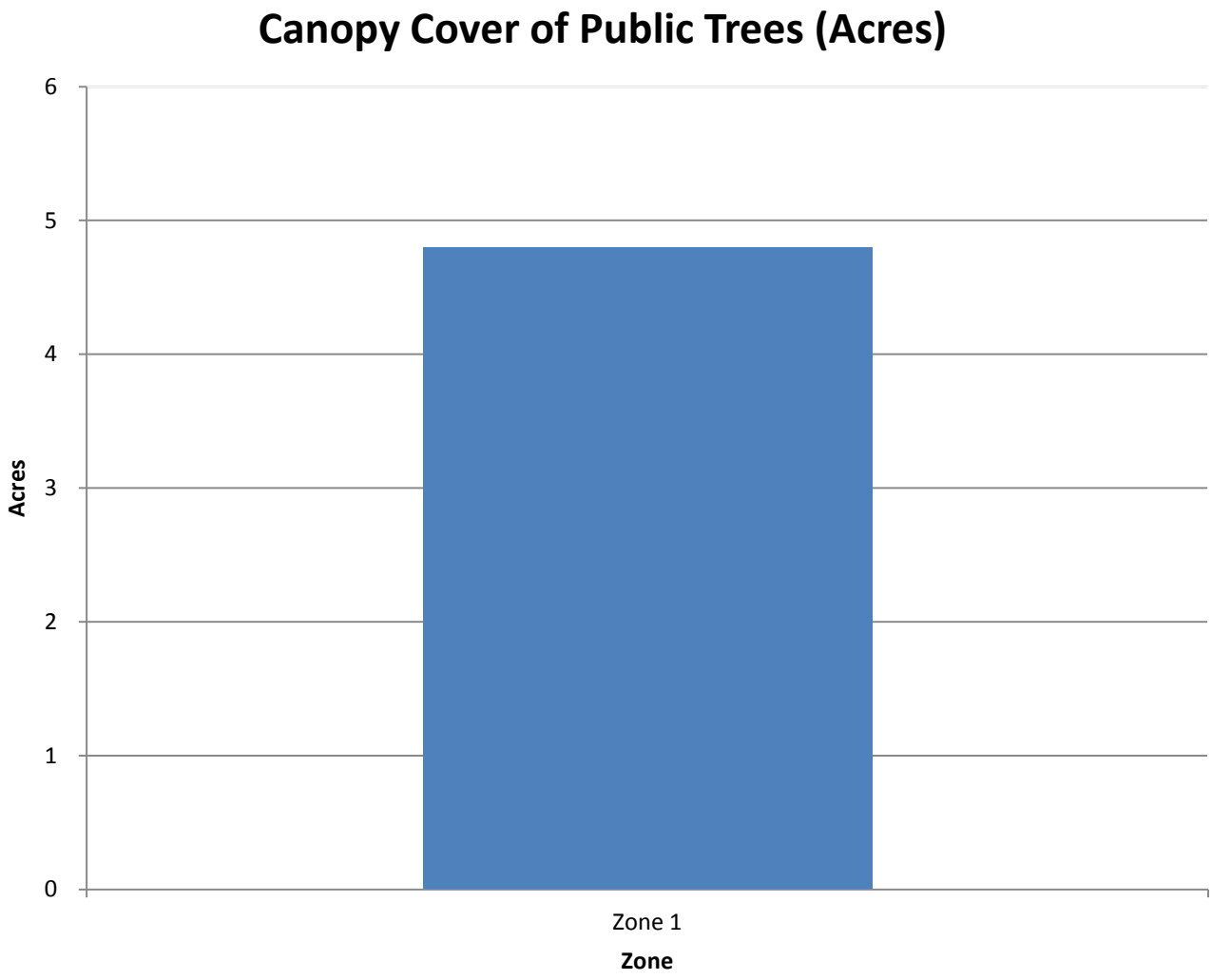


**Figure 5: Canopy Cover in Acres**

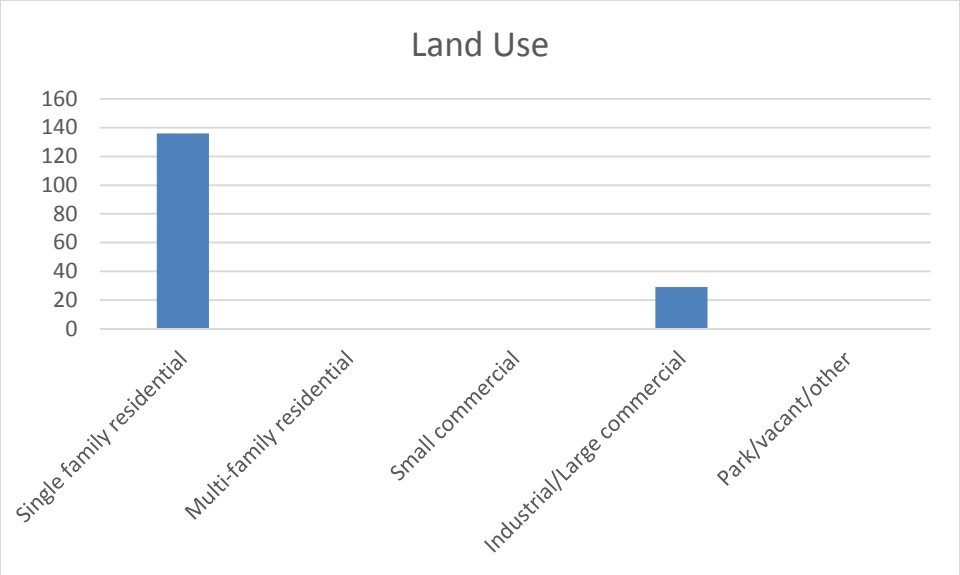


**Figure 6: Land Use of city/park trees**

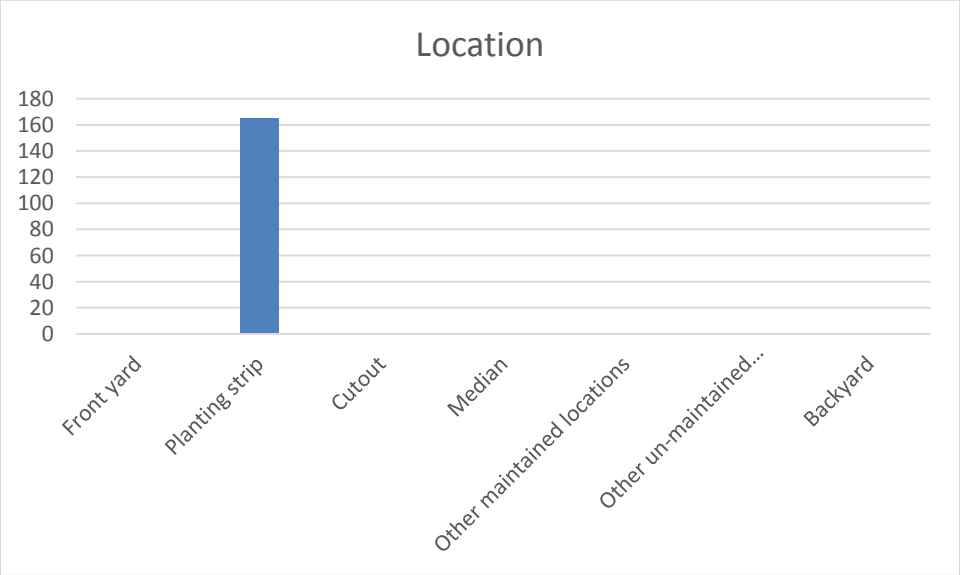


**Figure 7: Location of city/park trees**

## ***Appendix B: ArcGIS Mapping***


**Figure 1: Location of Ash Trees**


**Figure 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: Proposed Emerald Ash Borer Plan

**Ash Tree Removal**

Ash trees that become infested with EAB will die within 6-8 years and can present very serious risks to life and property. Once branches or trees die, the tissue can become very brittle and unpredictable within 1-2 years, making removal more dangerous and expensive for tree services. Therefore, it is recommended that ash trees be removed immediately as soon as signs and symptoms of EAB are detected in those trees. Dead, dying, and hazardous ash trees should be prioritized for removal first to mitigate public safety and risk. Next should be all ash in poor condition and displaying early signs and symptoms of EAB. *City ownership of the tree recommended for removal should be verified prior to any removal*

**EAB Quarantines**

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.

The entire State of Iowa is under a quarantine which prohibits the transport of regulated articles to areas outside the federal quarantine area. For a current quarantine map, please visit http://www.emeraldashborer.info/moving-firewood.php. County-to-county transport of regulated articles inside the State of Iowa is permitted, but discouraged.

**Wood Disposal**

Wood waste can be disposed of by typical means, such as chipping, composting, burning, etc. Cities and residents are encouraged to destroy ash materials promptly to prevent their spread to other neighboring communities and counties. Firewood from ash trees should be kept and used locally as much as possible.

**Canopy Replacement**

Replace all ash trees promptly with a diverse species mix as budgets allow. Encourage local residents to plant trees on their adjoining properties. All trees should meet the guidelines in the City Code.

**Postponed Work**

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on trees 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 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 either before or upon arrival of EAB. Preventative treatments using insecticides are available to protect highly valuable ash trees but must be administered for the remainder of the tree's life. Treatments are formulated either for homeowner use or via professionally-applied trunk injections, depending on tree size, in accordance with ISU Extension bulletin PM-2084 (available online for free).

# Appendix D: Recommended Tree Planting List

| IOWA TREE LIST | | | |
|---|---|---|---|
| | *This is a statewide list; Species survivability may vary by location. | | |
| | **Common Name** | **Scientific Name** | **Cultivars/ Selections** |
| SHADE TREES | Black Maple | *Acer nigrum* | |
| | Red Maple | *Acer rubrum* | Burgundy Belle, Red Sunset, Scarlet Jewel, Redpoint, Somerset |
| | Sugar Maple | *Acer saccharum* | Commemoration, Crescendo, Endowment, Fall Fiesta, Legacy, Green Mountain |
| | River Birch | *Betula nigra* | Heritage |
| | White-barked Birch | *Betula populifolia* | Whitespire Sr. |
| | American Elm | *Ulmus Americana* | Jefferson, Prairie Expedition (Lewis and Clark), Princeton |
| | Pecan | *Carya illinoinensis* | |
| | Shellbark Hickory | *Carya laciniosa* | |
| | Shagbark Hickory | *Carya ovata* | |
| | Hackberry | *Celtis occidentalis* | Chicagoland, Prairie Pride, Windy City |
| | Yellowwood | *Cladrastis kentuckea* | |
| | Turkish Filbert | *Corylus columa* | |
| | Ginkgo (male only) | *Ginkgo biloba* | Autumn Gold, Golden Colonnade, Halka, Magyar, Presidential Gold, Princeton Sentry |
| | Thornless Honeylocust | *Gleditisia triacanthos* | Northern Acclaim, Skyline, Shademaster |
| | Kentucky Coffeetree | *Gymnocladus dioicus* | |
| | Sweetgum | *Liquidambar styraciflua* | |
| | Tuliptree | *Liriodendron tulipifera* | |
| | Cucumbertree Magnolia | *Magnolia acuminata* | |
| | Blackgum | *Nyssa slyvatica* | |
| | London Planetree | *Platanus x acerfolia* | Bloodgood, Exclamation |
| | White Oak | *Quercus alba* | |
| | Swamp White Oak | *Quercus bicolor* | |
| | Scarlet Oak | *Quercus coccinea* | |
| | Shingle Oak | *Quercus imbricaria* | |
| | Bur Oak | *Quercus macrocarpa* | |
| | Chinkapin Oak | *Quercus muehlenbergii* | |
| | Pin Oak | *Quercus Palustris* | |
| | Northern Red Oak | *Quercus rubra* | |
| | American Linden | *Tilia americana* | Boulevard, Front Yard, Legend, American Sentry |
| | Silver Linden | *Tilia tomemtosa* | |
| | Littleleaf Linden | *Tilia Cordata* | Glenleven |
| LOW-GROWING TREES | Serviceberry | *Amelanchier spp.* | Autumn Brilliance, Cole's Select, Cumulus, Princess Diana, Strata |
| | American Hornbeam | *Carpinus caroliniana* | |
| | Eastern Redbud | *Cercis canadensis* | |
| | Pagoda Dogwood | *Cornus alternifolia* | |
| | Flowering Crabapple | *Malus spp.* | Adirondack, Cardinal, David, Donald Wyman, Doublooms, Floribunda, Golden Raindrops, Harvest Gold, Indian Magic, Louisa, Mary Potter, Purple Prince, Red Jewel, Royal Fountain, Royal Raindrops, Sugar Tyme |
| | American Hophombeam | *Ostyra virginiana* | |
| | American Plum | *Prunus americana* | |
| | Japanese Tree Lilac | *Syringa reticulata* | Ivory Silk, Summer Snow |
| CONIFERS | White Fir | *Abies concolor* | |
| | Norway Spruce | *Picea abies* | |
| | White Spruce | *Picea glauca* | |
| | Black Hills Spruce | *Picea glauca var. densata* | |
| | Serbian Spruce | *Picea omorika* | |
| | White Pine | *Pinus strobus* | |
| | Arborvitae | *Thuja occidentalis* | |
| | Canadian Hemlock | *Tsuga canadensis* | |
| | Larch | *Larix decidua* | |
| | Bald Cypress | *Taxodium distichum* | |

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