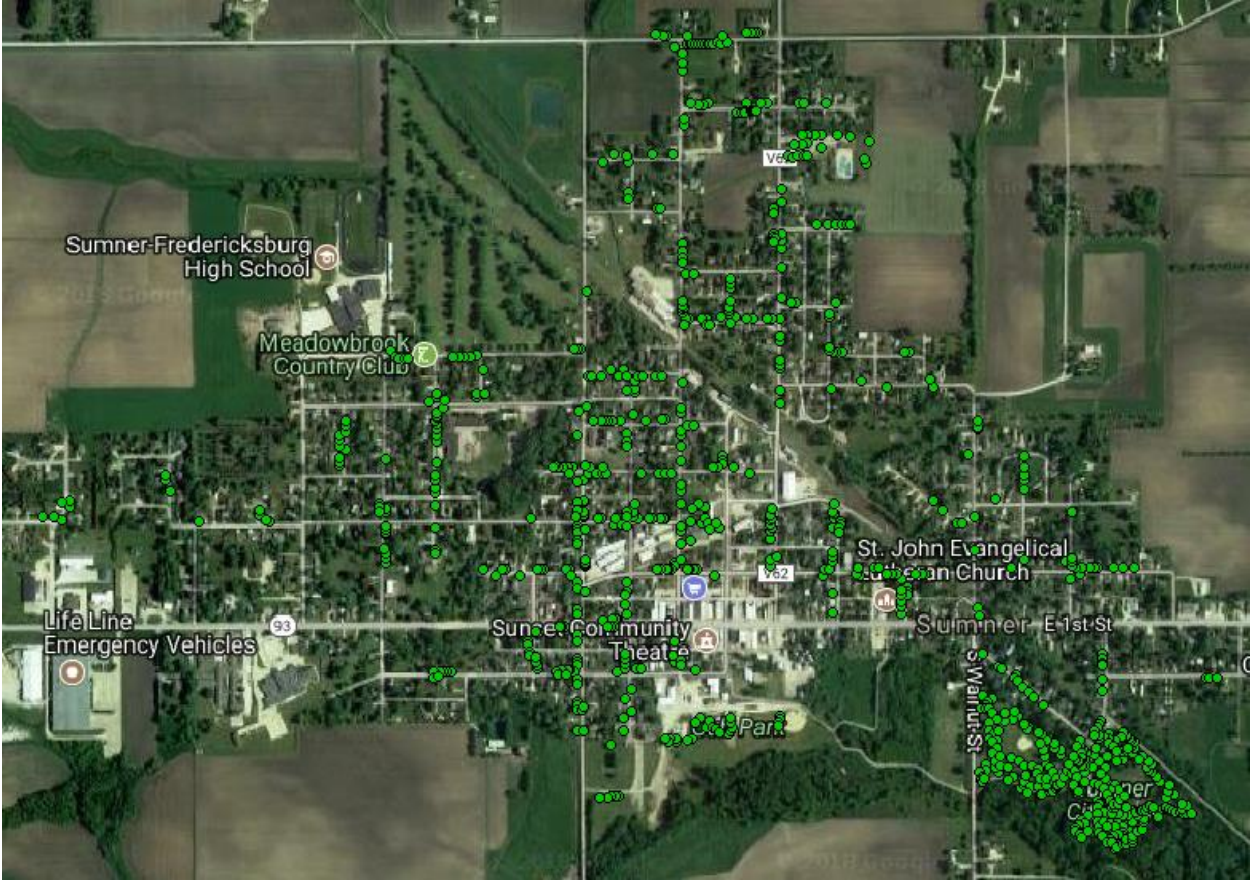


# Community Tree Management Plan for Sumner, IA



2017 Urban Forest Management Plan  
Prepared by ArborPro, Inc.  
In Partnership with the Iowa DNR



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# Executive Summary

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## Overview

This plan was developed to assist the City of Sumner 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 23.55% of Sumner's community, unless preventative treatment is used, will become infested and die once EAB becomes established in the community. 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 2017, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 379 trees inventoried.

- Sumner's trees provide \$144,055 of benefits annually, an average of \$173 a tree
- There are over 44 species of trees
- The top three genera are: Maple 37.37%, Ash 23.45%, and Oak 6.25%
- 85% of trees need some type of management or mitigation.
- 67 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 67 trees needing removal, 34 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\\*](#)
- 78 of the 195 ash trees should be carefully examined, as they present with some of the symptoms that could be related to an EAB infestation.
- All trees should be pruned on a routine schedule- one third of the city every other year
- Plant a diverse mix of trees that do not include: Ash, Maple, Cottonwood, Poplar, Box Elder, Bradford Pear, female Ginko, Chinese Elm, Scot's Pine, Austrian Pine, Willow or Black Walnut.
- Check ash trees with a visual survey yearly
- With the current budget it could take 24 years to remove ash – Suggestion: request a budget increase to \$10,000 annually and apply for grants to plant replacement trees

## Introduction

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

Trees are an important component of Sumner'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, storm water 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 Sumner 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 Sumner's urban forestry goals.

## Inventory

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In 2017, a tree inventory was conducted that included 100% of the city owned street trees and park trees. The tree data was collected using a hand held 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 832 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. Sumner's trees reduce energy related costs by approximately \$38,733 annually (Appendix A, Table 1). These savings are both in Electricity (184 MWh) and in Natural Gas (25,255 Therms).

#### **Annual Stormwater Benefits**

Sumner's trees intercept about 1,964,462 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$53,237 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 Sumner it is estimated that trees remove 303 lbs of air pollution (ozone (O<sub>3</sub>), particulate matter less than 10 microns (PM<sub>10</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and sulfur dioxide (SO<sub>2</sub>)) per year with a net value of \$6,467 (Appendix A, Table 3).

#### **Annual Carbon Benefits**

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Sumner, trees sequester about 436,623 lbs of carbon a year with an associated value of \$5,318 (Appendix A, Table 4). In addition, the trees store 7,203,283 lbs of carbon, with a yearly benefit of \$54,023 (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. Sumner receives \$40,299 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, Sumner's trees provide \$144,055

of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 832 trees in Sumner provide approximately \$173 annually (Appendix A, Table 7).

## **Forest Structure**

### **Species Distribution**

Sumner has over 44 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

|                         |     |             |
|-------------------------|-----|-------------|
| Green ash               | 194 | 23.31       |
| Silver maple            | 65  | 7.81        |
| Sugar maple             | 61  | 7.33        |
| Red maple               | 55  | 6.6         |
| Black walnut            | 34  | 4.08        |
| Pin oak                 | 26  | 3.12        |
| Northern red oak        | 14  | 1.68        |
| American basswood       | 11  | <b>1.32</b> |
| Northern hackberry      | 10  | 1.2         |
| Oak                     | 7   | 0.84        |
| American elm            | 6   | 0.72        |
| Bur oak                 | 5   | 0.6         |
| Hickory                 | 4   | 0.48        |
| American sycamore       | 2   | 0.24        |
| Eastern cottonwood      | 2   | 0.24        |
| White ash               | 1   | 0.12        |
| Elm                     | 1   | 0.12        |
| Norway maple            | 125 | 15.02       |
| River birch             | 15  | 1.8         |
| Littleleaf linden       | 12  | 1.44        |
| Honeylocust             | 10  | 1.2         |
| Boxelder                | 7   | 0.84        |
| Birch                   | 6   | 0.72        |
| Willow                  | 4   | 0.48        |
| Ohio buckeye            | 2   | 0.24        |
| Siberian elm            | 1   | 0.12        |
| Broadleaf Deciduous Mec | 1   | 0.12        |
| Apple                   | 54  | <b>6.49</b> |
| Amur maple              | 5   | 0.6         |
| Pear                    | 4   | 0.48        |
| Plum                    | 4   | 0.48        |
| Broadleaf Deciduous Sma | 2   | 0.24        |
| Eastern redbud          | 2   | 0.24        |
| Black cherry            | 1   | 0.12        |
| White mulberry          | 1   | 0.12        |
| Cherry plum             | 1   | 0.12        |
| Norway spruce           | 13  | 1.56        |
| Spruce                  | 10  | 1.2         |
| Scotch pine             | 9   | 1.08        |
| Ponderosa pine          | 3   | 0.36        |
| Blue spruce             | 23  | <b>2.76</b> |
| Conifer Evergreen Mediu | 7   | 0.84        |
| Austrian pine           | 3   | 0.36        |
| Eastern red cedar       | 2   | 0.24        |

## Age Class

Approximately one third (50.48%) of Sumner’s trees are between 0 and 18 inches in diameter at 4.5 ft. (Appendix A, Figure 2). It is preferred that the highest number of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Sumner’s size curve is on the upward side, indicating a mature to over-mature forest stand.

## Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Sumner indicate that 35.94% of the trees are in fair health, with 59.98% of the trees in good health, and only 3.25% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 43.39% of Sumner’s trees are in fair health for wood condition, with 42.67% in good wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 13.22% of the population. This 13.94% 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).

| <b>Priority Tasks for Public Trees by Zone (None)</b>                     |           |       |       |
|---|-----------|-------|-------|
| Total   | 25 (N/A)  | 3.00  | 3.00  |
| <b>Priority Tasks for Public Trees by Zone (Stake/Train)</b>              |           |       |       |
| Total   | 63 (N/A)  | 7.57  | 7.57  |
| <b>Priority Tasks for Public Trees by Zone (Crown cleaning)</b>           |           |       |       |
| Total   | 357 (N/A) | 42.91 | 42.91 |
| <b>Priority Tasks for Public Trees by Zone (Crown Raising)</b>            |           |       |       |
| Total   | 98 (N/A)  | 11.78 | 11.78 |
| <b>Priority Tasks for Public Trees by Zone (Crown reduction/thinning)</b> |           |       |       |
| Total   | 222 (N/A) | 26.68 | 26.68 |
| <b>Priority Tasks for Public Trees by Zone (Remove)</b>                   |           |       |       |
| Total   | 67 (N/A)  | 8.05  | 8.05  |

## Canopy Cover

The total canopy with both private and public trees is 1.25%, 1619 acres. The canopy cover included in the Sumner inventory includes approximately 20 acres (Appendix A, Figure 4). The

City's Canopy goal is 30%, in 30 years. To achieve this goal, it is estimated that 118 public and private trees need to be planted annually.

### Land Use and Location

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

#### Sumner

#### Land Use of Public Trees by Zone

3/8/2018

| Zone | Land Use                    | Tree Count | Standard Error | % of Zone | % of Public Trees |
|------|-----------------------------|------------|----------------|-----------|-------------------|
| 1    | Single family residential   | 488 (N/A)  |                | 58.65     | 58.65             |
|      | Multi-family residential    | 0 (N/A)    |                | 0.00      | 0.00              |
|      | Small commercial            | 15 (N/A)   |                | 1.80      | 1.80              |
|      | Industrial/Large commercial | 0 (N/A)    |                | 0.00      | 0.00              |
|      | Park/vacant/other           | 329 (N/A)  |                | 39.54     | 39.54             |
|      | Total                       | 832 (N/A)  |                | 100.00    | 100.00            |

#### Location

|           |     |      |
|-----------|-----|------|
| Back Yard | 832 | 100% |
|-----------|-----|------|

## 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

Sumner has 1 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There is 1 tree over 25 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 the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance.

#### 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 67 removals, only 35 are ash



tree. There is a total of 195 ash trees, and 78 of those have signs and symptoms that have been associated with EAB. In addition, there are 16 trees that are in poor health. [\\*City ownership of the trees recommended for removal should be verified prior to any removal\\*](#)

## Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six-year maintenance plan for further information.

## Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six-year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Sumner.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with maple (37.37%) (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 because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut. All trees planted must meet the restrictions in city ordinance.

## Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

**Six Year Maintenance Plan with No Additional Funding:** This will not meet the 62 trees noted for removal and other needs.

Year 1

Removal: 8 largest critical concern trees

Planting and Replacement: 9 trees to be planted in open locations  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 2 critical concern trees and 4 additional ash trees with poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 6 trees in open locations from year one removals  
Young Tree Pruning & Maintenance:  
Routine trimming: Contract to trim 1/3 of the city trees  
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 8 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 9 trees to be planted in open locations and locations from previous removals  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 6 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 7 trees in open locations from previous removals  
Routine trimming: Contract to trim 1/3 of the city trees  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

Year 5

Removal: 8 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 9 trees to be planted in open locations and locations from previous removals  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 6 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 7 trees in open locations from previous removals  
Routine trimming: Contract to trim 1/3 of the city trees  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

\*Reduction of ash over 6 years: 24 ash trees removed (approximately 12.3% of ash). It will take approximately 17 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.

\*\* To remove all ash trees within 6 years, the budget would need to be increased to \$19,500 a year. If the budget were increased to \$10,000 a year all ash could be removed in 13 years.

# Emerald Ash Borer Plan

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## **Ash Tree Removal**

Tree removal will be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). *\*City ownership of the tree recommended for removal should be verified prior to any removal\**

## **Treatment of Ash Trees**

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

## **EAB Quarantines**

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

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

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

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

## **Wood Disposal**

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website

[http://www.aphis.usda.gov/plant\\_health/plant\\_pest\\_info/emerald\\_ash\\_b/regulatory.shtml](http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml).  
Wood waste can be disposed of as you normally would if your county is not part of a quarantine.

### **Canopy Replacement**

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

### **Postponed Work**

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genera other than ash will be prioritized by hazardous or emergency situations only.

### **Monitoring**

It is recommended that ash trees be checked with a visual survey every year for tree death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

### **Private Ash Trees**

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if tree is not being treated. An example of City Code could state “If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.”

# Budget

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## Current Budget

Total \$23,796 over 6 years (\$3966/year)

### **FY 2018 Budget**

Removal: \$2700

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

Planting: \$700

Watering & Maintenance: \$500

### **FY 2019 Budget**

Removal: \$2000

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

Planting: \$600

Routine trimming: \$1000

Watering & Maintenance: \$300

### **FY 2020 Budget**

Removal: \$2700

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

Planting: \$900

Watering & Maintenance: \$500

### **FY 2021 Budget**

Removal: \$2000

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

Planting: \$600

Routine trimming: \$1,000

Watering & Maintenance: \$300

### **FY 2022 Budget**

Removal: \$2700

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

Planting: \$900

Watering & Maintenance: \$500

### **FY 2023 Budget**

Removal: \$2000

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

Planting: \$600

Routine trimming: \$1000

Watering & Maintenance: \$300

\*Reduction of ash over 6 years: approximately 24 ash trees removed (approximately 12.03% of ash). **It will take approximately 17 years to remove all ash with the current budget.**

## Purposed Budget Increase

EAB could potentially kill all ash trees in Sumner within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to \$19,500 a year. If the budget

were increased to \$10,000 a year all ash could be removed within 13 years. Additionally, it is recommended that Sumner apply for grants to fund replacement trees. Utility Company grants are usually between \$500 and \$10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at \$15 per inch, about 4 trees could be treated per year (every other year treatment). This would be 8 trees selected for treatment, and \*CITY\* would still need to find \$8,000 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately \$2,250 a year for treatment and leave \$1,800 for removal. These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Sumner. 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

Sumner

3/8/2018

Annual Energy Benefits of Public Trees by Species

| Species                   | Total Electricity (MWh) | Electricity (\$) | Total Natural Gas (Therms) | Natural Gas (\$) | Total (\$) | Standard Error | % of Total Tree Numbers | % of Total \$ | Avg. \$/tree |
|---------------------------|-------------------------|------------------|----------------------------|------------------|------------|----------------|-------------------------|---------------|--------------|
| Green ash                 | 51.39                   | 3,900.54         | 6,988.04                   | 6,848.28         | 10,748.82  | (N/A)          | 23.32                   | 27.75         | 55.41        |
| Norway maple              | 29.24                   | 2,219.01         | 4,202.17                   | 4,118.12         | 6,337.13   | (N/A)          | 15.02                   | 16.36         | 50.70        |
| Silver maple              | 22.45                   | 1,703.63         | 2,961.33                   | 2,902.10         | 4,605.73   | (N/A)          | 7.81                    | 11.89         | 70.86        |
| Sugar maple               | 17.43                   | 1,322.88         | 2,354.06                   | 2,306.97         | 3,629.86   | (N/A)          | 7.33                    | 9.37          | 59.51        |
| Red maple                 | 10.19                   | 773.50           | 1,358.31                   | 1,331.14         | 2,104.64   | (N/A)          | 6.61                    | 5.43          | 38.27        |
| Apple                     | 3.44                    | 261.24           | 547.07                     | 536.13           | 797.37     | (N/A)          | 6.49                    | 2.06          | 14.77        |
| Black walnut              | 7.00                    | 530.95           | 931.42                     | 912.79           | 1,443.74   | (N/A)          | 4.09                    | 3.73          | 42.46        |
| Pin oak                   | 8.11                    | 615.51           | 1,093.33                   | 1,071.46         | 1,686.97   | (N/A)          | 3.13                    | 4.36          | 64.88        |
| Blue spruce               | 2.36                    | 179.04           | 316.35                     | 310.02           | 489.06     | (N/A)          | 2.76                    | 1.26          | 21.26        |
| River birch               | 3.29                    | 249.47           | 475.48                     | 465.97           | 715.44     | (N/A)          | 1.80                    | 1.85          | 47.70        |
| Northern red oak          | 1.86                    | 141.15           | 257.17                     | 252.03           | 393.18     | (N/A)          | 1.68                    | 1.02          | 28.08        |
| Norway spruce             | 2.26                    | 171.23           | 300.23                     | 294.22           | 465.45     | (N/A)          | 1.56                    | 1.20          | 35.80        |
| Littleleaf linden         | 1.69                    | 128.22           | 224.30                     | 219.82           | 348.04     | (N/A)          | 1.44                    | 0.90          | 29.00        |
| American basswood         | 3.43                    | 260.03           | 496.76                     | 486.83           | 746.86     | (N/A)          | 1.32                    | 1.93          | 67.90        |
| Spruce                    | 1.02                    | 77.36            | 135.51                     | 132.80           | 210.16     | (N/A)          | 1.20                    | 0.54          | 21.02        |
| Northern hackberry        | 2.89                    | 219.38           | 406.02                     | 397.90           | 617.28     | (N/A)          | 1.20                    | 1.59          | 61.73        |
| Honeylocust               | 2.26                    | 171.19           | 304.46                     | 298.37           | 469.56     | (N/A)          | 1.20                    | 1.21          | 46.96        |
| Scotch pine               | 0.86                    | 65.18            | 106.57                     | 104.44           | 169.62     | (N/A)          | 1.08                    | 0.44          | 18.85        |
| Conifer Evergreen Medium  | 0.84                    | 63.48            | 105.64                     | 103.53           | 167.01     | (N/A)          | 0.84                    | 0.43          | 23.86        |
| Boxelder                  | 1.17                    | 88.74            | 152.69                     | 149.64           | 238.38     | (N/A)          | 0.84                    | 0.62          | 34.05        |
| Oak                       | 2.29                    | 173.74           | 324.16                     | 317.67           | 491.41     | (N/A)          | 0.84                    | 1.27          | 70.20        |
| American elm              | 1.41                    | 107.37           | 184.11                     | 180.43           | 287.80     | (N/A)          | 0.72                    | 0.74          | 47.97        |
| Birch                     | 0.82                    | 61.98            | 120.41                     | 118.00           | 179.98     | (N/A)          | 0.72                    | 0.46          | 30.00        |
| Bur oak                   | 0.61                    | 46.51            | 81.90                      | 80.27            | 126.78     | (N/A)          | 0.60                    | 0.33          | 25.36        |
| Amur maple                | 0.38                    | 28.56            | 57.92                      | 56.76            | 85.32      | (N/A)          | 0.60                    | 0.22          | 17.06        |
| Willow                    | 1.01                    | 76.61            | 151.25                     | 148.23           | 224.84     | (N/A)          | 0.48                    | 0.58          | 56.21        |
| Pear                      | 0.01                    | 1.02             | 2.50                       | 2.45             | 3.47       | (N/A)          | 0.48                    | 0.01          | 0.87         |
| Hickory                   | 0.97                    | 73.30            | 119.08                     | 116.70           | 190.01     | (N/A)          | 0.48                    | 0.49          | 47.50        |
| MAI                       | 0.00                    | 0.00             | 0.00                       | 0.00             | 0.00       | (N/A)          | 0.48                    | 0.00          | 0.00         |
| Plum                      | 0.01                    | 1.02             | 2.50                       | 2.45             | 3.47       | (N/A)          | 0.48                    | 0.01          | 0.87         |
| Austrian pine             | 0.42                    | 31.93            | 53.64                      | 52.56            | 84.49      | (N/A)          | 0.36                    | 0.22          | 28.16        |
| Ponderosa pine            | 0.24                    | 18.34            | 33.63                      | 32.95            | 51.29      | (N/A)          | 0.36                    | 0.13          | 17.10        |
| Ohio buckeye              | 0.34                    | 25.83            | 46.34                      | 45.42            | 71.25      | (N/A)          | 0.24                    | 0.18          | 35.62        |
| Broadleaf Deciduous Small | 0.04                    | 3.37             | 7.59                       | 7.44             | 10.81      | (N/A)          | 0.24                    | 0.03          | 5.40         |
| Eastern red cedar         | 0.10                    | 7.42             | 15.85                      | 15.53            | 22.95      | (N/A)          | 0.24                    | 0.06          | 11.47        |
| Eastern redbud            | 0.04                    | 3.37             | 7.59                       | 7.44             | 10.81      | (N/A)          | 0.24                    | 0.03          | 5.40         |
| QUMA                      | 0.00                    | 0.00             | 0.00                       | 0.00             | 0.00       | (N/A)          | 0.24                    | 0.00          | 0.00         |
| Eastern cottonwood        | 0.81                    | 61.77            | 109.97                     | 107.77           | 169.54     | (N/A)          | 0.24                    | 0.44          | 84.77        |
| American sycamore         | 0.78                    | 58.83            | 107.36                     | 105.21           | 164.04     | (N/A)          | 0.24                    | 0.42          | 82.02        |
| White mulberry            | 0.18                    | 13.96            | 24.67                      | 24.17            | 38.13      | (N/A)          | 0.12                    | 0.10          | 38.13        |
| White ash                 | 0.09                    | 7.04             | 13.33                      | 13.07            | 20.10      | (N/A)          | 0.12                    | 0.05          | 20.10        |
| Elm                       | 0.03                    | 2.20             | 3.69                       | 3.62             | 5.82       | (N/A)          | 0.12                    | 0.02          | 5.82         |
| CR                        | 0.00                    | 0.00             | 0.00                       | 0.00             | 0.00       | (N/A)          | 0.12                    | 0.00          | 0.00         |
| Black cherry              | 0.07                    | 5.62             | 12.83                      | 12.58            | 18.19      | (N/A)          | 0.12                    | 0.05          | 18.19        |
| Siberian elm              | 0.39                    | 29.95            | 53.21                      | 52.15            | 82.09      | (N/A)          | 0.12                    | 0.21          | 82.09        |
| Broadleaf Deciduous Medit | 0.00                    | 0.33             | 0.79                       | 0.78             | 1.10       | (N/A)          | 0.12                    | 0.00          | 1.10         |
| Cherry plum               | 0.02                    | 1.68             | 3.80                       | 3.72             | 5.40       | (N/A)          | 0.12                    | 0.01          | 5.40         |
| Total                     | 184.24                  | 13,983.45        | 25,255.02                  | 24,749.92        | 38,733.38  | (N/A)          | 100.00                  | 100.00        | 46.55        |

Annual Energy Benefits of Public Trees by Zone

| Zone  | Total Electricity (MWh) | Electricity (\$) | Total Natural Gas (Therms) | Natural Gas (\$) | Total (\$) | Standard Error | % of Total Tree Numbers | % of Total \$ | Avg. \$/Tree |
|-------|-------------------------|------------------|----------------------------|------------------|------------|----------------|-------------------------|---------------|--------------|
| 1     | 184.24                  | 13,983.45        | 25,255.02                  | 24,749.92        | 38,733.38  | (N/A)          | 100.00                  | 100.00        | 46.55        |
| Total | 184.24                  | 13,983.45        | 25,255.02                  | 24,749.92        | 38,733.38  | (N/A)          | 100.00                  | 100.00        | 46.55        |

## Table 2: Annual Storm Water Benefits

Sumner

3/8/2018

### Annual Stormwater Benefits of Public Trees by Species

| Species                   | Total Rainfall Interception (Gal) | Total (\$) | Standard Error | % of Total Tree Numbers | % of Total \$ | Avg. \$/tree |
|---------------------------|-----------------------------------|------------|----------------|-------------------------|---------------|--------------|
| Green ash                 | 555,117.18                        | 15,043.68  | (N/A)          | 23.32                   | 28.26         | 77.54        |
| Norway maple              | 258,182.18                        | 6,996.74   | (N/A)          | 15.02                   | 13.14         | 55.97        |
| Silver maple              | 329,475.11                        | 8,928.78   | (N/A)          | 7.81                    | 16.77         | 137.37       |
| Sugar maple               | 192,026.52                        | 5,203.92   | (N/A)          | 7.33                    | 9.78          | 85.31        |
| Red maple                 | 78,414.08                         | 2,125.02   | (N/A)          | 6.61                    | 3.99          | 38.64        |
| Apple                     | 13,067.11                         | 354.12     | (N/A)          | 6.49                    | 0.67          | 6.56         |
| Black walnut              | 60,221.77                         | 1,632.01   | (N/A)          | 4.09                    | 3.07          | 48.00        |
| Pin oak                   | 89,033.94                         | 2,412.82   | (N/A)          | 3.13                    | 4.53          | 92.80        |
| Blue spruce               | 30,992.53                         | 839.90     | (N/A)          | 2.76                    | 1.58          | 36.52        |
| River birch               | 31,375.92                         | 850.29     | (N/A)          | 1.80                    | 1.60          | 56.69        |
| Northern red oak          | 17,698.95                         | 479.64     | (N/A)          | 1.68                    | 0.90          | 34.26        |
| Norway spruce             | 53,318.61                         | 1,444.93   | (N/A)          | 1.56                    | 2.71          | 111.15       |
| Littleleaf linden         | 12,351.73                         | 334.73     | (N/A)          | 1.44                    | 0.63          | 27.89        |
| American basswood         | 39,676.98                         | 1,075.25   | (N/A)          | 1.32                    | 2.02          | 97.75        |
| Spruce                    | 15,522.75                         | 420.67     | (N/A)          | 1.20                    | 0.79          | 42.07        |
| Northern hackberry        | 23,788.62                         | 644.67     | (N/A)          | 1.20                    | 1.21          | 64.47        |
| Honeylocust               | 21,096.65                         | 571.72     | (N/A)          | 1.20                    | 1.07          | 57.17        |
| Scotch pine               | 12,567.11                         | 340.57     | (N/A)          | 1.08                    | 0.64          | 37.84        |
| Conifer Evergreen Medium  | 10,789.39                         | 292.39     | (N/A)          | 0.84                    | 0.55          | 41.77        |
| Boxelder                  | 9,617.18                          | 260.63     | (N/A)          | 0.84                    | 0.49          | 37.23        |
| Oak                       | 27,991.28                         | 758.56     | (N/A)          | 0.84                    | 1.42          | 108.37       |
| American elm              | 12,748.63                         | 345.49     | (N/A)          | 0.72                    | 0.65          | 57.58        |
| Birch                     | 5,658.46                          | 153.34     | (N/A)          | 0.72                    | 0.29          | 25.56        |
| Bur oak                   | 3,896.99                          | 105.61     | (N/A)          | 0.60                    | 0.20          | 21.12        |
| Amur maple                | 1,332.83                          | 36.12      | (N/A)          | 0.60                    | 0.07          | 7.22         |
| Willow                    | 10,593.93                         | 287.10     | (N/A)          | 0.48                    | 0.54          | 71.77        |
| Pear                      | 29.80                             | 0.81       | (N/A)          | 0.48                    | 0.00          | 0.20         |
| Hickory                   | 6,987.32                          | 189.36     | (N/A)          | 0.48                    | 0.36          | 47.34        |
| MAI                       | 0.00                              | 0.00       | (N/A)          | 0.48                    | 0.00          | 0.00         |
| Plum                      | 29.80                             | 0.81       | (N/A)          | 0.48                    | 0.00          | 0.20         |
| Austrian pine             | 6,013.22                          | 162.96     | (N/A)          | 0.36                    | 0.31          | 54.32        |
| Ponderosa pine            | 2,729.66                          | 73.97      | (N/A)          | 0.36                    | 0.14          | 24.66        |
| Ohio buckeye              | 1,995.05                          | 54.07      | (N/A)          | 0.24                    | 0.10          | 27.03        |
| Broadleaf Deciduous Small | 137.32                            | 3.72       | (N/A)          | 0.24                    | 0.01          | 1.86         |
| Eastern red cedar         | 1,318.43                          | 35.73      | (N/A)          | 0.24                    | 0.07          | 17.86        |
| Eastern redbud            | 137.32                            | 3.72       | (N/A)          | 0.24                    | 0.01          | 1.86         |
| QUMA                      | 0.00                              | 0.00       | (N/A)          | 0.24                    | 0.00          | 0.00         |
| Eastern cottonwood        | 11,181.87                         | 303.03     | (N/A)          | 0.24                    | 0.57          | 151.51       |
| American sycamore         | 10,981.05                         | 297.59     | (N/A)          | 0.24                    | 0.56          | 148.79       |
| White mulberry            | 666.53                            | 18.06      | (N/A)          | 0.12                    | 0.03          | 18.06        |
| White ash                 | 613.67                            | 16.63      | (N/A)          | 0.12                    | 0.03          | 16.63        |
| Elm                       | 171.63                            | 4.65       | (N/A)          | 0.12                    | 0.01          | 4.65         |
| CR                        | 0.00                              | 0.00       | (N/A)          | 0.12                    | 0.00          | 0.00         |
| Black cherry              | 264.49                            | 7.17       | (N/A)          | 0.12                    | 0.01          | 7.17         |
| Siberian elm              | 4,567.40                          | 123.78     | (N/A)          | 0.12                    | 0.23          | 123.78       |
| Broadleaf Deciduous Medit | 12.20                             | 0.33       | (N/A)          | 0.12                    | 0.00          | 0.33         |
| Cherry plum               | 68.66                             | 1.86       | (N/A)          | 0.12                    | 0.00          | 1.86         |
| Citywide total            | 1,964,461.86                      | 53,236.92  | (N/A)          | 100.00                  | 100.00        | 63.99        |

### Annual Stormwater Benefits of Public Trees by Zone

| Zone           | Total rainfall interception (Gal) | Total (\$) | Standard Error | % of Total Tree Numbers | % of Total \$ | Avg. \$/tree |
|----------------|-----------------------------------|------------|----------------|-------------------------|---------------|--------------|
| 1              | 1,964,461.86                      | 53,236.92  | (N/A)          | 100.00                  | 100.00        | 63.99        |
| Citywide total | 1,964,461.86                      | 53,236.92  | (N/A)          | 100.00                  | 100.00        | 63.99        |



# Table 3: Annual Air Quality Benefits

Summer

3/8/2018

Annual Air Quality Benefits of Public Trees by Species

| Species                   | Deposito           |            |           | Total               |                 | Total            |                   |                  |                  | BVOC       |                | BVOC           |            | Standard Error | % of Total |              |              |
|---------------------------|--------------------|------------|-----------|---------------------|-----------------|------------------|-------------------|------------------|------------------|------------|----------------|----------------|------------|----------------|------------|--------------|--------------|
|                           | Deposito n O3 (lb) | n NO2 (lb) | PM10 (lb) | Deposito n SO2 (lb) | Deposito n (\$) | Avoided NO2 (lb) | Avoided PM10 (lb) | Avoided VOC (lb) | Avoided SO2 (lb) | Total (\$) | Emissions (lb) | Emissions (\$) | Total (lb) |                | Total (\$) | Tree Numbers | Avg. \$/tree |
| Green ash                 | 69.06              | 11.04      | 33.17     | 3.10                | 368.12          | 244.95           | 35.70             | 34.04            | 232.92           | 1,526.95   | 0.00           | 0.00           | 663.97     | 1,895.07       | (N/A)      | 23.32        | 9.77         |
| Norway maple              | 50.79              | 8.76       | 25.22     | 2.25                | 275.16          | 141.63           | 20.48             | 19.50            | 132.65           | 877.60     | -12.07         | -45.28         | 389.21     | 1,107.48       | (N/A)      | 15.02        | 8.86         |
| Silver maple              | 59.38              | 10.06      | 28.97     | 2.63                | 319.63          | 105.90           | 15.50             | 14.79            | 101.54           | 662.37     | -31.60         | -118.51        | 307.18     | 863.50         | (N/A)      | 7.81         | 13.28        |
| Sugar maple               | 25.57              | 4.35       | 12.77     | 1.13                | 138.55          | 82.84            | 12.08             | 11.53            | 78.94            | 516.85     | -20.09         | -75.33         | 209.13     | 580.06         | (N/A)      | 7.33         | 9.51         |
| Red maple                 | 17.44              | 2.97       | 8.30      | 0.77                | 93.31           | 48.27            | 7.05              | 6.73             | 46.17            | 301.60     | -6.04          | -22.64         | 131.66     | 372.27         | (N/A)      | 6.61         | 6.77         |
| Apple                     | 3.13               | 0.52       | 1.60      | 0.14                | 17.02           | 17.10            | 2.44              | 2.32             | 15.60            | 104.86     | -0.02          | -0.07          | 42.83      | 121.81         | (N/A)      | 6.49         | 2.26         |
| Black walnut              | 5.86               | 0.94       | 3.10      | 0.26                | 32.04           | 33.16            | 4.85              | 4.62             | 31.71            | 207.17     | 0.00           | 0.00           | 84.49      | 239.21         | (N/A)      | 4.09         | 7.04         |
| Pin oak                   | 15.54              | 2.72       | 8.00      | 0.70                | 85.16           | 38.52            | 5.62              | 5.36             | 36.73            | 240.41     | -28.96         | -108.60        | 84.24      | 216.97         | (N/A)      | 3.13         | 8.34         |
| Blue spruce               | 3.89               | 0.77       | 3.31      | 0.48                | 25.95           | 11.17            | 1.63              | 1.56             | 10.68            | 69.78      | -11.04         | -41.41         | 22.44      | 54.31          | (N/A)      | 2.76         | 2.36         |
| River birch               | 6.51               | 1.12       | 3.20      | 0.29                | 35.17           | 15.95            | 2.30              | 2.19             | 14.91            | 98.76      | -1.52          | -5.70          | 44.96      | 128.23         | (N/A)      | 1.80         | 8.55         |
| Northern red oak          | 3.67               | 0.63       | 1.80      | 0.16                | 19.80           | 8.89             | 1.29              | 1.23             | 8.42             | 55.34      | -5.24          | -19.66         | 20.86      | 55.48          | (N/A)      | 1.68         | 3.96         |
| Norway spruce             | 6.49               | 1.29       | 5.15      | 0.80                | 42.24           | 10.67            | 1.56              | 1.49             | 10.22            | 66.70      | -31.29         | -117.33        | 6.37       | -8.39          | (N/A)      | 1.56         | -0.65        |
| Littleleaf linden         | 1.70               | 0.29       | 0.91      | 0.08                | 9.39            | 8.02             | 1.17              | 1.12             | 7.67             | 50.11      | -0.90          | -3.37          | 20.06      | 56.13          | (N/A)      | 1.44         | 4.68         |
| American basswood         | 5.48               | 0.93       | 2.67      | 0.24                | 29.50           | 16.63            | 2.40              | 2.29             | 15.54            | 102.97     | -4.63          | -17.37         | 41.56      | 115.11         | (N/A)      | 1.32         | 10.46        |
| Spruce                    | 1.70               | 0.34       | 1.45      | 0.21                | 11.37           | 4.82             | 0.70              | 0.67             | 4.62             | 30.13      | -6.32          | -23.71         | 8.19       | 17.79          | (N/A)      | 1.20         | 1.78         |
| Northern hackberry        | 3.31               | 0.57       | 1.76      | 0.15                | 18.25           | 13.92            | 2.02              | 1.92             | 13.11            | 86.43      | 0.00           | 0.00           | 36.75      | 104.68         | (N/A)      | 1.20         | 10.47        |
| Honeylocust               | 3.93               | 0.65       | 1.83      | 0.18                | 20.85           | 10.71            | 1.56              | 1.49             | 10.21            | 66.83      | -2.90          | -10.87         | 27.66      | 76.81          | (N/A)      | 1.20         | 7.68         |
| Scotch pine               | 1.38               | 0.27       | 1.17      | 0.17                | 9.21            | 3.99             | 0.59              | 0.56             | 3.89             | 25.13      | -5.07          | -19.00         | 6.96       | 15.33          | (N/A)      | 1.08         | 1.70         |
| Conifer Evergreen Medium  | 1.38               | 0.27       | 1.16      | 0.17                | 9.15            | 3.90             | 0.57              | 0.55             | 3.79             | 24.53      | -3.89          | -14.60         | 7.90       | 19.08          | (N/A)      | 0.84         | 2.73         |
| Boxelder                  | 1.02               | 0.16       | 0.53      | 0.05                | 5.54            | 5.51             | 0.81              | 0.77             | 5.30             | 34.48      | -0.48          | -1.80          | 13.65      | 38.22          | (N/A)      | 0.84         | 5.46         |
| Oak                       | 3.60               | 0.58       | 1.69      | 0.16                | 19.09           | 11.03            | 1.60              | 1.52             | 10.37            | 68.45      | 0.00           | 0.00           | 30.55      | 87.53          | (N/A)      | 0.84         | 12.50        |
| American elm              | 1.23               | 0.21       | 0.69      | 0.05                | 6.89            | 6.67             | 0.98              | 0.93             | 6.41             | 41.77      | 0.00           | 0.00           | 17.18      | 48.66          | (N/A)      | 0.72         | 8.11         |
| Birch                     | 0.88               | 0.15       | 0.47      | 0.04                | 4.86            | 3.98             | 0.57              | 0.55             | 3.71             | 24.62      | -0.23          | -0.87          | 10.12      | 28.61          | (N/A)      | 0.72         | 4.77         |
| Bur oak                   | 0.21               | 0.03       | 0.15      | 0.01                | 1.25            | 2.90             | 0.42              | 0.41             | 2.78             | 18.15      | 0.00           | 0.00           | 6.91       | 19.40          | (N/A)      | 0.60         | 3.88         |
| Amur maple                | 0.31               | 0.05       | 0.16      | 0.01                | 1.67            | 1.85             | 0.27              | 0.25             | 1.71             | 11.40      | 0.00           | -0.01          | 4.60       | 13.07          | (N/A)      | 0.60         | 2.61         |
| Willow                    | 2.28               | 0.39       | 1.10      | 0.10                | 12.25           | 4.94             | 0.71              | 0.68             | 4.58             | 30.50      | -0.52          | -1.97          | 14.26      | 40.79          | (N/A)      | 0.48         | 10.20        |
| Pear                      | 0.00               | 0.00       | 0.00      | 0.00                | 0.00            | 0.07             | 0.01              | 0.01             | 0.06             | 0.42       | 0.00           | 0.00           | 0.15       | 0.43           | (N/A)      | 0.48         | 0.11         |
| Hickory                   | 0.59               | 0.09       | 0.34      | 0.03                | 3.31            | 4.50             | 0.66              | 0.63             | 4.38             | 28.30      | 0.00           | 0.00           | 11.22      | 31.60          | (N/A)      | 0.48         | 7.90         |
| MAI                       | 0.00               | 0.00       | 0.00      | 0.00                | 0.00            | 0.00             | 0.00              | 0.00             | 0.00             | 0.00       | 0.00           | 0.00           | 0.00       | 0.00           | (N/A)      | 0.48         | 0.00         |
| Plum                      | 0.00               | 0.00       | 0.00      | 0.00                | 0.00            | 0.07             | 0.01              | 0.01             | 0.06             | 0.42       | 0.00           | 0.00           | 0.15       | 0.43           | (N/A)      | 0.48         | 0.11         |
| Austrian pine             | 0.92               | 0.18       | 0.74      | 0.11                | 6.02            | 1.97             | 0.29              | 0.28             | 1.90             | 12.35      | -2.25          | -8.43          | 4.15       | 9.94           | (N/A)      | 0.36         | 3.31         |
| Ponderosa pine            | 0.27               | 0.05       | 0.25      | 0.03                | 1.87            | 1.16             | 0.17              | 0.16             | 1.09             | 7.19       | -0.88          | -3.29          | 2.31       | 5.77           | (N/A)      | 0.36         | 1.92         |
| Ohio buckeye              | 0.27               | 0.05       | 0.15      | 0.01                | 1.54            | 1.63             | 0.24              | 0.23             | 1.54             | 10.13      | -0.08          | -0.29          | 4.05       | 11.39          | (N/A)      | 0.24         | 5.69         |
| Broadleaf Deciduous Small | 0.01               | 0.00       | 0.01      | 0.00                | 0.06            | 0.22             | 0.03              | 0.03             | 0.20             | 1.36       | 0.00           | 0.00           | 0.50       | 1.42           | (N/A)      | 0.24         | 0.71         |
| Eastern red cedar         | 0.13               | 0.02       | 0.12      | 0.02                | 0.87            | 0.49             | 0.07              | 0.07             | 0.44             | 2.98       | -0.70          | -2.62          | 0.65       | 1.23           | (N/A)      | 0.24         | 0.62         |
| Eastern redbud            | 0.01               | 0.00       | 0.01      | 0.00                | 0.06            | 0.22             | 0.03              | 0.03             | 0.20             | 1.36       | 0.00           | 0.00           | 0.50       | 1.42           | (N/A)      | 0.24         | 0.71         |
| QUAMA                     | 0.00               | 0.00       | 0.00      | 0.00                | 0.00            | 0.00             | 0.00              | 0.00             | 0.00             | 0.00       | 0.00           | 0.00           | 0.00       | 0.00           | (N/A)      | 0.24         | 0.00         |
| Eastern cottonwood        | 2.08               | 0.33       | 0.92      | 0.09                | 10.87           | 3.87             | 0.56              | 0.54             | 3.69             | 24.16      | 0.00           | 0.00           | 12.09      | 35.02          | (N/A)      | 0.24         | 17.51        |
| American sycamore         | 1.59               | 0.25       | 0.72      | 0.07                | 8.33            | 3.71             | 0.54              | 0.51             | 3.51             | 23.10      | 0.00           | 0.00           | 10.91      | 31.43          | (N/A)      | 0.24         | 15.71        |
| White mulberry            | 0.21               | 0.03       | 0.10      | 0.01                | 1.10            | 0.87             | 0.13              | 0.12             | 0.83             | 5.46       | 0.00           | 0.00           | 2.30       | 6.56           | (N/A)      | 0.12         | 6.56         |
| White ash                 | 0.02               | 0.00       | 0.02      | 0.00                | 0.13            | 0.45             | 0.06              | 0.06             | 0.42             | 2.77       | 0.00           | 0.00           | 1.04       | 2.91           | (N/A)      | 0.12         | 2.91         |
| Elm                       | 0.00               | 0.00       | 0.00      | 0.00                | 0.02            | 0.13             | 0.02              | 0.02             | 0.13             | 0.85       | 0.00           | 0.00           | 0.31       | 0.87           | (N/A)      | 0.12         | 0.87         |
| CR                        | 0.00               | 0.00       | 0.00      | 0.00                | 0.00            | 0.00             | 0.00              | 0.00             | 0.00             | 0.00       | 0.00           | 0.00           | 0.00       | 0.00           | (N/A)      | 0.12         | 0.00         |
| Black cherry              | 0.05               | 0.01       | 0.03      | 0.00                | 0.26            | 0.38             | 0.05              | 0.05             | 0.34             | 2.29       | 0.00           | 0.00           | 0.90       | 2.55           | (N/A)      | 0.12         | 2.55         |
| Siberian elm              | 0.82               | 0.14       | 0.39      | 0.04                | 4.41            | 1.88             | 0.27              | 0.26             | 1.79             | 11.70      | 0.00           | 0.00           | 5.59       | 16.11          | (N/A)      | 0.12         | 16.11        |
| Broadleaf Deciduous Medi  | 0.00               | 0.00       | 0.00      | 0.00                | 0.00            | 0.02             | 0.00              | 0.00             | 0.02             | 0.13       | 0.00           | 0.00           | 0.05       | 0.14           | (N/A)      | 0.12         | 0.14         |
| Cherry plum               | 0.00               | 0.00       | 0.00      | 0.00                | 0.03            | 0.11             | 0.02              | 0.02             | 0.10             | 0.68       | 0.00           | 0.00           | 0.25       | 0.71           | (N/A)      | 0.12         | 0.71         |
| Citywide Total            | 302.70             | 51.27      | 154.12    | 14.75               | 1,650.30        | 879.67           | 128.07            | 122.10           | 834.88           | 5,479.55   | -176.73        | -662.73        | 2,310.82   | 6,467.12       | (N/A)      | 100.00       | 7.77         |

Annual Air Quality Benefits of Public Trees by Zone

| Species        | Deposito           |            |           | Total               |                 | Total            |                   |                  |                  | BVOC       |                | BVOC           |            | Standard Error | % of Total |              |              |
|----------------|--------------------|------------|-----------|---------------------|-----------------|------------------|-------------------|------------------|------------------|------------|----------------|----------------|------------|----------------|------------|--------------|--------------|
|                | Deposito n O3 (lb) | n NO2 (lb) | PM10 (lb) | Deposito n SO2 (lb) | Deposito n (\$) | Avoided NO2 (lb) | Avoided PM10 (lb) | Avoided VOC (lb) | Avoided SO2 (lb) | Total (\$) | Emissions (lb) | Emissions (\$) | Total (lb) |                | Total (\$) | Tree Numbers | Avg. \$/tree |
| 1              | 302.70             | 51.27      | 154.12    | 14.75               | 1,650.30        | 879.67           | 128.07            | 122.10           | 834.88           | 5,479.55   | -176.73        | -662.73        | 2,310.82   | 6,467.12       | (N/A)      | 100.00       | 7.77         |
| Citywide Total | 302.70             | 51.27      | 154.12    | 14.75               | 1,650.30        | 879.67           | 128.07            | 122.10           | 834.88           | 5,479.55   | -176.73        | -662.73        | 2,310.82   | 6,467.12       | (N/A)      | 100.00       | 7.77         |

## Table 4: Annual Carbon Stored

Sumner

3/8/2018

### Stored CO2 Benefits of Public Trees by Species

| Species                   | Total stored<br>CO2 (lbs) | Total (\$) | Standard<br>Error | % of<br>Total<br>Tree<br>Numbers | % of<br>Total \$ | Avg.<br>\$/tree |
|---------------------------|---------------------------|------------|-------------------|----------------------------------|------------------|-----------------|
| Green ash                 | 2,271,001.22              | 17,032.51  | (N/A)             | 23.32                            | 31.53            | 87.80           |
| Norway maple              | 836,985.20                | 6,277.39   | (N/A)             | 15.02                            | 11.62            | 50.22           |
| Silver maple              | 1,427,256.04              | 10,704.42  | (N/A)             | 7.81                             | 19.81            | 164.68          |
| Sugar maple               | 732,831.49                | 5,496.24   | (N/A)             | 7.33                             | 10.17            | 90.10           |
| Red maple                 | 193,395.91                | 1,450.47   | (N/A)             | 6.61                             | 2.68             | 26.37           |
| Apple                     | 53,743.13                 | 403.07     | (N/A)             | 6.49                             | 0.75             | 7.46            |
| Black walnut              | 192,584.80                | 1,444.39   | (N/A)             | 4.09                             | 2.67             | 42.48           |
| Pin oak                   | 407,920.26                | 3,059.40   | (N/A)             | 3.13                             | 5.66             | 117.67          |
| Blue spruce               | 24,143.60                 | 181.08     | (N/A)             | 2.76                             | 0.34             | 7.87            |
| River birch               | 108,237.59                | 811.78     | (N/A)             | 1.80                             | 1.50             | 54.12           |
| Northern red oak          | 78,475.78                 | 588.57     | (N/A)             | 1.68                             | 1.09             | 42.04           |
| Norway spruce             | 80,783.66                 | 605.88     | (N/A)             | 1.56                             | 1.12             | 46.61           |
| Littleleaf linden         | 38,349.72                 | 287.62     | (N/A)             | 1.44                             | 0.53             | 23.97           |
| American basswood         | 200,219.10                | 1,501.64   | (N/A)             | 1.32                             | 2.78             | 136.51          |
| Spruce                    | 14,347.19                 | 107.60     | (N/A)             | 1.20                             | 0.20             | 10.76           |
| Northern hackberry        | 47,680.91                 | 357.61     | (N/A)             | 1.20                             | 0.66             | 35.76           |
| Honeylocust               | 49,762.37                 | 373.22     | (N/A)             | 1.20                             | 0.69             | 37.32           |
| Scotch pine               | 11,445.25                 | 85.84      | (N/A)             | 1.08                             | 0.16             | 9.54            |
| Conifer Evergreen Medium  | 8,536.59                  | 64.02      | (N/A)             | 0.84                             | 0.12             | 9.15            |
| Boxelder                  | 28,454.63                 | 213.41     | (N/A)             | 0.84                             | 0.40             | 30.49           |
| Oak                       | 116,119.96                | 870.90     | (N/A)             | 0.84                             | 1.61             | 124.41          |
| American elm              | 32,379.81                 | 242.85     | (N/A)             | 0.72                             | 0.45             | 40.47           |
| Birch                     | 14,888.29                 | 111.66     | (N/A)             | 0.72                             | 0.21             | 18.61           |
| Bur oak                   | 7,809.95                  | 58.57      | (N/A)             | 0.60                             | 0.11             | 11.71           |
| Amur maple                | 5,208.55                  | 39.06      | (N/A)             | 0.60                             | 0.07             | 7.81            |
| Willow                    | 37,606.25                 | 282.05     | (N/A)             | 0.48                             | 0.52             | 70.51           |
| Pear                      | 55.14                     | 0.41       | (N/A)             | 0.48                             | 0.00             | 0.10            |
| Hickory                   | 19,473.18                 | 146.05     | (N/A)             | 0.48                             | 0.27             | 36.51           |
| MAI                       | 0.00                      | 0.00       | (N/A)             | 0.48                             | 0.00             | 0.00            |
| Plum                      | 55.14                     | 0.41       | (N/A)             | 0.48                             | 0.00             | 0.10            |
| Austrian pine             | 7,129.94                  | 53.47      | (N/A)             | 0.36                             | 0.10             | 17.82           |
| Ponderosa pine            | 1,683.62                  | 12.63      | (N/A)             | 0.36                             | 0.02             | 4.21            |
| Ohio buckeye              | 4,724.83                  | 35.44      | (N/A)             | 0.24                             | 0.07             | 17.72           |
| Broadleaf Deciduous Small | 355.58                    | 2.67       | (N/A)             | 0.24                             | 0.00             | 1.33            |
| Eastern red cedar         | 554.23                    | 4.16       | (N/A)             | 0.24                             | 0.01             | 2.08            |
| Eastern redbud            | 355.58                    | 2.67       | (N/A)             | 0.24                             | 0.00             | 1.33            |
| QUMA                      | 0.00                      | 0.00       | (N/A)             | 0.24                             | 0.00             | 0.00            |
| Eastern cottonwood        | 71,754.75                 | 538.16     | (N/A)             | 0.24                             | 1.00             | 269.08          |
| American sycamore         | 51,886.31                 | 389.15     | (N/A)             | 0.24                             | 0.72             | 194.57          |
| White mulberry            | 3,037.16                  | 22.78      | (N/A)             | 0.12                             | 0.04             | 22.78           |
| White ash                 | 1,034.53                  | 7.76       | (N/A)             | 0.12                             | 0.01             | 7.76            |
| Elm                       | 185.46                    | 1.39       | (N/A)             | 0.12                             | 0.00             | 1.39            |
| CR                        | 0.00                      | 0.00       | (N/A)             | 0.12                             | 0.00             | 0.00            |
| Black cherry              | 907.91                    | 6.81       | (N/A)             | 0.12                             | 0.01             | 6.81            |
| Siberian elm              | 19,727.97                 | 147.96     | (N/A)             | 0.12                             | 0.27             | 147.96          |
| Broadleaf Deciduous Medi  | 16.84                     | 0.13       | (N/A)             | 0.12                             | 0.00             | 0.13            |
| Cherry plum               | 177.79                    | 1.33       | (N/A)             | 0.12                             | 0.00             | 1.33            |
| Citywide total            | 7,203,283.20              | 54,024.62  | (N/A)             | 100.00                           | 100.00           | 64.93           |

### Stored CO2 Benefits of Public Trees by Zone

| Zone           | Total stored<br>CO2 (lbs) | Total (\$) | Standard<br>Error | % of<br>Total<br>Tree<br>Numbers | % of<br>Total \$ | Avg.<br>\$/tree |
|----------------|---------------------------|------------|-------------------|----------------------------------|------------------|-----------------|
| 1              | 7,203,283.20              | 54,024.62  | (N/A)             | 100.00                           | 100.00           | 64.93           |
| Citywide total | 7,203,283.20              | 54,024.62  | (N/A)             | 100.00                           | 100.00           | 64.93           |

## Table 5: Annual Carbon Sequestered

Sumner

3/8/2018

Annual CO2 Benefits of Public Trees by Species

| Species                    | Sequestered (lb) | Sequestered (\$) | Decomposition Release (lb) | Maintenance Release (lb) | Total Release (\$) | Avoided (lb) | Avoided (\$) | Net Total (lb) | Net Total (\$) | Standard Error | % of Total   |               |              |
|----------------------------|------------------|------------------|----------------------------|--------------------------|--------------------|--------------|--------------|----------------|----------------|----------------|--------------|---------------|--------------|
|                            |                  |                  |                            |                          |                    |              |              |                |                |                | Tree Numbers | % of Total \$ | Avg. \$/tree |
| Green ash                  | 118,406.91       | 888.05           | - 10,900.81                | - 535.67                 | - 85.77            | 86,201.00    | 646.51       | 193,171.43     | 1,448.79       | (N/A)          | 23.32        | 27.24         | 7.47         |
| Norway maple               | 42,963.04        | 322.22           | - 4,018.98                 | - 301.67                 | - 32.40            | 49,039.53    | 367.80       | 87,681.91      | 657.61         | (N/A)          | 15.02        | 12.37         | 5.26         |
| Silver maple               | 99,699.39        | 747.75           | - 6,851.53                 | - 254.09                 | - 53.29            | 37,649.77    | 282.37       | 130,243.55     | 976.83         | (N/A)          | 7.81         | 18.37         | 15.03        |
| Sugar maple                | 38,809.79        | 291.07           | - 3,517.59                 | - 186.81                 | - 27.78            | 29,235.38    | 219.27       | 64,340.77      | 482.56         | (N/A)          | 7.33         | 9.07          | 7.91         |
| Red maple                  | 21,339.78        | 160.05           | - 928.46                   | - 93.60                  | - 7.67             | 17,094.05    | 128.21       | 37,411.76      | 280.59         | (N/A)          | 6.61         | 5.28          | 5.10         |
| Apple                      | 5,639.27         | 42.29            | - 258.36                   | - 52.85                  | - 2.33             | 5,773.28     | 43.30        | 11,101.34      | 83.26          | (N/A)          | 6.49         | 1.57          | 1.54         |
| Black walnut               | 15,749.48        | 118.12           | - 924.41                   | - 70.20                  | - 7.46             | 11,733.94    | 88.00        | 26,488.81      | 198.67         | (N/A)          | 4.09         | 3.74          | 5.84         |
| Pin oak                    | 37,468.79        | 281.02           | - 1,958.02                 | - 85.80                  | - 15.33            | 13,602.52    | 102.02       | 49,027.49      | 367.71         | (N/A)          | 3.13         | 6.91          | 14.14        |
| Blue spruce                | 1,816.21         | 13.62            | - 115.89                   | - 40.37                  | - 1.17             | 3,956.68     | 29.68        | 5,616.63       | 42.12          | (N/A)          | 2.76         | 0.79          | 1.83         |
| River birch                | 2,860.88         | 21.46            | - 520.94                   | - 38.22                  | - 4.19             | 5,513.19     | 41.35        | 7,814.91       | 58.61          | (N/A)          | 1.80         | 1.10          | 3.91         |
| Northern red oak           | 1,263.78         | 9.48             | - 376.88                   | - 23.99                  | - 3.01             | 3,119.41     | 23.40        | 3,982.32       | 29.87          | (N/A)          | 1.68         | 0.56          | 2.13         |
| Norway spruce              | 1,773.70         | 13.30            | - 387.76                   | - 46.41                  | - 3.26             | 3,784.14     | 28.38        | 5,123.67       | 38.43          | (N/A)          | 1.56         | 0.72          | 2.96         |
| Littleleaf linden          | 3,705.75         | 27.79            | - 184.12                   | - 20.09                  | - 1.53             | 2,833.72     | 21.25        | 6,335.27       | 47.51          | (N/A)          | 1.44         | 0.89          | 3.96         |
| American basswood          | 11,548.21        | 86.61            | - 961.05                   | - 40.17                  | - 7.51             | 5,746.60     | 43.10        | 16,293.58      | 122.20         | (N/A)          | 1.32         | 2.30          | 11.11        |
| Spruce                     | 1,084.64         | 8.13             | - 68.87                    | - 18.14                  | - 0.65             | 1,709.67     | 12.82        | 2,707.31       | 20.30          | (N/A)          | 1.20         | 0.38          | 2.03         |
| Northern hackberry         | 3,224.06         | 24.18            | - 228.87                   | - 25.74                  | - 1.91             | 4,848.25     | 36.36        | 7,817.70       | 58.63          | (N/A)          | 1.20         | 1.10          | 5.86         |
| Honeylocust                | 5,227.48         | 39.21            | - 239.47                   | - 18.72                  | - 1.94             | 3,783.20     | 28.37        | 8,752.49       | 65.64          | (N/A)          | 1.20         | 1.23          | 6.56         |
| Scotch pine                | 876.47           | 6.57             | - 54.95                    | - 14.63                  | - 0.52             | 1,440.42     | 10.80        | 2,247.32       | 16.85          | (N/A)          | 1.08         | 0.32          | 1.87         |
| Conifer Evergreen Medium   | 639.19           | 4.79             | - 40.98                    | - 13.65                  | - 0.41             | 1,402.97     | 10.52        | 1,987.53       | 14.91          | (N/A)          | 0.84         | 0.28          | 2.13         |
| Boxelder                   | 2,835.00         | 21.26            | - 136.58                   | - 12.87                  | - 1.12             | 1,961.05     | 14.71        | 4,646.61       | 34.85          | (N/A)          | 0.84         | 0.66          | 4.98         |
| Oak                        | 5,809.18         | 43.57            | - 557.38                   | - 24.57                  | - 4.36             | 3,839.60     | 28.80        | 9,066.84       | 68.00          | (N/A)          | 0.84         | 1.28          | 9.71         |
| American elm               | 1,573.16         | 11.80            | - 155.42                   | - 13.26                  | - 1.27             | 2,372.84     | 17.80        | 3,777.32       | 28.33          | (N/A)          | 0.72         | 0.53          | 4.72         |
| Birch                      | 1,533.12         | 11.50            | - 71.52                    | - 8.39                   | - 0.60             | 1,369.79     | 10.27        | 2,823.01       | 21.17          | (N/A)          | 0.72         | 0.40          | 3.53         |
| Bur oak                    | 1,280.52         | 9.60             | - 37.49                    | - 6.63                   | - 0.33             | 1,027.87     | 7.71         | 2,264.27       | 16.98          | (N/A)          | 0.60         | 0.32          | 3.40         |
| Amur maple                 | 571.27           | 4.28             | - 25.00                    | - 5.46                   | - 0.23             | 631.18       | 4.73         | 1,171.98       | 8.79           | (N/A)          | 0.60         | 0.17          | 1.76         |
| Willow                     | 693.86           | 5.20             | - 180.51                   | - 12.48                  | - 1.45             | 1,693.06     | 12.70        | 2,193.93       | 16.45          | (N/A)          | 0.48         | 0.31          | 4.11         |
| Pear                       | 34.73            | 0.26             | - 0.44                     | - 0.78                   | - 0.01             | 22.45        | 0.17         | 55.96          | 0.42           | (N/A)          | 0.48         | 0.01          | 0.10         |
| Hickory                    | 1,995.70         | 14.97            | - 93.47                    | - 8.58                   | - 0.77             | 1,619.99     | 12.15        | 3,513.64       | 26.35          | (N/A)          | 0.48         | 0.50          | 6.59         |
| MAI                        | 0.00             | 0.00             | 0.00                       | 0.00                     | 0.00               | 0.00         | 0.00         | 0.00           | 0.00           | (N/A)          | 0.48         | 0.00          | 0.00         |
| Plum                       | 34.73            | 0.26             | - 0.44                     | - 0.78                   | - 0.01             | 22.45        | 0.17         | 55.96          | 0.42           | (N/A)          | 0.48         | 0.01          | 0.10         |
| Austrian pine              | 369.94           | 2.77             | - 34.22                    | - 7.41                   | - 0.31             | 705.58       | 5.29         | 1,033.89       | 7.75           | (N/A)          | 0.36         | 0.15          | 2.58         |
| Ponderosa pine             | 220.80           | 1.66             | - 8.08                     | - 4.29                   | - 0.09             | 405.31       | 3.04         | 613.74         | 4.60           | (N/A)          | 0.36         | 0.09          | 1.53         |
| Ohio buckeye               | 609.90           | 4.57             | - 22.68                    | - 3.12                   | - 0.19             | 570.86       | 4.28         | 1,154.96       | 8.66           | (N/A)          | 0.24         | 0.16          | 4.33         |
| Broadleaf Deciduous Small  | 75.88            | 0.57             | - 1.71                     | - 1.17                   | - 0.02             | 74.38        | 0.56         | 147.38         | 1.11           | (N/A)          | 0.24         | 0.02          | 0.55         |
| Eastern red cedar          | 79.73            | 0.60             | - 2.66                     | - 2.34                   | - 0.04             | 163.88       | 1.23         | 238.60         | 1.79           | (N/A)          | 0.24         | 0.03          | 0.89         |
| Eastern redbud             | 75.88            | 0.57             | - 1.71                     | - 1.17                   | - 0.02             | 74.38        | 0.56         | 147.38         | 1.11           | (N/A)          | 0.24         | 0.02          | 0.55         |
| QUMA                       | 0.00             | 0.00             | 0.00                       | 0.00                     | 0.00               | 0.00         | 0.00         | 0.00           | 0.00           | (N/A)          | 0.24         | 0.00          | 0.00         |
| Eastern cottonwood         | 1,335.74         | 10.02            | - 344.42                   | - 9.36                   | - 2.65             | 1,365.20     | 10.24        | 2,347.15       | 17.60          | (N/A)          | 0.24         | 0.33          | 8.80         |
| American sycamore          | 1,919.18         | 14.39            | - 249.05                   | - 8.58                   | - 1.93             | 1,300.05     | 9.75         | 2,961.60       | 22.21          | (N/A)          | 0.24         | 0.42          | 11.11        |
| White mulberry             | 267.64           | 2.01             | - 14.58                    | - 1.95                   | - 0.12             | 308.49       | 2.31         | 559.60         | 4.20           | (N/A)          | 0.12         | 0.08          | 4.20         |
| White ash                  | 182.10           | 1.37             | - 4.97                     | - 1.17                   | - 0.05             | 155.53       | 1.17         | 331.50         | 2.49           | (N/A)          | 0.12         | 0.05          | 2.49         |
| Elm                        | 74.18            | 0.56             | - 0.89                     | - 0.59                   | - 0.01             | 48.64        | 0.36         | 121.35         | 0.91           | (N/A)          | 0.12         | 0.02          | 0.91         |
| CR                         | 0.00             | 0.00             | 0.00                       | 0.00                     | 0.00               | 0.00         | 0.00         | 0.00           | 0.00           | (N/A)          | 0.12         | 0.00          | 0.00         |
| Black cherry               | 113.87           | 0.85             | - 4.36                     | - 1.17                   | - 0.04             | 124.15       | 0.93         | 232.50         | 1.74           | (N/A)          | 0.12         | 0.03          | 1.74         |
| Siberian elm               | 796.56           | 5.97             | - 94.69                    | - 4.29                   | - 0.74             | 661.79       | 4.96         | 1,359.37       | 10.20          | (N/A)          | 0.12         | 0.19          | 10.20        |
| Broadleaf Deciduous Medium | 5.42             | 0.04             | - 0.13                     | - 0.20                   | 0.00               | 7.19         | 0.05         | 12.28          | 0.09           | (N/A)          | 0.12         | 0.00          | 0.09         |
| Cherry plum                | 37.94            | 0.28             | - 0.85                     | - 0.59                   | - 0.01             | 37.19        | 0.28         | 73.69          | 0.55           | (N/A)          | 0.12         | 0.01          | 0.55         |
| Citywide Total             | 436,622.88       | 3,274.67         | - 34,581.19                | - 2,021.97               | - 274.52           | 309,030.62   | 2,317.73     | 709,050.34     | 5,317.88       | (N/A)          | 100.00       | 100.00        | 6.39         |

Annual CO2 Benefits of Public Trees by Zone

| Zone           | Sequestered (lb) | Sequestered (\$) | Decomposition Release (lb) | Maintenance Release (lb) | Total Release (\$) | Avoided (lb) | Avoided (\$) | Net Total (lb) | Net Total (\$) | Standard Error | % of Total   |               |              |
|----------------|------------------|------------------|----------------------------|--------------------------|--------------------|--------------|--------------|----------------|----------------|----------------|--------------|---------------|--------------|
|                |                  |                  |                            |                          |                    |              |              |                |                |                | Tree Numbers | % of Total \$ | Avg. \$/tree |
| 1              | 436,622.88       | 3,274.67         | - 34,581.19                | - 2,021.97               | - 274.52           | 309,030.62   | 2,317.73     | 709,050.34     | 5,317.88       | (N/A)          | 100.00       | 100.00        | 6.39         |
| Citywide Total | 436,622.88       | 3,274.67         | - 34,581.19                | - 2,021.97               | - 274.52           | 309,030.62   | 2,317.73     | 709,050.34     | 5,317.88       | (N/A)          | 100.00       | 100.00        | 6.39         |

## Table 6: Annual Social and Aesthetic Benefits

Sumner

3/8/2018

### Annual Aesthetic/Other Benefit of Public Trees by Species

| Species                   | Total (\$)       | Standard Error | % of Total Tree Numbers | % of Total \$ | Avg. \$/tree |
|---------------------------|------------------|----------------|-------------------------|---------------|--------------|
| Green ash                 | 10,035.64        | (N/A)          | 23.32                   | 24.90         | 51.73        |
| Norway maple              | 4,162.28         | (N/A)          | 15.02                   | 10.33         | 33.30        |
| Silver maple              | 7,476.24         | (N/A)          | 7.81                    | 18.55         | 115.02       |
| Sugar maple               | 4,058.72         | (N/A)          | 7.33                    | 10.07         | 66.54        |
| Red maple                 | 2,840.99         | (N/A)          | 6.61                    | 7.05          | 51.65        |
| Apple                     | 318.17           | (N/A)          | 6.49                    | 0.79          | 5.89         |
| Black walnut              | 1,522.18         | (N/A)          | 4.09                    | 3.78          | 44.77        |
| Pin oak                   | 2,905.32         | (N/A)          | 3.13                    | 7.21          | 111.74       |
| Blue spruce               | 513.14           | (N/A)          | 2.76                    | 1.27          | 22.31        |
| River birch               | 296.44           | (N/A)          | 1.80                    | 0.74          | 19.76        |
| Northern red oak          | 115.81           | (N/A)          | 1.68                    | 0.29          | 8.27         |
| Norway spruce             | 293.35           | (N/A)          | 1.56                    | 0.73          | 22.57        |
| Littleleaf linden         | 434.20           | (N/A)          | 1.44                    | 1.08          | 36.18        |
| American basswood         | 827.99           | (N/A)          | 1.32                    | 2.05          | 75.27        |
| Spruce                    | 291.29           | (N/A)          | 1.20                    | 0.72          | 29.13        |
| Northern hackberry        | 482.83           | (N/A)          | 1.20                    | 1.20          | 48.28        |
| Honeylocust               | 1,146.39         | (N/A)          | 1.20                    | 2.84          | 114.64       |
| Scotch pine               | 242.86           | (N/A)          | 1.08                    | 0.60          | 26.98        |
| Conifer Evergreen Medium  | 167.19           | (N/A)          | 0.84                    | 0.41          | 23.88        |
| Boxelder                  | 264.81           | (N/A)          | 0.84                    | 0.66          | 37.83        |
| Oak                       | 445.35           | (N/A)          | 0.84                    | 1.11          | 63.62        |
| American elm              | 242.09           | (N/A)          | 0.72                    | 0.60          | 40.35        |
| Birch                     | 163.61           | (N/A)          | 0.72                    | 0.41          | 27.27        |
| Bur oak                   | 160.08           | (N/A)          | 0.60                    | 0.40          | 32.02        |
| Amur maple                | 32.40            | (N/A)          | 0.60                    | 0.08          | 6.48         |
| Willow                    | 69.28            | (N/A)          | 0.48                    | 0.17          | 17.32        |
| Pear                      | 0.13             | (N/A)          | 0.48                    | 0.00          | 0.03         |
| Hickory                   | 195.25           | (N/A)          | 0.48                    | 0.48          | 48.81        |
| MAI                       | 0.00             | (N/A)          | 0.48                    | 0.00          | 0.00         |
| Plum                      | 0.13             | (N/A)          | 0.48                    | 0.00          | 0.03         |
| Austrian pine             | 63.26            | (N/A)          | 0.36                    | 0.16          | 21.09        |
| Ponderosa pine            | 63.16            | (N/A)          | 0.36                    | 0.16          | 21.05        |
| Ohio buckeye              | 65.38            | (N/A)          | 0.24                    | 0.16          | 32.69        |
| Broadleaf Deciduous Small | 4.12             | (N/A)          | 0.24                    | 0.01          | 2.06         |
| Eastern red cedar         | 42.68            | (N/A)          | 0.24                    | 0.11          | 21.34        |
| Eastern redbud            | 4.12             | (N/A)          | 0.24                    | 0.01          | 2.06         |
| QUMA                      | 0.00             | (N/A)          | 0.24                    | 0.00          | 0.00         |
| Eastern cottonwood        | 94.16            | (N/A)          | 0.24                    | 0.23          | 47.08        |
| American sycamore         | 133.20           | (N/A)          | 0.24                    | 0.33          | 66.60        |
| White mulberry            | 15.48            | (N/A)          | 0.12                    | 0.04          | 15.48        |
| White ash                 | 33.42            | (N/A)          | 0.12                    | 0.08          | 33.42        |
| Elm                       | 14.73            | (N/A)          | 0.12                    | 0.04          | 14.73        |
| CR                        | 0.00             | (N/A)          | 0.12                    | 0.00          | 0.00         |
| Black cherry              | 6.40             | (N/A)          | 0.12                    | 0.02          | 6.40         |
| Siberian elm              | 50.67            | (N/A)          | 0.12                    | 0.13          | 50.67        |
| Broadleaf Deciduous Medit | 2.74             | (N/A)          | 0.12                    | 0.01          | 2.74         |
| Cherry plum               | 2.06             | (N/A)          | 0.12                    | 0.01          | 2.06         |
| <b>Citywide Total</b>     | <b>40,299.76</b> | <b>(N/A)</b>   | <b>100.00</b>           | <b>100.00</b> | <b>48.44</b> |

### Annual Aesthetic/Other Benefit of Public Trees by Zone

| Zone                  | Total (\$)       | Standard Error | % of Total Tree Numbers | % of Total (\$) | Avg \$/tree  |
|-----------------------|------------------|----------------|-------------------------|-----------------|--------------|
| 1                     | 40,299.76        | (N/A)          | 100.00                  | 100.00          | 48.44        |
| <b>Citywide Total</b> | <b>40,299.76</b> | <b>(N/A)</b>   | <b>100.00</b>           | <b>100.00</b>   | <b>48.44</b> |

## Table 7: Summary of Benefits in Dollars

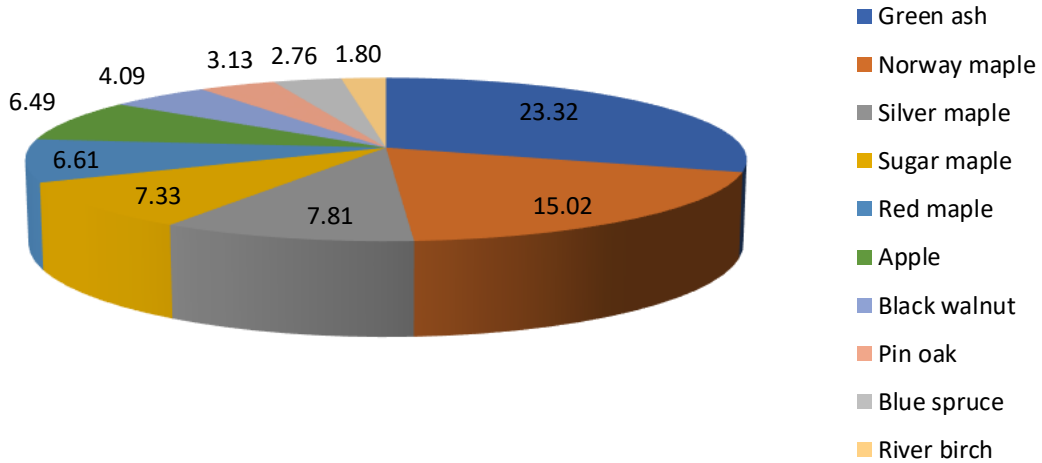
Sumner

3/8/2018

### Total Annual Benefits, Net Benefits, and Costs for Public Trees

| Benefits                  | Total (\$)     | Total Stat   | \$/tree       | Tree Stat    | \$/capita    | Capita Stat  |
|---------------------------|----------------|--------------|---------------|--------------|--------------|--------------|
| Energy                    | 38,733         | (N/A)        | 46.55         | (N/A)        | 19.39        | (N/A)        |
| CO2                       | 5,318          | (N/A)        | 6.39          | (N/A)        | 2.66         | (N/A)        |
| Air Quality               | 6,467          | (N/A)        | 7.77          | (N/A)        | 3.24         | (N/A)        |
| Stormwater                | 53,237         | (N/A)        | 63.99         | (N/A)        | 26.65        | (N/A)        |
| Aesthetic/Other           | 40,300         | (N/A)        | 48.44         | (N/A)        | 20.17        | (N/A)        |
| <b>Total Benefits</b>     | <b>144,055</b> | <b>(N/A)</b> | <b>173.14</b> | <b>(N/A)</b> | <b>72.10</b> | <b>(N/A)</b> |
| <b>Costs</b>              |                |              |               |              |              |              |
| Planting                  | 3,996          |              | 4.80          |              | 2.00         |              |
| Contract Pruning          | 3,996          |              | 4.80          |              | 2.00         |              |
| Pest Management           | 3,996          |              | 4.80          |              | 2.00         |              |
| Irrigation                | 3,996          |              | 4.80          |              | 2.00         |              |
| Removal                   | 3,996          |              | 4.80          |              | 2.00         |              |
| Administration            | 3,996          |              | 4.80          |              | 2.00         |              |
| Inspection/Service        | 3,996          |              | 4.80          |              | 2.00         |              |
| Infrastructure Repairs    | 3,996          |              | 4.80          |              | 2.00         |              |
| Litter Clean-up           | 3,996          |              | 4.80          |              | 2.00         |              |
| Liability/Claims          | 3,996          |              | 4.80          |              | 2.00         |              |
| Other Costs               | 3,996          |              | 4.80          |              | 2.00         |              |
| <b>Total Costs</b>        | <b>43,956</b>  |              | <b>52.83</b>  |              | <b>22.00</b> |              |
| <b>Benefit-cost ratio</b> | <b>100,099</b> | <b>(N/A)</b> |               |              |              |              |

**Figure 1: Species Distribution**

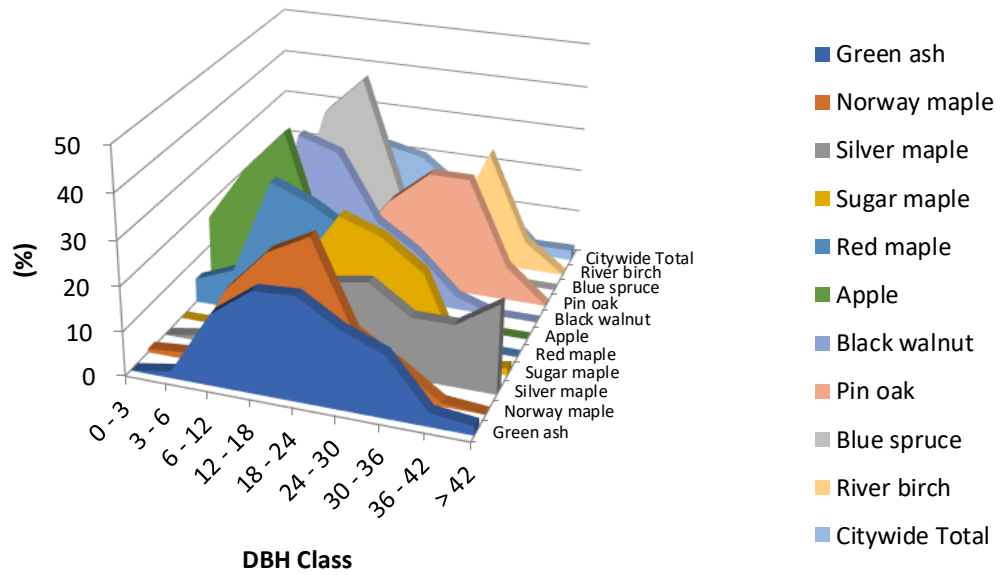


**Species Distribution of Public Trees  
3/8/2018**

| Species       | Percent |
|---------------|---------|
| Green ash     | 23.32   |
| Norway maple  | 15.02   |
| Silver maple  | 7.81    |
| Sugar maple   | 7.33    |
| Red maple     | 6.61    |
| Apple         | 6.49    |
| Black walnut  | 4.09    |
| Pin oak       | 3.13    |
| Blue spruce   | 2.76    |
| River birch   | 1.80    |
| Other Species | 21.63   |

**Figure 2: Relative Age Distribution**

**Relative Age Distribution of Top 10 Public Tree Species for 1 (%)**



**Sumner**

**3/8/2018**

**Relative Age Distribution of Public Tree Species for All Zones (%)**

DBH class (in)

| Zone           | 0 - 3 | 3 - 6 | 6 - 12 | 12 - 18 | 18 - 24 | 24 - 30 | 30 - 36 | 36 - 42 | > 42 |
|----------------|-------|-------|--------|---------|---------|---------|---------|---------|------|
| 1              | 3.85  | 5.17  | 19.35  | 22.12   | 20.19   | 13.46   | 11.18   | 2.28    | 2.40 |
| Citywide Total | 3.85  | 5.17  | 19.35  | 22.12   | 20.19   | 13.46   | 11.18   | 2.28    | 2.40 |

**Relative Age Distribution of Top 10 Public Tree Species for 1 (%)**

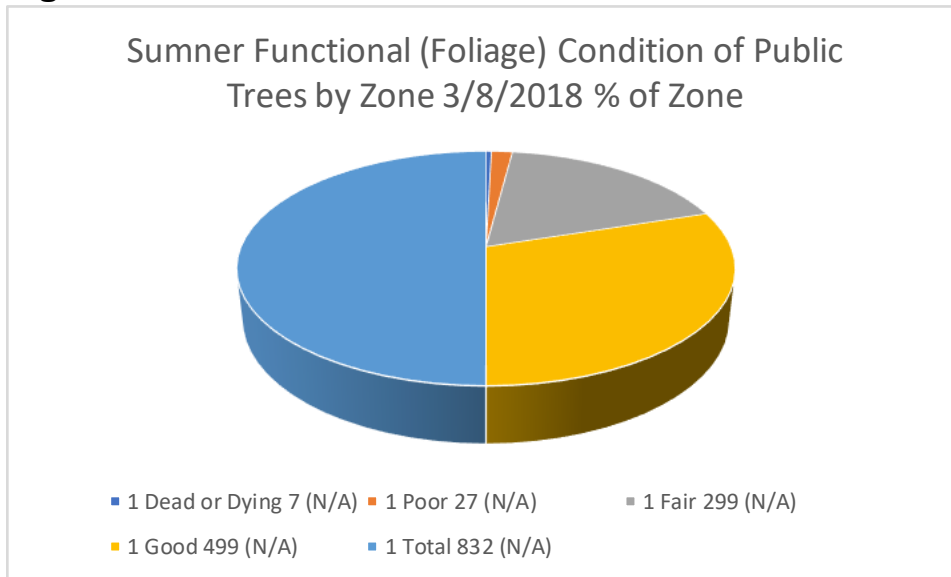
DBH class (in)

| Species        | 0 - 3 | 3 - 6 | 6 - 12 | 12 - 18 | 18 - 24 | 24 - 30 | 30 - 36 | 36 - 42 | > 42  |
|----------------|-------|-------|--------|---------|---------|---------|---------|---------|-------|
| Green ash      | 0.00  | 1.55  | 15.98  | 22.68   | 23.20   | 17.53   | 13.92   | 3.09    | 2.06  |
| Norway maple   | 0.80  | 1.60  | 17.60  | 27.20   | 32.00   | 12.80   | 7.20    | 0.80    | 0.00  |
| Silver maple   | 0.00  | 1.54  | 1.54   | 10.77   | 18.46   | 20.00   | 13.85   | 13.85   | 20.00 |
| Sugar maple    | 0.00  | 0.00  | 6.56   | 16.39   | 29.51   | 26.23   | 19.67   | 0.00    | 1.64  |
| Red maple      | 5.45  | 9.09  | 30.91  | 27.27   | 21.82   | 5.45    | 0.00    | 0.00    | 0.00  |
| Apple          | 16.67 | 29.63 | 38.89  | 11.11   | 3.70    | 0.00    | 0.00    | 0.00    | 0.00  |
| Black walnut   | 0.00  | 0.00  | 35.29  | 32.35   | 17.65   | 11.76   | 2.94    | 0.00    | 0.00  |
| Pin oak        | 0.00  | 0.00  | 11.54  | 7.69    | 19.23   | 26.92   | 26.92   | 7.69    | 0.00  |
| Blue spruce    | 0.00  | 4.35  | 34.78  | 43.48   | 17.39   | 0.00    | 0.00    | 0.00    | 0.00  |
| River birch    | 0.00  | 13.33 | 20.00  | 20.00   | 6.67    | 6.67    | 26.67   | 6.67    | 0.00  |
| Citywide Total | 3.85  | 5.17  | 19.35  | 22.12   | 20.19   | 13.46   | 11.18   | 2.28    | 2.40  |

**Figure 2: Relative Age Class**



**Figure 3: Functional Condition of all Trees**

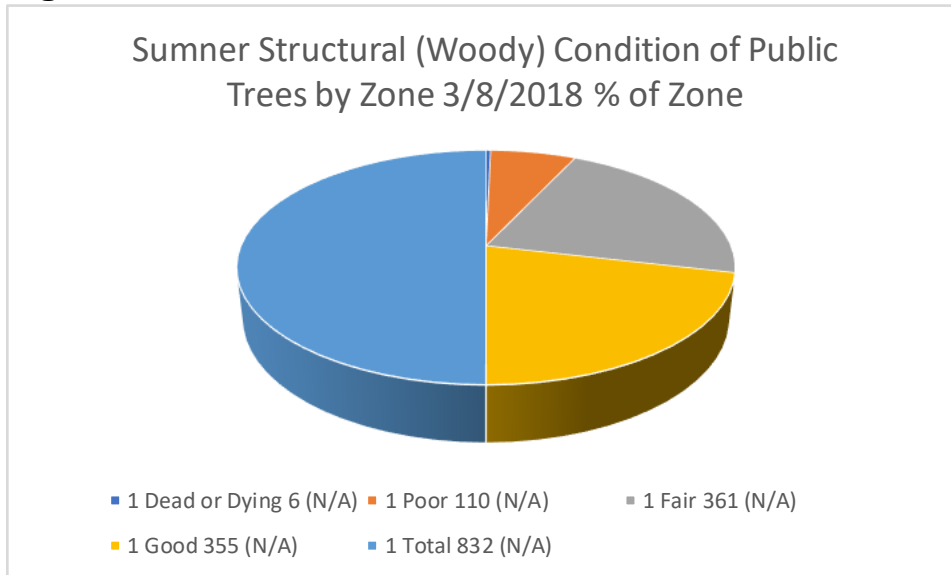


**Sumner  
Functional (Foliage) Condition of Public Trees by Zone  
3/8/2018**

| Zone | Condition     | Tree Count | Standard Error | % of Zone | % of Public Trees |
|------|---------------|------------|----------------|-----------|-------------------|
| 1    | Dead or Dying | 7 (N/A)    |                | 0.84      | 0.84              |
|      | Poor          | 27 (N/A)   |                | 3.25      | 3.25              |
|      | Fair          | 299 (N/A)  |                | 35.94     | 35.94             |
|      | Good          | 499 (N/A)  |                | 59.98     | 59.98             |
|      | Total         | 832 (N/A)  |                | 100.00    | 100.00            |

**Figure 3: Foliage Condition**

**Figure 4: Structural Condition of all Trees**

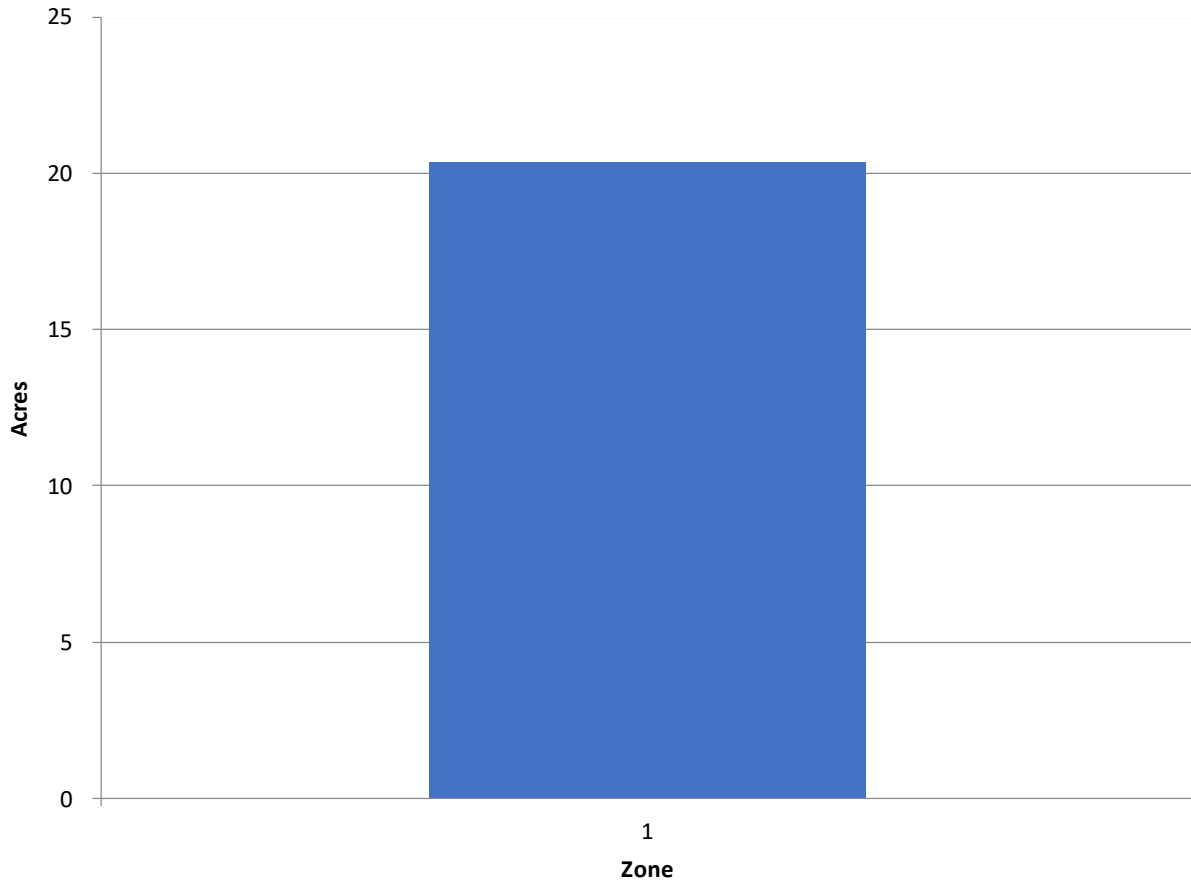


**Sumner  
Structural (Woody) Condition of Public Trees by Zone  
3/8/2018**

| <u>Zone</u> | <u>Condition</u> | <u>Tree Count</u> | <u>Standard Error</u> | <u>% of Zone</u> | <u>% of Public Trees</u> |
|-------------|------------------|-------------------|-----------------------|------------------|--------------------------|
| 1           | Dead or Dying    | 6 (N/A)           |                       | 0.72             | 0.72                     |
|             | Poor             | 110 (N/A)         |                       | 13.22            | 13.22                    |
|             | Fair             | 361 (N/A)         |                       | 43.39            | 43.39                    |
|             | Good             | 355 (N/A)         |                       | 42.67            | 42.67                    |
|             | Total            | 832 (N/A)         |                       | 100.00           | 100.00                   |

**Figure 4: Wood Condition**

## Canopy Cover of Public Trees (Acres)



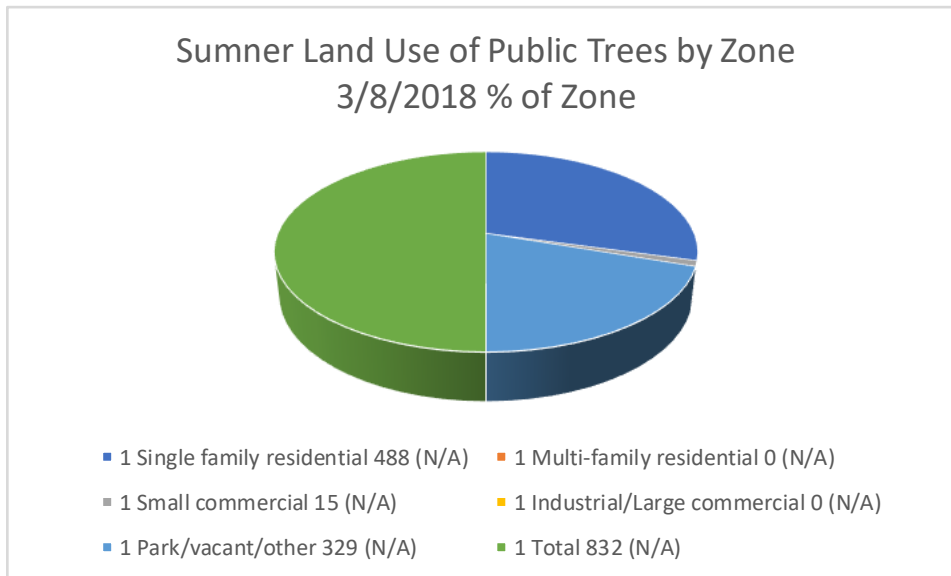
**Sumner**  
**Canopy Cover of Public Trees (Acres)**  
**3/8/2018**

| Zone           | Acres | % of Total Canopy |
|----------------|-------|-------------------|
| 1              | 20.32 | 100.00            |
| Citywide Total | 20.32 | 100.00            |

|                | Total Land Area | Total Street and Sidewalk Area | Total Canopy Cover | Canopy Cover as % of Total Land Area | Canopy Cover as % of Total Streets and Sidewalks |
|----------------|-----------------|--------------------------------|--------------------|--------------------------------------|--|
| Citywide Total | 1,619.20        | 26.91                          | 20.32              | 1.25                                 | 75.50  |

**Figure 5: Canopy Cover in Acres**

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



**Land Use of Public Trees by Zone  
3/8/2018**

| Zone | Land Use                    | Tree Count       | Standard Error | % of Zone     | % of Public Trees |
|------|-----------------------------|------------------|----------------|---------------|-------------------|
| 1    | Single family residential   | 488 (N/A)        |                | 58.65         | 58.65             |
|      | Multi-family residential    | 0 (N/A)          |                | 0.00          | 0.00              |
|      | Small commercial            | 15 (N/A)         |                | 1.80          | 1.80              |
|      | Industrial/Large commercial | 0 (N/A)          |                | 0.00          | 0.00              |
|      | Park/vacant/other           | 329 (N/A)        |                | 39.54         | 39.54             |
|      | <b>Total</b>                | <b>832 (N/A)</b> |                | <b>100.00</b> | <b>100.00</b>     |

## Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees

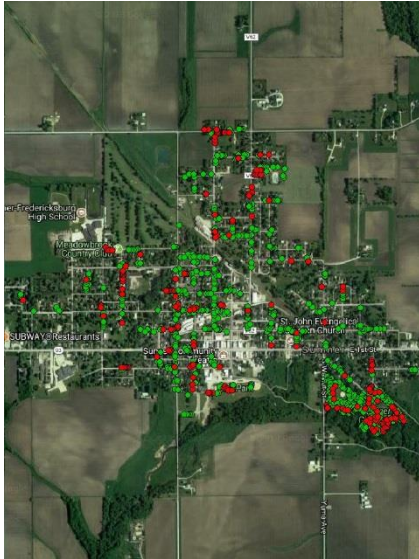
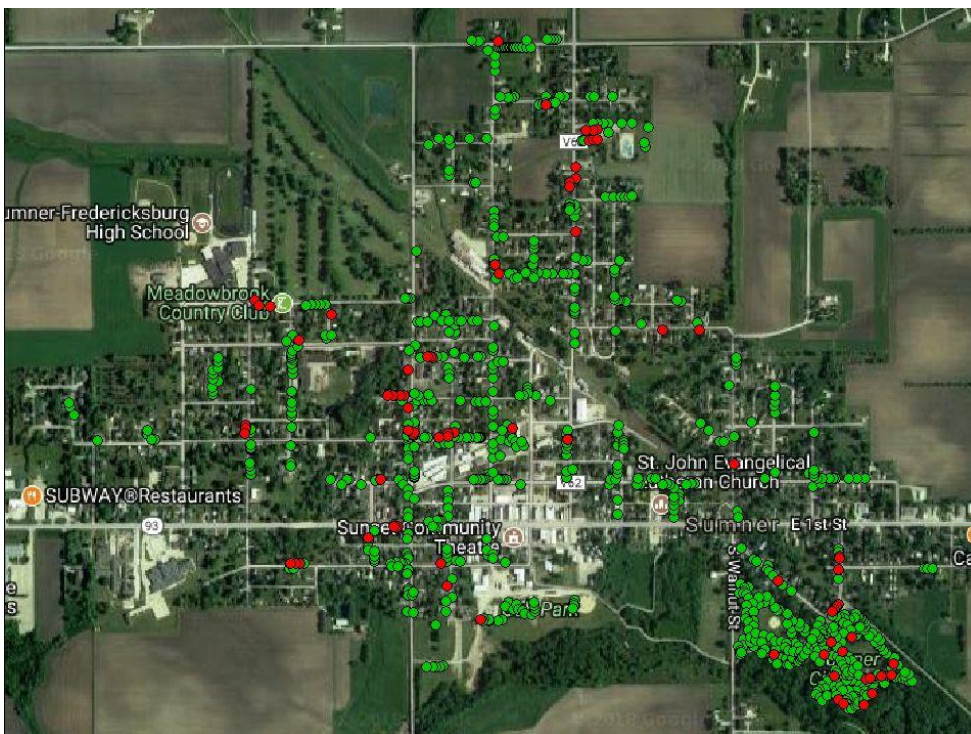
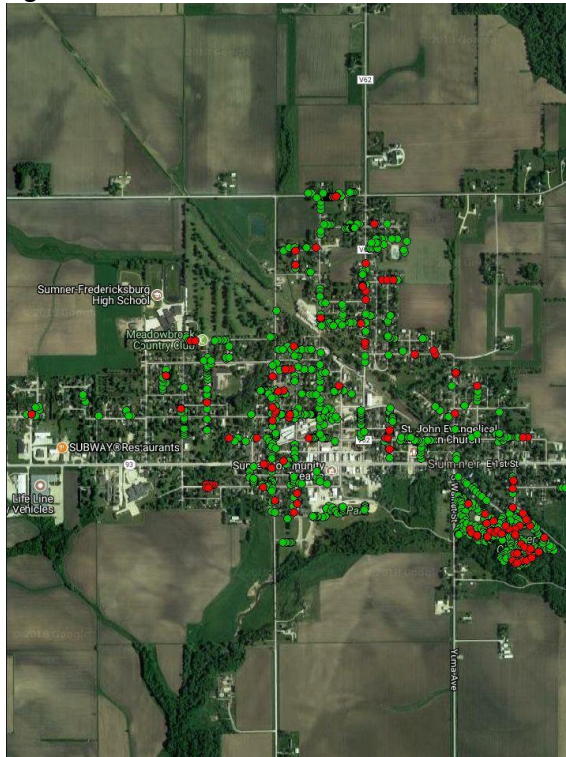


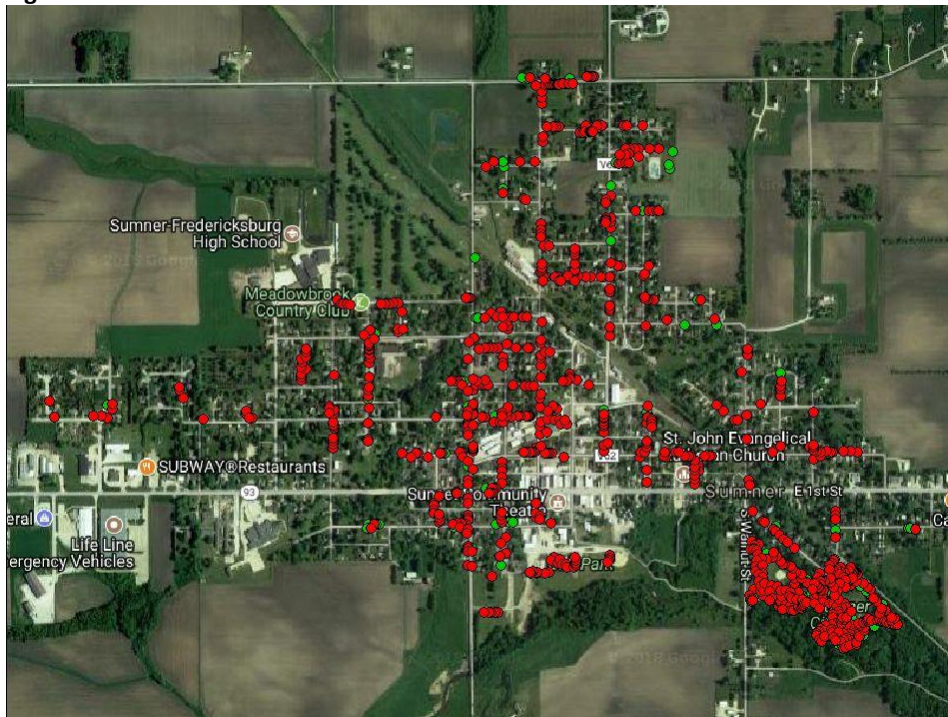
Figure 2: Location of EAB symptoms



**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: Sumner Tree Ordinances

## URBAN FORESTRY ORDINANCE

### CHAPTER 151

### TREES

151.01 Definition 151.04 Trimming Trees to Be Supervised

151.02 Planting Restrictions 151.05 Disease Control

151.03 Duty to Trim Trees 151.06 Inspection and Removal

**151.01 DEFINITION.** For use in this chapter, “parking” means 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.

**151.02 PLANTING RESTRICTIONS.** No tree shall be planted in any parking or street except in accordance with the following:

1. Alignment. All trees planted in any street shall be planted in the parking midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.
2. Spacing. Trees shall not be planted on any parking that is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.
3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut.

**151.03 DUTY TO TRIM TREES.** The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax.

*(Code of Iowa, Sec. 364.12[2c, d & e])*

**151.04 TRIMMING TREES TO BE SUPERVISED.** Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

**151.05 DISEASE CONTROL.** Any dead, diseased, or damaged tree or shrub that may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

**151.06 INSPECTION AND REMOVAL.** The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:

#### CHAPTER 151 TREES

CODE OF ORDINANCES, SUMNER, IOWA

- 754 -

1. City Property. If it is determined that any such condition exists on any public



property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.

2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant, or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.

*(Code of Iowa, Sec. 364.12[3b & h])*