Rolfe, IA

Urban Forestry Management Plan

SUMMER 2022

JEO CONSULTING GROUP

Table of Contents

Table of Contents

Table of Contents

Executive Summary

EXECUTIVE SUMMARY

Overview

This plan was developed to assist the City of Rolfe in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like 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 except mountain ash. There is a strong possibility that 30% of Rolfe's city-owned trees will die once EAB becomes established in the community, unless local leaders begin preventative treatment. 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 2022, JEO conducted a tree inventory 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 654 trees inventoried.

- Rolfe trees provide $129,692 of benefits annually, an average of $198 per tree
- There are over 48 species of trees
- The top three genera are: Maple 34%, Ash 30%, and Spruce 8%
- 53% of trees need some type of management
- 181 trees should be removed

Recommendations

We detail our core recommendations in the Recommendations Section. In the Emerald Ash Borer Plan, we include management recommendations. Below are some key recommendations.

- Out of the 181 trees needing removal, 66 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*
- 175 of the 198 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation.
- All trees should be pruned on a routine schedule: one third of the city every other year.
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Check ash trees yearly with a visual survey.
- With the current budget it could take 23 years to remove ash. We suggest that city officials request a budget increase to $12,000 annually and apply for grants to plant replacement trees.

Introduction

INTRODUCTION

This plan was developed to assist Rolfe with managing, budgeting, and future planning of their urban forest. Across the state, forestry budgets continue to decrease as a higher percentage of the budgets are devoted to 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, treatment, and replacement planting. With proper planning and management of the current canopy in Rolfe, these costs can be spread out over the years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important part of Rolfe's infrastructure and one of the city's greatest assets. The benefits of trees are immense. Trees improve air quality, intercept stormwater runoff, conserve energy, lower traffic speeds, increase property values, reduce crime, improve mental health, and create a desirable place to live, to name just a few. Good urban forestry management will maintain these important benefits for the people of Rolfe and future generations.

Urban forestry management sets goals and develops management strategies to achieve them. To develop management strategies, a comprehensive public tree inventory must be conducted. The inventory informs maintenance, removal schedules, tree planting, and budgeting. Aligning management actions with the tree inventory results will help meet Rolfe's urban forestry goals.

Assist Rolfe with Managing its Urban Forest

Inform on the Benefits of a Healthy Urban Forest

Establish Preventative Treatment for Emerald Ash Borer

Develop Efficient City Tree Management Techniques

Mitigate Public Safety Issues

Findings

INVENTORY

In 2022, JEO conducted a tree inventory that included 100% of the city-owned trees on both streets and parks. The team collected tree data using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

The data collectors' programming 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, for all ash trees, the team notes signs and symptoms associated with EAB including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

INVENTORY RESULTS

JEO entered the data collected for the 654 city trees into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. Following are results from the i-Tree STREETS analysis.

ANNUAL BENEFITS

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Rolfe's trees reduce energy-related costs by approximately $33,993 annually (Appendix A, Table 1). These savings are both in electricity (161.6 MWh) and in natural gas (22,170.6 Therms).

Annual Stormwater Benefits

Rolfe's trees intercept about 1,956,002 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $53,008 in benefit 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 lessens emissions of volatile organic matter (ozone). In Rolfe, it is estimated that trees remove 2,132 lbs of air pollution (ozone (O3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO2), and sulfur dioxide (SO2)) per year with a net value of $6,014 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Rolfe, trees sequester about 375,081 lbs of carbon per year with an associated value of $4,544 (Appendix A, Table 5). In addition, the trees store 8,001,830 lbs of carbon, with a yearly benefit of $60,014 (Appendix A, Table 4).

Annual Aesthetics Benefits

The social benefits of trees are hard to capture. The i-Tree 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. Rolfe receives $32,133 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of All Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Rolfe's trees provide $129,692 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 654 trees in Rolfe provide approximately $198 annually (Appendix A, Table 7).

ENERGY	STORMWATER	AIR QUALITY	CARBON	AESTHETICS	SUMMARY
• Reduce energy cost by **$33,993**	• Intercept 1,956,002 **gallons** • Provides **$53,008** benefit	• Remove 2,132 **lbs** of pollution • Net value of **$6,014**	• Sequester 375,081 **lbs** • Value of **$4,544** • Store 8,001,830 **lbs** • Value of **$60,014**	• **$32,133** in social benefits	• **$129,692** annual benefits • Each tree provides **$198** annually

FOREST STRUCTURE

Species Distribution

Rolfe has over 48 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

Maple	222	34%	Locust	5	1%
Ash	198	30%	Boxelder	4	<1%
Spruce	55	8%	Catalpa	4	<1%
Basswood/Linden	28	4%	Cottonwood	3	<1%
Cedar	26	4%	Poplar	3	<1%
Hackberry	25	4%	Other Deciduous	3	<1%
Walnut	21	3%	Buckeye	2	<1%
Elm	11	2%	Ginkgo	2	<1%
Birch	10	2%	Lilac	2	<1%
Oak	10	1%	Pine	2	<1%
Apple	9	1%	Mulberry	1	<1%
Coffee	7	1%			

Age Class

Most of Rolfe's trees (17%) are between 24 and 30 inches in diameter at 4.5 ft (Appendix A, Figure 2).

To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Rolfe's size curve is on the larger side, indicating a older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Rolfe indicate that 85% of the trees are in good health, with only 2% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 40% of Rolfe's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Seventeen percent of the tree population's wood condition is in poor health, dead, or dying. This 17% 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).

Action	Number of Trees	Percentage
Tree Removal	181	28%
Crown Cleaning	126	19%
Crown Reduction	25	4%
Crown Raising	14	2%
Tree Staking	3	<1%

Canopy Cover

The total canopy with both private and public trees is 123 acres or 18% cover. The canopy cover included in the Rolfe inventory includes approximately 19 acres (Appendix A, Figure 4). The city's canopy goal is to increase canopy by 20% in 30 years. To achieve this goal it is estimated that 5 trees need to be planted annually on public and private lands.

Land Use and Location

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

Land Use	Percentage
Single Family Residential	64%
Park/Vacant/Other	34%
Industrial/Large Commercial	2%
Small Commercial	0%
Multifamily Residential	0%

Recommendations

RECOMMENDATIONS

Risk Management

Hazardous trees can be a significant threat to both people and property. Trees that are dead, dying, or have large issues such as trunk cracks longer than 18 inches should be removed. Broken branches and branches that interfere with motorists' vision of pedestrians, vehicles, traffic signs and signals should be removed.

HAZARDOUS TREES

Rolfe has 7 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). We recommend starting with the large-diameter, critical concern trees first. There are 5 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Six-Year Maintenance Plan at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 27 trees with maintenance needs.

POOR TREE SPECIES

After removing the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 181 removals, 161 are ash trees. There are a total of 198 ash trees, and 175 of those have signs and symptoms that have been associated with EAB. In addition, there are 51 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 removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend 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 five years will replace the trees that are removed. We recommend planting 1.2 trees for every tree removed, since survival rates will not be 100%. 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 Rolfe.

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 (34%) (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: crabapple, Japanese Lilac, serviceberry, oak (red, white), hackberry, linden, elm (disease resistant), cork, London plane, ironwood hornbeam as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. We recommend 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.

EMERALD ASH BORER PLAN

Ash Tree Removal

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

Treatment of Ash Trees

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

EAB Quarantines

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

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

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

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

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be normally disposed of 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 151.02 (Appendix C). The new plantings will be a diverse mix and will not include crabapple, Japanese Lilac, serviceberry, oak (red, white), hackberry, linden, elm (disease resistant), cork, London plane, ironwood hornbeam.

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.

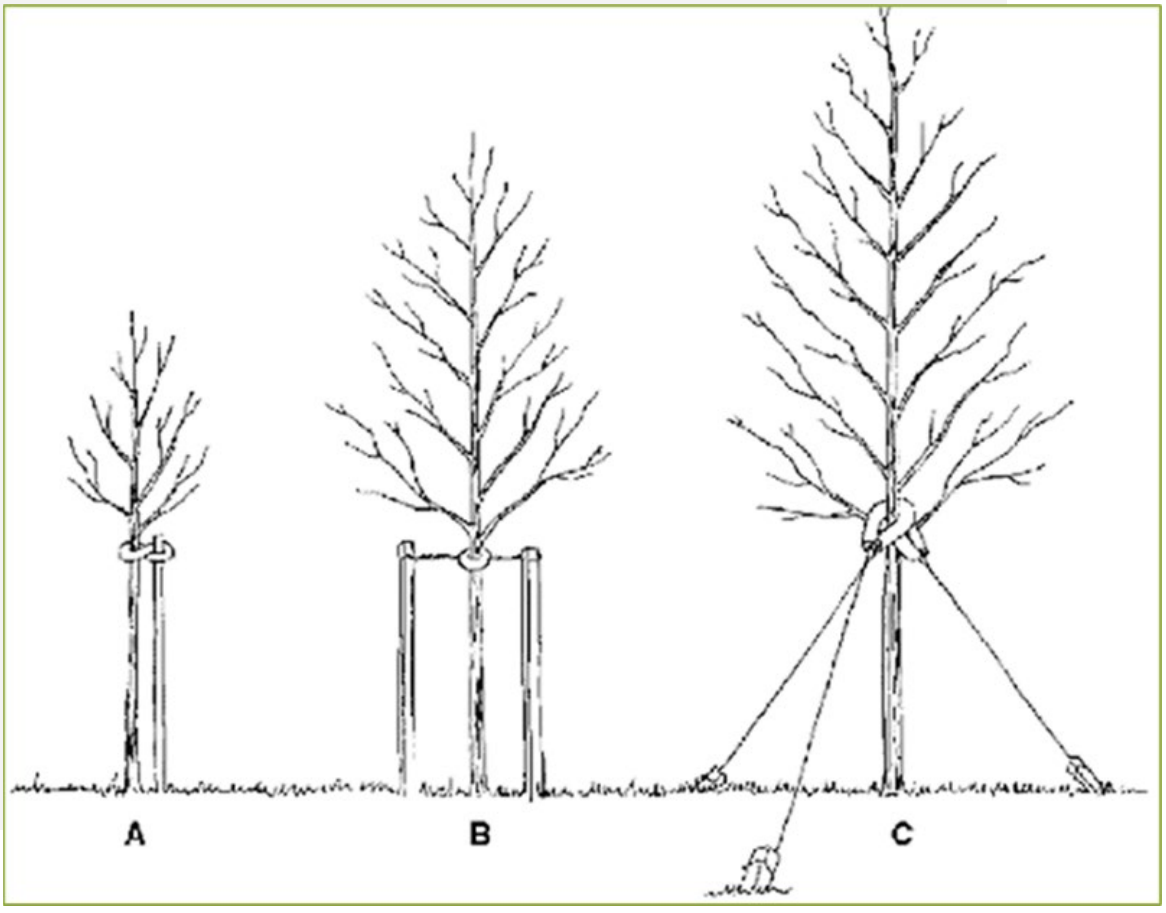
Monitoring

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

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 151.06 states “A property owner may remove a tree that is on personal property as long as the property owner does the actual work. Otherwise, the property owner must hire a licensed tree surgeon to remove the tree.”

Schedule & Budget



PROPOSED WORK SCHEDULE & BUDGET

Budget Allowance of $6,000/Year – (Based off Reported Yearly Tree Budget)

YEAR 1	Est. Cost
Remove 5 trees recommended for immediate removal	$3,500
Remove 2 ash tree in poor condition	$1,400
Plant 7 trees in open locations	$1,050
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$5,950**

YEAR 2	Est. Cost
Remove 5 trees recommended for immediate removal	$3,500
Plant 3 trees in open locations	$450
Prune 1/5 of city owned trees	$1,960
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$5,910**

YEAR 3	Est. Cost
Remove 2 trees recommended for immediate removal	$1,400
Remove 5 ash trees in poor condition	$3,500
Plant 7 trees in open locations	$1,050
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$5,950**

YEAR 4	Est. Cost
Remove 5 ash trees	$3,500
Plant 3 trees in open locations	$450
Prune 1/5 of city owned trees	$1,960
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$5,910**

YEAR 5	Est. Cost
Remove 7 ash trees	$4,900
Plant 7 trees in open locations	$1,050
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$5,950**

YEAR 6	Est. Cost
Remove 5 ash trees	$3,500
Plant 3 trees in open locations	$450
Prune 1/5 of city owned trees	$1,960
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$5,910**

Estimated costs based on average costs of $700/tree for removal, $150/tree for planting and maintenance, and $15/tree for pruning.

***To remove all ash trees within 6 years alone, the budget would need to be $23,100 a year. If the budget were increased to $12,000 a year all ash could be removed in 12 years.*

PROPOSED WORK SCHEDULE WITH INCREASED BUDGET

Budget Allowance of $12,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	Est. Cost
Remove 5 trees recommended for immediate removal	$3,500
Remove 10 ash trees in poor condition	$7,000
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$12,000**

YEAR 2	Est. Cost
Remove 11 ash trees in poor condition	$7,700
Plant 7 trees in open locations	$1,050
Prune 1/3 of city owned trees	$3,200
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$11,950**

YEAR 3	Est. Cost
Remove 15 ash trees	$10,500
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$12,000**

YEAR 4	Est. Cost
Remove 11 ash trees	$7,700
Plant 7 trees in open locations	$1,050
Prune 1/3 of city owned trees	$3,200
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$11,950**

YEAR 5	Est. Cost
Remove 12 ash trees	$8,400
Plant 24 trees in open locations	$3,600
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$12,000**

YEAR 6	Est. Cost
Remove 10 ash trees	$7,000
Plant 12 trees in open locations	$1,800
Prune 1/3 of city owned trees	$3,200
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$12,000**

Purposed Budget Increase

EAB could potentially kill all ash trees in Rolfe within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to $23,100 a year. If the budget were increased to $12,000 per year all ash could be removed within 12 years. Additionally, we recommend that Rolfe 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 considered by many communities is treating 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 removal 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). Eight trees would be selected for treatment, and Rolfe would still need to find $137,400 for removal. Alternatively, if there are 20 treatable trees, it would cost approximately $3,000 a year for treatment and leave $134,400 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 Rolfe. We suggest considering an increased budget to plan for this.

WORKS CITED

Census Bureau. 2010. http://censtats.census.gov/data/IA/1601964290.pdf(April, 2013)

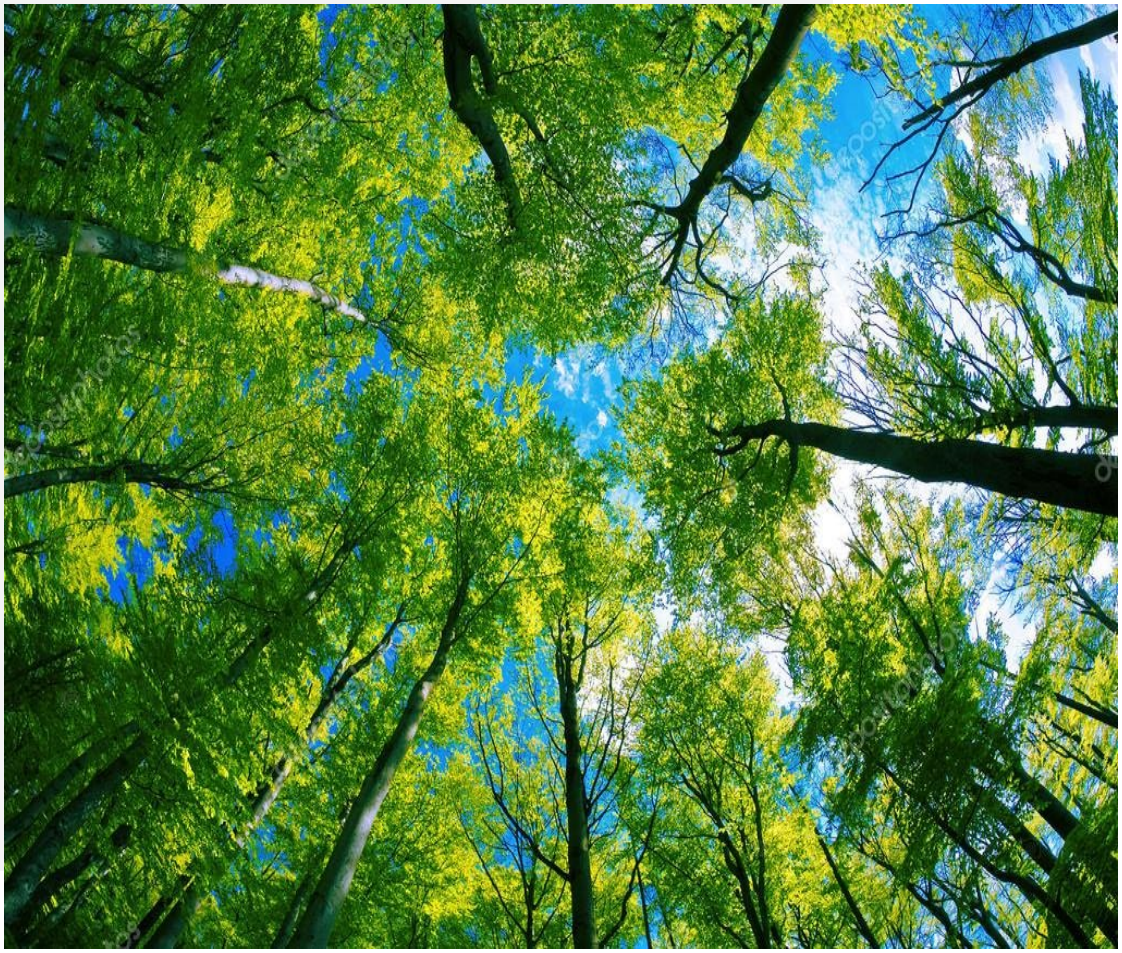
USDA Forest Service, et al. 2006. i-Tree Software Suite v1.0 User's Manual. Pp. 27-40.

McPherson EG, Simpson JR, Peper PJ, Gardner SL, Vargas KE, Ho J, Maco S, Xiao Q. 2005b. City of Charleston, South Carolina, municipal forest resource analysis. Internal Tech Rep. Davis, CA: U.S. Department of Agriculture, Center for Urban Forest Research. p. 57

Nowak, DJ and JF Dwyer. 2007. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, J. (ed.) Urban and Community Forestry in the Northeast. New York: Springer. Pp. 25-46.

Peper, Paula J; McPherson, E Gregory; Simpson, James R; Vargas, Kelaine E; Xiao, Qingfu 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-219. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. p.115

Appendices



APPENDIX A: i-TREE DATA

Table 1: Annual Energy Benefits

Rolfe

Annual Energy Benefits of Public Trees

2/7/2023

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	59.0	4,481	7,955.8	7,797	12,278	(N/A)	30.0	36.1	62.64
Norway maple	28.3	2,149	4,106.1	4,024	6,173	(N/A)	16.8	18.2	56.12
Silver maple	26.2	1,990	3,481.5	3,412	5,402	(N/A)	11.6	15.9	71.08
Northern hackberry	7.8	590	1,078.2	1,057	1,647	(N/A)	3.8	4.8	65.88
Spruce	2.1	159	284.4	279	438	(N/A)	3.7	1.3	18.24
Sugar maple	5.1	389	685.3	672	1,060	(N/A)	3.7	3.1	44.17
Northern white cedar	2.3	176	286.7	281	457	(N/A)	3.5	1.3	19.87
Black walnut	6.5	496	915.2	897	1,393	(N/A)	3.2	4.1	66.35
American basswood	4.7	355	684.3	671	1,026	(N/A)	2.8	3.0	56.99
Norway spruce	2.3	174	304.8	299	473	(N/A)	2.4	1.4	29.57
Blue spruce	1.5	113	204.3	200	313	(N/A)	2.1	0.9	22.36
Littleleaf linden	1.5	114	211.8	208	321	(N/A)	1.5	0.9	32.14
Black maple	2.7	203	375.6	368	571	(N/A)	1.5	1.7	57.07
Apple	0.8	58	123.0	121	178	(N/A)	1.4	0.5	19.81
American elm	0.6	47	74.0	73	119	(N/A)	1.2	0.4	14.89
Kentucky coffeetree	0.0	3	6.5	6	10	(N/A)	1.1	0.0	1.39
River birch	0.5	39	80.3	79	118	(N/A)	0.8	0.3	23.54
Honeylocust	0.5	39	71.3	70	109	(N/A)	0.8	0.3	21.85
Boxelder	0.7	53	90.0	88	142	(N/A)	0.6	0.4	35.42
Catalpa	0.9	65	116.8	114	180	(N/A)	0.6	0.5	44.88
Bur oak	0.8	58	103.2	101	159	(N/A)	0.5	0.5	52.96
Oak	0.0	1	1.4	1	2	(N/A)	0.5	0.0	0.66
Quaking aspen	0.6	43	67.7	66	109	(N/A)	0.5	0.3	36.36
Eastern red cedar	0.3	21	40.8	40	61	(N/A)	0.5	0.2	20.20
Tulip tree	0.0	0	0.9	1	1	(N/A)	0.3	0.0	0.66
Austrian pine	0.3	20	34.7	34	54	(N/A)	0.3	0.2	27.08
Cottonwood	0.7	50	93.7	92	142	(N/A)	0.3	0.4	70.91
Ohio buckeye	0.2	16	33.7	33	49	(N/A)	0.3	0.1	24.47
Ginkgo	0.0	0	0.8	1	1	(N/A)	0.3	0.0	0.57
Japanese tree lilac	0.1	6	13.5	13	19	(N/A)	0.3	0.1	9.53
Broadleaf Deciduous Small	0.0	1	1.2	1	2	(N/A)	0.3	0.0	0.87
Paper birch	0.4	27	50.5	50	77	(N/A)	0.3	0.2	38.36
Black poplar	0.8	62	110.0	108	170	(N/A)	0.3	0.5	84.77
Northern pin oak	0.0	0	0.8	1	1	(N/A)	0.2	0.0	1.10
Maple	0.1	8	16.5	16	25	(N/A)	0.2	0.1	24.58
Mulberry	0.2	14	24.7	24	38	(N/A)	0.2	0.1	38.13
Siberian elm	0.3	25	46.6	46	71	(N/A)	0.2	0.2	71.03
Swamp white oak	0.0	0	0.8	1	1	(N/A)	0.2	0.0	1.10
Black ash	0.1	8	16.9	17	24	(N/A)	0.2	0.1	24.47
Red maple	0.3	19	30.1	29	49	(N/A)	0.2	0.1	48.95
White ash	0.1	7	13.3	13	20	(N/A)	0.2	0.1	20.10
Black spruce	0.1	5	10.2	10	15	(N/A)	0.2	0.0	14.80
Broadleaf Deciduous Mediu	0.3	24	47.4	46	71	(N/A)	0.2	0.2	70.84
Chinese elm	0.4	33	59.0	58	91	(N/A)	0.2	0.3	91.02
Elm	0.5	37	63.1	62	99	(N/A)	0.2	0.3	98.63
Eastern cottonwood	0.5	37	63.1	62	99	(N/A)	0.2	0.3	98.63
White oak	0.4	29	53.7	53	82	(N/A)	0.2	0.2	82.02
Northern red oak	0.3	20	36.4	36	55	(N/A)	0.2	0.2	55.22
Total	161.6	12,266	22,170.6	21,727	33,993	(N/A)	100.0	100.0	51.98

Table 2: Annual Stormwater Benefits

Rolfe

Annual Stormwater Benefits of Public Trees

2/7/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	699,177	18,948	(N/A)	30.0	35.7	96.67
Norway maple	280,997	7,615	(N/A)	16.8	14.4	69.23
Silver maple	400,946	10,866	(N/A)	11.6	20.5	142.97
Northern hackberry	77,416	2,098	(N/A)	3.8	4.0	83.92
Spruce	25,154	682	(N/A)	3.7	1.3	28.40
Sugar maple	63,378	1,718	(N/A)	3.7	3.2	71.56
Northern white cedar	36,936	1,001	(N/A)	3.5	1.9	43.52
Black walnut	79,084	2,143	(N/A)	3.2	4.0	102.06
American basswood	57,494	1,558	(N/A)	2.8	2.9	86.56
Norway spruce	50,062	1,357	(N/A)	2.4	2.6	84.79
Blue spruce	21,410	580	(N/A)	2.1	1.1	41.44
Littleleaf linden	15,146	410	(N/A)	1.5	0.8	41.05
Black maple	26,428	716	(N/A)	1.5	1.4	71.62
Apple	4,081	111	(N/A)	1.4	0.2	12.29
American elm	4,668	127	(N/A)	1.2	0.2	15.81
Kentucky coffeetree	279	8	(N/A)	1.1	0.0	1.08
River birch	3,826	104	(N/A)	0.8	0.2	20.74
Honeylocust	5,370	146	(N/A)	0.8	0.3	29.11
Boxelder	6,279	170	(N/A)	0.6	0.3	42.54
Catalpa	12,919	350	(N/A)	0.6	0.7	87.53
Bur oak	6,647	180	(N/A)	0.5	0.3	60.04
Oak	54	1	(N/A)	0.5	0.0	0.48
Quaking aspen	3,539	96	(N/A)	0.5	0.2	31.97
Eastern red cedar	3,928	106	(N/A)	0.5	0.2	35.49
Tulip tree	36	1	(N/A)	0.3	0.0	0.48
Austrian pine	3,857	105	(N/A)	0.3	0.2	52.26
Cottonwood	7,886	214	(N/A)	0.3	0.4	106.85
Ohio buckeye	1,172	32	(N/A)	0.3	0.1	15.88
Ginkgo	14	0	(N/A)	0.3	0.0	0.19
Japanese tree lilac	272	7	(N/A)	0.3	0.0	3.68
Broadleaf Deciduous Small	15	0	(N/A)	0.3	0.0	0.20
Paper birch	4,115	112	(N/A)	0.3	0.2	55.75
Black poplar	11,182	303	(N/A)	0.3	0.6	151.51
Northern pin oak	12	0	(N/A)	0.2	0.0	0.33
Maple	625	17	(N/A)	0.2	0.0	16.95
Mulberry	667	18	(N/A)	0.2	0.0	18.06
Siberian elm	3,359	91	(N/A)	0.2	0.2	91.03
Swamp white oak	12	0	(N/A)	0.2	0.0	0.33
Black ash	586	16	(N/A)	0.2	0.0	15.88
Red maple	1,604	43	(N/A)	0.2	0.1	43.46
White ash	614	17	(N/A)	0.2	0.0	16.63
Black spruce	755	20	(N/A)	0.2	0.0	20.47
Broadleaf Deciduous Medium	3,764	102	(N/A)	0.2	0.2	102.01
Chinese elm	7,239	196	(N/A)	0.2	0.4	196.17
Elm	7,239	196	(N/A)	0.2	0.4	196.17
Eastern cottonwood	7,239	196	(N/A)	0.2	0.4	196.17
White oak	5,491	149	(N/A)	0.2	0.3	148.79
Northern red oak	3,030	82	(N/A)	0.2	0.2	82.12

Annual Stormwater Benefits of Public Trees

2/7/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Citywide total	1,956,002	53,008	(N/A)	100.0	100.0	81.05

Table 3: Annual Air Quality Benefits

Rolfe

Annual Air Quality Benefits of Public Trees

2/7/2023

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2								
Green ash	97.6	15.6	45.4	4.4	516	280.8	41.0	39.1	267.6	1,752	0.0	0	791.3	2,268	(N/A)	30.0	11.57
Norway maple	59.4	10.2	28.9	2.6	320	137.5	19.9	18.9	128.5	851	-13.8	-52	392.2	1,120	(N/A)	16.8	10.18
Silver maple	74.0	12.5	35.9	3.3	398	123.9	18.1	17.3	118.6	774	-39.0	-146	364.6	1,026	(N/A)	11.6	13.50
Northern hackberry	13.4	2.3	6.7	0.6	73	37.3	5.4	5.2	35.3	232	0.0	0	106.2	305	(N/A)	3.8	12.19
Spruce	2.6	0.5	2.4	0.3	18	10.0	1.5	1.4	9.5	62	-8.6	-32	19.4	48	(N/A)	3.7	1.98
Sugar maple	9.3	1.6	4.5	0.4	50	24.3	3.5	3.4	23.2	152	-7.2	-27	62.9	174	(N/A)	3.7	7.27
Northern white cedar	4.2	0.8	3.5	0.5	28	10.8	1.6	1.5	10.5	68	-17.9	-67	15.6	29	(N/A)	3.5	1.24
Black walnut	10.7	1.7	5.0	0.5	56	31.4	4.6	4.3	29.6	195	0.0	0	87.8	252	(N/A)	3.2	11.98
American basswood	8.2	1.4	4.0	0.4	44	22.8	3.3	3.1	21.2	141	-6.9	-26	57.5	159	(N/A)	2.8	8.84
Norway spruce	6.0	1.2	4.8	0.7	39	10.9	1.6	1.5	10.4	68	-28.5	-107	8.7	0	(N/A)	2.4	0.02
Blue spruce	3.2	0.6	2.6	0.4	21	7.1	1.0	1.0	6.7	44	-7.9	-29	14.9	36	(N/A)	2.1	2.56
Littleleaf linden	2.6	0.4	1.3	0.1	14	7.2	1.0	1.0	6.8	45	-1.3	-5	19.3	54	(N/A)	1.5	5.42
Black maple	6.8	1.2	3.1	0.3	36	12.8	1.9	1.8	12.1	80	-2.2	-8	37.7	108	(N/A)	1.5	10.75
Apple	1.4	0.2	0.6	0.1	7	3.8	0.5	0.5	3.4	23	0.0	0	10.6	31	(N/A)	1.4	3.40
American elm	2.2	0.4	1.0	0.1	12	2.8	0.4	0.4	2.8	18	0.0	0	10.1	30	(N/A)	1.2	3.70
Kentucky coffeetree	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	1	(N/A)	1.1	0.20
River birch	0.6	0.1	0.3	0.0	3	2.5	0.4	0.3	2.3	16	-0.2	-1	6.5	18	(N/A)	0.8	3.69
Honeylocust	1.0	0.2	0.5	0.0	5	2.5	0.4	0.3	2.4	15	-0.8	-3	6.4	18	(N/A)	0.8	3.56
Boxelder	0.7	0.1	0.4	0.0	4	3.3	0.5	0.5	3.2	21	-0.3	-1	8.4	23	(N/A)	0.6	5.85
Catalpa	2.0	0.3	0.9	0.1	10	4.1	0.6	0.6	3.9	25	0.0	0	12.4	36	(N/A)	0.6	8.93
Bur oak	0.6	0.1	0.3	0.0	4	3.6	0.5	0.5	3.4	23	0.0	0	9.2	26	(N/A)	0.5	8.70
Oak	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0	(N/A)	0.5	0.08
Quaking aspen	0.2	0.0	0.2	0.0	1	2.6	0.4	0.4	2.6	16	0.0	0	6.4	18	(N/A)	0.5	5.95
Eastern red cedar	0.7	0.1	0.6	0.1	5	1.3	0.2	0.2	1.2	8	-2.2	-8	2.4	5	(N/A)	0.5	1.66
Tulip tree	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0	(N/A)	0.3	0.08
Austrian pine	0.5	0.1	0.4	0.1	4	1.2	0.2	0.2	1.2	8	-1.4	-5	2.5	6	(N/A)	0.3	2.99
Cottonwood	1.0	0.2	0.5	0.0	5	3.2	0.5	0.4	3.0	20	0.0	0	8.7	25	(N/A)	0.3	12.48
Ohio buckeye	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	1.0	6	0.0	0	2.5	7	(N/A)	0.3	3.47
Ginkgo	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.3	0.07
Japanese tree lilac	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	2	0.0	0	0.9	3	(N/A)	0.3	1.33
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0	(N/A)	0.3	0.11
Paper birch	0.5	0.1	0.2	0.0	3	1.7	0.2	0.2	1.6	11	0.0	0	4.7	13	(N/A)	0.3	6.67
Black poplar	2.1	0.3	0.9	0.1	11	3.9	0.6	0.5	3.7	24	0.0	0	12.1	35	(N/A)	0.3	17.51
Northern pin oak	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.2	0.14

Rolfe

Annual Air Quality Benefits of Public Trees

2/7/2023

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2								
Maple	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.3	4	(N/A)	0.2	3.64
Mulberry	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	5	0.0	0	2.3	7	(N/A)	0.2	6.56
Siberian elm	0.5	0.1	0.3	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	13	(N/A)	0.2	12.72
Swamp white oak	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.2	0.14
Black ash	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3	(N/A)	0.2	3.47
Red maple	0.3	0.1	0.2	0.0	2	1.2	0.2	0.2	1.2	7	-0.1	0	3.1	9	(N/A)	0.2	8.75
White ash	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3	(N/A)	0.2	2.91
Black spruce	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	2	(N/A)	0.2	1.53
Broadleaf Deciduous Medium	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14	(N/A)	0.2	13.58
Chinese elm	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.2	19.04
Elm	1.6	0.3	0.7	0.1	8	2.3	0.3	0.3	2.2	14	0.0	0	7.7	23	(N/A)	0.2	22.55
Eastern cottonwood	1.6	0.3	0.7	0.1	8	2.3	0.3	0.3	2.2	14	0.0	0	7.7	23	(N/A)	0.2	22.55
White oak	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16	(N/A)	0.2	15.71
Northern red oak	0.7	0.1	0.3	0.0	4	1.2	0.2	0.2	1.2	8	-1.0	-4	2.9	8	(N/A)	0.2	7.65
Citywide total	319.7	53.8	158.6	15.6	1,730	771.9	112.4	107.1	732.3	4,808	-139.7	-524	2,131.7	6,014	(N/A)	100.0	9.20

Table 4: Annual Carbon Stored

Rolfe

Stored CO2 Benefits of Public Trees

2/7/2023

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	3,253,824	24,404	(N/A)	30.0	40.7	124.51
Norway maple	979,052	7,343	(N/A)	16.8	12.2	66.75
Silver maple	1,785,909	13,394	(N/A)	11.6	22.3	176.24
Northern hackberry	209,541	1,572	(N/A)	3.8	2.6	62.86
Spruce	17,469	131	(N/A)	3.7	0.2	5.46
Sugar maple	273,052	2,048	(N/A)	3.7	3.4	85.33
Northern white cedar	43,251	324	(N/A)	3.5	0.5	14.10
Black walnut	348,596	2,614	(N/A)	3.2	4.4	124.50
American basswood	302,992	2,272	(N/A)	2.8	3.8	126.25
Norway spruce	72,807	546	(N/A)	2.4	0.9	34.13
Blue spruce	25,269	190	(N/A)	2.1	0.3	13.54
Littleleaf linden	56,006	420	(N/A)	1.5	0.7	42.00
Black maple	72,608	545	(N/A)	1.5	0.9	54.46
Apple	22,099	166	(N/A)	1.4	0.3	18.42
American elm	41,525	311	(N/A)	1.2	0.5	38.93
Kentucky coffeetree	258	2	(N/A)	1.1	0.0	0.28
River birch	10,382	78	(N/A)	0.8	0.1	15.57
Honeylocust	13,194	99	(N/A)	0.8	0.2	19.79
Boxelder	21,747	163	(N/A)	0.6	0.3	40.78
Catalpa	65,399	490	(N/A)	0.6	0.8	122.62
Bur oak	20,587	154	(N/A)	0.5	0.3	51.47
Oak	36	0	(N/A)	0.5	0.0	0.09
Quaking aspen	8,378	63	(N/A)	0.5	0.1	20.95
Eastern red cedar	2,481	19	(N/A)	0.5	0.0	6.20
Tulip tree	24	0	(N/A)	0.3	0.0	0.09
Austrian pine	3,779	28	(N/A)	0.3	0.0	14.17
Cottonwood	31,546	237	(N/A)	0.3	0.4	118.30
Ohio buckeye	2,201	17	(N/A)	0.3	0.0	8.26
Ginkgo	9	0	(N/A)	0.3	0.0	0.03
Japanese tree lilac	922	7	(N/A)	0.3	0.0	3.46
Broadleaf Deciduous	28	0	(N/A)	0.3	0.0	0.10
Paper birch	15,958	120	(N/A)	0.3	0.2	59.84
Black poplar	71,755	538	(N/A)	0.3	0.9	269.08
Northern pin oak	17	0	(N/A)	0.2	0.0	0.13
Maple	1,101	8	(N/A)	0.2	0.0	8.26
Mulberry	3,037	23	(N/A)	0.2	0.0	22.78
Siberian elm	12,245	92	(N/A)	0.2	0.2	91.84
Swamp white oak	17	0	(N/A)	0.2	0.0	0.13
Black ash	1,101	8	(N/A)	0.2	0.0	8.26
Red maple	3,624	27	(N/A)	0.2	0.0	27.18
White ash	1,035	8	(N/A)	0.2	0.0	7.76
Black spruce	284	2	(N/A)	0.2	0.0	2.13
Broadleaf Deciduous	14,280	107	(N/A)	0.2	0.2	107.10
Chinese elm	39,259	294	(N/A)	0.2	0.5	294.44
Elm	55,982	420	(N/A)	0.2	0.7	419.86
Eastern cottonwood	55,982	420	(N/A)	0.2	0.7	419.86
White oak	25,943	195	(N/A)	0.2	0.3	194.57
Northern red oak	15,239	114	(N/A)	0.2	0.2	114.29
Citywide total	8,001,830	60,014	(N/A)	100.0	100.0	91.76

The value of stored carbon dioxide is calculated as the total amount of carbon dioxide sequestered annually over the life of each tree, summed for the population. This value should not be added to the Replacement Value or double-counting of the carbon dioxide storage benefit will occur.

Table 5: Annual Carbon Sequestered

Rolfe

Annual CO Benefits of Public Trees

2/7/2023

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	129,294	970	-15,618	-626	-122	99,037	743	212,087	1,591 (N/A)	30.0	35.0	8.12
Norway maple	33,258	249	-4,701	-309	-38	47,494	356	75,742	568 (N/A)	16.8	12.5	5.16
Silver maple	121,643	912	-8,572	-305	-67	43,981	330	156,747	1,176 (N/A)	11.6	25.9	15.47
Northern hackberry	9,890	74	-1,006	-74	-8	13,047	98	21,857	164 (N/A)	3.8	3.6	6.56
Spruce	1,964	15	-84	-37	-1	3,517	26	5,360	40 (N/A)	3.7	0.9	1.68
Sugar maple	12,670	95	-1,312	-59	-10	8,586	64	19,885	149 (N/A)	3.7	3.3	6.21
Northern white cedar	1,406	11	-208	-43	-2	3,889	29	5,045	38 (N/A)	3.5	0.8	1.65
Black walnut	15,728	118	-1,673	-71	-13	10,970	82	24,954	187 (N/A)	3.2	4.1	8.91
American basswood	17,058	128	-1,454	-57	-11	7,852	59	23,399	175 (N/A)	2.8	3.9	9.75
Norway spruce	1,926	14	-349	-46	-3	3,855	29	5,386	40 (N/A)	2.4	0.9	2.52
Blue spruce	918	7	-121	-28	-1	2,493	19	3,262	24 (N/A)	2.1	0.5	1.75
Littleleaf linden	2,853	21	-269	-20	-2	2,515	19	5,079	38 (N/A)	1.5	0.8	3.81
Black maple	3,859	29	-349	-26	-3	4,478	34	7,963	60 (N/A)	1.5	1.3	5.97
Apple	1,698	13	-106	-11	-1	1,275	10	2,855	21 (N/A)	1.4	0.5	2.38
American elm	813	6	-200	-8	-2	1,029	8	1,634	12 (N/A)	1.2	0.3	1.53
Kentucky coffeetree	90	1	-1	-2	0	75	1	162	1 (N/A)	1.1	0.0	0.17
River birch	1,019	8	-51	-6	0	863	6	1,826	14 (N/A)	0.8	0.3	2.74
Honeylocust	1,719	13	-63	-4	-1	871	7	2,522	19 (N/A)	0.8	0.4	3.78
Boxelder	1,932	14	-105	-8	-1	1,182	9	3,000	23 (N/A)	0.6	0.5	5.63
Catalpa	1,948	15	-314	-10	-2	1,437	11	3,062	23 (N/A)	0.6	0.5	5.74
Bur oak	1,765	13	-99	-7	-1	1,276	10	2,934	22 (N/A)	0.5	0.5	7.34
Oak	8	0	0	-1	0	13	0	20	0 (N/A)	0.5	0.0	0.05
Quaking aspen	1,099	8	-40	-5	0	944	7	1,999	15 (N/A)	0.5	0.3	5.00
Eastern red cedar	126	1	-12	-5	0	456	3	564	4 (N/A)	0.5	0.1	1.41
Tulip tree	5	0	0	0	0	9	0	13	0 (N/A)	0.3	0.0	0.05
Austrian pine	238	2	-18	-5	0	445	3	660	5 (N/A)	0.3	0.1	2.48
Cottonwood	1,714	13	-151	-7	-1	1,105	8	2,660	20 (N/A)	0.3	0.4	9.97
Ohio buckeye	448	3	-11	-2	0	352	3	787	6 (N/A)	0.3	0.1	2.95
Ginkgo	4	0	0	0	0	7	0	11	0 (N/A)	0.3	0.0	0.04
Japanese tree lilac	123	1	-4	-1	0	130	1	246	2 (N/A)	0.3	0.0	0.92
Broadleaf Deciduous Smal	17	0	0	0	0	11	0	28	0 (N/A)	0.3	0.0	0.10

Annual CO Benefits of Public Trees

2/7/2023

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Paper birch	931	7	-77	-4	-1	601	5	1,451	11 (N/A)	0.3	0.2	5.44
Black poplar	1,336	10	-344	-9	-3	1,365	10	2,347	18 (N/A)	0.3	0.4	8.80
Northern pin oak	5	0	0	0	0	7	0	12	0 (N/A)	0.2	0.0	0.09
Maple	165	1	-5	-1	0	186	1	344	3 (N/A)	0.2	0.1	2.58
Mulberry	268	2	-15	-2	0	308	2	560	4 (N/A)	0.2	0.1	4.20
Siberian elm	640	5	-59	-4	0	561	4	1,139	9 (N/A)	0.2	0.2	8.54
Swamp white oak	5	0	0	0	0	7	0	12	0 (N/A)	0.2	0.0	0.09
Black ash	224	2	-5	-1	0	176	1	393	3 (N/A)	0.2	0.1	2.95
Red maple	483	4	-17	-2	0	431	3	895	7 (N/A)	0.2	0.1	6.71
White ash	182	1	-5	-1	0	156	1	331	2 (N/A)	0.2	0.1	2.49
Black spruce	39	0	-1	-1	0	106	1	142	1 (N/A)	0.2	0.0	1.07
Broadleaf Deciduous Medi	370	3	-69	-4	-1	539	4	837	6 (N/A)	0.2	0.1	6.27
Chinese elm	912	7	-188	-5	-1	734	6	1,453	11 (N/A)	0.2	0.2	10.90
Elm	479	4	-269	-6	-2	813	6	1,017	8 (N/A)	0.2	0.2	7.63
Eastern cottonwood	479	4	-269	-6	-2	813	6	1,017	8 (N/A)	0.2	0.2	7.63
White oak	960	7	-125	-4	-1	650	5	1,481	11 (N/A)	0.2	0.2	11.11
Northern red oak	370	3	-73	-4	-1	432	3	725	5 (N/A)	0.2	0.1	5.44
Citywide total	375,081	2,813	-38,416	-1,837	-302	271,079	2,033	605,907	4,544 (N/A)	100.0	100.0	6.95

Table 6: Annual Social and Aesthetic Benefits

Rolfe

Annual Aesthetic/Other Benefits of Public Trees

2/7/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	10,386	(N/A)	30.0	32.3	52.99
Norway maple	3,124	(N/A)	16.8	9.7	28.40
Silver maple	8,982	(N/A)	11.6	28.0	118.19
Northern hackberry	1,289	(N/A)	3.8	4.0	51.58
Spruce	554	(N/A)	3.7	1.7	23.08
Sugar maple	1,265	(N/A)	3.7	3.9	52.70
Northern white cedar	416	(N/A)	3.5	1.3	18.07
Black walnut	1,227	(N/A)	3.2	3.8	58.42
American basswood	1,188	(N/A)	2.8	3.7	66.03
Norway spruce	348	(N/A)	2.4	1.1	21.72
Blue spruce	235	(N/A)	2.1	0.7	16.82
Littleleaf linden	315	(N/A)	1.5	1.0	31.53
Black maple	466	(N/A)	1.5	1.5	46.62
Apple	99	(N/A)	1.4	0.3	11.04
American elm	104	(N/A)	1.2	0.3	12.94
Kentucky coffeetree	46	(N/A)	1.1	0.1	6.62
River birch	111	(N/A)	0.8	0.3	22.22
Honeylocust	422	(N/A)	0.8	1.3	84.31
Boxelder	163	(N/A)	0.6	0.5	40.81
Catalpa	145	(N/A)	0.6	0.5	36.23
Bur oak	161	(N/A)	0.5	0.5	53.74
Oak	16	(N/A)	0.5	0.0	5.26
Quaking aspen	120	(N/A)	0.5	0.4	40.09
Eastern red cedar	49	(N/A)	0.5	0.2	16.24
Tulip tree	11	(N/A)	0.3	0.0	5.26
Austrian pine	45	(N/A)	0.3	0.1	22.60
Cottonwood	131	(N/A)	0.3	0.4	65.59
Ohio buckeye	52	(N/A)	0.3	0.2	26.22
Ginkgo	1	(N/A)	0.3	0.0	0.37
Japanese tree lilac	6	(N/A)	0.3	0.0	3.22
Broadleaf Deciduous Small	0	(N/A)	0.3	0.0	0.03
Paper birch	80	(N/A)	0.3	0.2	40.16
Black poplar	94	(N/A)	0.3	0.3	47.08
Northern pin oak	3	(N/A)	0.2	0.0	2.74
Maple	30	(N/A)	0.2	0.1	29.84
Mulberry	15	(N/A)	0.2	0.0	15.48
Siberian elm	46	(N/A)	0.2	0.1	46.00
Swamp white oak	3	(N/A)	0.2	0.0	2.74
Black ash	26	(N/A)	0.2	0.1	26.22
Red maple	66	(N/A)	0.2	0.2	65.89
White ash	33	(N/A)	0.2	0.1	33.42
Black spruce	21	(N/A)	0.2	0.1	21.08
Broadleaf Deciduous Medium	31	(N/A)	0.2	0.1	31.46
Chinese elm	58	(N/A)	0.2	0.2	58.34
Elm	29	(N/A)	0.2	0.1	28.57
Eastern cottonwood	29	(N/A)	0.2	0.1	28.57
White oak	67	(N/A)	0.2	0.2	66.60

Annual Aesthetic/Other Benefits of Public Trees

2/7/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern red oak	24	(N/A)	0.2	0.1	23.84
Citywide total	32,133	(N/A)	100.0	100.0	49.13

Table 7: Summary of Benefits in Dollars

Rolfe

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

2/7/2023

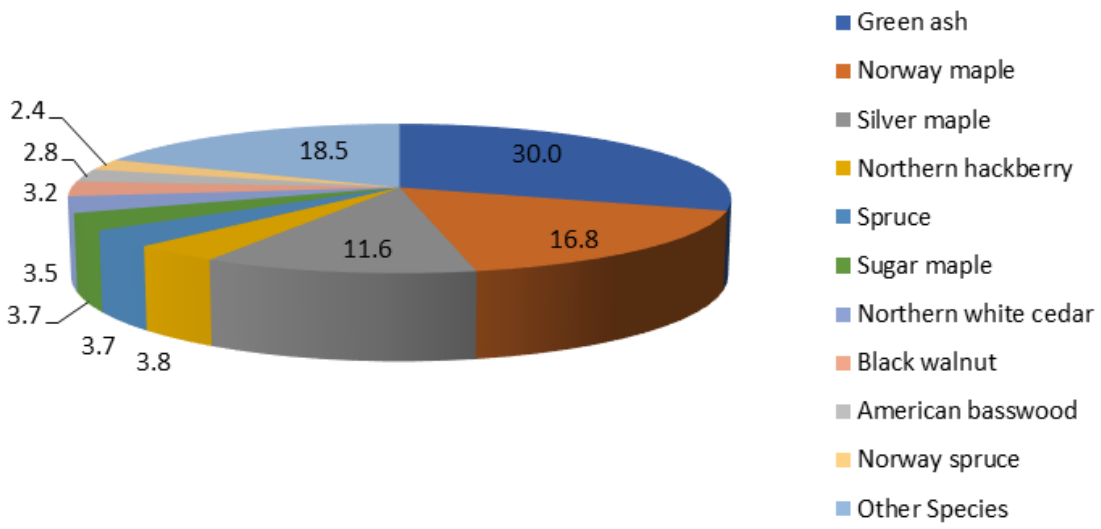
Benefits	Total ($)	Standard Error	$/tree	Standard Error	$/capita	Standard Error
Energy	33,993	(N/A)	51.98	(N/A)	66.78	(N/A)
CO2	4,544	(N/A)	6.95	(N/A)	8.93	(N/A)
Air Quality	6,014	(N/A)	9.20	(N/A)	11.81	(N/A)
Stormwater	53,008	(N/A)	81.05	(N/A)	104.14	(N/A)
Aesthetic/Other	32,133	(N/A)	49.13	(N/A)	63.13	(N/A)
Total Benefits	129,692	(N/A)	198.31	(N/A)	254.80	(N/A)
Costs						
Planting	0		0.00		0.00	
Contract Pruning	0		0.00		0.00	
Pest Management	0		0.00		0.00	
Irrigation	0		0.00		0.00	
Removal	0		0.00		0.00	
Administration	0		0.00		0.00	
Inspection/Service	0		0.00		0.00	
Infrastructure Repairs	0		0.00		0.00	
Litter Clean-up	0		0.00		0.00	
Liability/Claims	0		0.00		0.00	
Other Costs	0		0.00		0.00	
Total Costs	0		0.00		0.00	
Net Benefits	129,692	(N/A)	198.31	(N/A)	254.80	(N/A)
Benefit-cost ratio	0.00	(N/A)				

Figure 1: Species Distribution

Rolfe

Species Distribution of Public Trees

2/7/2023



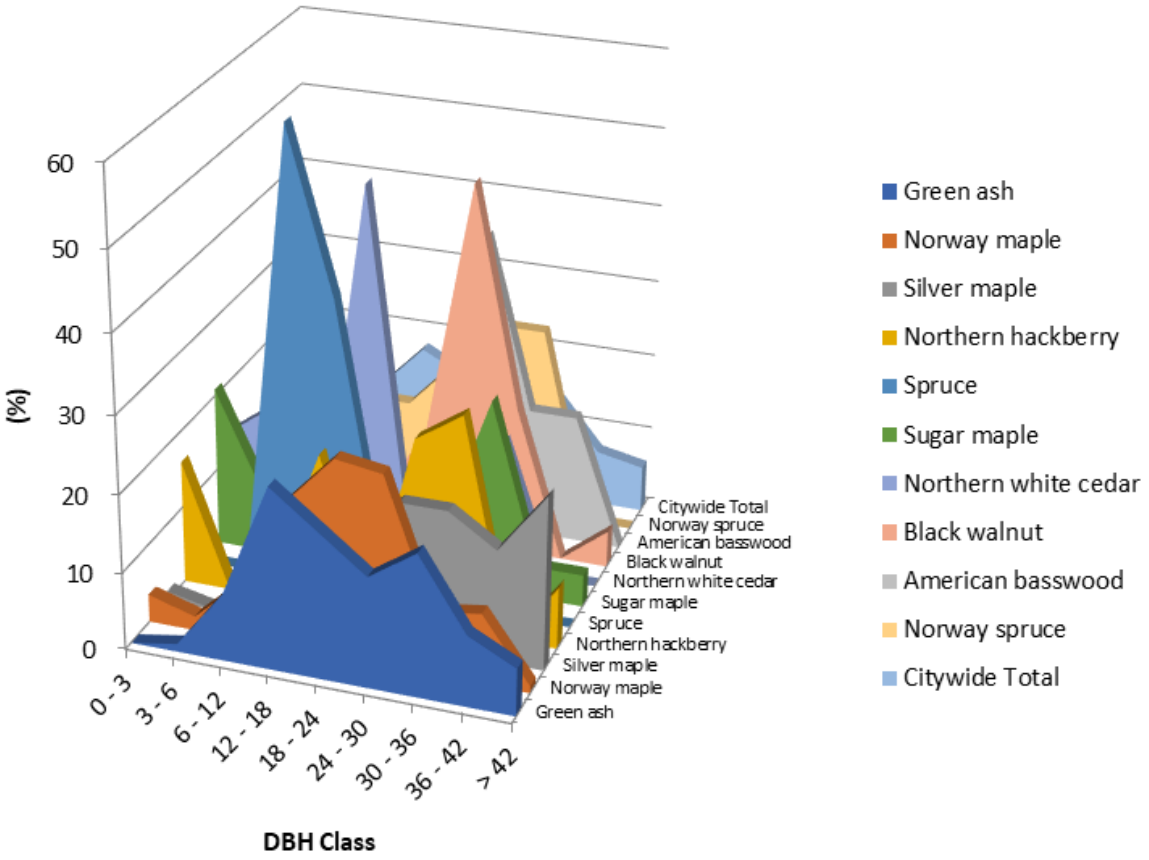
Species	Percent
Green ash	30.0
Norway maple	16.8
Silver maple	11.6
Northern hackberry	3.8
Spruce	3.7
Sugar maple	3.7
Northern white cedar	3.5
Black walnut	3.2
American basswood	2.8
Norway spruce	2.4
Other Species	18.5
Total	100.0

Figure 2: Relative Age Class

Rolfe

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

2/7/2023



	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	1.02	8.67	23.47	18.88	14.29	18.37	9.18	6.12
Norway maple	3.64	1.82	7.27	19.09	25.45	24.55	8.18	9.09	0.91
Silver maple	1.32	0.00	7.89	3.95	13.16	18.42	18.42	14.47	22.37
Northern hackberry	16.00	0.00	4.00	20.00	0.00	24.00	28.00	0.00	8.00
Spruce	0.00	0.00	58.33	37.50	4.17	0.00	0.00	0.00	0.00
Sugar maple	20.83	8.33	12.50	8.33	8.33	8.33	25.00	4.17	4.17
Northern white cedar	13.04	17.39	4.35	47.83	0.00	0.00	17.39	0.00	0.00
Black walnut	0.00	0.00	9.52	4.76	14.29	47.62	19.05	0.00	4.76
American basswood	11.11	11.11	0.00	0.00	5.56	38.89	16.67	16.67	0.00
Norway spruce	6.25	0.00	12.50	12.50	18.75	25.00	25.00	0.00	0.00
Citywide Total	8.41	3.06	11.62	17.74	14.68	17.13	14.22	7.19	5.96

Figure 3: Foliage Condition

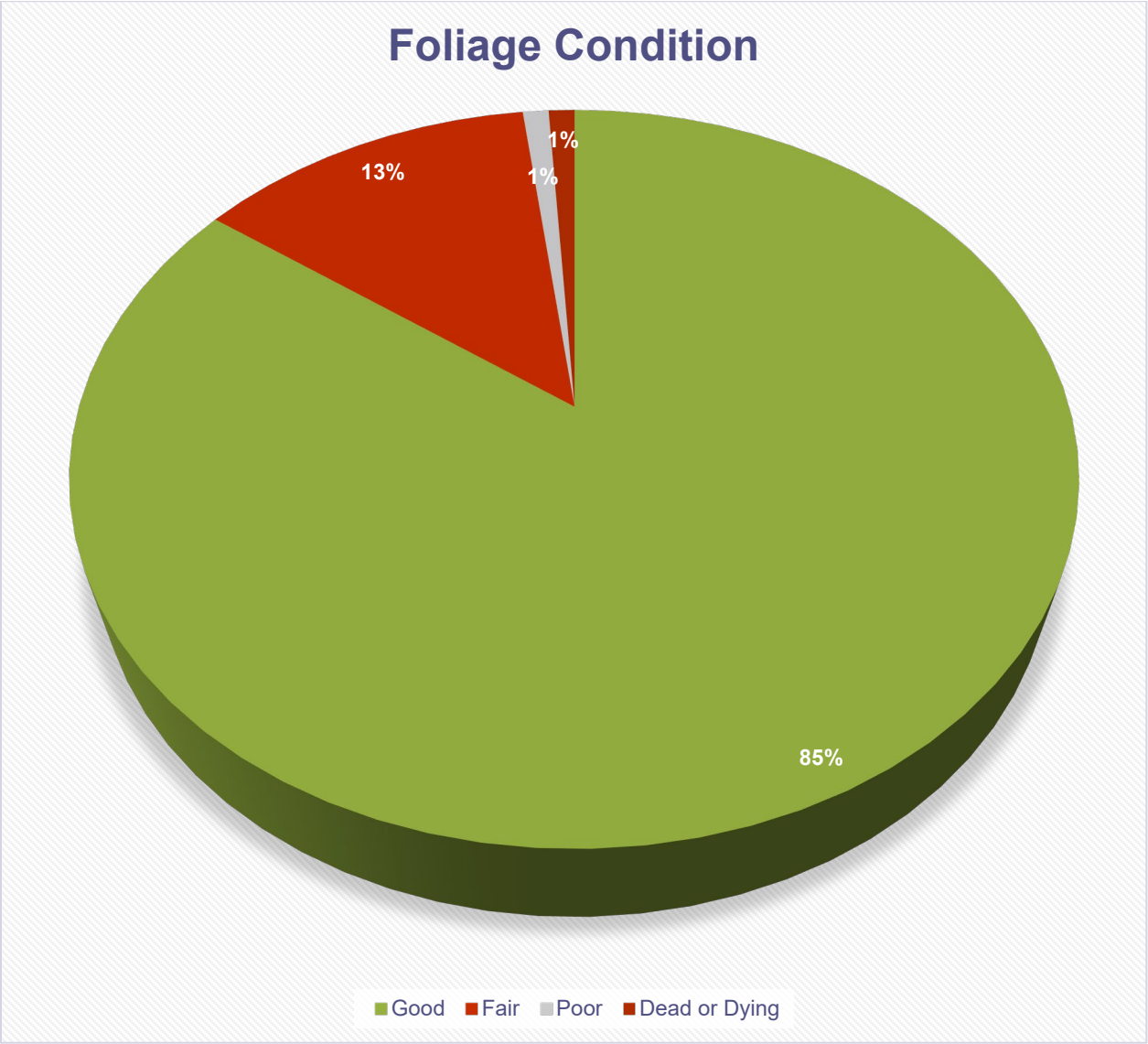


Figure 4: Wood Condition

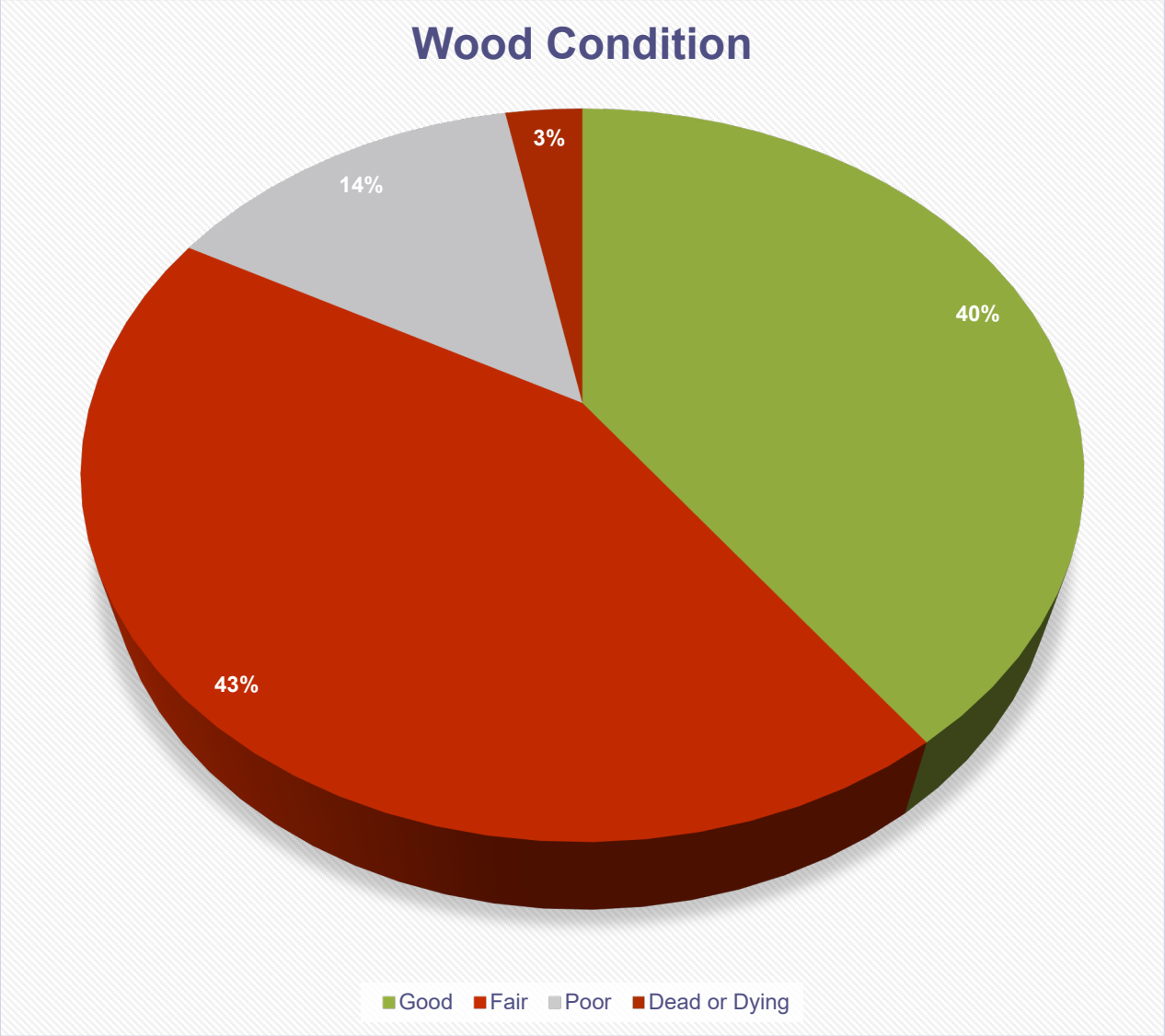
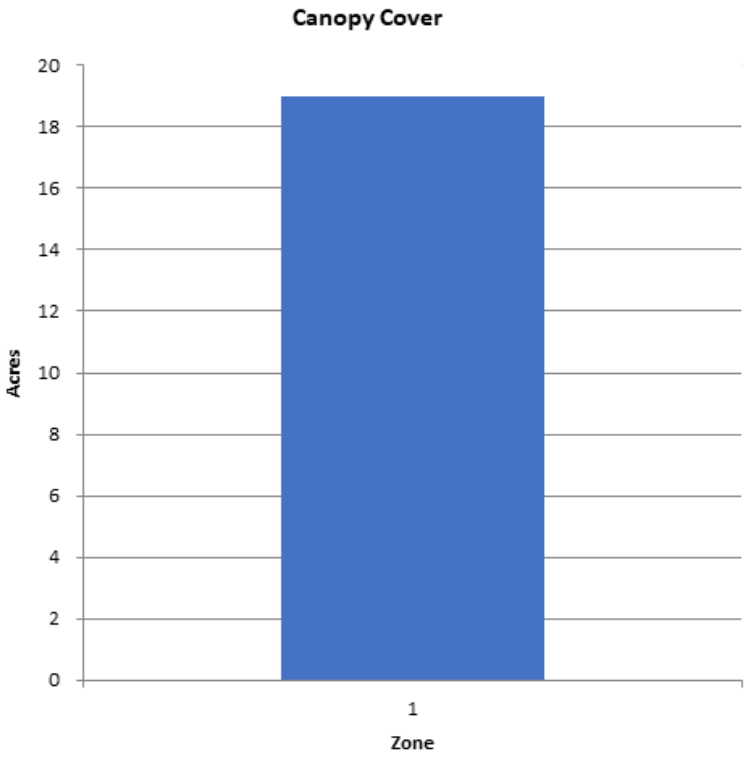


Figure 5: Canopy Cover in Acres

Rolfe

Canopy Cover of Public Trees (Acres)

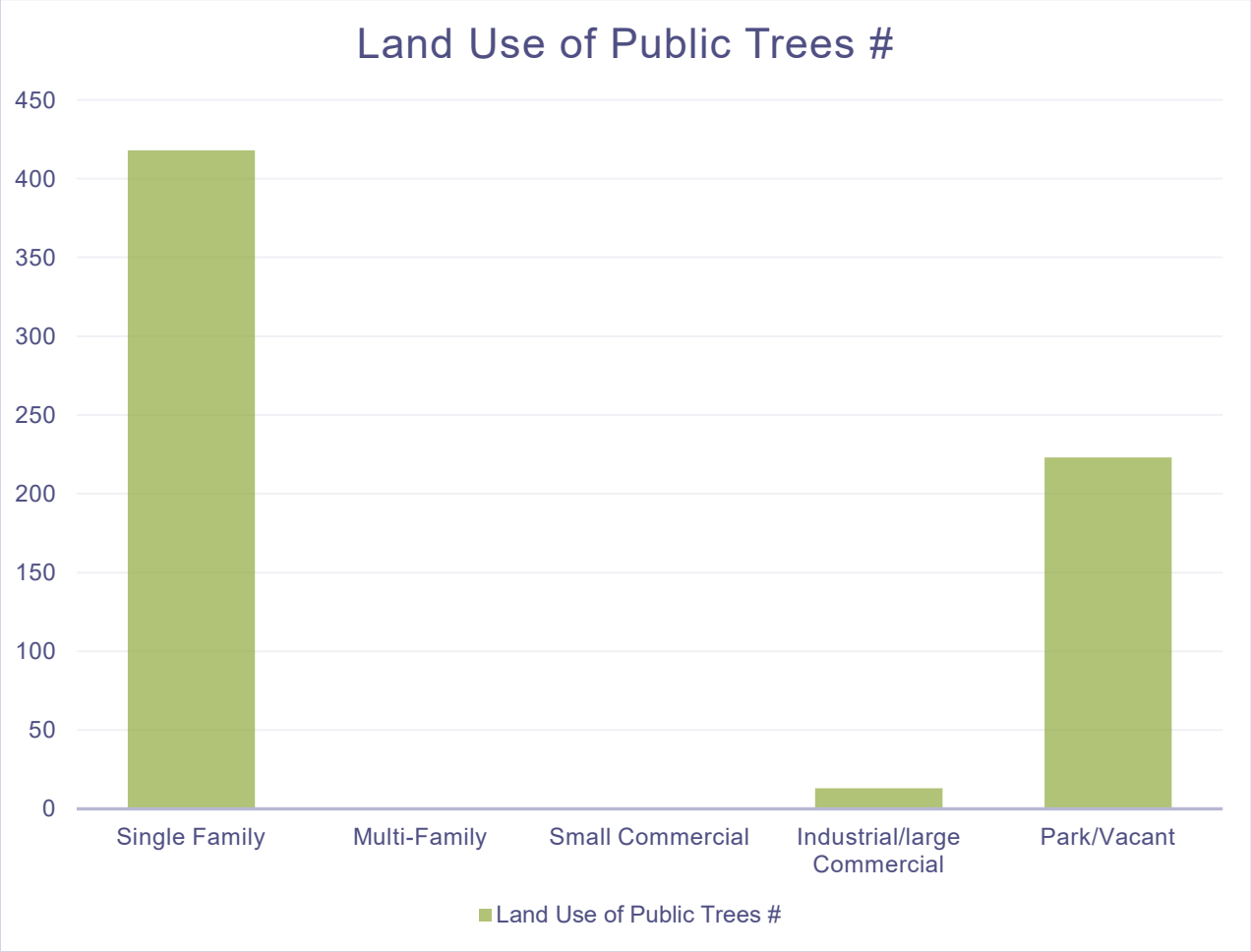
2/7/2023



Zone	Acres	% of Total Canopy Cover
1	19	100.0
Citywide total	19	100.0

	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	0	0	19	0.00	0.00

Figure 6: Land Use of City/Park Trees



APPENDIX B: ArcGIS MAPPING

Figure 1: Location of Ash Trees

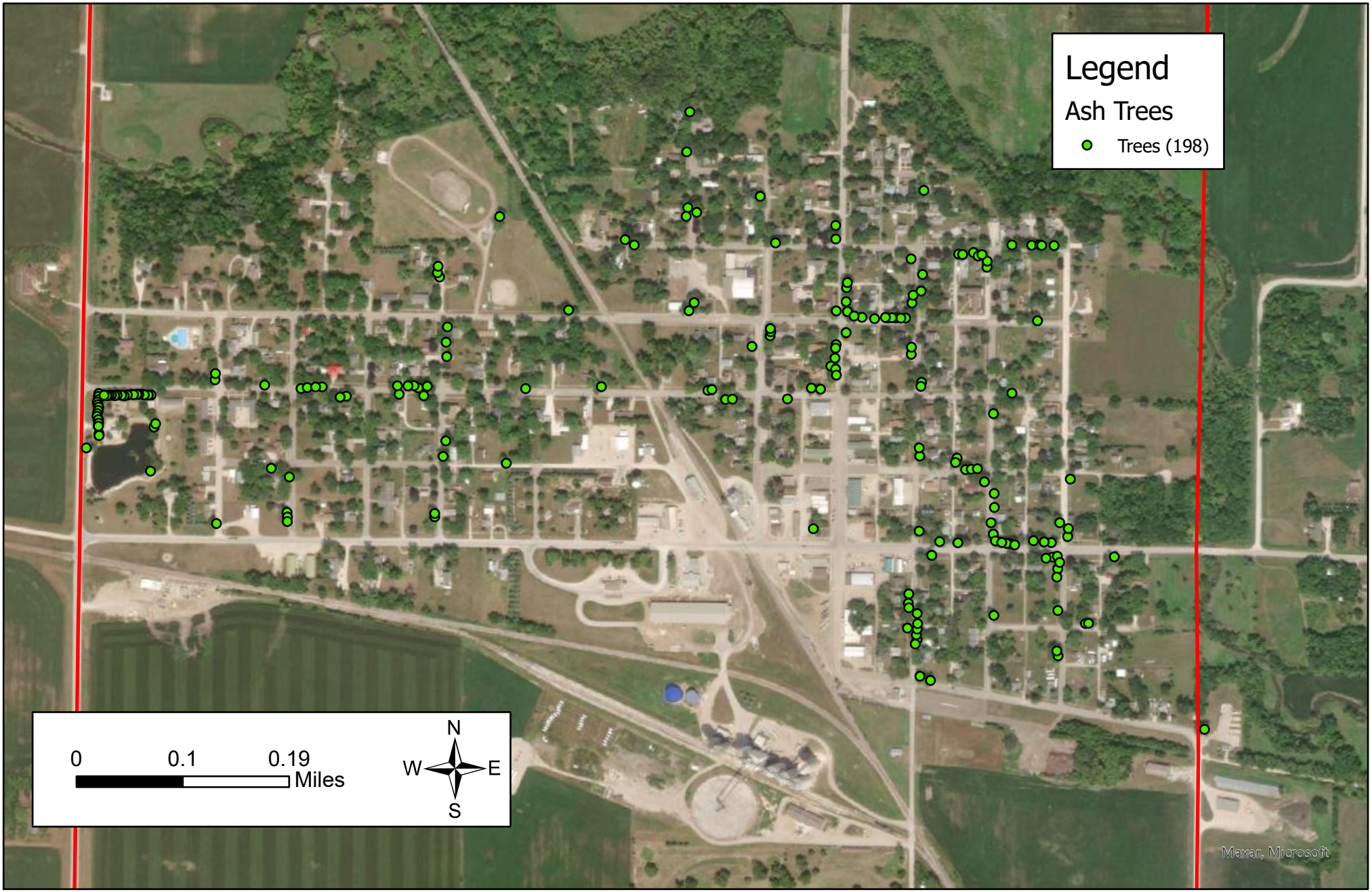
Figure 2: Location of EAB Symptoms

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

Figure 5: Maintenance Tasks

City ownership of the trees recommended for removal should be verified prior to any removal

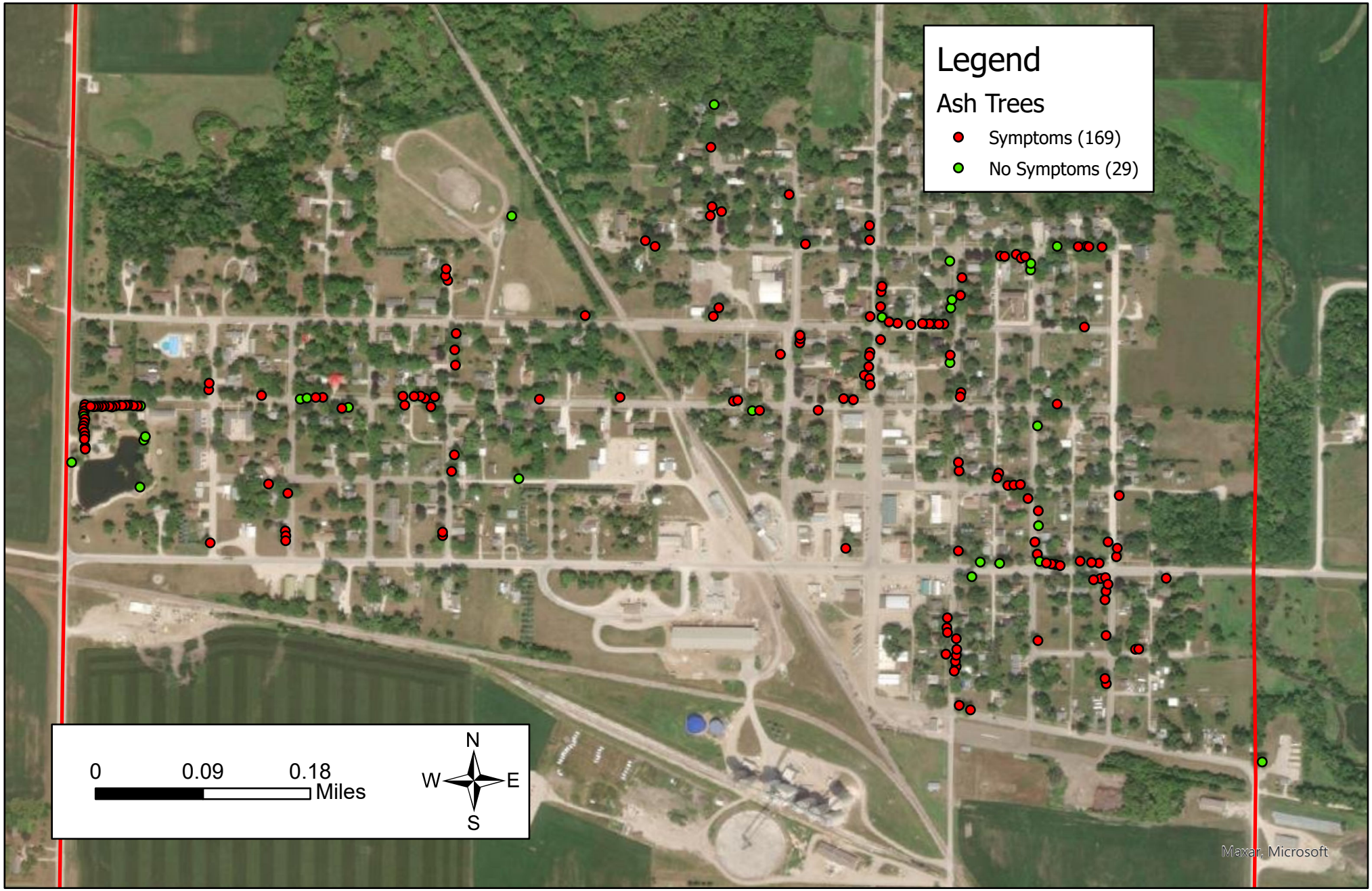


Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 1 - Ash Tree Location
Rolfe, Iowa

JEO CONSULTING GROUP INC

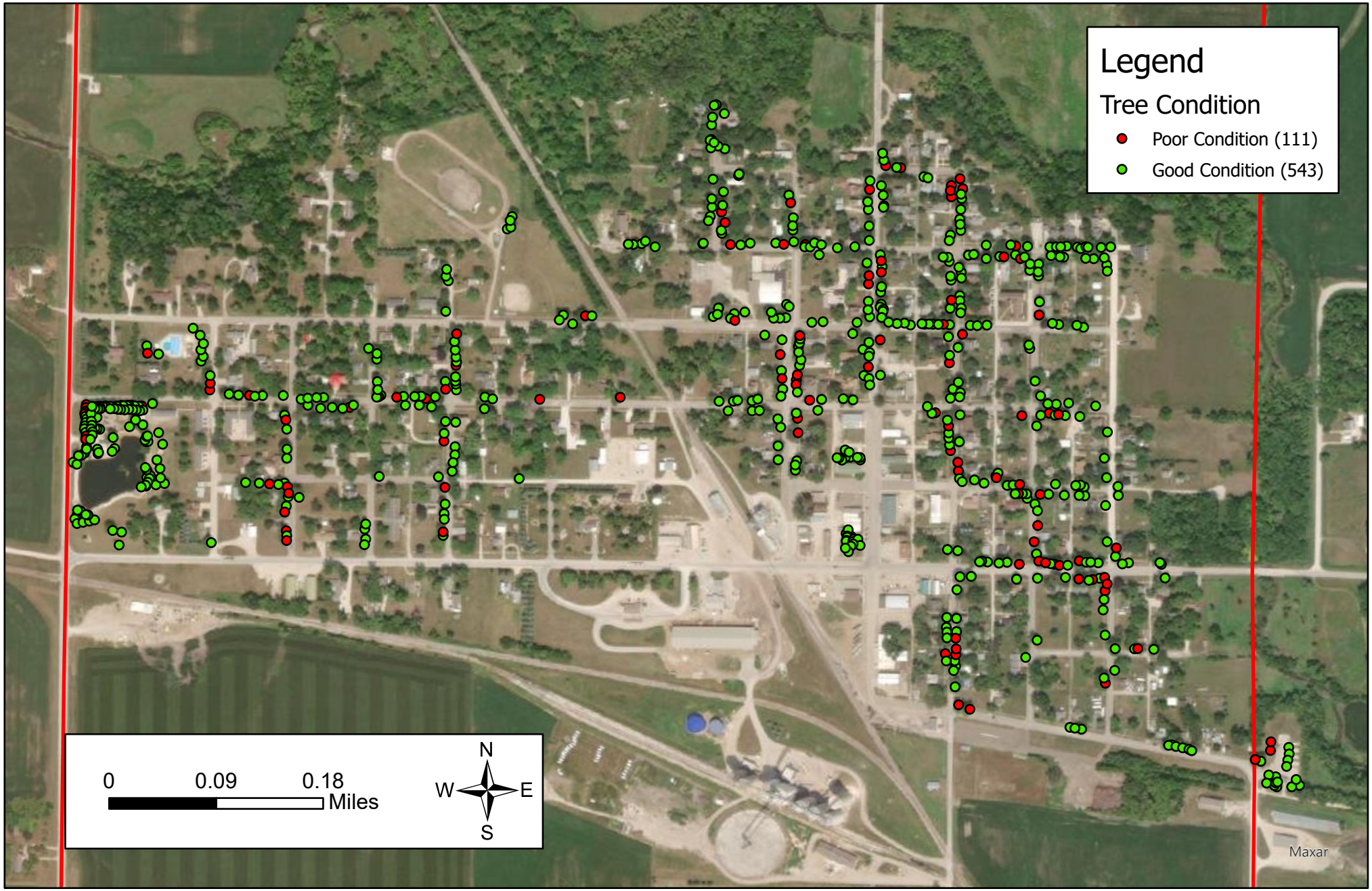


Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 2 - EAB Symptoms
Rolfe, Iowa

JEO CONSULTING GROUP INC

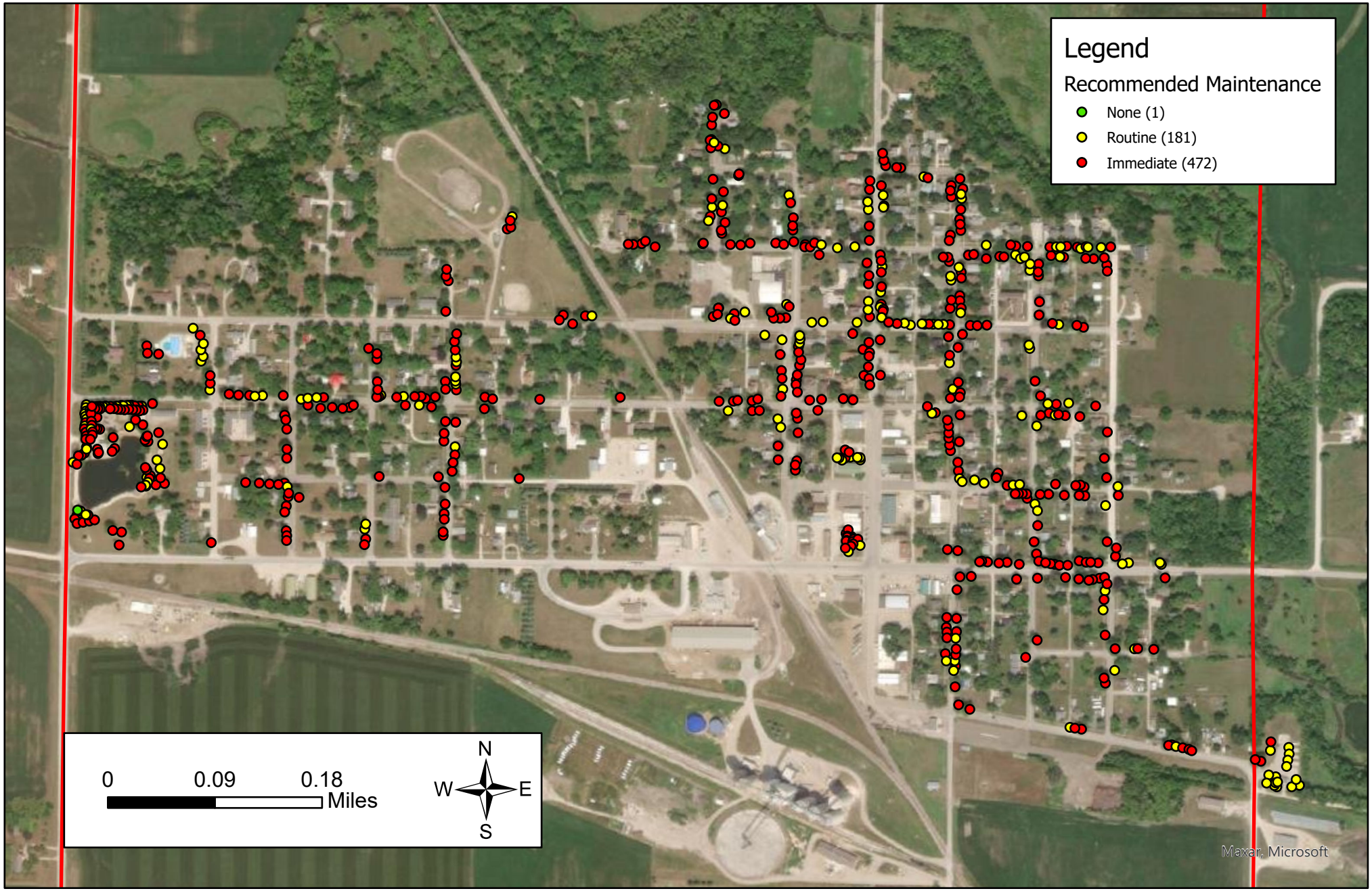


Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 3 - Poor Condition Trees
Rolfe, Iowa

JEO CONSULTING GROUP INC

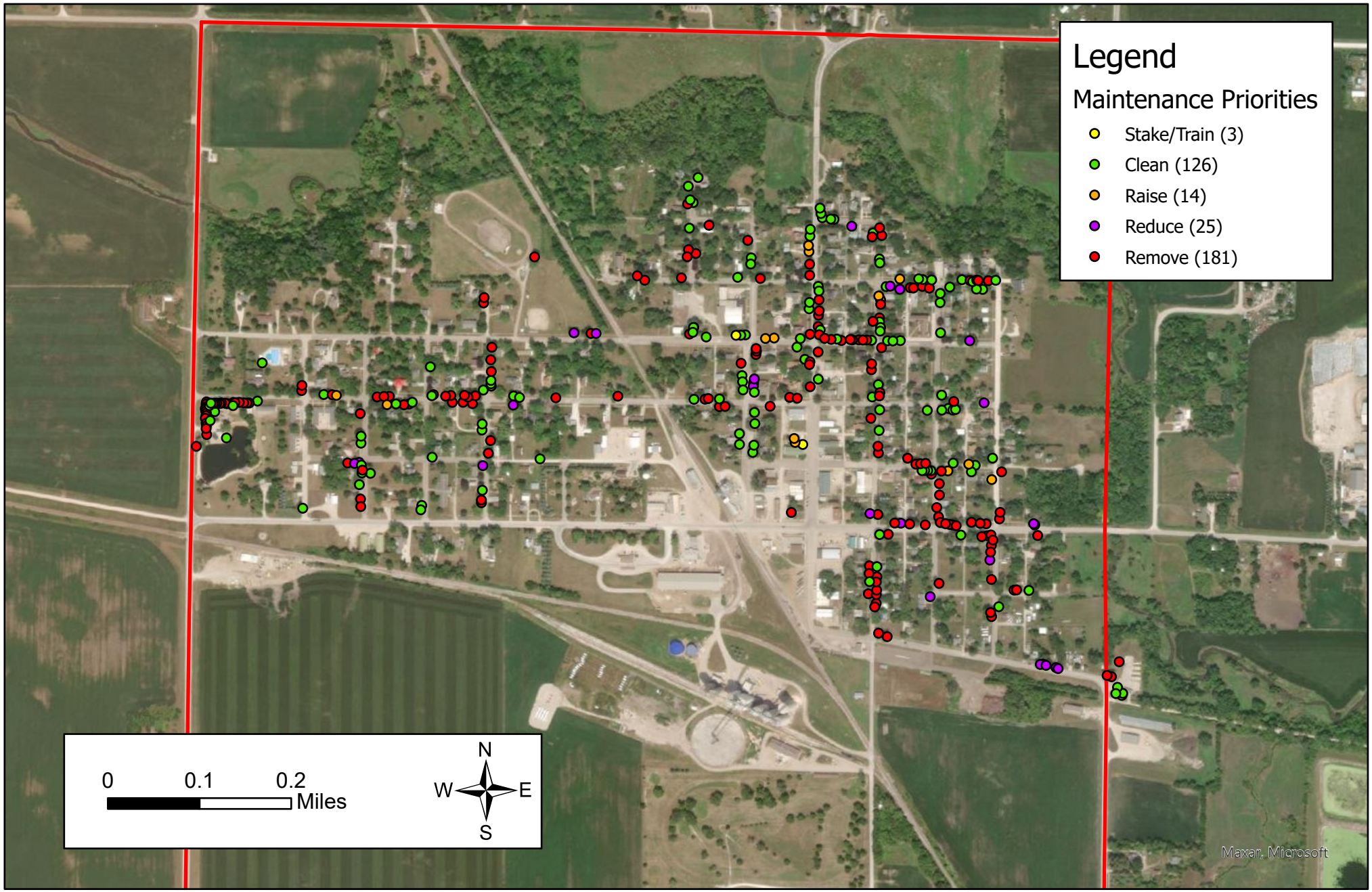


Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 4 - Recommended Maintenance
Rolfe, Iowa

JEO CONSULTING GROUP INC



Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 5 - Maintenance Priorities
Rolfe, Iowa

JEO CONSULTING GROUP INC

APPENDIX C: ROLFE TREE ORDINANCES

151.01 DEFINITIONS.
For use in this chapter, the following terms are defined:

1. "Boulevard" means the area given between the proposed or existing sidewalk and curb on a public street.
2. "Director of Public Works" means the Director of Public Works of the City or a duly appointed representative.

151.02 PERMITS FOR PLANTING TREES IN BOULEVARDS.
A permit must be secured at the office of the Director of Public Works before planting any tree in any boulevard within the corporate limits of the City. Trees are to be purchased and planted by the property owner of the land abutting the boulevard, or by a person retained by the property owner. Varieties of trees approved are those trees of the hard wood variety, having good appearance, adaptability to the climate, being long lived and generally free from injurious insects and diseases. Following are listed the approved varieties: Crabapple Linden Japanese Lilac Elm (Disease Resistant) Serviceberry Cork Oak (Red, White) London Plane Hackberry Ironwood Hornbeam (Ord. 473 – Jun. 18 Supp.)

151.03 TREE TRIMMING.
All property owners shall trim boulevard trees to a ground clearance of eight (8) feet. The City or City's agent will perform trimming of boulevard trees as deemed necessary. Public utilities may do such trimming as necessary to protect their utilities.

151.04 REGULATIONS FOR PLANTING TREES IN BOULEVARDS.

1. Trees must be of an approved variety and of nursery stock with a straight trunk.
2. No trees shall be placed so as to cause a traffic hazard, in the opinion of the Director of Public Works.
3. Trees shall be planted at least twenty-five (25) feet apart.
4. Trees shall not be planted closer than 25 feet from future or existing curb returns at intersections.
5. Trees shall be planted at least five (5) feet from driveways, visible or identifiable underground utility or light poles.
6. Except where a special permit is obtained from the Director of Public Works, no tree shall be planted on any boulevard where the distance between the nearest edge of the sidewalk and curb is less than four (4) feet.
7. All trees shall be planted equidistant from the nearest edge of the proposed or existing sidewalk and curb, except when the Director of Public Works directs otherwise.
8. The Director of Public Works may assist in staking out the location of the tree planting.
9. Trees shall be planted at least ten (10) feet from fire hydrants.

151.05 REMOVAL OF BOULEVARD TREES.

1. The City will remove trees that are determined by the Director of Public Works to be diseased, dangerous or a public nuisance.
2. Ordinary removal by the City will leave the stump in the ground, cut off at about boulevard level, then ground to below the surface of the boulevard.
3. Removal of any boulevard tree is to be approved by the Director of Public Works before starting removal.
4. Upon approval to remove a nuisance tree from the boulevard, the property owner may hire a licensed tree surgeon to remove this tree if the property owner takes full responsibility for the hauling, chipping, stump removal, replacement of the tree, and replacement of the lawn. Any income from the sale of the tree would then go to the property owner instead of the City. (Ord. 452 – Jul. 14 Supp.)

151.06 REMOVAL OF TREES ON PRIVATE PROPERTY.

1. A property owner may remove a tree that is on personal property as long as the property owner does the actual work. Otherwise, the property owner must hire a licensed tree surgeon to remove the tree. (Ord. 452 – Jul. 14 Supp.)

151.07 ABUSE OR MUTILATION OF TREES.
No person shall willfully damage, injure, mar, deface or destroy any tree on any boulevard in the City. (Ord. 452 – Jul. 14 Supp.)

151.08 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. (Ord. 452 – Jul. 14 Supp.)

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

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

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