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Villisca, IA
Urban Forestry Management Plan

SUMMER 2022

jeo 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 Villisca 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 3% of Villisca'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 704 trees inventoried.

- Villisca trees provide $132,024 of benefits annually, an average of $188 per tree
- There are over 49 species of trees
- The top three genera are: Maple 41%, Oak 20%, and Apple 7%
- 44% of trees need some type of management
- 37 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 37 trees needing removal, 19 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*
- 16 of the 21 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 6 years to remove ash. We suggest that city officials request a budget increase to $5,000 annually and apply for grants to plant replacement trees.

Introduction

INTRODUCTION

This plan was developed to assist Villisca 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 Villisca, 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 Villisca 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 Villisca 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 Villisca's urban forestry goals.

| **Assist Villisca 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 704 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. Villisca's trees reduce energy-related costs by approximately $33,864 annually (Appendix A, Table 1). These savings are both in electricity (159.9 MWh) and in natural gas (22,169.8 Therms).

Annual Stormwater Benefits

Villisca's trees intercept about 1,914,923 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $51,894 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 Villisca, it is estimated that trees remove 2,112 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 $5,938 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Villisca, trees sequester about 406,590 lbs of carbon per year with an associated value of $4,781 (Appendix A, Table 5). In addition, the trees store 7,403,421 lbs of carbon, with a yearly benefit of $55,526 (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. Villisca receives $35,547 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, Villisca's trees provide $132,024 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 704 trees in Villisca provide approximately $188 annually (Appendix A, Table 7).

ENERGY	STORMWATER	AIR QUALITY	CARBON	AESTHETICS	SUMMARY
• Reduce energy cost by **$33,864**	• Intercept 1,914,923 **gallons** • Provides **$51,894** benefit	• Remove 2,112 **lbs** of pollution • Net value of **$5,938**	• Sequester 406,590 **lbs** • Value of **$4,781** • Store 7,403,421 **lbs** • Value of **$55,526**	• **$35,547** in social benefits	• **$132,024** annual benefits • Each tree provides **$188** annually

FOREST STRUCTURE

Species Distribution

Villisca has over 49 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

Maple	290	41%		Walnut	5	1%
Oak	141	20%		Willow	4	<1%
Apple	49	7%		Pine	3	<1%
Spruce	45	6%		Tree of Heaven	3	<1%
Basswood/Linden	36	5%		Cedar	2	<1%
Ash	21	3%		Cherry	2	<1%
Elm	20	3%		Buckeye	1	<1%
Hackberry	18	3%		Buckthorn	1	<1%
Birch	15	2%		Catalpa	1	<1%
Pear	12	2%		Plum	1	<1%
Locust	9	1%		Cottonwood	1	<1%
Coffee Tree	8	1%		Magnolia	1	<1%
Hickory	7	1%		Poplar	1	<1%
Sycamore	6	1%		Redbud	1	<1%

Age Class

Most of Villisca's trees (20%) 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. Villisca'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 Villisca indicate that 85% of the trees are in good health, with only 6% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 84% of Villisca's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Seven percent of the tree population's wood condition is in poor health, dead, or dying. This 7% 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
Crown Cleaning	135	19%
Crown Raising	113	16%
Tree Removal	37	5%
Crown Reduction	25	4%
Tree Staking	2	<1%

Canopy Cover

The total canopy with both private and public trees is 105 acres or 9% cover. The canopy cover included in the Villisca inventory includes approximately 19 acres (Appendix A, Figure 4). The city's canopy goal is to increase canopy by 5% in 30 years. To achieve this goal it is estimated that 10 trees need to be planted annually on public and private lands.

Land Use and Location

The majority of Villisca'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	60%
Park/Vacant/Other	37%
Industrial/Large Commercial	3%
Multifamily Residential	1%
Small Commercial	<1%

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

Villisca has 24 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance Map (Appendix B, Figure 4). We recommend starting with the large-diameter, critical concern trees first. There are 4 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 10 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 37 removals, 19 are ash trees. There are a total of 21 ash trees, and 16 of those have signs and symptoms that have been associated with EAB. In addition, there is 1 tree 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 Villisca.

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 (41%) (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 6.17.2.2 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 6.17.2 (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 6.17.2 (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 6.17.7 states "DISEASED TREES SUBJECT TO REMOVAL. Diseased, dead, dying or injured trees within the city shall be removed as follows:

> 1. Living or Standing Trees. Any living or standing elm tree or part thereof infected with Dutch Elm Disease fungus or which harbors any of the elm bark beetles, that is scolytus multstriatus (eichb.) or hylurgopinus rufipes (marsh) or trees which have been determined to harbor the Emerald Ash Borer.

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

> 3. Injured or Dying Trees. Any tree which has been injured whether by disease or physical damage to the point that the tree will die, or its limbs might fall, shall be removed."

Schedule & Budget

A   B   C
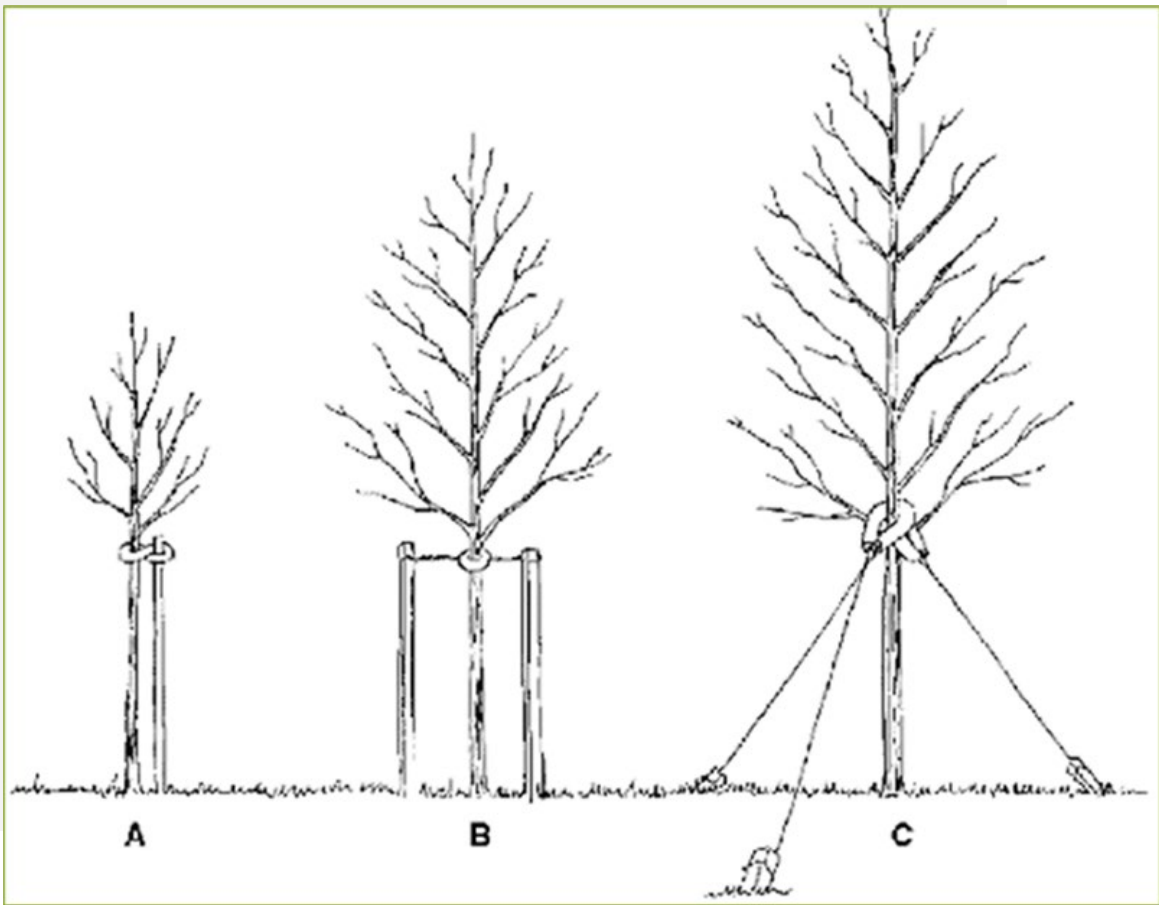
PROPOSED WORK SCHEDULE & BUDGET

Budget Allowance of $2,500/Year – (Based off Reported Yearly Tree Budget)

YEAR 1	Est. Cost
Remove 2 trees recommended for immediate removal	$1,400
Remove 1 ash tree in poor condition	$700
Plant 2 trees in open locations	$300
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$2,400**

YEAR 4	Est. Cost
Remove 1 ash tree	$700
	$
Prune 1/6 of city owned trees	$1,760
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$2,460**

YEAR 2	Est. Cost
Remove 1 tree recommended for immediate removal	$700
	$
Prune 1/6 of city owned trees	$1,760
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$2,460**

YEAR 5	Est. Cost
Remove 3 ash trees	$2,100
Plant 2 trees in open locations	$300
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$2,400**

YEAR 3	Est. Cost
Remove 1 tree recommended for immediate removal	$700
Remove 2 ash trees in poor condition	$1,400
Plant 2 trees in open locations	$300
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$2,400**

YEAR 6	Est. Cost
Remove 1 ash tree	$700
	$
Prune 1/6 of city owned trees	$1,760
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$4,860**

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 $2,500 a year.*

PROPOSED WORK SCHEDULE WITH INCREASED BUDGET

Budget Allowance of $5,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	Est. Cost
Remove 4 trees recommended for immediate removal	$2,800
Remove 1 ash trees in poor condition	$700
Plant 8 trees in open locations	$1,200
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$4,700**

YEAR 4	Est. Cost
Remove 3 ash trees	$2,100
Plant 7 trees in open locations	$1,050
Prune 1/6 of city owned trees	$1,760
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$4,910**

YEAR 2	Est. Cost
Remove 4 trees in poor condition	$2,800
Plant 2 trees in open locations	$300
Prune 1/6 of city owned trees	$1,760
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$4,560**

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

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

YEAR 6	Est. Cost
Remove 3 ash trees	$2,100
Plant 7 trees in open locations	$1,050
Prune 1/6 of city owned trees	$1,760
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$4,910**

Purposed Budget Increase

EAB could potentially kill all ash trees in Villisca within four years of its arrival. To remove all ash trees within six years, the budget would need to be $2,500 a year. If the budget were increased to $5,000 per year all ash could be removed within 3 years. Additionally, we recommend that Villisca 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). Four trees would be selected for treatment, and Villisca would still need to find $12,000 for removal. Alternatively, if there are four treatable trees, it would cost approximately $600 a year for treatment and leave $1,900 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 Villisca. We suggest considering an increased budget to plan for this.

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Appendices

APPENDIX A: i-TREE DATA

Table 1: Annual Energy Benefits

Villisca

Annual Energy Benefits of Public Trees

2/8/2023

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	46.4	3,521	6,111.6	5,989	9,511	(N/A)	20.2	28.1	66.98
Norway maple	15.4	1,170	2,213.6	2,169	3,339	(N/A)	9.8	9.9	48.39
Northern pin oak	17.8	1,349	2,632.1	2,579	3,928	(N/A)	8.1	11.6	68.92
Apple	3.1	235	489.2	479	714	(N/A)	7.0	2.1	14.58
Northern red oak	8.0	606	1,130.6	1,108	1,714	(N/A)	5.7	5.1	42.86
Sugar maple	7.8	590	1,039.4	1,019	1,609	(N/A)	5.0	4.8	45.96
Bur oak	4.6	348	633.3	621	968	(N/A)	4.8	2.9	28.48
Red maple	5.3	401	707.3	693	1,094	(N/A)	4.5	3.2	34.20
Blue spruce	2.7	202	377.3	370	572	(N/A)	4.3	1.7	19.07
American basswood	7.7	588	1,117.9	1,096	1,683	(N/A)	3.8	5.0	62.34
Northern hackberry	6.2	474	890.0	872	1,346	(N/A)	2.6	4.0	74.78
Green ash	5.1	386	709.9	696	1,081	(N/A)	2.3	3.2	67.59
Callery pear	1.6	122	239.9	235	357	(N/A)	1.7	1.1	29.78
Black maple	2.7	207	372.4	365	572	(N/A)	1.6	1.7	51.99
Honeylocust	2.5	193	335.5	329	522	(N/A)	1.3	1.5	57.97
American elm	0.3	25	47.5	47	72	(N/A)	1.3	0.2	7.98
Littleleaf linden	0.1	5	10.7	11	16	(N/A)	1.3	0.0	1.74
River birch	2.0	149	294.7	289	438	(N/A)	1.1	1.3	54.69
Kentucky coffeetree	1.7	130	240.5	236	366	(N/A)	1.1	1.1	45.71
Spruce	0.7	53	102.0	100	153	(N/A)	1.0	0.5	21.92
White oak	2.0	149	261.9	257	406	(N/A)	1.0	1.2	57.97
Hickory	1.9	146	264.7	259	405	(N/A)	1.0	1.2	57.86
Elm	1.2	89	166.6	163	252	(N/A)	0.9	0.7	42.03
American sycamore	2.1	161	296.6	291	452	(N/A)	0.9	1.3	75.35
Paper birch	1.3	97	177.5	174	271	(N/A)	0.9	0.8	45.18
White ash	2.3	176	287.7	282	458	(N/A)	0.7	1.4	91.55
Black spruce	0.5	35	65.3	64	99	(N/A)	0.7	0.3	19.71
Black walnut	1.3	95	168.3	165	260	(N/A)	0.7	0.8	52.08
Siberian elm	1.7	133	231.5	227	359	(N/A)	0.7	1.1	71.90
Willow	0.9	69	135.2	132	201	(N/A)	0.6	0.6	50.37
Tree of Heaven	0.0	1	2.4	2	3	(N/A)	0.4	0.0	1.10
Norway spruce	0.5	39	68.9	68	107	(N/A)	0.4	0.3	35.61
Oak	0.4	32	57.4	56	88	(N/A)	0.3	0.3	43.92
Black cherry	0.0	1	1.2	1	2	(N/A)	0.3	0.0	0.87
Eastern red cedar	0.1	7	15.9	16	23	(N/A)	0.3	0.1	11.47
Catalpa	0.0	2	3.7	4	6	(N/A)	0.1	0.0	5.82
Eastern redbud	0.0	0	0.6	1	1	(N/A)	0.1	0.0	0.87
Ohio buckeye	0.2	18	29.5	29	47	(N/A)	0.1	0.1	46.78
Buckthorn	0.2	15	31.6	31	46	(N/A)	0.1	0.1	46.14
Maple	0.0	3	5.2	5	8	(N/A)	0.1	0.0	7.85
Tulip tree	0.0	0	0.5	0	1	(N/A)	0.1	0.0	0.66
Birch	0.0	0	0.8	1	1	(N/A)	0.1	0.0	1.10
Scotch pine	0.1	11	19.7	19	30	(N/A)	0.1	0.1	30.47
Southern magnolia	0.3	20	36.3	36	56	(N/A)	0.1	0.2	55.99
Eastern white pine	0.1	11	19.7	19	30	(N/A)	0.1	0.1	30.47
Pin oak	0.4	33	56.2	55	88	(N/A)	0.1	0.3	87.97
Austrian pine	0.1	10	15.2	15	25	(N/A)	0.1	0.1	24.51
Eastern cottonwood	0.4	29	53.7	53	82	(N/A)	0.1	0.2	82.02
Cherry plum	0.0	0	0.6	1	1	(N/A)	0.1	0.0	0.87
Total	159.9	12,138	22,169.8	21,726	33,864	(N/A)	100.0	100.0	48.10

Table 2: Annual Stormwater Benefits

Villisca

Annual Stormwater Benefits of Public Trees

2/8/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	698,957	18,942	(N/A)	20.2	36.5	133.39
Norway maple	141,276	3,829	(N/A)	9.8	7.4	55.49
Northern pin oak	203,002	5,501	(N/A)	8.1	10.6	96.52
Apple	12,807	347	(N/A)	7.0	0.7	7.08
Northern red oak	90,517	2,453	(N/A)	5.7	4.7	61.33
Sugar maple	74,616	2,022	(N/A)	5.0	3.9	57.77
Bur oak	44,057	1,194	(N/A)	4.8	2.3	35.12
Red maple	41,778	1,132	(N/A)	4.5	2.2	35.38
Blue spruce	35,811	970	(N/A)	4.3	1.9	32.35
American basswood	104,029	2,819	(N/A)	3.8	5.4	104.41
Northern hackberry	64,913	1,759	(N/A)	2.6	3.4	97.73
Green ash	62,704	1,699	(N/A)	2.3	3.3	106.21
Callery pear	13,960	378	(N/A)	1.7	0.7	31.53
Black maple	24,527	665	(N/A)	1.6	1.3	60.43
Honeylocust	26,914	729	(N/A)	1.3	1.4	81.04
American elm	1,746	47	(N/A)	1.3	0.1	5.26
Littleleaf linden	235	6	(N/A)	1.3	0.0	0.71
River birch	19,903	539	(N/A)	1.1	1.0	67.42
Kentucky coffeetree	16,397	444	(N/A)	1.1	0.9	55.54
Spruce	12,925	350	(N/A)	1.0	0.7	50.04
White oak	23,198	629	(N/A)	1.0	1.2	89.81
Hickory	24,902	675	(N/A)	1.0	1.3	96.40
Elm	13,258	359	(N/A)	0.9	0.7	59.88
American sycamore	28,897	783	(N/A)	0.9	1.5	130.52
Paper birch	11,806	320	(N/A)	0.9	0.6	53.32
White ash	31,663	858	(N/A)	0.7	1.7	171.62
Black spruce	6,123	166	(N/A)	0.7	0.3	33.19
Black walnut	10,703	290	(N/A)	0.7	0.6	58.01
Siberian elm	18,560	503	(N/A)	0.7	1.0	100.59
Willow	10,020	272	(N/A)	0.6	0.5	67.89
Tree of Heaven	37	1	(N/A)	0.4	0.0	0.33
Norway spruce	12,178	330	(N/A)	0.4	0.6	110.01
Oak	5,662	153	(N/A)	0.3	0.3	76.72
Black cherry	15	0	(N/A)	0.3	0.0	0.20
Eastern red cedar	1,318	36	(N/A)	0.3	0.1	17.86
Catalpa	172	5	(N/A)	0.1	0.0	4.65
Eastern redbud	7	0	(N/A)	0.1	0.0	0.20
Ohio buckeye	1,409	38	(N/A)	0.1	0.1	38.19
Buckthorn	1,174	32	(N/A)	0.1	0.1	31.82
Maple	137	4	(N/A)	0.1	0.0	3.72
Tulip tree	18	0	(N/A)	0.1	0.0	0.48
Birch	12	0	(N/A)	0.1	0.0	0.33
Scotch pine	2,969	80	(N/A)	0.1	0.2	80.46
Southern magnolia	3,187	86	(N/A)	0.1	0.2	86.37
Eastern white pine	2,969	80	(N/A)	0.1	0.2	80.46
Pin oak	6,412	174	(N/A)	0.1	0.3	173.76
Austrian pine	1,544	42	(N/A)	0.1	0.1	41.85
Eastern cottonwood	5,491	149	(N/A)	0.1	0.3	148.79
Cherry plum	7	0	(N/A)	0.1	0.0	0.20

Annual Stormwater Benefits of Public Trees

2/8/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Citywide total	1,914,923	51,894	(N/A)	100.0	100.0	73.71

Table 3: Annual Air Quality Benefits

Villisca

Annual Air Quality Benefits of Public Trees

2/8/2023

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								
Silver maple	125.4	21.3	61.1	5.6	675	218.7	32.0	30.6	209.8	1,368	-65.4	-245	639.1	1,798	(N/A)	20.2	12.66
Norway maple	28.6	4.9	14.1	1.3	154	74.6	10.8	10.3	69.9	463	-6.7	-25	207.8	592	(N/A)	9.8	8.58
Northern pin oak	45.9	7.9	22.0	2.0	246	86.8	12.5	11.9	80.6	536	-10.4	-39	259.2	743	(N/A)	8.1	13.04
Apple	3.5	0.6	1.7	0.2	19	15.4	2.2	2.1	14.0	94	0.0	0	39.6	113	(N/A)	7.0	2.31
Northern red oak	19.8	3.4	9.5	0.9	106	38.4	5.6	5.3	36.2	239	-28.6	-107	90.4	238	(N/A)	5.7	5.94
Sugar maple	9.1	1.6	4.7	0.4	50	36.9	5.4	5.1	35.2	230	-7.3	-27	91.1	253	(N/A)	5.0	7.22
Bur oak	4.7	0.7	2.4	0.2	25	21.9	3.2	3.0	20.8	136	0.0	0	56.9	162	(N/A)	4.8	4.76
Red maple	9.5	1.6	4.5	0.4	51	25.1	3.7	3.5	23.9	156	-3.2	-12	69.0	195	(N/A)	4.5	6.10
Blue spruce	4.7	0.9	4.0	0.6	31	12.8	1.9	1.8	12.1	80	-12.6	-47	26.0	63	(N/A)	4.3	2.11
American basswood	15.7	2.7	7.5	0.7	84	37.5	5.4	5.2	35.1	233	-12.9	-49	96.9	268	(N/A)	3.8	9.93
Northern hackberry	10.6	1.8	5.3	0.5	57	30.2	4.4	4.2	28.3	187	0.0	0	85.2	245	(N/A)	2.6	13.59
Green ash	8.2	1.3	3.8	0.4	44	24.4	3.5	3.4	23.0	152	0.0	0	68.1	195	(N/A)	2.3	12.20
Callery pear	2.7	0.5	1.3	0.1	15	7.9	1.1	1.1	7.3	49	-0.6	-2	21.3	61	(N/A)	1.7	5.06
Black maple	6.0	1.0	2.8	0.3	32	13.0	1.9	1.8	12.3	81	-2.0	-8	37.2	106	(N/A)	1.6	9.60
Honeylocust	5.2	0.9	2.4	0.2	27	12.0	1.8	1.7	11.5	75	-4.0	-15	31.6	87	(N/A)	1.3	9.72
American elm	0.1	0.0	0.1	0.0	0	1.6	0.2	0.2	1.5	10	0.0	0	3.7	10	(N/A)	1.3	1.15
Littleleaf linden	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.7	2	(N/A)	1.3	0.23
River birch	4.2	0.7	2.0	0.2	23	9.6	1.4	1.3	8.9	59	-1.0	-4	27.3	78	(N/A)	1.1	9.77
Kentucky coffeetree	1.7	0.3	0.9	0.1	9	8.2	1.2	1.1	7.8	51	0.0	0	21.2	60	(N/A)	1.1	7.54
Spruce	1.5	0.3	1.2	0.2	10	3.4	0.5	0.5	3.2	21	-6.3	-24	4.4	7	(N/A)	1.0	1.03
White oak	3.1	0.5	1.5	0.1	16	9.3	1.4	1.3	8.9	58	0.0	0	26.1	75	(N/A)	1.0	10.66
Hickory	3.9	0.6	1.8	0.2	20	9.2	1.3	1.3	8.7	57	0.0	0	26.9	77	(N/A)	1.0	11.06
Elm	1.6	0.3	0.8	0.1	9	5.6	0.8	0.8	5.3	35	0.0	0	15.3	44	(N/A)	0.9	7.27
American sycamore	4.1	0.7	1.9	0.2	21	10.2	1.5	1.4	9.6	63	0.0	0	29.5	85	(N/A)	0.9	14.14
Paper birch	1.2	0.2	0.6	0.1	6	6.1	0.9	0.8	5.8	38	0.0	0	15.7	45	(N/A)	0.9	7.43
White ash	6.6	1.1	2.9	0.3	35	10.8	1.6	1.5	10.5	68	0.0	0	35.3	102	(N/A)	0.7	20.47
Black spruce	0.7	0.1	0.7	0.1	5	2.2	0.3	0.3	2.1	14	-2.1	-8	4.4	11	(N/A)	0.7	2.12
Black walnut	1.0	0.2	0.5	0.0	6	6.0	0.9	0.8	5.7	37	0.0	0	15.1	43	(N/A)	0.7	8.57
Siberian elm	3.2	0.5	1.5	0.1	17	8.3	1.2	1.2	7.9	52	0.0	0	23.9	69	(N/A)	0.7	13.74
Willow	2.2	0.4	1.1	0.1	12	4.4	0.6	0.6	4.1	27	-0.5	-2	13.1	37	(N/A)	0.6	9.36
Tree of Heaven	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	0.0	0	0.1	0	(N/A)	0.4	0.14
Norway spruce	1.5	0.3	1.2	0.2	10	2.4	0.4	0.3	2.3	15	-7.1	-27	1.5	-2	(N/A)	0.4	-0.57
Oak	0.8	0.1	0.4	0.0	4	2.0	0.3	0.3	1.9	12	0.0	0	5.8	17	(N/A)	0.3	8.29
Black cherry	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0	(N/A)	0.3	0.11
Eastern red cedar	0.1	0.0	0.1	0.0	1	0.5	0.1	0.1	0.4	3	-0.7	-3	0.6	1	(N/A)	0.3	0.62

Villisca

Annual Air Quality Benefits of Public Trees

2/8/2023

Species	Deposition (lb) O$_3$	NO$_2$	PM$_{10}$	SO$_2$	Total Depos. ($)	Avoided (lb) NO$_2$	PM$_{10}$	VOC	SO$_2$	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total Standard ($) Error	% of Total Trees	Avg. $/tree
Catalpa	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.1	0.87
Eastern redbud	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)	0.1	0.11
Ohio buckeye	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8 (N/A)	0.1	7.92
Buckthorn	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8 (N/A)	0.1	8.35
Maple	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1 (N/A)	0.1	1.12
Tulip tree	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)	0.1	0.08
Birch	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)	0.1	0.14
Scotch pine	0.3	0.1	0.3	0.0	2	0.7	0.1	0.1	0.7	4	-1.4	-5	0.9	1 (N/A)	0.1	1.45
Southern magnolia	0.3	0.1	0.3	0.0	2	1.3	0.2	0.2	1.2	8	-0.9	-3	2.6	7 (N/A)	0.1	6.63
Eastern white pine	0.3	0.1	0.3	0.0	2	0.7	0.1	0.1	0.7	4	-1.4	-5	0.9	1 (N/A)	0.1	1.45
Pin oak	1.3	0.2	0.7	0.1	7	2.0	0.3	0.3	2.0	13	-2.4	-9	4.5	11 (N/A)	0.1	10.96
Austrian pine	0.2	0.0	0.2	0.0	1	0.6	0.1	0.1	0.6	4	-0.6	-2	1.2	3 (N/A)	0.1	2.89
Eastern cottonwood	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16 (N/A)	0.1	15.71
Cherry plum	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)	0.1	0.11
Citywide total	340.9	58.0	168.5	15.9	1,844	765.5	111.3	106.1	724.4	4,763	-178.3	-669	2,112.3	5,938 (N/A)	100.0	8.43

Table 4: Annual Carbon Stored

Villisca

Stored CO2 Benefits of Public Trees

2/8/2023

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	2,936,717	22,025	(N/A)	20.2	39.7	155.11
Norway maple	470,810	3,531	(N/A)	9.8	6.4	51.18
Northern pin oak	756,955	5,677	(N/A)	8.1	10.2	99.60
Apple	57,998	435	(N/A)	7.0	0.8	8.88
Northern red oak	445,308	3,340	(N/A)	5.7	6.0	83.50
Sugar maple	260,619	1,955	(N/A)	5.0	3.5	55.85
Bur oak	150,559	1,129	(N/A)	4.8	2.0	33.21
Red maple	105,060	788	(N/A)	4.5	1.4	24.62
Blue spruce	31,981	240	(N/A)	4.3	0.4	8.00
American basswood	599,404	4,496	(N/A)	3.8	8.1	166.50
Northern hackberry	161,487	1,211	(N/A)	2.6	2.2	67.29
Green ash	267,747	2,008	(N/A)	2.3	3.6	125.51
Callery pear	44,801	336	(N/A)	1.7	0.6	28.00
Black maple	65,067	488	(N/A)	1.6	0.9	44.36
Honeylocust	66,588	499	(N/A)	1.3	0.9	55.49
American elm	3,701	28	(N/A)	1.3	0.0	3.08
Littleleaf linden	461	3	(N/A)	1.3	0.0	0.38
River birch	68,878	517	(N/A)	1.1	0.9	64.57
Kentucky coffeetree	54,322	407	(N/A)	1.1	0.7	50.93
Spruce	15,203	114	(N/A)	1.0	0.2	16.29
White oak	103,811	779	(N/A)	1.0	1.4	111.23
Hickory	129,614	972	(N/A)	1.0	1.8	138.87
Elm	52,255	392	(N/A)	0.9	0.7	65.32
American sycamore	134,293	1,007	(N/A)	0.9	1.8	167.87
Paper birch	38,429	288	(N/A)	0.9	0.5	48.04
White ash	99,205	744	(N/A)	0.7	1.3	148.81
Black spruce	4,632	35	(N/A)	0.7	0.1	6.95
Black walnut	32,717	245	(N/A)	0.7	0.4	49.08
Siberian elm	76,608	575	(N/A)	0.7	1.0	114.91
Willow	36,522	274	(N/A)	0.6	0.5	68.48
Tree of Heaven	51	0	(N/A)	0.4	0.0	0.13
Norway spruce	18,323	137	(N/A)	0.4	0.2	45.81
Oak	26,129	196	(N/A)	0.3	0.4	97.98
Black cherry	28	0	(N/A)	0.3	0.0	0.10
Eastern red cedar	554	4	(N/A)	0.3	0.0	2.08
Catalpa	185	1	(N/A)	0.1	0.0	1.39
Eastern redbud	14	0	(N/A)	0.1	0.0	0.10
Ohio buckeye	3,624	27	(N/A)	0.1	0.0	27.18
Buckthorn	6,743	51	(N/A)	0.1	0.1	50.57
Maple	218	2	(N/A)	0.1	0.0	1.64
Tulip tree	12	0	(N/A)	0.1	0.0	0.09
Birch	17	0	(N/A)	0.1	0.0	0.13
Scotch pine	3,343	25	(N/A)	0.1	0.0	25.07
Southern magnolia	4,397	33	(N/A)	0.1	0.1	32.98
Eastern white pine	3,343	25	(N/A)	0.1	0.0	25.07
Pin oak	37,616	282	(N/A)	0.1	0.5	282.12
Austrian pine	1,118	8	(N/A)	0.1	0.0	8.39
Eastern cottonwood	25,943	195	(N/A)	0.1	0.4	194.57
Cherry plum	14	0	(N/A)	0.1	0.0	0.10
Citywide total	7,403,421	55,526	(N/A)	100.0	100.0	78.87

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

Villisca

Annual CO_2 Benefits of Public Trees

2/8/2023

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
Silver maple	206,112	1,546	-14,099	-530	-110	77,819	584	269,303	2,020 (N/A)	20.2	42.2	14.22
Norway maple	22,495	169	-2,261	-159	-18	25,852	194	45,927	344 (N/A)	9.8	7.2	4.99
Northern pin oak	12,740	96	-3,633	-213	-29	29,812	224	38,707	290 (N/A)	8.1	6.1	5.09
Apple	4,979	37	-279	-47	-2	5,192	39	9,845	74 (N/A)	7.0	1.5	1.51
Northern red oak	4,956	37	-2,138	-109	-17	13,401	101	16,110	121 (N/A)	5.7	2.5	3.02
Sugar maple	15,668	118	-1,254	-82	-10	13,042	98	27,375	205 (N/A)	5.0	4.3	5.87
Bur oak	10,851	81	-723	-49	-6	7,686	58	17,765	133 (N/A)	4.8	2.8	3.92
Red maple	11,117	83	-504	-50	-4	8,865	66	19,428	146 (N/A)	4.5	3.0	4.55
Blue spruce	2,083	16	-154	-48	-2	4,475	34	6,357	48 (N/A)	4.3	1.0	1.59
American basswood	32,055	240	-2,877	-96	-22	12,987	97	42,069	316 (N/A)	3.8	6.6	11.69
Northern hackberry	8,336	63	-776	-60	-6	10,474	79	17,974	135 (N/A)	2.6	2.8	7.49
Green ash	12,525	94	-1,285	-55	-10	8,524	64	19,709	148 (N/A)	2.3	3.1	9.24
Callery pear	2,604	20	-216	-18	-2	2,702	20	5,072	38 (N/A)	1.7	0.8	3.17
Black maple	4,990	37	-312	-25	-3	4,572	34	9,224	69 (N/A)	1.6	1.4	6.29
Honeylocust	7,051	53	-320	-20	-3	4,263	32	10,973	82 (N/A)	1.3	1.7	9.14
American elm	480	4	-18	-6	0	558	4	1,014	8 (N/A)	1.3	0.2	0.85
Littleleaf linden	246	2	-4	-3	0	113	1	352	3 (N/A)	1.3	0.1	0.29
River birch	2,968	22	-331	-21	-3	3,288	25	5,904	44 (N/A)	1.1	0.9	5.53
Kentucky coffeetree	4,152	31	-261	-18	-2	2,874	22	6,748	51 (N/A)	1.1	1.1	6.33
Spruce	841	6	-73	-14	-1	1,181	9	1,936	15 (N/A)	1.0	0.3	2.07
White oak	4,243	32	-498	-21	-4	3,296	25	7,020	53 (N/A)	1.0	1.1	7.52
Hickory	4,157	31	-622	-22	-5	3,217	24	6,730	50 (N/A)	1.0	1.1	7.21
Elm	2,896	22	-251	-13	-2	1,966	15	4,598	34 (N/A)	0.9	0.7	5.75
American sycamore	5,055	38	-645	-23	-5	3,567	27	7,953	60 (N/A)	0.9	1.2	9.94
Paper birch	3,039	23	-184	-13	-1	2,145	16	4,987	37 (N/A)	0.9	0.8	6.23
White ash	5,868	44	-476	-20	-4	3,885	29	9,257	69 (N/A)	0.7	1.5	13.89
Black spruce	354	3	-22	-8	0	764	6	1,087	8 (N/A)	0.7	0.2	1.63
Black walnut	2,870	22	-157	-12	-1	2,110	16	4,811	36 (N/A)	0.7	0.8	7.22
Siberian elm	3,301	25	-368	-18	-3	2,931	22	5,846	44 (N/A)	0.7	0.9	8.77
Willow	845	6	-175	-11	-1	1,524	11	2,184	16 (N/A)	0.6	0.3	4.09
Tree of Heaven	16	0	0	-1	0	22	0	37	0 (N/A)	0.4	0.0	0.09
Norway spruce	443	3	-88	-11	-1	868	7	1,212	9 (N/A)	0.4	0.2	3.03

1

Annual CO$_2$ Benefits of Public Trees

2/8/2023

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
Oak	1,034	8	-125	-5	-1	699	5	1,602	12 (N/A)	0.3	0.3	6.01
Black cherry	17	0	0	0	0	11	0	28	0 (N/A)	0.3	0.0	0.10
Eastern red cedar	80	1	-3	-2	0	164	1	239	2 (N/A)	0.3	0.0	0.89
Catalpa	74	1	-1	-1	0	49	0	121	1 (N/A)	0.1	0.0	0.91
Eastern redbud	9	0	0	0	0	6	0	14	0 (N/A)	0.1	0.0	0.10
Ohio buckeye	386	3	-17	-2	0	395	3	762	6 (N/A)	0.1	0.1	5.71
Buckthorn	0	0	-32	-4	0	335	3	299	2 (N/A)	0.1	0.0	2.24
Maple	39	0	-1	-1	0	60	0	97	1 (N/A)	0.1	0.0	0.73
Tulip tree	3	0	0	0	0	4	0	7	0 (N/A)	0.1	0.0	0.05
Birch	5	0	0	0	0	7	0	12	0 (N/A)	0.1	0.0	0.09
Scotch pine	187	1	-16	-3	0	246	2	415	3 (N/A)	0.1	0.1	3.11
Southern magnolia	260	2	-21	-3	0	451	3	687	5 (N/A)	0.1	0.1	5.15
Eastern white pine	187	1	-16	-3	0	246	2	415	3 (N/A)	0.1	0.1	3.11
Pin oak	2,912	22	-181	-5	-1	728	5	3,454	26 (N/A)	0.1	0.5	25.90
Austrian pine	91	1	-5	-2	0	213	2	296	2 (N/A)	0.1	0.0	2.22
Eastern cottonwood	960	7	-125	-4	-1	650	5	1,481	11 (N/A)	0.1	0.2	11.11
Cherry plum	9	0	0	0	0	6	0	14	0 (N/A)	0.1	0.0	0.10
Citywide total	406,590	3,049	-35,549	-1,829	-280	268,243	2,012	637,456	4,781 (N/A)	100.0	100.0	6.79

Table 6: Annual Social and Aesthetic Benefits

Villisca

Annual Aesthetic/Other Benefits of Public Trees

2/8/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	15,605	(N/A)	20.2	43.9	109.89
Norway maple	2,154	(N/A)	9.8	6.1	31.22
Northern pin oak	1,111	(N/A)	8.1	3.1	19.49
Apple	279	(N/A)	7.0	0.8	5.70
Northern red oak	358	(N/A)	5.7	1.0	8.94
Sugar maple	1,705	(N/A)	5.0	4.8	48.73
Bur oak	1,042	(N/A)	4.8	2.9	30.64
Red maple	1,455	(N/A)	4.5	4.1	45.46
Blue spruce	599	(N/A)	4.3	1.7	19.98
American basswood	2,123	(N/A)	3.8	6.0	78.62
Northern hackberry	1,058	(N/A)	2.6	3.0	58.80
Green ash	966	(N/A)	2.3	2.7	60.36
Callery pear	271	(N/A)	1.7	0.8	22.59
Black maple	628	(N/A)	1.6	1.8	57.07
Honeylocust	1,698	(N/A)	1.3	4.8	188.64
American elm	89	(N/A)	1.3	0.3	9.90
Littleleaf linden	40	(N/A)	1.3	0.1	4.47
River birch	276	(N/A)	1.1	0.8	34.50
Kentucky coffeetree	376	(N/A)	1.1	1.1	47.00
Spruce	182	(N/A)	1.0	0.5	26.01
White oak	352	(N/A)	1.0	1.0	50.33
Hickory	321	(N/A)	1.0	0.9	45.92
Elm	252	(N/A)	0.9	0.7	42.04
American sycamore	371	(N/A)	0.9	1.0	61.86
Paper birch	284	(N/A)	0.9	0.8	47.32
White ash	564	(N/A)	0.7	1.6	112.73
Black spruce	108	(N/A)	0.7	0.3	21.69
Black walnut	265	(N/A)	0.7	0.7	52.95
Siberian elm	228	(N/A)	0.7	0.6	45.64
Willow	77	(N/A)	0.6	0.2	19.31
Tree of Heaven	8	(N/A)	0.4	0.0	2.74
Norway spruce	73	(N/A)	0.4	0.2	24.45
Oak	81	(N/A)	0.3	0.2	40.67
Black cherry	0	(N/A)	0.3	0.0	0.03
Eastern red cedar	43	(N/A)	0.3	0.1	21.34
Catalpa	15	(N/A)	0.1	0.0	14.73
Eastern redbud	0	(N/A)	0.1	0.0	0.03
Ohio buckeye	39	(N/A)	0.1	0.1	39.16
Buckthorn	0	(N/A)	0.1	0.0	0.00
Maple	7	(N/A)	0.1	0.0	7.28
Tulip tree	5	(N/A)	0.1	0.0	5.26
Birch	3	(N/A)	0.1	0.0	2.74
Scotch pine	47	(N/A)	0.1	0.1	47.08
Southern magnolia	41	(N/A)	0.1	0.1	41.22
Eastern white pine	47	(N/A)	0.1	0.1	47.08
Pin oak	206	(N/A)	0.1	0.6	205.74
Austrian pine	25	(N/A)	0.1	0.1	25.23
Eastern cottonwood	67	(N/A)	0.1	0.2	66.60

2/8/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Cherry plum	0	(N/A)	0.1	0.0	0.03
Citywide total	35,547	(N/A)	100.0	100.0	50.49

Table 7: Summary of Benefits in Dollars

Villisca

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

2/8/2023

Benefits	Total ($)	Standard Error	$/tree	Standard Error	$/capita	Standard Error
Energy	33,864	(N/A)	48.10	(N/A)	27.05	(N/A)
CO2	4,781	(N/A)	6.79	(N/A)	3.82	(N/A)
Air Quality	5,938	(N/A)	8.43	(N/A)	4.74	(N/A)
Stormwater	51,894	(N/A)	73.71	(N/A)	41.45	(N/A)
Aesthetic/Other	35,547	(N/A)	50.49	(N/A)	28.39	(N/A)
Total Benefits	132,024	(N/A)	187.53	(N/A)	105.45	(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	132,024	(N/A)	187.53	(N/A)	105.45	(N/A)
Benefit-cost ratio	0.00	(N/A)				

Figure 1: Species Distribution

Species Distribution of Public Trees

2/8/2023
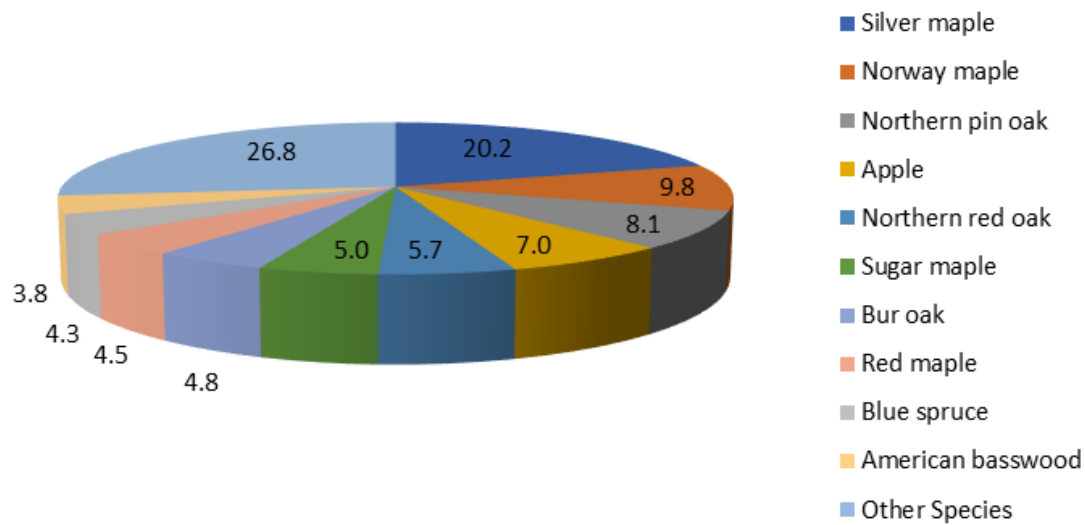
Species	Percent
Silver maple	20.2
Norway maple	9.8
Northern pin oak	8.1
Apple	7.0
Northern red oak	5.7
Sugar maple	5.0
Bur oak	4.8
Red maple	4.5
Blue spruce	4.3
American basswood	3.8
Other Species	26.8
Total	100.0

Figure 2: Relative Age Class

Villisca

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

2/8/2023
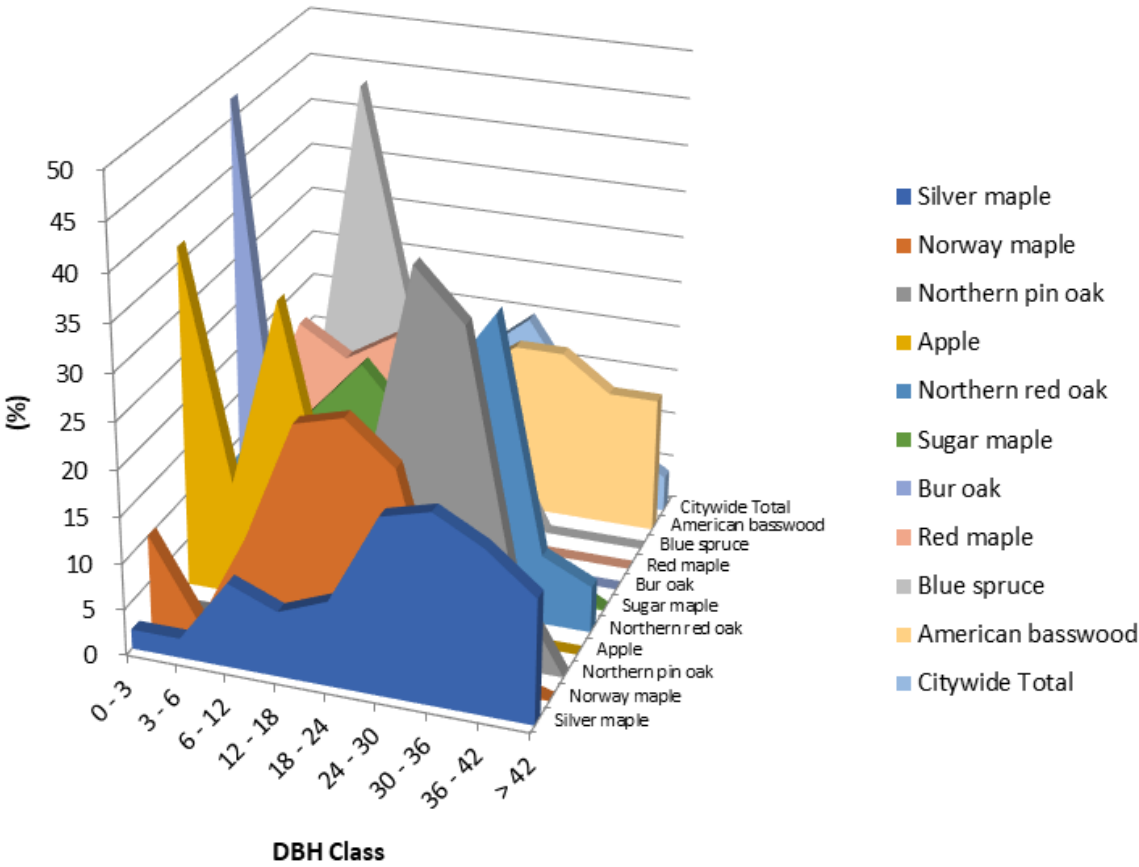
	DBH class	(in)							
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Silver maple	2.11	2.11	9.15	7.04	9.15	19.01	20.42	17.61	13.38
Norway maple	10.14	1.45	11.59	24.64	26.09	21.74	2.90	1.45	0.00
Northern pin oak	0.00	0.00	0.00	0.00	15.79	40.35	35.09	8.77	0.00
Apple	36.73	12.24	32.65	10.20	6.12	2.04	0.00	0.00	0.00
Northern red oak	7.50	15.00	2.50	0.00	5.00	25.00	32.50	7.50	5.00
Sugar maple	0.00	11.43	17.14	22.86	17.14	28.57	0.00	2.86	0.00
Bur oak	47.06	0.00	5.88	11.76	26.47	5.88	2.94	0.00	0.00
Red maple	9.38	21.88	18.75	21.88	21.88	6.25	0.00	0.00	0.00
Blue spruce	0.00	13.33	46.67	23.33	6.67	10.00	0.00	0.00	0.00
American basswood	11.11	3.70	3.70	0.00	14.81	18.52	18.52	14.81	14.81
Citywide Total	11.36	6.11	13.64	10.51	15.48	19.74	12.36	6.96	3.84

Figure 3: Foliage Condition

Foliage Condition

10%   2%   3%

85%

■Good ■Fair ■Poor ■Dead or Dying
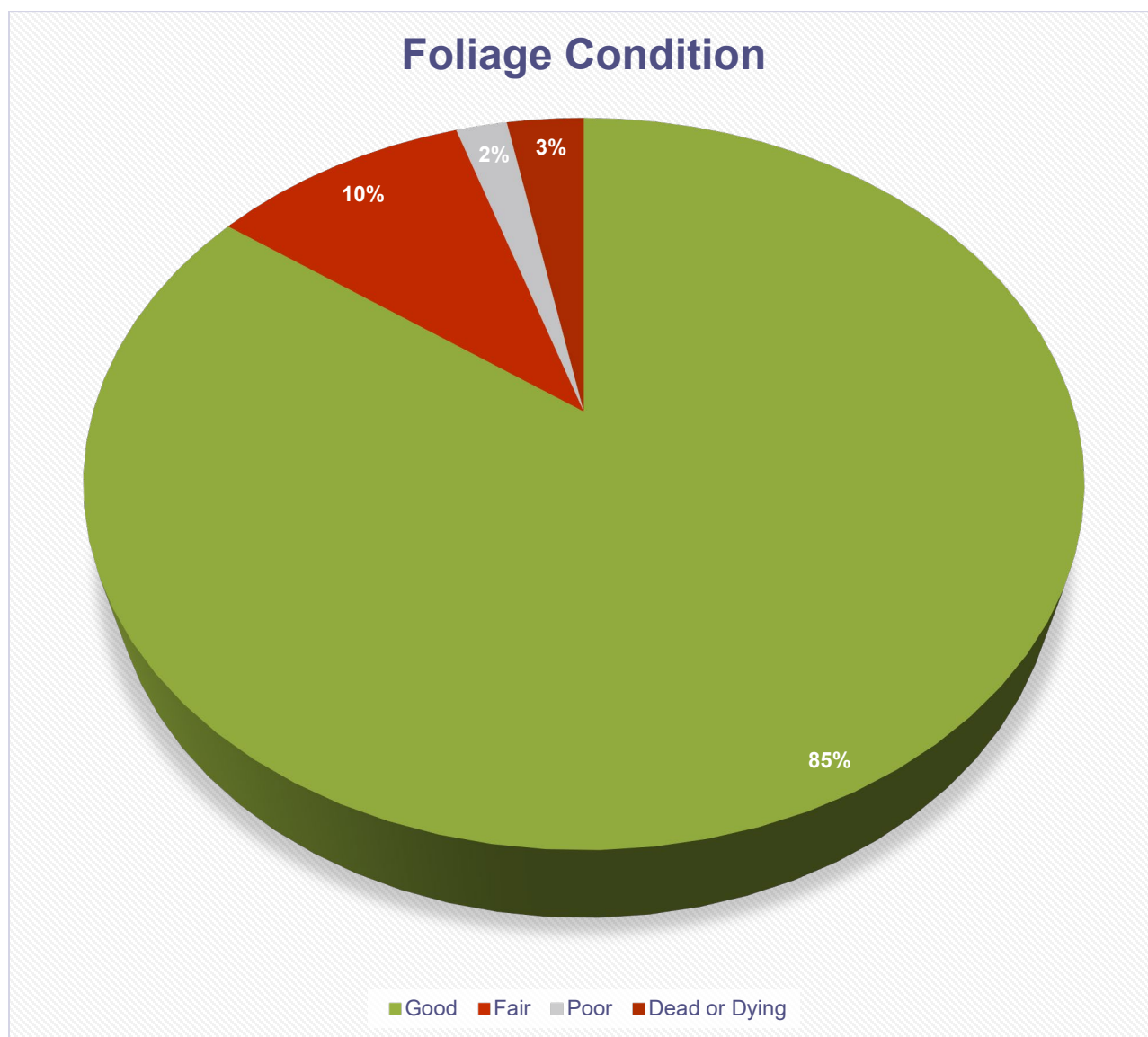
Figure 4: Wood Condition
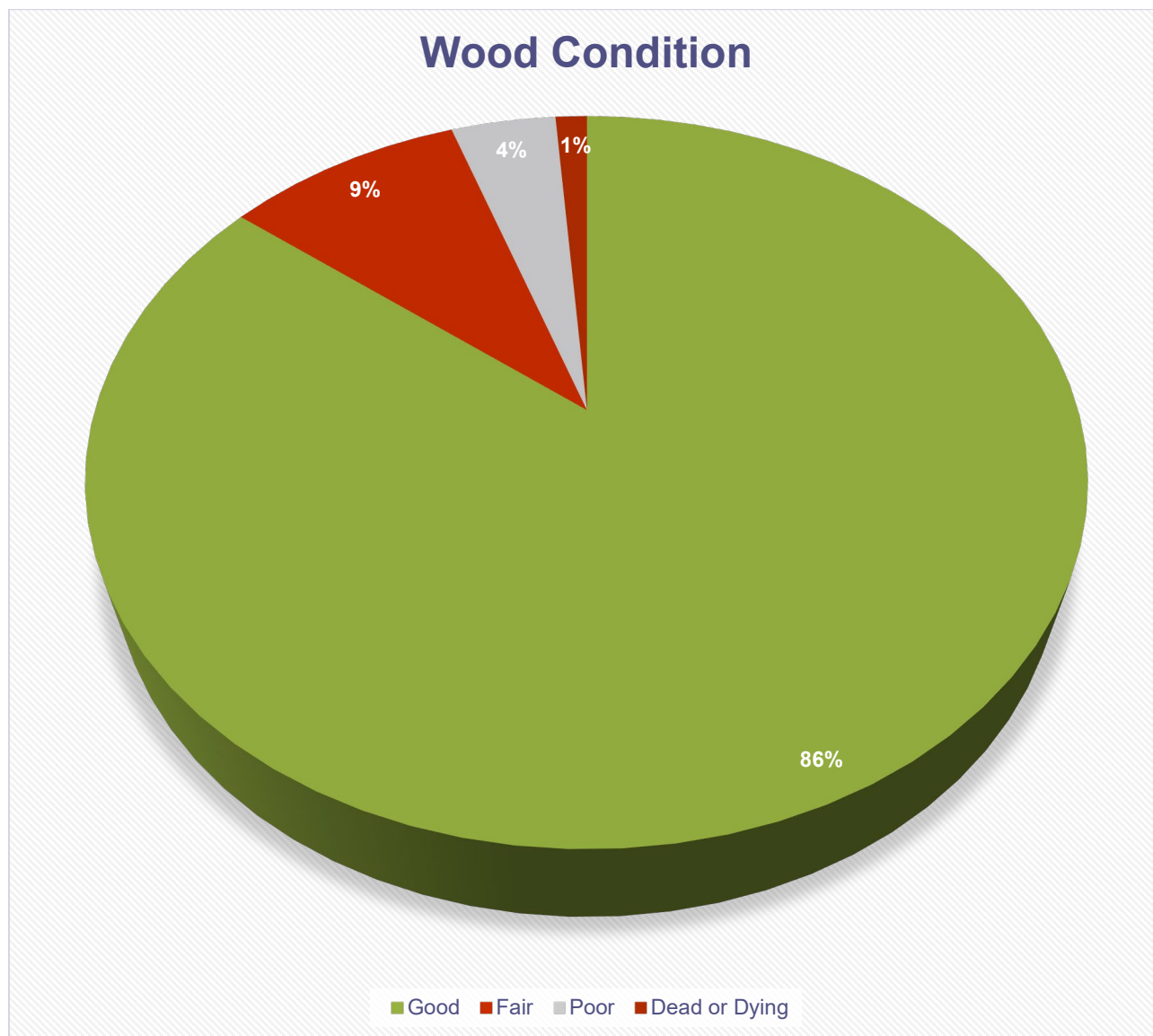
Figure 5: Canopy Cover in Acres

Villisca

Canopy Cover of Public Trees (Acres)

2/8/2023
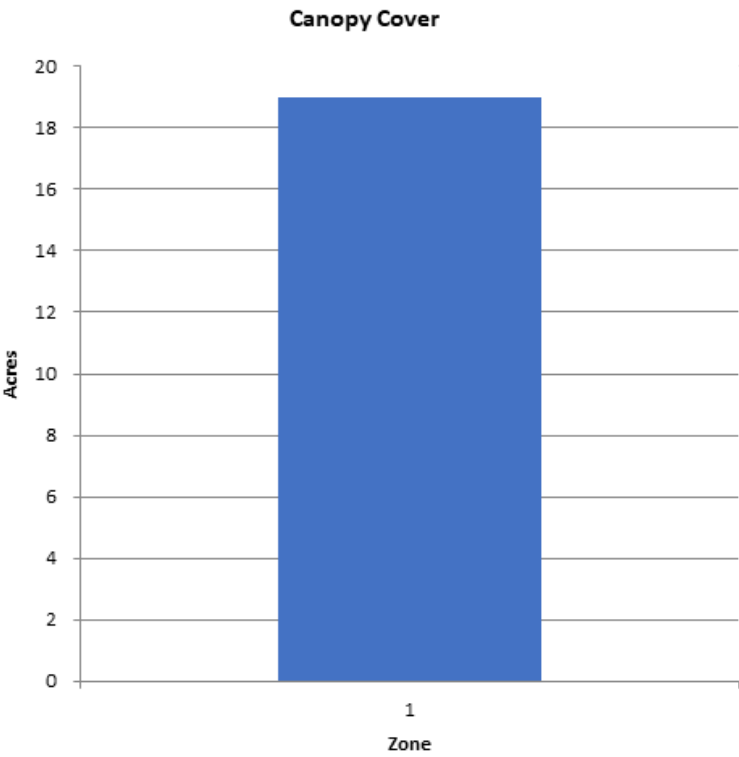
Canopy Cover

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

Land Use of Public Trees #
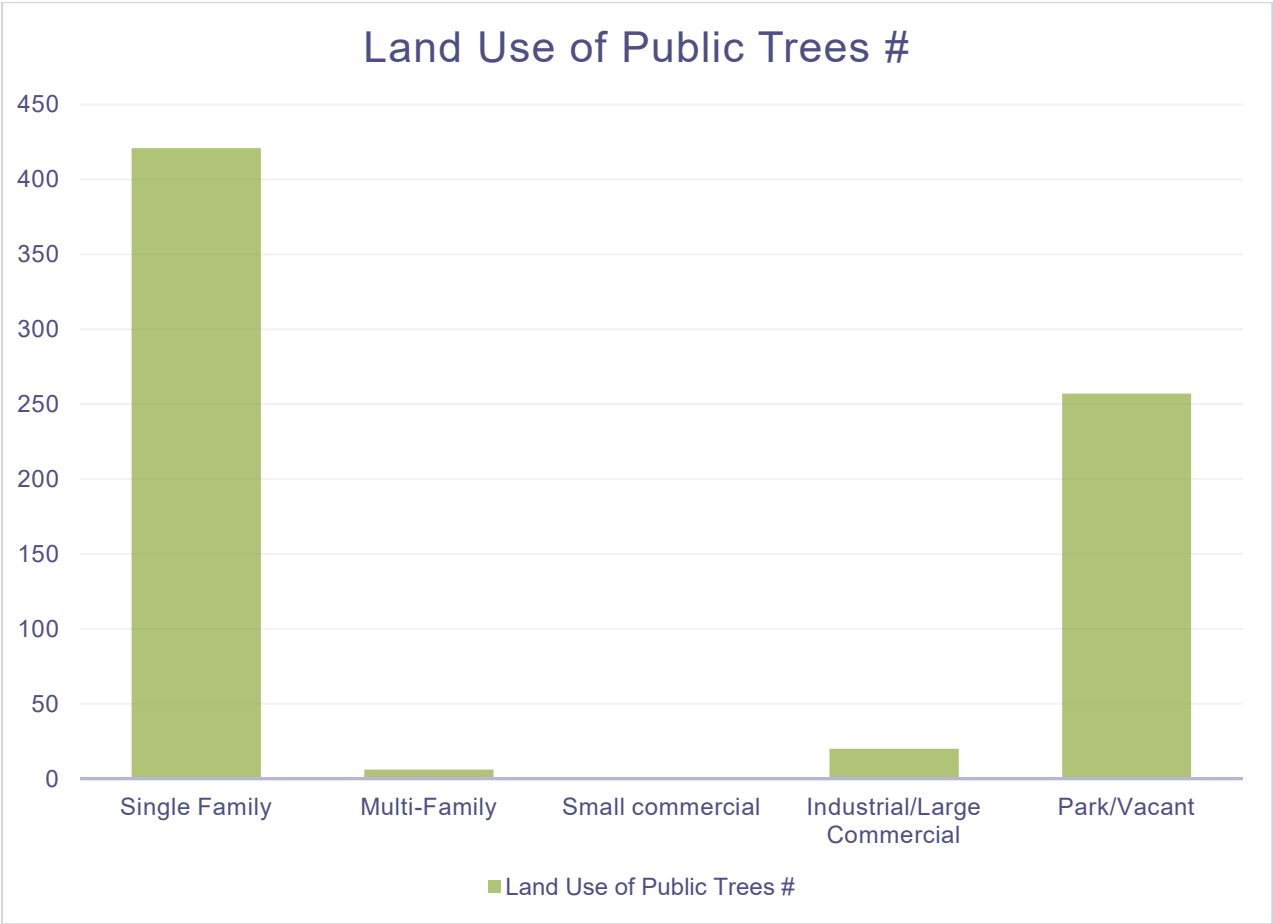
APPENDIX B: ArcGIS MAPPING

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

Legend

Ash Trees

● Trees (21)

0   0.15   0.3 Miles

N
W — E
S

2022 IDNR Tree Inventory

Figure 1 - Ash Tree Location
Villisca, Iowa
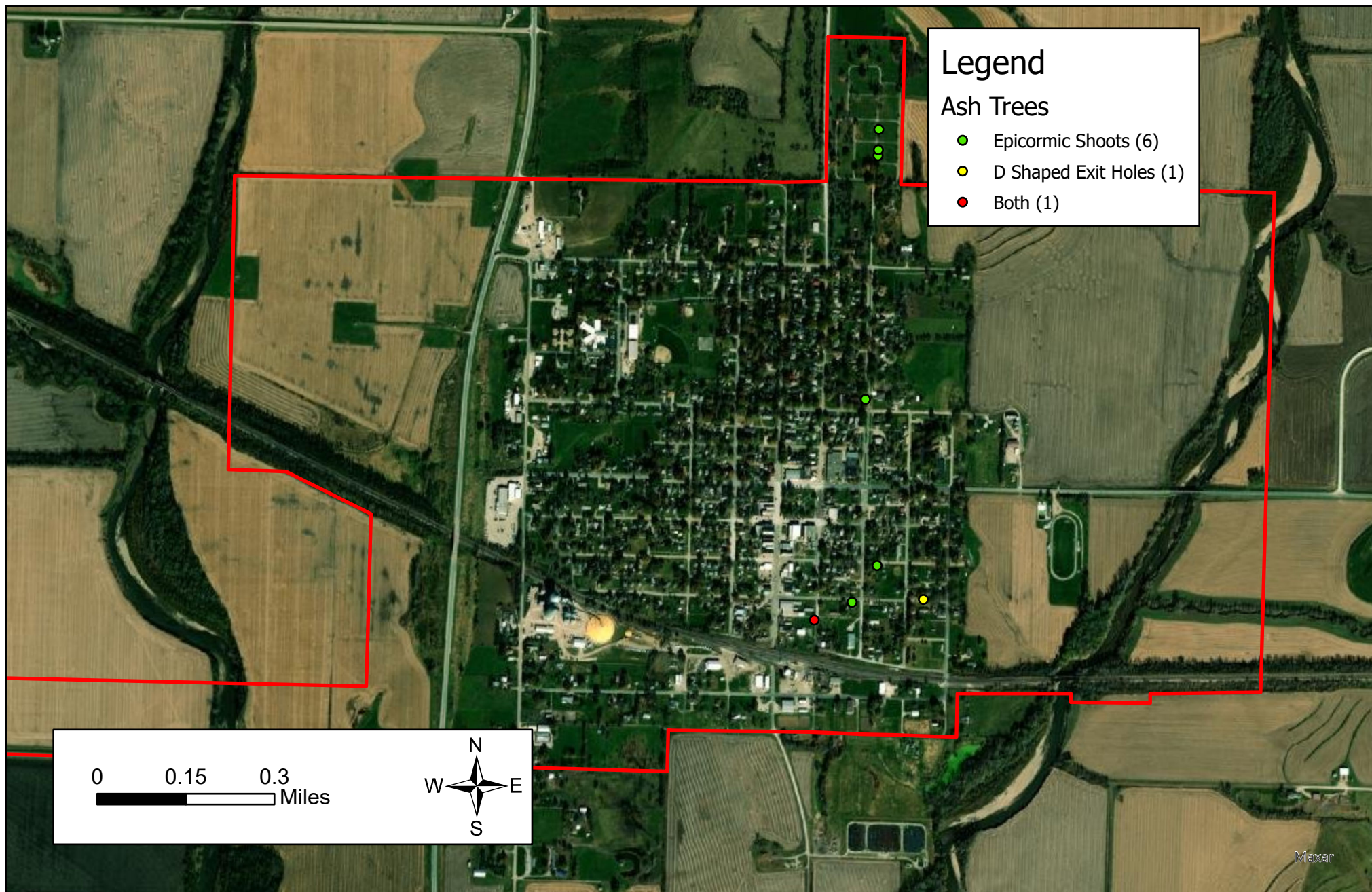
JEO CONSULTING GROUP INC

Maxar

Legend

Ash Trees

- 🟢 Epicormic Shoots (6)
- 🟡 D Shaped Exit Holes (1)
- 🔴 Both (1)

Maxar

0   0.15   0.3
Miles

N
W E
S

2022 IDNR Tree Inventory

Figure 2 - EAB Symptoms
Villisca, Iowa
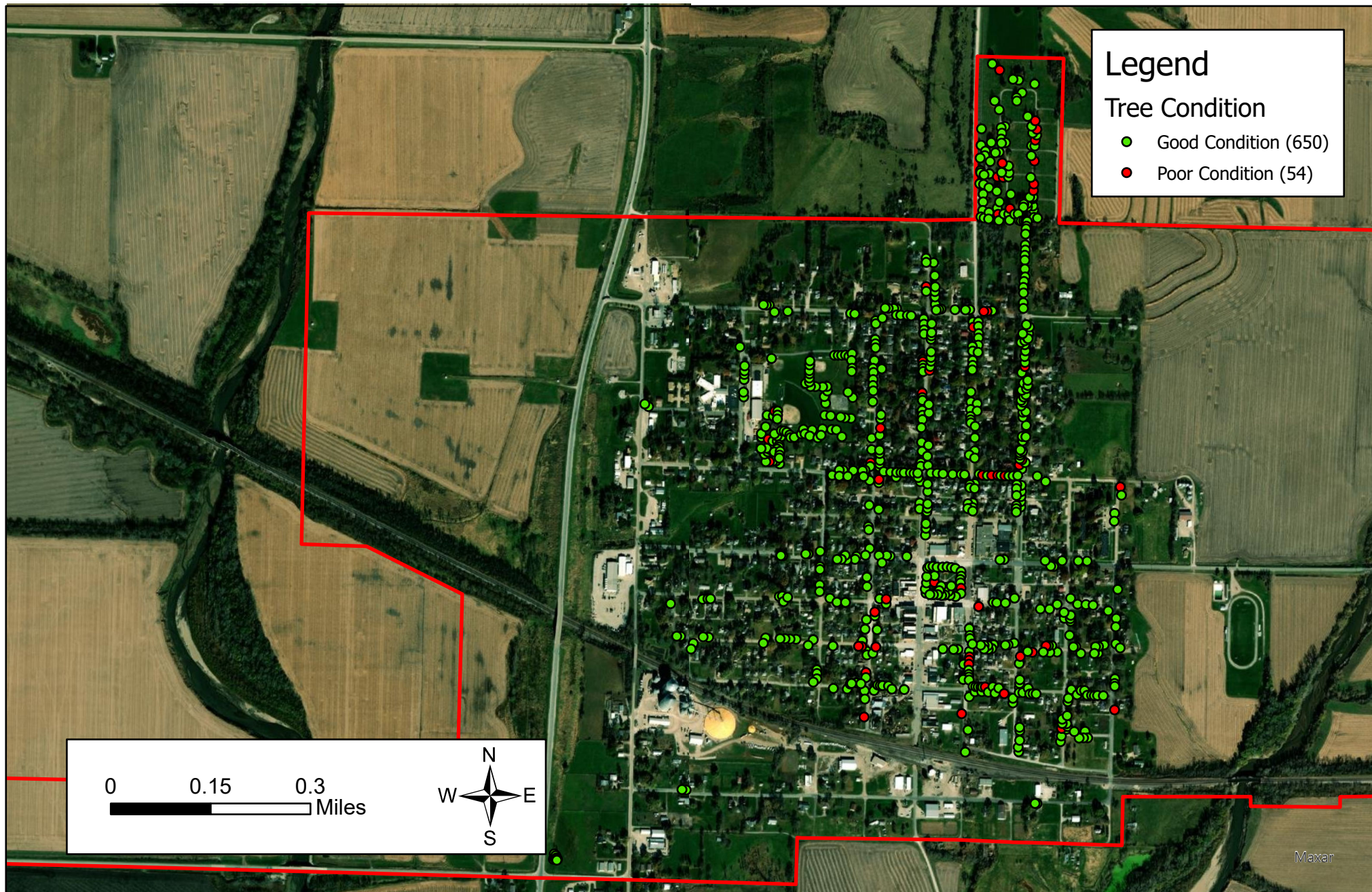
JEO CONSULTING GROUP INC

Legend

Tree Condition

- Good Condition (650)
- Poor Condition (54)

0   0.15   0.3 Miles

N W E S

2022 IDNR Tree Inventory

Figure 3 - Poor Condition Trees
Villisca, Iowa
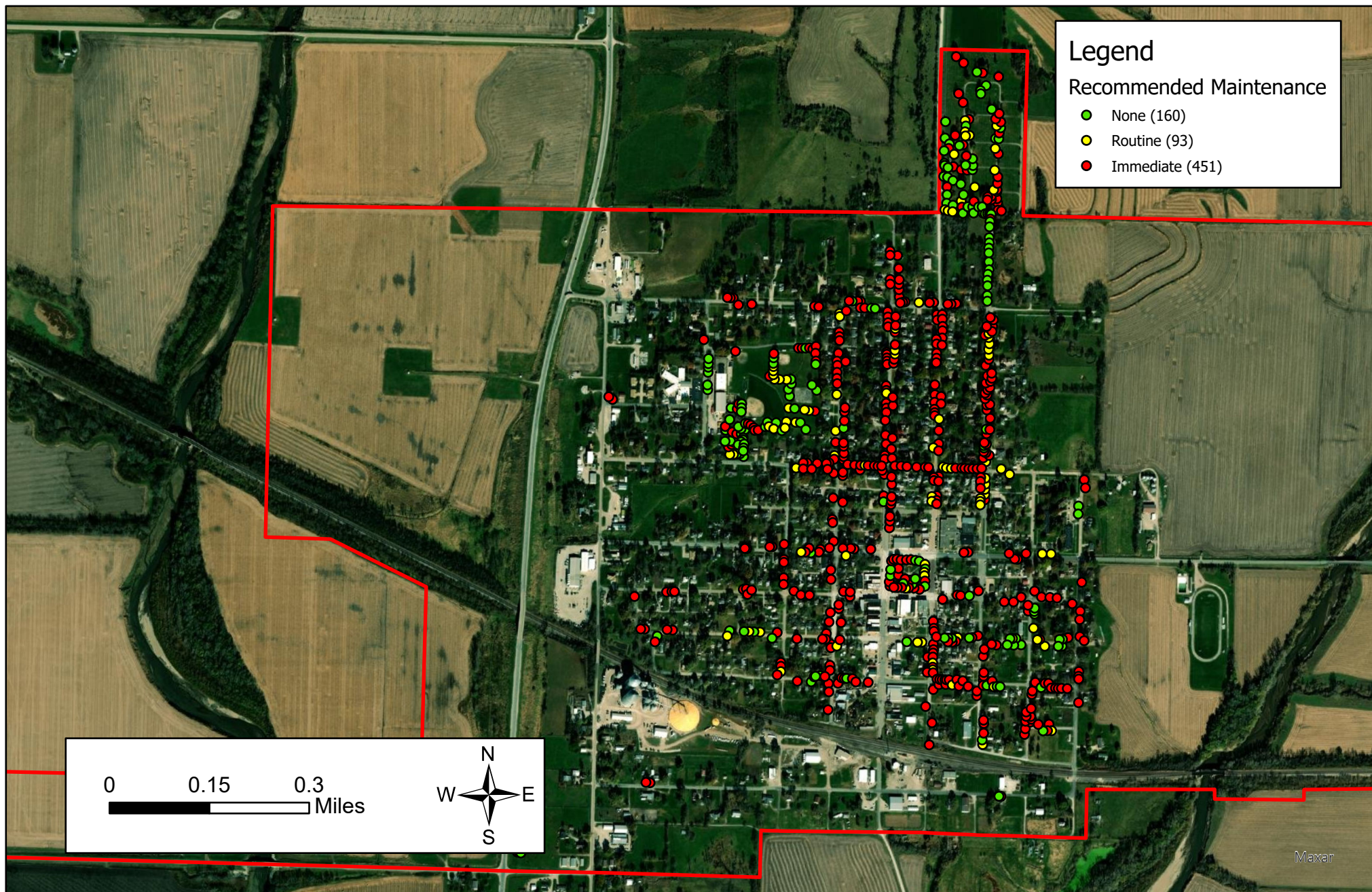
jeo
JEO CONSULTING GROUP INC

Maxar

Legend
Recommended Maintenance
- 🟢 None (160)
- 🟡 Routine (93)
- 🔴 Immediate (451)

N
W E
S

0   0.15   0.3 Miles

2022 IDNR Tree Inventory

Figure 4 - Recommended Maintenance
Villisca, Iowa
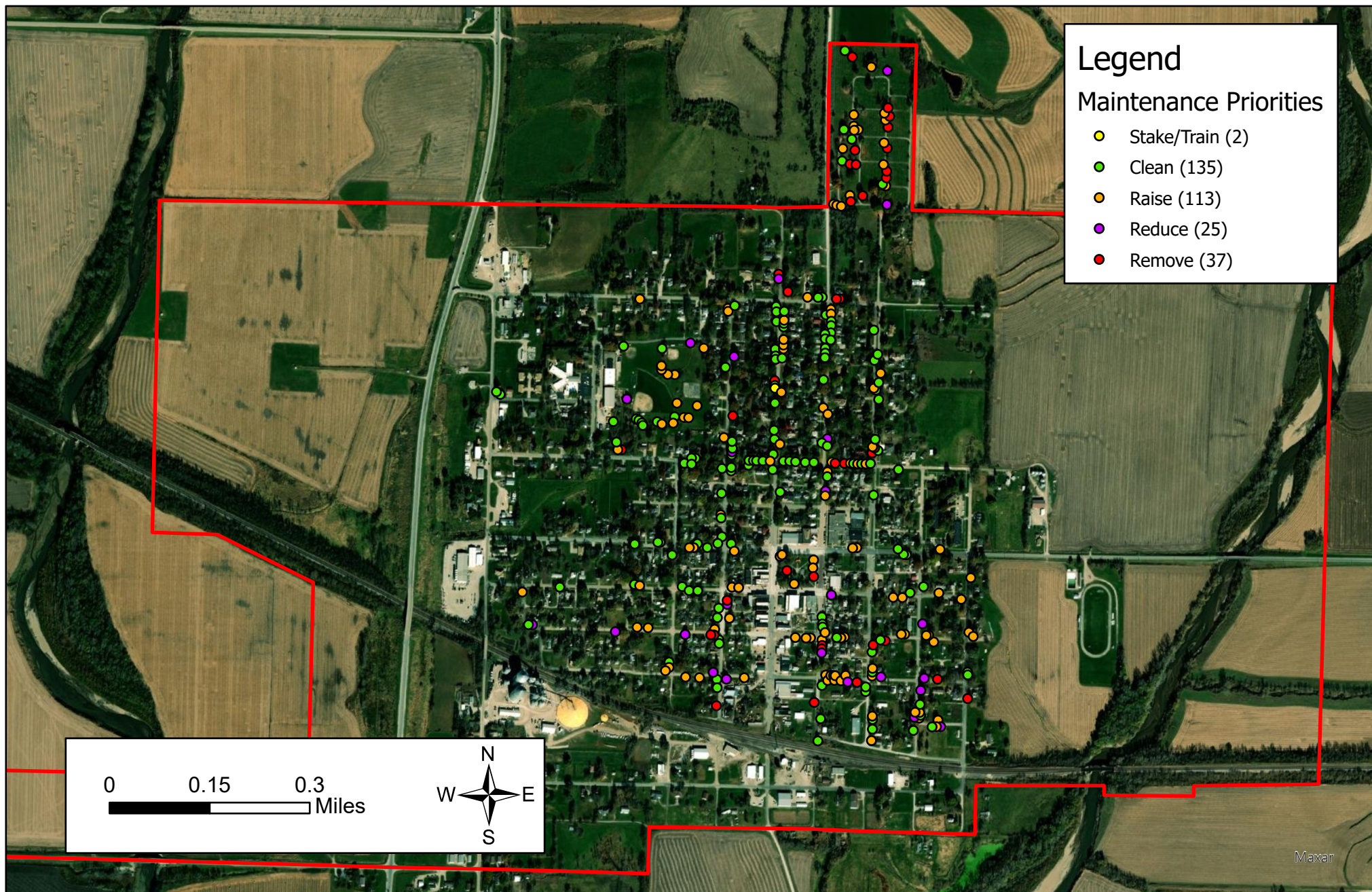
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JEO CONSULTING GROUP INC

Maxar

Legend

Maintenance Priorities

- 🟡 Stake/Train (2)
- 🟢 Clean (135)
- 🟠 Raise (113)
- 🟣 Reduce (25)
- 🔴 Remove (37)

0   0.15   0.3 Miles

N
W   E
S

2022 IDNR Tree Inventory

Figure 5 - Maintenance Priorities
Villisca, Iowa

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APPENDIX C: VILLISCA TREE ORDINANCES

6-17-1 DEFINITIONS. For use in this chapter, the following terms are defined:

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

2. "Director" shall mean the Director of Public Works or such other person as may be designated by the city council.

3. "Street" as used herein shall refer to that portion of a platted street which is not covered by concrete, asphalt, gravel, or otherwise used for vehicular travel.

6-17-2 PLANTING RESTRICTIONS. No tree shall be planted in any street or parking except in accordance with the following:

1. Alignment. All trees hereafter 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. Prohibited trees. No person shall hereinafter plant in any street, any fruit-bearing tree or any cotton bearing cottonwoods, poplars, box elder, Siberian elm (Chinese elm), evergreens, silver maple, Russian Olive, mulberry trees or any thorn bearing trees.

6-17-3 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.

6-17-4 ASSESSMENT. If the abutting property owner fails to trim the trees as required in this chapter, the city may serve notice on the abutting property owner requiring him to do so within five (5) days. If he fails to trim the trees 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.

6-17-5 TRIMMING TREES TO BE SUPERVISED. It shall be 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. Except that the property owner shall not be required to remove diseased trees or dead wood on the publicly owned property or right of way.

6-17-6 REMOVAL OF TREES. The Director shall remove, on the order of the city council, any tree on the streets of the city which interferes with the making of improvements or with travel thereon. He shall additionally remove any trees on the street, not on property, which have become diseased, or which constitute a danger to the public, or which may otherwise be declared a nuisance.

6-17-7 DISEASED TREES SUBJECT TO REMOVAL. Diseased, dead, dying or injured trees within the city shall be removed as follows:

1. Living or Standing Trees. Any living or standing elm tree or part thereof infected with Dutch Elm Disease fungus or which harbors any of the elm bark beetles, that is scolytus multstriatus (eichb.) or hylurgopinus rufipes (marsh) or trees which have been determined to harbor the Emerald Ash Borer.

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

3. Injured or Dying Trees. Any tree which has been injured whether by disease or physical damage to the point that the tree will die, or its limbs might fall, shall be removed.

6-17-8 DUTY TO REMOVE. No person, firm, or corporation shall permit any tree or material as defined in 6-17-7 to remain on the premises owned, controlled or occupied by such person, firm or corporation.

6-17-9 INSPECTION. The Director shall inspect or cause to be inspected all premises and places within the city to determine whether any condition as defined in Section 6-17-7 exists thereon, and shall also inspect or cause to be inspected any elm trees reported or suspected to be infected with the Dutch Elm Disease or any elm bark bearing material reported or suspected to be infected with the elm bark beetles.

6-17-10 REMOVAL FROM CITY PROPERTY. If the Director upon inspection or examination, in person or by some qualified person acting for him, shall determine that any condition as herein defined exists in or upon any public street, alley, park or any public place, including the strip between the curb and the lot line of private property, within the city and that the danger of other elm trees within the city is imminent, he shall immediately cause it to be removed and burned or otherwise correct the same in such manner as to destroy or prevent as fully as possible the spread of Dutch Elm Disease or the insect pests or vectors known to carry such disease fungus.

6-17-11 REMOVAL FROM PRIVATE PROPERTY. If the Director upon inspection or examination, in person or by some qualified person acting for him, shall determine with reasonable certainty that any condition as herein defined exists in or upon private premises and that the danger to other elm trees within the city is imminent, he shall immediately notify by certified mail the owner, occupant or person in charge of such property, to correct such condition within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within fourteen (14) days of receipt thereof, the city council may cause the nuisance to be removed and the cost assessed against the property. If the Director is unable to determine within reasonable certainty whether or not a tree on private premises is infected with Dutch Elm Disease, he is authorized to remove or cut specimens from said tree, and obtain a diagnosis thereof.

6-17-12 COMMERCIAL TREE SERVICE. Any person performing tree service, or any commercial tree service company working within the City of Villisca must obtain a permit from the office of the city clerk. To obtain a permit, the applicant must show proof of insurance and workman's compensation adequate for the protection of the citizens of the

city and the city itself. Liability insurance shall be a minimum of $300,000 for bodily injury and $100,000 for property damage.