North Liberty, IA:

2020 Urban Forest Management Plan

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Executive Summary

EXECUTIVE SUMMARY

Overview

This plan was developed to assist the City of North Liberty 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 6 percent of North Liberty'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 2020, 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 1,535 trees inventoried.

- North Liberty's trees provide $156,358 of benefits annually, an average of $101.86 per tree
- There are over 33 species of trees
- The top three genera are: maple 24.5%, apple 15%, and oak 15%
- 30 percent of trees need some type of management
- 90 trees should be removed

Recommendations

Below are some key recommendations, for further details see the Recommendation and Emerald Ash Borer Plan Sections:

- Out of the 90 trees needing removal, 21 trees are over 24 inches in diameter at 4.5 feet and must be addressed immediately. *City ownership of the trees recommended for removal should be verified prior to any removal*
- 16 of the 98 ash trees should be carefully examined, as they are believed to have shown 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 a suggested budget of $2 per capital, funds would be sufficient to remove all ash in 3 years. We suggest applying for grants to aid with planting and other maintenance needs.

Introduction

INTRODUCTION

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

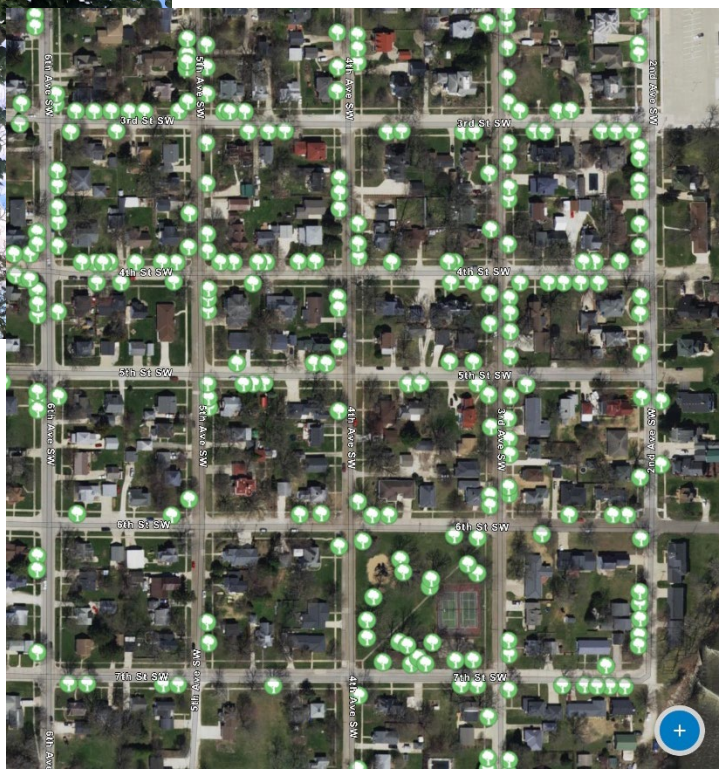
Assist North Liberty with Managing its Urban Forest

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



Inventory Results

INVENTORY

In 2020, JEO conducted a tree inventory that included 100 percent 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 ArcGIS 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 feet, 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 1,535 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. North Liberty's trees reduce energy-related costs by approximately $43,432 annually (Appendix A, Table 1). These savings are both in electricity (206.0 MWh) and in natural gas (28,362.2 Therms).

Annual Stormwater Benefits

North Liberty's trees intercept about 1,916,087 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $51,926 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 North Liberty, it is estimated that trees remove 2,445.5 pounds of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $6,754 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In North Liberty, trees sequester about 437,130 pounds of carbon per year with an associated value of $3,278 (Appendix A, Table 5). In addition, the trees store 5,810,257 pounds of carbon, with a yearly benefit of $43,577 (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. North Liberty receives $48,604 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, North Liberty's trees provide $156,358 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,535 trees in North Liberty provide approximately $101.86 annually (Appendix A, Table 7).

ENERGY	STORMWATER	AIR QUALITY	CARBON	AESTHETICS	SUMMARY
• Reduce energy cost by **$43,432**	• Intercept **1,916,087 gallons** • Provides **$51,926** benefit	• Remove **2,445.5 lbs** of pollution • Net value of **$6,754**	• Sequester **437,130 lbs** • Value of **$3,278** • Store **5,810,257 lbs** • Value of **$43,577**	• **$48,604** in social benefits	• **$156,358** annual benefits • Each tree provides **$101.86** annually

FOREST STRUCTURE

Species Distribution

North Liberty has over 33 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

Maple	377	24.5%
Apple	234	15%
Oak	234	15%
Spruce	163	10.5%
Ash	98	6%
Birch	67	4%
Pine	44	3%
Quaking Aspen	38	2.5%
Pear	34	2%
Hackberry	34	2%
Locust	32	2%
Basswood/Linden	25	1.5%
Cedar	25	1.5%
Eastern redbud	17	1%
Elm	15	1%
Walnut	11	<1%
Plum	9	<1%
Amur maple	7	<1%

Cherry	7	<1%
Japanese tree lilac	7	<1%
Kentucky Coffee	6	<1%
Mulberry	6	<1%
Sycamore	4	<1%
Boxelder	4	<1%
Willow	4	<1%
Ginkgo	4	<1%
Catalpa	2	<1%
Hemlock	2	<1%
Cottonwood	1	<1%
Sumac	1	<1%
Broadleaf Deciduous Other	19	1%
Conifer Evergreen Other	3	<1%
Broadleaf Evergreen Other	1	<1%

Age Class

Most of North Liberty's trees (55 percent) are between 3 and 12 inches in diameter at 4.5 feet (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. North Liberty's size curve is on the smaller side, indicating a younger 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 North Liberty indicate that 75 percent of the trees are in good health, with only 4 percent of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 66 percent of North Liberty's trees are in good health for wood condition
(Appendix A, Figure 4 & Appendix B, Figure 3). Three percent of the tree population's wood condition is in poor health, dead, or dying. This 7 percent 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	328	21%
Crown Reduction	115	7.5%
Tree Removal	90	6%
Crown Raising	13	<1%
Tree Staking	7	<1%

Canopy Cover

The total canopy with both private and public trees is 493 acres or around 10 percent. The canopy cover included in the Milo inventory includes approximately 21 acres (Appendix A, Figure 4). The city's canopy goal is to increase canopy by 10 percent in 30 years. To achieve this goal it is estimated that 52 trees need to be planted annually on public and private lands.

Land Use and Location

The majority of North Liberty'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
Park/Vacant/Other	81%
Single Family Residential	15%
Multifamily Residential	2%
Small Commercial	1%
Industrial/Large 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

North Liberty has 15 trees in need of 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 7 critical concern trees over 24 inches in diameter at 4.5 feet that should be addressed immediately. Please refer to the Proposed Schedule and Budget 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 463 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 90 removals, 15 are ash trees. There are a total of 98 ash trees, and 16 of those may have signs and symptoms that have been associated with EAB. In addition, there are 17 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 Schedule and Budget 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 percent. 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 North Liberty.

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 percent of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10 percent of the total urban forest. Presently, the forest is heavily planted with maple (24.5 percent) (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: Black Locust, Russian Olive, Box Elder, Siberian Elm, Cotton Bearing Poplar, Silver Maple/White River Maple (soft maples), Female Ginkgo, Tree of Heaven, and Green Ash as outlined in section 151.04 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.04 (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 151.04 (Appendix C). The new plantings will be a diverse mix and will not include Black Locust, Russian Olive, Box Elder, Siberian Elm, Cotton Bearing Poplar, Silver Maple/White River Maple (soft maples), Female Ginkgo, Tree of Heaven, Green Ash, and White Ash.

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 $37,700/Year – (Based off suggested budget of $2 per capita)

YEAR 1	Est. Cost
Remove 50 trees recommended for immediate removal	$35,000
Plant 17 trees in open locations	$2,550
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$37,550**

YEAR 2	Est. Cost
Remove 25 trees recommended for immediate removal	$17,500
Remove 15 ash in poor health	$10,500
Plant 13 trees in open locations	$1,950
Prune 1/3 of city owned trees	$7,675
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$37,625**

YEAR 3	Est. Cost
Remove 45 remaining ash	$31,500
Plant 41 trees in open locations	$6,150
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$37,650**

YEAR 4	Est. Cost
Remove 38 remaining ash	$26,600
Plant 22 trees in open locations	$3,300
Prune 1/3 of city owned trees	$7,675
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$37,575**

YEAR 5	Est. Cost
Plant 20 trees in open locations	$3,000
Prune 1/3 of city owned trees	$7,675
Additional removals/maintenance	$27,025
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$37,700**

YEAR 6	Est. Cost
Prune 1/3 of city owned trees	$7,675
Additional removal, planting and maintenance	$30,025
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$37,700**

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

Proposed Budget

EAB could potentially kill all ash trees in North Liberty within four years of its arrival. We recommend that North Liberty 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, this option is $300 per tree. All healthy ash in North Liberty could be treated with the current budget. This is an alternative to simply removal. 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 North Liberty.

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Appendices

APPENDIX A: i-TREE DATA

North Liberty

Annual Energy Benefits of Public Trees

1/29/2021

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	9.3	705	1,551.2	1,520	2,225	(N/A)	15.2	5.1	9.51
Red maple	14.7	1,118	1,973.4	1,934	3,052	(N/A)	7.8	7.0	25.64
Silver maple	23.8	1,806	3,138.3	3,076	4,881	(N/A)	6.0	11.2	53.06
Spruce	7.1	535	942.9	924	1,459	(N/A)	5.9	3.4	16.04
Norway maple	8.8	667	1,315.6	1,289	1,956	(N/A)	5.3	4.5	23.86
Pin oak	14.4	1,092	1,898.9	1,861	2,953	(N/A)	4.4	6.8	43.43
Northern red oak	8.0	606	1,106.9	1,085	1,691	(N/A)	4.4	3.9	24.86
River birch	13.4	1,017	1,880.9	1,843	2,861	(N/A)	4.1	6.6	45.41
Sugar maple	15.7	1,195	2,108.7	2,067	3,262	(N/A)	3.8	7.5	55.28
Blue spruce	4.8	365	648.0	635	1,000	(N/A)	3.3	2.3	19.61
Swamp white oak	5.0	380	742.0	727	1,107	(N/A)	2.8	2.5	25.75
Green ash	9.9	750	1,347.2	1,320	2,070	(N/A)	2.7	4.8	50.49
Eastern white pine	4.6	351	600.3	588	939	(N/A)	2.6	2.2	23.49
Quaking aspen	5.1	388	657.5	644	1,032	(N/A)	2.5	2.4	27.17
Northern hackberry	10.1	765	1,409.4	1,381	2,146	(N/A)	2.2	4.9	63.11
White ash	7.5	566	883.3	866	1,432	(N/A)	2.2	3.3	42.11
Callery pear	2.9	219	448.1	439	658	(N/A)	2.1	1.5	19.95
Honeylocust	6.2	470	830.1	813	1,284	(N/A)	2.1	3.0	40.12
Bur oak	2.0	151	260.5	255	406	(N/A)	1.8	0.9	14.51
Maple	3.2	245	450.5	442	686	(N/A)	1.6	1.6	27.44
Eastern red cedar	1.2	91	179.0	175	266	(N/A)	1.4	0.6	12.69
Norway spruce	1.5	113	202.1	198	311	(N/A)	1.3	0.7	15.56
Eastern redbud	0.6	43	91.3	89	133	(N/A)	1.1	0.3	7.81
Broadleaf Deciduous Small	0.4	32	74.1	73	105	(N/A)	1.0	0.2	7.00
Ash	2.8	216	409.9	402	617	(N/A)	1.0	1.4	41.16
Littleleaf linden	1.4	109	206.0	202	311	(N/A)	0.9	0.7	22.20
White oak	0.9	71	135.1	132	204	(N/A)	0.8	0.5	15.68
Elm	1.0	79	141.5	139	218	(N/A)	0.8	0.5	16.75
Oak	2.2	163	280.6	275	438	(N/A)	0.8	1.0	33.71
Black walnut	2.7	205	360.2	353	558	(N/A)	0.7	1.3	50.72
Plum	0.5	37	85.2	84	121	(N/A)	0.6	0.3	13.43
Black ash	1.0	78	140.8	138	216	(N/A)	0.5	0.5	27.03
Black cherry	1.1	86	176.8	173	259	(N/A)	0.5	0.6	37.01
Amur maple	0.9	67	125.0	122	190	(N/A)	0.5	0.4	27.11
American basswood	1.0	73	133.6	131	204	(N/A)	0.5	0.5	29.18
Japanese tree lilac	0.5	35	80.8	79	115	(N/A)	0.5	0.3	16.37
Kentucky coffeetree	0.7	56	85.6	84	140	(N/A)	0.4	0.3	23.30
Boxelder	0.7	55	93.5	92	146	(N/A)	0.3	0.3	36.62
Broadleaf Deciduous Mediu	0.5	37	69.4	68	105	(N/A)	0.3	0.2	26.18
Birch	0.4	32	67.4	66	98	(N/A)	0.3	0.2	24.47
Willow	1.2	93	181.8	178	271	(N/A)	0.3	0.6	67.80
Northern white cedar	0.2	12	26.9	26	38	(N/A)	0.3	0.1	9.59
Basswood	0.5	34	58.1	57	91	(N/A)	0.3	0.2	22.83
Ginkgo	0.2	15	27.7	27	42	(N/A)	0.3	0.1	10.53
Mulberry	0.8	59	119.5	117	177	(N/A)	0.3	0.4	44.14
American sycamore	0.8	61	94.7	93	153	(N/A)	0.3	0.4	38.33
Eastern hemlock	0.2	14	24.1	24	38	(N/A)	0.1	0.1	18.86
Scotch pine	0.3	22	39.4	39	61	(N/A)	0.1	0.1	30.47
Red pine	0.3	21	34.3	34	55	(N/A)	0.1	0.1	27.30
White mulberry	0.4	30	63.2	62	92	(N/A)	0.1	0.2	46.14
Catalpa	0.9	66	116.8	114	181	(N/A)	0.1	0.4	90.32
Conifer Evergreen Large	0.3	24	39.2	38	62	(N/A)	0.1	0.1	31.15
American elm	0.2	19	27.5	27	46	(N/A)	0.1	0.1	45.87
Broadleaf Evergreen Mediur	0.1	6	12.7	12	19	(N/A)	0.1	0.0	18.82
Conifer Evergreen Small	0.0	4	7.9	8	11	(N/A)	0.1	0.0	11.47
Cottonwood	0.1	7	13.7	13	21	(N/A)	0.1	0.0	20.64

Annual Energy Benefits of Public Trees

Table 1 Continued

1/29/2021

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sumac	0.1	6	12.8	13	18	(N/A)	0.1	0.0	18.19
Pear	0.1	6	12.8	13	18	(N/A)	0.1	0.0	18.19
Black spruce	0.1	10	15.2	15	25	(N/A)	0.1	0.1	24.51
Northern pin oak	0.3	20	39.6	39	59	(N/A)	0.1	0.1	58.69
Siberian elm	0.5	38	62.2	61	98	(N/A)	0.1	0.2	98.48
Total	206.0	15,638	28,362.2	27,795	43,432	(N/A)	100.0	100.0	28.29

Annual Stormwater Benefits of Public Trees

1/29/2021

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	32,188	872	(N/A)	15.2	1.7	3.73
Red maple	91,035	2,467	(N/A)	7.8	4.8	20.73
Silver maple	308,839	8,370	(N/A)	6.0	16.1	90.97
Spruce	86,589	2,347	(N/A)	5.9	4.5	25.79
Norway maple	51,127	1,386	(N/A)	5.3	2.7	16.90
Pin oak	128,223	3,475	(N/A)	4.4	6.7	51.10
Northern red oak	61,705	1,672	(N/A)	4.4	3.2	24.59
River birch	103,325	2,800	(N/A)	4.1	5.4	44.45
Sugar maple	216,068	5,855	(N/A)	3.8	11.3	99.24
Blue spruce	62,944	1,706	(N/A)	3.3	3.3	33.45
Swamp white oak	37,592	1,019	(N/A)	2.8	2.0	23.69
Green ash	107,011	2,900	(N/A)	2.7	5.6	70.73
Eastern white pine	82,241	2,229	(N/A)	2.6	4.3	55.72
Quaking aspen	32,365	877	(N/A)	2.5	1.7	23.08
Northern hackberry	89,822	2,434	(N/A)	2.2	4.7	71.59
White ash	62,159	1,685	(N/A)	2.2	3.2	49.54
Callery pear	15,753	427	(N/A)	2.1	0.8	12.94
Honeylocust	53,441	1,448	(N/A)	2.1	2.8	45.26
Bur oak	14,307	388	(N/A)	1.8	0.7	13.85
Maple	20,974	568	(N/A)	1.6	1.1	22.74
Eastern red cedar	17,249	467	(N/A)	1.4	0.9	22.26
Norway spruce	23,259	630	(N/A)	1.3	1.2	31.52
Eastern redbud	1,900	51	(N/A)	1.1	0.1	3.03
Broadleaf Deciduous Small	1,446	39	(N/A)	1.0	0.1	2.61
Ash	22,225	602	(N/A)	1.0	1.2	40.15
Littleleaf linden	10,390	282	(N/A)	0.9	0.5	20.11
White oak	6,004	163	(N/A)	0.8	0.3	12.52
Elm	6,579	178	(N/A)	0.8	0.3	13.71
Oak	20,437	554	(N/A)	0.8	1.1	42.60
Black walnut	30,384	823	(N/A)	0.7	1.6	74.85
Plum	1,732	47	(N/A)	0.6	0.1	5.21
Black ash	5,887	160	(N/A)	0.5	0.3	19.94
Black cherry	5,892	160	(N/A)	0.5	0.3	22.81
Amur maple	3,203	87	(N/A)	0.5	0.2	12.40
American basswood	6,845	185	(N/A)	0.5	0.4	26.50
Japanese tree lilac	1,656	45	(N/A)	0.5	0.1	6.41
Kentucky coffeetree	4,604	125	(N/A)	0.4	0.2	20.79
Boxelder	5,865	159	(N/A)	0.3	0.3	39.74
Broadleaf Deciduous Medium	2,744	74	(N/A)	0.3	0.1	18.59
Birch	2,344	64	(N/A)	0.3	0.1	15.88
Willow	13,772	373	(N/A)	0.3	0.7	93.31
Northern white cedar	1,617	44	(N/A)	0.3	0.1	10.95
Basswood	2,853	77	(N/A)	0.3	0.1	19.33
Ginkgo	1,261	34	(N/A)	0.3	0.1	8.54
Mulberry	4,189	114	(N/A)	0.3	0.2	28.38
American sycamore	5,005	136	(N/A)	0.3	0.3	33.91
Eastern hemlock	2,134	58	(N/A)	0.1	0.1	28.92
Scotch pine	5,938	161	(N/A)	0.1	0.3	80.46
Red pine	4,508	122	(N/A)	0.1	0.2	61.08

Annual Stormwater Benefits of Public Trees

Table 2 Continued

1/29/2021

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
White mulberry	2,348	64	(N/A)	0.1	0.1	31.82
Catalpa	12,729	345	(N/A)	0.1	0.7	172.48
Conifer Evergreen Large	6,143	166	(N/A)	0.1	0.3	83.24
American elm	1,391	38	(N/A)	0.1	0.1	37.69
Broadleaf Evergreen Medium	677	18	(N/A)	0.1	0.0	18.34
Conifer Evergreen Small	659	18	(N/A)	0.1	0.0	17.86
Cottonwood	608	16	(N/A)	0.1	0.0	16.47
Sumac	264	7	(N/A)	0.1	0.0	7.17
Pear	264	7	(N/A)	0.1	0.0	7.17
Black spruce	1,544	42	(N/A)	0.1	0.1	41.85
Northern pin oak	2,479	67	(N/A)	0.1	0.1	67.19
Siberian elm	7,351	199	(N/A)	0.1	0.4	199.22
Citywide total	1,916,087	51,926	(N/A)	100.0	100.0	33.83

Annual Air Quality Benefits of Public Trees

1/29/2021

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								
Apple	5.4	0.9	3.1	0.2	30	46.8	6.6	6.3	42.1	285	0.0	0	111.3	315	(N/A)	15.2	1.35
Red maple	16.1	2.7	8.2	0.7	88	69.8	10.2	9.7	66.7	436	-6.1	-23	178.1	501	(N/A)	7.8	4.21
Silver maple	49.2	8.3	24.7	2.2	267	112.2	16.4	15.7	107.7	702	-27.1	-102	309.4	868	(N/A)	6.0	9.43
Spruce	8.8	1.8	8.0	1.1	60	33.4	4.9	4.7	31.9	209	-31.1	-117	63.5	152	(N/A)	5.9	1.68
Norway maple	6.1	1.1	3.7	0.3	35	43.0	6.2	5.9	39.9	266	-1.8	-7	104.3	294	(N/A)	5.3	3.58
Pin oak	19.9	3.5	10.7	0.9	110	68.0	10.0	9.5	65.2	425	-38.5	-144	149.1	391	(N/A)	4.4	5.75
Northern red oak	11.4	2.0	5.9	0.5	62	38.2	5.6	5.3	36.2	238	-16.1	-60	88.8	239	(N/A)	4.4	3.52
River birch	18.6	3.2	9.5	0.8	101	64.5	9.4	8.9	60.8	401	-4.6	-17	171.1	485	(N/A)	4.1	7.70
Sugar maple	33.4	5.7	15.9	1.5	179	74.7	10.9	10.4	71.3	466	-25.8	-97	197.9	548	(N/A)	3.8	9.29
Blue spruce	7.9	1.6	6.8	1.0	53	22.8	3.3	3.2	21.8	142	-22.4	-84	46.0	112	(N/A)	3.3	2.19
Swamp white oak	6.4	1.1	3.4	0.3	35	24.5	3.5	3.4	22.7	151	-1.6	-6	63.6	180	(N/A)	2.8	4.19
Green ash	13.0	2.1	6.2	0.6	69	47.1	6.9	6.5	44.8	294	0.0	0	127.1	363	(N/A)	2.7	8.85
Eastern white pine	9.4	1.9	7.8	1.2	62	21.7	3.2	3.0	21.0	136	-39.8	-149	29.4	49	(N/A)	2.6	1.23
Quaking aspen	1.9	0.3	1.3	0.1	11	24.0	3.5	3.4	23.2	151	0.0	0	57.7	162	(N/A)	2.5	4.26
Northern hackberry	14.3	2.5	7.3	0.6	78	48.4	7.0	6.7	45.7	301	0.0	0	132.6	379	(N/A)	2.2	11.15
White ash	7.5	1.2	3.8	0.3	41	34.3	5.1	4.9	33.8	217	0.0	0	91.0	258	(N/A)	2.2	7.58
Callery pear	1.6	0.3	1.0	0.1	9	14.3	2.0	1.9	13.1	88	-0.5	-2	33.8	95	(N/A)	2.1	2.88
Honeylocust	9.7	1.6	4.6	0.4	52	29.4	4.3	4.1	28.1	183	-7.1	-27	75.0	208	(N/A)	2.1	6.51
Bur oak	1.0	0.2	0.6	0.0	6	9.4	1.4	1.3	9.0	59	0.0	0	22.9	64	(N/A)	1.8	2.30
Maple	3.7	0.6	1.9	0.2	20	15.4	2.2	2.1	14.6	96	-1.4	-5	39.4	111	(N/A)	1.6	4.44
Eastern red cedar	3.5	0.7	2.8	0.4	23	5.8	0.8	0.8	5.4	36	-9.5	-36	10.8	23	(N/A)	1.4	1.11
Norway spruce	2.5	0.5	2.2	0.3	17	7.1	1.0	1.0	6.8	44	-10.2	-38	11.2	23	(N/A)	1.3	1.14
Eastern redbud	0.3	0.1	0.2	0.0	2	2.8	0.4	0.4	2.6	17	0.0	0	6.8	19	(N/A)	1.1	1.13
Broadleaf Deciduous Small	0.2	0.0	0.1	0.0	1	2.2	0.3	0.3	1.9	13	0.0	0	5.1	14	(N/A)	1.0	0.96
Ash	4.0	0.7	2.0	0.2	22	13.8	2.0	1.9	12.9	85	-1.0	-4	36.5	103	(N/A)	1.0	6.89
Littleleaf linden	1.3	0.2	0.7	0.1	7	7.0	1.0	1.0	6.5	43	-0.7	-3	17.1	48	(N/A)	0.9	3.41
White oak	0.2	0.0	0.2	0.0	1	4.5	0.7	0.6	4.3	28	0.0	0	10.6	30	(N/A)	0.8	2.28
Elm	0.3	0.0	0.2	0.0	2	5.0	0.7	0.7	4.7	31	0.0	0	11.7	33	(N/A)	0.8	2.52
Oak	2.7	0.4	1.3	0.1	15	10.1	1.5	1.4	9.7	63	0.0	0	27.4	78	(N/A)	0.8	6.00
Black walnut	3.9	0.6	1.8	0.2	21	12.8	1.9	1.8	12.2	80	0.0	0	35.2	101	(N/A)	0.7	9.15
Plum	0.3	0.0	0.2	0.0	2	2.5	0.4	0.3	2.2	15	0.0	0	5.9	17	(N/A)	0.6	1.87
Black ash	0.8	0.1	0.4	0.0	4	4.9	0.7	0.7	4.7	31	-0.2	-1	12.2	34	(N/A)	0.5	4.29
Black cherry	2.0	0.3	0.9	0.1	11	5.6	0.8	0.8	5.1	34	0.0	0	15.6	45	(N/A)	0.5	6.43
Amur maple	0.9	0.2	0.4	0.0	5	4.3	0.6	0.6	4.0	27	0.0	0	11.1	31	(N/A)	0.5	4.49
American basswood	0.7	0.1	0.4	0.0	4	4.6	0.7	0.6	4.4	29	-0.7	-2	10.9	30	(N/A)	0.5	4.30
Japanese tree lilac	0.3	0.0	0.2	0.0	2	2.4	0.3	0.3	2.1	14	0.0	0	5.6	16	(N/A)	0.5	2.28

North Liberty

Annual Air Quality Benefits of Public Trees

Table 3 Continued

1/29/2021

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								
Kentucky coffeetree	0.3	0.1	0.2	0.0	2	3.4	0.5	0.5	3.3	21	0.0	0	8.3	23	(N/A)	0.4	3.88
Boxelder	0.6	0.1	0.3	0.0	3	3.4	0.5	0.5	3.3	21	-0.3	-1	8.4	24	(N/A)	0.3	5.89
Broadleaf Deciduous Medium	0.3	0.1	0.2	0.0	2	2.3	0.3	0.3	2.2	15	-0.1	0	5.7	16	(N/A)	0.3	4.02
Birch	0.2	0.0	0.2	0.0	1	2.1	0.3	0.3	1.9	13	-0.1	0	4.9	14	(N/A)	0.3	3.47
Willow	3.1	0.5	1.5	0.1	17	6.0	0.9	0.8	5.6	37	-0.7	-3	17.8	51	(N/A)	0.3	12.73
Northern white cedar	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.7	5	-0.4	-2	1.6	4	(N/A)	0.3	1.02
Basswood	0.2	0.0	0.1	0.0	1	2.1	0.3	0.3	2.1	13	0.0	0	5.1	14	(N/A)	0.3	3.57
Ginkgo	0.3	0.1	0.1	0.0	2	0.9	0.1	0.1	0.9	6	-0.1	0	2.5	7	(N/A)	0.3	1.78
Mulberry	1.5	0.2	0.7	0.1	8	3.8	0.6	0.5	3.5	24	0.0	0	11.0	32	(N/A)	0.3	7.90
American sycamore	0.4	0.1	0.2	0.0	2	3.7	0.5	0.5	3.6	23	0.0	0	9.0	25	(N/A)	0.3	6.31
Eastern hemlock	0.2	0.0	0.2	0.0	2	0.9	0.1	0.1	0.8	5	-0.7	-3	1.7	4	(N/A)	0.1	2.15
Scotch pine	0.7	0.1	0.6	0.1	5	1.4	0.2	0.2	1.3	9	-2.8	-10	1.8	3	(N/A)	0.1	1.45
Red pine	0.5	0.1	0.4	0.1	3	1.3	0.2	0.2	1.2	8	-1.9	-7	2.1	4	(N/A)	0.1	2.13
White mulberry	0.9	0.1	0.4	0.0	5	2.0	0.3	0.3	1.8	12	0.0	0	5.8	17	(N/A)	0.1	8.35
Catalpa	2.4	0.4	1.0	0.1	12	4.1	0.6	0.6	4.0	26	0.0	0	13.2	38	(N/A)	0.1	19.13
Conifer Evergreen Large	0.7	0.1	0.6	0.1	5	1.5	0.2	0.2	1.4	9	-3.4	-13	1.5	1	(N/A)	0.1	0.62
American elm	0.1	0.0	0.1	0.0	0	1.1	0.2	0.2	1.1	7	0.0	0	2.7	8	(N/A)	0.1	7.68
Broadleaf Evergreen Medium	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	-0.2	-1	0.8	2	(N/A)	0.1	2.10
Conifer Evergreen Small	0.1	0.0	0.1	0.0	0	0.2	0.0	0.0	0.2	1	-0.3	-1	0.3	1	(N/A)	0.1	0.62
Cottonwood	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3	(N/A)	0.1	2.99
Sumac	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3	(N/A)	0.1	2.55
Pear	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3	(N/A)	0.1	2.55
Black spruce	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
Northern pin oak	0.5	0.1	0.2	0.0	3	1.3	0.2	0.2	1.2	8	-0.1	0	3.6	10	(N/A)	0.1	10.16
Siberian elm	1.7	0.3	0.8	0.1	9	2.3	0.3	0.3	2.2	15	0.0	0	8.0	23	(N/A)	0.1	23.37
Citywide total	284.4	49.1	156.9	15.4	1,591	984.3	143.3	136.6	933.6	6,130	-258.0	-967	2,445.5	6,754	(N/A)	100.0	4.40

North Liberty

Table 4: Annual Carbon Stored

Stored CO_2 Benefits of Public Trees

1/29/2021

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	110,557	829	(N/A)	15.2	1.9	3.54
Red maple	193,960	1,455	(N/A)	7.8	3.3	12.22
Silver maple	1,132,792	8,496	(N/A)	6.0	19.5	92.35
Spruce	64,170	481	(N/A)	5.9	1.1	5.29
Norway maple	111,689	838	(N/A)	5.3	1.9	10.22
Pin oak	516,411	3,873	(N/A)	4.4	8.9	56.96
Northern red oak	222,514	1,669	(N/A)	4.4	3.8	24.54
River birch	305,810	2,294	(N/A)	4.1	5.3	36.41
Sugar maple	1,001,292	7,510	(N/A)	3.8	17.2	127.28
Blue spruce	50,411	378	(N/A)	3.3	0.9	7.41
Swamp white oak	109,667	823	(N/A)	2.8	1.9	19.13
Green ash	425,079	3,188	(N/A)	2.7	7.3	77.76
Eastern white pine	96,830	726	(N/A)	2.6	1.7	18.16
Quaking aspen	69,088	518	(N/A)	2.5	1.2	13.64
Northern hackberry	217,168	1,629	(N/A)	2.2	3.7	47.90
White ash	157,746	1,183	(N/A)	2.2	2.7	34.80
Callery pear	30,581	229	(N/A)	2.1	0.5	6.95
Honeylocust	123,034	923	(N/A)	2.1	2.1	28.84
Bur oak	35,467	266	(N/A)	1.8	0.6	9.50
Maple	45,046	338	(N/A)	1.6	0.8	13.51
Eastern red cedar	11,323	85	(N/A)	1.4	0.2	4.04
Norway spruce	23,425	176	(N/A)	1.3	0.4	8.78
Eastern redbud	6,448	48	(N/A)	1.1	0.1	2.84
Broadleaf Deciduous	4,603	35	(N/A)	1.0	0.1	2.30
Ash	66,652	500	(N/A)	1.0	1.1	33.33
Littleleaf linden	30,520	229	(N/A)	0.9	0.5	16.35
White oak	9,879	74	(N/A)	0.8	0.2	5.70
Elm	11,841	89	(N/A)	0.8	0.2	6.83
Oak	93,483	701	(N/A)	0.8	1.6	53.93
Black walnut	128,472	964	(N/A)	0.7	2.2	87.59
Plum	5,817	44	(N/A)	0.6	0.1	4.85
Black ash	13,729	103	(N/A)	0.5	0.2	12.87
Black cherry	31,824	239	(N/A)	0.5	0.5	34.10
Amur maple	13,978	105	(N/A)	0.5	0.2	14.98
American basswood	24,851	186	(N/A)	0.5	0.4	26.63
Japanese tree lilac	5,625	42	(N/A)	0.5	0.1	6.03
Kentucky coffeetree	11,225	84	(N/A)	0.4	0.2	14.03
Boxelder	16,294	122	(N/A)	0.3	0.3	30.55
Broadleaf Deciduous	6,044	45	(N/A)	0.3	0.1	11.33
Birch	4,403	33	(N/A)	0.3	0.1	8.26
Willow	50,786	381	(N/A)	0.3	0.9	95.22
Northern white cedar	590	4	(N/A)	0.3	0.0	1.11
Basswood	5,926	44	(N/A)	0.3	0.1	11.11
Ginkgo	4,217	32	(N/A)	0.3	0.1	7.91
Mulberry	23,265	174	(N/A)	0.3	0.4	43.62
American sycamore	12,050	90	(N/A)	0.3	0.2	22.59
Eastern hemlock	1,427	11	(N/A)	0.1	0.0	5.35
Scotch pine	6,685	50	(N/A)	0.1	0.1	25.07
Red pine	4,513	34	(N/A)	0.1	0.1	16.92
White mulberry	13,485	101	(N/A)	0.1	0.2	50.57
Catalpa	81,925	614	(N/A)	0.1	1.4	307.22
Conifer Evergreen La	8,661	65	(N/A)	0.1	0.1	32.48
American elm	3,037	23	(N/A)	0.1	0.1	22.78
Broadleaf Evergreen I	484	4	(N/A)	0.1	0.0	3.63
Conifer Evergreen Sn	277	2	(N/A)	0.1	0.0	2.08
Cottonwood	1,035	8	(N/A)	0.1	0.0	7.76

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.

Stored CO_2 Benefits of Public Trees

Table 4 Continued

1/29/2021

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sumac	908	7	(N/A)	0.1	0.0	6.81
Pear	908	7	(N/A)	0.1	0.0	6.81
Black spruce	1,118	8	(N/A)	0.1	0.0	8.39
Northern pin oak	7,945	60	(N/A)	0.1	0.1	59.59
Siberian elm	41,265	309	(N/A)	0.1	0.7	309.48
Citywide total	5,810,257	43,577	(N/A)	100.0	100.0	28.39

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.

North Liberty

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees

1/29/2021

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
Apple	14,955	112	-532	-175	-5	15,573	117	29,821	224 (N/A)	15.2	4.0	0.96
Red maple	23,683	178	-931	-143	-8	24,700	185	47,309	355 (N/A)	7.8	6.3	2.98
Silver maple	91,152	684	-5,444	-258	-43	39,907	299	125,358	940 (N/A)	6.0	16.7	10.22
Spruce	6,605	50	-308	-124	-3	11,830	89	18,002	135 (N/A)	5.9	2.4	1.48
Norway maple	17,544	132	-550	-94	-5	14,738	111	31,638	237 (N/A)	5.3	4.2	2.89
Pin oak	47,800	359	-2,479	-146	-20	24,142	181	69,318	520 (N/A)	4.4	9.2	7.65
Northern red oak	11,706	88	-1,068	-99	-9	13,387	100	23,926	179 (N/A)	4.4	3.2	2.64
River birch	22,951	172	-1,469	-129	-12	22,481	169	43,834	329 (N/A)	4.1	5.8	5.22
Sugar maple	42,585	319	-4,814	-186	-38	26,411	198	63,995	480 (N/A)	3.8	8.5	8.13
Blue spruce	3,687	28	-242	-83	-2	8,069	61	11,431	86 (N/A)	3.3	1.5	1.68
Swamp white oak	7,735	58	-536	-57	-4	8,403	63	15,545	117 (N/A)	2.8	2.1	2.71
Green ash	23,163	174	-2,040	-104	-16	16,569	124	37,587	282 (N/A)	2.7	5.0	6.88
Eastern white pine	5,286	40	-465	-83	-4	7,760	58	12,498	94 (N/A)	2.6	1.7	2.34
Quaking aspen	10,432	78	-332	-52	-3	8,577	64	18,625	140 (N/A)	2.5	2.5	3.68
Northern hackberry	11,882	89	-1,043	-93	-9	16,897	127	27,643	207 (N/A)	2.2	3.7	6.10
White ash	15,098	113	-758	-64	-6	12,513	94	26,789	201 (N/A)	2.2	3.6	5.91
Callery pear	6,084	46	-155	-33	-1	4,848	36	10,745	81 (N/A)	2.1	1.4	2.44
Honeylocust	16,850	126	-596	-51	-5	10,393	78	26,596	199 (N/A)	2.1	3.5	6.23
Bur oak	4,423	33	-170	-25	-1	3,338	25	7,565	57 (N/A)	1.8	1.0	2.03
Maple	4,213	32	-216	-32	-2	5,403	41	9,368	70 (N/A)	1.6	1.2	2.81
Eastern red cedar	174	1	-54	-23	-1	2,011	15	2,109	16 (N/A)	1.4	0.3	0.75
Norway spruce	1,335	10	-112	-28	-1	2,501	19	3,695	28 (N/A)	1.3	0.5	1.39
Eastern redbud	921	7	-31	-12	0	959	7	1,838	14 (N/A)	1.1	0.2	0.81
Broadleaf Deciduous Smal	697	5	-22	-9	0	716	5	1,382	10 (N/A)	1.0	0.2	0.69
Ash	4,421	33	-320	-29	-3	4,768	36	8,840	66 (N/A)	1.0	1.2	4.42
Littleleaf linden	4,185	31	-149	-19	-1	2,409	18	6,427	48 (N/A)	0.9	0.9	3.44
White oak	2,104	16	-47	-12	0	1,579	12	3,623	27 (N/A)	0.8	0.5	2.09
Elm	2,278	17	-57	-13	-1	1,747	13	3,955	30 (N/A)	0.8	0.5	2.28
Oak	4,239	32	-449	-23	-4	3,608	27	7,374	55 (N/A)	0.8	1.0	4.25
Black walnut	6,104	46	-617	-28	-5	4,529	34	9,988	75 (N/A)	0.7	1.3	6.81
Plum	768	6	-28	-8	0	825	6	1,556	12 (N/A)	0.6	0.2	1.30
Black ash	1,893	14	-68	-10	-1	1,730	13	3,545	27 (N/A)	0.5	0.5	3.32
Black cherry	974	7	-153	-18	-1	1,896	14	2,699	20 (N/A)	0.5	0.4	2.89

Annual CO_2 Benefits of Public Trees

Table 5 Continued

1/29/2021

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
Amur maple	1,307	10	-67	-10	-1	1,488	11	2,717	20 (N/A)	0.5	0.4	2.91
American basswood	1,864	14	-119	-11	-1	1,620	12	3,354	25 (N/A)	0.5	0.4	3.59
Japanese tree lilac	721	5	-27	-8	0	782	6	1,469	11 (N/A)	0.5	0.2	1.57
Kentucky coffeetree	1,415	11	-54	-7	0	1,236	9	2,591	19 (N/A)	0.4	0.3	3.24
Boxelder	1,712	13	-78	-8	-1	1,212	9	2,837	21 (N/A)	0.3	0.4	5.32
Broadleaf Deciduous Medi	929	7	-30	-5	0	811	6	1,706	13 (N/A)	0.3	0.2	3.20
Birch	896	7	-21	-5	0	703	5	1,573	12 (N/A)	0.3	0.2	2.95
Willow	1,580	12	-244	-13	-2	2,056	15	3,379	25 (N/A)	0.3	0.4	6.34
Northern white cedar	141	1	-3	-4	0	264	2	399	3 (N/A)	0.3	0.1	0.75
Basswood	937	7	-28	-5	0	759	6	1,663	12 (N/A)	0.3	0.2	3.12
Ginkgo	232	2	-20	-3	0	330	2	538	4 (N/A)	0.3	0.1	1.01
Mulberry	1,225	9	-112	-11	-1	1,313	10	2,415	18 (N/A)	0.3	0.3	4.53
American sycamore	1,545	12	-58	-7	0	1,337	10	2,817	21 (N/A)	0.3	0.4	5.28
Eastern hemlock	168	1	-7	-3	0	311	2	469	4 (N/A)	0.1	0.1	1.76
Scotch pine	375	3	-32	-5	0	493	4	830	6 (N/A)	0.1	0.1	3.11
Red pine	303	2	-22	-5	0	463	3	739	6 (N/A)	0.1	0.1	2.77
White mulberry	0	0	-65	-7	-1	670	5	598	4 (N/A)	0.1	0.1	2.24
Catalpa	1,438	11	-393	-10	-3	1,463	11	2,498	19 (N/A)	0.1	0.3	9.37
Conifer Evergreen Large	116	1	-42	-6	0	527	4	595	4 (N/A)	0.1	0.1	2.23
American elm	222	2	-15	-2	0	418	3	623	5 (N/A)	0.1	0.1	4.67
Broadleaf Evergreen Medi	56	0	-2	-1	0	141	1	194	1 (N/A)	0.1	0.0	1.45
Conifer Evergreen Small	40	0	-1	-1	0	82	1	119	1 (N/A)	0.1	0.0	0.89
Cottonwood	209	2	-5	-1	0	159	1	361	3 (N/A)	0.1	0.0	2.71
Sumac	114	1	-4	-1	0	124	1	232	2 (N/A)	0.1	0.0	1.74
Pear	114	1	-4	-1	0	124	1	232	2 (N/A)	0.1	0.0	1.74
Black spruce	91	1	-5	-2	0	213	2	296	2 (N/A)	0.1	0.0	2.22
Northern pin oak	470	4	-38	-3	0	440	3	869	7 (N/A)	0.1	0.1	6.52
Siberian elm	983	7	-198	-6	-2	829	6	1,608	12 (N/A)	0.1	0.2	12.06
Citywide total	437,130	3,278	-27,950	-2,414	-228	345,585	2,592	752,352	5,643 (N/A)	100.0	100.0	3.68

Annual Aesthetic/Other Benefits of Public Trees

1/29/2021

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	822	(N/A)	15.2	1.7	3.51
Red maple	3,635	(N/A)	7.8	7.5	30.54
Silver maple	7,589	(N/A)	6.0	15.6	82.49
Spruce	1,858	(N/A)	5.9	3.8	20.41
Norway maple	2,002	(N/A)	5.3	4.1	24.42
Pin oak	4,128	(N/A)	4.4	8.5	60.70
Northern red oak	1,041	(N/A)	4.4	2.1	15.31
River birch	2,267	(N/A)	4.1	4.7	35.99
Sugar maple	4,105	(N/A)	3.8	8.4	69.58
Blue spruce	1,057	(N/A)	3.3	2.2	20.73
Swamp white oak	872	(N/A)	2.8	1.8	20.27
Green ash	1,993	(N/A)	2.7	4.1	48.61
Eastern white pine	1,164	(N/A)	2.6	2.4	29.10
Quaking aspen	1,256	(N/A)	2.5	2.6	33.04
Northern hackberry	1,673	(N/A)	2.2	3.4	49.22
White ash	1,909	(N/A)	2.2	3.9	56.14
Callery pear	721	(N/A)	2.1	1.5	21.85
Honeylocust	3,852	(N/A)	2.1	7.9	120.39
Bur oak	592	(N/A)	1.8	1.2	21.16
Maple	697	(N/A)	1.6	1.4	27.88
Eastern red cedar	105	(N/A)	1.4	0.2	5.00
Norway spruce	384	(N/A)	1.3	0.8	19.18
Eastern redbud	51	(N/A)	1.1	0.1	2.98
Broadleaf Deciduous Small	36	(N/A)	1.0	0.1	2.41
Ash	458	(N/A)	1.0	0.9	30.52
Littleleaf linden	502	(N/A)	0.9	1.0	35.89
White oak	306	(N/A)	0.8	0.6	23.57
Elm	319	(N/A)	0.8	0.7	24.57
Oak	428	(N/A)	0.8	0.9	32.89
Black walnut	515	(N/A)	0.7	1.1	46.80
Plum	43	(N/A)	0.6	0.1	4.73
Black ash	209	(N/A)	0.5	0.4	26.07
Black cherry	57	(N/A)	0.5	0.1	8.16
Amur maple	75	(N/A)	0.5	0.2	10.68
American basswood	162	(N/A)	0.5	0.3	23.13
Japanese tree lilac	40	(N/A)	0.5	0.1	5.78
Kentucky coffeetree	163	(N/A)	0.4	0.3	27.14
Boxelder	157	(N/A)	0.3	0.3	39.36
Broadleaf Deciduous Medium	104	(N/A)	0.3	0.2	26.12
Birch	105	(N/A)	0.3	0.2	26.22
Willow	137	(N/A)	0.3	0.3	34.36
Northern white cedar	45	(N/A)	0.3	0.1	11.13
Basswood	118	(N/A)	0.3	0.2	29.43
Ginkgo	19	(N/A)	0.3	0.0	4.64
Mulberry	73	(N/A)	0.3	0.2	18.27
American sycamore	166	(N/A)	0.3	0.3	41.53
Eastern hemlock	48	(N/A)	0.1	0.1	23.87
Scotch pine	94	(N/A)	0.1	0.2	47.08

Annual Aesthetic/Other Benefits of Public Trees

Table 6 Continued

1/29/2021

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Red pine	79	(N/A)	0.1	0.2	39.70
White mulberry	0	(N/A)	0.1	0.0	0.00
Catalpa	95	(N/A)	0.1	0.2	47.59
Conifer Evergreen Large	32	(N/A)	0.1	0.1	16.16
American elm	37	(N/A)	0.1	0.1	36.79
Broadleaf Evergreen Medium	22	(N/A)	0.1	0.0	21.93
Conifer Evergreen Small	21	(N/A)	0.1	0.0	21.34
Cottonwood	29	(N/A)	0.1	0.1	28.56
Sumac	6	(N/A)	0.1	0.0	6.40
Pear	6	(N/A)	0.1	0.0	6.40
Black spruce	25	(N/A)	0.1	0.1	25.23
Northern pin oak	43	(N/A)	0.1	0.1	43.05
Siberian elm	54	(N/A)	0.1	0.1	54.03
Citywide total	48,604	(N/A)	100.0	100.0	31.66

North Liberty

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

1/29/2021

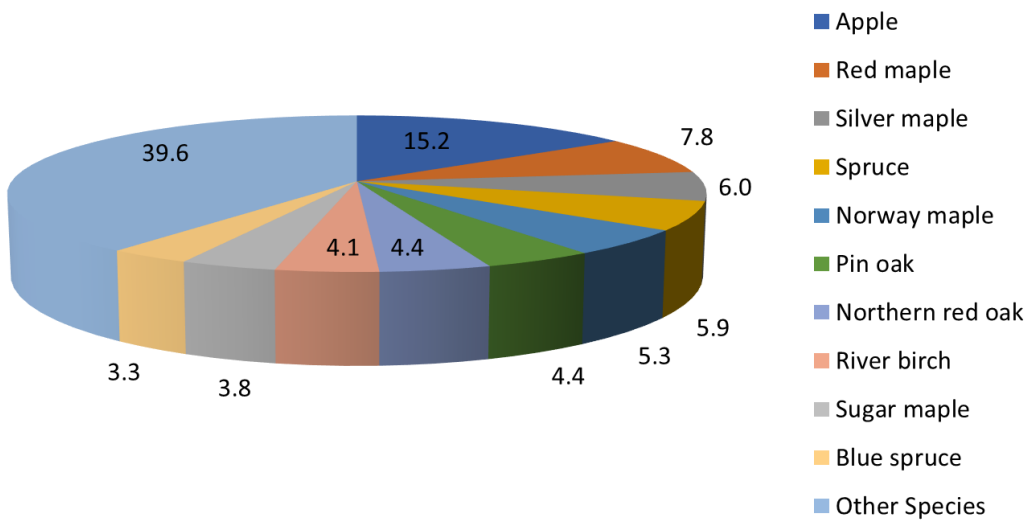
Benefits	Total ($)	Standard Error	$/tree	Standard Error	$/capita	Standard Error
Energy	43,432	(N/A)	28.29	(N/A)	0.00	(N/A)
CO2	5,643	(N/A)	3.68	(N/A)	0.00	(N/A)
Air Quality	6,754	(N/A)	4.40	(N/A)	0.00	(N/A)
Stormwater	51,926	(N/A)	33.83	(N/A)	0.00	(N/A)
Aesthetic/Other	48,604	(N/A)	31.66	(N/A)	0.00	(N/A)
Total Benefits	156,358	(N/A)	101.86	(N/A)	0.00	(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	156,358	(N/A)	101.86	(N/A)	0.00	(N/A)
Benefit-cost ratio	0.00	(N/A)				

North Liberty

Species Distribution of Public Trees

1/29/2021

Figure 1: Species Distribution



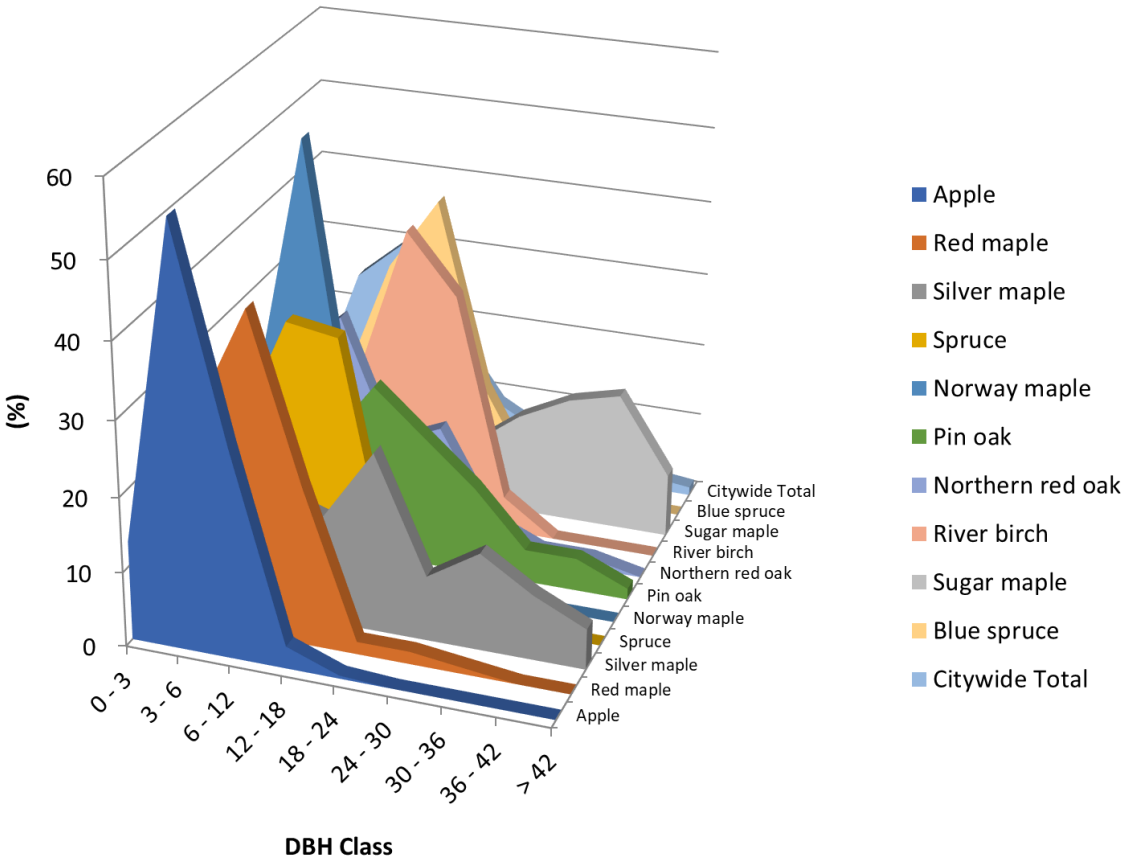
Species	Percent
Apple	15.2
Red maple	7.8
Silver maple	6.0
Spruce	5.9
Norway maple	5.3
Pin oak	4.4
Northern red oak	4.4
River birch	4.1
Sugar maple	3.8
Blue spruce	3.3
Other Species	39.6
Total	100.0

North Liberty

Figure 2: Relative Age Class

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

1/29/2021



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Apple	13.25	55.56	27.78	2.99	0.43	0.00	0.00	0.00	0.00
Red maple	3.36	28.57	42.86	21.01	1.68	1.68	0.84	0.00	0.00
Silver maple	0.00	9.78	16.30	14.13	23.91	8.70	13.04	8.70	5.43
Spruce	3.30	20.88	36.26	35.16	3.30	1.10	0.00	0.00	0.00
Norway maple	3.66	23.17	57.32	13.41	2.44	0.00	0.00	0.00	0.00
Pin oak	0.00	22.06	14.71	23.53	17.65	11.76	4.41	4.41	1.47
Northern red oak	10.29	23.53	29.41	13.24	16.18	4.41	1.47	1.47	0.00
River birch	3.17	1.59	19.05	39.68	31.75	4.76	0.00	0.00	0.00
Sugar maple	1.69	18.64	11.86	1.69	8.47	13.56	16.95	18.64	8.47
Blue spruce	3.92	11.76	29.41	39.22	13.73	1.96	0.00	0.00	0.00
Citywide Total	6.38	24.69	30.36	18.18	8.99	5.34	3.06	1.89	1.11

Figure 3: Foliage Condition

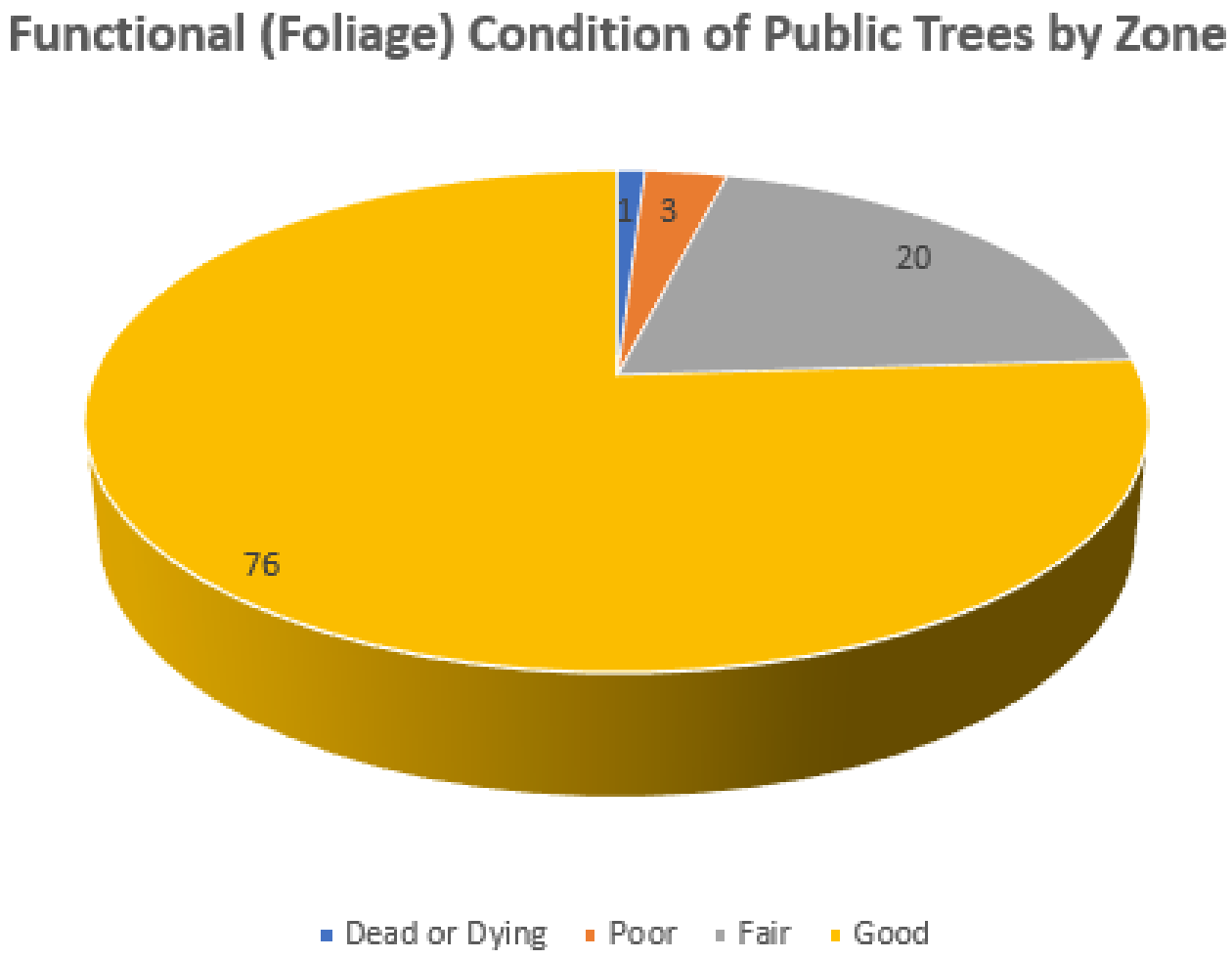


Figure 4: Wood Condition

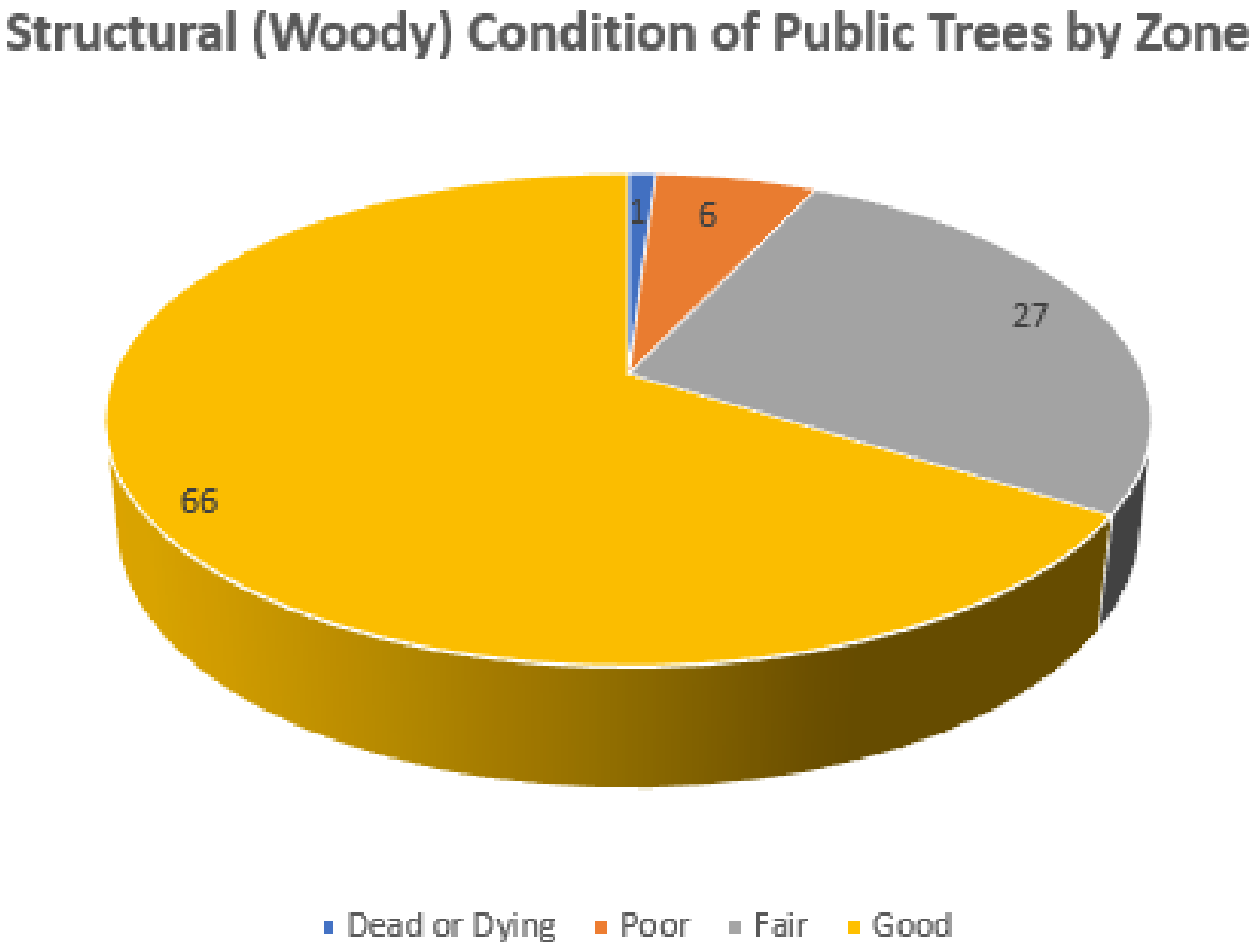
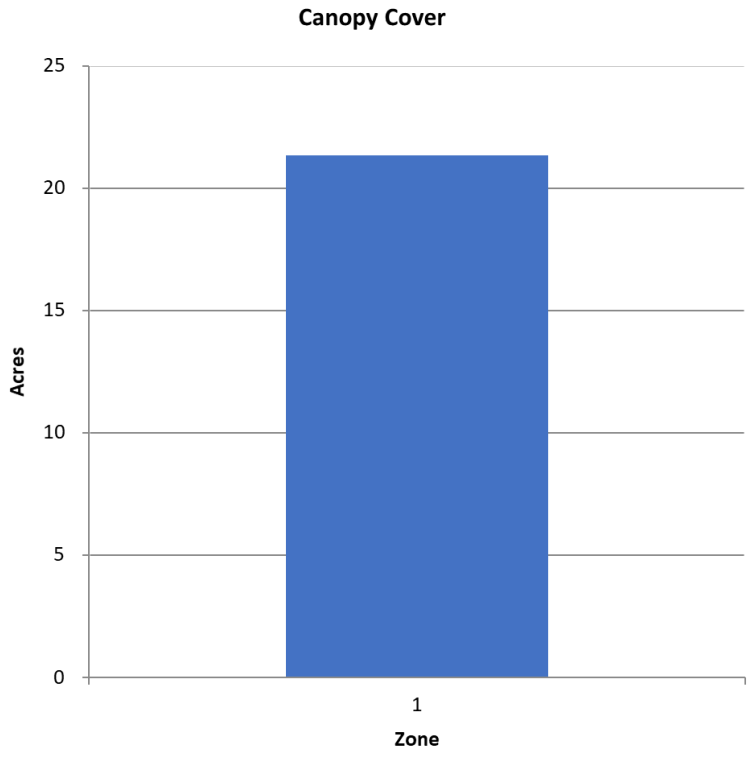


Figure 5: Canopy Cover in Acres

North Liberty

Canopy Cover of Public Trees (Acres)

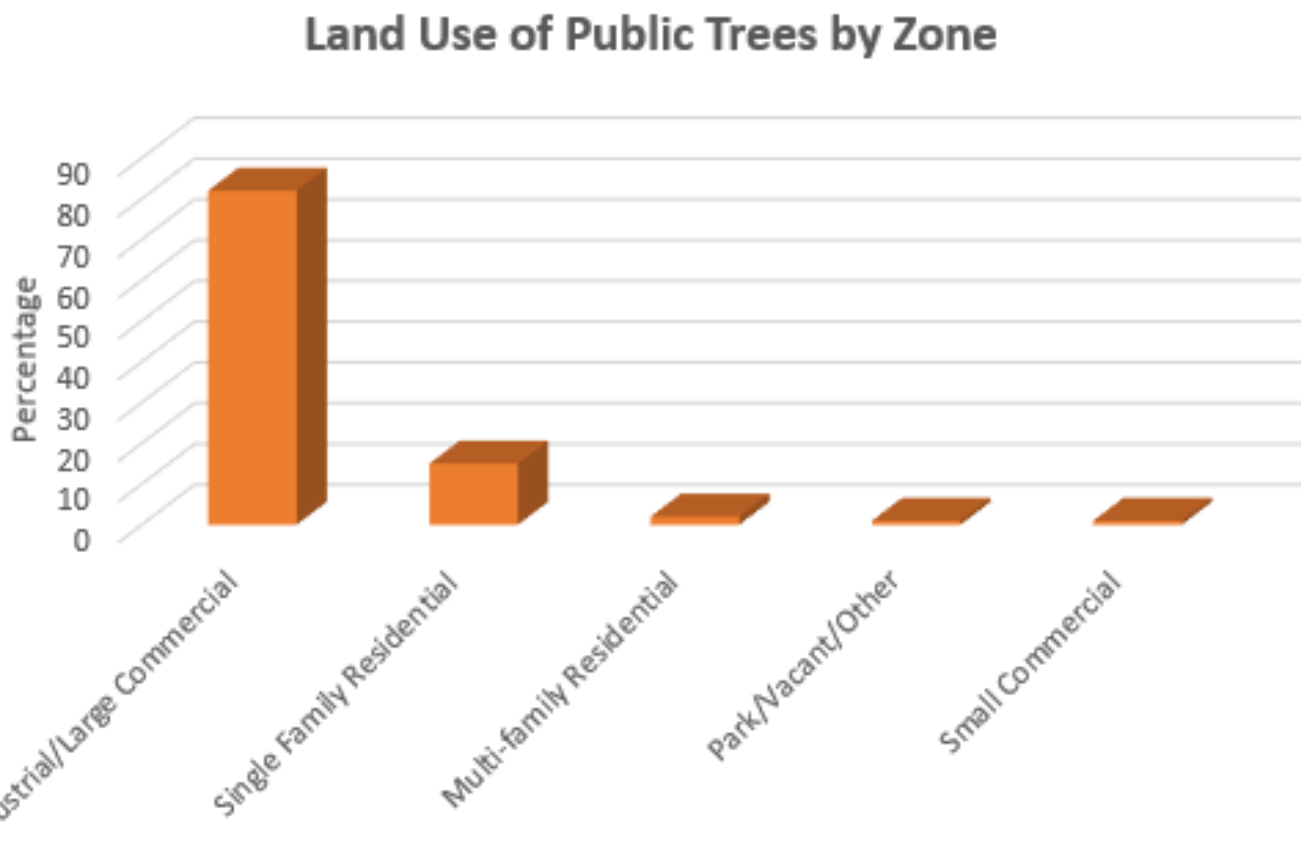
1/29/2021



Zone	Acres	% of Total Canopy Cover
1	21	100.0
Citywide total	21	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	21	0.00	0.00

Figure 6: Land Use of City/Park Trees



APPENDIX B: ArcGIS MAPPING

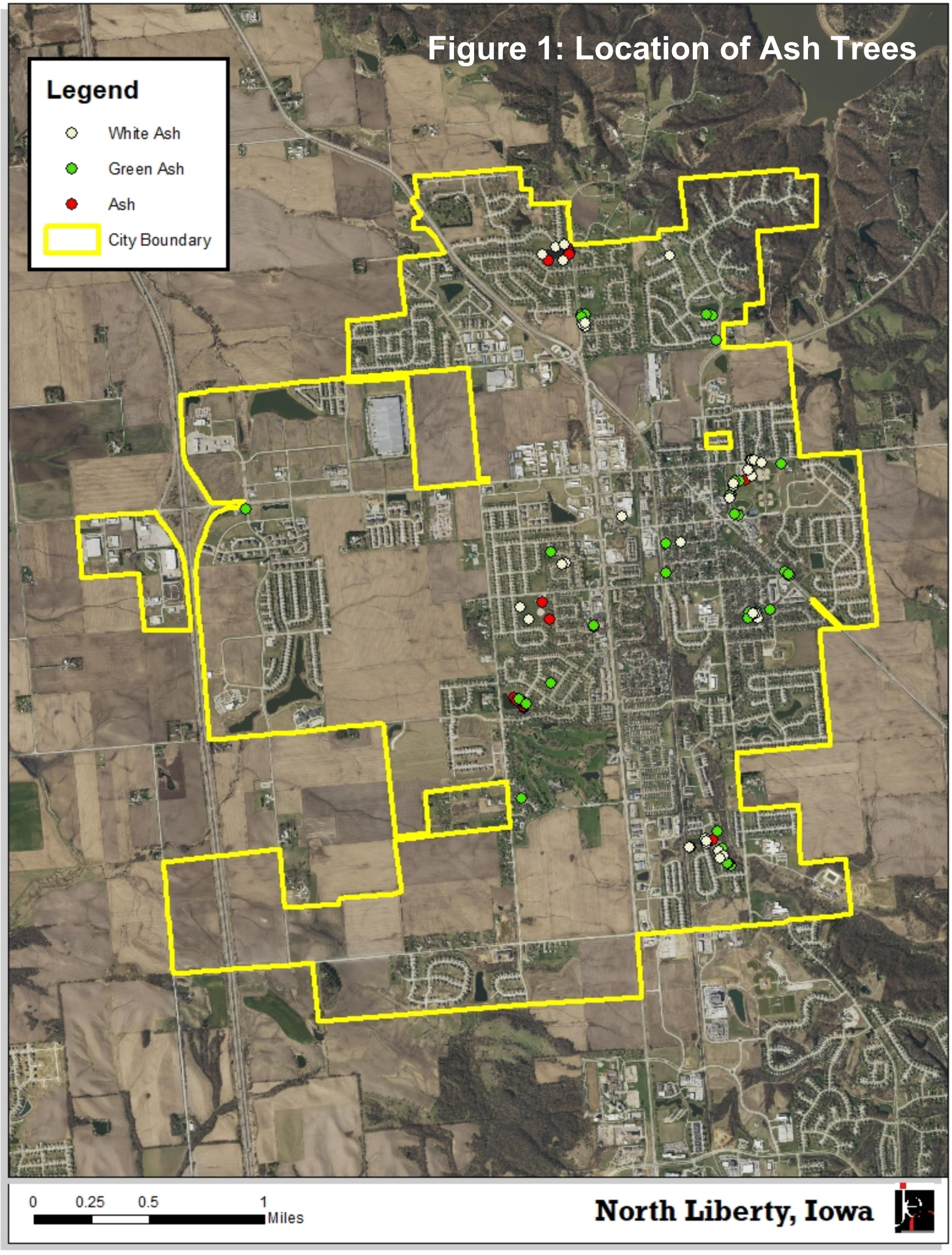


Figure 1: Location of Ash Trees
Legend
White Ash
Green Ash
Ash
City Boundary
0
0.25
0.5
1
Miles
North Liberty, Iowa

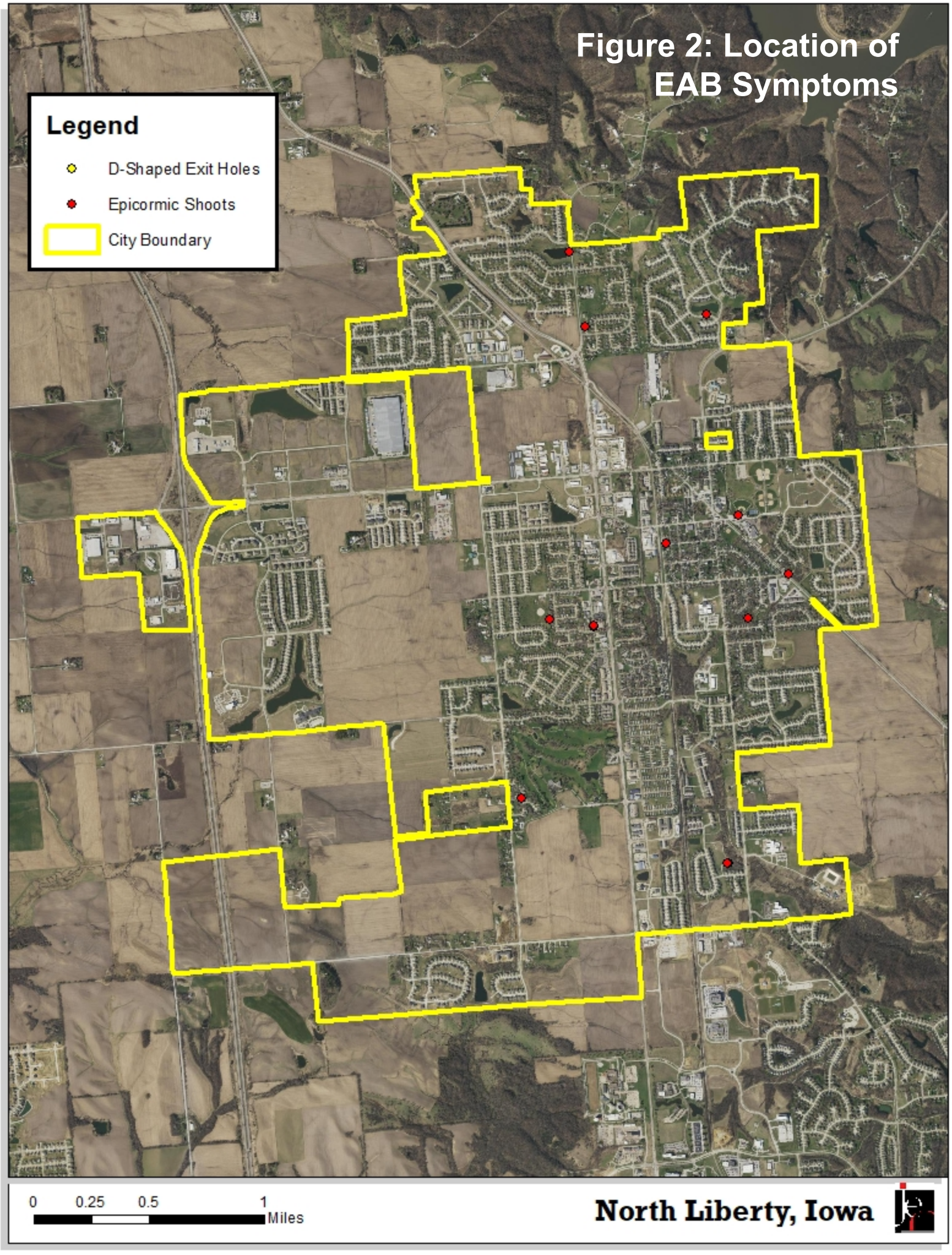


Figure 2: Location of EAB Symptoms
Legend
D-Shaped Exit Holes
Epicormic Shoots
City Boundary
0
0.25
0.5
1
Miles
North Liberty, Iowa

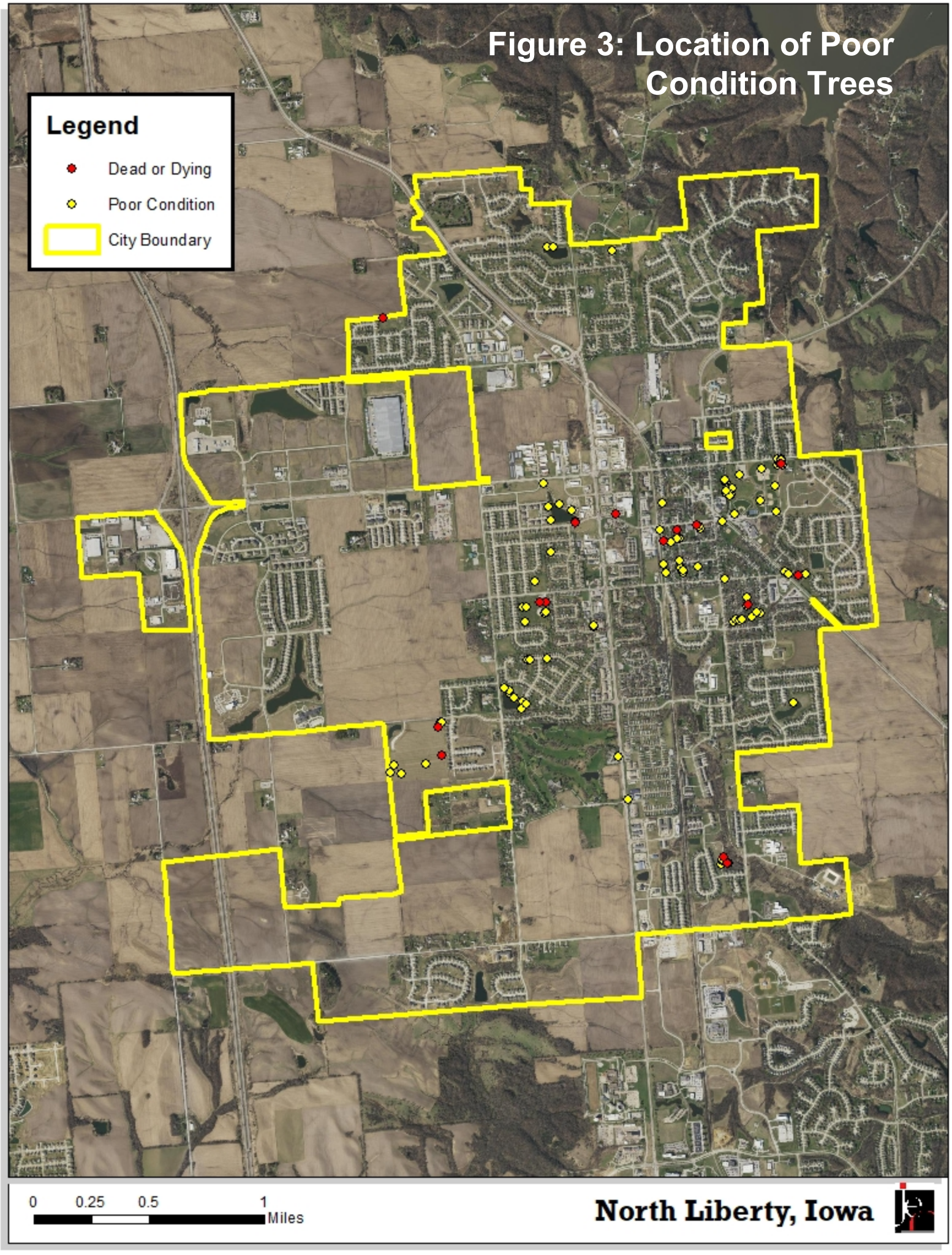
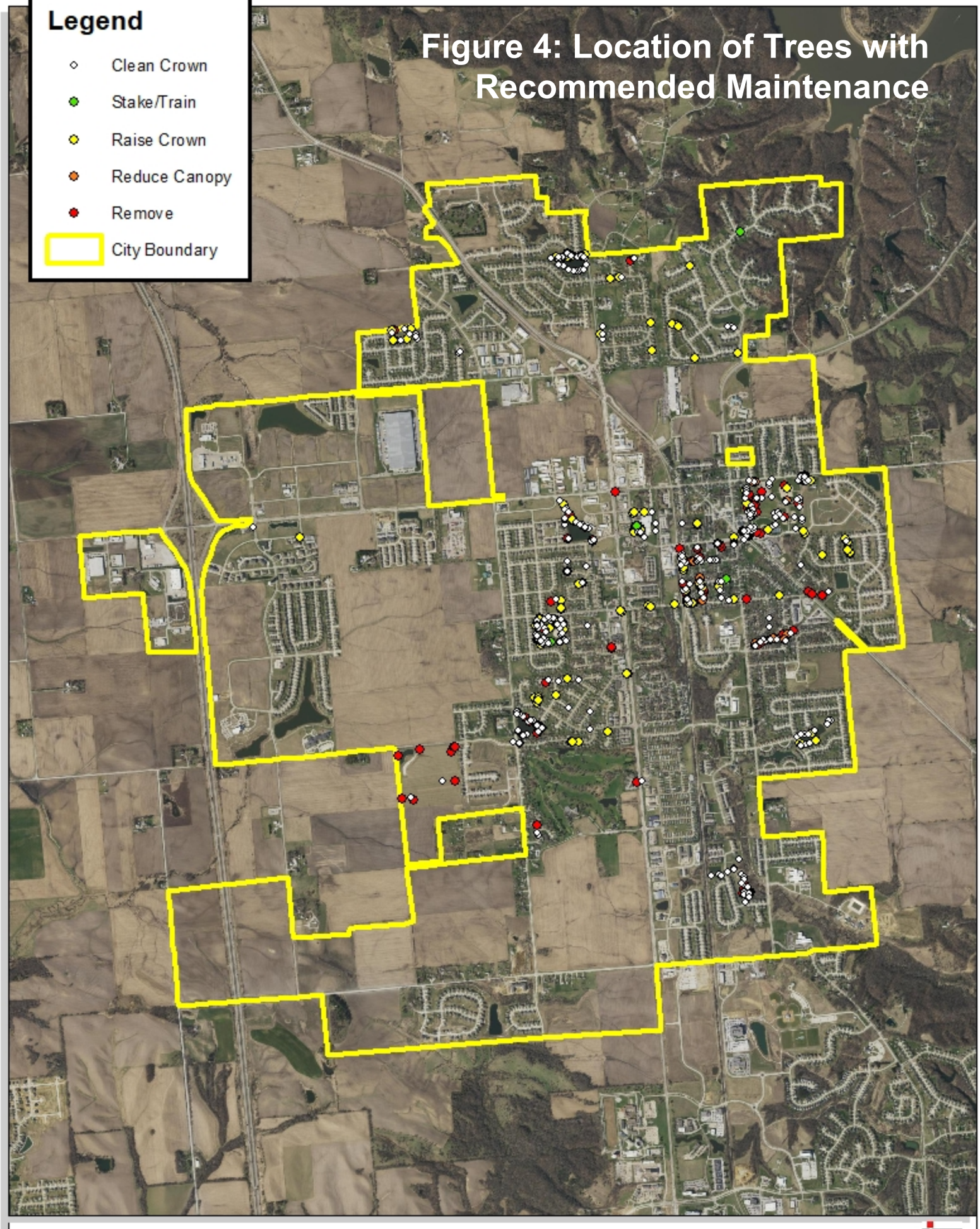


Figure 3: Location of Poor Condition Trees
Legend
Dead or Dying
Poor Condition
City Boundary
0
0.25
0.5
1
Miles
North Liberty, Iowa


Legend
Clean Crown
Stake/Train
Raise Crown
Reduce Canopy
Remove
City Boundary
Figure 4: Location of Trees with Recommended Maintenance
0
0.25
0.5
1
Miles
North Liberty, Iowa

APPENDIX C: NORTH LIBERTY TREE ORDINANCES

150.01 PURPOSE.
The purpose of this chapter is to regulate and preserve the appearance of the City by requiring trees, shrubs, and bushes to be uniformly located, and to regulate the planting and care of such trees, shrubs, and bushes in the City for the protection of public health, safety, and welfare.

150.02 DEFINITIONS.
For the purposes of this chapter, the following definitions apply:

1. "Owner" means a person owning private property in the City as shown by County records. This term includes the term "agent," "occupant," "tenant," and "person in control" of the property.
2. "Parking" means the area within a street right-of-way located between the back of the curb and edge of the sidewalk closest to the curb. Also referred to as "parkway."
3. "Private property" means all property not owned by the City.
4. "Public property" means any and all property located within the confines of the City and owned by the City or held in the name of the City by any departments, commissions, or agencies within the City government.
5. "Public right-of-way" means that portion of land between property lines that is dedicated and deeded to the City to provide the area necessary for the installation of street and sidewalk surfacing, public utilities, and other improvements.
6. Street" means the right-of-way dedicated to public use serving more than one property with vehicular access and frontage.

150.03 TREES, SHRUBS, OR BUSHES IN THE PUBLIC RIGHT-OF-WAY.

1. It is unlawful for any person to plant any tree, shrub, or bush in any public right-of-way or parking. In the event that the City or a private utility disturbs any public right-of-way or parking, the City or the private utility shall only be responsible for reseeding and establishing grass in the disturbed area.
2. The City of North Liberty may plant trees, shrubs, and/or bushes in the public right-of-way as a part of an approved City project, such as landscaped medians and boulevards.

150.04 PROHIBITED TREES.
The following species of trees are declared to be nuisances, and no person shall plant any of the following trees within the City:

Black Locust	Russian Olive
Box Elder	Siberian Elm
Cotton Bearing Poplar	Silver Maple/White River Maple (soft maples)
Female Ginkgo	Tree of Heaven
Green Ash	White Ash

150.05 DUTY TO TRIM.

1. All trees, shrubs, and bushes in the parking that overhang onto the street, alley, or other roadways of the City shall be trimmed immediately above such streets, alleys, or roadways and clear of the curb line, as determined to be necessary and appropriate by the Street Superintendent. The trimming under this subsection shall be the responsibility of the City.
2. All trees, shrubs, and bushes, whether in the parking or on private property that overhang onto any sidewalk or trail of the City shall be trimmed to a minimum height of eight (8) feet immediately above such sidewalk or trail. Any trees, shrubs, and bushes, whether in the parking or on private property, lower than eight (8) feet shall be trimmed so as to be at least two (2) feet clear of any sidewalk or trail. All trees on private property shall be trimmed to a minimum height of sixteen (16) feet immediately above and at least two (2) feet clear of any public street, alley or roadway. The trimming under this subsection shall be the responsibility of the property owners, agents, or occupants of property adjoining any sidewalk or trail.

150.06 REMOVAL OF TREES.
The City shall remove any tree standing on public property, or in the public right-of-way or parking thereof, which is dead, diseased, or declared to be a nuisance to public safety and may remove any other trees in its discretion. No compensation shall be paid to the abutting property owner regardless of whether the City or the property owner placed the tree in the public right-of-way or parking. Any person desiring to remove a live tree which has been planted in the public right-of-way or parking shall first obtain a permit from the Street Superintendent. If a permit is issued, the permittee must remove the tree at the permittee's own expense. No fee shall be charged for the permit to remove the tree.

150.07 TREE, SHRUB AND BUSH REMOVAL ON PUBLIC PROPERTY.
No trees, shrubs, bushes, or other parts thereof which are dead, decayed, diseased, or dying upon a street, public right-of-way, parking, or public property of the City and which constitute a hazard to the health, safety, or well-being of any person shall be allowed to remain in such condition. No trees, shrubs, or bushes shall be maintained in such a manner as to interfere with the moving of traffic upon the streets in a safe and orderly manner.

150.08 TREE, SHRUB, AND BUSH REMOVAL ON PRIVATE PROPERTY.
No trees, shrubs, or bushes or parts thereof on private property which are dead, decayed, diseased, or dying or which have become dangerous to the public shall be allowed to remain in such condition.

150.09 PERMIT AND REGULATION.

1. No trees, shrubs, or bushes may be planted on any public property or within any public utility easement without written permission of the City. No trees, shrubs, or bushes shall be planted under existing lines if, at maturity, it is likely to cause interference with those lines.
2. Trees required by City ordinance or approved site plans to be planted in and around parking lots, with the intent to provide shade for such parking lots, shall have a caliper of

at least two (2) inches at the time of planting and an anticipated mature height of at least fifteen (15) feet.

150.10 AUTHORITY OF THE COUNCIL.

1. The City shall have the authority to order the property owner, agent, or occupant of the property adjoining any sidewalk to prune, maintain, and care for all trees, shrubs, and bushes located on the street, public right-of-way, parking, or the adjoining property of the owner, agent, or occupant that have become dangerous to the public or that may interfere with the regular movement of pedestrian or other permitted traffic upon the sidewalks in a safe manner, by serving notice upon the property owner to comply with the order. This order is in addition to the requirements that all trees, shrubs, and bushes be trimmed as above described.
2. Should the adjoining property owner, agent, or occupant fail to comply with said order within thirty (30) days after receiving notice from the City, then the City may order the pruning or maintenance of such trees, shrubs, and bushes, and the City Council may assess the costs thereof against the adjoining property by resolution of the Council.

(Ch. 150 - Ord. 14-15 – Feb. 15 Supp.)