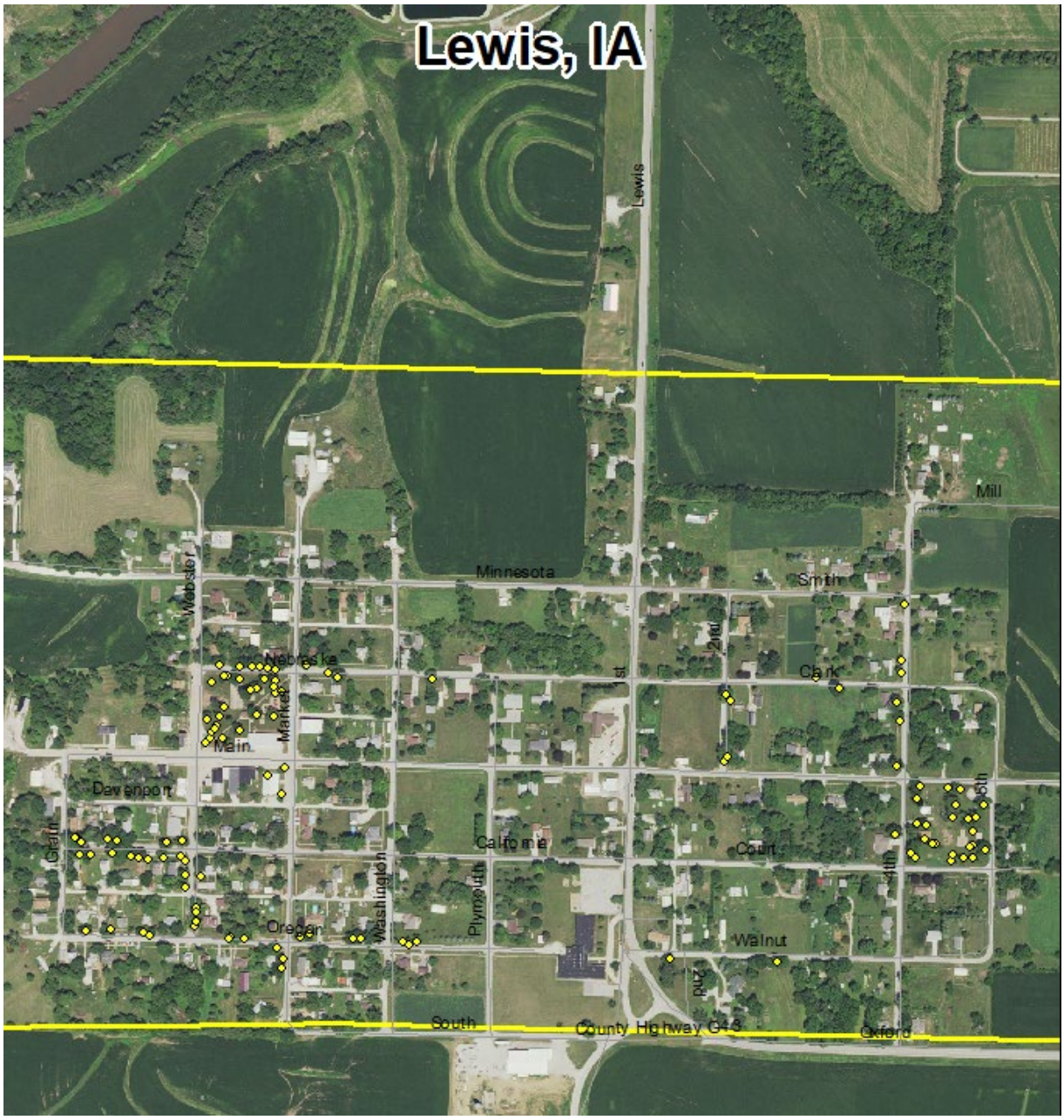
Lewis, IA



2018 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Lewis with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 18% of Lewis's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2017, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 115 trees inventoried.

- Lewis's trees provide $22,771 of benefits annually, an average of $198 a tree
- There are over 23 species of trees
- The top three genera are: Maple 35%, Ash 18%, and Walnut 7%
- 15% of trees are in need of some type of management
- 5 trees are recommended for removal

Recommendations

The core recommendations are detailed in the Recommendations Section. The Emerald Ash Borer Plan includes management recommendations as well. Below are some key recommendations.

- Of the 5 trees needing removal, one is a critical concern and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 4 of the 21 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation
- 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 with a visual survey yearly
- With the current budget it could take 24 years to remove ash – Suggestion: request a budget increase to $4,000 annually and apply for grants to plant replacement trees

Introduction

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

Trees are an important component of Lewis's infrastructure and one of the greatest assets to the community. The benefits of trees are immense. Trees provide the community with improved air quality, stormwater runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and create a desirable place to live, to name just a few benefits. It is essential that these benefits be maintained for the people of Lewis and future generations through good urban forestry management.

Good urban forestry management involves setting goals and developing management strategies to achieve these goals. An essential part of developing management strategies is a comprehensive public tree inventory. The inventory supplies information that will be used for maintenance, removal schedules, tree planting and budgeting. Basing actions on this information will help meet Lewis's urban forestry goals.

Inventory

In 2017, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected 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 programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms associated with EAB were noted for all ash trees. The signs and symptoms noted were canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

The data collected for the 115 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. The following are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Lewis's trees reduce energy related costs by approximately $6,183 annually (Appendix A, Table 1). These savings are both in Electricity (29.2 MWh) and in Natural Gas (4,046.4 Therms).

Annual Stormwater Benefits

Lewis's trees intercept about 344,890 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $9,347 of benefits to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Lewis, it is estimated that trees remove 386.1 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $1,093 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Lewis, trees sequester about 63,389 lbs of carbon a year with an associated value of $791 (Appendix A, Table 5). In addition, the trees store 1,373,083 lbs of carbon, with a yearly benefit of $10,298 (Appendix A, Table 4).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Lewis receives $5,357 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, Lewis's trees provide $22,771of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 115 trees in Lewis provide approximately $198 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

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

Maple	40	35%
Ash	21	18%

Walnut	8	7%
Apple (crabapple)	8	7%
Oak	8	7%
Elm	7	6%
Red buf	5	4%
Hackberry	5	4%
Honey Locust	3	3%
Buckeye	2	2%
Spruce	2	2%
Pine	2	2%
Linden	2	2%
Sycamore	1	1%
Pear	1	1%

Age Class

Most of Lewis's trees (45%) are between 24 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Lewis'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 overall health of the urban forest. The foliage condition results for Lewis indicate that 93% of the trees are in good health, with only 1% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 27% of Lewis's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 19% of the population. This 19% 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).

Crown Cleaning	11	10%
Crown Raising	0	0%
Tree Staking	0	0%
Tree Removal	5	4%
Crown Reduction	1	<1%

Canopy Cover

The total canopy with both private and public trees is 13%, 40 acres. The canopy cover included in the Lewis inventory includes approximately 3.5 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years. To achieve this goal it is estimated that 23 trees need to be planted annually on private and public lands.

Land Use and Location

The majority of Lewis'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	
Single family residential	60%
Park/vacant/other	0%
Industrial/Large commercial	39%
Small commercial	0%
Multifamily residential	0%

Location	
Planting strip	44%
Other maintained locations	0%
Cutout (surrounded by pavement)	0%
Front yard	56%

Recommendations

Risk Management

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

Hazardous trees

Lewis has one critical concern trees that need immediate removal and 4 other removals. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter trees first, however none of these trees are over 24 inches in diameter. Please refer to the six year maintenance plan at the end of this section. After all of the immediate removal trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 11 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 5 removals, 2 are ash trees. There are a total of 21 ash trees, and 4 of those have one sign and symptom that have been associated with EAB. In addition, there are 6 trees that are in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning

removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six year maintenance plan for further information.

Planting

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

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 (35%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Continual Monitoring

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

Six Year Maintenance Plan with <u>No Additional Funding</u>

Year 1

- Removal: 1 critical concern tree
- Planting and Replacement: 2 trees to be planted in open locations
- Young Tree Pruning & Maintenance:
- Visual Survey for signs and symptoms of EAB

Year 2

- Removal: 1 tree
- *Or saving for ash tree treatment and/or future ash removal
- Planting and Replacement: 1 trees in open locations from year one removals
- Young Tree Pruning & Maintenance
- Routine trimming: 1 tree
- Visual Survey for signs and symptoms of EAB

Year 3

- Removal: 1 tree
- *Or saving for ash tree treatment and/or future ash removal

Planting and Replacement: 2 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance
Visual Survey for signs and symptoms of EAB

Year 4
Removal: 1 tree
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 1 trees in open locations from year one removals
Young Tree Pruning & Maintenance
Routine trimming: 1 tree
Visual Survey for signs and symptoms of EAB

Year 5
Removal: 1 tree
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 2 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance
Visual Survey for signs and symptoms of EAB

Year 6
Removal: 1 tree - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 1 trees in open locations from year one removals
Young Tree Pruning & Maintenance
Routine trimming: 1 tree
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 3 ash trees removed (approximately 14% of ash). It will take approximately 24 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.
**To remove all ash trees within 6 years, the budget would need to be increased to $4,000 a year.

Emerald Ash Borer Plan

Ash Tree Removal

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

Treatment of Ash Trees

Chemical treatment can be effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if

EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. 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 disposed of as you normally would if your county is not part of a quarantine.

Canopy Replacement

As budget permits, all removed trees will be replaced. The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

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

Monitoring

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

Private Ash Trees
It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used.

Budget

Current Budget
Total $6,000 over 6 years ($1,000/year)

FY 2018 Budget
Removal: $800
*Or saving for ash tree treatment and/or future ash removal
Planting: $200

FY 2019 Budget
Removal: $800
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Routine trimming: $100

FY 2020 Budget
Removal: $800
*Or saving for ash tree treatment and/or future ash removal
Planting: $200

FY 2021 Budget
Removal: $800
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Routine trimming: $100

FY 2022 Budget
Removal: $800
*Or saving for ash tree treatment and/or future ash removal
Planting: $200

FY 2023 Budget
Removal: $800
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Routine trimming: $100

*Reduction of ash over 6 years: approximately 3 ash trees removed (approximately 14% of ash). **It will take approximately 24 years to remove all ash with the current budget.**

Purposed Budget Increase

EAB could potentially kill all ash trees in Lewis within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $4,000 a year. Additionally, it is recommended that Lewis apply for grants to fund replacement trees. Utility Company grants are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at $15 per inch, about 4 trees could be treated per year for $600 (every other year treatment). This would be 8 trees selected for treatment, and Lewis would still need to find $10,400 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $2,250 a year for treatment and leave $4,800 for removal. These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Lewis. It is suggested to consider increasing the budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Lewis

Annual Energy Benefits of Public Trees

4/1/2018

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	7.3	553	1,018.6	998	1,551	(N/A)	18.3	25.1	73.88
Silver maple	5.1	384	650.5	637	1,022	(N/A)	15.7	16.5	56.75
Norway maple	2.8	211	413.8	406	617	(N/A)	9.6	10.0	56.07
Apple	0.6	49	109.2	107	156	(N/A)	7.0	2.5	19.52
Black walnut	2.8	210	380.4	373	583	(N/A)	7.0	9.4	72.82
Northern red oak	1.7	130	243.2	238	369	(N/A)	6.1	6.0	52.67
Sugar maple	1.9	145	244.3	239	384	(N/A)	6.1	6.2	54.90
Siberian elm	2.1	163	286.3	281	444	(N/A)	5.2	7.2	73.95
Northern hackberry	1.7	125	239.6	235	360	(N/A)	4.3	5.8	72.06
Eastern redbud	0.3	24	55.1	54	78	(N/A)	4.3	1.3	15.64
Red maple	0.5	36	63.1	62	98	(N/A)	2.6	1.6	32.70
Honeylocust	0.5	41	73.8	72	114	(N/A)	2.6	1.8	37.89
Littleleaf linden	0.2	17	27.9	27	45	(N/A)	1.7	0.7	22.26
Ohio buckeye	0.2	16	33.7	33	49	(N/A)	1.7	0.8	24.47
Maple	0.0	0	0.7	1	1	(N/A)	0.9	0.0	1.03
Northern pin oak	0.3	20	39.6	39	59	(N/A)	0.9	0.9	58.69
American sycamore	0.4	29	53.7	53	82	(N/A)	0.9	1.3	82.02
Blue spruce	0.0	0	1.2	1	2	(N/A)	0.9	0.0	1.65
Norway spruce	0.1	11	19.7	19	30	(N/A)	0.9	0.5	30.47
Pear	0.0	2	3.8	4	5	(N/A)	0.9	0.1	5.40
Elm	0.4	33	59.0	58	91	(N/A)	0.9	1.5	91.02
Eastern white pine	0.1	11	19.7	19	30	(N/A)	0.9	0.5	30.47
Scotch pine	0.1	4	9.5	9	14	(N/A)	0.9	0.2	13.58
Total	29.2	2,218	4,046.4	3,965	6,183	(N/A)	100.0	100.0	53.77

Table 2: Annual Stormwater Benefits

Lewis

Annual Stormwater Benefits of Public Trees

4/1/2018

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	97,277	2,636	(N/A)	18.3	28.2	125.53
Silver maple	67,193	1,821	(N/A)	15.7	19.5	101.16
Norway maple	31,299	848	(N/A)	9.6	9.1	77.11
Apple	2,768	75	(N/A)	7.0	0.8	9.38
Black walnut	35,452	961	(N/A)	7.0	10.3	120.09
Northern red oak	19,229	521	(N/A)	6.1	5.6	74.44
Sugar maple	20,857	565	(N/A)	6.1	6.0	80.75
Siberian elm	22,999	623	(N/A)	5.2	6.7	103.88
Northern hackberry	16,637	451	(N/A)	4.3	4.8	90.17
Eastern redbud	1,127	31	(N/A)	4.3	0.3	6.11
Red maple	2,854	77	(N/A)	2.6	0.8	25.79
Honeylocust	2,811	76	(N/A)	2.6	0.8	25.40
Littleleaf linden	1,353	37	(N/A)	1.7	0.4	18.34
Ohio buckeye	1,172	32	(N/A)	1.7	0.3	15.88
Maple	12	0	(N/A)	0.9	0.0	0.32
Northern pin oak	2,479	67	(N/A)	0.9	0.7	67.19
American sycamore	5,491	149	(N/A)	0.9	1.6	148.79
Blue spruce	38	1	(N/A)	0.9	0.0	1.03
Norway spruce	2,969	80	(N/A)	0.9	0.9	80.46
Pear	69	2	(N/A)	0.9	0.0	1.86
Elm	7,239	196	(N/A)	0.9	2.1	196.17
Eastern white pine	2,969	80	(N/A)	0.9	0.9	80.46
Scotch pine	596	16	(N/A)	0.9	0.2	16.14
Citywide total	344,890	9,347	(N/A)	100.0	100.0	81.27

Table 3: Annual Air Quality Benefits

Lewis

Annual Air Quality Benefits of Public Trees

4/1/2018

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2								
Green ash	13.5	2.2	6.2	0.6	71	35.0	5.1	4.8	33.0	218	0.0	0	100.4	289	(N/A)	18.3	13.74
Silver maple	10.8	1.8	5.4	0.5	59	23.7	3.5	3.3	22.9	149	-5.7	-21	66.2	186	(N/A)	15.7	10.33
Norway maple	7.0	1.2	3.4	0.3	38	13.6	2.0	1.9	12.6	84	-1.6	-6	40.4	116	(N/A)	9.6	10.52
Apple	0.7	0.1	0.4	0.0	4	3.3	0.5	0.4	2.9	20	0.0	0	8.3	24	(N/A)	7.0	2.97
Black walnut	4.8	0.8	2.2	0.2	26	13.2	1.9	1.8	12.5	82	0.0	0	37.6	108	(N/A)	7.0	13.48
Northern red oak	4.2	0.7	2.0	0.2	23	8.3	1.2	1.1	7.8	51	-6.0	-23	19.5	51	(N/A)	6.1	7.32
Sugar maple	2.8	0.5	1.4	0.1	15	9.0	1.3	1.3	8.6	56	-2.2	-8	22.8	63	(N/A)	6.1	9.01
Siberian elm	3.9	0.7	1.9	0.2	21	10.2	1.5	1.4	9.7	64	0.0	0	29.5	85	(N/A)	5.2	14.11
Northern hackberry	2.6	0.5	1.3	0.1	14	8.0	1.2	1.1	7.5	50	0.0	0	22.3	64	(N/A)	4.3	12.80
Eastern redbud	0.2	0.0	0.1	0.0	1	1.6	0.2	0.2	1.4	10	0.0	0	3.8	11	(N/A)	4.3	2.18
Red maple	0.5	0.1	0.2	0.0	3	2.3	0.3	0.3	2.2	14	-0.2	-1	5.7	16	(N/A)	2.6	5.34
Honeylocust	0.4	0.1	0.2	0.0	2	2.6	0.4	0.4	2.5	16	-0.2	-1	6.3	17	(N/A)	2.6	5.82
Littleleaf linden	0.2	0.0	0.1	0.0	1	1.1	0.2	0.1	1.0	7	-0.1	0	2.6	7	(N/A)	1.7	3.61
Ohio buckeye	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	1.0	6	0.0	0	2.5	7	(N/A)	1.7	3.47
Maple	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)	0.9	0.13
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)	0.9	10.16
American sycamore	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)	0.9	15.71
Blue spruce	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)	0.9	0.18
Norway spruce	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)	0.9	1.45
Pear	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)	0.9	0.71
Elm	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.9	19.04
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)	0.9	1.45
Scotch pine	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	1	(N/A)	0.9	1.48
Citywide total	54.9	9.2	26.6	2.5	295	139.9	20.3	19.4	132.4	870	-19.1	-72	386.1	1,093	(N/A)	100.0	9.51

Table 4: Annual Carbon Stored

Lewis

Stored CO2 Benefits of Public Trees

4/1/2018

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	440,075	3,301	(N/A)	18.3	32.1	157.17
Silver maple	236,783	1,776	(N/A)	15.7	17.2	98.66
Norway maple	116,459	873	(N/A)	9.6	8.5	79.40
Apple	12,204	92	(N/A)	7.0	0.9	11.44
Black walnut	157,618	1,182	(N/A)	7.0	11.5	147.77
Northern red oak	92,631	695	(N/A)	6.1	6.7	99.25
Sugar maple	82,733	621	(N/A)	6.1	6.0	88.64
Siberian elm	94,194	706	(N/A)	5.2	6.9	117.74
Northern hackberry	39,630	297	(N/A)	4.3	2.9	59.44
Eastern redbud	3,809	29	(N/A)	4.3	0.3	5.71
Red maple	5,825	44	(N/A)	2.6	0.4	14.56
Honeylocust	4,853	36	(N/A)	2.6	0.4	12.13
Littleleaf linden	3,782	28	(N/A)	1.7	0.3	14.18
Ohio buckeye	2,201	17	(N/A)	1.7	0.2	8.26
Maple	17	0	(N/A)	0.9	0.0	0.13
Northern pin oak	7,945	60	(N/A)	0.9	0.6	59.59
American sycamore	25,943	195	(N/A)	0.9	1.9	194.57
Blue spruce	2	0	(N/A)	0.9	0.0	0.02
Norway spruce	3,343	25	(N/A)	0.9	0.2	25.07
Pear	178	1	(N/A)	0.9	0.0	1.33
Elm	39,259	294	(N/A)	0.9	2.9	294.44
Eastern white pine	3,343	25	(N/A)	0.9	0.2	25.07
Scotch pine	257	2	(N/A)	0.9	0.0	1.93
Citywide total	1,373,083	10,298	(N/A)	100.0	100.0	89.55

Table 5: Annual Carbon Sequestered

Lewis

Annual CO Benefits of Public Trees

4/1/2018

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	18,043	135	-2,112	-80	-16	12,227	92	28,077	211 (N/A)	18.3	26.6	10.03
Silver maple	19,104	143	-1,137	-54	-9	8,488	64	26,402	198 (N/A)	15.7	25.0	11.00
Norway maple	1,563	12	-559	-35	-4	4,668	35	5,637	42 (N/A)	9.6	5.3	3.84
Apple	692	5	-59	-11	-1	1,085	8	1,708	13 (N/A)	7.0	1.6	1.60
Black walnut	6,760	51	-757	-30	-6	4,637	35	10,610	80 (N/A)	7.0	10.1	9.95
Northern red oak	764	6	-445	-23	-4	2,881	22	3,177	24 (N/A)	6.1	3.0	3.40
Sugar maple	4,141	31	-397	-20	-3	3,201	24	6,925	52 (N/A)	6.1	6.6	7.42
Siberian elm	4,140	31	-452	-23	-4	3,606	27	7,271	55 (N/A)	5.2	6.9	9.09
Northern hackberry	2,165	16	-190	-16	-2	2,773	21	4,731	35 (N/A)	4.3	4.5	7.10
Eastern redbud	493	4	-18	-5	0	534	4	1,004	8 (N/A)	4.3	1.0	1.51
Red maple	814	6	-28	-4	0	802	6	1,583	12 (N/A)	2.6	1.5	3.96
Honeylocust	877	7	-23	-4	0	913	7	1,762	13 (N/A)	2.6	1.7	4.41
Littleleaf linden	574	4	-19	-3	0	380	3	933	7 (N/A)	1.7	0.9	3.50
Ohio buckeye	448	3	-11	-2	0	352	3	787	6 (N/A)	1.7	0.7	2.95
Maple	3	0	0	0	0	7	0	9	0 (N/A)	0.9	0.0	0.07
Northern pin oak	470	4	-38	-3	0	440	3	869	7 (N/A)	0.9	0.8	6.52
American sycamore	960	7	-125	-4	-1	650	5	1,481	11 (N/A)	0.9	1.4	11.11
Blue spruce	2	0	0	0	0	10	0	12	0 (N/A)	0.9	0.0	0.09
Norway spruce	187	1	-16	-3	0	246	2	415	3 (N/A)	0.9	0.4	3.11
Pear	38	0	-1	-1	0	37	0	74	1 (N/A)	0.9	0.1	0.55
Elm	912	7	-188	-5	-1	734	6	1,453	11 (N/A)	0.9	1.4	10.90
Eastern white pine	187	1	-16	-3	0	246	2	415	3 (N/A)	0.9	0.4	3.11
Scotch pine	53	0	-1	-1	0	94	1	145	1 (N/A)	0.9	0.1	1.08
Citywide total	63,389	475	-6,592	-329	-52	49,010	368	105,479	791 (N/A)	100.0	100.0	6.88

Table 6: Annual Social and Aesthetic Benefits

Lewis

Annual Aesthetic/Other Benefits of Public Trees

4/1/2018

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,322	(N/A)	18.3	24.7	62.93
Silver maple	1,573	(N/A)	15.7	29.4	87.38
Norway maple	150	(N/A)	9.6	2.8	13.60
Apple	38	(N/A)	7.0	0.7	4.81
Black walnut	502	(N/A)	7.0	9.4	62.77
Northern red oak	55	(N/A)	6.1	1.0	7.85
Sugar maple	430	(N/A)	6.1	8.0	61.39
Siberian elm	281	(N/A)	5.2	5.2	46.78
Northern hackberry	285	(N/A)	4.3	5.3	57.08
Eastern redbud	28	(N/A)	4.3	0.5	5.53
Red maple	126	(N/A)	2.6	2.3	41.85
Honeylocust	166	(N/A)	2.6	3.1	55.23
Littleleaf linden	66	(N/A)	1.7	1.2	32.81
Ohio buckeye	52	(N/A)	1.7	1.0	26.22
Maple	0	(N/A)	0.9	0.0	0.04
Northern pin oak	43	(N/A)	0.9	0.8	43.05
American sycamore	67	(N/A)	0.9	1.2	66.60
Blue spruce	5	(N/A)	0.9	0.1	5.03
Norway spruce	47	(N/A)	0.9	0.9	47.08
Pear	2	(N/A)	0.9	0.0	2.06
Elm	58	(N/A)	0.9	1.1	58.34
Eastern white pine	47	(N/A)	0.9	0.9	47.08
Scotch pine	15	(N/A)	0.9	0.3	15.42
Citywide total	5,357	(N/A)	100.0	100.0	46.58

Table 7: Summary of Benefits in Dollars

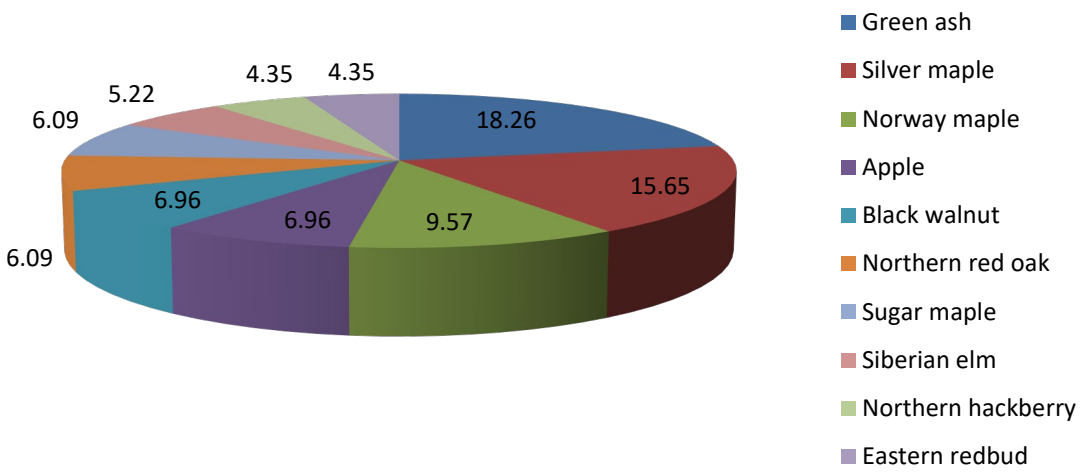

Figure 1: Species Distribution

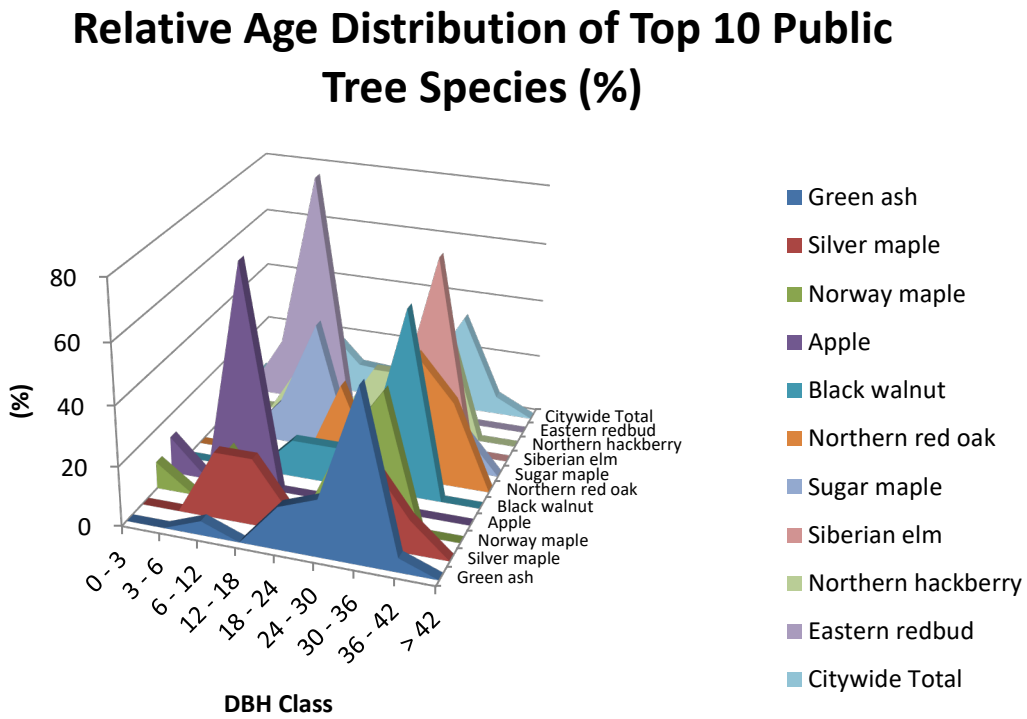

Figure 2: Relative Age Class

Figure 3: Foliage Condition

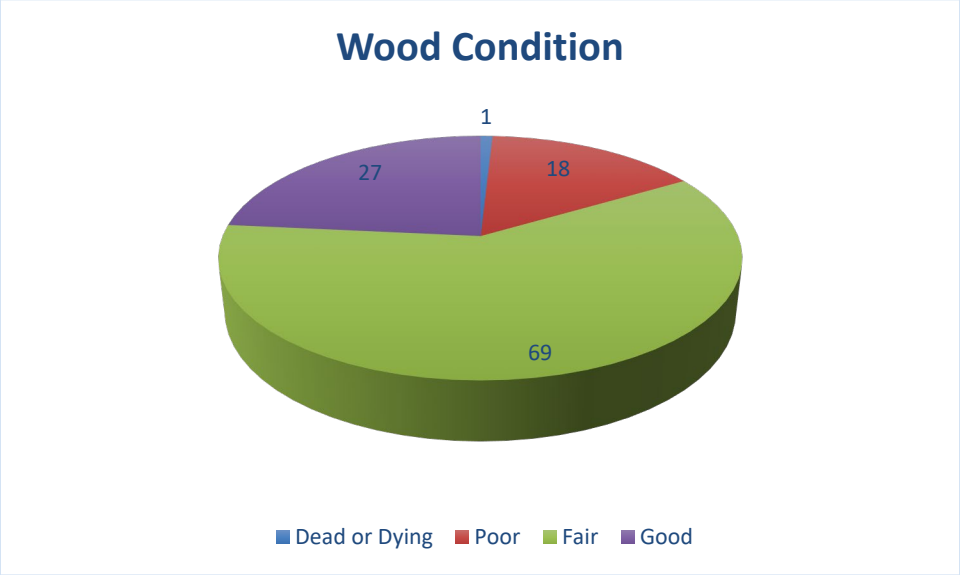

Figure 4: Wood Condition

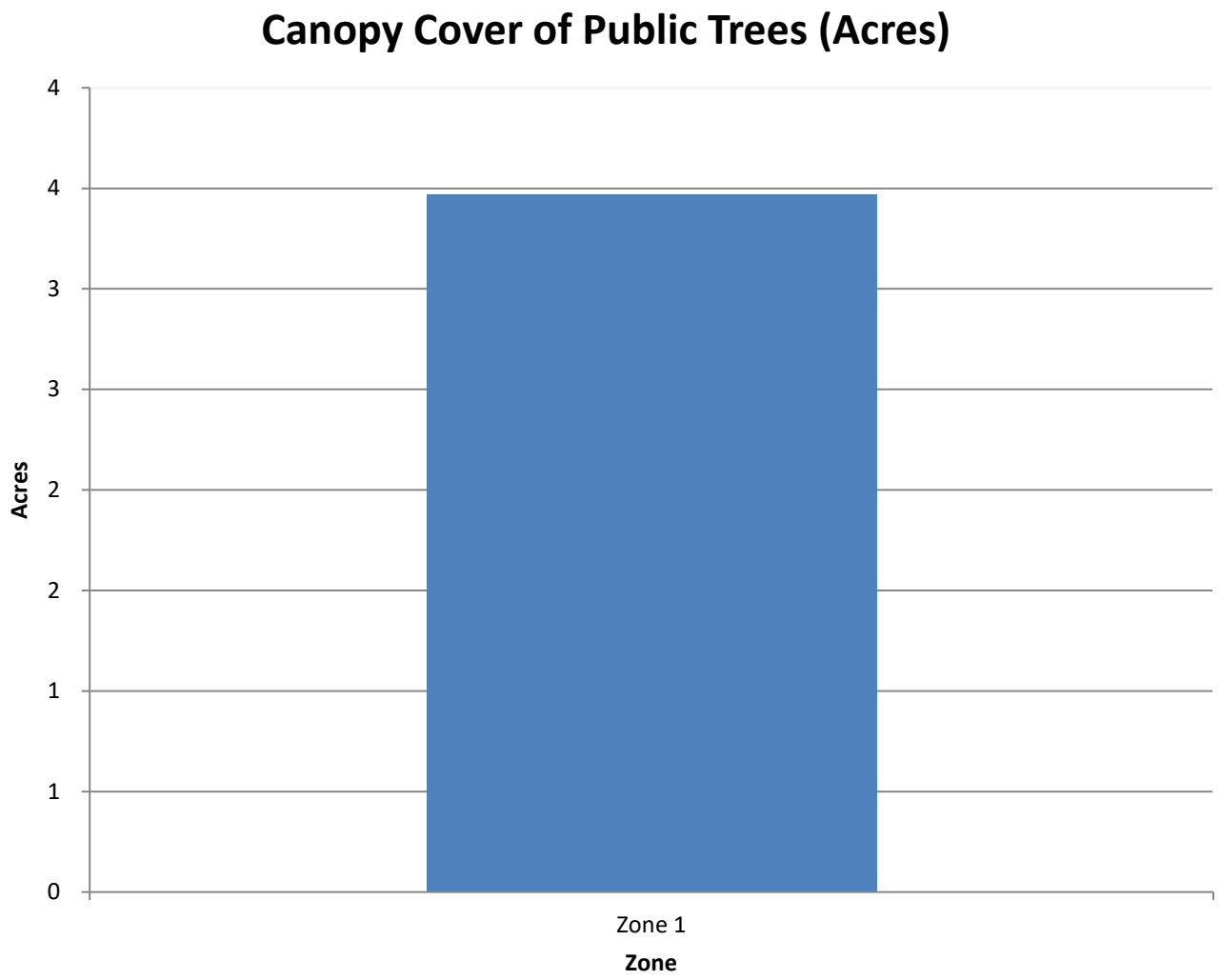

Figure 5: Canopy Cover in Acres

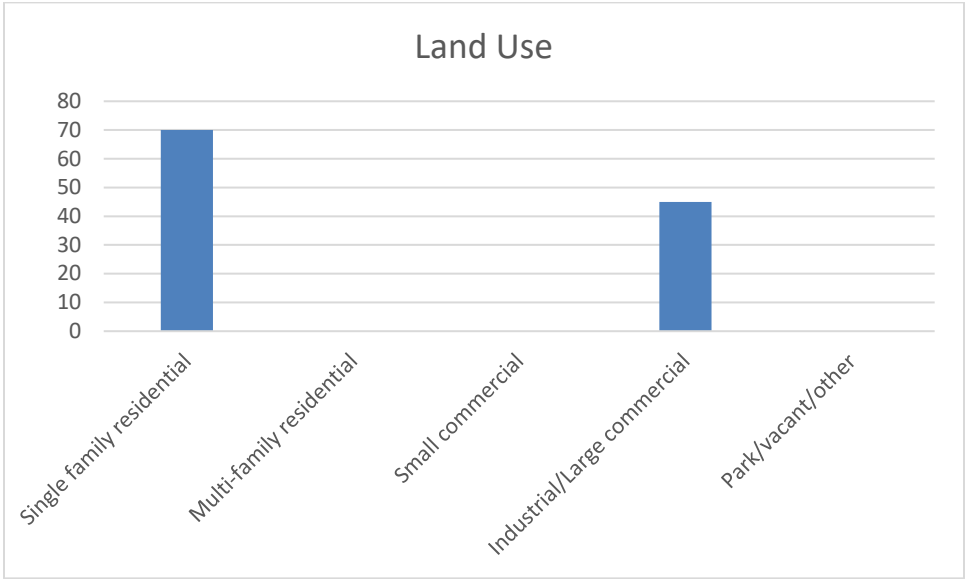

Figure 6: Land Use of city/park trees

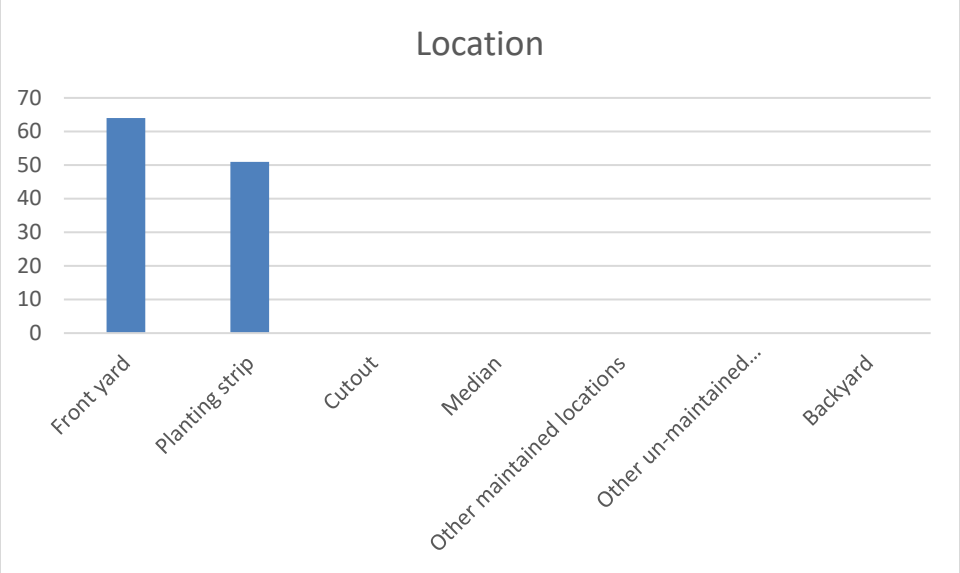

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees

Figure 2: Location of EAB symptoms

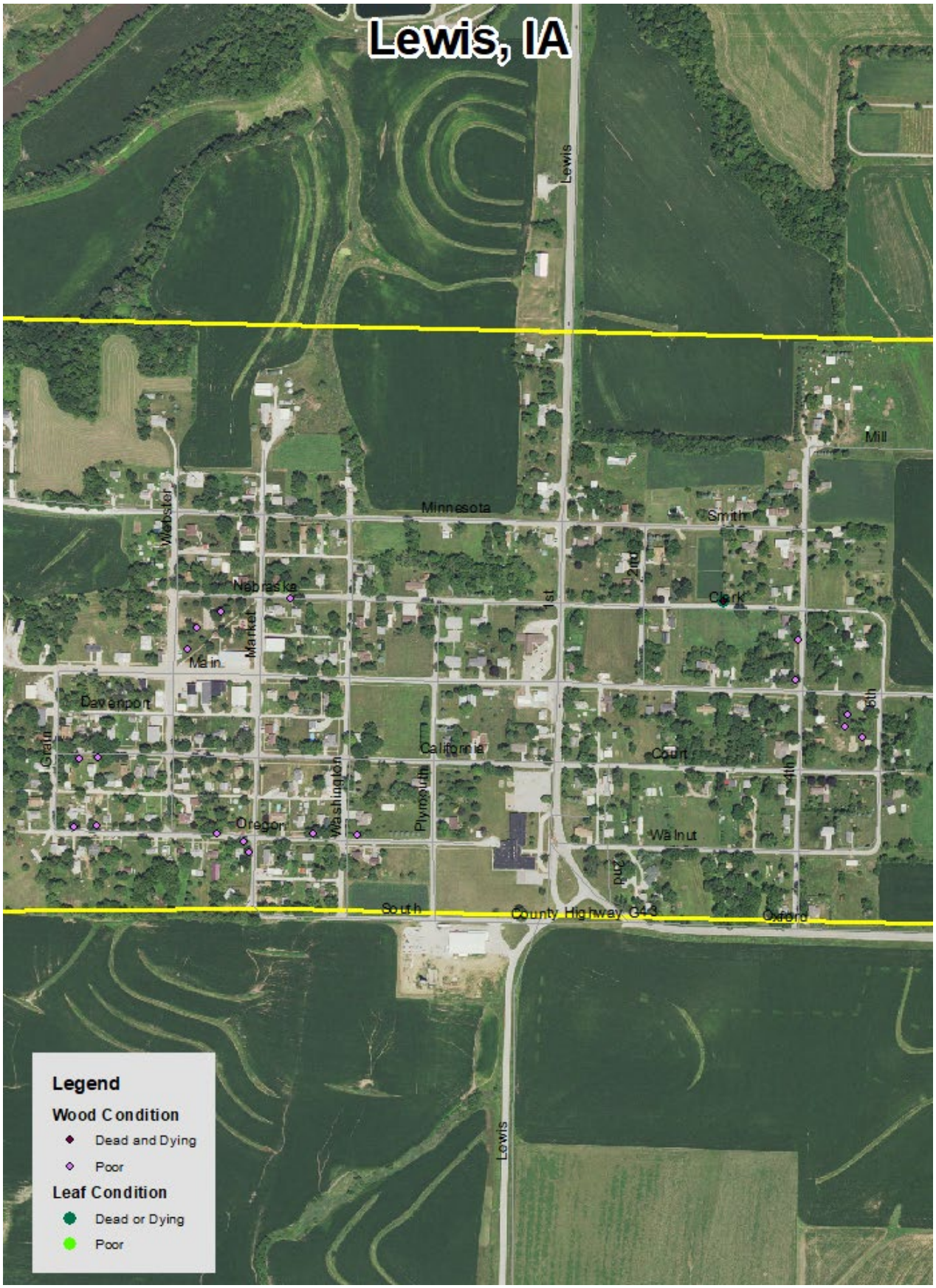

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal****

Appendix C: Lewis Tree Ordinances

3-2-3 OTHER CONDITIONS REGULATED. The following actions are required and may also be abated in the manner provided in this Ordinance: 1. The removal of diseased trees or dead wood, but not diseased trees and dead wood outside the lot and property lines and inside the curb lines upon the public street. (Code of Iowa, Sec. 364.12(3)(b))

7. The maintenance, by the property owner, of all property outside the lot and property lines and inside the curb lines upon public streets, including maintaining a fifteen (15) foot clearance above the street from trees extending over the streets, except as provided in Section 3-2-3(1).

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

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