

2017/2018 COMMUNITY TREE MANAGEMENT PLAN

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Executive Summary

Overview

This plan was developed to assist the City of Lawton with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows communities 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 are capable of killing all species of ash trees (this does not include mountain ash). There is a possibility that 40% of your municipally managed trees will die once EAB becomes established in the community. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2017, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street right of way and park trees. Below are some key findings of the 264 trees inventoried.

- Each of Lawton's municipal trees provides an average of \$197 worth of benefits to the community each year
- There are over 29 species of trees
- The top three genus are: Ash – 40.15%, Maple – 20.45%, and Black Walnut – 9.09%
- 10% of trees are in need of some type of management
- 18 trees are recommended for removal in the next 1-3 years

Recommendations

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

- All 18 trees recommended for removal were deemed immediate removals (timeframe is 1-3 years for removal). Nine (9) of the 18 trees recommended for removal are ash.
City ownership of the trees recommended for removal should be verified prior to any removal
- 35 of the 106 ash trees are in need of follow up because they are displaying signs and symptoms associated with EAB.
- All trees should be pruned on a routine schedule- one third of the city every two years.
- The costs of removing all of the current trees recommended for removal is \$9,000 (using an average contract discount value of \$500/tree). The costs for removing all ash trees (should EAB infest Lawton in the next 10 years) is \$48,500. Using these values, it is advisable to increase the yearly tree removal budget to at least \$5,800/year (over the next 10 years). This budget increase does not include tree replacement values, as the new tree ordinance does not allow for replanting in the city right of ways.

Introduction

This plan was developed to assist Lawton with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of

that money spent on tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal and replacement planting. With proper planning and management of the current canopy in Lawton, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Lawton'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 Lawton and future generations through good urban forestry management.

Good urban tree 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 Lawton's urban forestry goals.

Inventory

In 2017, a tree inventory was conducted that included 100% of the city owned street right of way and park trees. 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. Your community tree information is available for your use on a web-based GIS program. This GIS website, in addition to the fact sheet on how to operate the website, can be found at: <http://www.iowadnr.gov/Conservation/Forestry/Urban-Forestry/Community-Tree-Inventories>.

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 of 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 264 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Lawton's trees reduce energy related costs by approximately \$13,438 annually (Appendix A, Table 1). These savings are both in Electricity (63.8 MWh) and in Natural Gas (8,772 Therms).

Annual Stormwater Benefits

Lawton's trees intercept about 714,138 gallons of rainfall or snow melt each year (Appendix A, Table 2). This interception provides \$19,353 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 Lawton, it is estimated that trees remove 821.8 lbs of air pollution (ozone (O₃), particulate matter less than 10 microns (PM₁₀), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂)) per year with a net value of \$2,326 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere. In Lawton, trees sequester about 256,501 lbs of carbon a year with an associated value of \$1,924 (Appendix A, Table 5). In addition, the trees store 2,677,693 lbs of carbon, with a yearly benefit of \$20,083 (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. Lawton receives \$14,052 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Lawton's trees provide \$52,095 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 264 trees in Lawton provide approximately \$197 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Lawton has over 29 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Lawton Tree List by Genus		
Species	Number	Percent of Total
Ash	106	40.15%
Maple	54	20.45%
Walnut	24	9.09%
Honey Locust	15	5.68%
Spruce	14	5.3%
Apple	10	3.79%
Linden	9	3.41%
Elm	8	3.03%
Oak	5	1.89%
Pear	4	1.52%
Birch	4	1.52%
Tree Lilac	3	1.14%
Conifer	2	<1%
Juniper (red cedar)	2	<1%
Hackberry	1	<1%
Ginkgo	1	<1%
Pine	1	<1%
Buckeye	1	<1%
TOTALS	264	100.0%

Age Class

For age, a Bell Curve is preferred and should show the highest amount of trees around 18 inches in diameter at 4.5 ft. In Lawton, the highest quantity of trees fell in the 24 to 30 inch DBH age class, indicating an older than average stand of community trees. This follows along with what the city already suspects – that the canopy is aging. This can be remedied by encouraging landowners to plant native trees on their own land by selecting species suitable for the size of yard and environmental conditions of the area.

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 Lawton indicate that 97% of the trees were in good or fair health in 2016, with only 3% of the sampled trees in poor or dead/dying foliar health (Appendix A, Figure 3). Similarly, 90% of Lawton's trees are in good or fair health for wood condition (appendix A, Figure 4). Wood condition that is in poor health or is considered dead or dying is about 10% of the population. This 10% 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.

TASK	Number of Trees	% of Total trees
Clean	69	26%
Remove	18	7%
Reduce	2	<1%

Canopy Cover

The estimated canopy cover for the entire town of Lawton is 36.79 acres (as calculated by the Iowa DNR). The canopy cover estimated by i-tree for the inventoried right of way and park trees is 7.37 acres (Appendix A, Figure 5). According to the 2010 census, Lawton occupies 457 acres. Thus the canopy cover on city parks and right of way areas is about 1.6%, and over the entire community is 8%.

Land Use and Location

The majority of Lawton's city and park trees are in front yards and planting strips in single family residential neighborhoods and on industrial areas (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	85%
Large Commercial/industrial	10%
Multifamily Residential	3%
Small Commercial	1%

Location

Front yard	52.3%
Planting Strip	47.7%

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

Lawton has 17 mature tree immediate trees that are in need of removal as soon as possible (and 1 young tree that should be removed before it gets larger). These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figures 4 and 5). There are 69 total trees that were identified for cleaning, because they have hazardous limbs or defects that may impact their structure or health. Of the trees identified for cleaning (pruning/limbing), 2 need immediate removal (within the year), 34 should be cleaned within the next 3 years, and the final 33 trees should be addressed in the next 5 years. There are 2 trees recommended for crown reductions in the next 5 years (reducing limb weight or density to prevent structural issues later on). These recommendations are summarized on the following table.

PRIORITY TASK	CRITICAL CONCERN	MATURE TREE IMMEDIATE	MATURE TREE ROUTINE	YOUNG TREE IMMEDIATE	YOUNG TREE ROUTINE	TOTAL
NONE:		1	138		36	175
STAKE/TRAIN						
CLEAN	2	34	33			69
RAISE						
REDUCE			2			2
REMOVE		17		1		18
TREAT PEST/DISEASE						
TOTAL	2	52	173	1	36	264

Poor tree species

After the removal of the critical concern and immediate concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 1 & Appendix B, Figure 3). Of the 18 trees recommended for removal, 9 are ash trees. There are a total of 106 ash trees, and 35 trees have signs and symptoms that have been associated with EAB. Nineteen of the ash trees are considered to be in poor health or dead/dying. EAB symptomatic trees should be examined as soon as possible. [*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 five main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, crown reduction, and treat pest/disease. 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. Treat pest/disease trees showed indications of foliar or structural decline due to insect, disease, or rot. These trees should be investigated further by a certified arborist who can look into the integrity of the tree. It is recommended that all trees be pruned on a routine schedule every five to seven years.

Planting

It is suggested that for every tree removed, a replanting rate of 1.2 should be used, since survival rates will not be 100%. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing canopy cover in Lawton. With the tree ordinance change, we still encourage residents to plant native trees, if their site can safely accommodate a shade tree. If residents have any questions, please have them contact me for recommendations at 712.482.6245.

It is important to plant a diverse mix of species in Lawton 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, Lawton is heavily planted with Ash (40%) and Maple species (20%) (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, Chinese and Siberian elms, willow, and black walnut. All trees planted must meet the restrictions in city ordinance (Appendix C).

Bur oak, chinkapin oak, red oak, black oak, Kentucky coffee tree, American linden (basswood), thornless honey locust, black cherry, sycamore, and hackberry are all suited to Lawton's upland soils – and are presently underutilized. In addition, ironwood (*Ostrya virginiana*), eastern redbud (*Cercis canadensis*), and serviceberry (*Amelanchier arborea*) would make great alternatives to low growing trees for right of ways.

Recommended Species to plant in Western Iowa:

COMMON NAME	SCIENTIFIC NAME	CULTIVARS / SELECTIONS
LARGE SHADE TREES – Plant 35 feet apart and away from overhead power lines.		
White Oak	<i>Quercus alba</i>	
Bur Oak	<i>Quercus macrocarpa</i>	
Red Oak	<i>Quercus rubra</i>	
Black Oak	<i>Quercus velutina</i>	
Chinkapin Oak	<i>Quercus muehlenbergii</i>	
American Basswood (Linden)	<i>Tilia Americana</i>	Boulevard, Front Yard, Legend, Redmond
Thornless Honey locust	<i>Gleditsia triacanthos var. inermis</i>	Shademaster, Skyline
American elm	<i>Ulmus Americana</i>	Princeton, Valley Forge
Kentucky coffee tree	<i>Gymnocladus dioica</i>	Espresso
Black Cherry	<i>Prunus serotina</i>	
Hackberry	<i>Celtis occidentalis</i>	Chicagoland, Prairie Pride, Windy City
LOW GROWING TREES (less than 30 feet tall) planted as close as 12 feet.		
Eastern redbud	<i>Cercis canadensis</i>	
Downy Hawthorn	<i>Crataegus mollis</i>	
Ironwood (hop hornbeam)	<i>Ostrya virginiana</i>	
American hornbeam	<i>Carpinus caroliniana</i>	
Serviceberry	<i>Amelanchier arborea</i>	Autumn brilliance, Cumulus, Princess Diana

Flowering crabapple	<i>Malus</i>	Prairiefire, Adams, Sentinel, Snowdrift
Red mulberry	<i>Morus rubra</i>	
American (wild) plum	<i>Prunus americana</i>	

EVERGREEN TREES – planted 25 feet apart and away from overhead power lines.

Eastern White Pine	<i>Pinus strobes</i>	
Jack pine	<i>Pinus banksiana</i>	
Juniper (Eastern red cedar)	<i>Juniperus virginiana</i>	
Norway spruce	<i>Picea abies</i>	
Concolor fir	<i>Abies concolor</i>	Not suited for harsh, sunny/dry sites

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 death 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 should be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 3). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 1 & Appendix B, Figure 2). [*City ownership of the tree recommended for removal should be verified prior to any removal*](#)

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of over 25 million 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. The entire state of Iowa is under USDA quarantine for EAB.

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.

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? 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.

Canopy Replacement

Again, tree canopy replacement is encouraged as much as possible (even if it occurs on privately owned land by the choice of the landowner). All trees should meet the restrictions in city ordinance 151.02 (Appendix C). The new plantings should be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese/Siberian elm, 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 genus other than ash should 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 suggested that private property owners monitor the condition of their privately managed trees. There are numerous options available to them, including: removal and replanting, treating with insecticides, and monitoring until an issue arises. These options are spelled out in: <https://store.extension.iastate.edu/Product/Emerald-Ash-Borer-Management-Options>. Check your city tree ordinance to be sure additional actions are not required for these private trees.

Treating for EAB

Many landowners may have interest in treating their ash trees with insecticides to prevent infestation of their ash trees. This is only recommended by Iowa State University Extension when EAB has been found within 15 miles of the tree in question. The closest known population of EAB to Lawton is in SW Buena Vista County.

Insecticidal applications can have serious environmental side effects when improperly applied. “Do it yourself” insecticides (drenches, granulars) have per acre application limits. Encourage your residents to report ash treatments with the city or their neighbors – in order to prevent over-application of these insecticides. In addition, these DIY treatments are not suited for trees larger than 20” in diameter. Trees larger than 20” should be treated by a certified arborist. Please contact me if you have any questions.

My suggestion would be to start increasing the city tree budget for removals and replacements now. I would place all efforts and finances on removing declining trees and EAB casualty trees as they arise.

Maintenance Plan and Budget

The following tasks are placed in order of yearly priority. These tasks should be fulfilled as your budget or personnel time allows. Critical concern trees should be treated immediately, and immediate mature tree tasks should be completed within 2-3 years (which is their expected lifetime before they become critical concern trees). Mature tree routine trees should be followed up on within 5 years. For now, a priority list looks like this:

2018: Clean the two trees recommended for critical concern cleaning (see attached maps). Next, work towards contract pruning the 34 trees recommended for cleaning and the 17 trees in immediate need of removal. I recommend that this work only be done during winter months (to avoid tree health issues, and damage to nesting birds).

Discuss increasing tree removal budgets with city staff

Consider having a town meeting to discuss replanting options – on private ground only

2018-2020: Complete remaining tree removals and remaining tree cleaning projects (of the 34 identified for mature tree immediate cleaning)

Determine how much money can be budgeted over the next 10 years for potential forest health issues.

Encourage replanting of shade trees that have been removed – on private land only.

Monitor for suspicious ash trees.

2020-2022: Complete the crown cleaning of the 33 remaining trees indicated for mature tree cleaning. In addition, two trees were identified for crown reduction pruning, so those should be addressed during winter months as well.

Consider implementing a routine trimming (cleaning) regimen for the remaining city trees. Ideally, routine trimming should be done to 1/3 of the city's trees every 2 years. In other words, all public and right of way trees should be trimmed once every 6 years.

Also – consider evaluating Lawton's street trees again for hazards by 2022 (if not before).

Monitor for tree health issues – all species.

Proposed Budget Increase

Emerald Ash Borer could potentially kill all ash trees in Lawton within 4 years of its arrival. To remove and replace all 97 (106 total ash trees, 9 are recommended for removal) inventoried ash trees in addition to the 18 trees indicated for immediate removal, you would need to budget at

least an estimated \$5,800 per year for the next 10 years (calculated using \$500/tree removal price).

It is recommended that Lawton apply for grants to fund replacement trees on city owned properties (like parks). 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. The Trees for Kids Grant will be a great option for your community to use for tree planting projects on public lands. Trees Forever may also have community improvement grants that can assist with replanting expenses.

Works Cited

Census Bureau. 2000. <http://censtats.census.gov/data/IA/1601964290.pdf> (April, 2010)

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

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

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

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

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Lawton

Annual Energy Benefits of Public Trees

3/25/2018

Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Green ash	31.6	2,399	4,371.8	4,284	6,683	(N/A)	39.8	49.7	63.65
Silver maple	8.8	670	1,156.6	1,134	1,803	(N/A)	9.8	13.4	69.36
Black walnut	6.9	527	971.0	952	1,479	(N/A)	9.1	11.0	61.61
Honeylocust	3.9	295	511.9	502	796	(N/A)	5.7	5.9	53.09
Maple	0.7	54	98.1	96	150	(N/A)	5.3	1.1	10.74
Norway maple	1.6	119	235.6	231	350	(N/A)	4.9	2.6	26.89
Apple	0.9	70	139.4	137	207	(N/A)	3.8	1.5	20.71
Spruce	0.7	51	79.6	78	129	(N/A)	2.7	1.0	18.41
Littleleaf linden	1.0	72	137.5	135	207	(N/A)	2.7	1.5	29.58
Blue spruce	0.6	49	85.5	84	133	(N/A)	2.3	1.0	22.13
Siberian elm	2.0	148	261.8	257	405	(N/A)	1.9	3.0	80.94
Callery pear	0.4	29	53.3	52	81	(N/A)	1.5	0.6	20.33
Birch	0.4	34	68.8	67	101	(N/A)	1.5	0.8	25.28
Japanese tree lilac	0.2	17	38.5	38	55	(N/A)	1.1	0.4	18.19
American elm	1.4	109	189.1	185	294	(N/A)	1.1	2.2	98.09
Eastern red cedar	0.2	12	24.4	24	36	(N/A)	0.8	0.3	18.02
Northern red oak	0.3	20	37.6	37	57	(N/A)	0.8	0.4	28.45
Pin oak	0.5	38	67.6	66	104	(N/A)	0.8	0.8	51.95
American basswood	0.5	41	81.1	80	121	(N/A)	0.8	0.9	60.35
Conifer Evergreen Medium	0.1	5	10.2	10	15	(N/A)	0.4	0.1	14.80
White ash	0.1	7	13.3	13	20	(N/A)	0.4	0.1	20.10
Ginkgo	0.0	0	0.4	0	1	(N/A)	0.4	0.0	0.57
Conifer Evergreen Large	0.1	10	14.6	14	24	(N/A)	0.4	0.2	24.14
Eastern white pine	0.2	14	24.6	24	38	(N/A)	0.4	0.3	38.17
Black maple	0.1	8	16.5	16	25	(N/A)	0.4	0.2	24.58
Ohio buckeye	0.1	8	16.9	17	24	(N/A)	0.4	0.2	24.47
Black spruce	0.0	2	4.9	5	7	(N/A)	0.4	0.1	6.94
Northern hackberry	0.4	33	60.8	60	92	(N/A)	0.4	0.7	92.23
Bur oak	0.0	0	0.5	0	1	(N/A)	0.4	0.0	0.66
Total	63.8	4,841	8,771.8	8,596	13,438	(N/A)	100.0	100.0	50.90

Table 2: Annual Stormwater Benefits**Lawton****Annual Stormwater Benefits of Public Trees**

3/25/2018

Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Green ash	359,616	9,746	(N/A)	39.8	50.4	92.82
Silver maple	127,518	3,456	(N/A)	9.8	17.9	132.91
Black walnut	76,903	2,084	(N/A)	9.1	10.8	86.84
Honeylocust	31,284	848	(N/A)	5.7	4.4	56.52
Maple	3,736	101	(N/A)	5.3	0.5	7.23
Norway maple	11,826	320	(N/A)	4.9	1.7	24.65
Apple	3,337	90	(N/A)	3.8	0.5	9.04
Spruce	9,221	250	(N/A)	2.7	1.3	35.70
Littleleaf linden	8,758	237	(N/A)	2.7	1.2	33.91
Blue spruce	8,456	229	(N/A)	2.3	1.2	38.19
Siberian elm	23,204	629	(N/A)	1.9	3.2	125.77
Callery pear	2,170	59	(N/A)	1.5	0.3	14.70
Birch	3,391	92	(N/A)	1.5	0.5	22.97
Japanese tree lilac	793	22	(N/A)	1.1	0.1	7.17
American elm	13,653	370	(N/A)	1.1	1.9	123.33
Eastern red cedar	2,294	62	(N/A)	0.8	0.3	31.08
Northern red oak	3,049	83	(N/A)	0.8	0.4	41.32
Pin oak	5,522	150	(N/A)	0.8	0.8	74.82
American basswood	5,418	147	(N/A)	0.8	0.8	73.41
Conifer Evergreen Medium	755	20	(N/A)	0.4	0.1	20.47
White ash	614	17	(N/A)	0.4	0.1	16.63
Ginkgo	7	0	(N/A)	0.4	0.0	0.19
Conifer Evergreen Large	1,539	42	(N/A)	0.4	0.2	41.70
Eastern white pine	4,605	125	(N/A)	0.4	0.6	124.79
Black maple	625	17	(N/A)	0.4	0.1	16.95
Ohio buckeye	586	16	(N/A)	0.4	0.1	15.88
Black spruce	256	7	(N/A)	0.4	0.0	6.95
Northern hackberry	4,984	135	(N/A)	0.4	0.7	135.08
Bur oak	18	0	(N/A)	0.4	0.0	0.48
Citywide total	714,138	19,353	(N/A)	100.0	100.0	73.31

Table 3: Annual Air Quality Benefits

Lawton

Annual Air Quality Benefits of Public Trees

3/25/2018

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	45.0	7.2	21.4	2.0	239	151.3	22.0	21.0	143.2	942	0.0	0	413.2	1,181 (N/A)	39.8	11.25
Silver maple	21.4	3.6	10.5	0.9	115	41.6	6.1	5.8	39.9	260	-11.0	-41	118.9	334 (N/A)	9.8	12.86
Black walnut	9.2	1.5	4.4	0.4	49	33.3	4.8	4.6	31.5	207	0.0	0	89.8	256 (N/A)	9.1	10.68
Honeylocust	5.6	0.9	2.7	0.3	30	18.3	2.7	2.6	17.6	115	-4.0	-15	46.7	130 (N/A)	5.7	8.65
Maple	0.5	0.1	0.3	0.0	3	3.4	0.5	0.5	3.2	21	-0.2	-1	8.3	23 (N/A)	5.3	1.67
Norway maple	2.0	0.3	1.0	0.1	11	7.7	1.1	1.0	7.1	47	-0.5	-2	19.9	56 (N/A)	4.9	4.33
Apple	0.8	0.1	0.4	0.0	5	4.5	0.7	0.6	4.2	28	0.0	0	11.5	33 (N/A)	3.8	3.26
Spruce	1.0	0.2	0.9	0.1	7	3.1	0.5	0.4	3.0	19	-3.6	-13	5.6	13 (N/A)	2.7	1.83
Littleleaf linden	1.4	0.2	0.7	0.1	8	4.6	0.7	0.6	4.3	29	-0.7	-3	11.9	34 (N/A)	2.7	4.80
Blue spruce	1.1	0.2	0.9	0.1	7	3.0	0.4	0.4	2.9	19	-3.0	-11	6.1	15 (N/A)	2.3	2.47
Siberian elm	4.3	0.7	2.1	0.2	23	9.3	1.4	1.3	8.8	58	0.0	0	28.1	81 (N/A)	1.9	16.21
Callery pear	0.3	0.0	0.2	0.0	2	1.8	0.3	0.3	1.7	11	-0.1	0	4.5	13 (N/A)	1.5	3.18
Birch	0.6	0.1	0.3	0.0	3	2.2	0.3	0.3	2.0	13	-0.1	-1	5.7	16 (N/A)	1.5	4.01
Japanese tree lilac	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.0	7	0.0	0	2.7	8 (N/A)	1.1	2.55
American elm	3.4	0.6	1.6	0.1	18	6.8	1.0	0.9	6.5	42	0.0	0	20.9	61 (N/A)	1.1	20.17
Eastern red cedar	0.4	0.1	0.3	0.0	3	0.8	0.1	0.1	0.7	5	-1.3	-5	1.3	3 (N/A)	0.8	1.40
Northern red oak	0.7	0.1	0.3	0.0	4	1.3	0.2	0.2	1.2	8	-1.0	-4	3.0	8 (N/A)	0.8	3.93
Pin oak	1.0	0.2	0.5	0.0	5	2.4	0.3	0.3	2.2	15	-1.8	-7	5.2	13 (N/A)	0.8	6.63
American basswood	0.7	0.1	0.3	0.0	4	2.7	0.4	0.4	2.5	16	-0.6	-2	6.4	18 (N/A)	0.8	8.90
Conifer Evergreen Medium	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	2 (N/A)	0.4	1.53
White ash	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3 (N/A)	0.4	2.91
Ginkgo	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	0.4	0.07
Conifer Evergreen Large	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3 (N/A)	0.4	2.82
Eastern white pine	0.6	0.1	0.4	0.1	4	0.9	0.1	0.1	0.8	5	-2.9	-11	0.3	-2 (N/A)	0.4	-1.58
Black maple	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.3	4 (N/A)	0.4	3.64
Ohio buckeye	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3 (N/A)	0.4	3.47
Black spruce	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	-0.1	0	0.3	1 (N/A)	0.4	0.75
Northern hackberry	0.9	0.1	0.4	0.0	5	2.1	0.3	0.3	2.0	13	0.0	0	6.1	18 (N/A)	0.4	17.54
Bur oak	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	0.4	0.08
Citywide total	101.3	16.8	50.2	4.8	547	304.8	44.4	42.3	289.0	1,898	-31.6	-119	821.8	2,326 (N/A)	100.0	8.81

Table 4: Annual Carbon Stored**Lawton****Stored CO2 Benefits of Public Trees**

3/25/2018

Species	Total Stored CO2 (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Green ash	1,456,759	10,926	(N/A)	39.8	54.4	104.05
Silver maple	473,359	3,550	(N/A)	9.8	17.7	136.55
Black walnut	295,618	2,217	(N/A)	9.1	11.0	92.38
Honeylocust	70,278	527	(N/A)	5.7	2.6	35.14
Maple	7,220	54	(N/A)	5.3	0.3	3.87
Norway maple	33,031	248	(N/A)	4.9	1.2	19.06
Apple	13,679	103	(N/A)	3.8	0.5	10.26
Spruce	8,029	60	(N/A)	2.7	0.3	8.60
Littleleaf linden	30,138	226	(N/A)	2.7	1.1	32.29
Blue spruce	6,584	49	(N/A)	2.3	0.2	8.23
Siberian elm	105,210	789	(N/A)	1.9	3.9	157.82
Callery pear	4,960	37	(N/A)	1.5	0.2	9.30
Birch	9,483	71	(N/A)	1.5	0.4	17.78
Japanese tree lilac	2,724	20	(N/A)	1.1	0.1	6.81
American elm	68,809	516	(N/A)	1.1	2.6	172.02
Eastern red cedar	1,379	10	(N/A)	0.8	0.1	5.17
Northern red oak	15,251	114	(N/A)	0.8	0.6	57.19
Pin oak	25,976	195	(N/A)	0.8	1.0	97.41
American basswood	23,457	176	(N/A)	0.8	0.9	87.96
Conifer Evergreen M	284	2	(N/A)	0.4	0.0	2.13
White ash	1,035	8	(N/A)	0.4	0.0	7.76
Ginkgo	5	0	(N/A)	0.4	0.0	0.03
Conifer Evergreen La	1,170	9	(N/A)	0.4	0.0	8.78
Eastern white pine	7,490	56	(N/A)	0.4	0.3	56.18
Black maple	1,101	8	(N/A)	0.4	0.0	8.26
Ohio buckeye	1,101	8	(N/A)	0.4	0.0	8.26
Black spruce	43	0	(N/A)	0.4	0.0	0.32
Northern hackberry	13,507	101	(N/A)	0.4	0.5	101.30
Bur oak	12	0	(N/A)	0.4	0.0	0.09
Citywide total	2,677,693	20,083	(N/A)	100.0	100.0	76.07

Table 5: Annual Carbon Sequestered

Lawton

Annual CO₂ Benefits of Public Trees

3/25/2018

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	77,229	579	-6,992	-331	-55	53,016	398	122,922	922 (N/A)	39.8	47.9	8.78
Silver maple	35,852	269	-2,272	-96	-18	14,805	111	48,288	362 (N/A)	9.8	18.8	13.93
Black walnut	17,301	130	-1,419	-72	-11	11,648	87	27,457	206 (N/A)	9.1	10.7	8.58
Honeylocust	9,894	74	-337	-31	-3	6,513	49	16,039	120 (N/A)	5.7	6.3	8.02
Maple	1,060	8	-35	-9	0	1,198	9	2,215	17 (N/A)	5.3	0.9	1.19
Norway maple	2,937	22	-159	-17	-1	2,623	20	5,385	40 (N/A)	4.9	2.1	3.11
Apple	1,390	10	-66	-12	-1	1,557	12	2,869	22 (N/A)	3.8	1.1	2.15
Spruce	657	5	-39	-11	0	1,125	8	1,732	13 (N/A)	2.7	0.7	1.86
Littleleaf linden	3,110	23	-145	-12	-1	1,599	12	4,552	34 (N/A)	2.7	1.8	4.88
Blue spruce	496	4	-32	-11	0	1,083	8	1,537	12 (N/A)	2.3	0.6	1.92
Siberian elm	3,856	29	-505	-21	-4	3,275	25	6,604	50 (N/A)	1.9	2.6	9.91
Callery pear	711	5	-25	-4	0	643	5	1,325	10 (N/A)	1.5	0.5	2.48
Birch	885	7	-47	-5	0	745	6	1,578	12 (N/A)	1.5	0.6	2.96
Japanese tree lilac	342	3	-13	-4	0	372	3	697	5 (N/A)	1.1	0.3	1.74
American elm	1,787	13	-330	-14	-3	2,408	18	3,851	29 (N/A)	1.1	1.5	9.63
Eastern red cedar	40	0	-7	-3	0	269	2	299	2 (N/A)	0.8	0.1	1.12
Northern red oak	5	0	-73	-4	-1	443	3	371	3 (N/A)	0.8	0.1	1.39
Pin oak	2,359	18	-125	-5	-1	832	6	3,061	23 (N/A)	0.8	1.2	11.48
American basswood	1,522	11	-113	-6	-1	910	7	2,313	17 (N/A)	0.8	0.9	8.67
Conifer Evergreen Medium	39	0	-1	-1	0	106	1	142	1 (N/A)	0.4	0.1	1.07
White ash	182	1	-5	-1	0	156	1	331	2 (N/A)	0.4	0.1	2.49
Ginkgo	2	0	0	0	0	4	0	6	0 (N/A)	0.4	0.0	0.04
Conifer Evergreen Large	116	1	-6	-2	0	216	2	324	2 (N/A)	0.4	0.1	2.43
Eastern white pine	256	2	-36	-4	0	311	2	528	4 (N/A)	0.4	0.2	3.96
Black maple	165	1	-5	-1	0	186	1	344	3 (N/A)	0.4	0.1	2.58
Ohio buckeye	224	2	-5	-1	0	176	1	393	3 (N/A)	0.4	0.2	2.95
Black spruce	12	0	0	-1	0	48	0	60	0 (N/A)	0.4	0.0	0.45
Northern hackberry	616	5	-65	-4	-1	721	5	1,269	10 (N/A)	0.4	0.5	9.51
Bur oak	3	0	0	0	0	4	0	7	0 (N/A)	0.4	0.0	0.05
Citywide total	163,046	1,223	-12,856	-683	-102	106,994	802	256,501	1,924 (N/A)	100.0	100.0	7.29

Table 6: Annual Social and Aesthetic Benefits**Lawton****Annual Aesthetic/Other Benefits of Public Trees**

3/25/2018

Species	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Green ash	6,174	(N/A)	39.8	41.0	58.80
Silver maple	2,806	(N/A)	9.8	18.6	107.92
Black walnut	1,401	(N/A)	9.1	9.3	58.39
Honeylocust	2,196	(N/A)	5.7	14.6	146.38
Maple	169	(N/A)	5.3	1.1	12.10
Norway maple	310	(N/A)	4.9	2.1	23.87
Apple	79	(N/A)	3.8	0.5	7.85
Spruce	188	(N/A)	2.7	1.2	26.84
Littleleaf linden	339	(N/A)	2.7	2.3	48.42
Blue spruce	138	(N/A)	2.3	0.9	22.97
Siberian elm	247	(N/A)	1.9	1.6	49.48
Callery pear	81	(N/A)	1.5	0.5	20.25
Birch	95	(N/A)	1.5	0.6	23.76
Japanese tree lilac	19	(N/A)	1.1	0.1	6.40
American elm	231	(N/A)	1.1	1.5	77.09
Eastern red cedar	21	(N/A)	0.8	0.1	10.67
Northern red oak	2	(N/A)	0.8	0.0	0.77
Pin oak	180	(N/A)	0.8	1.2	90.08
American basswood	117	(N/A)	0.8	0.8	58.63
Conifer Evergreen Medium	21	(N/A)	0.4	0.1	21.08
White ash	33	(N/A)	0.4	0.2	33.42
Ginkgo	0	(N/A)	0.4	0.0	0.37
Conifer Evergreen Large	32	(N/A)	0.4	0.2	32.32
Eastern white pine	26	(N/A)	0.4	0.2	26.25
Black maple	30	(N/A)	0.4	0.2	29.84
Ohio buckeye	26	(N/A)	0.4	0.2	26.22
Black spruce	12	(N/A)	0.4	0.1	12.31
Northern hackberry	73	(N/A)	0.4	0.5	72.66
Bur oak	5	(N/A)	0.4	0.0	5.26
Citywide total	15,054	(N/A)	100.0	100.0	57.02

Table 7: Summary of Benefits in Dollars**Lawton****Total Annual Benefits of Public Trees by Species (\$)**

3/25/2018

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Green ash	6,683	922	1,181	9,746	6,174	24,706	(N/A)	47.4
Silver maple	1,803	362	334	3,456	2,806	8,762	(N/A)	16.8
Black walnut	1,479	206	256	2,084	1,401	5,426	(N/A)	10.4
Honeylocust	796	120	130	848	2,196	4,090	(N/A)	7.9
Maple	150	17	23	101	169	461	(N/A)	0.9
Norway maple	350	40	56	320	310	1,077	(N/A)	2.1
Apple	207	22	33	90	79	430	(N/A)	0.8
Spruce	129	13	13	250	188	592	(N/A)	1.1
Littleleaf linden	207	34	34	237	339	851	(N/A)	1.6
Blue spruce	133	12	15	229	138	526	(N/A)	1.0
Siberian elm	405	50	81	629	247	1,412	(N/A)	2.7
Callery pear	81	10	13	59	81	244	(N/A)	0.5
Birch	101	12	16	92	95	316	(N/A)	0.6
Japanese tree lilac	55	5	8	22	19	108	(N/A)	0.2
American elm	294	29	61	370	231	985	(N/A)	1.9
Eastern red cedar	36	2	3	62	21	125	(N/A)	0.2
Northern red oak	57	3	8	83	2	152	(N/A)	0.3
Pin oak	104	23	13	150	180	470	(N/A)	0.9
American basswood	121	17	18	147	117	420	(N/A)	0.8
Conifer Evergreen Medi	15	1	2	20	21	59	(N/A)	0.1
White ash	20	2	3	17	33	76	(N/A)	0.1
Ginkgo	1	0	0	0	0	1	(N/A)	0.0
Conifer Evergreen Large	24	2	3	42	32	103	(N/A)	0.2
Eastern white pine	38	4	-2	125	26	192	(N/A)	0.4
Black maple	25	3	4	17	30	78	(N/A)	0.1
Ohio buckeye	24	3	3	16	26	73	(N/A)	0.1
Black spruce	7	0	1	7	12	27	(N/A)	0.1
Northern hackberry	92	10	18	135	73	327	(N/A)	0.6
Bur oak	1	0	0	0	5	7	(N/A)	0.0
Citywide Total	13,438	1,924	2,326	19,353	15,054	52,095	(N/A)	100.0

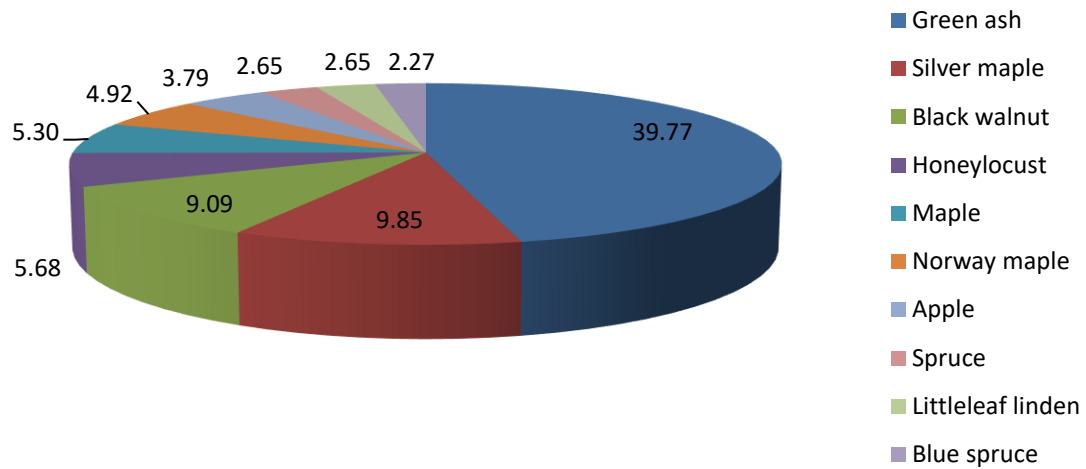


Figure 1: Species Distribution

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

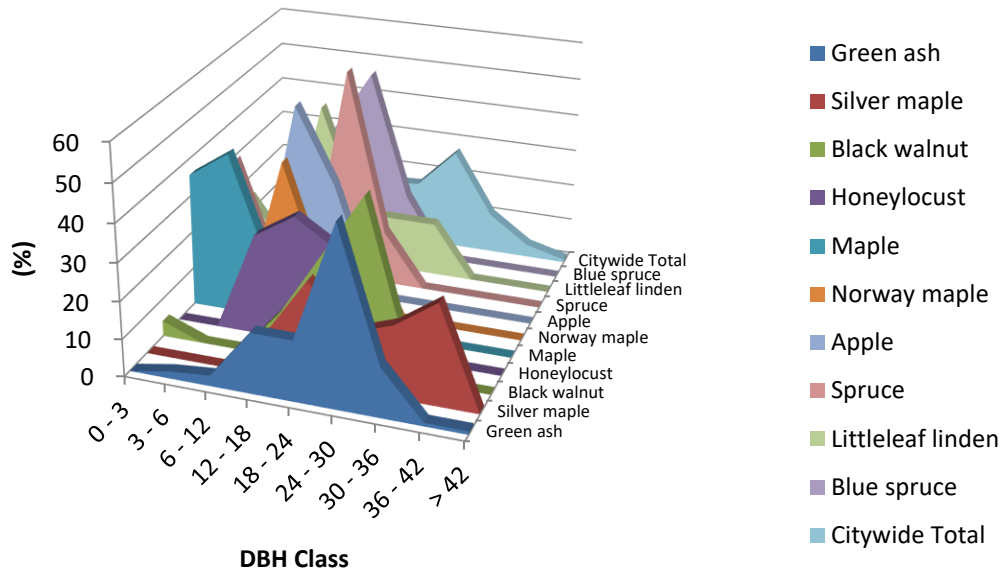


Figure 2: Relative Age Class

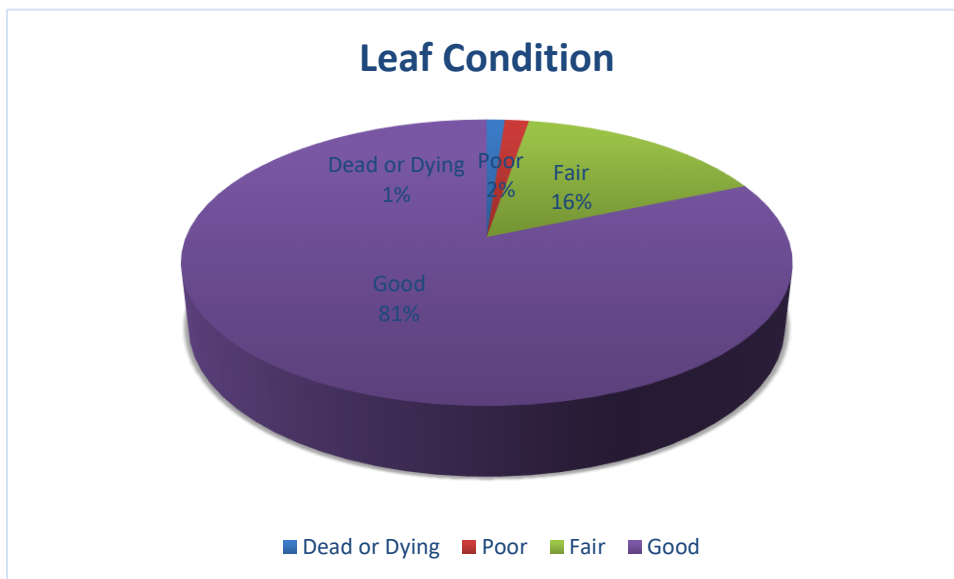


Figure 3: Foliage Condition

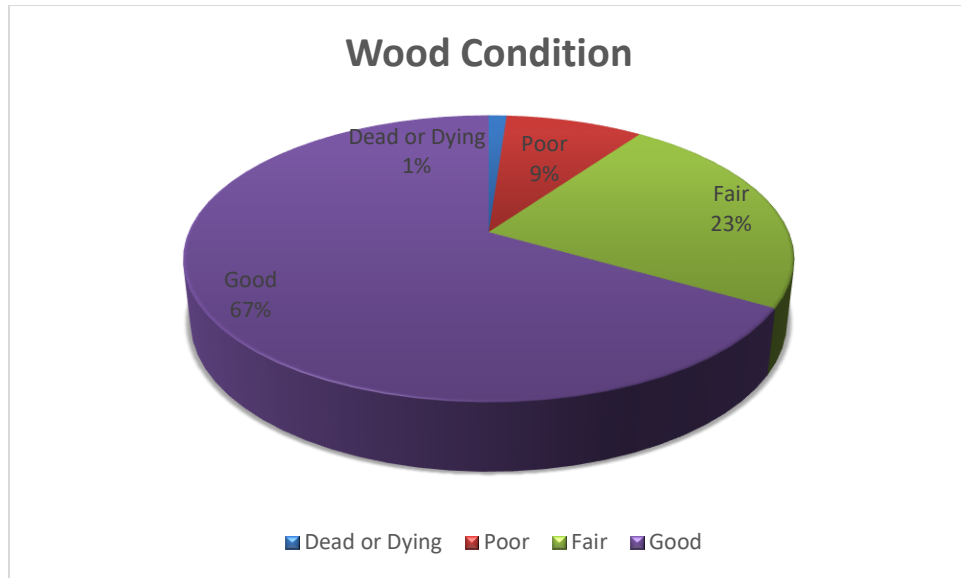


Figure 4: Wood Condition

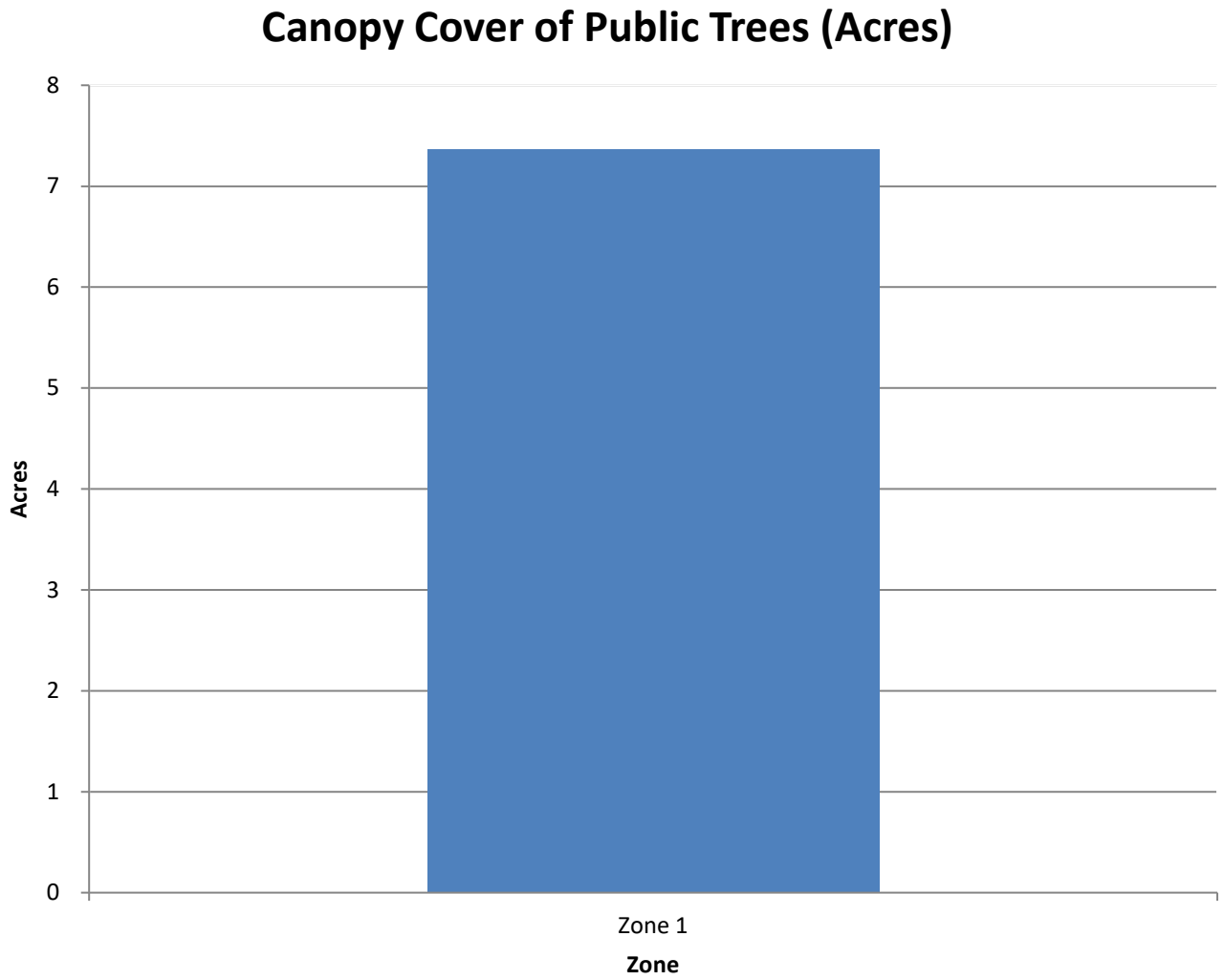


Figure 5: Canopy Cover in Acres

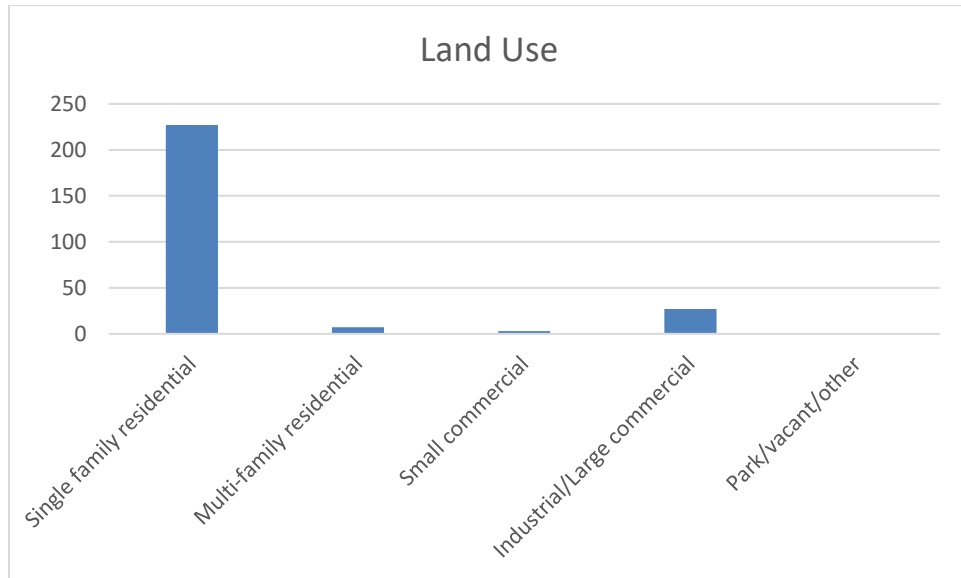


Figure 6: Land Use of city/park trees

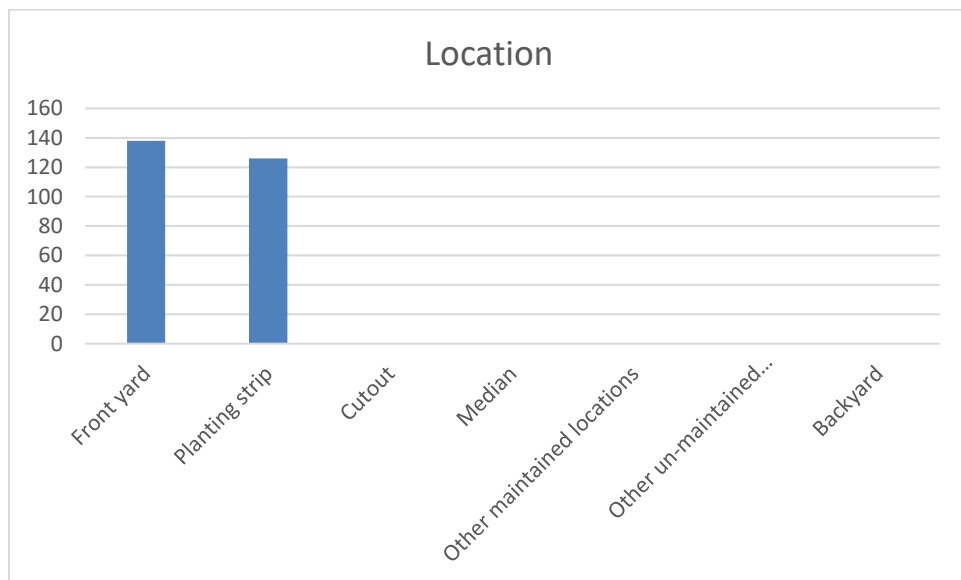


Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

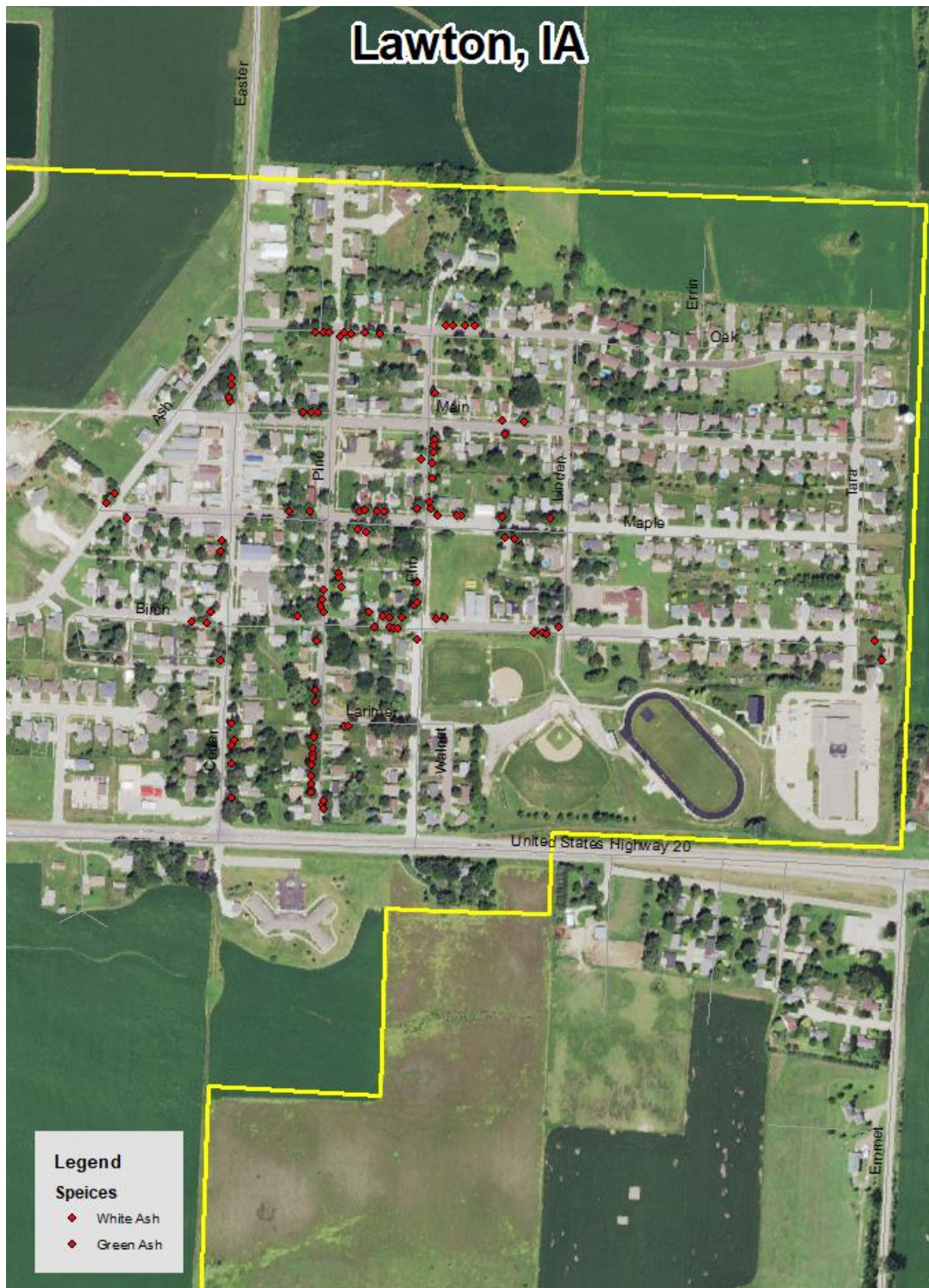


Figure 1: Location of Ash Trees

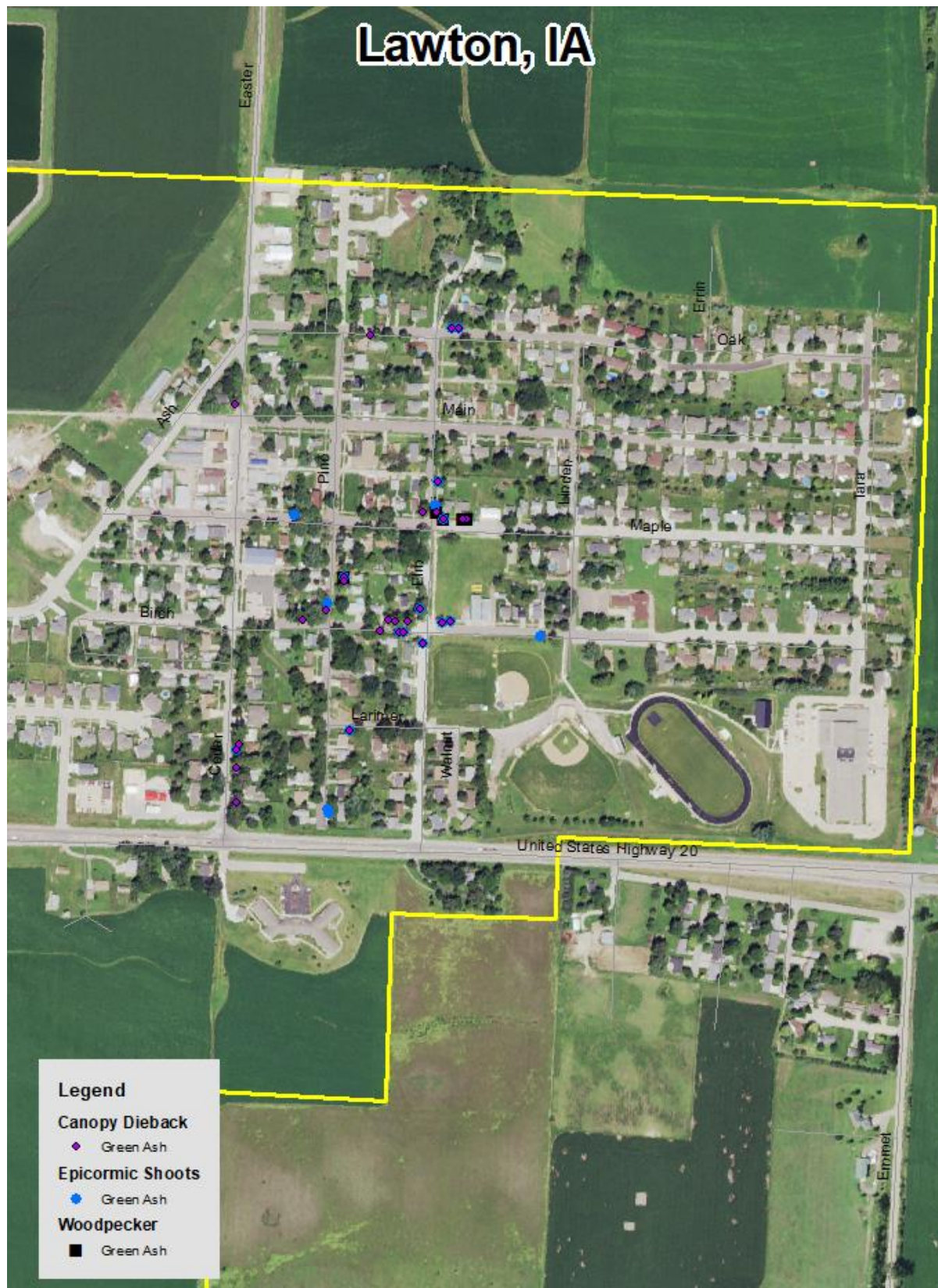


Figure 2: Location of EAB symptom



Figure 3: Location of Poor Condition Trees



Figure 4: Location of Trees with Recommended Maintenance

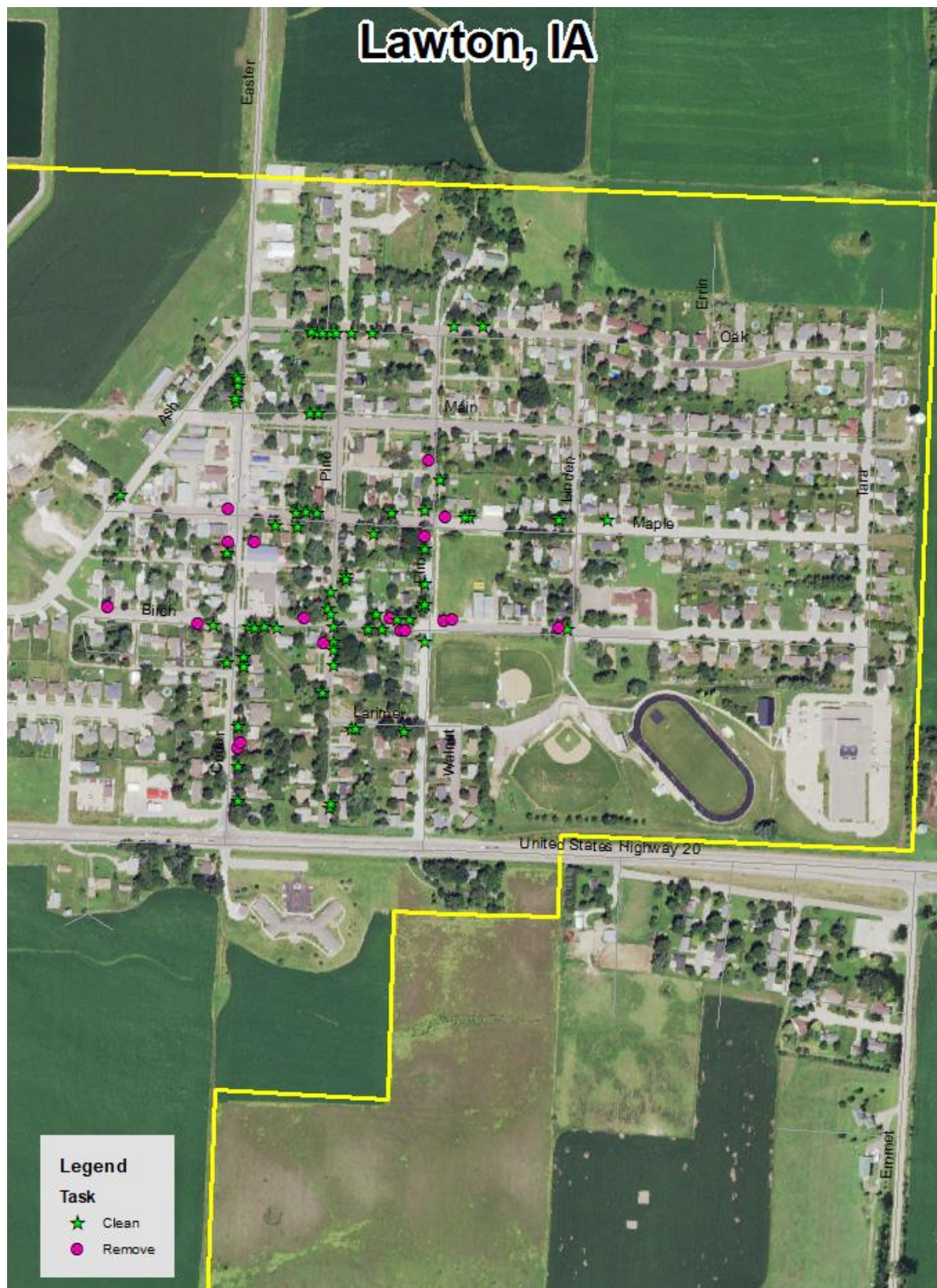


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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