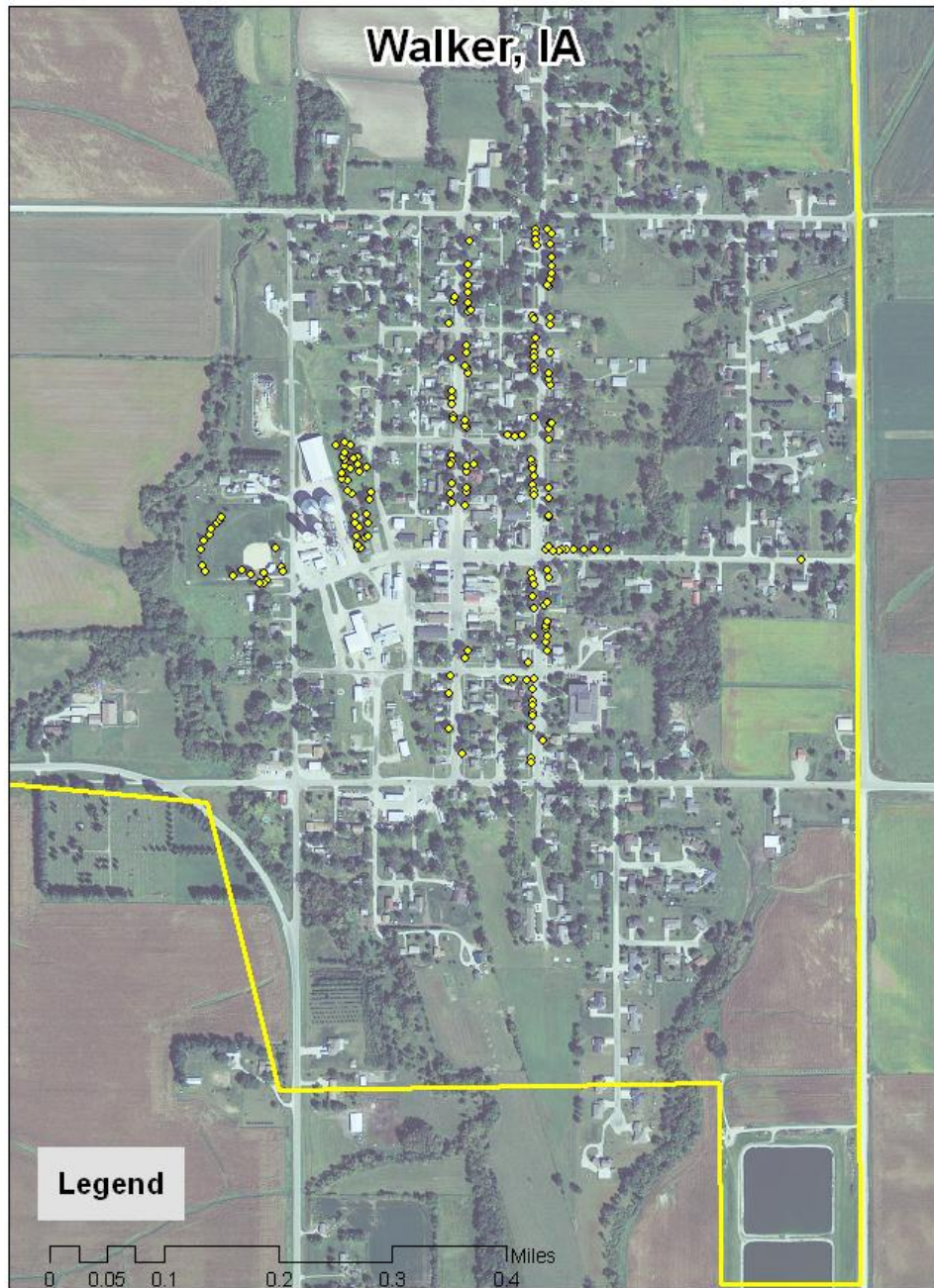


Walker, IA



2011 Management Plan

Prepared by Steven Swinonos
Bureau of Forestry, Iowa DNR



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Executive Summary

Overview

This plan was developed to assist the City of Walker 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 29% of Walker's city owned trees (ash) 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 2011, 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 183 trees inventoried.

- Walker's trees provide \$32,021 of benefits annually, an average of \$175 a tree
- There are over 32 species of trees
- The top three genus are: Maple 36%, Ash 29%, and Poplar 5%
- 14% of trees are in need of some type of management
- 3 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 3 trees needing removal, 1 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately [*City ownership of the trees recommended for removal should be verified prior to any removal*](#)
- 18 of the 53 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 other year
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Siberian elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly

Introduction

This plan was developed to assist Walker 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 tree canopy in Walker, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Walker'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 Walker 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 Walker's urban forestry goals.

Inventory

In 2011, 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 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 183 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. Walker's trees reduce energy related costs by approximately \$8,982 annually (Appendix A, Table 1). These savings are both in Electricity (42.7 MWh) and in Natural Gas (5,860.3 Therms).

Annual Stormwater Benefits

Walker's trees intercept about 433,620 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$11,752 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 mater (ozone). In Walker, it is estimated that trees remove 550 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 \$1,550 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Walker, trees sequester about 91,270 lbs of carbon a year with an associated value of \$1,161 (Appendix A, Table 4). In addition, the trees store 1,656,393 lbs of carbon, with a yearly benefit of \$12,423 (Appendix A, Table 5).

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. Walker receives \$8,576 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, Walker's trees provide \$32,021 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 183 trees in Walker provide approximately \$175 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Walker has over 32 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genus is as follows:

Maple(Silver,Red,Norway,Sugar)	65	36%
Ash	53	29%
Poplar	9	5%
Linden(American,Littleleaf)	7	4%
Hackberry	7	4%
Oak(Chinkapin,Red,Pin)	6	3%
Black Walnut	6	3%
Pine(Austrian,White)	5	3%
Ginkgo	4	3%
Birch	3	2%
Concolor Fir	2	1%
Honey locust	2	1%
Apple (Crab)	2	1%
Ornamental Cherry	2	1%
White Cedar	2	1%
Elm(American,Siberian)	2	1%
Kentucky Coffee Tree	1	<1%
Mulberry	1	<1%
Sycamore	1	<1%
Lilac	1	<1%
Other species	2	1%

Size Class

Most of Walker's trees (59%) are between 12 and 30 inches in diameter at 4.5 ft (Appendix A, Figure 2). For size, a Bell Curve is preferred and shows the highest amount of trees around 18 inches in diameter at 4.5 ft. Walker's size curve is on the larger side, indicating a larger than average stand. Generally with trees size does not indicate age.

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 Walker indicate that 93% of the trees are in good health, with less than 1% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 61% of Walker'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 2% of the population. This 14% 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	15	8%
Crown Raising	3	2%
Crown Reduce	4	2%
Tree Removal	3	2%

Canopy Cover

The canopy cover of Walker is approximately 5 acres (Appendix A, Figure 4). According to the 2000 census, Walker occupies 240 acres. Thus the canopy cover on city land is about 2%.

Land Use and Location

The majority of Walker's city and park trees are in planting strips in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure 7). The following describes the land use and locations for the street and park trees.

Land Use

Single family residential	72%
Park/vacant/other	28%

Location

Planting strip	100%
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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

Walker has 1 critical concern trees that needs cleaning. There are 3 other immediate concern trees that need attention, these trees need removal. One is a smaller diameter linden at the ball field. The others are a large ash and a medium Norway maple on the city parking. 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 cleaning first as this tree poses potential danger. The removals are not critical concerns but should be address as soon as possible. Please refer to the six year maintenance plan at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance that do not include trimming.

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 3 removals, 1 is an ash tree.

There are a total of 53 ash trees, and 18 of those have signs and symptoms that have been associated with EAB. In addition, there are 2 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 Walker.

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 (45%) (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, Siberian elm, evergreen, willow or black walnut. All trees planted must meet the restrictions in city ordinance.

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.

Six Year Maintenance Plan with No Additional Funding

Year 1

Clean: 1 Critical concern tree
Removal: 1 tree
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 1 intermediate concern ash tree
Routine trimming: Contract to trim 1/4 of the city trees
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 2 trees - removal of any new critical concern trees and ash in poor health
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 2 trees - removal of any new critical concern trees and ash in poor health
Routine trimming: Contract to trim 1/4 of the city trees
Visual Survey for signs and symptoms of EAB

Year 5

Removal: 2 trees - removal of any new critical concern trees and ash in poor health
previous removals
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 2 trees - removal of any new critical concern trees and ash in poor health
Routine trimming: Contract to trim ¼ of the city trees
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 4 ash trees removed (approximately 8% of ash). EAB could potentially start killing ash within 6 years of its arrival. This should leave adequate time for a strategy, the tree removals will increase once it arrives, but if they are kept up, the EAB population will be reduced decreasing their impact.

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*](#)

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.

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 ash trees will be replaced. All trees will meet the restrictions in city ordinance. 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 genus 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.

Budget

Current Budget

Total \$7,600 over 6 years (\$1,270/year)

FY 2012 Budget

Removal: \$750

FY 2013 Budget

Removal: \$500

Routine trimming: \$750

FY 2014 Budget

Removal: \$1,000

FY 2015 Budget

Removal: \$1,000

Routine trimming: \$750

FY 2016 Budget

Removal: \$1,000

FY 2017 Budget

Removal: \$1,000

Routine trimming: \$750

*Reduction of ash over 6 years: Approximately 4 ash trees removed (approximately 13% of ash). EAB could potentially start killing ash within 6 years of its arrival. This should leave adequate time for a strategy, the tree removals will increase once it arrives, but if they are kept up the EAB population will be reduced decreasing their impact.

Purposed Budget Increase

EAB could potentially kill all ash trees in Walker within 10-12 years of its arrival. To remove all ash trees within 10-12 years after the discovery of EAB the budget would need to be increased to \$3,000 a year. If the budget were increased to \$22,500 a year all ash could be removed within 1 year. Additionally, it is recommended that Walker 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.

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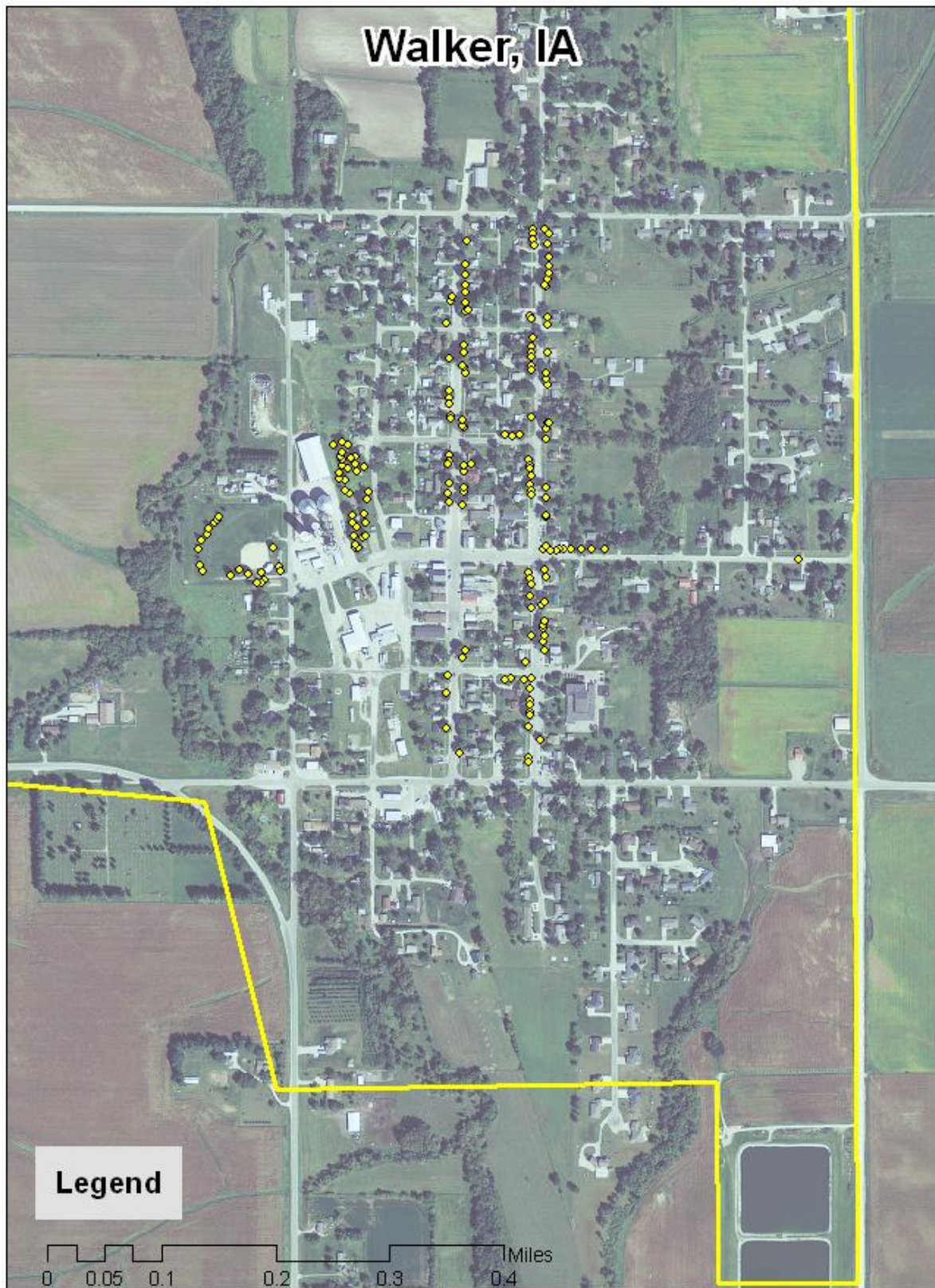
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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species

9/28/2011

Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standar d Error	% of Total Trees	% of Total \$	Avg. \$/tree
Ash	12.7	963	1,837.0	1,800	2,763	(N/A)	29.0	30.8	52.14
Silver maple	7.3	557	974.9	955	1,512	(N/A)	14.2	16.8	58.16
Norway maple	4.8	363	660.9	648	1,011	(N/A)	10.9	11.3	50.53
Sugar maple	3.7	283	486.3	477	760	(N/A)	7.1	8.5	58.45
Northern hackberry	1.5	115	227.1	223	337	(N/A)	3.8	3.8	48.15
Red maple	1.2	89	142.0	139	228	(N/A)	3.3	2.5	38.04
Black walnut	1.6	121	201.7	198	319	(N/A)	3.3	3.6	53.12
Black poplar	1.4	105	177.7	174	279	(N/A)	2.7	3.1	55.73
Ginkgo	0.7	55	98.9	97	152	(N/A)	2.2	1.7	38.08
Eastern white pine	0.5	41	63.6	62	103	(N/A)	2.2	1.2	25.72
American basswood	1.1	81	156.1	153	234	(N/A)	2.2	2.6	58.61
Northern red oak	0.3	25	42.9	42	67	(N/A)	1.6	0.8	22.36
Littleleaf linden	0.2	12	25.3	25	37	(N/A)	1.6	0.4	12.36
Broadleaf Deciduous	0.1	6	13.5	13	19	(N/A)	1.1	0.2	9.53
River birch	0.4	27	53.6	53	80	(N/A)	1.1	0.9	39.91
Conifer Evergreen	0.3	19	30.4	30	49	(N/A)	1.1	0.6	24.51
Honeylocust	0.7	56	94.8	93	149	(N/A)	1.1	1.7	74.28
Apple	0.4	28	49.3	48	76	(N/A)	1.1	0.9	38.13
Cottonwood	0.8	59	107.4	105	164	(N/A)	1.1	1.8	82.02
Quaking aspen	0.0	2	4.2	4	6	(N/A)	1.1	0.1	3.24
Kwanzan cherry	0.0	2	4.4	4	6	(N/A)	1.1	0.1	3.13
Pin oak	0.8	58	102.2	100	158	(N/A)	1.1	1.8	79.24
Northern white cedar	0.1	9	19.0	19	27	(N/A)	1.1	0.3	13.58
Other street trees	2.1	163	287.1	281	444	(N/A)	4.9	4.9	49.35
Citywide total	42.7	3,239	5,860.3	5,743	8,982	(N/A)	100.0	100.0	49.08

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

9/28/2011

Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Ash	117,678	3,189	(N/A)	29.0	27.1	60.18
Silver maple	92,760	2,514	(N/A)	14.2	21.4	96.69
Norway maple	37,665	1,021	(N/A)	10.9	8.7	51.04
Sugar maple	42,456	1,151	(N/A)	7.1	9.8	88.51
Northern hackberry	12,315	334	(N/A)	3.8	2.8	47.68
Red maple	7,178	195	(N/A)	3.3	1.7	32.42
Black walnut	13,747	373	(N/A)	3.3	3.2	62.10
Black poplar	14,720	399	(N/A)	2.7	3.4	79.79
Ginkgo	5,653	153	(N/A)	2.2	1.3	38.30
Eastern white pine	7,585	206	(N/A)	2.2	1.8	51.39
American basswood	13,647	370	(N/A)	2.2	3.2	92.47
Northern red oak	1,889	51	(N/A)	1.6	0.4	17.07
Littleleaf linden	928	25	(N/A)	1.6	0.2	8.38
Broadleaf Deciduous	272	7	(N/A)	1.1	0.1	3.68
River birch	3,927	106	(N/A)	1.1	0.9	53.21
Conifer Evergreen	3,088	84	(N/A)	1.1	0.7	41.85
Honeylocust	9,369	254	(N/A)	1.1	2.2	126.96
Apple	1,333	36	(N/A)	1.1	0.3	18.06
Cottonwood	10,980	298	(N/A)	1.1	2.5	148.79
Quaking aspen	190	5	(N/A)	1.1	0.0	2.57
Kwanzan cherry	76	2	(N/A)	1.1	0.0	1.03
Pin oak	10,002	271	(N/A)	1.1	2.3	135.53
Northern white cedar	1,191	32	(N/A)	1.1	0.3	16.14
Other street trees	24,972	677	(N/A)	4.9	5.8	75.20
Citywide total	433,620	11,752	(N/A)	100.0	100.0	64.22

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

9/28/2011

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								
Ash	23.9	4.1	11.8	1.1	129	61.6	8.9	8.5	57.6	381	-5.6	-21	171.7	489 (N/A)		29.0	9.23
Silver maple	15.7	2.7	7.9	0.7	85	34.7	5.1	4.8	33.2	217	-9.2	-34	95.5	267 (N/A)		14.2	10.29
Norway maple	7.0	1.2	3.5	0.3	38	22.9	3.3	3.2	21.7	143	-1.7	-6	61.4	174 (N/A)		10.9	8.71
Sugar maple	6.2	1.1	3.0	0.3	33	17.6	2.6	2.5	16.9	110	-4.9	-18	45.2	125 (N/A)		7.1	9.63
Northern hackberry	1.6	0.3	0.9	0.1	9	7.4	1.1	1.0	6.8	46	0.0	0	19.2	55 (N/A)		3.8	7.80
Red maple	1.4	0.2	0.7	0.1	7	5.4	0.8	0.8	5.3	34	-0.5	-2	14.2	40 (N/A)		3.3	6.63
Black walnut	1.4	0.2	0.7	0.1	8	7.5	1.1	1.0	7.2	47	0.0	0	19.3	55 (N/A)		3.3	9.11
Black poplar	2.3	0.4	1.1	0.1	12	6.5	1.0	0.9	6.2	41	0.0	0	18.4	53 (N/A)		2.7	10.57
Ginkgo	1.6	0.3	0.8	0.1	9	3.5	0.5	0.5	3.3	22	-0.5	-2	10.0	29 (N/A)		2.2	7.13
Eastern white pine	0.9	0.2	0.7	0.1	6	2.5	0.4	0.3	2.4	16	-3.0	-11	4.4	10 (N/A)		2.2	2.48
American basswood	2.0	0.3	1.0	0.1	11	5.2	0.8	0.7	4.9	32	-1.7	-6	13.3	37 (N/A)		2.2	9.20
Northern red oak	0.3	0.0	0.2	0.0	2	1.6	0.2	0.2	1.5	10	-0.4	-2	3.6	10 (N/A)		1.6	3.28
Littleleaf linden	0.1	0.0	0.1	0.0	0	0.8	0.1	0.1	0.7	5	0.0	0	1.8	5 (N/A)		1.6	1.72
Broadleaf Deciduous	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	2	0.0	0	0.9	3 (N/A)		1.1	1.33
River birch	0.9	0.2	0.4	0.0	5	1.8	0.3	0.2	1.6	11	-0.2	-1	5.2	15 (N/A)		1.1	7.40
Conifer Evergreen	0.4	0.1	0.3	0.0	3	1.2	0.2	0.2	1.1	7	-1.1	-4	2.4	6 (N/A)		1.1	2.89
Honeylocust	1.9	0.3	0.8	0.1	10	3.4	0.5	0.5	3.3	22	-1.5	-6	9.3	26 (N/A)		1.1	12.87
Apple	0.4	0.1	0.2	0.0	2	1.7	0.3	0.2	1.7	11	0.0	0	4.6	13 (N/A)		1.1	6.56
Cottonwood	1.6	0.3	0.7	0.1	8	3.7	0.5	0.5	3.5	23	0.0	0	10.9	31 (N/A)		1.1	15.71
Quaking aspen	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)		1.1	0.48
Kwanzan cherry	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)		1.1	0.41
Pin oak	1.9	0.3	1.0	0.1	10	3.6	0.5	0.5	3.5	23	-3.5	-13	8.0	20 (N/A)		1.1	10.00
Northern white cedar	0.1	0.0	0.1	0.0	1	0.6	0.1	0.1	0.5	3	-0.3	-1	1.1	3 (N/A)		1.1	1.48
Other street trees	4.1	0.7	2.0	0.2	22	10.2	1.5	1.4	9.7	64	-0.5	-2	29.2	84 (N/A)		4.9	9.29
Citywide total	75.7	12.9	37.8	3.5	410	204.0	29.7	28.3	193.4	1,270	-34.7	-130	550.5	1,550 (N/A)		100.0	8.47

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

9/28/2011

Species	Total Stored CO2 (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Ash	394,804	2,961	(N/A)	29.0	23.8	55.87
Silver maple	403,830	3,029	(N/A)	14.2	24.4	116.49
Norway maple	114,675	860	(N/A)	10.9	6.9	43.00
Sugar maple	184,553	1,384	(N/A)	7.1	11.1	106.47
Northern	23,494	176	(N/A)	3.8	1.4	25.17
Red maple	15,816	119	(N/A)	3.3	1.0	19.77
Black walnut	46,233	347	(N/A)	3.3	2.8	57.79
Black poplar	80,133	601	(N/A)	2.7	4.8	120.20
Ginkgo	23,478	176	(N/A)	2.2	1.4	44.02
Eastern white pine	6,853	51	(N/A)	2.2	0.4	12.85
American	77,948	585	(N/A)	2.2	4.7	146.15
Northern red oak	4,806	36	(N/A)	1.6	0.3	12.02
Littleleaf linden	2,062	15	(N/A)	1.6	0.1	5.15
Broadleaf	922	7	(N/A)	1.1	0.1	3.46
River birch	14,499	109	(N/A)	1.1	0.9	54.37
Conifer Evergreen	2,236	17	(N/A)	1.1	0.1	8.39
Honeylocust	24,490	184	(N/A)	1.1	1.5	91.84
Apple	6,074	46	(N/A)	1.1	0.4	22.78
Cottonwood	51,886	389	(N/A)	1.1	3.1	194.57
Quaking aspen	198	1	(N/A)	1.1	0.0	0.74
Kwanzan cherry	192	1	(N/A)	1.1	0.0	0.72
Pin oak	52,855	396	(N/A)	1.1	3.2	198.21
Northern white	513	4	(N/A)	1.1	0.0	1.93
Other street trees	56,174	929	(N/A)	4.9	7.5	103.20
Citywide total	1,656,393	12,423	(N/A)	100.0	100.0	67.88

Table 5: Annual Carbon Sequestered

Annual CO₂ Benefits of Public Trees by Species												
9/28/2011												
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
Ash	15,918	119	-1,895	-10	-14	21,287	160	35,299	265 (N/A)	29.0	22.8	5.00
Silver maple	30,053	225	-1,938	-5	-15	12,302	92	40,412	303 (N/A)	14.2	26.1	11.66
Norway maple	7,867	59	-550	-4	-4	8,019	60	15,332	115 (N/A)	10.9	9.9	5.75
Sugar maple	8,645	65	-886	-3	-7	6,261	47	14,017	105 (N/A)	7.1	9.1	8.09
Northern hackberry	1,639	12	-113	-1	-1	2,532	19	4,056	30 (N/A)	3.8	2.6	4.35
Red maple	2,137	16	-76	-1	-1	1,969	15	4,029	30 (N/A)	3.3	2.6	5.04
Black walnut	3,495	26	-222	-1	-2	2,676	20	5,948	45 (N/A)	3.3	3.8	7.44
Black poplar	2,435	18	-385	-1	-3	2,310	17	4,359	33 (N/A)	2.7	2.8	6.54
Ginkgo	16	0	-113	-1	-1	1,224	9	1,126	8 (N/A)	2.2	0.7	2.11
Eastern white pine	534	4	-33	-1	0	896	7	1,396	10 (N/A)	2.2	0.9	2.62
American basswood	4,215	32	-374	-1	-3	1,800	13	5,640	42 (N/A)	2.2	3.6	10.58
Northern red oak	484	4	-23	-1	0	553	4	1,013	8 (N/A)	1.6	0.7	2.53
Littleleaf linden	465	3	-10	-1	0	271	2	725	5 (N/A)	1.6	0.5	1.81
Broadleaf Deciduous	123	1	-4	0	0	130	1	248	2 (N/A)	1.1	0.2	0.93
River birch	466	3	-70	0	-1	603	5	999	7 (N/A)	1.1	0.6	3.75
Conifer Evergreen	181	1	-11	0	0	426	3	596	4 (N/A)	1.1	0.4	2.23
Honeylocust	1,486	11	-118	0	-1	1,230	9	2,597	19 (N/A)	1.1	1.7	9.74
Apple	535	4	-29	0	0	617	5	1,123	8 (N/A)	1.1	0.7	4.21
Cottonwood	1,919	14	-249	0	-2	1,300	10	2,970	22 (N/A)	1.1	1.9	11.14
Quaking aspen	77	1	-1	0	0	53	0	128	1 (N/A)	1.1	0.1	0.48
Kwanzan cherry	47	0	-1	0	0	43	0	88	1 (N/A)	1.1	0.1	0.33
Pin oak	4,403	33	-254	0	-2	1,289	10	5,438	41 (N/A)	1.1	3.5	20.39
Northern white cedar	105	1	-2	0	0	189	1	291	2 (N/A)	1.1	0.2	1.09
Other street trees	4,025	30	-594	-2	-4	3,596	27	7,025	53 (N/A)	4.9	4.5	5.85
Citywide total	91,270	685	-7,951	-36	-60	71,574	537	154,857	1,161 (N/A)	100.0	100.0	6.35

Table 6: Annual Social and Aesthetic Benefits

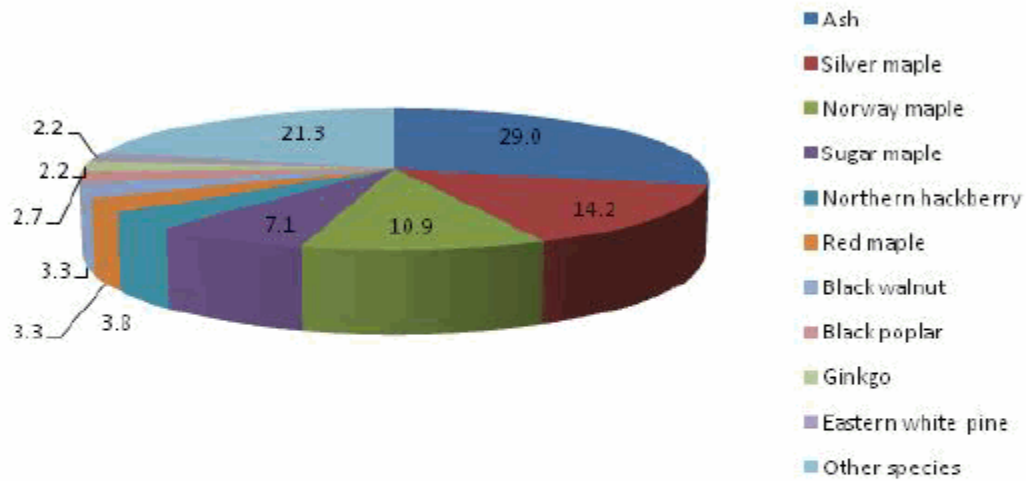
Annual Aesthetic/Other Benefits of Public Trees by Species					
9/28/2011					
Species	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Ash	1,553	(N/A)	29.0	18.1	29.30
Silver maple	2,373	(N/A)	14.2	27.7	91.28
Norway maple	765	(N/A)	10.9	8.9	38.26
Sugar maple	880	(N/A)	7.1	10.3	67.67
Northern hackberry	274	(N/A)	3.8	3.2	39.17
Red maple	301	(N/A)	3.3	3.5	50.11
Black walnut	315	(N/A)	3.3	3.7	52.43
Black poplar	214	(N/A)	2.7	2.5	42.89
Ginkgo	3	(N/A)	2.2	0.0	0.69
Eastern white pine	144	(N/A)	2.2	1.7	36.01
American basswood	284	(N/A)	2.2	3.3	70.89
Northern red oak	48	(N/A)	1.6	0.6	15.85
Littleleaf linden	65	(N/A)	1.6	0.8	21.71
Broadleaf Deciduous	6	(N/A)	1.1	0.1	3.22
River birch	44	(N/A)	1.1	0.5	22.17
Conifer Evergreen	50	(N/A)	1.1	0.6	25.23
Honeylocust	389	(N/A)	1.1	4.5	194.45
Apple	31	(N/A)	1.1	0.4	15.48
Cottonwood	133	(N/A)	1.1	1.6	66.60
Quaking aspen	20	(N/A)	1.1	0.2	10.00
Kwanzan cherry	2	(N/A)	1.1	0.0	1.05
Pin oak	322	(N/A)	1.1	3.8	161.06
Northern white cedar	31	(N/A)	1.1	0.4	15.42
Other street trees	328	(N/A)	4.9	3.8	36.49
Citywide total	8,576	(N/A)	100.0	100.0	46.86

Table 7: Summary of Benefits in Dollars

Total Annual Benefits of Public Trees by Species (\$)								
9/28/201								
Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Ash	2,763	265	489	3,189	1,553	8,260 (±0)		25.8
Silver maple	1,512	303	267	2,514	2,373	6,970 (±0)		21.8
Norway maple	1,011	115	174	1,021	765	3,086 (±0)		9.6
Sugar maple	760	105	125	1,151	880	3,021 (±0)		9.4
Northern hackberry	337	30	55	334	274	1,030 (±0)		3.2
Red maple	228	30	40	195	301	793 (±0)		2.5
Black walnut	319	45	55	373	315	1,105 (±0)		3.5
Black poplar	279	33	53	399	214	978 (±0)		3.1
Ginkgo	152	8	29	153	3	345 (±0)		1.1
Eastern white pine	103	10	10	206	144	473 (±0)		1.5
American basswood	234	42	37	370	284	967 (±0)		3.0
Northern red oak	67	8	10	51	48	183 (±0)		0.6
Littleleaf linden	37	5	5	25	65	138 (±0)		0.4
Broadleaf Deciduous	19	2	3	7	6	37 (±0)		0.1
River birch	80	7	15	106	44	253 (±0)		0.8
Conifer Evergreen	49	4	6	84	50	193 (±0)		0.6
Honeylocust	149	19	26	254	389	837 (±0)		2.6
Apple	76	8	13	36	31	165 (±0)		0.5
Cottonwood	164	22	31	298	133	649 (±0)		2.0
Quaking aspen	6	1	1	5	20	34 (±0)		0.1
Kwanzan cherry	6	1	1	2	2	12 (±0)		0.0
Pin oak	158	41	20	271	322	812 (±0)		2.5
Northern white cedar	27	2	3	32	31	95 (±0)		0.3
Other street trees	444	53	84	677	328	1,586 (±0)		5.0
Citywide Total	8,982	1,161	1,550	11,752	8,576	32,021 (±0)		100.0

Species Distribution of Public Trees (%)

9/28/2011

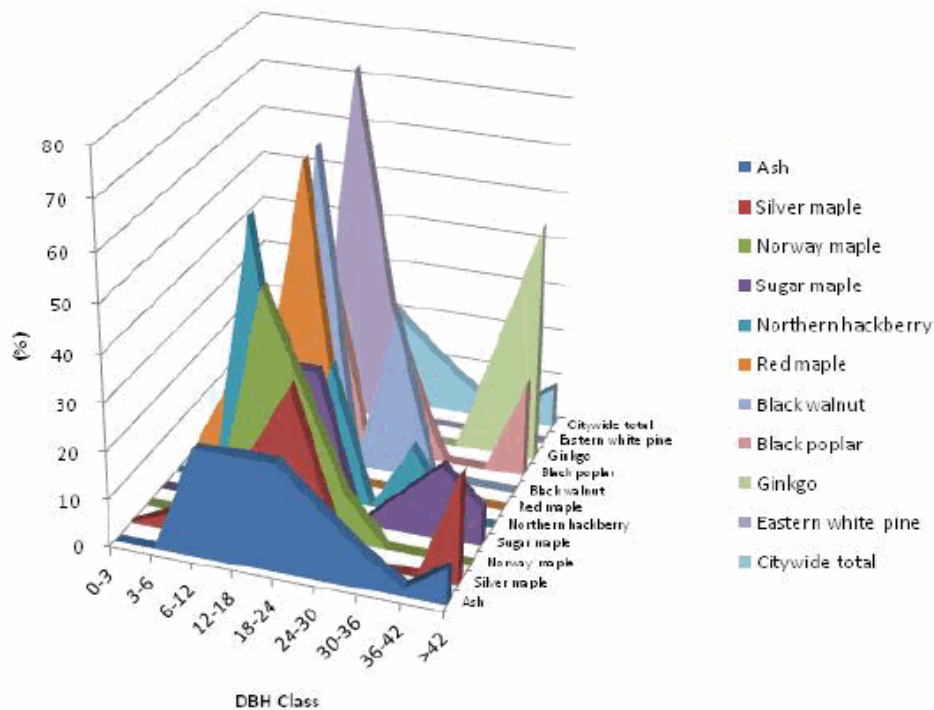


Species	Percent
Ash	29.0
Silver maple	14.2
Norway maple	10.9
Sugar maple	7.1
Northern hackberry	3.8
Red maple	3.3
Black walnut	3.3
Black poplar	2.7
Ginkgo	2.2
Eastern white pine	2.2
Other species	21.3
Total	100.0

Figure 1: Species Distribution

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

9/28/2011



Species	DBH class (in)								
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Ash	0.0	0.0	22.6	22.6	22.6	15.1	7.5	1.9	7.5
Silver maple	0.0	3.8	11.5	19.2	34.6	7.7	0.0	0.0	23.1
Norway maple	0.0	0.0	10.0	50.0	30.0	10.0	0.0	0.0	0.0
Sugar maple	0.0	0.0	7.7	30.8	30.8	0.0	7.7	15.4	7.7
Northern hackberry	0.0	0.0	57.1	0.0	28.6	0.0	14.3	0.0	0.0
Red maple	0.0	16.7	16.7	66.7	0.0	0.0	0.0	0.0	0.0
Black walnut	0.0	0.0	0.0	66.7	0.0	33.3	0.0	0.0	0.0
Black poplar	0.0	0.0	20.0	40.0	0.0	20.0	0.0	0.0	20.0
Ginkgo	0.0	25.0	0.0	0.0	0.0	0.0	0.0	25.0	50.0
Eastern white pine	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
Citywide total	2.2	4.4	18.0	27.9	19.1	11.5	4.9	3.3	8.7

Figure 2: Relative Age Class

Functional (Foliage) Condition of Public Trees by Species (%)

9/28/2011

Citywide total

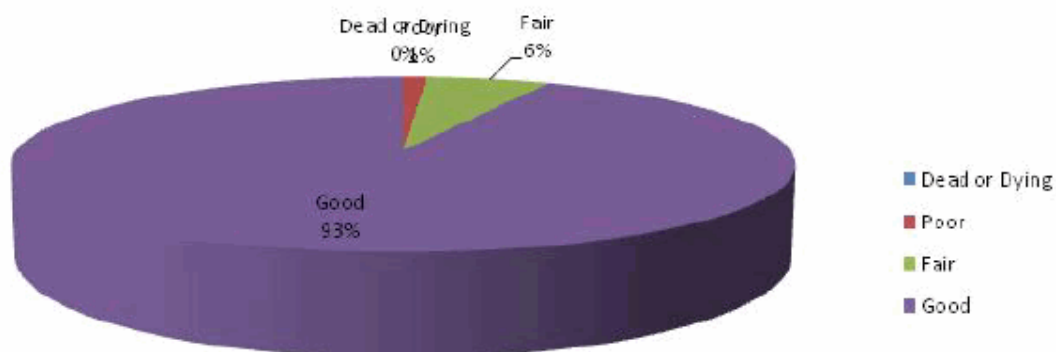


Figure 3: Foliage Condition

Structural (Woody) Condition of Public Trees by Species (%)

9/28/2011

Citywide total

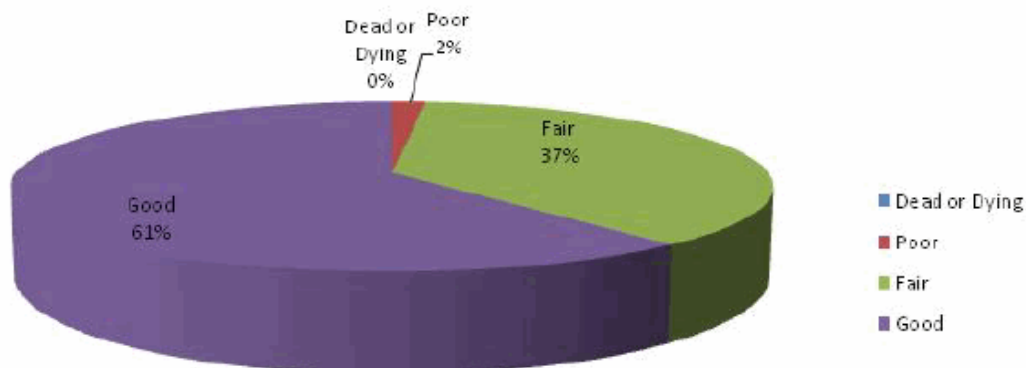
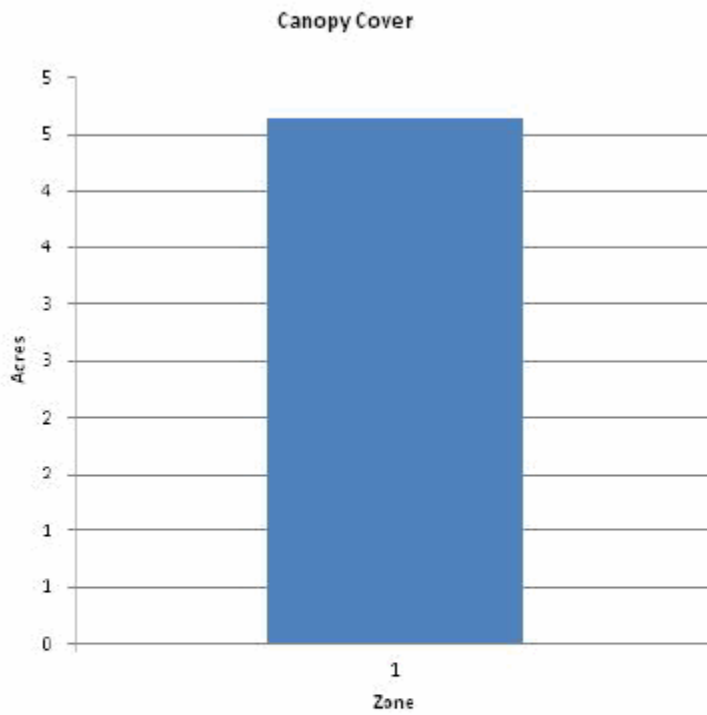


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

9/28/2011



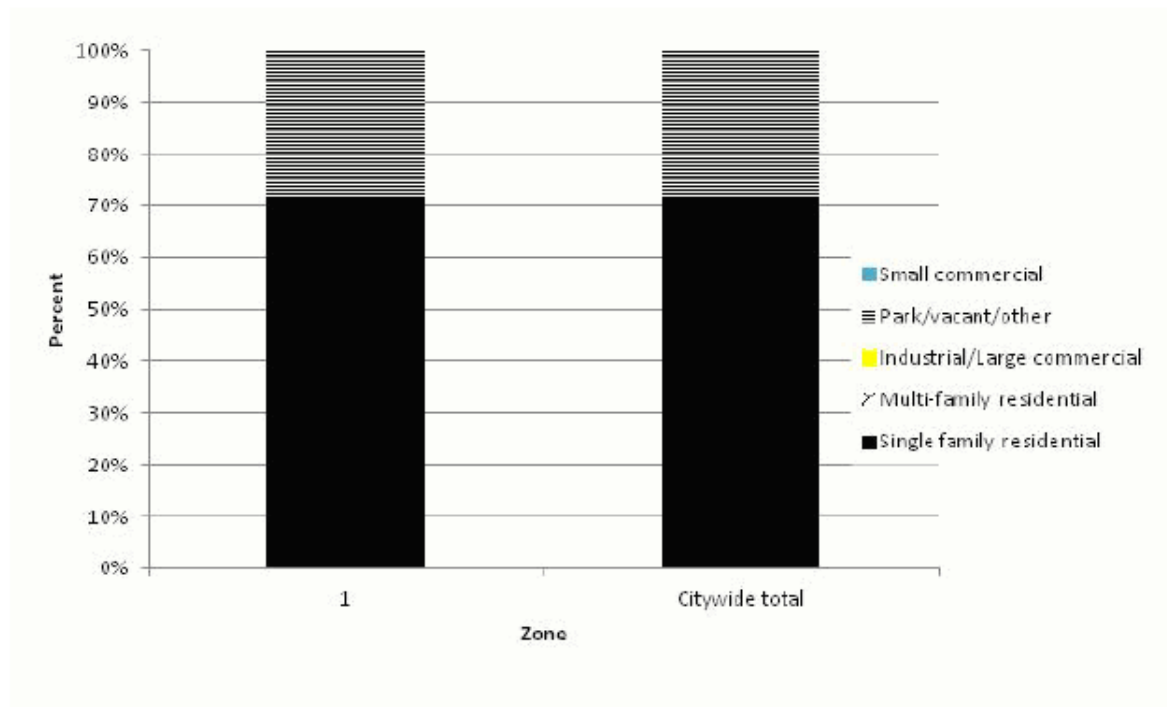
Zone	Acres	% of Total Canopy Cover
1	5	100.0
Citywide total	5	100.0

	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	0	0	5		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

9/28/2011

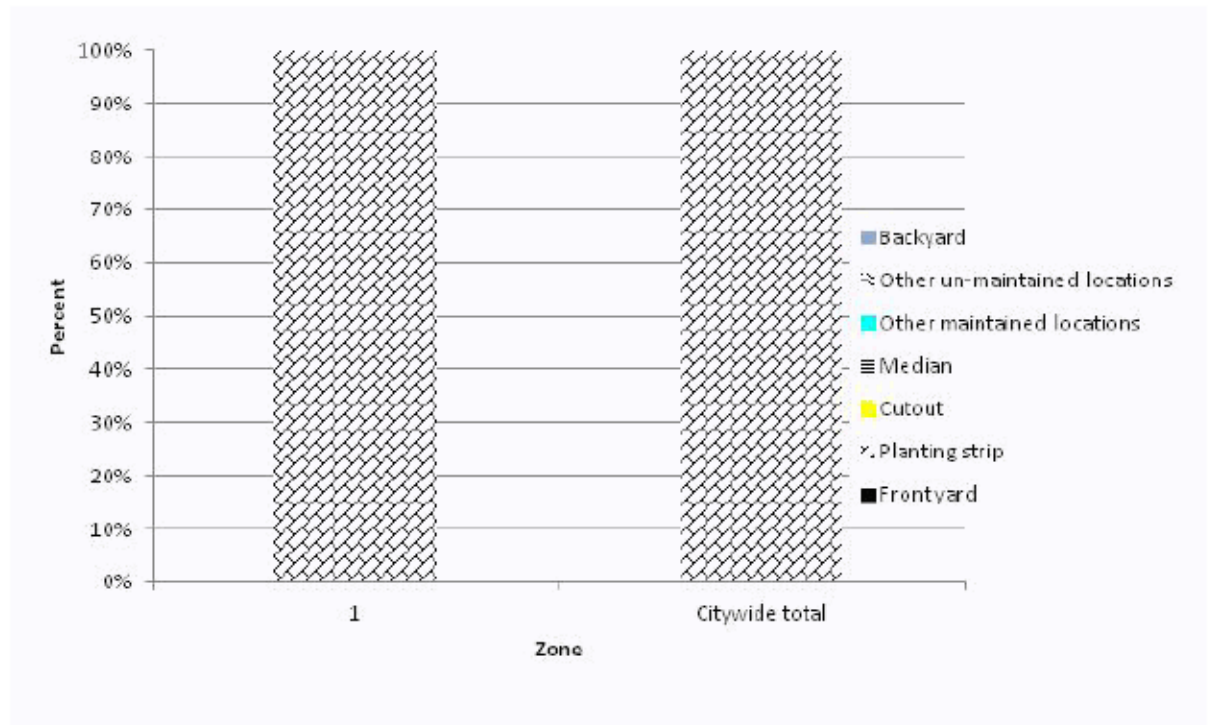


Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	71.6	0.0	0.0	28.4	0.0
Citywide total	71.6	0.0	0.0	28.4	0.0

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

9/28/2011



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Citywide total	0.0	100.0	0.0	0.0	0.0	0.0	0.0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

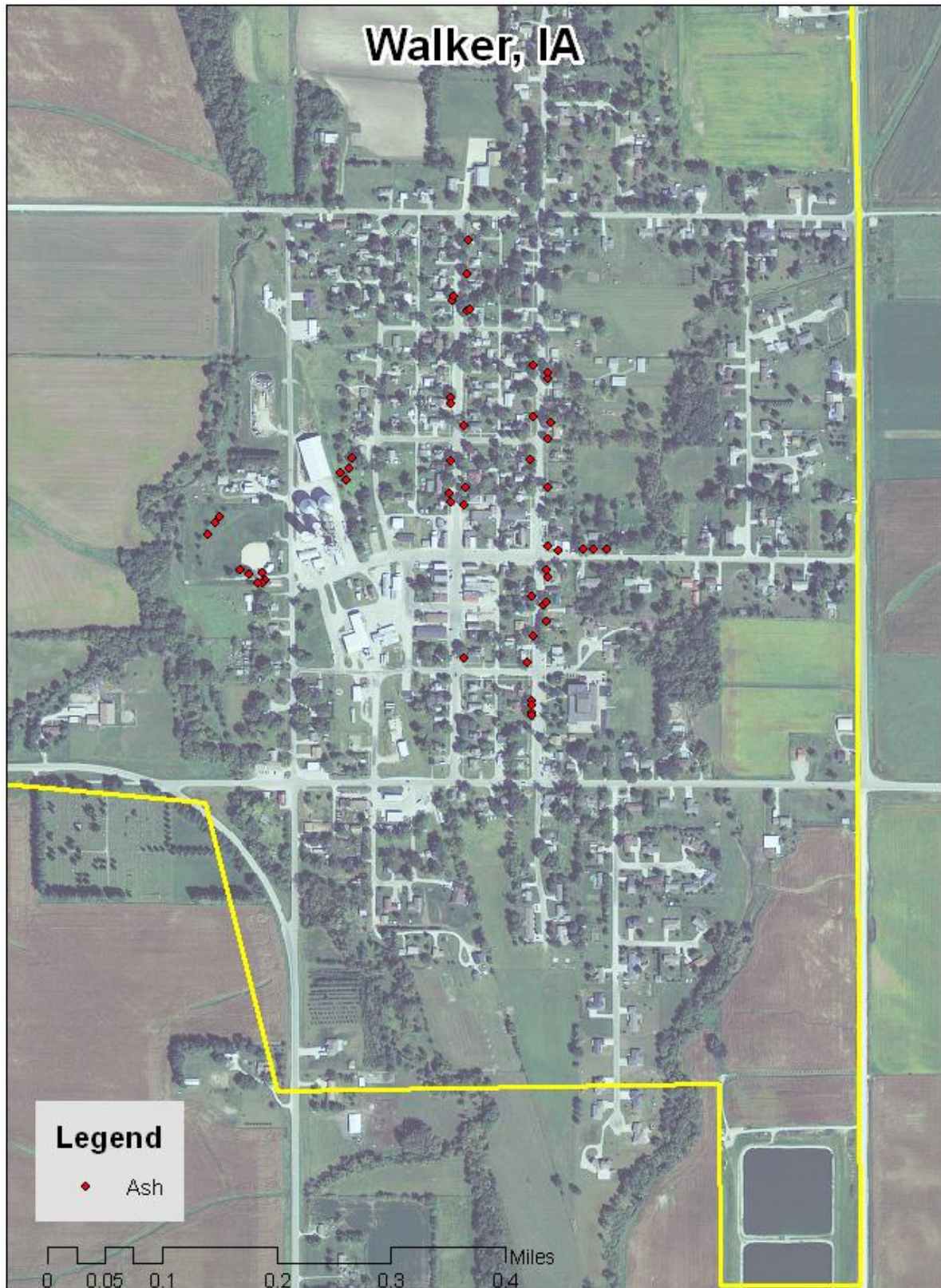


Figure 1: Location of Ash Trees

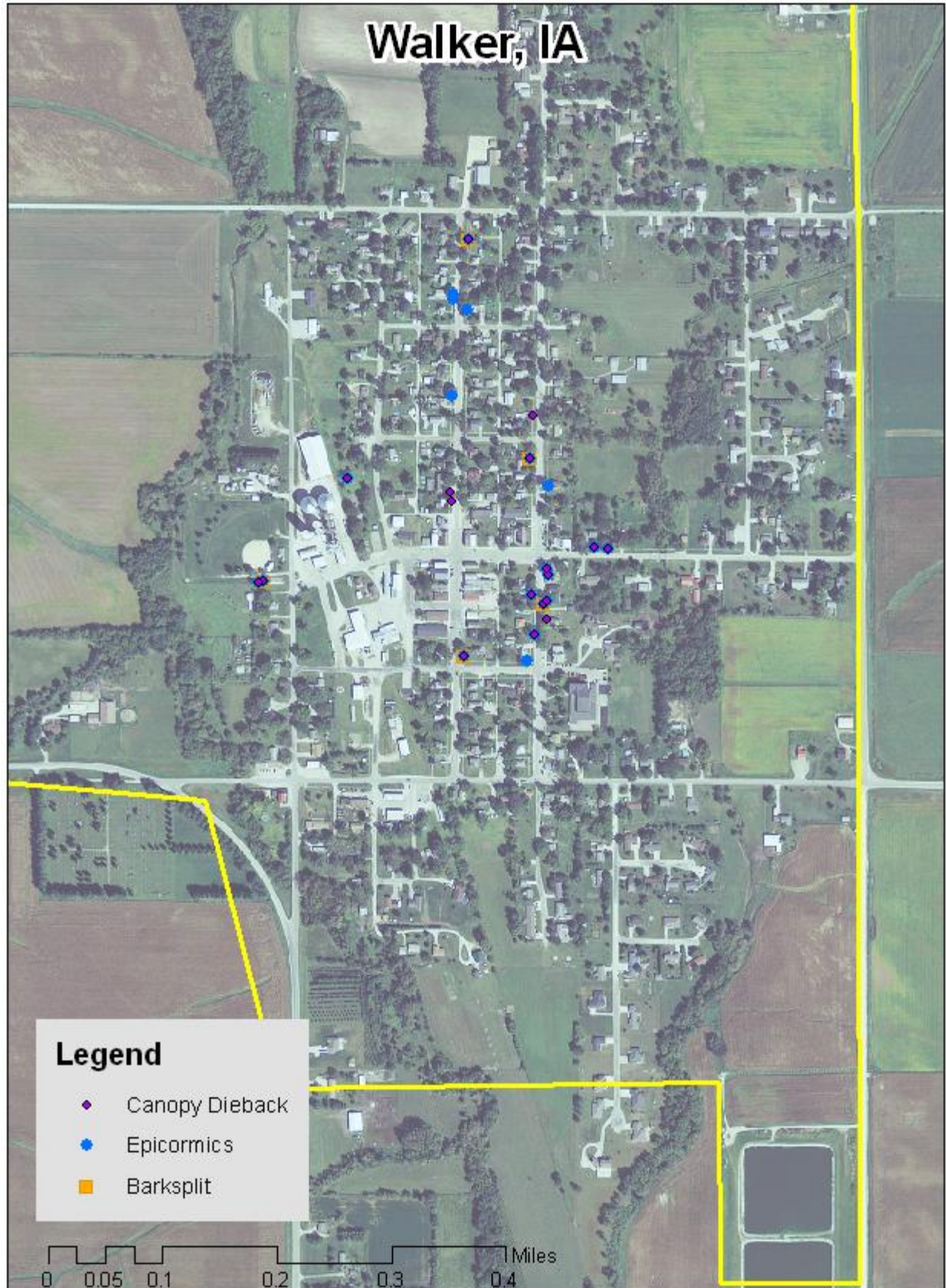


Figure 2: Location of EAB symptoms

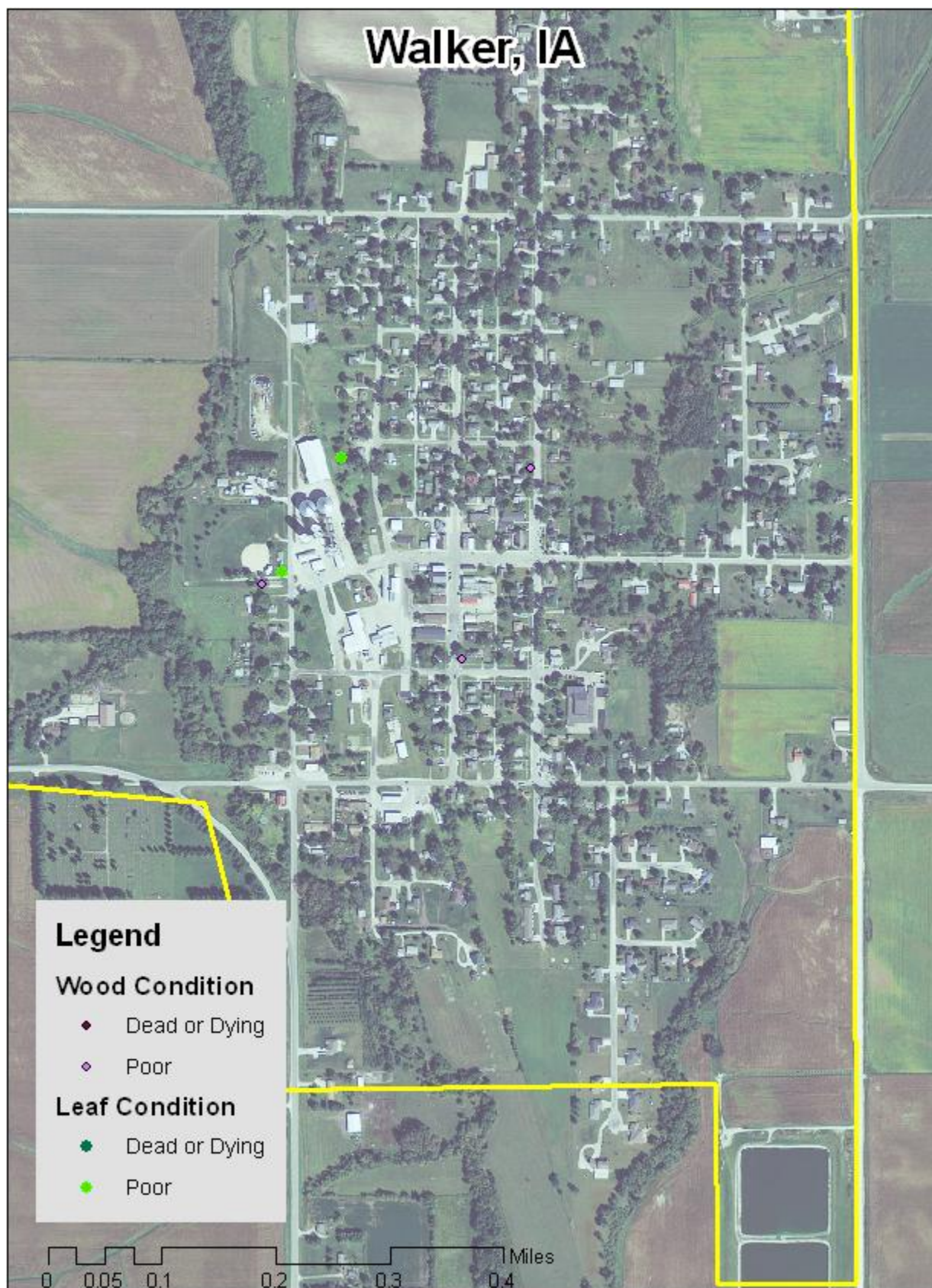


Figure 3: Location of Poor Condition Trees



Figure 4: Location of Trees with Recommended Maintenance

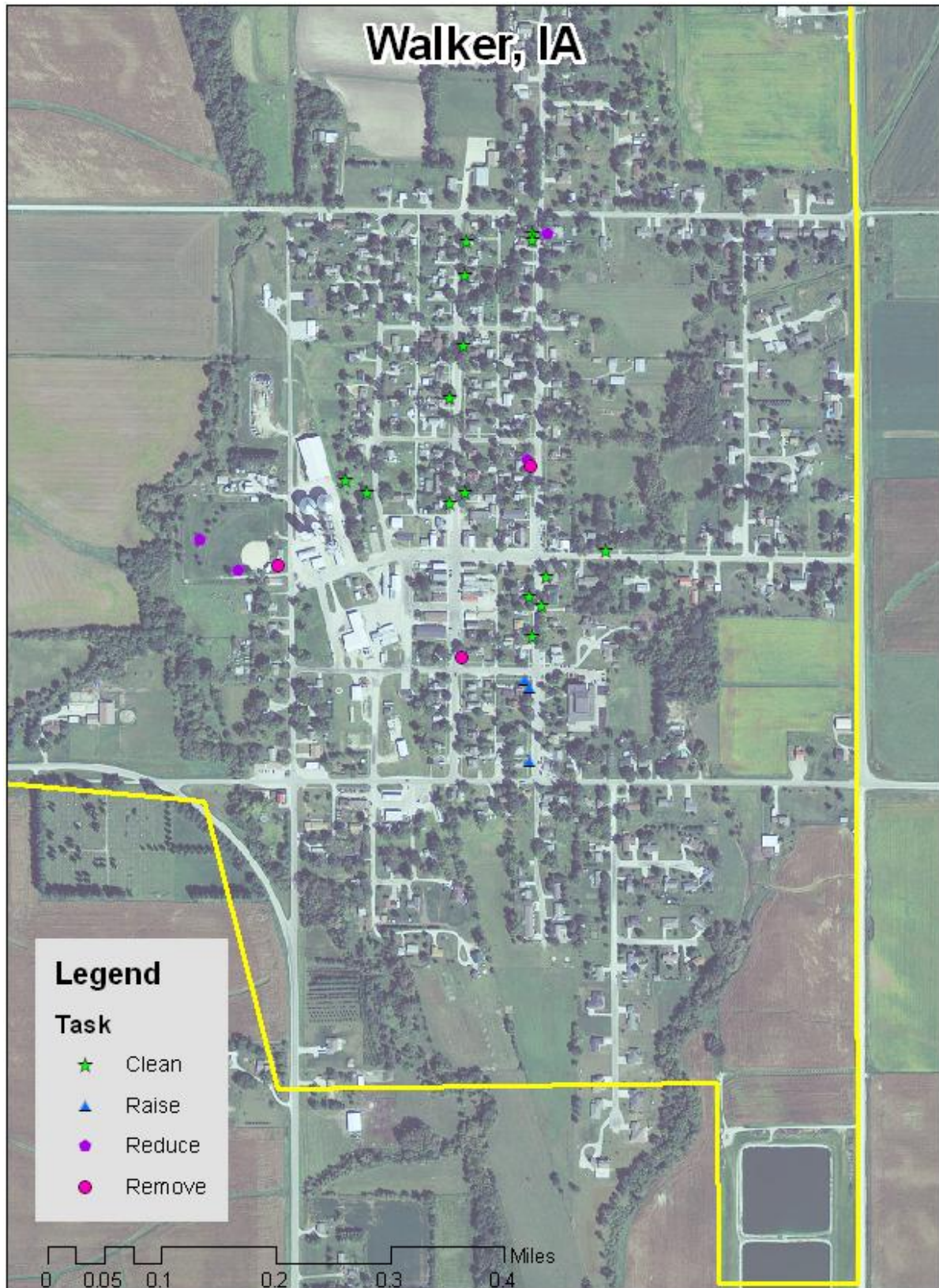


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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