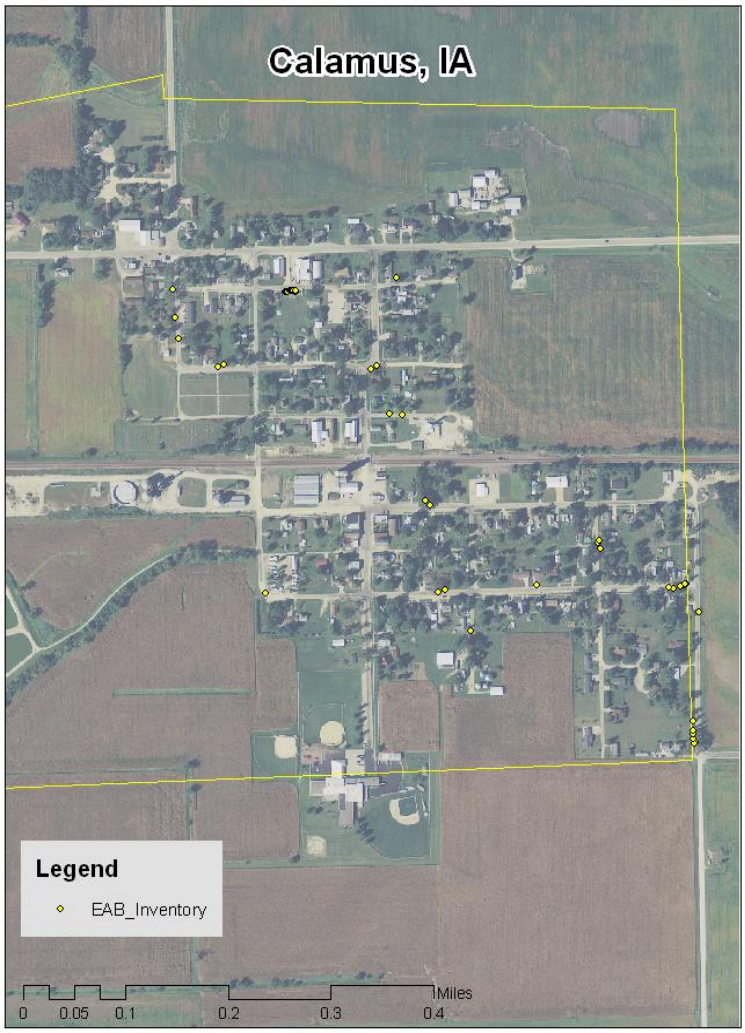
CALAMUS, IA



2011 Management Plan

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Executive Summary

Overview

This plan was developed to assist the City of Calamus with managing its urban forest, including a snapshot of the current situation and future planning. Trees can provide a multitude of benefits to the community, and sound management should increase the benefits given by a healthy urban forest. Management is especially important considering the serious threats posed by current known forest pests and those that may arise in the future. One known threat is 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 7.1% of Calamus's city owned trees (ash) will die once EAB becomes established in the community. With proper planning, management and keeping current of the options, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory, Results and Summary of Recommendations

In 2011, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and trees. Below are some key findings of the 29 trees inventoried.

- Calamus's trees provide $5,624 of benefits annually, an average of $134 a tree
- There are 11 species of trees
- The most common trees are: lilac 28.6% and Norway maple 11.9%
- 16 trees are in need of some type of management
- 1 tree is recommended for removal. This does not mean immediate removal, but when action is taken, removal is recommended. *City ownership of the trees recommended for removal should be verified prior to any removal*
- All trees should be visited on a routine schedule
- Plant a diverse mix of trees that do not include: ash, maple, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven or willow.

Introduction

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

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 Calamus 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 Calamus's urban forestry goals.

Inventory

In 2011, a tree inventory was conducted that included 100% of the city owned trees along the streets. 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 16 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. Calamus's trees reduce energy related costs by approximately $1,625 annually (Appendix A, Table 1). These savings are both in Electricity (MWh) and in Natural Gas (Therms).

Annual Stormwater Benefits

Calamus's trees intercept about 87,156 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $2,362 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 Calamus, it is estimated that trees remove 97 lbs. of air pollution (ozone (O_3), particulate matter less than 1.5 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $271 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Calamus, trees sequester about 23,722 lbs of carbon a year with an associated value of $178 (Appendix A, Table 5). In addition, the trees store 312,892 lbs of carbon, with a yearly benefit of $2,347
(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. Calamus receives $1,187 in annual social and aesthetic benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Calamus's trees provide $5,624 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 42 trees in Calamus provide approximately $134 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Calamus has 11 different tree species along city streets (Appendix A, Figure 1).
The distribution of trees by species is as follows:

Species	% of Trees
Lilac	28.6
Norway Maple	11.9
Silver Maple	7.1
Ash	7.1
Norway Spruce	7.1
Northern Pin Oak	7.1
Blue Spruce	4.8
Cottonwood	4.8
American Elm	4.8
Broadleaf Deciduous Small	2.4
Other Species	14.3

Size Class

There are 31% city street tree 0-6 " at 4.5 feet above ground. 9.5% of the trees are between 6 and 12" in diameter, 4.8% are between 12 and 18 inches in diameter, 26.2 % are 18-24 inches in diameter, 16.7% are 24-30, 7.1% are 30-36, 2.4% are 36-42, and 2.4% are over 42 inches in diameter at breast height(Appendix A, Figure 2). For size, a Bell Curve is preferred and shows the highest amount of trees around 10 inches in diameter at 4.5 ft. These figures suggest that there are enough small diameter trees to replace the larger ones if the same number of trees is desired.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage that was present on trees appeared moderately healthy with 24% ranked as fair and 74% ranked good (Appendix A, Figure 3 & Appendix B, Figure 3). 91% of Calamus's trees are in good or fair health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3) which is very good.

Management Needs

The following outlines the specific management needs of the street trees by number of trees.

Crown Raising (6 trees)- Crown should be raised by removing lower branches from the tree trunk or main branches to eliminate obstructions or clearance issues. 4 trees

Tree Removal (1 tree)– Tree is dangerous, dead or dying, and no amount of maintenance will increase longevity or safety. Trees may also have a defect that is not repairable. Tree removal is not necessarily immediate.

Crown Cleaning (6 trees) – Crown needs cleaning to remove dead, diseased, damaged, poorly attached, or crossing branches to increase the health or the longevity of tree. Most often this is the removal of dead interior branches.

Crown Reducing (3 trees)- Crown should be reduced/thinned by pruning to reduce tree height, spread, overcrowding, wind resistance, or an increase of light penetration. This is a typical recommendation when wires are nearby.

Canopy Cover

The canopy cover of Calamus is less than 1 acre.

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.

Ash trees

There are 3 ash tree listed as a city street tree. If there are ash trees in a city park or private property it is recommended that they be looked at every year to check for symptoms associated with Emerald Ash Borer. Symptoms include splits in the back, "D" shaped exit holes, wood pecker activity, canopy dieback and epicormic sprouts. *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. 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.

Pruning Practices


Two examples of improper cuts.

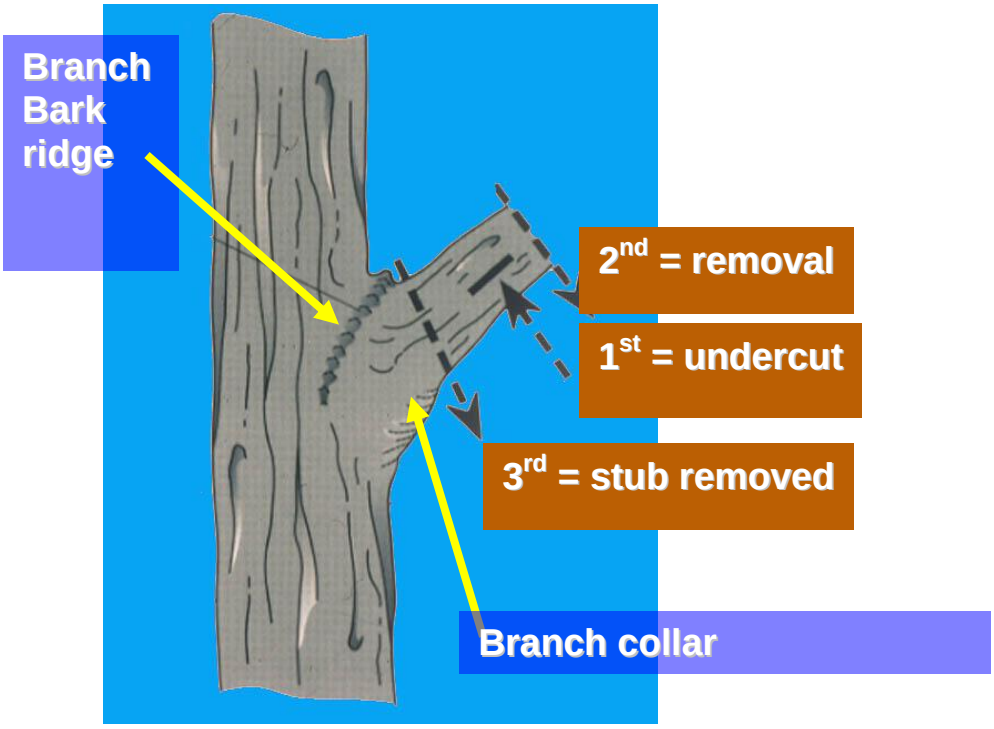
Consider the guidelines when pruning:

1. To avoid concerns related to the fungus that causes the disease oak wilt, all oak species should only be pruned between October 1 and February 28th.
2. All final cuts should be outside the branch collar.
3. Unless pruning broken oak branches between March 1 and September 30th pruning paints are not needed.

Branch collar

Proper Pruning

Improper Pruning



Proper Pruning Cut

Planting

There are locations where new trees could be planted. Select the appropriate species for the site to ensure a good fit for the tree and location. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees or even increasing the number helps ensure continuation of the benefits of the existing forest in Calamus.

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) 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 Ash (Appendix A, Figure 1). 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: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

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

Summary

Follow the movements of EAB on http://www.emeraldashborer.info/iowainfo.cfm. This site coordinates efforts from many agencies working together for a common cause. Currently EAB

is over 100 miles from Calamus. EAB could arrive in 1 year or 15 years. The proximity of the borer should dictate the rate at which ash is addressed.

Also follow developments as far as biologic controls and treatments. Research on insecticide injections of ash trees is just beginning. The early research shows repeated treatments could save ash trees, but more research is needed. Typically it is less expensive to cut and replace, but the option of tree injections may prove to be the best option in a small percentage of situations. Private homeowners may be more willing to incur the expense than a municipality if this proves effective.

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 trees in poor condition that develop into dead, dying and hazardous trees (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 the budget permits, all removed trees will be replaced. All trees will meet the restrictions of any city ordinances. The new plantings should be a diverse mix and will not include ash, maple, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow. There are many places in Calamus where trees could be planted.

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 as trees are infested with Emerald Ash Borer. Trees that are on private property are part of Calamus's urban forest. Private property owners should be given direction to the proper species to plant, spacing, and location.

Six Year Work Plan and Estimated Costs

Year 1:

Inspect all trees scheduled for maintenance	
Plant trees in open locations (2)	$100/tree

Year 2:

Inspect all trees scheduled for maintenance	
Remove 1 trees	$500/tree
Plant trees in open locations (2)	$100/tree

Year 3:

Inspect all trees scheduled for maintenance	
Plant trees in open locations (2)	$100/tree

Year 4:

Inspect all trees scheduled for maintenance	
Plant trees in open locations (1)	$100/tree

Year 5:

Inspect all trees scheduled for maintenance	
Plant trees in open locations (1)	$100/tree

Year 6:

Inspect all trees scheduled for maintenance	
Plant trees in open locations (1)	$100/tree

Funding

Depending on how the removals, maintenance and replanting are completed, this may be above the current budget. Calamus can 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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Calamus, IA
Legend
EAB_Inventory
Miles
0
0.05
0.1
0.2
0.3
0.4

Appendix A: i-Tree Data

Total Annual Benefits of Public Trees by Species ($)

10/15/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Lilac	101	12	16	51	49	228	(±0)	4.1
Norway maple	296	28	54	389	164	931	(±0)	16.6
Silver maple	162	26	26	207	214	635	(±0)	11.3
Ash	154	16	27	185	101	483	(±0)	8.6
Norway spruce	99	10	1	286	120	517	(±0)	9.2
Northern pin oak	154	16	27	185	101	483	(±0)	8.6
Blue spruce	31	3	3	64	25	126	(±0)	2.2
Cottonwood	156	16	32	266	86	556	(±0)	9.9
American elm	112	11	21	135	94	374	(±0)	6.6
Broadleaf Deciduous	5	1	1	2	2	11	(±0)	0.2
Black walnut	71	10	12	107	66	266	(±0)	4.7
Eastern red cedar	25	1	2	44	0	72	(±0)	1.3
Spruce	24	2	3	42	32	103	(±0)	1.8
Swamp white oak	71	4	14	102	0	190	(±0)	3.4
Bur oak	82	11	16	149	67	324	(±0)	5.8
Elm	82	11	16	149	67	324	(±0)	5.8
Other street trees	0	0	0	0	0	0	(±0)	0.0
Citywide Total	1,625	178	271	2,362	1,187	5,624	(±0)	100.0

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species

10/14/2011

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Lilac	0.4	32	70.2	69	101	(N/A)	28.6	6.2	8.42
Norway maple	1.3	101	198.7	195	296	(N/A)	11.9	18.2	59.13
Silver maple	0.8	60	103.9	102	162	(N/A)	7.1	10.0	53.98
Ash	0.7	52	103.8	102	154	(N/A)	7.1	9.5	51.33
Norway spruce	0.5	36	64.0	63	99	(N/A)	7.1	6.1	33.04
Northern pin oak	0.7	52	103.8	102	154	(N/A)	7.1	9.5	51.33
Blue spruce	0.1	11	20.7	20	31	(N/A)	4.8	1.9	15.65
Cottonwood	0.7	57	101.2	99	156	(N/A)	4.8	9.6	77.98
American elm	0.5	41	72.8	71	112	(N/A)	4.8	6.9	56.00
Broadleaf Deciduous	0.0	2	3.8	4	5	(N/A)	2.4	0.3	5.40
Black walnut	0.3	25	46.9	46	71	(N/A)	2.4	4.4	70.91
Eastern red cedar	0.1	8	16.4	16	25	(N/A)	2.4	1.5	24.57
Spruce	0.1	10	14.6	14	24	(N/A)	2.4	1.5	24.14
Swamp white oak	0.3	24	47.4	46	71	(N/A)	2.4	4.4	70.84
Bur oak	0.4	29	53.7	53	82	(N/A)	2.4	5.1	82.02
Elm	0.4	29	53.7	53	82	(N/A)	2.4	5.1	82.02
Other street trees	0.0	0	0.0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	7.5	571	1,075.6	1,054	1,625	(N/A)	100.0	100.0	38.69

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

10/14/2011

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Lilac	1,868	51	(N/A)	28.6	2.1	4.22
Norway maple	14,357	389	(N/A)	11.9	16.5	77.82
Silver maple	7,639	207	(N/A)	7.1	8.8	69.01
Ash	6,829	185	(N/A)	7.1	7.8	61.69
Norway spruce	10,542	286	(N/A)	7.1	12.1	95.24
Northern pin oak	6,829	185	(N/A)	7.1	7.8	61.69
Blue spruce	2,350	64	(N/A)	4.8	2.7	31.85
Cottonwood	9,829	266	(N/A)	4.8	11.3	133.19
American elm	4,983	135	(N/A)	4.8	5.7	67.53
Broadleaf Deciduous	69	2	(N/A)	2.4	0.1	1.86
Black walnut	3,943	107	(N/A)	2.4	4.5	106.85
Eastern red cedar	1,634	44	(N/A)	2.4	1.9	44.30
Spruce	1,539	42	(N/A)	2.4	1.8	41.70
Swamp white oak	3,764	102	(N/A)	2.4	4.3	102.01
Bur oak	5,490	149	(N/A)	2.4	6.3	148.79
Elm	5,490	149	(N/A)	2.4	6.3	148.79
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	87,156	2,362	(N/A)	100.0	100.0	56.24

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

10/14/2011

Species	Deposition (lb) O_3	NO_2	PM_{10}	SO_2	Total Depos. ($)	Avoided (lb) NO_2	PM_{10}	VOC	SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
Lilac	0.5	0.1	0.2	0.0	3	2.1	0.3	0.3	1.9	13	0.0	0	5.4	16	(N/A)	28.6	1.30
Norway maple	3.1	0.5	1.5	0.1	17	6.5	0.9	0.9	6.0	40	-0.7	-3	19.0	54	(N/A)	11.9	10.87
Silver maple	0.9	0.2	0.5	0.0	5	3.7	0.5	0.5	3.6	23	-0.6	-2	9.4	26	(N/A)	7.1	8.72
Ash	1.4	0.2	0.7	0.1	8	3.4	0.5	0.5	3.1	21	-0.3	-1	9.5	27	(N/A)	7.1	9.07
Norway spruce	1.3	0.2	1.0	0.2	8	2.3	0.3	0.3	2.2	14	-5.6	-21	2.1	1	(N/A)	7.1	0.44
Northern pin oak	1.4	0.2	0.7	0.1	8	3.4	0.5	0.5	3.1	21	-0.3	-1	9.5	27	(N/A)	7.1	9.07
Blue spruce	0.4	0.1	0.3	0.0	2	0.7	0.1	0.1	0.7	4	-0.9	-3	1.4	3	(N/A)	4.8	1.64
Cottonwood	1.9	0.3	0.8	0.1	10	3.6	0.5	0.5	3.4	22	0.0	0	11.0	32	(N/A)	4.8	15.94
American elm	1.0	0.2	0.5	0.0	5	2.6	0.4	0.4	2.4	16	0.0	0	7.3	21	(N/A)	4.8	10.53
Broadleaf Deciduous	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)	2.4	0.71
Black walnut	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12	(N/A)	2.4	12.48
Eastern red cedar	0.3	0.1	0.3	0.0	2	0.5	0.1	0.1	0.5	3	-0.9	-3	1.0	2	(N/A)	2.4	2.19
Spruce	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)	2.4	2.82
Swamp white oak	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14	(N/A)	2.4	13.58
Bur oak	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)	2.4	15.71
Elm	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)	2.4	15.71
Other street trees	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)	0.0	0.00
Citywide total	15.2	2.6	8.0	0.8	84	36.3	5.3	5.0	34.1	225	-10.1	-38	97.2	271	(N/A)	100.0	6.46

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

10/14/2011

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Lilac	8,534	64	(N/A)	28.6	2.7	5.33
Norway maple	51,886	389	(N/A)	11.9	16.6	77.83
Silver maple	19,515	146	(N/A)	7.1	6.2	48.79
Ash	23,326	175	(N/A)	7.1	7.5	58.32
Norway spruce	14,176	106	(N/A)	7.1	4.5	35.44
Northern pin oak	23,326	175	(N/A)	7.1	7.5	58.32
Blue spruce	2,663	20	(N/A)	4.8	0.9	9.99
Cottonwood	64,440	483	(N/A)	4.8	20.6	241.65
American elm	20,636	155	(N/A)	4.8	6.6	77.38
Broadleaf	178	1	(N/A)	2.4	0.1	1.33
Black walnut	15,773	118	(N/A)	2.4	5.0	118.30
Eastern red cedar	1,102	8	(N/A)	2.4	0.4	8.27
Spruce	1,170	9	(N/A)	2.4	0.4	8.78
Swamp white oak	14,280	107	(N/A)	2.4	4.6	107.10
Bur oak	25,943	195	(N/A)	2.4	8.3	194.57
Elm	25,943	195	(N/A)	2.4	8.3	194.57
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	312,892	2,347	(N/A)	100.0	100.0	55.87

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees by Species

10/14/2011

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Standar d Error	% of Total Trees	% of Total $	Avg. $/tree
Lilac	867	6	-41	-2	0	712	5	1,536	12	(N/A)	28.6	6.5	0.96
Norway maple	1,804	14	-249	-1	-2	2,232	17	3,786	28	(N/A)	11.9	16.0	5.68
Silver maple	2,295	17	-94	-1	-1	1,329	10	3,530	26	(N/A)	7.1	14.9	8.83
Ash	1,064	8	-112	-1	-1	1,154	9	2,106	16	(N/A)	7.1	8.9	5.26
Norway spruce	631	5	-68	-1	-1	804	6	1,366	10	(N/A)	7.1	5.8	3.41
Northern pin oak	1,064	8	-112	-1	-1	1,154	9	2,106	16	(N/A)	7.1	8.9	5.26
Blue spruce	149	1	-13	0	0	243	2	379	3	(N/A)	4.8	1.6	1.42
Cottonwood	1,139	9	-309	0	-2	1,254	9	2,083	16	(N/A)	4.8	8.8	7.81
American elm	677	5	-99	0	-1	900	7	1,477	11	(N/A)	4.8	6.2	5.54
Broadleaf Deciduous	38	0	-1	0	0	37	0	74	1	(N/A)	2.4	0.3	0.56
Black walnut	857	6	-76	0	-1	552	4	1,333	10	(N/A)	2.4	5.6	10.00
Eastern red cedar	0	0	-5	0	0	187	1	181	1	(N/A)	2.4	0.8	1.36
Spruce	116	1	-6	0	0	216	2	326	2	(N/A)	2.4	1.4	2.45
Swamp white oak	0	0	-69	0	-1	539	4	470	4	(N/A)	2.4	2.0	3.52
Bur oak	960	7	-125	0	-1	650	5	1,485	11	(N/A)	2.4	6.3	11.14
Elm	960	7	-125	0	-1	650	5	1,485	11	(N/A)	2.4	6.3	11.14
Other street trees	0	0	0	0	0	0	0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	12,618	95	-1,502	-8	-11	12,614	95	23,722	178	(N/A)	100.0	100.0	4.24

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

10/14/2011

Species	Total ($)	Standar d Error	% of Total Trees	% of Total $	Avg. $/tree
Lilac	49	(N/A)	28.6	4.2	4.12
Norway maple	164	(N/A)	11.9	13.8	32.73
Silver maple	214	(N/A)	7.1	18.0	71.22
Ash	101	(N/A)	7.1	8.5	33.58
Norway spruce	120	(N/A)	7.1	10.1	40.14
Northern pin oak	101	(N/A)	7.1	8.5	33.58
Blue spruce	25	(N/A)	4.8	2.1	12.50
Cottonwood	86	(N/A)	4.8	7.3	43.13
American elm	94	(N/A)	4.8	8.0	47.18
Broadleaf Deciduous	2	(N/A)	2.4	0.2	2.06
Black walnut	66	(N/A)	2.4	5.5	65.59
Eastern red cedar	0	(N/A)	2.4	0.0	0.00
Spruce	32	(N/A)	2.4	2.7	32.32
Swamp white oak	0	(N/A)	2.4	0.0	0.00
Bur oak	67	(N/A)	2.4	5.6	66.60
Elm	67	(N/A)	2.4	5.6	66.60
Other street trees	0	(±NaN)	0.0	0.0	0.00
Citywide total	1,187	(N/A)	100.0	100.0	28.27

Table 7: Summary of Benefits in Dollars

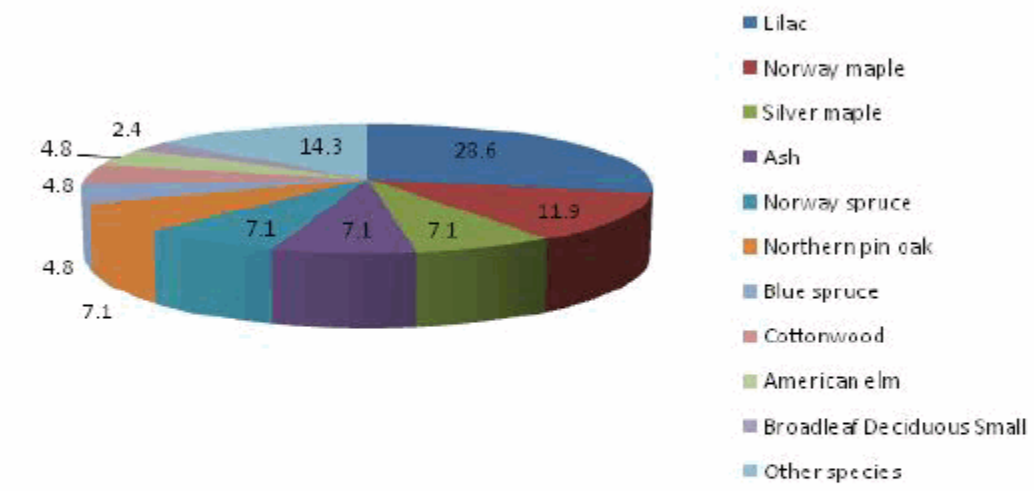
Total Annual Benefits of Public Trees by Species ($)

10/15/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Lilac	101	12	16	51	49	228	(±0)	4.1
Norway maple	296	28	54	389	164	931	(±0)	16.6
Silver maple	162	26	26	207	214	635	(±0)	11.3
Ash	154	16	27	185	101	483	(±0)	8.6
Norway spruce	99	10	1	286	120	517	(±0)	9.2
Northern pin oak	154	16	27	185	101	483	(±0)	8.6
Blue spruce	31	3	3	64	25	126	(±0)	2.2
Cottonwood	156	16	32	266	86	556	(±0)	9.9
American elm	112	11	21	135	94	374	(±0)	6.6
Broadleaf Deciduous	5	1	1	2	2	11	(±0)	0.2
Black walnut	71	10	12	107	66	266	(±0)	4.7
Eastern red cedar	25	1	2	44	0	72	(±0)	1.3
Spruce	24	2	3	42	32	103	(±0)	1.8
Swamp white oak	71	4	14	102	0	190	(±0)	3.4
Bur oak	82	11	16	149	67	324	(±0)	5.8
Elm	82	11	16	149	67	324	(±0)	5.8
Other street trees	0	0	0	0	0	0	(±0)	0.0
Citywide Total	1,625	178	271	2,362	1,187	5,624	(±0)	100.0

Species Distribution of Public Trees (%)

10/14/2011

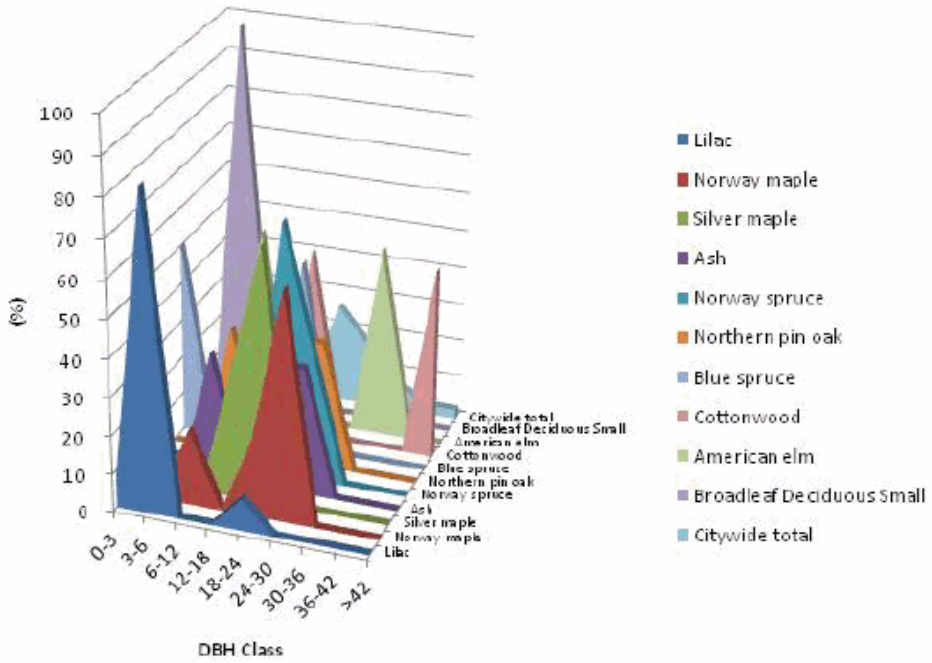


Species	Percent
Lilac	28.6
Norway maple	11.9
Silver maple	7.1
Ash	7.1
Norway spruce	7.1
Northern pin oak	7.1
Blue spruce	4.8
Cottonwood	4.8
American elm	4.8
Broadleaf Deciduous	2.4
Other species	14.3
Total	100.0

Figure 1: Species Distribution

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

10/14/2011



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Lilac	8.3	83.3	0.0	0.0	8.3	0.0	0.0	0.0	0.0
Norway maple	0.0	0.0	20.0	0.0	20.0	60.0	0.0	0.0	0.0
Silver maple	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0	0.0
Ash	0.0	0.0	33.3	0.0	33.3	33.3	0.0	0.0	0.0
Norway spruce	0.0	0.0	0.0	0.0	66.7	33.3	0.0	0.0	0.0
Northern pin oak	0.0	0.0	33.3	0.0	33.3	33.3	0.0	0.0	0.0
Blue spruce	50.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0
Cottonwood	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	50.0
American elm	0.0	0.0	50.0	0.0	0.0	0.0	50.0	0.0	0.0
Broadleaf Deciduous	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Citywide total	4.8	26.2	9.5	4.8	26.2	16.7	7.1	2.4	2.4

Figure 2: Relative Age Class

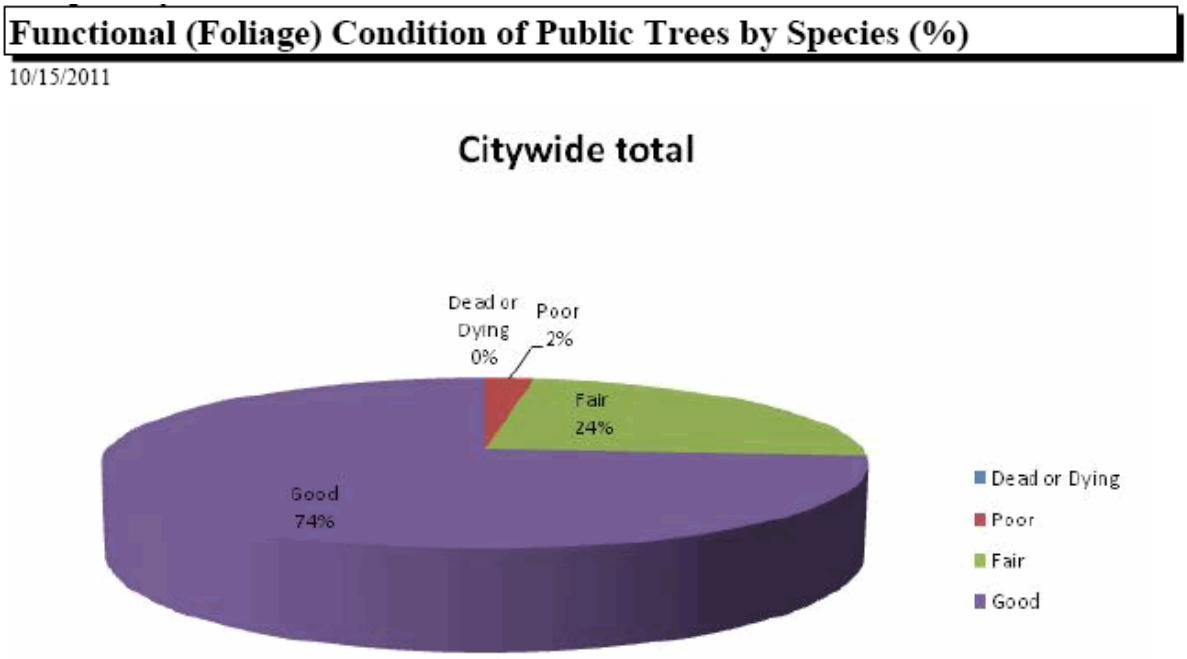


Figure 3: Foliage Condition

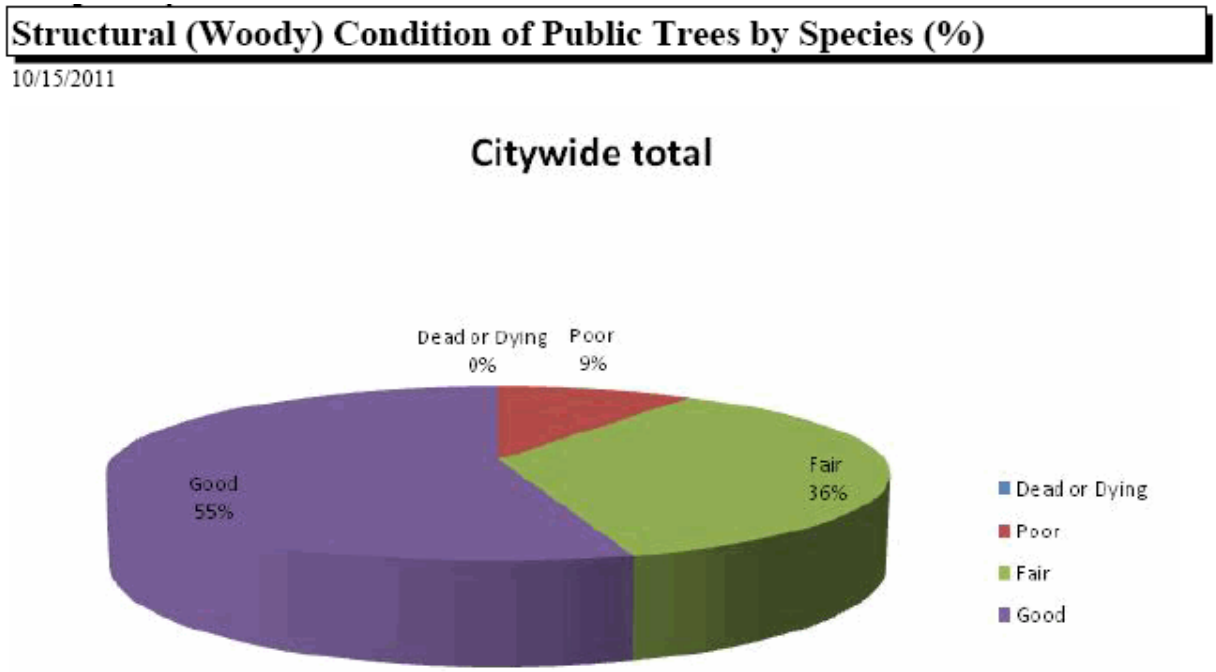
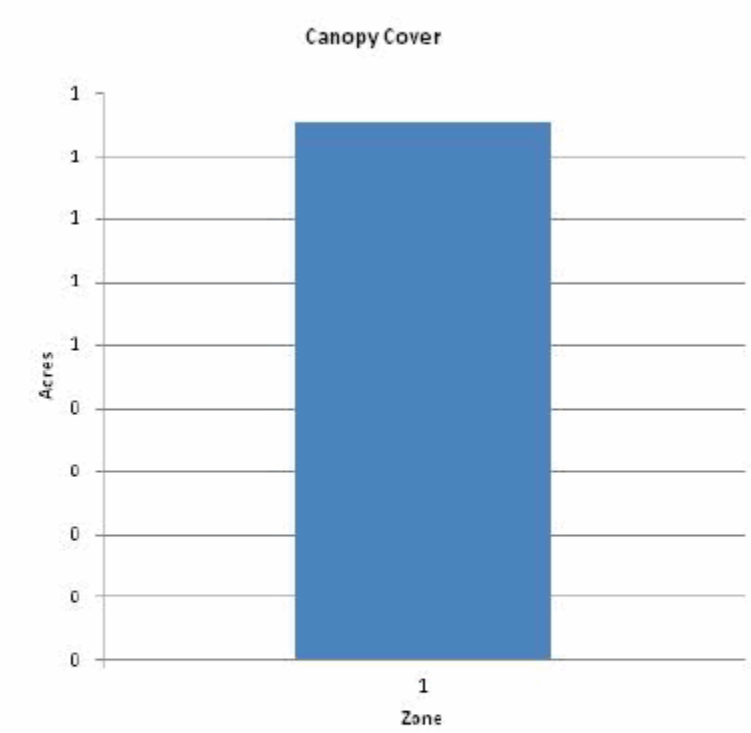


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

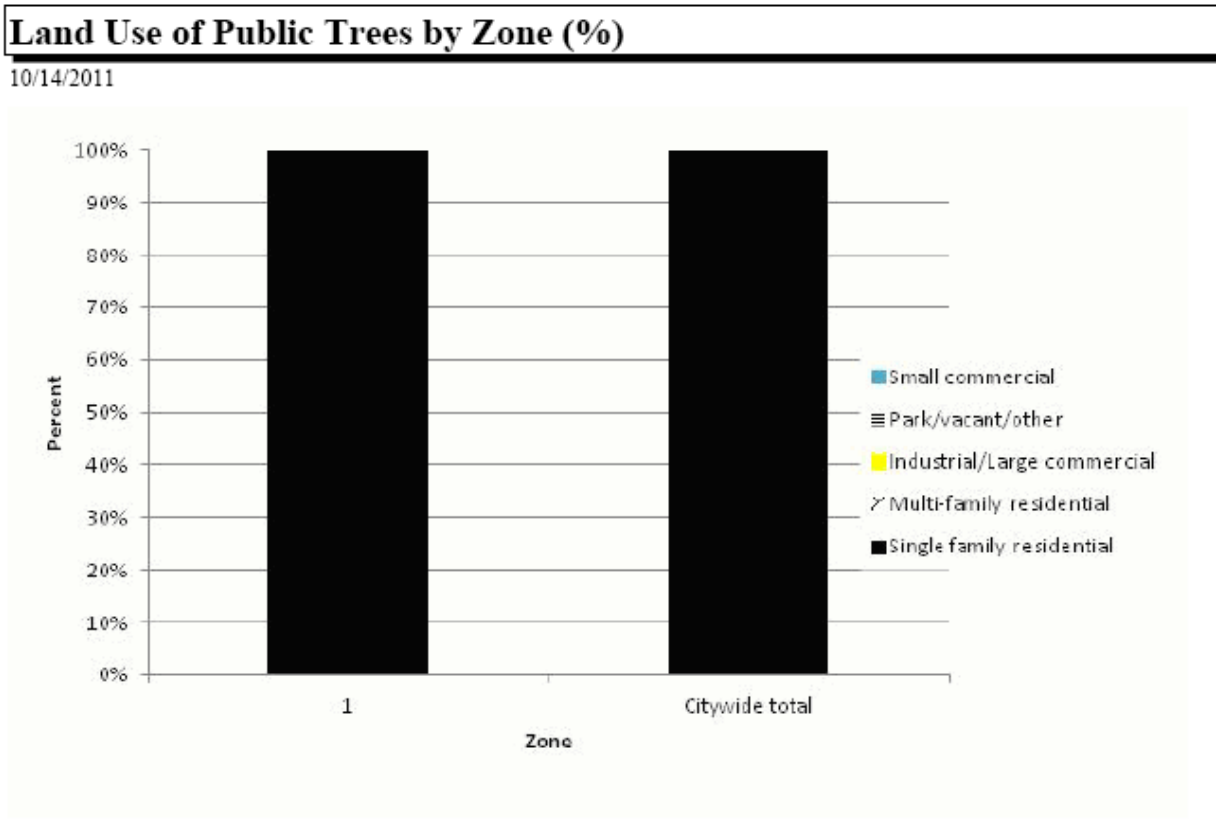
10/14/2011



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

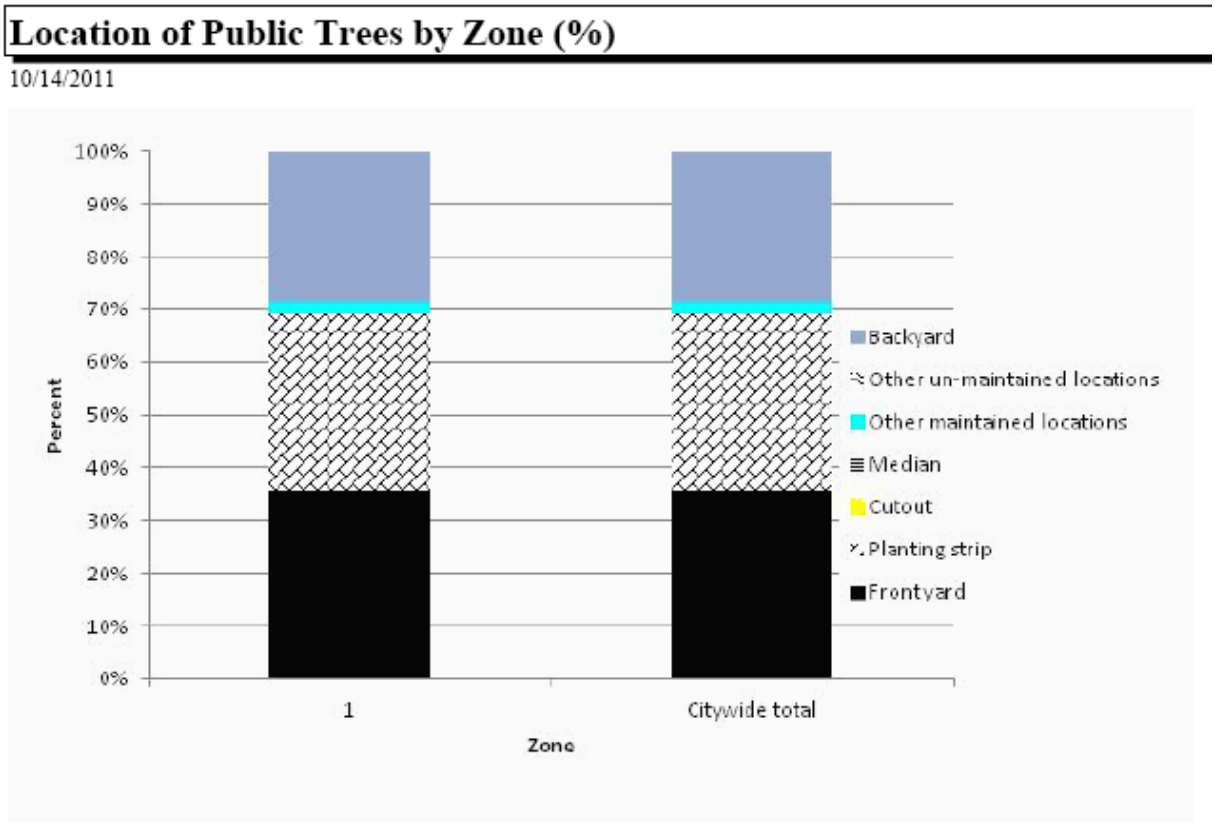
	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	1		

Figure 5: Canopy Cover in Acres



Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	100.0	0.0	0.0	0.0	0.0
Citywide total	100.0	0.0	0.0	0.0	0.0

Figure 6: Land Use of city/park trees



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	35.7	33.3	0.0	0.0	2.4	0.0	28.6
Citywide total	35.7	33.3	0.0	0.0	2.4	0.0	28.6

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees


Calamus, IA
Legend
Canopy Dieback
Epicormics
0
0.05
0.1
0.2
0.3
0.4
Miles

Figure 2: Location of EAB symptoms


Calamus, IA
Legend
Poor Wood Condition
Poor Leaf Condition
0
0.05
0.1
0.2
0.3
0.4
Miles

Figure 3: Location of Poor Condition Trees

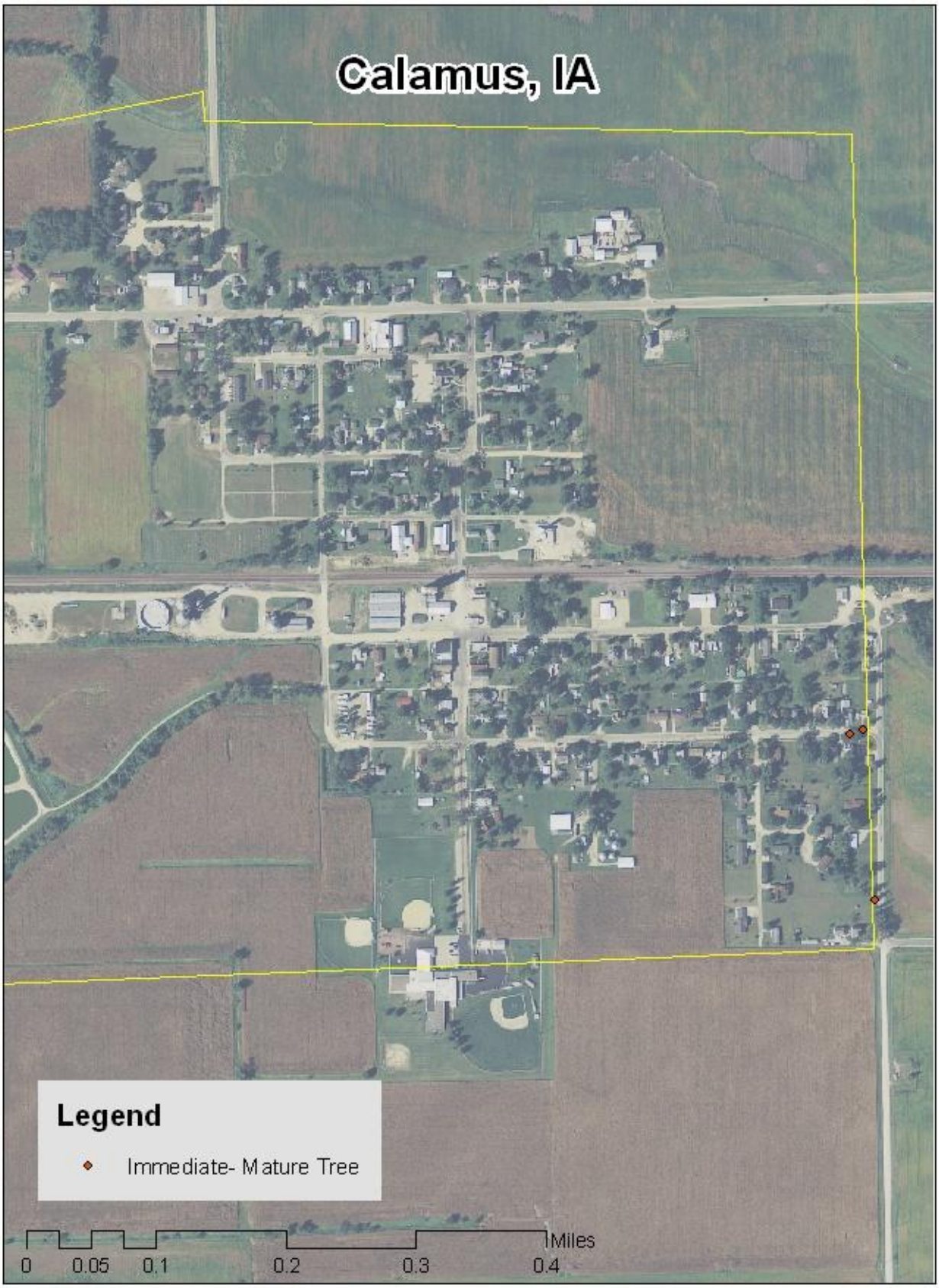

Calamus, IA
Legend
Immediate- Mature Tree
0
0.05
0.1
0.2
0.3
0.4
Miles

Figure 4: Location of Trees with Recommended Maintenance

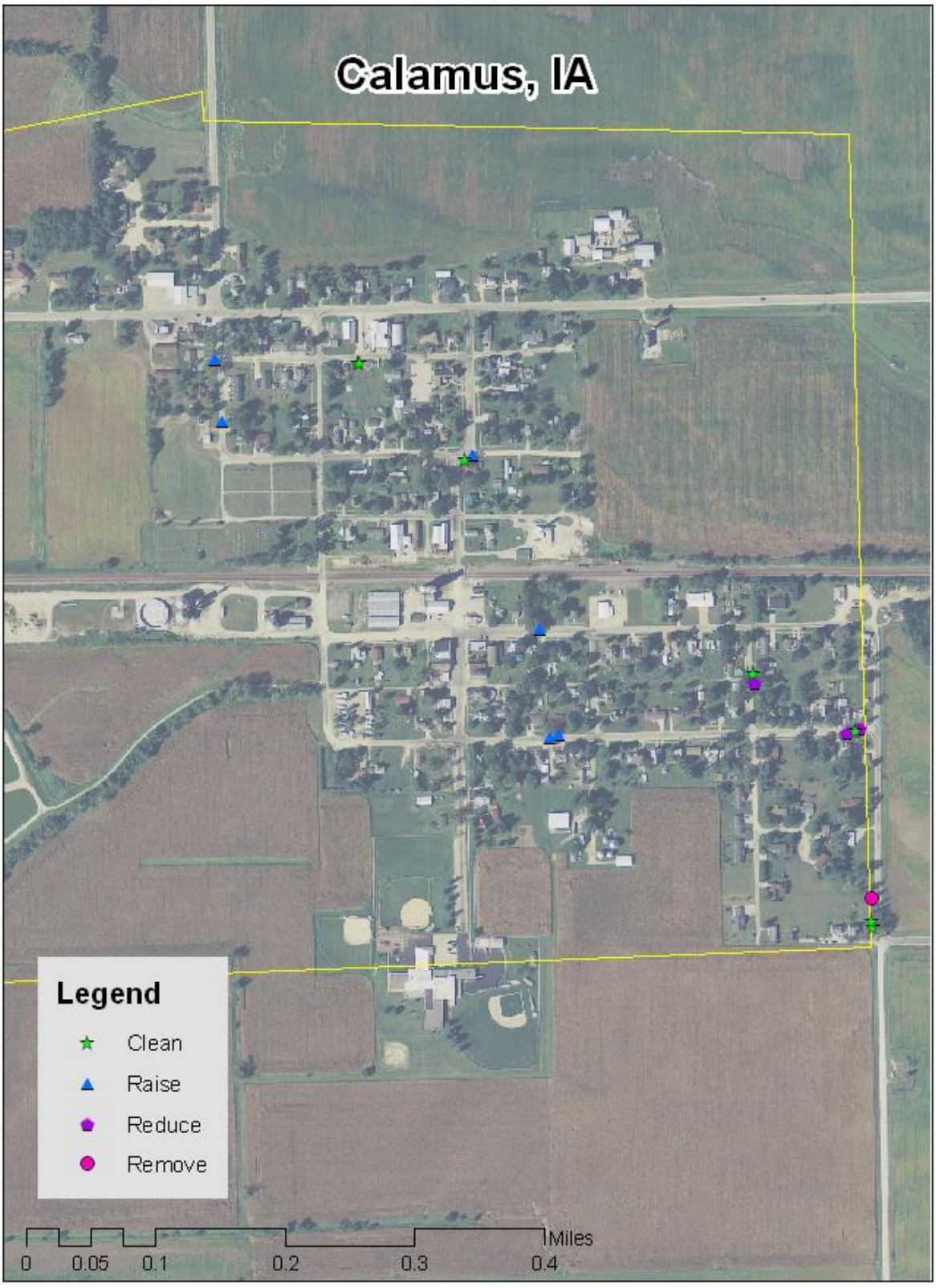


Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species

10/14/2011

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Ash	2.8	211	396.8	389	600	(N/A)	34.5	32.5	59.97
American sycamore	1.7	129	239.2	234	363	(N/A)	17.2	19.7	72.64
Northern hackberry	1.3	102	197.9	194	296	(N/A)	13.8	16.0	74.08
Honeylocust	1.3	100	170.5	167	267	(N/A)	13.8	14.5	66.78
Norway maple	0.5	36	59.0	58	94	(N/A)	6.9	5.1	46.78
Red maple	0.3	22	39.9	39	61	(N/A)	3.5	3.3	60.68
Cherry plum	0.2	14	24.7	24	38	(N/A)	3.5	2.1	38.13
Northern pin oak	0.3	24	47.4	46	71	(N/A)	3.5	3.8	70.84
Siberian elm	0.3	20	37.9	37	57	(N/A)	3.5	3.1	57.41
Other street trees	0.0	0	0.0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	8.7	658	1,213.4	1,189	1,847	(N/A)	100.0	100.0	63.69

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

10/14/2011

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Ash	26,721	724	(N/A)	34.5	30.9	72.42
American sycamore	21,456	582	(N/A)	17.2	24.8	116.30
Northern hackberry	12,101	328	(N/A)	13.8	14.0	81.99
Honeylocust	13,831	375	(N/A)	13.8	16.0	93.71
Norway maple	2,818	76	(N/A)	6.9	3.3	38.19
Red maple	2,867	78	(N/A)	3.5	3.3	77.70
Cherry plum	666	18	(N/A)	3.5	0.8	18.06
Northern pin oak	3,764	102	(N/A)	3.5	4.4	102.01
Siberian elm	2,290	62	(N/A)	3.5	2.7	62.07
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	86,514	2,345	(N/A)	100.0	100.0	80.85

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

10/14/2011

Species	Deposition (lb) O_3	NO_2	PM_{10}	SO_2	Total Depos. ($)	Avoided (lb) NO_2	PM_{10}	VOC	SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
Ash	5.6	1.0	2.7	0.2	30	13.4	1.9	1.9	12.6	83	-1.3	-5	38.1	109	(N/A)	34.5	10.86
American sycamore	2.8	0.5	1.3	0.1	15	8.2	1.2	1.1	7.7	51	0.0	0	22.9	66	(N/A)	17.2	13.14
Northern hackberry	1.7	0.3	0.9	0.1	10	6.6	0.9	0.9	6.1	41	0.0	0	17.5	50	(N/A)	13.8	12.53
Honeylocust	2.7	0.4	1.2	0.1	14	6.2	0.9	0.9	6.0	39	-2.1	-8	16.3	45	(N/A)	13.8	11.31
Norway maple	0.4	0.1	0.2	0.0	2	2.2	0.3	0.3	2.1	14	-0.1	0	5.6	16	(N/A)	6.9	7.92
Red maple	0.7	0.1	0.3	0.0	4	1.4	0.2	0.2	1.3	8	-0.2	-1	4.0	12	(N/A)	3.4	11.54
Cherry plum	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	5	0.0	0	2.3	7	(N/A)	3.4	6.56
Northern pin oak	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14	(N/A)	3.4	13.58
Siberian elm	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.3	9	(N/A)	3.4	9.47
Other street trees	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)	0.0	0.00
Citywide total	15.4	2.6	7.4	0.7	82	41.6	6.0	5.8	39.3	259	-3.9	-15	114.9	327	(N/A)	100.0	11.26

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

10/14/2011

Species	Total Stored CO2 (lbs)	Total ($)	Standar d Error	% of Total Trees	% of Total $	Avg. $/tree
Ash	91,829	689	(N/A)	34.5	32.6	68.87
American	91,890	689	(N/A)	17.2	32.6	137.83
Northern	24,379	183	(N/A)	13.8	8.7	45.71
Honeylocust	34,270	257	(N/A)	13.8	12.2	64.26
Norway maple	7,248	54	(N/A)	6.9	2.6	27.18
Red maple	7,945	60	(N/A)	3.5	2.8	59.59
Cherry plum	3,037	23	(N/A)	3.5	1.1	22.78
Northern pin oak	14,280	107	(N/A)	3.5	5.1	107.10
Siberian elm	6,743	51	(N/A)	3.5	2.4	50.57
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	281,620	2,112	(N/A)	100.0	100.0	72.83

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees by Species

10/14/2011

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Standar d Error	% of Total Trees	% of Total $	Avg. $/tree
Ash	3,678	28	-441	-2	-3	4,659	35	7,894	59	(N/A)	34.5	26.6	5.92
American sycamore	4,293	32	-441	-1	-3	2,846	21	6,697	50	(N/A)	17.2	22.6	10.04
Northern hackberry	1,707	13	-117	-1	-1	2,261	17	3,850	29	(N/A)	13.8	13.0	7.22
Honeylocust	4,382	33	-164	-1	-1	2,211	17	6,428	48	(N/A)	13.8	21.7	12.05
Norway maple	772	6	-35	0	0	790	6	1,527	11	(N/A)	6.9	5.1	5.73
Red maple	923	7	-38	0	0	477	4	1,362	10	(N/A)	3.5	4.6	10.21
Cherry plum	268	2	-15	0	0	308	2	561	4	(N/A)	3.5	1.9	4.21
Northern pin oak	0	0	-69	0	-1	539	4	470	4	(N/A)	3.5	1.6	3.52
Siberian elm	485	4	-32	0	0	447	3	900	7	(N/A)	3.5	3.0	6.75
Other street trees	0	0	0	0	0	0	0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	16,507	124	-1,352	-6	-10	14,539	109	29,688	223	(N/A)	100.0	100.0	7.68

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

10/14/2011

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Ash	341	(N/A)	34.5	15.4	34.10
American sycamore	322	(N/A)	17.2	14.6	64.41
Northern hackberry	232	(N/A)	13.8	10.5	57.91
Honeylocust	1,075	(N/A)	13.8	48.6	268.78
Norway maple	78	(N/A)	6.9	3.5	39.16
Red maple	109	(N/A)	3.5	4.9	109.08
Cherry plum	15	(N/A)	3.5	0.7	15.48
Northern pin oak	0	(N/A)	3.5	0.0	0.00
Siberian elm	40	(N/A)	3.5	1.8	39.94
Other street trees	0	(±NaN)	0.0	0.0	0.00
Citywide total	2,213	(N/A)	100.0	100.0	76.30

Table 7: Summary of Benefits in Dollars

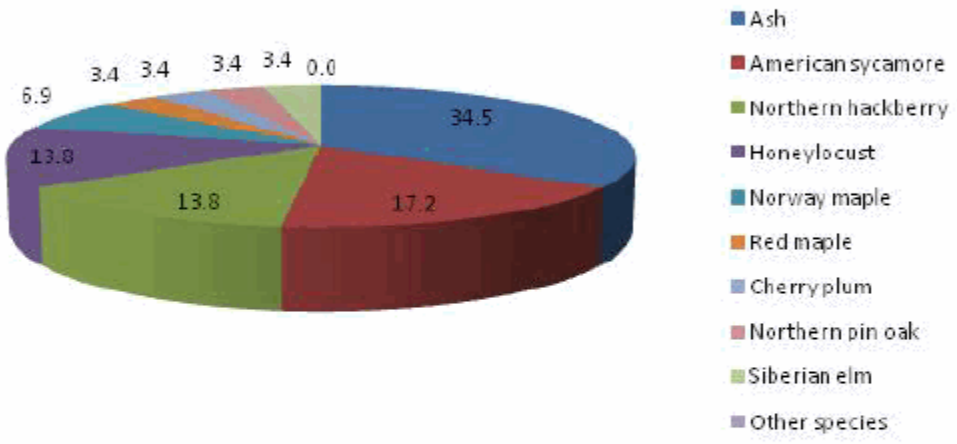
Total Annual Benefits of Public Trees by Species ($)

10/15/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Ash	600	59	109	724	341	1,833	(±0)	26.4
American sycamore	363	50	66	582	322	1,383	(±0)	19.9
Northern hackberry	296	29	50	328	232	935	(±0)	13.4
Honeylocust	267	48	45	375	1,075	1,811	(±0)	26.0
Norway maple	94	11	16	76	78	276	(±0)	4.0
Red maple	61	10	12	78	109	269	(±0)	3.9
Cherry plum	38	4	7	18	15	82	(±0)	1.2
Northern pin oak	71	4	14	102	0	190	(±0)	2.7
Siberian elm	57	7	9	62	40	176	(±0)	2.5
Other street trees	0	0	0	0	0	0	(±0)	0.0
Citywide Total	1,847	223	327	2,345	2,213	6,954	(±0)	100.0

Species Distribution of Public Trees (%)

10/14/2011

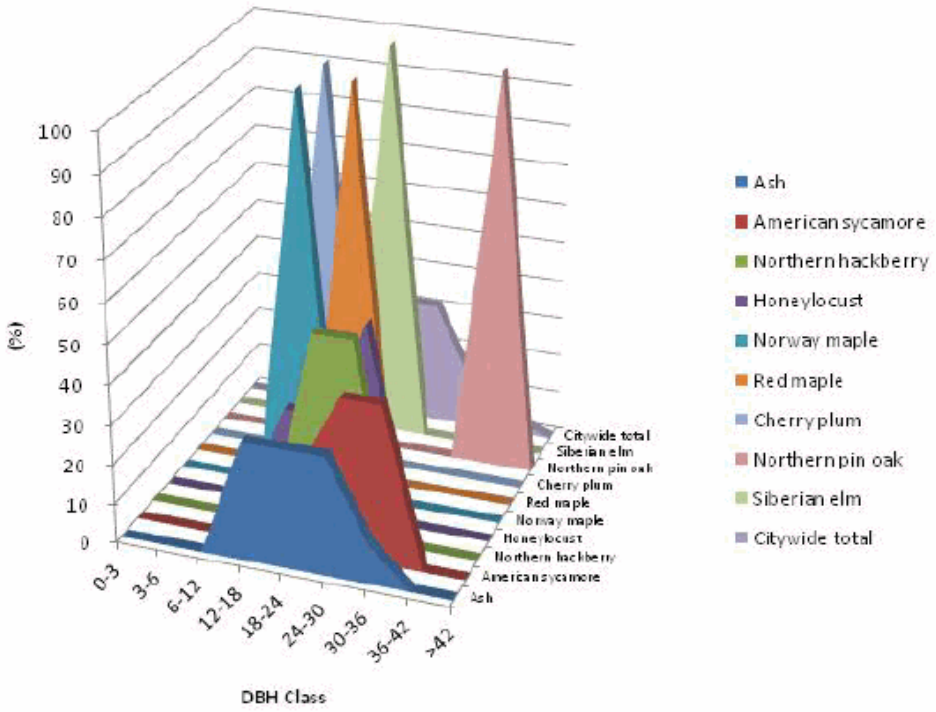


Species	Percent
Ash	34.5
American sycamore	17.2
Northern hackberry	13.8
Honeylocust	13.8
Norway maple	6.9
Red maple	3.4
Cherry plum	3.4
Northern pin oak	3.4
Siberian elm	3.4
Other species	0.0
Total	100.0

Figure 1: Species Distribution

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

10/14/2011



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Ash	0.0	0.0	0.0	30.0	30.0	30.0	10.0	0.0	0.0
American sycamore	0.0	0.0	0.0	0.0	20.0	40.0	40.0	0.0	0.0
Northern hackberry	0.0	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0
Honeylocust	0.0	0.0	0.0	25.0	25.0	50.0	0.0	0.0	0.0
Norway maple	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Red maple	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Cherry plum	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Northern pin oak	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Siberian elm	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Citywide total	0.0	0.0	0.0	24.1	31.0	31.0	10.3	3.4	0.0

Figure 2: Relative Age Class

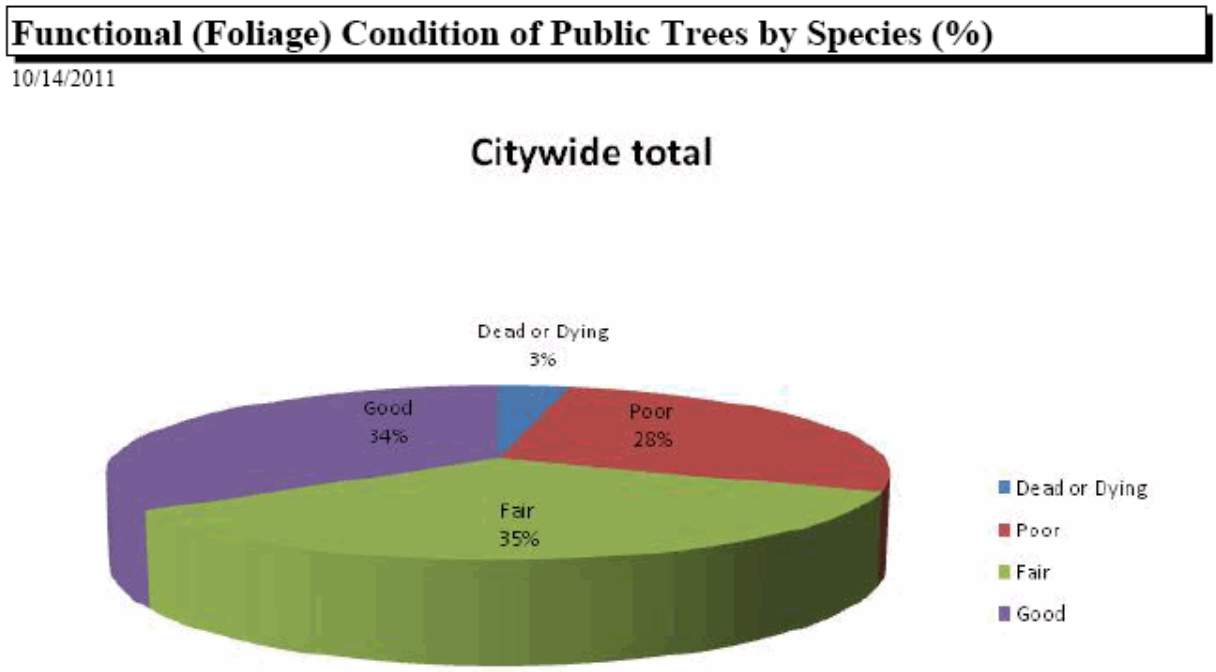


Figure 3: Foliage Condition

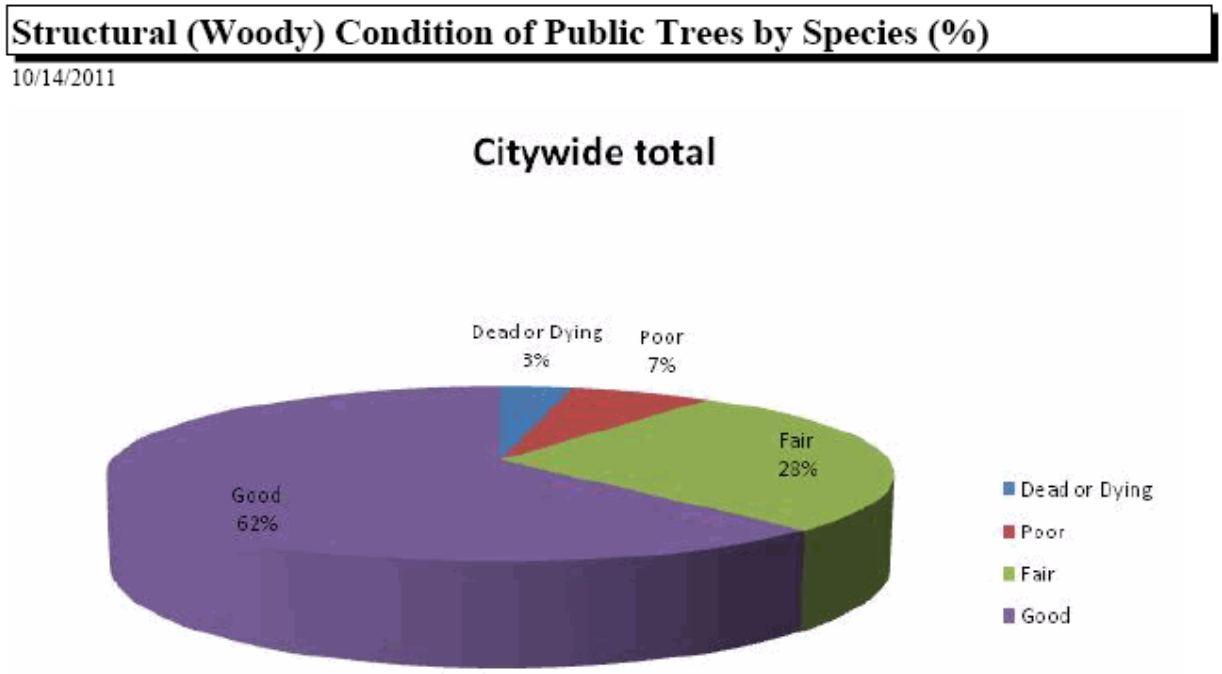
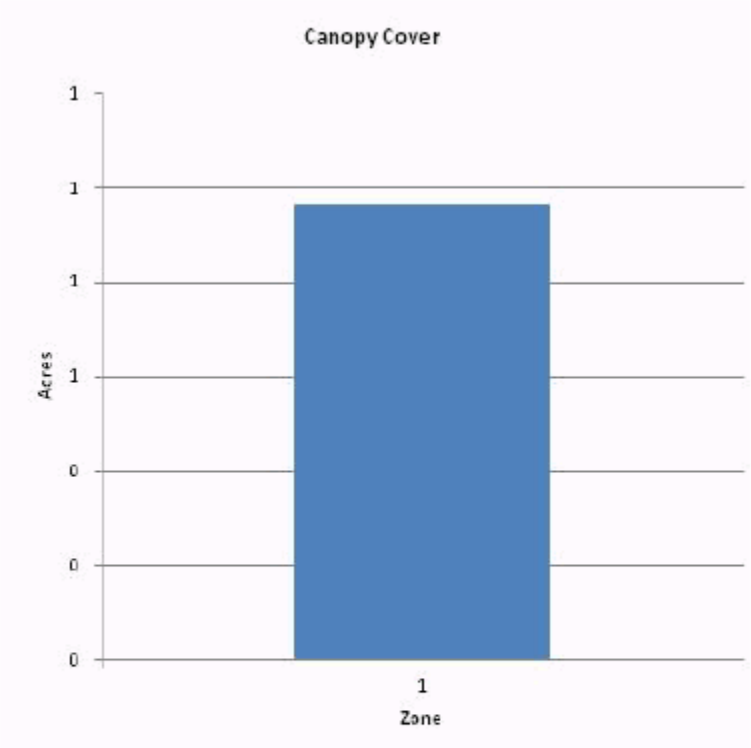


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

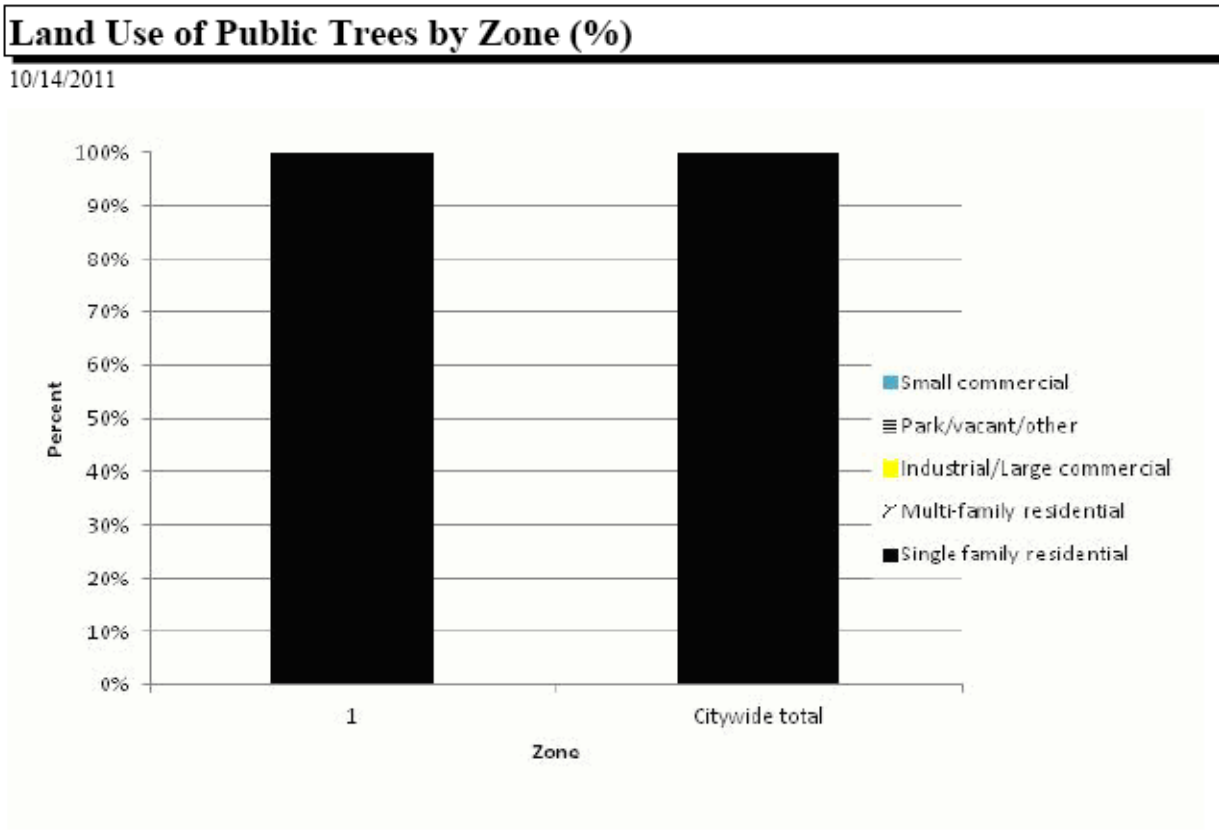
10/14/2011



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

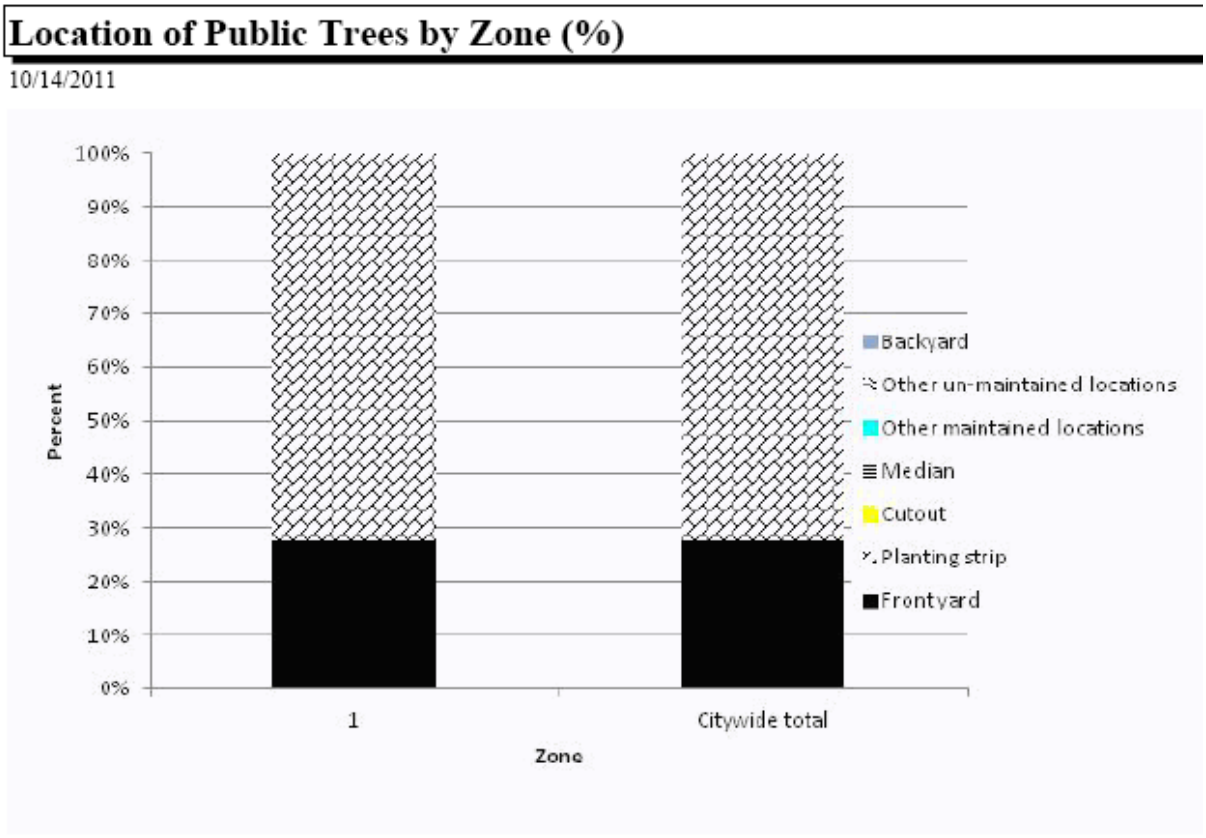
	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	1		

Figure 5: Canopy Cover in Acres



Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	100.0	0.0	0.0	0.0	0.0
Citywide total	100.0	0.0	0.0	0.0	0.0

Figure 6: Land Use of city/park trees



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	27.6	72.4	0.0	0.0	0.0	0.0	0.0
Citywide total	27.6	72.4	0.0	0.0	0.0	0.0	0.0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

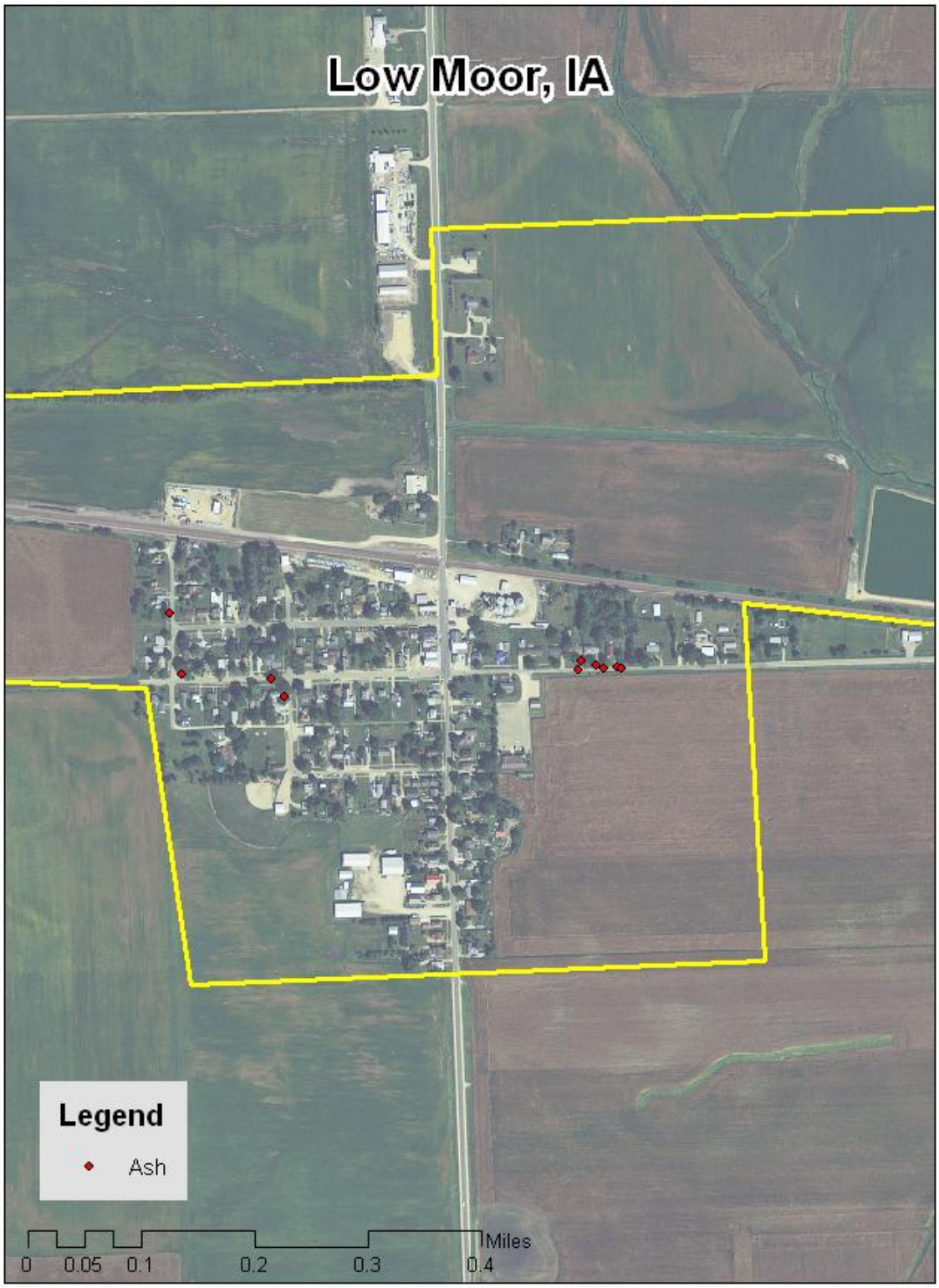


Figure 1: Location of Ash Trees

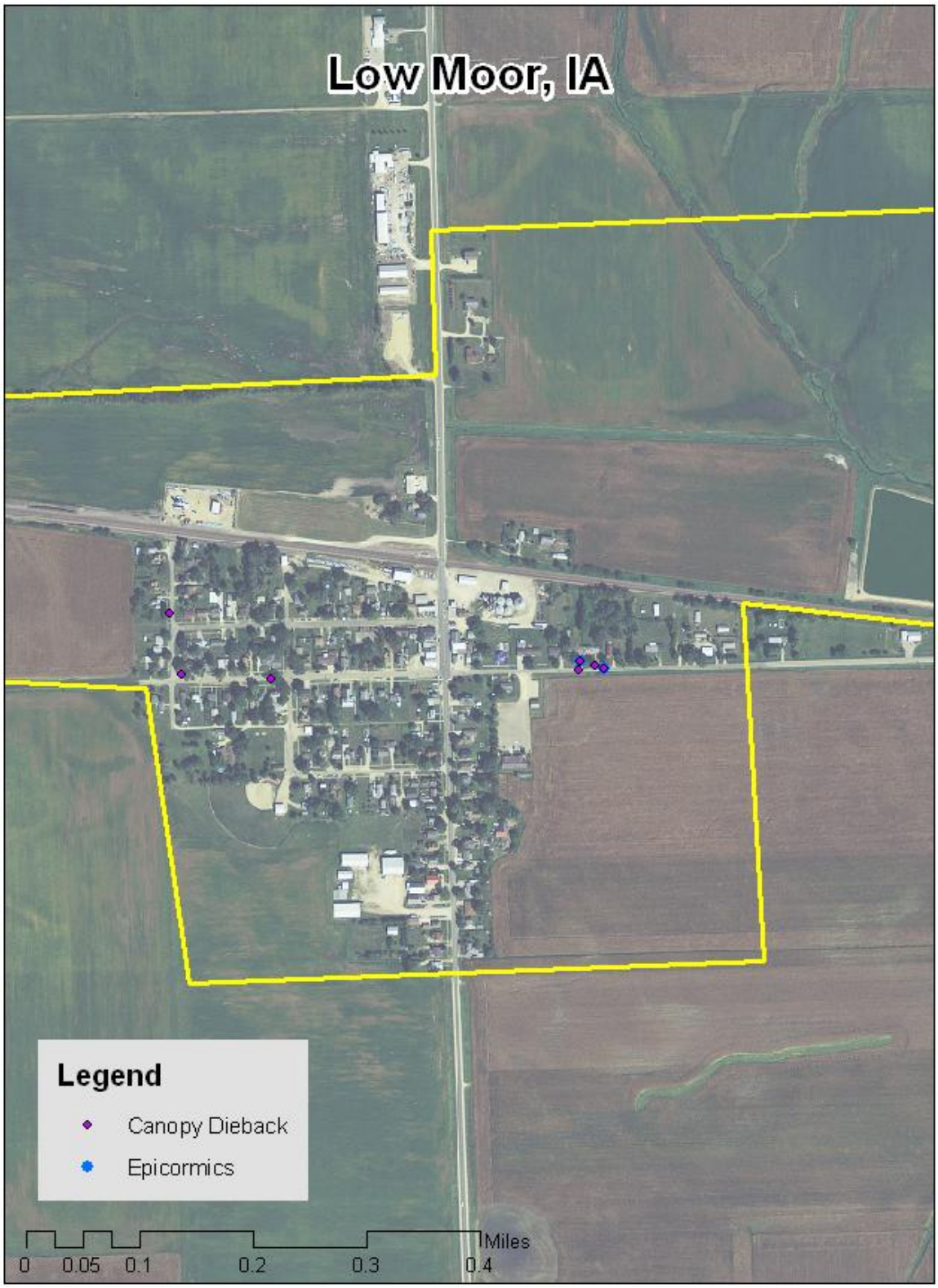


Figure 2: Location of EAB symptoms

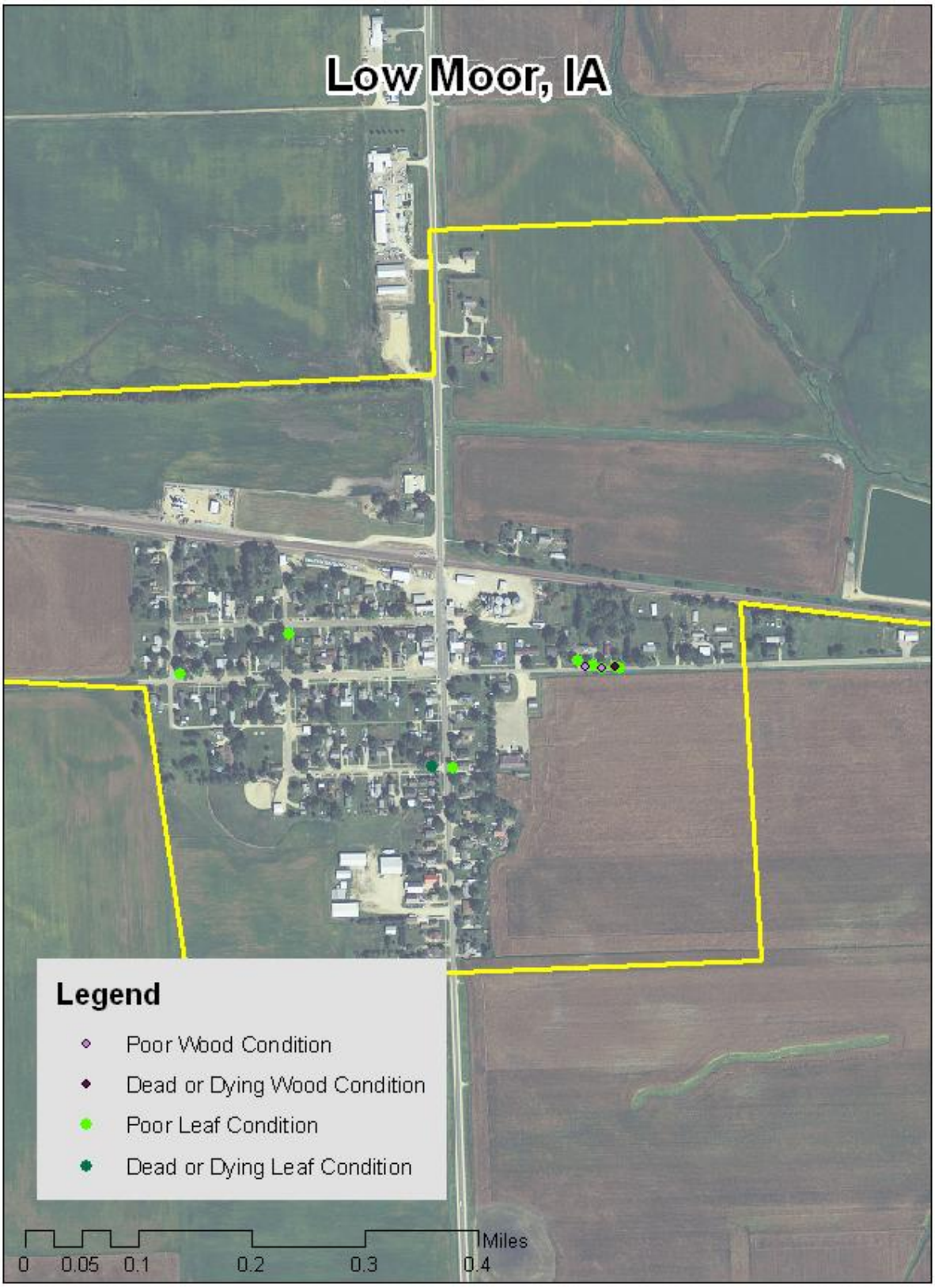


Figure 3: Location of Poor Condition Trees

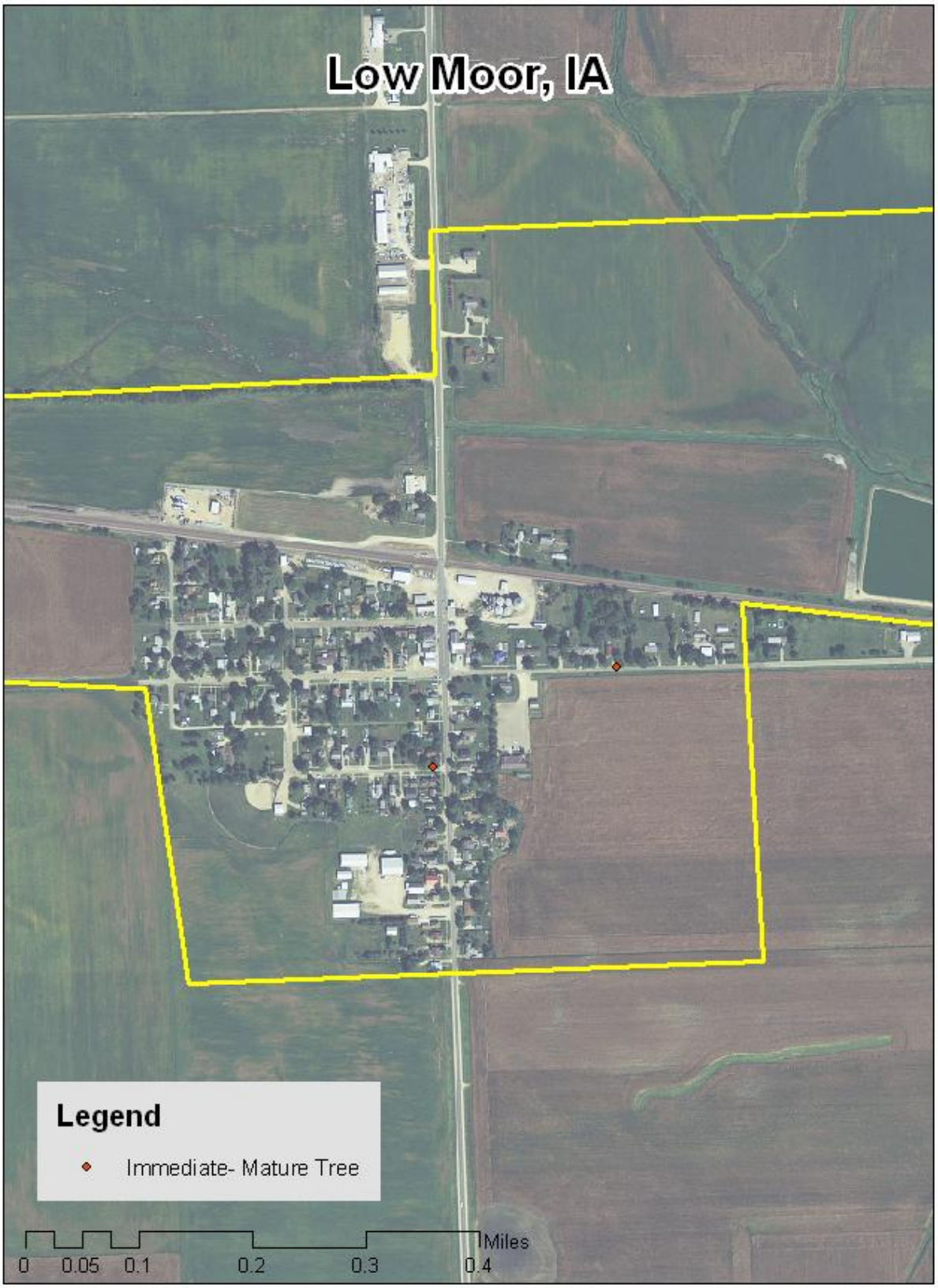


Figure 4: Location of Trees with Recommended Maintenance

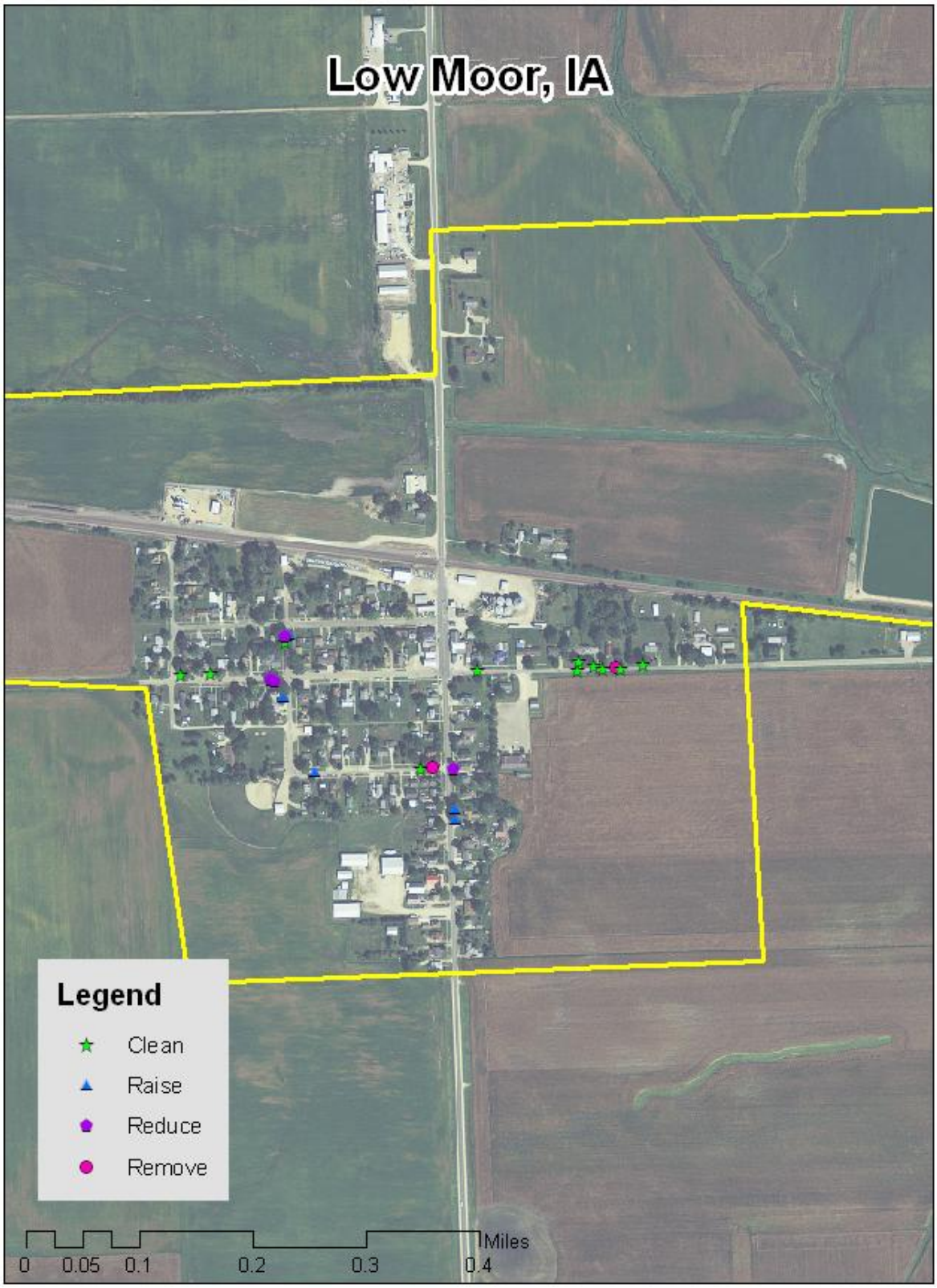


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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