EARLVILLE, IA
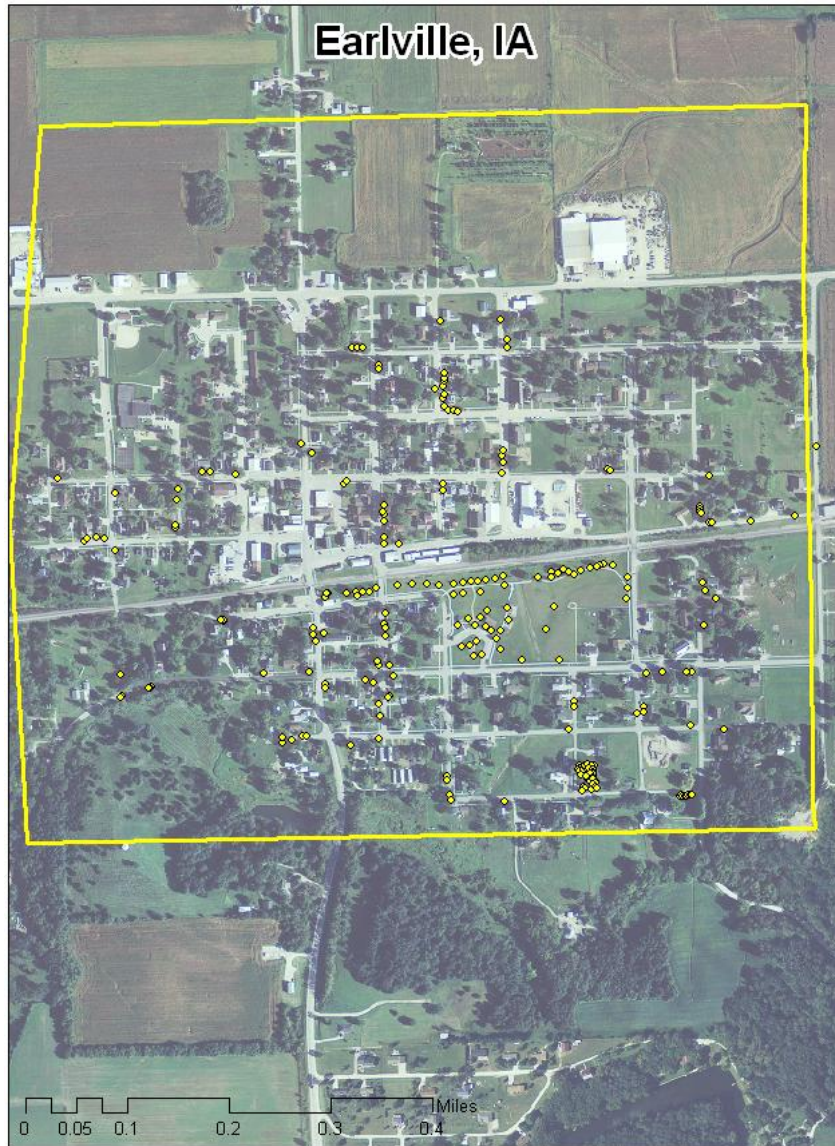

Earlville, IA

2012 Management Plan
Prepared by: Bruce Blaire
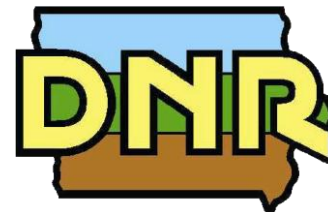Bureau of Forestry, Iowa DNR

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Executive Summary

Overview:

This plan was developed to assist the City of Earlville 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 that kills all species of our native ash trees. There is a strong possibility that over 5% of Earlville's city-managed ash trees could 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 several years mitigating public safety issues.

Inventory and Results:

In the summer of 2011, a street tree inventory was conducted using an integrated Global Positioning System (GPS) data collector. This involved a complete inventory of street trees within the City's Right-of-Way and some parkland. Below are some key findings of the 231 trees inventoried.

- Earlville street trees provide roughly $24,522 of annual benefits, an average of $106 per tree.
- The top three species groups are: Maples (38%), Arborvitae (12%) and Oak (9%).
- Approximately 32% of trees are in need of some type of management.
- For various reasons, 11 trees are recommended for removal.

Recommendations:

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

- One of the 11 ash trees inventoried is in need of follow up checking because it displays some 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 *does not include*: ash, soft maple, autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar and tree-of-heaven.
- Check ash trees with a visual survey yearly.

Introduction

This plan was developed to assist Earlville with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with a great proportion 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 Earlville, these costs can be extended over several years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important component of Earlville's infrastructure and are one of the greatest assets to the community. Through research, it has been shown that trees provide a community with numerous public benefits including: improved air quality, storm water runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and creating a desirable place to live. It is essential that these benefits be maintained for the people of Earlville and future generations through sound urban forestry management.

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

Inventory

In the summer of 2011, a tree inventory was conducted that included the city-owned street trees and some park trees. The tree data was collected using a handheld Global Positioning System (GPS) receiver/data logger. This devise records Geographic Information System (GIS) coordinates with an accuracy of 3 meters. The data can then 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 collector was written to be compatible with a state-of-the-art software suite called i-Tree. This software was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. This software is in the public domain and can be accessed for free.

To quantify the urban forest structure and its benefits, specific data is collected for each tree. This data includes: location, land use, tree species, diameter at 4.5 ft (DBH), 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 by the data loggers was downloaded and analyzed by software developed by the USDA Forest service called *Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM)*. This is software is also part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis of Earlville's inventory data.

Annual Benefits

Annual Energy Benefits:

Trees conserve energy by shading buildings and blocking winds. Earlville's trees reduce energy related costs by approximately $6,557 annually (Appendix A, Table 1). These savings are both in Electricity (31.5 MWh) and in Natural Gas (4,254 Therms).

Annual Storm water Benefits:

Earlville's trees intercept about 366,452 gallons of rainfall and snow melt per year (Appendix A, Table 2). This interception provides $8,305 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 that emit volatile organic matter (ozone). In Earlville, it is estimated that trees remove 385 lbs. of air pollution (ozone (O_3), particulate matter less than 10 microns (PM_{10}), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $1,075 (Appendix A, Table 3).

Annual Carbon Benefits:

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change.   Of the 231 trees inventoried, the amount of carbon stored amounts to approximately 1,026,887 total lbs of CO_2 (Appendix A, Table 4) . Those trees are sequestering about 70,643 lbs of carbon per year (Appendix A, Table 5). The benefits these trees provide from summer shading and from reductions in household wind infiltration in the winter result in approximately 52,797 fewer lbs of CO_2 being released into the atmosphere (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. Earlville receives approximately $7,658 in annual social benefits from its street trees (Appendix A, Table 6).

Financial Summary of all Benefits:

According to the USDA Forest Service i-Tree STRATUM analysis, Earlville's trees provide $24,522 of benefits annually. Benefits of individual trees vary based on size, species, health and location. On average, each of the 231 trees in Earlville's inventory provides approximately $106 annually (Appendix A, Table 7).

Forest Structure

Species Distribution:

There were over 40 different tree species surveyed. The distribution of trees by genus is as follows:

Genus	# of trees	% of total
Maple (*acer*)	87	37.7%
Arborvitae (*Thuja*)	27	11.7%
Oak (*quercus*)	21	9.1%
Apple (*malus*)	13	5.6%
Ash (*fraxius*)	11	4.8%
Willow (*Salix*)	11	4.8%
Spruce (*picea*)	10	4.3%
Lilac (*Syringa*)	6	2.6%
Elm (*ulmus*)	6	2.6%
Other broadleaves	6	2.6%
Walnut (*juglans*)	6	2.6%
Cherry (*prunus*)	5	2.2%
Other evergreens	3	1.3%
Eastern Red Cedar (*Juniperus*)	3	1.3%
White Mulberry (*morus*)	3	1.3%
Honeylocust (*gleditsia*)	2	0.9%
Linden (*tilia*)	2	0.9%
Pine (*Pinus*)	2	0.9%
Birch (*betula*)	2	0.9%
Pear (*Pyrus*)	2	0.9%
Ohio Buckeye (Aesculus)	1	0.4%
Sycamore (*Platinus*)	1	0.4%
Sumac (*Rhus*)	1	0.4%
	231	100.0%

Size Distribution:

The table below summarizes distribution of surveyed trees by their diameter in inches when measured at 4.5 above the ground.   Trees between 3 to 6 inches in diameter were most abundant (26%). The abundance of many younger trees reflects the many trees that were recently planted in the City's new park. The distribution is fairly flat, which is probably a good thing. See Appendix A, Figure 2 for a breakdown of size distributions by species.

Size Classes (inches of diameter at 4.5 feet)	# of trees	% of trees
0 - 3	37	16.0%
3 - 6	60	26.0%
6 - 12	39	16.9%
12 - 18	44	19.0%
18 - 24	24	10.4%
24 - 30	15	6.5%
30 - 36	4	1.7%
36 - 42	3	1.3%
42+	5	2.2%
	231	100.0%

Condition: Wood and Foliage:

Leaf condition is a good indicator of the overall health of urban trees. The foliage condition results for Earlville indicated that 87% of the trees were in good health, 11% in fair health, 2% in poor health or dead or dying. (Appendix A, Figure 3). Leaf health is largely a function of climatic factors during the growing season. This year was not too cool or too wet, therefore, leaf diseases were not as much an issue.

The condition of the wood in urban trees is another important indicator of tree health. The wood forms the structural support system for the leaves and branches.   Extensive decay in the main stem makes a tree structurally unsafe which leads to a tree becoming a safety hazard. In Earlville, 71% of the surveyed trees were in good health, 26% in fair health, 3% in poor health. (Appendix A, Figure 4). The 3% in poor condition should be assessed more carefully. Many of these trees with poor wood condition are being recommended for removal due to public safety concerns. The 26% in fair health is to a large extent a reflection of having many older Norway maple trees which tend to have problems with decay or cracking in their main stem.   The City already has too many maple trees, so please encourage far less planting of Norway maple; at least for awhile.

Management Needs:

Each surveyed tree was assessed for recommended maintenance needs. The following tables list the specific management needs and recommendations. (See Appendix B, figure 4).

Priority Task	# of trees	% of trees
none	158	68.4%
stake/train	34	14.7%
raise	16	6.9%
clean	12	5.2%
remove	11	4.8%
	231	100.0%

Maintenance Recommendation	# of trees	% of trees
None	156	67.5%
mature tree (routine)	45	19.5%
young tree (routine)	24	10.4%
young tree (immediate)	3	1.3%
mature tree (immediate)	3	1.3%
	231	100.0%

Land Use and Location:

The majority of Earlville's surveyed trees are in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use
Single family residential	56%
Park/vacant/other	44%

Location
Front yard	11%
Planting strip	32%
Back yard	13%
Other maintained locations (e.g. parks)	56%

Recommendations

Risk Management:

Hazardous trees can be a significant threat to both people and property. Trees that are dead or dying, or that have 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:

A total of 11 trees are recommended for removal for one reason or another. Of those, 2 tree had leaves and branches that were dead or dying and 5 had poor wood condition or showed signs of severe decay. These trees with severe decay could easily break off or topple over in storms or under ice and snow loads. Some of the trees were recommended for removal because they blocked the view for traffic or were growing in a bad location.

Pruning Cycle:

Proper pruning can extend the life and improve the overall health of trees, and can reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning (stake/train), crown cleaning (clean), crown raising (raise), and crown reduction (reduce). 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. Staking and training is recommended for younger trees so they can develop good architecture. It is recommended that all trees be pruned on a routine schedule every five to seven years.

Priority Task	# of trees	% of trees
none	158	68.4%
stake/train	34	14.7%
raise	16	6.9%
clean	12	5.2%
remove	11	4.8%
	231	100.0%

Planting:

Most of the planting over the next six years should replace the trees that are recommended for removal. It is recommended to plant two 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 as the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Earlville.

Since most insects and diseases target a particular genus (e.g. ash) or species (e.g. green ash) of trees, it is important to always plant a diverse mix of species. Current diversity recommendations advise that any genus (e.g. maple, oak or ash) not make up more than 20% of the urban forest. Any single species (e.g. silver maple, sugar maple, white oak or bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with Maple (38%) and Arborvitae (12%) (Appendix A, Figure 1). Maples should not be planted until this percentage is dramatically 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: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, and willow. I noticed that white poplar was recommended in your City Tree Ordinance. This tree can become invasive so should probably be taken off of your list.

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 (EAB) Plan

Ash Tree Removal:

Tree removal should 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 many millions ash trees throughout the Eastern United States and Canada. Ash in both forestlands and urban settings constitutes a very significant portion of the canopy cover. 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 its spread beyond its known locations 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 urban 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 your budget permits, all removed ash trees should be replaced. All trees should meet the restrictions in your city's ordinance (Appendix C). The new plantings should be a diverse mix and should not include ash, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

Postponed Work:

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

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 Earlville's urban forest. Private property owners should be given direction to the proper species to plant, spacing, and location. Earlville has a city ordinance for trees.

Budget

Purposed Budget Increase:

EAB could potentially kill all of the ash trees in Earlville within a decade after its arrival.   It is recommended that the City apply for grants to fund replacement tree planting. 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.   There were a total of 11 ash trees surveyed. We recommend that at least 1/2 (6 trees) of them be removed and replaced over the next 6 years. You should replant 2 trees for everyone removed. First, remove the ash tree showing signs and symptoms of possible EAB infestation (Appendix B, Figure 2). Next, remove any of the remaining 6 ash trees where they occur in groups throughout the City (Appendix B, Figure 1).   Finally, we recommend that the City adopt a policy of allocating somewhere between $2 to $4 per capita per year into a forestry budget to be used for planting, removals and maintenance of Earlville's urban forest.

Recommended Budget: <u>$5,700</u>.

FY 2011 Budget
      Removal: $500
      Planting: $200
      Routine trimming: $200
      Watering & Maintenance: $50

FY 2012 Budget
      Removal: $500
      Planting: $200
      Routine trimming: $200
      Watering & Maintenance: $50

FY 2013 Budget
      Removal: $500
      Planting: $200
      Routine trimming: $200
      Watering & Maintenance: $50

FY 2014 Budget
      Removal: $500
      Planting: $200
      Routine trimming: $200
      Watering & Maintenance: $50

FY 2015 Budget
       Removal: $500
       Planting: $200
       Routine trimming: $200
       Watering & Maintenance: $50

FY 2016 Budget
       Removal: $500
       Planting: $200
       Routine trimming: $200
       Watering & Maintenance: $50

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

Annual Energy Benefits of Public Trees by Species
10/18/2011

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	10.8	817	1,393.3	1,365	2,183	(N/A)	22.1	33.3	42.80
Northern white cedar	0.7	56	129.4	127	183	(N/A)	11.7	2.8	6.79
Norway maple	4.0	304	568.0	557	861	(N/A)	8.2	13.1	45.31
Apple	0.5	36	81.8	80	116	(N/A)	5.6	1.8	8.93
Willow	1.7	127	235.9	231	358	(N/A)	4.8	5.5	32.58
Northern red oak	0.6	47	81.0	79	126	(N/A)	3.9	1.9	14.00
Sugar maple	2.0	155	274.7	269	424	(N/A)	3.5	6.5	53.04
Blue spruce	0.4	31	56.3	55	86	(N/A)	3.0	1.3	12.33
Black walnut	1.3	102	180.5	177	279	(N/A)	2.6	4.3	46.47
Bur oak	2.1	163	289.7	284	447	(N/A)	2.6	6.8	74.44
Lilac	0.1	11	25.5	25	36	(N/A)	2.6	0.6	6.02
Pin oak	1.2	92	162.2	159	251	(N/A)	2.2	3.8	50.24
Red maple	0.4	31	52.5	51	82	(N/A)	1.7	1.3	20.60
Broadleaf Deciduous	0.1	8	17.9	18	25	(N/A)	1.7	0.4	6.33
Ash	0.2	12	24.6	24	36	(N/A)	1.7	0.5	8.92
Green ash	0.4	27	44.9	44	71	(N/A)	1.7	1.1	17.83
White ash	0.9	67	103.8	102	169	(N/A)	1.3	2.6	56.40
Eastern red cedar	0.1	10	19.6	19	29	(N/A)	1.3	0.4	9.70
White mulberry	0.3	21	41.3	40	62	(N/A)	1.3	0.9	20.58
Cherry plum	0.1	8	17.3	17	24	(N/A)	1.3	0.4	8.15
American elm	0.3	27	41.1	40	67	(N/A)	1.3	1.0	22.28
Siberian elm	0.5	38	57.2	56	94	(N/A)	1.3	1.4	31.39
Other street trees	2.6	199	355.0	348	546	(N/A)	12.6	8.3	18.84
Citywide total	31.5	2,389	4,253.5	4,168	6,557	(N/A)	100.0	100.0	28.39

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species
10/18/2011

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	120,877	3,276	(N/A)	22.1	39.4	64.24
Northern white cedar	7,275	197	(N/A)	11.7	2.4	7.30
Norway maple	33,958	920	(N/A)	8.2	11.1	48.44
Apple	1,627	44	(N/A)	5.6	0.5	3.39
Willow	9,737	264	(N/A)	4.8	3.2	23.99
Northern red oak	3,539	96	(N/A)	3.9	1.2	10.66
Sugar maple	19,599	531	(N/A)	3.5	6.4	66.40
Blue spruce	4,651	126	(N/A)	3.0	1.5	18.01
Black walnut	14,511	393	(N/A)	2.6	4.7	65.54
Bur oak	27,770	753	(N/A)	2.6	9.1	125.44
Lilac	485	13	(N/A)	2.6	0.2	2.19
Pin oak	11,275	306	(N/A)	2.2	3.7	61.12
Red maple	2,378	64	(N/A)	1.7	0.8	16.11
Broadleaf Deciduous	348	9	(N/A)	1.7	0.1	2.36
Ash	773	21	(N/A)	1.7	0.3	5.24
Green ash	2,263	61	(N/A)	1.7	0.7	15.33
White ash	10,158	275	(N/A)	1.3	3.3	91.77
Eastern red cedar	1,842	50	(N/A)	1.3	0.6	16.64
White mulberry	1,000	27	(N/A)	1.3	0.3	9.03
Cherry plum	341	9	(N/A)	1.3	0.1	3.08
American elm	1,921	52	(N/A)	1.3	0.6	17.35
Siberian elm	2,944	80	(N/A)	1.3	1.0	26.59
Other street trees	27,180	737	(N/A)	12.6	8.9	25.40
Citywide total	306,452	8,305	(N/A)	100.0	100.0	35.95

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

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							
Silver maple	17.6	3.0	9.1	0.8	96	50.6	7.4	7.1	48.8	317	-10.5	-39	133.9	374 (N/A)	22.1	7.33
Northern white cedar	0.4	0.1	0.5	0.0	3	3.8	0.5	0.5	3.4	23	-2.0	-7	7.3	19 (N/A)	11.7	0.69
Norway maple	6.5	1.1	3.3	0.3	35	19.3	2.8	2.7	18.2	120	-1.6	-6	52.7	150 (N/A)	8.2	7.88
Apple	0.2	0.0	0.2	0.0	1	2.4	0.3	0.3	2.1	15	0.0	0	5.6	16 (N/A)	5.6	1.23
Willow	1.3	0.2	0.7	0.1	7	8.1	1.2	1.1	7.6	50	-0.4	-1	19.9	56 (N/A)	4.8	5.09
Northern red oak	0.6	0.1	0.3	0.0	3	2.9	0.4	0.4	2.8	18	-0.8	-3	6.7	18 (N/A)	3.9	2.04
Sugar maple	2.4	0.4	1.2	0.1	13	9.7	1.4	1.4	9.3	61	-1.9	-7	23.9	66 (N/A)	3.5	8.31
Blue spruce	0.5	0.1	0.5	0.1	3	2.0	0.3	0.3	1.9	12	-1.5	-6	3.9	10 (N/A)	3.0	1.39
Black walnut	2.3	0.4	1.1	0.1	12	6.4	0.9	0.9	6.1	40	0.0	0	18.0	52 (N/A)	2.6	8.62
Bur oak	4.3	0.7	2.0	0.2	23	10.2	1.5	1.4	9.7	64	0.0	0	30.0	86 (N/A)	2.6	14.41
Lilac	0.1	0.0	0.0	0.0	0	0.7	0.1	0.1	0.7	5	0.0	0	1.7	5 (N/A)	2.6	0.82
Pin oak	1.8	0.3	0.9	0.1	10	5.8	0.8	0.8	5.5	36	-3.4	-13	12.6	33 (N/A)	2.2	6.61
Red maple	0.4	0.1	0.2	0.0	2	1.9	0.3	0.3	1.8	12	-0.2	-1	4.9	14 (N/A)	1.7	3.41
Broadleaf Deciduous	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3 (N/A)	1.7	0.87
Ash	0.1	0.0	0.0	0.0	0	0.8	0.1	0.1	0.7	5	0.0	0	1.8	5 (N/A)	1.7	1.24
Green ash	0.1	0.0	0.1	0.0	1	1.7	0.2	0.2	1.6	11	0.0	0	4.1	11 (N/A)	1.7	2.84
White ash	2.1	0.3	0.9	0.1	11	4.1	0.6	0.6	4.0	26	0.0	0	12.7	37 (N/A)	1.3	12.20
Eastern red cedar	0.3	0.1	0.3	0.0	2	0.6	0.1	0.1	0.6	4	-1.0	-4	1.2	2 (N/A)	1.3	0.82
White mulberry	0.3	0.0	0.1	0.0	1	1.4	0.2	0.2	1.3	8	0.0	0	3.5	10 (N/A)	1.3	3.27
Cherry plum	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3 (N/A)	1.3	1.12
American elm	0.1	0.0	0.1	0.0	1	1.6	0.2	0.2	1.6	10	0.0	0	3.8	11 (N/A)	1.3	3.59
Siberian elm	0.2	0.0	0.1	0.0	1	2.3	0.3	0.3	2.3	15	0.0	0	5.6	16 (N/A)	1.3	5.27
Other street trees	3.9	0.7	2.2	0.2	22	12.4	1.8	1.7	11.8	78	-5.7	-22	29.1	78 (N/A)	12.6	2.69
Citywide total	45.4	7.7	23.9	2.2	250	149.7	21.8	20.8	142.6	934	-29.0	-109	385.3	1,075 (N/A)	100.0	4.65

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	418,214	3,137 (N/A)		22.1	40.7	61.50
Northern white	1,905	14 (N/A)		11.7	0.2	0.53
Norway maple	107,073	803 (N/A)		8.2	10.4	42.27
Apple	5,306	40 (N/A)		5.6	0.5	3.06
Willow	22,201	167 (N/A)		4.8	2.2	15.14
Northern red oak	9,302	70 (N/A)		3.9	0.9	7.75
Sugar maple	67,080	503 (N/A)		3.5	6.5	62.89
Blue spruce	2,652	20 (N/A)		3.0	0.3	2.84
Black walnut	77,616	582 (N/A)		2.6	7.6	97.02
Bur oak	146,231	1,097 (N/A)		2.6	14.2	182.79
Lilac	1,469	11 (N/A)		2.6	0.1	1.84
Pin oak	45,169	339 (N/A)		2.2	4.4	67.75
Red maple	4,960	37 (N/A)		1.7	0.5	9.30
Broadleaf	1,113	8 (N/A)		1.7	0.1	2.09
Ash	1,353	10 (N/A)		1.7	0.1	2.54
Green ash	4,904	37 (N/A)		1.7	0.5	9.19
White ash	30,650	230 (N/A)		1.3	3.0	76.62
Eastern red cedar	1,148	9 (N/A)		1.3	0.1	2.87
White mulberry	4,123	31 (N/A)		1.3	0.4	10.31
Cherry plum	1,099	8 (N/A)		1.3	0.1	2.75
American elm	4,123	31 (N/A)		1.3	0.4	10.31
Siberian elm	6,252	47 (N/A)		1.3	0.6	15.63
Other street trees	28,551	472 (N/A)		12.6	6.1	16.28
Citywide total	1,026,887	7,702 (N/A)		100.0	100.0	33.34

Table 5: Annual Carbon Sequestered

Annual CO$_2$ Benefits of Public Trees by Species

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) d Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	36,756	276	-2,007	-10	-15	18,064	135	52,802	396 (N/A)	22.1	42.8	7.76
Northern white cedar	624	5	-9	-5	0	1,247	9	1,857	14 (N/A)	11.7	1.5	0.52
Norway maple	6,585	49	-514	-4	-4	6,725	50	12,793	96 (N/A)	8.2	10.4	5.05
Apple	756	6	-25	-3	0	792	6	1,520	11 (N/A)	5.6	1.2	0.88
Willow	3,111	23	-107	-2	-1	2,811	21	5,814	44 (N/A)	4.8	4.7	3.96
Northern red oak	882	7	-45	-2	0	1,031	8	1,866	14 (N/A)	3.9	1.5	1.56
Sugar maple	4,105	31	-322	-2	-2	3,428	26	7,210	54 (N/A)	3.5	5.8	6.76
Blue spruce	258	2	-13	-1	0	687	5	931	7 (N/A)	3.0	0.8	1.00
Black walnut	2,455	18	-373	-1	-3	2,252	17	4,333	33 (N/A)	2.6	3.5	5.42
Bur oak	4,407	33	-702	-1	-5	3,597	27	7,301	55 (N/A)	2.6	5.9	9.13
Lilac	245	2	-7	-1	0	247	2	484	4 (N/A)	2.6	0.4	0.60
Pin oak	4,481	34	-217	-1	-2	2,039	15	6,303	47 (N/A)	2.2	5.1	9.45
Red maple	690	5	-24	-1	0	684	5	1,349	10 (N/A)	1.7	1.1	2.53
Broadleaf Deciduous	169	1	-5	-1	0	173	1	336	3 (N/A)	1.7	0.3	0.63
Ash	330	2	-6	-1	0	255	2	578	4 (N/A)	1.7	0.5	1.08
Green ash	731	5	-24	-1	0	605	5	1,311	10 (N/A)	1.7	1.1	2.46
White ash	2,598	19	-147	-1	-1	1,490	11	3,941	30 (N/A)	1.3	3.2	9.85
Eastern red cedar	57	0	-6	-1	0	219	2	270	2 (N/A)	1.3	0.2	0.68
White mulberry	419	3	-20	-1	0	470	4	869	7 (N/A)	1.3	0.7	2.17
Cherry plum	160	1	-5	-1	0	167	1	322	2 (N/A)	1.3	0.3	0.80
American elm	377	3	-20	-1	0	586	4	942	7 (N/A)	1.3	0.8	2.36
Siberian elm	686	5	-30	-1	0	841	6	1,497	11 (N/A)	1.3	1.2	3.74
Other street trees	4,733	36	-302	-6	-2	4,387	33	8,813	66 (N/A)	12.6	7.1	2.28
Citywide total	75,618	567	-4,929	-45	-37	52,797	396	123,440	926 (N/A)	100.0	100.0	4.01

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

Species	Total ($)	Standard d Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	3,306	(N/A)	22.1	43.2	64.83
Northern white cedar	219	(N/A)	11.7	2.9	8.11
Norway maple	634	(N/A)	8.2	8.3	33.35
Apple	40	(N/A)	5.6	0.5	3.11
Willow	340	(N/A)	4.8	4.4	30.93
Northern red oak	88	(N/A)	3.9	1.2	9.82
Sugar maple	447	(N/A)	3.5	5.8	55.85
Blue spruce	114	(N/A)	3.0	1.5	16.22
Black walnut	224	(N/A)	2.6	2.9	37.27
Bur oak	330	(N/A)	2.6	4.3	54.92
Lilac	13	(N/A)	2.6	0.2	2.11
Pin oak	379	(N/A)	2.2	5.0	75.74
Red maple	103	(N/A)	1.7	1.4	25.76
Broadleaf Deciduous	9	(N/A)	1.7	0.1	2.13
Ash	45	(N/A)	1.7	0.6	11.15
Green ash	94	(N/A)	1.7	1.2	23.60
White ash	282	(N/A)	1.3	3.7	93.92
Eastern red cedar	31	(N/A)	1.3	0.4	10.44
White mulberry	24	(N/A)	1.3	0.3	7.98
Cherry plum	8	(N/A)	1.3	0.1	2.83
American elm	62	(N/A)	1.3	0.8	20.68
Siberian elm	78	(N/A)	1.3	1.0	26.08
Other street trees	789	(N/A)	12.6	10.3	27.20
Citywide total	7,658	(N/A)	100.0	100.0	33.15

**Table 7: Summary of Benefits in Dollars**

Total Annual Benefits of Public Trees by Species ($)

10/18/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	2,183	396	374	3,276	3,306	9,535	(±0)	38.9
Northern white cedar	183	14	19	197	219	632	(±0)	2.6
Norway maple	861	96	150	920	634	2,661	(±0)	10.8
Apple	116	11	16	44	40	228	(±0)	0.9
Willow	358	44	56	264	340	1,062	(±0)	4.3
Northern red oak	126	14	18	96	88	343	(±0)	1.4
Sugar maple	424	54	66	531	447	1,523	(±0)	6.2
Blue spruce	86	7	10	126	114	343	(±0)	1.4
Black walnut	279	32	52	393	224	980	(±0)	4.0
Bur oak	447	55	86	753	330	1,670	(±0)	6.8
Lilac	36	4	5	13	13	70	(±0)	0.3
Pin oak	251	47	33	306	379	1,016	(±0)	4.1
Red maple	82	10	14	64	103	274	(±0)	1.1
Broadleaf Deciduous	25	3	3	9	9	49	(±0)	0.2
Ash	36	4	5	21	45	110	(±0)	0.5
Green ash	71	10	11	61	94	248	(±0)	1.0
White ash	169	30	37	275	282	792	(±0)	3.2
Eastern red cedar	29	2	2	50	31	115	(±0)	0.5
White mulberry	62	7	10	27	24	129	(±0)	0.5
Cherry plum	24	2	3	9	8	48	(±0)	0.2
American elm	67	7	11	52	62	199	(±0)	0.8
Siberian elm	94	11	16	80	78	279	(±0)	1.1
Other street trees	546	66	78	737	789	2,216	(±0)	9.0
Citywide Total	6,557	926	1,075	8,305	7,658	24,522	(±0)	100.0

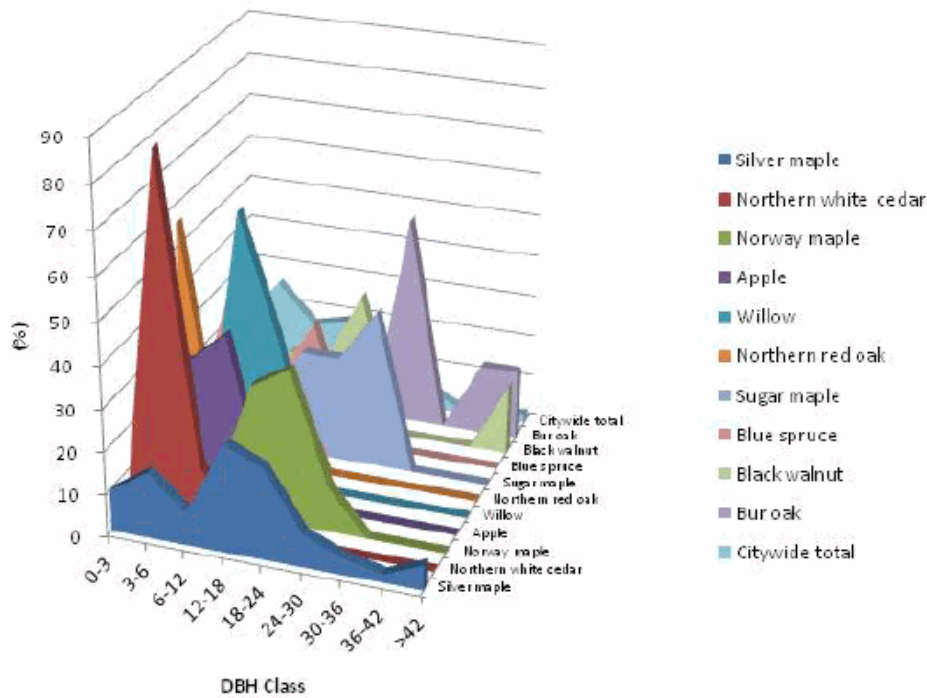## Species Distribution of Public Trees (%)

10/18/2011
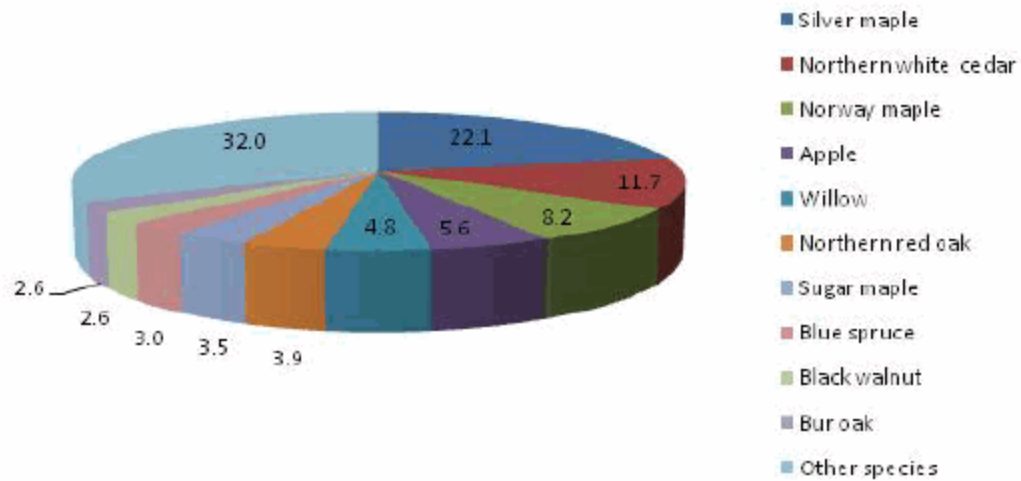
Species	Percent
Silver maple	22.1
Northern white cedar	11.7
Norway maple	8.2
Apple	5.6
Willow	4.8
Northern red oak	3.9
Sugar maple	3.5
Blue spruce	3.0
Black walnut	2.6
Bur oak	2.6
Other species	32.0
Total	100.0

Figure 1: Species Distribution

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

10/18/2011

	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Silver maple	9.8	15.7	7.8	25.5	21.6	7.8	3.9	2.0	5.9
Northern white cedar	0.0	85.2	14.8	0.0	0.0	0.0	0.0	0.0	0.0
Norway maple	15.8	0.0	5.3	31.6	36.8	10.5	0.0	0.0	0.0
Apple	30.8	30.8	38.5	0.0	0.0	0.0	0.0	0.0	0.0
Willow	0.0	0.0	63.6	36.4	0.0	0.0	0.0	0.0	0.0
Northern red oak	55.6	0.0	22.2	22.2	0.0	0.0	0.0	0.0	0.0
Sugar maple	0.0	0.0	12.5	25.0	25.0	37.5	0.0	0.0	0.0
Blue spruce	14.3	42.9	14.3	28.6	0.0	0.0	0.0	0.0	0.0
Black walnut	16.7	0.0	16.7	16.7	33.3	0.0	0.0	0.0	16.7
Bur oak	0.0	0.0	0.0	16.7	0.0	50.0	0.0	16.7	16.7
Citywide total	16.0	26.0	16.9	19.0	10.4	6.5	1.7	1.3	2.2

Figure 2: Relative Age Class

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

10/18/2011

Citywide total

Dead or Dying 0%
Poor 2%
Fair 11%
Good 87%

Legend:
- Dead or Dying
- Poor
- Fair
- Good
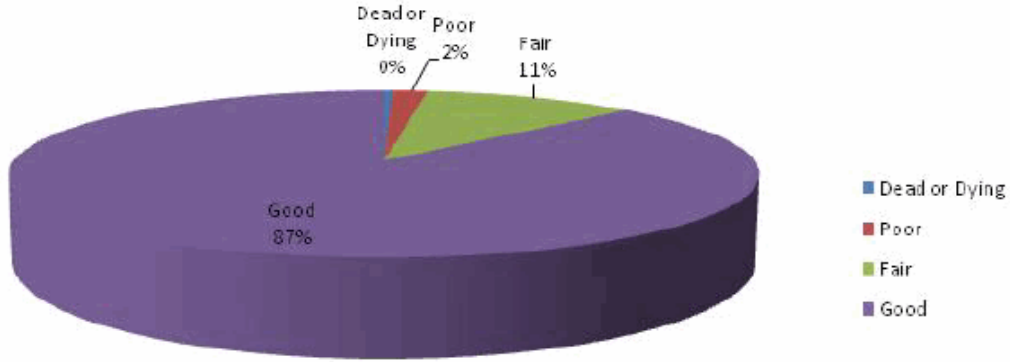
Figure 3: Foliage Condition

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

10/18/2011

Citywide total

Dead or Dying 0%
Poor 3%
Fair 26%
Good 71%

Legend:
- Dead or Dying
- Poor
- Fair
- Good
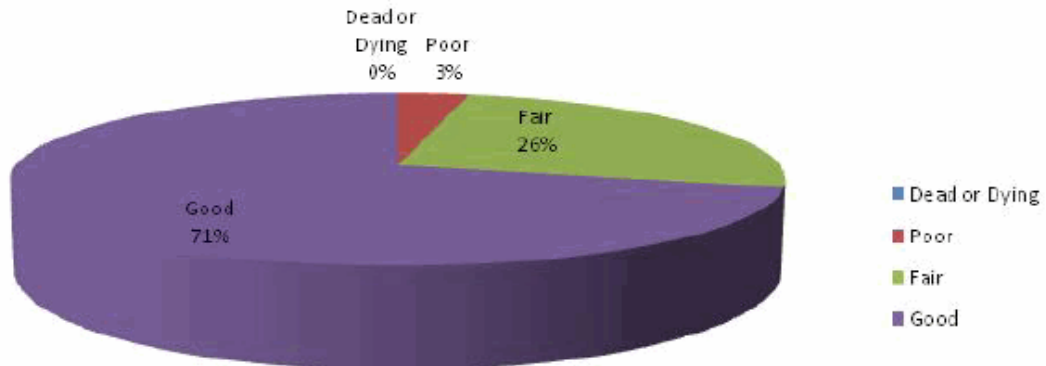
Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

10/18/2011
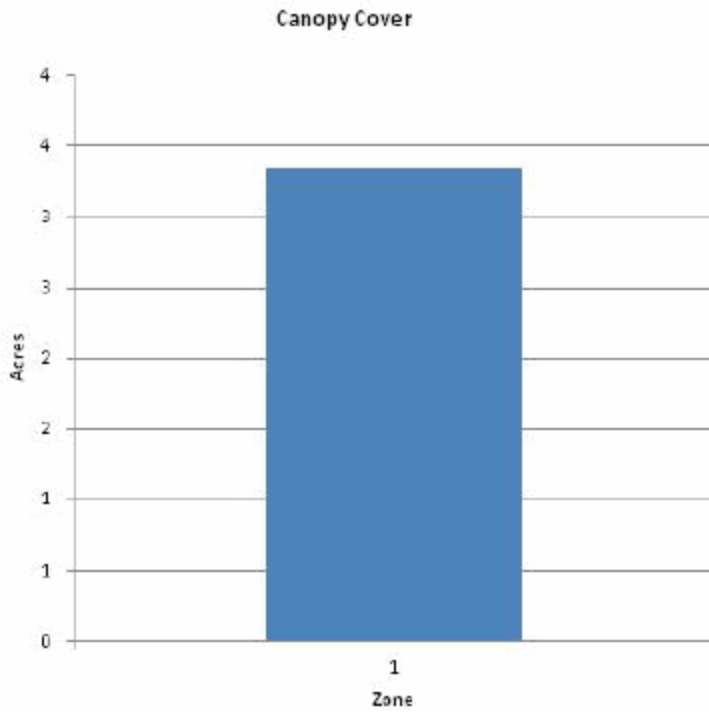
Zone	Acres	% of Total Canopy Cover
1	3	100.0
Citywide total	3	100.0

	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	3		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

10/18/2011

Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	56.7	0.0	0.0	43.3	0.0
Citywide total	56.7	0.0	0.0	43.3	0.0
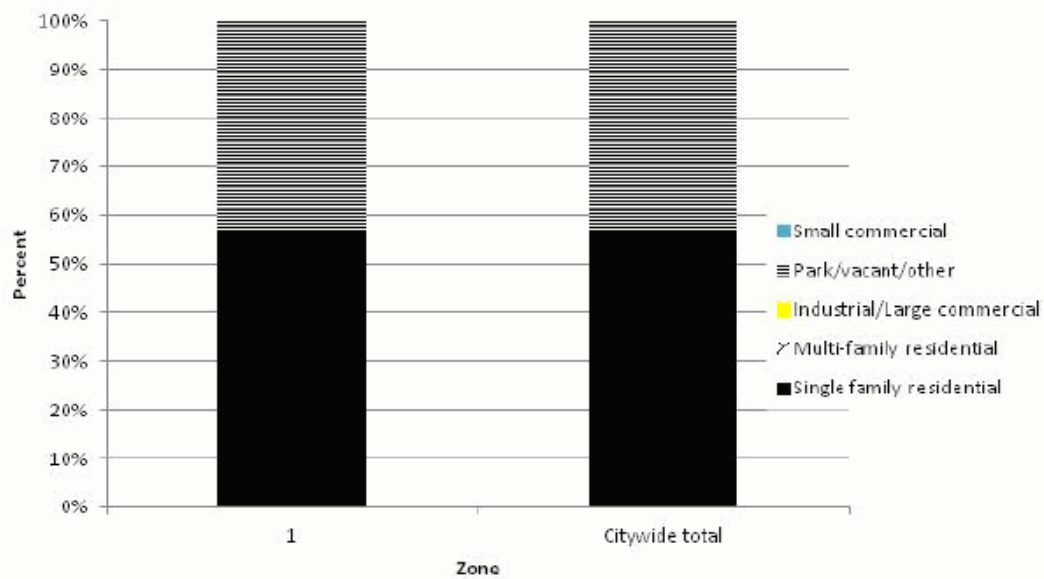
Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

10/18/2011

Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	11.3	32.0	0.0	0.0	43.7	0.0	13.0
Citywide total	11.3	32.0	0.0	0.0	43.7	0.0	13.0
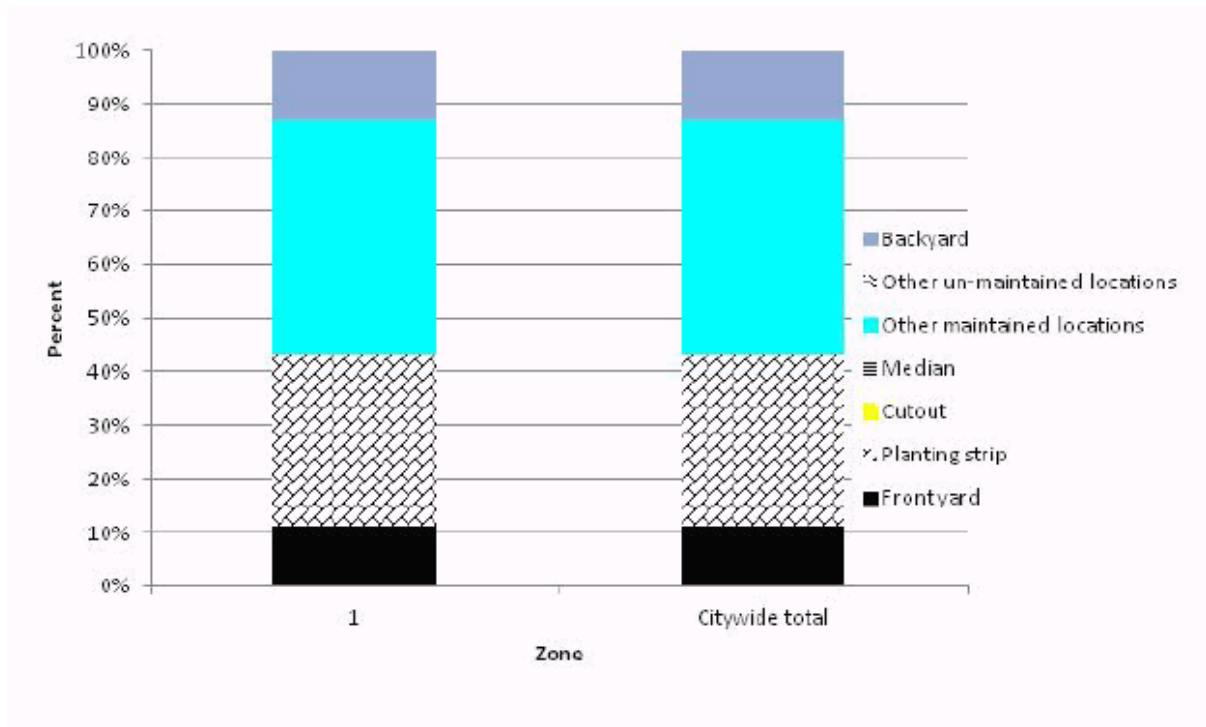
Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees
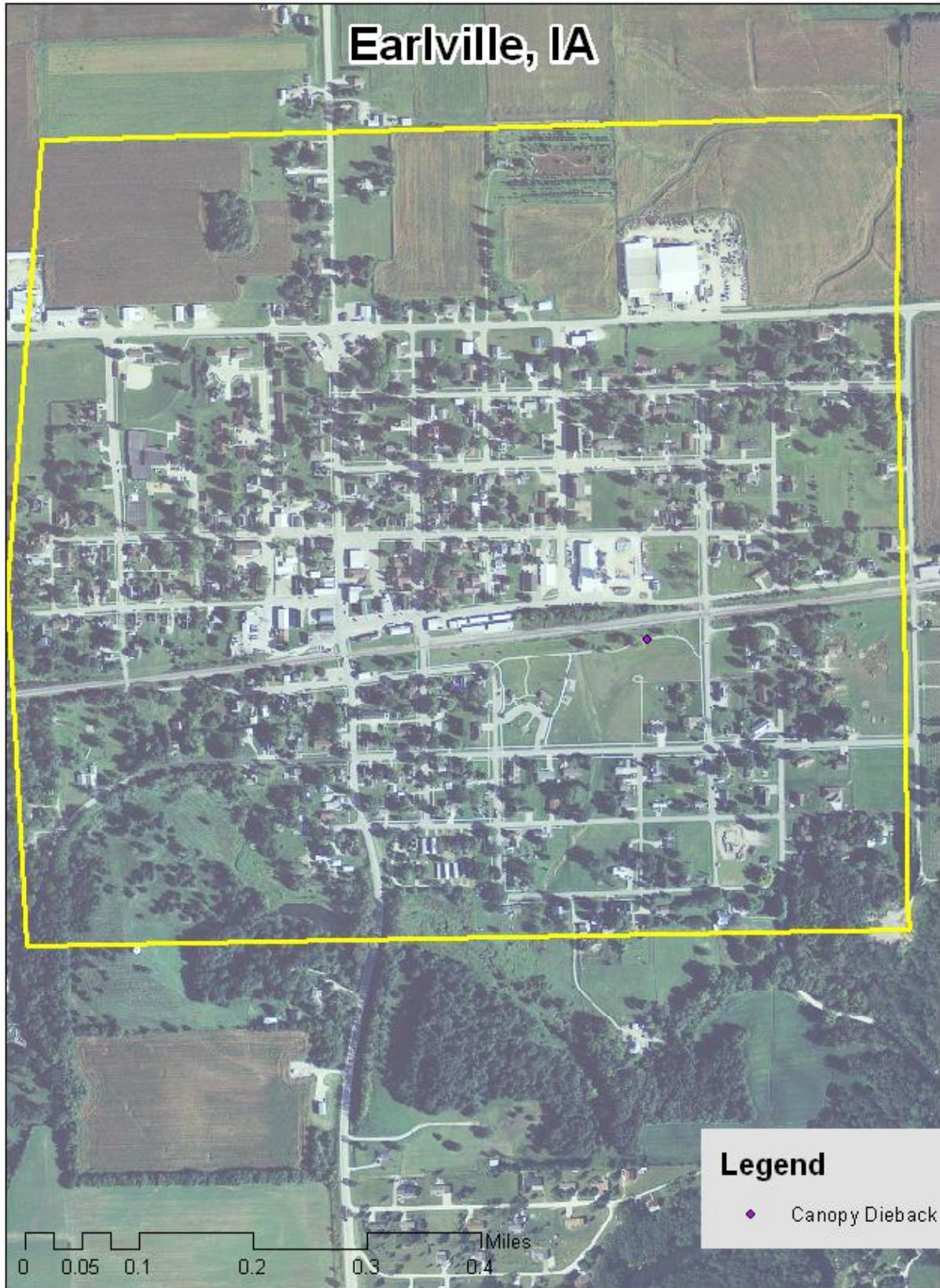
Figure 2: Location of EAB symptoms
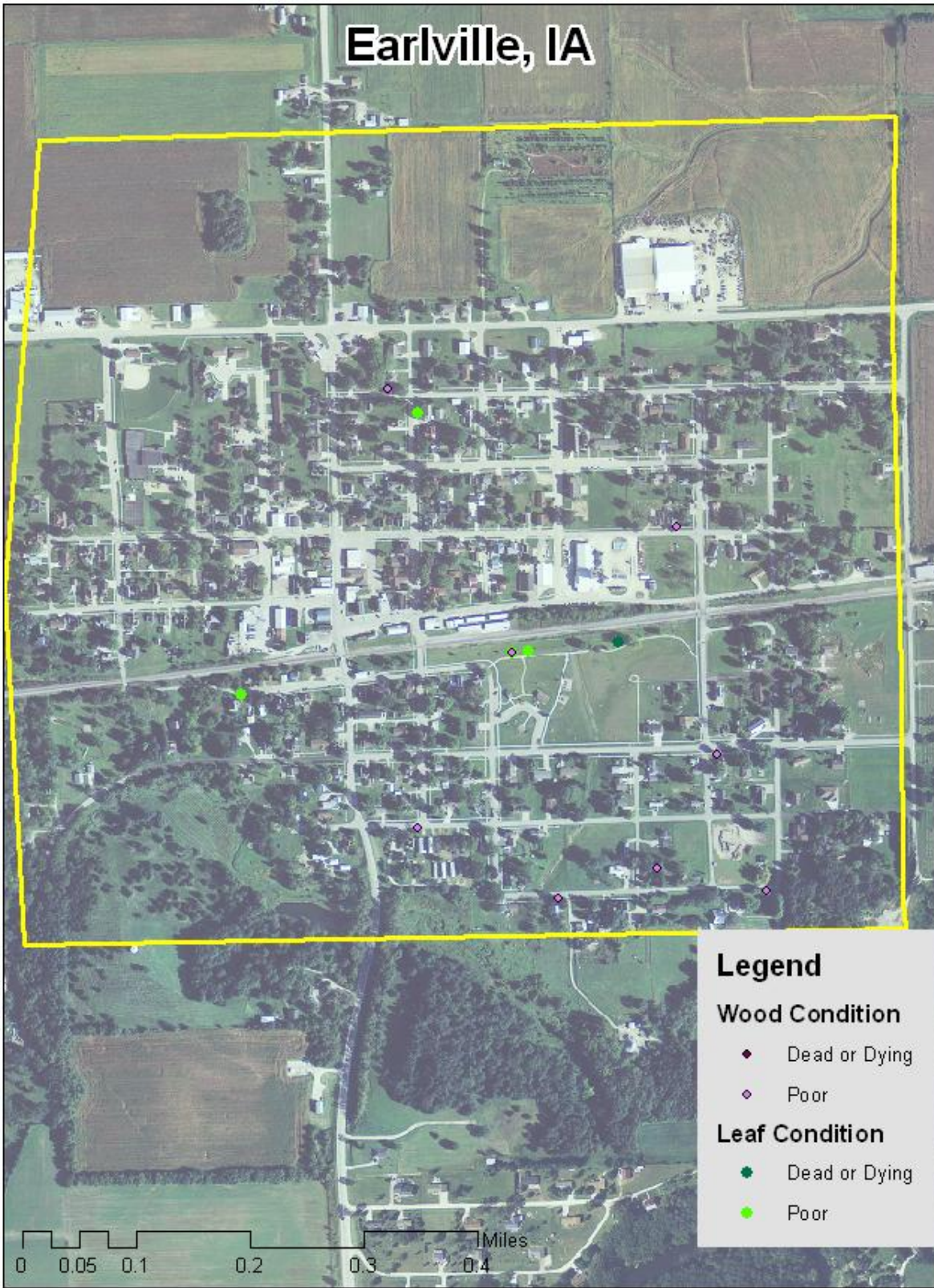
Figure 3: Location of Poor Condition Trees
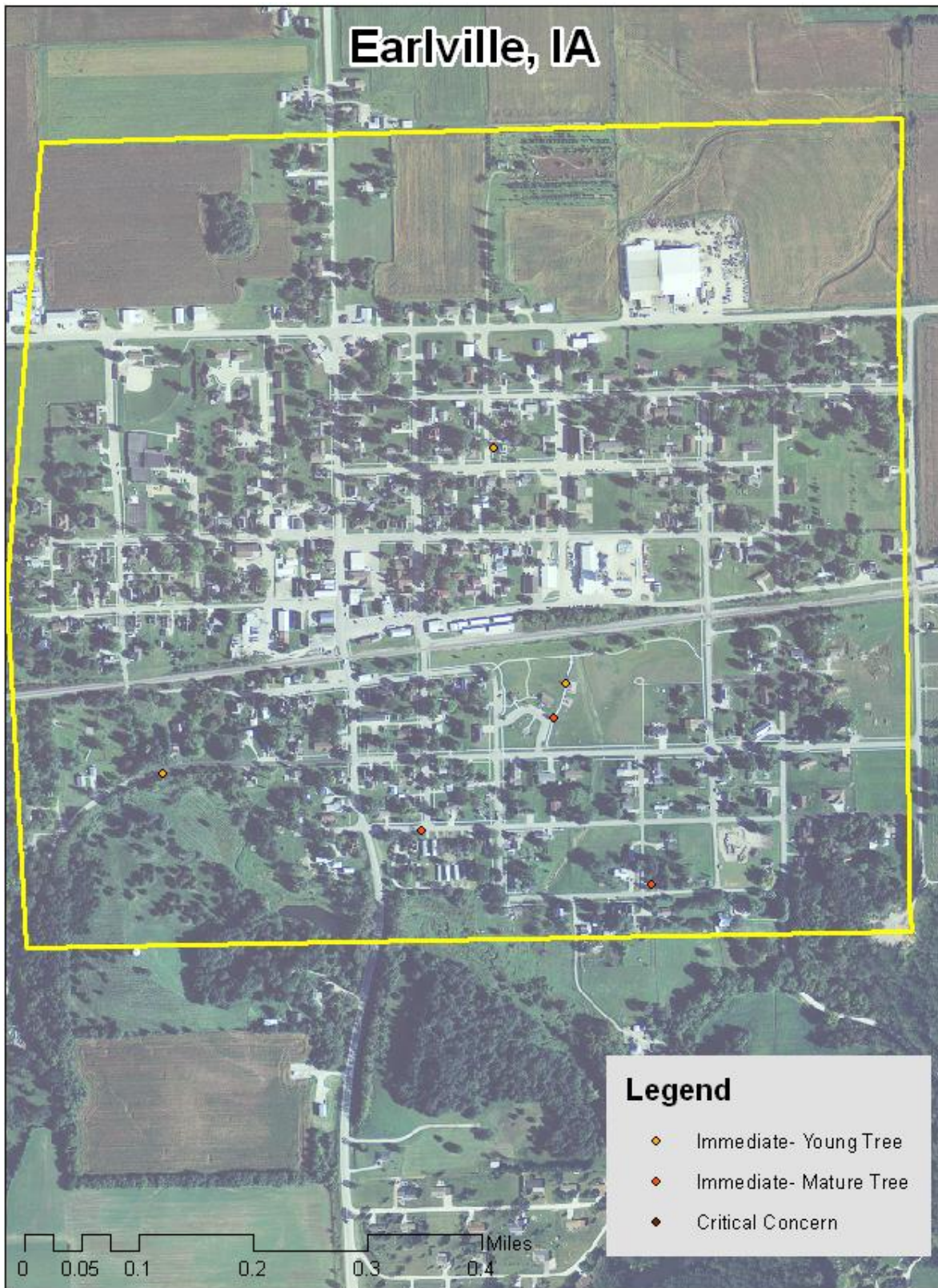
Figure 4: Location of Trees with Recommended Maintenance
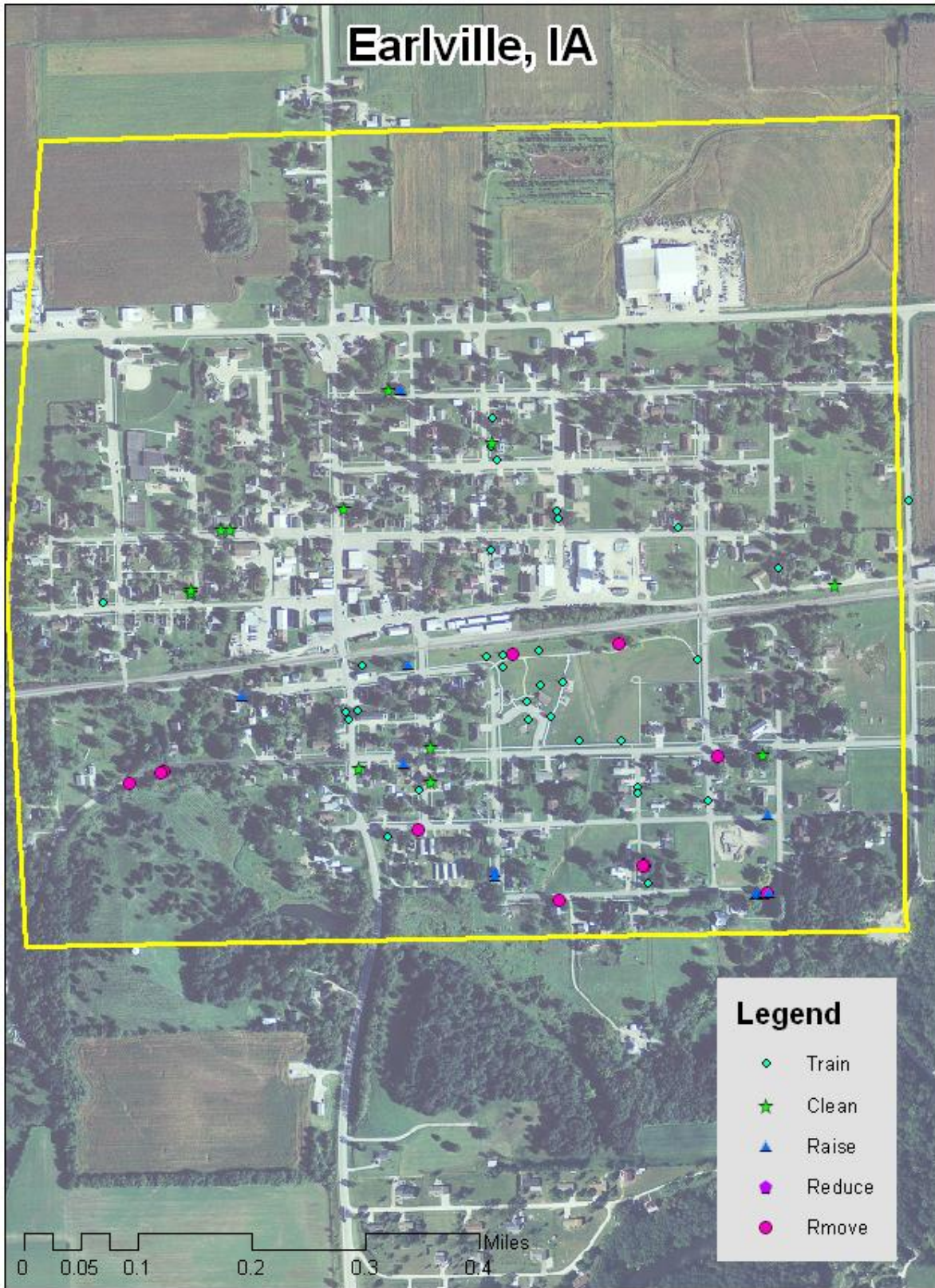
Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Earlville's Tree Ordinances

No ordinance information was made available.