2015 COMMUNITY TREE MANAGEMENT PLAN

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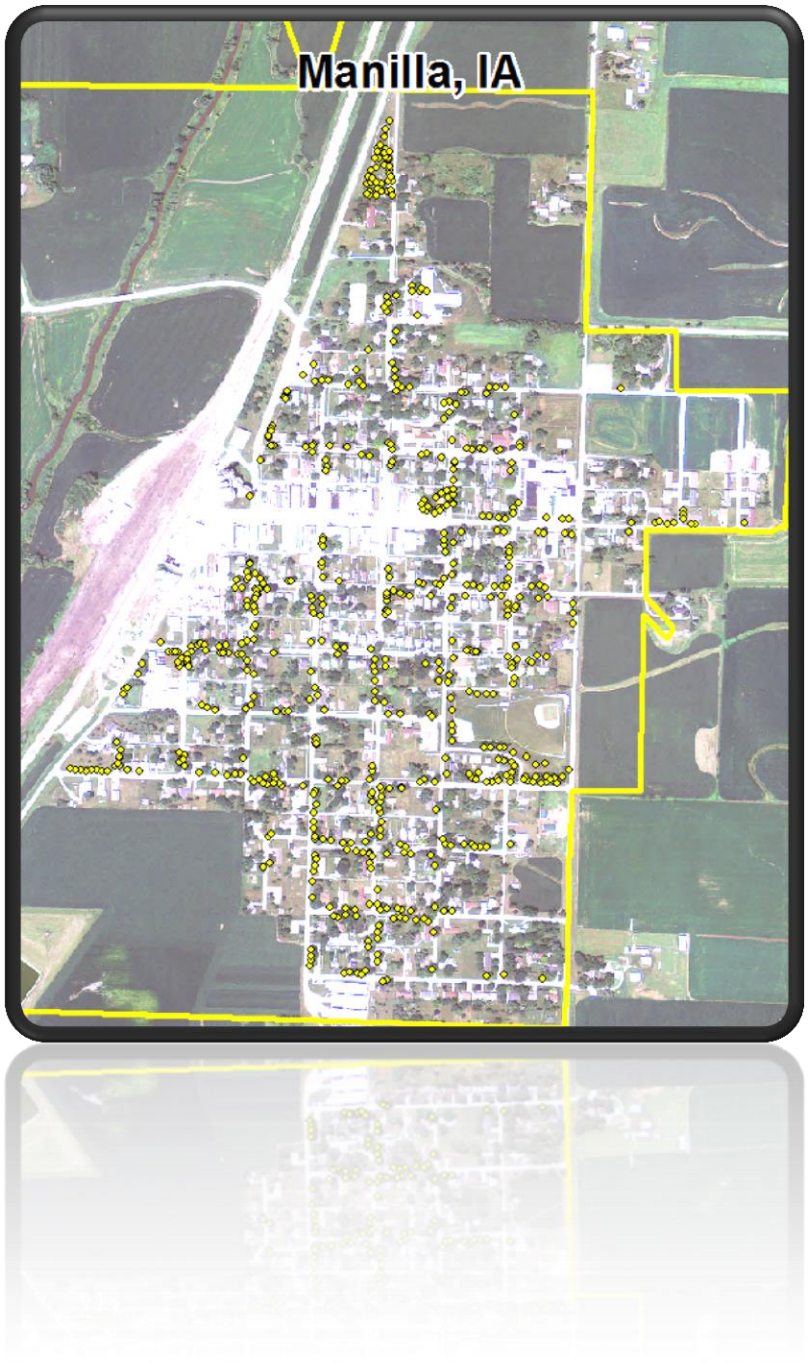

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Executive Summary

Overview

This plan was developed to assist the City of Manilla with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows communities to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a possibility that 31% of your municipally managed trees will die once EAB becomes established in the community. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2015, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street right of way and park trees. Below are some key findings of the 595 trees inventoried.

- Each of Manilla's municipal trees provides $169.48 worth of benefits to the community each year
- There are over 45 species of trees
- The top three genus are: Ash – 31.4%, Maple - 30.9%, and Oak - 9.4%
- 7% of trees are in need of some type of management
- 28 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 28 trees needing removal, one tree is considered of critical concern (requiring immediate attention), and the remaining 27 should be addressed as soon as possible in the next 2-3 years. Of the 28 removals, 26 trees are over 18" in diameter. *City ownership of the trees recommended for removal should be verified prior to any removal*
- 9 of the 187 ash trees are in need of follow up because they are displaying signs and symptoms associated with EAB
- All trees should be pruned on a routine schedule- one third of the city every two years.

Plant a diverse mix of trees that does not include: ash, maple, cottonwood, poplar, Chinese or Siberian elm, black locust, black walnut, tree of heaven, and Bradford/Callery Pear. Please also be careful not to plant the following shrubs, as they are considered invasive species: autumn olive, honeysuckles, salt cedar, rhododendron, multiflora rose, buckthorn, Japanese Barberry, Burning Bush, and Oriental bittersweet (a vine). When considering ornamental trees, shrubs, and plants, please always consider their country of origin. If you have any questions about a

particular plant's viability in your community – please feel free to give me a call at 712.482.6245.

- To remove and replace all right of way and city park ash (187 total trees) would cost an estimated $122,600. Community tree grants can help offset the estimated $33,600 in replacement tree costs. Budgeting $12,260 per year for contracted work or in-kind municipal time for the next 10 years should allow you to adequately be prepared for the repercussions of a potential EAB outbreak.

Introduction

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

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

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

Inventory

In 2015, a tree inventory was conducted that included 100% of the city owned street right of way and park trees. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document. Your community tree information is available for your use on a web-based GIS program. This GIS website, in addition to the fact sheet on how to operate the website, can be found at: http://www.iowadnr.gov/Conservation/Forestry/Urban-Forestry/Community-Tree-Inventories.

The programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

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

Inventory Results

The data collected for the 595 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. Findings

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Manilla's trees reduce energy related costs by approximately $26,959 annually (Appendix A, Table 1). These savings are both in Electricity (128.4 MWh) and in Natural Gas (17,568.3 Therms).

Annual Stormwater Benefits

Manilla's trees intercept about 1,381,566 gallons of rainfall or snow melt each year (Appendix A, Table 2). This interception provides $37,440 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 Manilla, it is estimated that trees remove 1600.4 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $4,487 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere. In Manilla, trees sequester about 304,729 lbs of carbon a year with an associated value of $2,285 (Appendix A, Table 5). In addition, the trees store 4,905,816 lbs of carbon, with a yearly benefit of $36,794 (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. Manilla receives $29,669 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, Manilla's trees provide $100,841 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 595 trees in Manilla provide approximately $169 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Manilla has over 45 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Manilla Percent by Genus		
Ash	187	31.4%
Maple	184	30.9%
Oak	56	9.4%
Spruce	47	7.9%
Apple	30	5.0%
Juniper	15	2.5%
Linden	10	1.7%
Pine	10	1.7%
Broadleaf Deciduous	9	1.5%
Pear	6	1.0%
Prunus (cherry/plum)	5	0.8%
Elm	5	0.8%
Hackberry	5	0.8%
Sycamore	4	0.7%
Kentucky coffee tree	4	0.7%
Birch	4	0.7%
Honey Locust	3	0.5%
Mulberry	3	0.5%
Willow	2	0.3%
Mountain ash	1	0.2%
Aspen	1	0.2%
Magnolia	1	0.2%
Tulip Tree	1	0.2%
Sweet Gum	1	0.2%
Evergreen/Conifer	1	0.2%

TOTAL TREES	595	100%

Age Class

42% of Manilla's trees fall between 6 and 18" in diameter. Another 22% of the tree population lies in the diameter range of 24-30". For age, a Bell Curve is preferred and shows the highest amount of trees around 18 inches in diameter at 4.5 ft. Manilla's size curve shows two waves, an intermediate wave up upcoming mature trees, and a maturing population of trees. Continue to plant trees, as feasible, to continue balancing out the maturing tree population in your community forest.

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 Manilla indicate that 97% of the trees were in good or fair health in 2014, with only 3% of the sampled trees in poor foliar health (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 93% of Manilla's trees are in good or fair health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health is about 7% of the population. This 7% 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 A, Figures 8 & 9).

TASK	**Number of Trees**	**% of Total trees**
Cleaning	66	11%
Removal	28	5%
Crown Raising	1	<1%
Treat pest/disease	2	<1%

Canopy Cover

The estimated canopy cover for the entire town of Manilla is approximately 56.64 acres (as calculated by the Iowa DNR). The canopy cover estimated by i-tree for the inventoried right of way and park trees is slightly over 14 acres (Appendix A, Figure 5). According to the 2010 census, Manilla occupies 661.2 acres. Thus the canopy cover on city parks and right of way areas is about 2.1%, and over the entire community is 9%.

Land Use and Location

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

Land Use	
Single Family Residential	74.6%
Park/Vacant/Other	19.5%
Small Commercial	5.0%
Multi-family Residential	<1%

Location	
Front yard	59%
Planting strip	41%

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

Manilla has 1 critical concern tree that needs immediate removal. This tree can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figures 4 and 5). In addition, there are 27 trees identified as needing removal in the next 1-3 years – and should be looked addressed as soon as feasible (see Figure 4 – Mature Tree Immediate map points). There are 2 mature trees that needs follow-up due to a forest health issue. Finally, there are 66 trees suggested for cleaning (5 trees of which need cleaning in the next 1-3 years), and 1 tree suggested for a crown raising. These recommendations are summarized on the following table.

PRIORITY TASK	CRITICAL CONCERN	MATURE TREE IMMEDIATE	MATURE TREE ROUTINE	YOUNG TREE IMMEDIATE	YOUNG TREE ROUTINE	NONE	TOTAL
NONE:			412		86		**498**
STAKE/TRAIN							
CLEAN		5	61				**66**
RAISE			1				**1**
REDUCE							
REMOVE	1	27					**28**
TREAT PEST/DISEASE			2				**2**
TOTAL	**1**	**32**	**476**		**86**		**595**

Poor tree species

After the removal of the critical concern and immediate concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 1 & Appendix B, Figure 3). Of the 28 removals, 9 are ash trees. There are a total of 187 ash trees, and 9 trees have signs and symptoms that have been associated with EAB (2 of those symptomatic trees are suggested for removal). In addition, there are 15 ash trees that are in poor health or dead/dying. EAB symptomatic trees should be examined as soon as possible. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are five main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, crown reduction, and treat pest/disease. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. Treat pest/disease trees showed indications of foliar or structural decline due to insect, disease, or rot. These trees should be investigated further by a certified arborist who can look into the integrity of the tree. It is recommended that all trees be pruned on a routine schedule every five to seven years.

Planting

It is suggested that for every tree removed, a replanting rate of 1.2 should be used, since survival rates will not be 100%. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Manilla.

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 Ash (31.4%) and Maple (30.9%) (Appendix A, Figure 1). *Maples should not be planted until this percentage can be lowered.* Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, Chinese elm, willow or black walnut, as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

Sycamore, bur oak, chinkapin oak, white oak, red oak, Kentucky coffee tree, American linden (basswood), thornless honey locust, and hackberry are all suited to Manilla's upland soils – and are presently underutilized. In addition, ironwood (*Ostrya virginiana*) and serviceberry (*Amalanchier arborea*) would make great alternatives to low growing trees for right of ways.

Recommended Species to plant in Western Iowa:

COMMON NAME	SCIENTIFIC NAME	CULTIVARS / SELECTIONS
LARGE SHADE TREES – Plant 35 feet apart and away from overhead power lines.		
White Oak	*Quercus alba*	
Bur Oak	*Quercus macrocarpa*	
Red Oak	*Quercus rubra*	
Black Oak	*Quercus veluntina*	
Chinkapin Oak	*Quercus muehlenbergii*	
American Basswood (Linden)	*Tilia Americana*	Boulevard, Front Yard, Legend, Redmond
Thornless Honeylocust	*Gleditsia triacanthos var. inermis*	Shademaster, Skyline
American elm	*Ulmus Americana*	Independence, New harmony, Valley Forge
Cottonwood (seedless) - ***Not recommended for planting near any homes or structures	*Populous deltoides*	Siouxland
Sycamore	*Plantanus occidentalis*	
Gingko	*Gingko biloba*	Male only – Shangri-La, Princeton sentry, Emperor
Kentucky coffee tree	*Gymnocladus diocius*	Expresso
Black Cherry	*Prunus serotina*	
Hackberry	*Celtis occidentalis*	Chicagoland, Prairie Pride, Windy City
LOW GROWING TREES (less than 30 feet tall) planted as close as 12 feet.		
Eastern redbud	*Cercis Canadensis*	
Downy Hawthorn	*Crataegus mollis*	
Ironwood (hop hornbeam)	*Ostrya virginiana*	
American hornbeam	*Carpinus caroliniana*	
Serviceberry	*Amalanchier arborea*	Autumn brilliance, Cumulus, Princess Diana
Flowering crabapple	*Malus*	Prairiefire, Adams, Sentinel, Snowdrift
Red mulberry	*Morus rubra*	
American (wild) plum	*Prunus americana*	
EVERGREEN TREES – planted 25 feet apart and away from overhead power lines.		
Eastern White Pine	*Pinus strobes*	
Jack pine	*Pinus banksiana*	
Juniper (Eastern red cedar)	*Juniperus virginiana*	
Norway spruce	*Picea abies*	
Concolor fir	*Abies concolor*	
Bald cypress	*Taxodium distichum*	
Arborvitae (Northern White cedar)	*Thuja occidentalis*	Techny, Brandon, Holmstrup

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree death and for

the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Emerald Ash Borer Plan

Ash Tree Removal

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

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of over 25 million ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles. The entire state of Iowa is under USDA quarantine for EAB.

A regulated article under the USDA's quarantine includes any of the following items:
- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

In addition, any other article, product or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB.

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees. Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml.

Canopy Replacement

As budget permits, all removed ash trees should be replaced. All trees should meet the restrictions in city ordinance 151.02 (Appendix C). The new plantings should be a diverse mix

and will not include ash, maple, cottonwood, poplar, box elder, Chinese 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 should be prioritized by hazardous or emergency situations only.

Monitoring

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

Private Ash Trees

It is strongly suggested that private property owners monitor the condition of their privately managed trees. There are numerous options available to them, including: removal and replanting, treating with insecticides, and monitoring until an issue arises. These options are spelled out in: https://store.extension.iastate.edu/Product/Emerald-Ash-Borer-Management-Options. Check your city tree ordinance to be sure additional actions are not required for these private trees.

Treating for EAB

Many landowners will want to treat their ash trees with insecticides to prolong the life of their ash trees. This is only recommended by Iowa State University Extension when EAB has been found within 15 miles of the tree in question. The closest known population of EAB to Manilla is in Boone.

Insecticidal injections or drenches can have serious environmental side effects when improperly applied. Some insecticides have application limits – like only treating 3 trees per acre, for instance. Encourage your residents to report ash treatments with the city or their neighbors – in order to prevent over-application of these insecticides. Please contact me if you have any questions. I would be more than happy to host an informational meeting on EAB and its effects on community ash trees.

My suggestion would be to start increasing the city tree budget for removals and replacements now. I would place all efforts and finances on replanting trees – and removing declining trees and EAB casualty trees as they arise. Your community should put heavy thought and consideration into your emerald ash borer plan. For instance, it may be more economical to budget for ash removals as they come, than it would be to treat each city-managed ash tree for the next 5 to 10 years.

Maintenance Plan and Budget

The following tasks are placed in order of yearly priority. These tasks should be fulfilled as your budget or personnel time allows. Critical concern trees should be treated immediately, and immediate mature tree tasks should be completed within 2-3 years (which is their expected lifetime before they become critical concern trees). If you are interested in creating a scheduled maintenance and replanting plan, based on a set budget, please contact me. For now, a priority list looks like this:

2016: Remove the 1 critical concern tree and perform crown cleaning on the 5 trees listed as mature tree immediate - cleaning.

Consider organizing public meetings to discuss EAB

Discuss increasing tree removal and replacement time or financial budgets with city staff

Look into tree planting grants for community entities (Trees for Kids, Trees Forever grants)

2016-2018: Complete remaining 27 mature tree immediate removals. Clean remaining 61 mature tree routine trees (if time allows), and raise the 1 mature tree routine tree.

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

Start replanting trees that you have removed, as time and finances permit. 34 trees should be replanted to replace the 28 hazard trees removed. 224 trees will be needed to replace all 178 remaining ash if an EAB infestation occurs. Plan on budgeting or requesting $150/tree for replanting and maintenance costs.

Monitor for suspicious ash trees.

2018-2020: Consider implementing a routine trimming (cleaning) regimen for the remaining city trees. Ideally, routine trimming should be done to 1/3 of the city's trees every 2 years. In other words, all public and right of way trees should be trimmed once every 6 years.

Also – consider evaluating Manilla's street trees again for hazards by 2020 (if not before).

Monitor for tree health issues – all species.

Proposed Budget Increase

Emerald Ash Borer could potentially kill all ash trees in Manilla within 4 years of its arrival. To remove and replace all 187 inventoried ash trees (9 ash trees are recommended for immediate hazard removal), you would need to budget an estimated $122,600 (calculated using $500/tree removal price and $150/tree replacement price). If municipal crews usually take down right of way and park trees, the removal costs will undoubtedly be much less than this figure. However, if you rely on contractors to remove and replant your city trees – you will want to be budgeting for at least $122,600 for the next 10 years.

It is recommended that Manilla 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. The Trees for Kids Grant will be a great option for your community to use for tree planting projects on public lands. Trees Forever may also have community improvement grants that can assist with replanting expenses.

Works Cited

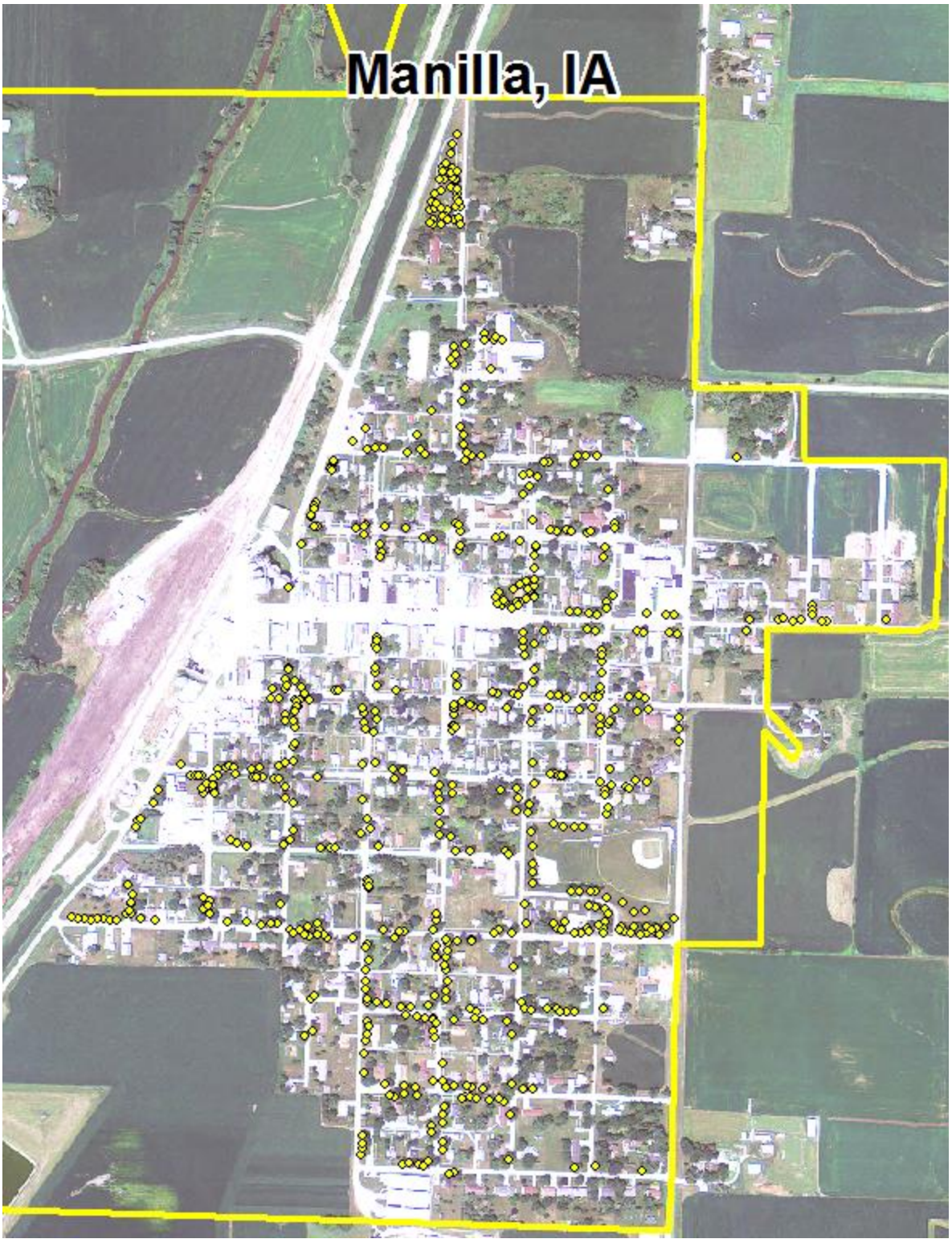
Census Bureau. 2000. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2010)

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

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

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

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


Manilla, IA

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Manilla

Annual Energy Benefits of Public Trees

12/7/2015

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	48.5	3,682	6,691.3	6,557	10,240	(N/A)	30.4	38.0	56.57
Silver maple	24.2	1,837	3,149.1	3,086	4,923	(N/A)	12.4	18.3	66.53
Sugar maple	10.7	811	1,401.0	1,373	2,184	(N/A)	7.1	8.1	52.01
Blue spruce	2.5	189	358.2	351	541	(N/A)	5.7	2.0	15.90
Norway maple	7.3	554	1,051.5	1,030	1,584	(N/A)	5.5	5.9	48.01
Apple	1.9	145	308.4	302	447	(N/A)	5.0	1.7	14.89
Maple	2.6	197	352.0	345	542	(N/A)	4.5	2.0	20.07
Pin oak	7.7	587	1,061.8	1,041	1,627	(N/A)	4.4	6.0	62.60
Northern red oak	1.9	146	268.3	263	409	(N/A)	2.9	1.5	24.04
Black walnut	4.0	301	535.4	525	826	(N/A)	2.5	3.1	55.04
Littleleaf linden	1.4	109	198.2	194	304	(N/A)	1.3	1.1	37.95
Spruce	0.3	25	55.4	54	79	(N/A)	1.2	0.3	11.30
Pear	0.5	37	76.6	75	112	(N/A)	1.0	0.4	18.63
Broadleaf Deciduous Small	0.1	7	16.4	16	23	(N/A)	1.0	0.1	3.89
Norway spruce	0.8	64	108.1	106	170	(N/A)	1.0	0.6	28.36
Bur oak	0.4	28	45.3	44	72	(N/A)	0.8	0.3	14.40
Cherry plum	0.5	37	73.5	72	109	(N/A)	0.8	0.4	21.75
Swamp white oak	0.3	25	52.1	51	76	(N/A)	0.8	0.3	15.12
White ash	0.5	35	66.7	65	101	(N/A)	0.8	0.4	20.10
Austrian pine	0.6	43	82.7	81	124	(N/A)	0.8	0.5	24.87
Northern hackberry	1.1	82	149.9	147	229	(N/A)	0.8	0.8	45.72
Siberian elm	1.1	87	156.4	153	240	(N/A)	0.7	0.9	60.00
Eastern white pine	0.7	52	88.4	87	139	(N/A)	0.7	0.5	34.66
Kentucky coffeetree	1.3	97	172.5	169	266	(N/A)	0.7	1.0	66.40
American sycamore	1.5	117	213.2	209	326	(N/A)	0.7	1.2	81.49
Amur maple	0.2	15	33.3	33	47	(N/A)	0.7	0.2	11.80
Birch	0.4	33	66.0	65	98	(N/A)	0.7	0.4	24.45
Red maple	0.6	45	79.6	78	123	(N/A)	0.7	0.5	30.67
Mulberry	0.3	21	41.3	40	62	(N/A)	0.5	0.2	20.58
Honeylocust	0.9	70	114.1	112	182	(N/A)	0.5	0.7	60.61
Willow	0.6	49	94.8	93	142	(N/A)	0.3	0.5	70.84
American basswood	0.5	37	72.8	71	108	(N/A)	0.3	0.4	53.99
Oak	0.6	45	85.0	83	128	(N/A)	0.3	0.5	64.12
Broadleaf Deciduous Large	0.8	58	105.8	104	162	(N/A)	0.3	0.6	80.97
Scotch pine	0.1	4	9.5	9	14	(N/A)	0.2	0.1	13.58
Elm	0.0	0	0.5	0	1	(N/A)	0.2	0.0	0.66
Tulip tree	0.4	33	59.0	58	91	(N/A)	0.2	0.3	91.02
Broadleaf Deciduous Mediu	0.0	3	6.2	6	9	(N/A)	0.2	0.0	8.99
Sweetgum	0.1	7	13.7	13	21	(N/A)	0.2	0.1	20.64
Conifer Evergreen Medium	0.0	2	4.9	5	7	(N/A)	0.2	0.0	6.94
White oak	0.0	0	0.5	0	1	(N/A)	0.2	0.0	0.66
Ash	0.0	3	6.2	6	9	(N/A)	0.2	0.0	8.99
Mountain ash	0.1	6	12.8	13	18	(N/A)	0.2	0.1	18.19
Quaking aspen	0.2	18	27.0	26	44	(N/A)	0.2	0.2	44.23
Southern magnolia	0.0	1	2.8	3	4	(N/A)	0.2	0.0	3.94
Total	128.4	9,742	17,568.3	17,217	26,959	(N/A)	100.0	100.0	45.31

Table 2: Annual Stormwater Benefits

Manilla

Annual Stormwater Benefits of Public Trees

12/7/2015

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	521,484	14,132	(N/A)	30.4	37.7	78.08
Silver maple	330,449	8,955	(N/A)	12.4	23.9	121.02
Sugar maple	103,890	2,815	(N/A)	7.1	7.5	67.03
Blue spruce	30,403	824	(N/A)	5.7	2.2	24.23
Norway maple	65,226	1,768	(N/A)	5.5	4.7	53.56
Apple	6,742	183	(N/A)	5.0	0.5	6.09
Maple	16,178	438	(N/A)	4.5	1.2	16.24
Pin oak	78,842	2,137	(N/A)	4.4	5.7	82.18
Northern red oak	10,981	298	(N/A)	2.9	0.8	17.51
Black walnut	38,013	1,030	(N/A)	2.5	2.8	68.68
Littleleaf linden	11,799	320	(N/A)	1.3	0.9	39.97
Spruce	3,403	92	(N/A)	1.2	0.2	13.18
Pear	1,732	47	(N/A)	1.0	0.1	7.82
Broadleaf Deciduous Small	290	8	(N/A)	1.0	0.0	1.31
Norway spruce	14,954	405	(N/A)	1.0	1.1	67.54
Bur oak	2,281	62	(N/A)	0.8	0.2	12.36
Cherry plum	2,181	59	(N/A)	0.8	0.2	11.82
Swamp white oak	1,782	48	(N/A)	0.8	0.1	9.66
White ash	3,068	83	(N/A)	0.8	0.2	16.63
Austrian pine	9,060	246	(N/A)	0.8	0.7	49.11
Northern hackberry	6,519	177	(N/A)	0.8	0.5	35.33
Siberian elm	12,173	330	(N/A)	0.7	0.9	82.47
Eastern white pine	15,353	416	(N/A)	0.7	1.1	104.01
Kentucky coffeetree	15,037	408	(N/A)	0.7	1.1	101.88
American sycamore	22,163	601	(N/A)	0.7	1.6	150.15
Amur maple	666	18	(N/A)	0.7	0.0	4.51
Birch	4,252	115	(N/A)	0.7	0.3	28.81
Red maple	3,480	94	(N/A)	0.7	0.3	23.58
Mulberry	1,000	27	(N/A)	0.5	0.1	9.03
Honeylocust	7,799	211	(N/A)	0.5	0.6	70.45
Willow	7,529	204	(N/A)	0.3	0.5	102.01
American basswood	4,266	116	(N/A)	0.3	0.3	57.80
Oak	6,534	177	(N/A)	0.3	0.5	88.53
Broadleaf Deciduous Large	11,182	303	(N/A)	0.3	0.8	151.51
Scotch pine	596	16	(N/A)	0.2	0.0	16.14
Elm	18	0	(N/A)	0.2	0.0	0.48
Tulip tree	7,239	196	(N/A)	0.2	0.5	196.17
Broadleaf Deciduous Medium	163	4	(N/A)	0.2	0.0	4.41
Sweetgum	608	16	(N/A)	0.2	0.0	16.47
Conifer Evergreen Medium	256	7	(N/A)	0.2	0.0	6.95
White oak	18	0	(N/A)	0.2	0.0	0.48
Ash	163	4	(N/A)	0.2	0.0	4.41
Mountain ash	264	7	(N/A)	0.2	0.0	7.17
Quaking aspen	1,466	40	(N/A)	0.2	0.1	39.72
Southern magnolia	56	2	(N/A)	0.2	0.0	1.53
Citywide total	1,381,556	37,440	(N/A)	100.0	100.0	62.92

Table 3: Annual Air Quality Benefits

Manilla

Annual Air Quality Benefits of Public Trees

12/7/2015

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($) Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2							
Green ash	61.8	9.9	29.9	2.8	330	232.1	33.8	32.2	219.9	1,445	0.0	0	622.2	1,775 (N/A)	30.4	9.80
Silver maple	54.8	9.3	27.2	2.4	296	113.8	16.7	15.9	109.5	713	-28.4	-106	321.2	903 (N/A)	12.4	12.20
Sugar maple	13.0	2.2	6.7	0.6	71	50.4	7.4	7.1	48.4	316	-10.3	-39	125.4	348 (N/A)	7.1	8.28
Blue spruce	3.3	0.7	3.0	0.4	23	12.0	1.7	1.7	11.3	75	-10.2	-38	23.9	59 (N/A)	5.7	1.73
Norway maple	12.9	2.2	6.4	0.6	70	35.4	5.1	4.9	33.1	219	-3.1	-12	97.6	278 (N/A)	5.5	8.42
Apple	1.4	0.2	0.7	0.1	8	9.5	1.4	1.3	8.6	58	0.0	0	23.2	66 (N/A)	5.0	2.19
Maple	2.9	0.5	1.5	0.1	16	12.3	1.8	1.7	11.8	77	-1.1	-4	31.5	88 (N/A)	4.5	3.28
Pin oak	12.9	2.3	6.8	0.6	71	36.9	5.4	5.1	35.0	230	-24.3	-91	80.6	210 (N/A)	4.4	8.06
Northern red oak	1.6	0.3	0.9	0.1	9	9.2	1.3	1.3	8.7	57	-2.2	-8	21.1	58 (N/A)	2.9	3.40
Black walnut	4.1	0.7	2.1	0.2	22	18.9	2.8	2.6	18.0	118	0.0	0	49.2	140 (N/A)	2.5	9.32
Littleleaf linden	1.7	0.3	0.9	0.1	9	6.9	1.0	1.0	6.5	43	-0.9	-3	17.5	49 (N/A)	1.3	6.13
Spruce	0.3	0.1	0.3	0.0	2	1.7	0.2	0.2	1.5	10	-0.9	-4	3.3	9 (N/A)	1.2	1.21
Pear	0.4	0.1	0.2	0.0	2	2.4	0.3	0.3	2.2	15	0.0	0	5.9	17 (N/A)	1.0	2.81
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3 (N/A)	1.0	0.51
Norway spruce	1.7	0.3	1.4	0.2	11	4.0	0.6	0.6	3.8	25	-6.6	-25	6.0	11 (N/A)	1.0	1.90
Bur oak	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)	0.8	2.29
Cherry plum	0.7	0.1	0.3	0.0	4	2.4	0.3	0.3	2.2	15	0.0	0	6.4	18 (N/A)	0.8	3.65
Swamp white oak	0.2	0.0	0.1	0.0	1	1.6	0.2	0.2	1.5	10	-0.1	0	3.8	11 (N/A)	0.8	2.14
White ash	0.1	0.0	0.1	0.0	1	2.2	0.3	0.3	2.1	14	0.0	0	5.2	15 (N/A)	0.8	2.91
Austrian pine	1.4	0.3	1.1	0.2	9	2.8	0.4	0.4	2.6	17	-3.4	-13	5.7	13 (N/A)	0.8	2.68
Northern hackberry	0.6	0.1	0.4	0.0	4	5.2	0.8	0.7	4.9	32	0.0	0	12.7	36 (N/A)	0.8	7.17
Siberian elm	2.0	0.3	1.0	0.1	11	5.4	0.8	0.8	5.2	34	0.0	0	15.6	45 (N/A)	0.7	11.20
Eastern white pine	1.9	0.4	1.5	0.2	12	3.2	0.5	0.5	3.1	20	-9.1	-34	2.1	-2 (N/A)	0.7	-0.48
Kentucky coffeetree	2.0	0.3	0.9	0.1	10	6.1	0.9	0.8	5.8	38	0.0	0	16.8	48 (N/A)	0.7	12.05
American sycamore	3.2	0.5	1.5	0.1	17	7.4	1.1	1.0	7.0	46	0.0	0	21.8	63 (N/A)	0.7	15.73
Amur maple	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	0.0	0	2.3	7 (N/A)	0.7	1.63
Birch	0.9	0.2	0.4	0.0	5	2.1	0.3	0.3	2.0	13	-0.2	-1	6.0	17 (N/A)	0.7	4.30
Red maple	0.6	0.1	0.3	0.0	3	2.8	0.4	0.4	2.7	17	-0.2	-1	7.0	20 (N/A)	0.7	4.92
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)	0.5	3.27
Honeylocust	1.4	0.2	0.7	0.1	8	4.3	0.6	0.6	4.2	27	-1.1	-4	11.1	31 (N/A)	0.5	10.23
Willow	1.7	0.3	0.8	0.1	9	3.1	0.5	0.4	2.9	19	-0.4	-1	9.5	27 (N/A)	0.3	13.58
American basswood	0.5	0.1	0.3	0.0	3	2.4	0.3	0.3	2.2	15	-0.4	-2	5.6	16 (N/A)	0.3	7.78
Oak	0.8	0.1	0.4	0.0	4	2.9	0.4	0.4	2.7	18	0.0	0	7.6	22 (N/A)	0.3	10.91
Broadleaf Deciduous Large	1.7	0.3	0.7	0.1	9	3.7	0.5	0.5	3.5	23	0.0	0	10.9	32 (N/A)	0.3	15.76
Scotch pine	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	1 (N/A)	0.2	1.48
Elm	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)	0.2	0.08
Tulip tree	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19 (N/A)	0.2	19.04
Broadleaf Deciduous Medium	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1 (N/A)	0.2	1.21
Sweetgum	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3 (N/A)	0.2	2.99
Conifer Evergreen Medium	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	-0.1	0	0.3	1 (N/A)	0.2	0.75
White oak	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	0.2	0.08
Ash	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1 (N/A)	0.2	1.21
Mountain ash	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.2	2.55
Quaking aspen	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	0.0	0	2.6	7 (N/A)	0.2	7.42
Southern magnolia	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	0.0	0	0.2	0 (N/A)	0.2	0.47
Citywide total	194.2	32.6	99.4	9.3	1,059	612.4	89.2	85.0	581.5	3,815	-103.2	-387	1,600.4	4,487 (N/A)	100.0	7.54

Table 4: Annual Carbon Stored

Manilla

Stored CO2 Benefits of Public Trees

12/7/2015

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,998,599	14,989	(N/A)	30.4	40.7	82.81
Silver maple	1,195,533	8,967	(N/A)	12.4	24.4	121.17
Sugar maple	371,771	2,788	(N/A)	7.1	7.6	66.39
Blue spruce	17,383	130	(N/A)	5.7	0.4	3.83
Norway maple	214,056	1,605	(N/A)	5.5	4.4	48.65
Apple	24,938	187	(N/A)	5.0	0.5	6.23
Maple	34,457	258	(N/A)	4.5	0.7	9.57
Pin oak	326,246	2,447	(N/A)	4.4	6.7	94.11
Northern red oak	25,130	188	(N/A)	2.9	0.5	11.09
Black walnut	132,088	991	(N/A)	2.5	2.7	66.04
Littleleaf linden	37,488	281	(N/A)	1.3	0.8	35.15
Spruce	1,360	10	(N/A)	1.2	0.0	1.46
Pear	6,683	50	(N/A)	1.0	0.1	8.35
Broadleaf Deciduous	739	6	(N/A)	1.0	0.0	0.92
Norway spruce	15,711	118	(N/A)	1.0	0.3	19.64
Bur oak	4,916	37	(N/A)	0.8	0.1	7.37
Cherry plum	10,879	82	(N/A)	0.8	0.2	16.32
Swamp white oak	3,336	25	(N/A)	0.8	0.1	5.00
White ash	5,173	39	(N/A)	0.8	0.1	7.76
Austrian pine	10,784	81	(N/A)	0.8	0.2	16.18
Northern hackberry	8,352	63	(N/A)	0.8	0.2	12.53
Siberian elm	49,249	369	(N/A)	0.7	1.0	92.34
Eastern white pine	23,641	177	(N/A)	0.7	0.5	44.33
Kentucky coffeetree	64,016	480	(N/A)	0.7	1.3	120.03
American sycamore	106,918	802	(N/A)	0.7	2.2	200.47
Amur maple	2,171	16	(N/A)	0.7	0.0	4.07
Birch	14,936	112	(N/A)	0.7	0.3	28.00
Red maple	6,926	52	(N/A)	0.7	0.1	12.99
Mulberry	4,123	31	(N/A)	0.5	0.1	10.31
Honeylocust	18,319	137	(N/A)	0.5	0.4	45.80
Willow	28,560	214	(N/A)	0.3	0.6	107.10
American basswood	16,436	123	(N/A)	0.3	0.3	61.63
Oak	24,230	182	(N/A)	0.3	0.5	90.86
Broadleaf Deciduous	55,031	413	(N/A)	0.3	1.1	206.37
Scotch pine	257	2	(N/A)	0.2	0.0	1.93
Elm	12	0	(N/A)	0.2	0.0	0.09
Tulip tree	39,259	294	(N/A)	0.2	0.8	294.44
Broadleaf Deciduous	218	2	(N/A)	0.2	0.0	1.64
Sweetgum	1,035	8	(N/A)	0.2	0.0	7.76
Conifer Evergreen M	43	0	(N/A)	0.2	0.0	0.32
White oak	12	0	(N/A)	0.2	0.0	0.09
Ash	218	2	(N/A)	0.2	0.0	1.64
Mountain ash	908	7	(N/A)	0.2	0.0	6.81
Quaking aspen	3,672	28	(N/A)	0.2	0.1	27.54
Southern magnolia	3	0	(N/A)	0.2	0.0	0.02
Citywide total	4,905,816	36,794	(N/A)	100.0	100.0	61.84

Table 5: Annual Carbon Sequestered

Manilla

Annual CO Benefits of Public Trees

12/7/2015

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	117,729	883	-9,593	-505	-4	0	0	107,631	807 (N/A)	30.4	35.3	4.46
Silver maple	94,031	705	-5,739	-257	-2	0	0	88,035	660 (N/A)	12.4	28.9	8.92
Sugar maple	21,475	161	-1,785	-109	-1	0	0	19,581	147 (N/A)	7.1	6.4	3.50
Blue spruce	1,674	13	-83	-43	0	0	0	1,547	12 (N/A)	5.7	0.5	0.34
Norway maple	11,438	86	-1,030	-74	-1	0	0	10,334	78 (N/A)	5.5	3.4	2.35
Apple	2,925	22	-120	-29	0	0	0	2,776	21 (N/A)	5.0	0.9	0.69
Maple	3,763	28	-166	-26	0	0	0	3,571	27 (N/A)	4.5	1.2	0.99
Pin oak	32,124	241	-1,566	-80	-1	0	0	30,478	229 (N/A)	4.4	10.0	8.79
Northern red oak	2,907	22	-121	-22	0	0	0	2,764	21 (N/A)	2.9	0.9	1.22
Black walnut	9,359	70	-634	-39	0	0	0	8,685	65 (N/A)	2.5	2.9	4.34
Littleleaf linden	4,357	33	-180	-16	0	0	0	4,161	31 (N/A)	1.3	1.4	3.90
Spruce	299	2	-7	-7	0	0	0	286	2 (N/A)	1.2	0.1	0.31
Pear	732	5	-32	-7	0	0	0	693	5 (N/A)	1.0	0.2	0.87
Broadleaf Deciduous Smal	169	1	-4	-3	0	0	0	163	1 (N/A)	1.0	0.1	0.20
Norway spruce	981	7	-75	-15	0	0	0	890	7 (N/A)	1.0	0.3	1.11
Bur oak	733	6	-24	-4	0	0	0	706	5 (N/A)	0.8	0.2	1.06
Cherry plum	428	3	-52	-7	0	0	0	368	3 (N/A)	0.8	0.1	0.55
Swamp white oak	683	5	-16	-4	0	0	0	663	5 (N/A)	0.8	0.2	0.99
White ash	911	7	-25	-6	0	0	0	880	7 (N/A)	0.8	0.3	1.32
Austrian pine	560	4	-52	-11	0	0	0	497	4 (N/A)	0.8	0.2	0.75
Northern hackberry	910	7	-40	-9	0	0	0	861	6 (N/A)	0.8	0.3	1.29
Siberian elm	2,196	16	-236	-12	0	0	0	1,948	15 (N/A)	0.7	0.6	3.65
Eastern white pine	628	5	-113	-13	0	0	0	501	4 (N/A)	0.7	0.2	0.94
Kentucky coffeetree	3,024	23	-307	-13	0	0	0	2,704	20 (N/A)	0.7	0.9	5.07
American sycamore	3,688	28	-513	-17	0	0	0	3,158	24 (N/A)	0.7	1.0	5.92
Amur maple	304	2	-10	-4	0	0	0	290	2 (N/A)	0.7	0.1	0.54
Birch	657	5	-74	-5	0	0	0	578	4 (N/A)	0.7	0.2	1.08
Red maple	979	7	-33	-5	0	0	0	940	7 (N/A)	0.7	0.3	1.76
Mulberry	419	3	-20	-4	0	0	0	396	3 (N/A)	0.5	0.1	0.99
Honeylocust	2,434	18	-88	-7	0	0	0	2,340	18 (N/A)	0.5	0.8	5.85
Willow	740	6	-137	-7	0	0	0	596	4 (N/A)	0.3	0.2	2.23
American basswood	1,194	9	-79	-5	0	0	0	1,110	8 (N/A)	0.3	0.4	4.16
Oak	1,517	11	-116	-6	0	0	0	1,394	10 (N/A)	0.3	0.5	5.23
Broadleaf Deciduous Larg	1,769	13	-264	-9	0	0	0	1,496	11 (N/A)	0.3	0.5	5.61
Scotch pine	53	0	-1	-1	0	0	0	50	0 (N/A)	0.2	0.0	0.38
Elm	3	0	0	0	0	0	0	2	0 (N/A)	0.2	0.0	0.02
Tulip tree	912	7	-188	-5	0	0	0	719	5 (N/A)	0.2	0.2	5.39
Broadleaf Deciduous Medi	96	1	-2	-1	0	0	0	93	1 (N/A)	0.2	0.0	0.70
Sweetgum	209	2	-5	-1	0	0	0	203	2 (N/A)	0.2	0.1	1.52
Conifer Evergreen Mediun	12	0	0	-1	0	0	0	11	0 (N/A)	0.2	0.0	0.08
White oak	3	0	0	0	0	0	0	2	0 (N/A)	0.2	0.0	0.02
Ash	96	1	-2	-1	0	0	0	93	1 (N/A)	0.2	0.0	0.70
Mountain ash	114	1	-4	-1	0	0	0	108	1 (N/A)	0.2	0.0	0.81
Quaking aspen	445	3	-18	-2	0	0	0	426	3 (N/A)	0.2	0.1	3.19
Southern magnolia	1	0	0	0	0	0	0	1	0 (N/A)	0.2	0.0	0.01
Citywide total	329,681	2,473	-23,555	-1,397	-10	0	0	304,729	2,285 (N/A)	100.0	100.0	3.84

Table 6: Annual Social and Aesthetic Benefits

Manilla

Annual Aesthetic/Other Benefits of Public Trees

12/7/2015

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	9,864	(N/A)	30.4	33.2	54.50
Silver maple	7,508	(N/A)	12.4	25.3	101.46
Sugar maple	2,321	(N/A)	7.1	7.8	55.25
Blue spruce	683	(N/A)	5.7	2.3	20.09
Norway maple	1,105	(N/A)	5.5	3.7	33.50
Apple	163	(N/A)	5.0	0.6	5.45
Maple	591	(N/A)	4.5	2.0	21.90
Pin oak	2,592	(N/A)	4.4	8.7	99.70
Northern red oak	300	(N/A)	2.9	1.0	17.63
Black walnut	817	(N/A)	2.5	2.8	54.44
Littleleaf linden	472	(N/A)	1.3	1.6	59.01
Spruce	91	(N/A)	1.2	0.3	12.97
Pear	41	(N/A)	1.0	0.1	6.85
Broadleaf Deciduous Small	8	(N/A)	1.0	0.0	1.38
Norway spruce	253	(N/A)	1.0	0.9	42.16
Bur oak	100	(N/A)	0.8	0.3	19.93
Cherry plum	24	(N/A)	0.8	0.1	4.80
Swamp white oak	84	(N/A)	0.8	0.3	16.83
White ash	167	(N/A)	0.8	0.6	33.42
Austrian pine	95	(N/A)	0.8	0.3	18.98
Northern hackberry	180	(N/A)	0.8	0.6	35.98
Siberian elm	162	(N/A)	0.7	0.5	40.38
Eastern white pine	85	(N/A)	0.7	0.3	21.21
Kentucky coffeetree	237	(N/A)	0.7	0.8	59.19
American sycamore	257	(N/A)	0.7	0.9	64.28
Amur maple	17	(N/A)	0.7	0.1	4.23
Birch	70	(N/A)	0.7	0.2	17.53
Red maple	155	(N/A)	0.7	0.5	38.85
Mulberry	24	(N/A)	0.5	0.1	7.98
Honeylocust	594	(N/A)	0.5	2.0	198.10
Willow	63	(N/A)	0.3	0.2	31.46
American basswood	95	(N/A)	0.3	0.3	47.53
Oak	123	(N/A)	0.3	0.4	61.64
Broadleaf Deciduous Large	124	(N/A)	0.3	0.4	61.96
Scotch pine	15	(N/A)	0.2	0.1	15.42
Elm	5	(N/A)	0.2	0.0	5.26
Tulip tree	58	(N/A)	0.2	0.2	58.34
Broadleaf Deciduous Medium	13	(N/A)	0.2	0.0	12.89
Sweetgum	29	(N/A)	0.2	0.1	28.56
Conifer Evergreen Medium	12	(N/A)	0.2	0.0	12.31
White oak	5	(N/A)	0.2	0.0	5.26
Ash	13	(N/A)	0.2	0.0	12.89
Mountain ash	6	(N/A)	0.2	0.0	6.40
Quaking aspen	46	(N/A)	0.2	0.2	45.86
Southern magnolia	0	(N/A)	0.2	0.0	0.01
Citywide total	29,669	(N/A)	100.0	100.0	49.86

Table 7: Summary of Benefits in Dollars

Manilla

Annual Benefits of Public Trees by Species ($/tree)

12/7/2015

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard E
Green ash	56.57	4.46	9.80	78.08	54.50	203.41	(N/A)
Silver maple	66.53	8.92	12.20	121.02	101.46	310.13	(N/A)
Sugar maple	52.01	3.50	8.28	67.03	55.25	186.07	(N/A)
Blue spruce	15.90	0.34	1.73	24.23	20.09	62.30	(N/A)
Norway maple	48.01	2.35	8.42	53.56	33.50	145.83	(N/A)
Apple	14.89	0.69	2.19	6.09	5.45	29.32	(N/A)
Maple	20.07	0.99	3.28	16.24	21.90	62.48	(N/A)
Pin oak	62.60	8.79	8.06	82.18	99.70	261.33	(N/A)
Northern red oak	24.04	1.22	3.40	17.51	17.63	63.80	(N/A)
Black walnut	55.04	4.34	9.32	68.68	54.44	191.82	(N/A)
Littleleaf linden	37.95	3.90	6.13	39.97	59.01	146.97	(N/A)
Spruce	11.30	0.31	1.21	13.18	12.97	38.96	(N/A)
Pear	18.63	0.87	2.81	7.82	6.85	36.98	(N/A)
Broadleaf Deciduous S	3.89	0.20	0.51	1.31	1.38	7.29	(N/A)
Norway spruce	28.36	1.11	1.90	67.54	42.16	141.08	(N/A)
Bur oak	14.40	1.06	2.29	12.36	19.93	50.04	(N/A)
Cherry plum	21.75	0.55	3.65	11.82	4.80	42.57	(N/A)
Swamp white oak	15.12	0.99	2.14	9.66	16.83	44.74	(N/A)
White ash	20.10	1.32	2.91	16.63	33.42	74.38	(N/A)
Austrian pine	24.87	0.75	2.68	49.11	18.98	96.39	(N/A)
Northern hackberry	45.72	1.29	7.17	35.33	35.98	125.50	(N/A)
Siberian elm	60.00	3.65	11.20	82.47	40.38	197.70	(N/A)
Eastern white pine	34.66	0.94	-0.48	104.01	21.21	160.35	(N/A)
Kentucky coffeetree	66.40	5.07	12.05	101.88	59.19	244.58	(N/A)
American sycamore	81.49	5.92	15.73	150.15	64.28	317.58	(N/A)
Amur maple	11.80	0.54	1.63	4.51	4.23	22.71	(N/A)
Birch	24.45	1.08	4.30	28.81	17.53	76.18	(N/A)
Red maple	30.67	1.76	4.92	23.58	38.85	99.78	(N/A)
Mulberry	20.58	0.99	3.27	9.03	7.98	41.85	(N/A)
Honeylocust	60.61	5.85	10.23	70.45	198.10	345.23	(N/A)
Willow	70.84	2.23	13.58	102.01	31.46	220.13	(N/A)
American basswood	53.99	4.16	7.78	57.80	47.53	171.26	(N/A)
Oak	64.12	5.23	10.91	88.53	61.64	230.42	(N/A)
Broadleaf Deciduous I	80.97	5.61	15.76	151.51	61.96	315.81	(N/A)
Scotch pine	13.58	0.38	1.48	16.14	15.42	46.99	(N/A)
Elm	0.66	0.02	0.08	0.48	5.26	6.50	(N/A)
Tulip tree	91.02	5.39	19.04	196.17	58.34	369.96	(N/A)
Broadleaf Deciduous M	8.99	0.70	1.21	4.41	12.89	28.19	(N/A)
Sweetgum	20.64	1.52	2.99	16.47	28.56	70.18	(N/A)
Conifer Evergreen Me	6.94	0.08	0.75	6.95	12.31	27.05	(N/A)
White oak	0.66	0.02	0.08	0.48	5.26	6.50	(N/A)
Ash	8.99	0.70	1.21	4.41	12.89	28.19	(N/A)
Mountain ash	18.19	0.81	2.55	7.17	6.40	35.12	(N/A)
Quaking aspen	44.23	3.19	7.42	39.72	45.86	140.41	(N/A)
Southern magnolia	3.94	0.01	0.47	1.53	0.01	5.96	(N/A)
Citywide Total	45.31	3.84	7.54	62.92	49.86	169.48	(N/A)

Table 8: Recommended Maintenance by Diameter Class

Manilla, IA

Recommended Maintenance for Public Trees (None)

12/7/2015

DBH Class (in)

Zone	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
1	0	0	0	0	0	0	0	0	0	0
Citywide total	0	0	0	0	0	0	0	0	0	0

DBH Class (in)

Maintenance Type	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	% of Total Population
None	0	0	0	0	0	0	0	0	0	0	0.00
Young tree (routine)	27	31	28	0	0	0	0	0	0	86	14.45
Young tree (immediate)	0	0	0	0	0	0	0	0	0	0	0.00
Mature tree (routine)	0	2	112	104	80	117	49	10	2	476	80.00
Mature tree (immediate)	0	0	2	5	5	14	3	3	0	32	5.38
Critical concern (public safety)	0	0	0	0	0	1	0	0	0	1	0.17
Citywide total	27	33	142	109	85	132	52	13	2	595	100.00

Table 9: Priority Maintenance Task by Diameter Class

Manilla, IA

Priority Task Summary for Public Trees (None)

12/7/2015

DBH Class (in)

Zone	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
1	27	33	138	97	65	88	38	10	2	498
Citywide total	27	33	138	97	65	88	38	10	2	498

DBH Class (in)

Maintenance Type	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	% of Total Population
None	27	33	138	97	65	88	38	10	2	498	83.70
Stake/Train	0	0	0	0	0	0	0	0	0	0	0.00
Clean	0	0	1	8	15	30	11	1	0	66	11.09
Raise	0	0	0	0	0	0	1	0	0	1	0.17
Reduce	0	0	0	0	0	0	0	0	0	0	0.00
Remove	0	0	2	4	4	14	2	2	0	28	4.71
Treat pest/disease	0	0	1	0	1	0	0	0	0	2	0.34
Citywide total	27	33	142	109	85	132	52	13	2	595	100.00

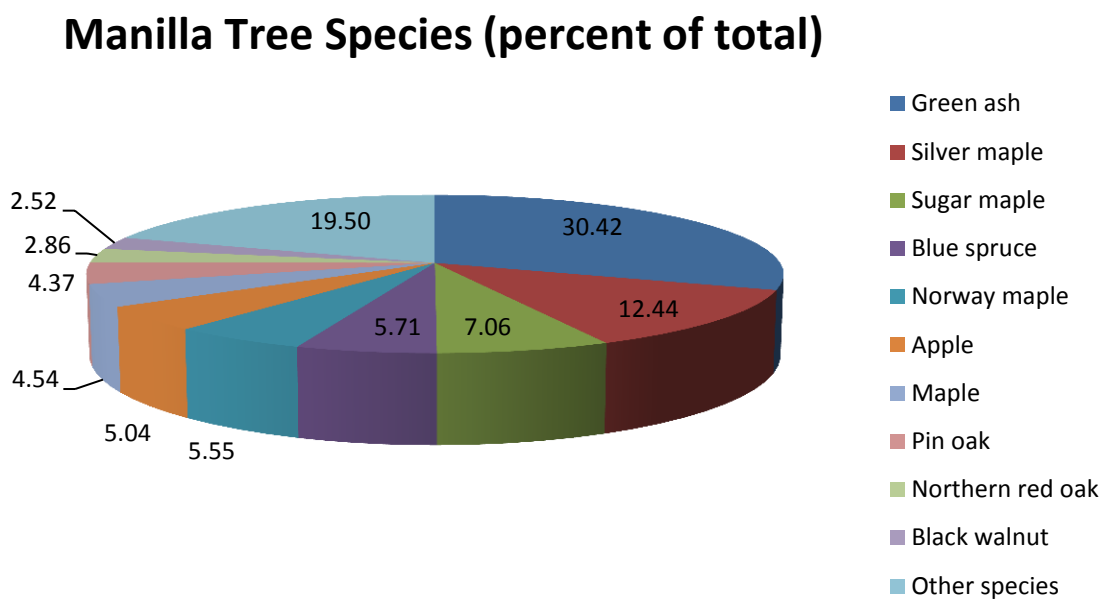


Figure 1: Species Distribution

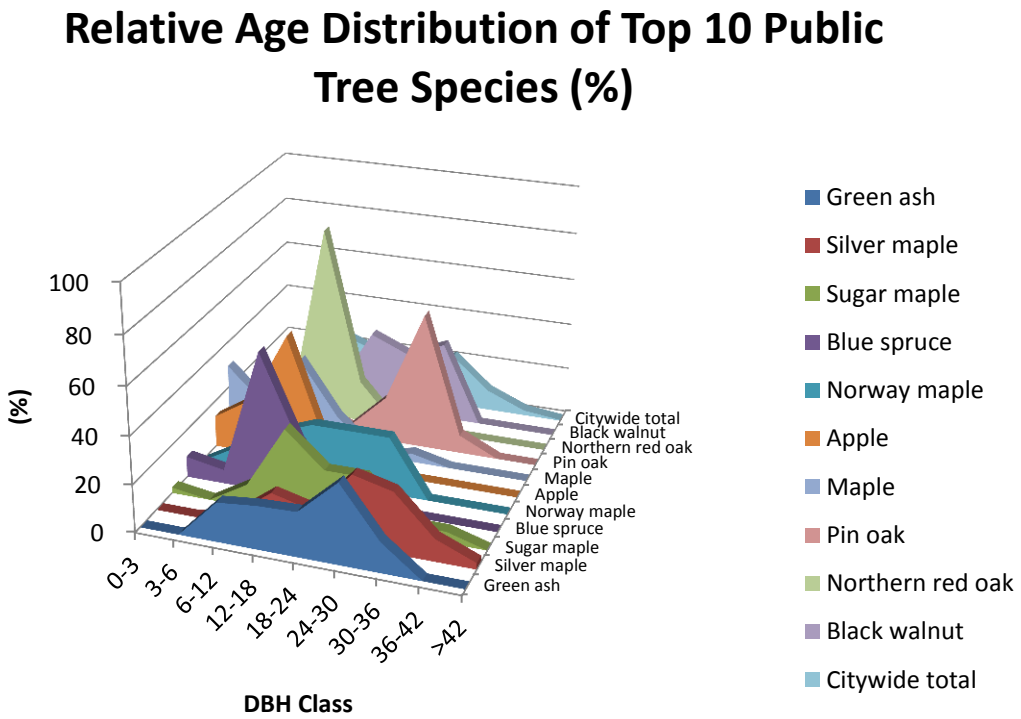


Figure 2: Relative Age Class

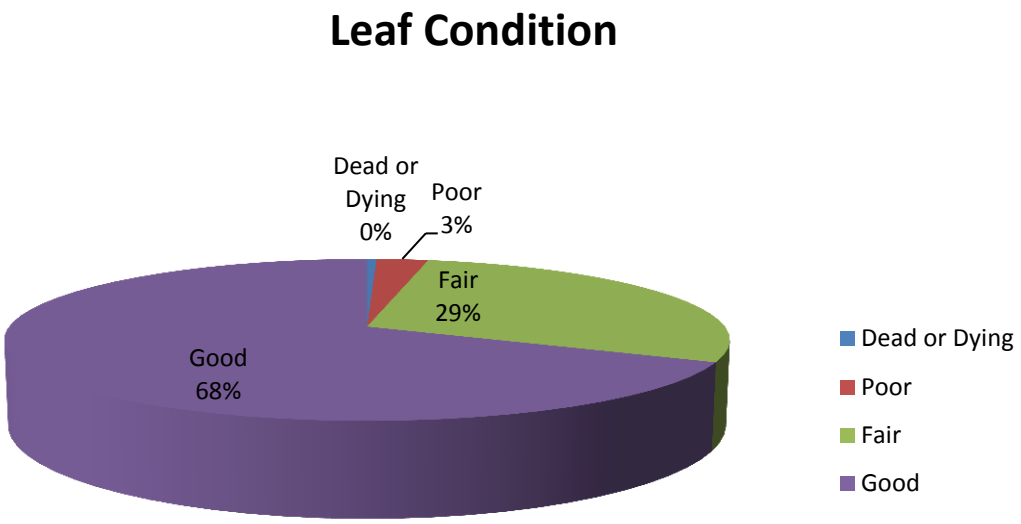


Figure 3: Foliage Condition

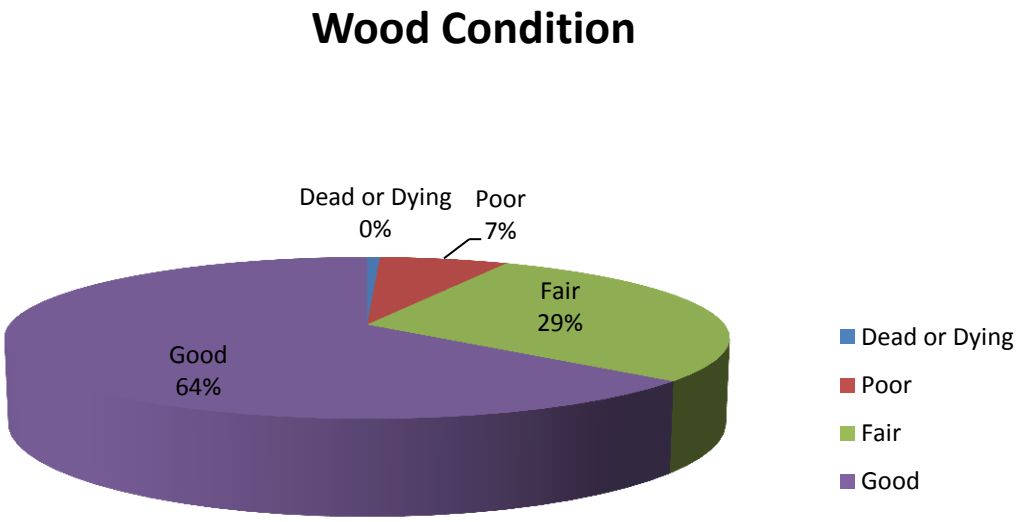


Figure 4: Wood Condition

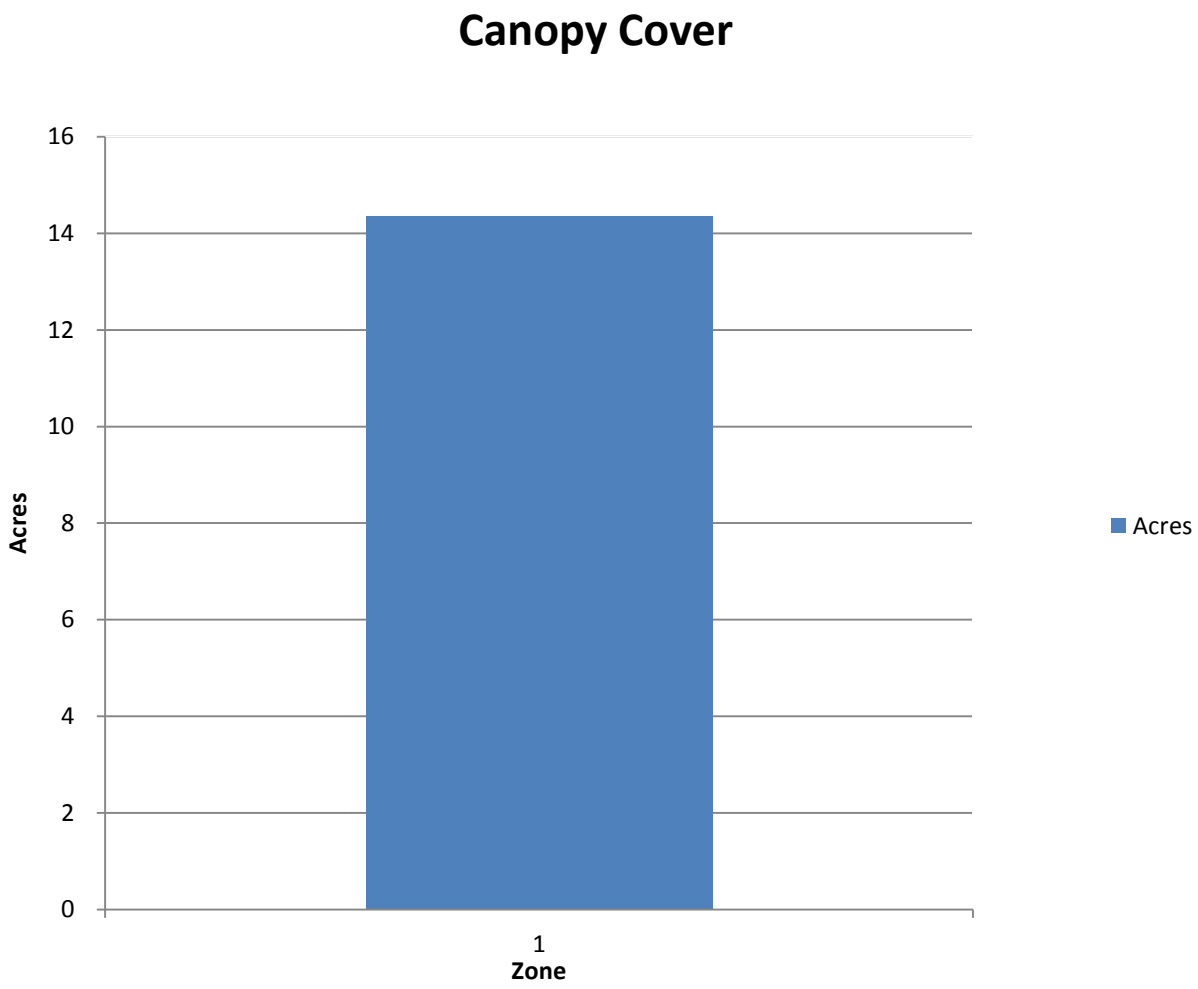


Figure 5: Canopy Cover in Acres

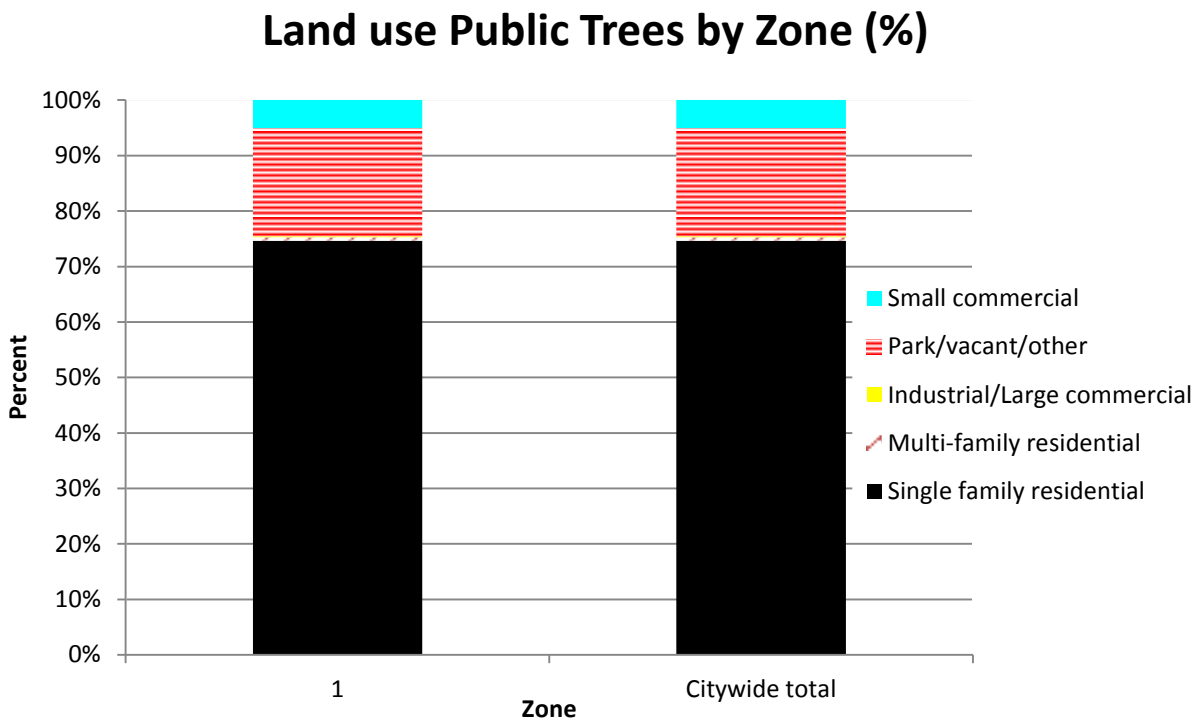


Figure 6: Land Use of city/park trees

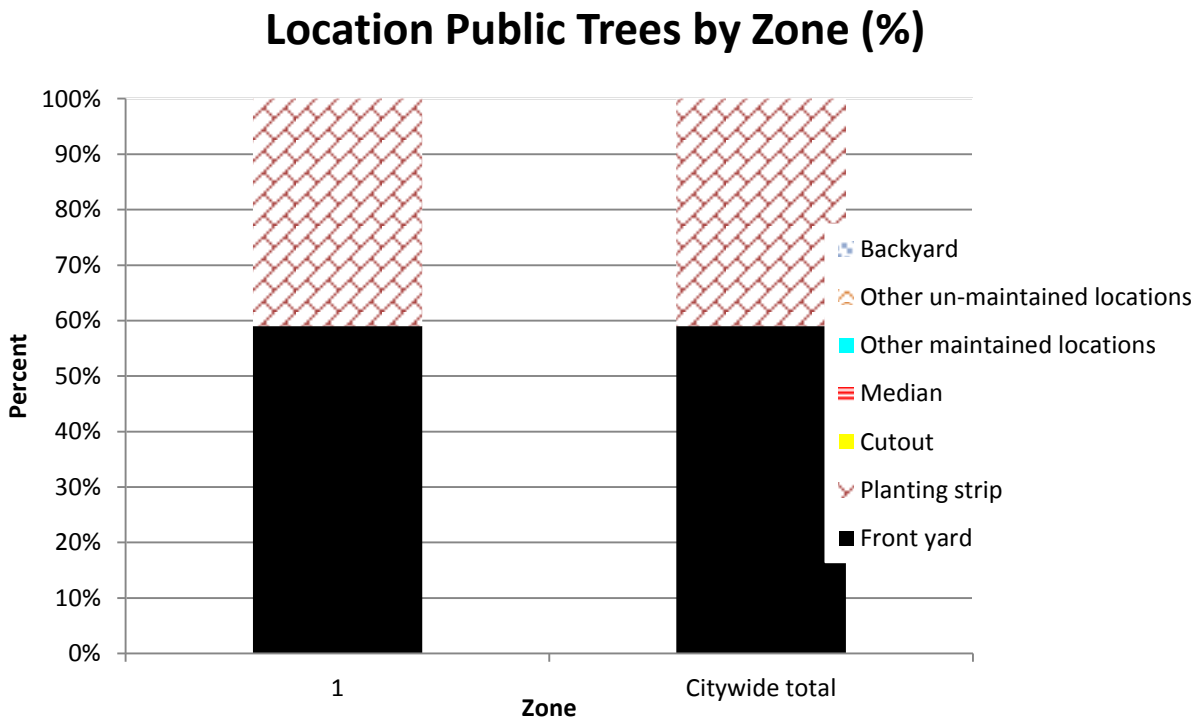


Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

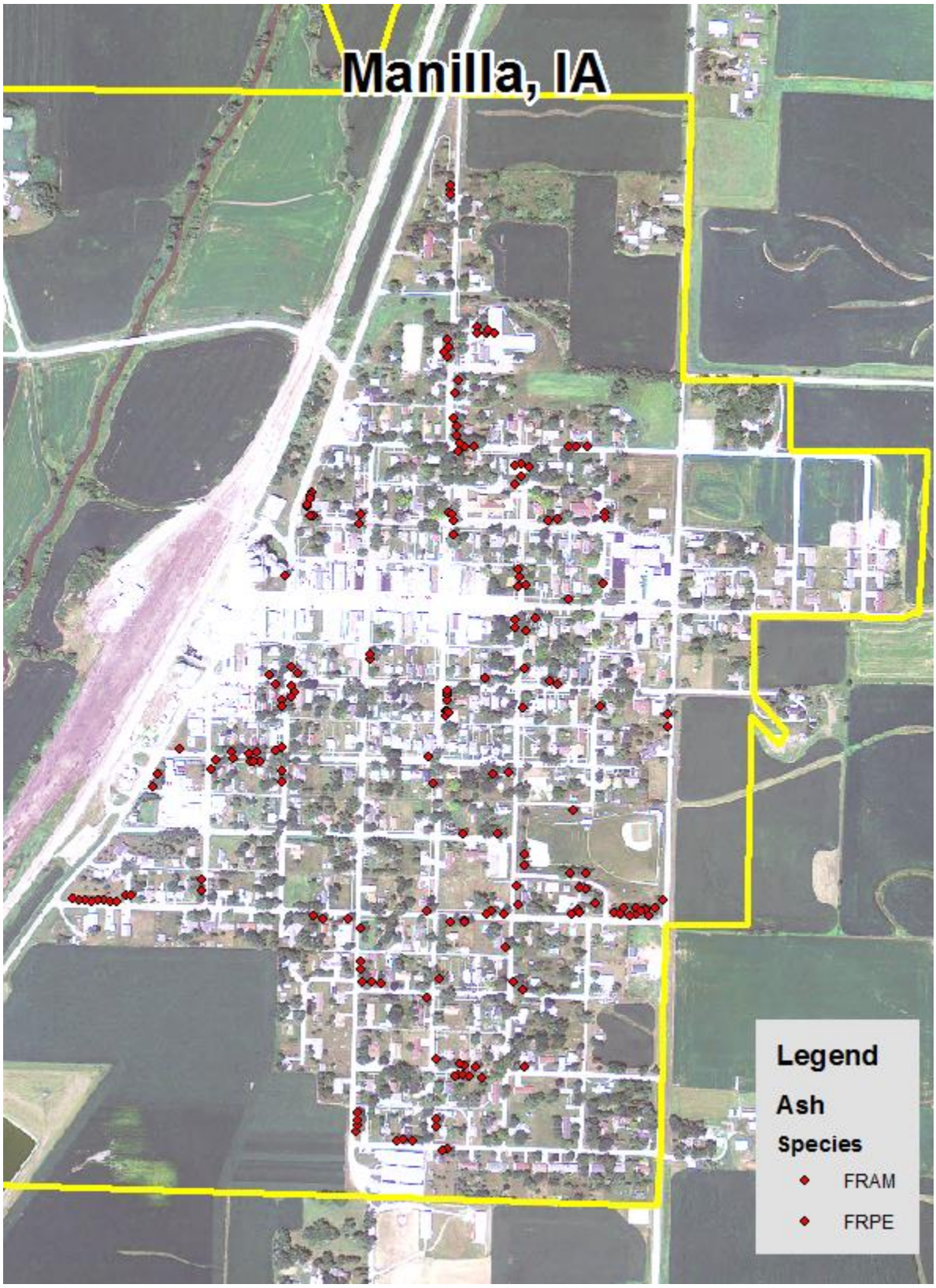


Figure 1: Location of Ash Trees

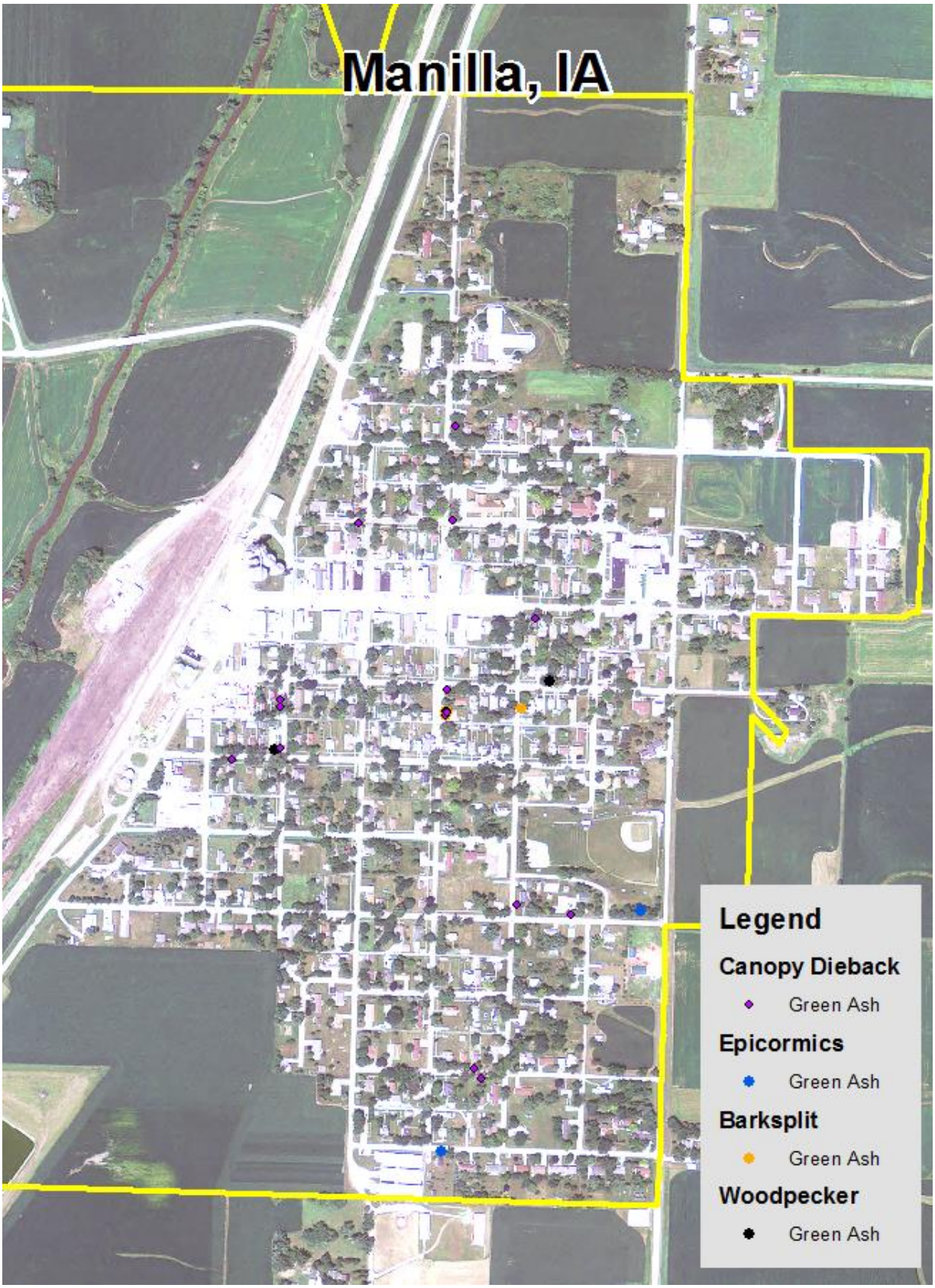


Figure 2: Location of EAB symptoms

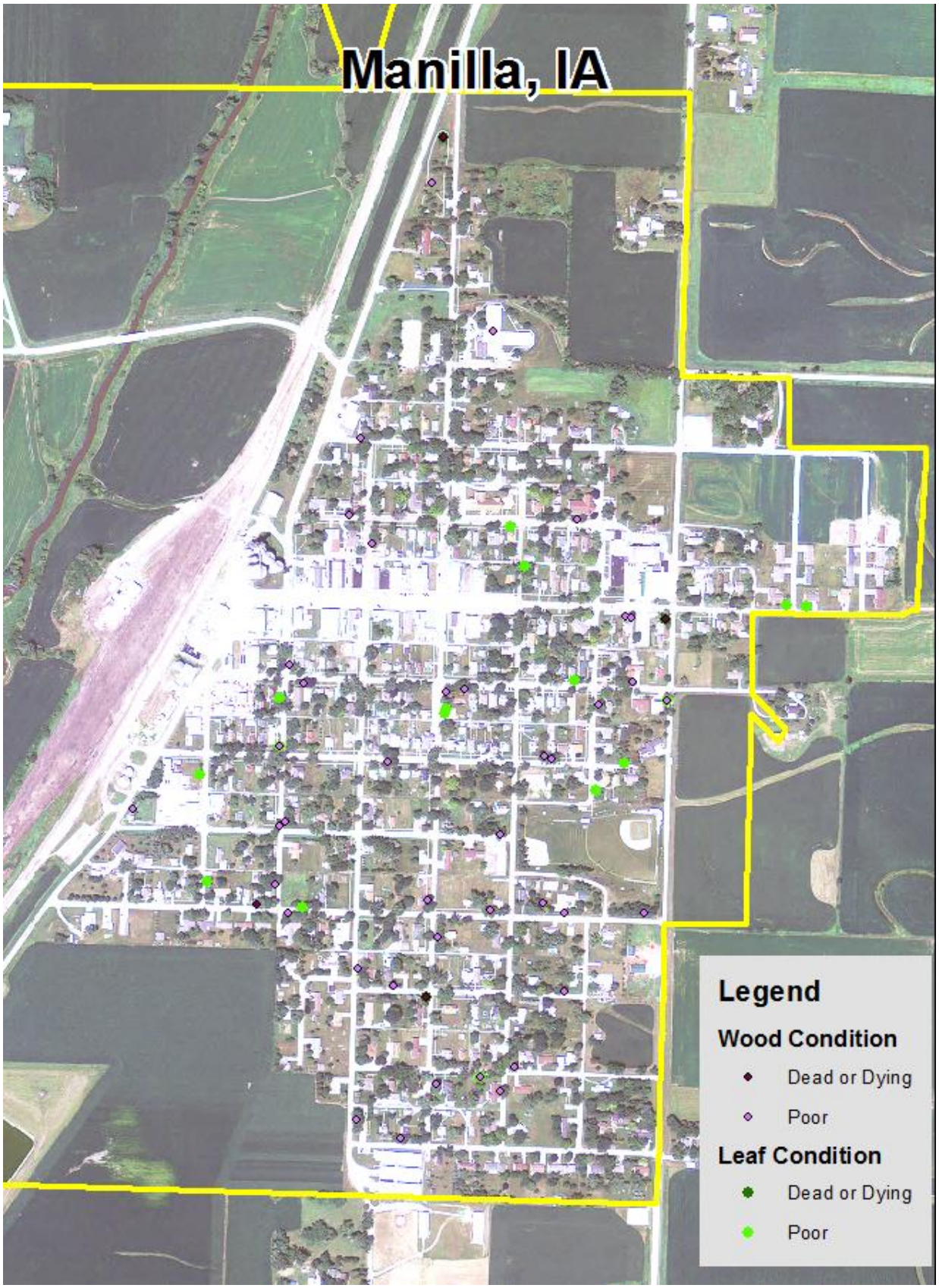


Figure 3: Location of Poor Condition Trees

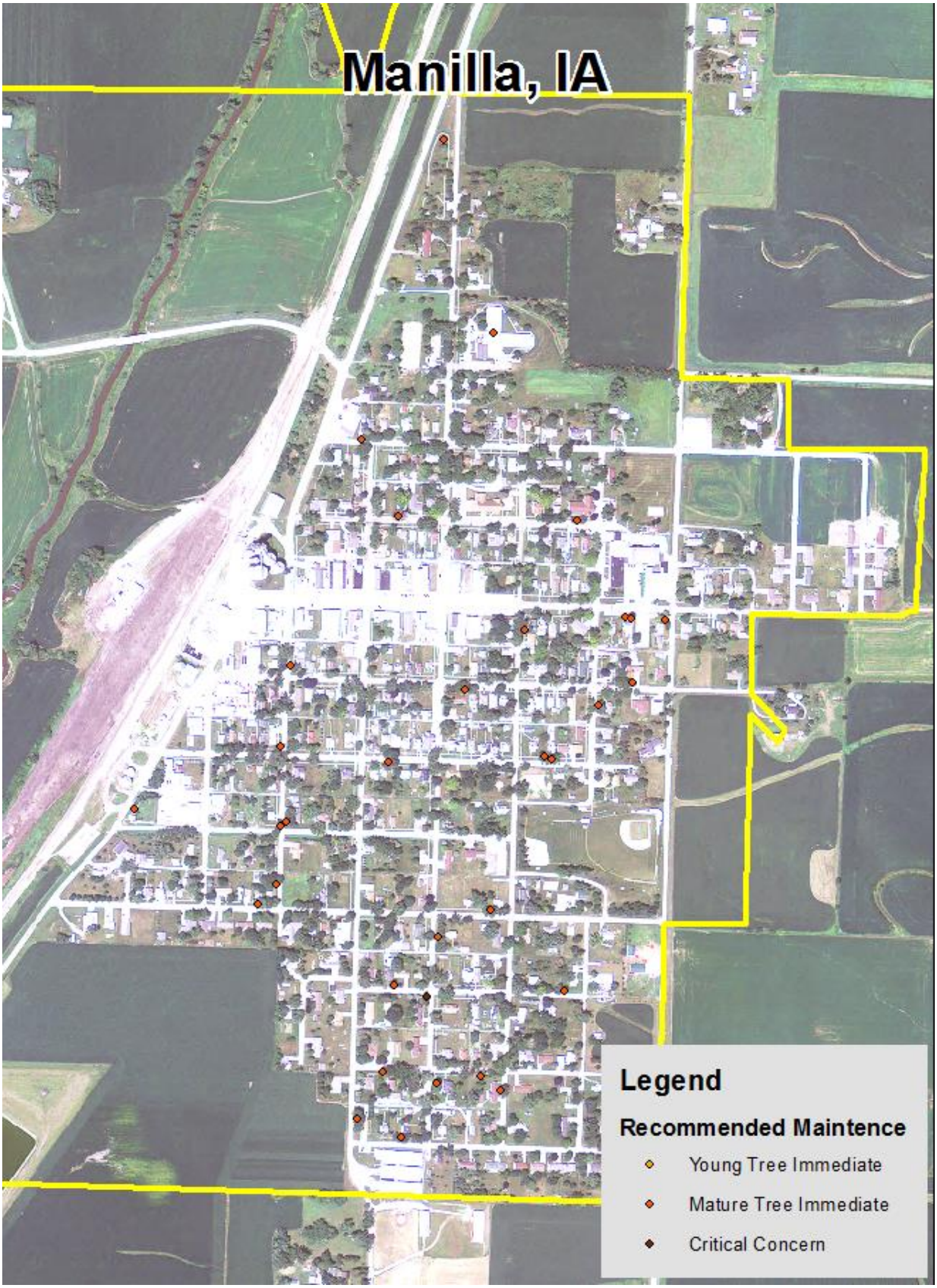


Figure 4: Location of Trees with Recommended Maintenance

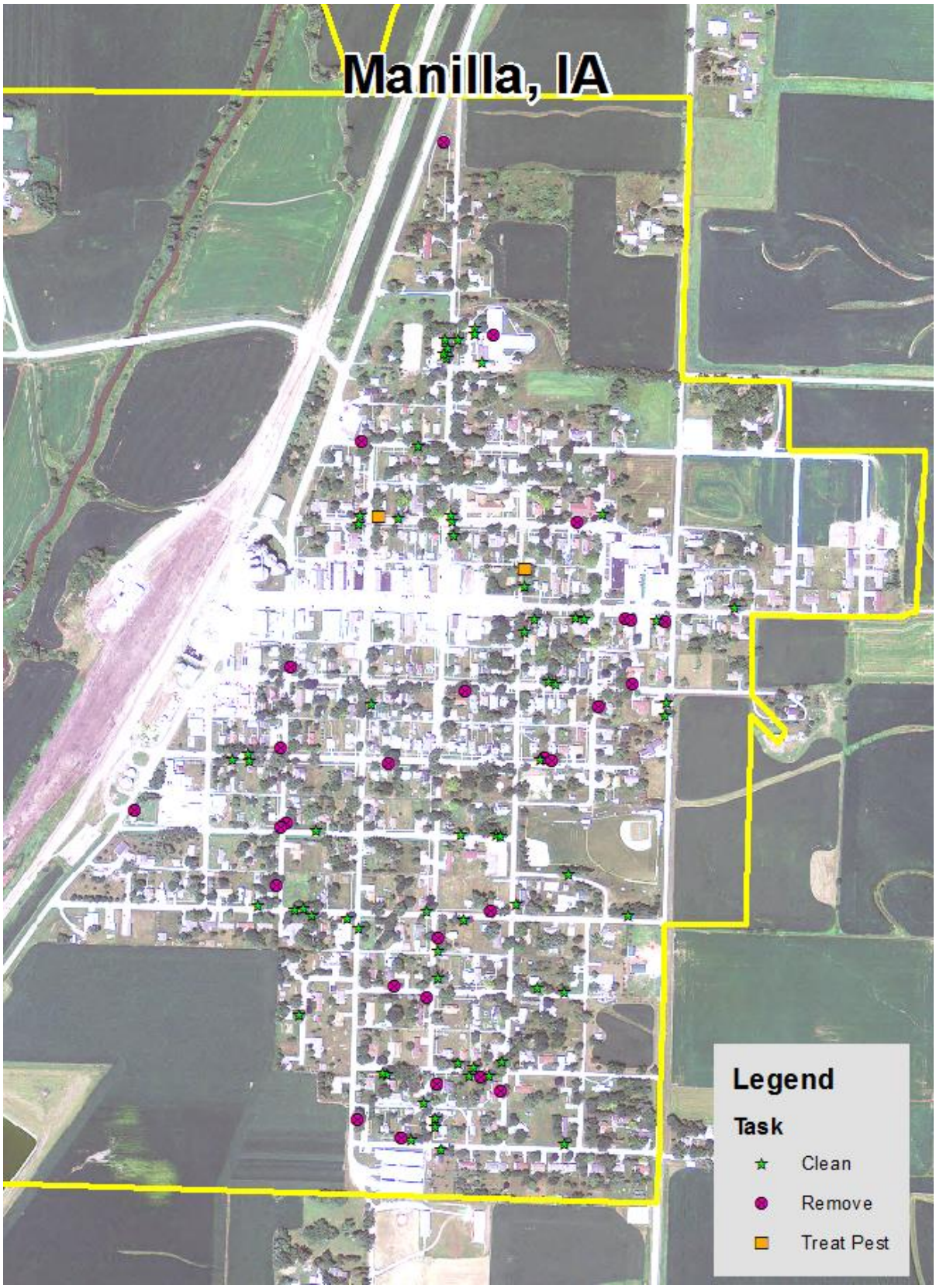


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

Appendix C: Example Tree Ordinance

CHAPTER 151
TREES AND GRASS

151.01 DEFINITION. For use in this chapter, "boulevard" means that part of the street, avenue or highway in the City not covered by sidewalk and lying between the lot line and the curb line; or, on unpaved streets, that part of the street, avenue or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

151.02 PLANTING RESTRICTIONS. No tree shall be planted in any boulevard or street except in accordance with the following:
1. Alignment. All tress planted in any street shall be planted in the boulevard midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.
2. Spacing. Trees shall not be planted on any boulevard which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.
3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

151.03 DUTY TO TRIM TREES. The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least eighteen (18) feet above the surface of a street, twenty (20) feet above the surface of a primary highway, and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the
City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax.
(Code of Iowa, Sec. 364.12[2c, d, & e])

151.04 TRIMMING TREES TO BE SUPERVISED. Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

151.05 DISEASE CONTROL. Any dead, diseased or damaged tree or shrub which may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

151.06 INSPECTION AND REMOVAL. The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests, and such trees and shrubs shall be subject to removal as follows:
1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.
2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.
(Code of Iowa, Sec. 364.12[3b & h])

151.07 CUTTING OR MOWING OF GRASS.
1. Duty to Cut and Mow Lawns and Lots. The owner of any property shall cut and mow all lawns and lots so that such growth shall be less than four (4) inches at all times.
2. Cutting and Mowing by City. If a property owner refuses or fails to cut and mow lawns and lots within forty-eight (48) hours after being delivered a notice from the City to perform such action, the Council may require said work to be done and the cost and expenses thereof shall be assessed to the property owner after due notice is given. The amount of such assessment shall be certified to the County Auditor as provided by law and the same shall be collected with and in the same manner as general property taxes.

The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

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

If you need accommodations because of disability to access the services of this Agency, please contact Director Chuck Gipp at 515-281-5918.