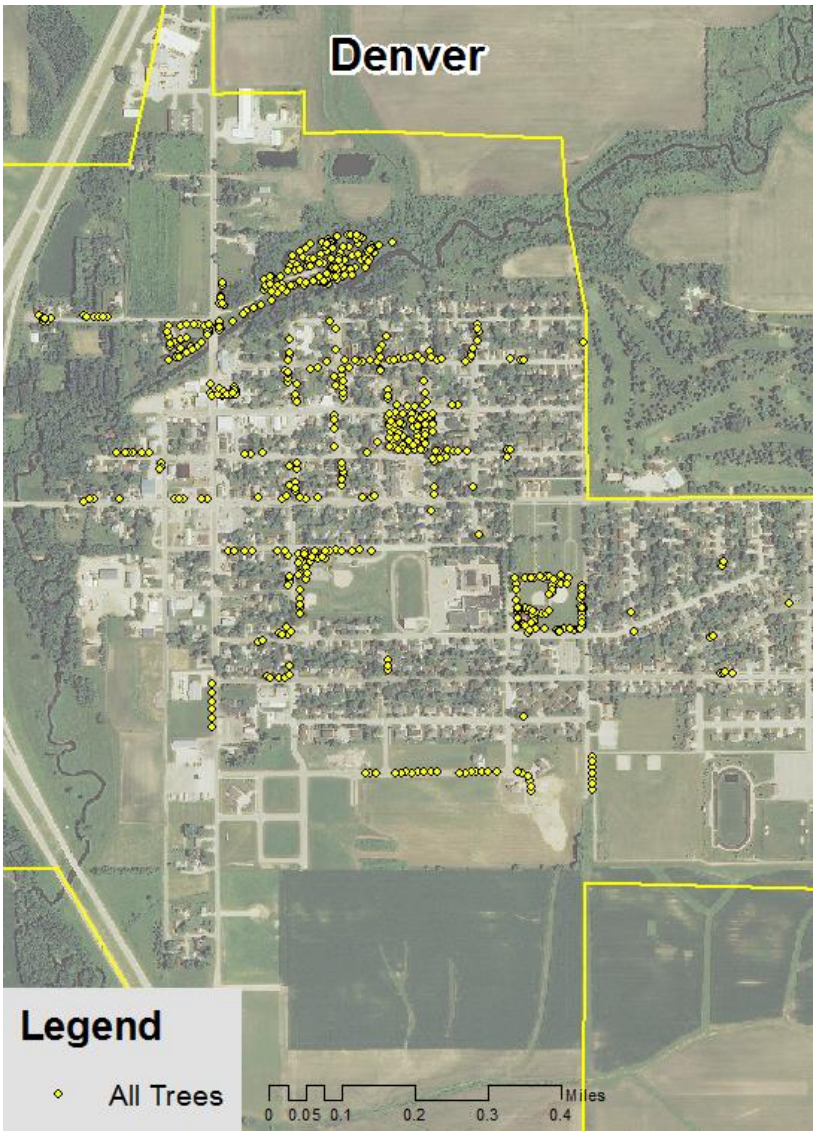
Denver, IA



2015 Urban Forest Management Plan
Prepared by Matt Brewer
Bureau of Forestry, Iowa DNR

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Executive Summary

Overview

This plan was developed to assist the City of Denver with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 13% of Denver's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. 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 2014, a tree inventory was conducted by Emma Hanigan, Iowa DNR, using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 629 trees inventoried.

- Denver's trees provide $88,383 of benefits annually, an average of $140 a tree
- There are over 39 species of trees
- The top three genera are: Maple 30%, Ash 13%, and Pine 9%
- 4% of trees are in need of some type of management
- 15 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 15 trees needing removal, 7 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 61 of the 80 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation
- All trees should be pruned on a routine schedule- one third of the city every other year
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly
- Budget impacts from ash removal – Suggestion: request a budget increase to at least $12,000 annually and apply for grants to plant replacement trees

Introduction

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

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

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

Inventory

In 2014, a tree inventory was conducted by Emma Hanigan, Iowa DNR, that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

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

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms associated with 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 629 city trees was entered into the USDA Forest Service program i-Tree Streets, part of the i-Tree suite. The following are results from the i-Tree Streets analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Denver's trees reduce energy related costs by approximately $23,050 annually (Appendix A, Table 1). These savings are both in Electricity (110.5 MWh) and in Natural Gas (14,964.8 Therms).

Annual Stormwater Benefits

Denver's trees intercept about 1,173,924 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $31,813 of benefits to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Denver, it is estimated that trees remove 1,310.3 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 $3,603 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Denver, trees sequester about 256,820 lbs of carbon a year with an associated value of $1,926 (Appendix A, Table 4). In addition, the trees store 3,987,758 lbs of carbon, with a yearly benefit of $29,908 (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. Denver receives $26,755 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree Streets analysis, Denver's trees provide $88,383 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 629 trees in Denver provide approximately $140 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Denver has over 39 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	186	30%
Ash	80	13%
Pine	58	9%
Oak	57	9%
Apple/Crabapple	45	7%
Northern White Cedar	39	6%
Spruce	23	4%
Hackberry	22	3%
Linden/Basswood	22	3%
Honeylocust	18	3%
Lilac	17	3%
Birch	11	2%
Elm	11	2%
Ginkgo	10	2%
Black Walnut	10	2%
Pear	9	1%
Aspen/Cottonwood	4	1%
Dogwood	2	<1%
Catalpa	1	<1%
Cherry/Plum	1	<1%
Sumac	1	<1%
Other Medium Deciduous	1	<1%
Other Large Evergreen	1	<1%

Age Class

Most of Denver's trees (64%) are between 0 and 18 inches in diameter at 4.5 ft (Appendix A, Figure 2), with another 24% between 24 and 36 inches in diameter. For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Denver's size curve includes a significant amount of trees that are on the smaller side, and also a good number of trees that are fairly large.

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 Denver indicate that 88% of the trees are in good health, with <1% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix

B, Figure 3). Additionally, 53% of Denver's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 5% of the population. This 5% is an estimate of trees that need management follow up.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3).

Tree Removal	15	2%
Crown Cleaning	12	2%
Crown Reduction	1	<1%

Canopy Cover

The total canopy with both private and public trees is 14%, 152 acres. The canopy cover included in the Denver inventory includes approximately 12 acres (Appendix A, Figure 4).

Land Use and Location

The majority of Denver's city and park trees are in front yards (no sidewalk) in Park/vacant/other settings (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use	
Park/vacant/other	61%
Single family residential	38%
Small commercial	<1%

Location	
Front yard	69%
Planting strip	26%
Median	4%
Cutout (surrounded by pavement)	<1%

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

Denver has 1 critical concern tree that needs immediate removal, and 1 critical concern tree that needs cleaning. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There is 1 tree over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the six year maintenance plan at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 28 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 15 removals, 12 are ash trees. There are a total of 80 ash trees, and 61 of those have signs and symptoms that have been associated with EAB. In addition, there are 13 trees that are in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six year maintenance plan for further information.

Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant at least 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same or greater number of trees helps ensure continuation of the benefits of the existing forest in Denver.

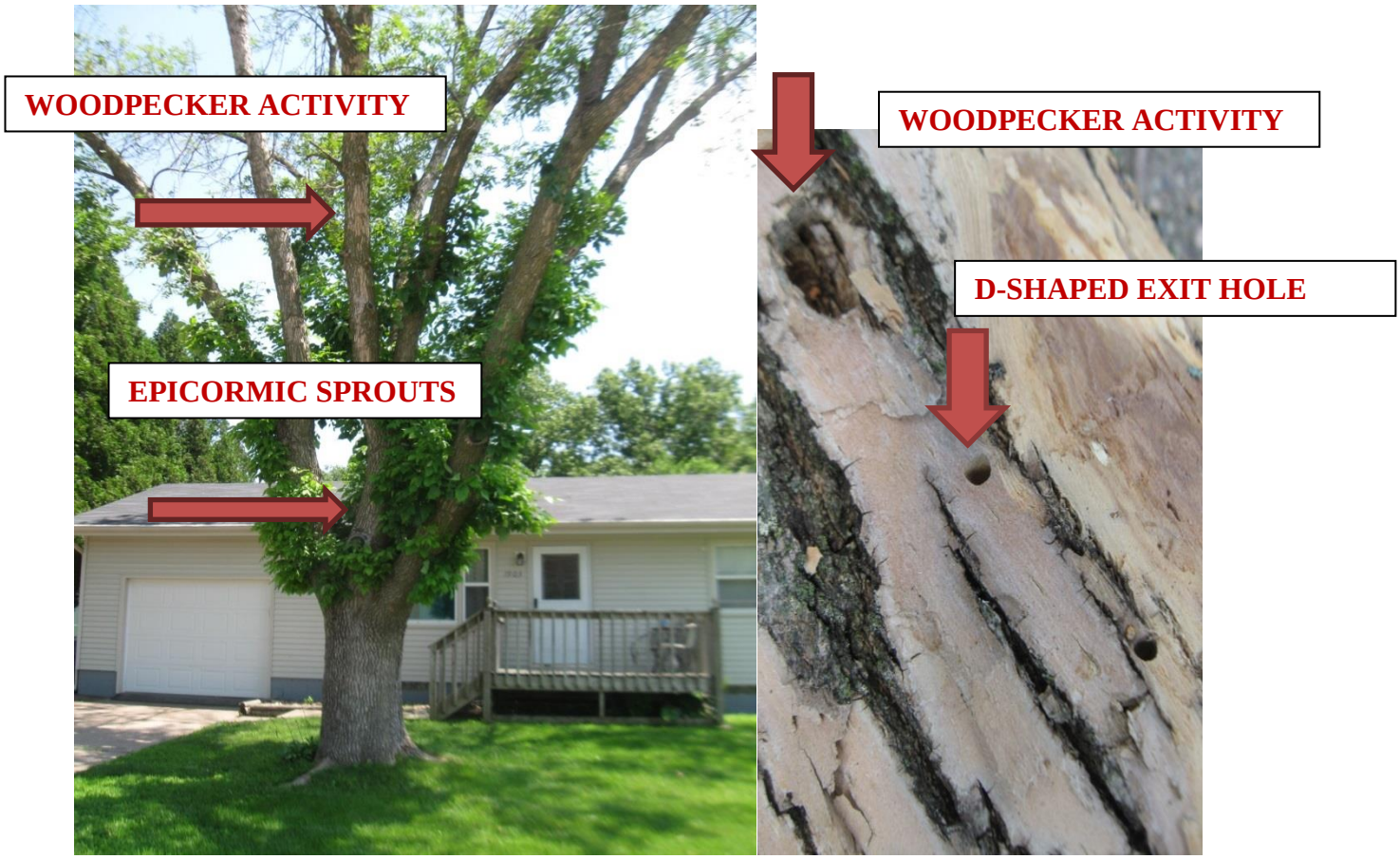
It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with maple (30%) (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. Preferred species are listed in section 12.24.025 of the city ordinance (Appendix C). Species to

avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut. All trees planted must meet the restrictions in city ordinance 12.24.025 (Appendix C).

Continual Monitoring For EAB

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 decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage (See examples below). Once EAB arrives in Denver, it could potentially kill all ash within 4 to 10 years of its arrival.

EAB infested tree in Muscatine with top thinning and many new green epicormic sprouts



EAB infested tree in Muscatine with sprouting, wood pecker activity, and D-shaped exit holes

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). *City ownership of the tree recommended for removal should be verified prior to any removal*

Treatment of Ash Trees

Chemical treatment can be an effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/

EAB Quarantines

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

A regulated article under the USDA's quarantine includes any of the following items:

- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

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

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? The entire state of Iowa is under quarantine, so regulated articles may not be moved into non-quarantined states. For more information, please visit http://www.emeraldashborer.info/.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance 12.24.025 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

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

Monitoring

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

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB. City Code 12.24.150 states "Upon receipt of a complaint, the City Council shall cause a notice to be issued to the owner of the property describing the property and the nuisance, which shall request the abatement of the nuisance within fourteen days of the receipt of the notice. The owner shall receive a signed copy of the complaint form.
(d) In the event the owner of the property refuses to abate the nuisance within fourteen days of the receipt of the notice, the complainant may charge the property owner with a violation of this section by signing the appropriate citation.".

Six Year Maintenance Plan and Cost Estimates

Year 1 (FY 2016)

Remove 1 critical concern tree that needs immediate attention	$900
Maintain 1 critical concern tree that needs immediate attention (cleaning)	$900
Remove 7 trees (marked for removal)	$6,300
Plant and Maintain 10 trees in open locations (pursue grants)	$1,000
Ash tree treatment (if elected), 13 trees in good condition, average 6–12"	avg. $135/tree
-$15 per inch, treated every two years, see note	
Visual Survey for signs and symptoms of EAB	

Year 2 (FY 2017)

Remove 7 trees (marked for removal)	$6,300
Plant and Maintain 9 trees in open locations (pursue grants)	$900
Ash tree treatment (if elected)	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

Year 3 (FY 2018)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected)	
Visual Survey for signs and symptoms of EAB	

Year 4 (FY 2019)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected)	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

Year 5 (FY 2020)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected)	
Visual Survey for signs and symptoms of EAB	

Year 6 (FY 2021)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected)	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

*****Reduction of ash in poor health will reduce exposure to Emerald Ash Borer over time. EAB could potentially kill all ash within 4 years of its arrival.
******Assuming a cost of $900 per tree for removal, the budget would need to be increased to $12,000 a year to remove all ash trees within 6 years.
*******Suggest a future (post ash removal and replacement) budget of at least $2 per capita (population 1,780). Currently, this amount would cover about 30% of what would be needed to remove EAB infested trees over a six year period. Suggest setting aside additional funds to prepare for the expected arrival of EAB. Planting would be at least partially dependent on receiving grant funds annually.

Proposed Budget Increase

EAB could potentially kill all ash trees in Denver within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $12,000 a year. If the budget were increased to $5,550 a year all ash could be removed within 13 years. Additionally, it is recommended that Denver 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.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For an example, if the average ash diameter is 20 inches and treatment costs $15 per inch, then treating 10 trees would cost about $3,000 (every other year treatment). This would be 10 trees selected for treatment, and Denver would still need to find $900 per tree for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $4,500 every two years for treatment and leave five less trees for removal (for at least two more years). These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Denver. It is suggested to consider increasing the budget to plan for this.

Works Cited

Census Bureau. 2010. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2013)

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

1/29/2015

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	20.5	1,560	2,682.4	2,629	4,188	(N/A)	12.6	18.2	53.02
Green ash	18.9	1,436	2,576.4	2,525	3,961	(N/A)	11.6	17.2	54.25
Eastern white pine	6.1	464	777.0	761	1,226	(N/A)	7.3	5.3	26.65
Apple	1.1	83	175.8	172	255	(N/A)	7.2	1.1	5.68
Norway maple	10.2	777	1,470.5	1,441	2,218	(N/A)	6.5	9.6	54.10
Northern white cedar	1.1	82	188.1	184	266	(N/A)	6.2	1.2	6.83
Silver maple	10.7	816	1,346.2	1,319	2,135	(N/A)	6.0	9.3	56.19
Pin oak	9.4	716	1,264.5	1,239	1,956	(N/A)	4.0	8.5	78.22
Northern hackberry	7.1	540	1,005.5	985	1,525	(N/A)	3.5	6.6	69.32
Honeylocust	4.5	340	587.3	576	915	(N/A)	2.9	4.0	50.85
Japanese tree lilac	0.4	33	73.6	72	105	(N/A)	2.7	0.5	6.16
Northern red oak	2.3	174	317.0	311	484	(N/A)	2.5	2.1	30.26
Red maple	0.8	64	125.9	123	187	(N/A)	2.4	0.8	12.47
American basswood	3.3	249	468.7	459	709	(N/A)	2.1	3.1	54.52
Maple	0.5	38	76.4	75	113	(N/A)	1.9	0.5	9.45
Blue spruce	1.0	78	154.3	151	229	(N/A)	1.9	1.0	19.09
River birch	1.1	82	166.0	163	245	(N/A)	1.7	1.1	22.28
Swamp white oak	0.4	29	53.6	53	81	(N/A)	1.7	0.4	7.40
Black walnut	2.2	170	295.4	289	459	(N/A)	1.6	2.0	45.92
Ginkgo	0.2	16	29.6	29	45	(N/A)	1.6	0.2	4.50
Littleleaf linden	0.2	16	33.3	33	49	(N/A)	1.4	0.2	5.45
American elm	2.0	153	222.1	218	370	(N/A)	1.4	1.6	41.14
Pear	0.5	35	79.3	78	113	(N/A)	1.4	0.5	12.51
Scotch pine	0.7	56	96.5	95	151	(N/A)	1.3	0.7	18.86
White ash	0.6	45	84.2	83	127	(N/A)	1.1	0.6	18.18
Norway spruce	0.1	10	23.8	23	34	(N/A)	1.0	0.1	5.61
Spruce	0.4	28	48.9	48	76	(N/A)	0.8	0.3	15.27
Bur oak	0.5	37	68.8	67	105	(N/A)	0.8	0.5	20.92
Eastern cottonwood	1.5	116	210.5	206	322	(N/A)	0.6	1.4	80.62
Austrian pine	0.2	14	25.4	25	39	(N/A)	0.3	0.2	19.66
Red pine	0.1	9	19.0	19	27	(N/A)	0.3	0.1	13.58
Elm	0.0	2	4.2	4	6	(N/A)	0.3	0.0	3.24
Dogwood	0.1	7	16.6	16	24	(N/A)	0.3	0.1	11.80
Catalpa	0.4	29	53.7	53	82	(N/A)	0.2	0.4	82.02
Conifer Evergreen Large	0.2	14	24.6	24	38	(N/A)	0.2	0.2	38.17
Broadleaf Deciduous Large	0.5	37	63.1	62	99	(N/A)	0.2	0.4	98.63
Plum	0.1	6	12.8	13	18	(N/A)	0.2	0.1	18.19
Sumac	0.1	6	12.8	13	18	(N/A)	0.2	0.1	18.19
Boxelder	0.2	17	30.8	30	47	(N/A)	0.2	0.2	46.76
Total	110.5	8,384	14,964.8	14,666	23,050	(N/A)	100.0	100.0	36.64

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

1/29/2015

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	199,501	5,406	(N/A)	12.6	17.0	68.44
Green ash	197,238	5,345	(N/A)	11.6	16.8	73.22
Eastern white pine	107,177	2,904	(N/A)	7.3	9.1	63.14
Apple	3,661	99	(N/A)	7.2	0.3	2.20
Norway maple	99,714	2,702	(N/A)	6.5	8.5	65.91
Northern white cedar	10,594	287	(N/A)	6.2	0.9	7.36
Silver maple	127,139	3,445	(N/A)	6.0	10.8	90.67
Pin oak	116,926	3,169	(N/A)	4.0	10.0	126.75
Northern hackberry	67,144	1,820	(N/A)	3.5	5.7	82.71
Honeylocust	45,376	1,230	(N/A)	2.9	3.9	68.32
Japanese tree lilac	1,363	37	(N/A)	2.7	0.1	2.17
Northern red oak	23,250	630	(N/A)	2.5	2.0	39.38
Red maple	4,596	125	(N/A)	2.4	0.4	8.30
American basswood	37,808	1,025	(N/A)	2.1	3.2	78.82
Maple	2,720	74	(N/A)	1.9	0.2	6.14
Blue spruce	14,794	401	(N/A)	1.9	1.3	33.41
River birch	5,999	163	(N/A)	1.7	0.5	14.78
Swamp white oak	1,983	54	(N/A)	1.7	0.2	4.88
Black walnut	23,500	637	(N/A)	1.6	2.0	63.69
Ginkgo	817	22	(N/A)	1.6	0.1	2.22
Littleleaf linden	949	26	(N/A)	1.4	0.1	2.86
American elm	11,224	304	(N/A)	1.4	1.0	33.80
Pear	1,597	43	(N/A)	1.4	0.1	4.81
Scotch pine	8,537	231	(N/A)	1.3	0.7	28.92
White ash	3,845	104	(N/A)	1.1	0.3	14.89
Norway spruce	1,277	35	(N/A)	1.0	0.1	5.77
Spruce	4,317	117	(N/A)	0.8	0.4	23.40
Bur oak	6,152	167	(N/A)	0.8	0.5	33.34
Eastern cottonwood	20,615	559	(N/A)	0.6	1.8	139.67
Austrian pine	2,300	62	(N/A)	0.3	0.2	31.16
Red pine	1,191	32	(N/A)	0.3	0.1	16.14
Elm	190	5	(N/A)	0.3	0.0	2.57
Dogwood	333	9	(N/A)	0.3	0.0	4.51
Catalpa	5,491	149	(N/A)	0.2	0.5	148.79
Conifer Evergreen Large	4,605	125	(N/A)	0.2	0.4	124.79
Broadleaf Deciduous Large	7,239	196	(N/A)	0.2	0.6	196.17
Plum	264	7	(N/A)	0.2	0.0	7.17
Sumac	264	7	(N/A)	0.2	0.0	7.17
Boxelder	2,233	61	(N/A)	0.2	0.2	60.52
Citywide total	1,173,924	31,813	(N/A)	100.0	100.0	50.58

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

1/29/2015

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								
Sugar maple	24.9	4.2	12.8	1.1	136	96.8	14.2	13.5	93.1	606	-19.9	-75	240.9	668	(N/A)	12.6	8.45
Green ash	23.0	3.7	11.2	1.0	123	90.2	13.1	12.5	85.7	562	0.0	0	240.6	685	(N/A)	11.6	9.39
Eastern white pine	12.5	2.5	10.3	1.5	82	28.6	4.2	4.0	27.7	180	-54.0	-203	37.3	59	(N/A)	7.3	1.29
Apple	0.7	0.1	0.4	0.0	4	5.5	0.8	0.7	5.0	33	0.0	0	13.1	37	(N/A)	7.2	0.82
Norway maple	21.0	3.6	10.2	0.9	113	49.6	7.2	6.8	46.5	307	-4.9	-18	140.9	402	(N/A)	6.5	9.81
Northern white cedar	0.6	0.1	0.8	0.1	4	5.5	0.8	0.7	4.9	33	-2.9	-11	10.6	27	(N/A)	6.2	0.70
Silver maple	19.7	3.3	10.0	0.9	107	50.1	7.4	7.1	48.7	315	-11.0	-41	136.1	381	(N/A)	6.0	10.02
Pin oak	21.8	3.8	11.0	1.0	119	44.8	6.5	6.2	42.7	280	-39.8	-149	98.0	249	(N/A)	4.0	9.95
Northern hackberry	10.3	1.8	5.3	0.5	56	34.3	5.0	4.7	32.3	213	0.0	0	94.1	269	(N/A)	3.5	12.24
Honeylocust	8.7	1.4	4.0	0.4	46	21.1	3.1	3.0	20.3	132	-6.7	-25	55.2	153	(N/A)	2.9	8.49
Japanese tree lilac	0.1	0.0	0.1	0.0	1	2.2	0.3	0.3	1.9	13	0.0	0	4.9	14	(N/A)	2.7	0.82
Northern red oak	4.9	0.9	2.4	0.2	27	10.9	1.6	1.5	10.4	68	-7.1	-27	25.7	68	(N/A)	2.5	4.26
Red maple	0.6	0.1	0.3	0.0	3	4.1	0.6	0.6	3.8	25	-0.3	-1	9.8	28	(N/A)	2.4	1.83
American basswood	5.3	0.9	2.6	0.2	29	15.9	2.3	2.2	14.9	99	-4.5	-17	39.8	110	(N/A)	2.1	8.48
Maple	0.3	0.1	0.2	0.0	2	2.5	0.4	0.3	2.3	15	-0.1	-1	5.9	17	(N/A)	1.9	1.38
Blue spruce	1.9	0.4	1.6	0.2	13	5.0	0.7	0.7	4.6	31	-5.3	-20	9.9	24	(N/A)	1.9	1.99
River birch	0.6	0.1	0.4	0.0	4	5.3	0.8	0.7	4.9	33	-0.2	-1	12.7	36	(N/A)	1.7	3.26
Swamp white oak	0.2	0.0	0.1	0.0	1	1.8	0.3	0.3	1.7	11	-0.1	0	4.5	13	(N/A)	1.7	1.14
Black walnut	2.9	0.5	1.4	0.1	15	10.6	1.5	1.5	10.1	66	0.0	0	28.6	81	(N/A)	1.6	8.15
Ginkgo	0.0	0.0	0.0	0.0	0	1.0	0.1	0.1	1.0	6	0.0	0	2.3	6	(N/A)	1.6	0.64
Littleleaf linden	0.1	0.0	0.0	0.0	0	1.1	0.2	0.1	1.0	7	0.0	0	2.4	7	(N/A)	1.4	0.75
American elm	0.6	0.1	0.5	0.0	4	9.1	1.4	1.3	9.1	58	0.0	0	22.2	62	(N/A)	1.4	6.89
Pear	0.2	0.0	0.1	0.0	1	2.3	0.3	0.3	2.1	14	0.0	0	5.5	16	(N/A)	1.4	1.73
Scotch pine	0.9	0.2	0.8	0.1	6	3.5	0.5	0.5	3.4	22	-2.8	-11	7.0	17	(N/A)	1.3	2.15
White ash	0.1	0.0	0.1	0.0	1	2.8	0.4	0.4	2.7	18	0.0	0	6.6	18	(N/A)	1.1	2.63
Norway spruce	0.0	0.0	0.1	0.0	0	0.7	0.1	0.1	0.6	4	-0.3	-1	1.3	3	(N/A)	1.0	0.56
Spruce	0.4	0.1	0.4	0.1	3	1.8	0.3	0.2	1.7	11	-1.4	-5	3.5	9	(N/A)	0.8	1.73
Bur oak	0.8	0.1	0.4	0.0	4	2.4	0.3	0.3	2.2	15	0.0	0	6.6	19	(N/A)	0.8	3.79
Eastern cottonwood	3.4	0.5	1.5	0.2	18	7.3	1.1	1.0	6.9	46	0.0	0	21.9	63	(N/A)	0.6	15.80
Austrian pine	0.3	0.1	0.2	0.0	2	0.9	0.1	0.1	0.9	6	-0.8	-3	1.8	4	(N/A)	0.3	2.21
Red pine	0.1	0.0	0.1	0.0	1	0.6	0.1	0.1	0.5	3	-0.3	-1	1.1	3	(N/A)	0.3	1.48
Elm	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1	(N/A)	0.3	0.48
Dogwood	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)	0.3	1.63
Catalpa	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16	(N/A)	0.2	15.71
Conifer Evergreen Large	0.6	0.1	0.4	0.1	4	0.9	0.1	0.1	0.8	5	-2.9	-11	0.3	-2	(N/A)	0.2	-1.58
Broadleaf Deciduous Large	1.6	0.3	0.7	0.1	8	2.3	0.3	0.3	2.2	14	0.0	0	7.7	23	(N/A)	0.2	22.55
Plum	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
Sumac	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
Boxelder	0.3	0.0	0.1	0.0	1	1.0	0.2	0.1	1.0	7	-0.1	0	2.7	8	(N/A)	0.2	7.54
Citywide total	170.3	29.3	91.1	9.0	944	525.7	76.7	73.1	500.5	3,279	-165.4	-620	1,310.3	3,603	(N/A)	100.0	5.73

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

1/29/2015

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	713,953	5,355	(N/A)	12.6	17.9	67.78
Green ash	746,959	5,602	(N/A)	11.6	18.7	76.74
Eastern white pine	133,226	999	(N/A)	7.3	3.3	21.72
Apple	12,868	97	(N/A)	7.2	0.3	2.14
Norway maple	345,919	2,594	(N/A)	6.5	8.7	63.28
Northern white cedar	2,800	21	(N/A)	6.2	0.1	0.54
Silver maple	449,703	3,373	(N/A)	6.0	11.3	88.76
Pin oak	578,180	4,336	(N/A)	4.0	14.5	173.45
Northern hackberry	155,339	1,165	(N/A)	3.5	3.9	52.96
Honeylocust	111,240	834	(N/A)	2.9	2.8	46.35
Japanese tree lilac	3,753	28	(N/A)	2.7	0.1	1.66
Northern red oak	107,942	810	(N/A)	2.5	2.7	50.60
Red maple	8,041	60	(N/A)	2.4	0.2	4.02
American basswood	197,371	1,480	(N/A)	2.1	4.9	113.87
Maple	4,739	36	(N/A)	1.9	0.1	2.96
Blue spruce	12,677	95	(N/A)	1.9	0.3	7.92
River birch	11,984	90	(N/A)	1.7	0.3	8.17
Swamp white oak	4,397	33	(N/A)	1.7	0.1	3.00
Black walnut	96,128	721	(N/A)	1.6	2.4	72.10
Ginkgo	773	6	(N/A)	1.6	0.0	0.58
Littleleaf linden	1,995	15	(N/A)	1.4	0.1	1.66
American elm	24,475	184	(N/A)	1.4	0.6	20.40
Pear	5,251	39	(N/A)	1.4	0.1	4.38
Scotch pine	5,708	43	(N/A)	1.3	0.1	5.35
White ash	6,393	48	(N/A)	1.1	0.2	6.85
Norway spruce	229	2	(N/A)	1.0	0.0	0.29
Spruce	2,856	21	(N/A)	0.8	0.1	4.28
Bur oak	27,014	203	(N/A)	0.8	0.7	40.52
Eastern cottonwood	113,471	851	(N/A)	0.6	2.8	212.76
Austrian pine	1,402	11	(N/A)	0.3	0.0	5.26
Red pine	513	4	(N/A)	0.3	0.0	1.93
Elm	198	1	(N/A)	0.3	0.0	0.74
Dogwood	1,086	8	(N/A)	0.3	0.0	4.07
Catalpa	25,943	195	(N/A)	0.2	0.7	194.57
Conifer Evergreen La	7,490	56	(N/A)	0.2	0.2	56.18
Broadleaf Deciduous	55,982	420	(N/A)	0.2	1.4	419.86
Plum	908	7	(N/A)	0.2	0.0	6.81
Sumac	908	7	(N/A)	0.2	0.0	6.81
Boxelder	7,945	60	(N/A)	0.2	0.2	59.59
Citywide total	3,987,758	29,908	(N/A)	100.0	100.0	47.55

Table 5: Annual Carbon Sequestered

Annual CO Benefits of Public Trees

1/29/2015

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
Sugar maple	41,093	308	-3,428	-209	-27	34,467	259	71,924	539 (N/A)	12.6	17.1	6.83
Green ash	44,968	337	-3,585	-194	-28	31,729	238	72,918	547 (N/A)	11.6	17.3	7.49
Eastern white pine	6,601	50	-639	-107	-6	10,265	77	16,120	121 (N/A)	7.3	3.8	2.63
Apple	1,798	13	-63	-22	-1	1,838	14	3,550	27 (N/A)	7.2	0.8	0.59
Norway maple	11,637	87	-1,661	-111	-13	17,175	129	27,041	203 (N/A)	6.5	6.4	4.95
Northern white cedar	910	7	-13	-26	0	1,814	14	2,684	20 (N/A)	6.2	0.6	0.52
Silver maple	37,400	281	-2,160	-108	-17	18,029	135	53,161	399 (N/A)	6.0	12.6	10.49
Pin oak	51,379	385	-2,775	-103	-22	15,832	119	64,333	482 (N/A)	4.0	15.3	19.30
Northern hackberry	8,742	66	-746	-66	-6	11,928	89	19,858	149 (N/A)	3.5	4.7	6.77
Honeylocust	14,366	108	-535	-35	-4	7,508	56	21,305	160 (N/A)	2.9	5.1	8.88
Japanese tree lilac	721	5	-18	-11	0	719	5	1,412	11 (N/A)	2.7	0.3	0.62
Northern red oak	2,601	20	-518	-30	-4	3,835	29	5,887	44 (N/A)	2.5	1.4	2.76
Red maple	1,215	9	-39	-10	0	1,407	11	2,573	19 (N/A)	2.4	0.6	1.29
American basswood	11,241	84	-947	-39	-7	5,512	41	15,766	118 (N/A)	2.1	3.7	9.10
Maple	719	5	-23	-7	0	850	6	1,540	12 (N/A)	1.9	0.4	0.96
Blue spruce	871	7	-61	-20	-1	1,722	13	2,512	19 (N/A)	1.9	0.6	1.57
River birch	2,240	17	-60	-12	-1	1,820	14	3,988	30 (N/A)	1.7	0.9	2.72
Swamp white oak	711	5	-24	-5	0	639	5	1,321	10 (N/A)	1.7	0.3	0.90
Black walnut	4,900	37	-461	-23	-4	3,750	28	8,165	61 (N/A)	1.6	1.9	6.12
Ginkgo	162	1	-4	-6	0	353	3	506	4 (N/A)	1.6	0.1	0.38
Littleleaf linden	576	4	-13	-5	0	362	3	920	7 (N/A)	1.4	0.2	0.77
American elm	1,817	14	-118	-16	-1	3,373	25	5,056	38 (N/A)	1.4	1.2	4.21
Pear	721	5	-25	-8	0	770	6	1,457	11 (N/A)	1.4	0.3	1.21
Scotch pine	673	5	-27	-12	0	1,244	9	1,876	14 (N/A)	1.3	0.4	1.76
White ash	1,158	9	-31	-8	0	988	7	2,108	16 (N/A)	1.1	0.5	2.26
Norway spruce	108	1	-1	-4	0	227	2	330	2 (N/A)	1.0	0.1	0.41
Spruce	340	3	-14	-6	0	628	5	948	7 (N/A)	0.8	0.2	1.42
Bur oak	1,176	9	-130	-6	-1	822	6	1,862	14 (N/A)	0.8	0.4	2.79
Eastern cottonwood	3,152	24	-545	-17	-4	2,567	19	5,158	39 (N/A)	0.6	1.2	9.67
Austrian pine	129	1	-7	-3	0	319	2	439	3 (N/A)	0.3	0.1	1.64
Red pine	105	1	-2	-2	0	189	1	289	2 (N/A)	0.3	0.1	1.08
Elm	77	1	-1	-1	0	53	0	128	1 (N/A)	0.3	0.0	0.48
Dogwood	152	1	-5	-2	0	161	1	306	2 (N/A)	0.3	0.1	1.15
Catalpa	960	7	-125	-4	-1	650	5	1,481	11 (N/A)	0.2	0.4	11.11
Conifer Evergreen Large	0	0	-36	-4	0	311	2	271	2 (N/A)	0.2	0.1	2.03
Broadleaf Deciduous Larg	479	4	-269	-6	-2	813	6	1,017	8 (N/A)	0.2	0.2	7.63
Plum	114	1	-4	-1	0	124	1	232	2 (N/A)	0.2	0.1	1.74
Sumac	114	1	-4	-1	0	124	1	232	2 (N/A)	0.2	0.1	1.74
Boxelder	694	5	-38	-3	0	366	3	1,020	8 (N/A)	0.2	0.2	7.65
Citywide total	256,820	1,926	-19,155	-1,254	-153	185,284	1,390	421,694	3,163 (N/A)	100.0	100.0	5.03

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

1/29/2015

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	4,457	(N/A)	12.6	16.7	56.42
Green ash	3,831	(N/A)	11.6	14.3	52.48
Eastern white pine	1,326	(N/A)	7.3	5.0	28.83
Apple	90	(N/A)	7.2	0.3	2.01
Norway maple	1,106	(N/A)	6.5	4.1	26.98
Northern white cedar	318	(N/A)	6.2	1.2	8.16
Silver maple	3,167	(N/A)	6.0	11.8	83.34
Pin oak	3,730	(N/A)	4.0	13.9	149.22
Northern hackberry	1,190	(N/A)	3.5	4.4	54.10
Honeylocust	3,522	(N/A)	2.9	13.2	195.69
Japanese tree lilac	39	(N/A)	2.7	0.1	2.31
Northern red oak	196	(N/A)	2.5	0.7	12.28
Red maple	216	(N/A)	2.4	0.8	14.43
American basswood	787	(N/A)	2.1	2.9	60.56
Maple	127	(N/A)	1.9	0.5	10.57
Blue spruce	240	(N/A)	1.9	0.9	19.98
River birch	261	(N/A)	1.7	1.0	23.76
Swamp white oak	97	(N/A)	1.7	0.4	8.82
Black walnut	442	(N/A)	1.6	1.7	44.23
Ginkgo	28	(N/A)	1.6	0.1	2.76
Littleleaf linden	92	(N/A)	1.4	0.3	10.23
American elm	300	(N/A)	1.4	1.1	33.30
Pear	40	(N/A)	1.4	0.2	4.47
Scotch pine	191	(N/A)	1.3	0.7	23.87
White ash	213	(N/A)	1.1	0.8	30.47
Norway spruce	41	(N/A)	1.0	0.2	6.83
Spruce	101	(N/A)	0.8	0.4	20.25
Bur oak	111	(N/A)	0.8	0.4	22.19
Eastern cottonwood	226	(N/A)	0.6	0.8	56.59
Austrian pine	46	(N/A)	0.3	0.2	23.16
Red pine	31	(N/A)	0.3	0.1	15.42
Elm	20	(N/A)	0.3	0.1	10.00
Dogwood	8	(N/A)	0.3	0.0	4.23
Catalpa	67	(N/A)	0.2	0.2	66.60
Conifer Evergreen Large	0	(N/A)	0.2	0.0	0.00
Broadleaf Deciduous Large	29	(N/A)	0.2	0.1	28.57
Plum	6	(N/A)	0.2	0.0	6.40
Sumac	6	(N/A)	0.2	0.0	6.40
Boxelder	52	(N/A)	0.2	0.2	51.63
Citywide total	26,755	(N/A)	100.0	100.0	42.54

Table 7: Summary of Benefits in Dollars

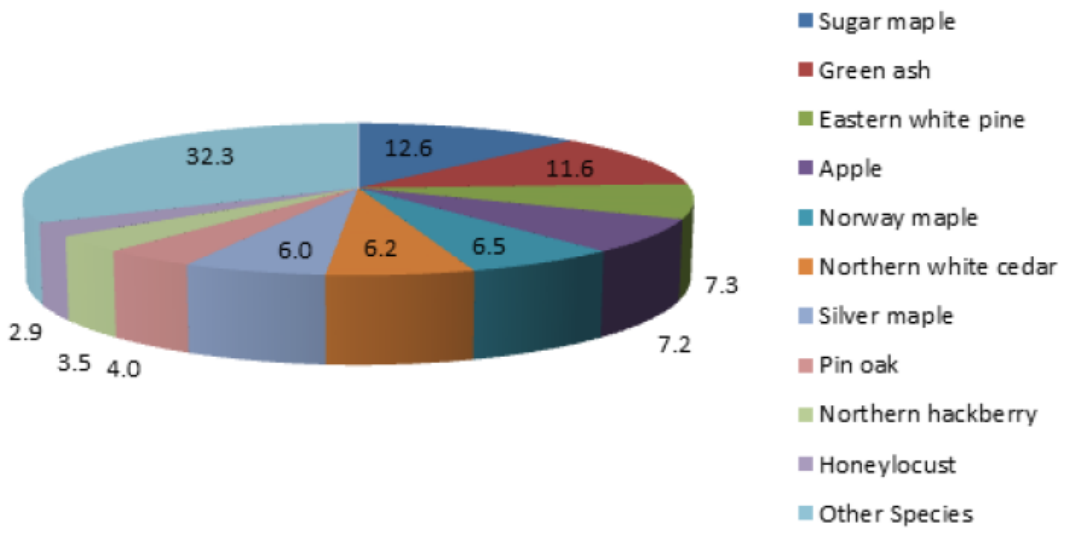
Total Annual Benefits of Public Trees by Species ($)

1/29/2015

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Sugar maple	4,188	539	668	5,406	4,457	15,260	(N/A)	17.3
Green ash	3,961	547	685	5,345	3,831	14,369	(N/A)	16.3
Eastern white pine	1,226	121	59	2,904	1,326	5,637	(N/A)	6.4
Apple	255	27	37	99	90	509	(N/A)	0.6
Norway maple	2,218	203	402	2,702	1,106	6,631	(N/A)	7.5
Northern white cedar	266	20	27	287	318	919	(N/A)	1.0
Silver maple	2,135	399	381	3,445	3,167	9,527	(N/A)	10.8
Pin oak	1,956	482	249	3,169	3,730	9,586	(N/A)	10.8
Northern hackberry	1,525	149	269	1,820	1,190	4,953	(N/A)	5.6
Honeylocust	915	160	153	1,230	3,522	5,980	(N/A)	6.8
Japanese tree lilac	105	11	14	37	39	205	(N/A)	0.2
Northern red oak	484	44	68	630	196	1,423	(N/A)	1.6
Red maple	187	19	28	125	216	575	(N/A)	0.7
American basswood	709	118	110	1,025	787	2,749	(N/A)	3.1
Maple	113	12	17	74	127	342	(N/A)	0.4
Blue spruce	229	19	24	401	240	913	(N/A)	1.0
River birch	245	30	36	163	261	735	(N/A)	0.8
Swamp white oak	81	10	13	54	97	255	(N/A)	0.3
Black walnut	459	61	81	637	442	1,681	(N/A)	1.9
Ginkgo	45	4	6	22	28	105	(N/A)	0.1
Littleleaf linden	49	7	7	26	92	180	(N/A)	0.2
American elm	370	38	62	304	300	1,074	(N/A)	1.2
Pear	113	11	16	43	40	223	(N/A)	0.3
Scotch pine	151	14	17	231	191	604	(N/A)	0.7
White ash	127	16	18	104	213	479	(N/A)	0.5
Norway spruce	34	2	3	35	41	115	(N/A)	0.1
Spruce	76	7	9	117	101	310	(N/A)	0.4
Bur oak	105	14	19	167	111	415	(N/A)	0.5
Eastern cottonwood	322	39	63	559	226	1,209	(N/A)	1.4
Austrian pine	39	3	4	62	46	156	(N/A)	0.2
Red pine	27	2	3	32	31	95	(N/A)	0.1
Elm	6	1	1	5	20	34	(N/A)	0.0
Dogwood	24	2	3	9	8	47	(N/A)	0.1
Catalpa	82	11	16	149	67	324	(N/A)	0.4
Conifer Evergreen Large	38	2	-2	125	0	163	(N/A)	0.2
Broadleaf Deciduous La	99	8	23	196	29	354	(N/A)	0.4
Plum	18	2	3	7	6	36	(N/A)	0.0
Sumac	18	2	3	7	6	36	(N/A)	0.0
Boxelder	47	8	8	61	52	174	(N/A)	0.2
Citywide Total	23,050	3,163	3,603	31,813	26,755	88,383	(N/A)	100.0

Species Distribution of Public Trees

1/29/2015

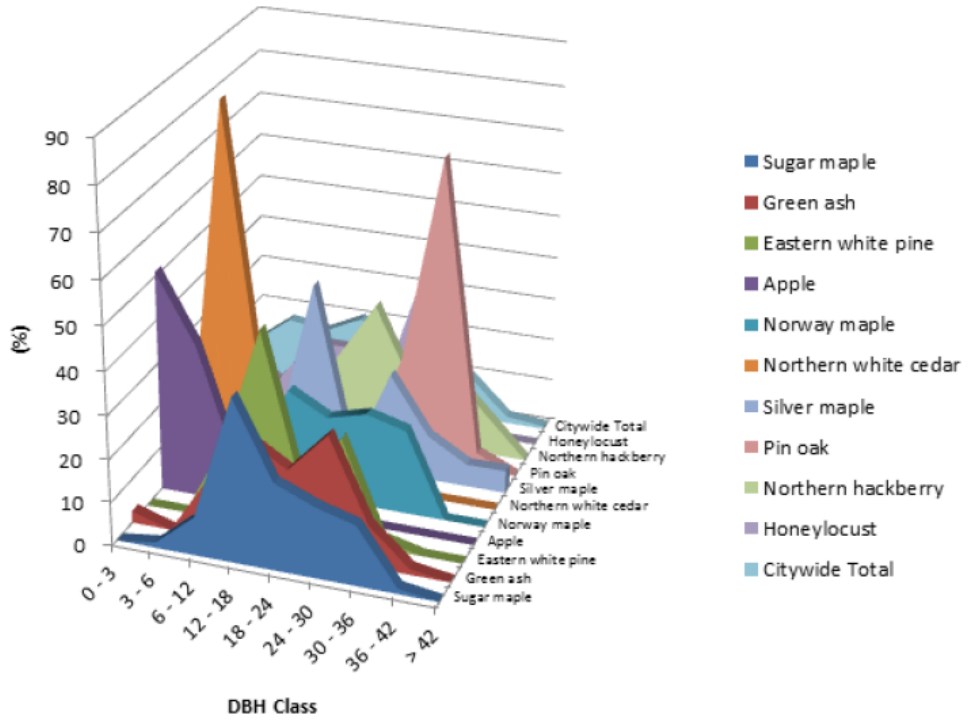


Species	Percent
Sugar maple	12.6
Green ash	11.6
Eastern white pine	7.3
Apple	7.2
Norway maple	6.5
Northern white cedar	6.2
Silver maple	6.0
Pin oak	4.0
Northern hackberry	3.5
Honeylocust	2.9
Other Species	32.3
Total	100.0

Figure 1: Species Distribution

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

1/29/2015



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Sugar maple	0.00	1.27	8.86	37.97	20.25	16.46	13.92	1.27	0.00
Green ash	2.74	0.00	13.70	24.66	19.18	28.77	9.59	1.37	0.00
Eastern white pine	0.00	0.00	17.39	45.65	10.87	23.91	2.17	0.00	0.00
Apple	51.11	35.56	8.89	4.44	0.00	0.00	0.00	0.00	0.00
Norway maple	7.32	0.00	7.32	24.39	19.51	21.95	19.51	0.00	0.00
Northern white cedar	0.00	84.62	15.38	0.00	0.00	0.00	0.00	0.00	0.00
Silver maple	0.00	5.26	5.26	42.11	2.63	23.68	10.53	5.26	5.26
Pin oak	0.00	0.00	0.00	0.00	0.00	24.00	72.00	4.00	0.00
Northern hackberry	4.55	0.00	4.55	18.18	31.82	13.64	18.18	9.09	0.00
Honeylocust	11.11	5.56	16.67	16.67	11.11	38.89	0.00	0.00	0.00
Citywide Total	10.49	17.33	16.06	20.35	9.54	13.99	10.02	1.59	0.64

Figure 2: Relative Age Class

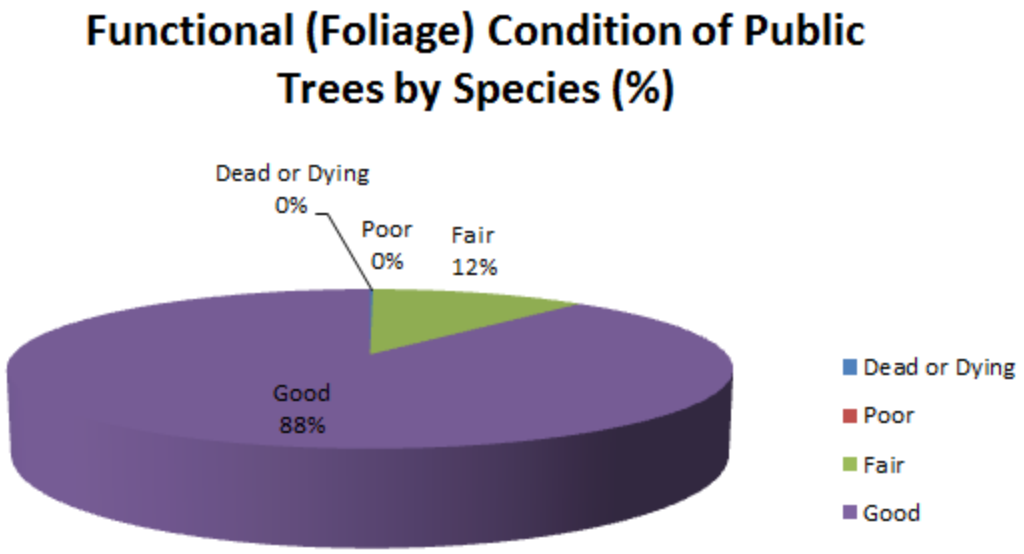


Figure 3: Foliage Condition

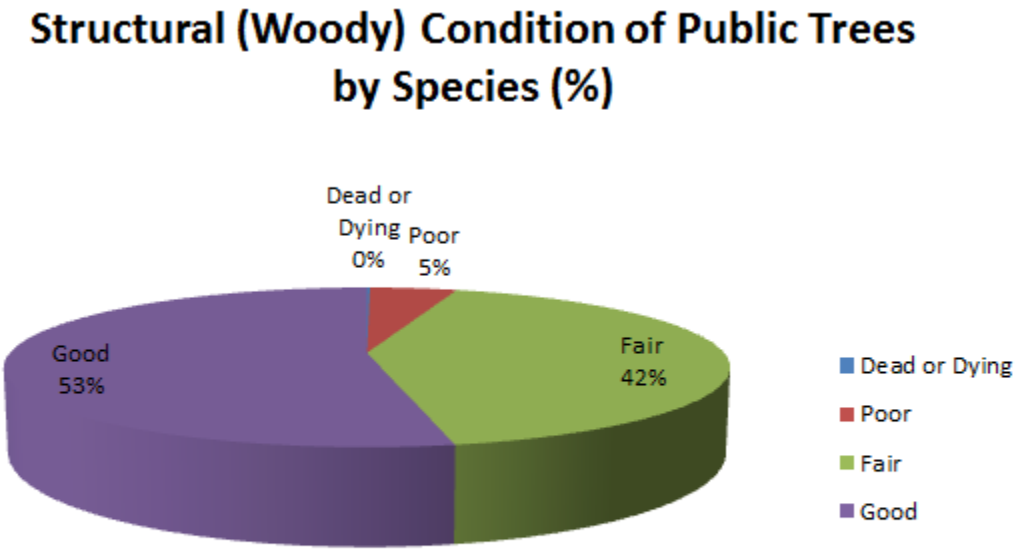
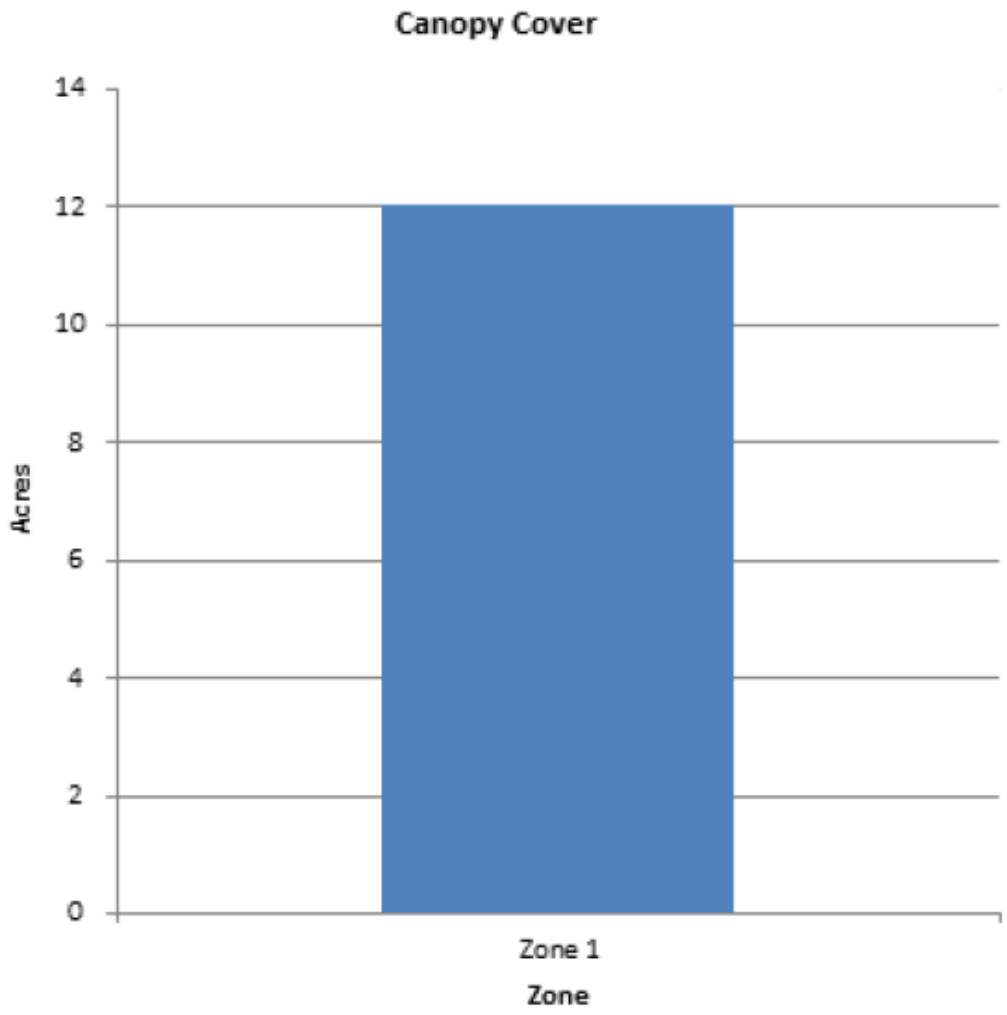


Figure 4: Wood Condition

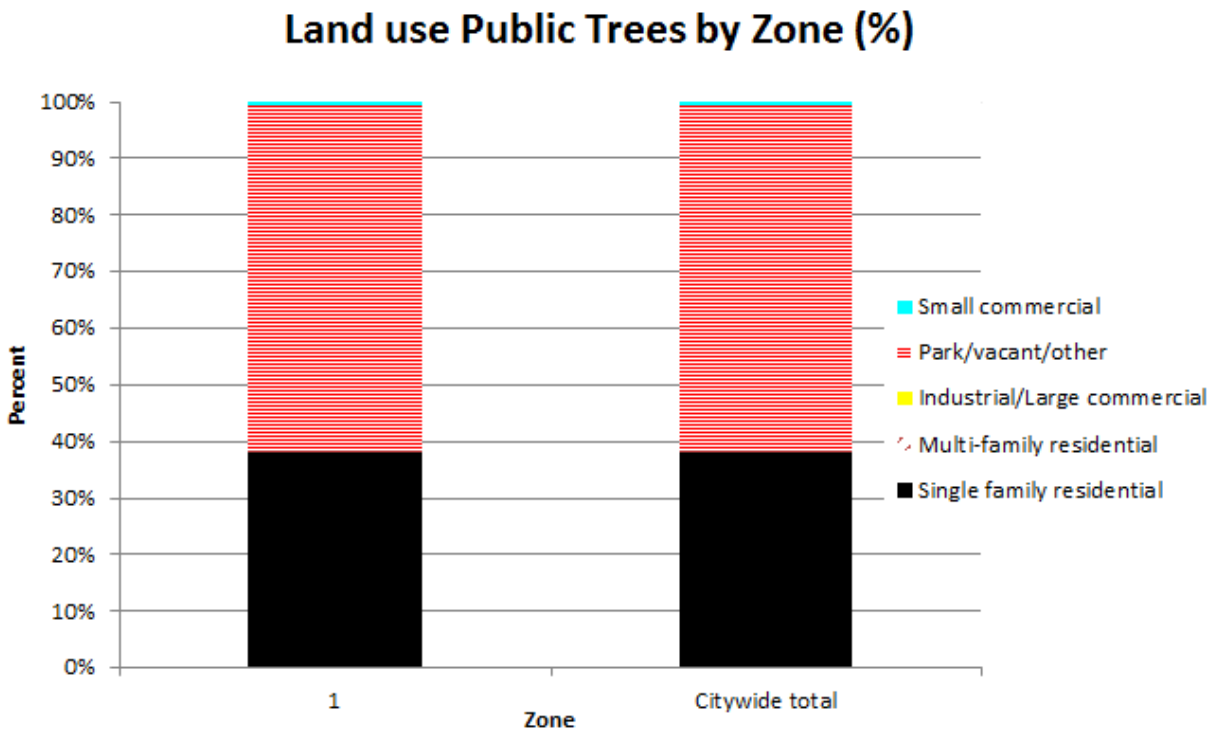
Canopy Cover of Public Trees (Acres)

1/29/2015



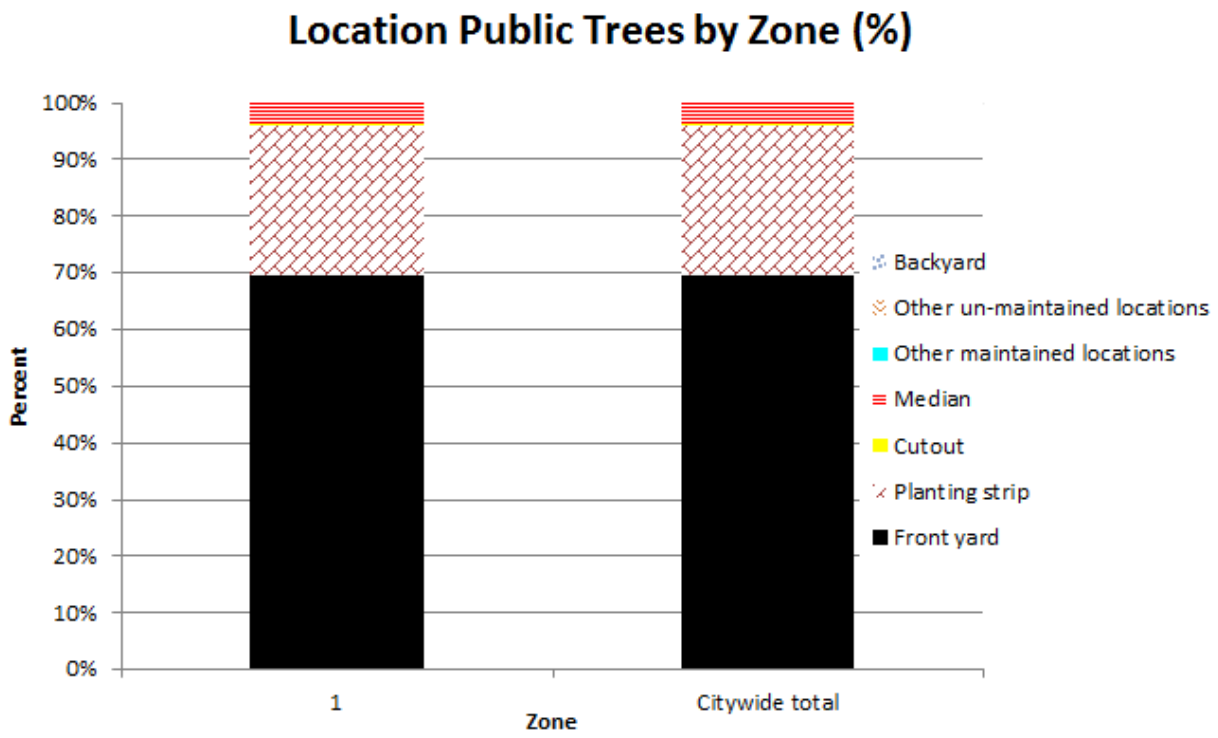
Zone	Acres	% of Total Canopy Cover
Zone 1	12	100.0
Citywide total	12	100.0

Figure 5: Canopy Cover in Acres



Zone	Single family residential	Multi-family residential	Industrial/Large commercial	Park/vacant /other	Small commercial
1	38.00	0.00	0.00	61.21	0.79
Citywide total	38.00	0.00	0.00	61.21	0.79

Figure 6: Land Use of city/park trees



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	69.48	26.39	0.32	3.82	0.00	0.00	0.00
Citywide total	69.48	26.39	0.32	3.82	0.00	0.00	0.00

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

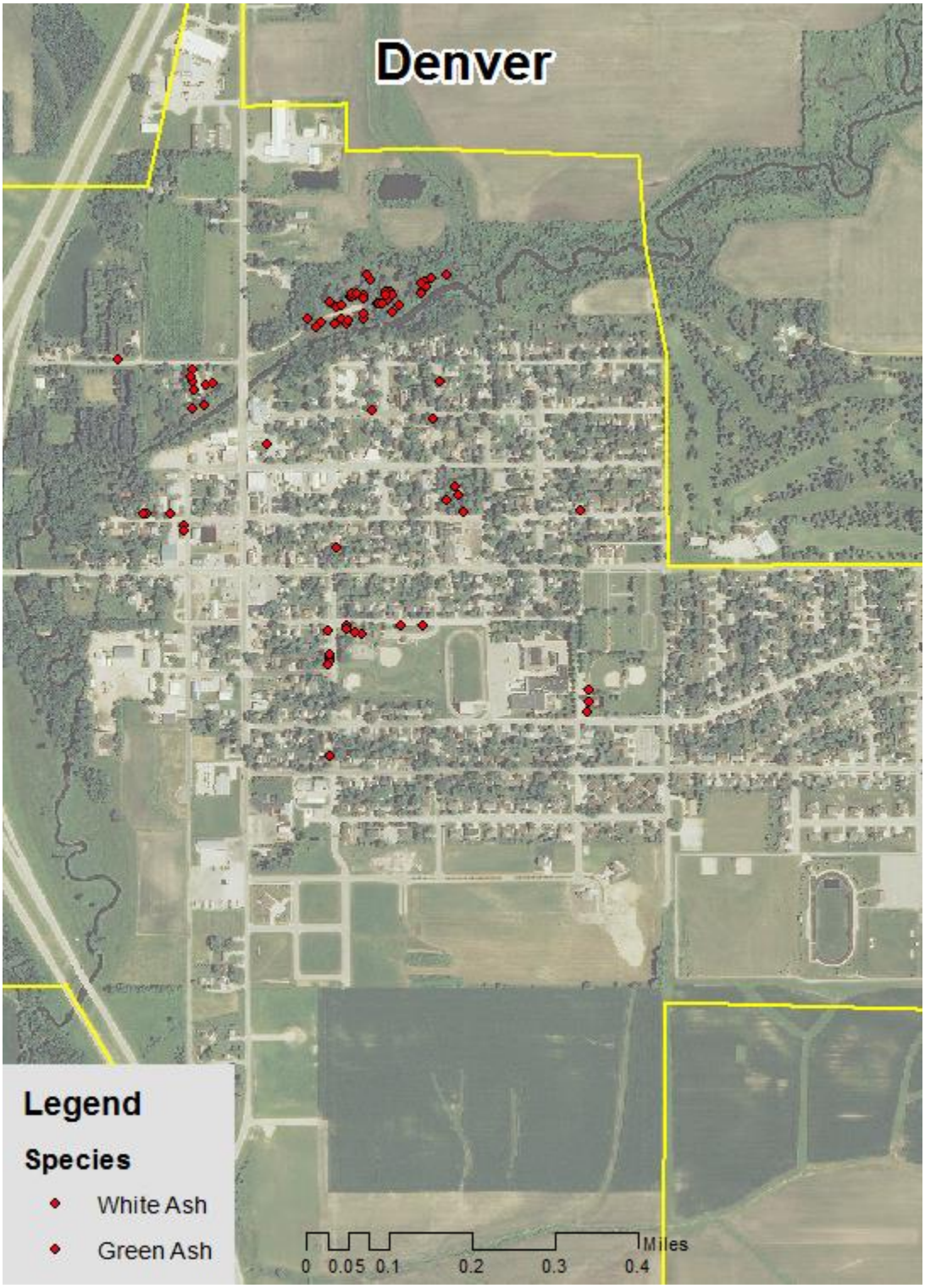


Figure 1: Location of Ash Trees

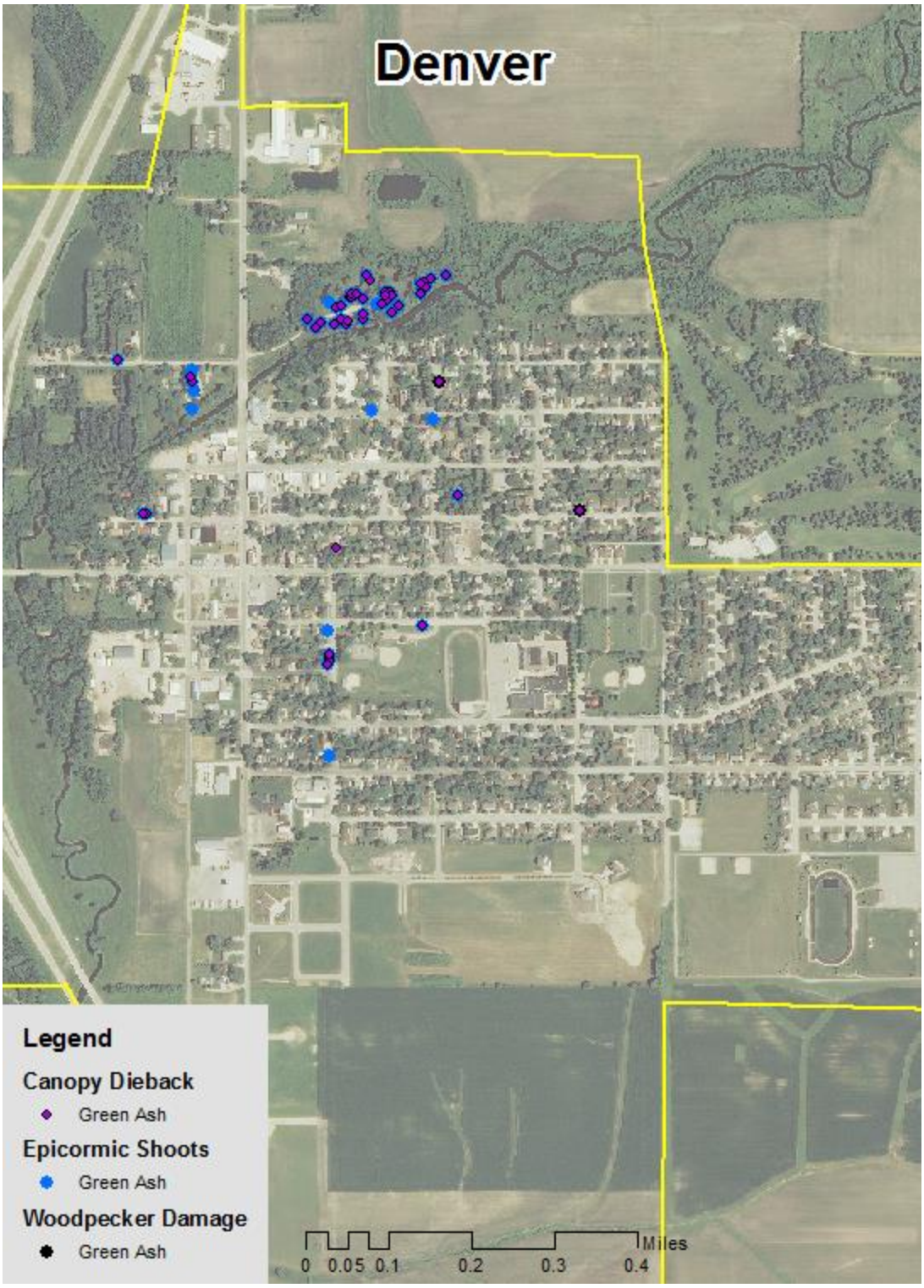


Figure 2: Location of EAB symptoms

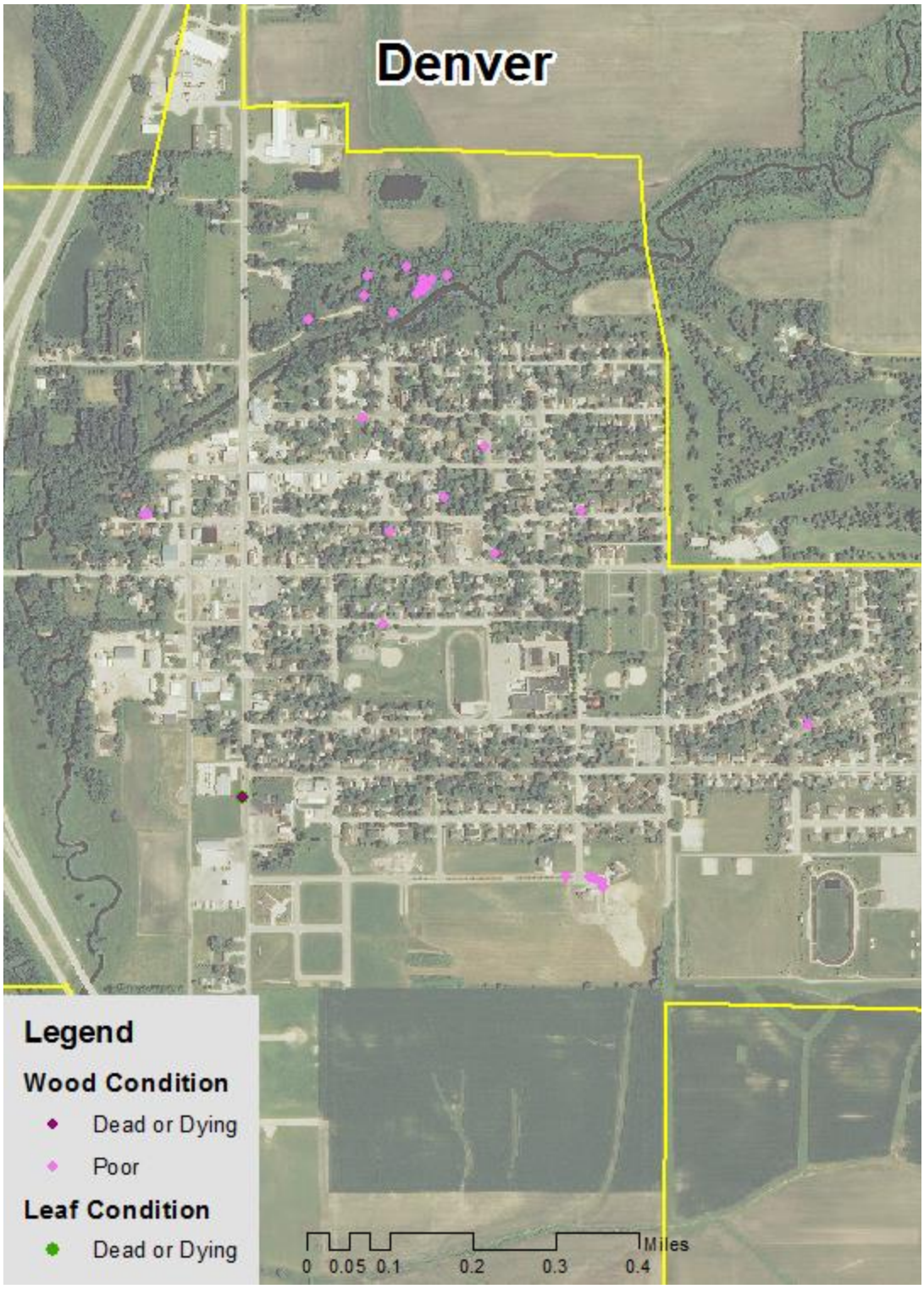


Figure 3: Location of Poor Condition Trees

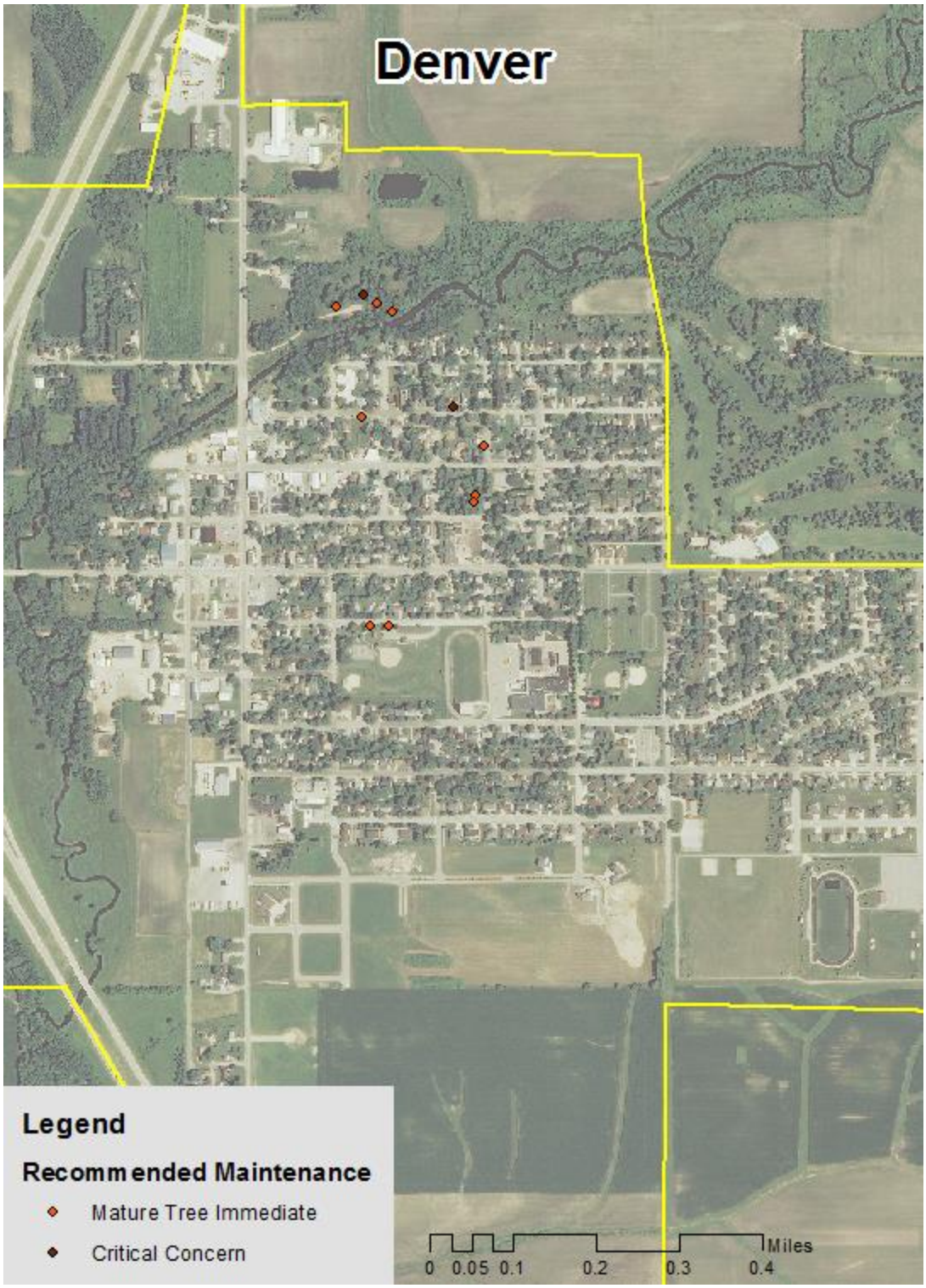


Figure 4: Location of Trees with Recommended Maintenance

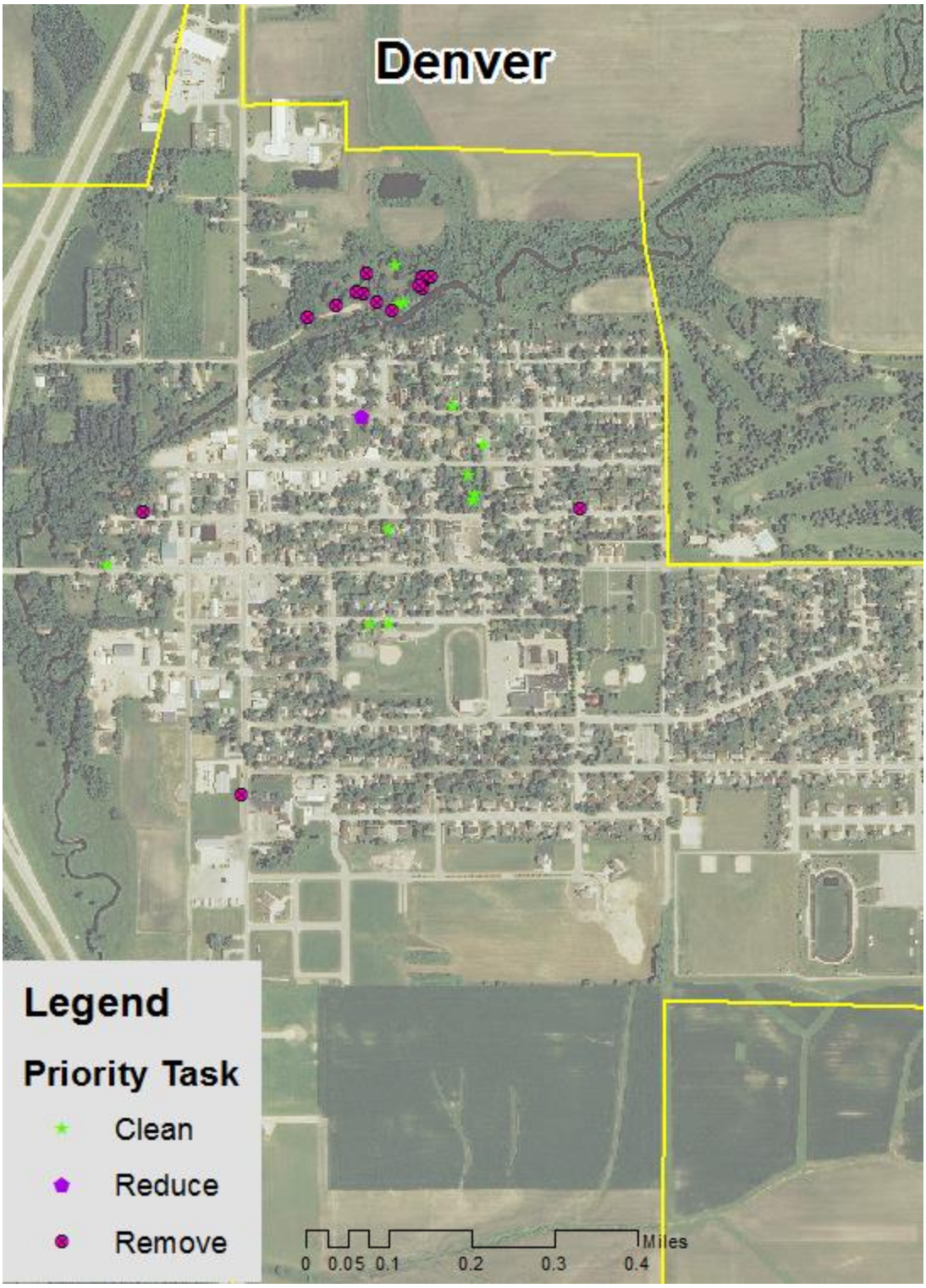


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

Appendix C: Denver Tree Ordinances

CHAPTER 12 CODE OF ORDINANCES
CODE OF ORDINANCES, DENVER, IOWA

Chapter 12.24
STREET TREES*

Sections:

12.24.010 Definitions. For use in this chapter, the following terms are defined:

(1) "Parking" 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.
(2) "Person" means any individual, firm, corporation, trust, association or any other organized group.
(3) "Property owner" means a person owning private property in the City as shown by the county auditor's plats of the City.
(4) "Public property" means any and all property located within the confines of the City and owned by the City or held in the name of the City by any of the departments, commissions or agencies within the City government.
(5) "Street" means the entire width between property lines of avenues or highways. (Ord. 1A-86 §1, 1986)
*For statutory provisions authorizing municipal corporations by ordinance to assume charge, custody and control of all trees and shrubbery upon the public streets, and to plant, prune, care

for, remove, and maintain all trees and shrubbery upon the public streets, see I.C.A. 368.32. Prior ordinance history: Ord. 35.

12.24.020 City Arborist--Position Created.

1. There is established the position of City Arborist, who shall be appointed by the City Council and shall have the authority and primary responsibility to implement the procedures of this chapter and supervise the general care of all trees and shrubs within the jurisdiction of the City.
2. The City Council shall have custody and control of all trees and shrubs growing now or hereinafter in any park, street or public property in the City and shall have power to supervise plant removal, care for and otherwise, maintain such trees and shrubs.
3. The City arborist shall be authorized to organize, direct and regulate the planning, maintenance, care and removal of any and all trees under the jurisdiction of the City Council.
4. The City arborist shall be authorized to direct the removal of any tree or shrub, or portion thereof whether diseased and/or unhealthy if such tree is located on private property and is declared a nuisance or hazard as defined in this chapter.
5. The City arborist shall, at the direction of the City Council, be authorized to organize, direct and supervise the sale of any trees or shrubs under the jurisdiction of the City as provided by this chapter. (Ord. 1A-86 52, 1986)

12.24.025 Creation of Tree Board.

There is hereby created and established a City Tree Board for the City of Denver, Iowa which shall consist of five members, citizens and residents of this City, who shall be appointed by the Mayor with the approval of the Council. One member of the Board shall also be a member of the City Parks and Recreation Committee and one member of the Board shall also be a City Utility employee or member of the Board of Trustees.
Term of Office. The full term of office for members of the City Tree Board shall be three years, and members shall hold the office from the first day of July following their appointment. The Mayor shall appoint two persons to the first City Tree Board for a one-year term, two persons to a two-year term, and one person to a full term.
Vacancy. In the event that a vacancy occurs on the Board, it shall be filed by appointment by the Mayor with the approval of the Council, and such appointee shall fill out the unexpired term of the member whose office was vacated.
Compensation. Members of the board shall serve without compensation.
Duties and Responsibilities. It shall be the responsibility of the Board to study, investigate, and develop and/or update annually, and administer a written plan for the care, preservation, pruning, planting, replanting, removal or disposition of trees and shrubs in parks, along streets and in other public areas. Such plan will be presented annually to the City Council and upon their acceptance and approval shall constitute the official comprehensive City Tree Plan for the City of Denver, Iowa. The Board, when requested by the City Council, shall consider, investigate, make finding, report and recommend upon any special matter of questions coming within the scope of its work.
Operation. The Board shall choose its own officers, make its own rules and regulations and keep a journal of its proceedings. A majority of the members shall be a quorum for the transaction of business.

Street Classification. The following list constitutes the official Street Tree Classifications for Denver, Iowa. Although, other species are not prohibited, property owners are encouraged to plant these species as street trees.
1. Small Trees Under Power Lines. Amur Maple (tree form), Flowering Crab, Hornbeam (American), Japanese Tree Lilac, Pagoda Dogwood, Serviceberry.
2. Shade Trees When No Power Lines Are Present. Ash (White or Green), Freeman Maple, Gingko Biloba, Hackberry, Hornbeam (European), Kentucky Coffee Tree, Linden, Red Oak, Swamp White Oak, White Oak.

Distance from Curb and Sidewalk. The distance trees may be planted from curbs or curb lines and sidewalks will be in accordance with the three species size classes listed above. No trees may be planted closer to any curb or sidewalk than the following: Small Trees, 2 feet; Medium Trees, 3 feet; and Large Trees, 4 feet, unless in conformity with Section 10.24.100. Distance from Street Corners and Fire Plugs. No Street Tree shall be planted closer than twenty (20) feet of any street corner, measured from the point of nearest intersecting curbs or curb lines. No street tree shall be planted closer than ten (10) feet of any fireplug.
Utilities. No Street Trees other than those species listed as Small Trees may be planted under or within 10 (10) lateral feet of any overhead utility wire, or over or within ten (10) lateral feet of any underground water line, sewer line, transmission line or other utility.
Public Tree Care. The City shall have the right to plant, prune, maintain and remove trees, plants and shrubs within the lines of all streets, alleys, avenues, lanes, squares and public grounds, as may be necessary to insure public safety or to preserve or enhance the symmetry and beauty of such public grounds. The City may remove or cause or order to be removed, any tree or part thereof which is in an unsafe condition or which by reason of its nature is injurious to sewers, electric power lines, gas lines, water lines, or other public improvements, or is affected with any injurious fungus, insect or other pest, provided, however, provided that such removal be conducted in accordance with tree removal policies of the tree plan. This Section does not prohibit the planting of Street Trees by adjacent property owners providing that the selection and location of said trees is in accordance with the Section.
Tree Topping. It shall be unlawful as a normal practice for any person, firm, or City department to top any Street Tree, park Tree, or other tree on public property. Topping is defined as the severe cutting back of limbs to stubs larger than three inches in diameter within the tree's crown to such a degree so as to remove the normal canopy and disfigure the tree. Trees severely damaged by storms or other causes. Or certain trees under utility wires or other obstructions where other pruning practices are impractical may be exempted from this ordinance at the determination of the City Tree Board. The City Tree Board shall adopt a tree topping policy in its Tree Plan to be followed by the City in pruning or topping trees.
Pruning, Corner Clearance. Every owner of any tree overhanging any street or right-of-way within the City shall prune the branches in accord with this Section and so that such branches shall not obstruct the light from any street lamp or obstruct the view of any street intersection and so that there shall be a clear space of eight (8) feet above the surface of the street or sidewalk except that trees which overhang a traveled way shall be trimmed to at least twelve (12) feet above the surface of the traveled way. Said owners shall remove all dead, diseased or dangerous trees, or broken or decayed limbs, which constitute a menace to the safety of the public. The City shall have the right to prune any tree or shrub on private property when it interferes with the

proper spread of lights along the street from a street light or interferes with visibility of any traffic control device or sign.
Dead or Diseased Tree Removal on Private Property. The City shall have the right to cause the removal of any dead or diseased trees on private property within the City, when such tress constitute a hazard to life and property or harbor insects or disease which constitute a potential threat to other trees within the City. The City Tree Board will notify in writing the owners of such trees. Removal shall be done by said owners at their own expense within sixty days after the date of service of notice. In the event of failure of owners to comply with such provisions, the City shall have the authority to remove such trees and charge the cost of removal on the owners property tax notice.

Removal of Stumps. Al stumps of street and park trees shall be removed below the surface of the ground so that the top of the stump shall not project above the surface of the ground. When the City causes a tree on City property to be removed, the City shall remove the stump to 6" below ground level.
Interference with City Tree Board. It shall be unlawful for any person to prevent, delay or interfere with the City Tree Board, or any of its agents, while engaging in and about the planting, cultivating, mulching, pruning, spraying, or removing of any Street Trees, Park Trees, or trees on private grounds, as authorized in this ordinance.
Review by City Council. The City Council shall have the right to review the conduct, acts and decisions of the City Tree Board. Any person may appeal from any ruling or order of the City Tree Board to the City Council who may hear the matter and make the final decision.

12.24.030 Permit Required. (a) Except as allowed in Section 12.24.120, no person shall cut or remove any tree or shrub on the streets or on public property without first obtaining a permit from the City arborist, who shall issue said permit if the proposed work is necessary and the proposed methods and workmanship are satisfactory.
(b) The City Arborist may demand the posting of bond or insurance before the permit is granted. Such bond or insurance shall be of sufficient amount to reasonable cover any damages that may occur to life or property while the provisions of the permit are being carried out.
(c) Every permit granted in accordance with this section by the City Arborist shall describe the work to be done, the estimated cost, define the species, sizes and location of all trees and shrubs concerned and contain a definite date of expiration.
(d) Any permit may be declared void if the terms are violated. (Ord. 1A-86 §3, 1986)

12.24.040 Businesses Removing, Cutting or Trimming-License Fees. No person shall engage in the business of removing, cutting or trimming of trees or shrubbery in the City without first obtaining a license therefor. The applicant shall submit written application to the City arborist setting forth his experience and qualifications. Upon determination by the City arborist that he is qualified, he shall be granted a license which shall allow the removal, cutting and trimming of trees and shrubbery in the City, which shall be an annual license commencing January 1st and terminating December 31st of each year. The license fee shall be ten dollars per year, which fee shall be paid prior to the issuance of the license. No trimming, cutting or removal shall be done until the license has been obtained. (Ord. 1A-86 §4, 1986)

12.24.050 Permits and Licenses--Exceptions. Sections of this chapter relating to permits and licenses shall not apply to: (1) The United States of America, the State of Iowa, county municipality or political subdivisions of the state, any department, bureau or agency of any of the foregoing or any official representative of any of the foregoing in pursuit of official duties; (2) Any person with reference to trees and shrubs on his own premises; (3) Any individual performing labor or services on or in connection with trees at the direction and under the personal supervision of a licensed tree trimmer while in the performance of such functions; (4) Any public utility engaged in tree trimming and/or tree removal for the purpose of line clearance in order to insure the continuity of utility service to the public. (5) Trimming and cutting which is in compliance with Section 12.24.120. (Ord. 1A-86 §5, 1986)

12.24.060 Tree Maintenance Business--Bond Required. Any person, before engaging in the business or occupation of removing, cutting or trimming trees in the City, shall deposit it with the City clerk a good and sufficient bond or evidence of insurance in the sum of not less than five thousand dollars, conditioned that such person shall faithfully comply with the provisions of this chapter and shall indemnify, save and keep harmless the City and its officers from any and all claims, damages and losses and actions by reason of any acts or things done under or by authority or permission granted in this chapter. (Ord. 1A-86 §6, 1986)

12.24.070 Tree maintenance Business--Insurance. Any person, before engaging in the business or occupation of removing, cutting or trimming trees in the City, shall furnish satisfactory evidence to the City arborist that the workmen employed by him are covered by a suitable workmen's compensation policy according to the laws of the state. (Ord. 1A-86 §7, 1986)

12.24.080 Felling of Trees and/or Limbs onto Streets. If a tree or limb will fall on any street, alley or sidewalk, the City arborist must be notified prior to felling.
(1) Safety requirements. The person to whom the permit is issued shall be responsible for placing such signs, flags, flares and barricades as are needed to warn persons of the danger of using the street, sidewalk or alley.
(2) Trees or branches, which are felled or trimmed onto public property, must be removed immediately unless an extension of time is granted by the City arborist in writing.
(3) Stump removal cavities must be cleared and refilled with soil in the same operation. At no time shall a cavity remain unfilled overnight. (Ord. 1A-86 §8, 1986)

12.24.090 Use of Trees and Shrubs. (a) No person shall fasten any sign, box, wire, rope or other material to, around or through any tree or shrub in any street, park or public place in the City except by the permission of the City arborist or when such materials are designed to preserve such tree or shrub and have been placed under a permit granted by the City arborist.
(b) No person shall deposit, place, store or maintain upon any street, park or public place in the City, any stone, brick sand, concrete or other material which shall impede the free passage of water, air and fertilizer to the roots of any tree or shrub growing therein except by permission of the City arborist or when such materials are designed for the construction of sidewalks, pavement, gutters or other public improvements under a permit granted by the City or some department thereof. (Ord. 1A-86 §§9, 10, 1986)

12.24.100 Arboricultural Specifications and Standards of Practice.

(1) Location.
(A) All trees and shrubs hereafter planted in any street shall be planted midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall not be planted within ten feet from the near edge of the road.
(B) Trees shall not be planted on the parking area if said parking is less than four feet nine inches in depth (sidewalk to curb) or contains less than twenty-four square feet of exposed soil or grass surface.
(C) Trees shall not be planted closer than thirty feet to the street intersections (property line extended) and four feet ten inches from any driveway.
(D) No tree shall be planted in the parking area whose mature size will encroach upon power lines or traffic signs.
(2) Trimming or Pruning.
(A) All cuts are to be made sufficiently close to the parent stem so that healing can readily start under normal conditions.
(B) All limbs over one inch in diameter must be bottom cut first to prevent stripping of bark as limbs fall. Any limbs which endanger other limbs, trees or property shall be lowered to the ground, not felled.
(C) To avoid the spreading of disease, tools shall be disinfected with alcohol before use on another tree. (Ord. 1A-86 511, 1986)

12.24.110 Removal of Trees. The City arborist shall remove, on the order of the Council, any tree on the streets of this municipality, which interferes with the making of improvements, or with travel thereon. He shall additionally remove any trees on the street, not on private property, which have become diseased or which constitute a public hazard or which may otherwise be declared a nuisance by the City arborist. (Ord. 1A-86 §12, 1986)

12.24.120 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 sixteen feet above the surface of the street and eight feet above the sidewalks. (Ord. 1A-86 §13, 1986)

12.24.130 Protecting Trees and Shrubs from Construction. During all building and construction operations, the contractor or builder shall erect suitable protective barriers around all trees and shrubs in any street, park or public place in the City in order to prevent said trees from being injured. (Ord. 1A-86 §14, 1986)

12.24.140 Damaging Trees or Shrubs. No person shall break, deface, injure, kill or destroy any tree or shrub or set fire or permit any fire to burn where such fire or heat thereof will injure any portion of any tree or shrub in any street, park or public place in the City. (Ord. 1A-86 §15, 1986)

12.24.150 Nuisances. (a) No person shall maintain, cause or permit any tree or shrub to be maintained in such a manner as to be considered a nuisance.
(b) In the event that such a nuisance occurs, a written complaint describing such nuisance and signed by the complainant must be filed with the City arborist or be filed by the City arborist.
(c) Upon receipt of a complaint, the City Council shall cause a notice to be issued to the owner of the property describing the property and the nuisance, which shall request the abatement of the

nuisance within fourteen days of the receipt of the notice. The owner shall receive a signed copy of the complaint form.
(d) In the event the owner of the property refuses to abate the nuisance within fourteen days of the receipt of the notice, the complainant may charge the property owner with a violation of this section by signing the appropriate citation. (Ord. 1A-86 §16, 1986)

12.24.160 Violations--Penalty. Violations of the provisions of this chapter shall, upon conviction, be subject to imprisonment not exceeding thirty days or a fine not exceeding one hundred dollars. (Ord. 1A-86 §17, 1986)