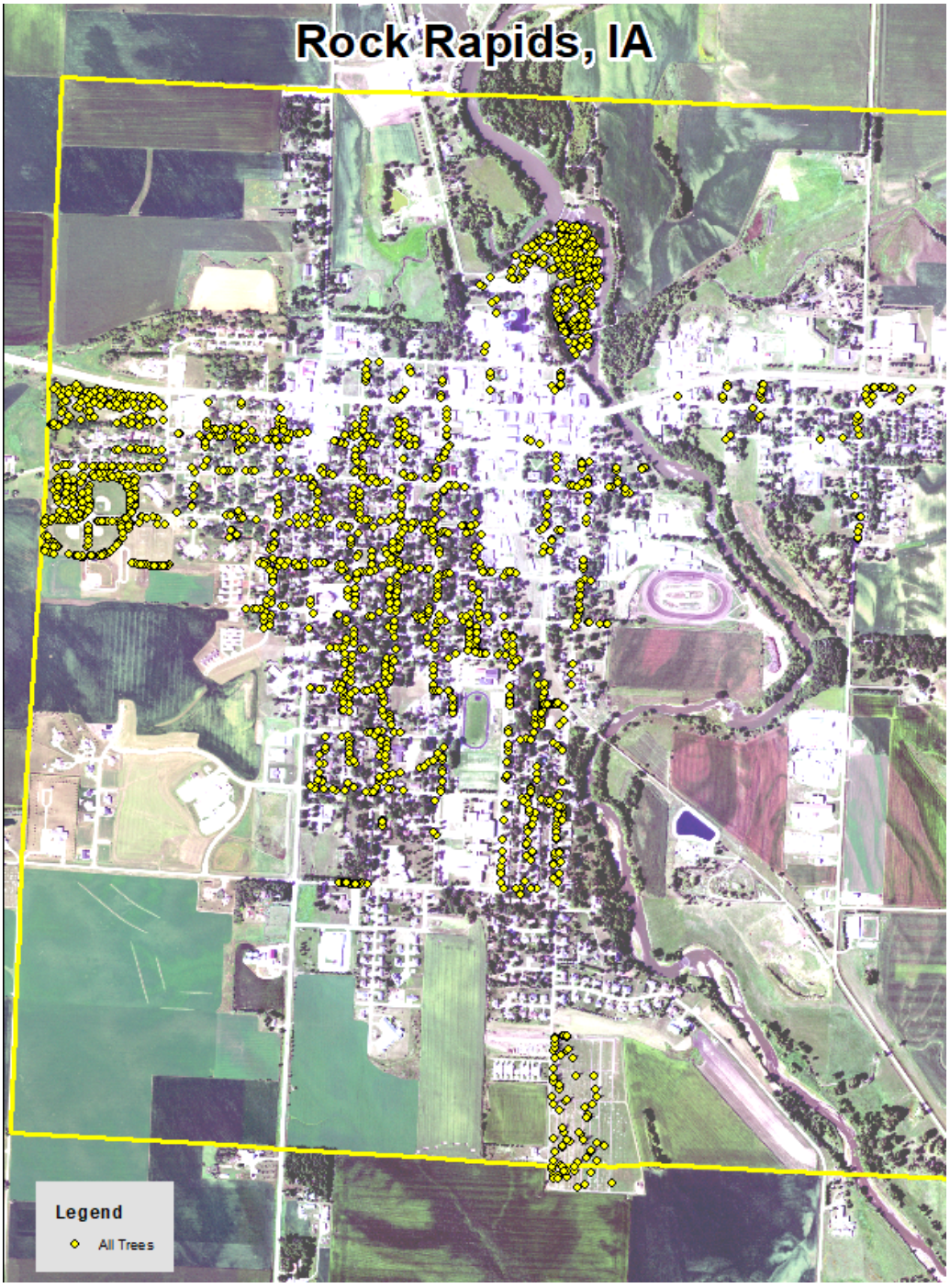
2023 Urban Forest Management Plan



For Rock Rapids, Iowa

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Executive Summary

Overview

This plan was developed to assist the City of Rock Rapids 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 21% of Rock Rapids' 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 2022, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 1,795 trees inventoried.

- Rock Rapids' trees provide $353,535 of benefits annually, an average of $197 a tree
- There are over 57 species of trees
- The top three genera are: Maple 36%, Ash 21%, and Spruce 10%
- 9% of trees are in need of some type of management
- 98 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 98 trees needing removal, 7 trees are critical concern and must be addressed immediately. Further, 7 other critical concern trees require immediate maintenance other than removal. *City ownership of the trees recommended for removal should be verified prior to any removal*
- 382 ash trees should be regularly monitored for 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
- With the current budget it could take 13 years to remove ash – Suggestion: request a budget increase to at least $70,000 annually and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Rock Rapids 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 recovery from Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal or treatment and replacement planting. With proper planning and management of the current canopy in Rock Rapids, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Rock Rapids' 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 Rock Rapids 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 Rock Rapids' urban forestry goals.

Inventory

In 2022, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

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

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms 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 1,795 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as 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. Rock Rapids' trees reduce energy related costs by approximately $89,738 annually (Appendix A, Table 1). These savings are both in Electricity (431.1 MWh) and in Natural Gas (58,182.5 Therms).

Annual Stormwater Benefits

Rock Rapids' trees intercept about 4,892,007 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $132,573 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 Rock Rapids, it is estimated that trees remove 5,511 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 $15,475 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Rock Rapids, trees sequester about 1,705,866 lbs of carbon a year with an associated value of $12,794 (Appendix A, Table 5). In addition, the trees store 17,104,075 lbs of carbon, with a yearly benefit of $128,281 (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. Rock Rapids receives $102,954 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, Rock Rapids' trees provide $353,535 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,795 trees in Rock Rapids provide approximately $197 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Rock Rapids has over 57 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	654	36%
Ash	382	21%
Spruce	172	10%
Hackberry	170	9%
Linden/Basswood	82	5%
Honeylocust	69	4%
Apple	56	3%
Oak	37	2%
Walnut	27	2%
Elm	20	1%
Buckeye	17	1%
Birch	14	1%
Cedar	13	1%
Pine	12	1%
Cottonwood/Poplar	11	1%
Dogwood	10	1%
Cherry	9	<1%
Unknown Conifer Evergreen	7	<1%
Unknown Broadleaf Deciduous	6	<1%
Kentucky coffeetree	5	<1%
Sumac	5	<1%
Eastern hophornbeam	3	<1%
Mulberry	3	<1%
Willow	3	<1%

Amur corktree	2	<1%
Catalpa	2	<1%
Sycamore	1	<1%
Gingko	1	<1%
Aspen	1	<1%
Buckthorn	1	<1%

Age Class

Most of Rock Rapids' trees (55%) are between 6 and 24 inches in diameter at 4.5 ft (Appendix A, Figure 2). 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. Rock Rapids' size curve is on the smaller side, indicating a younger than average stand.

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 Rock Rapids indicate that 96% of the trees are in good health, with only 4% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 2). Similarly, 88% of Rock Rapids' trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 2). Wood condition that is in poor health, dead or dying is about 12% of the population.

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 4).

Tree Removal	98	5%
Crown Cleaning	46	3%
Crown Reduction	9	<1%
Tree Staking	7	<1%
Crown Raising	2	<1%

Canopy Cover

The total canopy with both private and public trees is 10%, or 254 acres. The canopy cover on city-owned properties included in the Rock Rapids inventory includes approximately 49 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years on all lands. To achieve this goal it is estimated that 185 trees need to be planted annually on public and/or private lands.

Land Use and Location

The majority of Rock Rapids' city and park trees are in 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	55%
Park/vacant/other	43%
Industrial/Large commercial	2%
Small commercial	<1%
Multifamily residential	<1%

Location	
Planting strip	49%
Other maintained locations	37%
Front yard	13%
Median	<1%
Other un-maintained locations	<1%
Cutout (surrounded by pavement)	<1%

Changes in Forest Structure Since 2014 Plan

- 507 more trees inventoried (mostly due to the inclusion of Island Park Campground)
- $107,035 more in annual benefits
- 54 more trees recommended for removal
- Nearly 9% increase in total canopy cover for public and private trees

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

Rock Rapids has 7 critical concern trees that need immediate removal and 7 critical concern trees that need immediate cleaning/reducing. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 3). It is recommended to start with the large diameter critical concern trees first. There are 11 trees 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 154 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 2 & Appendix B, Figure 3). Of the 14 critical concern trees, 1 is an ash tree. There are a total of 382 ash trees. In addition, there are 83 trees of other species that are in poor health and 16 that are dead/dying. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

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

Planting

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

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 (36%) (Appendix A, Figure 1).

Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut. All trees planted must meet the restrictions in city ordinance Title VI, Ch. 3, Article 4 (Appendix C).

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

Budget and Emerald Ash Borer Plan

Six Year Maintenance Plan with <u>No Additional Funding</u>
Current Budget $44,000/year, Total $264,000 over 6 years

FY 2024 - Total: $41,100
Removal: 7 critical concern trees + 10 mature tree immediate, dead/dying trees + 18 other mature tree immediate = **$31,500**
Planting and Replacement: 35 x 1.2 = 42 trees to be planted in open locations, **$6,300**
Tree Pruning & Maintenance: Reduce/clean 7 critical concern trees + 19 mature tree immediate, and stake/train 2 young tree immediate + 5 young tree routine = **$3,300**
Visual Survey for signs and symptoms of EAB

FY 2025 - Total: $44,000
Removal: 35 mature tree immediate = **$31,500**
Planting and Replacement: 35 x 1.2 = 42 trees, **$6,300**
Tree Pruning & Maintenance: Reduce/clean 29 trees as noted and raise 2 young tree routine, **$3,100**
Routine trimming: ⅓ of city-owned trees is recommended, **$3,100**
Visual Survey for signs and symptoms of EAB

FY 2026 - Total: $44,000
Removal: 4 mature tree immediate + 4 young tree immediate + 19 mature tree routine + 1 young tree routine **(Note: This concludes all trees marked for removal/maintenance in the 2022 inventory. Proactive removal of ash will be prioritized beyond this point)** + 11 ash trees = **$35,100**
Planting and Replacement: 39 x 1.2 = 47 trees, **$7050**
Tree Pruning & Maintenance: As needed, **$1,850**
Visual Survey for signs and symptoms of EAB

FY 2027 - Total: $44,000
Removal: 36 ash trees, **$32,400**
Planting and Replacement: 36 x 1.2 = 43 trees, **$6,450**
Routine trimming: 1/3 of the city trees, **$3,000**
Tree Pruning & Maintenance: As needed, **$2,150**
Visual Survey for signs and symptoms of EAB

FY 2028 - Total: $44,000
Removal: 38 ash trees, **$34,200**
Planting and Replacement: 38 x 1.2 = 46 trees, **$6,900**
Tree Pruning & Maintenance: **$2,900**
Visual Survey for signs and symptoms of EAB

FY 2029 - Total: $44,000
Removal: 36 ash trees, **$32,400**
Planting and Replacement: 36 x 1.2 = 43 trees, **$6,450**
Routine trimming: 1/3 of the city trees, **$3,000**
Tree Pruning & Maintenance: **$2,150**
Visual Survey for signs and symptoms of EAB

*Amounts given are based on an estimate of $900/tree for removals, $150/tree for planting and maintenance, and $100/tree for pruning/maintenance in FY 2024 & 2025 only. Pruning/maintenance in FY 2026-2029 is allocated whatever funds remain after removals and planting.

Reduction of ash over 6 years

Approximately 137 ash trees removed (approximately 36% of ash). It will take approximately 13 years to remove/replace all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival. To remove/replace all ash trees within 6 years, the budget would need to be increased to approximately $88,000 a year. If the budget were increased to $70,000 a year all ash could be removed/replaced in 10 years.

Ash Tree Removal

Tree removal will be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 2). Next will be all ash in poor condition. *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 for your county.

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment

capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be disposed of as you normally would if your county is not part of a quarantine.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance Title VI, Ch. 3, Article 4 (Appendix C). The new plantings will be a diverse mix and should 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 if preventative treatments are not being used. City Code Title VI, Ch 3, Article 4.17 states, “The city shall notify the owner of any tree, shrub, bush or other woody vegetation located on private property to remove the tree, bush, shrub or other woody vegetation when such plant constitutes a public nuisance or is a hazard to person or property, or harbors insects, other pests, or disease. The city shall notify in writing the property owner of the property on which such tree, shrub, bush or other woody vegetation is located of the necessity to remove same. Upon such notice, the owner shall remove the planting at the owner’s expense within thirty (30) days. Notice shall either be given by personal service or by certified mail with return receipt barring the signature of the property owner. In the event the property owner fails to comply with the notice, the city may force compliance by legal process and if granted authority to perform the required action, may there after assess the costs against the property for collection in the same manner as a property tax.”

<u>Proposed Budget Increase</u>

EAB could potentially kill all ash trees in Rock Rapids within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to approximately $88,000 a year. Additionally, it is recommended that Rock Rapids 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. This is an alternative 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 when EAB is found in Rock Rapids. It is suggested to consider increasing the budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Rock Rapids

Annual Energy Benefits of Public Trees

2/1/2023

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	115.8	8,789	15,090.0	14,788	23,577	(N/A)	21.3	26.3	61.56
Green ash	103.1	7,828	13,760.5	13,485	21,313	(N/A)	21.1	23.8	56.38
Norway maple	45.7	3,465	6,403.6	6,276	9,741	(N/A)	10.3	10.9	52.65
Northern hackberry	51.8	3,931	7,325.8	7,179	11,110	(N/A)	9.5	12.4	65.35
Blue spruce	10.4	789	1,402.9	1,375	2,164	(N/A)	6.1	2.4	19.67
Honeylocust	21.3	1,620	2,760.3	2,705	4,325	(N/A)	3.8	4.8	62.69
Littleleaf linden	13.1	991	1,805.3	1,769	2,760	(N/A)	3.4	3.1	45.25
Apple	5.0	380	782.0	766	1,147	(N/A)	3.1	1.3	20.48
Spruce	5.0	379	648.6	636	1,014	(N/A)	2.7	1.1	21.13
Sugar maple	10.5	799	1,432.4	1,404	2,203	(N/A)	2.4	2.5	51.23
Black walnut	7.8	592	1,077.8	1,056	1,648	(N/A)	1.5	1.8	61.05
Amur maple	1.1	80	182.9	179	260	(N/A)	1.2	0.3	11.80
American basswood	7.7	586	1,102.2	1,080	1,666	(N/A)	1.2	1.9	79.32
Ohio buckeye	3.0	229	398.2	390	619	(N/A)	0.9	0.7	36.41
Bur oak	2.2	168	310.7	304	473	(N/A)	0.8	0.5	31.53
Norway spruce	2.4	183	314.7	308	491	(N/A)	0.8	0.5	35.07
Elm	2.2	166	293.2	287	453	(N/A)	0.7	0.5	34.85
Northern red oak	1.1	81	145.0	142	224	(N/A)	0.6	0.2	20.33
Red maple	1.8	140	242.8	238	378	(N/A)	0.6	0.4	34.37
Boxelder	2.0	150	265.9	261	411	(N/A)	0.6	0.5	41.07
Dogwood	0.1	5	12.6	12	18	(N/A)	0.6	0.0	1.77
Northern white cedar	1.3	97	151.1	148	245	(N/A)	0.6	0.3	24.48
River birch	1.2	93	172.7	169	263	(N/A)	0.4	0.3	32.84
Swamp white oak	0.5	38	80.6	79	117	(N/A)	0.4	0.1	16.71
Kwanzan cherry	0.3	24	55.7	55	79	(N/A)	0.3	0.1	13.17
Conifer Evergreen Large	1.0	73	122.8	120	193	(N/A)	0.3	0.2	32.21
Paper birch	1.0	75	122.2	120	195	(N/A)	0.3	0.2	32.43
Cottonwood	2.7	205	358.3	351	556	(N/A)	0.3	0.6	92.74
Sumac	0.0	3	6.3	6	9	(N/A)	0.3	0.0	1.77
Broadleaf Deciduous Small	0.1	8	18.5	18	26	(N/A)	0.3	0.0	5.24
Scotch pine	0.8	63	108.1	106	169	(N/A)	0.3	0.2	33.83
Kentucky coffeetree	0.3	21	32.1	31	52	(N/A)	0.3	0.1	10.40
Siberian elm	0.7	53	90.6	89	141	(N/A)	0.2	0.2	35.35
Austrian pine	0.2	19	35.1	34	53	(N/A)	0.2	0.1	13.30
American elm	1.2	91	163.9	161	251	(N/A)	0.2	0.3	83.80
Eastern red cedar	0.2	18	35.4	35	53	(N/A)	0.2	0.1	17.58
Black poplar	1.2	88	161.0	158	246	(N/A)	0.2	0.3	82.02
White mulberry	0.4	31	60.1	59	90	(N/A)	0.2	0.1	29.89
Willow	0.8	60	106.4	104	164	(N/A)	0.2	0.2	54.80
Eastern hophornbeam	0.0	1	1.9	2	3	(N/A)	0.2	0.0	0.87
Eastern white pine	0.0	3	7.9	8	11	(N/A)	0.1	0.0	5.61
Eastern cottonwood	0.8	58	105.8	104	162	(N/A)	0.1	0.2	80.97
Amur corktree	0.6	44	87.0	85	130	(N/A)	0.1	0.1	64.76
White oak	0.1	7	14.2	14	21	(N/A)	0.1	0.0	10.65
Catalpa	0.5	37	67.4	66	103	(N/A)	0.1	0.1	51.33
Black ash	0.1	6	12.4	12	18	(N/A)	0.1	0.0	8.99
White ash	0.5	41	56.8	56	96	(N/A)	0.1	0.1	48.12
Cherry plum	0.0	2	4.4	4	6	(N/A)	0.1	0.0	3.13
Conifer Evergreen Medium	0.1	5	10.2	10	15	(N/A)	0.1	0.0	14.80
Buckthorn	0.0	0	0.6	1	1	(N/A)	0.1	0.0	0.87
Red pine	0.1	10	14.6	14	24	(N/A)	0.1	0.0	24.14
Black cherry	0.0	0	0.6	1	1	(N/A)	0.1	0.0	0.87
Broadleaf Deciduous Mediu	0.2	18	29.5	29	47	(N/A)	0.1	0.1	46.78
Oak	0.0	0	0.5	0	1	(N/A)	0.1	0.0	0.66
Ginkgo	0.0	0	0.4	0	1	(N/A)	0.1	0.0	0.57
American sycamore	0.3	25	46.9	46	71	(N/A)	0.1	0.1	70.91

Quaking aspen	0.2	18	27.0	26	44 (N/A)	0.1	0.0	44.23
Pin oak	0.4	33	56.2	55	88 (N/A)	0.1	0.1	87.97
Total	431.1	32,719	58,182.5	57,019	89,738 (N/A)	100.0	100.0	49.99

Table 2: Annual Stormwater Benefits

Rock Rapids

Annual Stormwater Benefits of Public Trees

2/1/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,666,425	45,160	(N/A)	21.3	34.1	117.91
Green ash	1,098,345	29,765	(N/A)	21.1	22.5	78.74
Norway maple	399,009	10,813	(N/A)	10.3	8.2	58.45
Northern hackberry	475,475	12,885	(N/A)	9.5	9.7	75.80
Blue spruce	131,088	3,552	(N/A)	6.1	2.7	32.30
Honeylocust	220,250	5,969	(N/A)	3.8	4.5	86.50
Littleleaf linden	133,062	3,606	(N/A)	3.4	2.7	59.11
Apple	17,947	486	(N/A)	3.1	0.4	8.68
Spruce	72,568	1,967	(N/A)	2.7	1.5	40.97
Sugar maple	108,059	2,928	(N/A)	2.4	2.2	68.10
Black walnut	85,154	2,308	(N/A)	1.5	1.7	85.47
Amur maple	3,665	99	(N/A)	1.2	0.1	4.51
American basswood	111,184	3,013	(N/A)	1.2	2.3	143.48
Ohio buckeye	18,666	506	(N/A)	0.9	0.4	29.76
Bur oak	21,458	582	(N/A)	0.8	0.4	38.77
Norway spruce	55,062	1,492	(N/A)	0.8	1.1	106.58
Elm	23,158	628	(N/A)	0.7	0.5	48.27
Northern red oak	9,238	250	(N/A)	0.6	0.2	22.76
Red maple	14,461	392	(N/A)	0.6	0.3	35.63
Boxelder	19,820	537	(N/A)	0.6	0.4	53.71
Dogwood	197	5	(N/A)	0.6	0.0	0.53
Northern white cedar	17,509	474	(N/A)	0.6	0.4	47.45
River birch	7,157	194	(N/A)	0.4	0.1	24.24
Swamp white oak	2,681	73	(N/A)	0.4	0.1	10.38
Kwanzan cherry	1,134	31	(N/A)	0.3	0.0	5.12
Conifer Evergreen Large	19,860	538	(N/A)	0.3	0.4	89.70
Paper birch	6,220	169	(N/A)	0.3	0.1	28.09
Cottonwood	40,138	1,088	(N/A)	0.3	0.8	181.29
Sumac	98	3	(N/A)	0.3	0.0	0.53
Broadleaf Deciduous Small	355	10	(N/A)	0.3	0.0	1.93
Scotch pine	18,322	497	(N/A)	0.3	0.4	99.30
Kentucky coffeetree	1,691	46	(N/A)	0.3	0.0	9.16
Siberian elm	5,553	150	(N/A)	0.2	0.1	37.62
Austrian pine	2,813	76	(N/A)	0.2	0.1	19.06
American elm	11,881	322	(N/A)	0.2	0.2	107.33
Eastern red cedar	3,452	94	(N/A)	0.2	0.1	31.19
Black poplar	16,472	446	(N/A)	0.2	0.3	148.79
White mulberry	1,909	52	(N/A)	0.2	0.0	17.25
Willow	6,583	178	(N/A)	0.2	0.1	59.46
Eastern hophornbeam	22	1	(N/A)	0.2	0.0	0.20
Eastern white pine	426	12	(N/A)	0.1	0.0	5.77
Eastern cottonwood	11,182	303	(N/A)	0.1	0.2	151.51
Amur corktree	6,244	169	(N/A)	0.1	0.1	84.60
White oak	626	17	(N/A)	0.1	0.0	8.48
Catalpa	6,098	165	(N/A)	0.1	0.1	82.63
Black ash	325	9	(N/A)	0.1	0.0	4.41
White ash	3,325	90	(N/A)	0.1	0.1	45.05
Cherry plum	76	2	(N/A)	0.1	0.0	1.03
Conifer Evergreen Medium	755	20	(N/A)	0.1	0.0	20.47

Buckthorn	7	0	(N/A)	0.1	0.0	0.20
Red pine	1,539	42	(N/A)	0.1	0.0	41.70
Black cherry	7	0	(N/A)	0.1	0.0	0.20
Broadleaf Deciduous Medium	1,409	38	(N/A)	0.1	0.0	38.19
Oak	18	0	(N/A)	0.1	0.0	0.48
Ginkgo	7	0	(N/A)	0.1	0.0	0.19
American sycamore	3,943	107	(N/A)	0.1	0.1	106.85
Quaking aspen	1,466	40	(N/A)	0.1	0.0	39.72
Pin oak	6,412	174	(N/A)	0.1	0.1	173.76
Citywide total	4,892,007	132,573	(N/A)	100.0	100.0	73.86

Table 3: Annual Air Quality Benefits

Rock Rapids

Annual Air Quality Benefits of Public Trees

2/1/2023

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($) Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2							
Silver maple	286.1	48.5	140.6	12.7	1,543	544.5	79.8	76.2	523.8	3,410	-148.7	-558	1,563.6	4,396 (N/A)	21.3	11.48
Green ash	133.7	21.4	64.4	6.0	713	489.3	71.5	68.2	467.4	3,056	0.0	0	1,321.8	3,769 (N/A)	21.1	9.97
Norway maple	79.3	13.7	39.3	3.5	429	219.8	31.9	30.4	207.2	1,365	-18.8	-70	606.1	1,724 (N/A)	10.3	9.32
Northern hackberry	71.7	12.4	37.0	3.2	393	249.8	36.2	34.5	234.9	1,550	0.0	0	679.6	1,943 (N/A)	9.5	11.43
Blue spruce	15.9	3.2	13.8	2.0	107	49.3	7.2	6.9	47.0	308	-45.8	-172	99.5	243 (N/A)	6.1	2.21
Honeylocust	42.4	7.0	19.4	1.9	224	100.3	14.7	14.1	96.6	628	-32.7	-123	263.7	730 (N/A)	3.8	10.58
Littleleaf linden	23.1	4.0	11.3	1.0	125	62.6	9.1	8.7	59.3	390	-11.1	-42	168.0	473 (N/A)	3.4	7.75
Apple	4.2	0.7	2.1	0.2	23	24.8	3.5	3.4	22.7	152	0.0	0	61.6	175 (N/A)	3.1	3.12
Spruce	8.0	1.6	6.8	1.0	53	23.4	3.4	3.3	22.6	147	-30.6	-115	39.6	86 (N/A)	2.7	1.78
Sugar maple	13.6	2.3	7.0	0.6	74	50.1	7.3	7.0	47.7	313	-10.8	-41	124.8	346 (N/A)	2.4	8.05
Black walnut	10.2	1.6	4.9	0.5	55	37.3	5.4	5.2	35.4	232	0.0	0	100.6	287 (N/A)	1.5	10.63
Amur maple	0.5	0.1	0.3	0.0	3	5.4	0.8	0.7	4.8	33	0.0	0	12.6	36 (N/A)	1.2	1.63
American basswood	17.4	3.0	8.2	0.8	93	37.3	5.4	5.1	35.0	231	-14.1	-53	98.0	271 (N/A)	1.2	12.91
Ohio buckeye	2.9	0.5	1.5	0.1	16	14.3	2.1	2.0	13.7	89	-0.8	-3	36.3	102 (N/A)	0.9	6.02
Bur oak	2.2	0.4	1.1	0.1	12	10.6	1.5	1.5	10.1	66	0.0	0	27.5	78 (N/A)	0.8	5.22
Norway spruce	6.7	1.3	5.3	0.8	44	11.3	1.7	1.6	10.9	71	-32.5	-122	7.2	-7 (N/A)	0.8	-0.52
Elm	2.8	0.4	1.4	0.1	15	10.4	1.5	1.4	9.9	65	0.0	0	27.9	80 (N/A)	0.7	6.13
Northern red oak	1.8	0.3	0.9	0.1	10	5.1	0.7	0.7	4.9	32	-2.6	-10	11.9	32 (N/A)	0.6	2.90
Red maple	3.3	0.6	1.6	0.1	18	8.7	1.3	1.2	8.4	55	-1.1	-4	24.0	68 (N/A)	0.6	6.18
Boxelder	2.5	0.4	1.2	0.1	13	9.4	1.4	1.3	9.0	59	-1.0	-4	24.2	68 (N/A)	0.6	6.80
Dogwood	0.0	0.0	0.0	0.0	0	0.4	0.1	0.0	0.3	2	0.0	0	0.8	2 (N/A)	0.6	0.23
Northern white cedar	2.0	0.4	1.7	0.2	13	5.9	0.9	0.8	5.8	37	-7.4	-28	10.2	22 (N/A)	0.6	2.25
River birch	0.9	0.2	0.5	0.0	5	5.9	0.9	0.8	5.6	37	-0.3	-1	14.6	41 (N/A)	0.4	5.14
Swamp white oak	0.2	0.0	0.2	0.0	1	2.5	0.4	0.3	2.3	15	-0.1	0	5.8	16 (N/A)	0.4	2.35
Kwanzan cherry	0.2	0.0	0.1	0.0	1	1.6	0.2	0.2	1.5	10	0.0	0	3.9	11 (N/A)	0.3	1.83
Conifer Evergreen Large	2.4	0.5	1.9	0.3	16	4.5	0.7	0.6	4.4	28	-11.1	-41	4.2	2 (N/A)	0.3	0.39
Paper birch	0.4	0.1	0.3	0.0	2	4.6	0.7	0.6	4.5	29	0.0	0	11.1	31 (N/A)	0.3	5.21
Cottonwood	8.0	1.3	3.5	0.4	42	12.8	1.9	1.8	12.3	80	0.0	0	41.9	122 (N/A)	0.3	20.28
Sumac	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)	0.3	0.23
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.3	4 (N/A)	0.3	0.72
Scotch pine	2.2	0.4	1.8	0.3	14	3.9	0.6	0.5	3.8	25	-10.5	-39	3.0	0 (N/A)	0.3	-0.09
Kentucky coffeetree	0.1	0.0	0.1	0.0	1	1.2	0.2	0.2	1.2	8	0.0	0	3.0	9 (N/A)	0.3	1.71
Siberian elm	0.6	0.1	0.4	0.0	4	3.3	0.5	0.5	3.1	20	0.0	0	8.5	24 (N/A)	0.2	6.01
Austrian pine	0.3	0.1	0.3	0.0	2	1.2	0.2	0.2	1.1	7	-0.9	-3	2.4	6 (N/A)	0.2	1.48
American elm	2.1	0.4	1.0	0.1	11	5.7	0.8	0.8	5.4	36	0.0	0	16.4	47 (N/A)	0.2	15.68
Eastern red cedar	0.7	0.1	0.6	0.1	5	1.2	0.2	0.2	1.1	7	-1.9	-7	2.1	5 (N/A)	0.2	1.52
Black poplar	2.4	0.4	1.1	0.1	12	5.6	0.8	0.8	5.3	35	0.0	0	16.4	47 (N/A)	0.2	15.71
White mulberry	0.6	0.1	0.3	0.0	3	2.0	0.3	0.3	1.8	12	0.0	0	5.4	16 (N/A)	0.2	5.20
Willow	1.3	0.2	0.6	0.1	7	3.8	0.6	0.5	3.6	24	-0.3	-1	10.4	29 (N/A)	0.2	9.81
Eastern hophornbeam	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	0.2	0.11
Eastern white pine	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	-0.1	0	0.4	1 (N/A)	0.1	0.56
Eastern cottonwood	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)	0.1	15.76
Amur corktree	1.4	0.2	0.7	0.1	7	2.9	0.4	0.4	2.6	18	-0.3	-1	8.3	24 (N/A)	0.1	11.87
White oak	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)	0.1	1.54
Catalpa	0.8	0.1	0.4	0.0	4	2.3	0.3	0.3	2.2	14	0.0	0	6.5	19 (N/A)	0.1	9.35
Black ash	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	2 (N/A)	0.1	1.21
White ash	0.2	0.0	0.1	0.0	1	2.4	0.4	0.3	2.4	15	0.0	0	5.9	17 (N/A)	0.1	8.32
Cherry plum	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)	0.1	0.41
Conifer Evergreen Medium	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	2 (N/A)	0.1	1.53
Buckthorn	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)	0.1	0.11
Red pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3 (N/A)	0.1	2.82
Black cherry	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)	0.1	0.11
Broadleaf Deciduous Medium	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8 (N/A)	0.1	7.92
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)	0.1	0.08
Ginkgo	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)	0.1	0.07
American sycamore	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12 (N/A)	0.1	12.48
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)	0.1	7.42
Pin oak	1.3	0.2	0.7	0.1	7	2.0	0.3	0.3	2.0	13	-2.4	-9	4.5	11 (N/A)	0.1	10.96
Citywide total	759.4	128.6	385.7	36.8	4,137	2,049.7	299.0	285.2	1,953.1	12,788	-386.7	-1,450	5,510.9	15,475 (N/A)	100.0	8.62

Table 4: Annual Carbon Stored

Rock Rapids

Stored CO2 Benefits of Public Trees

2/1/2023

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	6,481,511	48,611	(N/A)	21.3	37.9	126.92
Green ash	4,375,303	32,815	(N/A)	21.1	25.6	86.81
Norway maple	1,308,023	9,810	(N/A)	10.3	7.6	53.03
Northern hackberry	1,067,899	8,009	(N/A)	9.5	6.2	47.11
Blue spruce	96,475	724	(N/A)	6.1	0.6	6.58
Honeylocust	544,443	4,083	(N/A)	3.8	3.2	59.18
Littleleaf linden	492,981	3,697	(N/A)	3.4	2.9	60.61
Apple	70,225	527	(N/A)	3.1	0.4	9.41
Spruce	70,154	526	(N/A)	2.7	0.4	10.96
Sugar maple	388,052	2,910	(N/A)	2.4	2.3	67.68
Black walnut	331,468	2,486	(N/A)	1.5	1.9	92.07
Amur maple	11,943	90	(N/A)	1.2	0.1	4.07
American basswood	664,540	4,984	(N/A)	1.2	3.9	237.34
Ohio buckeye	47,943	360	(N/A)	0.9	0.3	21.15
Bur oak	72,624	545	(N/A)	0.8	0.4	36.31
Norway spruce	83,929	629	(N/A)	0.8	0.5	44.96
Elm	94,047	705	(N/A)	0.7	0.5	54.26
Northern red oak	38,942	292	(N/A)	0.6	0.2	26.55
Red maple	36,481	274	(N/A)	0.6	0.2	24.87
Boxelder	79,821	599	(N/A)	0.6	0.5	59.87
Dogwood	466	3	(N/A)	0.6	0.0	0.35
Northern white cedar	17,109	128	(N/A)	0.6	0.1	12.83
River birch	16,376	123	(N/A)	0.4	0.1	15.35
Swamp white oak	4,856	36	(N/A)	0.4	0.0	5.20
Kwanzan cherry	3,823	29	(N/A)	0.3	0.0	4.78
Conifer Evergreen La	28,154	211	(N/A)	0.3	0.2	35.19
Paper birch	14,119	106	(N/A)	0.3	0.1	17.65
Cottonwood	278,959	2,092	(N/A)	0.3	1.6	348.70
Sumac	233	2	(N/A)	0.3	0.0	0.35
Broadleaf Deciduous	1,127	8	(N/A)	0.3	0.0	1.69
Scotch pine	26,984	202	(N/A)	0.3	0.2	40.48
Kentucky coffeetree	3,894	29	(N/A)	0.3	0.0	5.84
Siberian elm	16,368	123	(N/A)	0.2	0.1	30.69
Austrian pine	1,488	11	(N/A)	0.2	0.0	2.79
American elm	46,199	346	(N/A)	0.2	0.3	115.50
Eastern red cedar	2,247	17	(N/A)	0.2	0.0	5.62
Black poplar	77,829	584	(N/A)	0.2	0.5	194.57
White mulberry	9,958	75	(N/A)	0.2	0.1	24.89
Willow	21,528	161	(N/A)	0.2	0.1	53.82
Eastern hophornbeam	41	0	(N/A)	0.2	0.0	0.10
Eastern white pine	76	1	(N/A)	0.1	0.0	0.29
Eastern cottonwood	55,031	413	(N/A)	0.1	0.3	206.37
Amur corktree	22,225	167	(N/A)	0.1	0.1	83.35
White oak	1,047	8	(N/A)	0.1	0.0	3.93
Catalpa	26,978	202	(N/A)	0.1	0.2	101.17
Black ash	437	3	(N/A)	0.1	0.0	1.64
White ash	7,344	55	(N/A)	0.1	0.0	27.54
Cherry plum	192	1	(N/A)	0.1	0.0	0.72
Conifer Evergreen Ma	284	2	(N/A)	0.1	0.0	2.13
Buckthorn	14	0	(N/A)	0.1	0.0	0.10
Red pine	1,170	9	(N/A)	0.1	0.0	8.78
Black cherry	14	0	(N/A)	0.1	0.0	0.10
Broadleaf Deciduous	3,624	27	(N/A)	0.1	0.0	27.18
Oak	12	0	(N/A)	0.1	0.0	0.09
Ginkgo	5	0	(N/A)	0.1	0.0	0.03

American sycamore	15,773	118	(N/A)	0.1	0.1	118.30
Quaking aspen	3,672	28	(N/A)	0.1	0.0	27.54
Pin oak	37,616	282	(N/A)	0.1	0.2	282.12
Citywide total	17,104,075	128,281	(N/A)	100.0	100.0	71.47

Table 5: Annual Carbon Sequestered

Rock Rapids

Annual CO Benefits of Public Trees

2/1/2023

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
Silver maple	480,085	3,601	-31,125	-1,279	-243	194,239	1,457	641,921	4,814 (N/A)	21.3	37.6	12.57
Green ash	237,714	1,783	-21,002	-1,050	-165	172,991	1,297	388,653	2,915 (N/A)	21.1	22.8	7.71
Norway maple	59,177	444	-6,280	-470	-51	76,585	574	129,012	968 (N/A)	10.3	7.6	5.23
Northern hackberry	62,612	470	-5,127	-479	-42	86,864	651	143,870	1,079 (N/A)	9.5	8.4	6.35
Blue spruce	7,328	55	-463	-176	-5	17,432	131	24,121	181 (N/A)	6.1	1.4	1.64
Honeylocust	48,840	366	-2,613	-162	-21	35,810	269	81,875	614 (N/A)	3.8	4.8	8.90
Littleleaf linden	27,139	204	-2,369	-163	-19	21,900	164	46,508	349 (N/A)	3.4	2.7	5.72
Apple	7,556	57	-337	-69	-3	8,406	63	15,555	117 (N/A)	3.1	0.9	2.08
Spruce	5,099	38	-337	-86	-3	8,365	63	13,041	98 (N/A)	2.7	0.8	2.04
Sugar maple	22,180	166	-1,864	-112	-15	17,659	132	37,863	284 (N/A)	2.4	2.2	6.60
Black walnut	18,821	141	-1,591	-81	-13	13,087	98	30,237	227 (N/A)	1.5	1.8	8.40
Amur maple	1,670	13	-57	-19	-1	1,775	13	3,368	25 (N/A)	1.2	0.2	1.15
American basswood	34,630	260	-3,190	-96	-25	12,939	97	44,284	332 (N/A)	1.2	2.6	15.82
Ohio buckeye	5,198	39	-232	-27	-2	5,054	38	9,993	75 (N/A)	0.9	0.6	4.41
Bur oak	5,398	40	-349	-25	-3	3,722	28	8,747	66 (N/A)	0.8	0.5	4.37
Norway spruce	606	5	-403	-55	-3	4,035	30	4,183	31 (N/A)	0.8	0.2	2.24
Elm	4,886	37	-451	-24	-4	3,662	27	8,072	61 (N/A)	0.7	0.5	4.66
Northern red oak	1,529	11	-187	-14	-2	1,800	14	3,129	23 (N/A)	0.6	0.2	2.13
Red maple	2,657	20	-175	-17	-1	3,097	23	5,562	42 (N/A)	0.6	0.3	3.79
Boxelder	6,365	48	-383	-24	-3	3,317	25	9,275	70 (N/A)	0.6	0.5	6.96
Dogwood	145	1	-3	-3	0	119	1	259	2 (N/A)	0.6	0.0	0.19
Northern white cedar	1,233	9	-82	-20	-1	2,137	16	3,268	25 (N/A)	0.6	0.2	2.45
River birch	2,278	17	-79	-12	-1	2,064	15	4,252	32 (N/A)	0.4	0.2	3.99
Swamp white oak	1,092	8	-25	-6	0	840	6	1,901	14 (N/A)	0.4	0.1	2.04
Kwanzan cherry	502	4	-18	-5	0	539	4	1,018	8 (N/A)	0.3	0.1	1.27
Conifer Evergreen Large	931	7	-135	-18	-1	1,612	12	2,390	18 (N/A)	0.3	0.1	2.99
Paper birch	1,962	15	-68	-9	-1	1,655	12	3,540	27 (N/A)	0.3	0.2	4.43
Cottonwood	3,684	28	-1,339	-32	-10	4,538	34	6,852	51 (N/A)	0.3	0.4	8.56
Sumac	73	1	-1	-1	0	60	0	130	1 (N/A)	0.3	0.0	0.19
Broadleaf Deciduous Smal	178	1	-6	-2	0	178	1	348	3 (N/A)	0.3	0.0	0.52
Scotch pine	559	4	-130	-18	-1	1,396	10	1,808	14 (N/A)	0.3	0.1	2.71
Kentucky coffeetree	527	4	-19	-3	0	455	3	960	7 (N/A)	0.3	0.1	1.44
Siberian elm	1,173	9	-79	-7	-1	1,163	9	2,249	17 (N/A)	0.2	0.1	4.22
Austrian pine	153	1	-7	-4	0	416	3	558	4 (N/A)	0.2	0.0	1.05
American elm	1,474	11	-222	-11	-2	2,006	15	3,247	24 (N/A)	0.2	0.2	8.12
Eastern red cedar	99	1	-11	-4	0	400	3	484	4 (N/A)	0.2	0.0	1.21
Black poplar	2,879	22	-374	-13	-3	1,950	15	4,442	33 (N/A)	0.2	0.3	11.11
White mulberry	306	2	-48	-6	0	680	5	932	7 (N/A)	0.2	0.1	2.33
Willow	772	6	-103	-8	-1	1,329	10	1,989	15 (N/A)	0.2	0.1	4.97
Eastern hophornbeam	26	0	0	-1	0	17	0	42	0 (N/A)	0.2	0.0	0.10
Eastern white pine	36	0	0	-1	0	76	1	110	1 (N/A)	0.1	0.0	0.41
Eastern cottonwood	1,769	13	-264	-9	-2	1,287	10	2,783	21 (N/A)	0.1	0.2	10.44
Amur corktree	840	6	-107	-6	-1	979	7	1,706	13 (N/A)	0.1	0.1	6.40
White oak	211	2	-5	-1	0	163	1	368	3 (N/A)	0.1	0.0	1.38
Catalpa	1,168	9	-129	-5	-1	809	6	1,842	14 (N/A)	0.1	0.1	6.91
Black ash	191	1	-3	-1	0	129	1	316	2 (N/A)	0.1	0.0	1.18
White ash	987	7	-35	-4	0	898	7	1,846	14 (N/A)	0.1	0.1	6.92
Cherry plum	47	0	-1	-1	0	43	0	88	1 (N/A)	0.1	0.0	0.33
Conifer Evergreen Mediun	39	0	-1	-1	0	106	1	142	1 (N/A)	0.1	0.0	1.07
Buckthorn	9	0	0	0	0	6	0	14	0 (N/A)	0.1	0.0	0.10
Red pine	116	1	-6	-2	0	216	2	324	2 (N/A)	0.1	0.0	2.43
Black cherry	9	0	0	0	0	6	0	14	0 (N/A)	0.1	0.0	0.10
Broadleaf Deciduous Medi	386	3	-17	-2	0	395	3	762	6 (N/A)	0.1	0.0	5.71
Oak	3	0	0	0	0	4	0	7	0 (N/A)	0.1	0.0	0.05
Ginkgo	2	0	0	0	0	4	0	6	0 (N/A)	0.1	0.0	0.04
American sycamore	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	0.1	0.1	9.97
Quaking aspen	445	3	-18	-2	0	393	3	819	6 (N/A)	0.1	0.0	6.14
Pin oak	2,912	22	-181	-5	-1	728	5	3,454	26 (N/A)	0.1	0.2	25.90
Citywide total	1,069,565	8,022	-82,126	-4,660	-651	723,086	5,423	1,705,866	12,794 (N/A)	100.0	100.0	7.13

Table 6: Annual Social and Aesthetic Benefits

Rock Rapids

Annual Aesthetic/Other Benefits of Public Trees

2/1/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	37,625	(N/A)	21.3	36.5	98.24
Green ash	20,012	(N/A)	21.1	19.4	52.94
Norway maple	5,768	(N/A)	10.3	5.6	31.18
Northern hackberry	8,705	(N/A)	9.5	8.5	51.21
Blue spruce	2,393	(N/A)	6.1	2.3	21.76
Honeylocust	11,824	(N/A)	3.8	11.5	171.37
Littleleaf linden	2,829	(N/A)	3.4	2.7	46.37
Apple	429	(N/A)	3.1	0.4	7.65
Spruce	1,275	(N/A)	2.7	1.2	26.56
Sugar maple	2,400	(N/A)	2.4	2.3	55.81
Black walnut	1,552	(N/A)	1.5	1.5	57.48
Amur maple	93	(N/A)	1.2	0.1	4.23
American basswood	2,226	(N/A)	1.2	2.2	105.98
Ohio buckeye	542	(N/A)	0.9	0.5	31.87
Bur oak	527	(N/A)	0.8	0.5	35.13
Norway spruce	159	(N/A)	0.8	0.2	11.34
Elm	469	(N/A)	0.7	0.5	36.09
Northern red oak	127	(N/A)	0.6	0.1	11.54
Red maple	358	(N/A)	0.6	0.3	32.59
Boxelder	474	(N/A)	0.6	0.5	47.42
Dogwood	4	(N/A)	0.6	0.0	0.44
Northern white cedar	300	(N/A)	0.6	0.3	30.02
River birch	249	(N/A)	0.4	0.2	31.07
Swamp white oak	133	(N/A)	0.4	0.1	19.06
Kwanzan cherry	28	(N/A)	0.3	0.0	4.62
Conifer Evergreen Large	164	(N/A)	0.3	0.2	27.37
Paper birch	223	(N/A)	0.3	0.2	37.21
Cottonwood	238	(N/A)	0.3	0.2	39.70
Sumac	2	(N/A)	0.3	0.0	0.44
Broadleaf Deciduous Small	9	(N/A)	0.3	0.0	1.71
Scotch pine	106	(N/A)	0.3	0.1	21.13
Kentucky coffeetree	76	(N/A)	0.3	0.1	15.28
Siberian elm	114	(N/A)	0.2	0.1	28.57
Austrian pine	71	(N/A)	0.2	0.1	17.73
American elm	200	(N/A)	0.2	0.2	66.65
Eastern red cedar	41	(N/A)	0.2	0.0	13.58
Black poplar	200	(N/A)	0.2	0.2	66.60
White mulberry	18	(N/A)	0.2	0.0	5.85
Willow	78	(N/A)	0.2	0.1	26.11
Eastern hophornbeam	0	(N/A)	0.2	0.0	0.03
Eastern white pine	14	(N/A)	0.1	0.0	6.83
Eastern cottonwood	124	(N/A)	0.1	0.1	61.96
Amur corktree	75	(N/A)	0.1	0.1	37.26
White oak	34	(N/A)	0.1	0.0	16.91
Catalpa	95	(N/A)	0.1	0.1	47.58
Black ash	26	(N/A)	0.1	0.0	12.89
White ash	127	(N/A)	0.1	0.1	63.74
Cherry plum	2	(N/A)	0.1	0.0	1.05

Conifer Evergreen Medium	21 (N/A)	0.1	0.0	21.08
Buckthorn	0 (N/A)	0.1	0.0	0.03
Red pine	32 (N/A)	0.1	0.0	32.32
Black cherry	0 (N/A)	0.1	0.0	0.03
Broadleaf Deciduous Medium	39 (N/A)	0.1	0.0	39.16
Oak	5 (N/A)	0.1	0.0	5.26
Ginkgo	0 (N/A)	0.1	0.0	0.37
American sycamore	66 (N/A)	0.1	0.1	65.59
Quaking aspen	46 (N/A)	0.1	0.0	45.86
Pin oak	206 (N/A)	0.1	0.2	205.74
Citywide total	102,954 (N/A)	100.0	100.0	57.36

Table 7: Summary of Benefits in Dollars

Rock Rapids

Total Annual Benefits of Public Trees by Species ($)

2/1/2023

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	23,577	4,814	4,396	45,160	37,625	115,573	(N/A)	32.7
Green ash	21,313	2,915	3,769	29,765	20,012	77,774	(N/A)	22.0
Norway maple	9,741	968	1,724	10,813	5,768	29,014	(N/A)	8.2
Northern hackberry	11,110	1,079	1,943	12,885	8,705	35,722	(N/A)	10.1
Blue spruce	2,164	181	243	3,552	2,393	8,533	(N/A)	2.4
Honeylocust	4,325	614	730	5,969	11,824	23,463	(N/A)	6.6
Littleleaf linden	2,760	349	473	3,606	2,829	10,016	(N/A)	2.8
Apple	1,147	117	175	486	429	2,353	(N/A)	0.7
Spruce	1,014	98	86	1,967	1,275	4,439	(N/A)	1.3
Sugar maple	2,203	284	346	2,928	2,400	8,161	(N/A)	2.3
Black walnut	1,648	227	287	2,308	1,552	6,022	(N/A)	1.7
Amur maple	260	25	36	99	93	513	(N/A)	0.1
American basswood	1,666	332	271	3,013	2,226	7,508	(N/A)	2.1
Ohio buckeye	619	75	102	506	542	1,844	(N/A)	0.5
Bur oak	473	66	78	582	527	1,725	(N/A)	0.5
Norway spruce	491	31	-7	1,492	159	2,166	(N/A)	0.6
Elm	453	61	80	628	469	1,690	(N/A)	0.5
Northern red oak	224	23	32	250	127	656	(N/A)	0.2
Red maple	378	42	68	392	358	1,238	(N/A)	0.4
Boxelder	411	70	68	537	474	1,560	(N/A)	0.4
Dogwood	18	2	2	5	4	32	(N/A)	0.0
Northern white cedar	245	25	22	474	300	1,067	(N/A)	0.3
River birch	263	32	41	194	249	778	(N/A)	0.2
Swamp white oak	117	14	16	73	133	354	(N/A)	0.1
Kwanzan cherry	79	8	11	31	28	156	(N/A)	0.0
Conifer Evergreen Large	193	18	2	538	164	916	(N/A)	0.3
Paper birch	195	27	31	169	223	644	(N/A)	0.2
Cottonwood	556	51	122	1,088	238	2,055	(N/A)	0.6
Sumac	9	1	1	3	2	16	(N/A)	0.0
Broadleaf Deciduous Sm	26	3	4	10	9	51	(N/A)	0.0
Scotch pine	169	14	0	497	106	784	(N/A)	0.2
Kentucky coffeetree	52	7	9	46	76	190	(N/A)	0.1
Siberian elm	141	17	24	150	114	447	(N/A)	0.1
Austrian pine	53	4	6	76	71	210	(N/A)	0.1
American elm	251	24	47	322	200	845	(N/A)	0.2
Eastern red cedar	53	4	5	94	41	195	(N/A)	0.1
Black poplar	246	33	47	446	200	973	(N/A)	0.3
White mulberry	90	7	16	52	18	182	(N/A)	0.1
Willow	164	15	29	178	78	465	(N/A)	0.1
Eastern hophornbeam	3	0	0	1	0	4	(N/A)	0.0
Eastern white pine	11	1	1	12	14	38	(N/A)	0.0
Eastern cottonwood	162	21	32	303	124	641	(N/A)	0.2
Amur corktree	130	13	24	169	75	410	(N/A)	0.1
White oak	21	3	3	17	34	78	(N/A)	0.0
Catalpa	103	14	19	165	95	396	(N/A)	0.1
Black ash	18	2	2	9	26	57	(N/A)	0.0
White ash	96	14	17	90	127	344	(N/A)	0.1
Cherry plum	6	1	1	2	2	12	(N/A)	0.0

Conifer Evergreen Medi	15	1	2	20	21	59 (N/A)	0.0
Buckthorn	1	0	0	0	0	1 (N/A)	0.0
Red pine	24	2	3	42	32	103 (N/A)	0.0
Black cherry	1	0	0	0	0	1 (N/A)	0.0
Broadleaf Deciduous M	47	6	8	38	39	138 (N/A)	0.0
Oak	1	0	0	0	5	7 (N/A)	0.0
Ginkgo	1	0	0	0	0	1 (N/A)	0.0
American sycamore	71	10	12	107	66	266 (N/A)	0.1
Quaking aspen	44	6	7	40	46	143 (N/A)	0.0
Pin oak	88	26	11	174	206	504 (N/A)	0.1
Citywide Total	89,738	12,794	15,475	132,573	102,954	353,535 (N/A)	100.0

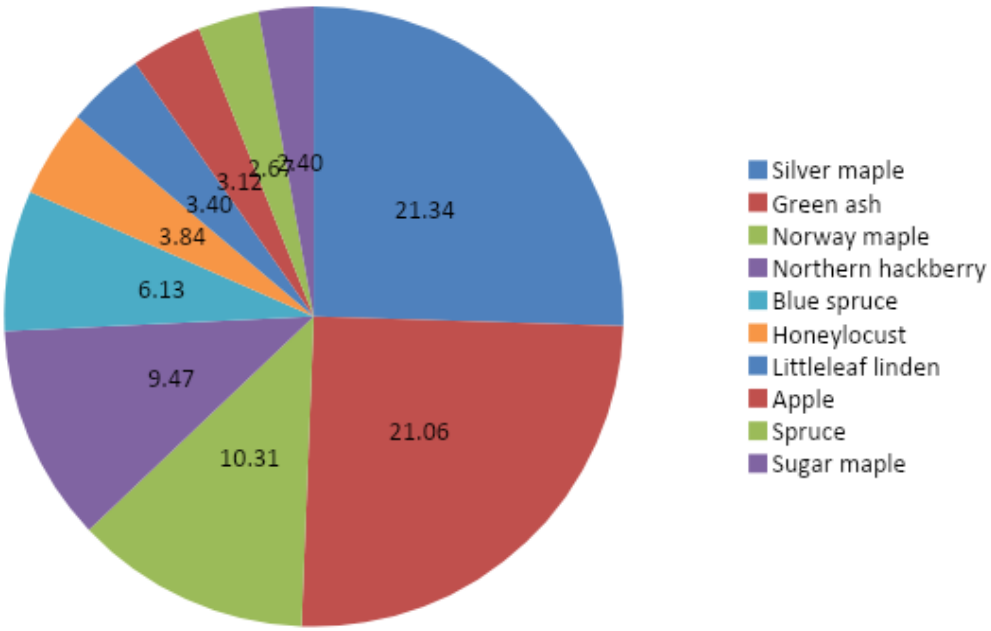

Figure 1: Species Distribution

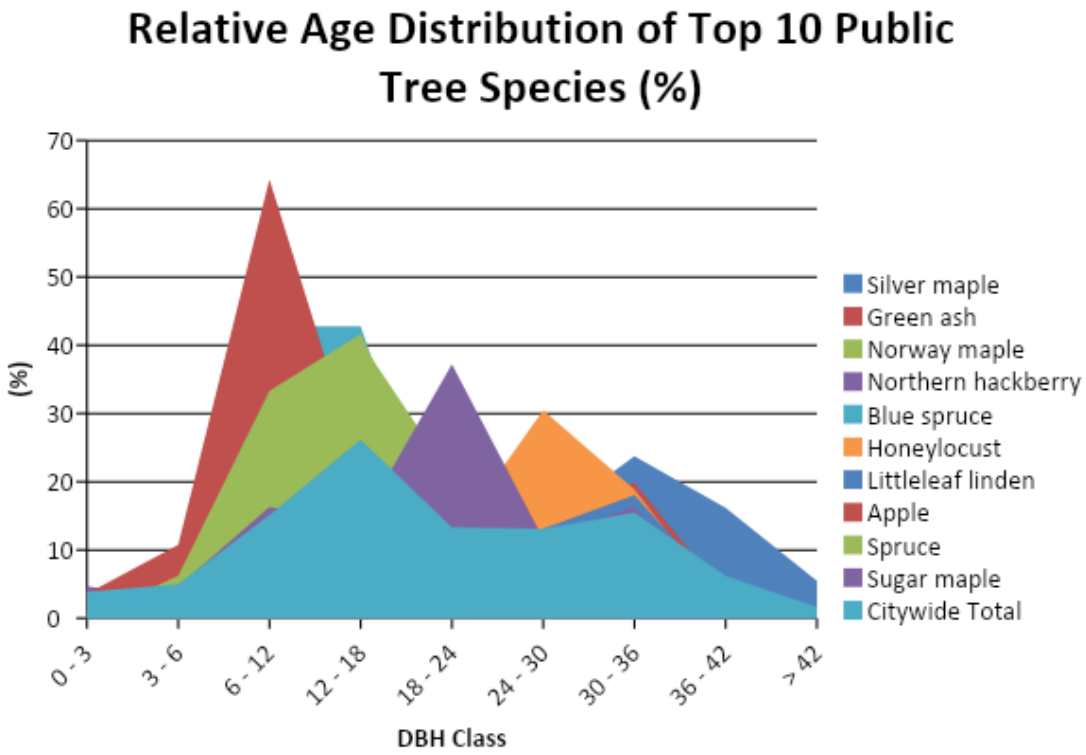

Figure 2: Relative Age Class

Figure 3: Foliage Condition

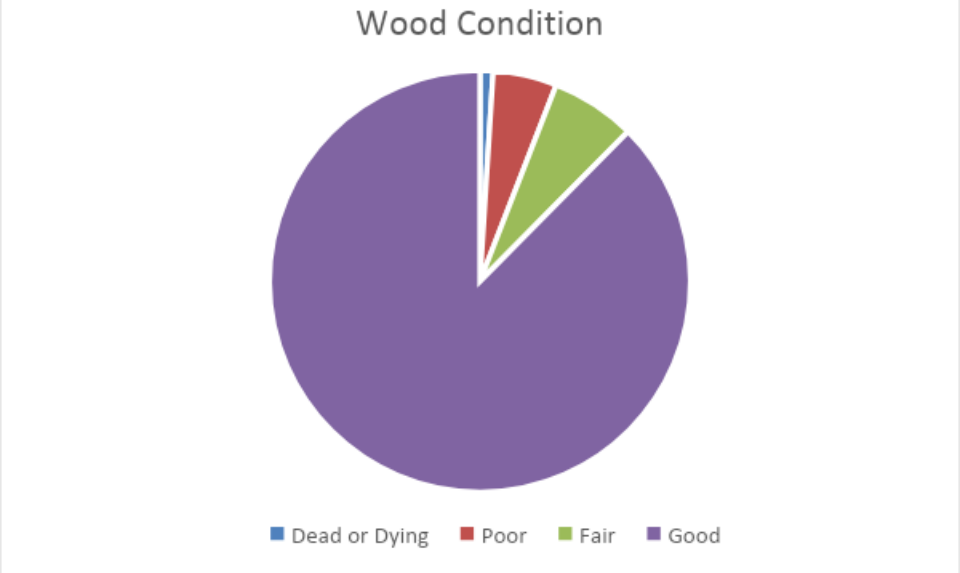

Figure 4: Wood Condition

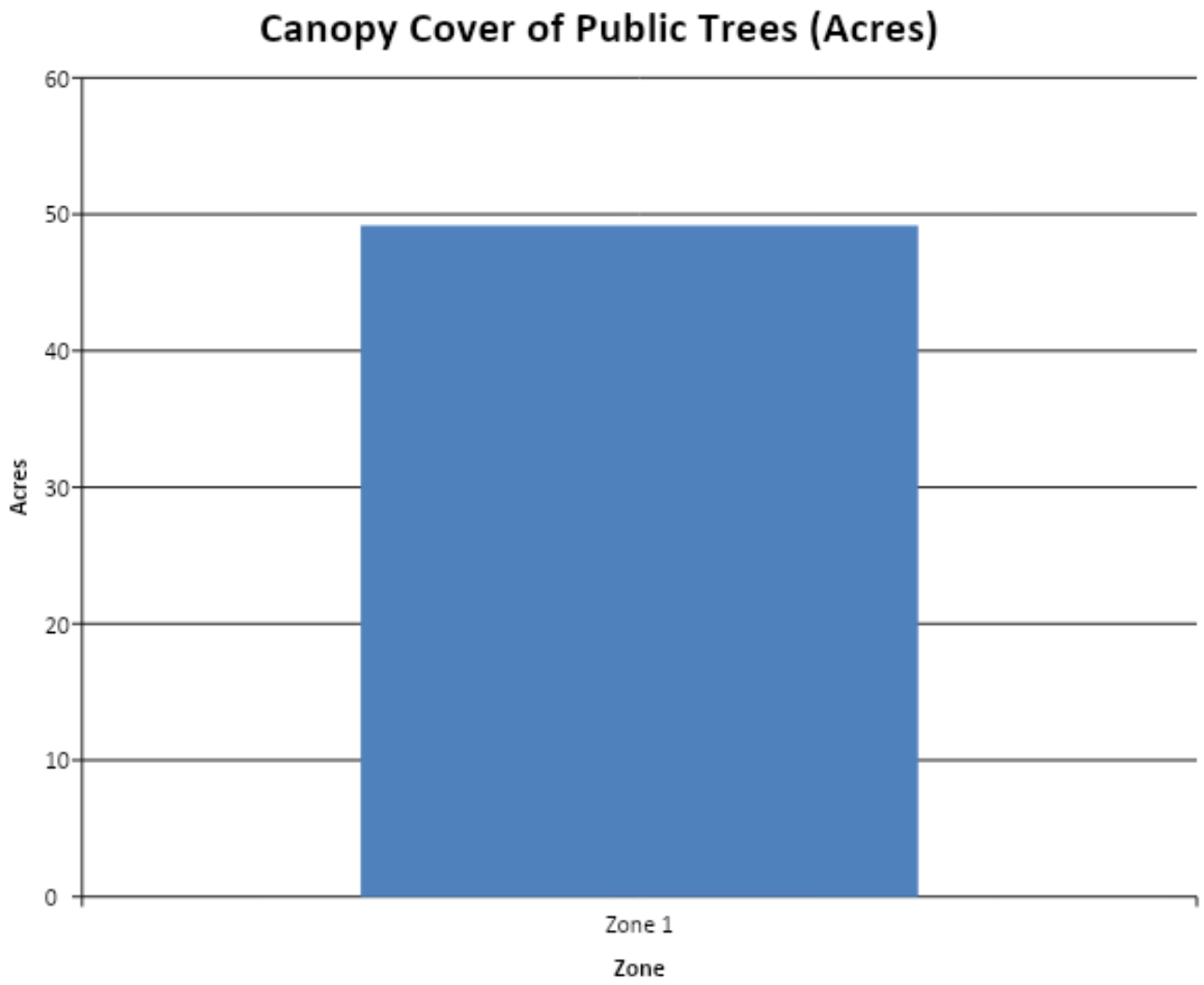

Figure 5: Canopy Cover in Acres

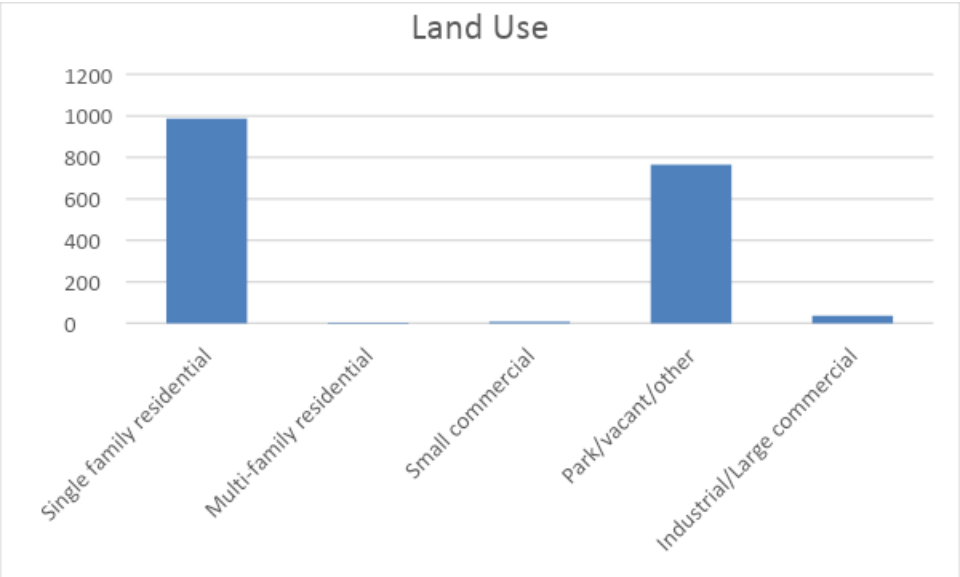

Figure 6: Land Use of city/park trees

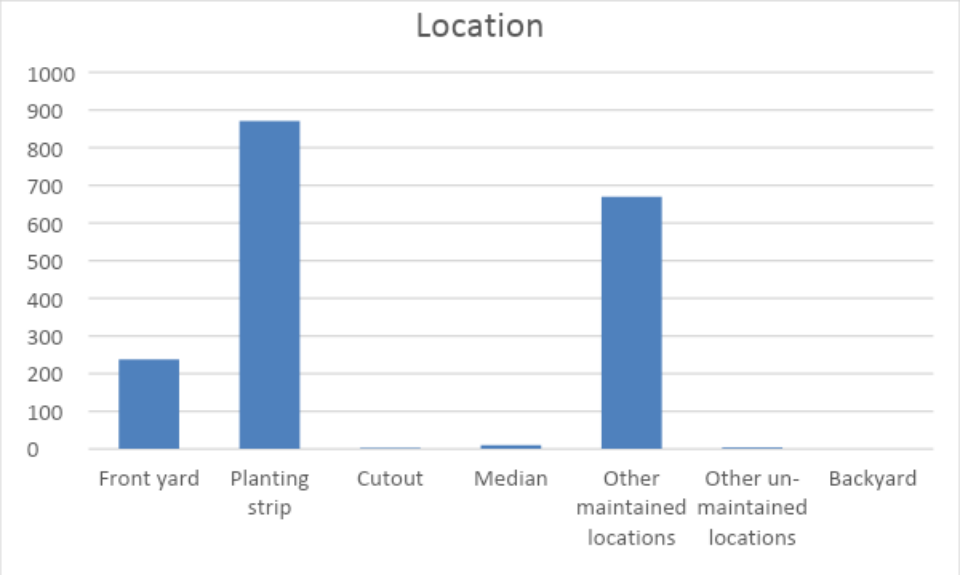

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

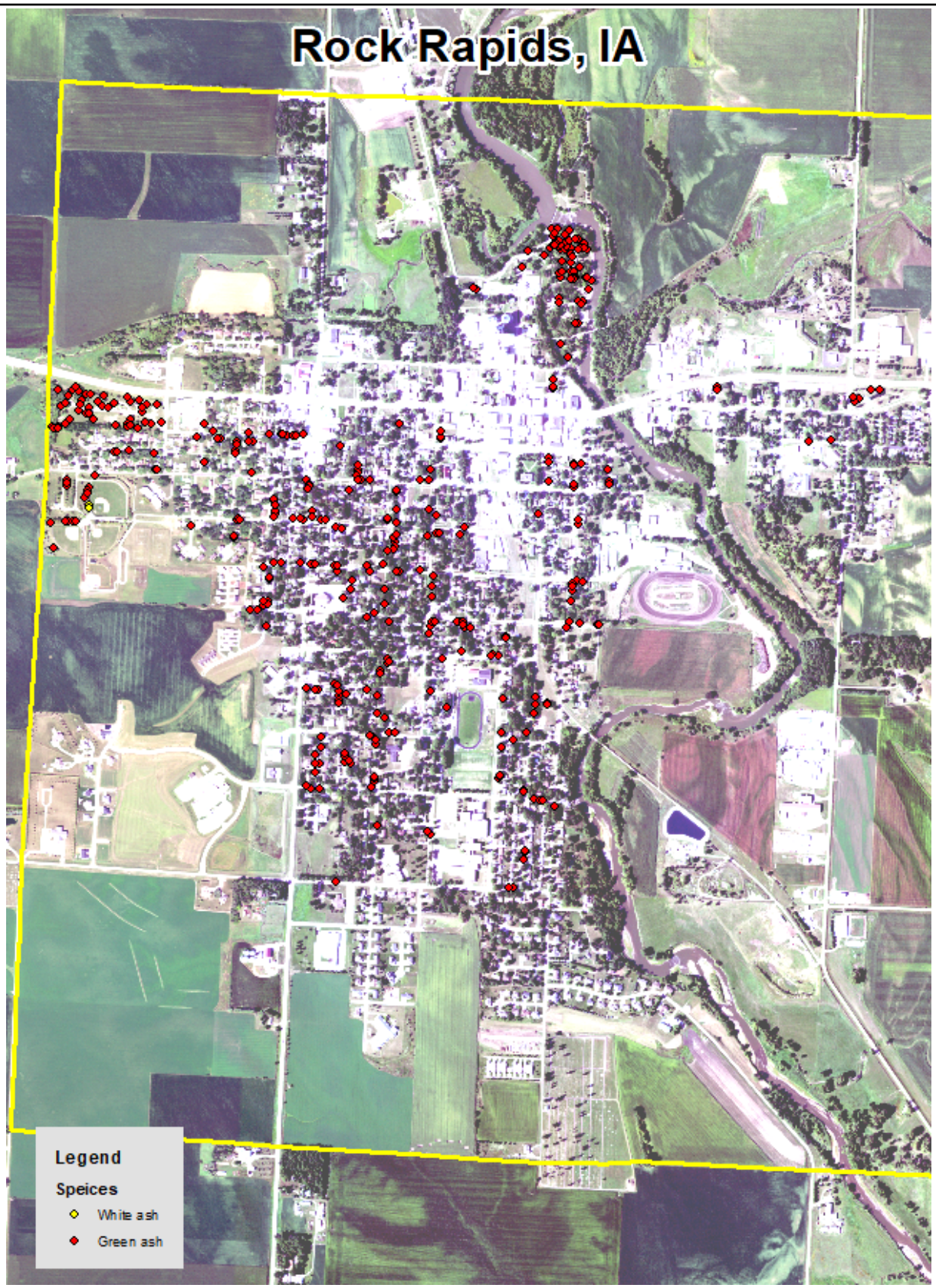

Figure 1: Location of Ash Trees

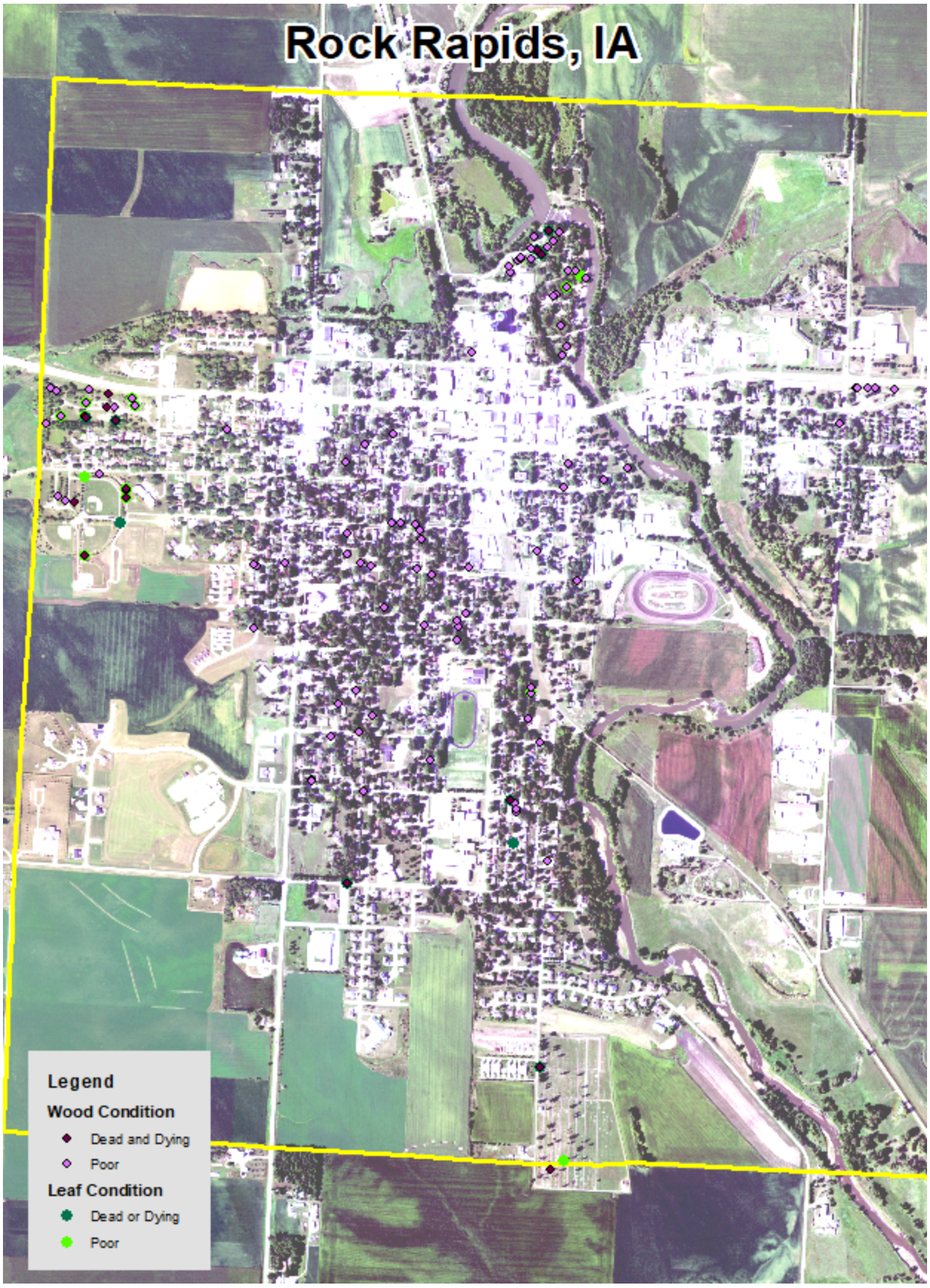

Figure 2: Location of Poor Condition Trees

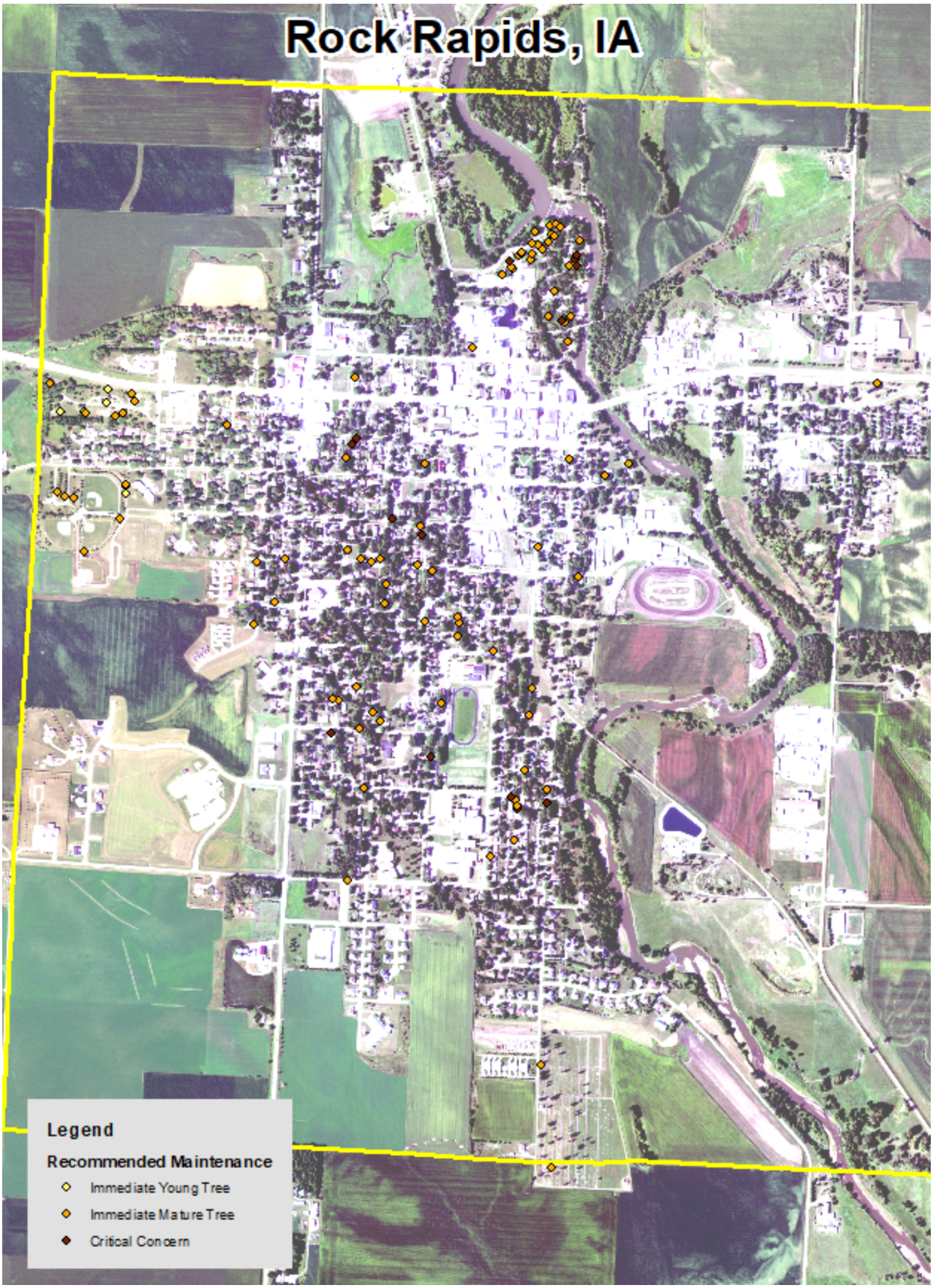

Figure 3: Location of Trees with Recommended Maintenance

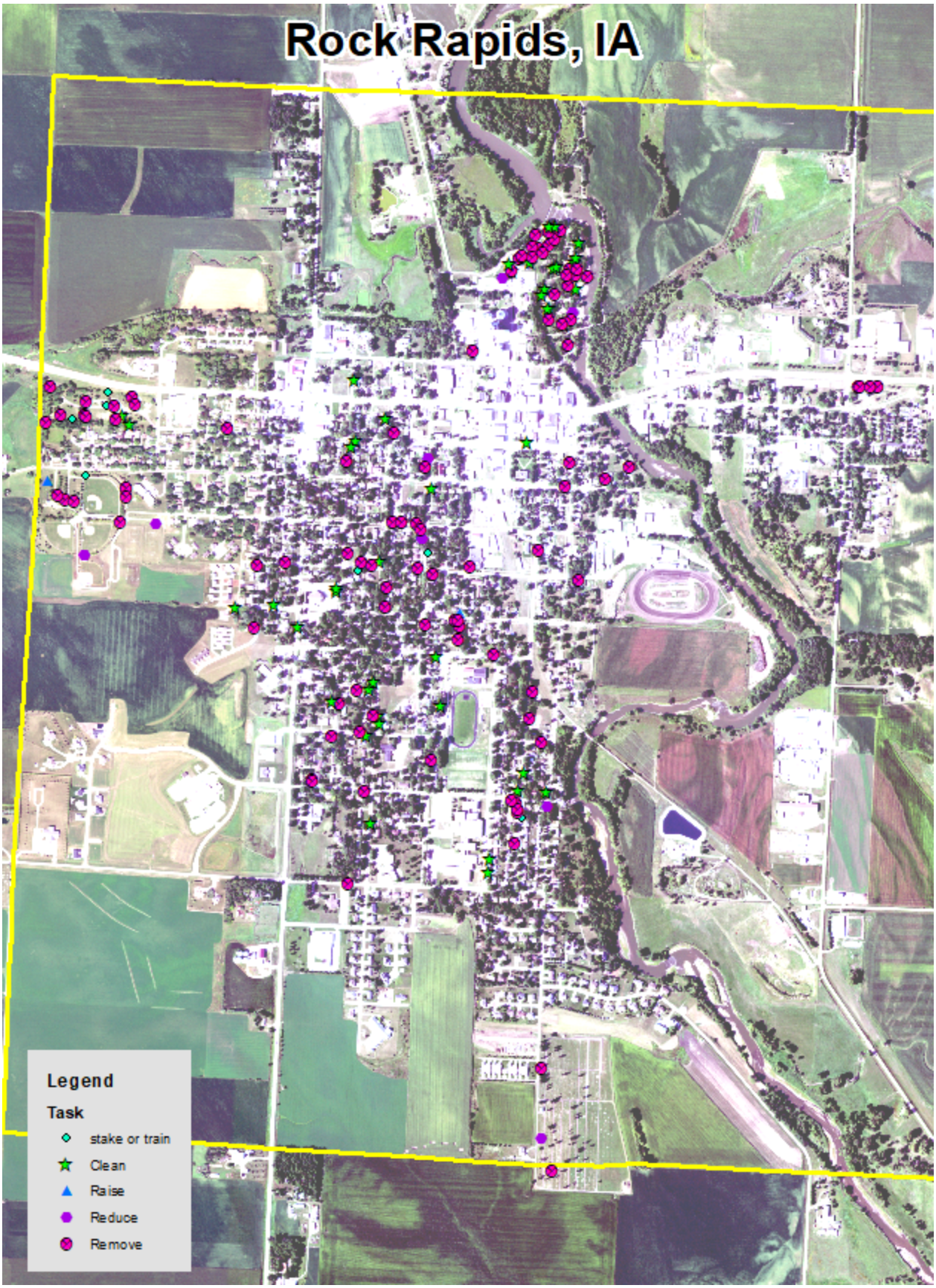

Figure 4: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Rock Rapids Tree Ordinances

TITLE VI

CITY OF ROCK RAPIDS, IOWA – 2016 CODE OF ORDINANCES

CHAPTER 3: TREES

ARTICLE 4 - MUNICIPAL TREE ORDINANCE

4.01 PURPOSE. The purpose of this ordinance (chapter) is to promote and protect the public health, safety and general welfare, as well as beautify and preserve the appearance of the city by providing for the regulation of the planting, maintenance, and removal of trees, shrubs, and other plants.

4.02 DEFINITIONS:

1. PARKING. Shall mean that part of the street, avenue or highway not covered by sidewalk and lying between the lot line and that portion of the street usually traveled by vehicular traffic. The term "tree lawn" may be used interchangeably.
2. LARGE TREES. Shall mean those trees attaining a height of 45 feet or more.
3. PARK. Shall mean all public parks having individual names.
4. URBAN FORESTER. Shall mean the superintendent of streets or such other person as may be designated by the council or city administrator.
5. TREE BOARD. Shall mean those five citizens and residents of the city who have been appointed by the mayor with the approval of the council.

4.03 TREE SERVICE BUSINESS. Shall mean any individual or company engaged in the planting, maintenance, pruning, or removal of trees that charges a fee or accepts other remuneration for the work completed.

4.04 URBAN FORESTER. The city shall designate an urban forester who will serve as an advisory member of the tree board. The superintendent of public works shall serve as the urban forester, in the absence of a separate position, for the duties assigned herein. The urban forester shall have the following general powers and duties: (1) to direct, manage, supervise, and control the city street program to include all planting, removal, maintenance, and protection of all trees and shrubs on public areas; (2) to guard all trees and shrubs within the city to prevent the spread of disease or pests and to eliminate dangerous conditions that may affect the life, health, or safety of persons or property; (3) such other powers and duties as are provided by the laws of Iowa; by ordinance of the city; and the tree board.

4.05 AUTHORITY. The urban forester, under the direction of the tree board, shall have the

authority and jurisdiction of regulating the planting, maintenance, and removal of trees on streets and other publicly owned property to ensure safety or preserve or enhance the aesthetics of such public sites. The urban forester shall have the authority to supervise or inspect all work done under a permit issued in accordance with terms of this ordinance. The urban forester shall have the authority to formulate and publish a master tree plan with the advice, hearing, and approval of the tree board.

4.06 PERMITS. Any person or tree service business who charges a fee to plant, spray, fertilize, preserve, prune, remove, cut above or below ground on any parking or municipal owned property shall first obtain an application and procure a permit from the urban forester or other specified municipal authority. The person receiving the permit shall abide by the arboricultural specifications and standards of practice adopted by the urban forester.

4.07 MAINTENANCE. All trees planted shall have trunks not less than one (1") inch in diameter at six (6") inches above the ground. No tree shall be planted closer than four (4') feet from the curb line or outer line of the sidewalk. Parking must be at least ten (10') feet in width for large tree plantings and at least eight (8') feet wide for medium trees and six (6') wide for small trees.

All trees shall be planted in line with each other and at a spacing of 40 to 60 feet for large trees and 30 to 40 feet for small or medium trees, depending on the species planted. No street tree shall be planted under or within 10 lateral feet of any overhead utility wire unless said species has a mature height five (5') feet below the lowest point of the overhead utility wire, or over or within 5 lateral feet of any underground utility wire. No trees or shrubs shall be planted on the parking within 50 lateral feet from corners or intersections as measured from the curb nearest the proposed planting. Trees shall be planted at least four (4') feet from any sidewalk, driveway or street.

All trees and shrubs on public or private property, which have branches overhanging a public street or sidewalk, shall have said branches trimmed to a clearance height of fourteen (14') feet on the street side and ten (10') feet on the sidewalk side.

Trees located in terraces or parking areas are the responsibility of the adjoining private property owner. The City reserves the right to remove or trim as necessary. However, the City assumes no responsibility or obligation concerning removal, or costs for removal, of trees in terraces or parking areas.

4.08 SPECIES, CULTIVARS, AND VARIETIES. The tree board shall develop and maintain a list of desirable trees for planting along streets in three classes: small, medium and large. A list of tree species not suitable for planting as street trees will also be created and enforced by the tree board.

4.09 OBSTRUCTION. It shall be the duty of any persons owning or occupying real property bordering on any street, upon which property there may be trees, to prune such trees in a manner that they will not obstruct or shade the street lights, obstruct the passage of pedestrians on sidewalks, obstruct vision of traffic signs, or obstruct view of any street or alley intersection. The minimum clearance of any overhanging portion thereof shall be 10 feet over sidewalks and 14 feet over all streets. All trees shall be planted at least four (4') feet from any permanent structure, sidewalk, driveway or street. When a person to whom an order is directed shall fail to comply within thirty (30) days, it shall be lawful for the city to prune such trees with the cost assessed to the owner as provided by law in special assessments.

4.10 NUISANCE AND CONDEMNATION. All street trees planted in violation of, or not maintained in strict compliance with the provision of this ordinance, or dangerous, are declared to constitute a public nuisance. The urban forester shall cause written notice to

be served on the property owner requiring such nuisances to be corrected within 30 days or the cost of correction may be assessed against the property owner, unless said assessment is waived by the urban forester or city administrator.

4.11 REMOVAL OF TREES. The Urban Forester shall have removed, on the order of the council, any tree on the streets of the city 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 danger to the public or which may otherwise be declared a nuisance.

(Code of Iowa, Sec. 364.12(2c))

4.12 MAINTENANCE OF PARKING OR TERRACE. It shall be the responsibility of the abutting property owner to maintain all property outside the lot and property line and inside the curb lines upon the public streets, except that the abutting property owner shall not be required to remove diseased trees or dead wood in the publicly owned property or right-of-way. Maintenance includes timely mowing, trimming trees and shrubs, and picking up litter.

4.13 FAILURE TO MAINTAIN PARKING OR TERRACE. If the abutting property owner does not perform an action required under the above section within a reasonable time, the City may perform the required action and assess the cost against the abutting property for collection in the same manner as a property tax.

4.14 PROTECTION OF TREES. During development, redevelopment, razing, or renovation, no more than 50 percent of the trees shall be damaged or removed except by specific permit issued by the tree board. No person shall intentionally damage, cut, carve, attach any rope, wire, nails, advertising posters, or other contrivance to any tree; allow any gaseous, liquid, chemical, or solid substance that is harmful to such trees to come in contact with them; or set fire or permit fire to burn when such fire or the heat will injure any portion of any tree located on public property including the parking area. Tree topping is prohibited on any publicly owned tree including those located in the parking areas.

4.15 APPEALS. Any person who receives an order from the urban forester and objects to all or a part thereof, within ten (10) days of receipt thereof, must notify the urban forester and the city administrator in writing, of the nature of the objection and request a hearing thereon before the city council. The hearing shall be held within then (10) days of notice to appellant. Within ten (10) days after such hearing, the mayor shall notify the appellant and the urban forester of the final decision.

4.16 INTERFERENCE. No person shall prevent, delay, or interfere with the urban forester or forester's assistants in the execution or enforcement of the ordinance.

4.17 DEAD OR DISEASED TREE REMOVAL ON PRIVATE PROPERTY. The city shall notify the owner of any tree, shrub, bush or other woody vegetation located on private property to remove the tree, bush, shrub or other woody vegetation when such plant constitutes a public nuisance or is a hazard to person or property, or harbors insects, other pests, or disease. The city shall notify in writing the property owner of the property on which such tree, shrub, bush or other woody vegetation is located of the necessity to remove same. Upon such notice, the owner shall remove the planting at the owner’s expense within thirty (30) days. Notice shall either be given by personal service or by certified mail with return receipt barring the signature of the property owner. In the event the property owner fails to comply with the notice, the city may force compliance by legal process and if granted authority to perform the required action, may there after assess the costs against the property for collection in the same manner as a property tax.

Code of Iowa, Chapter 364.12(3)(h) allows the City in an emergency to perform any

action which may be required to abate the emergency without prior notice, and assess the costs as provided in Chapter 364.12, after notice to the property owner and hearing.
4.18 DUTY TO REMOVE. No person, firm or corporation shall permit any diseased tree, dead wood to remain on the premises owned, controlled or occupied by the person within the City.
(Code of Iowa, Sec, 364.12(3b))
4.19 INSPECTION. The City shall inspect or cause to be inspected all premises and places within the City to determine whether any condition as defined in section 4.17 of this Article exists thereon, and shall also inspect or cause to be inspected any trees reported or suspected to constitute a public nuisance, a hazard to person or property, or harbors insects, other pests, or disease.
4.20 REMOVAL FROM CITY PROPERTY. If the City, upon inspection or examination, in person or by some qualified person acting for the City, shall determine that any condition as herein defined exists in or upon any public street, alley, park or any public place, including the strip between the curb and the lot line of private property within the City, and that the danger of other trees, shrubs, bushes, or woody vegetation within the City is imminent, the City shall immediately cause the tree, shrub, bush or woody vegetation to be removed and burned or otherwise correct the same in such manner as to destroy or prevent as fully as possible the spread of disease, or insect pests, or vectors known to carry such disease, insects, and/or fungus.
4.21 REMOVAL FROM PRIVATE PROPERTY. If the City upon inspection or examination, in person or by some qualified person acting for the City, shall determine with reasonable certainty that any condition as herein defined exists in or upon private premises, and that he danger to other trees within the City is imminent, he/she shall immediately notify by certified mail or personal delivery to the occupant or person in charge of such property, to correct such condition within thirty (30) days of said notification. If such owner, occupant or person in charge of said property fails to comply within thirty (30) days of receipt thereof, the Council may cause the nuisance to be removed and the cost assessed against the property for collection in the same manner as a property tax.
(Code of Iowa, Sec. 364.12(3b & h))
4.22 REASONABLE CERTAINTY. If the City is unable to determine with reasonable certainty whether or not a tree in or upon private premises is infected, diseased, or harboring insects or pests, a City representative is authorized to remove or cut specimens from said tree, and obtain a diagnosis of such specimens.
Editor's Note: Sections 4.17 to 4.22 were added at time of 2016 codification.

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