Dike, IA

2019 URBAN FOREST MANAGEMENT PLAN

IOWA DEPARTMENT OF NATURAL RESOURCES

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Executive Summary

Overview

This plan was developed to assist the City of Dike in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like 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 except mountain ash. There is a strong possibility that 21% of Dike's city-owned trees will die once EAB becomes established in the community, unless local leaders begin preventative treatment. 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 2019, JEO conducted a tree inventory 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 223 trees inventoried.

- Dike's trees provide $49,998 of benefits annually, an average of $224.21 per tree
- There are 15 species of trees
- The top three genera are: Maple 50%, Ash 21%, and Oak 8.5%
- 19% of trees need some type of management
- 6 trees should be removed

Recommendations

We detail our core recommendations in the Recommendations Section. In the Emerald Ash Borer Plan, we include management recommendations. Below are some key recommendations.

- Out of the 6 trees needing removal, 4 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*
- 4 of the 47 ash trees should be carefully examined, as they may 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 yearly with a visual survey.
- With the current budget it could take 13.5 years to remove ash. We suggest that city officials request a budget increase to $3,500 annually and apply for grants to plant replacement trees.

Introduction

This plan was developed to assist Dike with managing, budgeting, and future planning of their urban forest. Across the state, forestry budgets continue to decrease as a higher percentage of the budgets are devoted to 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, treatment, and replacement planting. With proper planning and management of the current canopy in Dike, these costs can be spread out over the years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important part of Dike's infrastructure and one of the city's greatest assets. The benefits of trees are immense. Trees improve air quality, intercept stormwater runoff, conserve energy, lower traffic speeds, increase property values, reduce crime, improve mental health, and create a desirable place to live, to name just a few. Good urban forestry management will maintain these important benefits for the people of Dike and future generations.

Urban forestry management sets goals and develops management strategies to achieve them. To develop management strategies, a comprehensive public tree inventory must be conducted. The inventory informs maintenance, removal schedules, tree planting, and budgeting. Aligning management actions with the tree inventory results will help meet Dike's urban forestry goals.

Inventory

In 2019, JEO conducted a tree inventory that included 100% of the city-owned trees on both streets and parks. The team collected tree data 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 data collectors' programming 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, for all ash trees, the team notes signs and symptoms associated with EAB including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

JEO entered the data collected for the 223 city trees into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. Below are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits
Trees conserve energy by shading buildings and blocking winds. Dike's trees reduce energy-related costs by approximately $13,617 annually (Appendix A, Table 1). These savings are both in electricity (64.7 MWh) and in natural gas (8,887.7 Therms).

Annual Stormwater Benefits
Dike's trees intercept about 771,889 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $20,918 in benefit 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 lessens emissions of volatile organic matter (ozone). In Dike, it is estimated that trees remove 891 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 $2,537 (Appendix A, Table 3).

Annual Carbon Benefits
Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Dike, trees sequester about 126,118 lbs of carbon per year with an associated value of $946 (Appendix A, Table 5). In addition, the trees store 3,063,562 lbs of carbon, with a yearly benefit of $22,977 (Appendix A, Table 4).

Annual Aesthetics Benefits
The social benefits of trees are hard to capture. The i-Tree 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. Dike receives $11,283 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, Dike's trees provide $49,998 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 223 trees in Dike provide approximately $224.21 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Dike has over 15 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	112	50%
Ash	47	21%
Oak	19	8.5%
Eastern Redbud	10	4.5%
Linden/Basswood	8	4%
Hackberry	6	3%
Locust	6	3%
Sycamore	3	1%
Alder	2	<1%
Broadleaf Deciduous Medium	2	<1%
Pear	2	<1%
Pine	2	<1%
Boxelder	1	<1%
Hickory	1	<1%
Spruce	1	<1%
Walnut	1	<1%

Age Class

Most of Dike's trees (39%) are between 24 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Dike's size curve indicates an average to older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Dike indicate that 75% 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 3). Similarly, 65% of Dike's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Four percent of the tree population's wood condition is in poor health, dead, or dying. This 4% 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).

Crown Cleaning	0	0%
Crown Raising	0	0%
Tree Staking	1	<1%
Tree Removal	6	3%
Crown Reduction	1	<1%

Land Use and Location

The majority of Dike's 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	89%
Park/vacant/other	1%
Industrial/Large commercial	10%
Small commercial	0%
Multifamily residential	0%

Recommendations

Risk Management

Hazardous trees can be a significant threat to both people and property. Trees that are dead, dying, or have large issues such as trunk cracks longer than 18 inches should be removed. Broken branches and branches that interfere with motorists' vision of pedestrians, vehicles, traffic signs and signals should be removed.

Hazardous trees

Dike has 6 trees that need immediate removal. These trees in addition to other trees needing maintenance can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). We recommend starting with the large-diameter, critical concern trees first. There are 4 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Proposed Work Schedule and Budget at the end of this section. After all the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 43 trees with maintenance needs.

Poor tree species

After removing the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 6 removals, 4 are ash trees. There are a total of 47 ash trees, and 4 of those have signs and symptoms that have been associated with EAB. In addition, there are 9 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 removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend that all trees be pruned on a routine schedule every five to seven years. Please refer to the Proposed Work Schedule and Budget for further information.

Planting

Most of the planting over the next five years will replace the trees that are removed. We recommend planting 1.2 trees for every tree removed, since survival rates will not be 100%. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Dike.

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 (50%) (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. While the city currently has no existing City Code in reference to tree species planting restrictions, we encourage the city to work with the Iowa Department of Natural Resources to develop a plan moving forward.

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. We recommend 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.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized by first removing dead, dying, hazardous trees (Appendix B, Figure 4). Next will be all ash in poor condition that display EAB signs and symptoms (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 providing 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 normally disposed of 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 outlined by the Iowa Department of Natural Resources. While the city currently has no existing City Code in reference to tree species restrictions, we encourage the city to work with the Iowa Department of Natural Resources to develop a plan moving forward. We encourage the new plantings to be a diverse mix and 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 EAB signs and symptoms including 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. While no city ordinances exist regarding the maintenance of privately owned trees, the Iowa Municipal Code 151.06 states "If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property."

Proposed Work Schedule and Budget

Budget Allowance of $2,418/Year – (Based off $2/Capita Calculation Due to no City Reporting)

YEAR 1	ESTIMATED COSTS
Remove 3 trees recommended for immediate removal	$2,100
Plant 2 trees in open locations	$300
Visual Survey of EAB Signs/Symptoms	

YEAR 2	
Remove 1 tree recommended for immediate removal	$700
Plant 3 trees in open locations	$450
Prune 1/3 of City Owned Trees	$1,125
Visual Survey of EAB Signs/Symptoms	

YEAR 3	
Remove 2 trees recommended for immediate removal	$1,400
Remove 1 ash trees (prioritize largest diameter)	$700
Plant 2 trees in open locations	$300
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Remove 1 ash tree (prioritize largest diameter)	$700
Plant 3 trees in open locations	$450
Prune 1/3 of City Owned Trees	$1,125
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 3 ash trees (prioritize largest diameter)	$2,100
Plant 2 trees in open locations	$300
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 1 ash tree (prioritize largest diameter)	$700
Plant 3 trees in open locations	$450
Prune 1/3 of City Owned Trees	$1,125
Visual Survey of EAB Signs/Symptoms	

Estimated costs based on average costs of $700/tree for removal, $150/tree for planting and maintenance, and $15/tree for pruning.

**To remove all ash trees within 6 years alone, the budget would need to be $5,500 a year. If the budget were increased to $3,500 a year all ash could be removed in 9.5 years.

Proposed Work Schedule with Increased Budget

Budget Allowance of $3,500/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	ESTIMATED COSTS
Remove 4 trees recommended for immediate removal	$2,800
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 2

Remove 2 trees recommended for immediate	$1,400
Plant 6 trees in open locations	$900
Prune 1/3 of City Owned Trees	$1,125
Visual Survey of EAB Signs/Symptoms	

YEAR 3

Remove 4 ash trees (prioritize largest diameter)	$2,800
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Remove 2 ash trees (prioritize largest diameter)	$1,400
Plant 6 trees in open locations	$900
Prune 1/3 of City Owned Trees	$1,125
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 4 ash trees (prioritize largest diameter)	$2,800
Plant 4 trees in open locations	$600
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 2 ash trees (prioritize largest diameter)	$1,400
Plant 6 trees in open locations	$900
Prune 1/3 of City Owned Trees	$1,125
Visual Survey of EAB Signs/Symptoms	

Purposed Budget Increase

EAB could potentially kill all ash trees in Dike within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to $5,500 a year. If the budget were increased to $3,500 per year all ash could be removed within 9.5 years. Additionally, we recommend that Dike 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 considered by many communities is treating 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 removal all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at $15 per inch, about 4 trees could be treated per year (every other year treatment). Eight trees would be selected for treatment, and Dike would still need to find $27,300 for removal of the remaining ash trees. Alternatively, if there are 5 treatable trees, it would cost approximately $1,500 a year for treatment and leave $2,000 for removal according to the proposed budget increase. These are alternatives to straight removal of ash trees. However, whether the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Dike. We suggest considering an increased budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

4/17/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	13.6	1,034	1,975.7	1,936	2,970	(N/A)	22.0	21.8	60.62
Green ash	11.0	832	1,488.0	1,458	2,290	(N/A)	14.8	16.8	69.39
Silver maple	10.2	771	1,333.2	1,306	2,078	(N/A)	12.6	15.3	74.21
Red maple	2.7	208	372.1	365	573	(N/A)	7.2	4.2	35.82
Black maple	4.2	317	569.0	558	875	(N/A)	6.7	6.4	58.34
White ash	5.3	404	645.3	632	1,036	(N/A)	5.8	7.6	79.71
Northern pin oak	3.5	268	521.6	511	779	(N/A)	4.9	5.7	70.84
Eastern redbud	0.9	69	143.0	140	209	(N/A)	4.5	1.5	20.90
Northern red oak	1.6	125	232.6	228	352	(N/A)	3.1	2.6	50.35
Northern hackberry	2.6	195	361.4	354	549	(N/A)	2.7	4.0	91.52
American basswood	2.2	167	315.6	309	476	(N/A)	2.7	3.5	79.40
Honeylocust	1.3	97	170.1	167	264	(N/A)	2.2	1.9	52.82
Sugar maple	1.3	100	171.6	168	268	(N/A)	1.8	2.0	67.11
American sycamore	1.2	88	149.1	146	234	(N/A)	1.3	1.7	77.96
Alder	0.4	29	56.3	55	84	(N/A)	0.9	0.6	42.14
Broadleaf Deciduous Med	0.1	6	12.4	12	18	(N/A)	0.9	0.1	8.99
Pear	0.1	7	16.6	16	24	(N/A)	0.9	0.2	11.80
Eastern white pine	0.3	21	34.3	34	55	(N/A)	0.9	0.4	27.30
Littleleaf linden	0.6	43	83.8	82	125	(N/A)	0.9	0.9	62.69
Black walnut	0.4	33	59.0	58	91	(N/A)	0.4	0.7	91.02
Boxelder	0.3	20	36.3	36	55	(N/A)	0.4	0.4	55.14
Swamp white oak	0.1	8	16.9	17	24	(N/A)	0.4	0.2	24.47
Black spruce	0.2	13	23.3	23	35	(N/A)	0.4	0.3	35.47
Black ash	0.3	20	39.6	39	59	(N/A)	0.4	0.4	58.69
Hickory	0.1	7	13.7	13	21	(N/A)	0.4	0.2	20.64
Black locust	0.3	24	47.4	46	71	(N/A)	0.4	0.5	70.84
Total	64.7	4,907	8,887.7	8,710	13,617	(N/A)	100.0	100.0	61.06

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

4/17/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	144,901	3,927	(N/A)	22.0	18.8	80.14
Green ash	138,079	3,742	(N/A)	14.8	17.9	113.39
Silver maple	153,943	4,172	(N/A)	12.6	19.9	148.99
Red maple	22,071	598	(N/A)	7.2	2.9	37.38
Black maple	39,215	1,063	(N/A)	6.7	5.1	70.85
White ash	66,749	1,809	(N/A)	5.8	8.6	139.15
Northern pin oak	41,408	1,122	(N/A)	4.9	5.4	102.01
Eastern redbud	3,253	88	(N/A)	4.5	0.4	8.82
Northern red oak	18,710	507	(N/A)	3.1	2.4	72.44
Northern hackberry	30,194	818	(N/A)	2.7	3.9	136.38
American basswood	31,128	844	(N/A)	2.7	4.0	140.60
Honeylocust	14,862	403	(N/A)	2.2	1.9	80.55
Sugar maple	16,246	440	(N/A)	1.8	2.1	110.07
American sycamore	15,943	432	(N/A)	1.3	2.1	144.02
Alder	1,841	50	(N/A)	0.9	0.2	24.94
Broadleaf Deciduous Medi	325	9	(N/A)	0.9	0.0	4.41
Pear	333	9	(N/A)	0.9	0.0	4.51
Eastern white pine	4,508	122	(N/A)	0.9	0.6	61.08
Littleleaf linden	7,488	203	(N/A)	0.9	1.0	101.46
Black walnut	7,239	196	(N/A)	0.4	0.9	196.17
Boxelder	3,090	84	(N/A)	0.4	0.4	83.73
Swamp white oak	586	16	(N/A)	0.4	0.1	15.88
Black spruce	2,925	79	(N/A)	0.4	0.4	79.26
Black ash	2,479	67	(N/A)	0.4	0.3	67.19
Hickory	608	16	(N/A)	0.4	0.1	16.47
Black locust	3,764	102	(N/A)	0.4	0.5	102.01
Citywide total	771,889	20,918	(N/A)	100.0	100.0	93.80

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

4/17/2020

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
	O3	NO2	PM10	SO2		NO2	PM10	VOC	SO2								
Norway maple	31.9	5.5	15.4	1.4	172	66.1	9.6	9.1	61.8	409	-7.3	-27	193.5	554	(N/A)	22.0	11.30
Green ash	20.7	3.3	9.5	0.9	109	52.2	7.6	7.3	49.7	326	0.0	0	151.2	435	(N/A)	14.8	13.17
Silver maple	27.1	4.6	13.2	1.2	146	47.9	7.0	6.7	46.0	300	-13.6	-51	140.0	394	(N/A)	12.6	14.08
Red maple	5.0	0.9	2.4	0.2	27	13.1	1.9	1.8	12.4	81	-1.7	-6	36.0	102	(N/A)	7.2	6.38
Black maple	10.0	1.7	4.6	0.4	53	19.9	2.9	2.8	18.9	124	-3.3	-12	57.9	165	(N/A)	6.7	10.98
White ash	13.5	2.2	6.0	0.6	71	24.6	3.6	3.5	24.1	155	0.0	0	78.1	226	(N/A)	5.8	17.37
Northern pin oak	9.5	1.6	4.5	0.4	51	17.2	2.5	2.4	16.0	106	-2.1	-8	52.1	149	(N/A)	4.9	13.58
Eastern redbud	0.7	0.1	0.4	0.0	4	4.5	0.6	0.6	4.1	28	0.0	0	11.1	32	(N/A)	4.5	3.16
Northern red oak	4.1	0.7	2.0	0.2	22	7.9	1.1	1.1	7.4	49	-5.9	-22	18.6	49	(N/A)	3.1	6.97
Northern hackberry	5.3	0.9	2.6	0.2	29	12.4	1.8	1.7	11.6	77	0.0	0	36.6	105	(N/A)	2.7	17.58
American basswood	4.8	0.8	2.3	0.2	26	10.7	1.5	1.5	10.0	66	-3.9	-15	27.8	77	(N/A)	2.7	12.84
Honeylocust	2.9	0.5	1.3	0.1	15	6.1	0.9	0.8	5.8	38	-2.3	-9	16.1	44	(N/A)	2.2	8.89
Sugar maple	2.7	0.5	1.3	0.1	14	6.2	0.9	0.9	6.0	39	-2.1	-8	16.4	45	(N/A)	1.8	11.37
American sycamore	2.9	0.5	1.3	0.1	15	5.4	0.8	0.8	5.2	34	0.0	0	16.9	49	(N/A)	1.3	16.34
Alder	0.6	0.1	0.3	0.0	3	1.9	0.3	0.3	1.7	12	0.0	0	5.2	15	(N/A)	0.9	7.45
Broadleaf Deciduous Medi	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)	0.9	1.21
Pear	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)	0.9	1.63
Eastern white pine	0.5	0.1	0.4	0.1	3	1.3	0.2	0.2	1.2	8	-1.9	-7	2.1	4	(N/A)	0.9	2.13
Littleleaf linden	1.4	0.2	0.7	0.1	8	2.8	0.4	0.4	2.6	17	-0.7	-3	7.9	22	(N/A)	0.9	11.21
Black walnut	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.4	19.04
Boxelder	0.4	0.1	0.2	0.0	2	1.2	0.2	0.2	1.2	8	-0.2	-1	3.3	9	(N/A)	0.4	9.31
Swamp white oak	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3	(N/A)	0.4	3.47
Black spruce	0.5	0.1	0.4	0.1	3	0.8	0.1	0.1	0.8	5	-1.1	-4	1.8	4	(N/A)	0.4	4.16
Black ash	0.5	0.1	0.2	0.0	3	1.3	0.2	0.2	1.2	8	-0.1	0	3.6	10	(N/A)	0.4	10.16
Hickory	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)	0.4	2.99
Black locust	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14	(N/A)	0.4	13.58
Citywide total	147.3	24.8	70.0	6.6	787	308.9	45.0	42.9	292.9	1,924	-46.5	-174	891.9	2,537	(N/A)	100.0	11.37

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

4/17/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	527,037	3,953	(N/A)	22.0	17.2	80.67
Green ash	698,370	5,238	(N/A)	14.8	22.8	158.72
Silver maple	593,677	4,453	(N/A)	12.6	19.4	159.02
Red maple	55,674	418	(N/A)	7.2	1.8	26.10
Black maple	106,216	797	(N/A)	6.7	3.5	53.11
White ash	204,965	1,537	(N/A)	5.8	6.7	118.25
Northern pin oak	157,082	1,178	(N/A)	4.9	5.1	107.10
Eastern redbud	12,607	95	(N/A)	4.5	0.4	9.46
Northern red oak	92,458	693	(N/A)	3.1	3.0	99.06
Northern hackberry	84,135	631	(N/A)	2.7	2.7	105.17
American basswood	184,128	1,381	(N/A)	2.7	6.0	230.16
Honeylocust	37,820	284	(N/A)	2.2	1.2	56.73
Sugar maple	81,395	610	(N/A)	1.8	2.7	152.62
American sycamore	98,912	742	(N/A)	1.3	3.2	247.28
Alder	9,780	73	(N/A)	0.9	0.3	36.67
Broadleaf Deciduou	437	3	(N/A)	0.9	0.0	1.64
Pear	1,086	8	(N/A)	0.9	0.0	4.07
Eastern white pine	4,513	34	(N/A)	0.9	0.1	16.92
Littleleaf linden	30,478	229	(N/A)	0.9	1.0	114.29
Black walnut	39,259	294	(N/A)	0.4	1.3	294.44
Boxelder	14,280	107	(N/A)	0.4	0.5	107.10
Swamp white oak	1,101	8	(N/A)	0.4	0.0	8.26
Black spruce	4,893	37	(N/A)	0.4	0.2	36.70
Black ash	7,945	60	(N/A)	0.4	0.3	59.59
Hickory	1,035	8	(N/A)	0.4	0.0	7.76
Black locust	14,280	107	(N/A)	0.4	0.5	107.10
Citywide total	3,063,562	22,977	(N/A)	100.0	100.0	103.03

Table 5: Annual Carbon Sequestered

| 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
Norway maple	10,208	77	-2,531	-159	-20	22,850	171	30,368	228 (N/A)	22.0	13.9	4.65
Green ash	22,971	172	-3,352	-119	-26	18,380	138	37,881	284 (N/A)	14.8	17.3	8.61
Silver maple	43,466	326	-2,850	-113	-22	17,049	128	57,553	432 (N/A)	12.6	26.3	15.42
Red maple	4,076	31	-267	-26	-2	4,608	35	8,391	63 (N/A)	7.2	3.8	3.93
Black maple	3,296	25	-510	-39	-4	7,016	53	9,764	73 (N/A)	6.7	4.5	4.88
White ash	12,884	97	-984	-45	-8	8,926	67	20,781	156 (N/A)	5.8	9.5	11.99
Northern pin oak	0	0	-754	-47	-6	5,924	44	5,123	38 (N/A)	4.9	2.3	3.49
Eastern redbud	1,370	10	-61	-13	-1	1,523	11	2,820	21 (N/A)	4.5	1.3	2.12
Northern red oak	517	4	-444	-22	-3	2,752	21	2,804	21 (N/A)	3.1	1.3	3.00
Northern hackberry	3,650	27	-404	-26	-3	4,308	32	7,528	56 (N/A)	2.7	3.4	9.41
American basswood	9,668	73	-884	-27	-7	3,693	28	12,450	93 (N/A)	2.7	5.7	15.56
Honeylocust	3,218	24	-182	-10	-1	2,152	16	5,178	39 (N/A)	2.2	2.4	7.77
Sugar maple	3,404	26	-391	-15	-3	2,215	17	5,213	39 (N/A)	1.8	2.4	9.77
American sycamore	1,836	14	-475	-13	-4	1,940	15	3,289	25 (N/A)	1.3	1.5	8.22
Alder	746	6	-47	-5	0	643	5	1,338	10 (N/A)	0.9	0.6	5.02
Broadleaf Deciduous M	191	1	-3	-1	0	129	1	316	2 (N/A)	0.9	0.1	1.18
Pear	152	1	-5	-2	0	161	1	306	2 (N/A)	0.9	0.1	1.15
Eastern white pine	303	2	-22	-5	0	463	3	739	6 (N/A)	0.9	0.3	2.77
Littleleaf linden	1,118	8	-146	-8	-1	955	7	1,920	14 (N/A)	0.9	0.9	7.20
Black walnut	912	7	-188	-5	-1	734	6	1,453	11 (N/A)	0.4	0.7	10.90
Boxelder	1,038	8	-69	-4	-1	433	3	1,399	10 (N/A)	0.4	0.6	10.49
Swamp white oak	224	2	-5	-1	0	176	1	393	3 (N/A)	0.4	0.2	2.95
Black spruce	189	1	-23	-4	0	280	2	441	3 (N/A)	0.4	0.2	3.31
Black ash	470	4	-38	-3	0	440	3	869	7 (N/A)	0.4	0.4	6.52
Hickory	209	2	-5	-1	0	159	1	361	3 (N/A)	0.4	0.2	2.71
Black locust	0	0	-69	-4	-1	539	4	466	3 (N/A)	0.4	0.2	3.49
Citywide total	126,118	946	-14,708	-715	-116	108,449	813	219,144	1,644 (N/A)	100.0	100.0	7.37

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

4/17/2020

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	951	(N/A)	22.0	8.4	19.40
Green ash	1,777	(N/A)	14.8	15.8	53.86
Silver maple	3,303	(N/A)	12.6	29.3	117.95
Red maple	557	(N/A)	7.2	4.9	34.82
Black maple	416	(N/A)	6.7	3.7	27.72
White ash	1,327	(N/A)	5.8	11.8	102.06
Northern pin oak	0	(N/A)	4.9	0.0	0.00
Eastern redbud	78	(N/A)	4.5	0.7	7.78
Northern red oak	40	(N/A)	3.1	0.4	5.73
Northern hackberry	429	(N/A)	2.7	3.8	71.54
American basswood	626	(N/A)	2.7	5.5	104.28
Honeylocust	817	(N/A)	2.2	7.2	163.38
Sugar maple	331	(N/A)	1.8	2.9	82.86
American sycamore	133	(N/A)	1.3	1.2	44.25
Alder	44	(N/A)	0.9	0.4	22.14
Broadleaf Deciduous Medi·	26	(N/A)	0.9	0.2	12.89
Pear	8	(N/A)	0.9	0.1	4.23
Eastern white pine	79	(N/A)	0.9	0.7	39.70
Littleleaf linden	106	(N/A)	0.9	0.9	53.02
Black walnut	58	(N/A)	0.4	0.5	58.34
Boxelder	65	(N/A)	0.4	0.6	65.43
Swamp white oak	26	(N/A)	0.4	0.2	26.22
Black spruce	13	(N/A)	0.4	0.1	12.81
Black ash	43	(N/A)	0.4	0.4	43.05
Hickory	29	(N/A)	0.4	0.3	28.56
Black locust	0	(N/A)	0.4	0.0	0.00
Citywide total	11,283	(N/A)	100.0	100.0	50.60

Table 7: Summary of Benefits in Dollars

Total Annual Benefits of Public Trees by Species ($)

4/17/202

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($) Standard Error	% of Total $
Norway maple	2,970	228	554	3,927	951	8,629 (N/A)	17.3
Green ash	2,290	284	435	3,742	1,777	8,528 (N/A)	17.1
Silver maple	2,078	432	394	4,172	3,303	10,378 (N/A)	20.8
Red maple	573	63	102	598	557	1,893 (N/A)	3.8
Black maple	875	73	165	1,063	416	2,592 (N/A)	5.2
White ash	1,036	156	226	1,809	1,327	4,554 (N/A)	9.1
Northern pin oak	779	38	149	1,122	0	2,089 (N/A)	4.2
Eastern redbud	209	21	32	88	78	428 (N/A)	0.9
Northern red oak	352	21	49	507	40	969 (N/A)	1.9
Northern hackberry	549	56	105	818	429	1,959 (N/A)	3.9
American basswood	476	93	77	844	626	2,116 (N/A)	4.2
Honeylocust	264	39	44	403	817	1,567 (N/A)	3.1
Sugar maple	268	39	45	440	331	1,125 (N/A)	2.2
American sycamore	234	25	49	432	133	872 (N/A)	1.7
Alder	84	10	15	50	44	203 (N/A)	0.4
Broadleaf Deciduous	18	2	2	9	26	57 (N/A)	0.1
Pear	24	2	3	9	8	47 (N/A)	0.1
Eastern white pine	55	6	4	122	79	266 (N/A)	0.5
Littleleaf linden	125	14	22	203	106	471 (N/A)	0.9
Black walnut	91	11	19	196	58	375 (N/A)	0.8
Boxelder	55	10	9	84	65	224 (N/A)	0.4
Swamp white oak	24	3	3	16	26	73 (N/A)	0.1
Black spruce	35	3	4	79	13	135 (N/A)	0.3
Black ash	59	7	10	67	43	186 (N/A)	0.4
Hickory	21	3	3	16	29	71 (N/A)	0.1
Black locust	71	3	14	102	0	190 (N/A)	0.4
Citywide Total	13,617	1,644	2,537	20,918	11,283	49,998 (N/A)	100.0

Species Distribution of Public Trees

4/17/2020
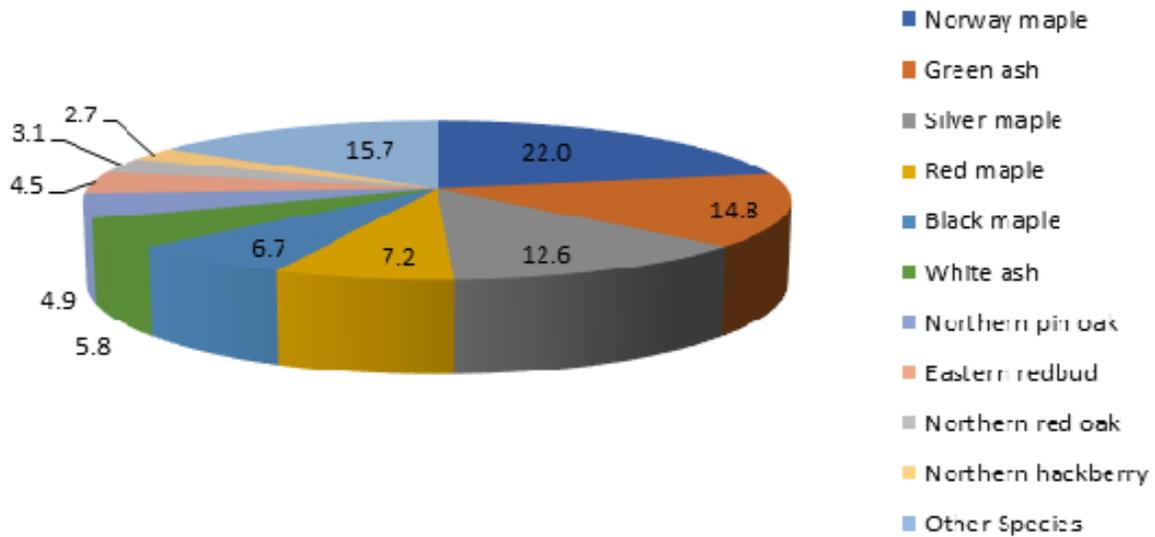
Species	Percent
Norway maple	22.0
Green ash	14.8
Silver maple	12.6
Red maple	7.2
Black maple	6.7
White ash	5.8
Northern pin oak	4.9
Eastern redbud	4.5
Northern red oak	3.1
Northern hackberry	2.7
Other Species	15.7
Total	100.0

Figure 1: Species Distribution

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

4/17/2020
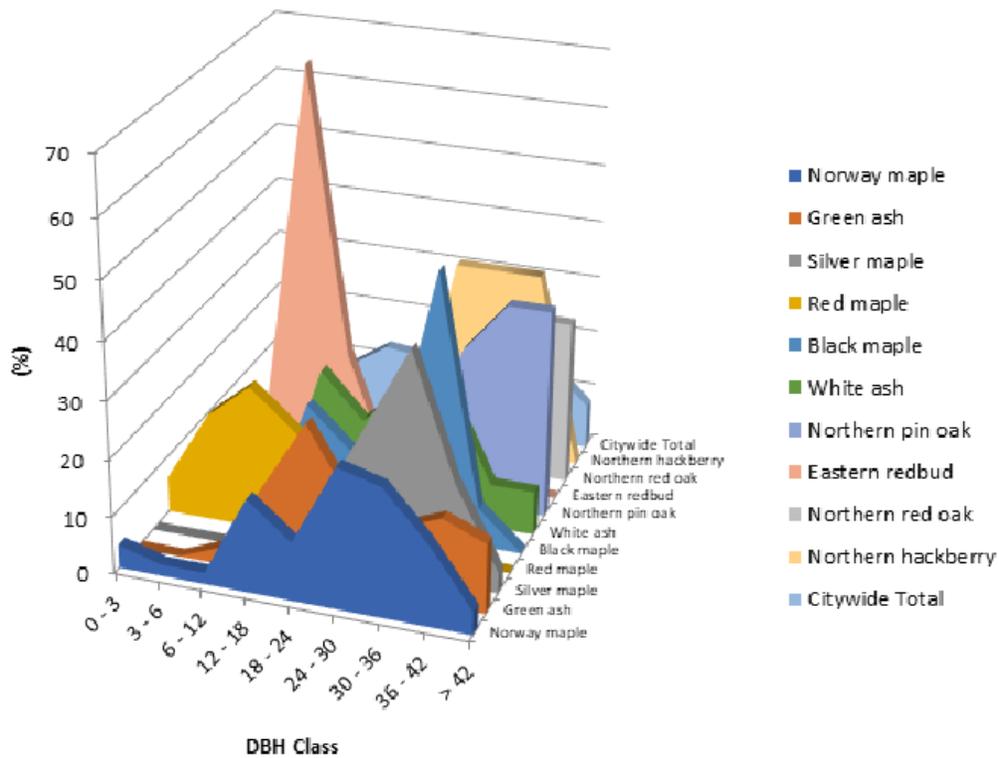
	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Norway maple	4.08	2.04	2.04	16.33	10.20	24.49	22.45	14.29	4.08
Green ash	0.00	0.00	3.03	15.15	27.27	15.15	12.12	15.15	12.12
Silver maple	0.00	0.00	0.00	3.57	10.71	25.00	39.29	17.86	3.57
Red maple	6.25	18.75	25.00	18.75	12.50	6.25	12.50	0.00	0.00
Black maple	0.00	0.00	0.00	20.00	13.33	13.33	46.67	6.67	0.00
White ash	0.00	0.00	0.00	23.08	15.38	23.08	23.08	7.69	7.69
Northern pin oak	0.00	0.00	0.00	0.00	0.00	0.00	27.27	36.36	36.36
Eastern redbud	0.00	10.00	70.00	20.00	0.00	0.00	0.00	0.00	0.00
Northern red oak	0.00	0.00	14.29	0.00	0.00	14.29	14.29	28.57	28.57
Northern hackberry	0.00	0.00	0.00	0.00	0.00	33.33	33.33	33.33	0.00
Citywide Total	1.35	4.04	8.07	13.00	12.11	17.94	21.08	14.80	7.62

Figure 2: Relative Age Class
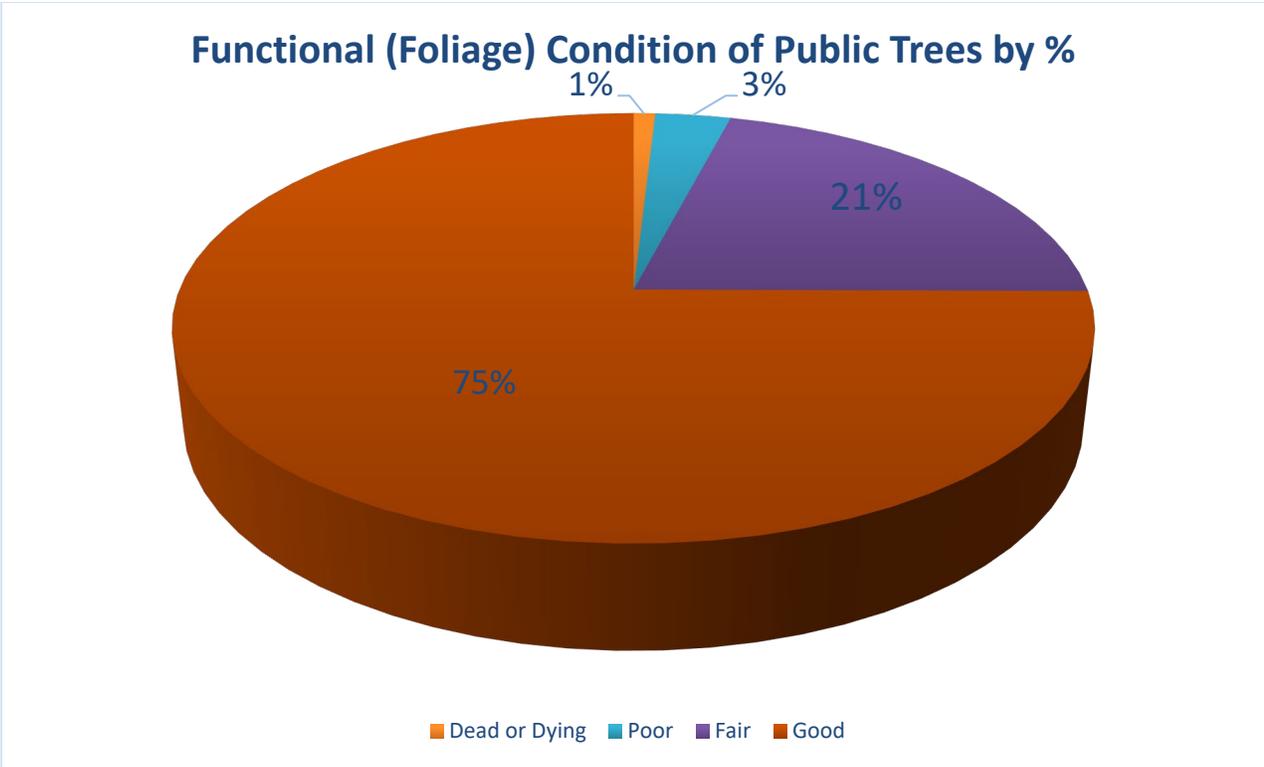
Figure 3: Foliage Condition
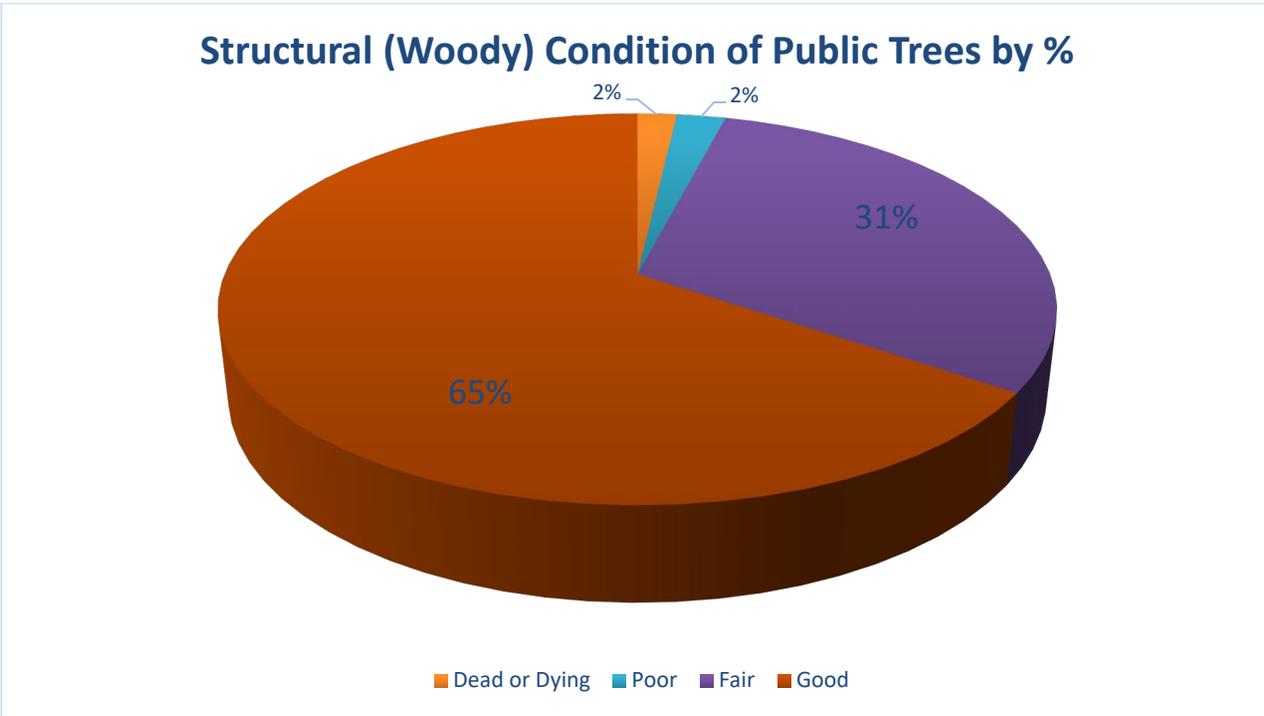
Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

4/17/2020
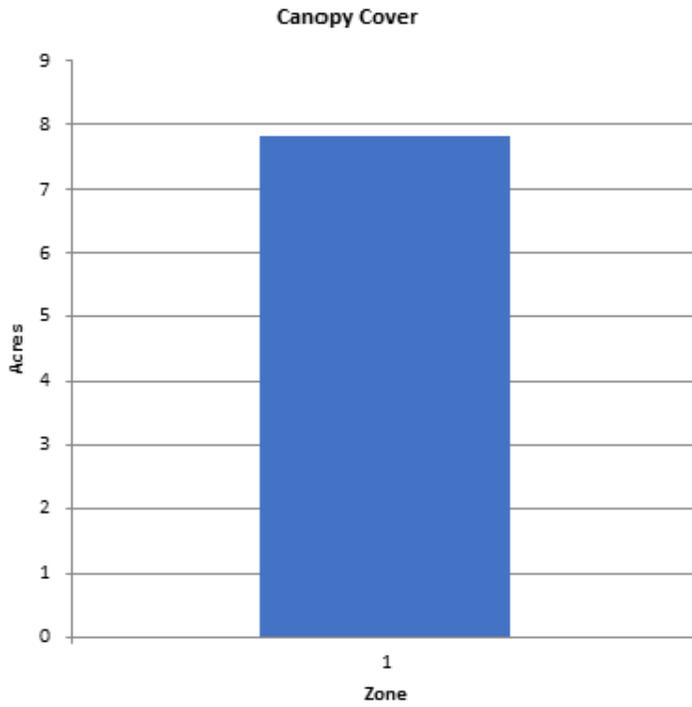
Canopy Cover

Zone	Acres	% of Total Canopy Cover
1	8	100.0
Citywide total	8	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide Total	0	0	8	0.00	0.00

Figure 5: Canopy Cover in Acres

Land Use of Public Trees
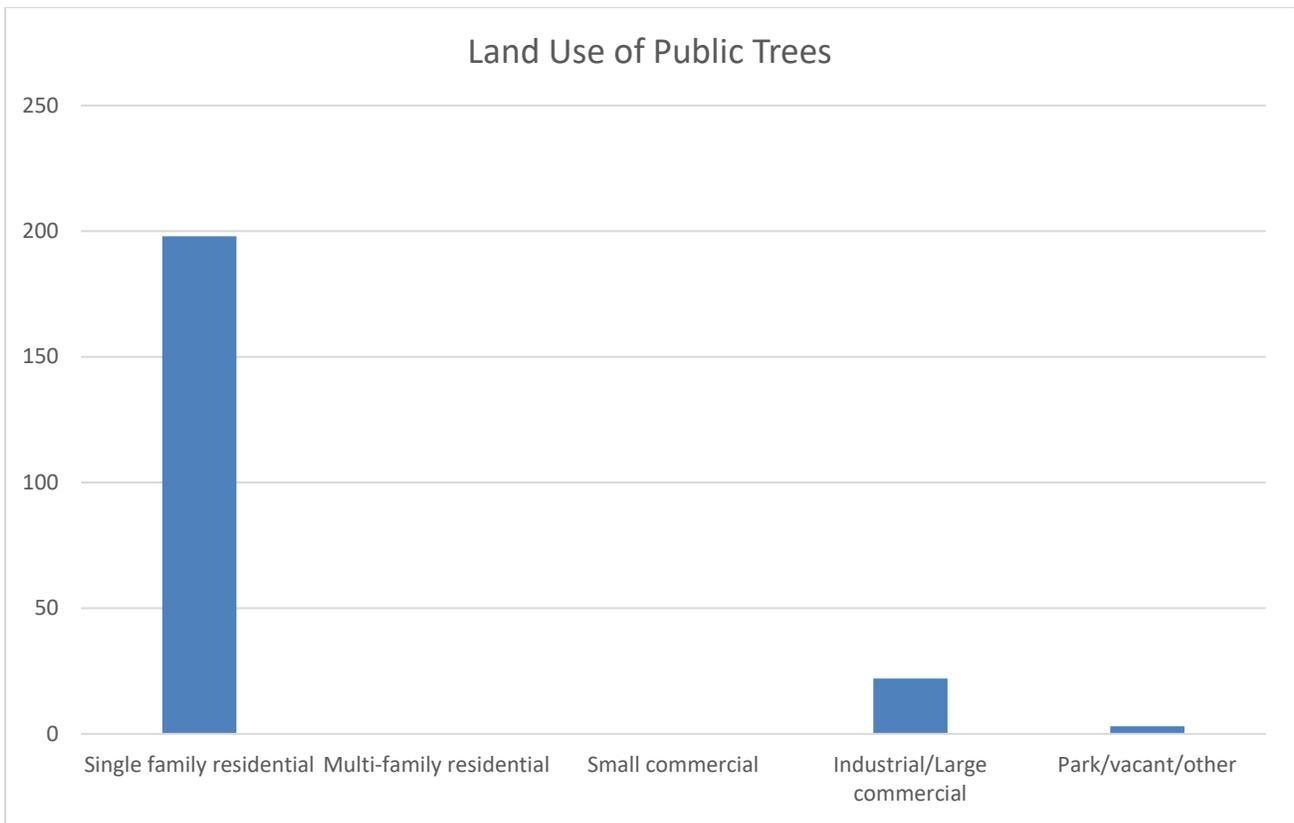
Figure 6: Land Use of city/park trees
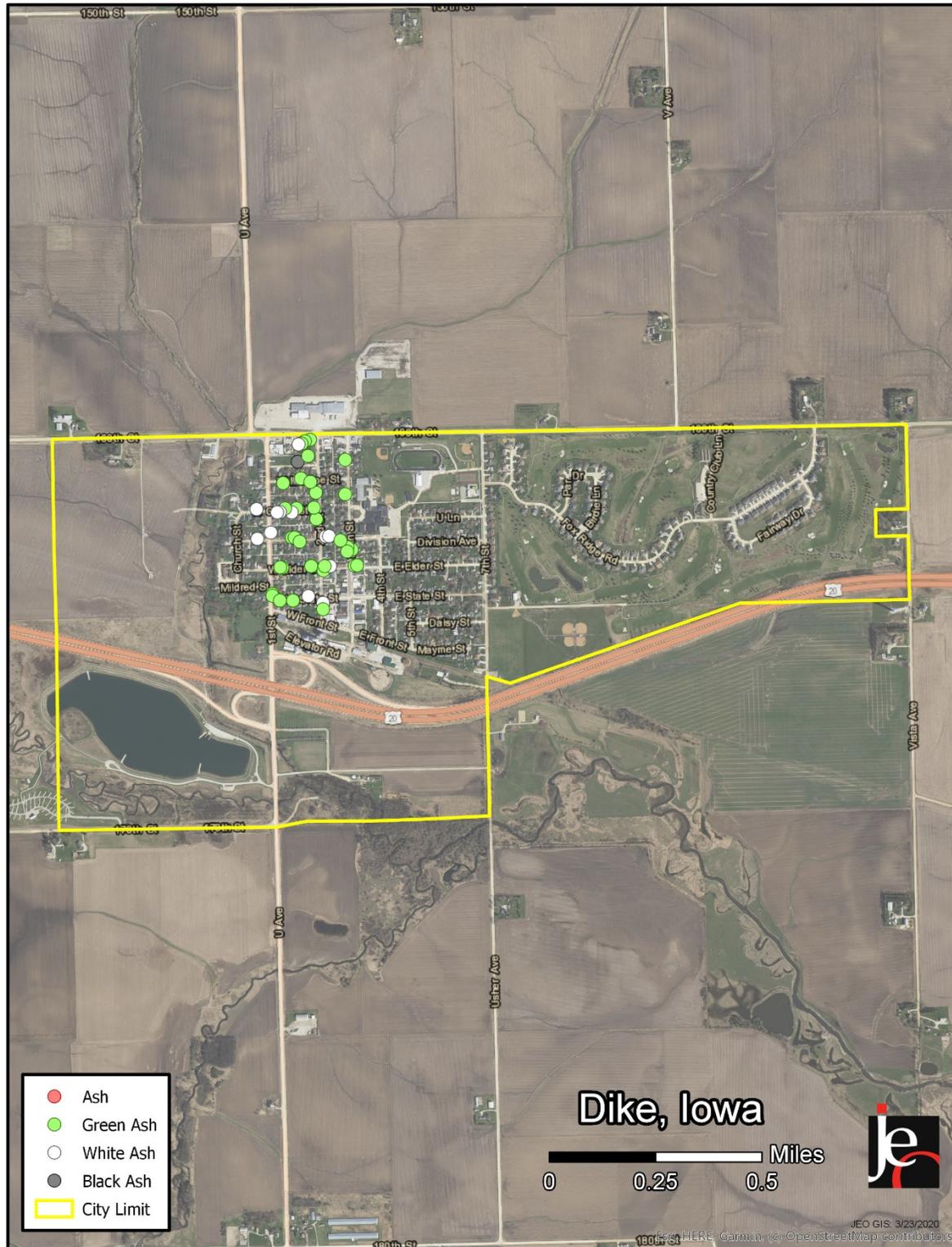
Figure 1: Location of Ash Trees
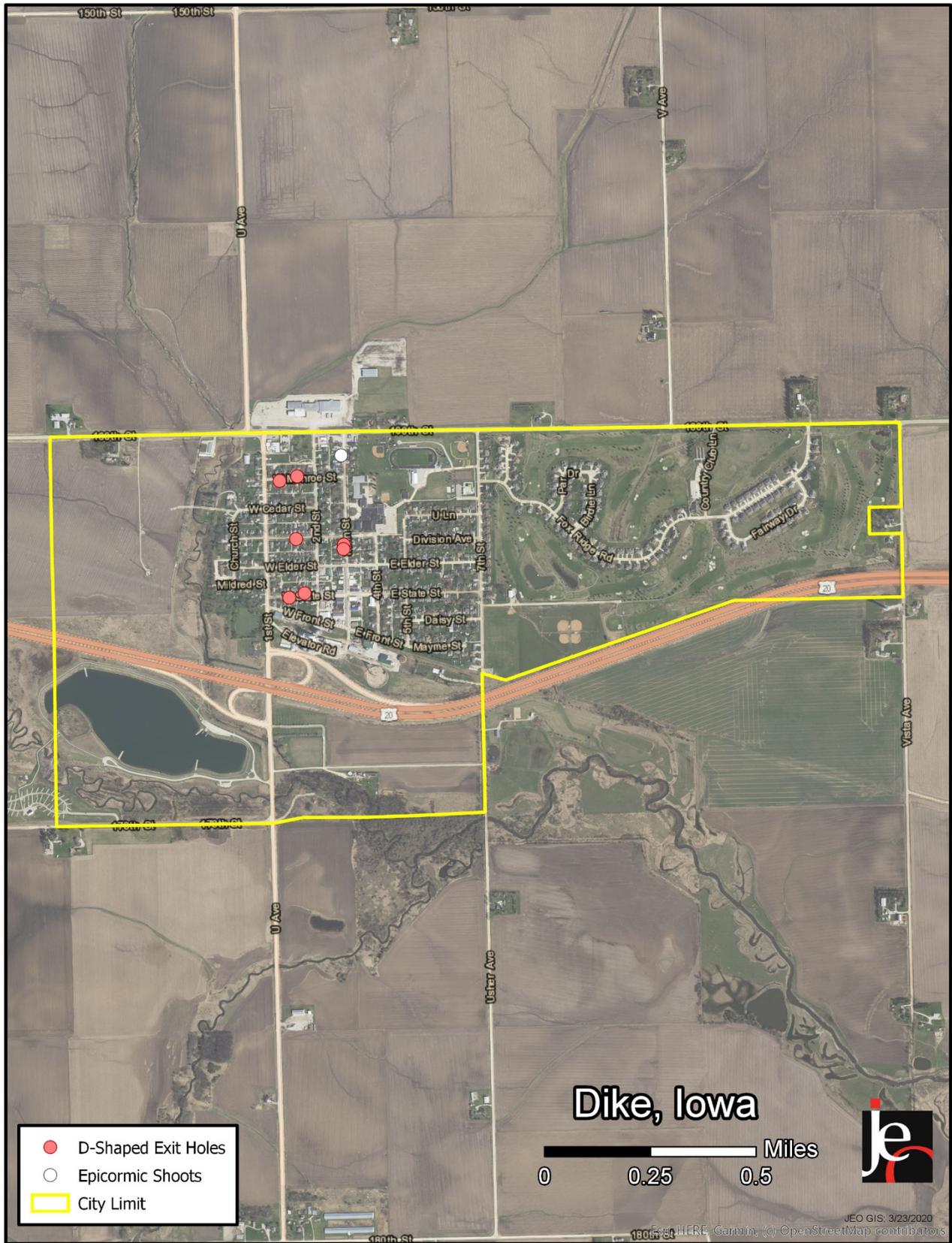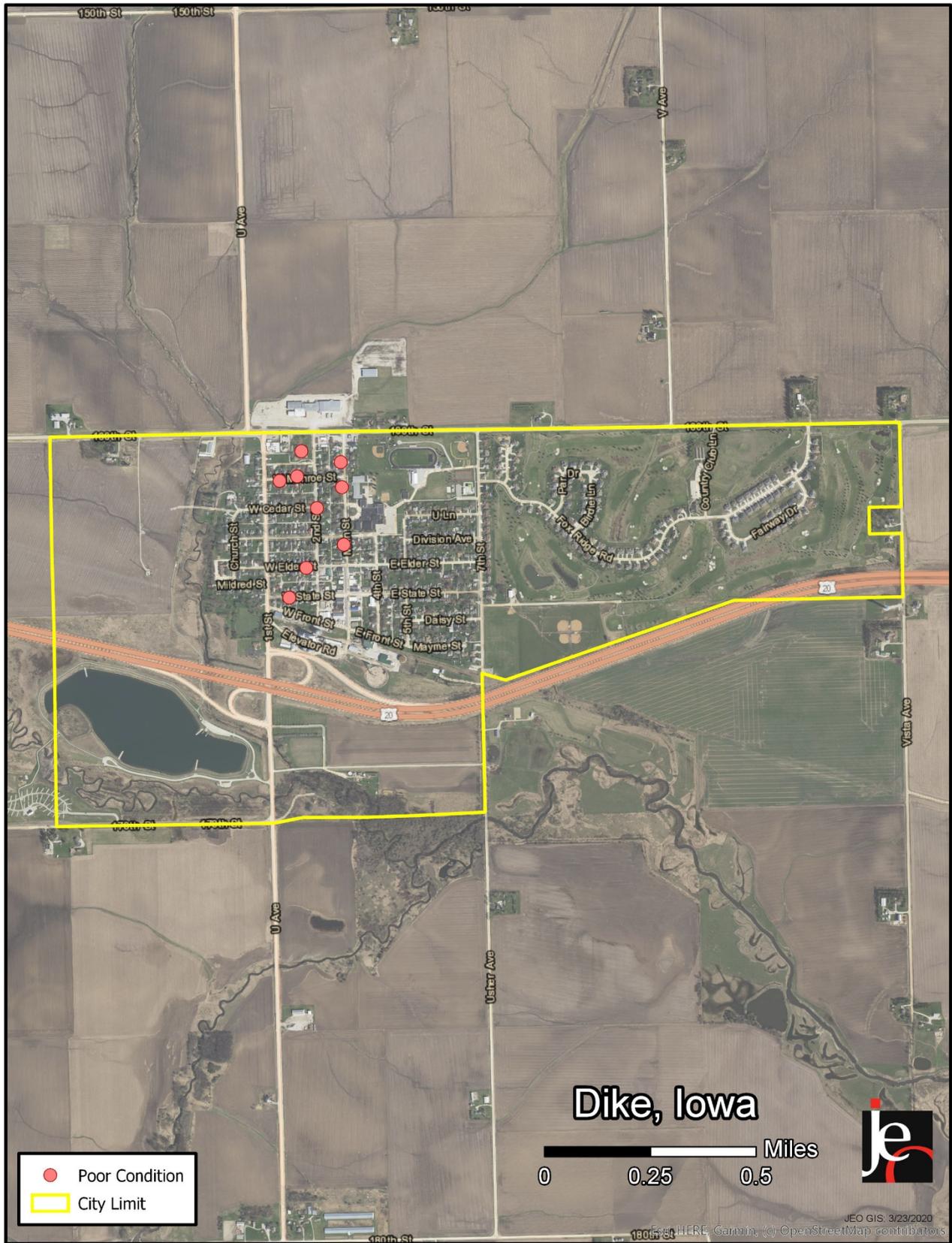
Figure 2: Location of EAB symptoms

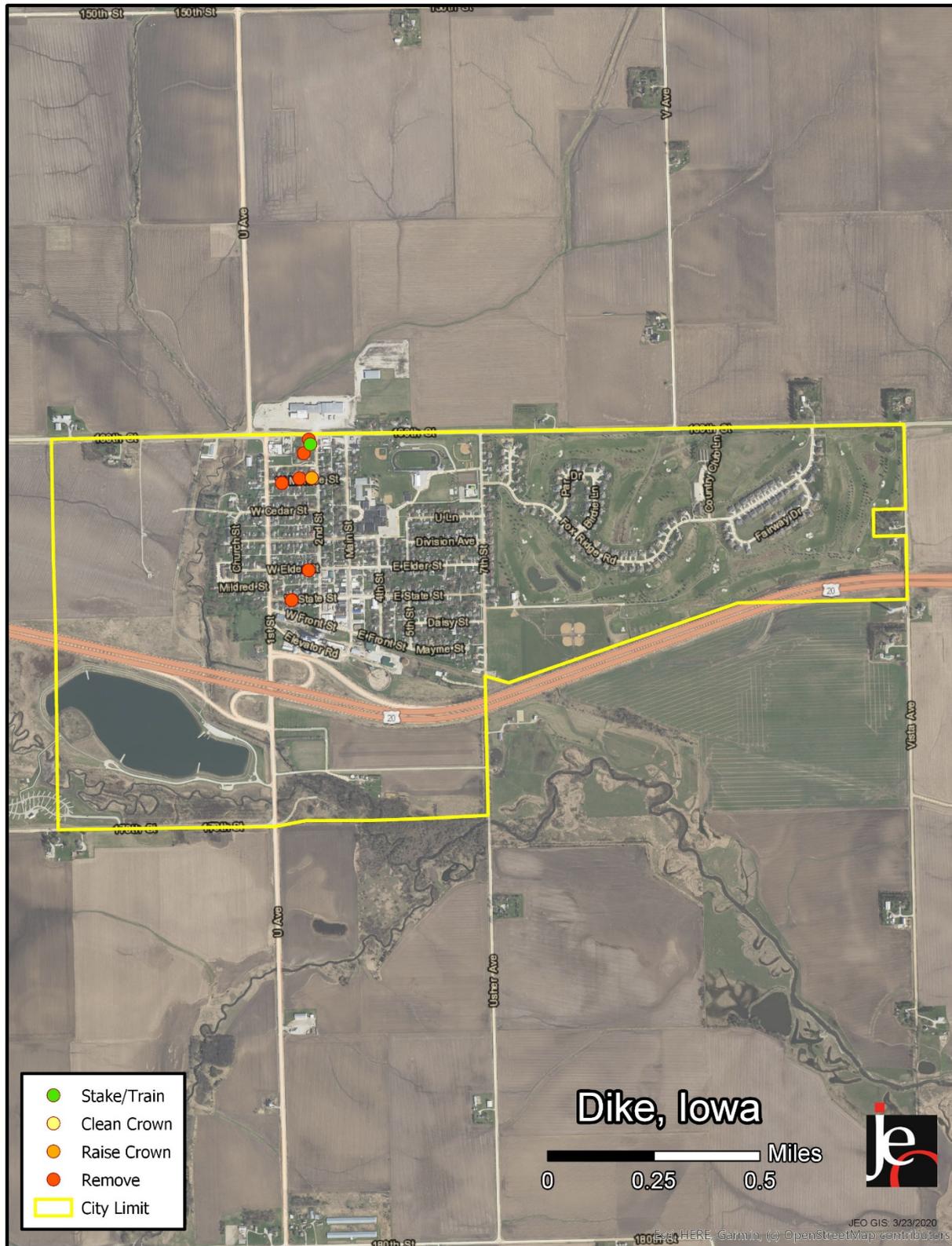**Figure 3: Location of Poor Condition Trees**

Figure 4: Location of Trees with Recommended Maintenance *City ownership of the trees recommended for removal should be verified prior to any removal*

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