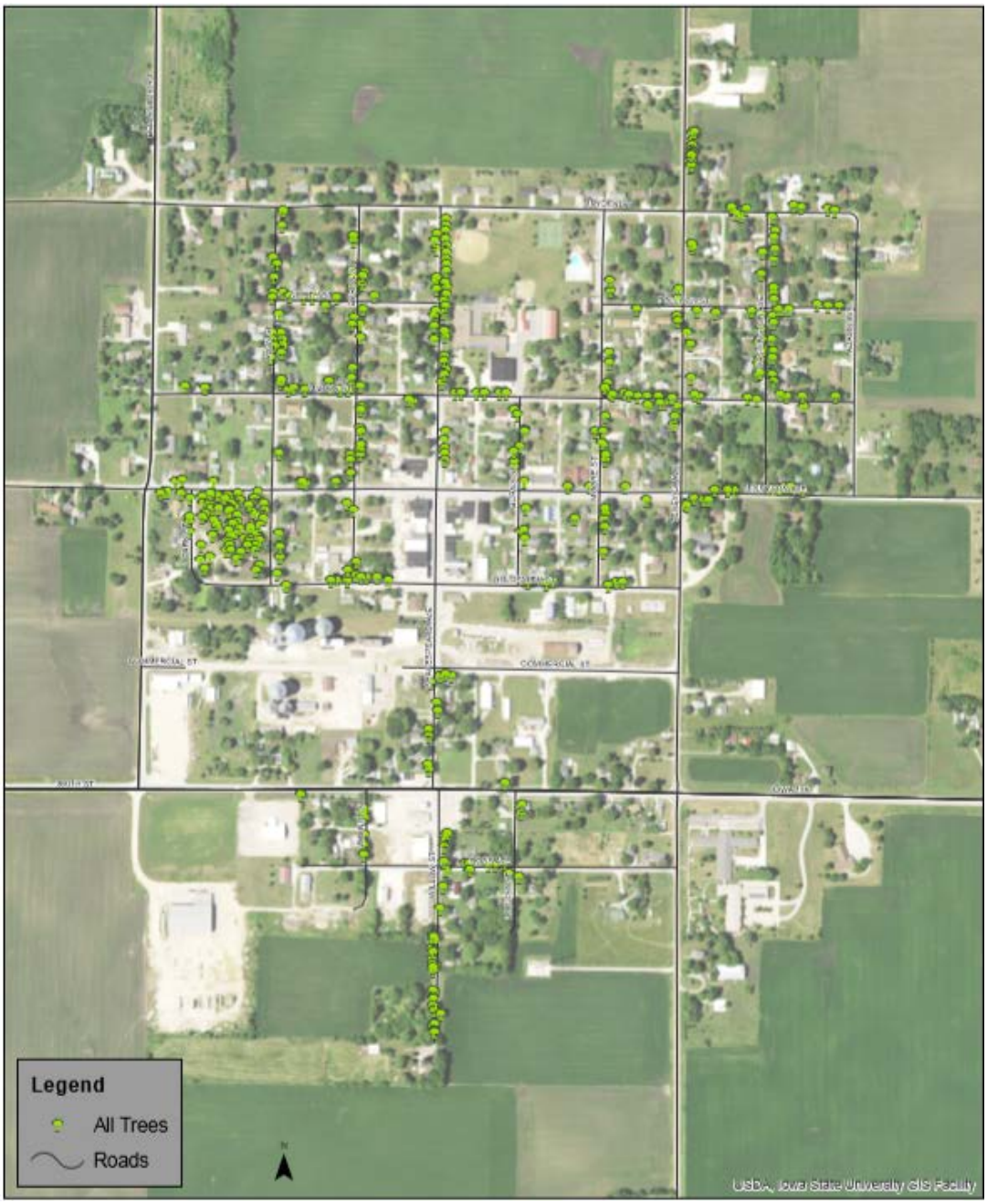
STRATFORD, IA



2018 Urban Forest Management Plan
Prepared by Richard Kittelson
Iowa Department of Natural Resources

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Executive Summary

Overview

This plan was developed to assist the City of Stratford 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 15.6% of Stratford's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2018, 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 429 trees inventoried.

- Stratford's trees provide $85,761 of benefits annually, an average of $200 a tree
- There are over 30 species of trees
- The top three genera are: Maple 38.5%, Ash 15.6%, and Walnut 9.3%
- 41% of trees are in need of some type of management
- 77 trees (60 ash) 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 77 trees needing removal, 47 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*
- 49 of the 67 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation
- All trees should be pruned on a routine schedule- one third of the city every other year
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly
- With the current budget it could take 24 years to remove ash – Suggestion: request a budget increase to $8,000 annually and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Stratford with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of that money spent on tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal or treatment and replacement planting. With proper planning and management of the current canopy in Stratford these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Stratford's infrastructure and one of the greatest assets to the community. The benefits of trees are immense. Trees provide the community with improved air quality, stormwater runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and create a desirable place to live, to name just a few benefits. It is essential that these benefits be maintained for the people of Stratford 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 Stratford's urban forestry goals.

Inventory

In 2018, 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 429 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. Stratford's trees reduce energy related costs by approximately $22,150 annually (Appendix A, Table 1). These savings are both in Electricity (105.3) and in Natural Gas (14,446 Therms).

Annual Stormwater Benefits

Stratford's trees intercept about 1,208,653 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $32,755 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 Stratford it is estimated that trees remove 1,082 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $3,919 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Stratford trees sequester about 262,916 lbs of carbon a year with an associated value of S1,972 (Appendix A, Table 5). In addition, the trees store 4,522,134 lbs of carbon, with a yearly benefit of $33,916 (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. Stratford receives $23,813 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, Stratford's trees provide $85,761 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 429 trees in Stratford provide approximately $200 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Stratford has over 30 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	165	38.5%
Ash	67	15.6%
Walnut	40	9.3%
Hackberry	28	6.5%
Linden/Basswood	13	3%
Spruce	12	2.8%
Oak	11	2.6%
Honeylocust	11	2.6%
Red Cedars	11	2.6%
Broadleaf Small	17	1.6%
Others less than 1% ea.	54	14.9%

Age Class

Most of Stratford's trees (43%) are between 18 and 30 inches in diameter at 4.5 ft (Appendix A, Figure 2) and another 18% greater than 30 inches. 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. Stratford's size curve is on the larger side, indicating an older 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 Stratford indicate that 97% of the trees are in fair to good health, with only 3% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 83% of Stratford's trees are in fair to good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 17% of the population. This 17% is an estimate of trees that need management follow up soon.

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	81	18.9%
Crown Raising	15	3.5%
Tree Staking	2	.47%

Tree Removal	77	18%
Crown Reduction	2	.47%

Canopy Cover

The total canopy with both park and public trees is 8%, 95 acres. The canopy cover included in the Stratford inventory includes approximately 12.5 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years. To achieve this goal it is estimated that 89 trees need to be planted annually.

Land Use and Location

The majority of Stratford'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	69.7%
Park/vacant/other	28.21%
Industrial/Large commercial	0%
Small commercial	2.1%
Multifamily residential	0%

Location	
Planting strip	69.93%
Other maintained locations	0%
Cutout (surrounded by pavement)	0%
Front yard	24.71%

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

Stratford has 7 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. These 7 trees over 24 inches in diameter at 4.5 ft. 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 100 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 77 removals, 60 are ash trees. There are a total of 67 ash trees, and 49 of those have signs and symptoms that have been associated with EAB. In addition, there are 23 ash trees that are in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

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

Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant 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 Stratford.

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 (38.5%) (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, as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

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.

Six Year Maintenance Plan with <u>No Additional Funding</u>

Year 1

Removal: 3 largest critical concern trees
Planting and Replacement: 4 trees to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 2 critical concern trees
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 3 trees in open locations from year one removals
Young Tree Pruning & Maintenance:
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 2 critical concern trees and 1 additional ash tree with poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 2 trees -ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 3 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 5

Removal: 3 trees -ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 2 trees -ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 3 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 8 ash trees removed (approximately 12% of ash). It will take approximately 24 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.
**To remove all ash trees within 6 years, the budget would need to be increased to $8,000 a year. If the budget were increased to $10,000 a year all ash could be removed in 5 years.

Emerald Ash Borer Plan

Ash Tree Removal

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

Treatment of Ash Trees

Chemical treatment can be 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 151.02 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

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

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

Private Ash Trees
It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 151.05 states:

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

City 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."

Budget

Current Budget
Total $12,000 over 6 years ($2,000/year)

FY 2019 Budget
Removal: $1,500
*Or saving for ash tree treatment and/or future ash removal
Planting: $400
Watering & Maintenance: $100

FY 2020 Budget
Removal: $1000
*Or saving for ash tree treatment and/or future ash removal
Planting: $300

Routine trimming: $600
Watering & Maintenance: $100

FY 2021 Budget
Removal: $1,500
*Or saving for ash tree treatment and/or future ash removal
Planting: $400
Watering & Maintenance: $100

FY 2022 Budget
Removal: $1000
*Or saving for ash tree treatment and/or future ash removal
Planting: $300
Routine trimming: $600
Watering & Maintenance: $100

FY 2023 Budget
Removal: $1,500
*Or saving for ash tree treatment and/or future ash removal
Planting: $400
Watering & Maintenance: $100

FY 2024 Budget
Removal: $1000
*Or saving for ash tree treatment and/or future ash removal
Planting: $300
Routine trimming: $600
Watering & Maintenance: $100

*Reduction of ash over 6 years: approximately 8 ash trees removed (approximately 12% of ash). **It will take approximately 24 years to remove all ash with the current budget.**

<u>Purposed Budget Increase</u>
EAB could potentially kill all ash trees in Stratford within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $8,000 a year. If the budget were increased to $10,000 a year all ash could be removed within 13 years. Additionally, it is recommended that Stratford apply for grants to fund replacement trees. Utility Company grants are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at $12 per inch, about 4 trees could be treated ($960) per year (1/2 treatable ash every other year treatment). This would be 7 total trees selected for treatment, and

Stratford would still need to find $1,040 for removal. Alternatively, if there are 7 treated trees every other year, it would cost approximately $1,680 every 2 years for treatment and leave $320 for removal and $0 for planting. These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees when EAB is found in Stratford. 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

Annual Energy Benefits of Public Trees by Species					12/10/2018				
Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	28.70	2,178.28	3,781.73	3,706.10	5,884.38	(N/A)	20.28	26.57	67.64
Green ash	18.43	1,399.03	2,575.23	2,523.73	3,922.76	(N/A)	14.22	17.71	64.31
Black walnut	10.85	823.76	1,489.63	1,459.84	2,283.60	(N/A)	9.32	10.31	57.09
Norway maple	5.47	415.28	796.95	781.01	1,196.29	(N/A)	6.76	5.40	41.25
Northern hackberry	10.25	777.67	1,426.46	1,397.93	2,175.60	(N/A)	6.53	9.82	77.70
Maple	2.18	165.15	299.67	293.67	458.83	(N/A)	4.20	2.07	25.49
Black maple	3.57	270.76	495.91	485.99	756.75	(N/A)	3.50	3.42	50.45
Sugar maple	3.42	259.74	466.50	457.17	716.91	(N/A)	3.03	3.24	55.15
Eastern red cedar	1.16	88.26	172.36	168.91	257.17	(N/A)	2.56	1.16	23.38
Honeylocust	4.03	305.99	521.48	511.05	817.04	(N/A)	2.56	3.69	74.28
Red maple	1.28	97.20	172.01	168.57	265.77	(N/A)	2.10	1.20	29.53
Broadleaf Deciduous Small	0.89	67.20	133.00	130.34	197.54	(N/A)	1.63	0.89	28.22
Blue spruce	0.65	49.10	78.32	76.75	125.85	(N/A)	1.63	0.57	17.98
Basswood	0.44	33.76	55.48	54.37	88.14	(N/A)	1.40	0.40	14.69
Apple	0.27	20.45	43.64	42.76	63.21	(N/A)	1.17	0.29	12.64
American basswood	0.32	24.52	50.62	49.61	74.12	(N/A)	1.17	0.33	14.82
River birch	0.94	71.57	132.26	129.61	201.19	(N/A)	1.17	0.91	40.24
White ash	1.25	94.57	156.10	152.98	247.54	(N/A)	1.17	1.12	49.51
Elm	1.89	143.52	258.04	252.88	396.40	(N/A)	1.17	1.79	79.28
Swamp white oak	0.48	36.71	69.39	68.00	104.71	(N/A)	0.93	0.47	26.18
Others	8.83	669.99	1,271.36	1,245.94	1,915.93		13.52	8.65	34.32
Total	105.30	7,992.50	14,446.15	14,157.23	22,149.73	(N/A)	100.00	100.00	51.63

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species			12/10/2018			
Species	Total Rainfall Interception (Gal)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	413,504.84	11,205.98	(N/A)	20.28	34.21	128.80
Green ash	217,823.09	5,903.01	(N/A)	14.22	18.02	96.77
Black walnut	113,154.52	3,066.49	(N/A)	9.32	9.36	76.66
Norway maple	48,575.96	1,316.41	(N/A)	6.76	4.02	45.39
Northern hackberry	97,837.24	2,651.39	(N/A)	6.53	8.09	94.69
Maple	15,907.67	431.10	(N/A)	4.20	1.32	23.95
Black maple	34,040.47	922.50	(N/A)	3.50	2.82	61.50
Sugar maple	35,385.26	958.94	(N/A)	3.03	2.93	73.76
Eastern red cedar	17,004.60	460.82	(N/A)	2.56	1.41	41.89
Honeylocust	51,532.51	1,396.53	(N/A)	2.56	4.26	126.96
Red maple	8,724.84	236.44	(N/A)	2.10	0.72	26.27
Broadleaf Deciduous Small	4,082.94	110.65	(N/A)	1.63	0.34	15.81
Blue spruce	7,797.86	211.32	(N/A)	1.63	0.65	30.19
Basswood	2,759.94	74.79	(N/A)	1.40	0.23	12.47
Apple	1,387.46	37.60	(N/A)	1.17	0.11	7.52
American basswood	1,656.31	44.89	(N/A)	1.17	0.14	8.98
River birch	6,469.39	175.32	(N/A)	1.17	0.54	35.06
White ash	10,389.04	281.54	(N/A)	1.17	0.86	56.31
Elm	24,954.43	676.27	(N/A)	1.17	2.06	135.25
Swamp white oak	2,743.72	74.35	(N/A)	0.93	0.23	18.59
Others	92,921.17	2,518.16		13.52	7.69	48.62
Citywide total	1,208,653.24	32,754.50	(N/A)	100.00	100.00	76.35

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species					12/10/2018												
Species	Deposition O3 (lb)	Deposition NO2 (lb)	Deposition PM10 (lb)	Deposition SO2 (lb)	Total Deposition ($)	Avoided NO2 (lb)	Avoided PM10 (lb)	Avoided VOC (lb)	Avoided SO2 (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Stand. Error	% of Total Trees	Avg. $/tree
Silver maple	72.86	12.35	35.67	3.23	392.57	135.34	19.81	18.91	129.83	846.67	- 38.30	- 143.64	389.70	1,095.60	(N/A)	20.28	12.59
Green ash	29.06	4.65	13.64	1.30	153.99	88.47	12.85	12.24	83.54	549.97	0.00	0.00	245.74	703.96	(N/A)	14.22	11.54
Black walnut	13.08	2.09	6.41	0.59	70.08	51.86	7.55	7.20	49.19	322.95	0.00	0.00	137.96	393.03	(N/A)	9.32	9.83
Norway maple	9.55	1.65	4.75	0.42	51.77	26.60	3.84	3.65	24.83	164.60	- 2.27	- 8.52	73.02	207.84	(N/A)	6.76	7.17
Northern hackberry	17.13	2.96	8.59	0.77	93.09	49.22	7.15	6.81	46.47	305.94	0.00	0.00	139.09	399.03	(N/A)	6.53	14.25
Maple	3.34	0.57	1.63	0.15	17.98	10.38	1.51	1.44	9.86	64.68	- 1.16	- 4.36	27.71	78.30	(N/A)	4.20	4.35
Black maple	8.66	1.48	3.99	0.38	45.96	17.07	2.48	2.37	16.16	106.23	- 2.83	- 10.61	49.75	141.58	(N/A)	3.50	9.44
Sugar maple	4.44	0.76	2.26	0.20	24.19	16.30	2.38	2.27	15.50	101.62	- 3.52	- 13.18	40.58	112.63	(N/A)	3.03	8.66
Eastern red cedar	3.50	0.69	2.76	0.43	22.73	5.65	0.81	0.78	5.26	34.93	- 9.38	- 35.18	10.50	22.48	(N/A)	2.56	2.04
Honeylocust	10.33	1.70	4.65	0.47	54.37	18.92	2.78	2.65	18.24	118.62	- 8.36	- 31.37	51.38	141.61	(N/A)	2.56	12.87
Red maple	1.71	0.29	0.85	0.08	9.26	6.08	0.89	0.85	5.80	37.94	- 0.62	- 2.34	15.91	44.86	(N/A)	2.10	4.98
Broadleaf Deciduous Small	1.34	0.22	0.62	0.06	7.08	4.33	0.62	0.59	4.01	26.71	- 0.01	- 0.03	11.79	33.77	(N/A)	1.63	4.82
Blue spruce	0.96	0.19	0.81	0.12	6.39	2.99	0.44	0.42	2.93	18.86	- 2.79	- 10.45	6.08	14.80	(N/A)	1.63	2.11
Basswood	0.14	0.02	0.11	0.01	0.86	2.07	0.31	0.29	2.02	13.03	0.00	0.00	4.96	13.89	(N/A)	1.40	2.32
Apple	0.45	0.07	0.21	0.02	2.37	1.34	0.19	0.18	1.22	8.23	0.00	- 0.01	3.68	10.59	(N/A)	1.17	2.12
American basswood	0.07	0.01	0.07	0.00	0.48	1.60	0.23	0.22	1.47	9.84	- 0.11	- 0.42	3.56	9.90	(N/A)	1.17	1.98
River birch	1.04	0.18	0.55	0.05	5.74	4.54	0.66	0.63	4.28	28.20	- 0.27	- 1.01	11.65	32.93	(N/A)	1.17	6.59
White ash	0.97	0.16	0.53	0.04	5.37	5.81	0.86	0.82	5.64	36.54	0.00	0.00	14.83	41.91	(N/A)	1.17	8.38
Elm	4.43	0.71	1.98	0.20	23.17	9.02	1.31	1.25	8.57	56.22	0.00	0.00	27.47	79.39	(N/A)	1.17	15.88
Swamp white oak	0.34	0.06	0.20	0.01	1.92	2.34	0.34	0.32	2.20	14.52	- 0.10	- 0.37	5.71	16.06	(N/A)	0.93	4.02
Others	16.89	2.87	8.63	0.88	92.33	42.71	6.18	5.88	40.01	264.66	- 8.68	- 32.55	115.37	324.44	(N/A)	13.52	5.74
Citywide Total	200.28	33.68	98.91	9.40	1,081.69	502.66	73.18	69.76	477.01	3,130.96	- 78.41	- 294.05	1,386.47	3,918.61	(N/A)	100.00	9.13

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species			12/10/2018			
Species	Total stored CO2 (lbs)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,693,302.97	12,699.77	(N/A)	20.28	37.44	145.97
Green ash	953,630.09	7,152.23	(N/A)	14.22	21.09	117.25
Black walnut	421,674.81	3,162.56	(N/A)	9.32	9.32	79.06
Norway maple	158,506.00	1,188.80	(N/A)	6.76	3.51	40.99
Northern hackberry	267,510.05	2,006.33	(N/A)	6.53	5.92	71.65
Maple	38,133.62	286.00	(N/A)	4.20	0.84	15.89
Black maple	92,559.91	694.20	(N/A)	3.50	2.05	46.28
Sugar maple	124,727.19	935.45	(N/A)	3.03	2.76	71.96
Eastern red cedar	11,297.82	84.73	(N/A)	2.56	0.25	7.70
Honeylocust	134,693.26	1,010.20	(N/A)	2.56	2.98	91.84
Red maple	19,831.59	148.74	(N/A)	2.10	0.44	16.53
Broadleaf Deciduous Sma	20,823.23	156.17	(N/A)	1.63	0.46	22.31
Blue spruce	5,595.67	41.97	(N/A)	1.63	0.12	6.00
Basswood	5,448.20	40.86	(N/A)	1.40	0.12	6.81
Apple	7,289.87	54.67	(N/A)	1.17	0.16	10.93
American basswood	3,447.10	25.85	(N/A)	1.17	0.08	5.17
River birch	17,394.94	130.46	(N/A)	1.17	0.38	26.09
White ash	25,293.56	189.70	(N/A)	1.17	0.56	37.94
Elm	151,967.18	1,139.75	(N/A)	1.17	3.36	227.95
Swamp white oak	6,043.96	45.33	(N/A)	0.93	0.13	11.33
Others	362,963.49	2,722.23		13.52	8.03	53.85
Citywide total	4,522,134.50	33,916.01	(N/A)	100.00	100.00	79.06

Table 5: Annual Carbon Sequestered

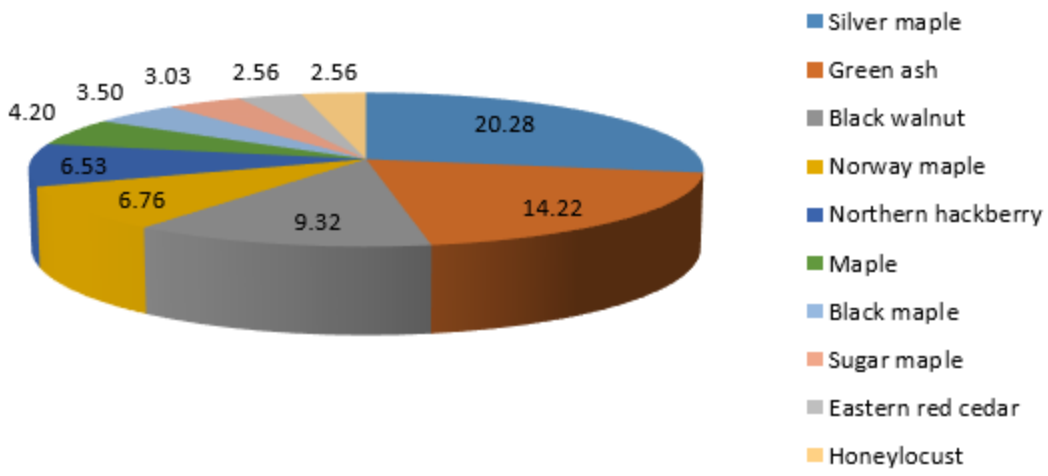
Annual CO2 Benefits of Public Trees by Species				12/10/2018									
Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	122,437.80	918.28	- 8,130.65	- 320.19	- 63.38	48,139.44	361.05	162,126.40	1,215.95	(N/A)	20.28	38.91	13.98
Green ash	43,591.53	326.94	- 4,577.42	- 197.93	- 35.82	30,918.27	231.89	69,734.45	523.01	(N/A)	14.22	16.74	8.57
Black walnut	26,205.14	196.54	- 2,024.04	- 111.15	- 16.01	18,204.81	136.54	42,274.76	317.06	(N/A)	9.32	10.15	7.93
Norway maple	8,388.49	62.91	- 765.72	- 57.92	- 6.18	9,177.63	68.83	16,742.48	125.57	(N/A)	6.76	4.02	4.33
Northern hackberry	12,789.88	95.92	- 1,284.05	- 96.72	- 10.36	17,186.21	128.90	28,595.31	214.46	(N/A)	6.53	6.86	7.66
Maple	4,836.71	36.28	- 183.10	- 22.23	- 1.54	3,649.86	27.37	8,281.25	62.11	(N/A)	4.20	1.99	3.45
Black maple	6,266.01	47.00	- 444.29	- 34.32	- 3.59	5,983.77	44.88	11,771.17	88.28	(N/A)	3.50	2.82	5.89
Sugar maple	7,291.79	54.69	- 598.74	- 36.08	- 4.76	5,740.09	43.05	12,397.05	92.98	(N/A)	3.03	2.98	7.15
Eastern red cedar	82.71	0.62	- 54.23	- 20.67	- 0.56	1,950.43	14.63	1,958.25	14.69	(N/A)	2.56	0.47	1.34
Honeylocust	4,457.36	33.43	- 646.53	- 30.03	- 5.07	6,762.30	50.72	10,543.10	79.07	(N/A)	2.56	2.53	7.19
Red maple	1,669.01	12.52	- 95.25	- 12.09	- 0.81	2,148.09	16.11	3,709.76	27.82	(N/A)	2.10	0.89	3.09
Broadleaf Deciduous Small	1,681.94	12.61	- 99.95	- 11.70	- 0.84	1,485.07	11.14	3,055.35	22.92	(N/A)	1.63	0.73	3.27
Blue spruce	456.96	3.43	- 26.87	- 10.14	- 0.28	1,085.00	8.14	1,504.95	11.29	(N/A)	1.63	0.36	1.61
Basswood	950.85	7.13	- 26.15	- 5.46	- 0.24	746.19	5.60	1,665.43	12.49	(N/A)	1.40	0.40	2.08
Apple	122.50	0.92	- 35.04	- 5.46	- 0.30	451.96	3.39	533.97	4.00	(N/A)	1.17	0.13	0.80
American basswood	427.46	3.21	- 16.55	- 4.68	- 0.16	541.78	4.06	948.02	7.11	(N/A)	1.17	0.23	1.42
River birch	1,689.71	12.67	- 83.50	- 8.97	- 0.69	1,581.75	11.86	3,178.99	23.84	(N/A)	1.17	0.76	4.77
White ash	2,859.25	21.44	- 121.41	- 10.53	- 0.99	2,089.87	15.67	4,817.17	36.13	(N/A)	1.17	1.16	7.23
Elm	3,331.17	24.98	- 729.44	- 21.45	- 5.63	3,171.78	23.79	5,752.06	43.14	(N/A)	1.17	1.38	8.63
Swamp white oak	929.46	6.97	- 29.71	- 4.88	- 0.26	811.24	6.08	1,706.12	12.80	(N/A)	0.93	0.41	3.20
Others	12,450.60	93.38	- 1,742.54	- 113.30	- 13.92	14,806.68	111.05	25,401.44	190.51		13.52	6.10	3.25
Citywide Total	262,916.34	1,971.87	- 21,715.17	- 1,135.89	- 171.38	176,632.21	1,324.74	416,697.49	3,125.23	(N/A)	100.00	100.00	7.28

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefit of Public Trees by Species				12/10/2018	
Species	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	9,416.85	(N/A)	20.28	39.55	108.24
Green ash	3,470.26	(N/A)	14.22	14.57	56.89
Black walnut	2,208.57	(N/A)	9.32	9.27	55.21
Norway maple	832.72	(N/A)	6.76	3.50	28.71
Northern hackberry	1,677.34	(N/A)	6.53	7.04	59.90
Maple	659.20	(N/A)	4.20	2.77	36.62
Black maple	764.75	(N/A)	3.50	3.21	50.98
Sugar maple	772.46	(N/A)	3.03	3.24	59.42
Eastern red cedar	35.05	(N/A)	2.56	0.15	3.19
Honeylocust	1,166.72	(N/A)	2.56	4.90	106.07
Red maple	258.45	(N/A)	2.10	1.09	28.72
Broadleaf Deciduous Small	99.08	(N/A)	1.63	0.42	14.15
Blue spruce	136.20	(N/A)	1.63	0.57	19.46
Basswood	133.35	(N/A)	1.40	0.56	22.22
Apple	6.21	(N/A)	1.17	0.03	1.24
American basswood	47.86	(N/A)	1.17	0.20	9.57
River birch	173.81	(N/A)	1.17	0.73	34.76
White ash	363.61	(N/A)	1.17	1.53	72.72
Elm	246.01	(N/A)	1.17	1.03	49.20
Swamp white oak	104.49	(N/A)	0.93	0.44	26.12
Others	1,239.55		13.52	5.21	20.84
Citywide Total	23,812.53	(N/A)	100.00	100.00	55.51

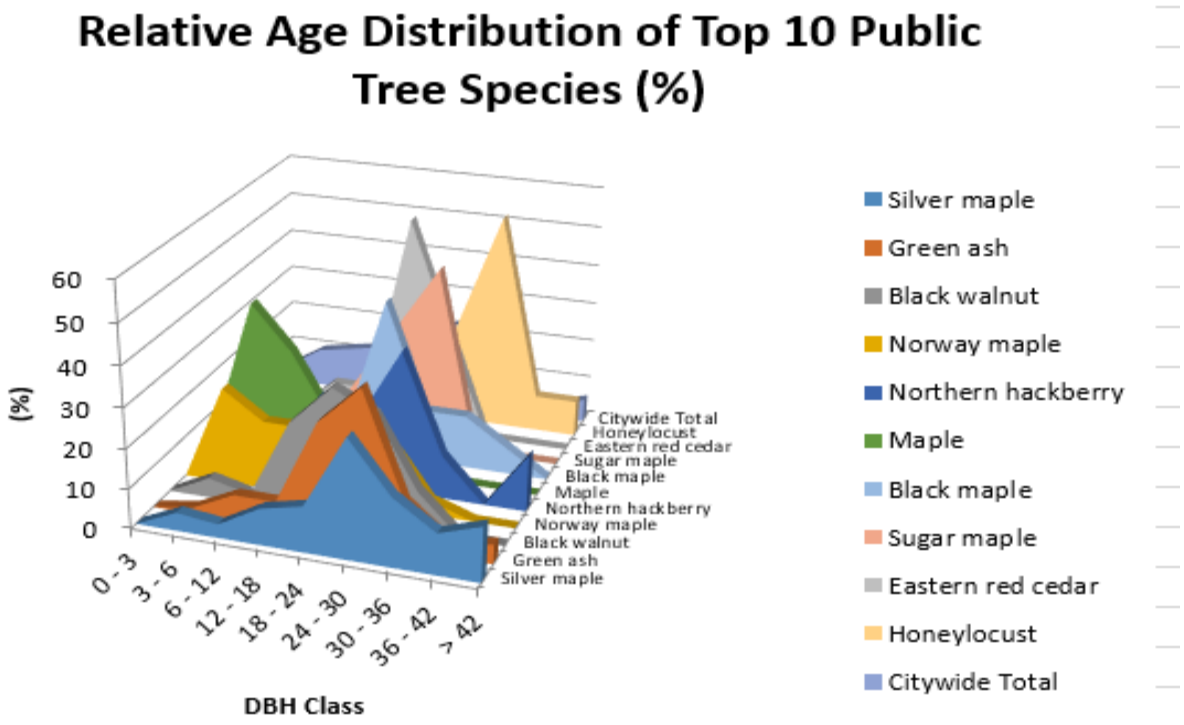
Table 7: Summary of Benefits in Dollars

Average Annual Benefits of Public Trees by Species ($/tree)					12/10/2018		
Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total	Stand. Error
Silver maple	67.64	13.98	12.59	128.80	108.24	331.25	(N/A)
Green ash	64.31	8.57	11.54	96.77	56.89	238.08	(N/A)
Black walnut	57.09	7.93	9.83	76.66	55.21	206.72	(N/A)
Norway maple	41.25	4.33	7.17	45.39	28.71	126.86	(N/A)
Northern hackberry	77.70	7.66	14.25	94.69	59.90	254.21	(N/A)
Maple	25.49	3.45	4.35	23.95	36.62	93.86	(N/A)
Black maple	50.45	5.89	9.44	61.50	50.98	178.26	(N/A)
Sugar maple	55.15	7.15	8.66	73.76	59.42	204.15	(N/A)
Eastern red cedar	23.38	1.34	2.04	41.89	3.19	71.84	(N/A)
Honeylocust	74.28	7.19	12.87	126.96	106.07	327.36	(N/A)
Red maple	29.53	3.09	4.98	26.27	28.72	92.59	(N/A)
Broadleaf Deciduous Small	28.22	3.27	4.82	15.81	14.15	66.28	(N/A)
Blue spruce	17.98	1.61	2.11	30.19	19.46	71.35	(N/A)
Basswood	14.69	2.08	2.32	12.47	22.22	53.78	(N/A)
Apple	12.64	0.80	2.12	7.52	1.24	24.32	(N/A)
American basswood	14.82	1.42	1.98	8.98	9.57	36.78	(N/A)
River birch	40.24	4.77	6.59	35.06	34.76	121.42	(N/A)
White ash	49.51	7.23	8.38	56.31	72.72	194.15	(N/A)
Elm	79.28	8.63	15.88	135.25	49.20	288.24	(N/A)
Swamp white oak	26.18	3.20	4.02	18.59	26.12	78.10	(N/A)
Others	1,029.71	97.37	172.13	1,458.73	625.09	3,383.03	
Citywide Total	51.63	7.28	9.13	76.35	55.51	199.91	(N/A)



12/10/2018	
Species Distribution of Public Trees for 1	
Species	Percent
Silver maple	20.28
Green ash	14.22
Black walnut	9.32
Norway maple	6.76
Northern hackberry	6.53
Maple	4.20
Black maple	3.50
Sugar maple	3.03
Eastern red cedar	2.56
Honeylocust	2.56
Other Species	27.04

Figure 1: Species Distribution



Relative Age Distribution of Top 10 Public Tree Species (%)									
12/10/2018	DBH class (in)								
Species	0 - 3	3 - 6	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	>42
Silver maple	0.00	4.60	3.45	9.20	11.49	29.89	17.24	10.34	13.79
Green ash	0.00	1.64	6.56	6.56	27.87	37.70	11.48	3.28	4.92
Black walnut	0.00	5.00	2.50	22.50	32.50	27.50	10.00	0.00	0.00
Norway maple	0.00	24.14	17.24	17.24	20.69	17.24	3.45	0.00	0.00
Northern hackberry	0.00	0.00	0.00	21.43	17.86	35.71	10.71	0.00	14.29
Maple	5.56	38.89	27.78	11.11	16.67	0.00	0.00	0.00	0.00
Black maple	0.00	13.33	6.67	6.67	40.00	13.33	13.33	6.67	0.00
Sugar maple	7.69	0.00	0.00	15.38	30.77	46.15	0.00	0.00	0.00
Eastern red cedar	0.00	0.00	9.09	9.09	54.55	27.27	0.00	0.00	0.00
Honeylocust	0.00	0.00	0.00	0.00	0.00	27.27	54.55	9.09	9.09
Citywide Total	3.50	9.79	11.66	13.52	19.35	23.31	10.02	3.03	5.83

Figure 2: Relative Age Class

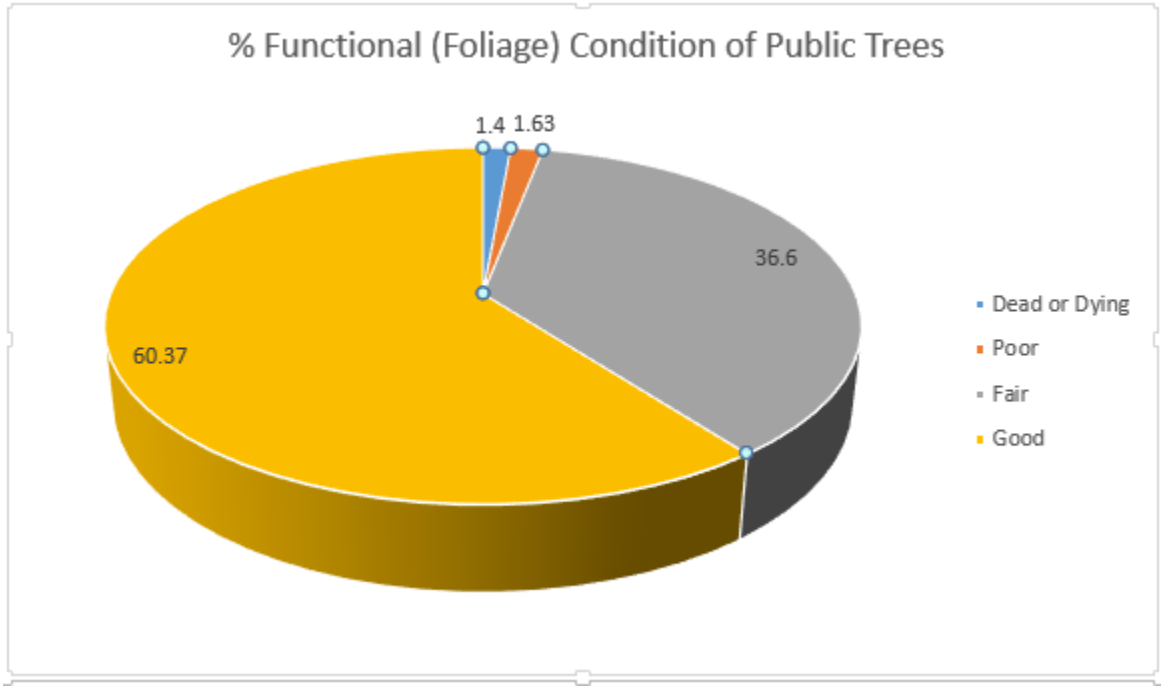


Figure 3: Foliage Condition

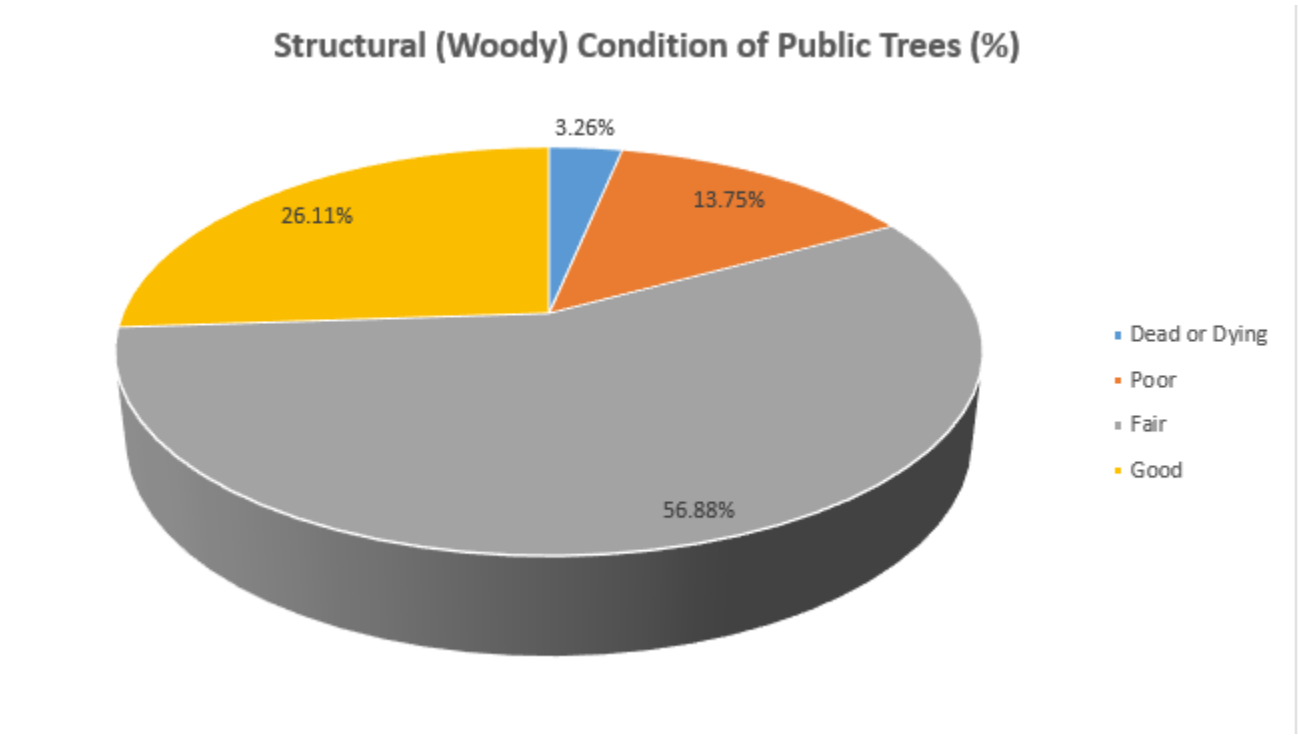
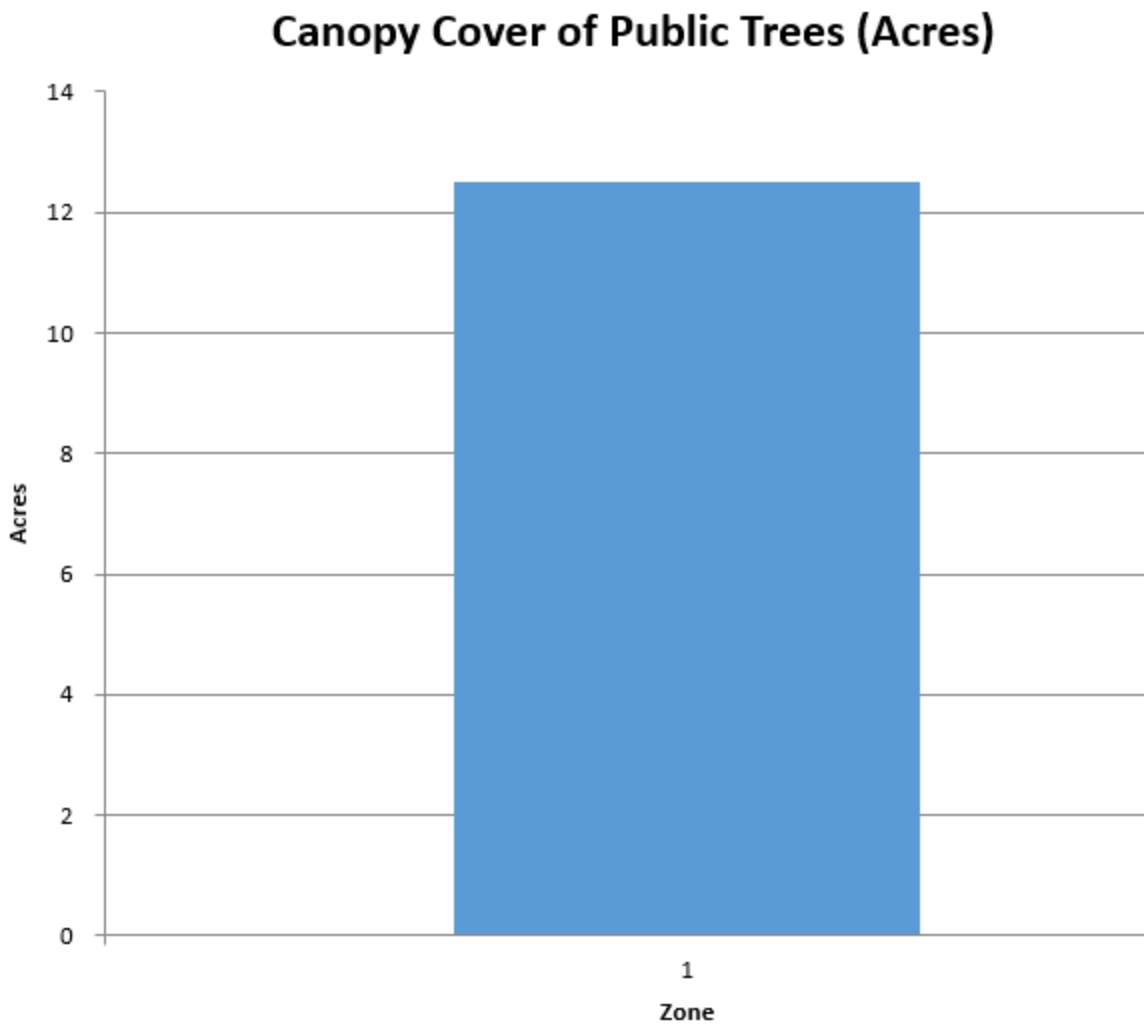
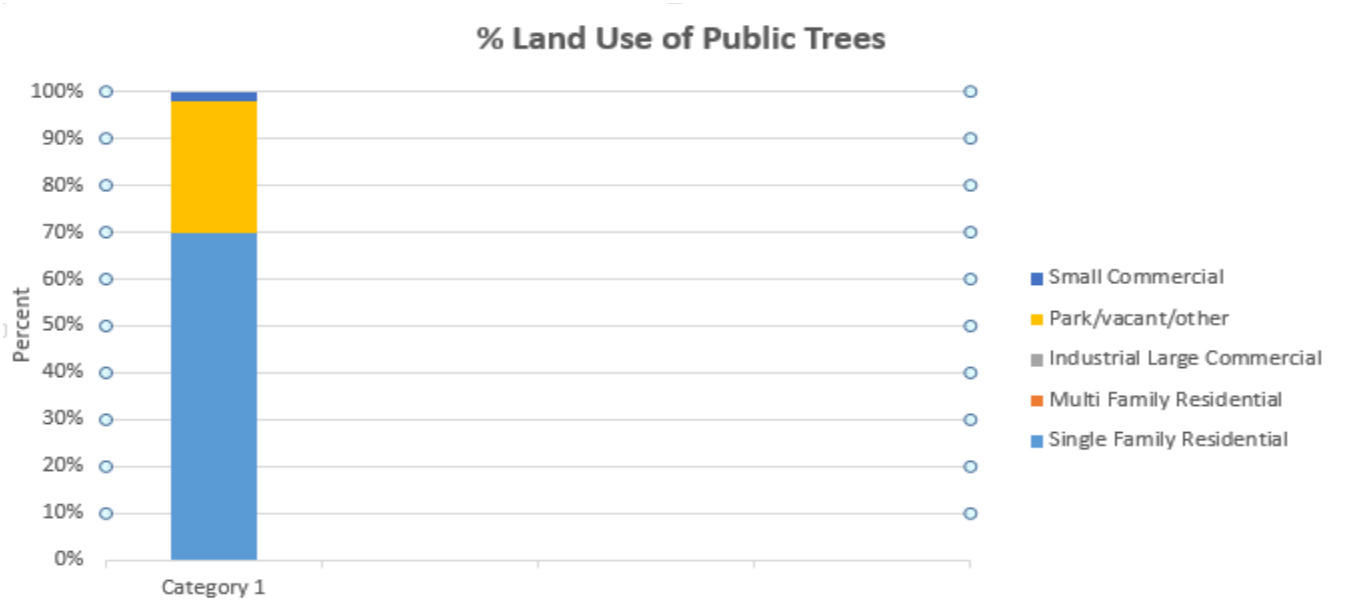


Figure 4: Wood Condition



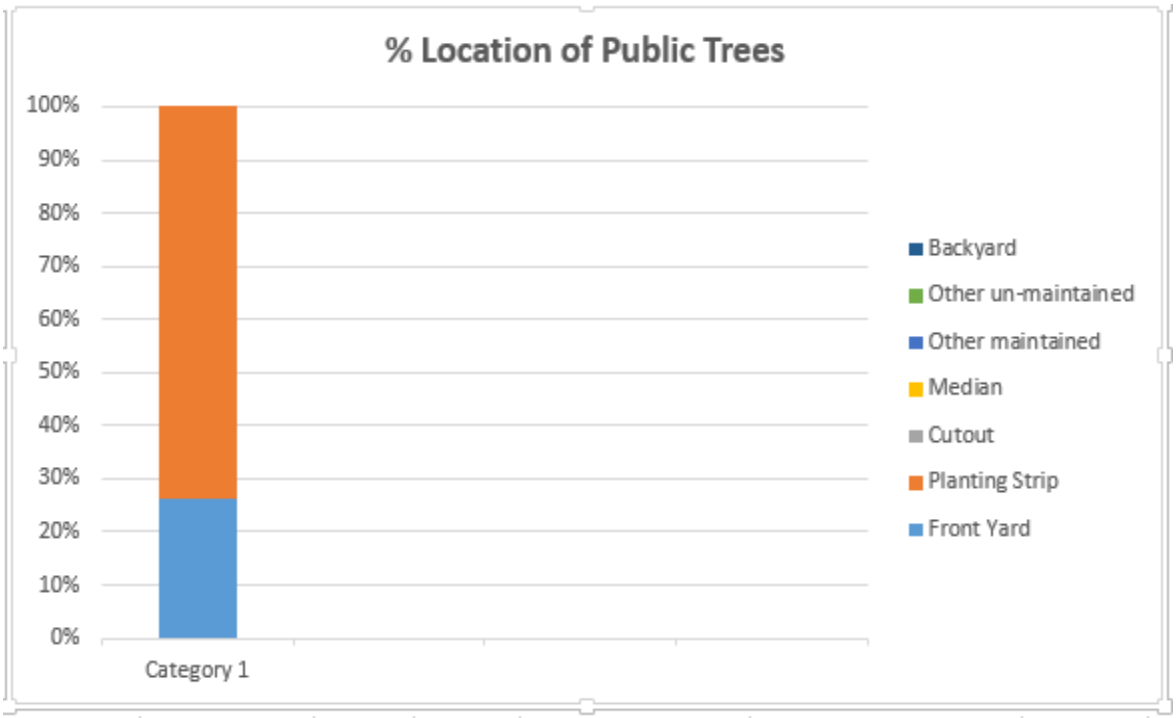
12/10/2018		
Zone	Acres	% of Total Canopy
1	12.51	13.20
Citywide Total	95.00	100.00

Figure 5: Canopy Cover in Acres



Single Family Residential	Multi Family Residential	Industrial Large Commercial	Park/vacant/other	Small Commercial
70%	0	0	28%	2.10%

Figure 6: Land Use of city/park trees



Front Yard	Planting Strip	Cutout	Median	Other maintained	Other un-maintained	Backyard
25%	69.93%	0%	0.00%	0%	0	0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1:

Location of Ash Trees
2018 Community Tree Inventory
Stratford, IA

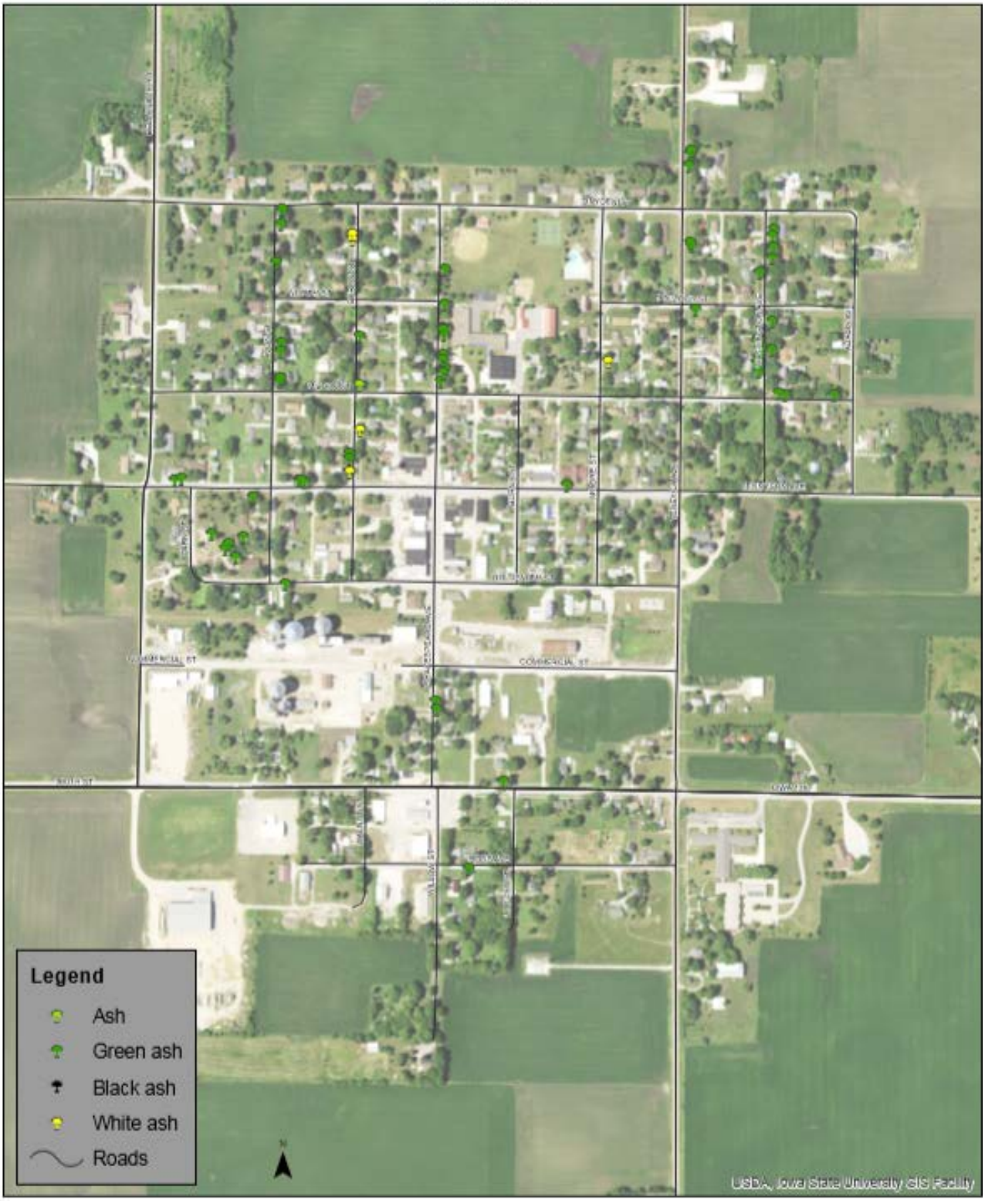


Figure 2:

Location of EAB Symptoms
2018 Community Tree Inventory
Stratford, IA

Figure 3a:

Location of Poor Condition Trees
2018 Community Tree Inventory
Stratford, IA

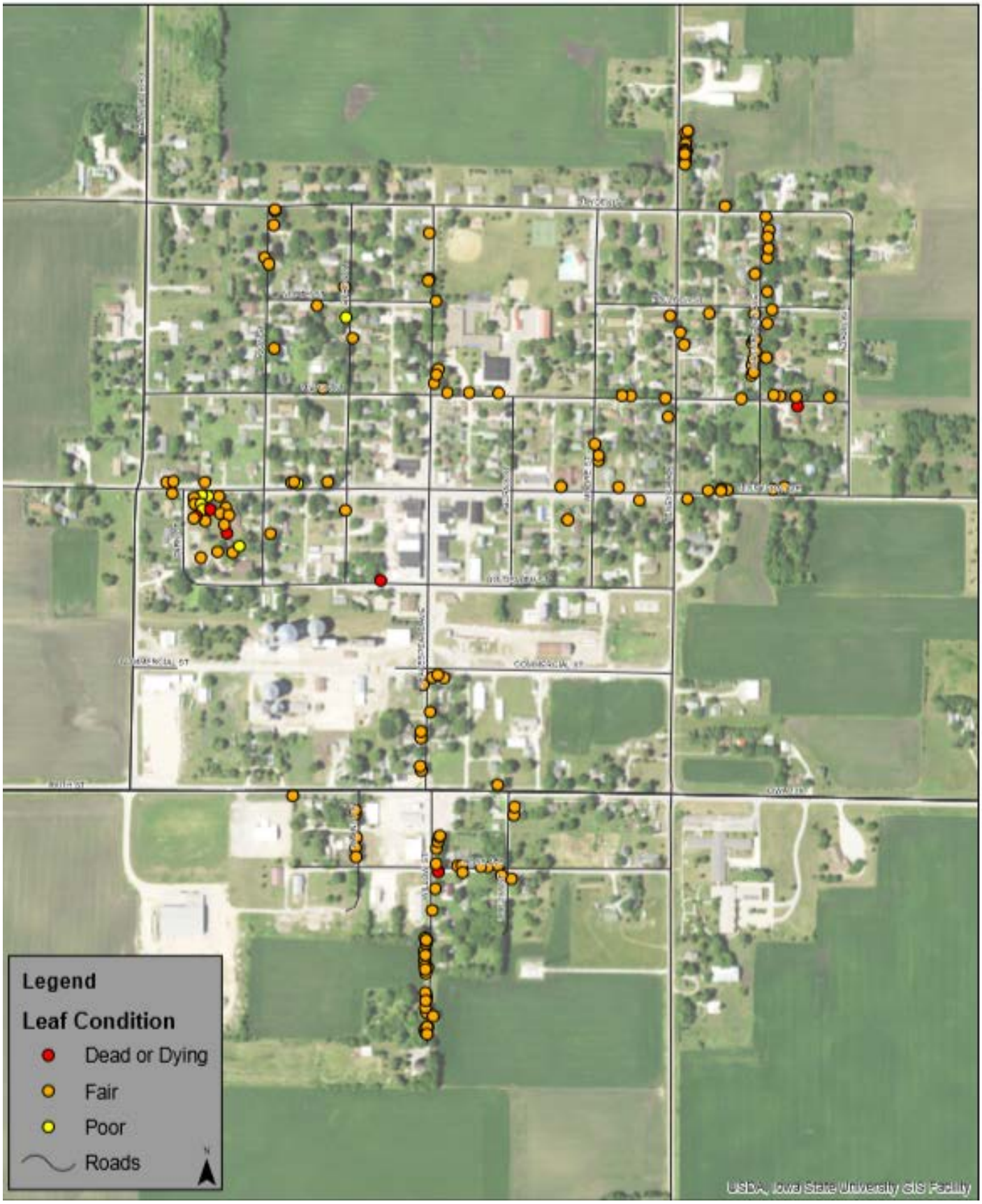


Figure 3b:

Location of Poor Condition Trees
2018 Community Tree Inventory
Stratford, IA

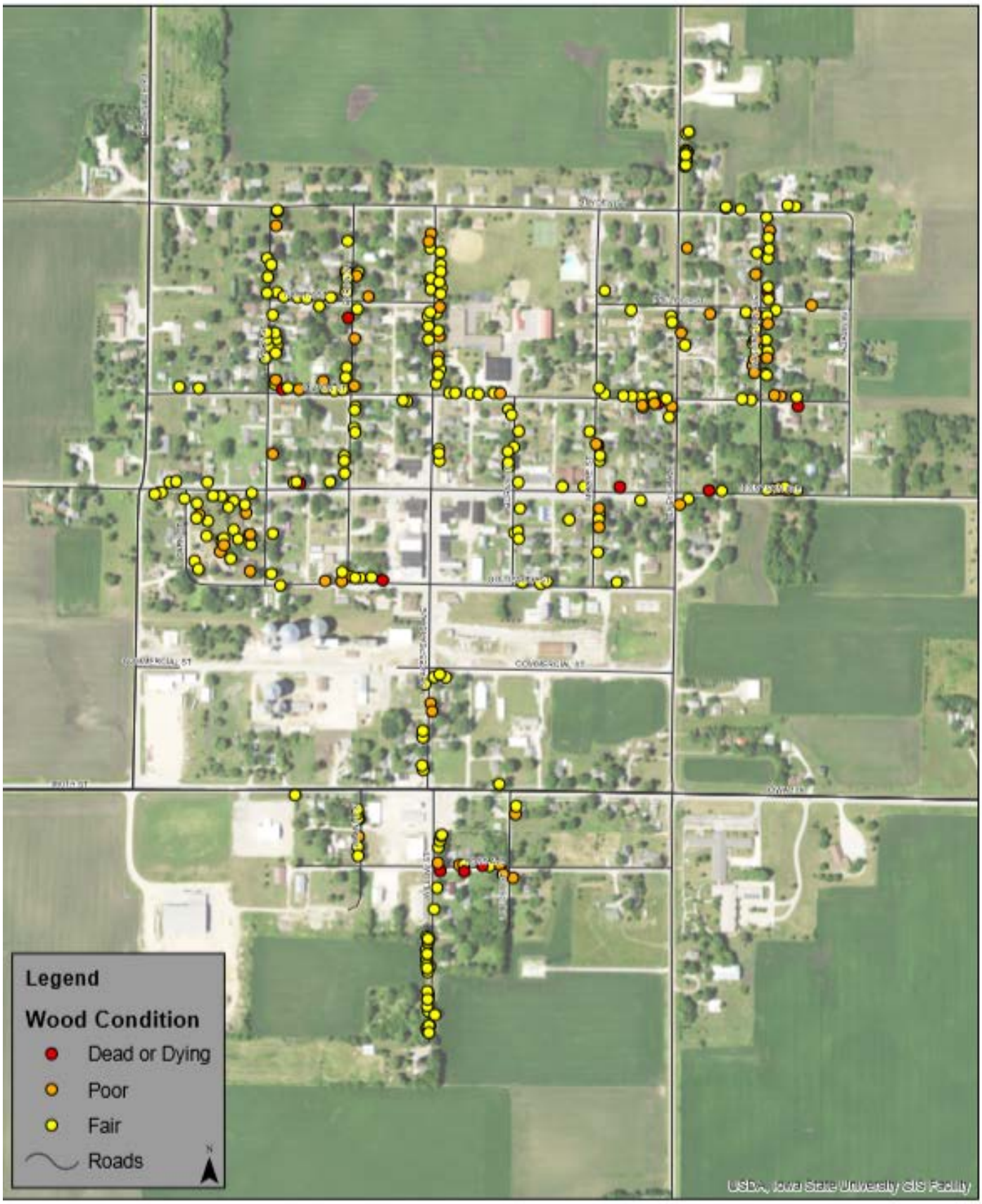


Figure 4:

Location of Trees with Recommended Maintenance
2018 Community Tree Inventory
Stratford, IA

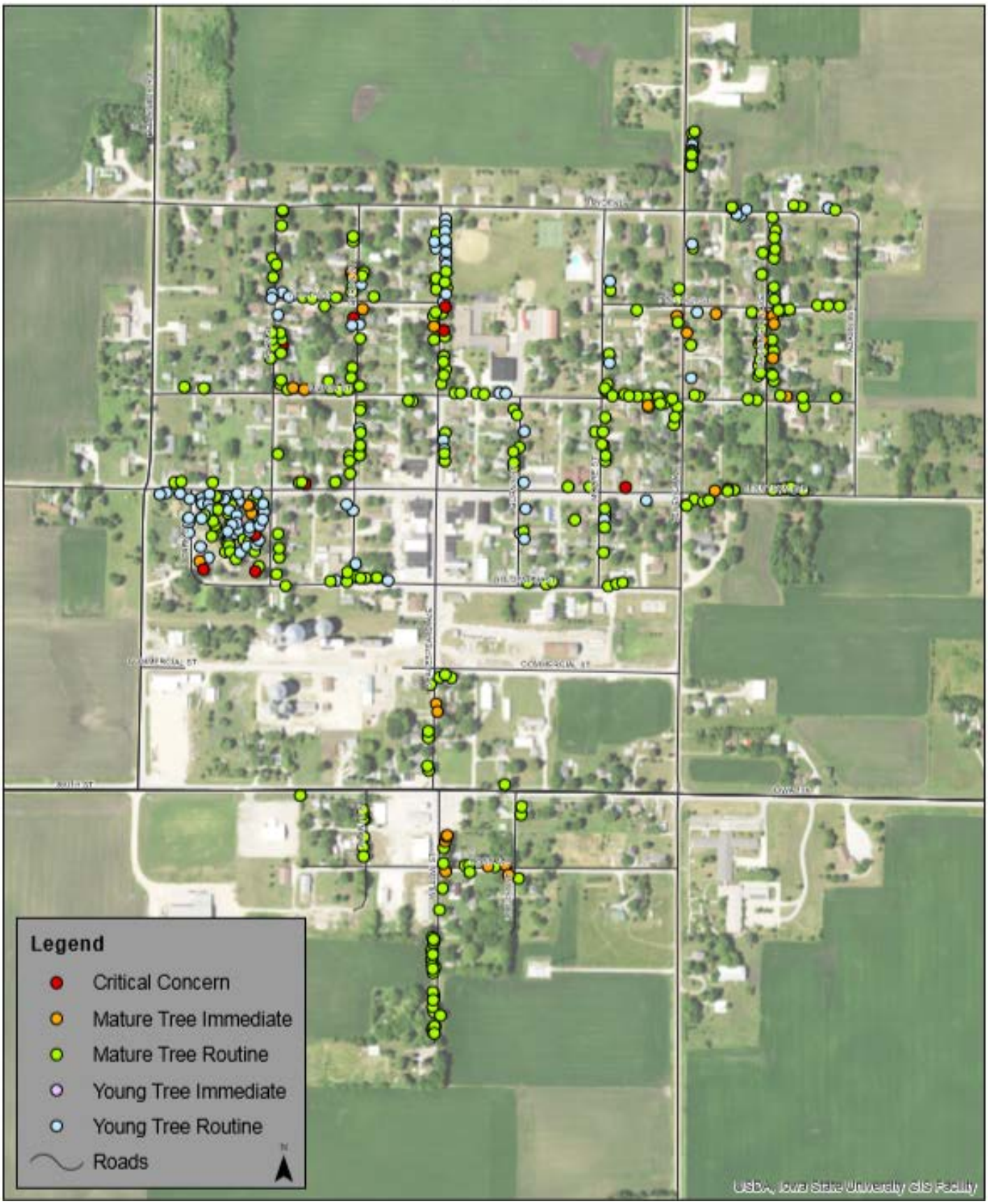


Figure 5:

Maintenance Tasks
2018 Community Tree Inventory
Stratford, IA

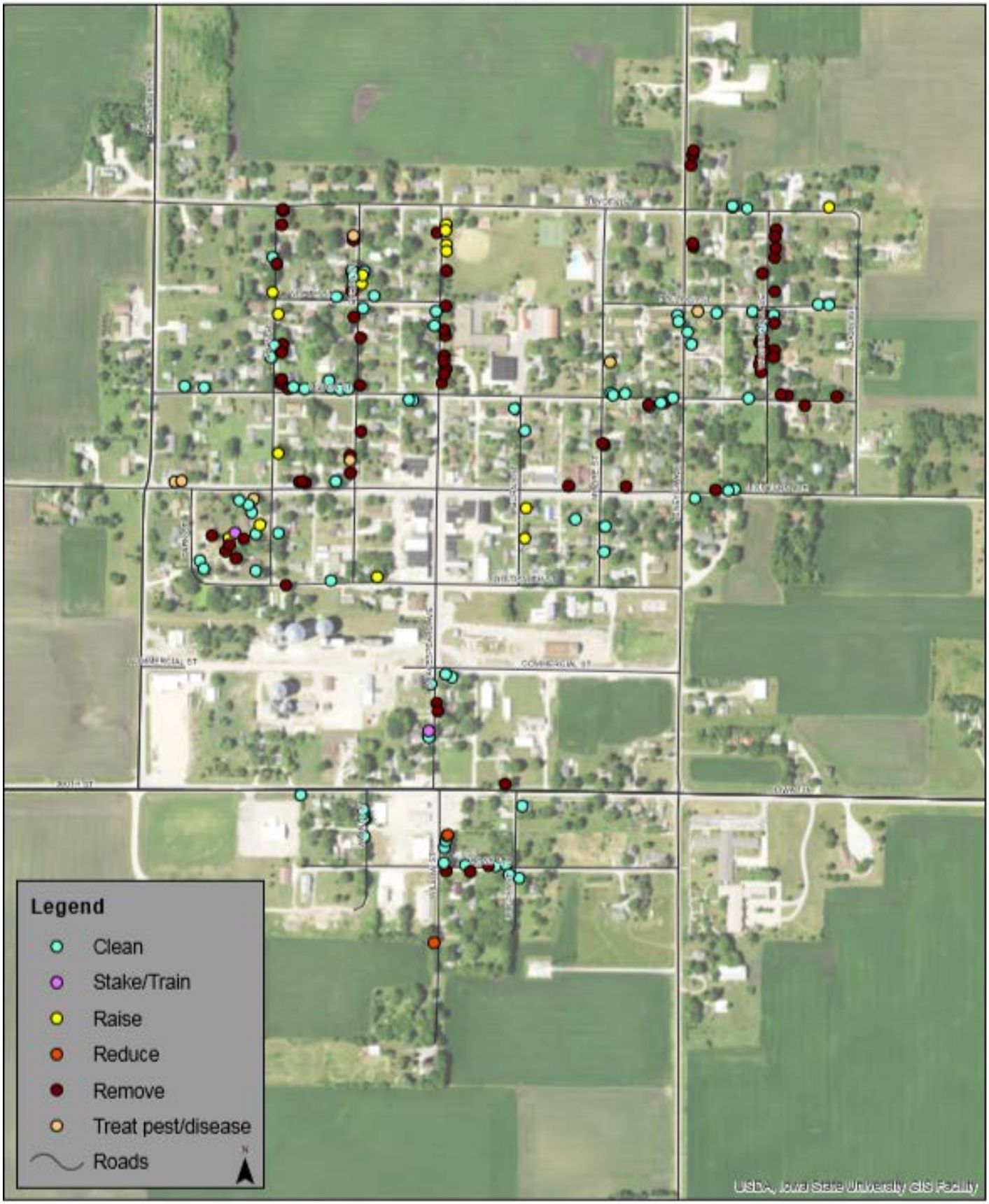


Figure 6:

Locaiton of Treatable Ash Trees
2018 Community Tree Inventory
Stratford, IA

Figure 7:

Removed Trees
2018 Community Tree Inventory
Stratford, IA

Appendix C: Stratford Tree Ordinances

CHAPTER 151

TREES

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

151.02 PLANTING RESTRICTIONS. No tree shall be planted in any parking or street except in accordance with the following:

1. Alignment. All trees planted in any street shall be planted in the parking midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.

2. Spacing. Trees shall not be planted on any parking which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.

3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

151.03 DUTY TO TRIM TREES. The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax.

(Code of Iowa, Sec. 364.12[2c, d & e])

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

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

151.06 INSPECTION AND REMOVAL. The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.

2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.

(Code of Iowa, Sec. 364.12[3b & h])

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

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

If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-725-8200.