2014 Urban Forest Management Plan

Castalia, Iowa

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Community Tree Inventory

Castalia, Iowa

Summary

This plan was developed to assist the City of Castalia with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows communities to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (does not include mountain ash). There is a strong possibility that 19% of Castalia's city owned trees (ash) will die once EAB becomes established in the community. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory & Results

In 2014, a tree inventory was conducted using Global Positioning System (GPS) data collectors. --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. The inventory was a complete inventory of street and park trees. Below are some key findings of the **85 trees inventoried.**

Inventory Overview

- Castalia's trees provide $12,001 of benefits annually, an average of $142 a tree
- There are over 17 species of trees
- The top three genus are: Maple 32%, Ash 19%, Spruce 18%
- 49% of trees are in need of some type of management
- 2 trees are recommended for removal.

General Recommendations

The following are key recommendations from the inventory:

- Of the 2 trees needing removal, 1 tree, an ash is over 24 inches in diameter at 4.5 ft and must be addressed immediately. The 2nd removal is a 3-6 in swamp white oak.
  **City ownership of the trees recommended for removal should be verified prior to any removal*
- After the removal of the 2 critical concern trees, ash trees in poor health should be assessed for removal.
- 5 of the 16 ash trees should be re-evaluated at a later date, because they are displaying signs and symptoms associated with EAB.
- All trees should be pruned on a routine schedule - one third of the city every other year.
- Plant a diverse mix of trees that does NOT include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Check ash trees with a visual survey yearly

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.

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

Detailed Inventory Results

The data collected for the 85 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

Annual Benefits

1. Annual Energy Benefits: Trees conserve energy by shading buildings and blocking winds. Castalia's trees reduce energy related costs by approximately $3,253.29 annually. These savings are both in Electricity (15.35 MWh) and in Natural Gas (2,088.52 Therms).

2. Annual Stormwater Benefits: Castalia's trees intercept about 156,145 gallons of rainfall or snowmelt a year. This interception provides $4,231.53 of benefits to the city.

3. 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 Castalia, it is estimated that trees remove 191.02 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 $534.54.

4. Annual Carbon Benefits: Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Castalia trees sequester about 36,655.62 lbs of carbon dioxide (CO2) a year with an associated value of $450. In addition, the trees store 464,808.10 lbs of carbon, with a yearly benefit of $3,486.

5. Annual Aesthetics Benefits: Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Castalia receives $3,532.02 in annual social benefits from trees.

Financial Summary of all Benefits: According to the USDA Forest Service i-Tree STRATUM analysis, Castalia's trees provide **$12,001.32 of benefits annually.** Benefits of individual trees vary based on size, species, health and location, but **on average each of the 85 trees in Castalia provide approximately $141.19 annually.**

Table 1: Annual Benefits of Public Trees

Benefits	Per Tree	Cumulative
Energy	$38.27	$3,253.29
CO_2	$5.29	$449.93
Air Quality	$6.29	$534.54
Stormwater	$49.78	$4,231.53
Aesthetic/Other	$41.55	$3,532.02
Total ($)	**$141.19**	**$12,001.32**

Forest Structure

1. Species & Genus Distribution: Castalia has over 17 different tree species along city streets and parks. The following figures and tables show the distribution of the most common trees species. 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, and it is recommended that they should not be planted until this percentage can be lowered.

Figure 1: Common Tree Species by Percentage

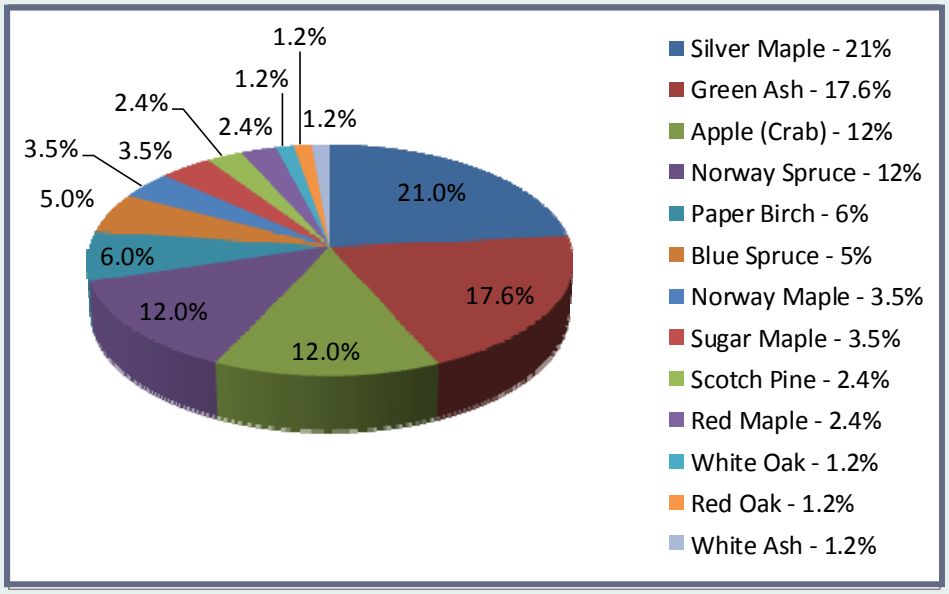
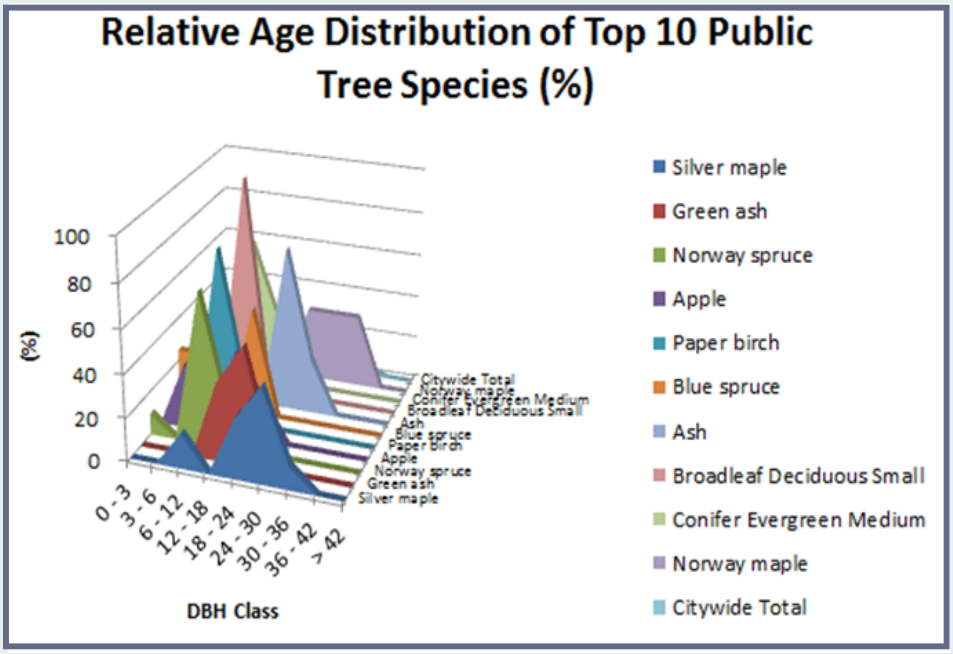


Table 2: Tree Species

Genus	No. of Trees
Silver Maple	18
Green Ash	15
Apple (Crab)	10
Norway Spruce	10
Paper Birch	5
Blue Spruce	4
Norway Maple	3
Sugar Maple	3
Scotch Pine	2
Red Maple	2
White Oak	1
Red Oak	1
White Ash	1

Figure 2: Age Distribution of Top 10 Public Tree Species (by Percentage)



2. Age Class: Castalia has a good balance of age classes. 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. Castalia's size curve is on the smaller side, indicating a younger than average stand. Refer to Figure 2 for this information.

3. 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 Castalia indicate that 94% of the trees are in fair-good health, with only 6%of the foliage in poor health, dead or dying. Similarly, 92% of Castalia's trees are in fair-good health for wood condition. Wood condition that is in poor health, dead or dying is about 8% of the population. This 8% is an estimate of trees that need management follow up soon.

4. Management Needs: The following management needs for Castalia's urban trees are outlined in Table 4. The table outlines the specific management needs of the street and park trees by number of trees and percent of the canopy.

- 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.
- Tree staking includes staking, training, mulching, etc.

5. Canopy Cover: Castalia occupies 371 acres. The tree canopy cover of Castalia is approximately 1.68 acres, about .45%.

6. Land Use and Location: The majority of Castalia's city and park trees are in the city park. Table 5 & Table 6 describe the land use and locations for the street and park trees.

Table 4: Management Needs

Technique	No of Trees	Percentage
Crown Cleaning	36	42.4%
Crown Raising	0	0%
Tree Staking	0	0%
Tree Removal	2	2.4%
Crown Reduction	4	5%

Table 5: Land Use

Single Family Residential	4.71%
Park/Vacant/Other	95.29%
Industrial/Large Commercial	0%
Small Commercial	0%
Multifamily Residential	0%

Table 6: Location Type

Planting Strip	4.71%
Other Maintained Location (Park)	95.29%
Front Yard	0%
Cutout (Surrounded by Pavement)	0%

Recommendations

1. 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.

2. Hazardous Trees: Castalia has 2 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Image 4 & Image 5). It is recommended to start with the large diameter critical concern trees first. There are 1 ash tree over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the *Six Year Maintenance Plan* at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance that do not include trimming. There is 1 tree with these needs.

3. Poor Tree Species: After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Image 3 & Appendix B, Image 4). Of the 2 removals, 1 is an ash trees. There are a total of 16 ash trees, and 5 of those have signs and symptoms that have been associated with EAB. In addition, there are 4 ash trees that are in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal.

4. 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.

5. 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%. 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 Castalia.

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 (32%). Maple 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 the city tree ordinance.

The importance of species diversity was brought to the forefront with the loss of the American elm from Dutch elm disease. When one genus (Maple) makes up a majority of the species (Norway Maple, Silver Maple, Sugar Maple) in a planting it is an unbalanced population. These unbalanced populations leave the population open to destruction from diseases and pests. Unfortunately, the lessons of the American elm are only recently being heeded. Communities typically replaced lost elms with a small but reliable selection of ash and Norway and silver maple. This left cities in the predicament they are finding themselves in now as they stand to lose a large percentage of their ash trees to the emerald ash borer.

6. Continual Monitoring: It is important to continuously check the health of all trees. Due to the imminent threat of Emerald Ash Borer to ash trees, it is recommended that 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. For a list of forest health threats, please visit the Iowa DNR's website at http://www.iowadnr.gov/Environment/Forestry/ForestHealth

Six Year Maintenance Plan with No Additional Funding

Year 1: Removal: 2 critical concern trees (1-24″ ash) and 1 ash in poor health or saving for ash tree treatment

Planting and Replacement: 4 trees to be planted in open locations

Visual Survey for signs and symptoms of EAB

Year 2: Removal: 3 ash in poor health or saving for ash tree treatment

Planting and Replacement: 4 trees in open locations

Routine pruning: 1/3 of trees (14)

Visual Survey for signs and symptoms of EAB

Year 3: Removal: 3 ash or saving for ash tree treatment

Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals

Visual Survey for signs and symptoms of EAB

Year 4: Removal: any new critical concern trees and/or 3 ash or saving for ash tree treatment

Planting and Replacement: 4 trees in open locations from previous removals

Routine pruning: 1/3 of trees (13)

Visual Survey for signs and symptoms of EAB

Year 5: Removal: Removal of any new critical concern trees and/or 3 ash or saving for ash tree treatment

Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals

Visual Survey for signs and symptoms of EAB

Year 6: Removal: Removal of any new critical concern trees and/or 2 ash or saving for ash tree treatment

Planting and Replacement: 4 trees in open locations from previous removals

Routine pruning: 1/3 of trees (13)

Visual Survey for signs and symptoms of EAB

Reduction of ash over 6 years: 16 ash trees removed (100% of ash). EAB could potentially kill all ash within 4 years of its arrival.

Emerald Ash Borer Plan

1. Ash Tree Removal

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

2. Treatment of Ash Trees

Chemical treatment can be effective, spreading 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/

Emerald Ash Borer Beetle next to D-shaped exit holes.

3. EAB Quarantines

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

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.

4. 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.

5. Canopy Replacement

As budget permits, all removed ash trees will be replaced. All trees will meet the restrictions in the city ordinance. 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.

6. Postponed Work

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

7. Monitoring (repeated)

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 die-back, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

8. Private Ash Trees

It is strongly recommended that private property owners start removing ash trees or treating healthy trees they desire to preserve on their property upon arrival of EAB or confirmed within 15 miles. Refer to City Ordinance for more information on private trees.

Proposed Budget

Total $16,590 over 6 years ($2,765/year)

FY 2015 Budget

Removal @ $700/tree: $2,100 *Or saving for ash tree treatment

Planting @ $100/tree: $400

Watering & Maintenance @ $50/tree: $200

FY 2016 Budget

Removal: $2,100 *Or saving for ash tree treatment

Planting: $400

Critical Concern Trimming: $1,900

Watering & Maintenance: $200

FY 2017 Budget

Removal: $2,100 *Or saving for ash tree treatment

Planting: $400

Watering & Maintenance: $200

FY 2018 Budget

Removal: $2,100 *Or saving for ash tree treatment

Planting: $400

Critical Concern Trimming: $200

Routine Pruning: $126

FY 2019 Budget

Removal: $2,100 *Or saving for ash tree treatment

Planting: $400

Watering & Maintenance: $200

FY 2020 Budget

Removal: $2,100 *Or saving for ash tree treatment

Planting: $400

Watering & Maintenance: $200

Routine Pruning: $126

*Reduction of ash over 6 years: 16 ash trees removed (100% of ash).

Proposed Budget Increase

EAB could potentially kill all ash trees in Castalia within 4 years of its arrival. Additionally, it is recommended that Castalia 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.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species									
Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	5.13	389.60	695.34	681.43	1,071.03	(N/A)	21.18	32.92	59.50
Green ash	2.84	215.93	383.49	375.82	591.75	(N/A)	12.94	18.19	53.80
Norway spruce	0.66	49.77	96.41	94.48	144.25	(N/A)	11.76	4.43	14.42
Apple	1.28	96.80	186.13	182.41	279.21	(N/A)	11.76	8.58	27.92
Paper birch	0.61	46.51	81.90	80.27	126.78	(N/A)	5.88	3.90	25.36
Blue spruce	0.29	21.92	36.42	35.69	57.61	(N/A)	4.71	1.77	14.40
Ash	1.11	84.10	166.12	162.79	246.90	(N/A)	4.71	7.59	61.72
Norway maple	0.90	68.65	134.40	131.71	200.36	(N/A)	3.53	6.16	66.79
Sugar maple	0.86	65.62	113.62	111.34	176.97	(N/A)	3.53	5.44	58.99
Red maple	0.15	11.13	21.73	21.30	32.43	(N/A)	2.35	1.00	16.21
Scotch pine	0.17	12.86	23.69	23.22	36.08	(N/A)	2.35	1.11	18.04
Spruce	0.06	4.27	9.50	9.31	13.58	(N/A)	1.18	0.42	13.58
White oak	0.03	2.20	3.69	3.62	5.82	(N/A)	1.18	0.18	5.82
White ash	0.42	31.87	54.49	53.40	85.27	(N/A)	1.18	2.62	85.27
Amur maple	0.02	1.68	3.80	3.72	5.40	(N/A)	1.18	0.17	5.40
Northern red oak	0.20	14.87	23.32	22.86	37.72	(N/A)	1.18	1.16	37.72
Swamp white oak	0.04	2.92	6.19	6.07	8.99	(N/A)	1.18	0.28	8.99
Other City Trees	0.58	44.05	90.93	89.11	133.16	(N/A)	8.24	4.09	20.23
Total	15.35	1,164.77	2,131.15	2,088.52	3,253.29	(N/A)	100.00	100.00	38.27

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species						
Species	Total Rainfall Interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	64,492.30	1,747.74	(N/A)	21.18	41.30	97.10
Green ash	25,349.24	686.96	(N/A)	12.94	16.23	62.45
Norway spruce	7,294.64	197.68	(N/A)	11.76	4.67	19.77
Apple	5,484.66	148.63	(N/A)	11.76	3.51	14.86
Paper birch	3,896.99	105.61	(N/A)	5.88	2.50	21.12
Blue spruce	3,383.25	91.69	(N/A)	4.71	2.17	22.92
Ash	11,202.19	303.58	(N/A)	4.71	7.17	75.89
Norway maple	10,007.97	271.22	(N/A)	3.53	6.41	90.41
Sugar maple	9,163.55	248.33	(N/A)	3.53	5.87	82.78
Red maple	762.56	20.67	(N/A)	2.35	0.49	10.33
Scotch pine	3,181.95	86.23	(N/A)	2.35	2.04	43.12
Spruce	595.52	16.14	(N/A)	1.18	0.38	16.14
White oak	171.63	4.65	(N/A)	1.18	0.11	4.65
White ash	5,299.45	143.62	(N/A)	1.18	3.39	143.62
Amur maple	68.66	1.86	(N/A)	1.18	0.04	1.86
Northern red oak	1,193.29	32.34	(N/A)	1.18	0.76	32.34
Swamp white oak	162.70	4.41	(N/A)	1.18	0.10	4.41
Other City Trees	4,434.60	120.18	(N/A)	8.24	2.84	16.88
Citywide total	156,145.15	4,231.53	(N/A)	100.00	100.00	49.78

Table 3: Annual Air Quality Benefits & Table 4: Annual Carbon Sequestered

Annual Air Quality Benefits of Public Trees by Species

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	9.77	1.66	4.96	0.43	53.16	24.37	3.56	3.39	23.23	152.08	- 5.22	- 19.57	66.15	185.66	(N/A)	21.18	10.31
Green ash	2.53	0.40	1.32	0.11	13.77	13.53	1.97	1.88	12.90	84.43	0.00	0.00	34.65	98.20	(N/A)	12.94	8.93
Norway spruce	0.69	0.14	0.67	0.09	4.86	3.18	0.46	0.44	2.97	19.70	- 2.27	- 8.53	6.37	16.03	(N/A)	11.76	1.60
Apple	1.75	0.29	0.82	0.08	9.32	6.19	0.89	0.85	5.78	38.31	- 0.01	- 0.03	16.65	47.59	(N/A)	11.76	4.76
Paper birch	0.21	0.03	0.15	0.01	1.25	2.90	0.42	0.41	2.78	18.15	0.00	0.00	6.91	19.40	(N/A)	5.88	3.88
Blue spruce	0.40	0.08	0.34	0.05	2.67	1.35	0.20	0.19	1.31	8.47	- 1.18	- 4.43	2.73	6.71	(N/A)	4.71	1.68
Ash	2.34	0.40	1.14	0.10	12.60	5.43	0.78	0.74	5.03	33.49	- 0.54	- 2.03	15.42	44.05	(N/A)	4.71	11.01
Norway maple	2.22	0.38	1.07	0.10	11.92	4.42	0.64	0.61	4.10	27.29	- 0.50	- 1.89	13.03	37.32	(N/A)	3.53	12.44
Sugar maple	1.20	0.20	0.60	0.05	6.50	4.08	0.60	0.57	3.92	25.54	- 0.94	- 3.54	10.28	28.50	(N/A)	3.53	9.50
Red maple	0.09	0.01	0.05	0.00	0.50	0.71	0.10	0.10	0.66	4.41	- 0.04	- 0.14	1.70	4.76	(N/A)	2.35	2.38
Scotch pine	0.35	0.07	0.29	0.04	2.33	0.81	0.12	0.11	0.77	5.05	- 1.43	- 5.38	1.13	2.00	(N/A)	2.35	1.00
Spruce	0.05	0.01	0.05	0.01	0.37	0.28	0.04	0.04	0.25	1.73	- 0.17	- 0.62	0.57	1.48	(N/A)	1.18	1.48
White oak	0.00	0.00	0.00	0.00	0.02	0.13	0.02	0.02	0.13	0.85	0.00	0.00	0.31	0.87	(N/A)	1.18	0.87
White ash	0.92	0.15	0.42	0.04	4.82	1.97	0.29	0.28	1.90	12.37	0.00	0.00	5.96	17.19	(N/A)	1.18	17.19
Amur maple	0.00	0.00	0.00	0.00	0.03	0.11	0.02	0.02	0.10	0.68	0.00	0.00	0.25	0.71	(N/A)	1.18	0.71
Northern red oak	0.21	0.04	0.11	0.01	1.16	0.90	0.13	0.13	0.89	5.71	- 0.29	- 1.08	2.13	5.79	(N/A)	1.18	5.79
Swamp white oak	0.01	0.00	0.01	0.00	0.05	0.19	0.03	0.03	0.17	1.18	0.00	- 0.01	0.43	1.21	(N/A)	1.18	1.21
Other City Trees	0.52	0.10	0.42	0.05	3.35	2.87	0.41	0.39	2.63	17.63	- 1.05	- 3.92	6.34	17.06	(N/A)	8.24	2.67
Citywide Total	23.26	3.97	12.43	1.18	128.69	73.46	10.68	10.18	69.52	457.04	- 13.65	- 51.19	191.02	534.54	(N/A)	100.00	6.29

Annual CO2 Benefits of Public Trees by Species

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	18,270.53	137.03	- 973.83	- 53.82	- 0.40	8,610.09	64.58	25,852.98	193.90	(N/A)	21.18	43.10	10.77
Green ash	6,596.37	49.47	- 389.79	- 27.69	- 0.21	4,772.04	35.79	10,950.93	82.13	(N/A)	12.94	18.25	7.47
Norway spruce	603.00	4.52	- 19.88	- 12.29	- 0.09	1,099.93	8.25	1,670.77	12.53	(N/A)	11.76	2.79	1.25
Apple	2,255.16	16.91	- 129.96	- 16.19	- 0.12	2,139.23	16.04	4,248.24	31.86	(N/A)	11.76	7.08	3.19
Paper birch	1,280.52	9.60	- 37.49	- 6.63	- 0.05	1,027.87	7.71	2,264.27	16.98	(N/A)	5.88	3.77	3.40
Blue spruce	195.19	1.46	- 10.96	- 4.68	- 0.04	484.45	3.63	664.00	4.98	(N/A)	4.71	1.11	1.24
Ash	1,779.79	13.35	- 182.96	- 11.70	- 0.09	1,858.65	13.94	3,443.78	25.83	(N/A)	4.71	5.74	6.46
Norway maple	839.96	6.30	- 175.23	- 10.53	- 0.08	1,517.20	11.38	2,171.40	16.29	(N/A)	3.53	3.62	5.43
Sugar maple	1,835.36	13.77	- 165.00	- 8.97	- 0.07	1,450.26	10.88	3,111.64	23.34	(N/A)	3.53	5.19	7.78
Red maple	204.00	1.53	- 6.33	- 1.76	- 0.01	245.95	1.84	441.86	3.31	(N/A)	2.35	0.74	1.66
Scotch pine	205.37	1.54	- 16.23	- 3.32	- 0.02	284.19	2.13	470.02	3.53	(N/A)	2.35	0.78	1.76
Spruce	52.63	0.39	- 1.23	- 1.17	- 0.01	94.41	0.71	144.63	1.08	(N/A)	1.18	0.24	1.08
White oak	74.18	0.56	- 0.89	- 0.59	0.00	48.64	0.36	121.35	0.91	(N/A)	1.18	0.20	0.91
White ash	1,315.21	9.86	- 75.71	- 3.51	- 0.03	704.37	5.28	1,940.36	14.55	(N/A)	1.18	3.23	14.55
Amur maple	37.94	0.28	- 0.85	- 0.59	0.00	37.19	0.28	73.69	0.55	(N/A)	1.18	0.12	0.55
Northern red oak	281.31	2.11	- 17.26	- 1.95	- 0.01	328.52	2.46	590.63	4.43	(N/A)	1.18	0.98	4.43
Swamp white oak	95.61	0.72	- 1.75	- 0.59	0.00	64.52	0.48	157.80	1.18	(N/A)	1.18	0.26	1.18
Other City Trees	733.50	5.50	- 26.45	- 8.97	- 0.07	973.57	7.30	1,671.64	12.54	(N/A)	8.24	2.79	2.05
Citywide Total	36,655.62	274.92	- 2,231.79	- 174.92	- 1.31	25,741.09	193.06	59,990.00	449.93	(N/A)	100.00	100.00	5.29

Table 5: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species						
Species	Total stored CO2 (lbs)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	202,881.21	1,521.61	(N/A)	21.18	43.65	84.53
Green ash	81,206.18	609.05	(N/A)	12.94	17.47	55.37
Norway spruce	4,139.78	31.05	(N/A)	11.76	0.89	3.10
Apple	27,075.34	203.07	(N/A)	11.76	5.83	20.31
Paper birch	7,809.95	58.57	(N/A)	5.88	1.68	11.71
Blue spruce	2,281.60	17.11	(N/A)	4.71	0.49	4.28
Ash	38,116.01	285.87	(N/A)	4.71	8.20	71.47
Norway maple	36,505.58	273.79	(N/A)	3.53	7.85	91.26
Sugar maple	34,375.25	257.81	(N/A)	3.53	7.40	85.94
Red maple	1,319.13	9.89	(N/A)	2.35	0.28	4.95
Scotch pine	3,380.92	25.36	(N/A)	2.35	0.73	12.68
Spruce	256.69	1.93	(N/A)	1.18	0.06	1.93
White oak	185.46	1.39	(N/A)	1.18	0.04	1.39
White ash	15,772.76	118.30	(N/A)	1.18	3.39	118.30
Amur maple	177.79	1.33	(N/A)	1.18	0.04	1.33
Northern red oak	3,595.00	26.96	(N/A)	1.18	0.77	26.96
Swamp white oak	218.47	1.64	(N/A)	1.18	0.05	1.64
Other City Trees	5,510.98	41.33	(N/A)	8.24	1.19	6.43
Citywide total	464,808.10	3,486.06	(N/A)	100.00	100.00	41.01

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefit of Public Trees by Species					
Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,568.86	(N/A)	21.18	44.42	87.16
Green ash	595.14	(N/A)	12.94	16.85	54.10
Norway spruce	178.35	(N/A)	11.76	5.05	17.83
Apple	132.11	(N/A)	11.76	3.74	13.21
Paper birch	160.08	(N/A)	5.88	4.53	32.02
Blue spruce	67.80	(N/A)	4.71	1.92	16.95
Ash	160.62	(N/A)	4.71	4.55	40.15
Norway maple	74.51	(N/A)	3.53	2.11	24.84
Sugar maple	195.17	(N/A)	3.53	5.53	65.06
Red maple	37.12	(N/A)	2.35	1.05	18.56
Scotch pine	53.91	(N/A)	2.35	1.53	26.96
Spruce	15.42	(N/A)	1.18	0.44	15.42
White oak	14.73	(N/A)	1.18	0.42	14.73
White ash	126.36	(N/A)	1.18	3.58	126.36
Amur maple	2.06	(N/A)	1.18	0.06	2.06
Northern red oak	24.08	(N/A)	1.18	0.68	24.08
Swamp white oak	12.89	(N/A)	1.18	0.36	12.89
Other City Trees	112.82	(N/A)	8.24	3.19	18.36
Citywide Total	3,532.02	(N/A)	100.00	100.00	41.55

Table 7: Summary of Benefits in Dollars

Average Annual Benefits of Public Trees by Species								
Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Stand. Error	% of Total $
Silver maple	1,071.03	193.90	185.66	1,747.74	1,568.86	4,767.19	(N/A)	39.72
Green ash	591.75	82.13	98.20	686.96	595.14	2,054.19	(N/A)	17.12
Norway spruce	144.25	12.53	16.03	197.68	178.35	548.84	(N/A)	4.57
Apple	279.21	31.86	47.59	148.63	132.11	639.40	(N/A)	5.33
Paper birch	126.78	16.98	19.40	105.61	160.08	428.84	(N/A)	3.57
Blue spruce	57.61	4.98	6.71	91.69	67.80	228.79	(N/A)	1.91
Ash	246.90	25.83	44.05	303.58	160.62	780.98	(N/A)	6.51
Norway maple	200.36	16.29	37.32	271.22	74.51	599.70	(N/A)	5.00
Sugar maple	176.97	23.34	28.50	248.33	195.17	672.30	(N/A)	5.60
Red maple	32.43	3.31	4.76	20.67	37.12	98.29	(N/A)	0.82
Scotch pine	36.08	3.53	2.00	86.23	53.91	181.75	(N/A)	1.51
Spruce	13.58	1.08	1.48	16.14	15.42	47.70	(N/A)	0.40
White oak	5.82	0.91	0.87	4.65	14.73	26.98	(N/A)	0.22
White ash	85.27	14.55	17.19	143.62	126.36	386.99	(N/A)	3.22
Amur maple	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)	0.09
Northern red oak	37.72	4.43	5.79	32.34	24.08	104.36	(N/A)	0.87
Swamp white oak	8.99	1.18	1.21	4.41	12.89	28.68	(N/A)	0.24
Other City Trees	133.16	12.54	17.06	120.18	112.82	395.76	(N/A)	3.30
Citywide Total	3,253.29	449.93	534.54	4,231.53	3,532.02	12,001.32	(N/A)	100.00

Figure 1: Species Distribution

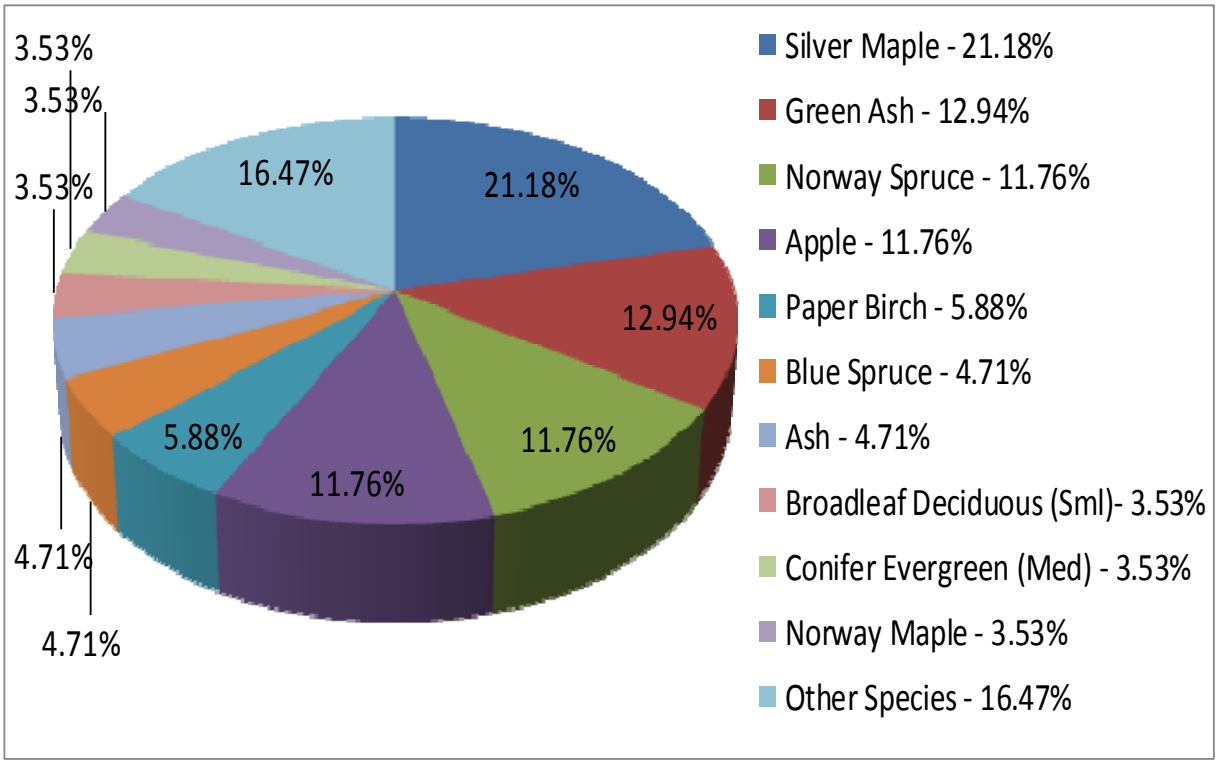


Figure 2: Relative Age Class

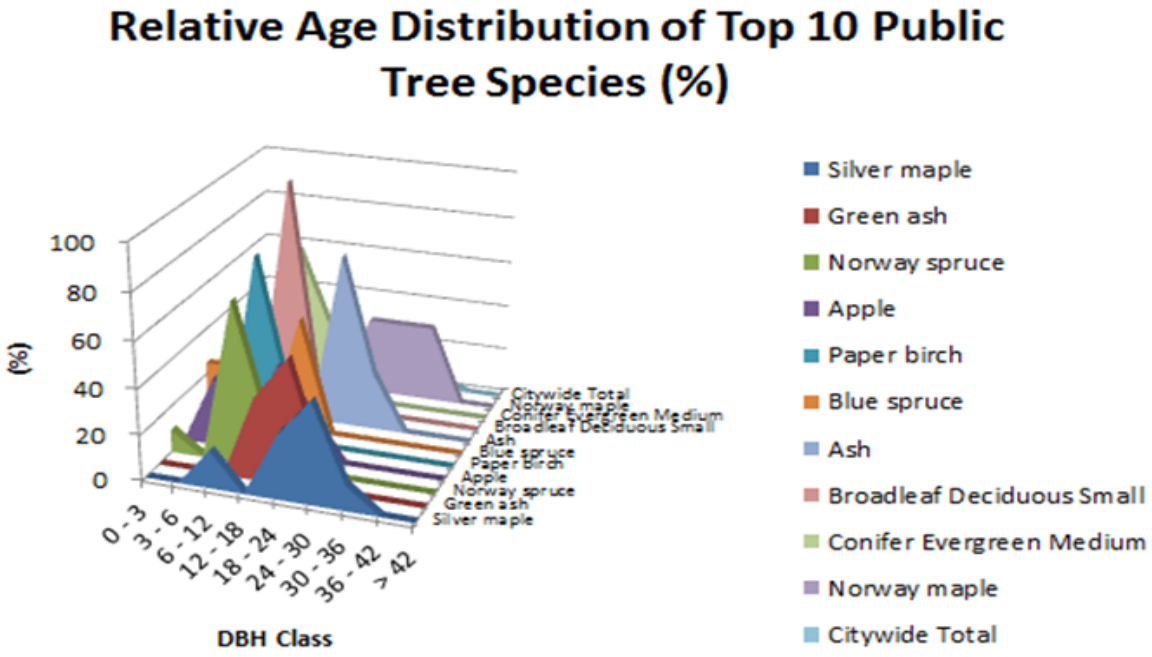


Table 8: Relative Age Class

	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	0.00	16.67	0.00	27.78	44.44	11.11	0.00	0.00
Green ash	0.00	0.00	0.00	36.36	54.55	9.09	0.00	0.00	0.00
Norway spruce	10.00	0.00	70.00	20.00	0.00	0.00	0.00	0.00	0.00
Apple	0.00	30.00	10.00	40.00	20.00	0.00	0.00	0.00	0.00
Paper birch	0.00	0.00	80.00	20.00	0.00	0.00	0.00	0.00	0.00
Blue spruce	25.00	25.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
Ash	0.00	0.00	0.00	0.00	75.00	25.00	0.00	0.00	0.00
Broadleaf Deciduous Sma	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Conifer Evergreen Mediu	0.00	0.00	66.67	33.33	0.00	0.00	0.00	0.00	0.00
Norway maple	0.00	0.00	0.00	0.00	33.33	33.33	33.33	0.00	0.00
Citywide Total	2.35	10.59	27.06	18.82	22.35	14.12	4.71	0.00	0.00

Figure 3: Foliage Condition

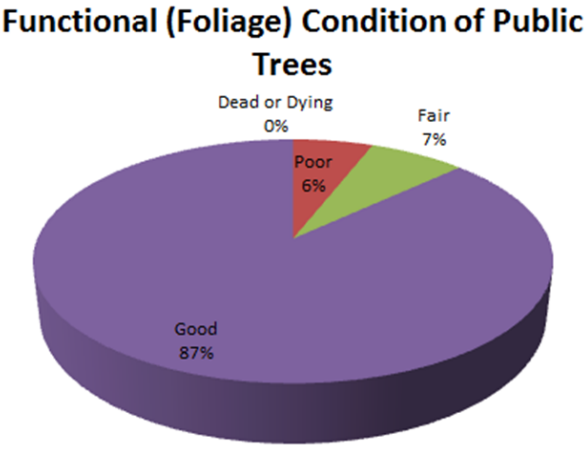


Figure 4: Wood Condition

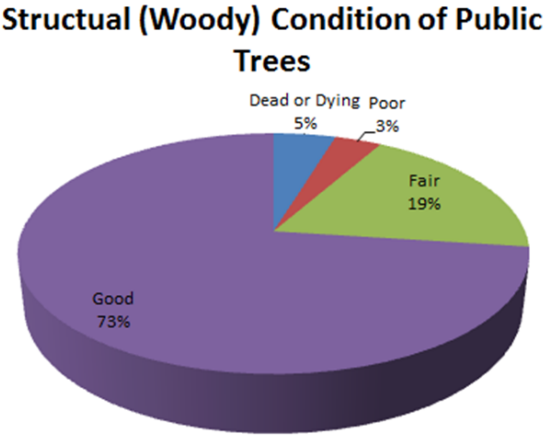


Figure 5: Land Use of City/Park Trees

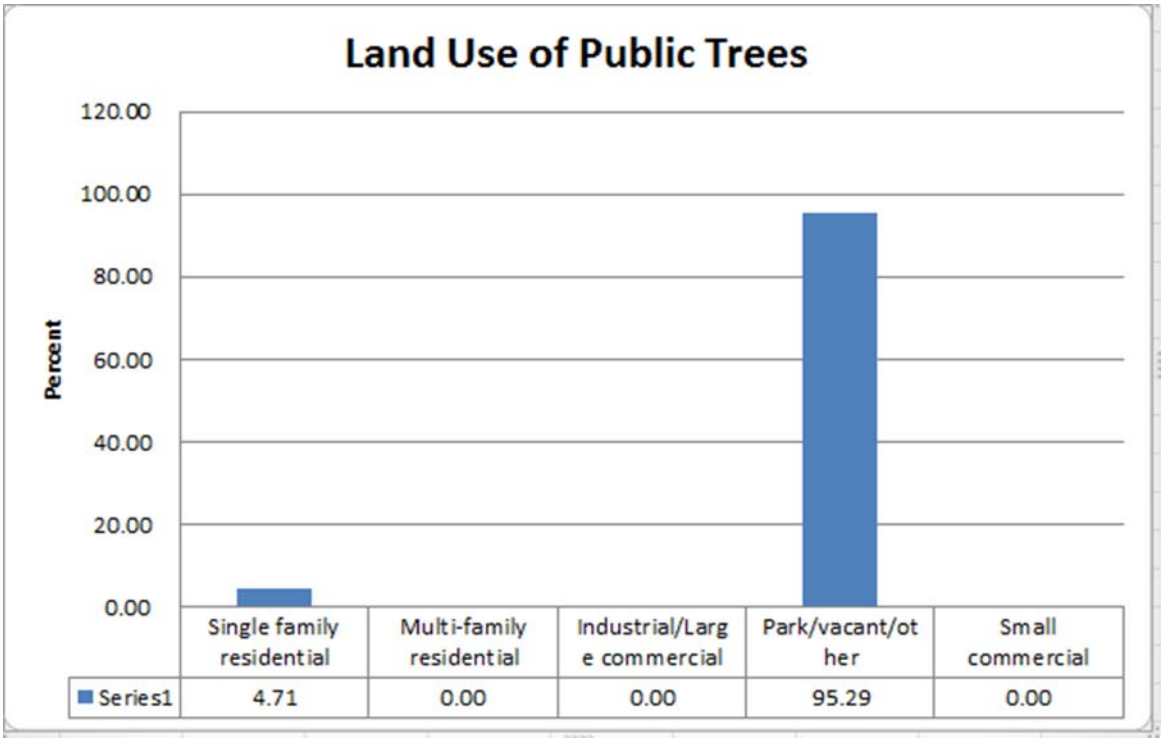
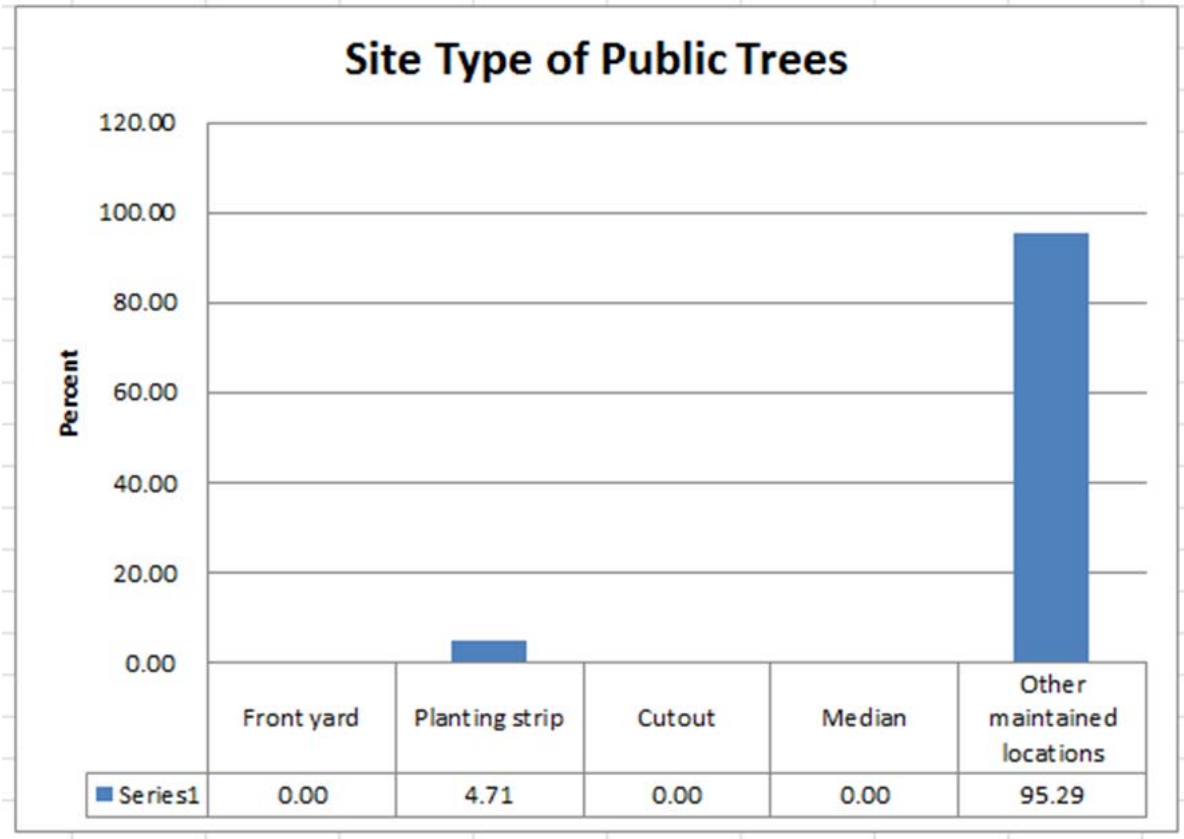


Figure 6: Location of City/Park Trees



Appendix B: ArcGIS Mapping

Image 1: Location of Ash Trees

Image 2: Location of EAB Symptoms

Image 3: Location of Poor Condition Ash Trees

Image 4: Location of Trees with Recommended Maintenance

Image 5: Maintenance Tasks

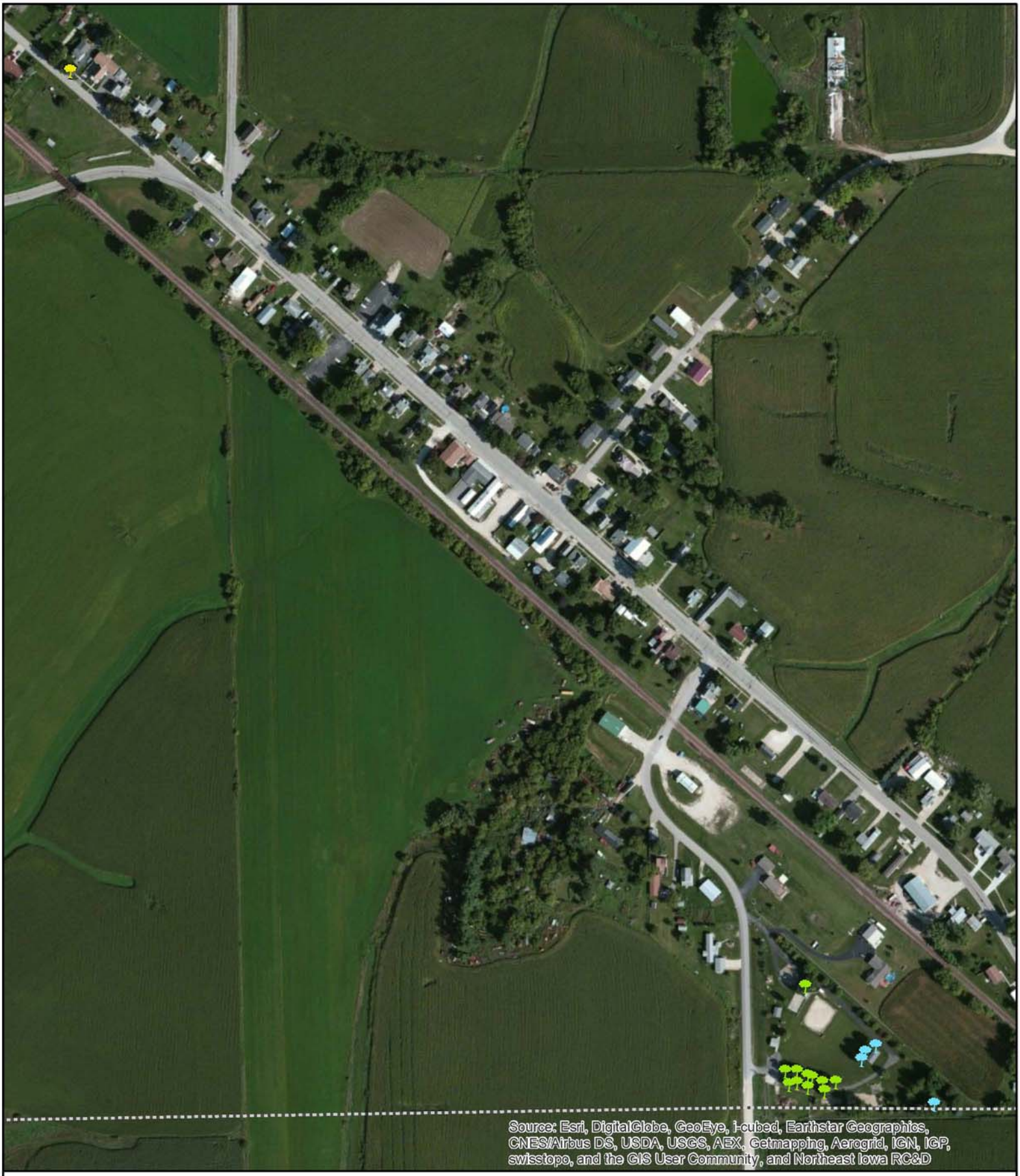


Image 1. Location of Ash Trees

Legend

- Green ash
- White ash
- Ash
- Black ash

Castalia, Iowa

0 0.035 0.07 0.14 Miles

N

Map created by Northeast Iowa RC&D
11/13/2014

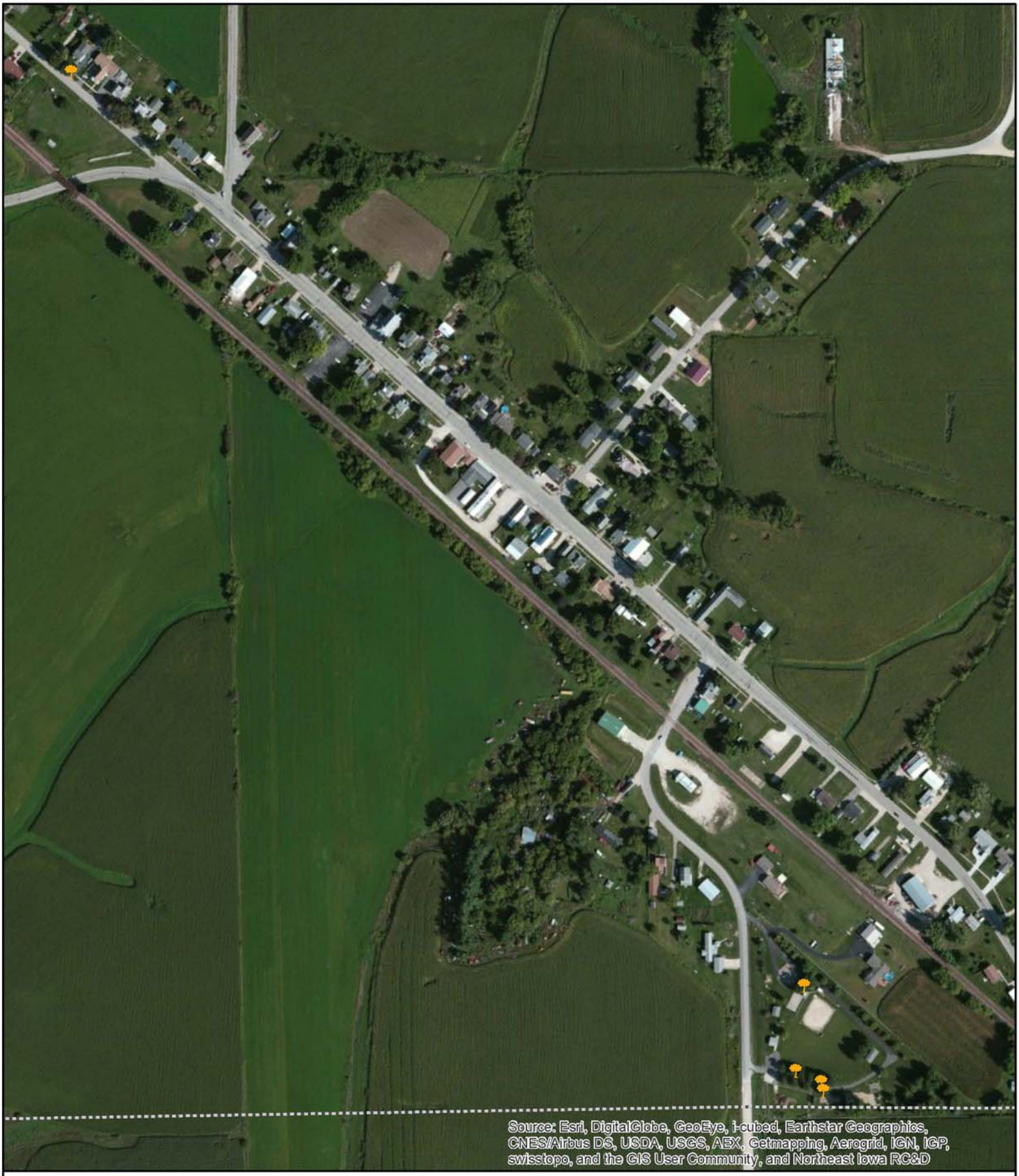


Image 2. Location of Trees with One or More Symptoms of EAB
(Canopy Dieback, Epicormic Shoots, Woodpecker Damage, Bark Splitting, or D-Shaped Exit Holes)

Legend

EAB Symptoms

City Limits

Castalia, Iowa

0 0.035 0.07 0.14 Miles

N

Map created by Northeast Iowa RC&D
11/13/2014

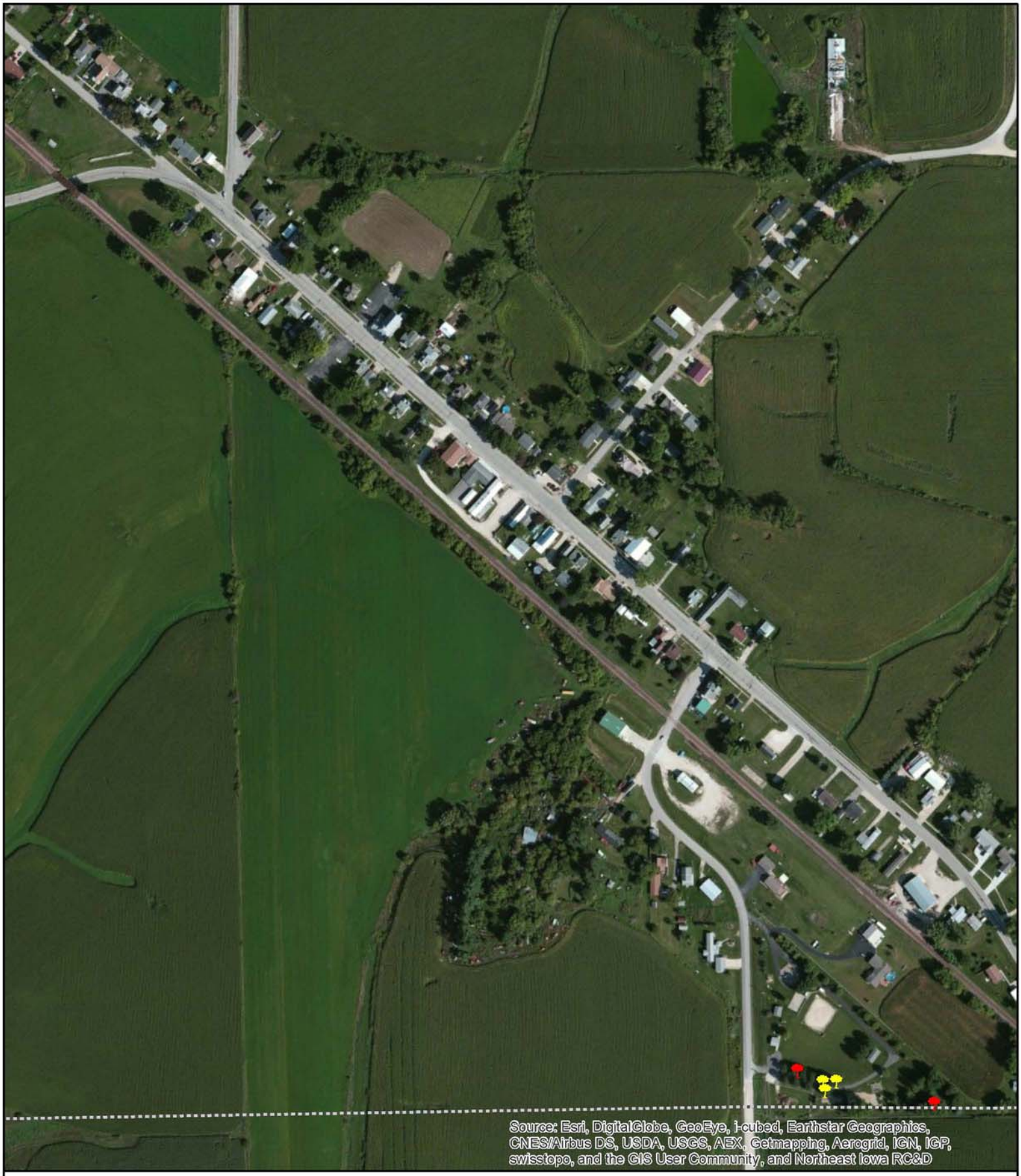


Image 3. Location of Poor Condition Ash Trees
(Wood and/or Leaves are Dead/Dying or in Poor Condition)

Legend

Dead or Dying Poor

Castalia, Iowa

0 0.035 0.07 0.14 Miles

N

Map created by Northeast Iowa RC&D
11/13/2014

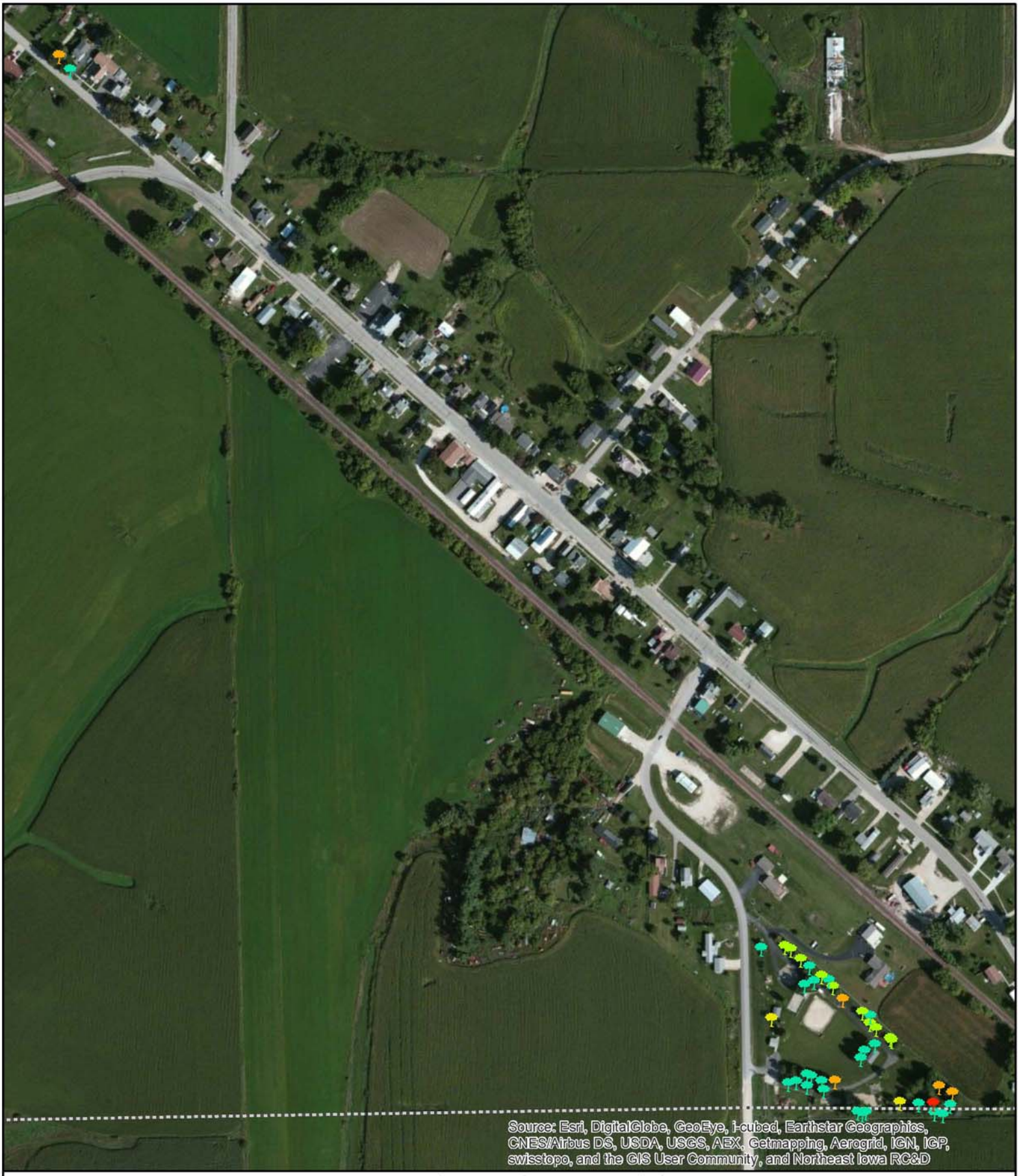


Image 4. Location of Trees with Recommended Maintenance

Castalia, Iowa

Legend

- Critical Concern
- Mature Tree Immediate
- Mature Tree Routine
- Young Tree Immediate
- Young Tree Routine

N

0 0.0275 0.055 0.11 Miles

Map created by Northeast Iowa RC&D
11/13/2014

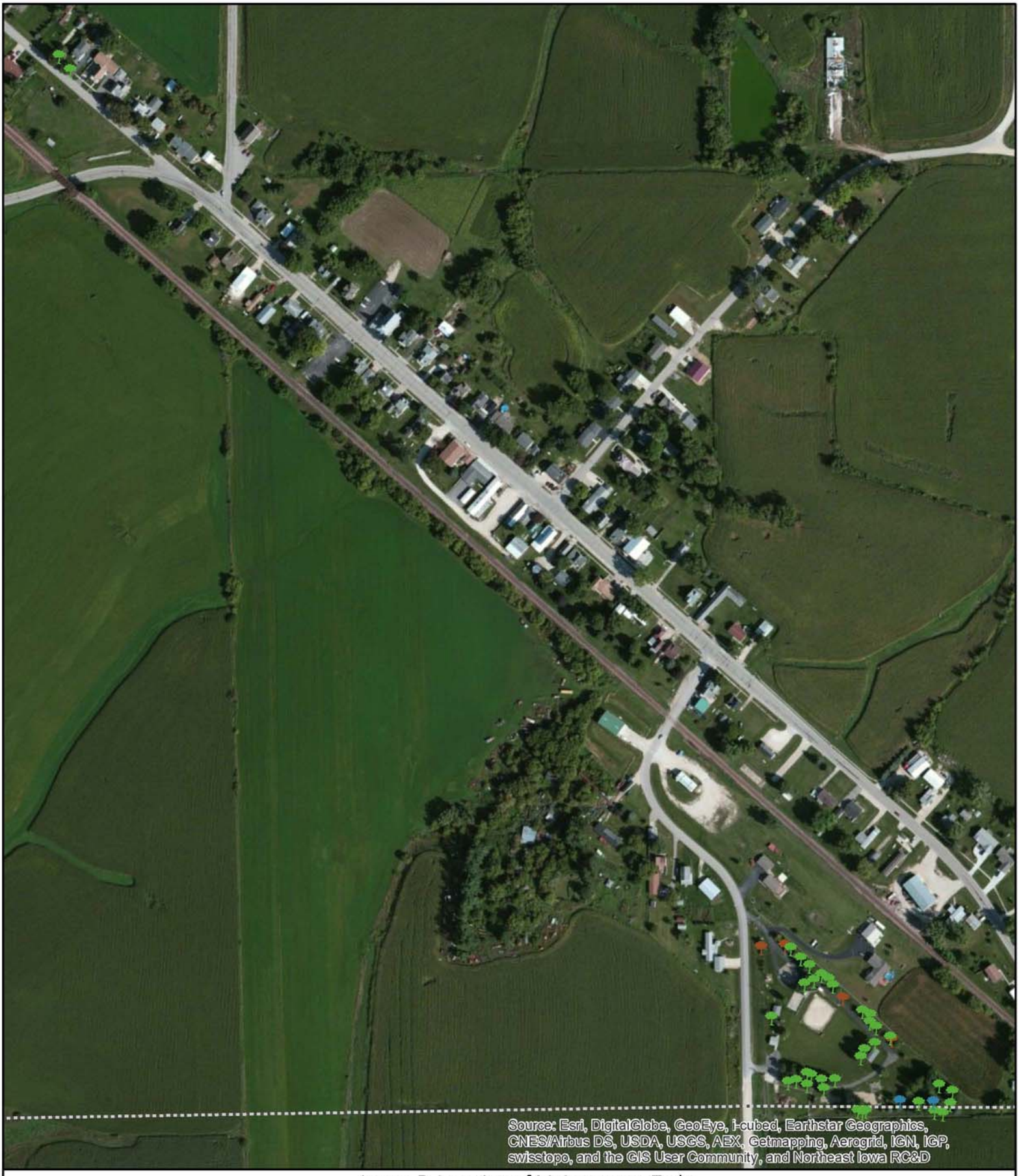


Image 5. Location of Maintenance Tasks

Castalia, Iowa

Legend

Clean | Raise | Reduce | Remove* | Stake/Train | Treat pest/disease

*City owned trees recommended for removal should be verified prior to any removal

N

0 0.0275 0.055 0.11 Miles

Map created by Northeast Iowa RC&D
11/20/2014

Appendix C: Suitable Shade Tree Lists

Shade Trees for Iowa

This document lists several shade tree selections suitable for the Iowa landscape. Nursery and landscape professionals have eliminated green, white, black, pumpkin, and blue ash from their inventories and designs since they are susceptible to the emerald ash borer, which kills ash trees. This destructive pest has been found in several states in the upper Midwest.

While not all-inclusive, this list does describe many useful species, many which are also pest-resistant. Not all trees appearing on this list will "work" in every landscape situation. Great care must be taken to carefully match trees to sites (including above- and below-ground spatial and environmental constraints) and to complement species existing nearby so that a diverse tree canopy will be maintained. *A healthy and diverse tree population is the best defense against current and future tree pests.*

Deciduous Shade Trees	**Height/Width**	**Growth Habit**
Alder		
Manchurian alder – *Alnus hirsuta*		
'Harbin' (**Prairie Horizon**®)	40'/30'	Upright
Amur maackia – *Maackia amurensis*	25'/25'	Upright-spreading
Baldcypresses		
Baldcypress –*Taxodium distichum*		
'Mickelson' (**Shawnee Brave**®)	55'/20'	Narrow-pyramid
'JFS-SGPN' (**Green Whisper**™)	55'/30'	Pyramidal
Birches		
Asian white birch – *Betula platyphylla*		
'VerDale' (**Prairie Vision**®)	35'/30'	Upright-oval
Gray birch – *Betula populifolia*		
'Whitespire Sr.'	40'/25'	Pyramidal-oval
Hybrid birch – *Betula* ×		
'Penci-2' (**Royal Frost**®)	40'/25'	Pyramidal
River birch – *Betula nigra*		
'Cully' (**Heritage**®)	45'/30'	Oval
Whitebarked Himalayan birch – *Betula utilis*		
'Madison' (**White Satin**™)	35'/20'	Broadly-pyramidal

	Height/Width	Growth Habit
Coffeetree		
Kentucky coffeetree – *Gymnocladus dioicus*		
'Espresso'	50'/35'	Oval
Cork trees		
Cork tree – *Phellodendron* species		
'Longenecker' (**Eye Stopper™**)	40'/35'	Rounded
'His Majesty'	40'/35'	Vase-shaped
Elms		
American elm – *Ulmus americana*		
'Jefferson'	70'/50'	Vase-shaped
'Princeton'	60'/40'	Vase-shaped
'Lewis & Clark' (**Prairie Expedition™**)	60'/50'	Umbrella-shaped
'New Harmony'	70'/70'	Vase-shaped
'Valley Forge'	70'/70'	Vase-shaped
Asian Elm Cultivars and Hybrids		
'Morton' (**Accolade™**)	70'/60'	Vase-shaped
'Morton Glossy' (**Triumph™**)	55'/45'	Vase-shaped
'New Horizon'	55'/40'	Upright-oval
'Prospector'	40'/30'	Vase-shaped
'Discovery'	50'/40'	Vase-shaped
European and Eurasian Hybrid Elm Cultivars		
'Patriot'	50'/40'	Stiff vase-shaped
Filbert		
Turkish filbert – *Corylus colurna*	40'/30'	Pyramidal
Gingkoes		
Ginkgo – *Ginkgo biloba*		
'Autumn Gold'	45'/35'	Broadly-pyramidal
'Halka'	45'/40'	Oval
'Magyar'	60'/40'	Upright-oval
'PNI 2720' (**Princeton Sentry®**)	40'/15'	Narrow-pyramidal
'JFS-UGA2' (**Golden Colonnade®**)	45'/25'	Narrow-oval
'The President' (**Presidential Gold®**)	50'/40'	Broadly-pyramidal

	Height/Width	Growth Habit
Hackberries		
Hackberry – *Celtis occidentalis*		
'JFS-KSU1' (**Prairie Sentinel™**)	45'/12'	Columnar
'Chicagoland'	50'/40'	Broadly-pyramidal
'Prairie Pride'	50'/40'	Oval
Honeylocusts		
Honeylocust – *Gleditsia triacanthos* var. *inermis*		
'Draves' (**Street Keeper™**)	45'/20'	Narrow-upright
'Harve' (**Northern Acclaim™**)	45'/35'	Upright-spreading
'Skycole' (**Skyline®**)	50'/35'	Pyramidal
Hornbeams		
European hornbeam – *Carpinus betulus*		
'JFS-KW1CB' (**Emerald Avenue®**)	40'/30'	Broadly-pyramidal
'Windy City'	45'/40'	Upright-spreading
Hophornbeam		
American hophornbeam – *Ostrya virginiana*	40'/25'	Upright-oval
Horsechestnuts		
Common horsechestnut – *Aesculus hippocastanum*		
'Baumannii'	50'/40'	Broadly-oval
Red horsechestnut – *Aesculus* × *carnea*		
'Briotii'	30'/35'	Round
'Fort McNair'	30'/30'	Round
Lindens		
American linden – *Tilia americana*		
'Boulevard'	60'/30'	Pyramidal
'Continental Appeal'	50'/30'	Narrow-oval
'Wandell' (**Legend®**)	40'/30'	Broad-pyramidal
'McKSentry' (**American Sentry®**)	45'/30'	Pyramidal
'Lincoln'	35'/25'	Pyramidal
'Redmond'	50'/35'	Pyramidal
Hybrid Linden – *Tilia* × *flavescens* (*americana* × *cordata*)		
'Glenleven'	50'/30'	Pyramidal

	Height/Width	Growth Habit
Littleleaf linden – *Tilia cordata*		
'Baileyi' (**Shamrock®**)	40'/30'	Pyramidal
'Corzam' (**Corinthian®**)	45'/15'	Narrow-pyramid
'Ronald' (**Norlin™**)	40'/30'	Pyramidal
Mongolian linden – *Tilia mongolica*		
'Harvest Gold'	30-40'/25-30'	Upright-oval
Silver linden – *Tilia tomentosa*		
'PNI 6051' (**Green Mountain®**)	45'/35'	Broad-pyramidal
'Sterling'	45'/35'	Broad-pyramidal
Magnolias		
Cucumbertree – *Magnolia acuminata*	50-80'/40-60'	Upright-oval
Maples		
Black maple – *Acer nigrum*	60'/60'	Round-spreading
Freeman maple – *Acer × freemanii*		
'Jeffersred' (**Autumn Blaze®**)	50'/45'	Broadly-oval
'DTR 102' (**Autumn Fantasy®**)	40'/30'	Broadly-oval
'Marmo'	50'/30'	Upright-oval
'Bailston' (**Matador™**)	40'/30'	Upright-oval
'Morgan' ('Indian Summer')	45'/40'	Rounded
'Sienna' (**Sienna Glen®**)	45'/35'	Pyramidal
'UMNAF#1' (**Firefall™**)	50'/30'	Upright-oval
Hybrid maple – *Acer truncatum × platanoides*		
'Warrenred' (**Pacific Sunset®**)	30'/25'	Upright-spreading
'JFS-KW202' (**Crimson Sunset™**)	35'/25'	Upright-oval
Miyabe maple – *Acer miyabei*		
'Morton' (**State Street™**)	45'/30'	Upright-oval
'JFS-KW3AMI' (**Rugged Ridge™**)	55'/40'	Upright-oval
Norway maple – *Acer platanoides*		
'Columnarbroad' (**Parkway®**)	40'/25'	Oval
'Deborah'	45'/40'	Rounded
'Emerald Queen'	50'/40'	Oval-upright
'Ezestre' (**Easy Street™**)	40'/20'	Narrow-pyramidal
'Fairview'	45'/35'	Upright-oval

	Height/Width	Growth Habit
'Pond' (**Emerald Lustre™**)	45'/40'	Rounded
'Princeton Gold'	35'/30'	Oval
Red maple – *Acer rubrum*		
'Bailcraig' (**Scarlet Jewell™**)	50'/30'	Upright
'Franksred' (**Red Sunset®**)	45'/35'	Upright-oval
'Magnificent Magenta' (**Burgundy Belle®**)	50'/40'	Oval
'Frank Jr.' (**Redpointe™**)	45'/30'	Pyramidal
'New World'	40'/20'	Narrow-oval
'Polara' (**Rubyfrost™**)	45'/40'	Broadly-oval
'Somerset'	45'/35'	Broadly-oval
Sugar maple – *Acer saccharum*		
'Autumn Splendor'	45'/40'	Broadly-oval
'JFS-KW8' (**Autumn Fest™**)	50'/35'	Upright-oval
'JFS-Caddo2' (**Flashfire™**)	45'/40'	Broadly-oval
'Bailsta' (**Fall Fiesta™**)	50'/50'	Upright-rounded
'Commemoration'	50'/35'	Oval-rounded
'Endowment'	50'/20'	Columnar
'Legacy'	50'/35'	Oval
'Morton' (**Crescendo™**)	40'/30'	Broadly-oval
'Green Mountain'	45'/35'	Broadly-oval
Planetrees		
London planetree – *Platanus × acerifolia*		
'Bloodgood'	50'/40'	Broadly-pyramidal
'Morton Circle' (**Exclamation™**)	55'/35'	Upright-pyramidal
Oaks		
Bur oak – *Quercus macrocarpa*	50-80'/40-80'	Spreading
'JFS-KW3' (**Urban Pinnacle™**)	55'/25'	Narrow-pyramidal
Chinkapin oak – *Quercus muehlenbergii*	45'/45'	Round
English/white oak – *Quercus bimundorum*		
'Crimschmidt' (**Crimson Spire™**)	45'/15'	Columnar
'Midwest' (**Prairie Stature™**)	50'/40'	Broadly-pyramidal
Hybrid oak – *Quercus ×*		
'Clemons' (**Heritage®**)	40-50'/40-50'	Broadly-pyramidal
'Long' (**Regal Prince®**)	45'/18'	Narrow-oval

	Height/Width	Growth Habit
Red oak – *Quercus rubra*	60-75'/60'	Spreading
Shingle oak – *Quercus imbricaria*	50'/40'	Broadly-oval
Swamp white oak – *Quercus bicolor*	60'/60'	Round
White oak – *Quercus alba*	50-70'/40-80'	Spreading
S weetgums		
Sweetgum – *Liquidambar styraciflua*		
'Clydesform' (**Emerald Sentinel**®)	30'/12'	Narrow-pyramid
'Moraine'	40'/25'	Pyramidal

Compiled by Jeff Iles, Department of Horticulture, Iowa State University
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Small-stature Trees for Iowa

This document lists several small-stature tree selections suitable for the Iowa landscape. Nursery and landscape professionals have eliminated green, white, black, pumpkin, and blue ash from their inventories and designs since they are susceptible to the emerald ash borer, which kills ash trees. This destructive pest has been found in several states in the upper Midwest.

While not all-inclusive, this list does describe many useful species, many which are also pest-resistant. Not all trees appearing on this list will "work" in every landscape situation. Great care must be taken to carefully match trees to sites (including above- and below-ground spatial and environmental constraints) and to complement species existing nearby so that a diverse tree canopy will be maintained. *A healthy and diverse tree population is the best defense against current and future tree pests.*

Deciduous Small-stature Trees	**Height/Width**	**Growth Habit**
Amur maackia – *Maackia amurensis*	20'/20'	Upright-spreading
Cherries		
Sargent cherry – *Prunus sargentii*		
'JFS-KW58' (**Pink Flair**®)	25'/15'	Upright
'Hokkaido Normandale' (**Spring Wonder**™)	25'/20'	Upright-spreading
Crabapples – *Malus* species		
'Adirondack'	18'/12'	Vase-shaped
'Beeson' (**May's Delight**®)	8'/8'	Upright-spreading
'Hub Tures' (**Spring Sensation**™)	10'/12'	Wide-spreading
'JFS-KW5' (**Royal Raindrops**®)	20'/15'	Upright-spreading
'Malusquest' (**Pink Sparkles**®)	15'/12'	Upright
'Orange Crush'	15'/15'	Round-spreading
Dogwoods		
Corneliancherry dogwood – *Cornus mas*	20'/20'	Round-spreading
Gray dogwood – *Cornus racemosa*		
'Jade' (**Snow Mantle**™)	15'/8'	Upright-spreading
Pagoda dogwood – *Cornus alternifolia*	20'/20'	Spreading

	Height/Width	Growth Habit
Hophornbeams		
American hophornbeam – *Ostrya virginiana*	25'/20'	Upright-spreading
Hornbeams		
American hornbeam – *Carpinus caroliniana*		
'J.N. Strain'	25'/25'	Spreading
'J.N. Upright' (**Firespire™**)	20'/10'	Upright
Lilacs		
Japanese tree lilac – *Syringa reticulata*		
'Bailnce' (**Snowdance™**)	18'/20'	Round-spreading
'Ivory Silk'	25'/15'	Upright
Pekin lilac – *Syringa reticulata* subsp. *pekinensis*		
'Morton' (**China Snow®**)	20'/20'	Upright-spreading
'SunDak' (**Copper Curls®**)	20'/15'	Upright-spreading
Magnolias		
Loebner magnolia – *Magnolia* × *loebneri*		
'Merrill'	25'/25'	Upright-spreading
'Ruth' (**Spring Welcome®**)	20'/20'	Round-spreading
Maples		
Tatarian maple – *Acer tataricum*		
'GarAnn' (**Hot Wings®**)	20'/25'	Round-spreading
Three-flower maple –*Acer triflorum*	25'/25'	Upright-spreading
Pears		
Callery pear – *Pyrus calleryana*		
'Glen's Form' (**Chanticleer®**)	40'/15'	Narrow-pyramid
Ussurian pear – *Pyrus ussuriensis*		
'MorDak' (**Prairie Gem®**)	25'/20'	Oval
'Bailfrost' (**Mountain Frost®**)	20'/15'	Upright-oval
Redbud		
American redbud – *Cercis canadensis*		
'Pink Trim' (**Northern Herald™**)	25'/25'	Spreading

Serviceberries

Allegheny serviceberry – *Amelanchier laevis*		
'Cumulus'	20'/15'	Upright-spreading
'JFS-Arb' (**Spring Flurry**®)	28'/20'	Upright-oval
Apple serviceberry – *Amelanchier* × *grandiflora*		
'Autumn Brilliance'	20'/15'	Upright-spreading
'Strata'	20'/20'	Horizontal

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