Conrad, IA

DEVICE 2019 URBAN FOREST MANAGEMENT PLAN IOWA DEPARTMENT OF NATURAL RESOURCES



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Executive Summary

Overview

This plan was developed to assist the City of Conrad in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees except mountain ash. There is a strong possibility that 8.5% of Conrad's city-owned trees will die once EAB becomes established in the community, unless local leaders begin preventative treatment. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2019, JEO conducted a tree inventory using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 438 trees inventoried.

- Conrad's trees provide \$87,840 of benefits annually, an average of \$200.55 per tree
- There are over 25 species of trees
- The top three genera are: Maple 39%, Oak 15%, and Ash 8.5%
- 2.5% of trees need some type of management
- 3 trees should be removed

Recommendations

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

- Out of the 3 trees needing removal, 1 tree is 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*
- All 38 ash trees should be carefully examined, as they may develop symptoms that could be related to an EAB infestation.
- All trees should be pruned on a routine schedule: one third of the city every other year.
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Check ash trees yearly with a visual survey.
- With the current budget it could take 12 years to remove ash. We suggest that city officials request a budget increase to \$3,500 annually and apply for grants to plant replacement trees.

Introduction

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

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

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

Inventory

In 2019, JEO conducted a tree inventory that included 100% of the city-owned trees on both streets and parks. The team collected tree data using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

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

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

Inventory Results

JEO entered the data collected for the 438 city trees into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. Below are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Conrad's trees reduce energy-related costs by approximately \$24,189 annually (Appendix A, Table 1). These savings are both in electricity (114.5 MWh) and in natural gas (15,810.9 Therms).

Annual Stormwater Benefits

Conrad's trees intercept about 1,433,856 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides \$38,857 in benefit to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and lessens emissions of volatile organic matter (ozone). In Conrad, it is estimated that trees remove 1,528.1 lbs of air pollution (ozone (O₃), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂)) per year with a net value of \$4,278 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Conrad, trees sequester about 207,326 lbs of carbon per year with an associated value of \$1,555 (Appendix A, Table 5). In addition, the trees store 5,454,016 lbs of carbon, with a yearly benefit of \$40,905 (Appendix A, Table 4).

Annual Aesthetics Benefits

The social benefits of trees are hard to capture. The i-Tree analysis does have a calculation for this area that includes aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Conrad receives \$17,726 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, Conrad's trees provide \$87,840 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 438 trees in Conrad provide approximately \$200.55 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Conrad has over 25 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	171	39%
Oak	65	15%
Ash	38	8.5%
Spruce	36	8%
Broadleaf Deciduous	24	5%
Pine	18	4%
Pear	13	3%
Hackberry	11	2.5%
Linden/Basswood	9	2%
Walnut	9	2%
Locust	7	1%
Boxelder	6	1%
Birch	6	1%
Alder	4	1%
Sycamore	3	<1%
Cottonwood	2	<1%
Hickory	2	<1%
Elm	2	<1%
Tulip tree	2	<1%
Ginkgo	1	<1%
Cherry	1	<1%
Other Evergreen	5	1%

Age Class

Most of Conrad's trees (34.25%) are between 30 and 42 inches in diameter at 4.5 ft (Appendix A, Figure 2). To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Conrad's size curve indicates an older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Conrad indicate that 87% of the trees are in good health, with only 2.5% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 83% of Conrad's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Three percent of the tree population's wood condition is in poor health, dead, or dying. This 3% is an estimate of trees that need management follow up.

Management Needs

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

Crown Cleaning	0	0%
Crown Raising	0	0%
Tree Staking	0	0%
Tree Removal	3	<1%
Crown Reduction	0	0%
Treat Pest/Disease	8	2%

Land Use and Location

The majority of Conrad's city and park trees are in planting strips in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure 7). The following describes the land use and locations for the street and park trees.

Land Use	
Single family residential	77%
Park/vacant/other	0%
Industrial/Large commercial	22.6%
Small commercial	0.46%
Multifamily residential	2%

Recommendations

Risk Management

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

Hazardous trees

Conrad has 3 trees suggested for immediate removal. These trees in addition to other trees needing maintenance can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). We recommend starting with the large-diameter, critical concern trees first. There is 1 tree over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Proposed Work Schedule and Budget at the end of this section. After all the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 8 trees with maintenance needs.

Poor tree species

After removing the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). There are a total of 38 ash trees, and so far none of them have signs and symptoms that have been associated with EAB. In addition, there are 14 trees that are in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend that all trees be pruned on a routine schedule every five to seven years. Please refer to the Six Year Maintenance Plan for further information.

Planting

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

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 (39%) (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. We recommend that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Emerald Ash Borer Plan

Ash Tree Removal

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

Treatment of Ash Trees

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

EAB Quarantines

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

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

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

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

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant health/plant pest info/emerald ash b/regulatory.shtml. Wood waste can be normally disposed of if your county is not part of a quarantine.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions 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 EAB signs and symptoms including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 151.06 states "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 fourteen (14) days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property."

Proposed Work Schedule and Budget

Budget Allowance of \$2,216/Year – (Based off \$2/Capita Calculation Due to no City Reporting)

<u>YEAR 1</u>	ESTIMATED COSTS
Remove 2 trees recommended for immediate removal Plant 5 trees in open locations Visual Survey of EAB Signs/Symptoms	\$1,400 \$750
<u>YEAR 2</u>	
Remove 1 tree recommended for immediate removal Remove 1 ash tree (prioritize largest diameter) Plant 5 trees in open locations Visual Survey of EAB Signs/Symptoms	\$700 \$700 \$750
YEAR 3	
Remove 2 ash trees (prioritize largest diameter) Plant 5 trees in open locations Visual Survey of EAB Signs/Symptoms	\$1,400 \$750
YEAR 4	
Remove 2 ash trees (prioritize largest diameter) Plant 5 trees in open locations Visual Survey of EAB Signs/Symptoms	\$1,400 \$750
YEAR 5	
Remove 2 ash trees (prioritize largest diameter) Plant 5 trees in open locations Visual Survey of EAB Signs/Symptoms	\$1,400 \$750

Conrad, IA

<u>YEAR 6</u>

Remove 2 ash trees (prioritize largest diameter)	\$1,400
Plant 5 trees in open locations	\$750
Visual Survey of EAB Signs/Symptoms	

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

**To remove all ash trees within 6 years alone, the budget would need to be \$4,500 a year. If the budget were increased to \$3,500 a year all ash could be removed in 7.5 years.

Proposed Work Schedule with Increased Budget

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

<u>YEAR 1</u>	ESTIMATED COSTS
Remove 3 trees recommended for immediate removal Remove 1 ash tree (prioritize largest diameter) Plant 4 trees in open locations Visual Survey of EAB Signs/Symptoms	\$2,100 \$700 \$600
<u>YEAR 2</u>	
Remove 1 ash tree (prioritize largest diameter) Plant 4 trees in open locations Prune 1/3 of City Owned Trees Visual Survey of EAB Signs/Symptoms	\$700 \$600 \$2,190
<u>YEAR 3</u>	
Remove 4 ash trees (prioritize largest diameter) Plant 4 trees in open locations Visual Survey of EAB Signs/Symptoms	\$2,800 \$600
YEAR 4	
Remove 1 ash tree (prioritize largest diameter) Plant 4 trees in open locations Prune 1/3 of City Owned Trees Visual Survey of EAB Signs/Symptoms	\$700 \$600 \$2,190

YEAR 5

Remove 4 ash trees (prioritize largest diameter) Plant 4 trees in open locations Visual Survey of EAB Signs/Symptoms	
<u>YEAR 6</u>	
Remove 1 ash tree (prioritize largest diameter) Plant 4 trees in open locations	\$700 \$600
Prune 1/3 of City Owned Trees	\$2,190
Visual Survey of EAB Signs/Symptoms	

Purposed Budget Increase

EAB could potentially kill all ash trees in Conrad within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to \$4,500 a year. If the budget were increased to \$3,500 per year all ash could be removed within 7.5 years. Additionally, we recommend that Conrad apply for grants to fund replacement trees. Utility Company grants are usually between \$500 and \$10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option considered by many communities is treating selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removal all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at \$15 per inch, about 4 trees could be treated per year (every other year treatment). Eight trees would be selected for treatment, and Conrad would still need to find \$21,000 for removal of the remaining ash. Alternatively, if there are 5 treatable trees, it would cost approximately \$1,500 a year for treatment and leave \$2,000 for removal. These are alternatives to straight removal of ash trees. However, whether the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Conrad. We suggest considering an increased budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

4/16/2020									
To	tal Electricity	Electricity	Total Natural	Natural	Total Standard	% of Total	% of	Avg.	
Species	(MWh)	(\$)	Gas (Therms)	Gas (\$)	(\$) Error	Trees	Total \$	\$/tree	
Norway maple	20.6	1,560	3,007.5	2,947	4,50/ (N/A)	15.8	18.6	65.32	
Silver maple	17.5	1,326	2,329.3	2,283	3,608 (N/A)	10.7	14.9	76.77	
Red maple	9.8	740	1,333.9	1,307	2,047 (N/A)	9.4	8.5	49.94	
Northern red oak	7.4	560	1,022.2	1,002	1,561 (N/A)	7.8	6.5	45.92	
Green ash	9.1	691	1,228.5	1,204	1,895 (N/A)	6.6	7.8	65.36	
Norway spruce	2.4	179	317.4	311	490 (N/A)	4.1	2.0	27.20	
Broadleaf Deciduous N	lei 2.8	210	386.1	378	588 (N/A)	3.9	2.4	34.60	
Pear	2.4	183	364.5	357	540 (N/A)	3.0	2.2	41.53	
Blue spruce	2.0	155	285.6	280	435 (N/A)	3.0	1.8	33.43	
Eastern white pine	1.9	147	255.9	251	398 (N/A)	2.7	1.6	33.15	
Northern hackbenry	5.1	385	698.7	685	1,070 (N/A)	2.5	4.4	97.25	
Black maple	2.3	174	316.0	310	484 (N/A)	2.5	2.0	43.97	
Northern pin oak	2.9	223	435.7	427	650 (N/A)	2.3	2.7	64.99	
Black walnut	3.3	254	452.5	443	697 (N/A)	2.1	2.9	77.45	
Littleleaf linden	2.1	158	301.1	295	453 (N/A)	1.8	1.9	56.60	
Scarlet oak	3.2	246	443.8	435	681 (N/A)	1.8	2.8	85.13	
White ash	4.1	312	489.4	480	792 (N/A)	1.8	3.3	99.02	
Broadleaf Deciduous S	m: 0.1	10	23.4	23	33 (N/A)	1.6	0.1	4.75	
Honeylocust	2.6	195	331.9	325	520 (N/A)	1.6	2.1	74.28	
Austrian pine	0.8	60	104.1	102	162 (N/A)	1.4	0.7	27.08	
Bur oak	2.4	181	323.8	317	499 (N/A)	1.4	2.1	83.09	
Boxelder	0.5	41	71.6	70	111 (N/A)	1.4	0.5	18.56	
Birch	1.2	93	185.0	181	274 (N/A)	1.4	1.1	45.63	
Black spruce	0.7	55	96.4	94	150 (N/A)	1.1	0.6	29.92	
Alder	0.0	2	5.7	6	8 (N/A)	0.9	0.0	2.00	
White oak	1.4	104	183.1	179	284 (N/A)	0.9	1.2	70.90	
Swamp white oak	0.2	19	39.9	39	58 (N/A)	0.7	0.2	19.31	
American sycamore	0.9	67	118.4	116	183 (N/A)	0.7	0.8	60.90	
Hickory	0.9	66	118.0	116	182 (N/A)	0.5	0.8	91.02	
Cottonwood	0.7	50	93.7	92	142 (N/A)	0.5	0.6	70.91	
Chinese elm	0.7	53	97.1	95	148 (N/A)	0.5	0.6	74.17	
Maple	0.3	22	35.3	35	57 (N/A)	0.5	0.2	28.40	
Conifer Evergreen Med	iu 0.2	14	25.4	25	39 (N/A)	0.5	0.2	19.66	
Conifer Evergreen Larg	e 0.4	28	49.2	48	76 (N/A)	0.5	0.3	38.17	
Tulip tree	0.0	0	0.9	1	1 (N/A)	0.5	0.0	0.66	
Eastern redbud	0.1	ň	25.7	25	36 (N/A)	0.5	0.2	18.19	
American basswood	0.4	2.7	51.4	50	77 (N/A)	0.2	0.3	77.27	
Black cherry	0.2	14	24.7	24	38 (N/A)	0.2	0.2	38.13	
Southern magnolie	0.3	20	36.3	36	56 (N/A)	0.2	0.2	55.99	
Broadleaf Deciduous L	er 0.0	20	37	4	6 (N/A)	0.2	0.0	5.82	
Ginken	0.0	19	32.0	31	49 (NJ/A)	0.2	0.0	49.28	
Black ash	0.2	10	29.5	20	47 (N/A)	0.2	0.2	46.78	
Sugar manla	0.2	20	367	36	56 (N/A)	0.2	0.2	55.65	
Tatal	1145	0 204	15 0100	15 405	24 180 (M/A)	100.0	100.0	55.00	
rotal	114.3	0,094	13,810.9	15,495	24,107 (IV/M)	100.0	100.0	22.22	

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

4/16/2020

Total rainfall Total interception (Gal) Species interception (Gal) () Norway maple 226,008 6,1 Silver maple 279,317 7,5 Red maple 87,553 2,3 Northern red oak 76,807 2,0 Green ash 107,535 2,9 Norway spruce 48,146 1,3 Broadleaf Deciduous Medit 19,837 5 Pear 12,323 3 Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,60 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,22 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,33 White ash 60,477 1,6 Decader Deciduous Smell 410	1 5) 25 59 73 14 55 48 548 548 52 59 57 70	Standard Error (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	% of Total Trees 15.8 10.7 9.4 7.8 6.6 4.1 3.9 3.0 3.0 3.0 2.7 2.5 2.5	% of Total \$ 15.8 19.5 6.1 5.4 7.5 3.4 1.4 0.9 2.5 3.0 4.4	Avg. \$/tree 88.77 161.05 57.87 61.22 100.49 72.49 31.62 25.69 73.46 95.70
Spectes Interception (Gar) (Gar) Norway maple 226,008 6,11 Silver maple 279,317 7,55 Red maple 87,553 2,33 Northern red oak 76,807 2,00 Green ash 107,535 2,9 Norway spruce 48,146 1,33 Broadleaf Deciduous Medit 19,837 55 Pear 12,323 33 Blue spruce 35,238 9 Eastern white pine 42,377 1,1- Northern hackberry 62,658 1,66 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	25 59 73 14 05 84 55 84 55 88 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	15.8 10.7 9.4 7.8 6.6 4.1 3.9 3.0 3.0 2.7 2.5 2.5	15.8 19.5 6.1 5.4 7.5 3.4 1.4 0.9 2.5 3.0 4.4	88.77 161.05 57.87 61.22 100.49 72.49 31.62 25.69 73.46 95.70
porway maple 220,008 6,1 Silver maple 279,317 7,5 Red maple 87,553 2,3 Northem red oak 76,807 2,0 Green ash 107,535 2,9 Norway spruce 48,146 1,3 Broadleaf Deciduous Medit 19,837 5. Pear 12,323 3 Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,6 Black maple 21,833 5 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	25 59 73 14 05 84 55 48 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	15.8 10.7 9.4 7.8 6.6 4.1 3.9 3.0 3.0 2.7 2.5 2.5	15.8 19.5 6.1 5.4 7.5 3.4 1.4 0.9 2.5 3.0 4.4	88.77 161.05 57.87 61.22 100.49 72.49 31.62 25.69 73.46 95.70
Driver maple 279,317 7,57 Red maple 87,553 2,33 Northem red oak 76,807 2,00 Green ash 107,535 2,9 Norway spruce 48,146 1,33 Broadleaf Deciduous Medit 19,837 5. Pear 12,323 33 Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,66 Black maple 21,833 51 Northern pin oak 33,180 8 Black walnut 46,388 1,22 Littleleaf linden 24,712 66 Scarlet oak 49,370 1,33 White ash 60,477 1,6 Decedies Deciduous Smell 410	59 73 81 14 05 84 55 84 55 88 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	10.7 9.4 7.8 6.6 4.1 3.9 3.0 3.0 2.7 2.5 2.5	19.5 6.1 5.4 7.5 3.4 1.4 0.9 2.5 3.0 4.4	101.05 57.87 61.22 100.49 72.49 31.62 25.69 73.46 95.70
Red maple 87,553 2,3 Northem red oak 76,807 2,0 Green ash 107,535 2,9 Norway spruce 48,146 1,3 Broadleaf Deciduous Medit 19,837 5 Pear 12,323 3 Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,66 Black maple 21,833 55 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	73 31 14 05 38 44 55 48 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	9.4 7.8 6.6 4.1 3.9 3.0 3.0 2.7 2.5 2.5	0.1 5.4 7.5 3.4 1.4 0.9 2.5 3.0 4.4	57.87 61.22 100.49 72.49 31.62 25.69 73.46 95.70
Normern red oak 70,807 2,0 Green ash 107,535 2,9 Norway spruce 48,146 1,3 Broadleaf Deciduous Medit 19,837 5 Pear 12,323 3 Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,66 Black maple 21,833 55 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Desceller Deciduous Smell 410	14 05 38 34 55 48 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	7.8 6.6 4.1 3.9 3.0 3.0 2.7 2.5 2.5	5.4 7.5 3.4 1.4 0.9 2.5 3.0 4.4	100.49 72.49 31.62 25.69 73.46 95.70
breen asn 107,535 2,9 Norway spruce 48,146 1,3 Broadleaf Deciduous Medit 19,837 5. Pear 12,323 3. Blue spruce 35,238 9. Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,60 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Descelleef Deciduous Smell 410	14 05 38 34 55 48 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	0.0 4.1 3.9 3.0 2.7 2.5 2.5	7.5 3.4 1.4 0.9 2.5 3.0 4.4	72.49 31.62 25.69 73.46 95.70
Norway spruce 48,146 1,3 Broadleaf Deciduous Medit 19,837 5. Pear 12,323 3. Blue spruce 35,238 9. Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,60 Black maple 21,833 55 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Descelleef Deciduous Smell 410	05 38 34 55 48 98 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	4.1 3.9 3.0 2.7 2.5 2.5	3.4 1.4 0.9 2.5 3.0 4.4	72.49 31.62 25.69 73.46 95.70
Broadleaf Deciduous Medit 19,837 5. Pear 12,323 3. Blue spruce 35,238 9. Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,6 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Descelleef Deciduous Smell 410	55 48 55 48 98 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	3.9 3.0 3.0 2.7 2.5 2.5	1.4 0.9 2.5 3.0 4.4	31.62 25.69 73.46 95.70
Pear 12,323 3 Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,6 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Denselles Deciduous Smell 410	54 55 48 98 92 99 57 70	(N/A) (N/A) (N/A) (N/A) (N/A) (N/A)	3.0 3.0 2.7 2.5 2.5	0.9 2.5 3.0 4.4	25.69 73.46 95.70
Blue spruce 35,238 9 Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,60 Black maple 21,833 50 Northern pin oak 33,180 80 Black walnut 46,388 1,22 Littleleaf linden 24,712 60 Scarlet oak 49,370 1,33 White ash 60,477 1,60	200 18 20 20 20 20 20 20 20 20 20 20 20 20 20	(N/A) (N/A) (N/A) (N/A) (N/A)	2.7 2.5 2.5	2.5 3.0 4.4	73.40 95.70
Eastern white pine 42,377 1,1 Northern hackberry 62,658 1,6 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	+8 98 92 99 57 70	(N/A) (N/A) (N/A) (N/A)	2.7 2.5 2.5	3.0 4.4	95.70
Northern hackberry 62,658 1,6 Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	98 92 99 57 70	(N/A) (N/A) (N/A)	2.5	4.4	1.2.4.2.2
Black maple 21,833 50 Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	92 99 57 70	(N/A) (N/A)	2.5		154.37
Northern pin oak 33,180 8 Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Breadleaf Daviduana Small 410	99 57 70	(N/A)	-	1.5	53.79
Black walnut 46,388 1,2 Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6	70	A 7/4 1	2.3	2.3	89.92
Littleleaf linden 24,712 6 Scarlet oak 49,370 1,3 White ash 60,477 1,6 Scarlet Deciduous Small 410	10	(N/A)	2.1	3.2	139.68
Scarlet oak 49,370 1,3 White ash 60,477 1,6 Proceducef Decidence Small 410		(N/A)	1.8	1.7	83.71
White ash 60,477 1,6.	8	(N/A)	1.8	3.4	167.24
Provident Decidence Small 410	9	(N/A)	1.8	4.2	204.87
bioadiear Deciduous Small 419	1	(N/A)	1.6	0.0	1.62
Honeylocust 32,793 8	89	(N/A)	1.6	2.3	126.96
Austrian pine 11,570 3	4	(N/A)	1.4	0.8	52.26
Buroak 33,741 9	4	(N/A)	1.4	2.4	152.40
Boxelder 3,726 1	01	(N/A)	1.4	0.3	16.83
Birch 11,766 3	9	(N/A)	1.4	0.8	53.14
Black spruce 11,250 3)5	(N/A)	1.1	0.8	60.98
Alder 91	2	(N/A)	0.9	0.0	0.62
White oak 18,534 5)2	(N/A)	0.9	1.3	125.57
Swamp white oak 1,335	6	(N/A)	0.7	0.1	12.06
American sycamore 14,496 3	93	(N/A)	0.7	1.0	130.94
Hickory 14,478 3	2	(N/A)	0.5	1.0	196.17
Cottonwood 7,886 2	4	(N/A)	0.5	0.5	106.85
Chinese elm 9,830 2	56	(N/A)	0.5	0.7	133.19
Maple 1,741	7	(N/A)	0.5	0.1	23.59
Conifer Evergreen Medium 2,300	52	(N/A)	0.5	0.2	31.16
Conifer Evergreen Large 9,209 2	50	(N/A)	0.5	0.6	124.79
Tulip tree 36	1	(N/A)	0.5	0.0	0.48
Eastern redbud 529	4	(N/A)	0.5	0.0	7.17
American basswood 4,609 1	25	(N/A)	0.2	0.3	124.90
Black cherry 667	8	(N/A)	0.2	0.0	18.06
Southern magnolia 3,187	86	(N/A)	0.2	0.2	86.37
Broadleaf Deciduous Large 172	5	(N/A)	0.2	0.0	4.65
Ginkgo 1,857	50	(N/A)	0.2	0.1	50.33
Black ash 1,409	8	(N/A)	0.2	0.1	38.19
Sugar maple 2,466	57	(N/A)	0.2	0.2	66.84
Citywide total 1,433,856 38,8	57	(N/A)	100.0	100.0	88.72

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

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		De	position	(lb)	Total		Avoid	led (lb)		Total	BVOC	BVOC	Total	Total Standard	% of Total	Ave
Species	03	NO2	\mathbf{PM}_{10}	so ₂	Depos. (\$)	NO2	\mathbf{PM}_{10}	VOC	so ₂ A	voided H (\$)	Emissions H (lb)	imissions (\$)	(lb)	(\$) Error	Trees	\$/tree
Norway maple	50.4	8.7	24.2	2.2	271	100.0	14.4	13.7	93.2	619	-11.5	-43	295.6	847 (N/A)	15.8	12.27
Silver maple	53.4	9.1	25.7	2.4	287	82.6	12.1	11.5	79.0	516	-28.2	-106	247.6	697 (N/A)	10.7	14.83
Red maple	21.5	3.7	10.0	1.0	115	46.5	6.8	6.5	44.2	290	-7.2	-27	132.9	377 (N/A)	9.4	9.21
Northern red oak	16.4	2.8	7.9	0.7	88	35.3	5.1	4.9	33.4	219	-23.6	-88	83.1	220 (N/A)	7.8	6.46
Green ash	14.1	2.3	6.6	0.6	75	43.3	6.3	6.0	41.3	270	0.0	0	120.6	345 (N/A)	6.6	11.90
Norway spruce	5.7	1.1	4.6	0.7	37	11.2	1.6	1.6	10.7	70	-25.9	-97	11.2	10 (N/A)	4.1	0.55
Broadleaf Deciduous Mediv	3.4	0.6	1.8	0.2	19	13.3	1.9	1.8	12.6	83	-0.9	-3	34.7	98 (N/A)	3.9	5.77
Pear	4.3	0.7	2.0	0.2	23	11.8	1.7	1.6	10.9	73	0.0	0	33.2	96 (N/A)	3.0	7.35
Blue spruce	6.3	1.2	5.0	0.8	41	9.8	1.4	1.4	9.2	61	-13.7	-51	21.4	50 (N/A)	3.0	3.88
Eastern white pine	5.1	1.0	4.1	0.6	33	9.1	1.3	1.3	8.8	57	-23.1	-87	8.2	4 (N/A)	2.7	0.30
Northern hackberry	12.3	2.1	5.9	0.6	66	24.3	3.5	3.4	23.0	151	0.0	0	75.1	217 (N/A)	2.5	19.77
Black maple	5.6	1.0	2.6	0.2	30	10.9	1.6	1.5	10.4	68	-1.8	-7	32.0	91 (N/A)	2.5	8.26
Northern pin oak	7.5	1.3	3.6	0.3	40	14.3	2.1	2.0	13.3	89	-1.7	-6	42.7	122 (N/A)	2.3	12.23
Black walnut	7.2	1.2	3.2	0.3	38	15.9	2.3	2.2	15.1	99	0.0	0	47.5	137 (N/A)	2.1	15.23
Littleleaf linden	4.6	0.8	2.2	0.2	24	10.1	1.5	1.4	9.4	62	-2.1	-8	28.0	79 (N/A)	1.8	9.86
Scarlet oak	7.5	1.2	3.4	0.3	39	15.5	2.3	2.1	14.7	96	0.0	0	47.0	136 (N/A)	1.8	16.97
White ash	14.4	2.3	6.3	0.6	75	19.0	2.8	2.7	18.6	120	0.0	0	66.8	195 (N/A)	1.8	24.36
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.7	0.1	0.1	0.6	4	0.0	0	1.6	4 (N/A)	1.6	0.62
Honeylocust	6.6	1.1	3.0	0.3	35	12.0	1.8	1.7	11.6	75	-5.3	-20	32.7	90 (N/A)	1.6	12.87
Austrian pine	1.6	0.3	1.3	0.2	11	3.7	0.5	0.5	3.6	23	-4.3	-16	7.6	18 (N/A)	1.4	2.99
Bur oak	5.9	0.9	2.6	0.3	31	11.4	1.7	1.6	10.8	71	0.0	0	35.1	102 (N/A)	1.4	16.94
Boxelder	0.3	0.0	0.2	0.0	2	2.6	0.4	0.4	2.5	16	-0.2	-1	6.1	17 (N/A)	1.4	2.83
Birch	2.4	0.4	1.2	0.1	13	6.0	0.9	0.8	5.5	37	-0.6	-2	16.7	48 (N/A)	1.4	7.95
Black spruce	1.8	0.4	1.4	0.2	12	3.4	0.5	0.5	3.3	21	-4.3	-16	7.3	17 (N/A)	1.1	3.44
Alder	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.1	1	0.0	0	0.4	1 (N/A)	0.9	0.26
White oak	2.7	0.4	1.2	0.1	14	6.5	1.0	0.9	6.2	41	0.0	0	19.1	55 (N/A)	0.9	13.71
Swamp white oak	0.1	0.0	0.1	0.0	1	1.2	0.2	0.2	1.1	8	0.0	0	2.9	8 (N/A)	0.7	2.72
American sycamore	2.3	0.4	1.0	0.1	12	4.2	0.6	0.6	4.0	26	0.0	0	13.2	38 (N/A)	0.7	12.72
Hickory	2.3	0.4	1.0	0.1	12	4.2	0.6	0.6	4.0	26	0.0	0	13.1	38 (N/A)	0.5	19.04
Cottonwood	1.0	0.2	0.5	0.0	5	3.2	0.5	0.4	3.0	20	0.0	0	8.7	25 (N/A)	0.5	12.48
Chinese elm	1.4	0.2	0.6	0.1	7	3.4	0.5	0.5	3.2	21	0.0	0	9.9	28 (N/A)	0.5	14.19
Maple	0.3	0.1	0.2	0.0	2	1.4	0.2	0.2	1.3	9	-0.1	0	3.5	10 (N/A)	0.5	4.94
Conifer Evergreen Medium	0.3	0.1	0.2	0.0	2	0.9	0.1	0.1	0.9	6	-0.8	-3	1.8	4 (N/A)	0.5	2.21
Conifer Evergreen Large	1.1	0.2	0.9	0.1	7	1.8	0.3	0.2	1.7	11	-5.7	-21	0.6	-3 (N/A)	0.5	-1.58
Tulip tree	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	0.5	0.08
Eastern redbud	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.7	5	0.0	0	1.8	5 (N/A)	0.5	2.55
American basswood	0.7	0.1	0.3	0.0	4	1.7	0.2	0.2	1.6	11	-0.6	-2	4.4	12 (N/A)	0.2	12.18
Black cherry	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	5	0.0	0	2.3	7 (N/A)	0.2	0.56
Southern magnolia	0.3	0.1	0.3	0.0	2	1.3	0.2	0.2	1.2	8	-0.9	-3	2.6	7 (N/A)	0.2	0.63
Broadleaf Deciduous Large	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.2	0.87
Ginkgo	0.5	0.1	0.3	0.0	3	1.1	0.2	0.2	1.1	7	-0.2	-1	3.3	9 (N/A)	0.2	9.29
Black ash	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8 (N/A)	0.2	7.92
Sugar maple	0.3	0.0	0.2	0.0	2	1.2	0.2	0.2	1.2	8	-0.2	-1	3.0	8 (N/A)	0.2	8.46
Citywide total	272.3	46.5	135.9	13.9	1,479	547.8	79.7	75.9	519.0	3,410	-162.9	-611	1,528.1	4,278 (N/A)	100.0	9.77

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

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	Total Stored	Total Standard	% of Total	% of	Avg.
Species	CO2 (lbs)	(\$) Error	Trees	Total \$	\$/tree
Norway maple	833,191	6,249 (N/A)	15.8	15.3	90.56
Silver maple	1,322,717	9,920 (N/A)	10.7	24.3	211.07
Red maple	232,143	1,741 (N/A)	9.4	4.3	42.47
Northern red oak	358,407	2,688 (N/A)	7.8	6.6	79.06
Green ash	464,652	3.485 (N/A)	6.6	8.5	120.17
Norway spruce	65.061	488 (N/A)	4.1	1.2	27.11
Broadleaf Deciduou	57 363	430 (N/A)	3.9	1.1	25.31
Pear	66 998	502 (N/A)	3.0	1.2	38.65
Blue spruce	56,774	426 (N/A)	3.0	1.0	32.75
Eastern white nine	58 678	440 (N/A)	2.7	11	36.67
Northern hackberry	203 536	1.527 (N/A)	2.5	3.7	138 77
Black manla	59 493	446 (N/A)	2.5	11	40.56
Northarn nin oak	123,287	925 (N/A)	2.2	2.3	92.47
Black walnut	243 376	1 825 (N/A)	2.5	4.5	202.81
ittlalaaf lindan	06 226	722 (NJ/A)	1.8	1.2	90.21
Saarlat aalt	250,626	1 880 (N/A)	1.0	1.0	234.07
Scarlet oak	200,000	1,000 (19/A)	1.0	4.0	195.04
white ash	197,373	1,460 (IN/A)	1.0	5.0	185.04
Droadlear Deciduou	1,081	8 (IN/A)	1.0	0.0	01.04
rioneylocust	0.5,/14	045 (IN/A) 95 (DI/A)	1.0	1.0	91.04
Austrian pine	11,558	85 (IN/A)	1.4	0.2	14.17
bur oak	201,396	1,510 (N/A)	1.4	3./	251.75
Boxelder	6,481	49 (N/A)	1.4	0.1	8.10
Birch	39,808	299 (N/A)	1.4	0.7	49.76
Black spruce	14,685	110 (N/A)	1.1	0.3	22.03
Alder	219	2 (N/A)	0.9	0.0	0.41
White oak	90,647	680 (N/A)	0.9	1.7	169.96
Swamp white oak	2,420	18 (N/A)	0.7	0.0	6.05
American sycamore	78,529	589 (N/A)	0.7	1.4	196.32
Hickory	78,517	589 (N/A)	0.5	1.4	294.44
Cottonwood	31,546	237 (N/A)	0.5	0.6	118.30
Chinese elm	47,716	358 (N/A)	0.5	0.9	178.94
Maple	3,843	29 (N/A)	0.5	0.1	14.41
Conifer Evergreen 1	1,402	11 (N/A)	0.5	0.0	5.26
Conifer Evergreen I	14,981	112 (N/A)	0.5	0.3	56.18
Tulip tree	24	0 (N/A)	0.5	0.0	0.09
Eastern redbud	1,816	14 (N/A)	0.5	0.0	6.81
American basswood	24,952	187 (N/A)	0.2	0.5	187.14
Black cherry	3,037	23 (N/A)	0.2	0.1	22.78
Southern magnolia	4,397	33 (N/A)	0.2	0.1	32.98
Broadleaf Deciduou	185	1 (N/A)	0.2	0.0	1.39
Ginkgo	7,800	59 (N/A)	0.2	0.1	58.50
Black ash	3.624	27 (N/A)	0.2	0.1	27.18
Sugar maple	7,945	60 (N/A)	0.2	0.1	59.59
Citywide total	5 4 5 4 0 1 6	40.905 (N/A)	100.0	100.0	93 39

Table 5: Annual Carbon Sequestered

Annual CO₂ Benefits of Public Trees

	Sequestered	Sequestered	Decomposition	Maintenance	Total	Avoided	Avoided	Net Total	Total Standard	% of Total	% of	Avg.
Species	(lb)	(\$)	Release (lb)	Release (lb)	Released (\$)	(lb)	(\$)	(lb)	(\$) Error	Trees	Total \$	\$/tree
Norway maple	9,523	/1	-3,999	-254	-32	34,478	259	39,748	298 (N/A)	15.8	10.7	4.32
Silver maple	86,107	646	-6,300	-209	-49	29,297	220	108,895	817 (N/A)	10.7	29.3	17.38
Red maple	12,003	90	-1,114	-91	-9	16,360	123	27,158	204 (N/A)	9.4	7.3	4.97
Northern red oak	6,600	0 50	-1,/20	-96	-14	12,367	93	17,151	129 (N/A)	7.8	4.6	3.78
Green ash	20,958	157	-2,230	-95	-17	15,279	115	33,912	254 (N/A)	6.6	9.1	8.77
Norway spruce	1,909	14	-312	-49	-3	3,946	30	5,494	41 (N/A)	4.1	1.5	2.29
Broadleaf Deciduous M	le 4,596	5 34	-277	-27	-2	4,639	35	8,931	67 (N/A)	3.9	2.4	3.94
Pear	3,577	27	-322	-33	-3	4,036	30	7,258	54 (N/A)	3.0	2.0	4.19
Blue spruce	1,128	8	-273	-43	-2	3,418	26	4,231	32 (N/A)	3.0	1.1	2.44
Eastern white pine	1,496	5 11	-282	-41	-2	3,250	24	4,423	33 (N/A)	2.7	1.2	2.76
Northern hackberry	7,268	55	-977	-53	-8	8,508	64	14,747	111(N/A)	2.5	4.0	10.05
Black maple	2,374	18	-286	-22	-2	3,844	29	5,910	44 (N/A)	2.5	1.6	4.03
Northern pin oak	1,434	11	-592	-37	-5	4,925	37	5,730	43 (N/A)	2.3	1.5	4.30
Black walnut	6,994	52	-1,168	-37	-9	5,605	42	11,393	85 (N/A)	2.1	3.1	9.49
Littleleaf linden	2,093	16	-462	-29	-4	3,485	26	5,088	38 (N/A)	1.8	1.4	4.77
Scarlet oak	7,384	55	-1,203	-37	-9	5,440	41	11,584	87 (N/A)	1.8	3.1	10.86
White ash	9,005	68	-947	-36	-7	6,905	52	14,927	112 (N/A)	1.8	4.0	13.99
Broadleaf Deciduous Sr	r 236	5 2	-5	-4	0	229	2	456	3 (N/A)	1.6	0.1	0.49
Honevlocust	0) 0	-411	-19	-3	4,303	32	3.873	29 (N/A)	1.6	1.0	4.15
Austrian pine	713	5	-54	-14	-1	1 336	10	1 981	15 (N/A)	14	0.5	2.48
Bur oak	4 346	33	-967	-27	-7	4 004	30	7 356	55 (N/A)	14	2.0	9 1 9
Boxelder	950	7	-33	-6	Ó	911	7	1 822	14 (N/A)	14	0.5	2.28
Birch	1 512	11	-191	-14		2 045	15	3 351	25 (N/A)	1.4	0.0	4 19
Black sprace	517	4	-70	-14	-1	1 218	0	1,651	12 (N/A)	11	0.4	2.48
Alder	64		1	1	0	54	ó	116	1 (N/A)	0.0	0.0	0.22
White oak	2 020		-435	-15	-3	2 303	17	4 782	36 (N/A)	0.0	1 3	8 97
Swamn white oak	544	4	-12	-13	-5	416	3	945	7 (N/A)	0.7	0.3	2.36
A moriorn automoro	1 9 7 7	14	277	10	2	1 472	11	2 012	22 (N/A)	0.7	0.0	7.00
Hildrom	1,027	14	-377	-10	-5	1,475	11	2,915	22 (IV/A)	0.7	0.0	10.00
Cottonwood	1,024	14	-577	-10	-5	1,409	0	2,500	22 (IV/A)	0.5	0.8	0.07
Collonwood Chinasa alm	1,714	13	-101	-/	-1	1,105	°	2,000	20 (IN/A)	0.5	0.7	9.97
Manle	1,572	, 12	-229	-0	-2	1,170	9	2,511	19 (N/A)	0.5	0.7	3.72
Conifer Evergreen Med	lin 120	0 1	-10	-3	ŏ	310	2	439	3 (N/A)	0.5	0.1	1.64
Conifer Evergreen Lord	10 12.		70	0	1	622	5	541	4 (N/A)	0.5	0.1	2.03
Tulin trae	50	5 0	-/2	-9	-1	022	0	12	4 (IV/A)	0.5	0.1	0.05
Fastors radbud	22	0 0	0	2	ŏ	240	Š	465	2 (N/A)	0.5	0.0	1.74
American become d	1 26	5 10	120	-2		240	4	1 0 2 5	14 (N/A)	0.5	0.1	12.74
American basswood	1,50.	5 10	-120	-4	-1	209	4	1,855	14 (IN/A)	0.2	0.5	15.70
Black cherry	200	8 2	-15	-2	0	508	2	000	4 (N/A)	0.2	0.2	4.20
Southern magnolia	260	0 2	-21	-3	0	451	3	687	2 (N/A)	0.2	0.2	2.12
Broadleat Deciduous L	at 74	+ 1	-1	-1	0	49	0	121	1 (N/A)	0.2	0.0	0.91
Ginkgo	319	9 2	-37	-4	0	396	3	6/4	5 (N/A)	0.2	0.2	5.06
Black ash	380	53	-17	-2	0	395	3	762	6 (N/A)	0.2	0.2	5.71
Sugar maple	523	3 4	-38	-3	0	435	3	917	7 (N/A)	0.2	0.2	6.88
Citywide total	207,320	6 1,555	-26,185	-1,374	-207	192,139	1,441	371,906	2,789(N/A)	100.0	100.0	6.37

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

	Standard	% of Total	% of Total	Avg.
Species Total (Error	Trees	S	\$/tree
Norway maple 8	94 (N/A)	15.8	5.0	12.96
Silver maple 6,1	77 (N/A)	10.7	34.8	131.43
Red maple 1,:	57 (N/A)	9.4	8.8	37.98
Northern red oak 4	90 (N/A)	7.8	2.8	14.41
Green ash 1,0	64 (N/A)	6.6	9.4	57.37
Norway spruce 4	21 (N/A)	4.1	2.4	23.39
Broadleaf Deciduous Medit 4	84 (N/A)	3.9	2.7	28.45
Pear 2	12 (N/A)	3.0	1.2	16.33
Blue spruce J	05 (N/A)	3.0	0.6	8.09
Eastern white pine 3	41 (N/A)	2.7	1.9	28.42
Northern hackberry 8	27 (N/A)	2.5	4.7	75.18
Black maple	91 (N/A)	2.5	1.6	26.49
Northern pin oak	32 (N/A)	2.3	0.7	13.22
Black walnut	05 (N/A)	2.1	2.8	56.10
Littleleaf linden 2	18 (N/A)	1.8	1.2	27.26
Scarlet oak	99 (N/A)	1.8	2.8	62.34
White ash	65 (N/A)	1.8	4 0	108.09
Broadlesf Deciduous Small	12 (N/A)	1.6	0.1	1 77
Honeylocust	0 (N/A)	1.6	0.0	0.00
Austrian nine	36 (N/A)	1.0	0.0	22.60
Bur osk	05 (N/A)	1.4	1.7	50.80
Develder 1	51 (N/A)	1.4	1./	26.14
Direh	51 (IV/A) 52 (IV/A)	1.4	0.9	20.14
Distriction Distriction	55 (IN/A)	1.4	0.9	40.05
Black spruce	85 (N/A)	1.1	0.5	10.05
Alder	2 (N/A)	0.9	0.0	0.54
white oak 2	20 (N/A)	0.9	1.2	55.05
Swamp white oak	65 (N/A)	0.7	0.4	21.78
American sycamore 1	22 (N/A)	0.7	0.7	40.65
Hickory	17 (N/A)	0.5	0.7	58.34
Cottonwood 1	31 (N/A)	0.5	0.7	65.59
Chinese elm 1	16 (N/A)	0.5	0.7	58.01
Maple	73 (N/A)	0.5	0.4	36.59
Conifer Evergreen Medium	46 (N/A)	0.5	0.3	23.16
Conifer Evergreen Large	0 (N/A)	0.5	0.0	0.00
Tulip tree	11 (N/A)	0.5	0.1	5.26
Eastern redbud	13 (N/A)	0.5	0.1	6.40
American basswood	94 (N/A)	0.2	0.5	94.13
Black cherry	15 (N/A)	0.2	0.1	15.48
Southern magnolia	41 (N/A)	0.2	0.2	41.22
Broadleaf Deciduous Large	15 (N/A)	0.2	0.1	14.73
Ginkgo	23 (N/A)	0.2	0.1	22.94
Black ash	39 (N/A)	0.2	0.2	39.16
Sugar maple	59 (N/A)	0.2	0.3	58.58

Table 7: Summary of Benefits in Dollars

Annual Benefits of Public Trees by Species (\$/tree)

4/16/2020						
Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total (\$) Standard Error
Norway maple	65.32	4.32	12.27	88.77	12.96	183.64 (N/A)
Silver maple	76.77	17.38	14.83	161.05	131.43	401.47 (N/A)
Red maple	49.94	4.97	9.21	57.87	37.98	159.97 (N/A)
Northern red oak	45.92	3.78	6.46	61.22	14.41	131.80 (N/A)
Green ash	65.36	8.77	11.90	100.49	57.37	243.88 (N/A)
Norway spruce	27.20	2.29	0.55	72.49	23.39	125.92 (N/A)
Broadleaf Deciduou	34.60	3.94	5.77	31.62	28.45	104.39 (N/A)
Pear	41.53	4.19	7.35	25.69	16.33	95.09 (N/A)
Blue spruce	33.43	2.44	3.88	73.46	8.09	121.29 (N/A)
Eastern white pine	33.15	2.76	0.30	95.70	28.42	160.34 (N/A)
Northern hackberry	97.25	10.05	19.77	154.37	75.18	356.62 (N/A)
Black maple	43.97	4.03	8.26	53.79	26.49	136.54 (N/A)
Northern pin oak	64.99	4.30	12.23	89.92	13.22	184.65 (N/A)
Black walnut	77.45	9.49	15.23	139.68	56.10	297.96 (N/A)
Littleleaf linden	56.60	4.77	9.86	83.71	27.26	182.20 (N/A)
Scarlet oak	85.13	10.86	16.97	167.24	62.34	342.55 (N/A)
White ash	99.02	13.99	24.36	204.87	108.09	450.32 (N/A)
Broadleaf Deciduou	4.75	0.49	0.62	1.62	1.77	9.26 (N/A)
Honevlocust	74.28	4.15	12.87	126.96	0.00	21826 (N/A)
Austrian pine	27.08	2.48	2.99	52.26	22.60	107.41 (N/A)
Buroak	83.09	9.19	16.94	152.40	50.89	312.52 (N/A)
Boxelder	18.56	2.28	2.83	16.83	25.14	65.63 (N/A)
Birch	45.63	4.19	7.95	53.14	25.53	136.45 (N/A)
Black spruce	29.92	2.48	3.44	60.98	16.65	113.46 (N/A)
Alder	2.00	0.22	0.26	0.62	0.54	3.63 (N/A)
White oak	70.90	8.97	13.71	125.57	55.05	27420 (N/A)
Swamp white oak	19.31	2.36	2.72	12.06	21.78	58.22 (N/A)
American svcamore	60.90	7.28	12.72	130.94	40.65	252.49 (N/A)
Hickory	91.02	10.90	19.04	196.17	58.34	375.47 (N/A)
Cottonwood	70.91	9.97	12.48	106.85	65.59	265.81 (N/A)
Chinese elm	74.17	9.42	14.19	133.19	58.01	288.98 (N/A)
Maple	28.40	3.72	4.94	23.59	36.59	97.24 (N/A)
Conifer Evergreen N	19.66	1.64	2.21	31.16	23.16	77.83 (N/A)
Conifer Evergreen I	38.17	2.03	-1.58	124.79	0.00	163.41 (N/A)
Tulip tree	0.66	0.05	0.08	0.48	5.26	6.53 (N/A)
Eastern redbud	18.19	1.74	2.55	7.17	6.40	36.05 (N/A)
American basswood	77.27	13.76	12.18	124.90	94.13	322.23 (N/A)
Black cherry	38.13	4.20	6.56	18.06	15.48	82.43 (N/A)
Southern magnolia	55.99	5.15	6.63	86.37	41.22	19537 (N/A)
Broadleaf Deciduou	5.82	0.91	0.87	4,65	14.73	26.98 (N/A)
Ginkeo	49.28	5.06	9.29	50.33	22.94	13690 (N/A)
Black ash	46.78	5.71	7.92	38.19	39.16	137.75 (N/A)
Sugar maple	55.65	6.88	8.46	66.84	58.58	196.41 (N/A)
Citywide Total	55.23	6.37	9.77	88.72	40.47	200.55 (N/A)

Species Distribution of Public Trees

4/16/2020



- Norway maple
- Silver maple
- 🖩 Red maple
- / 🗧 Northern red oak
 - Green ash
 - Norway spruce
 - Broadleaf Deciduous Medium
 - Pear
 - Blue spruce
 - Eastern white pine
 - Other Species

Species	Percent
Norway maple	15.8
Silvermaple	10.7
Redmaple	9.4
Northern red oak	7.8
Green ash	6.6
Norway spruce	4.1
Broadleaf Deciduous Me	3.9
Pear	3.0
Blue spruce	3.0
Eastern white pine	2.7
Other Species	33.1
Total	100.0

Figure 1: Species Distribution



Figure 2: Relative Age Class



Figure 3: Foliage Condition



Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

4/16/2020



Zone	Acres % of	Total Canopy (Cover	
1	14	1	00.0	
Citywide total	14	1	0.00	
	Total Street	Total Ca	nopy Cover as	Canopy Cover as % of
Total Lar	d and Sidewalk	Canopy %	of Total Land	Total Streets and
Ar	ea Area	a Cover	Area	Sidewalks

0

14

Figure 5: Canopy Cover in Acres

0

Citywide Total

0.00

0.00



Figure 6: Land Use of city/park trees

Appendix B: ArcGIS Mapping



Figure 1: Location of Ash Trees



Figure 2: Location of EAB symptoms



Figure 3: Location of Poor Condition Trees



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

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 (measured from the extended property lines) 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 fruitbearing 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. Removal of trees from public property shall be at the City's expense.

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 fourteen (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])

151.07 DESTRUCTION OF NOXIOUS WEEDS.

It is the duty of every property owner or person, owning or occupying real estate within the corporation limits of the City, to remove from their property or the streets or highways adjoining property all noxious weeds thereon as defined by State law at such times and in such manner as the Council shall provide by resolution. The Council may fix by resolution a date for the destruction of noxious weeds. The Council shall publish a notice of said resolution in one publication of a newspaper of general circulation which serves the City. The notice shall state therein the time for destruction of such weeds, the manner of destroying the same, if other than by cutting, and that unless said resolution is complied with, the Council will cause said weeds to be destroyed and the cost thereof taxed against the owner of the property.

151.08 CONTROL OF VEGETATION.

It is the duty of every owner and the person occupying any real estate within the corporation limits of the City which is platted or used for residential, commercial or industrial purposes, other than property being used as timberland or for agricultural purposes, to maintain the property in such a condition so that all uncultivated vegetation thereon is cut, sprayed or otherwise controlled so that the height does not exceed six (6) inches.

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 lowa Civil Rights Commission, 1-800-457-4416, or write to the lowa 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.