2015 City of Missoula, Montana

Urban Forest Master Management Plan

Prepared by:
Urban Forest Management Plan Working Group
Adopted April 20, 2015

THE GARDEN CITY
MISSOULA
HUB OF FIVE VALLEYS

Parks & Recreation
City of Missoula • 100 Hickory • 721-PARK

Foreword

Management plans are documents used to guide future activities. These plans can be very broad in scope or they can be very specific in both scope and duration. This management plan is very broad in scope, long in duration and contains numerous implementation strategies requiring further study and refinement. **It is a framework.** It will also be used to generate annual work plans. When reading this management plan, remember that many detailed, specific plans will be generated to direct implementation of the management plan.

Acknowledgments

Urban Forest Management Plan Working Group

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- Margie Ewing, Regional Urban & Community Forestry Program Manager US Forest Service
- Christopher Gray, Arborist Technician, City of Missoula
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- Karen Sippy, Executive Director Trees for Missoula
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- UM Institute for Tourism and Recreation Research, Norma Nickerson, Director

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Executive Summary

Vision Statement

We, as citizens of Missoula, recognize that we are the benefactors of the past, as well as the stewards of the future. We envision a healthy, vibrant, safe and sustainable urban forest for current and future generations. We strive to address the urban forest issues of the day in a proactive, cooperative manner, while always keeping a keen eye towards the future.

Missoula's urban forest is a critical thread in the social fabric of the community. Missoulians have enjoyed the existing urban forest for over 100 years. The trees of the urban forest are an integral component of our lives, neighborhoods and city. The community-wide benefits of a vibrant urban forest are well documented and supported, from economic to environmental to social. As of November 2014 Missoula's urban forest consisting of 24,424 trees was valued at $86.4 million; a dynamic asset that provides $2.5 million in annual socio-economic benefits.

The recently conducted public survey shows that the citizens of Missoula highly value their urban forest and the benefits provided by the forest. However, the very urban forest enjoyed by the citizens of Missoula is under threat due to age, insufficient maintenance and a lack of active reforestation.

Without intensive management and financial input, the urban forest will significantly change within the next 20 years. These changes include:

- A 67 percent decrease in tree population, from 24,400 to 8,050 trees
- A 42 percent decrease in annual socio-economic benefits, from $2,459,000 to $1,036,000
- An overall decline in environmental benefits and the social fabric of Missoula.

Public Participation Process

To ensure all citizens of Missoula had an opportunity to participate in the management plan development process, multiple opportunities were provided for citizen input including a public interest survey, stakeholder meetings, neighborhood council meetings, citizen workshops, Park Board reviews and staff reviews. This management plan responds to the issues and desires of the community.

Management Goals

The following Urban Forest Management Plan goals reflect the values of Missoula citizens towards their urban forest. While each goal has equal weight, the order is based upon citizen input. The quantity and reliance on Norway maples as a street tree is reflected in the first of 16 Goals for the Urban Forest Management Plan.

Manage

- Create and maintain a diverse urban forest for maximum tree health and longevity.
- Establish consistent tree maintenance for optimal structural stability of public trees.
- Maintain accurate inventory information as a basis for sound management decisions.
- Establish work priorities for maximum staff effectiveness.
- Establish an aggressive planting program to maintain the existing urban forest treed neighborhoods and expand into non-treed neighborhoods.
- Establish a supply chain of appropriate tree stock for the city planting programs.

Plan

- Look at urban forest management activities well into the future.
- Investigate stable funding sources to ensure the urban forest is properly managed and maintained.
- Incorporate trees into infrastructure planning so that trees do not damage the infrastructure.
- Conduct periodic management plan updates.

Protect

- Consistently enforce the street tree ordinances to protect public trees from damage or loss.
- Manage insect pests in a proactive manner.

Engage

- Provide community forestry leadership through example, public education and outreach.
- Establish tree canopy cover for maximum community benefit.
- Manage tree risk to reduce the exposure of the city and its residents to financial hardship.
- Foster community involvement for community buy-in of the urban forestry program.

Key Recommendations

The following 18 Key Recommendations summarize the Urban Forest Management Plan implementation strategies found in Part 7 of the Plan and provide guidance on the implementation of the Plan Goals and Objectives. The recommendations are based upon input from the Urban Forest Management Plan Working Group members, community stakeholders and citizens.

Manage

- Manage tree risk to reduce the likelihood damage, injury or death associated with tree failures.
- Promptly remove dead, dying, diseased and unsound trees in preparation of replanting.
- Implement an aggressive reforestation program to maintain the presence of trees in Missoula neighborhoods.
- Provide consistent maintenance for all mature trees on a cyclical basis to increase the longevity of public trees.
- Provide adequate staff and equipment to implement the Urban Forest Management Plan and consistently enforce street tree ordinances.
- Provide young tree formative pruning in a timely manner to ensure saplings trees start life with proper form and structure.
- Repurpose removed trees for park-related programs.

Plan

- Develop and implement a comprehensive tree-planting plan that ensures species diversity and meets shading goals while preserving neighborhood identity.
- Develop and implement stable funding sources for core urban forestry activities.
- Develop and implement alternative funding sources for supporting urban forestry activities.
- Provide periodic reports on the Urban Forest Management Plan and update the Plan on a periodic basis.

Protect

- Update the three existing ordinances for relevance and consistency, and to support implementation of the Urban Forest Management Plan.

- Develop and implement pest management programs that monitor existing pest problems and new pest problems that threaten the urban forest.
- Update and distribute the Tree Standards Manual for use by citizens, stakeholders, staff and Green Industry groups within the community.

Engage

- Use existing City forums to coordinate departmental activities that impact the urban forest.
- Provide ongoing educational opportunities for all Missoulians, from grade school students to senior citizens to "Green Industry" trades on the benefits of the urban forest.
- Develop and implement community volunteer programs the further the Urban Forest. Management Plan and provide citizens with a sense of program ownership.
- Develop and implement interactive opportunities for citizens to participate in the urban forest management program.

Implementation

Missoulians have enjoyed the current urban forest for over 100 years. The urban forest defines our neighborhoods and our city. Implementation of the Urban Forest Management Plan for future generations of Missoulians will take time and adequate resources. The Implementation Strategies shown in Part 7 of the Urban Forest Management Plan provide a detailed roadmap for the long-term management of the urban forest for ***future generations***.

Glossary of Terms and Acronyms

Absorption To take in something, such as a liquid, in a natural or gradual way

Adsorption The adhesion in an extremely thin layer of molecules (as of gases, solutes, or liquids) to the surfaces of solid bodies or liquids with which they are in contact.

ANSI American National Standards Institute

ASCA American Society of Consulting Arborists

BMP Best Management Practices

BVOC Botanical Volatile Organic Compound, a volatile organic compound released by a plant.

d.b.h. The measurement of a tree's diameter taken at breast height, also written as DBH.

ETc Evapotranspiration coefficient, the multiplier that converts the reference field evapotranspiration rate to the specific plant.

ETr Evapotranspiration reference, the amount of water used by the reference plant, alfalfa, each year.

Evapotranspiration The loss of water through leaf structures.

FTE Full Time Equivalent, a way of measuring length of employment in a year.

IPM Integrated Pest Management

ISA International Society of Arboriculture

i-Tree A USFS computer analysis program developed to quantify the economic benefits of urban trees.

Management Plan A long term urban forest management plan for the city of Missoula.

Monoculture An urban forest comprised primarily of one or two species.

NRCS Natural Resource Conservation Service

OSHA Occupational Safety and Health Administration

Public Trees Trees located within the public right-of-way or on public property.

Risk The potential to cause damage, injury or death.

Risk Management The process of managing hazards and their associated risks.

ROW Right-of-Way

SID Special Improvement District

S.W.O.T. A public participation process asking for input on a particular program regarding its Strengths, Weaknesses, Opportunities and Threats.

TFM Trees for Missoula

Tree Class The height of a tree based upon its height; Class I is 10' to 30', Class II is 30' to 60', and Class III is over 60'.

Tree Failure The loss of a branch, limb, trunk or root system of a tree.

TreeWorks The inventory software used to collect and management tree data.

Urban Forest The sum of all trees within a geographical or political boundary.

Urban Forester The individual who manages the urban forest an all related activities.

VOC Volatile Organic Compound, a hydrocarbon that reacts with sunlight to form ozone.

Part 1
Need and Authorization

Urban Forest Master Management Plan Development

Need

Missoula's urban forest is a critical thread in the social fabric of the community. Missoulians have enjoyed the current urban forest for over 100 years. The recently conducted public survey shows that the citizens of Missoula highly value their urban forest and the benefits provided by the forest. The trees of the urban forest are an integral component of our lives, neighborhoods and city.

That uniting thread within our community is under threat. Of the 24,400 public urban forest trees inventoried as of November 2014, 21.5 percent are in poor condition, 8.4 percent are in very poor condition and 1.3 percent are dead. 30.5 percent of the 24,400 street trees are Norway maple and are very near the end of their lifespan. (41.5 percent of the poor trees and 43.1 percent of the very poor trees are Norway maple.) Just over 35% of the public urban forest, Norway maples and dead trees will disappear over the next decade.

The city is self-insured for losses associated with claims against the city arising from tree failures. We as citizens pay for claims brought against the city arising from tree failures. Therefore, aging, decaying and poorly maintained trees are at a much greater risk for failure, which increases the exposure of the city to significant financial losses.

Optimal neighborhood street canopy cover ranges between 30 and 40 percent. Numerous neighborhoods in Missoula have little or no street tree canopy. These neighborhoods are denied the socio-economic benefits enjoyed by the five older neighborhoods. Other well canopied neighborhoods are rapidly losing their street tree canopy.

Our failing public trees and barren neighborhoods clearly define the need to develop and implement a long term management plan for the urban forest to maintain a critical thread in the community social fabric.

Benefit

A long term urban forest management plan is essential in keeping a critical thread in the social fabric from disappearing. Replenishment of the urban forest will allow future generations to enjoy the benefits enjoyed by current and past generations.

A long term urban forest management plan serves as the roadmap for the orderly renewal of the urban forest. It also serves as the framework for the development of future ordinances, landscape design standards, urban forest maintenance standards and associated programs necessary to implement the management plan.

Essence of Time

Trees are living organisms and take a lifetime to grow. They have finite lifespans. They respond uniquely to environmental stresses. They also respond most favorably to proper planting, care and maintenance. An orderly management plan is essential to maximize the favorable response from our urban forest.

Because trees take a lifetime to grow and respond unfavorably to poor management, time is of the essence in the development and implementation of a long term urban forest management plan.

Establishment

On December 4, 2013, the Parks and Conservation Committee accepted staff's recommendation for the development of a long term management plan for the city of Missoula's urban forest. The full Council adopted Resolution Number 7838 at its December 9, 2013 meeting, authorizing the development of an urban forest management plan. A copy of the title is included below, with the full resolution contained in Appendix A. With that authority, staff formed a management plan working group to develop the management plan.

RESOLUTION NUMBER 7838

A resolution of the Missoula City Council in support of the development of a long term management plan for the Missoula Urban Forest, including reallocation of existing and available FY 14 Park District Funds for plan development.

Volunteers and experts in the field of urban and community forestry were asked to participate in the working group. The core working group is comprised of two urban forestry staff members, the Parks and Recreation Director, a representative of the Park Board, a representative of Trees for Missoula, a representative of Montana Department of Natural Resources and Conservation, and a representative of the US Forest Service. The working group includes the following individuals:

Working Group and Qualifications

Christopher Boza, City Forester

Chris Boza has over 34 year experience in urban forest management. During that time, he has written management plans for the cities of San Jose and Chico, California, and Hayden, Idaho. He has facilitated and conducted public interest surveys used to develop urban forest management and park development master plans. He has facilitated or conducted street tree inventories in cities such as Sterling Heights, Michigan; Chico, California; Couer d'Alene, Idaho; Hayden, Idaho; and, Missoula, Montana.

Chris received his undergraduate degree in Urban Forestry from Michigan Technological University and completed graduate coursework in Rural and Town Planning at Chico State University. His education and experience in Urban Forest Management provide strong insight and knowledge into the development and implementation of an urban forest management plan.

Christopher Gray , Arborist Technician

Christopher Gray is the Lead Arborist Technician for the City of Missoula. He began his career in the arboriculture field 21 years ago with the City of Missoula's Urban Forestry Division as an Assistant Arborist. He moved to the Arborist Technician position in 2000 and has continues his work in the field as the Lead Arborist for the City of Missoula since 2011. Christopher is and ISA Certified Arborist, ISA Tree Risk Assessment Qualified, EHAP certified and a Forest Service Class "C" faller.

Over the last decade Christopher has concentrated his efforts towards safety and training for the Urban Forestry Division. In 2004 Christopher designed and chaired the Missoula Parks and Recreation safety committee as a collaborative effort with the Montana Municipal Insurance Authority. Christopher oversees all training for current and new employees in the Urban Forestry Division and provides trainings for the maintenance staff of Parks and Recreation. He has provided training for the Missoula Fire Department in Ariel rescue techniques for tree climbers and lift truck operators. Teaming with the Montana DNRC and U.S. Forest Service he provides chainsaw training for the public and city personnel. Christopher maintains his arboricultural expertise through daily field operations and is a valued liaison between the urban forestry division and the public.

Jamie Kirby, Urban and Community Forester

Jamie Kirby is the Urban & Community Forestry Program Manager for the Montana Department of Natural Resources and Conservation. Jamie is a Hellgate High School alumnus and has a degree in Forest Resource Management from the University of Montana. Jamie worked as a wildland fire prevention and education specialist for several years before converting to urban forestry in 2008. Since then she became Certified Arborist and member with the International Society of Arboriculture, ISA Rocky Mountain Chapter, Society of Municipal Arborists and currently on the editing committee for the City Trees publication. She also serves on the Montana Urban and Community Forestry Association and intermittently with the University of Montana Arboretum Committee.

Margie Costa Ewing, Regional Urban & Community Forestry Program Manager

Margie Ewing-Costa has worked for the USFS for over 35 years in various positons such as forester, soil scientist, and Forest Staff Officer and District Ranger. In 2005 she became the Regional Urban & Community Forestry Program Manager for the five Western States. She has extensive knowledge of urban & community forestry principles and practices and has evaluated many urban forestry projects in western communities. She also serves on a National Urban & Community Forestry Science Delivery team bringing the latest science, practice and policy on urban forestry and the environment.

Susan Ridgeway, Park Board

Susan has practiced law for over 20 years and is the owner of Susan G. Ridgeway, PLLC. Her practice areas include real property, construction, family law, small business, and civil litigation. She serves on the Missoula City Parks and Recreation Board and is also a board member of Friends of Missoula Parks, Inc. Her past community service includes: Blue Mountain Clinic (past board member and president), Missoula Community School (past executive board member), Missoula County Public Schools (Community Conversation participant 2006, Academic Freedom Policy Committee 2009, Grading Policy

Committee 2012, Writing Coach 2011 to present), Missoula Strikers (team manager, assistant coach, or referee 2005-2012).

Donna Gaukler, Director, Missoula Parks and Recreation

Donna Gaukler, CPRP, has been the Director of Parks and Recreation for the City of Missoula, Montana, since 2002. She has facilitated and overseen the development of numerous planning documents for Parks and Recreation, all of which have been substantially implemented and remain viable today. Some of these include the Comprehensive Urban Area Parks and Recreation Plan, Aquatics Facilities and Operations Plan, Conservation Lands Management Plan, Parks Assets Management Plan, and several Community and Neighborhood Park Plans.

Donna received her undergraduate degree, with honors, in Parks and Recreation Administration with a minor in Business from North Dakota State University. Her education and experience in Parks and Recreation provides unique insight and knowledge in the successful development and implementation of important Community Plans.

Karen Sippy, Director, Trees For Missoula

Karen Sippy arrived in Missoula in 2003. After working as a middle school teacher, public speaker and sales manager, it was time to retire to a life of volunteerism and design. She has been a volunteer and advocate for Missoula's trails, trees and parks for over 8 years.

In 2006, Karen became a founding board member of the Grant Creek Trails Association (GCTA), a 501c3 non-profit. Through GCTA's work, Karen has gained experience working with city, county, state and federal processes. She now understands and appreciates how a non-profit advocacy group can be a successful partner.

Karen is also a founding member of Trees for Missoula (TFM), an urban forest friends group. Since 2011, she has worked closely with Missoula's Urban Forestry Division, in an effort to identify how the community and TFM volunteers could best promote a healthy urban forest. She also represents TFM and the urban forest on the Missoula Art Park Committee. She serves on the board of Friends of Missoula Parks (FMP), a 501c3 non-profit that encourages and supports groups and projects that enhance Missoula's parks and trails. Karen holds a B.S. in Education from the University of Kansas.

Supporting Member
Norma P. Nickerson, Ph.D. Director, Institute for Tourism and Recreation Research

Norma P. Nickerson, Ph.D., is a Research Professor and Director of the Institute for Tourism and Recreation Research (ITRR), at The University of Montana. Dr. Nickerson's expertise lies in survey research, methodology, and questionnaire design related to human behaviors, attitudes, and perceptions.

Purpose and Duties

The purpose of the working group is to develop a long term management plan for Missoula's urban forest. A budget of $9,000 was established for costs associated with conducting public interest surveys, holding stakeholder meetings and incidental development costs.

Duties of the working group include the following:

- Meeting on a bi-weekly basis to develop the management plan.
- Complying with MCA regulations for public participation.
- Conducting a public interest survey.
- Conducting stakeholder interest meetings.
- Conducting public workshops.
- Soliciting Park Board input.
- Soliciting Council input.
- Providing Council updates.

Limitations

The working group is limited to the development of a long term urban forest management plan. Once the management plan is complete and adopted by Council, the duties of the working group are complete, and the working group will be dismissed.

Implementation

Once the management plan has been adopted via Council Resolution, Parks and Recreation Department staff will be responsible for implementation.

Part 2
Missoula Urban Forest Background

Urban Forest History

The natural history of the Missoula valley is relatively recent in terms of geologic time.

Figure 1. Indigenous settlements

The valley hillsides are millions of years old, predominantly covered with Tertiary sediments, with the valley base containing various types and layers of unconsolidated fill. Glacial Lake Missoula filled the Missoula Valley with more than a thousand feet of water off and on for about 200,000 of the past 212,000 years. Ice dams to the west of the valley would catch and retain water in the valley forming the glacial lake. Periodically, the dam would give way creating a cataclysmic flood event. As the glacial lake filled and drained over the years, much of the top soil was stripped away leaving a flat valley floor with a thin, nutrient-poor soil layer covering a deep, gravelly bed. The City of Missoula, built directly on top of this layer and therefore does not have a soil base with adequate nutrients or water retention necessary for trees to grow and thrive. Before settlement, the Missoula valley was a broad plane without trees except for the small riparian zones of the Clark Fork River and its tributaries.

Figure 2. Early Missoula

Historic photographs from the 19th century show the Missoula Valley to be an open prairie. In this image of Missoula in 1891, there are few trees, even in the Clark Fork floodplain.

Missoula's history with shade trees began with western expansion during the late 19th century when permanent residents arrived in the valley. Most settlers moved from the eastern regions of the United States where older, developed cities had streets lined with mature trees. The severity of Missoula's summer sun combined with the desire to recreate their former environment, prompted the settlers to plant new trees. The first record of trees being imported into the Missoula valley dates to 1874 when Judge Frank Woody and Francis Worden planted the first fruit trees, cherry and apple. That same year Francis Worden planted imported Norway Maples around his home on East Pine Street. Two decades later, the first Missoula ordinance pertaining to trees was written. In 1896, Ordinance number 77 was written to protect shade and fruit trees from the threat of tying or hitching of livestock. Protecting the few trees in the valley was crucial not only for the shade they created, but also as an economic necessity to protect the income generated from the fruit trees used to feed the miners in the Butte Montana

Figure 3. Missoula today

mines. This Ordinance carried a fine of up to $25, the equivalent of $690 today, demonstrating the importance placed on the growing urban forest.

As Missoula's infrastructure grew, sprinkling districts were added with resolution 15a signed in 1906. The sprinkling districts were designed for dust abatement on Missoula's unpaved streets from June through September. These districts were also used to give the small urban forest the water it needed for survival in Missoula's arid summer. With this available water supply, the path was set for the establishment of a large urban forest.

Special improvement district (SID) number 2 passed on April 9th, 1909.This was the first street and landscape SID used by city planners to finance improvements for developing neighborhoods. SID number 2 established curbs, sidewalks, boulevards and the planting of trees along University Ave from Higgins to Maurice Avenue. The cost of the University Avenue SID was projected at $19,872, with each 3900 square foot lot to pay $138 dollars, approximately $3,300 today. There would follow 74 more landscape and street improvement SIDs well into the 1930's These SIDs played a major role in establishing the layout and feel of Missoula today. The predominant street tree chosen was the Norway maple (*Acer platanoides*), which remains the predominant canopy species in rights of way in Missoula's historic districts.

The first comprehensive ordinance for Missoula's urban forest was number 811 passed on April 8th, 1953. This ordinance allowed the city to have control of the planting, pruning and removal of trees and vegetation on city right of ways and public places. Ordinance 811 also empowered the city to directed abutting property owners to prune or remove any tree or vegetation with a 30-day notice. A desirable street tree planting list was established as well as a list of prohibited trees.

Over time, as the streets of Missoula changed from dirt to pavement, dust was no longer the issue it once was. So by the early 1960s, the sprinkling districts evolved to a flushing, street cleaning and maintenance district where the tree lined right-of-ways no longer received their regular water. With the end of street sprinkling, the trees that were once benefitting and thriving from consistent watering began their steady decline.

By the 1980s some Missoula residents began to notice the degrading urban canopy. The Council on Urban Forestry (CUF) was formed by the Missoula Parks and Recreation Board to help provide the proper resources needed to maintain a healthy urban canopy. CUF realized changes were needed to the city's outdated ordinances in order to insure proper tree care for the right-of-way trees. The original comprehensive ordinance for Missoula trees had undergone small revisions from its 1953 writing, but it still did not reflect modern arboricultural practices. Though an ordinance was in place to protect trees, many private companies damaged right-of-way trees by using poor practices including the practice of topping trees. Recognizing the need for an updated ordinance but not having the ability to make legal changes to city laws, CUF lobbied to have an Urban Forester added as a new position within Parks and Recreation. In 1991 Missoula's first Urban Forester was hired, and by 1992 Missoula's first

comprehensive ordinance was revised with Ordinance 2807 signed on March 16, 1992. Missoula's ordinance chapter 12.32 not only set standards of care for the urban forest, but also prohibited poor pruning practices such as topping, tipping and shaping. The ordinance allowed for fines to be levied upon residents for these practices and for failure to properly water trees adjacent to their property. By 1994 an entire Urban Forestry division was added to the Parks and Recreation Department consisting of an Urban Forester, one full time Arborist, two 10 month seasonal Arborist Assistants and one 6 month seasonal tree waterer. By the late 1990s CUF had disbanded and the newly formed Tree Board of the Missoula Park Board absorbed their duties.

City of Missoula right-of-way and park tree inventories have been conducted four times with the first starting in 1973, and again in 1993, 2003 and 2013. These inventories have allowed urban foresters to determine the best management practices for the health of the urban canopy and the community. In 1996, an ongoing pruning cycle was established through block pruning projects with both in-house staff and contract crews. By the early 2000s the pruning cycle was approximately 22 years between routine maintenance per tree. Inflation, economic down turn, an aging forest and drought have pushed the pruning cycle longer and longer over the last decade. By 2013 the pruning cycle was over 50 years.

The decline of Missoula's urban forest from age and drought has increased and is moving forward exponentially. The Urban Forestry Division is now dedicated to mitigating high risk trees and the liability they pose through removing dead trees and giving palliative care to trees with significant dieback. Currently, the division can no longer provide the level of care to healthier trees it did a decade ago and has abandoned maintaining a pruning cycle. The majority of the original forests planted in 1910 will most likely die out over the next twenty years leaving the Urban Forestry staff to plan for the regeneration of the forestry through new planting strategies, maintenance strategies, public education programs and funding goals. The City of Missoula's urban forest has reached the start of a new era much as it did in the early 1900s with its inception and the in 1980s with the start of an Urban Forestry program.

Current Community

At 69,100 residents, Missoula is the second largest city in the state of Montana. Missoula is situated at the junction of five river valleys; the Bitterroot, the Clark Fork, the Rattlesnake and Grant Creek Valleys. These five valleys give Missoula its second moniker: "Hub of Five Valleys." According to the 2010 Census, Missoula covers a land area of 27.67 square miles.

Missoula is the home of the University of Montana. The city is also home to several major USFS management facilities and a Montana Department of Natural Resource and Conservation office. All of these resources are available to the community to assist with urban forest management.

Current Urban Forest Condition

Climate

At an elevation of 3,209 feet, Missoula is in the rain shadow of the surrounding mountains, particularly the Bitterroot Mountains to the West. The Bitterroots range in height from 7,000 feet to 12,000 feet, which intercepts moisture through a process called orographic lifting. This can be seen in Figure 4, where the mountains receive over 40 inches of precipitation per year and the valleys to the East receive little precipitation. As a result of the rain shadow, the climate is dry with an average rainfall of only 14.09 inches (357.8 mm) of precipitation per year and classified as semi-arid.

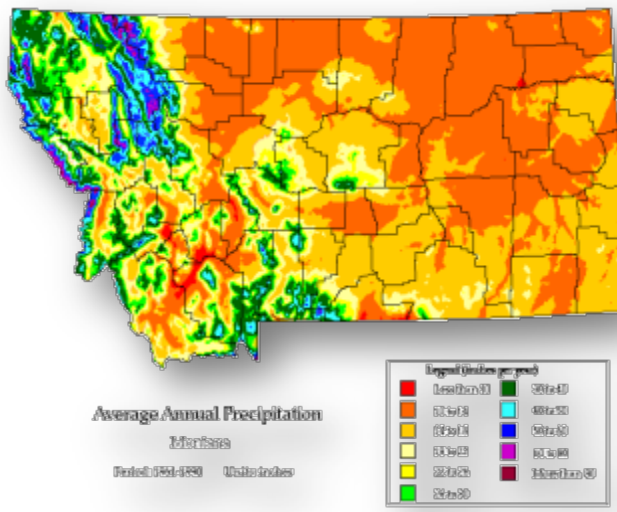

Figure 4. Precipitation map

The average reference evapotranspiration rate (ETr) for Corvallis, Montana is 43.19 inches (1097 mm) per year. The evapotranspiration coefficient (ETc) for turf is 0.80. The ETc for trees ranges from 0.39 for fruit trees to 1.00 for poplars.

The average high temperature of 85.9 F (29.9 C) occurs in July, with a record high of 107 F (42 C) occurring on July 2007. The average low temperature of 16.7 F (-8.5 C) occurs in December, with the record low temperature of -33 F (-36 C) occurring on January 1933 and February 1988.

Because of the very dry conditions, Summer temperature variations between day and night average above 30 F (17 C). These very dry conditions also allow early and late hard frosts to occur, which can damage or kill many species of tree. The cyclical low temperatures of -20 to -25 F (-28.9 to -31.6 C) places Missoula at the edge of the USDA Plant Hardiness Zone of 4b.

Average Annual Minimum Temperature		
Temperature (°C)		**Temperature (°F)**
-45.6 and Below	**1**	Below -50
-42.8 to -45.5	**2a**	-45 to -50
-40.0 to -42.7	**2b**	-40 to -45
-37.3 to -40.0	**3a**	-35 to -40
-34.5 to -37.2	**3b**	-30 to -35
-31.7 to -34.4	**4a**	-25 to -30
-28.9 to -31.6	**4b**	-20 to -25
-26.2 to -28.8	**5a**	-15 to -20
-23.4 to -26.1	**5b**	-10 to -15

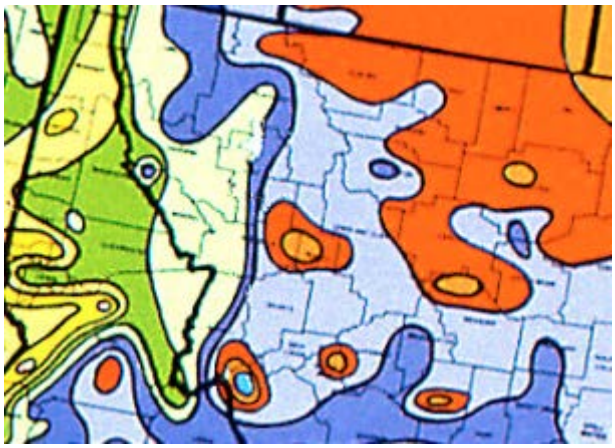

Figure 5. 2006 USDA climate zone map

Soils

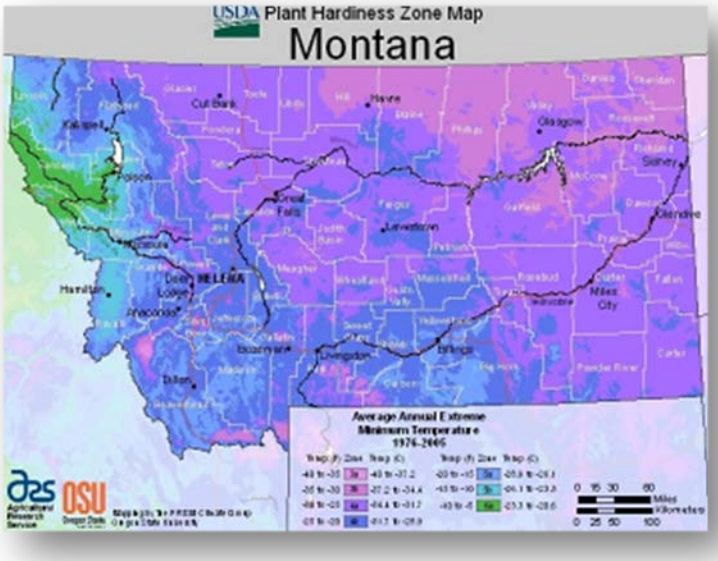

Figure 6. 2014 USDA plant hardiness zone map

Geologically, Missoula sits on the bottom of glacial Lake Missoula, where water depths reached 950 feet (290 m) above the valley floor. The repeated glacial lake deposited sand, gravel and cobble on the valley floor and clays on the valley edges. The lower valley floor soil drains very rapidly, while the edges drain much slower. Both conditions make it difficult to grow many species of trees.

The NRCS soil maps for the area generally define Missoula soils as urban land. To get an idea of what the soil in Missoula may have been like prior to development, the soils on the periphery can be used as a reference. Table 1 describes the primary soil types in Missoula. These soils are listed as well drained or extremely well drained. Since the NRCS is geared towards agriculture, the usefulness of a soil type is defined in terms of agricultural value. Appendix H provides a complete listing of all urban and peripheral soils.

Several creeks in the area were rerouted to reduce flooding and increase farmable land. Pattee Creek, for instance, does not flow in its original channel. The neighborhoods built on the original stream channel and alluvial fan will have significantly different soils than neighborhoods a short distance away. These variations in soil composition greatly affect the performance of street trees for one neighborhood to the next.

Table 1. Primary Missoula Soil Types

40% of soil in Missoula County is classified as "urban land" soil, which must be significantly amended to support healthy urban tree growth.

NRCS Soil Name	Composition	Drainage	Usefulness	Percentage*
Urban land	Disturbed	Engineered	Questionable	40.2
Argixerolls	Complex composition	Well drained	Farmland	20.1
Moise	Gravelly loam	Extremely well drained	Farmland	13.9
Other	Non-arable lands; gravel pits, water, rock outcroppings			7.6
Bigarm	Gravelly loam	Extremely well drained	Irrigated farmland	6.3
Orthents	Gravel and cobble	Extremely well drained	Non-productive farmland	3.7
Grassvalley	Gravelly loam	Well drained	Farmland	2.7
Grantsdale	Loam	Well drained	Irrigated farmland	2.6
Desmet	Loam	Well drained	Irrigated farmland	2.0
Hollandlake	Gravelly loam	Well drained	Non-productive farmland	0.9

*Percentage in area of interest: Missoula County Area, Montana.

Urban soils are highly modified. One of the common threads between all of the soil types is their depth. The surface depth on all of the soils is relatively shallow, from 8 to 24 inches. Structures and infrastructure must be built on stable soil. During normal construction, the surface layers are stripped of soil with organic material. As a result, many of our neighborhoods are built on non-productive gravelly sub-soil.

Canopy Cover

The exact amount of canopy cover over Missoula streets is not known. The optimal goal is between 30 and 40 percent. According to the National Land Cover Database, the canopy cover in Missoula area ranges between 0 and 10 percent. That is not surprising since the area was once grassland.

Not all neighborhoods are sparsely treed. The early neighborhoods planted through the SIDs are heavily treed and therefore have a denser canopy cover. The heavily treed neighborhoods include the North Side, West Side, University, and Rose Garden neighborhoods.

Some neighborhoods are sparsely treed, such as the Lewis and Clark neighborhood. Other neighborhoods, such as the Rose Garden and University neighborhoods are split, with heavy tree canopy on the North and little tree canopy in the South. In these two neighborhoods, there are wide boulevards to the North and contiguous, monolithic sidewalk, with little boulevard behind the sidewalk, to the South. These differences reflect changing attitudes in subdivision design and tree planting that occurred in the 1940s.

UF Program Overview

Missoula's Urban Forest Program is a division of the Missoula Parks and Recreation Department. The division is comprised of two sections, the Urban Forestry Section and the Greenways and Horticulture Section. The program is overseen by a full time City Forester. A breakdown of staffing is shown below in Table 2a. This management plan will focus on the urban forestry component of the division.

Table 2a. Current Urban Forestry Division Staffing

2.7 Arborist FTEs maintain 24,424 trees.

Staff Classification	Urban Forestry	Greenways and Horticulture
Maintenance Tech		1 (One) 1.0 FTE
Maintenance Tech Assistant		1 (One) 0.833 FTE
Maintenance Worker		1 (One) 0.583 FTE
Park Attendant		2 (Two) 0.417 FTE
Arborist Tech	1 (One) 1.0 FTE	
Arborist Tech Assistant	2 (Two) 0.833 FTE	
Park Attendant	1 (One) 0.417 FTE	
FTE:	**3**	**3.3**

All members of the Urban Forestry Section, except Park Attendants, maintain credentials from the International Society of Arboriculture and the Tree Care Industry Association. Item B.6.b of Section III of the Appendix to Missoula Municipal Code, Chapter 12.32, calls for tree work on public trees to be done by Certified Arborists. Table 2b details the credentials of Urban Forestry Section staff.

Table 2b. Current Urban Forestry Section Credentials

Staff Classification	FTE	Required Credentials	Optional Credentials
City Forester	1.0	Certified Arborist Tree Risk Assessor	Municipal Specialist
Arborist Tech	1.0	Certified Arborist Electrical Hazards Awareness	Tree Risk Assessor
Arborist Tech Assistant	1.6	Electrical Hazards Awareness	Certified Arborist Certified Tree Worker Tree Risk Assessor
Park Attendant	.8	None Required	None Required

Urban Forest Assessment

- ***At the end of the 2014 inventory season, the Treeworks database contained records of 24,424 trees, 238 stumps and 368 removal sites.***

In 2012, the Urban Forestry Division (UF), received a grant from the Montana Department of Natural Resources and Conservation (DNRC), with funding from the U.S. Forest Service, to conduct a citywide tree resource assessment.

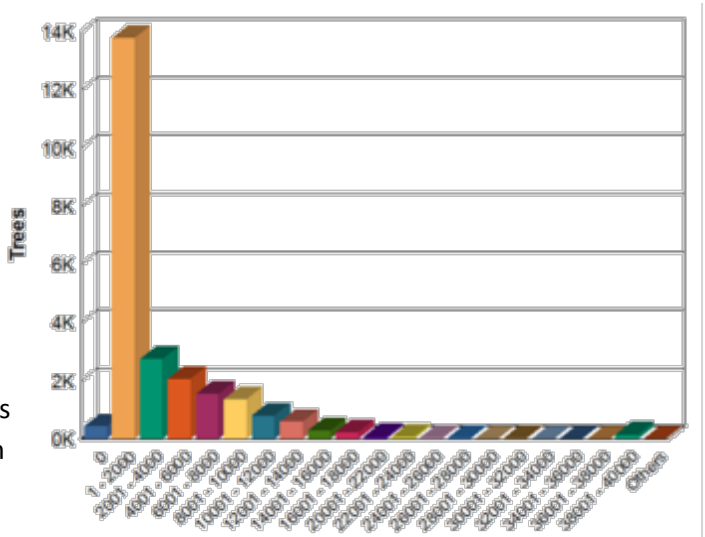

Figure 7. Public tree values ($)

The initial inventory of Missoula's right-of-way (ROW) trees was conducted in 2013 by the Urban Forestry Division with volunteers from the Trees for Missoula (TFM) non-profit. Approximately 74.23% of the public streets in Missoula were inventoried. Using the ArcGIS software suite and TreeWorks extension, a database was created that provides geographic information and tree-specific data. At the end of 2013, the database contained records of 20,545 trees. Since the initial inventory of 2013, over 606 trees have been removed. Over 4,000 park and street trees have been added to the inventory. A brief summary of the updated inventory for species distribution, diameter distribution and condition distribution is shown below in Figures 8 through 10, respectively.

Appraised Values

- ***The total appraised hard asset value of the City of Missoula's urban forest is approximately $86.4 million.***

Figure 7 shows the distribution of appraised urban forest value. Dollar value brackets are shown on the lower axis, while the number of trees per value bracket is shown on the left axis. Based upon the bar graph, over 12,000 trees have a value between $1 and $2,000. The next two highest value brackets, $2,001 to $6,000, contain approximately 4,200 trees. The 321 dead trees and 238 stumps have no value and show up under the $0 value bracket.

The *Missoula Public Tree Inventory Report*, dated September 30, 2013, outlines in great detail the inventory protocols used during the Summer of 2013, and is included as Appendix F. The report also contains a detailed analysis of the 2013 inventory results. For consistency, the same protocols described in the report are being used during ongoing inventory data collection efforts.

Species Composition and Diversity

- ***Maple species, taken in whole, comprise 39.4% of the total inventoried tree population.***

Norway maples (*Acer platanoides*) accounted for 29.14% of the total street tree population shown in Figure 8. This total includes the Crimson King, Schwedler, and Emerald Queen cultivars. Previous estimates, including the 2003 Missoula tree census, suggested this species comprised about 60% of the public tree resource. Relative composition has declined due to city annexation, new developments, an expanded tree census area, and tree removals commensurate with natural senescence.

Maple species, taken in whole, comprise 39.4% of the total inventoried tree population. Species of the ash (*Fraxinus*) genus cover 12.2% of Missoula's inventoried trees. Collectively, the maple and ash genus comprise 51.6% of the surveyed urban forest. The four most abundant genera in Missoula (Figure 8), with respective cultivars included, make up 61.8% of Missoula's canopy. The remaining 38.2% of species in Missoula are fairly diverse.

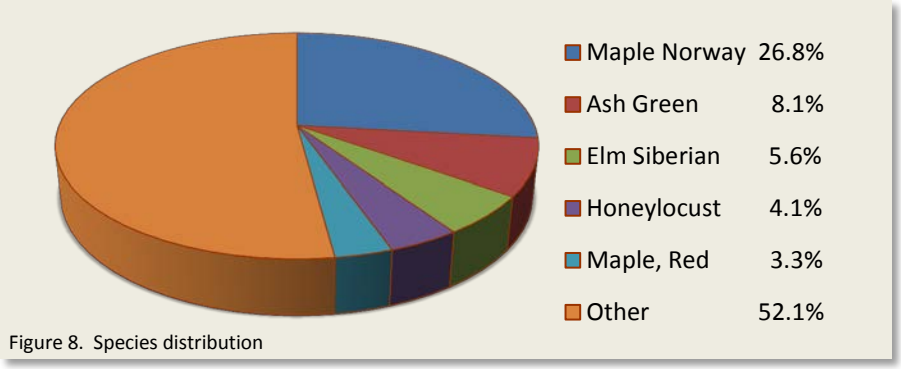

Figure 8. Species distribution

Clusters of monocultures exist in certain neighborhoods and zones.

For example, 73.4% of Missoula's downtown trees are Honeylocusts (*Gleditsia triacanthos*). Similarly, the majority of ROW trees in the Northside, Westside, University and Rose Park neighborhoods are Norway maples.

Species diversity is important for several reasons. First and foremost, species diversity reduces the likelihood of a serious disease or insect pest decimating the urban forest. Dutch elm disease in the 1960s and emerald ash borer in the 2000s are two examples of introduced host specific pests that decimated urban forests across the country. To minimize the risk, the recommended urban forest species composition is no more than 10 percent of one species, 20 percent of one genus and no more than 30 percent of one family. The street tree population in Missoula does not meet this recommendation.

DBH Size Class

The average DBH (diameter at breast height) size class for all public trees inventoried in the City is approximately 11.5 inches. Since DBH is a good indicator of age, the data indicates that there is a lack of diversity in both age and size of Missoula's urban forest. DBH is also a good indicator of growth rate. Many trees in Missoula are stunted, which is reflected by the low diameters. The majority of trees are 12 inches or under. Few trees are over 30 inches, which is considered a large tree for Missoula.

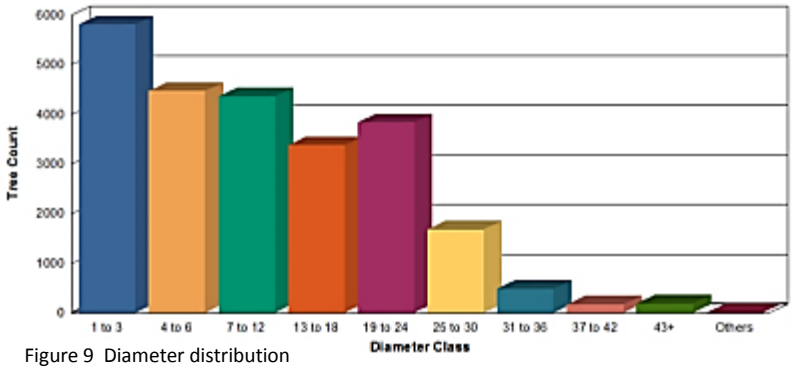

Figure 9 Diameter distribution

Clusters of even-aged trees are particularly evident in areas such as the University District and new developments. An ideal forest structure would contain trees evenly distributed across all size classes. Similar to species diversity, age diversity is important because it promotes urban forest stand stability, resistance to biotic and abiotic disturbances and resilience after a disturbance. This diversity reduces the likelihood of losing even-aged trees in a short time period.

Tree Condition Ratings

- ***Based upon the percentages in Table 10, 31 percent of the existing urban forest will be removed within the next 10 years.***

Another 30 percent will be removed in the next 10-year period. The total loss over the next 20 year period could reach 61 percent of the urban forest, or 14,884 trees. If all of the trees in Fair condition degrade to the point of removal, 67 percent, or 16,348 trees will be lost in 20 years.

Trees were assigned a condition rating from Dead (0) to Excellent (90). These conditions are defined as follows:

- Excellent (90): Tree structure is appropriate to species type and physiology, with few if any structural defects. No insect or disease problems noted.
- Good (80): Few structural defects, not topped, no dieback, and minimal deadwood. Structural defects, i.e. deadwood, can be solved through pruning. Few insect or disease problems noted.
- Fair (70): Tree is healthy or in natural senescence, not topped, and may have some structural defects that may not be correctable through pruning. Some insect or disease problems noted. Nearly all of these trees will be removed within 20 years.
- Poor (50): Tree has had numerous structural or cultural defects – pruning will not improve the condition rating. The tree is topped or has dieback at 30-50%. Insect or disease problem prevalent. These trees will be removed within the next 5 to 10 years.
- Very poor (30): The tree has major dieback, multiple hazards, or is less than 50% alive. Very poor trees tend to be removals or approaching removal necessity. These trees will be removed within 5 years or less.
- Dead (0): 10% or less live woody tissue. These trees should be removed in a timely manner.

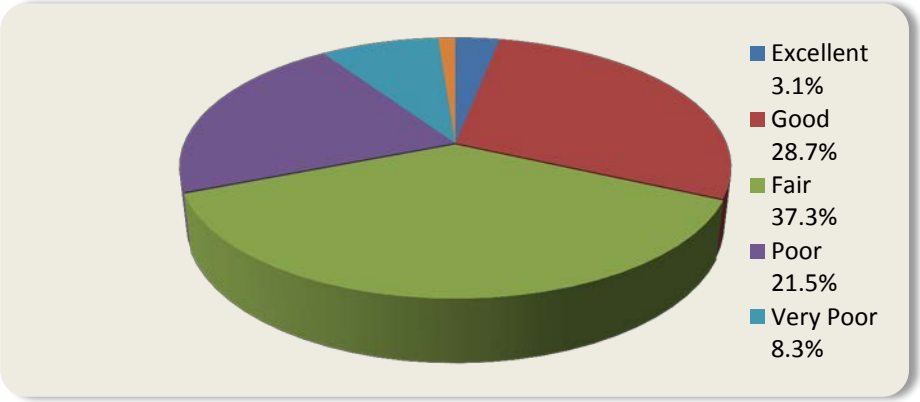

Figure 10. Tree condition distribution

Cultural Defects

In this tree inventory, cultural defects describe misguided attempts to plant trees or provide tree care. Topping and improper pruning account for 26.2% of and 13.2% of the top five cultural defects. A topped tree has been disfigured due to the cutting back of its crown to a stub or non-lateral branch. This

method has been practiced based on the conception that topping will promote growth and prevent tree danger by reducing height. In reality, topping results in a high risk tree with splayed growth.

Improper pruning describes flush cuts and cuts leaving behind stubs. A proper cut should follow the branch collar, without cutting into this tissue between the main stem and the branch.

Planting defects were also prevalent in this inventory.

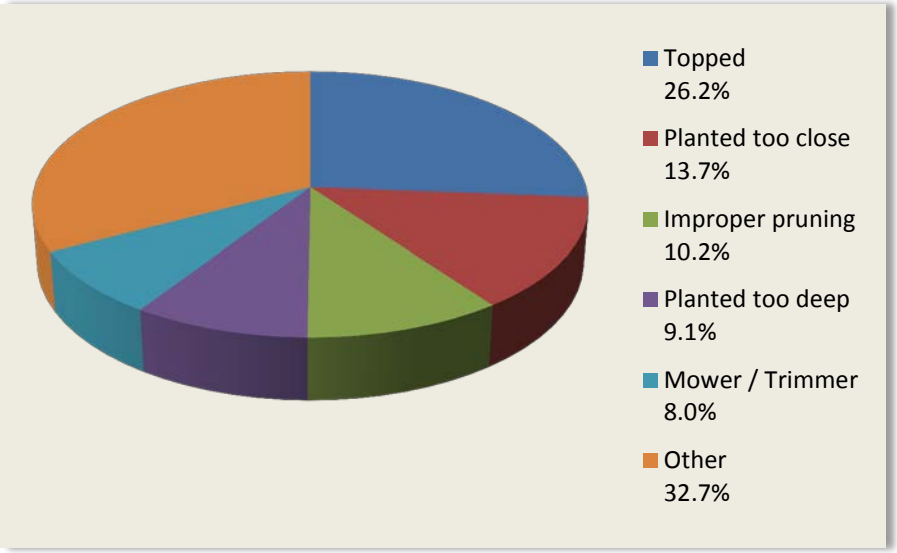

Figure 11. Tree defect distribution

Trees planted too close together, 13.7%, is mainly attributable to the Norway maples planting in the 5 older neighborhoods. The maples were planted on 20 to 25 foot spacing. Per the approved street tree species list for Missoula, Norway maples are Class II, Medium sized trees with an optimal spacing is 30 to 35 feet.

A large number of new trees, 9.1%, are planted too deep. Trees planted too deep lacks an exposed root collar, which suffocates the roots and fosters circling roots. This cultural defect is very prevalent on new, commercially planted trees.

The fifth most common cultural defect is a lack of water stress, which results in leaf scorch. Because making an accurately determination of water stress is difficult, the number of trees suffering from a lack of water may be much higher. Regardless, drought stress is a common issue in Missoula due to the arid climate. With water being a costly item, many property owners forgo watering the street trees.

Because so many entities are allowed to plant and prune public trees, oversight and enforcement is difficult. Mistakes in planting and pruning are made. Only the most egregious violations are identified and prosecuted.

Typical Planting Locations for Public ROW Trees

Public trees are typically planted within the public right-of-way, within parks, on city owned parcels and along greenways. Trees in these areas receive the bulk of the maintenance by both the city and the abutting property owner.

Public trees also grow in alleys, which are public right-of-ways. These trees are typically volunteer trees originating from blowing seeds or animal transported seed. Alley trees create maintenance concerns for utility companies, refuse disposal firms and public safety agencies. Because the trees are volunteers and they are out of sight, alley trees are typically are not included in urban forest management plans. Alley trees are not included in the inventory.

Planting Site Size

- ***63% of planting sites are less than 10' in width. Planting plans must take into consideration the wide variety of site sizes.***

Planting site sizes vary significantly for area to area. Figure 12 summarizes the planting site sizes in Missoula. Open sites are comprised of two site types. A portion of the open sites have no curb, gutter of sidewalk within the boulevard. The remaining open sites are located in boulevards behind a monolithic curb and sidewalk. It is difficult to differentiate between the two because of the way certain inventory fields were defined.

Based upon the summary, 52.2 percent of the public trees are planted in a boulevard between the sidewalk and curb. This is the typical configuration in the old and very new neighborhoods. During the period between WW II and the late 1990s, monolithic sidewalks were the norm.

Other sites are typically tree wells and boulevards less than 3 feet in width.

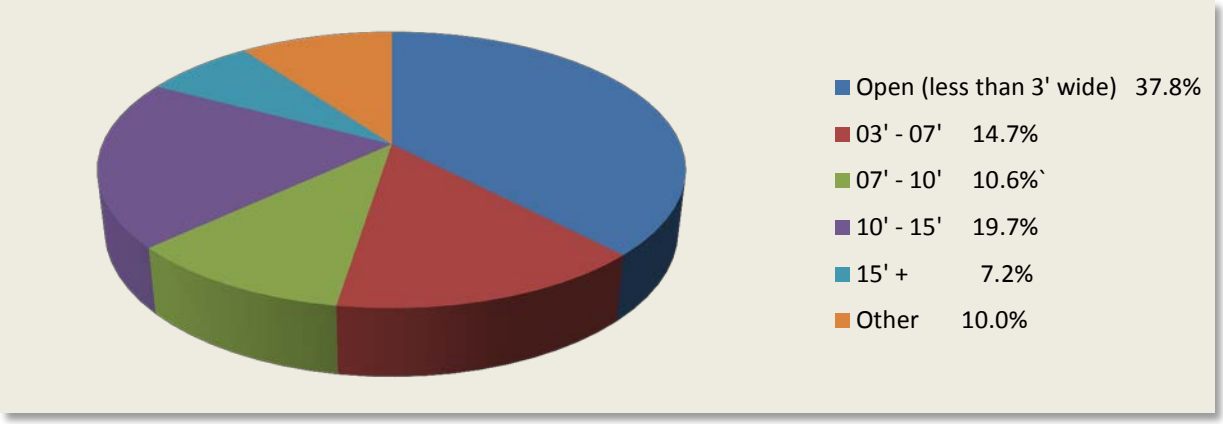

Figure 12. Planting Site Size Summary

Tree Lawn Boulevard

A tree lawn boulevard is bordered by a sidewalk on one side and curbing on the other. The curb and sidewalk borders clearly define the boulevard, which make it very difficult to mistake for any other planting area. Boulevards in Missoula range in width from 3' to over 20'. The wider the boulevard the larger size of tree can be planted.

Figure 13. Tree lawn boulevard

Monolithic Boulevard

A monolithic boulevard is located behind the sidewalk. The curb and sidewalk are located adjacent to each other, which makes it very difficult to determine where the boulevard ends. Many residents with monolithic boulevards mistakenly believe their property extends to the back of sidewalk. Monolithic boulevards range in distance from 5' to over 20' behind the sidewalk. Encroachments by property owners make it difficult to plant trees in the monolithic boulevard.

Figure 14. Monolithic boulevard

Tree Well

A tree well is located within a paved area. The typical tree well ranges in size from 3' to 5'. Tree wells significantly restrict tree root growth. While large trees are often are planted in tree wells, only small trees will do well. Because improper planting preparation is the norm in tree wells, tree roots damage surrounding concrete, which in turn results in the premature removal of tree and costly repair of concrete.

Figures 15 a. b. Tree wells

Minimal Improvement Boulevard

Figure 16. Minimal improvement boulevard

A minimally improved boulevard may have curbs, gutters and sidewalks, or any combination thereof. It is difficult to determine where the boulevard begins and ends. Boulevards here range in distance from 5' to over 20'. Many residents believe their property extends to the street. Minimally improved boulevards are often used as parking areas, which significantly impact existing trees and precludes the ability to plant new trees.

No Improvement Boulevard

A no improvements boulevard contains no curbs, gutters or sidewalks. It is difficult to determine where the boulevard ends. Boulevards here range in distance from 5' to over 20'. Many residents believe their property extends to the street. Minimally improved boulevards are often used as parking areas, which significantly impact existing trees and precludes the ability to plant new trees.

F Figure 17. No improvement boulevard

Alleys

Alleys are typically located between parcels and serve as access for utility companies, refuse disposal firms and public safety agencies. The typical alley in Missoula ranges from 12' to 20' wide and can be paved or unpaved. Distribution and secondary power lines and telecommunication lines are typically located on one side of the alley. Trees are not intentionally planted in alleys.

Figure 18. Trees in alleys

Planting Programs

Street tree planting occurs through four primary approaches. These approaches include Park staff planting, city department planting, land development planting and homeowner planting.

Staff Planting

Urban forestry staff plant approximately 150 trees per year. This tree planting approach is very consistent from year to year. Under the staff tree planting program, trees are planted where trees were removed, where a homeowner asked for a tree to be planted or where a homeowner participated in the cost share program. The waiting list for a new tree is long, with a 2 to 3 year wait the norm. If a homeowner participates in the cost share program and pays $200 per tree, they are moved up in the planting schedule.

Departmental Planting

Departmental street tree planting typically occurs through the Missoula Redevelopment Agency or the Engineering Division of the Development Services Department. This tree planting approach is not consistent. Trees are planted only when there is a funded construction project.

Land Development Planting

Developers street tree planting typically occurs as a condition land use entitlement or as required by the Missoula Municipal Code. The tree planting approach is not consistent. Trees are planted only when development takes place.

Homeowner Planting

Homeowners periodically plant new street trees. In the course of a typical year, less than 10 planting permits are issued to homeowners. Homeowner planting without a permit occurs on a regular basis. The tree planting approach is not consistent.

Tree Maintenance

Public tree maintenance is primarily conducted by an urban forestry staff of 1 permanent year round employee, 2 permanent seasonal employees and 1 non-permanent seasonal employee. A small portion of the public tree maintenance work is done by contract.

City Staff

The programs staffed by urban forestry crews are limited. The annual urban forestry work plan includes the following programs listed below in Table 3.

Table 3. Current Urban Forestry Annual Work Plan

Program	Duration per Year	Staff Requirements
High Risk Tree Removals	9 Months	3 Workers
Planting	2.5 Months	3 Workers
Holiday Decorations	2 Weeks	3 Workers
Service Request	As Time Allows	As Needed Per Job
Young Tree Watering	5 Months	1 Worker

High risk tree removals, planting and holiday decorations take priority over all other activities, except for emergencies and snow removal. Service requests are a low priority activity, with wait times as long as 2 years for service.

Contractual

The programs conducted by contract include stump removal and tree removal.

Utility-Tree Conflicts

- ***There are 2,078 trees located under Northwestern Energy electric distribution lines in the city of Missoula. Trees growing under utility lines are pruned in a manner that decreases their natural lifespan, increases their risk for failure, and decreases their aesthetic appeal.***

Figure 19 Utility – tree conflict

Trees under distribution lines must be trimmed on a periodic basis to maintain clearance between the tree and conductors. Figure 19 illustrates a distribution line in conflict with boulevard trees within the public ROW.

Electric utility lines are divided into three classifications, depending on nominal voltage, also known as the minimum voltage. Secondary lines have voltages less than 750 volts. Distribution lines have voltages ranging from 751 volts to 21,000 volts. Transmission lines have voltages over 21,000 volts and can go as high as 500,000 volts. Treeworks divides the trees under primary power lines and trees under multiple utility lines. For Treeworks, primary lines are electric distribution and transmission lines, while multiple utility lines include primary and secondary electric lines. Appendix G provides Treeworks summaries of tree condition, diameter and species distributions under primary and multiple utility lines. Alley trees are not included in these summaries.

Figure 20 and 21 show the distribution of species under the two groups of power lines. Most of the species are larger Class II and Class III trees, while a smaller percentage are smaller Class I trees.

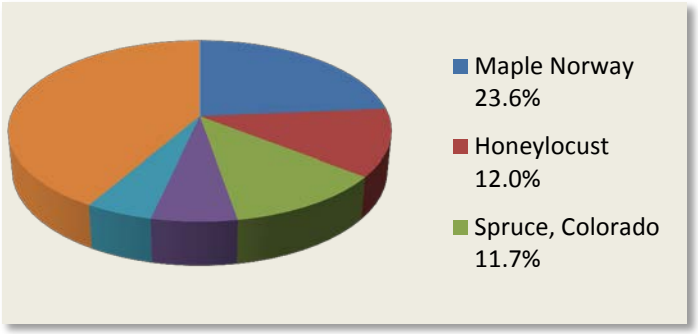

Figure 20. Multiple utility line species distribution

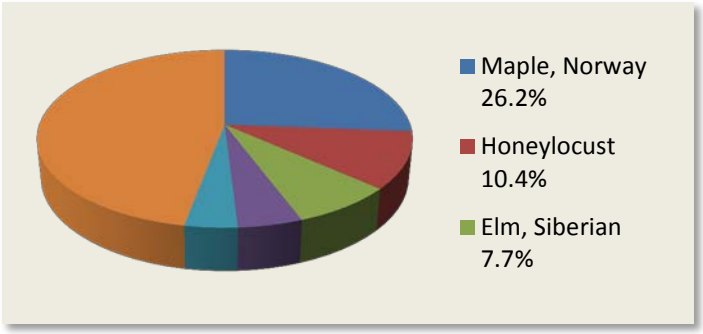

Figure 21. Primary utility line species distribution

Condition of trees under power lines

- ***80% of public trees growing under utility lines are in Poor to Dead condition and are candidates for near-term removal and replacement.***

Figure 22 and 23 show the distribution of tree conditions under both types of power lines. Just fewer than 45 percent of the trees under multiple utility locations are in Poor to Dead condition. Just fewer than 35 percent of the trees under primary distribution lines are in Poor to Dead Condition. Trees under multiple utility lines are typically pruned to a much lower height, which in turn has a much greater impact on the trees. The Poor to Dead trees are candidates for near-term removal and replacement.

The remaining trees are in Excellent to Fair condition. Once the Poor to Dead trees are removed and replaced, the remaining Class II and Class III trees become candidates for removal and replacement.

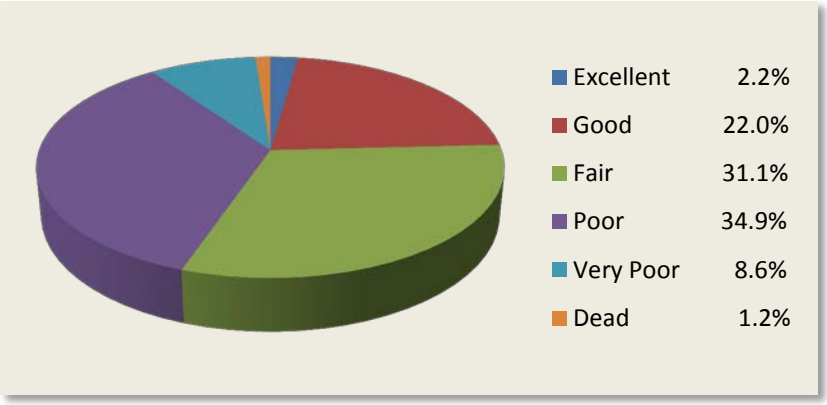

Figure 22. Multiple utility line tree condition distribution

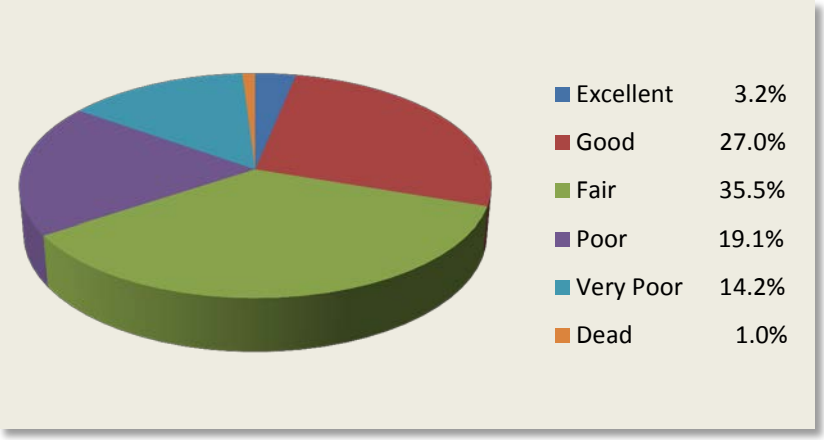

Figure 23. Primary utility line tree condition distribution

The Montana Code Annotated Section 69-4-101 authorizes utilities to construct their facilities within the public right-of-way. This section also states the powers of city or town councils are not restricted by the section. To that end, the Missoula City Council exercised its right to regulate how Northwestern Energy prunes public trees for line clearance by enacting Missoula Municipal Code Sections 12.32.060, Permit Requirements, and 12.32.100, Public Utilities.

Part 3
Public Participation Process

The development of a far reaching management plan of any type cannot occur in a vacuum. To ensure the citizens of Missoula had an opportunity to participate in the management plan development process; six activities were taken to involve residents. The six activities included a public interest survey, a stakeholder S.W.O.T. session, a series of neighborhood council meetings, follow-up stakeholder meetings, citizen workshops and follow-up neighborhood council meetings.

Public Interest Survey

- ***Residents see a need for the city to remove hazardous public trees; prune trees to reduce future hazards; replace dead/dying trees, and; ensure new trees are planted and cared for properly.***

The first public outreach activity, a public interest survey, was conducted in May and June of 2014. The Institute for Tourism and Recreation Research – University of Montana assisted in the development and implementation of the survey and wrote the survey report. To ensure the survey was statistically valid, 2,000 residential addresses were randomly selected from the city's Geographic Information System (GIS) residential address database. A minimum of 400 responses were needed to maintain validity; 408 responses were received. The complete survey report is provided in Appendix E.

The questionnaire responses show strong support for the urban forest in Missoula, and were in favor of a continuation of the urban forestry program. As stated in the survey report:

"Results show that Missoulians are profoundly supportive of public trees. Residents agree that their utilitarian purposes (e.g. shade, helping decrease pollution) are of value to the community. The aesthetic purposes tend to make their neighborhoods more enjoyable and Missoula a nicer place to live. Public trees provide a quality of life that Missoula residents appreciate. The majority of Missoula residents are willing to support the removal of hazardous trees, pruning, planting, and basic maintenance of public trees."

The top five aspects of why Missoula residents value the public trees are for their beauty (95%); making neighborhoods more enjoyable (93%); shade (92%); the ability of trees to improve air quality (91%), and; because it makes Missoula a nicer place to live (90%).

Residents see a need for the city to remove hazardous public trees (93%); prune trees to reduce future hazards (90%); replace dead/dying trees with young trees (88%), and; ensure new trees are planted and cared for properly (87%).

Further results of the survey can be summarized by the following statements:

- When asked what they would do for Missoula's public trees, residents were in most agreement with watering the trees in front of their house (79%); encouraging adequate funding for maintenance of trees (76%), and; willingness to call the city about problem trees (72%).
- Personal responsibility toward public trees decreased slightly in regards to funding. The support is high when it is simply requiring one to encourage funding (76%). As it gets more specific as to how to fund public trees, such as separate revenue sources (53%-56%) or higher taxes (47%), the number of residents, while still supportive, decreases.
- All respondents were very supportive of public trees, but those residents with boulevard trees in front of their home showed a slightly higher level of support.
- Many Missoulians suggested that the urban forest master plan focus on tree species diversity to discourage an insect or disease plague that could wipe out too many trees at one time and to emphasize native trees as much as possible.

The management plan implications of the survey can be summed up by the following statements:

- The Missoula Urban Forest Master Plan needs to stress the maintenance of Missoula's public trees - removing hazardous trees, replacing dead and dying trees with young trees, and pruning trees.
- Focus needs to be on the variety of tree species when planting new trees as well as native species. The city of Missoula should study the implications of requiring all new development (residential and commercial) to build boulevards as well as planting and maintaining trees within the boulevard.
- Residents want Missoula to fund the maintenance of public trees but are cautious about developing separate revenue sources for the urban forest and even less likely to support a separate tax, either city-wide or by neighborhood.
- Education about the physical and emotional benefits of trees as well as the cost of maintaining trees should be a section within the Urban Forest Management Plan.

S.W.O.T. Analysis

The second activity, a stakeholder S.W.O.T. session, was conducted on June 3 and 4, 2014. A stakeholder was defined as a business or government entity with a direct stake in the long term continuation of Missoula's urban forest. With over 85 stakeholders, the S.W.O.T. process was broken into two sessions. Stakeholders listed their thoughts on the Strengths, Weaknesses, Opportunities and Threats to the urban forest which were then categorized in terms of importance; extremely important, very important and important. The complete results of the S.W.O.T. sessions are summarized in Appendix B.

Based upon S.W.O.T. sessions, the **S**trengths of Missoula's urban forest can be summed up as follows:

- Quality of life; a significant thread in the community fabric.
- Community support; values of the urban forest.
- Council support; promote the urban forest.
- Good staff; well trained and capable.

Based upon S.W.O.T. sessions, the **W**eaknesses of Missoula's urban forest can be summed up as follows:

- Management turnover; frequent urban foresters.
- Lack of inter-departmental communication; multiple departments prune and remove trees.
- Inconsistent application of standards; multiple City departments plant trees.
- Lack of adequate funding and staff; 3 FTE staff members for 24,424 trees.

Based upon S.W.O.T. sessions, the **O**pportunities of Missoula's urban forest can be summed up as follows:

- Creating industry partnerships; advocates and alternative funding.
- Alternative funding programs; reduce General Fund dependency.
- Community momentum; awareness.

Based upon S.W.O.T. sessions, the **T**hreats of Missoula's urban forest can be summed up as follows:

- Monoculture canopies; lack of species diversity.
- Increase in rental properties; absentee landlords.
- Risk management; costly failures result in reactionary decisions.
- High cost of water; arid environment.
- Budget constraints; tied to General Fund.

Neighborhood Councils

The third activity, Neighborhood Council meetings, was held over a period of several months, from January to May of 2014. The neighborhood council meetings were facilitated by the City Clerk's Office of Neighborhoods.

Sentiments expressed at the meetings can be summed up by the following statements:

- The tree ordinance is enforced inconsistently; three conflicting Ordinances.
- Trees are dying faster than they are being replaced.
- Attendees were concerned about urban forestry funding.

Management Plan Review Workshops

The remaining activities, including stakeholder plan reviews, public workshops and neighborhood council meetings, were held in January and February of 2015 to give stakeholders and citizens the opportunity to review the draft management plan and provide comments.

During the stakeholder and citizen workshops, three preference exercises were conducted. These exercises gave attendees the ability to select their preferences for goals and objectives, maintenance expenditures and funding sources. The results of these exercises are summarized in Appendix I.

The results of the exercises can be summarized as follows:

- Attendees placed the highest preference on the planting, species diversity, and consistent maintenance and enforcement goals and objectives.
- Attendees placed the highest expenditure preference on planting, public education and consistent enforcement. Pruning and removal expenditures were close behind enforcement expenditures.
- Attendees placed the highest funding preference on incorporating tree maintenance into existing street maintenance districts followed by the creating an incentive for citizens to water street trees.

Part 4
Urban Forest Functions and Benefits

The urban forest serves many functions and provides many benefits to the community. In the past, these functions and benefits were not easily quantified. Through years of research, a suite of analysis tools, cumulatively referred to as i-Tree, were developed to assist in quantifying the functions and benefits provided by the urban forest. An i-Tree analysis of the inventory data was conducted to quantify the benefits of Missoula's urban forest. The analysis is contained in Appendix C.

i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the value of community trees and the environmental services that the trees provide.

The i-Tree analysis was done on September 9, 2014, using data collected as of August 25, 2014. A total of 22,876 tree records were included in the analysis. The August 25, 2014, record number is lower than the 24,424 tree records used elsewhere in this plan. Data collection continued into November of 2014, adding over 1,600 tree records to the inventory.

Basic Asset Value

In November 2014, the basic asset value of Missoula's urban forest was calculated at $86.4 million by the TreeWorks software using industry protocols found in the *Guide for Plant Appraisal*, 9th Edition.

Trees can provide numerous functions and benefits to the community. First and foremost the urban forest is an economic asset to the community; the trees making up the forest have individual value. As shown in Figure 7 in Part 2, a typical tree in Missoula can have a value ranging from $1,000 to $10,000. The value of a tree is determined by a number of factors such as species, size, location and condition. When considered as a whole, the community forest can represent an asset worth millions of dollars.

Cumulative Benefits

When considered as a whole, the city's public trees provide a significant ***annual*** economic benefit to the community and its citizens. In summary, the economic value of the benefits provided by the public trees is shown in the table on the right.

Table 4. 2014 Total Annual Benefit from Public Trees

Total Number of Public Trees: 24,424			
Benefits	**Total ($)**	**$/tree**	**$/capita**
Energy	$285,117	$12.46	$4.17
CO2	53,055	2.32	0.78
Air Quality	31,874	1.39	0.47
Storm water	369,745	16.16	5.41
Aesthetic/Other	1,719,021	75.15	25.13
Total Benefits	**$ 2,458,812**	**$107.48**	**$35.95**

2008 City Tree Canopy

The illustration on the right depicts a computer generated view of the current urban forest canopy in the University Neighborhood using a software program called Community Viz. This view was generated in 2008. Note the consistent canopy along the streets.

Figure 24. 2008 Computer generated canopy view – University District

2035 Projected City Tree Canopy

Anticipated benefit loss if status quo maintained

The illustration at right depicts a computer generated view of the University Neighborhood urban forest canopy in 20 years. This view illustrates the canopy cover under a status quo management program. Note the lack of tree canopy along the streets.

Figure 25. Predicted 2020 tree canopy if status quo maintained – University District.

If the status quo urban forest management is continued, the socio-economic benefits in Table 4 will decline over time. Without care and maintenance, the condition of existing trees will decline. The current condition rating is moved down one rating during each subsequent i-Tree analysis for twenty years out. The table below illustrates the decline in socio-economic value twenty years into the future.

Table 5. Decline in Total Annual Benefit from Public Trees by 2035 if status quo maintained.

Total Number of Public Trees: 8050 by 2035 - 67% decline from 2015

Benefits	Total ($)	$/tree	$/capita	Decline from 2015 total $ values
Energy	$182,615	$22.87	$2.65	**-36%**
CO2	29,259	3.66	0.42	**-45%**
Air Quality	29,847	3.74	0.43	**-6%**
Storm water	229,846	28.78	3.33	**-38%**
Aesthetic/Other	564,123	28.78	8.18	**-67%**
Total Benefits	**1,035,690**	**129.69**	**15.01**	**-58%**

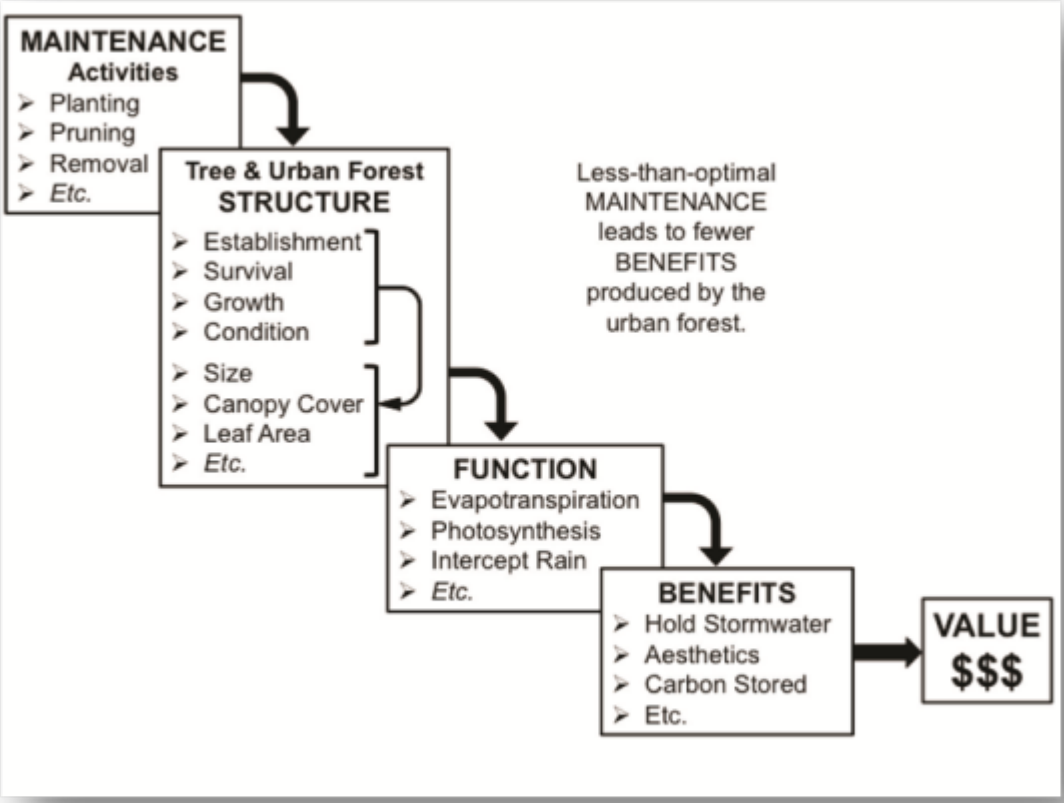

Figure 26. Determining net tree benefit value. Courtesy of Richard J. Hauer, Jessica M. Vogt, Burnell C. Fischer and the International Society of Arboriculture, February 2015.

Environmental Function and Benefits

Community trees serve a number of environmental functions. These functions must be considered when determining the economic benefits of a tree. The four primary environmental functions provided by trees include energy use reduction, carbon dioxide sequestration, air quality enhancement and stormwater mitigation. Each of these functions is quantified in the i-Tree analyses shown in Appendix C. The remaining functions are grouped together into a category called aesthetic and other benefits.

Energy Use Reduction

Ambient Air Temperature

Trees assist in moderating ambient air temperatures in two ways; first, through shading, and second by evaporative cooling. By shading surfaces such as paving, the trees limit solar gain. This reduction in solar gain reduces the ambient air temperature. The temperatures above exposed grassland can be 9 to 12 degrees hotter than in shaded areas and form what is termed a “heat island”. The heat from these islands drifts into surrounding areas, raising the ambient air temperature around the structure. The heat island effect of paved areas, such as parking lots and streets, is even greater. Ambient air temperature increases can be felt and measured one-quarter of a mile or more from the source.

By reducing heat island and reducing ambient air temperature, trees reduce air conditioning costs. Scientific studies have shown that for every degree in ambient air temperature reduction, there is a 2.5% reduction in cooling costs. An ambient air temperature reduction of 10 degrees would yield a 25% reduction in air conditioning costs.

Trees also help cool the air by evaporative cooling. As trees respire, they release water vapor into the air. The released water cools the surrounding air, much in the same manner as an evaporative house cooler. Evaporative cooling also reduces outside ambient air temperatures, which in turn reduces air conditioning costs.

Wind Breaks

According to the i-Tree analysis, the 22,876 public trees provide a total annual energy use reduction benefit of $285,117. This equals $12.46 per tree and $4.17 per capita benefit to the community.

Strategically planted evergreens reduce winter heat loss by breaking the wind. The reduction in wind speed and the disruption in air flow reducing heat loss from the surface of a building. A reduction in heat loss equated to lower heating costs.

Carbon Sequestration

The annual net carbon dioxide benefit to Missoula from the public trees is 7,073,953 lbs. or $53,055 per year. This figure is a combination of sequestered carbon and avoided carbon, less the releases due to decomposition and maintenance. This equals 309 lbs. of carbon per tree, per year, on average, for a value of $2.32 per tree and $0.78 per capita.

All living plants with chlorophyll use carbon dioxide in the process of photosynthesis. Photosynthesis is the process of combining carbon dioxide and water in the presence of sunlight by the chlorophyll to produce carbohydrates (sugar) and oxygen. The carbohydrates are used by the plant to facilitate and maintain growth.

Trees use large quantities of carbohydrates to produce woody and leafy structures. The woody structures are the roots, trunks and branches that we see as a tree. Because trees use large quantities of carbohydrates in the production of woody structures, they are exceptional at sequestering carbon. Carbon, in the form of carbon dioxide, is considered to be a significant greenhouse gas.

Air Quality

Based upon the i-Tree software calculations of air quality benefits value for public trees, a net total of 17,582 lbs. of air pollutants are captured by public trees per year, with a value of $31,874. This equates to a net value of $1.39 per tree and $0.47 per capita.

Trees remove both solid and gaseous pollutants from the air. Solid particulate pollutants adhere to leafy surfaces and to rough bark surfaces. The particulates are washed from the tree to the ground by rainfall. Gaseous pollutants are captured externally on the leaves and internally by leaves during the processes of photosynthesis and respiration. While beneficial to the environment, the adsorption of gaseous pollutants can cause leaf damage to sensitive trees.

The primary pollutants of concern when considering the benefits of trees are ozone, oxides of nitrogen and sulfur, VOCs and PM10. Ozone is both good and bad. In the upper atmosphere it intercepts

ultraviolet light and protects us from harmful sunlight, which is good. In the lower atmosphere, ozone is a strong oxidant that damages sinus and lung tissues, which is bad. Oxides of nitrogen and sulfur combine with water to form nitric and sulfuric acid, which damage sinus and lung tissues. They also can form acid rain. Cars parked in the hot sun release volatile organic compounds (VOCs) into the atmosphere. The VOCs react with the sun to form ozone. PM10 is a dust particle less than ten microns wide. Particles of this size are small enough to enter the smallest air sacs in the lung, causing significant lung damage.

Trees are not perfect. Some trees release significant amounts of botanical VOCs (BVOCs) into the atmosphere. The BVOCs also react in sunlight to form ozone. A typical spruce tree in Missoula releases 190 lbs. of VOC per year into the atmosphere, which yields a net gain of 49.6 lbs. of pollutant per tree, per year.

Stormwater Retention

Based upon the i-Tree software calculations of stormwater benefit value for public trees, a total of 34,235,635 gallons of water are intercepted by public trees per year, with a value of $369,745. This equates to a net value of $16.16 per tree and $5.41 per capita per year.

Trees assist in stormwater retention primarily by absorbing falling rain. The leafy canopy intercepts rain drops. A portion of the rain water adheres to the leaf surfaces, while another portion is absorbed by the bark. The rain water is released into the soil at a much slower rate, allowing the water to percolate into the soil, rather than running off rapidly.

While Missoula typically only received 14” of precipitation per year, the area does receive summer rain storms that drop significant amounts of precipitation in short periods of time. These rapid bursts of rainfall wash pollutants from the roadways into area creeks and into drywells.

Aesthetic and Other Benefits

Based upon the i-Tree software calculations of aesthetic and other benefit values for public trees, a benefit value of $2,458,812 is provided by public trees per year. This equates to a net value of $75.15 per tree and $25.13 per capita per year.

The i-Tree software combines the aesthetic and other environmental benefits into one grouping labeled Aesthetic/Other. Because the grouping is broad and all inclusive, it is difficult to quantify and assign the benefits to the specific functions.

The following functions form the Aesthetic/Other group shown in the i-Tree analysis.

Soil Retention

Trees assist in soil retention and erosion control primarily by intercepting falling rain. The leafy canopy intercepts and diffuses rain drops, allowing the water to fall to the ground at a lower velocity.

Tree roots also assist in soil retention by forming a dense mat of feeder roots. These small roots act as a binding agent for soil particles. Leaf litter under a tree also absorbs rain water. The water that does not pass through is used by decay organisms, or evaporates.

Wildlife Habitat
Trees provide habitat for wildlife. These animals enhance the recreational and educational opportunities of the community. Corridors of trees and other vegetation connecting natural areas in the urban environment add to the wildlife habitat and increase wildlife diversity.

Pavement Preservation
Asphalt pavement is primarily degraded by three factors, abrasion, hardening, and expansion and contraction. Abrasion occurs when vehicles travel on the asphalt surface. Hardening occurs when volatile compounds in the oil evaporate, causing the asphalt to become brittle and leading to cracks. Expansion and contraction occurs as the asphalt is heated during the day and cooled at night, causing cracks to form. The latter factors allow water to enter the paving base, causing the roadway subgrade to fail.

By casting shade over the roadway, trees cool the asphalt paving surface. By cooling the asphalt, volatile compounds do not readily evaporate, nor does the pavement substantially expand and contract. Because older trees have larger canopies and cast more shade, older trees provide more benefits than small saplings.

Aesthetics
Community trees add color, texture and form to the landscape. They soften the straight lines of urban development. Studies have shown that trees are the single most positive influence of scenic quality.

Public Safety
Community trees create an inviting environment for residents. When residents congregate in an area, crime drops. Conversely, areas devoid of trees tend to keep people away, which lead to higher crime rates. Studies indicate that community trees have a moderating effect on personal interactions. Studies further indicate traffic speeds are reduced on tree lined and shaded streets.

Retail Preference
Consumer studies have shown that shoppers favor treed settings and shaded parking lots. Shoppers stay longer and spend more money at well landscaped businesses.

Real Estate Preferences
Buyers prefer homes with multiple trees and tree lined streets. Studies undertaken by the National Association of Realtors indicate buyers are willing to pay 3-7% more for homes on treed lots. All things being equal, a home on a tree lined street will sell faster than on a barren street.

Psychological
Studies indicate that humans gain substantial pleasure from trees. Views of trees from the home or office tend of reduce mental fatigue. Planting trees can form bonds within a community. Community trees create a setting for relaxing recreational activities. People living in treed communities experience less stress and are less likely to receive treatment for depression.

Human Health
Community trees have the ability to reduce stress levels; green is a soothing color. Studies indicate that drivers on tree lined streets have reduced stress levels than those drivers on barren streets and drive

slower. Reduced stress levels improve outlook and immune system response. Pregnant women in shaded neighborhoods have a higher percentage of full-term births. Shade reduces exposure to ultraviolet light, reducing the potential for skin cancers.

Noise Reduction

Trees tend to absorb higher noise frequencies. These are the frequencies that tend to be more distressing to humans.

Part 5
Missoula Urban Forest Vision

Background

The urban forest we enjoy today is a result of the urban forest envisioned over 100 years ago by early 20th century citizens of Missoula. However, that vision is beginning to fade away as the trees planted by the early residents begin to age and fade away.

As early 21st century citizens of Missoula, we too must envision what the urban forest will look like over the next 100 years. To that end, and with the aid of thoughtful input from Missoula citizens, this long term management plan establishes a long term vision for Missoula's urban forest well into the future.

The public interest survey shown in Appendix A included several questions seeking citizen input regarding a long term vision for Missoula's urban forest. Public sentiment was also gleaned from respondent's comments at the end of the survey questionnaire. The responses and comments were synthesized into the vision statement below.

Vision Statement

Taking information from the public interest survey report, S.W.O.T. analysis and Neighborhood Council meetings, the working group developed a series of guiding principles for Missoula's urban forest. The long term vision for the urban forest was synthesized by the working group and can be succinctly described in the following statement:

We, as citizens of Missoula, recognize that we are the benefactors of the past, as well as the stewards of the future. We believe a healthy, vibrant, safe and sustainable urban forest for current and future generations. We strive to address the urban forest issues of the day in a proactive, cooperative manner, while always keeping a keen eye towards the future.

Specific Guiding Principle Components

The over-arching vision for Missoula's urban forest is comprised of several specific guiding principles, which are reflected in following statements:

- An urban forest comprised of multiple species, genera and families so that no insect or disease pathogen, currently in Missoula or introduced at a later date, has the potential to decimate the tree population.
- Selection of appropriate trees must consider the climate and cultural requirements of Missoula.
- A healthy and vibrant urban forest, where trees thrive and grow to maturity is a necessity.
- An urban forest that is sustainable by planting long-lived trees that do not consume scarce resources, such as water, in an inefficient manner.
- An urban forest must be well maintained.
- An urban forest that is safe, where risks are properly managed.
- A citizenry that is well educated in the benefits and costs of a well maintained, safe urban forest.

- The community supports long term management of the urban forest for current and future generations.
- An urban forest program is funded commensurate with the tangible and non-tangible value to Missoula citizens.

Part 6
Missoula Urban Forest Goals and Objectives

Goals and Objectives are typically used first as a roadmap to implement a management plan and then as a measure of accomplishment when reviewing past work activities. To understand goals and objectives we must understand the definition of both words. A goal is defined as: "something that you are trying to do or achieve; the end toward which effort is directed." An objective is defined as: "something toward which effort is directed, an aim, goal, or end of action." By definition then, the goal is the end accomplishment and the objective is the action taken to reach that end.

Each of the goals below has its genesis in one or more of the guiding principles that serve as the foundation for the long term vision for Missoula's urban forest. Using the definitions listed above and the vision statement's guiding principles, the following 15 goals and their objectives provide the initial roadmap for an active urban forest management program.

During the public review process, workshop attendees were given the opportunity to rank the Goals and Objectives established by the working group. The summary rankings for the Goals and Objectives are shown on Page 4 of Appendix I.

While listed in the order of preference by the public, all of the goals listed below have an equal standing in the management plan. Planting programs typically rank high in public priorities because of the instant feeling of accomplishment. However, consistent maintenance of trees is equally important to the long term success of an urban forest. Based upon public input during the workshops, species diversity, aggressive planting and consistent maintenance were clearly at the top of the priority list, showing the attendees understand the connection between tree planting and ongoing maintenance.

Management Goals and Objectives

Goal 1.

Create and maintain a diverse urban forest for maximum tree health and longevity.

Objectives:

1. Periodically update & distribute lists of approved tree and plant species and their appropriate use.
2. Implement species diversity requirements.
3. No more than 10% of a single species.
4. No more than 20% of a single genus.
5. No more than 30% of a single family.
6. Develop planting plans that maintain neighborhood identity.
7. Develop planting plans that foster tree diversity without looking completely random.

Goal 2.

Establish an aggressive planting program to maintain the existing urban forest treed neighborhoods and expand into non treed neighborhoods.

Objectives:

1. Prioritize tree planting sites to install trees in the most appropriate planting sites.

2. Develop a planting site rating system, 1 to 5, to ensure appropriate sites are planted first.
3. Select appropriate trees for specific planting sites.
4. Implement a planting program to install 900 trees per year.
5. Time planting to avoid even-age street trees.
6. Incorporate Northwestern Energy replacement program into city planting program.
7. Leverage MRA, engineering and private development funds to maximize planting opportunities.

Goal 3.

Establish consistent tree maintenance for optimal structural stability of public trees.

Objectives:

1. Update the Municipal Code and refine Code maintenance responsibilities.
2. Develop, adopt and implement tree maintenance standards.
3. Develop, adopt and implement tree planting details.
4. Develop, fund and implement a formative pruning program for young trees.
5. Develop, fund and implement cyclical and programmatic pruning programs.
6. Provide adequate staffing for tree maintenance efforts.
7. Develop and implement an alley tree management program.

Goal 4.

Consistently enforce the street tree ordinances to ensure public trees are protected from damage or loss.

Objectives:

1. Provide adequate staffing for enforcement, monitoring and oversight of ordinances.
2. Apply enforcement in a fair, even handed manner.

Goal 5.

Look at urban forest management activities well into the future.

Objectives:

1. Review the management plan on a biennial basis.
2. Develop 5 and 10 year forecasts for the urban forestry program.
3. Review and revise the 5 and 10-year forecasts on an annual basis.
4. Provide an annual state of the urban forest address to the City Council, Park Board and general public.

Goal 6.

Investigate stable funding sources to ensure the urban forest is properly managed and maintained.

Objectives:

1. Develop and implement alternative sources of revenue for program operation.
2. Create and implement budget policies directing funds towards a community tree program.
3. Explore and pursue grants and other funding mechanisms from public and private sources to support tree-related activities.
4. Refine and expand the memorial tree and cost share programs.

Goal 7.

Establish a supply chain of appropriate tree stock for the city planting programs.

Objectives:

1. Develop tree quality specifications specific to Missoula.
2. Develop and implement a contract tree growing protocol.
3. Develop and construct a tree nursery on city property.

Goal 8.

Provide community forestry leadership through example, public education and outreach.

Objectives:

1. Develop and maintain an up-to-date urban forestry library, available to the public.
2. Develop and maintain an active community forestry page on the City of Missoula web site.
3. Create and distribute printed materials to target audiences and conduct educational workshops on proper tree selection, planting and maintenance.
4. Develop and implement an urban forestry curriculum for K-12 students.
5. Emphasize the functionality of community trees.
6. Organize and conduct an annual Arbor Day Celebration.
7. Create and publish a weekly urban forestry article for publication in local newspapers.

Goal 9.

Maintain accurate inventory information as a basis for sound management decisions.

Objectives:

1. Complete the current inventory efforts.
2. Conduct periodic inventory updates to refresh data.
3. Inventory all potential planting locations in Missoula.
4. Update inventory databases as work is completed.

Goal 10.

Establish work priorities for maximum staff effectiveness.

Objectives:

1. Create a protocol for setting work priorities.
2. Create basic criteria for tree removals.
3. Use industry BMPs when establishing priorities.

Goal 11.

Incorporate trees into infrastructure planning so that trees do not damage the infrastructure.

Objectives:

1. Develop, adopt and implement soil protocols.
2. Develop, adopt and implement soil preparation details.
3. Develop and implement root intrusion protocols.
4. Develop, adopt and implement preservation and protection standards for trees during development and construction projects.
5. Update the Complete Streets resolution of 2009 to include street trees as a part of a “Complete Street.”
6. Develop, adopt and implement a utility placement strategy to avoid losing planting locations.

Goal 12.

Establish tree canopy cover for maximum community benefit.

Objectives:

1. Develop a canopy target matrix for specific land use zones.
2. Set a target of 5% to 20% canopy over non-treed streets in 20 years.
3. Set a target of 10% to 30% canopy over treed streets in 20 years.
4. Set a target of 50% canopy over all residential streets in 40 years.

Goal 13.

Manage tree risk to reduce the exposure of the city and its residents to financial hardship.

Objectives:

1. Adopt and incorporate ISA risk assessment protocols.
2. Develop and implement risk abatement action thresholds.
3. Develop and implement a scheduled pruning program.
4. Incorporate risk management protocols into work priorities.

Goal 14.

Foster community involvement for community buy-in of the urban forestry program.

Objectives:

1. Create a Neighborhood Council presentation.
2. Create and implement citizen feedback opportunities.
3. Create and implement tree maintenance opportunities for citizen volunteers.
4. Foster participatory activities for citizen support groups such as Trees For Missoula.
5. Create an interactive urban forest website.

Goal 15.

Manage insect pests in a proactive manner.

Objectives:

1. Monitor insect and disease pest problems before they arrive in Montana.
2. Use IPM protocols to determine suppression action thresholds.
3. Use the most effective, and least toxic, methods to control insect and disease problems.

Goal 16.

Conduct periodic management plan updates.

Objectives:

1. Review urban forest Management Plan on a periodic basis and update as needed.
2. Set a schedule for periodic updates.

Part 7
Implementation Strategies

Implementation strategies provide guidance on how to meet the management plan goals and objectives. Each major implementation strategy group contains several specific strategies addressing the listed goals and objectives from Part 6.

Risk Management

Goals and Objectives Addressed

The following G&Os are addressed in the Risk Management implementation strategies: 3.1, 3.4, 3.5, 3.6, 3.7, 4.1, 6.1, 7.1, 9.4, 10.1, 10.2, 11.3, 13.1, 13.2, 13.3.

Risk Management Strategies

Trees are living organisms and respond individually to environmental stresses. Because individual responses vary, every tree has the potential to be a hazard, which has an associate risk. We manage the risk based upon the likelihood to cause damage, injury or death. By reducing the likelihood of damage, injury or death associated with tree failures, fewer tax dollars are spent on liability claims.

1. Incorporate the current American National Standards Institute (ANSI) A300-Part 9, Tree Risk Assessment, and International Society of Arboriculture (ISA) Tree Risk Assessment Best Management Practices (BMP) as the foundation of the urban forest risk management plan. Use the quantitative assessment process.

2. Establish, adopt and implement the 3 levels of review for tree risk assessment. The three levels of review typically include the following levels:
    - Basic tree review for defects.
    - Visual tree assessment using ANSI and ISA BMP criteria for determining risk.
    - In-depth tree assessment using tools such as the resistograph or sonic tomograph.

3. Establish, adopt and implement specific criteria for tree removal. The criteria for tree removal typically include the following criteria:
    - The tree is dead. The threshold for removal is typically 50 percent or greater of the canopy dead. The location of deadwood removal cuts, and the impact to the overall tree structure, must be considered in the decision to remove a tree.
    - The tree is dying.
    - The tree is diseased.
    - The tree is structurally unsound. Structurally unsound trees that cannot be corrected by traditional pruning techniques are removed. Advanced tree preservation techniques such as cabling and bracing are reserved for high value trees.
    - The tree inhibits all economically viable uses of private property.

4. Establish a dwell time for trees identified as a candidate for removal; the greater the risk for tree failure, the higher the priority for removal. The maximum dwell time for any removal is 6 months. Provide adequate funding to meet the maximum dwell time.

5. Establish a formal working relationship between the City Forester and City Risk Manager. Risk management and urban forest management must be considered on an equal basis.

6. Establish a consistent tree failure reporting protocol. The City Forester must be notified of all tree failures within the city. When a tree failure causes property damage, injury or death, the City Forester must be called to conduct a post failure assessment before clean-up operations begin.

7. Train and qualify all field staff on risk assessment techniques. Appropriately trained and qualified field staff can identify and address tree risks in a timely manner.

Risk Management Benefits

Managing tree risk is an integral part of an urban forest management program. Tree failures have the potential to cause property damage, personal injury or death. When a tree failure causes damage, injury or death, the city is exposed to potential liability. That liability can have significant financial impacts to the city and the urban forestry program.

Removals

Goals and Objectives Addressed

The following G&Os are addressed in the Risk Management implementation strategies: 2.6, 6.1, 9.4, 10.1, 10.2, 13.2.

Removal Strategies

The removal of dead, dying, diseased or unsound trees is the first step towards renewing the urban forest. Timely removal of trees and stumps reduces the dwell time between tree removal and tree replacement.

1. Remove trees and stumps together at one time. When trees are removed, the maximum dwell time for stump removal should be no more than one month. Stump removal must be completed in a manner that prepares the site for replanting.

2. Allow time for grieving. Where feasible, increase the homeowner tree removal notification period from 3 months to 6 months. The additional time will allow homeowners and opportunity to “grieve” over the loss of the tree.

3. Establish a removal program for Class II and Class III trees under distribution lines located in the public right-of-way or on city property. Class II and Class III trees grow up and into the lines and create the risk of line failure or death, which necessitates repetitive and costly pruning. Remove trees based upon need rather than convenience. Identify tree removal candidates based upon the five criteria for removal identified in the Risk Management Strategies of this management plan.

4. Develop an alley tree removal program. Partner with Northwestern Energy to remove and stump treat trees under primary and secondary electric distribution lines. Set aside

adequate funding to remove and stump treat trees beyond the primary and secondary electric distribution lines.

5. Develop specific storm response protocols. The specific storm events are as follows:
   - Ice Storms
   - Early/Late Snow Storms
   - Wind Storms

6. Create a market for removal logs. Treat the wood as an asset to be sold, with the proceeds being used to fund urban forestry operations. This will require the creation of an enterprise fund to segregate log sale revenue from the General Fund.

Removal Benefits

Removing trees and stumps on timely basis reduces the city's exposure to liabilities associated with tree failures. It is also the first step in creating planting spaces to rejuvenate the urban forest.

Planting

Goals and Objectives Addressed

The following G&Os are addressed in the Risk Management implementation strategies: 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 6.1, 7.1, 7.2, 7.3, 8.3, 9.4, 11.1, 11.2, 11.3, 11.5, 11.6, 12.1, 12.2, 12.3, 12.4, 14.3.

Planting Strategies

A well-developed planting program is imperative to the long-term success of Missoula's urban forest. This program is the foundation of the urban forest for future generations.

1. Define street trees as an integral component of a developed street. Once defined as a component of a developed street, amend Resolution 7227 "Complete Streets Resolution" and related policy to include street trees.
2. Develop a city funded replacement planting program to install 400 trees per year in the five neighborhoods that have senescent Norway maples. At 400 trees per year, the 8,800 maples will be replaced in approximately 22 years. Staggering the plantings will also provide age variability in the neighborhood trees, while still maintaining neighborhood continuity.
3. Develop a city funded planting program to install 500 trees per year in all other neighborhoods of the city. With an estimated 7,000 higher quality planting spaces, these spaces can be planted in 14 years. This program will create a sense of neighborhood in areas where street trees are lacking.
4. Establish two planting seasons, Spring and Fall, for maximum flexibility in tree planting efforts. The Spring season would run from mid-April to mid-June. The Fall season would run from mid-September to mid-October. At 13 trees per day, two-thirds of the 900 trees would be planted in the Spring, with the remaining one-third planted in the Fall.

5. Develop volunteer tree planting efforts to install 100 city provided trees per year. This will bring the total annual tree planting to 1,000 trees. Volunteer planting efforts also provide an opportunity for community buy-in in the urban forestry program.
6. Guide and coordinate the Missoula Redevelopment Agency tree planting efforts to ensure trees are planted for long term success. To ensure tree planting stock is of the highest quality, use trees from the city's nursery.
7. New street trees to be contract grown. Purchasing trees on the open market exposes the planting program to the vagaries of market availability. By contractually growing trees, the certainty of availability is assured, trees are grown to consistent quality standards and purchase costs are significantly lower. Trees grown by contract are of a higher quality and therefore less likely to fail after installation. Contract growing trees will also allow for an orderly replacement of trees.
8. Develop and adopt tree planting standards to ensure tree installation is consistent, whether the installation is done through the Parks and Recreation Department, other city agencies or the private sector. The planting standards will be based upon the most current ANSI standards and ISA BMPs. Planting standards not only include the tree stock, but also include the site preparation. Industry BMPs call out specific soil volumes for Class I (Small) through Class III (Large) trees. Trees provided for installation by other city agencies or the private sector must meet the current ANSI Z60.1 standards and the ISA BMPs for tree stock.
9. Select trees for specific sites based upon the site conditions and constraints. A tree that is not suitable for a specific site will not provide maximum, long-term benefits to the community. The approved tree list should provide all of the pertinent information needed to select a tree appropriate to specific site. Class II and Class III trees shall not be planted directly under electrical distribution lines, or where root growing medium is restricted.
10. Adopt and use the "10-20-30" rule for establishing the tree species composition of Missoula's urban forest. Species diversity is critical to maintaining the health of the urban forest by reducing the likelihood of an introduced disease or insect pest significantly affecting the tree population. The urban forest shall be comprised of less than 10 percent of any one species, 20 percent of any one genus or 30 percent of any one family.
11. Develop a planting protocol that offers species consistency on a street, while at the same time maintaining species diversity overall. Create an area-wide planting plan that identifies a primary and secondary species for every street block. Incorporate adequate species variation within that area.
12. Consistently enforce planting standards. Regardless of who installs the trees, the tree must be planted to the adopted standards in a consistent manner to ensure long term growth and benefit to the community. Use existing regulations to enforce proper tree installation. Modify existing regulations if necessary to enforce proper tree installation.
13. Provide for initial and long term watering to ensure tree establishment and growth. Water costs are high in Missoula. Create a financial incentive, such as gray water usage, to offset costs incurred by the abutting property owner for consistent watering. Create the incentive by eliminating the sewer fees associated with irrigation water usage.

Planting Benefits

High quality trees, properly installed in an appropriate site, with adequate water, survive and consistently outperform over a longer lifespan, poor quality trees that are poorly installed and are not watered.

Consistent Maintenance

Goals and Objectives Addressed

The following G&Os are addressed in the Consistent Maintenance implementation strategies: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.1, 4.2, 6.1, 6.2, 6.3, 7.1, 8.3, 9.4, 10.1, 11.4, 11.5, 13.1, 13.3, 14.3.

Maintenance Standards and Enforcement Strategies

For trees to thrive and perform, they must be maintained. Ongoing maintenance is essential to the long-term survival of newly planted, young and mature trees.

1. Establish, adopt and implement the ANSI standards and ISA BMPs as the foundation for tree care operations in Missoula. Standards and BMPs are periodically updated. When writing ordinances or resolutions incorporating the standards and BMPs as the foundation for operations, the standards or BMPs must be referenced as the "current standard or BMP". At a minimum the following standards and BMPs must be incorporated into tree care operations:

    - ANSI Z60.1 Standard for Nursery Stock
    - ANSI Z133.1 Safety Standards for Tree Care Operations
    - ANSI A300 Parts 1 – 10 Standards for Tree Care Operations
    - ISA BMP Series 1 – 10
    - OSHA 1910.269 – Vertical Standard

2. Define who is qualified to provide tree care to city trees. Rather than defining a person qualified to conduct tree care operations as a Certified Arborists, change the definition to "Qualified Arborist". Tree care work may be done by any of the individuals list below. When non-qualified individuals are conducting tree care work, they must be under the direct supervision of a Qualified Arborist. A Qualified Arborist can be any of the following individuals:
    - ISA Certified Tree Worker
    - ISA Certified Aerial Lift Specialist
    - ISA Certified Arborist
    - ISA Certified Municipal Specialist
    - ISA Certified Utility Specialist
    - ISA Board Certified Master Arborist
    - ASCA Registered Consulting Arborist

3. Establish consistent enforcement of urban forest ordinances and standards. Urban forest ordinances are found in three chapters of the municipal code; Chapter 12.18 Obstructions, Chapter 12.32 Comprehensive Tree and Shrub Planting, Pruning and Maintenance Regulations, and Chapter 12.48 Boulevards. Condense and/or edit the chapters for consistent messaging and consistent enforcement. Update existing standards for consistency with industry practices.

Conduct a periodic review of the ordinances and standards for relevance and consistency with industry practices.

4. Develop a line clearance maintenance program for trees under distribution and secondary power lines. Use the ANSI A300 and ISA BMPs as a foundation of a line clearance pruning program for Missoula trees. Identify specific treatment options for trees along streets and in alleys.

5. Establish programmatic pruning for city trees. Programmatic pruning targets specific maintenance needs within the urban forest. Typical programmatic pruning includes:
    - Sign and signal pruning
    - Clearance pruning
    - Roadway chipseal pruning
    - Street light clearance pruning

6. Establish a cyclical pruning program for city trees. According to Figure 26, the typical pruning cycle range from 4 to 5 years. A cycle less than 4 years, while optimal, has a lower marginal return and is reserved for high use locations, such as specialty parks or business districts. A cycle greater than 5 years returns a diminishing benefit. Prune trees on the following cycles:
    - High use parks – 3 years
    - Low use parks – 5 years
    - Street trees – 4 to 5 years
    - Downtown trees – 2 years
    - Commuter trails – 3 years
    - Low use trails – 5 years

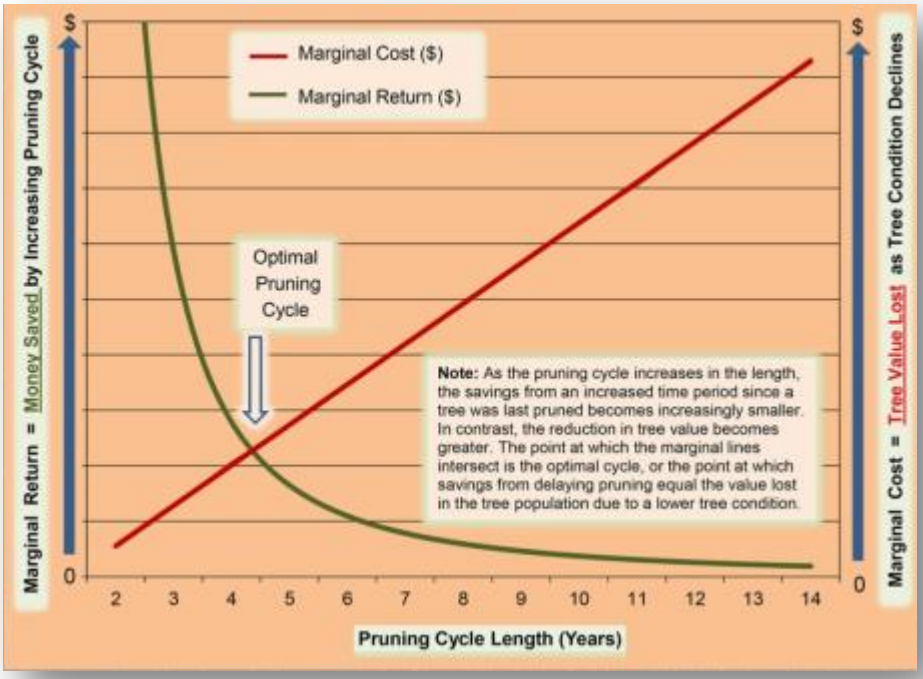

Figure 27. Optimal pruning cycle based upon marginal return of dollars expended on tree maintenance. Adapted from Miller and Sylvester, 1981. Courtesy of Richard J. Hauer, Jessica M. Vogt, Burnell C. Fischer and the International Society of Arboriculture, February 2015.

1. Establish a formative pruning program for newly planted trees. Formative pruning is critical in the formation of good tree structure. Prune newly planted trees 2 and 5 years after planting. Use the 5-Step method when pruning newly planted trees.

2. Provide adequate watering for street trees. The average water need for a moderate water use tree in Missoula is 24 inches per year. (Examples) Prioritize planting sites based upon access to supplemental irrigation. Sites that have access to irrigation rate a 1, high priority. Sites without access to irrigation rate a 5, or very low priority. Do not plant trees on priority 5 sites unless consistent irrigation can be provided.

3. Provide protection from mowers, line trimmers and chemicals, especially young trees. Lawn maintenance equipment is second only to improper watering in the number of young trees damaged or destroyed each year. Protect trees from lawn maintenance equipment through cultural and mechanical means. Use mulch as the primary cultural buffer around trees.

4. Maintain a continuous inventory of city trees. Electronically update records as maintenance work is completed. Field review high use park tree data every 3 years. Field review all remaining trees every 5 years.

Maintenance Benefits

Maintained trees perform better and live longer than non-maintained trees in a number of ways. First, maintained trees have a lower risk of failure. Second, a well maintained tree has a greater probability of providing maximum socio-economic benefits to the community as calculated by the i-Tree analysis. And finally, well maintained trees create a sense of place and pride within neighborhoods.

Education

Goals and Objectives Addressed

The following G&Os are addressed in the Education implementation strategies: 1.1, 1.4, 3.1, 3.2, 3.7, 4.1, 5.1, 6.1, 6.2, 6.3, 7.1, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 10.1, 10.2, 11.4, 14.1, 14.2, 14.3, 14.5.

Education Strategies

A well informed citizenry is the best ally in the maintenance of the urban forest. Well educated citizens properly care for trees.

1. Develop and implement a homeowner seminar series. Tailor the program to emphasize maintenance topics at least one month prior to the activity. Partner with the University, Cooperative Extension and Libraries for maximum exposure.

2. Create a K-12 tree education program for local schools. In particular, focus on the 3rd through 4th and 9th through 12th grades. The program would include the following:

    - Start and art contest for 9th through 12th graders.
    - Distribute tree seedlings and art buttons to 4th graders.
    - Establish an outdoor sensory class for 3rd graders.
    - Partner with the Montana Natural History Center.

3. Offer homeowner tree advice through the Master Gardener Program.

4. Develop a "Green Industry" program for the allied green industry trades. The allied trades typically include landscape installation and maintenance contractors, Landscape Architect, plant nurseries, irrigation contractors and pest control contractors. Schedule ½- day classes throughout the year covering topics relevant to tree care operations.

5. Become a driving force for tree care maintenance operator education in Western Montana. This can be accomplished in a number of ways. First, emphasize membership in the Rocky Mountain Chapter (RMC) of the ISA. Second, serve as the host for RMC seminars. Third, serve as the host for certification examinations.

Education Benefits

The benefit of an educated populace and industry leads to well-maintained trees. Trees that are properly maintained perform better and provide maximum socio-economic benefits to the community. Education also assists in enforcement ordinances and standards.

Staffing and Equipment

Goals and Objectives Addressed

The following G&Os are addressed in the Staffing and Equipment implementation strategies: 2.3, 2.6, 3.4, 3.5, 3.6, 3.7, 4.1, 5.1, 5.2, 5.3, 6.1, 6.2, 6.3, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4, 8.6, 8.7, 9.1, 9.2, 9.3, 9.4, 10.1, 13.1, 13.2, 13.3, 14.1, 14.3.

Staffing Strategies

Tree care requires year-round, trained staff members to maintain a vibrant urban forest. Unlike many park maintenance operations, tree care maintenance is a 12 month operation, with base staffing consistent throughout the year. Additional staff may be brought in for peak season programming.

At a minimum, the following staff composition is needed to adequately maintain an urban forest population of 27,000 to 33,000 public trees. The staff positions are Arborist Technician – AT, Assistant Arborist Technician – ATA, Arborist Worker – AW, and Park Attendant – PA, based upon Full Time Equivalency (FTE). A new staff position, Crew Leader – CL would be added for field oversight. Existing (E) or new (N) positions are identified in the column labeled E/N.

Table 6. Adequate Staffing Levels

Program Component	Staff	Quantity	E/N	FTE	Program Impact
Field Oversight	CL	1	N	1.0	Manages field operations
Programmatic Maintenance	AT ATA AW	1 2 2	N N N	1.0 1.0 0.58	Addresses program pruning
Removals and Service Requests	AT ATA	1 2	E E	1.0 1.0	Addresses citizen concerns
Cyclical Pruning	AT ATA	1 2	N N	1.0 1.0	Provides regular preventative maintenance
Watering	PA	2	E (1) N (1)	0.417	Ensures trees are established
Inventory Data Management	ATA	1	N	0.67	Provides data updates

Equipment Strategies

Tree care requires specialized equipment to properly maintain the urban forest.
Provide adequate equipment for tree maintenance operations. For maximum equipment operation time, equipment usage scheduling is considered. Existing (E) or new (N) equipment is identified in the column labeled E/N.

Table 7. Equipment Requirements

Program Component	Equipment	Quantity	Existing/New
Programmatic Maintenance • Sign and signal pruning • Clearance pruning • Roadway chipseal pruning • Street light clearance pruning • Planting	55' Aerial Lift	1.0	E
	15-yard Chip Truck	1.0	N
	Medium Duty Chipper	1.0	N
	Loader Backhoe	0.4	E
	10,000 GVWR Flat Trailer	0.4	E
	5-yard Dump Truck	0.4	N
Removals and Service Requests	55' + 14' Elevator Aerial Lift	1.0	N
	15-yard Chip Truck	1.0	E
	Heavy Duty Chipper	1.0	E
	Grapple Truck	1.0	E
	Stump Grinder	1.0	E
	Loader Backhoe	0.3	E
	5-yard Dump Truck	0.3	N
Cyclical Pruning	12-yard Forestry Truck	1.0	N
	Medium Duty Chipper	1.0	N
Watering	1-ton Flatbed w/ Portable Tank	2.0	E (1) N (1)
Inventory Data Management	½-ton Pick-up	0.67	N

Staffing and Equipment Benefits

Adequately staffed and equipped crews are most productive. Trees that are well maintained perform better over a longer useful lifespan and provide maximum socio-economic benefits to the community.

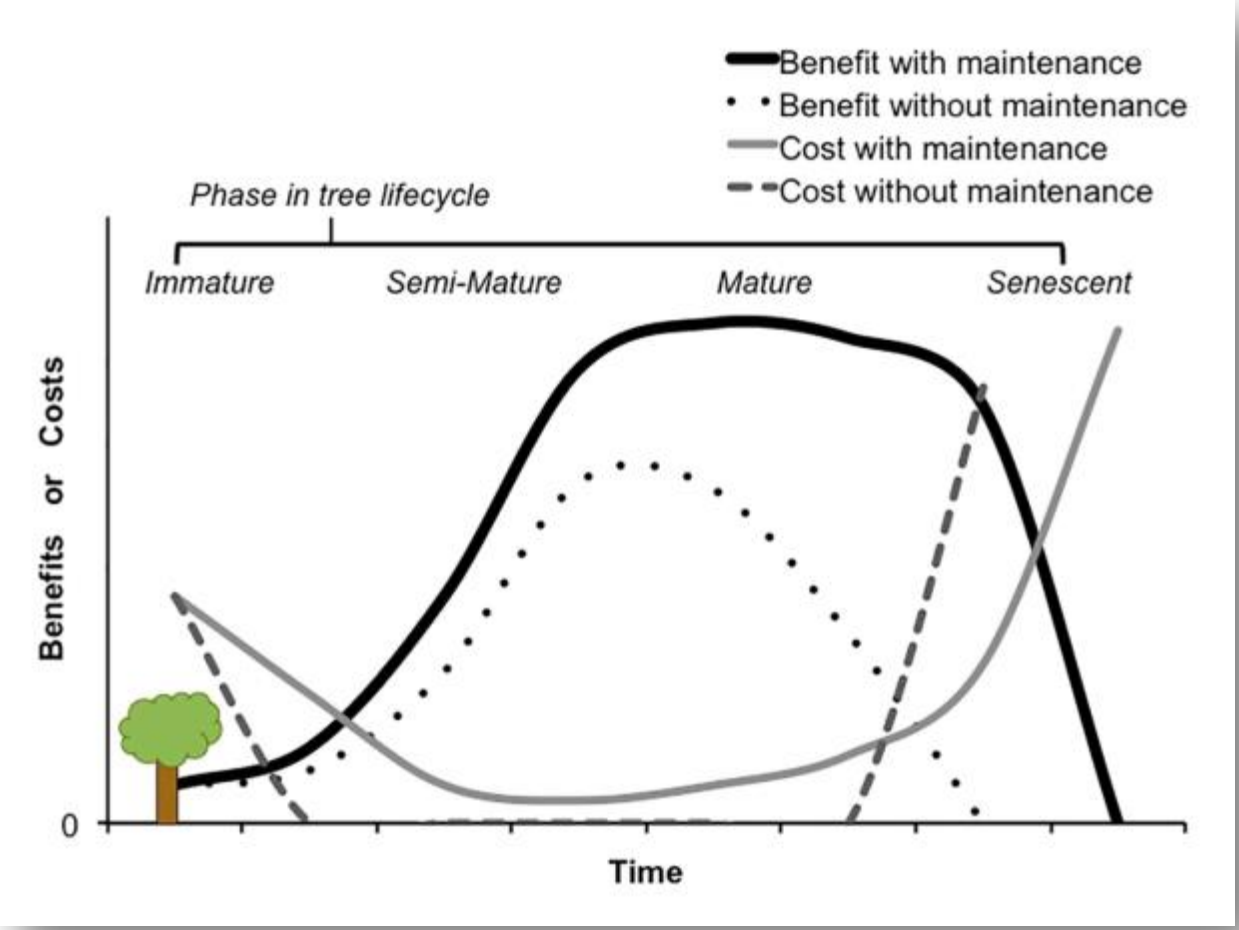

Figure 28. Costs and benefit profiles over the lifetime of an individual tree. Courtesy of Richard J. Hauer, Jessica M. Vogt, Burnell C. Fischer and the International Society of Arboriculture, February 2015.

Figure 28 illustrates the general trends in benefits from a tree over time where maintenance is provided as compared to a tree where maintenance is not provided. A maintained tree provides greater benefits over a longer timespan than a similar tree that is not maintained. Adequately staffing and equipping Missoula's urban forestry program would facilitate a gradual shift from the benefits curve without maintenance to the benefits curve with maintenance.

Community Resources

Goals and Objectives Addressed

The following G&Os are addressed in the Community Resources implementation strategies: 32., 3.3, 5.1, 5.2, 5.3, 6.1, 6.3, 7.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 11.1, 11.2, 14.1, 14.2, 14.3.

Resource Strategies

Volunteers provide valuable input into urban forest management and maintenance. Volunteer efforts also provide a community buy-in into the urban forestry program.

1. Incorporate volunteer efforts into tree care operations. Typical activities include the following:
   - Arbor Day activities
   - Educational outreach
   - K-12 educational programs
   - Tree planting
   - Young tree pruning

2. Leverage city funds with grant and foundation funding opportunities. Where feasible, connect grant funded programs with volunteer programs.

3. Use local technical, professional and scholastic expertise for urban forest problem solving.

4. Encourage Neighborhood Council participation in urban forestry programs affecting the various neighborhoods.

Resource Benefits

Community buy-in provides the backing needed to ensure a program succeeds. Community members are also advocates for the urban forestry program. This is especially true in times of economic downturns.

Funding

Goals and Objectives Addressed

The following G&Os are addressed in the Funding implementation strategies: 2.3, 2.6, 2.7, 3.4, 3.5, 3.6, 4.1, 5.1, 6.1, 6.2, 6.3, 7.1, 11.2, 11.4, 12.3, 13.2, 13.3.

Funding Strategies

Trees are a living asset that requires consistent care and maintenance to realize maximum economic community benefits. An urban forest is one of the few public infrastructure improvements that increase in value over time. A steady funding stream is necessary for both capital and operational expenses to pay for the urban forestry program. The funding strategies listed below are examples of funding methods used by cities around the country.

1. Use the existing park district as a revenue source. The park district has additional assessment capacity that can be used for urban forest maintenance activities. While not enough to fund the entire operation, it can be used as seed and/or match money for alternative funding sources.

2. Create a separate urban forest assessment district. To ensure equitable maintenance throughout the city, the district must be across the entire city. While certain neighborhoods may wish to create districts for their area, they must remember the public trees belong to all citizens.

3. Sell carbon credits. The i-Tree analysis in Appendix C indicates the current urban forest has the ability to sequester 3,536 tons of carbon per year. Use the funds from carbon credits for the initial planting and long term maintenance or new trees. Since the carbon sequestration potential for existing or senescing trees is greatly diminished, carbon credits could not be sold for much of the current urban forest. New trees replacing senescent trees would sequester significantly more carbon and would be suitable for carbon credit sales.

4. Create an incentive for residents to water trees by providing a watering rebate on the property owner's sewer bill. Water used for irrigation does not go through the WPCP. Therefore, irrigation water should not be charged a fee for WPCP operations.

5. Create an endowment fund for urban forestry maintenance operations. An endowment would provide a vehicle for citizens to make donations or bequeaths for urban forestry maintenance activities. Seed money would be needed to establish the endowment.

6. Include tree maintenance in the street maintenance districts. Street trees are an integral part of the street infrastructure and should be funded as such. Cities such as Milwaukee, Wisconsin, incorporate tree maintenance into street maintenance funding mechanisms.

7. Use the local only one-cent gas tax on vehicle fuels to fund tree maintenance. Street trees significantly offset the adverse effects of internal combustion vehicles. The gas tax would provide a steady revenue stream to fund ongoing tree maintenance.

8. Add a percentage to the Transient Occupancy Tax (TOT) to fund the planting program. One of the draws to Missoula is the tree lined street. Without the trees, the draw will be reduced. Visitors to Missoula enjoy the benefits; this is an avenue to pay for it.

9. Implement a vehicle and bicycle license tab system. The tab system would provide an avenue for collecting revenues needed to maintain the street tree infrastructure.

10. Add a utility tax. The urban forest provides thousands of dollars' worth of energy benefits. To maintain those benefits, the trees must be maintained.

11. Actively pursue grants. Apply for and use grant funds for specific capital purchases or specific programs with defined start and end dates.

12. Develop private-public partnerships to fund specific urban forest management functions and activities. Leverage city dollars for maximum program impact.

13. Develop and implement a “round-up program” for utility bills. The funds generated by rounding up a utility bill to the nearest dollar can be used for specific implementation strategies, such as the educational programs.

14. Use urban wood waste. Create markets for urban wood waste to reduce landfill expenses and supplement general fund revenue.

Funding Benefits

Consistent funding provides the resources to maximize the community realization of socio-economic benefits from the urban forest.

Marketing and Outreach

Goals and Objectives Addressed

The following G&Os are addressed in the Marketing and Outreach implementation strategies: 1.1, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 4.1, 4.2, 5.1, 6.1, 6.2, 6.3, 7.1, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 11.2, 11.3, 11.4, 12.1, 13.2, 14.1, 14.2, 14.3.

Marketing and Outreach Strategies

It is vital for an urban forestry division to remain in contact with the community.

1. Use social media to disseminate information regarding urban forestry activities. Social media is used successfully in other markets for similar activities.

2. Create a weekly column in the local newspaper. Columns can use a number of different formats to distribute information; question and answer, factoid, advice and discussion are typical formats.

3. Coordinate marketing and outreach with local non-profit organizations, such as Trees for Missoula, to extend the dissemination of information to the community.

4. Create and implement an interactive urban forest website allowing citizens the ability to view inventory data, place service requests, select and purchase items such as cost-share and memorial trees. Provide on-line resource links within the urban forest web page.

5. Coordinate urban forestry messaging with other city departments, with community service groups, auxiliary school groups and homeowner association groups.

6. Incorporate Neighborhood Councils into outreach efforts. The Neighborhood Council Liaison sends out city updates to residents on a weekly basis. Provide timely information for distribution via the weekly updates.

Marketing and Outreach Benefits

Real-time citizen interaction fosters community interest and involvement. Community members become advocates for the urban forestry program.

Pest Management

Goals and Objectives Addressed

The following G&Os are addressed in the Marketing and Outreach implementation strategies: 1.1, 1.2, 2.1, 2.2, 2.4, 3.4, 3.5, 4.1, 7.1, 8.2, 8.7, 11.2, 11.3, 11.4, 15.1, 15.2, 15.3.

Pest Management Strategies

Trees are living organisms. As such, they are vulnerable to various insect and disease pest problems. In order to protect our urban forest investment, pest management is an active part of the management plan.

1. Coordinate with the County Agricultural Commissioner's office, the Montana Department of Agriculture and the Montana Department of Natural Resources and Conservation on monitoring efforts of insect and disease pests that threaten Montana. Proactively address disease and insect problems before they become economically disruptive to the community.

2. Develop and implement tree list containing trees with the fewest insect and disease problems. Starting out with trees that are pest free reduces the likelihood of requiring pest suppression efforts.

3. Develop and implement IPM management protocols for city trees. Set specific economic disruption thresholds for pest control activities. Establish the most effective and least toxic suppression method as the preferred initial method of suppression.

Pest Management Benefits

Pest management protects our urban forestry investment and reduces the risk of significant tree loss.

Ongoing Plan Management and Updating

Goals and Objectives Addressed

The following G&Os are addressed in the Marketing and Outreach implementation strategies: 1.1, 2.4, 3.1, 5.1, 5.2, 5.3, 6.2, 9.2, 9.3, 10.3, 12.1, 14.2.

Ongoing Plan Management and Updating Strategies

To maintain relevancy, the management plan must be periodically reviewed and updated.

1. Conduct periodic citizen and stakeholder workshops in order to gauge perception and acceptance of the management plan.

2. Conduct a yearly staff management plan review to determine plan effectiveness. Provide recommended changes to the plan as needed.

3. Provide a written and verbal state of the urban forest report to the Park and Recreation Board and City Council.

4. Conduct a formal 5-year review of the entire urban forest management plan. This will include additional public interest surveys, stakeholder analysis and i-Tree analysis.

Ongoing Plan Management and Updating Benefits

Economics, climate, societal norms and industry knowledge and standards are continually changing. To maintain relevancy, the management plan must adapt to these changes.

Part 8: Implementation and Phasing

Implementation Costs

Implementing the management plan will cost money. To offset the financial impact of the plan, **implementation strategies can be phased in over time. The highest priority strategies should be** implemented within the first 5 years of the plan.

Table 8 illustrates the forecasted Operating budget based upon anticipated urban forest maintenance needs. The annual labor costs do not include the City Forester; only costs directly associated with urban forest maintenance.

Table 8. Management Plan Operations Implementation Costs

Phase and Budget Year	Incremental Yearly Staff Labor Costs	New Yearly Base Staff Labor Costs	Yearly Supply Costs	Yearly Contractual Costs	Yearly Program Support Costs
Base FY 2015	$0	$164,795	$28,304	$60,000	$0
Phase 1 FY 2016	$120,534	$285, 329	$29,000	$60,000	$0
Phase 1 FY 2017	$14,184	$299,513	$184,000	$149,000	$309,000
Phase 2 FY 2018	$172,650	$472,163	$184,000	$90,000	$309,000
Phase 3 FY 2020	$255,095	$727,258	$184,000	$60,000	$309,000

Column 1 indicates the phase and fiscal year associated with the costs.

Column 2 identifies the yearly incremental labor costs additions associated with each phase of program implementation. These costs include hourly wage and benefits. No additional staff requests are anticipated beyond 2020.

Column 3 identifies the cumulative staff costs. FY 2015 is the base year. The FY 2016 request plus the FY 2015 base becomes the new base cost for FY 2017. The process repeats itself until full staffing is reached in FY 2020.

Column 4 identifies the yearly supply costs. By FY 2017, the first contract grown trees will be purchased to be ready for the 2020 planting season. (The planting season straddles the budget years.) The anticipated price to contract grow trees is $155 per tree, for a total of $155,000 per year. The cost to contract growth trees will remain fairly constant each year. Trees purchased in FY2017 will be planted in FY2020. Note that normal annual supply costs are in addition to the cost of contract growing trees.

Column 5 identifies yearly contractual costs. The yearly contractual costs for removals will peak in FY 2017, when crews begin implementing programs such as street clearance and sign and signal clearance. As additional staffing is added to the program, contractual dollars begin to drop.

Column 6 identifies the costs associated with support programs for the urban forestry program. Support costs include the expenses associated with risk management, code enforcement, programmed vehicle

replacement, education and outreach, program management and volunteer programs. These costs will vary from year to year.

Table 9 illustrates Capital budget costs associated with management plan implementation. All costs are based upon 2015 dollars and are associated with the one-time purchase of durable equipment. Annual contributions to the programmed equipment replacement fund are included in Column 6 of Table 8.

Table 9. Management Plan Capital Implementation Costs

Phase and Budget Year	CIP Replacement Equipment Costs	Additional Equipment Costs
Phase 1 FY 2016	$0	$0
Phase 1 FY 2017	$140,000	$190,000
Phase 2 FY 2018	$178,000	$400,000
Phase 3 FY 2020	$45,000	$110,000

Column 1 indicates the phase and fiscal year associated with the costs.

Column 2 identifies existing capital equipment replacements programmed into the Capital Improvement Program.

Column 3 identifies the additional capital equipment purchases needed to fully implement each phase of the urban forestry program. The equipment included in Phase I FY 2017 will support the second tree crew. The equipment included in Phase II FY 2018 will support the third tree crew. The equipment in Phase III FY 2020 will support the tree planting program.

Implementation Phasing

The management plan and its implementation strategies can be phased in over time. Table 18 describes the implementation timelines into the future.

Table 10. Implementation Phasing

	Phase I		Phase II	Phase III		Beyond planning period		
Task Group	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**	**2035**
Management Plan Review		Initial update						
					Thorough update	Thorough update	Thorough update	Thorough update
Risk Management	Develop a Risk Management program							
		Implement Program						
Removals	Develop a removal phasing program					Review effectiveness	Review effectiveness	Review effectiveness
		Initiate program						
								Remove last of original Norway maples
		Develop log sale program						
			Implement log sale program					
Canopy Analysis	Compute canopy coverage					Verify goal effectiveness	Verify goal effectiveness	Verify goal effectiveness
		Establish canopy coverage goals						
			Develop planting program					
Planting	Develop planting standards and details					Verify planting effectiveness	Verify planting effectiveness	Verify planting effectiveness
		Implement the 10-20-30 Rule						
		Develop tree supply chain						
			Implement contract growing					
					Begin planting program			
			Develop volunteer program					
					Begin volunteer planting			
Maintenance	Update ordinances							
		Update Tree Standards						

Table 10. Implementation Phasing

	Phase I		Phase II	Phase III		Beyond planning period		
Task Group	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**	**2035**
			Develop program for cyclical pruning					
		Implement programmatic pruning						
					Implement cyclical pruning	Verify cyclical effectiveness	Verify cyclical effectiveness	Verify cyclical effectiveness
Education		Develop homeowner training						
		Develop K-12 programs						
			Integrate into Master Gardener program					
	Develop Green Industry seminars							
		Implement seminars						
Staffing Equipment		Implement Phase 1 staffing						
			Implement Phase 2 staffing					
					Implement Phase 3 staffing			
	Purchase Phase 1 equipment							
		Purchase Phase 2 equipment						
				Purchase Phase 3 equipment				
Community Resources		Develop volunteer formative pruning						
			Implement volunteer pruning					
Funding	Explore funding options	Explore funding options	Explore funding options	Explore funding options	Explore funding options	Explore funding options	Explore funding options	Explore funding options
		Develop funding mechanisms	Develop funding mechanisms	Develop funding mechanisms	Develop funding mechanisms	Develop funding mechanisms	Develop funding mechanisms	Develop funding mechanisms
Marketing	Use social media							
		Write weekly tree column						
		Enable on-line transactions						
Pest Management		Develop an IPM program						
			Implement IPM program					

Benefit/Cost Analysis

- ***Using the data from the i-Tree analysis in Appendix C we see that the current benefit/cost ratio for Missoula's urban forest is $6.96 in benefits for every $1.00 spent on maintenance.***

The benefit/cost ratio is higher than the norm for one reason; we spend only a fraction of the funding needed to maintain the urban forest for maximum community benefit. However, the current urban forest is largely senescent, that is, aging. The current benefit/cost ratio will begin to plummet within a few short years as the Norway maple population dies out and the young tree population stagnates.

To maintain its value, the community forest must receive periodic care. The net economic value of the community forest is determined by the ratio of the costs to the benefits. Typical benefit/cost ratios in a hypothetical northern mountain and prairie community range from 1.13:1, 1.59:1, to 2.29:1 for small, medium and large trees, respectively. For each $1 spent on a small tree, the benefit is $1.13, or a 13% return on investment. For each $1 spent on a large tree, the benefit is $2.29, or a 129% return on investment. Again, as tree care diminishes, the tree value goes down, and the return on investment through community benefits is greatly diminished.

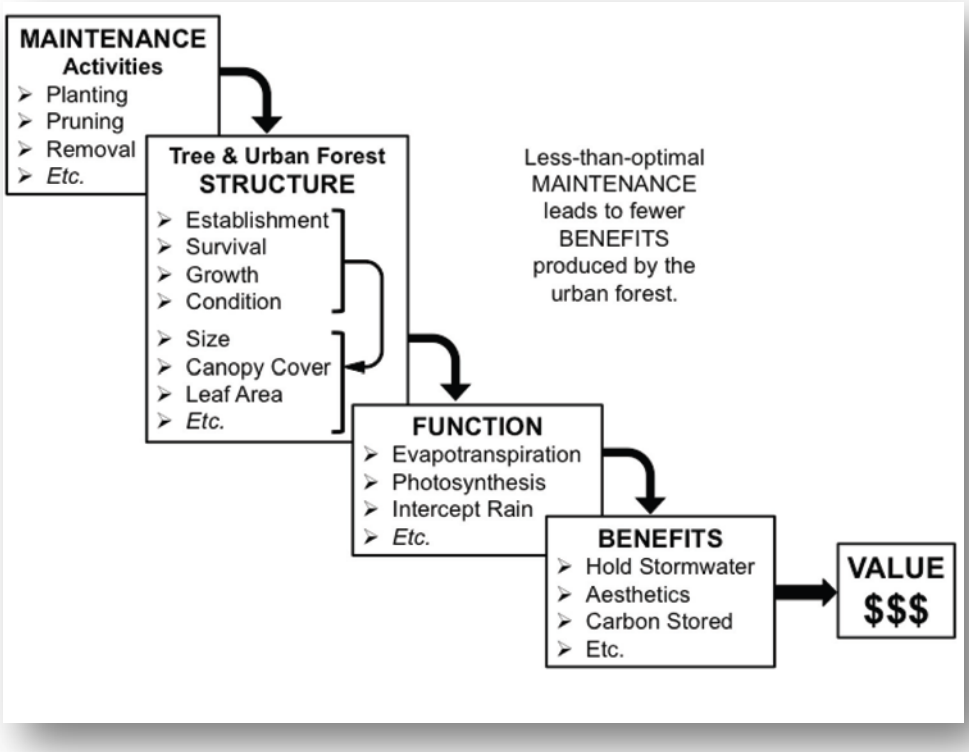

Figure 29. Determining net tree benefit value. Courtesy of Richard J. Hauer, Jessica M. Vogt, Burnell C. Fischer and the International Society of Arboriculture, February 2015.

Part 9
Limitations

An urban forest management plan is not a static document. The plan should be reviewed on a yearly basis and updated, at the most, every 5 years.

The Urban Forest must be considered as an integral component of the urban infrastructure. When constructing new or repairing existing infrastructure, the urban forest and its components must be include in the planning and construction process. If trees are not included in the process, they will be adversely affected by the improvements and fail prematurely.

Urban forest maintenance is inclusive. For the urban forest to provide maximum socio-economic benefit, it must be maintained. Tree planting efforts without ongoing maintenance will not succeed. If newly planted trees cannot be adequately maintained, they must not be planted.

Consistent application and enforcement is a prerequisite for the success of an urban forest management plan. Implementing an urban forest plan often requires making difficult choices. To receive maximum benefit from the urban forest, sufficient funding must be provided to facilitate management efforts. The Mayor and City Council must be prepared to make difficult decisions regarding the funding, implementation and enforcement of the urban forest management plan.

Appendix A
Management Plan Authorization

RESOLUTION NUMBER 7838

A resolution of the Missoula City Council in support of the development of a long term management plan for the Missoula Urban Forest, including reallocation of existing and available FY 14 Park District Funds for plan development.

Whereas, the City of Missoula recently completed a census of street trees in the city, which identified over 20,500 street trees at a combined physical asset value over $70,000,000; and

Whereas, the census identified numerous issues compromising the long term performance and value of the street trees for current and future generations; and

Whereas, it is well established that street trees play a critical role in the health and wellness of a community; and

Whereas, it is within the Parks and Recreation Department's and City's mission to enhance the quality of life in our community by promoting health and wellness; and

Whereas, a long term management plan can guide the City in its efforts to improve the management of the Urban Forest for maximum socio-economic and environmental values, and

Whereas, the Parks and Recreation Department staff is prepared to develop a long term management plan, guided in part by a public interest survey;

Now therefore be it resolved, that the Missoula City Council supports the development of a long term management plan for the Missoula urban forest; and.

Be it further resolved that the Missoula City Council supports the reallocation of $9,000 in Park District Funds slated for Risk Tree Removal funding to complete the management plan.

PASSED AND ADOPTED this 9th day of December, 2013.

ATTEST:
/s/ Martha L. Rehbein
Martha L. Rehbein, CMC
City Clerk

APPROVED:
/s/ John Engen
John Engen
Mayor

Appendix B
S.W.O.T. Analysis

S.W.O.T. Analysis is used as a way of looking at a program to determine stakeholder sentiment for a particular program. S.W.O.T. is an acronym for:

- **S**trengths
- **W**eaknesses
- **O**pportunities
- **T**hreats

In its simplest form, the analysis looks at the real and/or perceived strengths, weaknesses, opportunities and threats to a program from the stakeholder perspective. After a brief introduction, the stakeholders break into groups for brainstorming sessions. During that time, the groups write down their thoughts on strengths, weaknesses, opportunities and threats to the program. After all of the ideas and thoughts are written down, the groups rate the priority of each strength, weakness, opportunity or threat.

During the priority rating process, the stakeholders were each given 6 red and 6 green dots. The red dots represented extremely important issues. Green dots represented very important issues. Issues without dots were rated as important.

The results of the analysis are included on the following pages. Note the numbers after each issue. The numbers represent the number of dots each topic received. If no dots were received, the issue was categorized as important.

S.W.O.T. Analysis 6/3/2014

Strengths:

Extremely Important:
- Community Support/ Neighborhood Councils (1)
- Staff (1)
- Good Inventory (1)

Very Important:
- Growing Season (2)

Important:
- Council Support
- Environmentally Focused Residents
- Tree City USA

Weaknesses:

Extremely Important:
- Plan Reviews/ Vertical Assessment (2)
- Inconsistent Standards (1)

Very Important:
- No Plan (6)
- Lack of Communication/PSA's/Education (1)
- Need to share value (1)
- Poor Soils (1)
- Community Apathy- "City will do it." (1)

Important:
- Budget Constraints

Opportunities:

Extremely Important:
- Right Tree Right Place (8)
- Partnerships with others - Um, BID, NW Energy, etc… (5)
- NW Energy Tree Replacement program (4)
- URD's (3)
- Community Momentum (2)
- Tree wells with irrigation (1)

Important:
- Alternative Funding
- BID Tree Care
- Community Service Program
- Define Trim/Vegetation Policies

Threats:

Extremely Important:
- Uniclass/ Monoculture/ Old Neighborhoods (4)
- Dying Trees/ Safety Hazards (3)
- Rental Properties- wiil/compliance (2)
- Budget Constraints (1)

Very Important:
- Environmental Growing Conditions (2)
- Budget Constrains (1)
- Regulatory Constraints (1)
- No Act on Decision (1)

Participants:

Contact information available upon request

Levi Arnio- Northwestern Energy

Linda McCarthy- Missoula Downtown Association

Monte Sipe- City of Missoula Engineering

Nate Linder – Northwestern Energy

Scott Bernhardt- Northwestern Energy

Vicki Judd- Northwestern Energy

S.W.O.T. Analysis 6/4/2014

Strengths:

Very Important:

Green, Shade, Quality of Life (2)

Important:

Community Support
Council Support
Staff
Good equipment and qualified staff

Weaknesses:

Extremely Important:

Recent UF Instability/turn-over (2)
Care (2)
Where is funding going- Let's see an itemized budget (2)
Various city dept. not talking to each other (1)
Dept. is under-funded and under staffed, low bid contracting (1)
Inconsistent Standards (1)
Broad/ variable issues- too many priorities (1)

Very Important:

Various city dept. not talking to each other (2)
Dept. is under-funded and under staffed, low bid contracting (1)
Lack of industry involvement (1)

Important:

No plan
Budget Constraints
Tree Snobbery

Opportunities:

Extremely Important:

Partnering with Allied Industry- MNLA, ASLA, AMTOPP, Tree city USA (1)
Working with utility companies (1)
Inmate/Community Service labor force (1)

Very Important:

Inmate/ Community Service labor force (1)

Important:

DNRC
Public Awareness- trees and climate change
Alternative Funding- grants, FEMA
Community Momentum

Threats:

Extremely Important:
- Liabilities associated with dead trees and limbs (4)
- Low bid contracting (3)
- Water (3)
- Utility Companies (1)

Very Important:
- Public misperception (1)
- Budget Constraints (1)

Important:
- Environmental growing conditions
- Regulatory Constraints- MDT, ROW and planting areas
- Cars
- Utility lines

Participants:

Contact information available upon request

Rob Dillon- Robert Dillon Tree Service

Mark Vandermeer- Watershed Consulting

Sam Strickland- All Things Green LLC

Bill Caras- Caras Nursery

Jennie Meinershagan- Landscape Architecture Studio

Appendix C
i-Tree Analysis

An i-Tree analysis uses local tree data to calculate the various benefits and costs associated with an urban forest tree population. The predecessor to the i-Tree analysis software was developed in the early 1990s as a way of looking at the costs and benefits of an urban forestry program.

The following sheets contain the i-Tree analysis conducted on September 9, 2014. The data used was captured as of August 25, 2014, and represents a snapshot of public tree information. Inventory systems are continuously updated; data, and therefore i-Tree analyses continually change.

The table Total Annual Benefits, Net Benefits, and Costs for Public Trees indicates an annual economic contribution of $2,458,812 to the community. In terms of benefits to costs, the ratio is 6.96 dollars in benefits for every dollar of cost. Bear in mind this ratio is for an existing, aging urban forest. The ratio will be skewed downward as older trees are removed and new replacement trees are planted. As the newly planted trees grow, the ratio will once again begin to move upward.

Appendix C includes the following tables:

- Total Annual Benefits, Net Benefits, and Costs for Public Trees
- Total Annual Benefits of Public Trees by Species ($)
- Relative Performance Index for Public Trees
- Replacement Value of Public Trees

Total Annual Benefits, Net Benefits and Costs for Public Trees (9/9/2014)

Benefits	Total ($)	Standard Error	$/tree	Standard Error	$/capita	Standard Error
Energy	285,117	(N/A)	12.46	(N/A)	4.17	(N/A)
CO2	53,055	(N/A)	2.32	(N/A)	0.78	(N/A)
Air Quality	31,874	(N/A)	1.39	(N/A)	0.47	(N/A)
Stormwater	369,745	(N/A)	16.16	(N/A)	5.41	(N/A)
Aesthetic/Other	1,719,021	(N/A)	75.15	(N/A)	25.13	(N/A)
Total Benefits	**2,458,812**	**(N/A)**	**107.48**	**(N/A)**	**35.95**	**(N/A)**

Costs			
Planting	39,847	1.74	`
Contract Pruning	125,205	5.47	1.83
Pest Management	1	0.00	0.00
Irrigation	17,293	0.76	0.25
Removal	75,000	3.28	1.10
Administration	4,694	0.21	0.07
Inspection/Service	9,498	0.42	0.14
Infrastructure Repairs	1	0.00	0.00
Litter Clean-up	1	0.00	0.00
Liability/Claims	1	0.00	0.00
Other Costs	81,816	3.58	1.20
Total Costs	**353,357**	**15.45**	**5.17**
Net Benefits	**2,105,455**	**(N/A)**	**92.04**	**(N/A)**	**30.78**	**(N/A)**
Benefit-cost ratio	**6.96**	**(N/A)**				

Total Annual Benefits of Public Trees by Species ($)

Species	Energy	CO2	Air Quality	Storm water	Aesthetic/Other	Total $ Error
Norway maple	129,925	24,556	17,155	153,752	544,244	869,633 (N/A)
Green ash	14,247	2,777	1,460	13,325	177,375	209,185 (N/A)
Siberian elm	31,659	6,053	4,741	63,403	196,438	302,293 (N/A)
Crabapple	3,654	784	555	1,822	37,913	44,729 (N/A)
Honeylocust	9,125	1,612	476	9,210	98,955	119,378 (N/A)
Red maple	3,588	699	310	3,171	55,456	63,224 (N/A)
Blue spruce	7,499	1,160	-687	17,557	39,252	64,782 (N/A)
Quaking aspen	3,802	674	274	3,371	34,918	43,039 (N/A)
Ponderosa pine	5,424	657	-186	8,807	25,681	40,383 (N/A)
American basswood	3,517	540	232	2,817	33,040	40,145 (N/A)
Common chokecherry	1,139	245	162	572	12,550	14,668 (N/A)
Box elder	9,326	1,804	1,641	9,902	45,133	67,807 (N/A)
Littleleaf linden	2,039	300	239	2,278	22,871	27,727 (N/A)
Silver maple	8,645	1,935	1,140	10,184	46,262	68,166 (N/A)
White ash	3,135	492	247	2,123	37,434	43,430 (N/A)
Sugar maple	5,685	1,259	647	7,344	20,075	35,010 (N/A)
Black cottonwood	6,086	1,067	1,121	7,132	26,972	42,378 (N/A)
Cherry plum	729	155	107	345	8,273	9,610 (N/A)
Bur oak	1,424	260	-52	1,265	12,749	15,646 (N/A)
Freeman maple	1,212	237	105	1,103	18,705	21,363 (N/A)
Douglas fir	4,212	602	-426	10,002	15,010	29,400 (N/A)
Austrian pine	1,964	310	-5	4,953	11,701	18,923 (N/A)
Plum	504	69	107	831	4,093	5,604 (N/A)
Hawthorn	546	109	92	253	5,387	6,386 (N/A)
Showy mountain ash	939	181	197	475	6,437	8,228 (N/A)
Swamp white oak	594	115	52	510	8,697	9,968 (N/A)
American mountain ash	1,078	196	232	545	6,346	8,396 (N/A)
Black locust	3,312	628	626	3,697	13,371	21,634 (N/A)
Spruce	2,060	294	-219	4,856	6,982	13,972 (N/A)
Pear	308	62	24	379	2,589	3,362 (N/A)
Northern hackberry	312	44	29	438	6,416	7,238 (N/A)
Eastern cottonwood	2,007	386	316	2,056	12,243	17,008 (N/A)
Black poplar	1,935	376	314	2,013	11,706	16,345 (N/A)
Horsechestnut	1,485	269	192	1,698	7,824	11,466 (N/A)
Engelmann spruce	1,332	216	-113	3,138	7,237	11,808 (N/A)
Scotch pine	680	104	-4	1,706	5,134	7,621 (N/A)
Japanese tree lilac	164	34	16	66	2,597	2,877 (N/A)
Tatar maple	251	54	37	119	2,848	3,308 (N/A)
Ash	593	114	53	539	7,999	9,299 (N/A)

Total Annual Benefits of Public Trees by Species ($)

Species	Energy	CO2	Air Quality	Storm water	Aesthetic/Other	Total $ Error
Northern white cedar	729	122	-65	1,720	5,182	7,687 (N/A)
Juniper	222	32	-42	645	2,506	3,363 (N/A)
Northern red oak	329	63	27	284	4,791	5,495 (N/A)
Serviceberry	106	21	12	39	1,753	1,931 (N/A)
Sweet mountain pine	212	30	-44	683	2,044	2,926 (N/A)
European white birch	827	161	115	804	6,375	8,282 (N/A)
Black ash	154	30	11	126	3,059	3,380 (N/A)
Paper birch	556	112	77	524	4,663	5,932 (N/A)
Willow	1,064	197	189	1,181	5,261	7,892 (N/A)
Apricot	250	51	47	124	1,966	2,437 (N/A)
Kentucky coffeetree	203	34	18	235	2,132	2,623 (N/A)
River birch	140	27	12	111	2,077	2,365 (N/A)
Western larch	175	32	-14	396	1,780	2,370 (N/A)
Oak leaf mountain ash	60	13	5	26	902	1,006 (N/A)
European mountain ash	226	41	48	119	1,373	1,805 (N/A)
Black walnut	376	75	50	349	3,104	3,953 (N/A)
Rocky mountain juniper	95	13	-26	408	663	1,153 (N/A)
Birch	60	12	4	52	1,926	2,053 (N/A)
Amur maple	79	16	12	37	841	985 (N/A)
Peach	41	9	3	17	689	758 (N/A)
American elm	126	24	12	84	3,295	3,541 (N/A)
Elm	97	19	11	82	1,240	1,450 (N/A)
Western red cedar	380	59	-35	901	1,753	3,058 (N/A)
Maple	38	7	2	17	788	852 (N/A)
Lodgepole pine	90	13	0	210	974	1,286 (N/A)
Russian olive	180	29	39	106	816	1,170 (N/A)
Oak	118	23	13	100	1,322	1,576 (N/A)
English oak	137	28	19	133	1,270	1,587 (N/A)
Northern catalpa	63	12	7	51	855	988 (N/A)
Norway spruce	219	35	-19	515	1,159	1,909 (N/A)
Pin oak	77	11	12	85	638	822 (N/A)
Fir	157	25	36	82	689	990 (N/A)
Bigtooth aspen	39	9	5	20	459	532 (N/A)
Rocky mountain maple	32	6	2	27	708	776 (N/A)
European hornbeam	69	11	3	45	841	970 (N/A)
Bristlecone pine	20	3	-2	30	396	447 (N/A)
Ohio buckeye	42	7	2	28	774	852 (N/A)
White poplar	185	26	39	254	614	1,117 (N/A)
Subalpine fir	92	16	-7	215	726	1,042 (N/A)

Total Annual Benefits of Public Trees by Species ($)

Species	Energy	CO2	Air Quality	Storm water	Aesthetic/Other	Total $ Error
London planetree "blood	19	4	1	12	406	441 (N/A)
Scarlet oak	226	47	42	239	1,097	1,651 (N/A)
Common juniper	46	6	-8	127	232	403 (N/A)
Ginkgo	16	3	1	9	334	363 (N/A)
Eastern redbud	6	1	0	1	168	176 (N/A)
White fir	34	6	-3	79	326	442 (N/A)
White oak	41	8	3	38	589	679 (N/A)
Limber pine	78	13	-6	182	442	707 (N/A)
Lilac	71	11	17	38	278	416 (N/A)
American beech	21	4	2	19	367	413 (N/A)
Northern pin oak	95	19	14	90	657	876 (N/A)
Dogwood	7	1	0	2	126	137 (N/A)
Japanese maple	2	1	0	2	355	360 (N/A)
Sweetgum	9	2	1	5	181	196 (N/A)
Sumac	28	5	6	13	199	250 (N/A)
Grand fir	47	8	-4	112	310	473 (N/A)
Sycamore maple	78	15	9	91	334	528 (N/A)
Mountain ash	6	1	0	2	102	112 (N/A)
Eastern hophornbeam	7	1	0	4	211	224 (N/A)
Tulip tree	6	1	0	4	126	137 (N/A)
Paperbark maple	1	0	0	1	142	144 (N/A)
European larch	6	1	0	4	140	152 (N/A)
Western white pine	1	0	0	1	8	31 (N/A)
White spruce	1	0	0	1	21	22 (N/A)
Mulberry	11	2	1	9	72	95 (N/A)
Black cherry	22	4	3	19	155	204 (N/A)
Honeysuckle	19	3	5	9	81	117 (N/A)
Hickory	1	0	0	0	27	29 (N/A)
London planetree	1	0	0	0	27	29 (N/A)
American hornbean	1	0	0	0	24	25 (N/A)
Amur maackia	2	0	0	1	27	31 (N/A)
Black oak	10	2	1	10	125	148 (N/A)
Citywide Total	**285,117**	**53,055**	**31,874**	**369,745**	**1,719,021**	**2,458,812 (N/A)**

Relative Performance Index for Public Trees

Species	Dead	Very poor	Poor	Fair	Good	Excellent	RPI	# of Trees /Standard Error
Norway maple	0.50	13.64	32.59	39.14	13.84	0.29	0.94	6,627 (N/A)
Green ash	1.11	3.75	13.05	71.67	10.31	0.11	1.05	1,892 (N/A)
Siberian elm	1.38	10.63	34.23	49.35	4.41	0.00	0.93	1,157 (N/A)
Crabapple	0.88	2.98	10.70	25.18	56.05	4.21	1.15	1,140 (N/A)
Honeylocust	1.22	2.34	10.77	23.88	61.18	0.61	1.15	984 (N/A)
OTHER	79.11	3.16	4.18	9.24	3.29	1.01	0.21	790 (N/A)
Red maple	2.30	5.25	15.36	35.60	39.05	2.43	1.07	781 (N/A)
Blue spruce	1.18	3.10	14.60	34.37	38.94	7.82	1.12	678 (N/A)
Quaking aspen	4.12	10.91	19.14	31.69	33.95	0.21	0.99	486 (N/A)
Ponderosa pine	1.29	1.51	5.81	22.15	47.10	22.15	1.21	465 (N/A)
American basswood	1.86	3.26	13.49	25.12	48.60	7.67	1.13	430 (N/A)
Common chokecherry	1.01	1.27	8.35	26.33	61.01	2.03	1.17	395 (N/A)
Box elder	0.26	20.52	49.35	28.31	1.30	0.26	0.82	385 (N/A)
Littleleaf linden	1.36	4.36	16.62	28.34	46.59	2.72	1.10	367 (N/A)
Silver maple	0.93	20.19	39.13	26.40	11.80	1.55	0.87	322 (N/A)
White ash	1.31	3.61	7.21	27.87	57.70	2.30	1.15	305 (N/A)
ACPLCK	0.66	2.33	14.29	54.82	27.57	0.33	1.09	301 (N/A)
Sugar maple	0.33	12.37	20.40	32.11	28.09	6.69	1.03	299 (N/A)
Black cottonwood	8.06	13.92	39.56	30.77	7.69	0.00	0.82	273 (N/A)
Cherry plum	0.38	7.69	15.38	27.69	43.85	5.00	1.09	260 (N/A)
Bur oak	2.02	3.64	6.48	13.77	49.80	24.29	1.20	247 (N/A)
Freeman maple	0.41	5.79	19.01	50.00	24.79	0.00	1.05	242 (N/A)
Douglas fir	1.69	2.95	9.28	24.47	52.74	8.86	1.16	237 (N/A)
FRAMAA	0.49	1.94	7.77	28.64	56.31	4.85	1.17	206 (N/A)
Austrian pine	0.00	0.53	14.89	41.49	37.77	5.32	1.14	188 (N/A)
Plum	0.58	2.34	15.20	29.82	50.29	1.75	1.13	171 (N/A)
Hawthorn	1.24	5.59	20.50	19.88	50.31	2.48	1.08	161 (N/A)
Showy mountain ash	0.71	7.80	14.18	16.31	56.03	4.96	1.11	141 (N/A)
Swamp white oak	2.33	3.88	10.08	21.71	41.86	20.16	1.16	129 (N/A)
American mountain ash	2.34	11.72	12.50	40.63	30.47	2.34	1.03	128 (N/A)
Black locust	2.44	14.63	20.33	50.41	12.20	0.00	0.95	123 (N/A)
Spruce	3.33	2.50	8.33	31.67	45.00	9.17	1.13	120 (N/A)
Pear	0.88	0.00	7.96	30.09	56.64	4.42	1.18	113 (N/A)
Northern hackberry	4.59	12.84	12.84	42.20	26.61	0.92	0.98	109 (N/A)
Eastern cottonwood	3.77	16.04	21.70	32.08	26.42	0.00	0.94	106 (N/A)
Black poplar	4.76	10.48	16.19	57.14	11.43	0.00	0.96	105 (N/A)
Horsechestnut	1.96	5.88	13.73	32.35	41.18	4.90	1.09	102 (N/A)
Engelmann spruce	2.02	4.04	15.15	23.23	55.56	0.00	1.10	99 (N/A)
Scotch pine	1.02	2.04	6.12	29.59	52.04	9.18	1.18	98 (N/A)
Japanese tree lilac	1.03	19.59	14.43	35.05	29.90	0.00	0.98	97 (N/A)
Tatar maple	0.00	2.25	17.98	32.58	46.07	1.12	1.12	89 (N/A)
Ash	10.11	10.11	24.72	42.70	11.24	1.12	0.88	89 (N/A)
Northern white cedar	0.00	0.00	1.35	40.54	58.11	0.00	1.20	74 (N/A)
Juniper	0.00	1.47	22.06	29.41	47.06	0.00	1.11	68 (N/A)
Northern red oak	1.49	5.97	13.43	26.87	44.78	7.46	1.11	67 (N/A)
Serviceberry	6.06	1.52	10.61	27.27	53.03	1.52	1.09	66 (N/A)
Sweet mountain pine	4.84	3.23	3.23	43.55	45.16	0.00	1.10	62 (N/A)

Relative Performance Index for Public Trees

Species	Dead	Very poor	Poor	Fair	Good	Excellent	RPI	# of Trees /Standard Error
Black ash	42.86	23.21	8.93	12.50	12.50	0.00	0.48	56 (N/A)
European white birch	8.93	8.93	17.86	25.00	37.50	1.79	0.96	56 (N/A)
Paper birch	3.70	1.85	16.67	24.07	53.70	0.00	1.09	54 (N/A)
Willow	3.77	18.87	30.19	37.74	9.43	0.00	0.87	53 (N/A)
Apricot	0.00	0.00	19.15	34.04	42.55	4.26	1.13	47 (N/A)
ACSA	2.44	0.00	12.20	17.07	68.29	0.00	1.15	41 (N/A)
Kentucky coffee tree	2.56	0.00	10.26	25.64	33.33	28.21	1.19	39 (N/A)
River birch	0.00	0.00	13.51	40.54	45.95	0.00	1.14	37 (N/A)
Western larch	5.88	5.88	8.82	11.76	26.47	41.18	1.15	34 (N/A)
Oak leaf mountain ash	14.71	11.76	2.94	17.65	35.29	17.65	0.98	34 (N/A)
European mountain ash	0.00	6.25	28.13	40.63	21.88	3.13	1.03	32 (N/A)
Black walnut	3.33	6.67	16.67	36.67	26.67	10.00	1.05	30 (N/A)
Rocky mountain juniper	0.00	17.86	17.86	28.57	32.14	3.57	1.00	28 (N/A)
Amur maple	0.00	7.41	25.93	22.22	44.44	0.00	1.05	27 (N/A)
Birch	0.00	7.41	25.93	14.81	33.33	18.52	1.09	27 (N/A)
American elm	0.00	0.00	7.69	53.85	34.62	3.85	1.15	26 (N/A)
Peach	0.00	7.69	7.69	19.23	50.00	15.38	1.17	26 (N/A)
Western red cedar	0.00	16.00	28.00	40.00	16.00	0.00	0.95	25 (N/A)
Elm	4.00	8.00	12.00	36.00	36.00	4.00	1.05	25 (N/A)
Maple	16.67	8.33	12.50	50.00	8.33	4.17	0.86	24 (N/A)
GLTRS	0.00	8.70	13.04	26.09	43.48	8.70	1.11	23 (N/A)
Lodgepole pine	0.00	4.35	8.70	34.78	21.74	30.43	1.19	23 (N/A)
Russian olive	0.00	4.55	9.09	40.91	40.91	4.55	1.13	22 (N/A)
Oak	15.00	15.00	0.00	30.00	35.00	5.00	0.92	20 (N/A)
Northern catalpa	0.00	0.00	17.65	11.76	41.18	29.41	1.21	17 (N/A)
English oak	0.00	0.00	35.29	11.76	41.18	11.76	1.10	17 (N/A)
Norway spruce	0.00	0.00	0.00	50.00	43.75	6.25	1.20	16 (N/A)
Pin oak	0.00	28.57	7.14	42.86	21.43	0.00	0.94	14 (N/A)
Fir	0.00	0.00	21.43	0.00	50.00	28.57	1.21	14 (N/A)
Bigtooth aspen	0.00	28.57	42.86	0.00	28.57	0.00	0.84	14 (N/A)
Rocky mountain maple	7.69	53.85	0.00	23.08	15.38	0.00	0.71	13 (N/A)
Bristlecone pine	0.00	0.00	8.33	50.00	25.00	16.67	1.18	12 (N/A)
European hornbeam	0.00	16.67	41.67	0.00	41.67	0.00	0.94	12 (N/A)
Ohio buckeye	0.00	0.00	9.09	0.00	63.64	27.27	1.27	11 (N/A)
London planetree "bloodgood"	10.00	10.00	30.00	20.00	20.00	10.00	0.90	10 (N/A)
White poplar	0.00	20.00	20.00	40.00	20.00	0.00	0.95	10 (N/A)
Scarlet oak	0.00	0.00	30.00	20.00	30.00	20.00	1.13	10 (N/A)
Subalpine fir	0.00	10.00	0.00	0.00	60.00	30.00	1.24	10 (N/A)
Ginkgo	11.11	0.00	0.00	22.22	33.33	33.33	1.15	9 (N/A)
Common juniper	0.00	0.00	0.00	100.00	0.00	0.00	1.11	9 (N/A)
Eastern redbud	0.00	0.00	14.29	57.14	28.57	0.00	1.11	7 (N/A)
Limber pine	0.00	0.00	16.67	16.67	66.67	0.00	1.16	6 (N/A)
White oak	0.00	0.00	50.00	50.00	0.00	0.00	0.95	6 (N/A)
White fir	0.00	0.00	0.00	0.00	33.33	66.67	1.38	6 (N/A)

Relative Performance Index for Public Trees

Species	Dead	Very poor	Poor	Fair	Good	Excellent	RPI	# of Trees /Standard Error
Sweetgum	0.00	0.00	20.00	40.00	40.00	0.00	1.11	5 (N/A)
Dogwood	0.00	0.00	0.00	20.00	40.00	40.00	1.30	5 (N/A)
Sumac	0.00	0.00	0.00	40.00	60.00	0.00	1.21	5 (N/A)
American beech	0.00	0.00	0.00	20.00	80.00	0.00	1.24	5 (N/A)
Lilac	0.00	0.00	0.00	40.00	60.00	0.00	1.21	5 (N/A)
Japanese maple	0.00	0.00	0.00	20.00	80.00	0.00	1.24	5 (N/A)
Northern pin oak	0.00	20.00	0.00	40.00	40.00	0.00	1.05	5 (N/A)
Grand fir	0.00	0.00	25.00	0.00	25.00	50.00	1.23	4 (N/A)
Sycamore maple	0.00	25.00	25.00	25.00	25.00	0.00	0.91	4 (N/A)
Mountain ash	25.00	0.00	0.00	25.00	25.00	25.00	0.95	4 (N/A)
Tulip tree	0.00	0.00	0.00	0.00	33.33	66.67	1.38	3 (N/A)
Eastern hophornbeam	0.00	0.00	66.67	0.00	33.33	0.00	0.95	3 (N/A)
Paperbark maple	0.00	0.00	0.00	50.00	50.00	0.00	1.19	2 (N/A)
Western white pine	0.00	0.00	100.00	0.00	0.00	0.00	0.79	2 (N/A)
European larch	0.00	0.00	0.00	50.00	0.00	50.00	1.27	2 (N/A)
CESP	0.00	0.00	0.00	0.00	100.00	0.00	1.27	2 (N/A)
Black cherry	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
Black oak	0.00	0.00	0.00	0.00	0.00	100.00	1.43	1 (N/A)
American hornbean	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
Honeysuckle	0.00	0.00	100.00	0.00	0.00	0.00	0.79	1 (N/A)
Mulberry	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
Hickory	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
London planetree	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
Amur maackia	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
White spruce	0.00	0.00	0.00	0.00	100.00	0.00	1.27	1 (N/A)
Citywide	**4.11**	**8.19**	**20.86**	**36.31**	**27.72**	**2.80**	**1.00**	**22,876 (N/A)**

Replacement Value of Public Trees

Standard Error (±0)

Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total
Norway maple	51,760	148,298	973,228	5,140,621	17,116,055	11,217,589	1,601,132	635,282	160,223	37,044,189
Siberian elm	20,991	48,111	204591	479,990	865,461	1,552,363	935,124	780,661	420,076	5,307,367
Blue spruce	21,423	47,597	153,029	415,433	647,294	858,548	348,121	244,478	85,153	2,821,077
Green ash	32,314	393,835	765,252	196,600	166,814	104,078	35,010	16,159	18,040	1,728,102
Douglas fir	3,371	4,369	53,318	129,102	298,230	550,514	235,523	115,003	172,518	1,561,948
Ponderosa pine	8,453	28,582	169,054	243,179	326,784	339,554	163,915	97,160	41,758	1,418,440
Silver maple	4,508	9,527	42,296	69,528	165,901	95526	343,899	201,179	179,234	1,411,598
Crabapple	66,536	243,347	443,298	271,795	122,530	56,619	13,267	24,551	0	1,241,942
Honeylocust	27,009	113,131	772,099	227,471	83,831	0	0	0	0	1,223,540
Box elder	3,890	9,444	47,484	130,983	255,199	346241	136,419	174010	99,209	1,202,878
Black cottonwood	1,755	12,506	54,301	61,559	160,308	193,732	143,639	221,654	335,033	1,184,486
Sugar maple	11,894	18,638	49,686	71,629	496,136	339,002	65,685	0	0	1,052,671
Black locust	782	3,490	15,468	29,321	105,003	221,567	129,537	124,653	92,778	722,599
Austrian pine	695	2,161	57,888	273,247	267,897	116,283	0	0	0	718,171
Spruce	4,442	8,014	12,863	17,503	84,250	268,667	218,813	55,401	0	669,952
American basswood	30,984	72,282	180,058	79,119	130,020	110,775	18,348	21,194	0	642,780
Littleleaf linden	31,176	62,508	100,202	13,968	101,577	88,089	62,750	0	51,042	511,312
Red maple	59,154	185,719	186,522	50,995	10,668	9,335	0	0	0	502,393
Horsechestnut	6,148	7,127	19,363	66,539	170,402	85,629	103,466	40,986	0	499,659
Quaking aspen	20,372	43,601	131,908	98,483	53,842	44,057	0	11,416	38,261	441,941
Common chokecherry	28,853	75,590	171,735	39,431	30,085	12,787	34,499	0	0	392,980
American mountain ash	3,131	9,181	57,215	85,769	178,225	56,619	0	0	0	390,140
Showy mountain ash	6,910	11,967	54,983	125,756	104,707	20,091	18,574	0	27,431	370,417
Bur oak	18,951	46,183	124,691	72,604	39,640	61,232	0	0	0	363,302
Plum	10,308	20,822	75,358	86,401	64,627	54,803	0	0	0	312,318
Eastern cottonwood	2,167	5,041	24,097	72,786	61,164	47,296	14,004	16,159	54,121	296,835
Engelmann spruce	299	1,912	27,550	76,954	88,713	75,443	20,945	0	0	291,816
White ash	11,439	61,032	167,900	19,040	13,245	0	0	0	0	272,656
Northern white cedar	0	5,513	63,208	14,575	75,378	49,532	19,207	25,400	0	252,813
Scotch pine	1,694	7,585	40,319	80,706	68,888	28,603	0	0	24,553	252,348
Black poplar	1,650	4,550	29,086	23,943	62,242	35,745	30,645	0	43,069	230,929
Cherry plum	20,639	46,690	72,227	47,549	38,999	0	0	0	0	226,105
Hawthorn	13,953	30,103	36,458	32,998	73,486	0	0	0	0	186,999
Freeman maple	11,492	66,344	67,973	9,768	0	4,075	0	0	0	159,652
Sweet mountain pine	551	1,610	18,801	25,305	43,198	28,062	11,240	12,996	0	141,764
Willow	953	2,132	6,344	12,201	21,760	15,163	29,143	16,004	30,370	134,070
Juniper	251	5,355	19,280	20,031	34,266	21,288	16,860	0	16,594	133,925
European white birch	1,096	3,454	29,260	24,145	31,292	10,558	10,890	14,381	0	125,075
Swamp white oak	14,894	29,415	55,508	13,207	9,591	0	0	0	0	122,617
Western red cedar	313	490	7,506	14,054	33,166	46,229	0	0	0	101,759
Paper birch	3,232	6,845	10,530	25,245	11,171	28,080	16,289	0	0	101,393
Pear	12,205	25,230	42,827	17,208	0	0	0	0	0	97,470
European mountain ash	938	4,232	11,610	16,227	26,734	9,132	0	0	27,431	96,303
Rocky mountain juniper	134	0	4,551	16,949	30,722	2,903	7,025	14,853	16,594	93,730
Russian olive	0	3,284	13,842	8,693	11,139	36,528	0	17,536	0	91,023
Apricot	1,649	8,026	22,103	23,760	30,075	0	0	0	0	85,615
Tatar maple	7,246	21,280	21,746	27,368	6,425	0	0	0	0	84,065
Fir	455	1,240	2,009	10,431	33,417	31,049	0	0	0	78,602
Black walnut	1,443	3,140	8,420	17,862	26,536	11,931	0	0	0	69,332
Scarlet oak	0	2,017	1,703	0	10,144	31,458	19,200	0	0	64,522

Replacement Value of Public Trees

Standard Error (±0)

Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total
Norway spruce	208	0	7,248	13,472	13,337	30,043	0	0	0	64,307
Northern hackberry	15,618	9,197	10,959	7,699	6,852	12,796	0	0	0	63,120
Ash	2,541	13,429	32,727	8,307	0	0	0	0	0	57,004
Western larch	1,286	4,962	13,234	13,013	9,045	13,208	0	0	0	54,749
Lilac	0	0	1,912	4,311	17,716	0	22,476	0	0	46,414
White poplar	0	1,022	2,068	0	0	0	9,751	18,370	14,356	45,567
Japanese tree lilac	10,325	19,035	10,514	0	3,543	0	0	0	0	43,418
Serviceberry	10,389	9,414	1,748	5,180	9,954	0	0	0	0	36,685
Northern red oak	2,768	6,776	23,072	3,373	0	0	0	0	0	35,990
Kentucky coffee tree	4,391	5,206	19,065	0	6,962	0	0	0	0	35,623
English oak	1,523	2,431	7,324	0	0	18,338	0	0	0	29,616
Pin oak	1,725	1,164	3,193	0	0	0	0	22,179	0	28,261
Common juniper	0	282	0	10,786	8,271	6,773	0	0	0	26,112
Subalpine fir	0	1,041	6,716	9,890	8,040	0	0	0	0	25,688
Limber pine	0	509	1,571	10,733	0	11,288	0	0	0	24,102
Lodgepole pine	1,046	2,967	7,569	12,158	0	0	0	0	0	23,741
Amur maple	998	6,799	3,101	4,020	7,726	0	0	0	0	22,644
Oak	1,925	1,784	6,598	3,734	8,115	0	0	0	0	22,157
American elm	3,829	2,623	2,456	5,231	5,786	0	0	0	0	19,926
River birch	4,518	3,878	7,853	3,606	0	0	0	0	0	19,855
Sycamore maple	0	0	0	7,457	10,923	0	0	0	0	18,380
Elm	3,348	3,016	2,105	0	0	9,433	0	0	0	17,903
Grand fir	0	0	2,765	4,685	8,040	0	0	0	0	15,490
Northern pin oak	0	194	1,303	2,769	11,171	0	0	0	0	15,436
Oak leaf mountain ash	2,332	8,983	1,786	0	0	0	0	0	0	13,101
White fir	179	1,611	1,631	0	9,406	0	0	0	0	12,828
Black ash	2,471	6,727	3,419	0	0	0	0	0	0	12,618
Northern catalpa	2,685	3,586	0	0	4,790	0	0	0	0	11,062
Birch	4,400	2,034	0	0	4,297	0	0	0	0	10,731
Sumac	455	584	1,563	0	7,797	0	0	0	0	10,399
Bigtooth aspen	626	1,313	7,591	0	0	0	0	0	0	9,530
Peach	3,412	4,743	1,340	0	0	0	0	0	0	9,495
European hornbeam	232	4,505	2,278	0	0	0	0	0	0	7,016
Ohio buckeye	1,548	3,277	1,822	0	0	0	0	0	0	6,647
Honeysuckle	0	0	0	0	5,570	0	0	0	0	5,570
Maple	3998	1,486	0	0	0	0	0	0	0	5,484
White oak	0	969	3,419	0	0	0	0	0	0	4,389
Bristlecone pine	518	1,691	1,916	0	0	0	0	0	0	4,125
Rocky mountain maple	540	2,797	0	0	0	0	0	0	0	3,336
Ginkgo	1,914	1,410	0	0	0	0	0	0	0	3,324
Black cherry	0	0	0	3,165	0	0	0	0	0	3,165
American beech	249	1,551	1,303	0	0	0	0	0	0	3,102
London planetree "blood	1,293	1,422	0	0	0	0	0	0	0	2,714
Dogwood	891	1,252	0	0	0	0	0	0	0	2,143
Mulberry	0	0	1,822	0	0	0	0	0	0	1,822
Japanese maple	1,509	0	0	0	0	0	0	0	0	1,509
Sweetgum	959	517	0	0	0	0	0	0	0	1,476
Black oak	0	0	1,465	0	0	0	0	0	0	1,465
Mountain ash	287	1,167	0	0	0	0	0	0	0	1,455
Eastern redbud	1,393	0	0	0	0	0	0	0	0	1,393

Replacement Value of Public Trees

Standard Error (±0)

Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total
Tulip tree	648	680	0	0	0	0	0	0	0	1,327
Eastern hophornbeam	387	655	0	0	0	0	0	0	0	1,042
European larch	271	737	0	0	0	0	0	0	0	1,008
Amur maackia	0	584	0	0	0	0	0	0	0	584
Paperbark maple	580	0	0	0	0	0	0	0	0	580
White spruce	284	0	0	0	0	0	0	0	0	284
London planetree	284	0	0	0	0	0	0	0	0	284
Hickory	284	0	0	0	0	0	0	0	0	284
American hornbean	227	0	0	0	0	0	0	0	0	227
Western white pine	205	0	0	0	0	0	0	0	0	205
Citywide Total	**686,003**	**2,122,566**	**5,927,207**	**9,261,622**	**23,054,578**	**17,718,654**	**4,835,393**	**2,921,667**	**1,947,844**	**68,475,533**

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