PITTSBURGH URBAN FOREST MASTER PLAN

A Road Map for the Effective Management of our Urban Forest
“To exist as a nation, to prosper as a state, to live as a people, we must have trees.”

— Theodore Roosevelt
Pittsburgh Urban Forest Master Plan
A Road Map for the Effective Management of Our Urban Forest

2012

Prepared for:
Tree Pittsburgh
5427 Penn Avenue, Pittsburgh, Pennsylvania 15206
412-362-6360

Prepared by:
Davey Resource Group
1500 North Mantua Street
P.O. Box 5193
Kent, Ohio 44240
800-828-8312
Steering Committee Members

Danielle Crumrine  
Tree Pittsburgh

Matthew Erb  
Tree Pittsburgh

Lisa Ceoffe  
City Forester, City of Pittsburgh

Jeffrey Bergman  
Western Pennsylvania Conservancy, TreeVitalize® Pittsburgh

Phil Gruszka  
Pittsburgh Parks Conservancy

Andrew Dash  
Department of City Planning, City of Pittsburgh

Jenny Arkett  
Duquesne Light Pittsburgh Shade Tree Commission

Dr. Bill Elmendorf  
The Pennsylvania State University

Matt Smuts  
Urban Redevelopment Authority of Pittsburgh

Judy Wagner  
Western Pennsylvania Conservancy

Ellen Roane  
Pennsylvania Department of Conservation & Natural Resources Bureau of Forestry

Joe Gregory  
Davey Resource Group

Megan Cieslak  
Allegheny County Sanitary Authority (ALCOSAN)

Janie French  
Pennsylvania Environmental Council

Steve Quick  
Remaking Cities Institute, Carnegie Mellon University

Bethany Davidson  
Pittsburgh Community Reinvestment Group

Anne Cumming  
United States Department of Agriculture Forest Service

Project Team

Tree Pittsburgh provided funding, oversight, and direction.

City of Pittsburgh provided information regarding existing city plans and the urban forest program budget.

Davey Resource Group completed the street tree inventory and management plan [1], the park tree inventory [2], the municipal forest resource analysis (STRATUM) [3], and the i-Tree ecosystem analysis [4], and prepared this Urban Forest Master Plan in collaboration with Tree Pittsburgh and the master plan Steering Committee.

Jackson/Clark Partners facilitated the Pittsburgh Urban Forest Master Planning Benchmarking Report [5] and the comprehensive public outreach campaign to engage a wide range of stakeholders in the master planning process.

University of Vermont Spatial Analysis Lab provided the urban tree canopy analysis. [6]

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Trees provide many benefits to the City of Pittsburgh. This mature oak tree on the cover, growing in the West End Overlook, provides estimated benefits of $165 each year. [7] If it is properly cared for, these benefits will continue to accrue positively over time. When taking into account the 2.6 million trees across the City, the magnitude of benefits compels our community to connect with and engage partners to plan for, protect, and manage this vital resource for future generations.

Cover photograph taken by Joey Kennedy
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EXECUTIVE SUMMARY

Introduction

Pittsburgh is situated on a point where the Allegheny and Monongahela Rivers join to become the Ohio River. In 1753, George Washington secured a British outpost on this point and since that time Pittsburgh has been ever changing. In the beginning, Pittsburgh relied heavily upon fire and trade, but as the settlers moved in, the Native Americans were pushed out of the area. With modernization, inventions, and progress came an era of industrialism, and Pittsburgh became an important manufacturing and commercial center to the region, thriving from its oil, iron, and steel industries. The benefits of trees, including their aesthetic value, were not fully understood, and trees were cleared to make way for prosperity. It was not until well after the Industrial Revolution that the City and its residents realized the need for urban trees.

Once the steel capital of the world, the growth of Pittsburgh and its economy was fueled by heavy industry and the extensive trade of steel—to the detriment of local air and water quality and ultimately human health. After the collapse of the region’s steel industry, Pittsburgh successfully adapted by shifting its industry base to health care, education, technology, and financial services, and Pittsburgh is now a thriving city once more.

Pittsburgh has been ranked as the #1 Most Livable City in the United States in several independent studies since 2007—most recently in February, 2011 by the London-based Economist Intelligence Unit; then in May, 2010 by Forbes; and by Places Rated Almanac in 2007. [8,9,10] This is an honor in which the City takes great pride. The role Pittsburgh’s urban forest played in this remarkable transformation from smoke and soot covered to green is significant.

Pittsburgh's urban forest—including all trees on public and private lands within the city boundaries—softens the industrial landscape and provides a green sanctuary in an otherwise unforgiving hardscape, which greatly contributes to the City’s livability. The City’s street and park trees, and all trees on private lands, play a prominent role in the benefits afforded to the community by the City, and the community relies on a series of partnerships, community groups, and city departments to maintain and care for this resource.

This Urban Forest Master Plan is intended to bring the community together around a shared vision for our urban forest, creating substantial returns from this investment, and ensuring that it thrives for future generations.

Framework

The plan recognizes that the relationship between trees and people and places is beneficial. Trees positively affect human and public health and are valuable assets to our community, as they provide us many environmental, economic, and social benefits. The keystones, goals, and recommendations established in this plan will guide us to achieving our vision for the urban forest, and are stretched beyond the basic tenants of the right tree right place concept. We must work together as partners in the urban forest to consider tree choices and locations in light of the overall benefits trees provide and how these benefits can positively influence our city as a whole, while making positive changes at the neighborhood level.

The shared vision for the urban forest will be achieved through a coordinated effort of all public and private entities working in partnership to implement the recommendations of this plan. The appropriate urban forest partner will take the lead to coordinate and oversee the implementation of assigned recommendations.

The Appendix of this plan contains a list of acronyms, a glossary, references cited, tree diversity goals and recommendations, and a DVD with a compendium of existing data, plans, and reports.

Planning Process

The plan was guided by Tree Pittsburgh, a nonprofit environmental organization dedicated to enhancing the City’s vitality by restoring and protecting city trees, and by the Pittsburgh Urban Forest Master Planning Steering Committee. The framework for the process was based on understanding what we have, what we want, how we get there, and how we are doing. This process is referred to as adaptive management and is commonly used for resource planning and management. [11] This model provides a good conceptual framework for the process of improving urban forest management and it serves as the structure for how this plan has been organized.
What Do We Have?

The urban forest framework includes all of the existing forest management resources and plans already in place and that the many urban forestry management partners share in planting, caring for, and maintaining our urban forest. The 2012 state of the urban forest section summarizes data obtained from the street tree inventory and management plan (2005), the park tree inventory (2007), the municipal forest resource analysis (2008), the i-Tree ecosystem analysis (2011), and the Urban Tree Canopy Analysis (2011). [1,2,3,4,6]

### Pittsburgh Urban Forest Benchmark Values

**Urban Tree Canopy (UTC) Cover (2011)**
- UTC, all areas: 40%
- UTC, excluding water: 42%

**Estimated Tree Count**
- Street Trees (2005): 30,538
- Park Trees (2007): 5,666
- Complete Urban Forest (2011): 2,628,000
- Street Trees Per Capita (2008): 0.09
- Total Trees Per Capita (2011): 8.7

**Species Diversity**: # of Species Exceeding the Recommended 10%
- Street Trees (2005): 4
- Park Trees (2007): 1
- Complete Urban Forest (2011): 2

**Pest Susceptibility (2011)**
- Asian Longhorned Beetle: 1,780,000 Trees (67%)
- Emerald Ash Borer: 250,000 Trees (9%)
- Dutch Elm Disease: 220,000 Trees (8%)
- Gypsy Moth: 175,000 Trees (7%)

**Street Tree Benefits (2008)**
- Total Annual Benefit: $2,400,975
- Annual Per Tree Benefit: $53
- Annual Per Capita Benefit: $8

**Urban Forest Benefits (2011)**
- Total Annual Benefit: $7,232,600
- Annual Per Tree Benefit: $3
- Annual Per Capita Benefit: $24

**Structural Value**
- Street (2005): $37 million
- Park (2007): $16.5 million
- Complete Urban Forest (2011): $1.13 billion

Our urban forest is comprised of all trees on private and public lands within the city boundaries; these trees improve the environment and make our city a more desirable place to live, work, and play.
What Do We Want?

Our shared vision for the urban forest was based on the outreach campaign, Tell Us Your Tree Story. The campaign engaged urban forest partners and the public through tree volunteer meetings, partner surveys, public surveys, and community meetings. The vision was established by synthesizing feedback from the public, the Steering Committee, and Tree Pittsburgh as to what everyone wants out of their urban forest over the next 20 years. The process revealed the community most valued trees for their ability to improve the quality of life and help define Pittsburgh’s character.

How Do We Get There?

Goals and recommendations based on the keystones of urban forestry—connect, engage, manage, plan, and protect—will guide us to achieving our 20-year vision for the urban forest. Recommendations are established by analyzing current conditions and issues related to urban forestry management across the City. The vision, keystones, and goals are presented below with recommendations considered the top priority for implementation.

Over the next 20 years, Pittsburgh’s urban forest will be a vital and well-managed asset that is locally valued and nationally recognized for its positive social, environmental, economic, and public health impacts on the community and the greater region.

How Are We Doing?

Implementation of the plan requires continual monitoring, analysis, and revision. Progress towards accomplishing recommendations and reaching the shared vision will need to be measured and shared with urban forest partners. A report card and a state of the urban forest report that measure how we are doing will be created to keep stakeholders aware of accomplishments made and efforts yet to be realized.
INTRODUCTION

Purpose

Tree Pittsburgh and their partners developed this Urban Forest Master Plan for the City of Pittsburgh as well as for all who manage, protect, and plant trees. Our urban forest is comprised of all trees on private and public lands within the city boundaries; these trees improve the environment and make our city a more desirable place to live, work, and play. This plan provides detailed recommendations for the proactive management, protection, and growth of Pittsburgh’s urban forest and describes a shared vision for the future of our urban forest to inspire and engage residents, business owners, elected officials, and community organizations. The purpose of the plan is to:

- Address environmental challenges.
- Coordinate a shared vision for the future of our urban forest.
- Develop baseline metrics and clear goals for urban forest managers.
- Cultivate lasting advocacy and increase civic participation.
- Facilitate efficiency and cooperation among all urban forest partners.

Project Background

Tree Pittsburgh is a nonprofit, environmental organization dedicated to enhancing the City’s vitality by restoring and protecting city trees. In the summer of 2010, Tree Pittsburgh launched Pittsburgh’s Urban Forest Master Planning initiative—Trees for the Future. Tree Pittsburgh hosted a symposium, convening over 50 key stakeholders from Pittsburgh, the region, and the nation, to begin the work of creating a master plan for the urban forest. The symposium resulted in the development of a collaborative framework to make preliminary fundraising efforts and to form the Pittsburgh Urban Forest Master Planning Steering Committee.

To gain insight and to better inform the work being done in Pittsburgh, the Steering Committee evaluated the urban forest planning efforts in six other US cities. The Pittsburgh Urban Forest Master Planning Benchmarking Report provides a summary of the outcomes across key focus areas of the urban forest programs for the six cities studied: planning process, leadership, partnership, community, marketing, urban forest data analysis, and funding. [5]

In 2011, after a year of steady preparation and planning, the Steering Committee, led by Tree Pittsburgh, selected a project team to begin an intensive community outreach and education initiative and to create this Urban Forest Master Plan for protecting, growing, and maintaining our urban forest.

Process

Developing an urban forest master plan requires continual assessment of what we have, what we want, how we get there, and how we are doing. The planning process requires input from many sources, thoughtful analysis, a coordinated vision, and time.

What do we have? The Urban Forest Management Framework section of this plan describes how our trees are currently managed and cared for by public agencies and stakeholder groups, and it provides an overview of existing urban forest plans. The 2012 State of the Urban Forest section summarizes data obtained from the street tree inventory and management plan, the park tree inventory, the municipal forest resource analysis, the i-Tree ecosystem analysis, and the urban tree canopy analysis. [1,2,3,4,6]

What do we want? A comprehensive, public outreach campaign was designed to engage stakeholders and to identify key issues. The results were used to formulate and clarify the overall shared vision for the future of our urban forest.

How do we get there? Keystones of urban forestry and the goals for achieving the 20-year vision for the urban forest are established. Recommendations are developed from careful review of 15 urban forestry management issues. Case studies are presented to illustrate successful implementation of these recommendations.

How are we doing? Continual monitoring will be needed to measure the progress towards established goals. Recommendations are categorized by stakeholder groups so that all who care for our urban forest can work toward achieving a unified vision. As progress is made, further evaluation will be needed to refine the future goals of the urban forest program.
Historical Background

Shade Tree Commission

The City’s awareness of the need to protect its urban trees can be documented as early as 1879, when its first tree preservation ordinance was adopted, making it illegal for people to tie their horses to street trees. In 1895, the Civic Club of Allegheny County was formed to better municipal government, improve social conditions, increase educational opportunities, and create a more beautiful city. In 1904, a Forestry Committee was created within the Civic Club to advocate for the City’s involvement in tree care and pest protection. The committee sent frequent requests to the City to enforce the law by fining drivers for tying horses to trees, and the chair of the Forestry Committee published several articles on how to beautify Pittsburgh by planting and pruning trees. [12]

As a result of Pennsylvania legislation allowing municipalities to create commissions to regulate the planting and care of street trees, and with the urging of the Civic Club of Allegheny County, the City of Pittsburgh created a Shade Tree Commission in 1910. The Commission chose trees that were the most suitable for Pittsburgh’s streets and advised homeowners on proper tree care. William Grimes, a graduate of Yale Forestry School, was appointed the first City Forester. By 1914, funding for the Commission was cut and the Commission was disbanded. [12]

The Shade Tree Commission was re-established in 1998 in response to the recommendation from the Carnegie Mellon University (CMU) report, Pittsburgh's Urban Forest: Planting for the Future [13]. Today, the Shade Tree Commission is a nonprofit organization, linked to the Mayor’s Office, tasked with restoring and maintaining the City’s tree population and directing the expenditure of funds from the Shade Tree Trust Fund to advance urban forestry initiatives. [12]

Carnegie Mellon University Report

A consortium of Carnegie Mellon University (CMU) graduate departments conducted a study of Pittsburgh’s urban forest in 1995. The report, Pittsburgh’s Urban Forest: Planting for the Future, described an urban forest that was clearly in decline. The CMU report made three key recommendations: re-establish the Shade Tree Commission, improve the maintenance of young trees, and conduct a comprehensive inventory of Pittsburgh’s street trees. [13]

In 1879, Pittsburgh adopted a tree preservation ordinance, making it illegal for people to tie their horses to trees. The fine was $5.00 or 10 days in the workhouse.

Municipal Forestry Program

In 1914, a Street Tree Division was formed within the City’s Bureau of Parks. The Street Tree Division took over the responsibilities of the dissolved Shade Tree Commission, including the care and planting of street trees, and the care of young trees in the City’s nursery located within Highland Park [12].

During prosperous times in the 1970s, the Forestry Division, located within the Department of Public Works, maintained a staff of over 30 people, including a City Forester. By the 1990s, with the decline of the economy and population within the City, the Forestry Division was reduced to a staff of 12 people. Continued funding cutbacks restricted the Division’s ability to plant and properly maintain trees. [12]

An urban forest position was created within the City Planning Department in 2008. The primary responsibilities of the Urban Forester included reviewing proposed developments, serving on the Shade Tree Commission, and supporting neighborhood greening projects. The City Forester position within the Forestry Division remained responsible for operations, permitting, technical support, and was primarily consumed with conducting inspections of sidewalks to assess damage caused by city trees and related liability. [12]

In early 2012, with the departure of the City Forester, the position of Urban Forester and their responsibilities were moved to the Forestry Division within the Department of Public Works. The Urban Forester assumed the responsibilities and title of the vacant City Forester position.

Today, Pittsburgh’s Forestry Division includes a City Forester, Forestry Foreman (second in command), and 14 supporting staff; they are responsible for the care of over 30,000 street trees, forested rights-of-way, and an extensive network of parks and other greenspaces. Due to budget constraints, the division does not have staff to conduct preventive care and operates only in crisis-management maintenance. The City Forester works to coordinate with nonprofit groups involved in the care and maintenance of trees, reviews development plans for impacts to city trees, reviews and approves permits, provides technical support, and works with the Forestry Foreman to clear the backlog of requests to inspect and assess property and sidewalk damage caused by city trees, and to coordinate contracts related to tree pruning. The Urban Forester position remains vacant within the Forestry Division.
Parks

The Pittsburgh Parks Conservancy was founded in December, 1996 by a group of citizens concerned with the deteriorating conditions of Pittsburgh’s parks. In 1998, the Conservancy signed an official public-private partnership agreement with the City of Pittsburgh with the mission to improve quality of life for the people of Pittsburgh by restoring the park system to excellence in partnership with the City. [14]

Today, Pittsburgh’s park system comprises 2,887 acres and includes 5 large regional parks (the four historic regional parks and the newly created Emerald View Park) and 141 smaller parks. [14]

**Schenley Park**, the first city park, was created in 1889 from land donated by Captain Edward Schenley and his wife, Mary. Schenley Park is listed on the National Register of Historic Places as a historic district between the neighborhoods of Oakland, Greenfield, and Squirrel Hill. The park is made up of 434 acres, making it the second largest park in Pittsburgh. [14]

**Highland Park** was created to address Pittsburgh’s need for a municipal water system. In 1879, a drinking water reservoir was created for the City in an area surrounded by public land and green space. People were attracted to the site for its scenic beauty, and the reservoir became increasingly popular for picnics and passive recreation. In 1889, the City established Highland Park by ordinance; this park is 378 acres and includes the Reservoir Loop, a favorite trail for walkers and joggers. [14]

**Riverview Park** is a jewel of Pittsburgh’s North Side. Created in 1894, the park predates the City of Allegheny’s annexation to the City of Pittsburgh in 1907. Formed largely from farmland, today’s Riverview Park is 259 acres and is known for its dense woodlands, steep hillsides, and wooded trails. [14]

**Frick Park** today includes 644 acres and is the largest park. It opened in 1927 and includes land bequeathed by Henry Clay Frick. Recently, 106 acres were annexed to the park through the process that created the Summerset at Frick Park housing development and restored the Nine Mile Run stream valley. Frick Park now stretches from its northern borders in Point Breeze down to the Monongahela River. [14]

**Emerald View Park**, formerly known as the Grand View Scenic Byway, totals 257 acres and was transferred from the Allegheny Land Trust to the City in 2010. The park overlooks the Allegheny and Monongahela Rivers and preserves the scenic views from the Mount Washington hillside. The Mount Washington Community Development Corporation together with the City of Pittsburgh oversees the management of Emerald View Park. [14]

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Tree Pittsburgh

Members of the Shade Tree Commission and concerned citizens recognized a long-felt need for a nonprofit organization dedicated to the health and well-being of our urban forest. In 2006, Friends of the Pittsburgh Urban Forest was founded with the mission to enhance the City's vitality by restoring and protecting the urban forest through tree maintenance, tree planting, community education, and advocacy. The organization’s vision is to be a leader in creating a healthy, attractive, and safe urban forest by inspiring and engaging citizens to maintain, plant, and protect trees.

In 2010, Friends of the Pittsburgh Urban Forest changed its name to Tree Pittsburgh.

**TreeVitalize®**

TreeVitalize® is Pennsylvania Department of Conservation and Natural Resources (DCNR) partnership to restore tree cover in Pennsylvania communities, educate citizens about planting trees as an act of caring for our environment, and build capacity among local governments to understand, protect, and restore their urban trees. The program began in southeast Pennsylvania in partnership with the Pennsylvania Horticultural Society. In 2004, the Pennsylvania DCNR launched TreeVitalize® to increase public awareness of the importance of community trees and to reverse the loss of tree cover in the state’s metropolitan areas. In 2008, the Pennsylvania DCNR expanded the TreeVitalize® program to the Pittsburgh region, and a Project Director was hired through the Western Pennsylvania Conservancy. Today, TreeVitalize® Pittsburgh is a joint project of Allegheny County, The City of Pittsburgh, the Pennsylvania DCNR, the Western Pennsylvania Conservancy, and Tree Pittsburgh. By the end of 2012, TreeVitalize® will have planted 20,000 trees in the Pittsburgh region.
Urban Forest Management Framework

A successful urban forestry program requires organized leadership; comprehensive baseline studies; dedicated personnel; effective community involvement; adequate funding; and a coordinated planning effort to protect, manage, and grow the urban forest. [15]

Pittsburgh, much like other financially constrained cities, relies on assistance from many public and private entities to manage the urban forest. These partners understand that the public investment and stewardship of the urban forest produces benefits that far outweigh the costs and that investing in Pittsburgh’s green infrastructure makes sense economically, environmentally, and socially. The complexity of managing so many partners presents challenges. Having many different partners can lead to roadblocks, inefficiencies, and makes coordinating projects challenging.

The existing management framework described below includes several current plans and resources related to urban forest management and review of the roles and responsibilities of the primary public and private entities that are collectively responsible for the future of our urban forest.

Existing Urban Forest Management Resources


Pittsburgh Code of Ordinances, Title Nine: Zoning Code, Article VI: Development Standards includes landscaping and tree requirements intended to encourage planting appropriate vegetation and the preservation of existing vegetation to enhance the built environment, to protect and sustain the natural environment, and to reduce potential nuisances by requiring a visual screen (http://library.municode.com/index.aspx?clientId=13525). [16]

Regional Parks Master Plan (2001) contains a history of each of the four historic parks, environmental conditions, and recommendations for future projects and maintenance (Appendix E). [17]

An Ecological and Physical Investigation of Pittsburgh Hillsides (2004) describes the beneficial role of natural wooded hillsides and considers the use of zoning restrictions to protect them. Steep slopes account for approximately 11% of the landscape within Pittsburgh’s city limits (Appendix E). [18]

Street Tree Inventory and Management Plan (2005) is a comprehensive, seven-year action plan for Pittsburgh’s inventoried tree population. The management plan includes an analysis of the current tree population, the environment in which they grow, and maintenance needs, as well as long-range management recommendations (Appendix E). [1]

Park Tree Inventory (2007) is a park and greenspace tree inventory of four prominent parks—Schenley, Highland, Riverview, and Frick. Data were collected for over 5,600 publicly managed park trees, including landscape trees and trees with associated heightened risk (Appendix E). [2]

Municipal Forest Resource Analysis (2008) provides the benefits of street trees and the cost of maintenance was calculated using the 2005 street tree inventory and i-Tree Streets benefits modeling software from the USDA Forest Service. The results of the analysis are still used today to promote management decisions that will improve human health and environmental quality (Appendix E). [3]

The Allegheny Riverfront Plan (2010) establishes six vision goals for the Allegheny Riverfront. The vision for the plan recognizes the benefits that trees provide and recommends a tree canopy goal of 40% cover (Appendix E). [19]

Pittsburgh Regional Parks Natural Areas Study (2010) is part of a multi-phased, natural areas program for the long-term study of the ecological management of Schenley, Highland, Riverview, and Frick Parks (Appendix E). [20]

i-Tree Ecosystem Analysis (2011) assessed the vegetation structure, function, and value of the entire urban forest (public and private) in Pittsburgh. Data collected from field plots located throughout Pittsburgh were analyzed using the i-Tree Eco model developed by the USDA Forest Service (Appendix E). [4]

Urban Tree Canopy Analysis (2011) was performed based on 2010 data and using the USDA Forest Service’s Tree Canopy Assessment Protocols. Establishing tree canopy goals is crucial for communities seeking to improve their green infrastructure. A tree canopy assessment is the first step in this goal-setting process, providing estimates for the amount of tree canopy currently present in a city as well as the amount of tree canopy that could theoretically be established (Appendix E). [6]

OpenSpace PGH (estimated completion date, 2012) is one component of PlanPGH and will address issues of ownership, management, maintenance, and connectivity of Pittsburgh’s open space systems. The Open Space Plan will provide the City a clear direction in land use and infrastructure decisions by identifying the best use of Pittsburgh’s vacant, green, and recreational spaces and their associated programming (http://planpgh.com/). [21]

PlanPGH (plan adoption, 2014), the City’s first Comprehensive Plan, has the goal of enhancing quality of life in Pittsburgh through the effective and efficient use of its natural systems, infrastructure, cultural assets, recreational amenities, and economic resources. This Urban Forest Master Plan is the detailed planning effort that will help implement the vision and goals of the Open Space Plan (OpenSpacePGH), which is one component of PlanPGH (http://planpgh.com/). [21]
Local Non-Government Organizations

- Mount Washington Community Development Corporation works with the City of Pittsburgh to oversee the management of Emerald View Park.
- Pittsburgh Parks Conservancy works in partnership with the City to restore the City’s park system.
- Tree Pittsburgh is dedicated to enhancing the City’s vitality by restoring and protecting city trees.
- Tree Tenders is a group of volunteers organized and trained by Tree Pittsburgh dedicated to making a difference in Pittsburgh by planting and caring for our trees.
- TreeVitalize® Pittsburgh is a Pennsylvania DCNR partnership to restore tree cover in Pennsylvania communities, educate citizens about planting trees as an act of caring for our environment, and build capacity among local governments to understand, protect, and restore their urban trees.
- Urban EcoSteward Program is a group of volunteers trained by the Pittsburgh Parks Conservancy who maintain specific sections of park land.
- Western Pennsylvania Conservancy protects and restores exceptional places to provide our region with clean waters and healthy forests, wildlife, and natural areas for the benefit of present and future generations.

Private Groups

- Cemeteries maintain trees on large parcels of land owned by private cemetery organizations.
- Duquesne Light Company supports Arbor Day activities, provides volunteers, and coordinates with the Forestry Division to provide line clearance where street trees and overhead utilities intersect.
- Residents plant and maintain trees on their properties and volunteer through the Tree Tender and Urban EcoSteward Programs.
- Private Universities and Colleges conduct research related to urban forestry related issues and provide interns to many nonprofit groups. Plant and maintain trees on campuses.
- Tree Care Companies work under contract and in partnership with the urban forest partners to provide expertise and tree care.

Public Agencies

- Allegheny County is responsible for managing nine county parks.
- Bureau of Building Inspection is responsible for inspecting and assessing sidewalk and property damage caused by trees.
- Department of City Planning sets the framework for the City’s development through policy and development review by the Planning Commission and through administration of the zoning ordinance.
- Forestry Division, part of the Department of Public Works, is responsible for removing, pruning, and planting trees; inspecting, permitting, installing holiday trees, and enforcing ordinances.
- Streets/Parks Maintenance Division is a division of the Department of Public Works responsible for maintaining trees within Pittsburgh’s parks and along streets.
- Pennsylvania Department of Conservation and Natural Resources is responsible for maintaining and preserving the state’s 117 state parks and 20 state forests; providing information on the state’s natural resources; and working with communities to benefit local recreation and natural areas.
- Pennsylvania Department of Transportation plants and maintains trees along state and federal highways.
- Pittsburgh Shade Tree Commission is commissioned by the Mayor’s office with the task of restoring and maintaining the City’s tree population.
- Public Universities and Colleges conduct research related to urban forestry related issues and provide interns to many nonprofit groups. Plant and maintain trees on campuses.
- United States Department of Agriculture Forest Service provides grants and technical assistance to urban forestry related projects.
2012 State of the Urban Forest

Pittsburgh’s Urban Forest Structure and Function

An urban forest is defined as all of the woody and herbaceous vegetation found within an urban area, including street trees; trees on private property; trees on public areas, in city parks, and along river corridors; and wooded areas. Since 2005, several studies have been commissioned in order to get a clearer understanding of the complex interaction of our urban forest with the rest of the City—its citizens, businesses, buildings, streets, and other infrastructure. Some of these studies compiled a baseline data set, others quantified the benefits that trees provide, and others established benchmarks and determined goals for managing this complex resource. This 2012 State of the Urban Forest summarizes the results of those studies, which serve as the basis for many of the recommendations in this plan.

Trees are an integral component of any community’s environment, adding tremendous value to the landscape. [22] Trees provide shade and act as windbreaks, helping to decrease commercial energy consumption. They help stabilize the soil by controlling wind and water erosion, and they improve water quality by reducing stormwater runoff. They also help buffer noise levels, cleanse pollutants from the air, produce oxygen and absorb carbon dioxide, and provide habitat for wildlife. Beyond the many environmental and economic benefits trees provide, they positively impact human health and improve our quality of life through a host of psychological and social benefits. With proper care and protection, a tree’s value will appreciate over time. In 2008, Tree Pittsburgh commissioned a municipal forest resource analysis that utilized data from the 2005 tree inventory to calculate the benefits street trees provide and to compare those benefits with the cost of maintenance. [1,3]

The benefits that trees provide extend beyond what is calculated only from those trees on public lands (street and park trees); trees on private property comprise the majority of our urban forest within the City. Tree Pittsburgh: the 2011 i-Tree Ecosystem Analysis and the 2011 Urban Tree Canopy Analysis. [4,6]

Urban Forest Resource Structure

The 2011 i-Tree Ecosystem Analysis, completed by Davey Resource Group, revealed that Pittsburgh’s urban forest contained an estimated 2,628,000 trees, with an overall tree density of 73.4 trees per acre. Over 58% of our urban forest is comprised of relatively young trees (less than 6 inches in diameter at 4.5 feet above ground). Citywide, the three most common species are black locust (13%), Norway maple (12%), and black cherry (11%). Trees on residential land make up the highest percentage of the resource (32%), followed by commercial land (26%) and public/government land (23%). Norway maple is estimated to make up 16% of all trees on residential land. The average acre of residential land has 36 trees on it, 11.5 of which are maple. Monoculture (an overly large number of the same species) should be avoided as much as possible, for a species-specific pest or disease can cause significant loss. For example, American elm was the dominant tree species in the eastern US cities in the early 20th century; when Dutch elm disease arrived in the 1950s, resulting tree losses were devastating. Similar scenarios are now foreseeable for Asian longhorned beetle and emerald ash borer. [4]

Pittsburgh’s urban forest is an enormous asset; the associated costs of purchasing and replanting our entire urban forest in its current condition (structural value) would reach an astonishing $1.13 billion. [4]
Urban Tree Canopy

Tree canopy is composed of the leaves, stems, and branches of all trees within a specific area, as viewed from above. Pittsburgh’s urban tree canopy was assessed in 2011 using USDA Forest Service assessment protocols. The City of Pittsburgh has 14,883 acres of tree canopy, equal to 42% of all land area (35,468 acres). The results of this study can be used to develop an action plan to improve the overall canopy cover; success can be measured by monitoring canopy cover every 5 to 10 years. [6]

<table>
<thead>
<tr>
<th>Top 10 Neighborhoods</th>
<th>Percentage Canopy Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hays</td>
<td>82%</td>
</tr>
<tr>
<td>Glen Hazel</td>
<td>81%</td>
</tr>
<tr>
<td>St. Clair</td>
<td>69%</td>
</tr>
<tr>
<td>New Homestead</td>
<td>67%</td>
</tr>
<tr>
<td>Perry North</td>
<td>64%</td>
</tr>
<tr>
<td>Spring Garden</td>
<td>63%</td>
</tr>
<tr>
<td>Regent Square</td>
<td>61%</td>
</tr>
<tr>
<td>Ridgemont</td>
<td>61%</td>
</tr>
<tr>
<td>Arlington Heights</td>
<td>60%</td>
</tr>
<tr>
<td>Oakwood</td>
<td>59%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bottom 10 Neighborhoods</th>
<th>Percentage Canopy Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chateau</td>
<td>5%</td>
</tr>
<tr>
<td>North Shore</td>
<td>7%</td>
</tr>
<tr>
<td>Central Business District</td>
<td>8%</td>
</tr>
<tr>
<td>Bluff</td>
<td>12%</td>
</tr>
<tr>
<td>Southside Flats</td>
<td>12%</td>
</tr>
<tr>
<td>Strip District</td>
<td>12%</td>
</tr>
<tr>
<td>East Allegheny</td>
<td>14%</td>
</tr>
<tr>
<td>Lower Lawrenceville</td>
<td>15%</td>
</tr>
<tr>
<td>Manchester</td>
<td>17%</td>
</tr>
<tr>
<td>Bloomfield</td>
<td>18%</td>
</tr>
</tbody>
</table>
Street Tree Resource Structure
Street trees serve as the basis of our green infrastructure, form scenic corridors, and create a sense of unity and character throughout the City. Led by the efforts of the Shade Tree Commission, Pittsburgh’s 2005 street tree inventory was the crucial first step towards better understanding of this resource, which was reported to include over 30,000 trees representing over 130 distinct species. The 2005 inventory report estimated the value of Pittsburgh’s 30,538 publicly managed street trees to be $37 million (or $448 per resident). [1]

The 2005 inventory data indicated that 48% of Pittsburgh’s street trees were only in fair condition, 26% in good condition, 22% in poor condition, and almost 3% in critical condition or dead. Trees in fair condition can return to good condition if managed properly, and trees in poor condition can become hazards if neglected. Trees must be maintained to increase their useful lifespan and to preserve their benefits. Hazardous limbs and dead and dying trees must be removed promptly to reduce risk to the public. The City of Pittsburgh regularly performs maintenance activities for the purpose of risk reduction. [1]

To sustain and grow this valuable resource, new trees must continually be planted. The street tree canopy cover is less than 10% of the total street and sidewalk area (5,461 acres) within the City. Comparing these data to the 2011 urban tree canopy assessment, the street tree population comprises only 3.5% of the total canopy within Pittsburgh. [6]

Park Tree Resource Structure
Although it is a smaller part of our complete urban forest, our park system is the component that people often care about the most. In 2007, the Pittsburgh Parks Conservancy commissioned the park and greenspace tree inventory of four prominent parks—Schenley, Highland, Riverview, and Frick. Data were collected for over 5,600 publicly managed park trees, including landscape trees and trees with associated heightened risk.

It is generally recommended that no single species accounts for more than 10% of an urban forest’s tree population, and that no single genus (group of closely related species) comprises more than 20%. The species diversity of the inventoried park trees is better than that of our street tree population: 120 distinct species, with only one species (pin oak) exceeding 10%. The 2007 park tree inventory data indicated that 74% of the park trees were in fair to good condition and that 84% were medium- and large-sized trees (greater than 7 inches in diameter at 4.5 feet above ground). The park tree inventory data were used to estimate the value of Pittsburgh’s 5,666 regional park trees to be $16.5 million. [24]

*Inventory of park trees included only the landscape portions of Schenley, Highland, Riverview, and Frick parks.

Newly planted flowering cherry trees (Prunus x 'Accolade') along Monitor Street.
Growing a Diverse Urban Forest

Working in partnership with community groups, nonprofits, and municipal agencies, TreeVitalize® Pittsburgh is a joint project of Allegheny County, the City of Pittsburgh, the Pennsylvania DCNR, the Western Pennsylvania Conservancy, the Pennsylvania Urban & Community Forestry Council, and Tree Pittsburgh. Since 2008, the TreeVitalize® program has significantly expanded the resource, improved the species distribution and urban tree diversity within the City, and established a local framework for cooperation and partnership in urban forestry. [25]

TreeVitalize® Pittsburgh set a goal to plant 20,000 trees by 2012 throughout the Pittsburgh region. Since 2008, they have planted over 50 different genera and over 90 unique species and have channeled over $5.2 million for planting. As of spring 2012, over 13,000 trees have been planted along streets, parks, and riverfronts. As a direct result of these efforts, the community realizes more social, environmental, and economic benefits and more opportunities for residents to interact with the urban forest. [25]

Species diversity, the variety of species in a given population, affects the overall population’s ability to sustain threats from pests and diseases. Although a more diverse assortment of species is currently being utilized in planting operations, the top genus planted by TreeVitalize® continues to be maple (16%). However, the relative dominance of maple among street and park tree populations has significantly been reduced through these recent tree planting efforts. [25]

### Top 5 Tree Genera Planted by TreeVitalize®

<table>
<thead>
<tr>
<th>Genus</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maple</td>
<td>16%</td>
</tr>
<tr>
<td>Elm</td>
<td>8%</td>
</tr>
<tr>
<td>Oak</td>
<td>6%</td>
</tr>
<tr>
<td>Lilac-tree</td>
<td>6%</td>
</tr>
<tr>
<td>Serviceberry</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42%</strong></td>
</tr>
</tbody>
</table>

2008–2011 TreeVitalize® Data

Pests and Diseases in the Urban Forest Can Pose a Significant and Costly Threat

- Asian longhorned beetle (ALB) are insects that bore into and kill a wide range of hardwood species, including maple. ALB poses a threat to 67.1% of our urban forest, a potential loss of $733 million in damage to the structure. [4]
- Dutch elm disease has devastated the US population of American elm, one of the most significant street tree species in the twentieth century. Some elm species have shown varying degrees of resistance, but Pittsburgh could lose 7.9% of its trees to this pest, a potential loss of $30.4 million in structural value. [4]
- Emerald ash borer (EAB) are invasive insects that have killed millions of ash trees throughout the US since 2002. EAB threaten 8.8% of our urban forest, a potential loss of $64.8 million in structural damage. [4]
- Gypsy moth feed on many species, including oak, causing widespread defoliation and tree death if outbreak conditions last several years. This pest threatens 5.7% of our urban forest, a potential loss of $173 million in structural value. [4]

The structural, or compensatory, value of Pittsburgh’s urban forest is estimated at $1.13 billion. This value represents the cost to replace all the trees and can be viewed as the value of the urban forest as a structural asset. Trees are assets that appreciate in value over time, if given proper care and maintenance. With such a rich asset of immense value, this resource is worth careful planning, maintenance, and protection. [4]

**Impact of Major Urban Forest Pests**

- **Asian Longhorned Beetle**
- **Gypsy Moth**
- **Emerald Ash Borer**
- **Dutch Elm Disease**

**Structural value**  **Percentage of Total Urban Forest**

TreeVitalize® tree planting event in Brighton Heights.
Environmental, Economic, and Social Benefits of the Urban Forest

Our urban forest yields benefits that far outweigh the overall cost of maintaining this asset; investing in green infrastructure makes sense economically, environmentally, and socially.

Based on 2005 estimates, Pittsburgh’s street trees provide cumulative benefits valued at an average of $81 per tree per year, for a gross total value of $2.4 million annually. Trees help conserve and reduce energy use, reduce local carbon dioxide levels, improve air quality, mitigate stormwater runoff, and provide other benefits associated with aesthetic value, property value, and quality of life. When the City’s annual tree-related expenditures were considered ($816,400), the net annual benefit (benefits minus costs) to the City is $1.6 million, with an average net benefit of $53 per year for an individual street tree. [3, 4]

Energy: Trees provide shade by intercepting sunlight and wind and reducing air movement, which results in savings in energy costs for climate-controlled buildings. Pittsburgh’s urban forest is estimated to reduce energy-related costs to residential buildings by $3.15 million annually (2002 prices). Street trees alone account for $1.2 million in energy benefits. This may be the most direct benefit in terms to which the average Pittsburgh homeowner can relate. The average street tree on the right-of-way in front of their property produces $40.66 in annual savings to that homeowner. [3, 4]

Carbon: As part of their metabolic process, trees sequester carbon dioxide (CO₂) in the form of woody and foliar biomass. The gross sequestration of Pittsburgh’s urban forest is about 14,200 tons of carbon per year, with an associated value of $262,000. Net carbon sequestration in the urban forest is about 10,100 tons. [3, 4]

Trees also reduce CO₂ indirectly through a decrease in energy demand; the entire urban forest provides an estimated benefit of $70,600 annually by reducing the amount of carbon released by fossil-fuel based power plants (a reduction of 3,840 tons of carbon emissions). Due to their proximity to residential buildings, street trees account for a significant portion of the urban forest’s CO₂ reduction, providing the average Pittsburgh homeowner with an estimate of $9.73 in net carbon benefits. [3, 4]

Air Quality: In the American Lung Association State of the Air 2011, Pittsburgh was ranked third on the list of the most polluted metropolitan areas (on short-term and annual airborne particle measurement scales). Trees improve air quality by absorbing and reducing air pollutants (ozone [O₃], carbon monoxide [CO], nitrogen dioxide [NOₓ], particulate matter less than 10 microns (PM₁₀), and sulfur dioxide [SO₂]). The i-Tree Eco analysis estimated that Pittsburgh’s urban forest removes 532 tons of air pollution per year, with an associated value of $3.75 million. Street trees alone account for $252,935 in annual air quality improvements. [3, 4, 23]

Stormwater: A tree’s surface area (including leaves, branches, and trunk) acts as a catch for rainfall; as trees intercept and store water, they reduce runoff volume and delay the onset of peak stormwater flows. A tree creates porous space in the soil through its root system, thus increasing the capacity and rate of soil infiltration, which then reduces overland flow during periods of peak runoff. Tree canopies reduce soil erosion and surface transport by diminishing the impact of raindrops on barren surfaces. With an average savings of $11 per street tree per year, Pittsburgh’s street trees intercept an estimated 41.8 million gallons of stormwater annually, for an estimated value of $534,601. [3, 4]

Aesthetics: The estimated total annual benefit associated with property value, aesthetics, and other social and economic improvements is $572,882, for an average of $19.33 per street tree. Aesthetic and social benefits were not calculated for the entire urban forest. [3, 4]

Social: In addition to the quantified environmental and economic benefits, research has shown that trees provide many social benefits that help to improve quality of life. Trees can lead to reduced crime rates, decreased amounts of human stress, and shorter lengths of hospital stays. Kuo and Sullivan (2001(a)) studied apartment buildings in Chicago and found that buildings with high levels of greenery had 52% fewer crimes than those without any trees, and buildings with medium amounts of greenery had 42% fewer crimes. [3, 4, 26]

Tree-lined streets also make our streets safer by reducing traffic speeds and the amount of stress drivers feel which likely reduces road rage (Wolf, 1998(b); Kuo and Sullivan, 2001(b)). Ulrich (1984, 1986) found that hospital patients who were recovering from surgery and had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall. [27, 28, 29, 30]
Conclusion
Changing the common perception of the urban forest is the first step toward establishing sound tree-related policies; public education is crucial. Several studies have recently been conducted for different components of Pittsburgh’s urban forest; together, they establish a baseline to help city officials develop sound tree-related policies, to help urban forest managers make informed decisions, and to help concerned citizens become advocates for the urban forest. [31]

Investing in green infrastructure has proven to be worth the venture. Periodically taking measure of the composition, extent, and vitality of our urban forest will be necessary to gauge the success of the City’s urban forestry programs. The urban forest benchmark values can be used to set goals, to inform partners and key stakeholders of the state of the urban forest, and to measure future progress against the goals of this plan. [31]
WHAT DO WE WANT?

Outreach Campaign

The public outreach campaign, Tell Us Your Tree Story, played a crucial part of Pittsburgh’s Urban Forest Master Planning initiative. This campaign was designed to engage a wide range of stakeholders in the planning process, to learn what we want, and to give the public a means to communicate. The Outreach Report included in Appendix E provides an overview of the outreach campaign as well as a summary of outcomes of outreach efforts. [32]

The campaign’s goal was to develop an identity and brand for planning work that would resonate with a broad group of stakeholders and that would be more accessible than marketing the initiative as an urban planning process. Marketing materials (including posters, fliers, table tents, buttons, and tote bags) were distributed at outreach events, community meetings, and in neighborhood businesses throughout Pittsburgh.

This intensive community outreach campaign and education initiative included reaching out to tree volunteers, surveying the public and key stakeholders, obtaining tree stories, and conducting community meetings.

Outreach started with a series of four Tree Lover volunteer meetings. Tree Tenders and other dedicated supporters were invited to learn more about the plan and how they could contribute and support outreach efforts.

Tree Stories

Throughout the public involvement process, residents were asked to provide their tree stories, to share their favorite tree memory through video, photography, artwork, or writing (poetry or prose). Video testimonials were obtained at the tree volunteer events and community meetings.

Community Meetings

Nearly 100 residents participated in three community meetings that were designed to provide an easily understandable overview of the data collected for the Master Planning process and to gather specific information from the public. During an interactive session, attendees were asked to complete public surveys and to answer questions specific to their neighborhoods. The results were grouped as tree assets, tree needs, communication, and sustainable funding ideas.

Campaign Components

A comprehensive campaign was developed to engage a large number of people by leveraging existing community relationships and networks. Outreach efforts included:

Tree Volunteer Meetings for existing Tree Tenders, Tree Lovers, and other volunteer groups were conducted throughout the City to launch the campaign and to recruit additional volunteers.

Partner Surveys were collected from key stakeholders, including Steering Committee representatives and local elected officials.

Public Surveys were distributed online, at key community events, and by social service organizations. The goal was to survey 1,000 people during January 2012, and a total of 1,699 were completed.

Tree Stories were testimonials using various forms of personal expression to describe what people like about trees.

Community Meetings were held to update the public on the state of Pittsburgh’s urban forest, to collect survey data, and to gather detailed input regarding community assets and needs.

Tree Assets: included Tree Pittsburgh and staff, Tree Tenders, parks and green spaces, undeveloped land, riverfront trails, committed volunteers, individual neighborhood tree projects, private property owners, and cemeteries.

Tree Needs: included coordinated maintenance and accountability, removing and replacing dead trees, additional outreach and education, neighborhood and business district planning, invasive species education, homeowner assistance and resources, and sidewalk repair.

Communications: included word-of-mouth, electronic and social media, and print media.

Sustainable Funding Ideas: included taxes, small consumer donations, annual fees, grants, codes, and tree-related product sales.

Community Meeting Questions

- What are your goals for the urban forest?
- What is your vision?
- What is the best way to communicate information regarding trees to you?
- What funding options make sense?

Mayor Luke Ravenstahl’s Tree Story

Hello everybody, this is Mayor Luke Ravenstahl, and I am here today to share with you my tree story. When we grew up on the north side of Pittsburgh, we had a huge tree in our front yard. We had a very small front yard. My brothers and I would always play in that yard and we would always use the tree as a prop whether it was throwing a ball off of it or playing in the sandbox next to it. That is my first memory of a tree and using a tree. That tree still stands there in that front yard and it’s bigger than ever, and I remember it as a young kid seeming like it was larger than life. That’s my tree story.
Public Survey Overview

Jackson/Clark Partners, Davey Resource Group, and Tree Pittsburgh developed a brief, widely accessible survey to gather significant public input and quantifiable data on key factors from interested members of the general public. Responses were collected from online computer surveys, person-to-person surveys, and survey form collection boxes. The online survey was promoted from e-mail list servers, partner organization websites, and news media. On-site surveys were conducted at public events, community meetings, the Penn Avenue Arts Initiative’s monthly Unblurred event, the Pittsburgh Children’s Museum, the Kingsley Association’s Urban Green Growth Collaborative, and Operation Better Block’s monthly Homewood community meeting. Survey form collection boxes were placed in noticeable locations at 15 businesses and nonprofit organizations with significant levels of foot traffic.

Key areas targeted for public input included benefits of trees, problems with trees, specific needs for additional support public action points, and a 20-year vision for Pittsburgh’s urban forest. A total of 1,699 people took the survey. The final survey data were captured in a single on-line database and is included in Appendix E.

Survey Responses—Tree Benefits

Respondents were presented with a list of the benefits of trees and were asked to select the three that were most important to them (“other” was a free-form option).

- Improve the quality of life and help define Pittsburgh’s character: 894 (52% of responses).
- Provide shade and cool their surroundings: 615 (36% of responses).
- Provide wildlife habitat: 606 (37% of responses).
- Protect water quality and reduce stormwater runoff and flooding: 570 (34% of responses).
- Create safer, more pleasant neighborhoods and business districts: 538 (32% of responses).
- Clean the air: 521 (31% of responses).
- Provide relaxation and enjoyment: 458 (27% of responses).
- Reduce erosion and stabilize hillsides: 382 (22% of responses).
- Increase property values: 183 (11% of responses).
- Lower my energy use and bills: 169 (10% of responses).
- Reduce noise pollution: 161 (9% of responses).

Survey selections on the benefits of trees can be grouped into three overall categories:

- Quality of life (city character, shade, habitat, and enjoyment): 3,108 total responses (61% of collective responses).
- Pollution mitigation (water, air, noise, and erosion): 1,634 total responses (32% of collective responses).
- Economic benefits (energy savings and increased property value): 352 total responses (7% of collective responses).

Survey Responses—Tree Problems

Respondents were given a list of common problems they might encounter with public trees (street or park trees) and were asked to check all that apply (“other” was a free-form option):

- Sidewalks and pavement cracking: 878 (52% of responses).
- There aren’t enough trees in my neighborhood: 743 (44% of responses).
- Leaves and fruit dropping: 467 (27% of responses).
- Tree roots and underground pipe problems: 428 (25% of responses).
- Blocking traffic, sidewalks, signs, and/or street lights: 377 (22% of responses).
- Safety problems created from trees and limbs falling: 321 (19% of responses).
- Attract bugs and other pests: 168 (10% of responses).
- Trees cost too much money: 34 (2% of responses)
- “Other” responses most frequently noted problems with harmful utility pruning practices.

Survey Responses—Tree Needs

Respondents were asked to identify from a given list what they considered to be the single most critical need of Pittsburgh’s urban forest (“other” was a free-form option):

- More trees: 569 responses.
- Better maintenance and care: 460 responses.
- To be protected for future generations: 445 responses.
- “Other” responses most frequently noted issues with limiting harmful utilities pruning practices and issues with tree species selection.

Survey Responses—Tree Action

Respondents were asked to indicate what they would be willing to do to ensure Pittsburgh’s trees are maintained and protected for future generations. They were presented with a list of suggested actions and were asked to check all that apply (“other” was a free-form option):

- Support new legislation or rules about planting and tree protection: 1,083 (64% of responses).
- Plant new trees on my property when trees die or need to be removed: 959 (56% of responses).
- Support the city dedicating more funding to support Pittsburgh’s trees: 946 (56% of responses).
- Volunteer to plant and maintain trees on public property: 847 (50% of responses).
- Support a 1% fee or tax, similar to the recent library tax, dedicated to tree care and maintenance: 622 (37% of responses).
Vision

The multiple quantitative and qualitative studies outlined so far shaped the 20-year vision statement for Pittsburgh’s urban forest by helping us understand what we have and what we want. Definitions of key words that form this vision statement are presented to refine the expression of this understanding. The stated keystones—connect, engage, manage, plan, protect—were developed from the shared vision in order to guide how we get there. Our shared vision and stated goals will be used to measure how we are doing.

Over the next 20 years, Pittsburgh's urban forest will be a vital and well-managed asset that is locally valued and nationally recognized for its positive social, environmental, economic, and public health impacts on the community and the greater region.

Definitions

- **Vital (adj):** full of life and vigor; of the utmost importance
  - Pittsburgh's urban forest is vital to the character and everyday functions of the City, including human and ecological health. To remain vital, the urban forest must be protected and managed.

- **Well-managed (adj):** administered in a successful manner
  - Pittsburgh’s urban forest must be well managed across all public and private entities. The community must be engaged so that both the public and private urban forest needs will be proactively managed and protected. This will require that all entities that care for the urban forest are connected through a shared vision.

- **Social (adj):** tending to form cooperative and interdependent relationships with others
  - Pittsburgh's urban forest offers valuable social opportunities and health benefits to the community. Recognizing and promoting these benefits will engage and inspire the community to play their role in managing the urban forest.

- **Environmental (noun):** the complex of physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival
  - Pittsburgh is an urban ecosystem and its trees provide ecological functions and benefits to the community that help minimize the negative impacts of urban land use. This resource must be protected and managed with a coordinated vision and purpose.

- **Economic (adj):** of or relating to economics or the economy; justified in terms of profitability
  - Our urban forest is a sound investment for the future of the community; the benefits derived from maintaining and protecting this resource far outweigh the costs.

- **Public Health (noun):** the science and art of preventing disease, prolonging life, and promoting health through the organized efforts and informed choices of society, public and private organizations, communities, and individuals
  - Pittsburgh’s urban forest plays an important role in human health. Trees provide environmental, social, and economic benefits to residents and visitors of Pittsburgh alike. Careful management, protection, and planning of the urban forest will sustain these benefits and provide for direct connection and opportunities for all to engage with trees.
Guided by the 20-year vision, we established five keystones of sustainable urban forestry: connect, engage, manage, plan, and protect. Fifteen goals were developed within this structure to guide the future management of the urban forest; including trees in backyards, along streets, in parks, on hillsides, and every place a tree can grow.

The goals were developed by analyzing current conditions and examining the pertinent urban forestry management issues that exist in the City today. Recommendations are presented to assist urban forestry partners across the City to achieve these goals and, ultimately, the 20-year vision.

Case studies are presented to draw on lessons learned from successful programs and to describe techniques to support local implementation.

The keystones provide the framework for the plan’s treatment of the following components:
- Engage: Neighborhood Tree Advocacy, Public Outreach and Education, Volunteerism.
- Manage: Funding, Proactive Management, Risk Management, Tree Planting.
- Protect: Exotic and Invasive Pests and Diseases, Tree Protection During Infrastructure Improvements.

Together, these keystones, goals, and recommendations will guide how we get there.

**Connect**
- Connect urban forestry partners through a single vision.
- Utilize urban forestry research in conjunction with on-the-ground operations.
- Increase access to trees so that all can enjoy and benefit.

**Engage**
- Focus on neighborhood-based initiatives and solutions to urban forestry issues.
- Implement a coordinated and comprehensive outreach and education campaign.
- Encourage public and private participation in urban forest management through volunteerism.

**Manage**
- Match funding to desired level of service for urban forestry management.
- Develop a proactive management regime for public trees.
- Develop a proactive risk management program for public trees.
- Ensure tree benefits for future generations through a sustainable planting program.

**Plan**
- Incorporate urban forestry practices into the City’s stormwater management efforts.
- Achieve 60% urban tree canopy cover in 20 years.
- Establish a comprehensive tree emergency response and recovery plan.

**Protect**
- Monitor the resource for exotic and invasive pests and diseases.
- Protect trees and preserve their role in defining the City’s character.
INTERAGENCY COOPERATION AND PARTNERSHIPS

Goal: Connect urban forestry partners through a single vision

Programmed urban forestry in Pittsburgh began as early as 1889, when the Department of Public Works developed Schenley Park, after Mary Schenley donated 300 acres and the City purchased an additional 120 acres of her Pittsburgh-area holdings. This park provided citizens a respite from the air pollution during the industrial heyday. Soon thereafter, two urban forestry agencies were established: the first Pittsburgh Shade Tree Commission in 1910 and the Street Tree Division created in Pittsburgh’s Bureau of Parks in 1914. Neither of these organizations survived long as originally formed, and the urban forest deteriorated due to disease (notably Dutch elm disease), urbanization, and neglect. Toward the end of the 20th century, public and governmental interest in urban forestry gained momentum and many organizations were established as a result; existing environmental stewardship groups found a new mission in urban forestry and related fields such as watershed management. [12,33]

Current Conditions

The post-industrial City of Pittsburgh has become widely known for its livability, rebounding and reinvented economy, and green initiatives. Urban forestry has played an important role in this urban renaissance. For example, Schenley Park was designated one of “America’s Coolest City Parks” by Travel + Leisure magazine in April 2011. [34]

There are several agencies that include urban forestry as a major component of their mission, and there are other organizations that affect the urban forest indirectly. Some groups function together seamlessly, others partner on projects periodically, and sometimes communication and cooperation could be greatly improved among them. Enhancing cooperation and partnerships with pertinent agencies through improved communication and coordination by the Forestry Division can reduce wasted resources and create a more cohesive urban forestry program.

Issues

- Some of the agencies that have a significant impact on Pittsburgh’s urban forest do not maintain trees as a primary function of their mission.
- Lack of communication and disparate missions can lead to wasted resources. For example, Duquesne Light’s mission is to reliably provide electricity to Pittsburgh; trees that are planted such that they interfere with power distribution may need to be significantly pruned, which is expensive and diminishes the tree’s function.
- While there is no “right or wrong” organizational structure for an urban forestry program, a successful and sustainable program typically does not share specific responsibilities or resources with other agencies.
- Urban forest management staff, equipment, funding, and regulations are most effective when they are centralized in one department.
- The City’s Forestry Division is charged with maintaining the urban forest and has the legal authority to do so, but it lacks the resources to operate a proactive urban forestry program or to effectively respond to requests for service.
- Based on the public outreach campaign results, sidewalk and pavement cracking is a top concern. The City currently utilizes multiple departments to handle this issue.
- The urban forester position within the Forestry Division is currently vacant.

Recommendations

- Convene a summit of all agencies with a major impact on our urban forest to formalize communication methods, identify cooperative projects, and seek synergy.
- Recommendations presented in this plan should be implemented by appropriate urban forest partners with lead agencies assigned to coordinate and oversee implementation.
- This plan should be adopted and appended as part of City code.
- Formally describe urban forest management responsibilities across all agencies and partners.
- As long as urban forestry responsibility and funding are divided among various agencies, the City should ensure the means to increase interdepartmental communication and cooperation for plans and projects that may affect the urban forest.
- Identify cooperative projects that connect private land owners to the City’s urban forest goals.
- Perform a comprehensive operational review of the City’s Forestry Division.
- Encourage nearby colleges and universities to attain Tree Campus USA status.
- Strengthen cooperation with the community by securing a seat on Campus Tree Advisory Committees for the City Forester or a member of the Pittsburgh Shade Tree Commission.
Case Study: Interagency Cooperation and Partnerships

Impact of TreeVitalize® Program

Project Description
Responding to an alarming loss of trees in Pennsylvania’s metropolitan areas, TreeVitalize® is a Pennsylvania DCNR partnership to restore tree cover in Pennsylvania communities, to educate citizens about planting trees as an act of caring for our environment, and to build capacity among local governments to understand, protect, and restore their urban trees. [25]

In 2004, the Pennsylvania Department of Conservation and Natural Resources launched TreeVitalize® southeastern Pennsylvania. In spring of 2008, the Pennsylvania Department of Conservation and Natural Resources expanded TreeVitalize® to metropolitan areas statewide including the Pittsburgh area. TreeVitalize® Pittsburgh is a joint project of Allegheny County, the City of Pittsburgh, the Pennsylvania Department of Conservation and Natural Resources, the Western Pennsylvania Conservancy, and Tree Pittsburgh. [25]

Statewide partners of TreeVitalize® include:
- Pennsylvania Department of Conservation and Natural Resources.
  - Bureau of Forestry
  - Bureau of Recreation and Conservation
  - Office of the Secretary
- USDA Forest Service Northeastern Area.
- Pennsylvania Urban & Community Forestry Council.
- The Pennsylvania State University.
  - Department of Ecosystem Science and Management
  - Penn State Extension

Pittsburgh metropolitan area partners of TreeVitalize® include:
- Allegheny County Parks Department.
- City of Pittsburgh.
- Tree Pittsburgh.
- Western Pennsylvania Conservancy.

Accomplishments
The program achieved its goal of planting 20,000 trees in the original five-county southeastern Pennsylvania region. Over 300,000 trees have been planted, with a goal of one million trees to be planted statewide. TreeVitalize® forged over 50 public and private partnerships. Partners in New Jersey and Delaware founded Plant One Million to foster tree planting in the tri-state area. In the Pittsburgh metropolitan area, the DCNR committed $1 million to TreeVitalize® that was matched by over $1 million in private contributions. [25]

Lessons Learned
Forming focused partnerships creates great synergy. When members of an alliance operate cohesively, goals that seem out of reach can be attained. Interagency cooperation and partnerships are essential to success.
With few exceptions, municipalities rarely include a formal research component in their urban forestry master plan. While research has been conducted in Pittsburgh’s urban forest, an official position regarding cooperation and collaboration with students and research scientists has not been taken. Urban forestry research is a relatively young field with enormous potential for enhancing the quality of life in US cities. Pittsburgh has the opportunity to be at the forefront of this nascent movement.

**Current Conditions**

Encouraging and collaborating with urban forestry research could yield enormous benefits to the City of Pittsburgh. Opportunities for research include the use of vegetation to prevent landslides and the development of early threat detection protocols (to protect against invasive species, exotic insects, and diseases).

There are many threats and opportunities in the urban forest. Threats include invasive, exotic insects, and diseases. Opportunities include managing the urban forest to enhance the urban environment in ways that make our cities healthier places to live.

There are possibilities to not only encourage but to collaborate with ongoing urban forestry research that could have enormous benefits to the City of Pittsburgh. Examples include current research into the role of vegetation with regard to landslides and early pest detection protocols.

Currently, a University of Pittsburgh graduate student is conducting research that addresses the landslide issues of Pittsburgh and the importance of our urban forest in stabilizing the City’s slopes. Specifically, she is examining how non-native forest pathogens such as emerald ash borer and oak wilt might increase landslide susceptibility by reducing canopy cover. The research utilizes the Pittsburgh i-Tree plot data to calculate importance values for each species; the data are then used to predict the location of ash and oak trees. The predicted locations are compared with areas of the City most susceptible to landslides. Her report will be completed in 2012.

Current urban forestry research subjects that would directly benefit Pittsburgh include:

- A study of the most successful strategies and best management practices currently employed to deal with the arrival of emerald ash borer could help save the City hundreds of thousands of dollars.
- Participating in ongoing and future research into landslides and vegetation cover can have a direct impact on property values and safety in Pittsburgh.
- Recently published research conducted in Baltimore and elsewhere correlates higher urban tree canopy with lower crime rates. Collaborating in future research in this subject could lead to a strategy for reducing crime in Pittsburgh and to safer cities everywhere.
- Trials of the suitability of underused tree species can lead to increased diversity of Pittsburgh’s urban forest, thus, helping to protect it against catastrophic effects of pests and diseases such as oak wilt and Asian longhorned beetle.
Case Study: Research

The City of Ithaca, NY Master Plan for Parks & Forestry

Project Description

The City of Ithaca, NY Master Plan for Parks & Forestry Vision Statement contains this clause, “The City of Ithaca will cooperate in urban forestry research with Cornell University and other agencies to ensure that we will lead the nation in developing and utilizing better methods in our urban forestry program.” This Master Plan was formally approved by the City of Ithaca Board of Public Works, the body vested with the authority to make city policy regarding all public works activities. [35]

Subsequently, the City of Ithaca has cooperated in urban forestry research with many agencies, individuals, and organizations, including the USDA Forest Service, West Virginia University, Virginia Polytechnic Institute and State University, University of Toronto, Davey Institute, Cornell University Department of Natural Resources, and the Cornell University Urban Horticulture Institute. The results of these research collaborations have been very beneficial to the City of Ithaca.

Transplanting Success of Balled-and-Burlapped Versus Bare-Root Trees in the Urban Landscape by Michelle J. Buckstrup and Nina L. Bassuk. [36]

In this study, 1.5-inch caliper, balled-and-burlapped (B&B) and bare-root hackberry, American hophornbeam, and swamp white oak were paired and planted on sites throughout the City of Ithaca, New York. Half of the trees were planted in fall, half in spring.

Survival and growth rates were measured and compared and the research project was published in the Journal of Arboriculture in November 2000. [36]

The researchers benefited from logistical support from the Ithaca Department of Public Works Parks & Forestry Section. The City used its inventory of vacant planting sites and its geographic information system to identify available research plots. The City transported the trees from the nursery and provided equipment and staff for planting the B&B trees.

The City received scores of free street trees for vacant planting sites. The bare-root trees were planted by students organized by Cornell University.

The City also benefited from the lessons learned about bare-root tree planting and was subsequently awarded a grant from the USDA Forest Service through the New York State Department of Environmental Conservation to produce a video about bare-root tree planting. This video has been used for training by the City of Ithaca as well as many other cities and agencies across North America, including Keep America Beautiful and the Pennsylvania Horticulture Society in its Tree Tenders program.

The collaborative effort enabled the Urban Horticulture Institute and the City of Ithaca to accomplish much more together than they could have done alone. The synergy created by this project was typical of similar collaborations in urban forestry research.

Accomplishments

- Scores of street trees purchased by Cornell University planted throughout the City of Ithaca.
- A new, cost-effective, bare-root tree planting method developed.
- A model demonstrated for municipal cooperation in urban forestry research.

Lessons Learned

- Public sector collaboration in research is an appropriate function of local government.
- It is beneficial to define and formalize the role of city agencies in research collaboration.
- The benefits of cooperating in research can greatly outweigh the costs to the municipality.
- Initial investments in research by municipal agencies can subsequently result in successful urban forestry grant applications.
EQUITABLE URBAN FOREST BENEFITS

Goal: Increase access to trees so that all can enjoy and benefit

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, sex, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. It emerged as a concept in the United States in the 1980s as a response to the inequitable distribution of environmental burdens. More recently, the concept has been broadened to include inequities regarding urban forest benefits as these benefits have become more quantifiable. Trees provide environmental, economic, and social benefits that should be accessible to all. The extent of tree canopy cover corresponds to the magnitude of benefits provided by trees. [37, 38, 39, 42, 44, 45, 48–51]

Efforts to address environmental justice have historically focused on remediating environmental burdens such as the clean-up of urban brownfields and industrial wastes. Fewer efforts have been made to increase environmental amenities such as ecosystem services or urban forest benefits. Without a healthy urban forest, communities do not gain many of the benefits that contribute positively to quality of life:

- Well-designed and maintained parks can deter crime.
- Greenery has a calming effect.
- Green spaces are places where residents can gather and build communities.
- Green spaces give neighborhoods the appearance of being cared for.
- Trees can reduce air pollution and energy costs.

[37–43]

Current Conditions

In cities throughout the world, the density and health of the urban forest in residential areas often coincides with the economic status of the people who live there. In the poorer neighborhoods, there are frequently fewer trees, private gardens, or public open space. [44]

According to 2010 census data, over 26% of the Pittsburgh population is black or African American. Twenty-two percent of the population of Pittsburgh lives below the poverty level, compared to 12.4% statewide. [45]

Pittsburgh’s overall tree canopy is 42% of the total land area; however, 46 of the City’s 90 neighborhoods have canopy cover below this benchmark, and of those 46 neighborhoods, 17 have poverty rates and African American populations higher than the citywide averages. Economically disadvantaged neighborhoods in Pittsburgh, as in most US cities, have relatively low tree canopy cover. For all of Pennsylvania, the homeownership rate is 71%. Citywide in Pittsburgh, the homeownership rate is 52%, but in some neighborhoods it is substantially lower. Vacant lots, vacant houses, and abandoned properties are also associated with low urban tree canopy. Low homeownership rate and vacant lots and houses can be significant impediments to equitable distribution of urban forest benefits. [45]

Utilizing the results from the 2011 canopy assessment as proxy for the distribution of urban forest benefits across the City, neighborhoods can be identified and targeted for urban forestry outreach and strategic planting projects that help improve access to the urban forest resource. Existing and possible tree canopy figures can assist urban forestry partners with prioritizing project locations and setting realistic and achievable neighborhood-based canopy goals.

### Issues

Equitable access to urban forest benefits must overcome hurdles:

- Tree planting programs can be biased toward owner-occupied homes and owner-occupied neighborhoods. [44]
- High vacancy rates can lead to inequities of urban forest benefits if local policies deter planting trees adjacent to vacant houses and lots. [46]
- Policies that require property owner permission can reduce renters’ participation in tree planting efforts. [44, 46]
- Tree canopy is lower in low-income and minority neighborhoods.

### Recommendations

- Give priority for urban forestry and outreach activities to disadvantaged communities that are currently gaining the least benefit from the urban forest.
- Align communications actions with the Vibrant Cities & Urban Forests 2012 Recommendation #9. Ensure equal access to urban forestry and green infrastructure resources. [47]
- Prioritize neighborhoods for future tree planting and protection efforts to increase deficient tree canopy figures and allow for more equitable canopy cover across the City.
- Recruit volunteers from disadvantaged neighborhoods.
- Respond to resident requests for trees rather than property owner requests.
- In neighborhoods with long-term vacant properties, respond to adjacent residents’ requests to plant trees in front of the vacant properties.
- Do not allow absentee landlords to veto tree planting on adjacent public property.
- Increase education efforts regarding urban forest benefits, such as reduced energy costs, to increase demand for and support of public tree planting.

### How Do We Get There?

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Average % Below Poverty</th>
<th>Average Race Demographics</th>
<th>% Tree Canopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allegheny Center</td>
<td>34%</td>
<td>49% White</td>
<td>29%</td>
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<td>Allentown</td>
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<tr>
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### Tree Canopy Cover by Neighborhood

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<th>Neighborhood</th>
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<th>% Possible Tree Canopy</th>
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<td>Overbrook</td>
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2011 Urban Tree Canopy Analysis
Trees provide benefits for all to enjoy.

Children help plant trees and make the urban forest grow.
Greening Hunts Point: A Community Forestry Management Plan

**Project Description**

Hunts Point is a low-income community of color in the South Bronx. According to 2000 census data, nearly two-thirds of the residents are of Latin descent and 25% identify as African Americans. It is located in the 16th Congressional District, which is the poorest district in the nation and has unemployment rates among the highest nationwide. The community is home to the country’s largest food distribution center. At Hunts Point Market alone, some 15,000 trucks roll in and out daily. Diesel emissions from heavy truck traffic pollute the air. The South Bronx is surrounded by several major highways, including Interstates 95, 87, 278, and 895. Hunts Point has some of the highest asthma related hospitalization rates in the country.

“If you live in the South Bronx, your child is twice as likely to attend a school near a highway as other children in the city,” according to Rae Zimmerman, professor of planning and public administration at the Robert F. Wagner Graduate School of Public Service. According to the Environmental Protection Agency, the fine particles in diesel air pollution cause lung cancer and make asthma worse. New scientific findings suggest that diesel exhaust not only exacerbates asthma, but may be a causal agent. Soot particles spewing from the exhaust of diesel trucks constitute a major contributor to the alarmingly high rates of asthma symptoms among school-aged children in the South Bronx, according to the results of a five-year study by researchers at New York University’s School of Medicine and Robert F. Wagner Graduate School of Public Service. This manifests itself in higher asthma rates, some of the highest in the nation for children who live in this area. Currently, 30% of the community’s youth are suffering from asthma. [48-52]

In Hunts Point, the comparative lack of trees, parks, or green open spaces contributes to the problem. A US Forest Service statistical sampling revealed a relatively low 19.8% canopy cover for the Bronx and indicated an even lower 3.5% canopy cover in Hunts Point. A New York City Parks and Recreation tree inventory showed that Hunts Point street tree density was very low compared to the rest of the City.

Studies have found a negative correlation between the number of tree-lined streets and asthma rates. Columbia University researchers found that asthma rates among children aged four and five fell by 25% for every 343 trees per square kilometer. Trees act as natural filters. They take out pollutants, such as CO2 and diesel soot, and emit cleaner air. It makes good sense that increasing tree canopy cover is part of the solution to air quality and asthma issues.

**Purpose:** The purpose of this project was to develop a comprehensive community forestry management plan for the greening of Hunts Point and to start the implementation of that plan.

**Vision Statement:** This partnership envisions Hunts Point with a healthy urban forest leading to a significant reduction in asthma rates.

**Partners:**

- Greening for Breathing is a local, non-profit group that formed in response to the high local levels of childhood asthma.
- The New York Tree Trust is a public/private partnership supporting the forestry mission of the New York City Department of Parks & Recreation.
- The NYC Department of Parks and Recreation’s Central Forestry and Horticulture Division plants and manages street trees.
- The New York State Department of Environmental Conservation’s Urban and Community Forestry Program provides assistance for local government, citizen groups, service clubs, and other organizations interested in promoting community forestry.

**Accomplishments:**

- Inventory of every existing street tree in the project area.
- Identification of potential street tree planting sites.
- Establishment of greening goals:
  - Increase the number of trees planted
  - Increase the health of the urban forest
  - Employ tree planting site preparation and maintenance techniques to maximize tree longevity
  - Involve the community in all aspects of the Greening Plan
- Development of a strategy to reach these goals.
- Consensus on clear objectives:
  - Reach an 80% stocking level in the designated priority management zone over 5 years
  - Improve the survival rate and health of young trees
  - Increase community members’ awareness of the relationship between trees and air quality

**Lessons Learned:**

- A strategy for greening must include not only tree planting but also the components of protection, stewardship, and outreach.
- With an existing plan in place, funded through PlaNYC, Hunt’s Point was poised to be among the first focus areas for the MillionTreesNYC campaign.
- The resulting plan could serve as a model for other New York City communities looking to work with New York City Parks and Recreation to improve their urban forest.

*South Bronx Greening for Breathing Volunteers.*

The Greening Hunts Point project includes street tree planting.
NEIGHBORHOOD TREE ADVOCACY

Goal: Focus on neighborhood-based initiatives and solutions to urban forestry issues

Pittsburgh is home to 90 unique neighborhoods, ranging from the old historic areas to newer developments. Pittsburgh is truly a city of neighborhoods, and the residents celebrate these geographic and cultural enclaves. This sense of place and source of pride strongly motivates many residents to be actively engaged in maintaining or improving the character of their neighborhoods.

Our urban forest is just as unique as our neighborhoods. Citywide, the canopy cover is 42%. On a neighborhood basis, there are vast disparities between the composition and condition of the urban forest when comparing neighborhoods, ranging from 5% to 85% canopy cover. [6]

Engaging and supporting individual and neighborhood tree advocacy is a highly effective means of promoting a healthy, safe, and sustainable urban forest, and creating equitable access to urban forest resources. Community members have the greatest stake in and commitment to transforming neighborhoods. As residents and business owners, they have a vested interest in their neighborhoods’ quality and success; they have a deeper understanding of their community and which issues to focus on that make sense.

The effectiveness of neighborhood tree advocates to affect change comes from these characteristics of the advocates themselves:

**Ability to Voice Specific Needs and Wants of their Neighborhood**—Tree advocates are in regular contact with neighborhood leaders, residents, and businesses.

**Ability to Reach People**—Tree advocates can distribute information effectively.

**Credibility with Decision Leaders**—Many tree advocates have earned the respect of other community members and have established relationships with these stakeholders, including the media, public policy makers, city and county staff, local allied nonprofits, potential funding organizations, and elected and appointed community leaders.

**Trust of Neighbors (Ability to Educate and Influence)**—Neighborhood tree advocates are viewed as trusted sources of urban forest information.

**Ability to Empower and Mobilize People**—Because of their relationships and ability to communicate quickly and effectively with neighbors, tree advocates can assist in mobilizing them to participate in urban forestry events and to take action on urban forestry issues.

**Understanding the Neighborhood**—Because they are integrated into the community where they live and serve, tree advocates can make sure that the efforts and projects of Tree Pittsburgh and the City are pertinent and useful to the community.

**Issues**

- To work effectively with neighborhood tree advocates, it is important to recognize the challenges they face and the likely implications for their ability and/or willingness to become an advocate for the urban forest. A common challenge for tree advocates is that they have time constraints.
- Individuals and established community groups are likely working with a limited budget and do not have their own resources to spare for urban forestry initiatives. Some level of funding/support should accompany any request for advocacy work.
- While the goal may be to increase individual participation and community-based activism, Tree Pittsburgh may be approaching potential advocates who may not know what the concept of a sustainable urban forest is, or how increasing tree canopy benefits the neighborhood, or what kind of maintenance trees require to be safe and healthy.
- Based on public outreach campaign results, residents are willing to support new legislation or rules regarding tree planting and tree protection.

**Recommendations**

- Solicit feedback and input directly from neighborhood tree advocates about how to increase activism and interest in the urban forest.
- Educate and inform the neighborhood tree advocates on larger citywide issues, such as changes and improvements to urban forestry legislation and funding, and engage them to collectively support these important issues as appropriate.
- Engage citizen groups and local organizations to identify neighborhood issues that trees and their benefits can help address. Use trees and urban forestry projects as tools to make positive change at the neighborhood level.
- Tree Pittsburgh should continue to be the primary agency that facilitates neighborhood urban forestry needs and opportunities.
- Tree Pittsburgh should strengthen the relationship with community development entities to help develop neighborhood-focused, urban forestry projects.
Neighborhood Tree Advocacy Case Study

Successful Advocacy in Pittsburgh Neighborhoods

Project Description

Polish Hill—Polish Hill is a small neighborhood situated within Pittsburgh’s famous hillsides. It has 35% canopy cover and is one of the more active and successful community-based urban forestry initiatives. Interest and action for tree care and planting in Polish Hill began with a community garden project that showed residents how to interact with nature in an urban environment, collectively creating small but significant changes in their neighborhood. With help from Tree Pittsburgh, the Polish Hill Civic Association built on the success of the community garden to create a neighborhood green team and Tree Tenders group. Polish Hill is considering posting QR Code® tags on trees, holding urban edibles walking tours, and planning events designed specifically to inspire their neighbors to interact with their trees and each other. [53]

Lessons Learned

- Electronic communication and personal interaction with residents are the best communication methods to inform and engage citizens. The messaging efforts need to come from neighborhood leaders who are out in the community every day.
- Partnering with other neighborhood councils and groups is very successful but currently limited. These collaborative efforts should be expanded and conducted on an informal basis.
- Identify the “social butterflies” in the community to be advocates for neighborhood tree projects; they can learn more about trees, but their keen, innate people skills are highly valuable for generating interest and support.
- When organizing a tree event, it is important to learn from both success and failure.
- Be respectful of other people’s time. Understand people have time constraints to volunteer and may be equally committed to other groups and causes, and that meetings and events need to be scheduled in the evenings or weekends to accommodate most people’s schedules.

Highland Park—Highland Park is a small, historic neighborhood situated adjacent to the Allegheny River, the 500-acre Highland Park, and the Pittsburgh Zoo. It has nearly 50% canopy cover and is another of the more active and successful community-based urban forestry programs. Interest and action for tree care and planting in Highland Park began with a single request for a replacement tree denied by the City due to lack of funds. TreeVitalize® and Tree Pittsburgh had just begun operating, and the resident went to Tree Pittsburgh for assistance; that resident became the community’s first Tree Tender, and is now a Director of the Highland Park Community Council and is still a champion for neighborhood trees. There are now 35 Tree Tenders who care for the neighborhood trees and organize over a dozen tree-related events each year. [54]

Lessons Learned

- Electronic communication (via the Council’s website and listserv) and personal interaction with residents are the best communication methods to inform and engage citizens.
- Partnering with adjacent neighborhood councils and groups is very successful. Highland Park’s first tree planting was done in cooperation with East Liberty. Additional planting events have since been held with East Liberty, and the Council is trying to assist Morningside to establish a tree program and to organize a joint planting project.
- Dispelling misconceptions continues to be a challenge. People are reluctant to plant more trees or care for them since they perceive trees as messy, disruptive to pipes and sidewalks, or dangerous. It is important to educate and enlighten residents about their concerns, in terms they can understand.
- Volunteer management is also a challenge but must be dealt with, understanding that fellow residents have limited time and shifting family and work priorities. Offering food and drinks at every tree-related event tends to draw more people since it then becomes a social event as well.
- When starting and sustaining a tree program, willing partners and excited volunteers are necessary to get the word out and to recruit others to the cause.
- Interacting with other community groups, even if they are not doing tree-related work, will help neighborhood advocates learn from observing the organizational, partnering, and leadership skills of others.
- Scheduling a season’s events well in advance is needed to ensure a place on people’s calendars.

“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.”

Margaret Mead
1901-1978

Immaculate Heart of Mary Church in the Polish Hill neighborhood.

“My vision is that I play a direct part in making Pittsburgh’s urban forest grow and caring for it, as well as involving much of my community in this endeavor too!”

Anonymous, 2011
Tree Pittsburgh Public Opinion Survey
PUBLIC OUTREACH AND EDUCATION
Goal: Implement a coordinated and comprehensive outreach and education campaign

Prior to 1995, public awareness and education levels about proper tree care and planting and the importance of trees in neighborhoods and in the city-at-large were lacking in Pittsburgh. The Carnegie Mellon University report documented that the urban forest was in severe decline as an indirect result of this lack of awareness and public engagement. As a result of this report, the City re-established the Pittsburgh Shade Tree Commission (PSTC) in 1998 in order to preserve and maintain as many trees within the City as possible by increasing public education and support for urban forestry. To promote education, the PSTC created the Tree Stewards program—trained volunteers who assist the Public Works Department with tree planting and maintenance and act as “ambassadors” for the PSTC and the public forest. [13]

Tree Pittsburgh (originally known as Friends of the Urban Forest) was founded in 2006 by the Pittsburgh Shade Tree Commission, and has grown to be the primary agent in providing public education, outreach, and engagement in the care and protection of our urban forest. Public outreach is key to Tree Pittsburgh’s vision of being the local leader in growing a sustainable urban forest.

Current Conditions
The City, PSTC, and Tree Pittsburgh use very similar techniques and outlets for conducting public education and increasing awareness: websites, community newsletters, social media, neighborhood meetings, volunteer training, special events, and tree planting and maintenance projects that engage the public. Currently, Tree Pittsburgh is actively seeking to improve and expand its education and outreach efforts by launching the “Tell Us Your Tree Story” campaign, and further engaging the services of professional public relations and graphic arts firms. Successful partnerships have been established with TreeVitalize®, Western Pennsylvania Conservancy, Nine-Mile-Run Watershed Council, and numerous neighborhood development groups.

Public outreach and education could be considered part of almost every urban forest management action, so it is difficult to define the financial and staff resources of the primary agencies dedicated toward this effort. The City and the PSTC spend time maintaining websites and educating citizens during daily activities as well as at special events, but this is not quantified. Tree Pittsburgh has a defined budget and currently almost $170,000 is expended for outreach and education. In 2008, Tree Pittsburgh created an Outreach Coordinator position dedicated to this effort, but the position is responsible for other tasks as well.

Issues
Tree Pittsburgh and the City currently do not have a coordinated communications plan and messaging to guide them, or current and potential partners, in efficiently and effectively delivering information on important urban forest issues.

Recommendations
- No stable funding currently exists for broader urban forestry outreach efforts from the City.
- No clear procedures or policies exist for communication to improve coordination and gain greater awareness among city agencies that impact the urban forest.
- There is a lack of a coordinated communication efforts by the City and Tree Pittsburgh with the utility company and other large stakeholders.
- Current communication efforts are not specifically tailored to the diverse cultural and socioeconomic groups that work and live within the City. It is important to build on a community’s existing communications infrastructure and to ensure equity in communication efforts by considering language barriers, educational level, and cultural values.
- There is a need to reach out to and connect with people who are indifferent to, or care little about, the value of trees.
- Most communication efforts to date have been to promote Tree Pittsburgh events and activities. There is a lack of outreach to the general public on proper tree care and planting.
- The public outreach campaign results indicated a need for education related to particular tree issues the public perceives negatively: infrastructure conflicts, leaf and fruit litter, and utility conflicts.

Students from the Montessori Public School identify trees on Arbor Day.

Example of media from the Tell Your Tree Story campaign.
The “Fit Forest Campaign”; City of Elgin, Illinois

Project Description

Just recently, the City of Elgin’s urban forest was at risk from multiple threats, and their urban forestry program was not focused on sustainability. The City and key stakeholders knew that action was required to protect this resource and that the public has the greatest influence on it. As most of the trees that comprise Elgin’s urban forest are on privately owned property, city residents, property owners, and business owners influence this resource by how well they care for the trees on their respective properties.

The public further influences their urban forest by participating in public processes regarding land development, program funding allocations, and urban forest legislation. The citizens of Elgin effectively own both the public and private urban forests, and the City knew that without greater political support and increased citizen understanding and commitment, the urban forest in Elgin would be at risk. With American Recovery and Reinvestment Act of 2009 (ARRA) funding support, a comprehensive public education campaign was created for the City—The Fit Forest. City staff and community partners work cooperatively to educate the public about the benefits of trees, the City’s urban forestry program, and what can be done to improve trees on private and public land.

Accomplishments

The Fit Forest is a multi-faceted, education campaign, created by the professional firm of C.E.L., meant to inspire Elgin residents and visitors to grow a healthy, safe, community forest by providing tools and education regarding tree maintenance, risk reduction, tree planting, maximizing tree benefits, controlling invasive pests and diseases, reusing and recycling wood waste, and improving native ecosystem habitats.

Key messages were announced at community events and on the City’s and partners’ websites. The marketing toolkit contained event banners, topical fact sheets, magnets, bracelets, gift bags, sports bags, temporary tattoos, PSAs, and other media resources. As part of the Fit Forest’s “Go for the Green” theme, City officials were able to reward residents and businesses for their green efforts by presenting certificates of merit and Fit Forest gold medals to wear or display proudly at their homes, in their offices, and even on their trees.

Everyone was encouraged to be part of the greening of Elgin. The City makes all printed materials available in Spanish and leverages the resources of the Elgin Community Network to communicate urban forestry news, events, and messages at neighborhood meetings, community events, such as concerts in the park, and other special events such as Arbor Day, National Public Works Week, 4th of July Parade, Green Expo, and the Citywide Block Party.

Lessons Learned

- By developing and implementing the Fit Forest education campaign, the City’s urban forester learned that there is great benefit to having theme and concise, targeted messages ready to engage citizens in the care of the community forest and to help them understand the goals and responsibilities of the City’s urban forest management program. More specifically, the City learned:
  - Sharing the campaign messages and products with allied agencies maximized the effectiveness of the outreach. Collaborating with diverse groups (such as the Elgin Area Chamber of Commerce, Commonwealth Edison, public libraries, and the Elgin Community Network) leveraged the City’s campaign to reach more people in more ways.
  - Collaboration on the education campaign led to unexpected financial support by the controlling utility company. When presented with a professional, cohesive public outreach program that reflected their own values, the utility company pledged significant funds to support proper tree planting in the rights-of-way.
  - It is important that the City’s urban forester be a key participant in developing and disseminating the campaign messaging, but it is not a City Forester’s expertise. A communications professional or specialist should be charged with the details creating the campaign elements and implementing related and new initiatives.
Goal: Encourage public and private participation in urban forest management through volunteerism

It is said that volunteers have time to give, not time to waste, and that they are unpaid not because they are worthless, but because they are priceless.

Understanding what volunteers value about their role and what motivates them to give their time, skills, and energy is crucial to recruiting, retaining, and motivating them.

Motivation—keeping employment skills up-to-date; building a resume, making a difference in the environment, widening a social network, feeling like a part of something bigger, learning new things and having new experiences, requirements for school, and reacting to an issue.

Recruiting Methods—web, mailing, word of mouth, targeted, and public relation efforts.

Retention—rewards, recognition, and enjoyable events.

Results—stronger programs, cost savings, and community buy-in.

There is clearly an important role for volunteers in urban forestry; this is evidenced by the proliferation of similar volunteer organizations that provide citizen-based municipal tree care across North America. These organizations may have different names for the volunteers: Citizen Foresters (Washington, DC, and Newport, RI); Tree Stewards (Portland, OR; Fall River, MA; and Richmond, VA); Citizen Pruners (Binghamton, NY; New York, NY; and Thunder Bay, ON); and Tree Tenders (Philadelphia and Pittsburgh, PA). Volunteers are usually involved with tree planting, pruning, mulching, watering, and other activities related to tree establishment. Most often they are organized either through their respective state university cooperative extension or a local nonprofit. They are often the strongest advocates for urban forestry in their municipality.

They frequently work in harmony with municipal employees and public sector unions. In Ithaca, NY, the Cornell Cooperative Extension-organized Citizen Pruners works with public works employees represented by the Civil Service Employees Association. Rather than taking jobs away from professional arborists and city employees, these volunteers are seen to strengthen municipal programs through advocacy. They fill niches and accomplish tasks that would otherwise go undone.

Current Conditions

Tree Tenders is a training program that empowers concerned residents to make dramatic strides towards restoring and caring for their local tree canopy. The Tree Tenders training course was developed by the Pennsylvania Horticultural Society (PHS) in collaboration with Penn State Extension. It is based on PHS’s Tree Tenders program, which since 1993 has trained over 3,200 volunteers in 150 neighborhoods across Pennsylvania. The course is designed for lay people and experts alike. The 8-hour training covers simple tree physiology, urban stresses on trees, basic pruning and tree pit care, and tree identification. Since 2004, the program has been supported by the Pennsylvania Department of Conservation and Natural Resource’s TreeVitalize® initiative and continues in support of their mission to increase Pennsylvania’s tree canopy.

Tree Tenders, led by Tree Pittsburgh, is making a difference in Pittsburgh, planting, performing tree maintenance, and organizing their community. To date, there are over 1,000 Tree Tenders in the Pittsburgh area. “Tree Tenders are the National Guard of the arborist world, a civilian group taking care of what the pros can’t quite get to.” Pittsburgh City Paper, Best Way to Get Your Hands Dirty, 2011. [56]
Case Study: Volunteerism

CommuniTree Stewards, Syracuse, New York

Project Description
Necessity is the mother of invention: such was the case with the CommuniTree Steward program in Syracuse, NY, run by Cornell Cooperative Extension (CCE) of Onondaga County. Syracuse’s urban tree canopy had been on the decline since the spread of Dutch elm disease of the 1950s and was further reduced by the 1998 Labor Day Storm. These events drove home two salient lessons: diversify tree species and prune weak branch unions while trees are still young. [58, 59]

Funded by the City of Syracuse and Onondaga County, the CommuniTree Steward Program started in 2002 as a way to cost-effectively plant and maintain trees by exchanging tree maintenance classes for volunteer work on public trees.

Students enroll in the winter and begin the required CCE courses in April. Course work includes tree biology, soils, basic pruning, structural pruning, proper mulching, watering, tree identification, matching tree species to the site, and tree planting (bare-root and container). Students are closely monitored and instructed during urban forestry projects; by the end of the summer, most are doing excellent work and need little supervision. When fall comes along, CommuniTree Stewards participate in large-scale, bare-root planting events. Veteran Tree Stewards, who return yearly to work on tree projects and plantings, will often pair up with new Tree Stewards and will serve as instructors.

Accomplishments
This program developed a highly skilled, motivated volunteer workforce who planted and maintained thousands of trees in the City of Syracuse and Onondaga County villages. Volunteers are also able to serve on specialty projects such as tree inventories and invasive species mapping.

Veteran CommuniTree Stewards have gone on to organize their own neighborhood and park tree projects, so the program has had an impact beyond its own projects.

Tree Stewards make very good ambassadors for the cause of increasing the urban tree canopy. They are knowledgeable and can effectively respond to objections and dispel misconceptions regarding tree-related issues.

Lessons Learned
Program success largely hinges on effective recruitment, management, and retention of volunteers:

- Make it fun and sociable: they are volunteers, not employees. Make time for visiting after training and project work.
- Be organized: start on time, end on time, and do not overwork them. Celebrate what was accomplished, do not complain about what was not completed.
- Keep them safe: emphasize tool safety and utility wire safety, provide high-visibility safety vests.
- Keep it interesting: provide more advanced workshops for veteran stewards.
- Tact and diplomacy: keep a level head if a difficult situation arises.
**Funding**

**Goal: Match funding to desired level of service for urban forestry management**

Urban forestry and public education services often must compete for funding with established community services such as law enforcement, fire protection, and infrastructure construction and repair. Decreased and insufficient funding is one of the greatest challenges facing our nation’s urban forests today.

No doubt the level of funding will determine the viability and sustainability of Pittsburgh’s urban forestry program within the broader context of all of the City’s responsibilities. Only with sufficient financial resources can the City’s urban forestry program best fulfill its mission, respond to change and challenges, and serve the public.

No precise formula exists to determine how much funding is needed for a proactive, sustainable forestry program. There should be sufficient funding for performing preventive tree maintenance, emergency response, and adequate planting, as well as for staff, equipment, and contractual services. Based on reports that 3,130 communities submitted to the National Arbor Day Foundation for Tree City, USA certification in 2006, the average municipal urban forestry budget for a city the size of Pittsburgh was $1,870,000, an average expenditure of $5.83 per capita. Based on these averages, the City’s annual budget is 36% below the average, and the per capita spending amount is 38% below average. [50]

**Current Conditions**

Funding for our urban forestry program comes from a variety of sources. The following table displays the primary and secondary sources of funds and estimated amounts for 2012: [60]

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Pittsburgh</td>
<td>$1,208,000</td>
</tr>
<tr>
<td>Pittsburgh Shade Tree Commission</td>
<td>$120,000</td>
</tr>
<tr>
<td>Tree Pittsburgh</td>
<td>$933,000*</td>
</tr>
<tr>
<td>DCNR/TreeVitalize®</td>
<td>$400,000**</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$2,661,000</strong></td>
</tr>
</tbody>
</table>

* Includes a $500,000 USFS special grant that will not be renewed.
** TreeVitalize® program’s $200,000-per-year funding agreement with DCNR will end after 2012; it will continue to fund planting for the next five years but at a greatly reduced rate. Western Pennsylvania Conservancy also provides a 50/50 in-kind match. [25]

<table>
<thead>
<tr>
<th>Activity</th>
<th>Amount</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting</td>
<td>$444,000</td>
<td>17%</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$1,160,000</td>
<td>44%</td>
</tr>
<tr>
<td>Public Outreach</td>
<td>$249,500</td>
<td>9%</td>
</tr>
<tr>
<td>Administration</td>
<td>$348,000</td>
<td>13%</td>
</tr>
<tr>
<td>Other</td>
<td>$459,000</td>
<td>17%</td>
</tr>
</tbody>
</table>

Urban forestry budgets in US cities are typically allocated for maintenance (58%, includes pruning and removal), planting (14%), and administration (8%). [61, 62] There is no national standard for effective urban forest budget allocation. Planting should be a significant portion of the total budget, second only to maintenance, and generally should not exceed 50% of the operating budget.

Pittsburgh’s urban forestry program funding allocation from all sources is generalized; the allocation should be continually adjusted depending on condition of the trees, planting needs, incidences of severe weather, insect and disease threats, and the desires of the citizens and community leaders at the time budgets are developed.

**Issues**

- Current public surveys and feedback indicate that only a minority (14%) of citizens would support a special fee or small tax increase to generate additional funds to support urban forest management. The majority (60%) of citizens clearly wants more tree planting and maintenance services but does not want to pay for it through increased taxes.
- An accurate accounting of the true and complete budget for urban forest management in Pittsburgh is prevented by the various accounting methods of partners, the sharing of grant funds between more than one agency, accounting overlaps/duplication, the lack of consistent documentation of in-kind services for grants, and lack of readily available and comparable financial data for every entity that works in the City’s urban forest. Therefore, it is unknown whether the current funding levels of the City, Tree Pittsburgh, and other partners are sufficient to achieve the goals of each agency and the master plan.

**Recommendations**

- Reassess the City’s urban forestry program budget in terms of achieving street tree and UTC planting goals, the recommended seven-year preventive maintenance cycle, and the young tree maintenance programs.
- Each major entity providing services should accurately account for urban forestry-related income and expenses.
- Each major entity providing urban forestry services should perform a cost-benefit analysis to inform future management decisions that maximize benefits.
- Launch a public, education campaign to develop the political support needed for any necessary budget increases, emphasizing sound resource management as a positive investment.
- Sustain established partnerships and create new partnerships as a means to leverage resources needed to accomplish urban forestry goals.
- Increase penalties for developers and builders who damage trees and ensure enforcement.
Case Study: Funding

**Funding Mechanisms in Various US Cities**

*Special Assessments:* One of the most stable sources of funding for urban forestry programs is a special assessment. Some states authorize cities to assess all property owners for specific public benefits and services such as stormwater and sewer systems, and public trees. The assessment can be levied as a fee per foot of right-of-way frontage or as a percentage of the property value. The cities of Cincinnati and Toledo, Ohio have a frontage street tree assessment authorized by state and city codes that has been in effect for over 30 years. The same enabling state law restricts the use of this revenue for anything other than maintenance and planting of trees. The City of Pittsburgh should investigate the legality and potential for a citywide special assessment to fund the urban program pursuant to PA. STAT. ANN. tit. 53, §§ 721,1081 (construct, reconstruct, pave, grade, alter, or renew streets, alleys, sidewalks, parking, landscaping, bridges, sewers, drains, and piers). Special assessments are approved annually by Council with the support of the community. In Cincinnati, the average cost to property owners is $7/year, and the assessment generates over $1 million annually for the program. A special assessment in Pittsburgh could supplement and/or reduce general fund support.

*Neighborhood Improvement Districts (NIDs):* In Pittsburgh, NIDs already exist (the Pittsburgh Downtown Partnership and the Oakland Business Improvement District) and offer a legal and equitable way to generate funds to provide a variety of enhanced and new services that would be less likely to come from the City. Often described as offering the services of “safe, clean, and green,” NIDs can help plant and maintain trees as well as fund other infrastructure upgrades and neighborhood needs. There is interest to move the City’s best prepared Main Street programs into NIDs which follow a model that has been one of the most successful nationwide. Tree Pittsburgh should campaign that the idea of creating NIDs and ensure that higher level urban forest management services are included in the NID budgets.

*Taxes:* Many cities throughout the US attain funding for urban forestry through special taxes. St. Louis, Missouri implements a property transfer tax and a sales tax (1/2 cent) to pay for the City’s urban forest program. In Burlingame, California, a portion of a gas tax has provided $100,000 to the urban forestry’s departmental budget in previous years. While new taxes are currently politically unpopular, earmarking a small percentage of existing taxes may be a source of revenue to consider.

*Capital Improvement Project Budgets:* Capitals have large, comprehensive budgets that have been carefully determined. All aspects and impacts of the project can be accounted for with these kinds of funds. Although restricted to the specific project, often tree maintenance, tree preservation, and planting can be included as a valid expenditure. If trees are viewed and defined as a capital asset, then during road and bridge construction and utility projects, funds can be allocated for protection of existing trees, remediation treatment for any trees impacted by construction activities, and planting new trees after the project is complete. The City of Milwaukee has had success making trees part of its street and road improvement projects for decades.

*Tree Work Permit, Development, and Inspection Fees:* These common funding mechanisms can be used for urban forest management, to the extent permitted under state and local codes.

Examples include:

- Permit and Plan Review and Inspection Fees: Cities often require private developers and businesses to provide funding for plan review and site inspection. Charging for this time and expertise needed to approve permit applications, review plans, and make site inspections might be a viable option to finance additional urban forestry positions.
- Development Fees: Landowners in a “benefit area” may be required to pay for a proportionate share of the public facilities required to serve a development. Trees can be considered public facilities, and the costs to plant and care for them can be supported by these fees. Developers could also be required to pay a set amount to support a community’s overall urban forestry program, as a cost of doing business within the city limits. The fee could be a percentage of the total project cost, based on the number of housing units built, or based on the area of land being developed.

*Compensatory Payments and Environmental Fines:* Trees on public land are public property, and the City should be compensated for the loss or damage to public property. If tree damage or loss occurs due to a development project, vehicular accident, vandalism, private utility work, etc., then the responsible party should be required to pay for the appraisal or replacement value or repair costs. This source may not generate a great deal of money, but it is a legitimate and often under-utilized source of funds. Generally, the compensation is collected from the insurance company of the person/agency responsible for the damage or directly from the business that caused the damage to public trees. Compensation funds can be used to remediate the specific damage or for other legitimate urban forestry functions. Environmental fines can be another legitimate source of compensation. Environmental fines are often required to pay significant sums through environmental court fines. By coordinating with the environmental agency, all or a portion of those fines can be directed to the urban forestry program.

*Sale of Municipal Wood Products:* If City policies allow public property to be sold, the wood waste from tree maintenance can be a source of funds. Rather than pay for removal and disposal, many cities sell excess wood products (firewood, hardwood timber, rough wood chip mulch, and compost) to the general public and commercial businesses. A new trend is to use the removal of a significant or historic public tree as a source of creative fund raising. The logs and usable wood are given to local craftsmen who create furniture, sculpture, and other collectibles from it. These are sold and proceeds are returned to the urban forestry program. Another new trend is to use tree removals due to invasive insects and disease as a source of quality lumber products. The cities of Winnipeg, Manitoba, and Cincinnati sell logs from trees that have succumbed to Dutch elm disease and EAB to local companies that mill dimension lumber as environmentally sustainable products used in buildings and projects that qualify for LEED certification.

*Biogenic Utility Payments:* A biogenic utility is a utility based on the net benefit of freed energy and other benefits from trees, which can be calculated in dollars, pounds of pollution filtered, gallons of rainwater intercepted, and kWh of energy not used. Trees provide Pittsburgh measurable benefits as documented by the i-Tree Streets and Eco reports—the annual value of avoided energy and air pollution control costs exceeds $3 million each, $350,000 in storm water mitigation, and nearly $95.5 million in carbon storage and sequestration. The City of Kent, Ohio performed a feasibility study to explore the possibility of calculating the economic value of the beneficial functions trees perform and devising a funding mechanism to pay for these functions. The income generated would be used to manage and enhance the urban forest to meet goals of increased canopy cover within the City. The rationale is that urban forests, like urban infrastructure, require planning, management, and oversight; they are not self-sustaining like natural forests. In Colorado, Denver Water, the utility that supplies drinking water to 1.3 million people, and the Forest Service signed a $33 million cost-sharing agreement for forest management and watershed restoration. The average residential water user will pay an extra $47 every year, or the cost of 5 years to match the Forest Service’s $165 million allocation. Denver’s agreement is an example of an emerging financial tool, “ecosystem services,” in which a market value is applied to environmental functions that users usually exploit without payment. Healthy forests provide safe drinking water as well as other environmental and public health and safety benefits at far lower cost than it would take to build infrastructure to replace those services. Other cities are realizing this, and Pittsburgh may want to begin exploring this developing trend in municipal financing. [3, 4]
Proactive urban forest management includes assessing the resource (an inventory), developing a management plan, engaging citizens and other stakeholders in a plan process and program operations, thoughtful planting of new trees in targeted locations, establishing systematic inspection and maintenance cycles that include training young trees, and supporting research that seeks to better understand the urban ecosystem.

Proactive management can reduce program costs, increase public safety, reduce utility outages from storms, and improve the appearance of the urban environment.

Current Conditions

The City’s 2005 street tree inventory and management plan provided direction for the urban forest management program and recommended a continual routine maintenance cycle for the tree population to ensure the pruning of all trees every seven years. This part of the plan has not been implemented, and the City does not have sufficient resources to respond to all requests for service to street trees. [1]

While cyclical pruning reduces long-term costs because of pruning crew efficiencies, it can also prevent problems before they exist in the case of pruning to train young trees. Young trees that receive training pruning develop good form and long, straight trunks with few defects. The resulting trees are structurally more sound with less chance of failure as they mature.

A 2008 i-Tree analysis of Pittsburgh’s public street trees indicated that they provided $2.4 million in annual benefits ($81 per street tree, $7.38 per capita). When compared with the annual costs of $815,400, these benefits provide a benefit-cost ratio of $2.94 (that is, the City received $2.94 in benefits for every dollar spent on street tree programs). This benefit-cost ratio indicates a positive net return on investments made to the City’s street trees; however, a closer look reveals that this positive value may not be sustainable. [3]

Pittsburgh has an aging tree population and is spending a large portion of its resources on removals and very little on tree planting. Proper maintenance and regular pruning is crucial to maintaining these levels of benefits in the existing tree population and can result in the difference between a functional street tree and a tree with defects that create an unacceptable level of risk. In 2008, the City was only allocating 2% of its tree-related funding to pruning. To achieve a sustainable resource, these trends must be reversed.

Issues

- The last comprehensive street tree inventory occurred in 2005 and has not been regularly updated.
- No current protocol exists for a regular inspection of street trees to monitor maintenance needs, risk, and pests. Updating the tree inventory will identify required maintenance and will monitor the population for high-threat pests (such as emerald ash borer, oak wilt, and Asian longhorned beetle) that can rapidly devastate our urban forest.
- Engaging the public during the development of urban forestry plans (both citywide and project focused) will reduce the chance for costly delays and greatly improve overall public opinion about the state of our urban forest. If dissent occurs, a strong background of support from other engaged citizens can help to educate and inform those with different opinions and to avoid public reactions that might hinder effective program functioning.

Recommendations

- Regularly monitor public trees for maintenance needs, risks, and pests.
- Develop a protocol that provides for regular updating of the public tree inventory.
- Implement a cyclical maintenance schedule of all street trees that provides for a seven-year cycle of inspection.
- Ensure that cyclical maintenance includes pruning of medium-sized and large trees to reduce risk and extend the productive life.
- Ensure that cyclical pruning also includes care for newly planted and young trees in their formative years.
- Communicate and engage with the community regarding the urban forest plan.
- Ensure the Tree Tender program continues so that the City can narrow its focus on mature tree care.
Cincinnati, Ohio Urban Forestry Department

Project Description
The Urban Forestry Program in the City of Cincinnati, Ohio is responsible for planting, maintaining, and protecting more than 80,000 street trees on more than 1,000 miles of public rights-of-way. The program is currently part of the Park Board’s Natural Resource Management Section.

Accomplishments
Urban forestry activities are funded through a dedicated urban forestry property tax of $0.18 per “front foot” for each property owner that abuts a public right-of-way. The assessment has been in place for 30 years and currently provides $1.8 million annually. State law requires that funds generated from this dedicated tax be used solely for urban forestry activities.

Services provided from the collected funds include emergency response to streets blocked by fallen limbs or trees, individual service requests for pruning or removal of hazardous trees, planting of about 3,000 trees each year, and stump grinding. The funds also provide support for proactive activities such as young tree training and fertilizing of 4,000 small trees at three and six years after planting. Trees greater than 6 inches in diameter (at 4.5 feet above ground) that are located on public property receive preventive maintenance at least once every six years. The City is divided into six management zones and all public trees within each zone are visited block by block (or park by park) to increase efficiency.

Maintenance and planting work is contracted to local professionals, and City staff provides program administration, inspections, and other support. City staff consists of five urban foresters and three urban forestry technicians; all are Certified Arborists (through the International Society of Arboriculture) and are Ohio Licensed Pesticide Applicators. Additional proactive efforts include education programs for schools and community groups.

Lessons Learned
Utilizing a highly trained staff supported by a dedicated tax, the City of Cincinnati has been able to create efficiencies with performing tree work on a proactive basis and has improved the overall health of its urban forest. The protocol has created efficiencies in service and reduced per tree costs for maintenance. While most of work is proactive and performed systematically, there are still about 350 individual service requests each year that are addressed.

Cincinnati is divided into six management zones, and all public trees within each zone are visited once every six years.
RISK MANAGEMENT

Goal: Develop a proactive risk management program for public trees

Trees provide valuable benefits to a community, and these benefits typically increase as a tree matures. Along with this increase in benefits can come an associated increase in risk. Entire trees may fail, or limbs may fall from standing trees. Understanding risk, identifying levels of risk, and taking reasonable steps to mitigate or reduce risk are challenges that face those who manage the urban forest.

The first step in dealing with this challenge is performing an inventory of public trees to determine the level of benefits and risk that are present. Pittsburgh’s 2005 street tree inventory assessed 31,524 tree sites and found that 909 trees (2.88%) were considered high-priority removals as a result of severe risk. An additional 1,546 (4.90%) trees were identified as needing high-priority pruning. Additional trees were identified for priority removals and pruning that posed high or moderate levels of risk. By the end of 2008, much of priority risk management work was completed reducing overall tree risk to a more acceptable level. The cost of this work was significant.

Current Conditions

The 2005 street tree inventory provided a baseline for tree condition data; however, an urban forest continually changes over time. New trees are planted each year and younger trees grow larger. As they grow, they increase the level of risk if they are not systematically monitored on a periodic basis. The City of Pittsburgh utilizes a tree database and tree management software that enables them to keep records of all inspections and maintenance activities. [1]

Pittsburgh’s public urban forestry is currently managed with a system that addresses only the most urgent needs and requests, which means that many young and middle aged trees do not receive valuable periodic maintenance. Young tree training and a cyclical pruning program can focus resources on smaller trees that are less costly to maintain, and create older trees with fewer defects.

Issues

- The 2008 i-Tree analysis of Pittsburgh’s street trees indicated that for every dollar spent on the street tree program at that time, there was a net return of $2.94. Increasing public safety by reducing tree defects can reduce potential costs and improve overall street tree health. [3]
- Some communities have experienced serious negative publicity following incidents of high-risk trees causing injury. This can translate into a loss of public support for urban forestry programs.
- While identifying and removing high-risk trees and limbs is a critical part of a risk management program, preventing risk can reduce costs, increase public safety, and create a healthier urban forest. A stronger emphasis on systematic inspection and maintenance needs to occur in Pittsburgh to take advantage of these positive benefits.
- Repairs to existing infrastructure can cause damage to tree roots and may increase risk to unacceptable levels. Sidewalk and curb repair often requires the removal of offending roots that may also provide critical support.
- Underground utility repairs or installation also sever critical roots needed for tree stability. A quick inspection by an arborist can determine the extent of root damage that can occur without causing unacceptable risk.

Recommendations

- Facilitate a systematic tree maintenance program for public trees.
- Maintain an updated tree inventory with risk rating data that utilize the tree risk assessment standards in ANSI A300 (Part 9) and the Best Management Practices published by the ISA that address both tree inventories and tree risk assessment. [63, 64, 65]
- Create a prioritization scheme in the public tree inventory that rates trees based on risk levels.
- Use qualified individuals such as ISA Certified Arborists to monitor public infrastructure improvements for potential increase in tree risk and to identify potentially high-risk trees as part of regularly scheduled inventory updates.
- Perform re-inspections after storms that include heavy winds or snow that may increase branch loading.
- Promptly remove and prune trees identified with severe and high risk.
- Integrate a sidewalk repair program with proper arboricultural practices and a permit system that tracks proposed work near public trees.
- Maintain adequate funding levels for risk management using in-house funding or partnerships with nonprofits or obtain new funding stream.
Removal of High-Risk Trees in the Squirrel Hill Neighborhood

**Project Description**

The 2005 Pittsburgh street tree inventory identified 555 trees with significant defects in the Squirrel Hill neighborhood, and the trees were scheduled for removal between 2006 and 2008. Tree Pittsburgh (known as Friends of the Pittsburgh Urban Forest in 2006) raised much of the funding necessary to complete Priority 1 pruning work throughout the City and in the Squirrel Hill neighborhood. Additional funding came from the Shade Tree Commission’s trust fund and the City’s capital funding sources.

**Accomplishments**

The City began removing trees in Squirrel Hill neighborhood in late 2007. The area surrounding Squirrel Hill is one of the more densely tree populated areas of the City and many of the several blocks were lined with large oaks and London planes. Plans included removal of 555 trees in the neighborhood and replanting with some of the 4,200 trees slated for the City between 2007 and 2011.

A public meeting was held in the area in 2005 when the original project plans were underway. However, Squirrel Hill residents were surprised when forestry crews appeared and began removing trees in 2007. A meeting was called in January 2008 and attracted over 70 residents who were upset about the removals. The meeting was attended by City officials and the Director of Tree Pittsburgh.

Comments from residents at the meeting included concern for trees throughout the City, not just Squirrel Hill. One resident lamented the potential loss of a row of seven, large London plane trees near her home. City officials countered with their concerns about public safety and explained that they were implementing a planned program to revitalize the City’s street tree population by removing high-risk trees and replacing them with new trees where appropriate. Representatives from Tree Pittsburgh agreed with the City’s proactive stance and reported that caring for trees should take priority over planting new ones.

**Lessons Learned**

A moratorium on public tree removals was called in January 2008 and in July 2008; the Pittsburgh City Council adopted new legislation that required the City to notify residents at least four weeks before cutting down street trees unless the trees pose an immediate hazard. Residents then had the right to appeal the removal. The legislation also required replanting at or near where trees were removed.

While useful, the legislation may not have been necessary if better communication with local residents had been part of a tree management program. To casual observers, tree removal is always much less appealing than new tree planting. However, good communication about sustainable urban forestry would help to reduce concerns about tree removals that improve public safety. A comprehensive program will always include new tree plantings, systematic maintenance, and removals.

Sources: [66-70]
TREE PLANTING

Goal: Ensure tree benefits for future generations through a sustainable planting program

A few decades ago, Pittsburgh had a robust tree planting program and even operated a municipal tree nursery, but by 2006 relatively little city funding was allocated for tree planting. While some city projects had tree planting components, no formal planting program existed. Funding and managing a citywide planting program is essential; without a balanced approach to tree maintenance and tree planting, the urban forest is unsustainable.

Current Conditions

Working in partnership with community groups, nonprofits, and municipal agencies, TreeVitalize® Pittsburgh is a joint project of Allegheny County, The City of Pittsburgh, the PA Department of Conservation and Natural Resources, Tree Pittsburgh, and the Western Pennsylvania Conservancy. Since 2008, the TreeVitalize® program has leveraged over $5.2 million for planting projects and has become a model for cooperation and partnership among the many urban forestry partners in the City. [25]

The benefits that trees provide our City must be maintained and expanded through a sustainably funded tree planting program. Without a tree planting program, Pittsburgh’s tree resource, especially the street tree resource, will decline and become a burdensome liability. Canopy goals cannot be met and benefits from the urban forest remain stagnant or even decline. Equally as unsustainable is the planting of trees without dedicated funding for long-term maintenance of new trees.

With the challenging goal of increasing tree canopy cover citywide from 42% to 60% over the next 20 years, significant amounts of trees will need to be planted. A wide variety of methods are currently employed to increase overall tree canopy in Pittsburgh. These range from creating cut-outs in sidewalks for street trees, incorporating structural soils and Silva Cells to increase rooting volume in heavily built areas, to planting smaller, bare-root trees in native soil and establishing seedlings in naturalized areas.

Urban forestry partners across the City currently utilize a variety of proven, well-adapted, but relatively uncommon species for all types of planting projects. The Pittsburgh Shade Tree Committee publishes and maintains a recommended species list for plantings along streets that includes selections for use under power lines. Tree Pittsburgh maintains policy guidelines to assist tree planting agencies with achieving overall resource diversity objectives. See Appendix D for the Tree Diversity Goals and Recommendations.

Tree Pittsburgh also operates a small nursery within the City for small-scale production of trees. The purpose of this nursery is to propagate and grow genetically local, native trees for restoration and reforestation projects on river banks, hillsides, parks, and vacant lots.

Issues

- Based on the most current data, Pittsburgh’s street tree population has four species that together represent 44% of the street tree population (Acer platanoides, Pyrus calleryana, Acer rubrum, and Tilia cordata).
- While diversity among the tree resource has steadily improved since 2008, maple continues to dominate the street tree population.
- Pests and diseases (both native and exotic) pose serious threats to many species in the Pittsburgh urban forest. ALB and emerald ash borer are two very significant examples. EAB threatens 8.8% and ALB 67.1% of the urban forest.
- According to survey results, in Pittsburgh there is broad support for more trees in general, for people planting on their own private property, and for increased funding for street tree planting.
- In the heavily urbanized areas of the City where street trees can provide the greatest benefits, planting sites must be planned for and engineered into the built environment.
- Currently, there is no funding for planting in the City’s municipal budget and no City codes that require tree planting as part of development projects that are not consistently enforced.
- The City’s current tree request form process limits the tree planting program’s effectiveness.

Recommendations

- Choose performance-based planting strategies geared towards improving specific benefits, such as planting conifers to improve air quality through year-round particulate matter removal.
- Establish street tree stocking goals for each neighborhood and for the entire City.
- Expand the Pittsburgh Shade Tree Committee’s recommended species list to include options for parks and private property.
- Emphasize the preferential use of locally grown trees and locally sourced seeds for nursery trees, such as those of the Pittsburgh Tree nursery, to improve the likelihood of tree survival, offset the impact of abiotic stressors on urban trees, and to preserve genetic diversity.
- Adopt Tree Pittsburgh’s Tree Diversity Goals and Recommendations for all agencies that plant trees.
- Reduce or minimize conflicts between trees and infrastructure by careful species selection, site evaluation, and the tenants of the Right Tree Right Place concept.
- Enforce city codes that require tree planting to be a part of development projects.
- Facilitate tree planting on private and public properties to help the City sustain and improve its overall tree canopy cover and resulting benefits.
- Develop programs that assist private property owners with tree purchase, selection, and planting.
- Target natural areas and forested hillsides for restoration planting projects.
- Ensure there is sustainable funding for necessary levels of tree maintenance to grow newly planted trees into safe and healthy, mature trees.
- Track all new tree plantings in an accurate and reliable inventory system to facilitate the use of tree data for research purposes, project costs, maintenance needs, and to evaluate progress towards diversity objectives.

Volunteers can easily plant bare-root trees without use of heavy equipment.

Tree planting on Memory Lane in the Hill District.
Case Study: Tree Planting

Hartwood Acres Park 1,000 Trees Project, May 2, 2009

Project Description
At Hartwood Acres, National Wildlife Federation members from around the country joined with local volunteers to plant more than 1,000 seedling trees in a sloping meadow near the Saxonburg Boulevard park entrance. And a large area that had previously been routinely mowed was allowed to naturalize. Simultaneously, other volunteers were doing a smaller planting project at North Park.

The project was financed by the National Wildlife Federation and the Pittsburgh-based Katherine Mabis McKenna Foundation. The plantings were sponsored in collaboration with TreeVitalize®, a partnership of nonprofit and government agencies, including the Western Pennsylvania Conservancy, Tree Pittsburgh (know as Friends of Pittsburgh Urban Forest in 2009), the City of Pittsburgh, Allegheny County, and the State Department of Conservation and Natural Resources (DCNR).

The seedlings planted at Hartwood Acres were one to three years old. They were planted with a plastic tube covering them above the surface to protect the young trees from deer, but allowing them to get air, light, and water.

Accomplishments
The trees are doing well; protected by tree tubes, they are growing rapidly.

Lessons Learned
While it is very important to plant medium- to large-caliper street and park trees, establishing these trees in the heavily built, urbanized environment can cost between $1,500 to $2,000. In these situations, it is appropriate to plant a $300 tree in a $1,500 “hole”. This is critical work that often requires a high level of planning and engineering for each tree planted. A way to significantly increase canopy over time and realize a tremendous return on investment is to plant smaller trees wherever feasible. Going down the scale this would include 1.25-inch stock, 0.5- to 1-inch whips, 3-gallon potted trees, 2-year transplants, and seedlings.

Due to lower risk exposure and shorter production schedules, nurseries are able to provide greater diversity of species with smaller stock. The use of volunteers greatly enhances the return on investment and directly involves citizens in their urban forest. The use of social media, specifically Twitter and Flickr in this case, helped ensure the success of the project.

Recommendations
- Utilize the Hartwood Acres model to plant tens of thousands of young trees.
- Work with local nurseries to increase diversity by encouraging the propagation of desired species and varieties.
- Explore contract growing with local tree growers to ensure the availability of required quantities.
- Continue to employ social media to recruit, organize, and celebrate volunteer tree planters.
- Identify and prioritize appropriate planting sites such as vacant lots, brownfields, medians, and parks.
- Give high priority to mowed areas that can appropriately be allowed to revert to forest. This gives the added advantages of reducing greenhouse gas emissions and lowering fuel, labor, and equipment expenses.
- Create public education messages for use during and after a storm event appropriate for all types of media.
STORMWATER MANAGEMENT

Goal: Incorporate urban forestry practices into the City’s stormwater management plan

In a natural setting, trees control stormwater runoff and protect surface waters from sediment and nutrient loading. In an urban setting, trees reduce the amount of runoff that enters stormwater and combined sewer overflow systems. Acting as mini-reservoirs, trees control stormwater at the source and reduce the peak of a rain event. According to the National Tree Benefit Calculator, www.treecenter.com/calculator, a single, mature sugar maple can intercept several thousand gallons of stormwater per year. [7] It does this by:

- intercepting and holding rain on leaves, branches, and bark.
- increasing infiltration and storage of rainwater through its root system.
- reducing soil erosion by slowing rainfall before it strikes the soil.

Water bodies in urban areas that receive stormwater runoff are often threatened by pollution. Rain flushes salt, oil, gasoline, hydraulic fluids, and other contaminants directly into bodies of water, creating imbalance to their complex, aquatic ecosystems. Rain events can also cause combined sanitary sewers and storm systems to overflow, dumping untreated sewage into our lakes, streams, and rivers.

According to the USDA Forest Service Center for Watershed Protection, stormwater runoff is the number one factor in the decline of urban streams and decreasing urban water quality. Regarding trees and stormwater, the Center has reached these conclusions:

- Watershed health is linked to the amount of forest in the watershed and its distribution.
- Increased tree cover and tree size result in reduced total runoff rates (for example, 10% tree cover results in 2–5% reduced runoff).
- Tree canopy has a greater effect on small storm events than on large storm events.
- Effects on runoff are greatest when urban trees are large and well established.
- Trees and stormwater management infrastructure can coexist if planned and designed from the start.

Current Conditions

Pittsburgh has combined sewer outflow systems; during rainfall events, excess runoff can mix with raw sewage. By intercepting rainfall and controlling runoff at the source, trees can reduce the extent of this problem. This is especially important in an urban setting with a significant quantity of impervious surfaces in close proximity to the Allegheny, Monongahela, and Ohio Rivers.

According to the 2011 Urban Tree Canopy Analysis, Pittsburgh is covered by 33% impervious surface. Historically, Pittsburgh’s stormwater management has involved collecting, transporting, and dumping it as quickly as possible into the Allegheny and Monongahela Rivers. Pittsburgh’s 38-inch average annual precipitation is not extreme by any means; however, storm events have occurred with increasing frequency that would tax any system to the limit. Notably, Hurricane Ivan resulted in 6 inches of rain during a 12-hour period in September 2004. [6]

If our rivers and streams are to recover, we need to improve our methods of managing stormwater. Urban forestry practices that combine planning, engineering, and arboriculture to create functional green infrastructure can greatly mitigate the harm caused by urban runoff. Significantly increasing tree canopy, creating bioswales, and reducing impervious surfaces are all methods that must be used in combination to have the necessary impact.

To effectively use trees to manage stormwater runoff, the site must be designed properly and, sometimes, even engineered. Site design is critical to the success of any project, even when the project seems as simple as planting a tree.

A tree’s ability to establish, grow to its full potential, and remain healthy is largely dependent upon soil volume. If too little soil is available, the tree will not reach full stature, regardless of what species is planted. Trees without adequate soil volume tend to be short lived and do not function as useful components of a city’s infrastructure. Poorly designed sites and those lacking adequate soil and space generally require continual, costly plant health care and often continual replanting of trees. Designing a site for success—providing both soil and space—will grow the biggest tree the site can accommodate and, thus, divert and absorb the most stormwater.

Tree planting schemes that are designed and engineered with trees as a consideration, not an afterthought, will produce trees that grow to their maximum size, extending dense canopies and providing the greatest stormwater utility benefit, as well as other environmental and economic benefits. Site design elements that make sense in our City include:

- Suspended pavement and structural cells.
- Permeable pavements.
- Structural soils.
- Stormwater tree pits.

Stormwater management systems designed to mimic natural areas can be integrated into community, street, building, and even site developments to reduce the damaging effects of urban runoff on rivers and streams and relieve pressures on combined sewer and stormwater systems.

- Forested bioswales.
- Green roofs.
- Green streets.

For more information on these design elements and stormwater management systems, please refer to the Stormwater to Street Trees – Engineering Urban Forests for Stormwater Management found in Appendix E.
Issues

- Trees are typically not considered part of either grey or green stormwater management systems; they are generally, and falsely, considered landscaping. When planting a tree as landscaping, the stormwater utility benefits it might provide should also be considered when determining its placement.
- Impervious surfaces and compacted soils in urban areas prevent the infiltration of runoff into the ground, which creates challenges for stormwater management and urban forestry.
- Streetscape designs and individual tree planting spaces often fail to address the needs of trees. Common design failures include compacted soil, improper (too small) tree pit size, a lack of soil for root growth, and impervious surfaces.
- Some parking lots in Pittsburgh have been retrofitted to increase tree planting. These projects mostly involved asphalt removal to create an opening in which a tree can be planted, but rooting volume is not often sufficient for a large tree to thrive.
- A medium- to large-sized tree requires approximately 1,000 cubic feet of rooting volume in order to thrive into mature form.
- Measuring the value of constructing parking lots that integrate high canop y coverage is difficult, while the increased cost is readily apparent. Availability of construction materials such as structural soils and porous asphalt is limited and will remain so until demand increases. Costs for these materials are significantly higher than typical asphalt and gravel base material.
- Retrofitting existing parking lots is more challenging than planning and engineering new, green infrastructure parking lots. As the science of urban forestry advances, quantification of ecosystem services such as energy savings, air pollution reduction, and stormwater mitigation will become more exact.
- Increased canopy cover can have a significant beneficial effect on stormwater management. The greatest opportunity to increase canopy cover lies within residential land use.
- Lack of enforcement of landscape tree planting and permeable areas for developments and parking lots.
- Not all watersheds within Pittsburgh have stormwater plans.

Recommendations

- Target urban tree planting and tree canopy expansion efforts based on increasing stormwater benefits.
- Identify local stormwater improvement needs at the neighborhood level and prioritize feasible tree planting schemes, site design elements for trees, and stormwater management systems that can be implemented.
- Target parking lots as a feasible land use for green infrastructure retrofits, utilizing porous pavement, structural soils, and trees.
- Advocate for the use of suspended pavement and structural cells during appropriate redevelopment projects.
- Utilize stormwater tree pit designs to increase infiltration and limit compaction, and engineer them to receive and process street and rooftop runoff.

Philadelphia’s Stormwater Solution

Philadelphia has embarked on a $2 billion, 25-year project to improve the way it processes stormwater. The old system combines sewage and stormwater, which cause sewage overflows during heavy rains. The new project will replace as much as one-third of the City’s existing impervious cover—about 4,000 acres—with natural or porous surfaces that can intercept stormwater, store it, and release it at a controlled rate.

Proposals include natural water storage and filtering solutions such as rain gardens, curbside planters, and green rooftops. Porous asphalt, concrete, and paving slabs will be installed in car parks and on streets. Together, these technologies should prevent between 5 and 8 billion gallons of wastewater from overflowing each year. [71]

New York City’s Stormwater Solution

Impervious surfaces cover approximately 72% of New York City’s 305 square miles in land area and contribute to a significant amount of stormwater runoff.

The NYC Department of Environmental Protection has made a broad, citywide effort to better manage stormwater using a variety of innovative, sustainable, green infrastructure. Improved stormwater management is an important component of the PlanNYC initiative and Sustainable Stormwater Management Plan. Green infrastructure, or source controls, is a set of techniques that detain or retain stormwater runoff through capture and controlled release, infiltration into the ground, vegetative uptake, and evapotranspiration, thereby reducing the need for end-of-pipe stormwater storage and treatment systems. [72]

Some types of green infrastructure New York City is employing are:

- A rain barrel giveaway program.
- Street-side swales and enhanced tree pits.
- Rooftop detention, including green roofs, blue roofs, and control roofs.
- The Staten Island Bluebelt—a program that preserves natural drainage corridors, including streams, ponds, and wetlands.
Case Study: Stormwater Management

Tabor to the River, Portland, Oregon

Project Description

The Brooklyn Creek Basin covers about 2.3 square miles in the City of Portland, Oregon, from Mt. Tabor to the Willamette River between SE Hawthorne and SE Powell Boulevards. A major creek once flowed freely from Mt. Tabor to the Willamette River through what is today known as the Brooklyn Neighborhood. Long ago, the City diverted this creek, and many other free-flowing streams, into underground sewer pipes to make way for development. The combined sewer system serving the Brooklyn Creek Basin today mixes sewage from homes and businesses and stormwater runoff from streets in the same pipes. Parts of the sewer system are a century old. Because of increases in pavement and other impervious surfaces, and decreases in tree canopy, the volume of stormwater the system manages is much greater than it was designed to manage 100 years ago. Very heavy rains can cause sewers to back up into basements, flood streets, and overflow to the Willamette River. [73]

The Tabor to the River-Brooklyn Creek Basin Program addresses stormwater management and watershed health issues by:

- adding more than 500 green street facilities, vegetated curb extensions, and street-side planters that will collect street stormwater runoff and let it soak into the ground as soil and vegetation filter pollutants.
- repairing or replacing 81,000 feet of sewer pipe, adding new pipe, and installing new manholes as necessary.
- planting nearly 3,500 street trees to absorb rain and reduce and slow stormwater runoff.
- restoring natural areas in the basin by removing invasive vegetation and introducing native plants.
- working with private property owners to construct facilities that will collect and manage roof and parking lot runoff.
- repairing or replacing 81,000 feet of sewer pipe, adding new pipe, and installing new manholes as necessary.

Accomplishments (as of spring 2011)

- Built 137 green street facilities.
- Created 16 private property rain gardens.
- Planted 400 street trees.
- Replaced or repaired 8,000 feet of sewer pipe.
- Removed 26.5 acres of invasive plants and planted 4,800 native shrubs and trees in natural areas.

Lessons Learned

- Resolving these problems with only pipe solutions would cost an estimated $144 million.
- Adding sustainable, green stormwater management systems reduces the cost to $86 million.
- The additional benefits include enhanced water quality and watershed health.
**Green Parking Lot in Ithaca, New York**

**Project Description**

In collaboration with the Cornell University Urban Horticulture Institute and other partners, the City of Ithaca built a parking lot that compounded benefits in green infrastructure by combining porous asphalt, a base of CU-Structural Soil™ (also known as CU-Soil™) capable of holding a 100-year rain event, and disease-resistant hybrid elms. The trees cool the surface and ambient temperature, slow the rain, and when transpiring pump out pure water into the atmosphere. To make this powerful illustration of how trees are an integral component of urban, wet weather green infrastructure even more obvious, it is sited next to a flood control channel. No catch basins, water pipes, or outfalls connect to this parking lot. [74]

The parking lot is completely underlain with a 30-inch base of CU Structural Soil. For research purposes, half of the paved surface is typical asphalt and half is porous asphalt. Monitoring wells were installed from the surface to the bottom of the base course. The base sits on un-compacted, clay loam soil. [74]

Relatively narrow slots were cut into the asphalt, and trees were planted at a grade directly into the CU Structural Soil. This enables a high percentage of canopy coverage while devoting more space to parking spots. Since the open areas are at grade, they can receive runoff directly. In the porous half of the parking lot, rainwater also quickly percolates from the paved surface.

In this way, through slots in the surface and by permeable pavement, all the water that falls on the parking lot is systematically handled.

Disease-resistant, large-maturing, fast-growing trees were selected to attain a high canopy cover in a relatively short time. Canopy cover of approximately 50% has been attained on the site in less than 10 years.

**Accomplishments**

The parking lot has held up remarkably well since its construction in 2005. Freeze/thaw cycles have not heaved the surface. Tree growth rate has been rapid. Maintenance has been typical for the most part.

One interesting and surprising maintenance issue is that the porous asphalt actually requires less deicing salt because when snow and ice melt in the daytime, the water infiltrates leaving a drier surface when temperatures drop below freezing at night.

**Lessons Learned**

While surface parking lots comprise a significant amount of the impervious urban area, they represent the greatest opportunity for increasing stormwater infiltration, bioremediation of pollutants, and improving the health of rivers, streams, and lakes.

Maintenance of green parking lots can actually be less costly due to extended asphalt life resulting from shading ultraviolet radiation and decreased use of deicing salt due to melt water infiltration.

Increased costs upfront results in future environmental benefits.
**URBAN TREE CANOPY COVER GOALS**

**Goal: Achieve 60% urban tree canopy cover in 20 years**

Tree canopy is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. The amount of tree canopy cover data drives the amount of benefits that an urban forest provides (for example, intercepting rainfall, controlling stormwater, improving water quality, reducing energy demands, lowering surrounding air temperatures, reducing air pollution, enhancing property values, and providing wildlife habitat).

Establishing a realistic and achievable tree canopy cover goal is a crucial step for communities seeking to improve their green infrastructure and to capitalize on the environmental services that trees provide. Before establishing a goal, communities need to assess their current tree canopy cover levels and determine what is physically and biologically possible to achieve. An Urban Tree Canopy (UTC) analysis establishes a baseline for tree canopy cover and enables goal setting.

Tree Pittsburgh commissioned the 2011 UTC analysis that utilized 2010 data, high-resolution aerial imagery, LiDAR, and GIS to analyze citywide tree canopy cover. The UTC analysis provides information about canopy cover location and conditions where trees are absent, including political boundaries (neighborhoods, wards), existing land use (residential, commercial, industrial), and demographics (poverty rate, population density, crime rates, age distribution). The GIS data that include environmental and sociological information help determine what is preferable in terms of protecting and expanding tree canopy. Stakeholders and planners can use GIS to query specific tree canopy and land use metrics for a specific parcel or set of parcels, specific neighborhoods, or watersheds. This information can be used to develop policy and regulations to control tree canopy loss, or to provide direction and justification for tree canopy enhancement. [6]

**Current Conditions**

The 2011 UTC assessment indicates that Pittsburgh’s overall tree canopy is 42% of the total land area, indicating a rich urban forest resource within the City that warrants protection. While this figure is a higher overall percentage than many cities, analysis indicates that it is unevenly distributed. Most of the City’s residents live in neighborhoods with substantially less canopy cover, some neighborhoods as low as 5%. [6]

While the City’s overall canopy cover is 42%, an additional 33% of the land area meets criteria for establishing trees (“possible tree canopy”). Some of this area (24%) is currently grass and shrubs that could be converted to tree cover, and the remainder (9%) is currently impervious but could be modified to support trees and tree canopy. It is easier to establish trees in vegetated areas, but converting land that is currently impervious has greater benefits for stormwater reduction, water quality, and mitigating summer temperatures. [6]

The UTC analysis also studied existing and possible tree canopy within land use types (for example, parks, neighborhoods, river buffers, watersheds, and individual parcels). Residential land is the largest contributor to the City’s overall tree canopy (35% of all existing tree canopy) and accounts for the greatest opportunity to increase canopy, at 38% of all land identified as “possible tree canopy”. [6]

Analysis indicates that some neighborhoods have exceptionally high tree canopy levels while others are extremely low. For example, the Hays neighborhood currently has 81% canopy cover and Glen Hazel has 86%. The Chateau neighborhood has 5% canopy cover and North Shore has 6%. Focusing efforts on areas with the greatest need in terms of tree canopy may seem to be logical, but the analysis must also consider “possible tree canopy” at the neighborhood level. The Chateau neighborhood, at 5% current tree canopy, also has one of the largest “possible tree canopy” levels at 47%, indicating a combination of need and potential. [6]

Watersheds within the Mid-Atlantic region are considered to have “good” stream health if tree canopy is 45% or above. Tree canopy cover and “possible tree canopy” were analyzed for each of the 12 watersheds within Pittsburgh’s boundaries. Three of the six major watersheds that intersect the City have tree canopy levels far below the recommended 45% level.
Pittsburgh’s Land Cover

2012

Land Cover by Land Area
- Tree Canopy - 41.70%
- Grass/Shrub - 22.56%
- Bare Earth - 0.20%
- Buildings - 12.17%
- Roads/Railroads - 12.74%
- Other Paved Surfaces - 9.63%
- Water

City Level

Neighborhood Level

Parcel Level

Street Level
Factors that are assessed in the UTC analysis can be compiled into a “Tree Canopy Opportunity Index”. This process identifies areas at the land type, neighborhood, park, watershed, or parcel level where enhanced tree care, tree protection, and tree planting would be most effective. Maps can be generated at various resolutions to identify areas of greatest benefit enhancement based on levels of importance selected by stakeholders and planners. Accurate information about existing tree canopy provides a valuable baseline that can be used to identify an overall canopy goal as well as where to prioritize increasing canopy in specific areas. Tree Pittsburgh’s goal is to achieve 60% canopy cover over the next 20 years. With 75% canopy cover theoretically possible (42% existing tree canopy plus 33% possible tree canopy), 60% appears to be a challenging, yet achievable goal.[6]

This overall goal can be more easily approached incrementally by assessing possible tree canopy cover at a smaller scale, such as land use type, neighborhood, watershed, or individual parcel. Areas that currently do not have tree canopy can be assessed to determine their suitability for tree planting. A local approach to a big canopy cover goal helps engage stakeholders, helps urban forest managers determine the highest priority needs, and increases the likelihood that planting projects will be successful in the long term.

The UTC analysis helps determine where tree planting efforts should be concentrated; however, tree benefit quantification data must be considered to determine the number and species of trees to be planted. Setting performance-driven canopy goals that link desired benefits (rather than only the percent of cover) will provide direction for planting projects. Benefit quantification data from recent i-Tree studies will enable tree planting organizations to determine how many trees and what types to strategically plant for the purpose of increasing specific benefits.

For example, the 2011 i-Tree Eco data estimate that the 2.62 million trees in our City remove 532 tons of air pollution (ozone [O₃], carbon monoxide [CO], nitrogen dioxide [NO₂], particulate matter less than 10 microns [PM₁₀], and sulfur dioxide [SO₂]) per year with an associated value of $3.75 million. To double that benefit, the resource would need to double in size. However, a more strategic approach can be utilized to increase net air quality benefits by selecting species that are proven performers for air quality benefits. Typically, large-canopied trees with large leaf surface areas that are not high biogenic, volatile organic compound (BVOC) emitters produce the greatest benefits. According to the 2008 street tree benefit analysis, London planetrees are among the top producers of net air quality benefits in the City. On a per tree basis, Pittsburgh’s pin oaks produced the greatest net air quality improvement.[4]

### Pittsburgh Tree Canopy Assessment 2011

**Issues**

- A community’s ability to increase canopy cover is limited by available and suitable space, political constraints (including funding), and organizational capacity.
- Tree canopy is not evenly distributed throughout the City, and opportunities for enhancing tree canopy are scattered as well. Thoughtful interpretation of existing tree inventories and urban tree canopy studies will require input from stakeholders, planners, city staff, and urban foresters in order to find the best locations for enhanced tree care, tree protection, and tree planting.
- Tree canopy covers less than 10% of the total street and sidewalk area within the City and the total street tree population comprises only 3-5% of the total tree canopy in Pittsburgh. Canopy cover over paved surfaces has added value by reducing maintenance as trees along streets have been shown to reduce the wear on asphalt by lowering surface temperatures, thereby reducing maintenance costs. [6]
- Public land in Pittsburgh contains 26% of Pittsburgh’s tree canopy. While this appears to provide an opportunity for land that can be converted to tree cover, only 27% of this area is listed as “possible tree canopy”. [6]
- The best opportunity for increasing tree canopy appears to be on residential land (38% listed as “possible tree canopy”), although it would require a significant amount of regulatory influence and public education. Residential land covers more area than any other land type and contains 35% of the City’s existing tree canopy. [6]
- The key to the success of any planting project is adequate funding for long-term maintenance.

**Recommendations**

- Develop achievable, minimum canopy cover goals for each land use type, neighborhood, and watershed utilizing UTC and i-Tree data.
- Develop a backyard tree planting program and education campaign designed to increase canopy cover on residential land.
- Utilize the UTC analysis in conjunction with the i-Tree analyses to increase awareness about the relationship between trees and environmental quality and to engage stakeholders in tree planting.
- Set a goal to maximize street tree stocking levels.
- Target parks and other public land to maximize possible canopy coverage.
- Adopt performance-based planting strategies by selecting species based on desired benefit outcomes rather than canopy cover alone.
- Design a backyard tree planting and tree care toolkit for private landowners interested in planting trees to increase benefits that guide people to choose species and planting locations that maximize benefits.
- Share established tree canopy goals and share the UTC analysis with stakeholders concerned with the urban forest.
- Budget adequately to maintain trees after planting.
- Generate positive canopy impacts on small-scale development and redevelopment projects by incorporating canopy goals into municipal landscape requirements for streetscapes, parking lots, and other sites.
Allegheny Riverfront Vision Plan, Pittsburgh, Pennsylvania

Project Description
The Allegheny Riverfront Vision Plan creates a new direction for the banks of the Allegheny River and for the Strip District and Lawrenceville riverfront communities. Its vision is based on respecting fundamental ecological principles with goals of increasing residential and business connections, increasing the quality of urban living, and achieving a regenerative and sustainable market for long-term investment. Recommendations include substantial investments in tree planting to increase the area’s canopy coverage. [19]

The plan covers nearly 2,000 acres of the Allegheny Riverfront from downtown Pittsburgh at 11th Street, and the city boundary at Washington Boulevard in Highland Park. Two neighborhoods comprise most of the study area—the Strip District and Lawrenceville. Three residential communities are included and define the eastern end of the study area. Over the course of the 12-month planning process, residents, business, and stakeholders were engaged and provided valuable input. Several existing planning documents for the study area were developed over the last 10 years and provided a strong foundation on which the Allegheny Riverfront Plan was based. [19]

Accomplishments
The plan divides the study area in two key linear zones that define the character of the riverfront area. The linear zones are defined based, in part, on ecological principles. Tree canopy goals were established for each of the zones that are combined to create an overall tree canopy goal in the study area of 40%. For example, a tree canopy cover goal of 80% was established for the first 100 feet of riparian buffer and all of the AVRR corridor, known as the Green Boulevard. A goal of 40% canopy cover was established for the transition zone and service zones, while a goal of 25% was established for the preservation zone, an area with residential neighborhoods. [19]

Well-planned tree planting at the levels that achieve target canopy coverage will provide large-scale, evapo-transpiration functions.

Lessons Learned
A fundamental measure of a plan’s success is its viability. Plans that base their vision on a thorough analysis of current ecology have taken a critical first step in developing a plan that is achievable. The plan’s authors realized that most of the natural landscape is missing from the Allegheny Riverfront Area and that ecological planning should be approached as restoration ecology. This included plan components that restore the hydrologic cycle by capturing the rain and increasing vegetative cover. By recognizing the value of trees as a viable tool to reduce stormwater runoff, the plan utilizes current tree canopy data along with existing hardscapes conditions, to develop realistic canopy goals that create environmentally sustainable neighborhoods that can thrive economically and socially. [19]
STORM PREPAREDNESS

Goal: Establish a comprehensive tree emergency response and recovery plan

The National Weather Service reports that in Allegheny County from 1950 through 2011, there have been 953 severe weather events resulting in 21 deaths, 714 injuries, and over $4.80 million in property damage. On average, there were 15 storm events resulting in $7.9 million in property damage per year. In the Pittsburgh area, severe weather takes the forms of tornados, hurricanes, flooding, thunderstorms and high winds, and snow, ice, and hail. [75]

To date, the City’s response to small, moderate, and severe storms has been adequate. Citizen complaints and reports are addressed quickly as crews and equipment from multiple city departments can be called into action. Through the City’s pre-qualified tree work contract, there is a proactive purchasing mechanism in place to efficiently secure more personnel and equipment as needed.

Current Conditions

Resource—With over 31,000 public trees and a 42% canopy cover, both of which are widely distributed within the city limits, during each storm the City has a significant amount of risk exposure for damage to persons and/or property and a significant potential for large amounts of woody debris to be collected, stored, and processed. Nearly 20% of the public forest is comprised of species that are known to be prone to storm damage. According to the 2005 tree inventory, the condition of the majority of these storm-prone trees is only poor to fair. [1]

Structure—The City’s Office of Emergency Management and Homeland Security is the lead agency in the event of a severe, citywide storm emergency. The Forestry Division is the lead agency for minor storm events. However, moderate storms requiring a multi-departmental response reveal a significant lack of coordination on many levels, which leads to inefficiencies in terms of timely and corrective actions and use of public funds. For example, there are no predetermined wood waste storage yards or efficient methods for processing or properly disposing debris. The utility company performs a significant amount of storm damage mitigation within the public urban forest, but this is not coordinated with the City. This decentralization of crews, equipment, and funding hinders a more effective storm response by the City.

Funding—Funding for storm response typically comes from the operations budget of Forestry and/or the responding department. When severe storms cause significant damage, state and federal reimbursements are sought. At this date, storm expenditures can be accounted for, but budget analysis is cumbersome and may not capture all true expenses related to emergency response in the urban forest.

Issues

- The City currently does not have an emergency plan specifically for the urban forest.
- During and after a storm event, there is a lack of communication and coordination between City departments and the utility company.
- Other departments do not seek out the Forestry Division for expertise and training.
- Whether storm damage mitigation work is performed by City, utility, or contracted crews, hazards are abated but no corrective or restorative pruning is performed on public trees. This leaves trees in a weakened condition, aesthetically unappealing, and creates inefficiencies and an unnecessary funding burden when trees must be visited multiple times to accomplish proper pruning.
- No funding is ear-marked for a citywide, cyclical, preventive maintenance program, nor for response to or damage from storm events that do not qualify for reimbursement from Federal Emergency Management Agency (FEMA).
- Based on current species and condition information, a large portion of the public tree resource is highly susceptible to storm damage.
- Based on the public outreach campaign results, citizens want more trees; however, increased numbers of trees and canopy cover could mean more potential risk of damage and greater amounts of debris after storms. With expanded planting efforts, it is more critical that a routine maintenance program be established and that an emergency response plan is in place.

Recommendations

- Create a comprehensive Tree Emergency Response and Recovery Plan to analyze existing resources, risk levels, funding, and partnerships and to recommend protocols and strategies to increase emergency response efficiencies, decrease costs, and improve communication.
- Implement i-Tree Storm.
- Create an urban forest emergency maintenance fund earmarked only for severe weather response when an emergency is declared by the Mayor and ratified by the City Council or by the Emergency Management Director.
- Strengthen the partnership with Duquesne Light to find synergies and define pre-storm and post-storm roles and responsibilities.
- Cross-train appropriate staff in other departments in proper tree pruning, removal, and debris handling and safety procedures to increase the number of qualified personnel available to assist during an emergency.
- Establish a preventive maintenance program/cycle for public trees, plant storm-resistant tree species, and perform structural pruning on all newly planted trees.
- Change the city policy prohibiting the sale of wood products recovered from storms, such as firewood, sawlogs, and mulch to allow for reuse and be a source of revenue.
- Create public education messages for use during and after a storm event appropriate for all types of media.

Severe storms can result in downed trees and road closures.
Fort Wayne, Indiana

**Project Description**
After decades of a variety of severe weather events and after a particularly devastating ice storm in 2008, the City of Fort Wayne’s urban forest managers knew it was time to create a plan and have the resources identified and in place to be better prepared for the next emergency situation. This decision to create a plan was not only made to reduce risk and damage, but was further supported by the fact that FEMA reimbursement for urban forest storm damage mitigation was not being recovered because the City did not properly document mitigation expenditures. Fort Wayne spent hundreds of thousands of dollars on urban forest damage cleanup and recovery for which they did not get reimbursed. In 2011, the City completed its urban forest emergency plan and implemented software and departmental protocols to comply with local, state, and FEMA regulations as well as requirements for reimbursement.

**Accomplishments**
Fort Wayne’s Urban Forestry Storm Response and Recovery Plan details improved policies and procedures to increase the efficiency and productivity of tree risk reduction and storm response and recovery operations. The plan addresses making improvements to many facets of the urban forestry program, integrates the urban forest storm plan into the City’s overall emergency storm response system, and describes the role of the local, county, state, and federal government before, during, and after a storm emergency in the City. The Plan also addressed topics ranging from long-term management objectives to short-term program priorities. As a result of the Plan process, a citywide risk analysis and GIS-based mapping was performed; debris storage and processing yards were identified; media-ready public education and public service announcements were created; and greater synergy and communications between the City, County, and controlling utility companies were established.

Fort Wayne is now fully prepared to assess damage and quantify debris in the critical first hours after any storm by using the US Forest Service’s public domain software application, i-Tree Storm. The i-Tree Storm program was installed on computers in the Parks and Recreation Department and the required, yet simple, 2% sample street and private tree inventory database was completed. Urban forest managers and field staff were trained to use the software and collect field data immediately after a storm event. With this software application and its components, the City is now prepared to better respond to an emergency, accurately assess total urban forest damage and potential debris, and provide that vital information to emergency officials in a concise and FEMA-approved format.

**Lessons Learned**
Through the Urban Forestry Storm Response and Recovery Plan project process, the City’s urban forester learned that despite some operational and administrative gaps, they had most of the expertise, processes, and equipment to deal with the after-effects of severe weather events. But greater efficiencies could be realized by streamlining certain aspects of the response and coordinating better with other departments and utilities. More specifically, the City learned:

- The proper use of i-Tree Storm will enable the City to apply for the appropriate reimbursement from FEMA.
- For long-term sustainability of the urban forest and to reduce the amount of damage after storms, their cyclical, preventive maintenance program should be funded to achieve a shorter rotation schedule.
- Species selection for tree planting should favor “storm-proof” species, and that structural pruning during young tree maintenance should be a priority.
- Communicating quickly, appropriately, and honestly with citizens decreases overall risk and aids in cleanup activities.

Case Study: Storm Preparedness

Resulting tree damage after the 2008 ice storm in Fort Wayne, Indiana.
Exotic and Invasive Pests and Diseases

Goal: Monitor the resource for exotic and invasive pests and diseases

Exotic and invasive pests are plants, animals, insects, or diseases that are typically imported or released accidentally from other regions of the world. In their native lands, these species often have natural predators and other controls to keep populations and ecosystem damage at low, manageable levels. However, when introduced here without natural checks and balances, their populations increase dramatically and they can severely affect trees and ecosystems. The effects of invasive pests and diseases are directly correlated to a reduction in the quality of structural and functional urban forest benefits. Our global economy has set the stage for an increasing number of threats each year as more and more goods are shipped to the United States from overseas.

The city of Pittsburgh has experience with exotic and invasive pests. Like many cities, it experienced the devastating loss of many of its elm trees during the mid-1900s that came as a result of Dutch elm disease (DED). Since that time, the City has remained vigilant for threats from several exotic and invasive pests.

Current Conditions

While historic pest problems typically occurred one at a time, Pittsburgh is now faced with several real threats from exotic and invasive pests. While not a complete list, the primary focus is on the following threats:

**Emerald Ash Borer (EAB)**—First found in the Pittsburgh area in 2007, this destructive insect has claimed tens of millions of ash trees in Michigan since it was first discovered there in 2002. The small, metallic-green borer has spread to nearly all of the northeastern United States and has claimed millions of ash trees in Pennsylvania.

EAB is an obvious threat to ash trees in Pittsburgh. While there are only 387 ash located along city streets, there are thousands more in public parks and woodlands and yards. When EAB strikes an area, it causes the total obliteration of all ash trees. The wood in ash trees that die from EAB becomes very brittle and poses a serious threat to public safety. Chemical treatments are typically reserved for select groups of ash trees while plans are made for removal and replanting of trees killed by the pest.

**Oak Wilt**—This destructive fungus is lethal to trees in the red oak group. It has claimed a large number of oaks and the City is taking an aggressive approach to treat and control its spread. There are approximately 1,750 oaks along public streets, and more located within manicured park areas, and still more within woodland areas and private property. While treatments exist, they require early diagnosis and treatment to be successful. Oak wilt typically attacks small pockets or groups of oak trees. Several parks and neighborhoods have been targeted for control measures.

**Oriental Bittersweet**—This invasive plant, native to Asia, is a climbing vine and trailing shrub capable of supressing trees and shading out beneficial plants. It is believed to have been introduced as an ornamental plant and is still commonly cultivated which further promotes its spread. Its prolific distribution, primarily by birds and suckering, and tolerance to shade, make oriental bittersweet a considerable forest pest. It can have an adverse effect on a tree rooting capability by adding weight to the crown and increasing the chance for windthrow in a storm or blow-over during excessive snowfall. The human cultivation, biological properties, and wide distribution make oriental bittersweet difficult to effectively manage.

**Tree-of-Heaven**—Introduced by English settlers to the United States, tree-of-heaven was once a popular tree both for its resistance to pollution and supposed homeopathic properties. As a non-native species from China, tree-of-heaven poses an imminent threat to the biotic integrity of Pittsburgh’s urban forests including its forested hillsides. Currently ranking as the sixth most prominent species and composing 5.3% of Pittsburgh’s urban forest, tree-of-heaven has effectively naturalized and impacted natural forest succession (In Tree Eco 2011). Its adaptive growth requirements, seed viability, and allelopathic nature make it a difficult-to-control pest that has infiltrated public and private lands.

Other Pests—Asian longhorned beetle (ALB) is another destructive borer that attacks a wide range of hardwood trees, primarily maple. While it has not been discovered in Pittsburgh, it is still considered a high-risk pest in the area by the United States Department of Agriculture.

While Dutch elm disease claimed thousands of elm trees in the past, the City has taken proactive steps to minimize its impact on the future population of elm in Pittsburgh. While elm have not been planted for years, many naturally occurring elm exist.

Some landscapes in city parks are now seeing new elm planted that are DED-resistant cultivars. Several invasive Norway maples in Schenley Park were removed and replaced with DED-resistant elm cultivars.

Other threats to Pittsburgh’s urban forest include the hemlock woolly adelgid and gypsy moth. While neither of these pests currently have the destructive force as oak wilt or EAB, both are present in Pittsburgh.

Issues

- There is currently no unified plan for regular monitoring of exotic and invasive pests.
- No action plan exists for appropriate response to imminent or existing outbreaks.
- Future pests are difficult, if not impossible, to prepare for or to predict.
- The street tree population is dominated by maple.
- The largest portion of the urban forest is held on private land and difficult to monitor for pests.
- Exotic and invasive pests pose a significant risk to the urban forest in terms of structural value and resource extent.
- The public may be uninformed or unaware of exotic and invasive pest threats on their property.

Recommendations

- Identify the highest level, exotic pest threats and develop strategies for monitoring, control, removals, and replanting. Strategies should include information about utilization of limited resources and methods to secure funding to prevent or deal with existing pest issues.
- Utilize existing street tree inventory data to monitor public street trees for high-priority, exotic pest threat zones.
- Educate city staff, stakeholders, and the general public about exotic pest threats and provide information about identification and treatment options.
- Create citizen watch programs to assist with early detection of exotic pests. Dovetail these programs with additional education about urban forestry issues.
- Offer homeowner incentives to combat invasive species on private property.

**Oak leaves infected with oak wilt. Photo from USDA Forest Service, Forest Insect and Disease Leaflet #29, Oak Wilt.**

**An adult emerald ash borer and the destructive galleries it creates on the tree trunk. Photo from USDA Forest Service.**
Case Study: Exotic and Invasive Pests and Diseases

Oak Wilt Tree Removal Project in Frick Park

Project Description
Oak wilt is a fungal disease that threatens oak trees and has become a large issue in the Pittsburgh area. It is a particularly virulent disease, meaning it can spread rapidly within groves of oaks that are located in close proximity to one another. Oaks in woodland areas that become infected can spread the disease to adjacent oaks via root grafts or borers that fly from infected trees to healthy trees. Many of Pittsburgh’s parks have woodland areas with heavy oak populations that are threatened by oak wilt. Frick Park is Pittsburgh’s largest municipal park and covers 561 acres. It is located approximately four miles east of downtown Pittsburgh near the Squirrel Hill neighborhood. [79–83]

Accomplishments
In 2009, City staff realized that a grove of oak trees in Frick Park were infected with the oak wilt fungus, and the potential for rapid spread to nearby areas, including private land, was a major concern. A plan was developed to control this spread, eliminate the pocket of infected trees, and treat nearby trees to reduce the chance of spread.

Trees were removed from a two-acre grove within Frick Park located near Kensington Street in April 2010. While the removal of infected trees seems drastic, this practice known as “sanitation” is a commonly practiced and widely accepted means of treatment to reduce the chance of spreading the fungus. Other treatments included the use of vibratory plows to slice through the ground and sever any potential connection between roots of infected oaks and adjacent healthy oaks. The nearby remaining oaks at the periphery of the removal area were also treated with fungicide injections to further reduce the potential for spread. The chemical treatment is effective only in the very early stages of infection; thus, its use on the adjacent trees is appropriate, while treating oaks with advanced infections is not warranted.

City staff and the Pittsburgh Parks Conservancy jumped on the education opportunity this project created and heavily publicized the project and held on-site classes to demonstrate some of the treatments.

Lessons Learned
While the removal of two acres of trees on public lands in an urban area can create quite a stir, this example was successful in limiting the spread of the oak wilt fungus and provided valuable information about how to treat future infection pockets. It was also a reminder of the need for vigilance to identify infected trees early so that treatment can be performed on a smaller scale. Seizing the education opportunities provided on-site public observation of the devastating impact of exotic and invasive pests.
TREE PROTECTION DURING INFRASTRUCTURE IMPROVEMENTS

Goal: Protect trees and preserve their role in defining the City’s character

One of the best ways to maintain or improve Pittsburgh’s current tree canopy level of 42% is to ensure that the current population of trees is protected from harmful activities such as indiscriminate damage or removal during proposed construction. Large, established trees typically provide the most benefits to a community, but can also be the most challenging to protect. Trees often compete with other conflicting needs in urban areas. Nearby activities threaten trees directly and indirectly, and damage is often caused by those without adequate knowledge about tree biology.

Current Conditions

Despite the tree protection measures that are in place, the City continues to lose street trees from sidewalk work and other infrastructure improvements. There is language in the City Code that provides vague powers to the Pittsburgh Tree Commission for “protecting trees during construction and development”; however, it provides no specific authority or direction to do so (Title 4, Article XIII, Chapter 487).[16]

• Public Trees—Chapters 483 and 485 of Article XIII of the City Code contain language about protecting public trees from damage, including the authority to receive compensation from construction, excavation, gas leaks, and pet damage. But the language provides no direct authority to specific departments to effectively carry out this mandate. There is currently no clear authority for which departments respond to specific issues that impact public trees. [16]

No clear channels of communication exist between departments or agencies that would benefit from arboricultural expertise when permitted work threatens public trees, or when sidewalk or street improvements are planned. The City does not utilize a defined set of arboricultural standards when planning infrastructure improvements.

Utilizing standards and input from the City Forester would greatly reduce damage to public trees when these types of projects are planned. This step can also greatly improve public safety by removing trees that suffer traumatic root loss. [84]

Private Trees—Just as with public trees, City code provides no specific mandates for the protection of desirable trees on private property. The site plan review process Chapter 922 does require showing the location of woodlands and single trees that are 18 inches in diameter (at 4.5 feet above ground) and larger. However, there are no provisions mandating their protection. [16]

Chapter 918 of the City code also contains landscaping requirements that include language about tree planting on development sites, but the planting density is not related to the loss of trees on the site. [16]

Issues

• Lack of enforcement of current city standards and codes.
• The public outreach campaign results suggest that trees contribute greatly to the character of the city and are, therefore, worth protecting and preserving.
• The potential for landslides is a major concern along the City’s forested hillsides.
• The City lacks specifications and standards for the protection of public trees during repairs or improvements to existing infrastructure and the planning of new infrastructure.
• There is no clearly defined requirement or authority for specific departments to practice or enforce tree protection policies, specifications, or standards.
• The City lacks specific ordinance language that requires the protection of trees on private property.

Recommendations

• Update and enforce ordinances that protect existing tree resources both on public and private lands.
• Develop a set of arboricultural standards for all work that occurs near public trees. The standards should apply to permitted work by private contractors and municipal crews who perform any type of work that may impact trees.
• Develop ordinance protection for the City’s forested hillsides.
• Create clear authority with an interagency and interdepartmental communication process for inspection, monitoring, and enforcement of protection of public trees during infrastructure improvements by public agencies, or permitted work on public rights-of-way near public trees.
• Create a dedicated account for funds from remediation and fines that is strictly for funding other tree-related projects.
• Incorporate tree protection best management practices and examples of poor practices in a public outreach campaign.
• Create a private property tree protection ordinance.
Case Study: Tree Protection During Infrastructure Improvements

**Bakery Square Tree Protection**

The protection of trees during redevelopment projects in major metropolitan areas requires good communication between the developer and municipal departments that include planning, public works, and forestry. While redevelopment can provide tremendous energy and vitality to an urban neighborhood, it does not have to be at the expense of neighborhood character. Thoughtful redevelopment recognizes the value of architectural design and the preservation of existing trees that often define a neighborhood. [85, 86]

**Project Description**

Bakery Square is a recent redevelopment project located six miles from downtown Pittsburgh at the northeast corner of Penn Avenue and East Liberty Boulevard. It is the site of the historic Nabisco Bakery and was blighted in 2006 after its last tenant left in 2004. In 2007, Walnut Capital purchased the site and began environmental remediation and site planning. While the vast majority of the site was redeveloped with private funding, there were grants and tax increment financing that assisted with environmental issues and traffic concerns. Adequate road access was critical to the project; however, several large-diameter oaks lined streets that were targeted for additional lanes and other improvements. It appeared that trees would be lost based on the original plans.

**Accomplishments**

Arborists with the Pittsburgh Forestry Division stepped in and began a dialogue with the development planning team. Issues included communicating the value of the mature oaks to the neighborhood and the potential value they could bring to the project itself. The project pursued LEED green building certification and the tree protection would complement this pursuit.

Over 25 oaks were preserved by adjusting the new road configuration. Each tree was evaluated and assigned specific needs to help with tolerating the nearby construction activities. Chemical treatments included the use of Cambistat, a growth regulator that also promotes the development of new tree roots.

**Lessons Learned**

The protection of mature trees around the project site adds greatly to the environmental benefits and helps to connect the new construction with the preserved architecture and surrounding neighborhood. The involvement of an arborist with the development planning team and City departments provides valuable input to project design. Creating and maintaining this type of communication is a positive step and opens the door to future planning efforts with an arborist’s voice at the table.
**Summary of Recommendations**

Our urban forest is comprised of all trees on private and public lands within the city boundaries; these trees improve the environment and make our City a more desirable place to live, work, and play. Many urban forest partners play an integral role in planning, protecting, and managing our urban forest. It is important that we connect with and engage these partners to reach our shared vision for the urban forest.

These recommendations—established as a result of evaluating urban forestry practices—provide the means to achieve our shared vision and are designed to connect and engage all partners that play an integral role in planning, managing, and protecting our urban forest. The goals provide the framework for developing recommendations.

This section illustrates how these partners and stakeholders can work together to accomplish the recommendations, which are prioritized for each goal statement based on guidance from the Steering Committee. Stakeholders are categorized as federal, state, city, local non-governmental organization (NGO), private sector, and residential. Throughout the plan, these groups are collectively termed urban forest partners.

**Vision**

Over the next 20 years, Pittsburgh’s urban forest will be a vital and well-managed asset that is locally valued and nationally recognized for its positive social, environmental, economic, and public health impacts on the community and the greater region.

**Keystones**

- **CONNECT**
  - Connect urban forestry partners through a single vision.
  - Utilize urban forestry research in conjunction with on-the-ground operations.
  - Increase access to trees so that all can enjoy and benefit.

- **ENGAGE**
  - Focus on neighborhood-based initiatives and solutions to urban forestry issues.
  - Implement a coordinated and comprehensive outreach and education campaign.
  - Encourage public and private participation in urban forest management through volunteerism.

- **MANAGE**
  - Match funding to desired level of service for urban forestry management.
  - Develop a proactive management regime for public trees.
  - Develop a proactive risk management program for public trees.
  - Ensure tree benefits for future generations through a sustainable planting program.

- **PLAN**
  - Incorporate urban forestry practices into the City’s stormwater management plan.
  - Achieve 60% urban tree canopy cover in 20 years.
  - Establish a comprehensive tree emergency response and recovery plan.

- **PROTECT**
  - Monitor the resource for exotic and invasive pests and diseases.
  - Protect trees and preserve their role in defining the City’s character.
INTERAGENCY COOPERATION

- Convene a summit of all agencies with a major impact on our urban forest to formalize communication methods, identify cooperative projects, and seek synergy.
- Recommendations presented in this plan should be implemented by appropriate urban forest partners with lead agencies assigned to coordinate and oversee implementation.
- This plan should be adopted and appended as part of City code.
- Formally describe urban forest management responsibilities across all agencies and partners.
- As long as urban forestry responsibility and funding are divided among various agencies, the City should ensure the means to increase interdepartmental communication and cooperation for plans and projects that may affect the urban forest.
- Identify cooperative projects that connect private land owners to the City’s urban forest goals.
- Perform a comprehensive operational review of the City’s Forestry Division.
- Encourage nearby colleges and universities to attain Tree Campus USA status.
- Strengthen cooperation with the community by securing a seat on Campus Tree Advisory Committees for the City Forester or a member of the Pittsburgh Shade Tree Commission.

RESEARCH

- Convey the benefits of local urban forestry research to all stakeholders.
- Feature pertinent urban forestry research in media.
- Build consensus within city government for a municipal forestry research component and establish that component as an appropriate function with formal approval by incorporating it in city code.
- Identify or propose research that would provide tangible benefits to the urban forestry operation and to the City in general.
- Collaborate and cooperate with urban forestry researchers for mutual advantage.
- Support urban ecosystem-focused and collaborative research.
- Partner with USDA Forest Service Research Station in Pennsylvania.
- Reach out to educational institutions with offers of study locations or volunteers for data collection to engage the public and provide additional information that increases urban forest health.

EQUITABLE URBAN FOREST BENEFITS

- Give priority for urban forestry and outreach activities to disadvantaged communities that are currently gaining the least benefit from the urban forest.
- Align communications actions with the Vibrant Cities & Urban Forests 2012 Recommendation #9. **Ensure equal access to urban forestry and green infrastructure resources.**
- Prioritize neighborhoods for future tree planting and protection efforts to increase deficient tree canopy figures and allow for more equitable canopy cover across the City.
- Recruit volunteers from disadvantaged neighborhoods.
- Respond to resident requests for trees rather than property owner requests.
- In neighborhoods with long-term vacant properties, respond to adjacent residents’ requests to plant trees in front of the vacant properties.
- Do not allow absentee landlords to veto tree planting on adjacent public property.
- Increase education efforts regarding urban forest benefits, such as reduced energy costs, to increase demand for and support of public tree planting.
ENGAGE

- Focus on neighborhood-based initiatives and solutions to urban forestry issues.
- Implement a coordinated and comprehensive outreach and education campaign.
- Encourage public and private participation in urban forest management through volunteerism.

NEIGHBORHOOD TREE ADVOCACY

- Solicit feedback and input directly from neighborhood tree advocates about how to increase activism and interest in the urban forest.
- Educate and inform the neighborhood tree advocates on larger citywide issues, such as changes and improvements to urban forestry legislation and funding, and engage them to collectively support these important issues as appropriate.
- Engage citizen groups and local organizations to identify neighborhood issues that trees and their benefits can help address. Use trees and urban forestry projects as tools to make positive change at the neighborhood level.
- Tree Pittsburgh should continue to be the primary agency that facilitates neighborhood urban forestry needs and opportunities.
- Tree Pittsburgh should strengthen the relationship with the community development entities to help develop neighborhood-focused, urban forestry projects.

PUBLIC OUTREACH AND EDUCATION

- Create and sustain a comprehensive communications plan that addresses effective ways to engage all stakeholders.
- Expand the neighborhood communications network by identifying advocate groups or representatives in every neighborhood.
- Hire staff who are dedicated solely to public outreach and education.
- Consider direct advertising of Pittsburgh’s urban forest “brand” to reach more citizens and decision-makers.
- Identify the most effective means of communication for residents in each neighborhood.
- Create an education program for orienting newly elected public officials to Tree Pittsburgh’s and the City’s urban forestry program, efforts, and goals, and promote interdepartmental education opportunities.
- Explore potential funding opportunities for public outreach efforts and projects with foundations, private firms, and government grants.
- Align communications actions with the Vibrant Cities & Urban Forests 2012 Recommendation #1, Create a national education and awareness campaign.

VOLUNTEERISM

- Concentrate volunteer efforts on disadvantaged neighborhoods where tree canopy is lowest.
- Examine similar programs in the US and Canada and adopt innovative practices for use in Pittsburgh.
- Formalize the relationship between the Tree Tenders program and the City of Pittsburgh with a Memorandum of Agreement or other contractual understanding.
- Create an advanced Tree Tenders course aimed at arborist certification for veteran Tree Tenders.
- Create synergy by increasing collaboration with other organizations involved in environmental efforts such as the Pittsburgh Parks Conservancy Urban Ecosteward Program and Western Pennsylvania Conservancy’s extensive volunteer program.
- Foster corporate and university volunteer programs by engaging the principles of civic stewardship.
**MANAGE**

- Match funding to desired level of service for urban forestry management.
- Develop a proactive management regime for public trees.
- Develop a proactive risk management program for public trees.
- Ensure tree benefits for future generations through a sustainable planting program.

<table>
<thead>
<tr>
<th>FUNDING</th>
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<tbody>
<tr>
<td>- Reassess the City’s urban forestry program budget in terms of achieving street tree and UTC planting goals, the recommended seven-year preventive maintenance cycle, and the young tree maintenance programs.</td>
</tr>
<tr>
<td>- Each major entity providing services should accurately account for urban forestry-related income and expenses.</td>
</tr>
<tr>
<td>- Each major entity providing urban forestry services should perform a cost-benefit analysis to inform future management decisions that maximize benefits.</td>
</tr>
<tr>
<td>- Launch a public, education campaign to develop the political support needed for any necessary budget increases, emphasizing sound resource management as a positive investment.</td>
</tr>
<tr>
<td>- Sustain established partnerships and create new partnerships as a means to leverage resources needed to accomplish urban forestry goals.</td>
</tr>
<tr>
<td>- Increase penalties for developers and builders who damage trees and ensure enforcement.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>PROACTIVE MANAGEMENT</th>
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<tbody>
<tr>
<td>- Regularly monitor public trees for maintenance needs, risk, and pests.</td>
</tr>
<tr>
<td>- Develop a protocol that provides for regular updating of the public tree inventory.</td>
</tr>
<tr>
<td>- Implement a cyclical maintenance schedule of all street trees that provides for a seven-year cycle of inspection.</td>
</tr>
<tr>
<td>- Ensure that cyclical maintenance includes pruning of medium-sized and large trees to reduce risk and extend the productive life.</td>
</tr>
<tr>
<td>- Ensure cyclical pruning also includes care for newly planted and young trees in their formative years.</td>
</tr>
<tr>
<td>- Communicate and engage with the community regarding the urban forest plan.</td>
</tr>
<tr>
<td>- Ensure the Tree Tender program continues so that the City can narrow its focus on mature tree care.</td>
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</tbody>
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<thead>
<tr>
<th>RISK MANAGEMENT</th>
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<tr>
<td>- Facilitate a systematic tree maintenance program for public trees.</td>
</tr>
<tr>
<td>- Maintain an updated tree inventory with risk rating data that utilize the tree risk assessment standards in ANSI A300 (Part 9) and Best Management Practices published by the ISA that address both tree inventories and tree risk assessment.</td>
</tr>
<tr>
<td>- Create a prioritization scheme in the public tree inventory that rates trees based on risk levels.</td>
</tr>
<tr>
<td>- Use qualified individuals such as ISA Certified Arborists to monitor public infrastructure improvements for potential increase in tree risk and to identify potentially high-risk trees as part of regularly scheduled inventory updates.</td>
</tr>
<tr>
<td>- Perform re-inspections after storms that include heavy winds or snow that may increase branch loading.</td>
</tr>
<tr>
<td>- Promptly remove and prune trees identified with severe and high risk.</td>
</tr>
<tr>
<td>- Integrate a sidewalk repair program with proper arboricultural practices and a permit system that tracks proposed work near public trees.</td>
</tr>
<tr>
<td>- Maintain adequate funding levels for risk management using in-house funding or partnerships with non-profits or obtain new funding stream.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>TREE PLANTING</th>
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<tbody>
<tr>
<td>- Choose performance-based planting strategies geared towards improving specific benefits, such as planting conifers to improve air quality through year-round particulate matter removal.</td>
</tr>
<tr>
<td>- Establish street tree stocking goals for each neighborhood and the entire City.</td>
</tr>
<tr>
<td>- Emphasize the preferential use of locally grown trees and locally sourced seeds for nursery trees, such as those of the Tree Pittsburgh nursery, to improve the likelihood of tree survival, offset the impact of abiotic stressors on urban trees, and to preserve genetic diversity.</td>
</tr>
<tr>
<td>- Expand the Pittsburgh Shade Tree Committee’s recommended species list to include options for parks and private property.</td>
</tr>
<tr>
<td>- Promote species selection, site evaluation, and the tenants of the Right Tree Right Place concept.</td>
</tr>
<tr>
<td>- Enforce city codes that require tree planting to be a part of development projects.</td>
</tr>
<tr>
<td>- Facilitate tree planting on private and public properties to help the City sustain and improve its overall tree canopy cover and resulting benefits.</td>
</tr>
<tr>
<td>- Develop programs that assist private property owners with tree purchase, selection, and planting.</td>
</tr>
<tr>
<td>- Ensure there is sustainable funding for necessary levels of tree maintenance to grow newly planted trees into safe and healthy, mature trees.</td>
</tr>
<tr>
<td>- Track all new tree plantings in an accurate and reliable inventory system to facilitate the use of tree data for research purposes, project costs, maintenance needs, and to evaluate progress towards diversity objectives.</td>
</tr>
</tbody>
</table>
**PLAN**

- Incorporate urban forestry practices into the City’s stormwater management plan.
- Achieve 60% urban tree canopy cover in 20 years.
- Establish a comprehensive tree emergency response and recovery plan.

<table>
<thead>
<tr>
<th>STORMWATER MANAGEMENT</th>
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<tbody>
<tr>
<td>• Target urban tree planting and tree canopy expansion efforts based on increasing stormwater benefits.</td>
</tr>
<tr>
<td>• Identify local stormwater improvement needs at the neighborhood level and prioritize feasible tree planting schemes, site design elements for trees, and stormwater management systems that can be implemented.</td>
</tr>
<tr>
<td>• Advocate for the use of suspended pavement and structural cells during appropriate redevelopment projects.</td>
</tr>
<tr>
<td>• Utilize stormwater tree pit designs to increase infiltration and limit compaction, and engineer them to receive and process street and rooftop runoff.</td>
</tr>
<tr>
<td>• Prioritize streets where forested bioswales and green street systems may be most feasible or preferred to traditional streetscape design.</td>
</tr>
<tr>
<td>• Whenever space limitations allow, large, maturing trees should be the preferred choice to decrease stormwater peak flows.</td>
</tr>
<tr>
<td>• Encourage and assist homeowners to help reduce stormwater runoff by planting large-growing trees on their property.</td>
</tr>
<tr>
<td>• Require that sufficient rooting volume should be planned for and engineered in the design of new and retrofitted sidewalks and parking lots to support large-growing trees.</td>
</tr>
<tr>
<td>• Current City code should be enforced consistently by all City Departments.</td>
</tr>
<tr>
<td>• All stormwater plans should have urban forestry as a component.</td>
</tr>
<tr>
<td>• Prioritize watersheds for future tree planting and protection efforts.</td>
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<thead>
<tr>
<th>URBAN TREE CANOPY GOALS</th>
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<tbody>
<tr>
<td>• Develop achievable, minimum canopy cover goals for each land use type, neighborhood, and watershed utilizing UTC and i-Tree data.</td>
</tr>
<tr>
<td>• Develop a backyard tree planting program and education campaign designed to increase canopy cover on residential land.</td>
</tr>
<tr>
<td>• Utilize the UTC analysis in conjunction with the i-Tree analyses to increase awareness about the relationship between trees and environmental quality and to engage stakeholders in tree planting.</td>
</tr>
<tr>
<td>• Set a goal to maximize street tree stocking levels.</td>
</tr>
<tr>
<td>• Target parks and other public land to maximize possible canopy coverage.</td>
</tr>
<tr>
<td>• Adopt performance-based planting strategies by selecting species based on desired benefit outcomes rather than canopy cover alone.</td>
</tr>
<tr>
<td>• Design a backyard tree planting and tree care toolkit for private landowners interested in planting trees to increase benefits that guide people to choose species and planting locations that maximize benefits.</td>
</tr>
<tr>
<td>• Share established tree canopy goals and share the UTC analysis with stakeholders concerned with the urban forest.</td>
</tr>
<tr>
<td>• Budget adequately to maintain trees after planting.</td>
</tr>
<tr>
<td>• Generate positive canopy impacts on small-scale development and redevelopment projects by incorporating canopy goals into municipal landscape requirements for streetscapes, parking lots, and other sites.</td>
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<tr>
<th>STORM PREPAREDNESS</th>
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<tbody>
<tr>
<td>• Create a comprehensive Tree Emergency Response and Recovery Plan to analyze existing resources, risk levels, funding, and partnerships and to recommend protocols and strategies to increase emergency response efficiencies, decrease costs, and improve communication.</td>
</tr>
<tr>
<td>• Implement i-Tree Storm.</td>
</tr>
<tr>
<td>• Create an urban forest emergency maintenance fund earmarked only for severe weather response when an emergency is declared by the Mayor and ratified by the City Council or by the Emergency Management Director.</td>
</tr>
<tr>
<td>• Strengthen the partnership with Duquesne Light to find synergies and define pre-storm and post-storm roles and responsibilities.</td>
</tr>
<tr>
<td>• Cross-train appropriate staff in other departments in proper tree pruning, removal, and debris handling and safety procedures to increase the number of qualified personnel available to assist during an emergency.</td>
</tr>
<tr>
<td>• Establish a preventive maintenance program/cycle for public trees, plant storm-resistant tree species, and perform structural pruning on all newly planted trees.</td>
</tr>
<tr>
<td>• Change the city policy prohibiting the sale of wood products recovered from storms, such as firewood, sawlogs, and mulch to allow for reuse and be a source of revenue.</td>
</tr>
<tr>
<td>• Create public education messages for use during and after a storm event appropriate for all types of media.</td>
</tr>
</tbody>
</table>
## Exotic and Invasive Pests

- Identify the highest level, exotic pest threats and develop strategies for monitoring, control, removals, and replanting. Strategies should include information about utilization of limited resources and methods to secure funding to prevent or deal with existing pest issues.
- Utilize existing street tree inventory data to monitor public street trees for high-priority, exotic pest threat zones.
- Educate city staff, stakeholders, and the general public about exotic pest threats and provide information about identification and treatment options.
- Create citizen watch programs to assist with early detection of exotic pests. Dovetail these programs with additional education about urban forestry issues.
- Offer homeowner incentives to combat invasive species on private property.

### Tree Protection

- Update and enforce ordinances that protect existing tree resources on both public and private lands.
- Develop a set of arboricultural standards for all work that occurs near public trees. The standards should apply to permitted work by private contractors and municipal crews who perform any type of work that may impact trees.
- Develop ordinance protection for the City’s forested hillsides.
- Create clear authority with an interagency and interdepartmental communication process for inspection, monitoring, and enforcement of protection of public trees during infrastructure improvements by public agencies, or permitted work on public rights-of-way near public trees.
- Create a dedicated account for funds from remediation and fines that is strictly for funding other tree-related projects.
- Incorporate tree protection best management practices and examples of poor practices in a public outreach campaign.
- Create a private property tree protection ordinance.
This master plan will be updated and revised periodically to reflect changes in the urban forest resource structure and function, to incorporate changes in industry standards, to consider community response, and to measure the progress of the urban forest partners in implementing the recommendations and reaching the established goals.

Knowing how we are doing will require a continual process of evaluation. This section presents examples of how to monitor, analyze, and revise the plan, which will keep stakeholders informed of the status of our urban forest program.

Monitor

To monitor progress toward implementing the plan recommendations, a report card should be created and distributed to the public every two to three years. This will measure the progress toward implementing the plan recommendations. The following example provides a suggested reporting structure to measure success toward accomplishing each goal. Other indicators to measure progress may need to be developed to ensure a thorough and accurate evaluation. Examples of urban forest industry reports are available; Pittsburgh’s report card may draw on components of these to refine the City’s report.

Example Report Card

- **CONNECT**
  - List recommendations achieved, ongoing, and not started.
  - List urban forest partners that have adopted and use the plan.
  - Describe urban forest research initiatives.
  - Number of trees planted and their location.
  - Other successes.

- **ENGAGE**
  - List recommendations achieved, ongoing, and not started.
  - Number of new neighborhood initiatives related to urban forestry.
  - Describe public outreach and education efforts.
  - Number of volunteer efforts.
  - Other successes.

- **MANAGE**
  - List recommendations achieved, ongoing, and not started.
  - Report current funding levels for urban forestry programs.
  - Describe implementation of proactive management efforts.
  - Report on the progress of implementing a risk management program.
  - Number of trees planted and maintained.
  - Other successes.

- **PLAN**
  - List recommendations achieved, ongoing, and not started.
  - Describe efforts to incorporate urban forestry practices into stormwater management.
  - Report the current urban tree canopy and efforts to increase canopy.
  - Report on the establishment of a tree emergency response and recovery plan.
  - Other successes.

- **PROTECT**
  - Report the current threat of exotic and invasive pests and diseases.
  - Describe tree protection efforts.
  - Other successes.

Sacramento California’s State of the Trees Report was first published in 1996 and again in 2000, and includes tree population data, budgets for city and park trees, tree benefits, current conditions, and recommendations.

Tree Report Card, created by Casey Trees, a Washington, DC-based firm, measures tree coverage, tree health, tree planting, and tree protection.
### Pittsburgh Urban Forest Benchmark Values

**Urban Tree Canopy (UTC) Cover (2011)**
- UTC, all areas: 40%
- UTC, excluding water: 42%

**Estimated Tree Count**
- Street Trees (2005): 30,538
- Complete Urban Forest (2011): 2,628,000
- Street Trees Per Capita (2008): 0.09
- Total Trees Per Capita (2011): 8.7

**Species Diversity:** # of Species Exceeding the Recommended 10%
- Street Trees (2005): 4
- Park Trees (2007): 1
- Complete Urban Forest (2011): 2

**Pest Susceptibility (2011)**
- Asian Longhorned Beetle: 1,780,000 Trees (67%)
- Emerald Ash Borer: 230,000 Trees (8%)
- Dutch Elm Disease: 220,000 Trees (8%)
- Gypsy Moth: 175,000 Trees (7%)

**Street Tree Benefits (2008)**
- Total Annual Benefit: $2,490,975
- Annual Per Tree Benefit: $53
- Annual Per Capita Benefit: $8

**Urban Forest Benefits (2011)**
- Total Annual Benefit: $7,232,600
- Annual Per Tree Benefit: $3
- Annual Per Capita Benefit: $24

**Structural Value**
- Street (2005): $37 million
- Park (2007): $16.5 million
- Complete Urban Forest (2011): $1.13 billion

### Analyze

Measuring accomplishment of the recommendations will require ongoing analysis. A state of the urban forest report should be prepared and distributed to the public every 5 to 10 years. Analysis may include an updated street tree inventory, i-Tree Benefits analyses, or urban tree canopy assessments.

The state of the urban forest report should include the benchmark values as reported in the plan as of 2012, so that we can measure and compare changes to the urban forest.

### Revise

Completion of this plan is the first step towards meeting our vision for the urban forest. Continual monitoring, analysis, and reporting will help to keep urban forest partners involved and focused on accomplishing the recommendations. Plans are typically revised every 10 to 15 years; however, the plan will need formal revision to respond and adapt to changes as they develop. Formal revision of the plan should coincide with the update of PlanPGH and the OpenSpace component. Recommendations and goals of each should be compared. Revisions to the plan should occur with major events, such as newly discovered pests or diseases or significant changes to industry standards or legal codes.

### Conclusion

To build and maintain support for the plan, urban forest partners and decision makers must be kept aware of the successes and challenges in accomplishing the recommendations. The report card and the state of the urban forest report will be distributed as part of a public campaign. With the involvement of the urban forest partners and continued monitoring, analysis, and revision, this plan will become a living document.
# APPENDIX A

## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AFSCME</td>
<td>American Federation of State, County, and Municipal Employees</td>
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<tr>
<td>ALB</td>
<td>Asian longhorned beetle</td>
</tr>
<tr>
<td>ALCOSAN</td>
<td>Allegheny County Sanitary Authority</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<tr>
<td>ARRA</td>
<td>American Recovery and Reinvestment Act of 2009</td>
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<tr>
<td>AVRR</td>
<td>Allegheny Valley Railroad</td>
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<tr>
<td>B&amp;B</td>
<td>balled-and-burlapped</td>
</tr>
<tr>
<td>CCE</td>
<td>Cornell Cooperative Extension</td>
</tr>
<tr>
<td>CMU</td>
<td>Carnegie Mellon University</td>
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<tr>
<td>CO</td>
<td>carbon monoxide</td>
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<td>CO₂</td>
<td>carbon dioxide</td>
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<tr>
<td>CU</td>
<td>Cornell University</td>
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<tr>
<td>DBH</td>
<td>diameter at breast height</td>
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<tr>
<td>DCNR</td>
<td>Pennsylvania Department of Conservation and Natural Resources</td>
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<tr>
<td>DED</td>
<td>Dutch elm disease</td>
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<tr>
<td>EAB</td>
<td>emerald ash borer</td>
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<tr>
<td>GM</td>
<td>gypsy moth</td>
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<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
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<tr>
<td>GIS</td>
<td>geographic information system</td>
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<tr>
<td>ISA</td>
<td>International Society of Arboriculture</td>
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<tr>
<td>i-TREE tools</td>
<td>tools from the U.S. Forest Service for assessing and managing community forests</td>
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<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<tr>
<td>LiDAR</td>
<td>light detection and ranging</td>
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<tr>
<td>NADF</td>
<td>National Arbor Day Foundation</td>
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<tr>
<td>NGO</td>
<td>non-governmental organization</td>
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<td>NID</td>
<td>neighborhood improvement district</td>
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<td>NO₂</td>
<td>nitrogen dioxide</td>
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<td>O₃</td>
<td>ozone</td>
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<tr>
<td>OpenSpacePGH</td>
<td>Pittsburgh’s open space, parks, and recreation plan (a component of PlanPGH, planpgh.com)</td>
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<tr>
<td>PHS</td>
<td>Pennsylvania Horticultural Society</td>
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<tr>
<td>PlanPGH</td>
<td>Pittsburgh’s comprehensive plan (planpgh.com)</td>
</tr>
<tr>
<td>PlaNYC</td>
<td>New York City long-term, sustainability agenda</td>
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<tr>
<td>PSTC</td>
<td>Pittsburgh Shade Tree Commission</td>
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<tr>
<td>QR Code®</td>
<td>a two-dimensional symbol, similar to a barcode, that is easily read by smartphones and is often used for marketing efforts</td>
</tr>
<tr>
<td>SO₂</td>
<td>sulfur dioxide</td>
</tr>
<tr>
<td>STRATUM</td>
<td>Street Tree Management Tool for Urban Forest Managers, a component of the US Forest Service’s i-Tree software suite</td>
</tr>
<tr>
<td>TCIA</td>
<td>Tree Care Industry Association</td>
</tr>
<tr>
<td>the City</td>
<td>the government of the city of Pittsburgh</td>
</tr>
<tr>
<td>the State</td>
<td>the government of the state of Pennsylvania</td>
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<tr>
<td>USDA</td>
<td>US Department of Agriculture</td>
</tr>
<tr>
<td>USFS</td>
<td>US Forest Service</td>
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<tr>
<td>USFWS</td>
<td>US Fish and Wildlife Service</td>
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<tr>
<td>UTC</td>
<td>urban tree canopy</td>
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<td>BVOCs</td>
<td>biogenic volatile organic compounds</td>
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<td>WPC</td>
<td>Western Pennsylvania Conservancy</td>
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Appendix B

Glossary

501(c)(3): A charitable, nonprofit organization that is tax exempt under section 501(c)(3) of the Internal Revenue Code, that does not attempt to influence legislation as a substantial part of its activities and that does not participate in any campaign activity for or against political candidates. The term charitable is used in its generally accepted legal sense and includes advancement of education or science, maintaining public works, lessening the burdens of government, and combating community deterioration. [Source: irs.gov] http://www.irs.gov/charities/charitable/article/0, id-qe60909,00.html

aesthetic benefits: The estimated total annual benefit associated with property value, aesthetics, and other social and economic improvements is $572,882, for an average of $19.33 per street tree. Aesthetic and social benefits were not calculated for the entire urban forest.

air quality benefits: In the American Lung Association State of the Air 2011, Pittsburgh was ranked third on the list of the most polluted metropolitan areas (on short- and annual airborne particle measurement scales). Trees improve air quality by absorbing and reducing air pollutants (ozone [O₃], carbon monoxide [CO], nitrogen dioxide [NO₂], particulate matter less than 10 microns (PM₁₀), and sulfur dioxide [SO₂]). The t-tree Eco analysis estimated that Pittsburgh’s urban forest removes 532 tons of air pollution per year, with an associated value of $3.75 million. Street trees alone account for $252,935 in annual air quality improvements.

ALB: The Asian longhorned beetle is a destructive wood-boring pest of maple and other hardwoods. ALB was first discovered in the US 1996 and is believed to have been introduced into the US from wood pallets and other wood-packing material accompanying cargo shipments from Asia. [Source: aphis.usda.gov] http://www.aphis.usda.gov/plant_health/plant Pest_info/ALB/index.shtml

American National Standards Institute (ANSI): ANSI is a private, non-profit organization that facilitates the standardization work of its members in the US. ANSI’s goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and maintain their integrity.

ANSI A300 standards: Tree care performance parameters established by ANSI; can be used to develop specifications for specific tree maintenance.

arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

balled-and-burlapped (B&B): A tree or other plant dug and removed from the ground for re-planting, with the roots and soil wrapped in burlap. [Source: isa-arbor.com/dictionary].

benefit-cost ratio: The ratio of the cumulative benefits provided by trees, expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

biogenic utility: A utility based on the net benefit of freed energy and other benefits from trees, which can be calculated in dollars, pounds of pollution filtered, gallons of rainwater intercepted, and kwh of energy not used.

biogenic volatile organic compounds (BVOCs): BVOC emissions are a widespread and ubiquitous source to background air and are part of the natural background chemistry. It is only after anthropogenic emissions are added to the natural background that harmful levels of ozone result. However, biogenic emissions must be considered when examining anthropogenic emission control strategies. [Source: epa.gov] http://www.epa.gov/AMD/pdf/epa_science_forum2.PDF

bioswales: Bioswales are storm water runoff conveyance systems that provide an alternative to storm sewers. They can absorb low flows or carry runoff from heavy rains and snowmelt to storm sewer inlets or directly to surface waters. Bioswales improve water quality by enhancing infiltration of the first flush of storm water runoff and filtering the large storm flows they convey. [Source: usgs.gov] ftp://ftp-fc.sc.egov.usda.gov/MT/www/technical/water/Bioswale.pdf

blue roofs: Blue roofs are non-vegetated source controls that detain stormwater. Weirs at the roof drain inlets and along the roof can create temporary ponding and gradual release of stormwater. Coupled with light-colored roofing material, they can provide sustainability benefits through rooftop cooling. [Source: nyc.gov] http://www.nyc.gov/html/dep/html/stormwater/green_plot_project_psi18.shtml

carbon benefits: As part of their metabolic process, trees sequester carbon dioxide (CO₂) in the form of woody and foliar biomass. The gross sequestration of Pittsburgh’s urban forest is about 14,200 tons of carbon per year, with an associated value of $262,000. Net carbon sequestration in the urban forest is about 10,100 tons. Trees also reduce CO₂ indirectly through a decrease in energy demand; the entire urban forest provides an estimated benefit of $70,600 annually by reducing the amount of carbon released by fossil-fuel based power plants (a reduction of 3,840 tons of carbon emissions). Due to their proximity to residential buildings, street trees account for a significant portion of the urban forest’s CO₂ reduction, providing the average Pittsburgh homeowner with an estimate of $9.73 in net carbon benefits.

carbon dioxide (CO₂): A colorless, odorless, non-poisonous gas that is a normal part of earth’s atmosphere. Carbon dioxide is a product of fossil-fuel combustion as well as other processes. It is considered a greenhouse gas as it traps heat radiated into the atmosphere and thereby contributes to the potential for global warming. [Source: epa.gov] http://www.epa.gov/energy/efficiency/carbon_emissions/glossary.html


carbon sequestration: The fixation of atmospheric carbon dioxide in a reservoir (for example, a tree) that absorbs or takes up released carbon from another part of the carbon cycle through biological or physical processes. [Source: epa.gov] http://www.epa.gov/energy/efficiency/carbon_emissions/glossary.html

carbon storage: Carbon stored in the urban forest over the life of the trees as a result of sequestration measured in pounds as the CO₂ equivalent.

catch basin: Catch basins, also known as storm drain inlets and curb inlets, are inlets to the storm drain system. They typically include a grate or curb inlet and a sump to capture sediment, debris, and pollutants. Catch basins are used in combined sewer overflowwatersheds to capture floats and settle some solids, and they act as pretreatment for other treatment processes by capturing large sediments. [Source: epa.gov] http://cfpub.epa.gov/ndps/stormwater/memolbmps/index.cfm?action=fact-sheet_results&view=specific&bmp=77

CO: See carbon monoxide (CO).

CO₂: See carbon dioxide (CO₂).

compensatory value: See structural value.

condition: The general condition of each tree rated during the inventory according to the following categories adapted from the ISA’s rating system: excellent (100%), very good (90%), good (80%), fair (60%), poor, (40%), critical (20%), dead (0%).


CU-Structural Soil™: Soil mix developed at Cornell University that may be used as a base to safely bear pavement loads after compaction that will also allow root penetration and tree growth.

cyclical pruning: Continual routine maintenance cycle to ensure the pruning of all trees every seven years. Cyclical pruning reduces long-term costs because of pruning crew efficiencies, and it can prevent problems before they exist in the case of pruning to train young trees. Young trees that receive training pruning develop good form and long, straight trunks with few defects. The resulting trees are structurally more sound with less chance of failure as they mature.

canopy assessment: See urban tree canopy (UTC) assessment.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

canopy: Branches and foliage which make up a tree’s crown.
Dutch elm disease (DED): Dutch elm disease (DED) is one of the most destructive shade tree diseases in North America. The disease affects American elms (and other elm species, to a varying extent), killing individual branches and eventually the entire tree within one to several years. (Source: na.fs.fed.us) http://na.fs.fed.us/ebp/ded/.

ecosystem: The complex of a living community and its physical and chemical environment, functioning together as a unit in nature, with some inherent stability. (Source: epa.gov) http://www.epa.gov/globe/elcor/glossary.html.

emerald ash borer (EAB): An exotic beetle that was discovered in southeastern Michigan in 2002. The adult beetles nibble on ash foliage like a cause little damage. The larvae (the immature stage) feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. Emerald ash borer probably arrived in the United States on solid wood-packed material carried in cargo ships or airliners originating in its native Asia. (Source: emeraldashborer.info).

energy benefits: Trees provide shade by intercepting sunlight and wind and reducing air movement, which results in savings in energy costs for climate-controlled buildings. Pittsburgh's urban forest is estimated to reduce energy-related costs to residential buildings by $3.45 million annually (2002 prices). Street trees alone account for $1.2 million in energy benefits. This may be the most direct benefit in terms to the average Pittsburgh homeowners can relate. The average street tree on the right-of-way in front of their property produces $40.66 in annual savings to that homeowner.

environmental justice: The fair treatment and meaningful involvement of all people regardless of race, color, sex, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

evapotranspiration: The sum of evaporation and transpiration. Excluding evaporation from surface-water bodies, evapotranspiration would be defined as the water lost to the atmosphere from the ground surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants whose roots tap the capillary fringe of the groundwater table. (Source: ga.water.usgs.gov) http://ga.water.usgs.gov/edu/watercycleevapotranspiration.html.

exotic (pests/diseases): Exotic pests are organisms that are introduced into an area beyond their natural range and become pests in the new environment. They are also referred to as alien, non-native, or introduced pests. (Source: cdifa.ca.gov) http://www.cdifa.ca.gov/invasives/.

genera: plural of genus.

genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to give you a better understanding of how it all interrelates.

global positioning system (GPS): GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

green infrastructure: Green infrastructure uses natural features provide environmental and community benefits (for example, to manage stormwater). By improving the environment and preserving open space, green infrastructure supports sustainable communities. (Source: water.epa.gov) http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

green roofs: Green roofs consist of a vegetative layer that grows in a specially designed soil, which sits on top of a drainage layer. Green roofs are more costly than conventional roofs but are capable of absorbing and retaining large amounts of stormwater. Green roofs provide sustainability benefits such as absorbing air and noise pollution, rooftop cooling by reducing UV radiation absorption, creating living environments for birds, and increasing the quality of life for residents. (Source: nyc.gov) http://www.nyc.gov/html/dep/html/stormwater/green_pilot_project_ps18html.shtm.

green stormwater management system: Using green infrastructure (vegetation and soil) to manage rainfallwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also flood mitigation and air quality management. (Source: water.epa.gov) http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

green streets: A natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods. Through various combinations of plants and soils, these objectives can be met on different types of streets in many settings. Green street features may include vegetated curb extensions, sidewalks planters, landscaped medians, vegetated swales, permeable paving, and street trees. (Source: water.epa.gov) http://water.epa.gov/aboutow/eparecovery/upload/2009_09_10_eparecovery_EPA_ARRA_Green_Streets_FINAL.pdf.

greenspace: A land use planning and conservation term used to describe protected areas of undeveloped landscapes.

gray stormwater management system: Using single-purpose stormwater infrastructure, such as piping, to dispose of rainfall. (Source: water.epa.gov) http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.
gross annual benefit: Calculation specific to i-Tree Streets, it is the estimation of the combined stormwater, energy, air quality, carbon dioxide, and aesthetic/other benefits reported for one year.

gypsy moth (GM): One of North America's most devastating forest pests. The species originally evolved in Europe and Asia and has existed there for thousands of years. In either 1868 or 1866, the gypsy moth was accidentally introduced to the US. The gypsy moth is known to feed on the foliage of hundreds of species of plants in North America but its most common hosts are oaks and aspen. Gypsy moth hosts are located throughout most of the coterminous US, but the highest concentrations of host trees are in the southern Appalachian Mountains, the Ozark Mountains, and in the northern Lake States. A major concern is the potential loss of economically and ecologically dominant oak species. Most studies of forest compositional changes with gypsy moth defoliation indicate that less susceptible species will dominate the forest, so in effect, forests may have fewer gypsy moth problems in the future. (Source: fs.fed.us) http://www.fs.fed.us/ne/morgantown/4557/gmoth/.

high-risk tree: Trees that cannot be cost-effectively or practically treated. The majority of the trees in this category have multiple or significant defects affecting less than 40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely between 4–20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

impervious surface: Surface material (for example, pavement) that impedes the infiltration of water into soil. A significant portion of rainfall in a natural watershed is absorbed into soil, stored as groundwater, and discharged to streams through seeps and springs. Flooding is less significant in these conditions because some of the runoff during a storm is absorbed into the ground. As watershed are urbanized, many vegetated areas are replaced by impervious surfaces, which reduces the area where infiltration to groundwater can occur. Thus, much more stormwater runoff occurs, which results in an increased likelihood of more frequent and more severe flooding. (Source: ga.water.usgs.gov) http://ga.water.usgs.gov/edu/impervious.html.
invasive (pest/disease): An invasive species is a species that does not occur naturally in a specific area and whose introduction does or is likely to cause economic (including agricultural) or environmental harm or harm to human health. Common traits of invasive pests and pathogens include rapid reproduction, fast growth, wide dispersal, altering of growth or form to suit a particular habitat, tolerating a wide range of environmental conditions and the ability to feed on a variety of different foods. (Source: cdfa.ca.gov) http://www.cdfa.ca.gov/invasives/.

invasive (exotic tree): A tree species that is out of its original biological community. Its introduction into an area causes or is likely to cause economic or environmental harm, or harm to human health. An invasive, exotic tree has the ability to thrive and spread aggressively outside its natural range. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

inventory: See Tree Inventory.

i-Tree Canopy: The i-Tree Canopy tool allows easy and accurate estimation of tree and other cover classes (e.g., grass, building, roads, etc.) within a city or any bound area. This tool randomly lays points (number determined by the user) onto Google Earth imagery and the user then classifies what cover class each point falls upon. The user can define any cover classes that they like and the program will show estimation results throughout the interpretation process.

i-Tree Streets: i-Tree Streets is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits: energy conservation, air quality improvement, CO2 reduction, stormwater control, and property value increase. (Formerly STRATUM)

i-Tree tools: State-of-the-art, peer-reviewed software suite from the US 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 structure of community trees and the environmental services that trees provide.

landslide: A type of “mass wasting” which denotes any down slope movement of soil and rock under the direct influence of gravity. The term “landslide” encompasses events such as rock falls, topples, slides, spreads, and flows, such as debris flows, such as mudflows. Landslides can be initiated by factors such as rainfall, changes in groundwater, disturbance and change of a slope by construction activities. Failure of a slope occurs when the force that is pulling the slope down (gravity) exceeds the strength of the earth materials that compose the slope. They can move slowly (millimeters per year) or can move quickly and disastrously, as is the case with debris-flows. Debris-flows can travel down a hillside of speeds up to 50-100 miles per hour (more commonly, 30-50 miles per hour), depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall in susceptible areas. (Source: landslides.usgs.gov) http://landslides.usgs.gov/learning/faq/.


monoculture: A population dominated by one single species or very few species.

Municipal Forest Resource Analysis: Analyses that combine results of a citywide inventory with benefit/cost modeling data. The structure and written content of these analyses come from the entire series of Municipal Forest Resource Analysis reports published and prepared by the USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research. The Municipal Forest Resource Analysis Reports are companions to the regional Tree Guides and i-Tree’s STRATUM application developed by the USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research (Source: fs.fed.us and Davey Resource Group).

net annual benefits: Citywide benefits and costs calculated according to category and summed. Net benefits are calculated as benefits minus costs.

nitrogen dioxide (NO₂): Nitrogen dioxide is a compound typically created during the combustion processes and is a major contributor to smog formation and acid deposition.

NO₂: See nitrogen dioxide (NO₂).

non-native: See invasive (exotic tree) and invasive (pest/disease).

O₃: See ozone (O₃).

oak wilt: An aggressive disease that affects many species of oak. First identified in 1944, it is one of the most serious tree diseases in the eastern US, killing thousands of oaks each year in forests, woodlots, and home landscapes. The fungal pathogens that causes the disease is thought by most to be native to the eastern US, but difficulty in isolating and identifying the fungus delayed recognition of the extent of its impact until the 1980s. (Source: na.fs.fed.us) http://na.fs.fed.us/pubs/detail.cfm?id=921.

 ordinance: See Tree Ordinance.

outfall: The point where water flows from a conduit, stream, or drain, where effluent is discharged into receiving waters. (Source: (Source: ofmpub.epa.gov))

pervious pavement: Refers to a wide variety of surfaces, including concrete, asphalt, and various types of grid and paver systems, that allow for rapid infiltration of water.

particulate matter (PM₉.₅): A major class of air pollutants consisting of tiny (less than 10 microns) solid or liquid particles of soot, dust, smoke, fumes, and mists.

pathogen: Microorganisms (for example, bacteria, viruses, or parasites) that can cause disease in other organisms (for example, humans, animals, or plants). Some pathogens are highly specific to particular species; others can require two or more types of organisms to complete their life cycles, while others can opportunistically move among several or many host species. (Source: ofmpub.epa.gov)

PM₉.₅: See particulate matter (PM₉.₅).

pruning: The selective removal of plant parts to meet specific goals and objectives.

restorative pruning: Selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.

right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

risk assessment: Risk assessment uses protocol based on the US Forest Service Community Tree Risk Rating System to assess the probability of tree (or tree part) failure (or structural defect(s) that will likely result in failure) based on observed, current conditions; the probability of target impact by the tree or tree part (determined by use and occupancy of the area), and other risk factors.

risk: Combination of the probability of an event occurring and its consequence.

SO₂: See sulfur dioxide (SO₂).

social benefits: In addition to the quantified environmental and economic benefits, research has shown that trees provide many social benefits that help to improve quality of life. Trees can lead to reduced crime rates, decreased amounts of human stress, and shorter lengths of hospital stays. Kuo and Sullivan (2001(a)) studied apartment buildings in Chicago and found that buildings with high levels of greener had 52% fewer crimes than those without any trees, and buildings with medium amounts of greener had 42% fewer crimes. Tree-lined streets also make our streets safer by reducing traffic speeds and the amount of stress drivers feel which likely reduces road rage (Wolf, 1998(b); Kuo and Sullivan, 2001(b)). Ulrich (1984, 1986) found that hospital patients who were recovering from surgery and had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall.
species: Fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding. An organism belonging to such a category, represented in binomial nomenclature by an un-capitalized Latin adjective or noun following a capitalized genus name.

stem: A woody structure bearing buds, foliage, and giving rise to other stems.

stormwater benefits: A tree’s surface area (including leaves, branches, and trunk) acts as a catch for rainfall; as trees intercept and store water, they reduce runoff volume and delay the onset of peak stormwater flows. A tree creates porous space in the soil through its root system, thus increasing the capacity and rate of soil infiltration, which then reduces overland flow during periods of peak runoff. Tree canopies reduce soil erosion and surface transport by diminishing the impact of raindrops on barren surfaces. With an average savings of $11 per street tree per year, Pittsburgh’s street trees intercept an estimated 41.8 million gallons of stormwater annually, for an estimated value of $334,601.

street tree: A street tree is defined as a tree within the right-of-way.

structural soils: See CU-Structural Soil™.

structural value: Represent the cost to replace all trees and can be viewed as the value of the urban forest as a structural asset.

sulfur dioxide (SO₂): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

swale: A low-lying or depressed and often wet stretch of land.

topping: Topping is not an acceptable pruning practice. Reduction of tree size using internodal cuts without regard to tree health or structural integrity.

training pruning: Based on ANSI A300 Standards, pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees, up to 20 feet in height, can be worked with a pole pruner by a person standing on the ground.

transpiration: The process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere.

tree benefit: An environmental, economic, or social improvement that benefited the community and resulted mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

tree inventory: A comprehensive database containing information or records about individual trees typically collected by an arborist.

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed community forest. Tree ordinances simply provide the authorization and standards for management activities.

tree size: The diameter of a tree to the nearest inch in one-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

urban forest: All trees on private and public lands within a municipality or a community.

urban tree canopy (UTC) assessment: A study performed of land cover classes to gain an understanding of the tree canopy coverage, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. Typically performed using aerial photographs, GIS data, or Lidar.

watershed: An area of land where all of the water that is under it or drains off of it goes into the same lake, river, or ocean.

zoning: A system of land use regulations which designates the permitted uses of land based on location.

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**Appendix B**
References


17. LaQuatra Bonei Associates/Michael A. Stern; Biohabitats, Inc.; Tai + Lee Architects; LANDSCAPES • LA • Planning • HP; and Earthware/Landbase Systems. [2007?]. Pittsburgh’s Regional Parks Master Plan: A New Ethic of Stewardship.


20. Biohabitats, Inc. [2010?] Pittsburgh Regional Parks Natural Areas Study: Natural Areas Program Phase 1 Report: Assessment Results and Management Plan Framework (draft).


Appendix C

42. The Society of Municipal Arborists List-serve. 2012. Member responses: Steve Cothrel, City Forester for Upper Arlington, OH; Gordon Mann (retired) Director of Public Works, City of Redwood City; Doug Still, City Forester for Providence, RI; Nick Kuhn, former City Forester for Albuquerque, NM (now with MO Dept. of Conservation); and Terrence Flatey, Urban Forestry & Natural Resources Manager for Renton, WA. June.
52. Southern California Environmental Health Center (SCEHSC) at the University of Southern California. n.d. Fact Sheet: Asthma and Diesel.


APPENDIX D

Tree Diversity Goals and Recommendations

Based on the most current urban forest data for the City of Pittsburgh, there is great potential to diversify the tree population by avoiding the planting of the most common tree species and encouraging the use of proven, well-adapted, but relatively uncommon species for all types of planting projects.

Diversity Goals

Tree Pittsburgh has adopted standard diversity recommendations for urban tree populations and established the following goals for the distribution of species in our urban forest:

- No single tree species should represent more than 10% of the population.
- No single genus should represent more than 20% of the population.
- No single family should represent 30% of the population.

Currently, Pittsburgh’s street tree population has four species exceeding these thresholds. Therefore, the use of any species and/or cultivar of maple (Acer) should be avoided whenever possible or represent no more than 5% of the trees used on any given planting project. Hedge maple (Acer campestre) is excluded from this limit.

Table 1. Street Tree Inventory Data from 2005 for Species Exceeding the 10% Population Goal for Street Trees

<table>
<thead>
<tr>
<th>Species (street trees only)</th>
<th>Percentage of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer platanoides (Norway maple)</td>
<td>14%</td>
</tr>
<tr>
<td>Pyrus calleryana (callery pear)</td>
<td>10%</td>
</tr>
<tr>
<td>Acer rubrum (red maple)</td>
<td>10%</td>
</tr>
<tr>
<td>Tilia cordata (littleleaf linden)</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 2. Street Tree Inventory Data from for 2005 Genera Exceeding the 20% Population Goal for Street Trees

<table>
<thead>
<tr>
<th>Genera (street trees only)</th>
<th>Percentage of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer (maple)</td>
<td>30%</td>
</tr>
</tbody>
</table>

Moratorium and Restriction

The urban forest is currently compromised by the presence of several existing pests, diseases, and other invasive threats or nuisances. To promote improved diversity, the following species should be restricted against use on planting projects. This list is subject to change based on future information about invasive, structural, and insect and disease resistance characteristics of species/cultivars and is intended to be reviewed annually. The species listed below may be planted for urban forestry research purposes only.

Table 3. Trees Restricted From Use on Public Planting Projects

<table>
<thead>
<tr>
<th>Restricted Species</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer platanoides</td>
<td>Any cultivar</td>
</tr>
<tr>
<td>Castanea spp.</td>
<td>Any species or cultivar or hybrid</td>
</tr>
<tr>
<td>Fraxinus spp.</td>
<td>Any species or cultivar</td>
</tr>
<tr>
<td>Juglans spp.</td>
<td>Any species or cultivar</td>
</tr>
<tr>
<td>Pyrus calleryana</td>
<td>Any species or cultivar or hybrid</td>
</tr>
<tr>
<td>Quercus Sect. Lobatae (red oak family)</td>
<td>Any species or cultivar or hybrid</td>
</tr>
<tr>
<td>Tilia cordata</td>
<td>Any species or cultivar or hybrid</td>
</tr>
<tr>
<td>Tsuga canadensis</td>
<td>Any species or cultivar or hybrid</td>
</tr>
<tr>
<td>Ulmus americana (straight species and variety ‘Liberty’)</td>
<td></td>
</tr>
<tr>
<td>Ulmus x ‘Frontier’</td>
<td></td>
</tr>
</tbody>
</table>

Systematic Diversity of Street Tree Plantings

To achieve the desired diversity, Tree Pittsburgh encourages the use of the Systematic Diversity concept: trees should be planted in alternating groups (3-6 trees) of different tree species down a city street or along a frontage. Where feasible, no tree species should represent more than 20-25% of a block segment. Tree Pittsburgh encourages using many species of trees that offer visual similarity to balance the desires for the uniform look of monocultures. Monoculture plantings along a street should be avoided.

Table 4. Systematic Diversity Based on Number of Trees Required

<table>
<thead>
<tr>
<th># Trees Required</th>
<th># Tree Varieties/Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>1-2</td>
</tr>
<tr>
<td>5-15</td>
<td>2-3</td>
</tr>
<tr>
<td>15-25</td>
<td>3-5</td>
</tr>
<tr>
<td>25-50</td>
<td>5-7</td>
</tr>
<tr>
<td>50-100</td>
<td>7-10</td>
</tr>
<tr>
<td>100+</td>
<td>10+</td>
</tr>
</tbody>
</table>
Asian Longhorned Beetle

Asian Longhorned Beetle (ALB) is the most current and significant known threat to our urban forest. Invasion of this insect would result in catastrophic losses to the City’s urban forest. Limiting the planting of ALB host species is necessary to increase diversity of the tree population and to protect against the future threat of ALB.

It is recommended that the following genera represent no more than a combined 25% of the selections for any given planting.

<table>
<thead>
<tr>
<th>ALB Preferred Host Species</th>
<th>ALB Occasional Host Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer *</td>
<td>Albizia</td>
</tr>
<tr>
<td>Aesculus</td>
<td>Cercidiphyllum</td>
</tr>
<tr>
<td>Betula</td>
<td>Fraxinus**</td>
</tr>
<tr>
<td>Salix</td>
<td>Platanus</td>
</tr>
<tr>
<td>Ulmus***</td>
<td>Populus</td>
</tr>
<tr>
<td>Sorbus</td>
<td></td>
</tr>
</tbody>
</table>

Source: Asian Longhorned Beetle: Annotated Host List; Revised March 11, 2011; Alan Sawyer
USDA-APHIS-PPQ, Center for Plant Health Science and Technology, Otis Laboratory

* The use of any species and/or cultivar of maple (Acer) should represent no more than 5% of the trees used on any given planting project.

** The use of any species and/or cultivar of ash (Fraxinus) is strictly prohibited.

*** The use of American elm (Ulmus americana) straight species and variety ‘Liberty’ and Ulmus x ‘Frontier’ is strictly prohibited.

Conifers

Historically, conifers have made up anywhere from 8% to 100% of Pennsylvania’s forests depending on which era is studied. The native hemlocks (Tsuga canadensis) and white pines (Pinus strobus) disappeared from Pittsburgh’s landscape centuries ago. Today, conifers planted by property owners such as blue spruce (Picea pungens) and other ornamentals represent the only conifers in the City. Conifers represent a great resource in achieving diversity. Gymnosperms, being an entirely different classification of plants than the majority of trees (angiosperms) currently planted, are not subject to the same pests and diseases, with a few exceptions. Conifers also offer tremendous opportunities for air quality improvements and wildlife habitat. At this time, there are no known natural stands of conifers nor any reproducing stands (native or naturalized) within the city.

To increase diversity, a minimum of 20% of any non-street tree planting project must be comprised of conifers. Plantings of parks, trails, medians, traffic islands, vacant lots, river banks, public spaces, and plantings of all other spaces are encouraged to follow this recommendation.

Conifers that are appropriate as street trees include ginkgo (Ginkgo biloba), baldcypress (Taxodium distichum), and dawn redwood (Metasequoia glyptostroboides). It is recommended that these three species make up 10% of street tree plantings.

Summary of Tree Planting Diversity Goals

<table>
<thead>
<tr>
<th>Goal</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>• No single species should make up more than 10% of a planting/population.</td>
</tr>
<tr>
<td>20%</td>
<td>• No single genus should make up more than 20% of a planting/population.</td>
</tr>
<tr>
<td>5%</td>
<td>• Maple (Acer) may not comprise more than 5% of any given planting project.</td>
</tr>
<tr>
<td>25%</td>
<td>• ALB host species may not exceed 25% for any given planting project.</td>
</tr>
<tr>
<td>20%</td>
<td>• Any non-street tree planting project is recommended to have at least 20% of the species be conifers.</td>
</tr>
<tr>
<td>10%</td>
<td>• Any street tree planting project should have 10% of the species be conifers.</td>
</tr>
</tbody>
</table>

These Tree Planting Diversity Recommendations were last revised on June 28, 2012.

Sources

This document is based upon current urban forestry data for the City of Pittsburgh and the following sources:


Compendium of Existing Plans and Data

This Appendix includes the following data, plans, and reports on the enclosed DVD:

- Allegheny Riverfront Vision Plan
- An Ecological and Physical Investigation of Pittsburgh’s Hillsides
- i-Tree Ecosystem Analysis and Data
- Municipal Forest Resource Analysis and Data
- Park Tree Inventory Data
- Pittsburgh Regional Park Natural Areas Study
- Pittsburgh’s Regional Parks Master Plan
- Stormwater to Street Trees – Engineering Urban Forests for Stormwater Management
- Tree Inventory and Management Plan and Data
- Urban Forest Master Planning Benchmarking Report
- Urban Forest Master Planning Outreach Report and Public Survey Results
- Urban Tree Canopy Analysis and Data