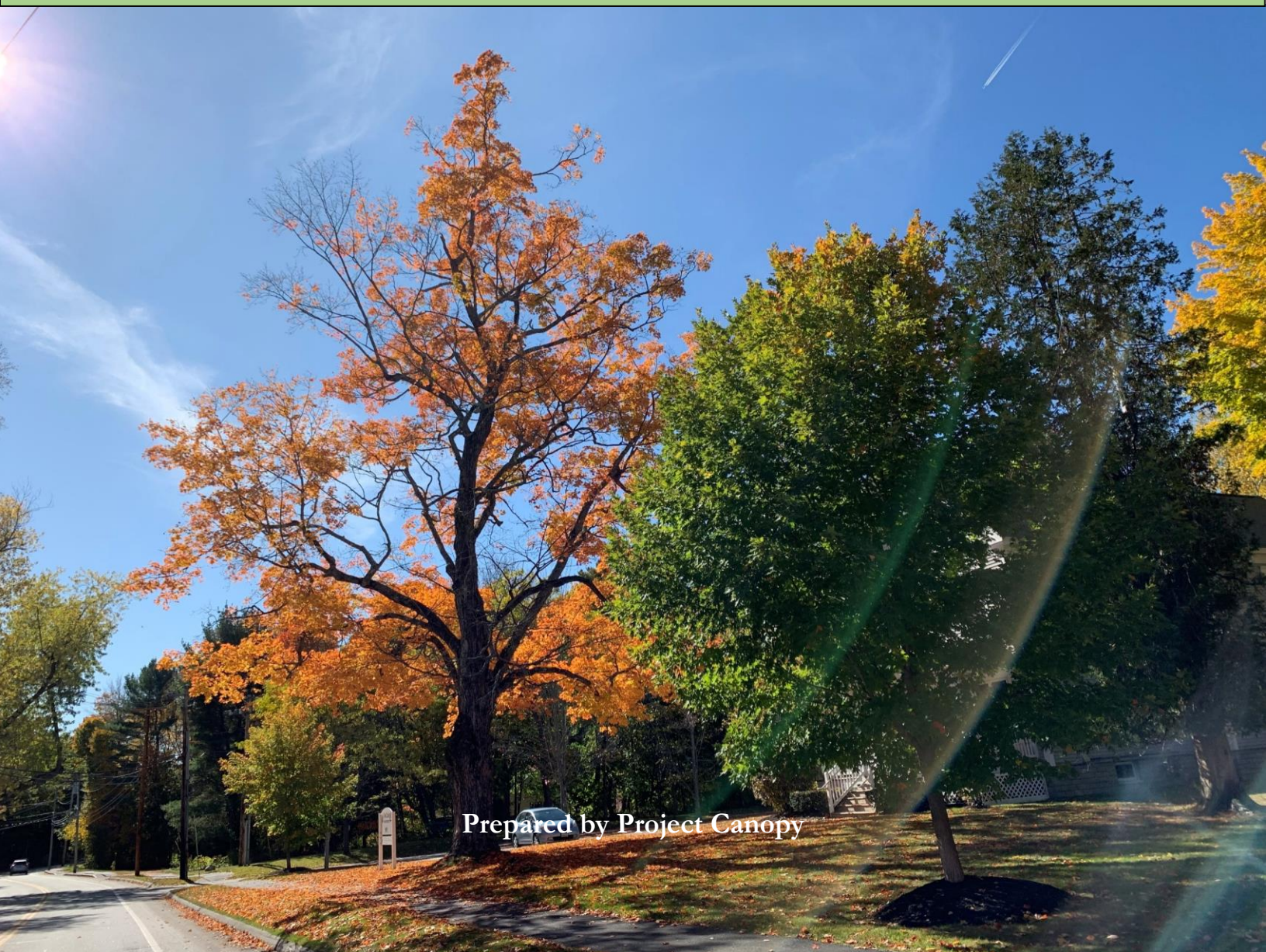
Town of Freeport
Street Tree Inventory Report
2019



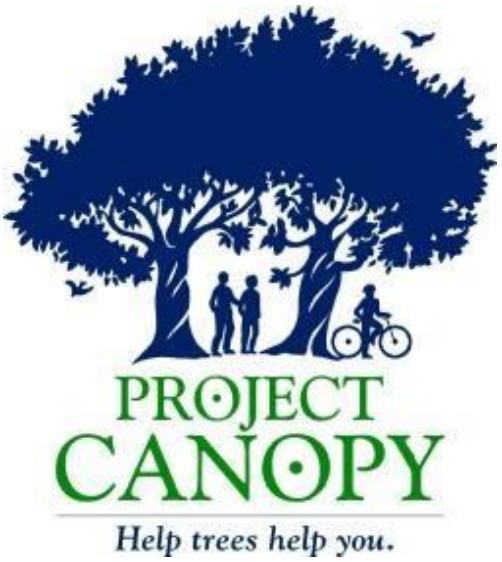
Acknowledgements
This report was made possible with funding from the USDA Forest Service.

About Project Canopy
Project Canopy is Maine's urban and community forest program, a program of the Maine Forest Service under Maine's Department of Agriculture, Conservation and Forestry. It educates people about the benefits trees provide, and how trees make people's lives better. It connects people who have a particular expertise to people who need that expertise. It helps build bridges with town and city governments, and it knows how to communicate in a local, political environment. And just as important, Project Canopy helps people talk about success stories, so that they can find the motivation --- and inspiration --- that is crucial for developing creative, long-term community forestry programs.

The Maine Forest Service has an incredible reservoir of knowledge and expertise. The challenge for us is to get that knowledge to the people who can use it. Any long-term community forestry program needs commitment and understanding from many different corners. Project Canopy's role is to get people in different corners talking to each other, so that awareness about trees can grow by leaps and bounds. We do that by using down-to-earth strategies and deploying technical experts into the field to lend hands-on assistance.

For example:

- Helping recruit and organize volunteers;
- Providing model community tree ordinances;
- Assisting in fund-raising efforts;
- Training tree stewards;
- Providing street tree inventory software;
- Helping communities appoint/elect a community tree warden;
- Linking communities to other Maine communities with successful tree programs;
- Providing lists of local foresters and arborists;
- Building bridges to national community tree organizations;
- Assisting in development of a long-term community tree plan;



And much more.

Table of Contents

Executive Summary

The goal of the Freeport Street Tree Inventory was to accurately locate, quantify and identify the trees existing in the right of way (ROW) along Freeport's downtown, villages and major residential streets. A complete inventory of public trees that includes parks, cemeteries and municipal properties, can serve as a baseline to determine canopy cover, locate available planting sites, and track individual tree conditions. With this information, the town can create a management plan for its public trees that will serve its residents, businesses and visitors, now and into the future.

State and local government, town boards and committees, conservation agencies, and private landowners all play an important role in monitoring and maintaining urban forests. Public trees provide a number of benefits to a community, including reducing stormwater runoff, reducing air pollution, reducing energy costs, and sequestering carbon dioxide (CO_2). The 323 public trees that were inventoried provide an estimated $5,069[1] in these benefits annually to the residents, visitors and businesses of Freeport. They store nearly $60,000 of carbon and have a structural value close to $1.3 million[2]. In addition to the street trees inventoried, an aerial tree canopy assessment was completed for the downtown village area assessed in the inventory – encompassing both public and private land - that indicated an existing tree canopy cover of 25% and an estimated long-term stored CO_2 value of $272,235.[3]

[1] Avoided runoff value is calculated by the price $0.104/ft³. The user-designated weather station reported 42.5 inches of total annual precipitation. Energy saving value is calculated based on the prices of $160.00 per MWH and $18.20 per MBTU. Pollution removal value is calculated based on the prices of $0.69 per pound (CO), $0.21 per pound (O3), $0.03 per pound (NO2), $0.01 per pound (SO2), $12.49 per pound (PM2.5).
[2] Carbon storage and gross carbon sequestration value is calculated based on the price of $0.08528 per pound. Structural value is the estimated local cost of having to replace a tree with a similar tree.
[3] i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.777 @ $1,333.50 | NO2 7.788 @ $264.87 | O3 49.156 @$2,269.19 | PM2.5 2.507 @ $99,840.13 | SO2 2.661 @ $95.34 | PM10* 12.550 @ $6,268.44 | CO2seq 10,010.267 @ $46.51 | CO2stor is a total biomass amount of 251,395.359 @ $46.51

Summary of Findings

Forest Diversity

- Of the 323 street trees inventoried, there are 35 different species in 19 different genera.
- The five most common tree genera by number of trees are *Acer* (maple), *Quercus* (oak), *Fraxinus* (ash), *Tilia* (linden), and *Pinus* (pine), making up more than 86% of Freeport's street trees.
- The five most common species are *Acer platanoides* (Norway maple) at 23%, *Acer saccharum* (sugar maple) at 14%, *Quercus rubra* (northern red oak) at 10%, *Acer rubrum* (red maple) at 10%, and *Tilia cordata* (littleleaf linden) at 5%.
- *Acer* and *Fraxinus* species together represent 63% percent of Freeport's street trees. Invasive tree pests currently threaten both of these genera: the Asian long horned beetle (ALB) and the emerald ash borer (EAB), respectively.
- *Quercus* species represent 14% of Freeport's street trees. Browntail moth and winter moth prefer to feed on oak foliage as well as that of fruit trees. Closely monitor these species for pest damage and consider limiting plantings of these species while moth populations remain high.

Forest Structure

- More than one-half of the inventoried street trees (56%) have a diameter at breast height (DBH) measurement over 18" in diameter, indicating a rather mature tree population.
- Over one-quarter (27%) of Freeport's public trees are 12-18" in diameter.
- The remaining size class distribution of inventoried trees is represented as follows: 1% at 0-3", 4% at 3-6" and 13% at 6-12".

Forest Cover

- There is an existing urban tree canopy (UTC) cover of 25% in Freeport's downtown and residential area.
- This aerial analysis was done using over 1000 data points within the approximately .3 mi covered in the downtown inventory, encompassing both public and private land.
- Trees could potentially cover an additional 23% of Freeport's land surface. These "possible UTC" areas include low-lying vegetation or grassland, and some currently impervious surfaces (e.g. parking lots).
- The remaining 52% of Freeport's land area is buildings, roads, agricultural land and other permanent features and is generally unsuited to UTC improvement.

Forest Health

- The majority (82% or 265) of Freeport's inventoried street trees were assessed as being in "Excellent" or "Good" condition. Of the remaining trees, 43 (13%)

are considered to be in "Fair" condition, seven (2%) are in "Poor" condition, nine (3%) are in "Critical" condition and only one (<1%) tree was found to be "Dead or Dying" (Figure 4).

- All of the inventoried trees should be annually monitored by a Maine licensed arborist, a Tree Warden, or another qualified individual.
- One tree was determined to be in critical need of attention due to imminent hazards to human health or infrastructure, but 26 trees were assessed to be in immediate need of maintenance.

Summary of Recommendations

A healthy public tree population is contingent upon proper management, stewardship, and a municipality's commitment to understanding and maintaining its urban forest. A comprehensive public tree inventory is an important piece of a vibrant community tree program, along with other components described in the Discussion and Recommendations section of this report.

Based on the results of the Freeport street tree inventory, our priority recommendations are:

- Remove the 1 dying tree identified in the inventory and inspect and prune the remaining 27 in need of immediate attention.
- Promote longevity and integrity of a sustainable and diverse public tree population by establishing a systematic and routine structural pruning and planting program.
- Strive for an urban tree canopy cover percentage of 35-40% by working with private landowners, maintaining the integrity of existing large canopy shade trees, and prioritizing new tree plantings in continued urban development and existing downtown neighborhoods.
- Develop ordinances that require planting of trees in new developments, establish guidelines for planting/removal of trees in public ROW and create the position of a Tree Warden in the town (may be volunteer or stipend position).
- Adopt Complete streets practices, narrowing streets by installing esplanades, bump-outs, and more sidewalks in the residential areas; thereby slowing traffic, and allowing for increased planting sites for trees.
- Explore and encourage installation of green infrastructure/stormwater best management practices (BMPs) where appropriate: green roofs, rain gardens, permeable pavement and re-engineering of tree wells and sidewalks for improved root growth of street trees.

Introduction

Project Description

Freeport, Maine is known worldwide as the home of L.L. Bean, but it also boasts Wolfe's Neck State Park, the Desert of Maine, and the home of Olympic gold medalist, Joan Benoit Samuelson. State Route 1 and I-295 bisect the town, dividing the downtown and villages from the more rural western side of town. A gateway between Maine's largest city of Portland to its south and Midcoast Maine to its north, Freeport's Comprehensive Plan and Vision for 2020 were written in 2011. Included in these guiding documents are goals for maintaining large tracts of undeveloped fields and forests, and providing opportunities to enjoy these places; protecting environmentally sensitive areas; continuing to improve air and water quality, ensuring an adequate supply of potable drinking water; improving the flow of traffic both vehicular and pedestrian in the village to reduce congestion and improve traffic safety; and reduce their dependence on non-renewable energy resources.

The Freeport Sustainability Committee approached Project Canopy in March of 2019 to help conduct a public tree inventory of the Town, thereby providing it with the first step in achieving many of these goals. Utilizing this report to construct the framework of an urban forest management plan will set Freeport on a path to establishing a diverse and robust population of public trees that will pay it forward for decades to come. Incorporating a forest pest management plan as a component of this larger effort will establish a baseline and protocol to follow when invasive insects such as the emerald ash borer (EAB) and Asian longhorn beetle (ALB) threaten Freeport's trees.

Town Profile

The Town of Freeport, in Cumberland County, is located just south of "Midcoast" Maine, part of the Casco Bay Watershed. Situated at the northeastern extremity of Casco Bay, Freeport is drained by the Harraseeket River. Historically a shipbuilding town, Leon Leonwood Bean would forever change Freeport's trajectory in 1912 when he opened a small store selling his "Maine Hunting Shoe". More than 100 years later, the town has evolved into the premiere shopping destination for visitors from all over the globe.

Much of Freeport Village lies along coastal Route 1 and is easily accessible from I-295. While small stands of mature eastern white pine and northern red oak dot the landscape along the outer reaches of the main roads, much of the village is commercial or residential with limited mature tree canopy. Freeport has a beautiful historic downtown, anchored by brick buildings and majestic homes surrounding the retail corridor. Vehicular traffic can be extremely heavy during the summer and holiday season, and with Amtrak's *Downeaster* train service from Portland and Boston's North Station, as well as METRO service between Brunswick and Portland, pedestrian traffic can be even heavier. Freeport now boasts upwards of 3.5 million visitors annually[4].

Methodology

In the spring and summer of 2019, Project Canopy staff and Freeport volunteers completed a thorough street tree inventory of Freeport's downtown, village and main residential streets. Twenty-five (25) separate roads along Freeport's downtown and villages were inventoried. Public street trees were defined as individually managed trees within 25' from center of the street, or in esplanades between the street and the sidewalk. Trees that could potentially impact the public ROW yet were planted on private property were also included. Naturally growing stands and wholly private trees were not inventoried. The included land area was approximately .35 square miles, comprising the most densely populated areas of Freeport.

Eighteen (18) volunteers attended two training sessions held in early summer outlining the inventory protocol. Each tree was inventoried into the i-Tree Eco data collector using a mobile device such as a smartphone or tablet. Data recorded for each tree included street name/#, GPS location, site type, species, height, diameter at breast height (DBH), canopy size, condition, a recommendation for maintenance, wire and sidewalk conflicts, building interactions and any pest signs or symptoms. Data collection quality may vary by individual volunteers. Staff conducted random checks for tree id and measurement accuracy. Data were then analyzed by staff using i-Tree Eco. Project Canopy staff also utilized i-Tree Canopy to determine the total canopy cover as well as potential for additional planting in the downtown village area inventoried. Over one thousand points of data were analyzed to extrapolate an estimated canopy cover with a margin of error less than 1.6%.

[4] https://en.wikipedia.org/wiki/Freeport,_Maine

i-Tree is a free software suite developed by the USDA Forest Service (www.itreetools.org). i-Tree Eco uses regionally adapted models along with local hourly air pollution and meteorological data to quantify the structure, ecological benefits, and monetary value of community trees. i-Tree Canopy uses aerial imagery and random point locations to produce an estimate of land cover of a defined area - including tree canopy cover - that encompasses both public and private property.

Inventory Results

Urban Forest Diversity

Of 323 trees inventoried within the public ROW, there are a total of 35 different species in 19 different genera. The five most common tree genera, *Acer* (maple), *Quercus* (oak), *Fraxinus* (ash), *Tilia* (linden), and *Pinus* (pine), make up more than 86% of Freeport's street trees. The five most common species are *Acer platanoides* (Norway maple) at 23%, *Acer saccharum* (sugar maple) at 14%, *Quercus rubra* (northern red oak) at 10%, *Acer rubrum* (red maple) at 10% and *Tilia cordata* (littleleaf linden) at 5%. (Figure 1). A complete species and genera list can be found in Appendix 1.

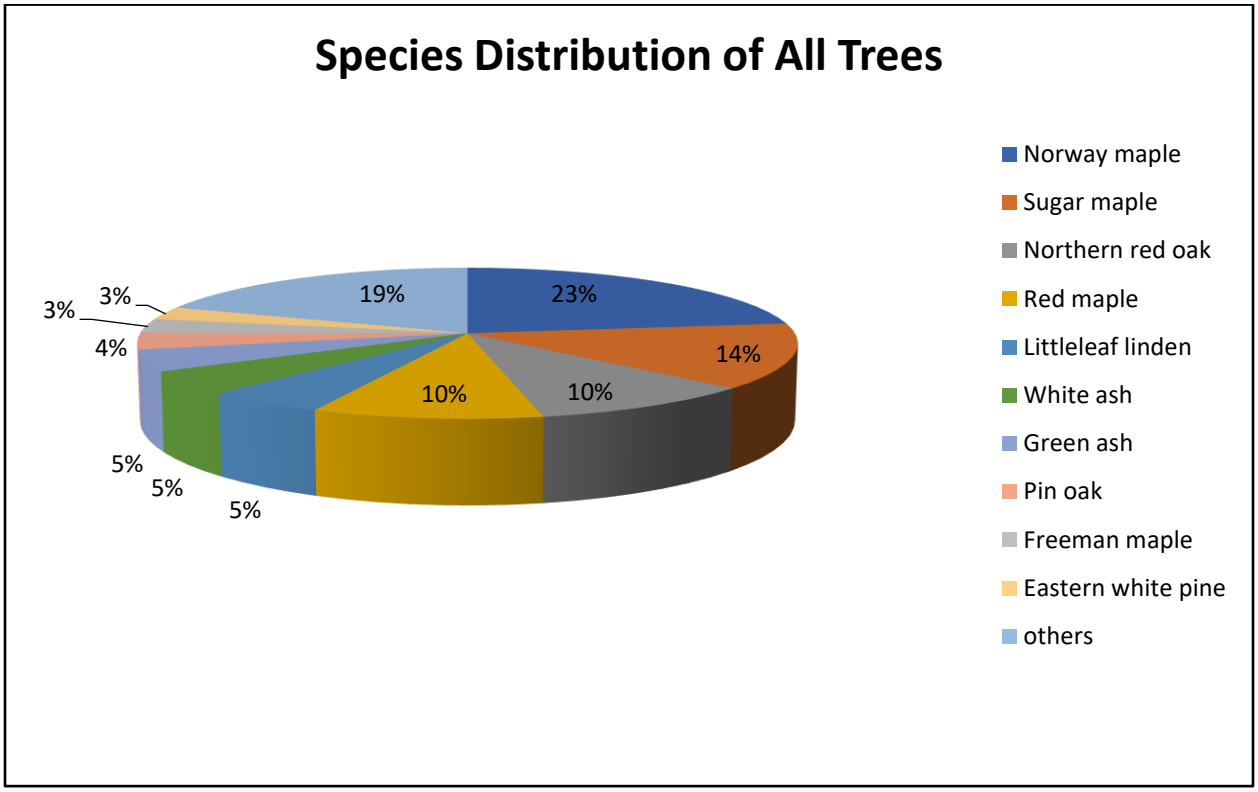


Figure 1. Species distribution of all trees inventoried

Urban Forest Structure

In descending order by percent size class, the diameter distribution represented by Freeport's street trees is: 27% (88) at 12-18", 25% (80) at 18-24", 6% (52) at 24-30", 13% (41) at 6-12", 8% (26) at 30-36", 14% (13) at 3-6", 4% (12) at 36-42", 3% (8) at 42+", and 1% (5) at 0-3" (Figure 2). Thus, approximately 80% of inventoried trees are between 6 and 30 inches. Since size class distribution can be correlated to age

structure of the urban forest, it is clear that Freeport's public tree population is reaching maturity and would benefit from increased planting of young trees. A diversity of ages in a tree population ensures that as trees mature and die back, there are others to take their place at the top. There are many large, mature and declining shade trees along East Street and South Street, and Middle Street in South Freeport, which will need to be replaced over the next few years.

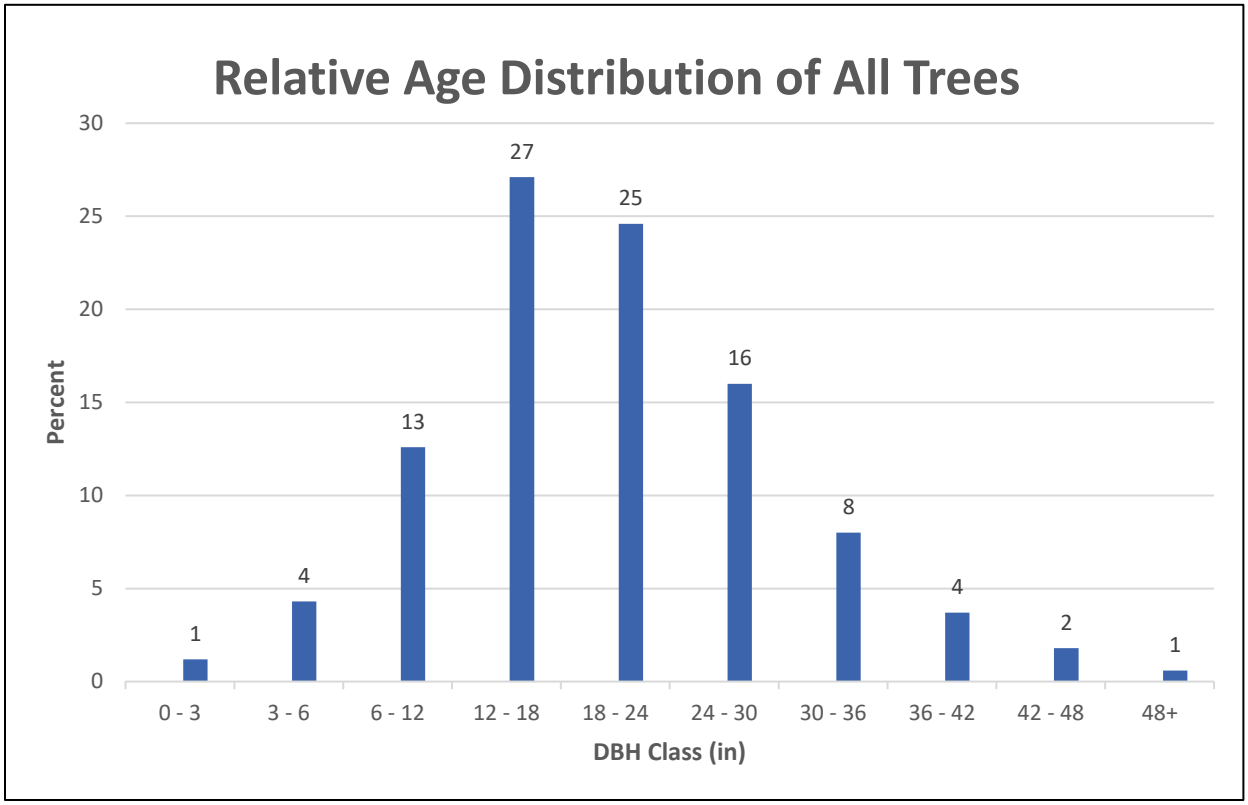


Figure 2. Percent of public trees represented in each diameter class (inches)

The composition of genera and species within each of these size classes (Figure 3) indicates that species such as Freeman maple and green ash are the youngest trees (planted as part of retail projects), while species like red oak, littleleaf linden and pin oak represent the larger size classes and thus, the most mature and in need of regular maintenance.

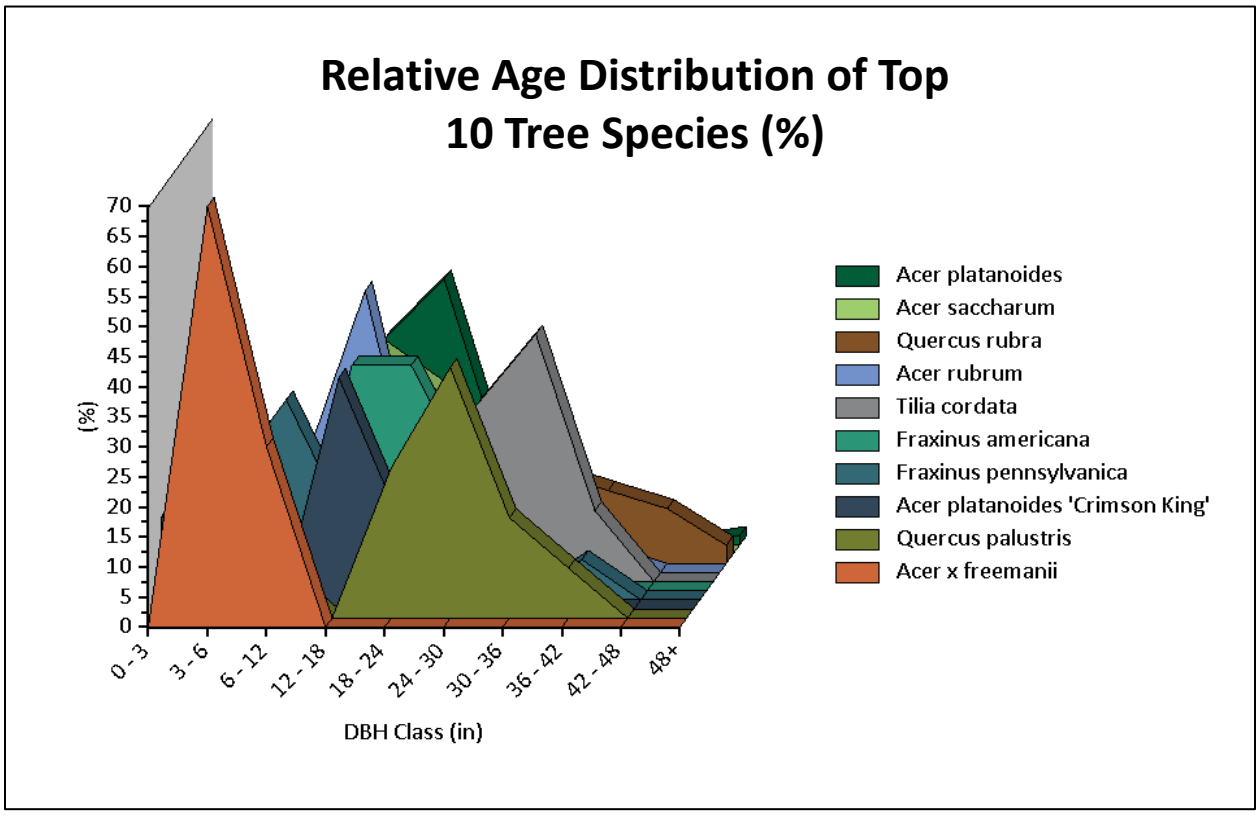


Figure 3. Diameter (and age) distribution of the ten most common species

Urban Forest Health

The majority (82% or 265) of Freeport's inventoried street trees were assessed as being in "Excellent" or "Good" condition. Of the remaining trees, 43 (13%) are considered to be in "Fair" condition, seven (2%) are in "Poor" condition, nine (3%) are in "Critical" condition and only one (<1%) tree was found to be "Dead or Dying" The one "Dying" tree is a Norway maple off West St along the parking lot behind the town hall. It is not big enough to cause a hazard, but left standing is an embarrassment to the town and should be removed and replanted. The full spreadsheet including GPS coordinates detailing the location and condition of inventoried trees will be provided to the town.

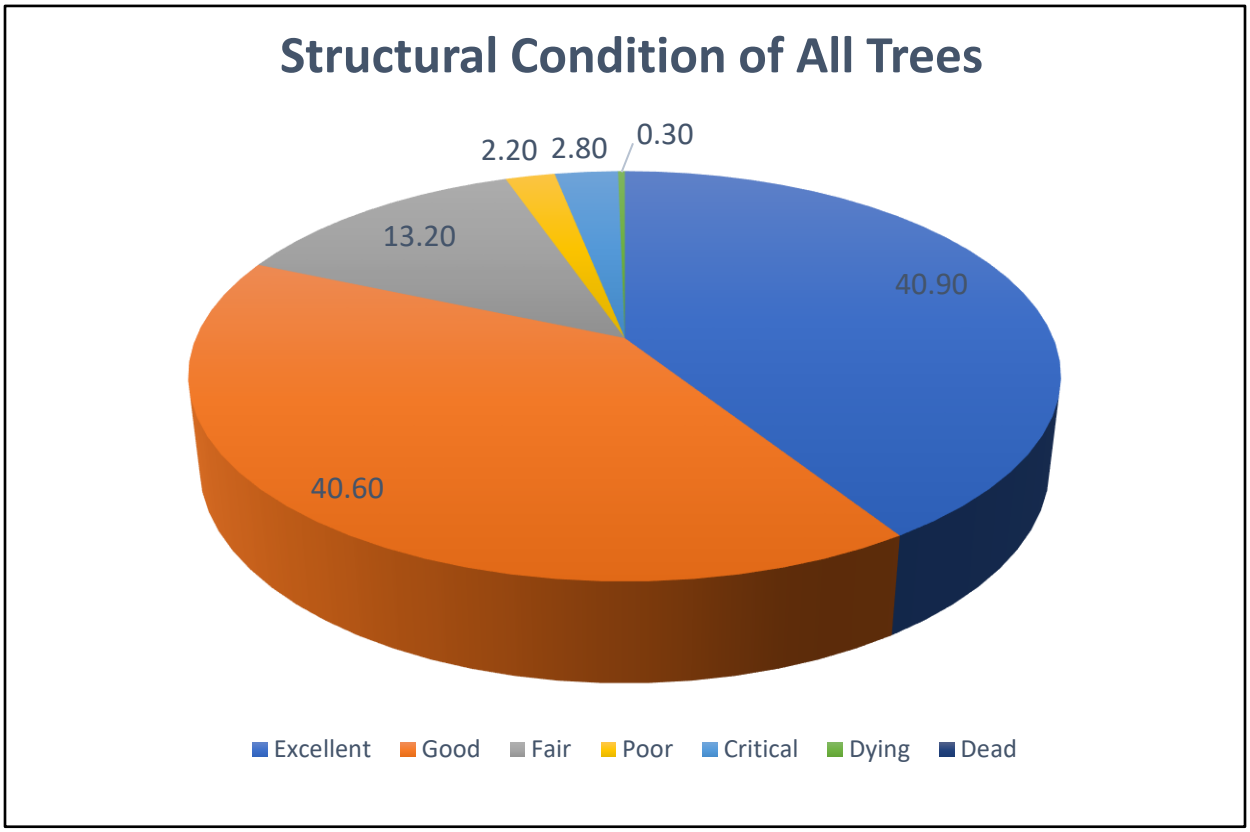


Figure 4. Percentage of street trees in each condition class

In conducting the inventory, Project Canopy staff recommends all inventoried trees receive an initial inspection since there has not been any regular tree monitoring plan in place. These trees should be inspected by a Maine licensed arborist, a Tree Warden, or another qualified individual in a timely matter. The Department of Agriculture, Conservation and Forestry maintains a list of Maine Licensed Arborists here: https://www.maine.gov/dacf/php/arborist/ArboristList.shtml

Twenty-seven (27) trees were flagged as in need of immediate or critical attention, causing a concern for public safety. Trees that were flagged as in need of critical attention expressed one or more of the following conditions:

- The tree has a visible defect affecting >40% of the tree,
- The tree poses a hazard to people/infrastructure/cars,
- The tree is growing into utility wires,
- The tree is dead or in poor condition.

Although Freeport's public trees are generally healthy (95% assessed as in "Excellent", "Good" or "Fair" condition), proper maintenance and monitoring is required to promote the health, longevity, and benefits of any urban forest.

Economic Benefit and Ecosystem Services

The Town of Freeport's public tree inventory data were analyzed using i-Tree Eco software to determine the monetary value of the ecosystem services provided by the street trees. The 323 street trees provide a total of **$5,069 in annual benefits** by filtering air pollutants, mitigating stormwater runoff, sequestering carbon dioxide (CO_2) and conserving energy. On average, **each street tree offers $16, or $.60 per capita, annually in savings or services**.

Figure 5 and Table 1 provide an overview of each ecosystem service provided by Freeport's street trees. Many tree benefits equate directly to the amount of healthy leaf surface in the canopy. Freeport's inventoried trees cover about 7.73 acres and provide 31.56 acres of leaf area. It is important to recognize that the trees inventoried through this project are located on the approximately .35 square miles of land along the main streets and downtown; expanding the inventory in Freeport's 34.7 total square miles of land area or even simply including parks, cemeteries and municipal properties, would increase these figures dramatically. It is also noteworthy that larger (mature) and long-lived trees provide substantially more benefits than small and young trees. **Regular maintenance and care are needed to provide for public tree health, longevity, and maximized urban forest benefits.**

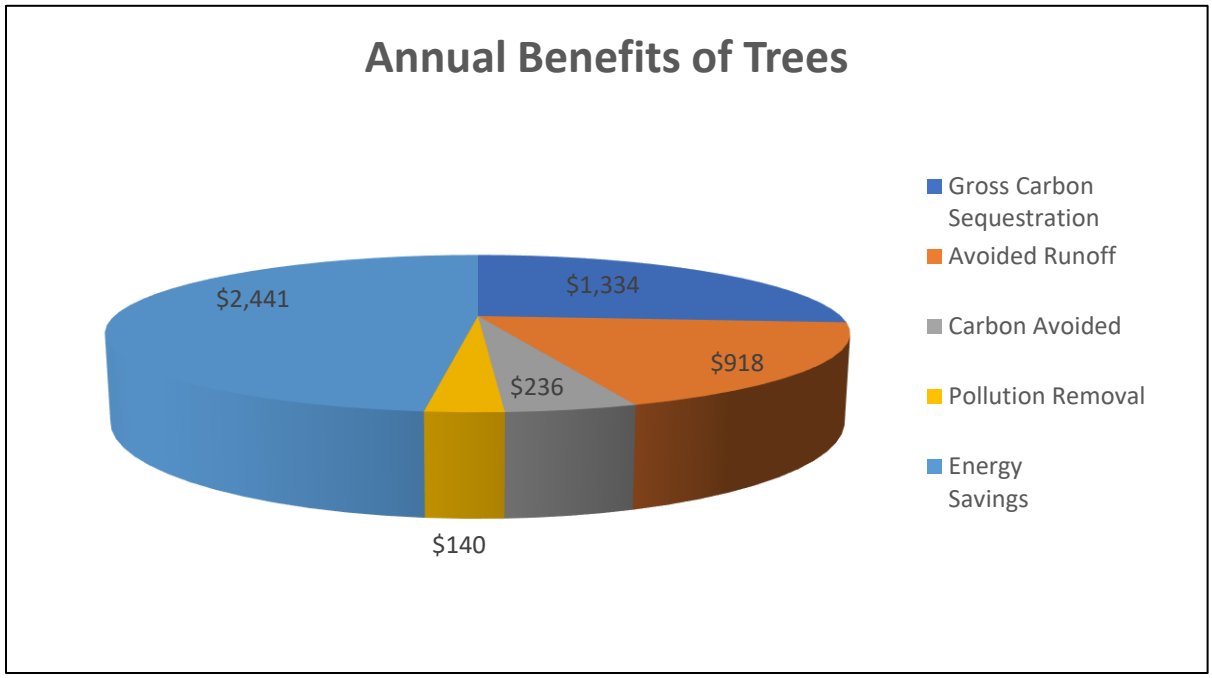


Figure 5. Summary of benefits provided annually by inventoried trees

Saving the town nearly $2500 annually in avoided heating and cooling costs, energy conservation is the most significant benefit provided by Freeport's public trees. (Table 1). It is important to note that these values are derived from species, diameter class (inches), and condition class inventory data of each tree; the larger the tree canopy, the more energy benefits provided by the tree. To learn how to continue to benefit from the energy conservation potential of urban trees, refer to the Arbor Day

Foundation's Trees and Energy Conservations webpage at
www.arborday.org/trees/climatechange/summershade.cfm

Benefit Type	Benefit Description	Total Value of Trees Inventoried	Average Value/Tree
Energy conservation	Reduced natural gas use in winter and reduced electricity use for air conditioning in summer	$2.419	$7.31
Carbon dioxide	Annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.	$1,372	$4.15
Air Quality	Quantifies the air pollutants (O_3, NO_2, SO_2, PM_{10}) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, VOCs, SO_2) due to reduced electricity use. Also reported are the potential negative effects of trees on air quality due to BVOC emissions.	$143	$.43
Stormwater	Reductions in annual stormwater run-off due to rainfall interception by trees.	$934	$2.82
Stored carbon dioxide	Tallies all of the carbon dioxide stored in the urban forest over the life of the trees as a result of sequestration; *not an annual benefit but a cumulative benefit.	$61,455*	$185.66*

Table 1. Annual environmental and monetary benefits provided by Freeport's street trees

Poor air quality is a common problem in many urban areas. It can lead to decreased human health, damage to landscape materials and ecosystem processes, and reduced visibility. The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from the power sources. Trees also emit volatile organic compounds that can contribute to ozone formation. However, integrative studies have revealed that an increase in tree cover leads to reduced ozone formation (Nowak and Dwyer 2000).

Freeport's street trees remove an estimated 268 pounds of air pollution{ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter less than 2.5 microns ($PM2.5)^{2,}$ and sulfur dioxide (SO_2)} per year with an associated value of $140. (Figure 6).

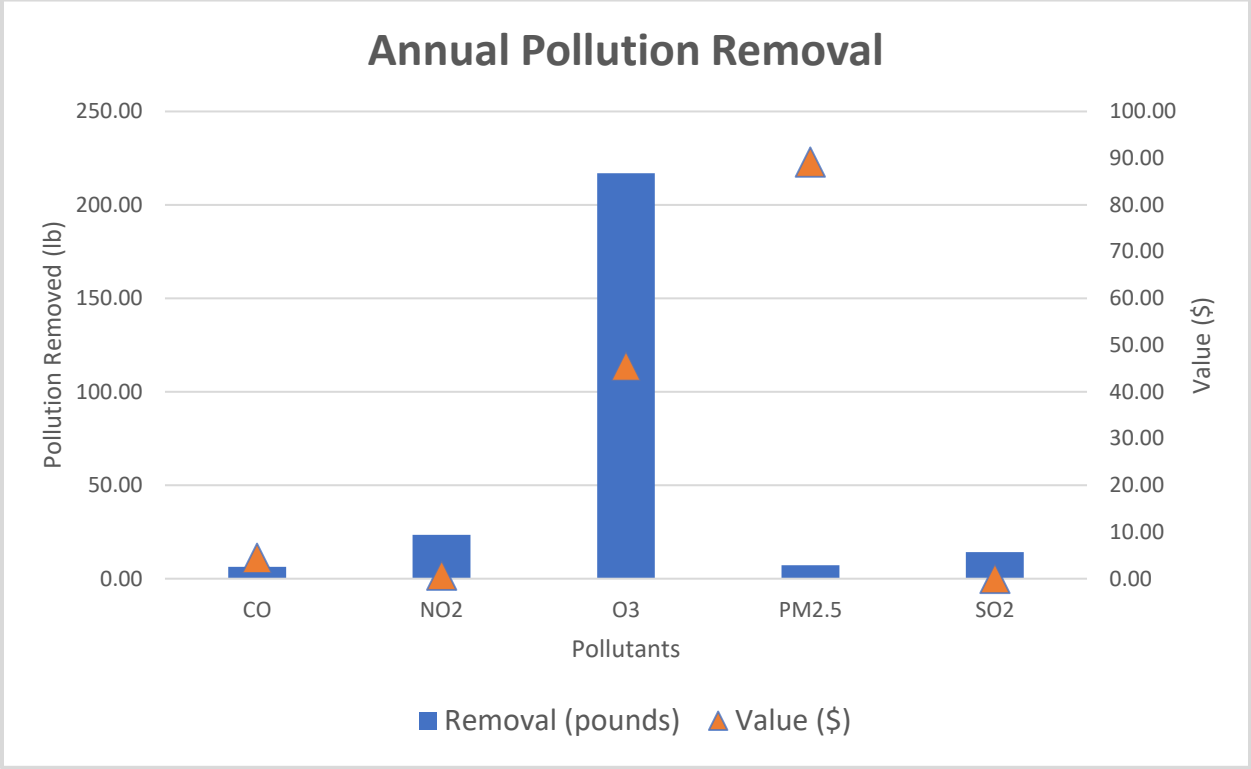


Figure 6. Annual pollution removal (bars) and value (points) by street trees

Full Canopy Assessment

As a complement to the street tree inventory, Project Canopy staff completed an urban tree canopy (UTC) assessment for the downtown area encompassed by the street tree inventory effort in Freeport. i-Tree Canopy is a free, easy-to-use, online application that allows users to assess total tree cover over an area based on randomly generated map points and user-defined land cover types. Like i-Tree Eco, this tool also assigns dollar values to the benefits associated with the overall tree canopy cover. The aim of this type of assessment is to help citizens and decision-makers better understand the existing and potential tree canopy in their community.

Bow St has ample space for street trees to be planted along the sidewalk.

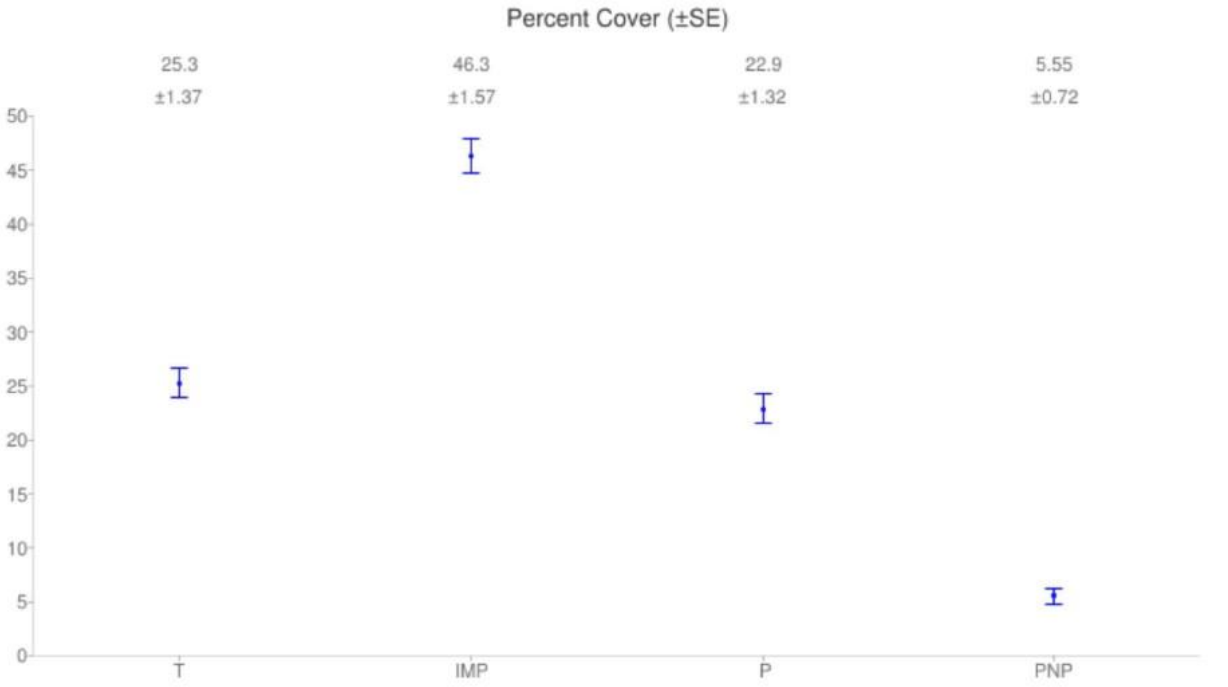
Based on Freeport's i-Tree Canopy assessment, approximately 25% of the land area is currently occupied by tree canopy (Figure 7). Currently 52% of the total area is occupied by buildings and other non-plantable areas (parking lots, roads and agricultural land), however, some of this could be converted to tree canopy – such as tree islands and buffer strips in parking lots as well as green roofs. **Downtown Freeport's canopy cover could potentially increase by more than 23% on open lands of low-lying vegetation and re-engineering of some parking lots.** There are a multitude of spots in which substantial trees can be planted – particularly along Elm St., School St. Upper Bow St., in parking lots such as the train station and along

South Freeport Rd in front of the Post Office and L'Ecole Francaise du Maine. Encouraging the installation of green roofs in new construction and in substantial renovations of existing buildings alone would make a tremendous impact in reducing stormwater runoff and cooling costs.

i-Tree Canopy v6.1

Cover Assessment and Tree Benefits Report

Estimated using random sampling statistics on 1/10/20



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	255	25.3 ±1.37
Impervious surface	Pavement, building	IMP	467	46.3 ±1.57
Plantable area	Potential space for new trees	P	231	22.9 ±1.32
Pervious non-plantable	water, agriculture, etc	PNP	56	5.55 ±0.72

Figure 7. i-Tree Canopy assessment for the inventory area of downtown Freeport including both public and private land. The above image shows the ground cover composition distribution.

Figure 8 compliments the i-Tree Eco analysis of the monetary value of benefits provided by Freeport's street trees by estimating the air quality benefits and corresponding monetary value of the full urban forest canopy (both public and private land). Of note is an estimated $10,840 in annual CO_2 sequestration value and $272,235 in CO_2 storage.

Tree Benefit Estimates

Abbr.	Benefit Description	Value (USD)	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$24.12	±1.31	36.30 lb	±1.97
NO2	Nitrogen Dioxide removed annually	$48.03	±2.60	363.95 lb	±19.70
O3	Ozone removed annually	$2,597.04	±140.59	1.15 T	±0.06
PM2.5	Particulate Matter less than 2.5 microns removed annually	$5,827.79	±315.48	117.16 lb	±6.34
SO2	Sulfur Dioxide removed annually	$5.91	±0.32	124.35 lb	±6.73
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$1,831.54	±99.15	586.44 lb	±31.75
CO2seq	Carbon Dioxide squestered annually in trees	$10,840.07	±586.82	233.89 T	±12.66
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$272,234.79	±14,737.15	5,873.81 T	±317.97

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.777 @ $1,333.50 | NO2 7.788 @ $264.87 | O3 49.156 @ $2,269.19 | PM2.5 2.507 @ $99,840.13 | SO2 2.661 @ $95.34 | PM10 12.550 @ $6,268.44 | CO2seq 10,010.267 @ $46.51 | CO2stor is a total biomass amount of 251,395.359 @ $46.51*
Note: Currency is in USD
Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

About i-Tree Canopy

The concept and prototype of this program were developed by David J. Nowak, Jeffery T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted to i-Tree by David Ellingsworth, Mike Binkley, and Scott Maco (The Davey Tree Expert Company).

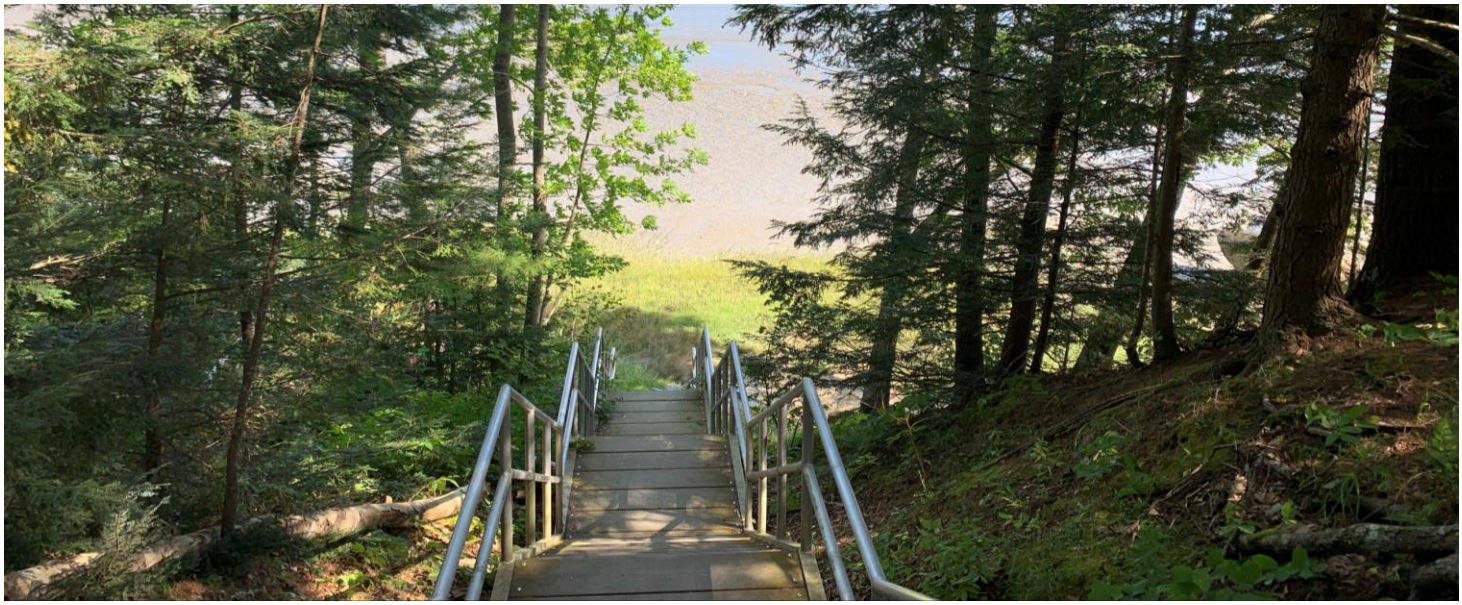
Limitations of i-Tree Canopy

The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. As the number of points increase, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be too high to have any real certainty of the estimate.

A Cooperative Initiative Between:

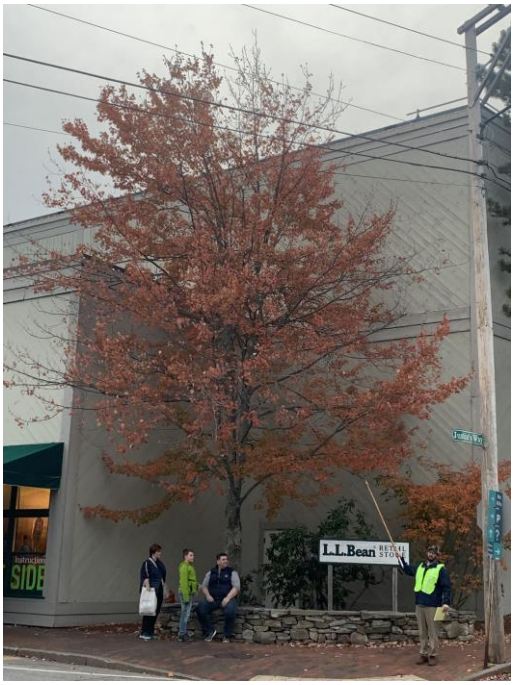
DAVEY Arbor Day Foundation SMA Society of Municipal Arborists ISA Casey Trees Washington DC

www.itreetools.org



Municipal Tree Program

Freeport's participation in this project is just the first step in their journey towards a robust and sustainable urban forest. As the town continues to evolve as a shopping destination, with the potential for increased vehicular traffic as well as mass transit, consideration of their urban forest will be important. The 2019 street tree inventory and this report lay a foundation for better understanding the management needs and value of Freeport's street trees, as well as the ways in which residents and town leadership can be engaged for tree stewardship. A community that participates in planting and caring for their urban forest will respect and steward that forest much more than if it happens without their involvement.



Town Manager Peter Joseph inventories a red maple in front of L.L.Bean on Main St.

Freeport boasts a beautiful, bustling downtown, with great local shops and restaurants. Wide sunny sidewalks are a perfect spot to add substantial tree wells, planters and even rain gardens and stormwater catch basins. A 2005 study determined shoppers in business districts with robust tree canopy will spend 9 to 12% more for products. They will travel greater distance to visit a district having high quality trees and spend more time there once they arrive (K.L. Wolf, Business District Streetscapes, Trees and Consumer Response. *Journal of Forestry*). Trees can calm traffic and reduce vehicle speeds by appearing to narrow the width of the roadway. In an area where streets were widened and trees were *not* present, accidents increased by almost 500% within an 8-year period (Swift et al, Residential Street Typology and Injury Accident Frequency, 2006). Tree lined streets and sidewalks encourage visitors and residents to walk and ride bikes, rather than drive personal vehicles due to the reduced urban heat island effect, ultimately reducing the need for increased parking. Numerous other studies demonstrate the benefits trees have on urban neighborhoods – from reduction in crime, to increased health, reduced energy costs and increase in property values.

Freeport should seriously consider investing in the green infrastructure of its downtown and nearby neighborhoods by adding esplanades and tree wells and planting appropriate street trees and other green infrastructure.

Recommendations:
We recommend that Freeport's Town Manager, Council and staff note the following considerations to continue to develop the municipal tree program:

- Complete this initial inventory by including all parks, cemeteries and schools as well as other municipally owned properties.
- Work with Project Canopy staff to develop a management plan based on the results of the completed inventory to prioritize goals and establish a timeline for the program.
- Develop ordinances that require planting of trees in new developments, establish guidelines for planting/removal of trees in public ROW and create the position of a Tree Warden in the Town (may be volunteer or stipend position).
- Advocate for an explicit annual budget line for Freeport's trees; funds should be allocated not only for tree removals, but also for regular planting, maintenance, and monitoring of the public trees.
- Continue to encourage the formation of a citizen tree committee or board to help coordinate and implement the town's tree program and encourage community involvement.
- Ensure that those who are caring for Freeport's public trees are trained in best tree care practices. Public trees should be structurally pruned to promote long-term integrity, newly-planted trees should be planted correctly and irrigated to promote proper establishment, mulch should be applied properly and mechanical and compaction damage should be minimized during any construction or regular maintenance activities.
- Encourage citizens and businesses to participate in stewardship activities; particularly because of the trees in the *Acer* (maple) and *Fraxinus* (ash) genera, residents should be aware of the signs and symptoms of EAB and ALB and should be empowered to monitor for these invasive forest pests.
- Plan for the arrival of EAB and ALB by developing an invasive forest pest preparedness plan, perhaps as a component of the overall management plan for Freeport's public trees; this process will inform future planning efforts for other threats to the urban forest.
- Communicate the benefits of Freeport's public trees at local events and to local leadership, and encourage citizen and local business participation.
- Encourage businesses and residents to plant and maintain trees on their private property to increase diversity, overall urban tree canopy cover, and the benefits provided by trees to citizens and visitors of Freeport.
- Consider becoming a Tree City USA, a program of the Arbor Day Foundation that provides the framework necessary for communities to manage and expand their public trees.
- Consider new planting sites along Rt 1 and South Freeport Rd and surrounding neighborhoods.

Urban Forest Diversity and Structure

An important best management practice in urban forestry is to maintain a diverse range of species. It is recommended that communities work towards a goal of no more than 20% representation of a single genus (for example, *Acer*) in a tree population and no more than 10% of one species (for example, *Acer saccharum*). Resistance to disease and insect infestation is one of the many reasons that diversity of public trees is of particular concern. A more diverse urban forest is more resistant to environmental stressors, and can therefore remain healthy and resilient in the face of change. Furthermore, **maintaining greater diversity can prevent a rapid loss of tree canopy due to insect and disease issues as well as natural end-of-life.**

In Freeport, 35 species and 19 genera are represented as public trees. More than half (53%) of street trees inventoried are in the maple (*Acer*) genus, which is much more than the recommended representation within the public tree population. Norway, sugar, red and silver maple comprise 23%, 14%, 10% and 3% of the total tree population, respectively. Of note, Norway maple is the most prevalent individual species in Freeport but is now considered to be a non-native invasive species in Maine. Although an aesthetically pleasing and fast-growing tree, Norway maple can spread into nearby forests and out-compete native species such as sugar and red maple. In fact, Maine's Invasive Plant Rule (2017)[5] prohibits buying, selling, importing, exporting or growing Norway maple, as well as 32 other invasive plant species. Norway maples are also inherently fragile and can become hazard trees as they mature and large branches are subjected to heavy snow and ice loads.

Ash trees (*Fraxinus*) comprise 10% of Freeport's public tree canopy. Streets such as Main St., Park St. and Middle St. in South Freeport are lined heavily with ash – the demise of all these trees at once would be devastating for those neighborhoods and the town as a whole. Both ash and maple trees are currently threatened by invasive tree pests; EAB and ALB, respectively. While ALB has not been discovered to-date in Maine, the largest ALB infestation in North America is just to our south in Worcester, MA, and with the discovery of EAB in York and Aroostook counties in 2018 & in Cumberland County in 2019, most of Maine is now within a couple hours' travel of infestations of EAB. The Maine Forest Service now recommends treating or removing urban ash trees once EAB is detected within ten miles of the area. For more information on quarantines and treatment of EAB, visit https://www.maine.gov/dacf/php/caps/EAB/index.shtml

Green ash at corner of Middle and Bow St

[5] https://www.maine.gov/dacf/php/horticulture/invasiveplants.shtml

The town of Freeport hosts 45 oak trees and nine fruit trees along its streets, representing 17% of inventoried trees. Browntail moth and winter moth prefer to feed on oak foliage as well as that of fruit trees and have ravaged the area's trees over the last few years. While the wet cold spring of 2019 knocked the larval population down substantially, it will take a few more seasons to determine if the decline will continue. Closely monitor these tree species for pest damage and consider limiting new plantings of these species while moth populations remain high.

56% of Freeport's inventoried public trees are more than 18" in diameter, indicating a rather mature tree population that will need increasing monitoring and maintenance as they age and decline. Increased planting of younger trees now, will increase diversity and allow new trees to establish and fill-in as older trees are removed. It is important to emphasize that mature shade trees provide significant benefits, but in order to reach maturity the maintenance of young public trees must be a prioritized investment.

<u>Recommendations:</u>
We recommend that Freeport continues to develop its species and structural diversity by:

- Planting new species and increasing the number of lesser represented species in order to promote long-term health and resilience of individual trees and Freeport's overall public tree population.
- Due to the high number of existing maple (*Acer*) trees in Freeport, we suggest prioritizing other species for future plantings and new Norway maple trees should not be planted.
- Existing ash (*Fraxinus*) trees should be continually monitored for signs and symptoms of EAB and new ash trees should not be planted.
- As Freeport's street trees mature, promote their health and integrity with a systematic structural pruning and maintenance cycle.
- Consider new planting sites along Main St., Bow St. and Elm St., and working with larger businesses such as L.L. Bean, McDonalds and CVS as well as local spots like L'Ecole Francaise du Maine to increase plantings along the roadway and in their parking lots.

A sugar maple brightens up a cloudy fall day along Park St.

Urban Forest Health

Overall, Freeport appears to have a fairly healthy population of street trees. A dedicated tree care budget and established maintenance program (opposed to explicit funds only for the removal of trees) would bolster the support for the continued health of its urban forest. Approximately 6% (17) of Freeport's street trees are considered to be in "Poor", "Critical" or "Dead" condition. Twenty-seven (27) trees need immediate attention (either hazard pruning or removal) to prevent hazards to the public.

Residential streets such as East and Kendall Streets are lined with many lovely old trees, but sadly many are nearing the end of their lifespan and should be regularly inspected with plans made for staggered removal and replanting. Much of the mature canopy within the villages is situated on private property, but has the potential to impact the public ROW once they fail. Conversations with landowners should begin now to determine the best course of action moving forward.

Many of the neighborhoods have wooded spots that do not appear to be maintained that harbor invasive and noxious plant species. The end of Kendall St. adjacent to the school is overrun with asiatic bittersweet, honeysuckle and multiflora rose. A dry stream bed on the south side of Park St in South Freeport is another neglected spot with lots of Japanese knotweed, and old ash and black locust trees that are declining and could cause hazards in the future. And just down the hill from the town office, a stretch of honeysuckle, knotweed and autumn olive are thriving. These non-native plants can out-compete and even strangle trees.

Invasive plants at end of Kendall St.

All the inventoried trees are recommended for inspection and maintenance by a Maine licensed Arborist, the Tree Warden, or another qualified individual.

Low soil volume and fertility, soil compaction, exposure to road salt spray, root damage, mechanical damage to the trunk or branches by weed whackers or snowplows, and improper pruning and planting are some of the contributing factors that may lead to decreased tree health in an urban setting.

Recommendations:
In order to ensure the long-term health and vibrancy of Freeport's public trees, we recommend the following activities:

- Prioritize the inspection and pruning of the 27 trees that have been flagged as critical or immediate hazards by a Maine licensed Arborist or Tree Warden.
- Develop a plan to remove and replace, the one dead tree inventoried and any others that will arise.
- Remove invasive plant species such as bittersweet, autumn olive and honeysuckle near inventoried trees.
- Establish a routine and systematic pruning cycle (multi-year) for all public trees to reduce the occurrence of branch failures due to poor structure, minimize conflicts with people and infrastructure, improve lines of sight, reduce storm damage, and protect public safety.
- Create a pest management plan that includes planning for treating or removing urban ash trees once EAB is detected within ten miles of the area.
- Encourage a culture of continual monitoring and updating the tree inventory as necessary as regular tree management occurs; consider assigning the responsibility of inventory database maintenance to one individual; Project Canopy staff is available to assist in developing a tree management regime.
- Explore and encourage installation of green infrastructure/stormwater best management practices (BMPs) where appropriate: green roofs, rain gardens, permeable pavement and re-engineering of tree wells and sidewalks for improved root growth of street trees.
- Look at partnering with schools, master gardeners, scout troops and other local groups to help with invasive removals and restoration planting days.

Assessment Tools
Using free and accessible i-Tree software developed by the USDA Forest Service, Project Canopy staff was able to assess the benefits, value, and extent of Freeport's street tree canopy. i-Tree Eco allowed us to determine the dollar value of the ecosystem services provided by the 323 inventoried trees. Freeport's street trees alone generate over $5,000 annually through the benefits of air quality improvement, carbon storage, energy savings, and storm water control. In fact, if Freeport had to replace all of the inventoried trees at once, **their structural value would cost close to $1.3 million.**

As canopy increases, these benefits and savings will only increase. The trees of Freeport provide services to the town in the following ways:

- Air quality: **Trees improve air quality** by removing air pollutants through their leaves, altering emissions from building energy use, and by lowering air temperature.

- Energy use: Trees influence temperature and energy use by providing shade, transpiring moisture, and reducing wind speeds, **mitigating the need for heating of buildings in the winter and cooling in the summer.**
- Stored carbon and sequestered carbon dioxide: Trees store carbon in their tissues as they accumulate biomass over time; an estimated 770 million tons of carbon, valued at $14.3 billion, is stored in the public forests in the contiguous United States. Trees also mitigate greenhouse gas emissions by sequestering carbon dioxide through the process of photosynthesis.
- Storm water run-off: Trees and soil **improve water quality and reduce costs** associated with stormwater treatment by retaining or slowing flow of rain and snow-melt.

And while not addressed in the quantified benefits outlined in this study:

- Benefits to retail businesses: **People shop more often, longer in well-landscaped areas** & will pay up to 12% more for parking and goods/services
- Aesthetics: Trees can make an urban or suburban environment a more pleasant and satisfying place to live, work, and spend leisure time. In economic terms, presence of particularly mature shade trees can **significantly increase property value.**
- **Numerous health benefits** associated with the mere presence of trees. For example, hospital patients with window views of trees have been shown to recover faster than patients without such views.

Using a random sample method and based on assessing land cover types, i-Tree Canopy allowed us to measure the overall tree canopy cover within the boundaries of the inventoried downtown area, capturing both private and public tree canopy totals.

<u>Recommendations:</u>
We recommend that Freeport's Town Manager and Council members explore the results of the two i-Tree assessments detailed in this report and:

- Use the information generated through i-Tree Eco and i-Tree Canopy to promote the understanding of tree benefits and the investment in urban forest management and local stewardship.
- Use the i-Tree Canopy UTC and land cover assessment to inform and promote efforts towards an overall urban canopy cover of 35-40% (up from the current 25%). This might include outreach to private property owners to communicate tree benefits and encourage tree planting on their land.
- Explore the other free assessment tools in the i-Tree tools suite (www.itreetools.org).

Conclusion

Trees in our downtowns and commercial landscapes contribute to a thriving economy, promote our sense of community, protect our natural resources, preserve our cultural heritage, and increase our overall well-being. Well-planned and planted trees calm traffic, boost retail sales, reduce stormwater fees, provide cooling shade for parking lots and buildings, and can create a visual gateway welcoming visitors to the destination of Freeport. Larger shade trees can also provide heating and cooling savings to homes and businesses. This report is one component of an effort by the Town of Freeport to understand, manage, and steward its public tree population. The recommendations outlined in this report are based on Project Canopy staff's observations and data analysis combined with their experience and evaluation; they should be considered by Freeport's leadership based on long-term vision and capacity.

Looking ahead, Freeport should focus efforts on establishing a maintenance and pruning program for the public tree population, planting trees in the downtown, maintaining the quality of its mature trees in the neighborhoods and rural stretches, increasing its genera and species diversity, and increasing total canopy cover. With improved monitoring, regular maintenance, and an engaged and informed citizenry, the potential for a healthy, sustainable urban forest is attainable.

Appendix 1. Full Species and Genera List for Freeport

Common Name	Scientific Name	# of Trees	% of Total Trees
Norway maple	*Acer platanoides*	74	22.80
Sugar maple	*Acer saccharum*	44	13.50
Northern red oak	*Quercus rubra*	32	10.20
Red maple	*Acer rubrum*	32	9.80
Littleleaf linden	*Tilia cordata*	20	5.30
White ash	*Fraxinus americana*	15	4.90
Green ash	*Fraxinus pennsylvanica*	15	4.60
Pin oak	*Quercus palustris*	12	3.70
Freeman maple	*Acer x freemanii*	10	3.10
Eastern white pine	*Pinus strobus*	9	2.80
Silver maple	*Acer saccharinum*	8	2.50
Paper birch	*Betula papyrifera*	6	1.80
American elm	*Ulmus americana*	6	1.80
Horsechestnut	*Aesculus hippocastanum*	5	1.50
Black locust	*Robinia pseudoacacia*	5	1.50
Apple/crabapple	*Malus spp.*	4	1.20
Honeylocust	*Gleditsia triacanthos*	3	< 1
Black cherry	*Prunus serotina*	3	< 1
Northern catalpa	*Catalpa speciosa*	2	< 1
Magnolia	*Magnolia*	2	< 1
Red pine	*Pinus resinosa*	2	< 1
Flowering pear	*Pyrus calleryana*	2	< 1
Weeping willow	*Salix spp*	2	< 1
Eastern hemlock	*Tsuga canadensis*	2	< 1
Black maple	*Acer negundo*	1	< 1
Japanese maple	*Acer palmatum*	1	< 1
Yellow birch	*Betula alleghaniensis*	1	< 1
River birch	*Betula nigra*	1	< 1
Larch	*Larix laricina*	1	< 1
Norway spruce	*Picea abies*	1	< 1
White spruce	*Picea glauca*	1	< 1
Blue spruce	*Picea pungens*	1	< 1
	Total	**323**	**100%**

Appendix 2. Recommended Planting List

Common name	Latin name	Street or Lawn Tree
Small Trees 15' – 25' (this group can be used for planting under wires)		
Hedge Maple	*Acer campestre*	S/L
'Three-flowered' Maple*	*Acer triflorum*	S/L
Shadbush*	*Amelanchier*	L
Hawthorns*	*Crataegus*	S/L
Flowering Crabapple	*Malus spp*	S/L
Cherry*	*Prunus spp*	S/L
Paperbark Maple	*Acer griseum*	L
Korean Maple	*Acer sieboldianum*	L
Dogwood	*Cornus kousa*	L
Magnolias	*Magnolia spp.*	L
American Hophornbeam*	*Ostrya virginiana*	L
Sourwood*	*Oxydendrum arboretum*	L
Stewartia	*Stewartia pseudocamellia & koreana*	L
Medium Sized Trees 25' - 45'		
River Birch*	*Betula nigra*	L
American or European Hornbeam*	*Carpinus caroliniana & betulus*	L
Katsuratree*	*Cercidiphyllum*	L
American Yellowood	*Cladrastis*	S/L
Turkish Filbert	*Corylus colurna*	S
Honeylocust	*Gleditsia*	S
Tupelo*	*Nyssa sylvatica*	L
Korean Mountainash	*Sorbus alnifolia*	S/L
Large Trees 45' + Large trees should not be planted close to utility lines and need room to grow.		
Red Maple	*Acer rubrum*	S
Sugar Maple	*Acer saccharum*	L (away from deicing salt)
Catalpa	*Catalpa*	L
Beech	*Fagus*	L
Ginkgo*	*Ginkgo biloba*	S/L
Tuliptree	*Liriodendron*	S
Cucumber Magnolia	*Magnolia acuminata*	L
American Elm	*Ulmus*	S/L
Zelkova	*Zelkova*	S/L
Pin oak	*Quercus palustris*	L
Bur oak	*Quercus macrocarpa*	L
Swamp white oak*	*Quercus bicolor*	L
American hornbeam	*Carpinus carolinia*	L
Northern hackberry	*Celtis occidentalis*	L
Sugar hackberry	*Celtis laevigata*	L
American sycamore	*Platanus occidentalis*	L
London planetree	*Platanus x. acerifolia*	L
Horse chestnut	*Aesculus x carnea*	L
Kentucky coffeetree	*Gymnocladus dioicus*	L