PORTLAND PARKS & RECREATION

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Street Tree Inventory Report
Rose City Park Neighborhood

October 2016

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Cover Photos (from top left to bottom right):
1) Vibrant magenta flowers on a crape myrtle (*Lagerstroemia indica*).
2) The cones and foliage of a cryptomeria (*Cryptomeria* sp.)
3) Lacy sprays of tiny flowers on a sourwood (*Oxydendrum arboreum*).
4) The foliage of a silverleaf oak (*Quercus hypoleucoides*).
5) An unusual ridged fruit on a Carolina silverbell (*Halesia caroliniana*).
6) The cones of a dawn redwood (*Metasequoia glyptostroboides*), a relict species native to China.
7) The attractive bark of a lacebark elm (*Ulmus parvifolia*).
8) Bright vermillion clusters of fruit on a Chinese pistache (*Pistacia chinensis*).

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Contents

Volunteers, guided by Portland Parks & Recreation Urban Forestry staff, collected data on all 5,723 street trees within Rose City Park neighborhood to compile the neighborhood's first complete street tree inventory. The data are being used to inform the creation of a Neighborhood Tree Plan to guide volunteers in caring for their community's trees.

Key Findings

This report provides the results of a street tree inventory conducted in the Rose City Park neighborhood in 2016, along with Portland Parks & Recreation (PP&R) Urban Forestry staff recommendations for the Rose City Park tree team. Over the course of six work days, 69 volunteers contributed more than 514 hours collecting data on each of the neighborhood's 5,723 street trees.

URBAN FOREST STRUCTURE

- **Rose City Park's street tree population is dominated by cherry, Norway maple, dogwood, plum, and red maple, and does not meet recommended species diversity guidelines.** While 106 tree types were found in this inventory, only two families, Rosaceae and Sapindaceae, account for more than 50% of the street tree resource. Furthermore, both the *Acer* (maple) and *Prunus* (plum, cherry) genera are over represented, leaving Rose City Park's street tree population vulnerable to pests, pathogens, and effects of a changing climate.

- **The dominance of broadleaf deciduous trees (94%) in Rose City Park points to a need to plant more evergreen trees for year-round benefits and to create a more resilient urban forest.**

- **There are many young trees in Rose City Park.** This is likely the result of successful tree planting efforts in recent years and provides an opportunity for inexpensive young tree maintenance activities that will reduce future costs and ensure the longevity of these trees. If young trees are properly cared for today, Rose City Park will have a healthier age distribution of street trees in the future.

- **Only 18% of Rose City Park's street trees are large form varieties.** Large form trees are necessary to increase canopy cover and the benefits they provide for Rose City Park's residents. Planting the estimated 839 large available spaces identified in this inventory will maximize tree canopy in Rose City Park's rights-of-way.

TREE CONDITION

- **The majority of trees inventoried in Rose City Park are in fair or good condition, however, almost half of poor-rated trees are in the Rosaceae family and 39% of hawthorns are poor.**

PLANTING SITES AND STOCKING LEVEL

- **Only 73% of street tree planting sites have trees in Rose City Park and more than 40% of empty planting sites are large sites.** Planting efforts should focus on the largest sites with no overhead high voltage wires first, as large form trees will provide the most long-term benefits to the neighborhood.

- **Only one-third of Rose City Park's planting sites contain trees appropriate for the site.** Despite small sites making up just 5% of all sites where trees were found, 40% of trees inventoried are small form. Small form trees in large sites are a missed opportunity because larger trees contribute many times more benefits to the community.

URBAN FOREST VALUE AND BENEFITS

- **Rose City Park's street trees produce an estimated $813,356 annually in environmental and aesthetic benefits.** The replacement value of this resource is $18.9 million. Planting efforts focused on appropriately sized trees distributed across the neighborhood will ensure that future benefits are equitably distributed among all residents.

*Clockwise from top left: 1) This young dove tree (*Davidia involucrata*), native to China, is a rare species in Portland. Planting more uncommon trees adds species diversity to the Rose City Park urban forest. 2) Mature trees, like this pagoda tree (*Sophora japonica*), provide shade for residents and pedestrians. 3) At 56.0" DBH, this elm (*Ulmus *sp.) is the largest diameter street tree in Rose City Park. 4) This broadleaf evergreen oak (*Quercus *sp.) will provide year-round benefits of aesthetic value, canopy cover, and storm water interception at times when other deciduous trees have lost their leaves.*

About Portland's Street Tree Inventory

THE IMPORTANCE OF STREET TREES

Street trees are an important public asset in urban environments, serving as a buffer between our transportation corridors and our homes while enhancing the livability of our city. As integral components of a community's green infrastructure, street trees provide multiple economic, environmental, and social benefits such as cleaner air and water, cooler summer temperatures, safer streets, and increased property values. Unlike traditional, "grey" infrastructure, which begins to deteriorate the moment it is installed, the benefits that street trees provide increase over the lifetime of the tree, making their planting and maintenance one of the best investments a city and its residents can make.

While street trees are only one component of Portland's urban forest, they are particularly important because they are the trees that residents interact with most. Having adequate information about the street tree population allows a community to make informed decisions about species selection, planting, and maintenance priorities. Information on the location, condition, and diversity of the street tree population enables our communities to steward this resource and ensure its continued benefits into the future. Undertaking a street tree inventory is not only an investment in the current and future well-being of the trees, but in the community itself.

> *Urban forests are complex, living resources that interact both positively and negatively with the surrounding environment. They produce multiple benefits and have associated management costs. In order to fully realize the benefits, a sound understanding of the urban forest resource is needed. This understanding starts at the most basic level with a forest inventory to provide baseline data for management decisions.*

THE INVENTORY PROCESS

Portland's Tree Inventory Project began with a pilot street tree inventory in 2010, and since then many neighborhoods have partnered with Urban Forestry to inventory street trees and create action-oriented Neighborhood Tree Plans. By the end of 2016, volunteers identified, measured, and mapped almost 220,000 street trees! Neighborhood groups interested in trees begin by gathering volunteers to help conduct an inventory. Urban Forestry staff provides training, tools, and event organization. Together information is collected on tree species, size, health, site conditions, and available planting spaces.

Urban Forestry staff analyze data for each neighborhood and present findings to stakeholders at an annual Tree Summit in November. At the summit, neighborhood groups begin developing tree plans that set achievable strategies to improve existing trees, expand tree canopy, and connect the neighborhood with City and nonprofit resources. The resulting Neighborhood Tree Plan is based on the status and health of street trees and recommends specific actions to improve and expand this resource. Urban Forestry then partners with groups to organize stewardship events, including pruning, planting, and educational workshops.

The Tree Inventory Project supports Portland's *Urban Forest Management Plan* goals: to manage the urban forest in order to maximize community benefits for all residents; to develop and maintain support for the urban forest; and to protect, preserve, restore, and expand Portland's urban forest.

Neighborhood tree teams and volunteers are the backbone of this inventory. This partnership between residents and government is key to successful management of street trees in Portland, where Urban Forestry regulates street tree removal, planting, and maintenance through a permitting process, and property owners are responsible for the care and maintenance of trees. Creating a healthy urban forest depends on the active engagement of residents to care for their street trees.

If you would like to get involved with Rose City Park's urban forest, contact the Rose City Park Neighborhood Association by visiting http://www.rcpna.org/ or contact Urban Forestry.

Data from the inventory are available to the public in spreadsheet or ArcGIS format. Visit the Tree Inventory Project website at http://portlandoregon.gov/parks/treeinventory to learn more about the project and download reports, data, and maps.

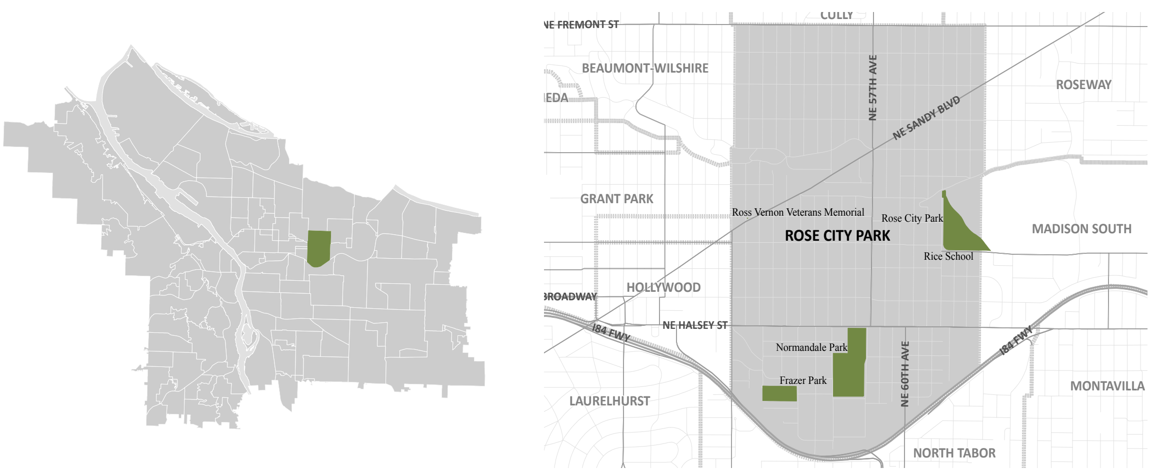
Clockwise from top left: 1) Large empty spaces with no overhead wires provide an ideal opportunity to increase canopy in Rose City Park, as they can support the growth of large form trees. 2) Infrastructure can be modified to coexist with established trees. 3) Poor condition trees like these hawthorns (Crataegus *spp.) should be monitored individually and considered for removal and replacement; 39% of hawthorns in Rose City Park are in poor condition.*

Neighborhood Characteristics

A neighborhood's history and land use have an important effect on the presence and condition of street trees and the urban forest. Over time, different development patterns have been more or less favorable to street trees. Areas of Portland's neighborhoods that were designed without the inclusion of street trees or with small planting spaces limit the potential for street trees. With redevelopment of areas and new designs that include adequate space for trees, there is opportunity for increased use of street trees to expand overall tree canopy. Because care and maintenance of Portland's street trees is the responsibility of the adjacent property owner, rates of homeownership and income level also influence the presence and condition of trees in a neighborhood, as the cost of proper maintenance over a tree's lifetime can be a barrier to planting and care.

Rose City Park is a neighborhood in Northeast Portland, located in the Willamette River watershed, extending into the Columbia Slough Watershed at its northern boundary (Figure 1). The Rose City Park neighborhood boundaries are NE Fremont Street to the north, I-84 freeway to the south, NE 65th Avenue to the east, and NE 47th Avenue to the west.

Figure 1: Location of Rose City Park neighborhood in Portland



Rose City Park was first platted in 1907, the year of the first Portland Rose Festival, establishing Portland as 'The City of Roses.' In the center of the neighborhood stands a statue of George Washington, dedicated in Portland in 1927 by Henry Waldo Coe, a prominent Oregon politician. Parks in the neighborhood include Rose City Park, Normandale Park, and Frazer Park.

Currently, the Rose City Park neighborhood is primarily single-family residential with businesses concentrated along the commercial districts of Sandy Boulevard and NE Fremont Street. Rose City Park School is the only public school in the neighborhood, currently a campus of the Beaverly Cleary K-8 School.

Tree canopy covers 22% of Rose City Park, slightly lower than Portland's citywide canopy level of 29% (Metro 2008). Rose City Park's population density is higher than citywide at 12 persons/acre (Table 1). Home ownership is much greater than citywide averages, as 73% of homes in Rose City Park are owner-occupied. Thirty-two percent of households are considered low-income which is less than citywide averages.

Table 1: Neighborhood and citywide demographics

Demographics (2010 Census)	Rose City Park	Portland
Area	748 acres	85,376 acres
Population	8,982	583,776
Density	12 persons/acre	7 persons/acre
Race	85% white, 2% black, 4% Hispanic/ Latino, 1% Native American, 6% Asian, 0% Pacific Islander, 3% mixed race	72% white, 6% black, 9% Hispanic/Latino, 1% Native American, 7% Asian, 1% Pacific Islander, 4% mixed race
% of properties occupied by homeowners	73%	54%
% of low income households	32%	45%

Urban Forest Composition

SPECIES DIVERSITY AND TREE TYPE COMPOSITION

A diverse tree population in terms of species, age, form, and function maximizes urban forest benefits through time while minimizing costs and risk. Maintaining a diverse species mix is a critical way to promote a healthy and resilient urban forest. The conventional metric for evaluating urban forest species diversity is the 10-20-30 rule (Santamour 1990), according to which the urban forest population consists of no more than 10% of one species, 20% of one genus, or 30% of one family. However, this guideline has been found to be inadequate in some cases, leaving cities vulnerable to catastrophic forest loss due to pests and pathogens (Raupp et. al 2006). Considering Portland's temperate climate, where a great variety of trees are able to thrive, limiting this to 5-10-20, as other progressive urban forestry programs have, should be the goal. Trees were identified to the genus or species level and categorized as "tree types" (Appendix A).

Results

Rose City Park's public rights-of-way host a wide variety of tree types. The street tree population consists of 5,665 living trees of 106 types (Appendix B). Cherry is the most common tree type, representing 10% of all street trees (Table 2). Norway maple, dogwood, plum, and red maple are also common, representing 8.2%, 7.9%, 6.8%, and 5.9% of trees, respectively. The most common 15 tree types comprise 66.6% of the resource, leaving the

*A planting strip that includes cherry trees (*Prunus *spp.), which are the most abundant street tree type in Rose City Park.*

remaining tree types to each represent 1.8% or less of the neighborhood's total street tree population.

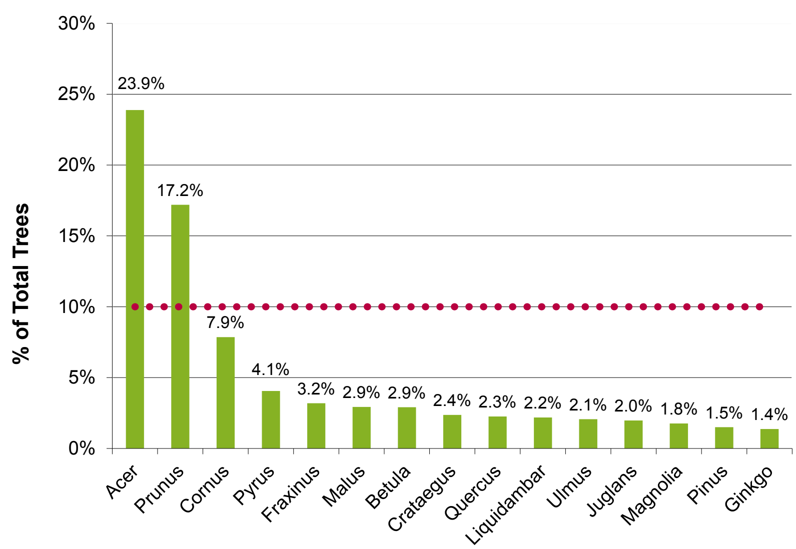
Ninety-two genera are represented in the neighborhood. The *Acer* genus comprises a significant portion of the resource at 23.9%, followed by *Prunus* at 17.2% (Figure 2). All other genera comprise 7.9% or less of the resource each.

Forty-two families are represented in the neighborhood and the ten most abundant families comprise 81.9% of the resource (Table 3). Rosaceae, Sapindaceae, and Cornaceae are the most common families and represent 26.7%, 24.6%, and 8.4% of trees, respectively. All other families represent 4% or less of the resource each.

Table 2: The 15 most abundant street tree types in Rose City Park

Common Name	Scientific Name	# of Trees	% of Total	Mean DBH
cherry	*Prunus* spp.	569	10.0%	10.9
maple, Norway	*Acer platanoides*	464	8.2%	14.4
dogwood	*Cornus* spp.	445	7.9%	6.2
plum	*Prunus* spp.	388	6.8%	9.9
maple, red	*Acer rubrum*	337	5.9%	9.2
pear	*Pyrus* spp.	230	4.1%	8.5
maple, other	*Acer* spp.	202	3.6%	11.5
maple, Japanese	*Acer palmatum*	194	3.4%	6.0
ash	*Fraxinus* spp.	181	3.2%	9.8
birch	*Betula* spp.	165	2.9%	14.6
hawthorn	*Crataegus* spp.	134	2.4%	10.0
sweetgum	*Liquidambar* spp.	124	2.2%	15.1
elm	*Ulmus* spp.	117	2.1%	22.3
walnut	*Juglans* spp.	112	2.0%	18.4
oak, deciduous	*Quercus* spp.	110	1.9%	8.0
all other		1,893	33.4%	8.1
Total		*5,665*	*100.0%*	*9.9*

Figure 2: The 15 most abundant street tree genera in Rose City Park, with maximum (10%) in red



The Bottom Line
Rose City Park does not meet the 5-10-20 guideline. Of most concern is that the *Acer* genus, which has over double the recommended percentage for a single genus. Furthermore, over half of all trees belong to only two families, Rosaceae and Sapindaceae.

Loss of street trees can have significant impact at the neighborhood scale. Increasing diversity at the genus and family level can help reduce risk and expense due to the introduction of Asian longhorned beetle, emerald ash borer, or other potential pests and pathogens which predominately attack only select genera. To illustrate impact from pests, vulnerable tree types are mapped (Appendix D).

Table 3: The 10 most abundant tree families in Rose City Park

Family Scientific Name	Tree Types Included in the Family	# of Trees	% of Total
Rosaceae	apple, cherry, crabapple, hawthorn, medlar, mountain-ash, peach, pear, plum, *Prunus* (other), quince, serviceberry	1,530	26.7%
Sapindaceae	boxelder, golden rain tree, horsechestnut, maple	1,408	24.6%
Cornaceae	dogwood, dove tree, tupelo	478	8.4%
Oleaceae	ash, fringe tree, lilac tree, olive	229	4.0%
Betulaceae	alder, birch, hophornbeam, hornbeam	219	3.8%
Ulmaceae	elm, zelkova	180	3.1%
Fagaceae	beech, chestnut, oak	179	3.1%
Pinaceae	cedar, Douglas-fir, fir, hemlock, pine, spruce	169	3.0%
Leguminosae	black locust, golden chain tree, honey locust, Kentucky coffeetree, mimosa tree, pagoda tree, redbud, yellow wood	149	2.6%
Magnoliaceae	magnolia, tulip poplar	146	2.6%
all other		1,036	18.1%
Total		*5,723*	*100.0%*

Nearly 40% of all trees in Rose City Park are susceptible to emerald ash borer, Asian longhorned beetle, Dutch elm disease, or bronze birch borer.

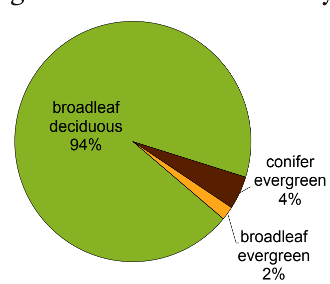
FUNCTIONAL TREE TYPE

Trees are categorized into functional types: broadleaf, conifer, or palm and either deciduous or evergreen. In Portland, where the majority of precipitation falls in winter, evergreens reduce storm water runoff during these wet months, improving water quality in our streams and rivers when this function is most needed. During the dry summer months, many evergreen conifers are less reliant on water availability than broadleaf deciduous trees which require more water to drive photosynthesis. Despite their advantages, conifers are challenging to place in rights-of-way, as they typically require larger spaces and their growth form conflicts with overhead wires and traffic sightlines.

Results

Broadleaf deciduous trees dominate the landscape, accounting for 94% of all street trees in Rose City Park (Figure 3). Coniferous evergreens comprise the next largest portion of Rose City Park's street trees at 4%. Broadleaf evergreen trees comprise just 2% of the total.

Figure 3: Functional tree types



The Bottom Line

The street tree population is dominated by broadleaf deciduous trees. Increasing use of evergreens, both broadleaf and conifer, would enhance certain benefits including reduced storm water runoff, and also provide winter cover and habitat for urban wildlife. Though conifers still need adequate water during establishment, in general they require less water than broadleaf deciduous trees during the increasingly warm and dry Portland summers. Large planting sites without overhead wires provide an opportunity for planting these important trees.

SIZE CLASS DISTRIBUTION

Age diversity ensures the continuity of canopy coverage and benefits through time. Although tree species have different lifespans and mature at different sizes, older trees will generally have a larger size, as measured by diameter at breast height (DBH). As trees increase in size and age, the value of the tree and the magnitude of the benefits that it provides also increase until the tree nears the end of its lifespan and begins to decline.

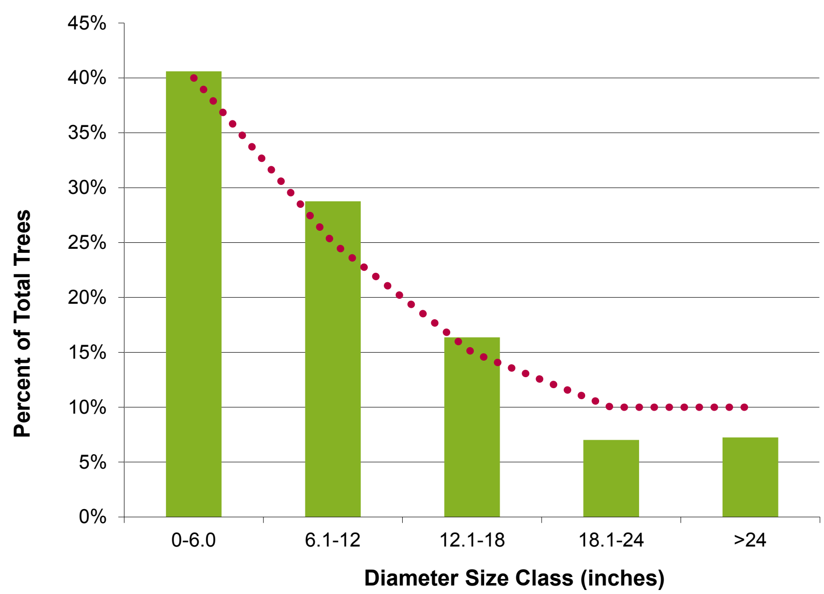
The general management principle underlying size class distribution is to maintain a consistent proportion of young trees in the population—recognizing that there will be some level of mortality as trees grow—while also keeping a good distribution of mid to large sized trees. This will ensure a sustainable age class structure and produce maximum urban forest benefits over time.

Trees were categorized into diameter size classes (Figure 4; Appendices C, E, F). Trees that are 0" to 6.0" in diameter represent young trees. Trees that are 6.1" to 18" in diameter represent midlife trees, as well as mature, small form trees. Trees that are 18.1" or greater in diameter represent mature trees.

Results

Rose City Park's streets host a wide range of tree sizes from the smallest sapling to the largest tree, a 56" DBH elm (*Ulmus* sp.). In Rose City Park, the greatest proportion of trees is in the medium diameter size classes. Small trees account for 40% of the neighborhood inventory with 21.5% percent of all trees that are 3" DBH or less, and 19.1% that are between 3.1" and 6.0". Mid-size trees with DBH between 6.1" and 18.0" represent 45.1% of trees. Only 14.3% are larger than 18.1" DBH (Figure 4).

Figure 4: Trees by diameter size class, with ideal distribution in red



Of tree types that represent at least 0.5% of the population, the types with the largest average size DBH are horse chestnut, silver maple, and elm, with mean DBH of 28.1", 23.9", and 22.3", respectively (Appendix B).

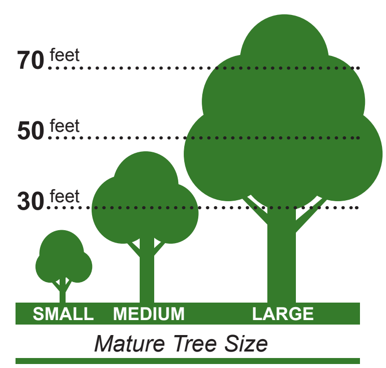
The Bottom Line

Because the greatest proportion of trees in Rose City Park are in the smallest size classes, there is an opportunity to address important establishment and pruning needs and therefore reduce future maintenance costs and increase the life span of Rose City Park's street trees. Proper pruning of young trees can reduce the likelihood of future hazards and liabilities, such as a limb falling, which is not only potentially costly and dangerous, but can also increase the possibility of decay and mortality in a tree. Making the correct pruning decisions when trees are young ensures the least cost and most benefit to homeowners and the community over a tree's lifetime. Currently the size class distribution in Rose City Park is nearly ideal, however lacking in large trees. Ideally, Rose City Park would have a greater proportion of larger trees, and caring for today's young trees is the only way to accomplish that goal.

MATURE TREE FORM DISTRIBUTION

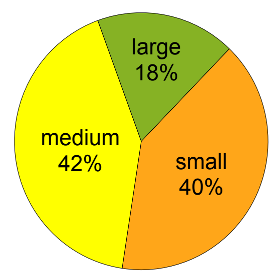
Mature tree size is determined by the height, canopy width, and general form of the tree at maturity; tree types are classified as small, medium, or large. Generally, small trees grow to 30' in height, medium trees grow to 50' in height, and large trees grow over 50' in height (Figure 5). Large form trees also have the potential for greatest longevity, living longer than most small form trees.

Figure 5: Tree form sizes



While some neighborhoods, due to their design, may not have many spaces big enough to accommodate large form trees, it is important that the spaces that do exist are planted with trees that will grow to be large at maturity. The cost to a community of under planting large spaces can be great over the course of a tree's lifetime. Research has shown that while small and large form trees have similar annual costs of care and maintenance, a large form tree will live four times longer on average and provide over 16 times the benefits over its lifetime (CUFR 2006). In the case of certain benefits, the disparity is much greater; for example, large trees have been found to remove 60-70 times more air pollution annually than small trees (Nowak 1994).

Figure 6: Mature tree size



Results

Small form trees account for 40% of the resource, medium form trees account for 42% of the resource, and large form trees account for 18% of the resource (Figure 6) in Rose City Park.

The Bottom Line

Long lived and large form trees provide substantially more benefits than small and medium form trees. Therefore, planting trees that will be large at maturity helps to ensure that canopy cover and its benefits will be maintained or enhanced even as some trees die or are removed. Rose City Park's most common large form tree types include elm, walnut, and deciduous oak. Planting, maintenance, and care for young, large form trees will ensure that when they reach maturity, they will provide the most benefits to the community and the environment.

IMPORTANCE VALUE

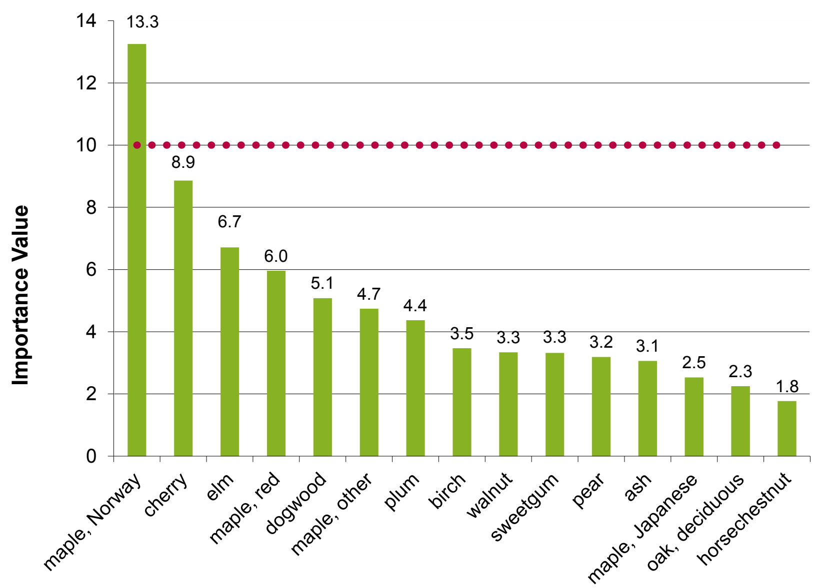
Another way to evaluate how reliant a community is on a single tree type is importance value. Importance value is a calculation based on relative abundance and relative leaf area. In other words, it accounts for how many trees of the type there are and how much of the neighborhood's canopy they represent at the time of inventory. The value informs us which tree types dominate the urban forest structure. For example, a tree type might represent 10% of a population, but have an importance value of 25 because of its large average size. Conversely, another tree type representing 10% of the population may only have an importance value of 5 if it represents young or small form trees.

Importance values tell us which tree types provide the bulk of the benefits for a particular snapshot in time and will change through time as trees grow and species composition changes. Reliance on only a few tree types of high importance value is risky, as loss from a pest, pathogen, or a catastrophic event may put excessive strain on the urban forest even though only a single tree type may be affected.

Importance values were calculated using iTree Streets, an urban forest analysis software suite developed by the USDA Forest Service.

Results
Norway maple has the highest importance value of 13.3 (Figure 7). Thus, the Rose City Park urban forest is reliant on this species due to its current size and abundance. The next highest importance values are for cherry at 8.9, elm at 6.7, and red maple at 6.0. All other tree types had importance values of 5.1 or less.

Figure 7: Tree types with the highest importance values, with recommended maximum (10) in red



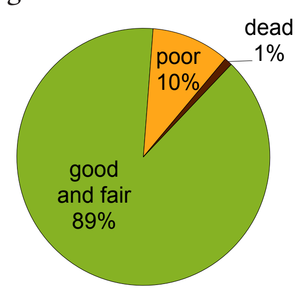
The Bottom Line
Trees with the highest importance values, such as Norway maple and cherry, should be de-emphasized in future plantings to ensure that the street tree population is less susceptible to loss from a pest or pathogen impacting those tree types. Rose City Park's heavy reliance on these tree types in the present means that their loss would have a serious impact on the neighborhood's urban forest. Increasing the level of maintenance of these large, mature trees will help prolong their lifespan, reduce hazards, and keep these high value members of the urban forest contributing to the neighborhood.

Tree Condition

The urban environment is a challenging place for trees to thrive because of limited growing space, compacted soil, poor air quality, and direct damage from vehicles and pedestrians. Tree condition reflects species hardiness, site conditions, and maintenance history. Street trees that are well suited to Portland's climate are able to withstand the challenges of growing in an urban environment, and have been well maintained, are generally the most successful.

Tree condition was assessed by assigning trees to one of four categories: good, fair, poor, or dead. These ratings reflect whether or not a tree is likely to continue contributing to the urban forest (good and fair trees) or whether the tree is at or near the end of its life (poor and dead trees). Because it was subjective for volunteers to determine the difference between good and fair ratings, these categories are reported together.

Figure 8: Tree condition



Results
The majority of street trees in Rose City Park, 89%, are in good or fair condition, while 10% are poor and 1% of trees are dead (Figure 8, Appendix G).

Of the most commonly found tree types, the healthiest trees are sweet gum, deciduous oak, and red maple, of which more than 96% are rated good or fair (Table 4). In poorest condition are hawthorn, of which 38.8% are rated poor. Interestingly, 47.8% of all trees in Rose City Park that are rated poor are in the Rosaceae family and 28.2% are in the *Prunus* genus.

Table 4: Tree condition for the most abundant tree types

Common Name	Scientific Name	% of Total (# of Trees) Good/Fair	Poor
ash	*Fraxinus* spp.	87.3% (158)	12.7% (23)
birch	*Betula* spp.	82.4% (136)	17.6% (29)
cherry	*Prunus* spp.	81.9% (466)	18.1% (103)
dogwood	*Cornus* spp.	92.4% (411)	7.6% (34)
elm	*Ulmus* spp.	88% (103)	12% (14)
hawthorn	*Crataegus* spp.	61.2% (82)	38.8% (52)
maple, Japanese	*Acer palmatum*	94.8% (184)	5.2% (10)
maple, Norway	*Acer platanoides*	94.6% (439)	5.4% (25)
maple, other	*Acer* spp.	89.1% (180)	10.9% (22)
maple, red	*Acer rubrum*	96.7% (326)	3.3% (11)
oak, deciduous	*Quercus* spp.	98.2% (108)	1.8% (2)
pear	*Pyrus* spp.	91.7% (211)	8.3% (19)
plum	*Prunus* spp.	85.8% (333)	14.2% (55)
sweetgum	*Liquidambar* spp.	98.4% (122)	1.6% (2)
walnut	*Juglans* spp.	91.1% (102)	8.9% (10)

Tree size, and thus life stage, did impact tree condition ratings. While the percentage of dead trees is small overall, the greatest percentage of dead trees, 46.6% occurs within the 0" to 3.0" DBH class. The bulk of these young trees likely died due to lack of adequate watering. Young trees need 15 gallons of water each week during Portland's dry summer months for the first two years after planting. Establishment of young trees is critical as it is not until trees attain larger sizes that they provide the greatest benefits.

More than 50% of trees rated as poor are in the midsized classes with a DBH of between 6.1" and 18". In Rose City Park, trees rated as poor in this medium size class correspond with the high proportion of hawthorn, cherry, and plum, which are maturing small form trees reaching the end of their lifespan. While larger, more mature trees naturally decline with age, preventative maintenance including proper pruning (e.g., not topping) can extend their lifespan and reduce their risk of failure.

The Bottom Line

Large trees in poor condition pose the largest potential risk of failure (i.e., falling apart). Proper early maintenance on young trees, such as structural pruning, is much less expensive than attempting to correct issues in larger trees that have been unmaintained or improperly pruned. Important maintenance activities for young trees include structural pruning to remove co-dominant leaders and pruning trees for branch clearance over sidewalks and roadways to reduce the likelihood of branches being hit by vehicles. Though only a small portion of the street trees in Rose City Park are in poor condition, a substantial proportion of trees in the *Prunus* genus are in poor and declining condition. Furthermore, of all trees rated as poor, nearly half are in the Rosaceae family, which is over represented in Rose City Park and therefore replacement of these trees represents a great opportunity to improve Rose City Park's urban forest. All poor rated trees should be monitored and individually evaluated for potential risk and replacement opportunities.

Planting Site Composition and Stocking Level

Planting site composition varies greatly amongst neighborhoods and this directly impacts a neighborhood's capacity for growing large trees that provide the most canopy coverage and benefits. While some neighborhoods are lucky enough to have inherited wide planting sites and mature trees, many areas of Portland struggle to establish tree canopy in small planting sites, which are challenging spaces for trees to grow due to limited soil and growing space. Understanding a neighborhood's composition and distribution of planting sites allows for a more strategic tree planting effort and informs us of potential challenges to tree planting and tree development within the right-of-way.

PLANTING SITES

Street trees grow in a diverse array of planting sites ranging from traditional grassy strips between curbs and sidewalks, to concrete cutouts, and unimproved areas without curbs or sidewalks. Tree growth is limited by site width; wider sites provide more soil to support growth and more space aboveground to reduce conflicts with sidewalks and streets. Overhead high voltage wires limit the height of trees, as trees will be pruned away from wires for safety.

Planting site sizes are categorized as small, medium, or large based on the width of the planting site and presence of overhead wires. These categories reflect the mature tree size that can be supported by the site. In other words, small planting sites can support small trees such as dogwoods and snowbells and large planting sites can support large trees such as oaks and elms. Improved planting sites (i.e., with curbs and sidewalks) generally have a clearly defined width while unimproved sites (i.e., without curbs and sidewalks) do not.

Results

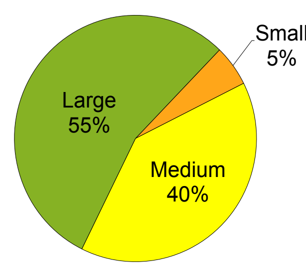
Most street trees in Rose City Park are found in improved rights-of-way, with only 2.2% in unimproved rights-of-way (Table 5, Appendix H). Strips are the most common tree planting site representing 95.2% of site types. Unimproved sites are concentrated at the southern end of the neighborhood with a small cluster east of Rose City Park.

In Rose City Park, 5% of planting sites where street trees are found are small, 40% are medium, and 50% are large sites (Figure 9, Appendix I). Small sites are mixed throughout the neighborhood south of Halsey Street, and are also concentrated in two areas along Fremont Street and the western half of Sandy Boulevard.

Table 5: Planting site types

Site Type		# of Trees	% of Total
improved sites	curbtight	9	0.2%
	cutout	105	1.8%
	median	25	0.4%
	strip	5,451	95.2%
	swale	5	0.1%
	Improved Totals	*5,595*	*97.8%*
unimproved sites	curb only	33	0.6%
	no curb or sidewalk	95	1.7%
	Unimproved Totals	*128*	*2.2%*
Overall		**5,723**	**100.0%**

Figure 9: Planting site sizes



STOCKING LEVEL

Street tree stocking level reflects the percentage of planting spaces that are currently occupied by trees. In Portland, trees are more likely to be planted in large planting sites and improved planting sites. Because this project did not inventory all available planting sites, but only sites where trees are currently growing, data for planting site sizes were supplemented with available planting space data collected by Urban Forestry and the Bureau of Environmental Services (BES) staff between 2009 and 2016 (See Appendix A for methods).

Results

Ideally, stocking level should be near 100%. Rose City Park's stocking level is 75% for improved sites and 24% for unimproved sites (Table 6). According to the BES data, 2,012 empty spaces have been identified for tree planting (Appendices J and K). Higher stocking levels are generally observed in larger planting sites and large, improved planting sites are at least 80% stocked.

Table 6: Street tree stocking level

Size Type	Size Size	Planting Site Description	Stocking Level	Available Planting Spaces
improved sites	small	3.0 - 3.9' with or without wires	35%	315
	medium	4.0 - 5.9' with or without wires, ≥6.0' with wires	76%	731
	large	≥6.0' without wires	80%	709
	uncategorized	mixed	82%	28
	Improved Site Totals		*75%*	*1,783*
unimproved sites	medium	4.0 - 5.9' with or without wires, ≥6.0' with wires	18%	111
	large	≥6.0' without wires	29%	118
	Unimproved Site Totals		*24%*	*229*
Total			**73%**	**2,012**

RIGHT TREE IN THE RIGHT PLACE

Selecting an appropriately sized tree for the site is important for maximizing benefits and minimizing avoidable costs. A tree well suited to its location has fewer obstacles to reaching maturity, which maximizes the benefits it provides the community and environment over its lifetime. However, an inappropriately sized tree may cost more to maintain, be less healthy, and have a shorter lifespan, thereby providing fewer benefits.

A small form tree planted in a large planting site is a missed opportunity because larger trees contribute many times more benefits than do smaller ones. Planting these sites and replacing undersized trees is especially important in neighborhoods that contain few large planting sites to begin with. Although permits and appropriate species selection are required to plant street trees, historically trees may have been planted without regard to appropriate tree selection.

Results

Overall, 33% of trees are planted in sites that are the appropriate size for their type (Table 7). Sixty percent of all trees are too small for their planting site, and 7% of trees are too large for their site. Looking closer at only the large sites, 75.4% of trees are undersized for the site. Large sites represent over half of all sites where trees are found, and yet large form trees comprise only 18% of the population. Conversely, small sites make up only 5% of sites in Rose City Park, but small trees make up 40% of the total population.

Table 7: Tree form fit in planting sites

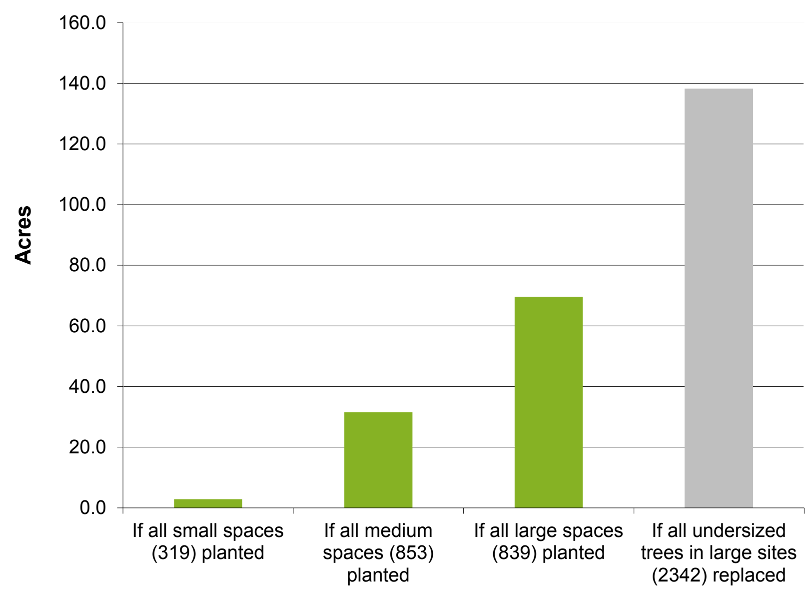
Fit	% of trees	# of trees
Tree form is too small for the site	60%	3,423
Tree form is appropriate size for the site	33%	1,904
Tree form is too big for the site	7%	396
Total	*100%*	*5,723*

The Bottom Line

Planting all available sites with appropriately sized trees will ensure that trees live to maturity at the least cost to homeowners and the community. Because of the importance of large trees to the urban forest, planting large, empty spaces should be a tree team's top priority, followed by replacing poor condition, undersized trees in large planting sites. In Rose City Park, this includes an estimated 839 large sites and 223 poor condition, undersized trees in large planting spaces. Planting only the large, empty spaces would yield 69 acres of potential canopy in 30 years (Appendix A, Figure 10). These benefits are more than nine times greater than if small trees are planted in these large sites.

How would planting all available spaces impact Rose City Park's canopy? Planting all sites would provide 104 additional acres. Furthermore, if all the currently undersized trees in large planting spaces had been planted with large form trees, this would add another 138 acres of potential canopy. Combined, taking these actions would double Rose City Park's canopy cover!

Figure 10: Potential acres of tree canopy from planting



Replacement Value

Replacement value is an estimate of the full cost of replacing a tree at its current size and condition, should it be removed for some reason. Replacement value is calculated using the tree's current size, along with information on regional species ratings, trunk diameter, and replacement costs. Replacement values were calculated using the iTree Streets program. Replacement values are generally highest for the largest, more abundant tree types.

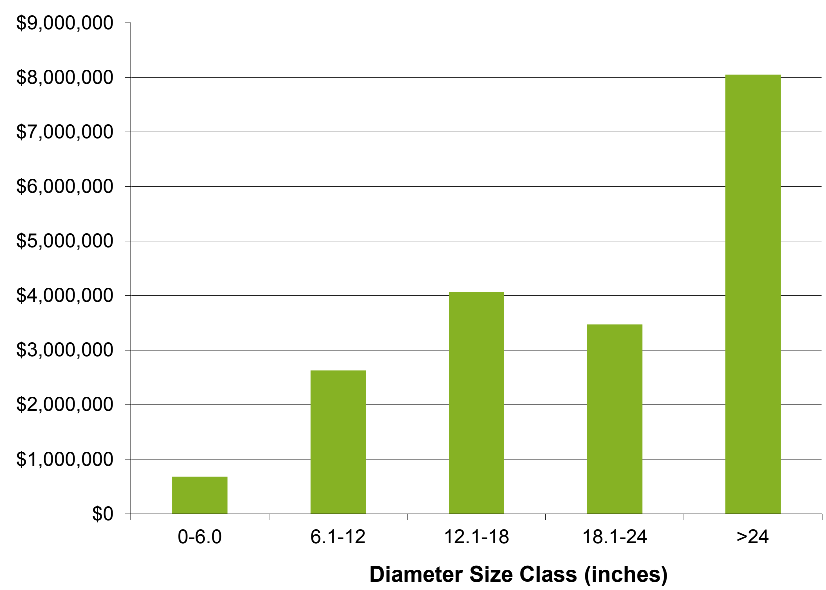
Results

The replacement cost of Rose City Park's street tree population is valued at $18.9 million (Figure 11). The most valuable size class of trees is large trees (>24" DBH). Because value increases with the size of the tree, even though trees that are greater than 24" DBH only make up 7.3% of the population, they account for 42.6% of the total replacement value. The tree types with the greatest replacement values are Norway maple ($2,750,107), cherry ($1,937,468), elm ($1,432,686), red maple ($894,962), and walnut ($868,081). These five tree types account for 41.7% of the total replacement value.

The Bottom Line

Similar to importance value, high replacement values are both a function of the abundance and size of an existing tree type and do not necessarily represent tree types that should be planted in the future. Healthy, diverse, and resilient urban forests have high replacement values as a whole with no one tree type representing a disproportionate amount. In Rose City Park, de-emphasizing tree types that are already over represented in the population will decrease vulnerability to pests and pathogens in the future. The high replacement value for the neighborhood's largest trees shows the need to care for and protect the largest, most valuable trees in the neighborhood.

Figure 11: Replacement values by diameter size class



Environmental and Aesthetic Benefits

The amount of environmental and aesthetic benefit a tree may provide over its lifetime is a function of its mature size and longevity. Trees with a larger mature size and longer lifespan such as Douglas-fir or oak will provide significantly greater benefits than small ornamental trees such as dogwoods or snowbells. The calculation indicates the benefits that trees currently provide: as trees grow and the population changes, benefits derived from the various tree types will change within a neighborhood.

Rose City Park's street tree population was assessed to quantify the dollar value of annual environmental services and aesthetic benefits provided by trees: aesthetic/property value increase, air quality improvement, carbon dioxide reduction, energy savings, and storm water processing. Calculations were made using iTree Streets. The iTree model relies on tree size and species from the inventory, as well as Portland's current pricing for electricity and natural gas, regional benefit prices for air quality, regional storm water interception costs, and the neighborhood's median home resale value (Zillow 2016).

Results

Rose City Park's street trees provide approximately $813,356 annually in environmental services and aesthetic benefits (Table 8). An average tree in Rose City Park provides $142.12 worth of benefits annually.

Table 8: Valuation of annual environmental and aesthetic benefits

Benefits	Total ($)	Total ($) per tree
Aesthetic/Other	$553,799	$96.77
Air Quality	$8,400	$1.47
CO_2	$4,145	$0.72
Energy	$136,633	$23.87
Stormwater	$110,380	$19.29
Total	*$813,356*	*$142.12*

Large form trees produce more benefits on average than smaller trees. Of the most common tree types, elm and walnut provide the highest annual benefits per tree, at approximately $263 - $363 per tree (Table 9). Norway maple, sweetgum, maple other (those not identified to species, see Appendix A), and deciduous oak also provide a high level of

Table 9: Average annual environmental and aesthetic benefits provided by Rose City Park's most abundant street tree types

Tree Type	Aesthetic/ Property Value	Air Quality	CO_2 Reduction	Energy Savings	Stormwater Processing	Total ($) per tree
elm	$191.65	$5.76	$1.62	$83.56	$81.05	$363.65
walnut	$170.46	$3.00	$1.61	$48.43	$39.63	$263.13
maple, Norway	$157.54	$2.79	$1.29	$43.47	$37.23	$242.32
sweetgum	$146.31	$1.84	$1.09	$42.52	$33.01	$224.77
maple, other	$145.71	$2.17	$1.03	$33.98	$28.89	$211.78
oak, deciduous	$149.29	$1.63	$0.72	$26.31	$22.92	$200.86
maple, red	$137.00	$1.72	$0.62	$27.57	$18.72	$185.63
ash	$122.54	$1.45	$0.74	$22.55	$17.39	$164.66
maple, Japanese	$126.41	$0.91	$0.49	$14.62	$11.83	$154.25
birch	$91.37	$1.96	$0.46	$30.89	$25.26	$149.94
dogwood	$82.05	$0.54	$0.30	$12.29	$8.79	$103.96
cherry	$59.34	$1.43	$0.56	$21.83	$15.29	$98.45
pear	$52.72	$1.64	$0.58	$21.36	$16.20	$92.50
plum	$62.80	$0.97	$1.20	$15.01	$7.48	$87.46
hawthorn	$61.06	$0.98	$1.20	$15.15	$7.46	$85.85

annual benefit between $200 and $242. Plum and hawthorn provide the least amount of benefits, ranging from $85 to $87 annually.

The Bottom Line
Large, empty planting spaces in Rose City Park represent not only an opportunity to expand canopy, but also represent thousands of dollars in potential environmental and aesthetic benefits to Rose City Park residents. If Rose City Park planted all 839 of the available large planting spaces with appropriately sized large form trees, in 30 years they will have provided $1,624,472 in net benefits. Conversely, if all available large planting spaces were planted with small form trees, over the same time period they would have only provided $173,170 in net benefits.

Carefully selecting and planting appropriately sized trees directly impacts the amount of benefits provided by the urban forest. Trees that live longer will always produce more benefits to the community—small form trees have a much shorter lifespan than large form trees and may begin to decline after 30 years, just when large form trees are reaching maturity with decades of benefits to the community to come.

The Future Forest of Rose City Park

RECENT PLANTING TRENDS

Different species of trees fall in and out of favor over time due to developments in the nursery industry, tree performance, and personal preferences. Portland's street tree population reflects this history, and by comparing the most recently planted trees to the rest of the population we can infer what that trend may mean for the future. Ideally, new plantings will be diverse and show increases in the planting of those large form species which maximize environmental and aesthetic benefits. Established trees (>3"DBH) are compared to recently planted trees (≤3" DBH) and those with a change of 2.5% or greater were graphed to illustrate recent trends in planting (Figure 12, 13).

Results
Norway maple, cherry, and plum, which make up over a quarter of Rose City Park's established street trees as a whole, have been planted far less often in recent years, which will lead to greater long-term species diversity (Figure 12). The steep decline of Norway maple (-8.4%) is likely due to the listing of the species on the City's nuisance plant list, which means it is no longer permitted for right-of-way planting.

Of tree types that have increased in number, deciduous oak is seeing the largest increase, with a change of +3%. Apple and ginkgo have also increased, with changes of +2.8% and +2.7%, respectively. Even with increased plantings of each, all three tree types are still well below the recommended 5% threshold for a single species (Table 2, Figure 13). In order to diversify Rose City Park's urban forest, increased planting of additional species, especially large form trees, with low representation within the population is needed.

Figure 12: Planting trend: Tree types planted less frequently

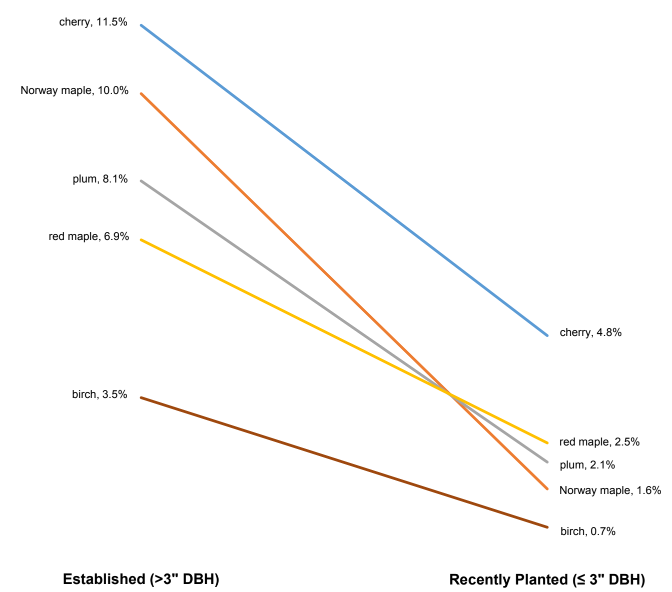
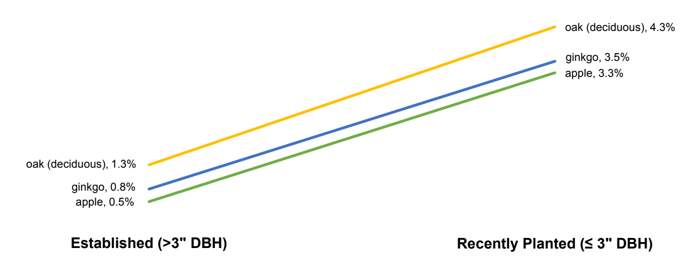


Figure 13: Planting trend: Tree types planted more frequently



The Bottom Line
The decrease of Norway maple, red maple, cherry, and plum in recent plantings is a positive trend as the *Acer* and *Prunus* genera and Sapindaceae and Rosaceae families are over represented in Rose City Park. However, cherry, a small form, short lived tree, is still exceeding deciduous oaks in recent plantings, despite the downward trend of planting cherries.

Trees planted more frequently in recent years include only two tree types that are new to the neighborhood. Ginkgo and apple are non-existent or very uncommon in the established tree population. The upward trend of apple is unfortunate, as it belongs to the Rosaceae family and is a small form tree. However, ginkgo and deciduous oak are large form trees and will help increase urban diversity.

TREE COMPOSITION WITHIN LARGE, MEDIUM, AND SMALL PLANTING SITES

Ideally, the mature form of a tree should match the size of its planting site. Appropriately-sized trees maximize benefits to the community while minimizing costly infrastructure conflicts. Table 7 provides an overall picture of undersized trees in Rose City Park, however a closer look at where the most recently planted trees have been planted can show whether trends in planting are moving in the right direction. The mature form of recently planted trees (≤ 3” DBH) found in large, medium, and small planting sites was compared to established trees (> 3”DBH).

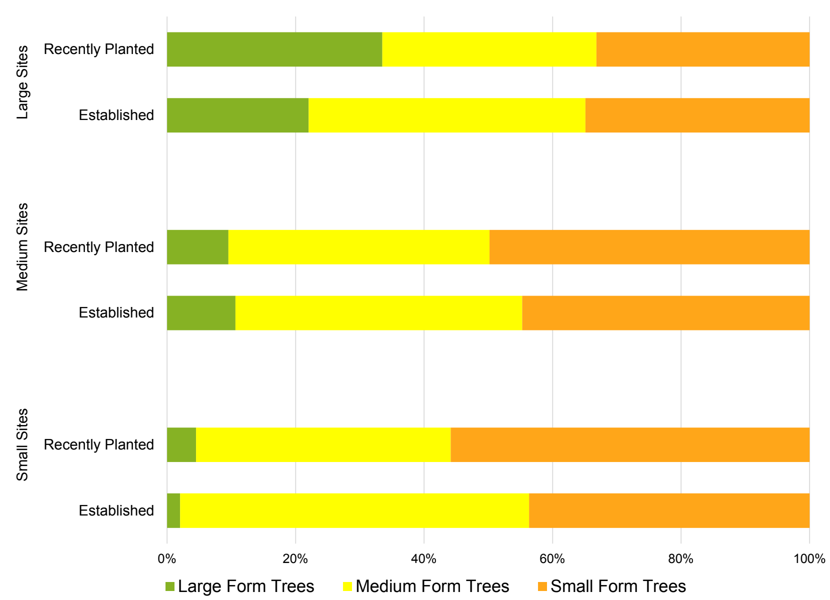
Results

The proportion of large trees being planted in large sites is increasing in Rose City Park but still represents only one third of recently planted trees in large sites (Figure 14). The planting of medium form trees has decreased in all sites. Small form trees make up an increasing proportion of recently planted trees in both small and medium sites, while being planted slightly less often in large sites.

The Bottom Line

Small form trees are over represented in Rose City Park’s rights-of-way, and recent plantings continue this trend. Findings show that small form trees are increasingly planted in small and medium sites, with half of all recently planted medium sites being planted with small trees. Additionally, two thirds of recently planted large sites have been planted with small and medium form trees, representing a missed opportunity for these sites. Continued efforts to plant appropriately sized trees in Rose City Park’s rights-of-way will ensure that tree canopy and its benefits are maximized in the neighborhood for the long-term.

Figure 14: Planting Trend: Mature tree form size shifts



*Planting more appropriately sized trees in Rose City Park's rights-of-way, like these large form tulip poplars (*Liriodendron tulipifera*) growing in a wide strip, will ensure that canopy benefits are maximized in the neighborhood.*

Volunteers identify trees and collect data during the August 13 street tree inventory workday in Rose City Park.

Recommendations

Based on street tree inventory data presented in this report, Urban Forestry staff make the following recommendations for the Rose City Park neighborhood.

PLANTING FOR DIVERSITY AND SIZE

- Reduce dependence on trees in the Roseaceae and Sapindaceae families, and specifically trees in the *Acer* and *Prunus* genera by planting a diverse array of species, genera, and families. A more diverse urban forest will be more resilient to pests, pathogens, and changing climate conditions. Select species from Urban Forestry's Approved Street Tree Lists (www.portlandoregon.gov/trees/plantinglists).

- Prioritize planting opportunities to plant large, high-performing trees that will provide high levels of benefits over their lifetime. These trees would be best planted in the estimated 839 large planting sites (>6' wide without overhead wires) that have been identified for planting (Appendix K).

- Plant trees in all available planting spaces but plant in the smallest spaces last. Trees in small planting spaces provide fewer benefits and are more likely to cause sidewalk and clearance problems in a shorter time frame than if they were planted in larger spaces. However, all plantings help contribute to a neighborhood "tree ethic" and encourage others to plant and maintain street trees. Rose City Park's street tree stocking level is 73% and 2,012 spaces have been identified for planting street trees (Appendix J).

- Take advantage of existing planting programs, such as low-cost trees available through Friends of Trees. These plantings are currently subsidized by the City.

YOUNG TREE ESTABLISHMENT AND MAINTENANCE

- Properly water and establish young trees. With 21.5% of trees being 3" DBH or less, special attention should be paid to this vulnerable population (Appendix E). Small trees represent the future generation of street trees, and early care and training will pay off in future benefits.

- Structurally prune young trees to promote proper form as street trees. This includes removing low limbs for pedestrian and traffic clearance and removing co-dominant leaders. Structural pruning is critical in the first ten years after planting and can prevent future problems and expense. The 40.6% of trees that are 6" DBH or less should be evaluated for structural pruning needs.

- Educate property owners on how to properly care for young street trees (branch and root pruning, watering, and mulching) in order to reduce and delay future problems and conflicts with infrastructure.

*Planting trees like this rare Kentucky coffeetree (*Gymnocladus dioicus*) improves the diversity of the urban forest.*

MATURE TREE PROTECTION AND ADVOCACY

- Maintain and care for large, mature trees. Only 14.3% of trees in Rose City Park are larger than 18" diameter. Trees provide the most benefits as they reach maturity and tree care is also the most expensive for these large trees. Increasing the level of maintenance of large, mature trees will help prolong their lifespan, reduce hazards, and keep these high-value members of the urban forest contributing to the neighborhood.

- Seek funding or assistance for low income property owners to care for their mature trees.

- Retain existing large trees that are in fair and good condition. Benefits are lost when older trees are removed and replaced with smaller and younger tree species, due to the time it takes for young trees to mature.

- Encourage planning for larger trees as redevelopment takes place in the neighborhood. Wider planting sites and cutouts (>6') will result in larger, healthier, longer-lived trees that provide many times more benefits to the community than smaller trees.

- Promote the importance and benefits of large form species and mature trees within the community.

*This mature false cypress (*Chamaecyparis *sp.) provides canopy benefits year-round.*

REPLACEMENTS - RIGHT TREE, RIGHT PLACE

- Encourage removal and replacement of dead trees and assessment of trees in poor condition. Eleven percent of Rose City Park's trees are dead (58 trees) or in poor condition (571 trees) (Appendix G). Further assessment of trees for hazards by a certified arborist can help with prioritization for replacement.

- Encourage replacement of underperforming species, including undersized trees in large rights-of-way, with higher functioning, appropriately sized trees. In large planting sites, 2,342 trees have been identified as being too small for their respective site, 223 of which are in poor condition. Furthermore, 47.8% of trees rated as poor are in the Rosaceae family. Given that this family is already over represented in the street tree population, these trees should be evaluated on an individual basis for replacement.

*Large trees will grow healthier and larger when planted in the right space, unlike this topped tulip poplar (*Liriodendron tulipifera*) growing under high voltage wires.*

Next Steps: Tree Plans and Tree Teams

The experience of participating in a street tree inventory and the findings in this report will help empower the neighborhood to make informed decisions regarding the management and stewardship of the local urban forest. Street trees are a critical component of a community and the 5,723 street trees and 2,012 available planting spaces detailed in this report are a good starting point for the neighborhood Tree Team to begin improving and expanding the urban forest.

NEIGHBORHOOD TREE TEAMS

Volunteers who have participated in the Tree Inventory Project are encouraged to form or join a neighborhood Tree Team. A neighborhood Tree Team is a group of volunteers who are interested in addressing the needs of a neighborhood's urban forest through activities such as the inventory, education and advocacy, and year-round stewardship events.

TREE PLANS

Urban Forestry knows that local Tree Teams are the best stewards of their urban forest. Having completed the inventory, they can now use these findings to create a Tree Plan—a customized stewardship plan created and executed by neighborhood Tree Teams for their urban forest.

Tree Plans will include a vision statement, goals, objectives, and recommendations for property owners. Using inventory data, Tree Teams can identify the specific needs of their neighborhood's urban forest and create goals that target these needs.

Once a Tree Plan is established, tree teams can take action toward improving their neighborhood's urban forest, with special access to Urban Forestry's staff and resources.

WORKSHOPS

In the year following the inventory, Urban Forestry will support two stewardship events for each neighborhood that completes a street tree inventory, with staff dedicated to assist tree teams in coordinating the events.

Neighborhoods may host a variety of events, including:

- Tree planting in community spaces
- Tree pruning, with a focus on structural pruning for young trees
- Young tree care
- Educational tree tours and lessons on topics such as species selection for diversity, invasive species recognition and removal, heritage trees, and addressing pests and pathogens
- Programs customized for the neighborhood based upon inventory findings

Young street trees benefit greatly from structural pruning in the first ten years after planting.

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Appendix A: Methods

Street trees are defined in this project as woody plants in the public right-of-way with a single or few trunks and a minimum mature size of 15’. In the summer of 2016, street trees adjacent to every tax lot within the neighborhood boundaries were inventoried by trained volunteers and Urban Forestry staff.

DATA COLLECTED

Data collected included: tree type identified to species or genus, tree condition, location, size (diameter at breast height), planting site width, planting site type, and presence of overhead high voltage lines.

Tree type: Trees were identified to the genus or species. Six maples were identified to the species level: bigleaf (*Acer macrophyllum*), Japanese (*A. palmatum*), Norway (*A. platanoides*), paperbark (*A. griseum*), red (*A. rubrum*) and silver (*A. saccharinum*) maples. All other maple species were identified as “maple, other.” All dead trees were listed as “unknown” tree type, as identification of these plants was uncertain.

Tree condition: Trees were rated as good, fair, poor, or dead. These general ratings reflect whether or not a tree is likely to continue contributing to the urban forest (good and fair trees) or whether the tree is at or near the end of its life (poor and dead trees). The following guidelines were used:

> Good: The tree has strong structure and is healthy and vigorous with no apparent problems. Trunks are solid with no bark damage and the crown is full. Roots show no signs of heaving or visible crossing, and there are no major wounds, decay, conks, or cavities.
>
> Fair: The tree is in average condition. Structural problems may be present, including results of pruning for high voltage electrical lines. Tree may have dead branches and some canopy loss. Wounds are minimal and there is no major decay.
>
> Poor: The tree is in a general state of decline as indicated by major wounds, root heaving, dead limbs resulting in major canopy loss, and/or visible signs of decay indicated by major rot or fungal growth.
>
> Dead: The tree is dead with no live leaves. Dead trees were excluded from data analysis, with the exception of tree condition statistics and total number of trees inventoried.

Tree size: Diameter at breast height (4.5’ above ground) was measured with a diameter tape. Measurements of trees with branches, forks, or swelling at 4.5’ were taken lower on the tree so a representative size was obtained. Trees with three or fewer multiple stems were measured individually and Urban Forestry staff made final diameter calculations using the formula $\sqrt{(x^2+y^2+z^2)}$. Trees with greater than three multiple stems were measured below branching.

Planting site type: Planting site types were placed into one of the following categories.

> Improved sites:
> Curbtight: The curb and sidewalk are continuous, and tree is planted adjacent to tax lot.
> Cutout: The site is a concrete cutout, also called a tree pit or tree well.
> Median: The site is in the middle of the street separated by a curb.
> Planting strip: The tree is a planting strip between a curb and a sidewalk.
> Swale: The tree is in the middle of a bioswale designed for storm water capture.

Unimproved sites:
Curb only: The site has a curb but no sidewalk.
No curb or sidewalk: The site has no curb or sidewalk.
Other: Sites not falling under above scenarios.

Planting site width: Planting site width was measured for all improved site types except curbtight areas. Planting strips were measured from the inside of the curb to the beginning of the sidewalk and cutouts, medians, and swales were measured from inside edge to inside edge perpendicular to the street. No widths were taken for unimproved planting site types or curbtight areas.

High voltage wires: The presence of high voltage wires above the planting space was recorded.

Stocking level: Planting space size and availability is subject to a number of guidelines, including width of the planting site, presence/absence of high voltage power lines, and distance from conflicts (property lines, stop signs, and underground utilities). Because this project did not inventory all available planting sites, but only sites where trees are currently growing, data for planting site sizes were supplemented with available planting space data collected by Urban Forestry and the Bureau of Environmental Services between 2009 and 2016. These data were compared with existing tree data collected at the same time and used to calculate stocking level. Some industrial, commercial, and multi-family residential areas may have been excluded in the analysis, making this a conservative estimate of available sites.

DATA COLLECTION METHODS

Volunteer neighborhood coordinators recruited volunteers to conduct street tree inventories during work days. Volunteers interested in being inventory team leaders attended a half-day training to learn to identify tree species and site conditions, and how to collect and record data.

During work days, team leaders were paired with novice volunteers to collect data in a three to four block area. Groups were given a clipboard containing a map, data entry sheets, tree type abbreviations, and a list of trees planted by Friends of Trees in the neighborhood. Volunteers wore safety vests and carried a 2-sided diameter/measuring tape for measuring tree size and site width, a tree identification book, and bags for collecting samples.

In addition to Urban Forestry staff, one or more volunteer arborists-on-call were available on inventory work days to assist volunteers with questions. Accuracy was stressed as highly important, and volunteers utilized the arborist-on-call to verify species identification as questions arose. Data were collected on paper maps and forms, and later digitized in ArcGIS by Urban Forestry staff and trained volunteers.

Accuracy of volunteer-collected data was checked by Urban Forestry staff and corrections were made as necessary. Remaining areas not completed during inventory work days were inventoried by volunteer team leaders or staff. A 10% sample of the final data found species identifications to be more than 95% accurate.

CALCULATION OF BENEFITS AND CANOPY PROJECTION

Projected benefits were calculated using 30-year estimates of average annual net benefits provided in the Western Washington and Oregon Community Tree Care Guide (McPherson et al. 2002). Projected canopy cover estimates assume the mature spread of small, medium, and large trees to 20'x 20', 40' x 40', and 60' x 60', respectively. In some cases the data for available planting spaces from the Bureau of Environmental Services (BES) included planting sites that were not categorized by size. Therefore, for the purposes of calculating projected benefits, these spaces were assumed to have a similar proportion of small, medium, and large sites, as were categorized by BES in the neighborhood.

Appendix B: Street trees of Rose City Park by tree type

Common Name	Scientific Name	Family	# of Trees	% of Total	Mean DBH
alder	*Alnus* spp.	Betulaceae	2	0.0%	6.4
apple	*Malus domestica*	Rosaceae	63	1.1%	3.4
ash	*Fraxinus* spp.	Oleaceae	181	3.2%	9.8
bay laurel	*Laurus nobilis*	Lauraceae	1	0.0%	3.2
beech	*Fagus* spp.	Fagaceae	45	0.8%	4.6
birch	*Betula* spp.	Betulaceae	165	2.9%	14.6
black locust	*Robinia pseudoacacia*	Leguminosae	17	0.3%	19.0
boxelder	*Acer negundo*	Sapindaceae	27	0.5%	11.8
cascara	*Rhamnus purshiana*	Rhamnaceae	12	0.2%	1.0
catalpa	*Catalpa* spp.	Bignoniaceae	28	0.5%	13.2
cedar	*Cedrus* spp.	Pinaceae	28	0.5%	18.9
chaste tree	*Vitex* spp.	Lamiaceae	1	0.0%	5.2
cherry	*Prunus* spp.	Rosaceae	569	9.9%	10.9
chestnut	*Castanea* spp.	Fagaceae	6	0.1%	33.9
chitalpa	*x Chitalpa tashkentensis*	Bignoniaceae	1	0.0%	1.0
citrus	*Citrus* spp.	Rutaceae	1	0.0%	5.0
corktree	*Phellodendron* spp.	Rutaceae	1	0.0%	1.1
crabapple	*Malus* spp.	Rosaceae	103	1.8%	6.0
crape myrtle	*Lagerstroemia indica*	Lythraceae	39	0.7%	3.8
cryptomeria	*Cryptomeria* spp.	Taxodiaceae	3	0.1%	4.9
cypress	*Cupressus* spp.	Cupressaceae	25	0.4%	3.0
dawn redwood	*Metasequoia glyptostroboides*	Taxodiaceae	7	0.1%	4.8
dogwood	*Cornus* spp.	Cornaceae	445	7.8%	6.2
Douglas-fir	*Pseudotsuga menziesii*	Pinaceae	34	0.6%	18.4
dove tree	*Davidia involucrata*	Cornaceae	2	0.0%	1.7
elm	*Ulmus* spp.	Ulmaceae	117	2.0%	22.3
eucalyptus	*Eucalyptus* spp.	Myrtoideae	11	0.2%	8.6
false cypress	*Chamaecyparis* spp.	Cupressaceae	32	0.6%	12.0
fig	*Ficus* spp.	Moraceae	30	0.5%	4.4
fir	*Abies* spp.	Pinaceae	4	0.1%	3.5
fringe tree	*Chionanthus* spp.	Oleaceae	11	0.2%	1.7
giant sequoia	*Sequoiadendron giganteum*	Taxodiaceae	3	0.1%	37.1
ginkgo	*Ginkgo biloba*	Ginkgoaceae	78	1.4%	4.2
glorybower	*Clerodendrum* spp.	Verbenaceae	64	1.1%	5.1
golden chain tree	*Laburnum* spp.	Leguminosae	12	0.2%	5.0
golden rain tree	*Koelreuteria paniculata*	Sapindaceae	19	0.3%	7.4
hackberry	*Celtis occidentalis*	Cannabaceae	2	0.0%	6.2
hawthorn	*Crataegus* spp.	Rosaceae	134	2.3%	10.0
hemlock	*Tsuga* spp.	Pinaceae	4	0.1%	12.1
holly	*Ilex* spp.	Aquifoliaceae	4	0.1%	8.8

Common Name	Scientific Name	Family	# of Trees	% of Total	Mean DBH
honey locust	*Gleditsia triacanthos*	Leguminosae	19	0.3%	5.4
hophornbeam	*Ostrya* spp.	Betulaceae	3	0.1%	1.2
hornbeam	*Carpinus* spp.	Betulaceae	49	0.9%	4.6
horsechestnut	*Aesculus* spp.	Sapindaceae	36	0.6%	28.1
incense cedar	*Calocedrus decurrens*	Cupressaceae	4	0.1%	7.2
jujube	*Ziziphus jujuba*	Rhamnaceae	2	0.0%	1.3
juniper	*Juniperus* spp.	Cupressaceae	1	0.0%	7.3
katsura	*Cercidiphyllum japonicum*	Cercidiphyllaceae	69	1.2%	8.0
Kentucky coffeetree	*Gymnocladus dioica*	Leguminosae	5	0.1%	2.6
lilac tree	*Syringa reticulata*	Oleaceae	28	0.5%	2.9
linden	*Tilia* spp.	Malvaceae	67	1.2%	11.4
madrone	*Arbutus menziesii*	Ericaceae	2	0.0%	0.0
magnolia, deciduous	*Magnolia* spp.	Magnoliaceae	49	0.9%	5.5
magnolia, evergreen	*Magnolia* spp.	Magnoliaceae	51	0.9%	3.7
maple, bigleaf	*Acer macrophyllum*	Sapindaceae	28	0.5%	10.7
maple, Japanese	*Acer palmatum*	Sapindaceae	194	3.4%	6.0
maple, Norway	*Acer platanoides*	Sapindaceae	464	8.1%	14.4
maple, other	*Acer* spp.	Sapindaceae	202	3.5%	11.5
maple, paperbark	*Acer griseum*	Sapindaceae	75	1.3%	4.0
maple, red	*Acer rubrum*	Sapindaceae	337	5.9%	9.2
maple, silver	*Acer saccharinum*	Sapindaceae	26	0.5%	23.9
medlar	*Mespilus* spp.	Rosaceae	1	0.0%	1.2
mimosa tree	*Albizia julibrissin*	Leguminosae	9	0.2%	14.6
mountain-ash	*Sorbus* spp.	Rosaceae	15	0.3%	12.5
mulberry	*Morus* spp.	Moraceae	1	0.0%	18.2
myrtlewood	*Umbellularia californica*	Lauraceae	5	0.1%	12.4
oak, deciduous	*Quercus* spp.	Fagaceae	110	1.9%	8.0
oak, evergreen	*Quercus* spp.	Fagaceae	18	0.3%	4.8
oleaster	*Elaeagnus* spp.	Elaeagnaceae	1	0.0%	7.4
olive	*Olea* spp.	Oleaceae	9	0.2%	2.7
pagoda tree	*Sophora japonica*	Leguminosae	3	0.1%	14.4
palm	*Trachycarpus* spp.	Arecaceae	3	0.1%	7.9
paw paw	*Asimina triloba*	Annonaceae	2	0.0%	2.2
peach	*Prunus persica*	Rosaceae	4	0.1%	3.2
pear	*Pyrus* spp.	Rosaceae	230	4.0%	8.5
Persian ironwood	*Parrotia persica*	Hamamelidaceae	45	0.8%	3.4
persimmon	*Diospyros* spp.	Ebenaceae	7	0.1%	3.4
pine	*Pinus* spp.	Pinaceae	85	1.5%	11.6
planetree	*Platanus* spp.	Platanaceae	26	0.5%	17.6
plum	*Prunus* spp.	Rosaceae	388	6.8%	9.9
poplar	*Populus* spp.	Salicaceae	14	0.2%	8.5
Prunus, other	*Prunus* spp.	Rosaceae	13	0.2%	11.5

Common Name	Scientific Name	Family	# of Trees	% of Total	Mean DBH
quince	*Cydonia oblonga*	Rosaceae	3	0.1%	5.4
redbud	*Cercis* spp.	Leguminosae	76	1.3%	5.7
rose of Sharon	*Hibiscus syriacus*	Malvaceae	1	0.0%	1.3
sassafras	*Sassafras albidum*	Lauraceae	2	0.0%	1.7
serviceberry	*Amelanchier* spp.	Rosaceae	7	0.1%	2.9
seven son flower	*Heptacodium miconioides*	Caprifoliaceae	1	0.0%	4.0
silverbell	*Halesia* spp.	Styracaceae	1	0.0%	11.0
smoketree	*Cotinus* spp.	Anacardiaceae	15	0.3%	3.1
snowbell	*Styrax* spp.	Styracaceae	45	0.8%	3.1
sourwood	*Oxydendrum arboreum*	Ericaceae	8	0.1%	2.6
spruce	*Picea* spp.	Pinaceae	14	0.2%	13.3
stewartia	*Stewartia pseudocamellia*	Theaceae	18	0.3%	1.9
strawberry tree	*Arbutus* spp.	Ericaceae	1	0.0%	5.6
sumac	*Rhus* spp.	Anacardiaceae	1	0.0%	2.8
sweetgum	*Liquidambar* spp.	Altingiaceae	124	2.2%	15.1
tree-of-heaven	*Ailanthus altissima*	Simaroubaceae	29	0.5%	12.8
tulip poplar	*Liriodendron tulipifera*	Magnoliaceae	46	0.8%	16.8
tupelo	*Nyssa* spp.	Cornaceae	31	0.5%	2.0
unknown (dead)	*unknown*	unknown	58	1.0%	6.4
viburnum	*Viburnum* spp.	Adoxaceae	1	0.0%	1.0
walnut	*Juglans* spp.	Juglandaceae	112	2.0%	18.4
Western redcedar	*Thuja plicata*	Cupressaceae	17	0.3%	10.6
willow	*Salix* spp.	Salicaceae	10	0.2%	8.7
yellow wood	*Cladrastis kentukea*	Leguminosae	8	0.1%	6.8
zelkova	*Zelkova serrata*	Ulmaceae	63	1.1%	7.2
Total			*5,723*	*100.0%*	*9.9*

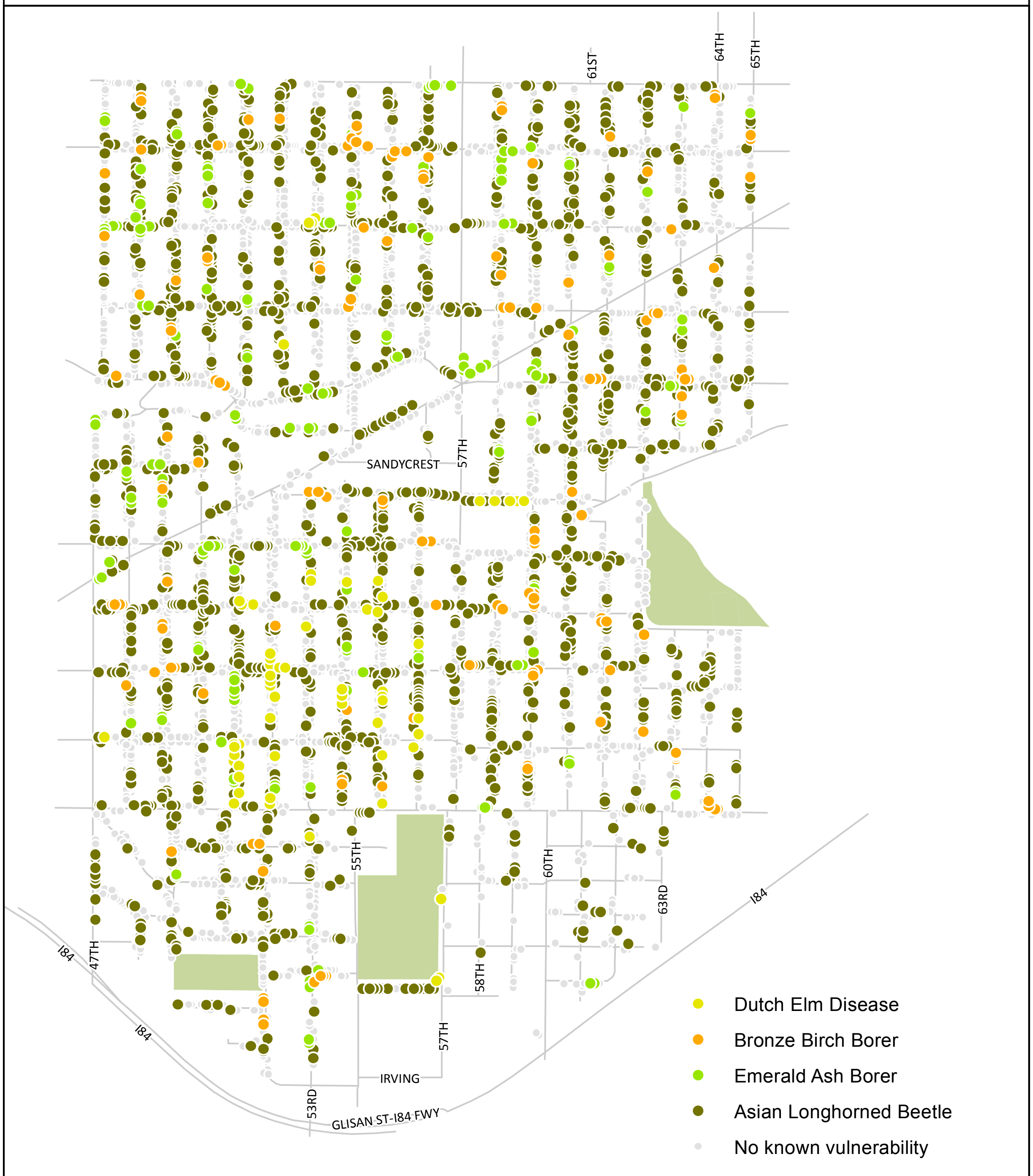
Volunteers identify trees and collect data during the July 9 and August 27 tree inventory workdays in Rose City Park.

Appendix C: Street trees of Rose City Park by size

Appendix D: Vulnerability to key pests

Rose City Park Street Tree Inventory 2016

Vulnerability to key pests



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http://portlandoregon.gov/parks/treeinventory

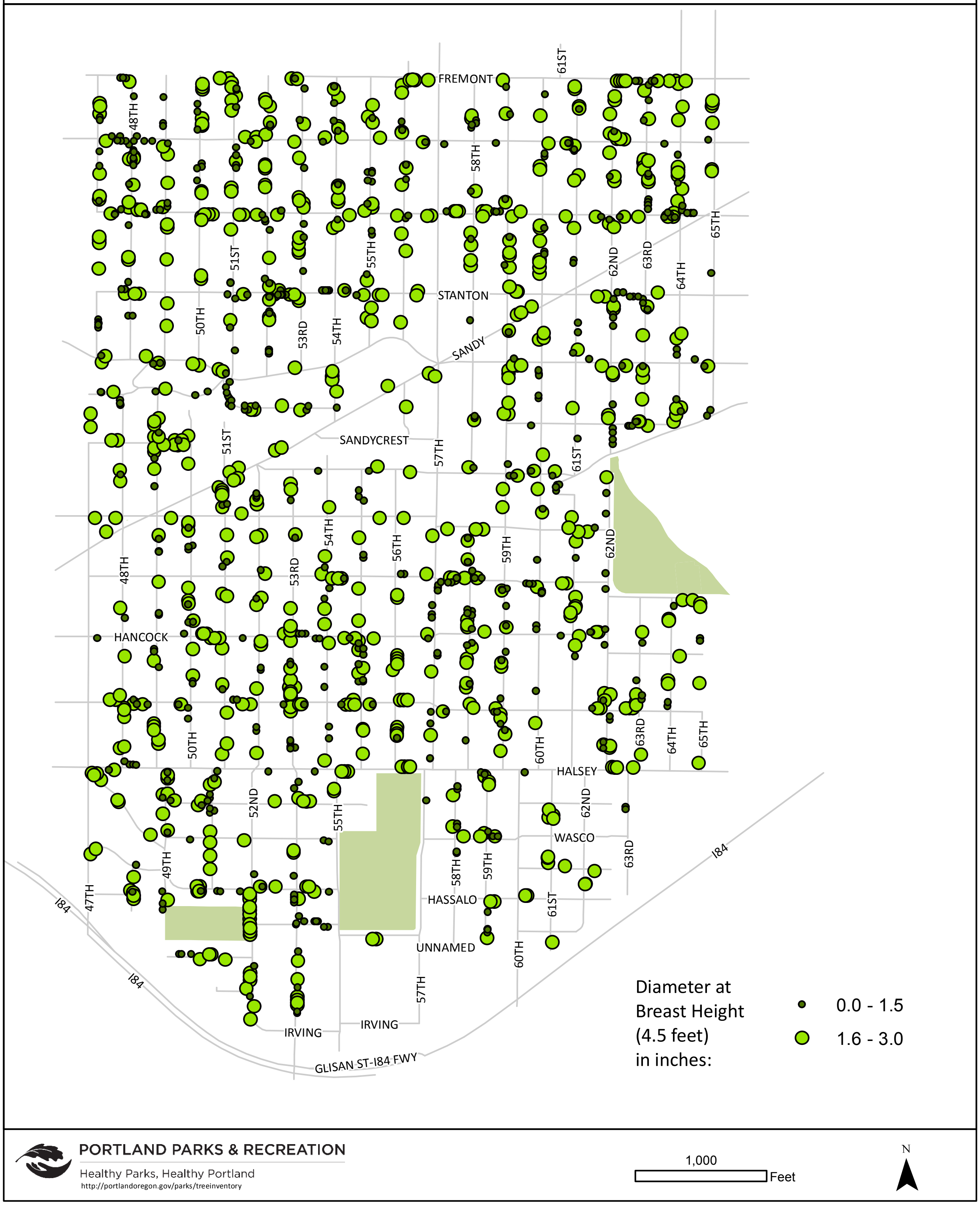
1,000 Feet

N

Appendix E: Young street trees (trees ≤ 3” DBH)

Rose City Park Street Tree Inventory 2016

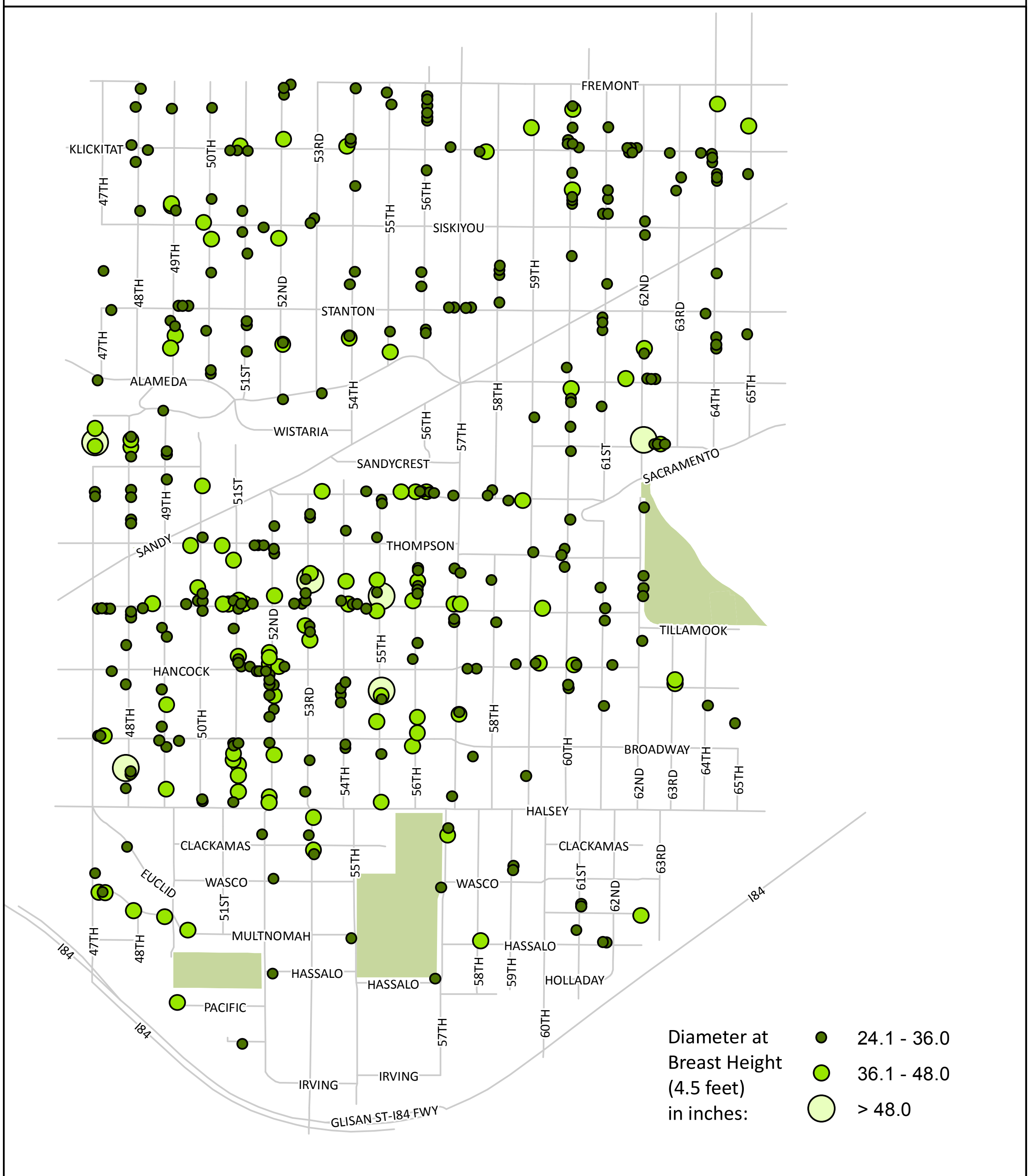
Young street trees (trees ≤ 3” DBH)



Appendix F: Large street trees (trees > 24” DBH)

Rose City Park Street Tree Inventory 2016

Large street trees (trees > 24" DBH)



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1,000 Feet

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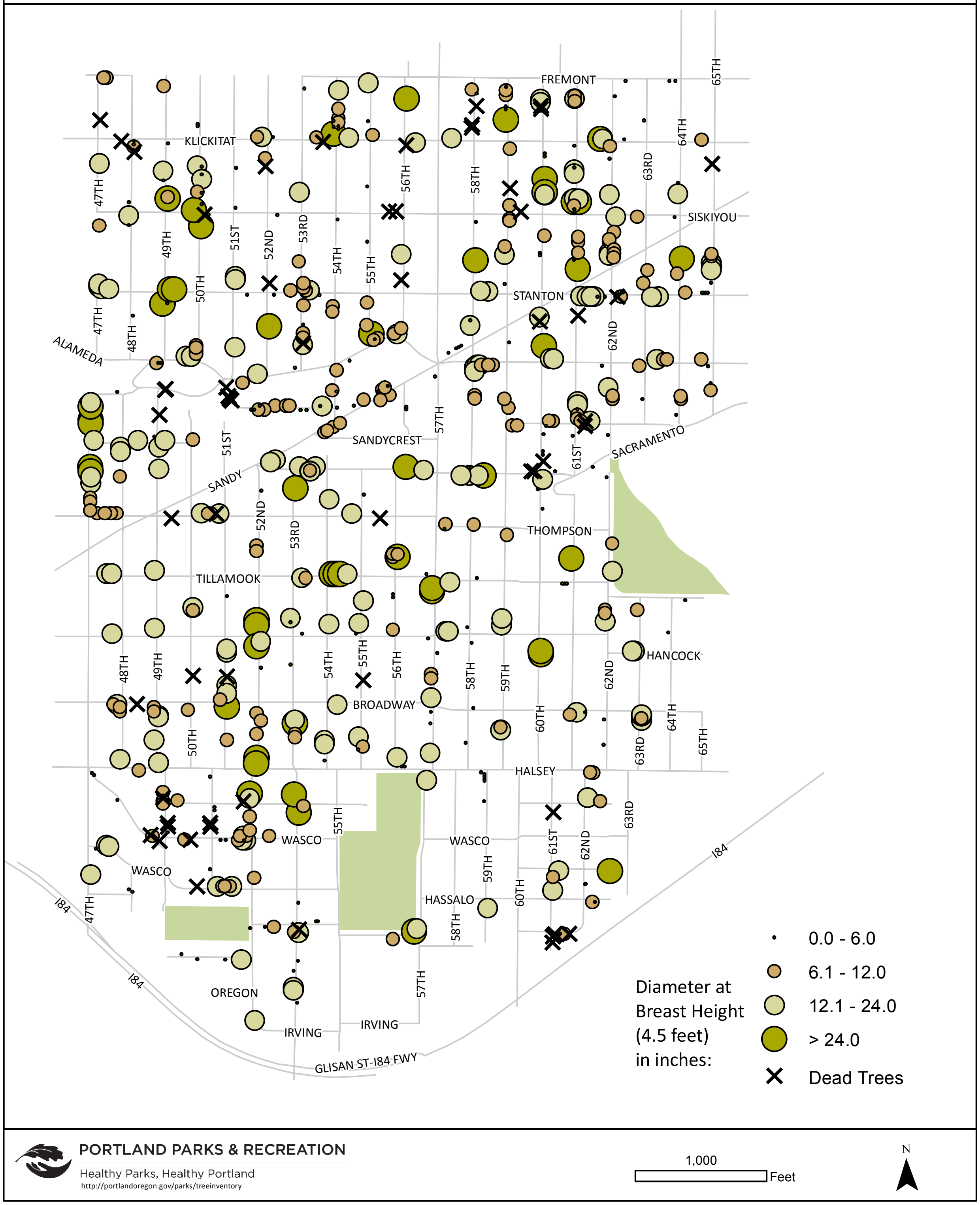
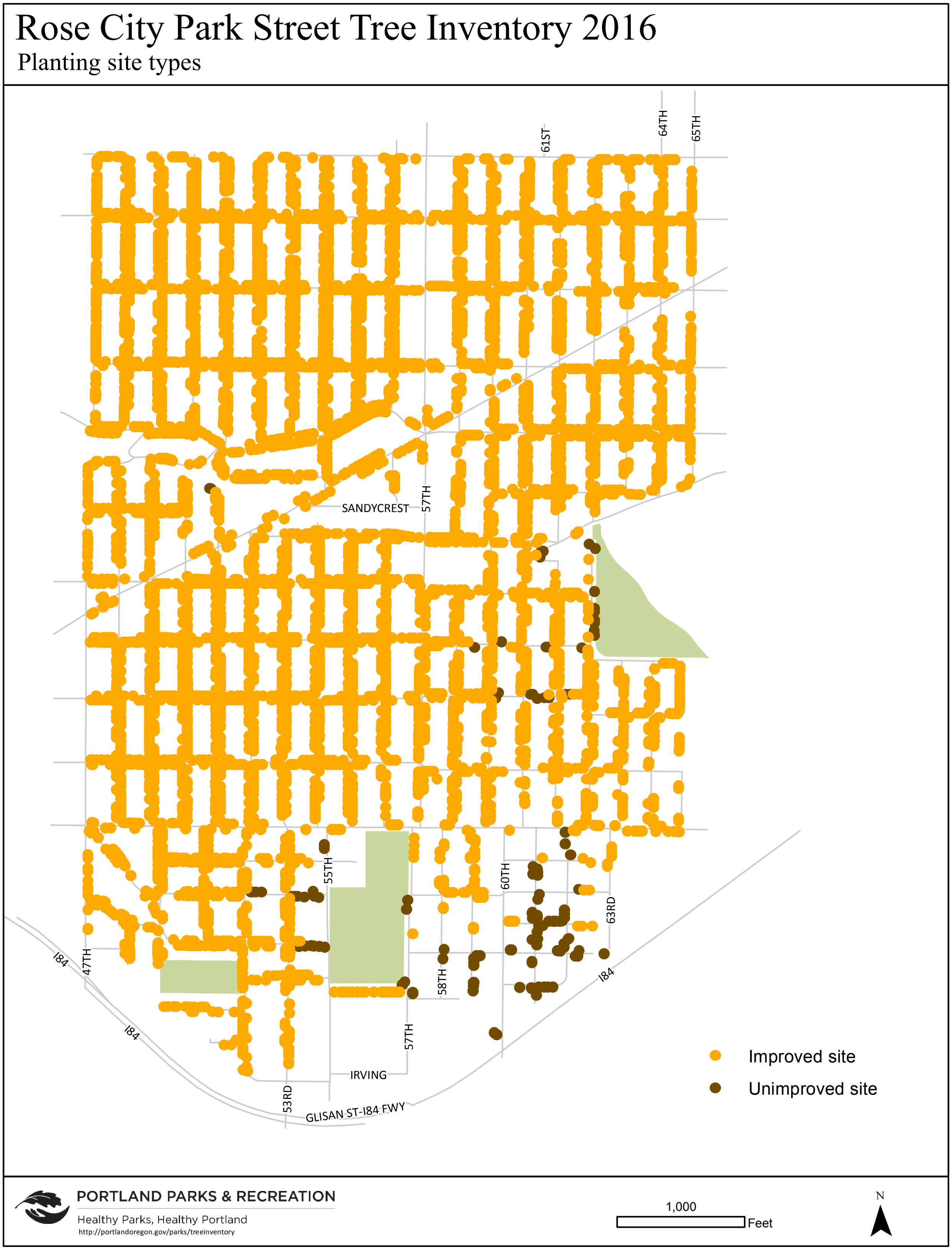
Appendix G: Poor and dead street trees

Rose City Park Street Tree Inventory 2016

Poor and dead street trees



Appendix H: Planting site types

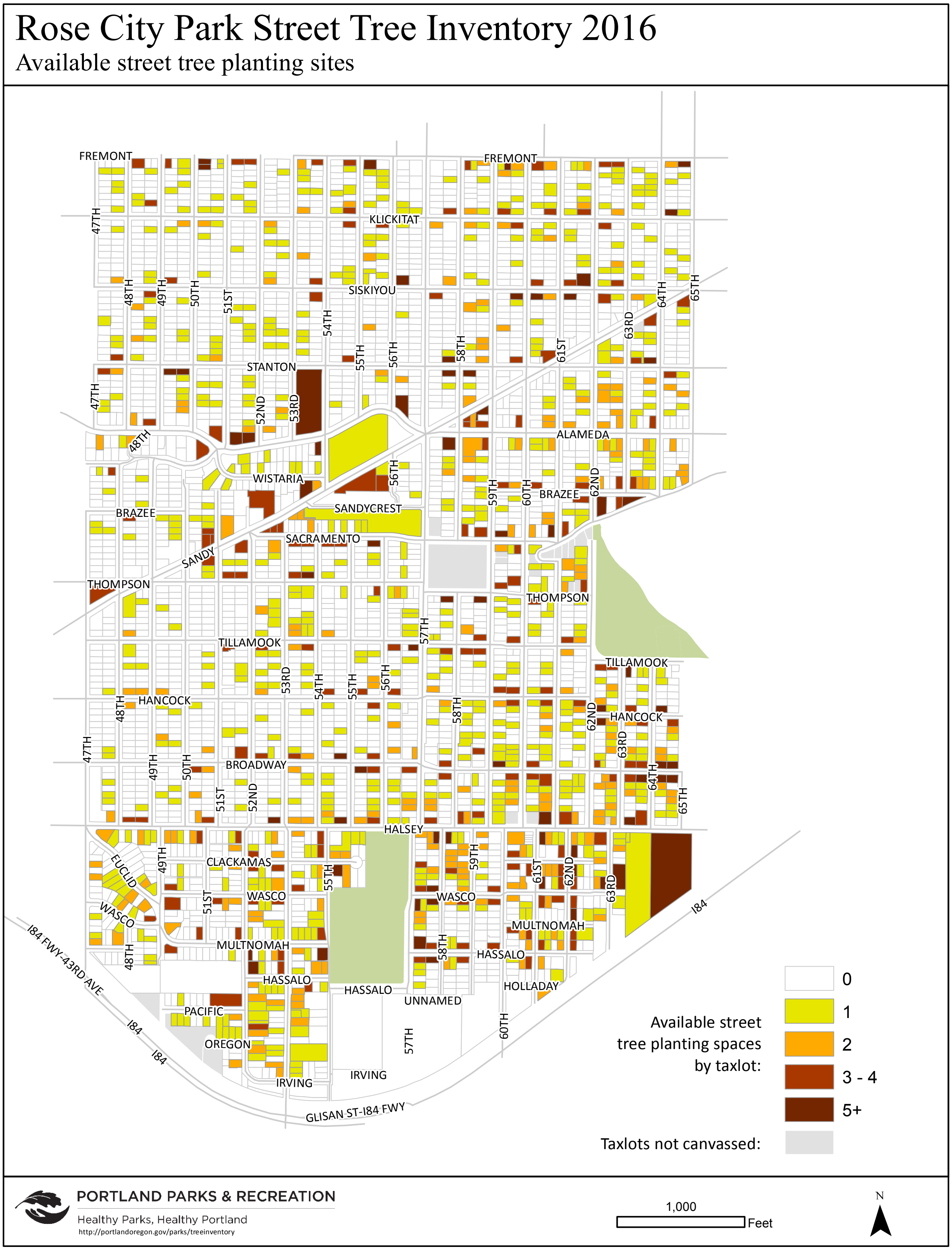


Appendix I: Planting site sizes

Rose City Park Street Tree Inventory 2016

Planting site sizes

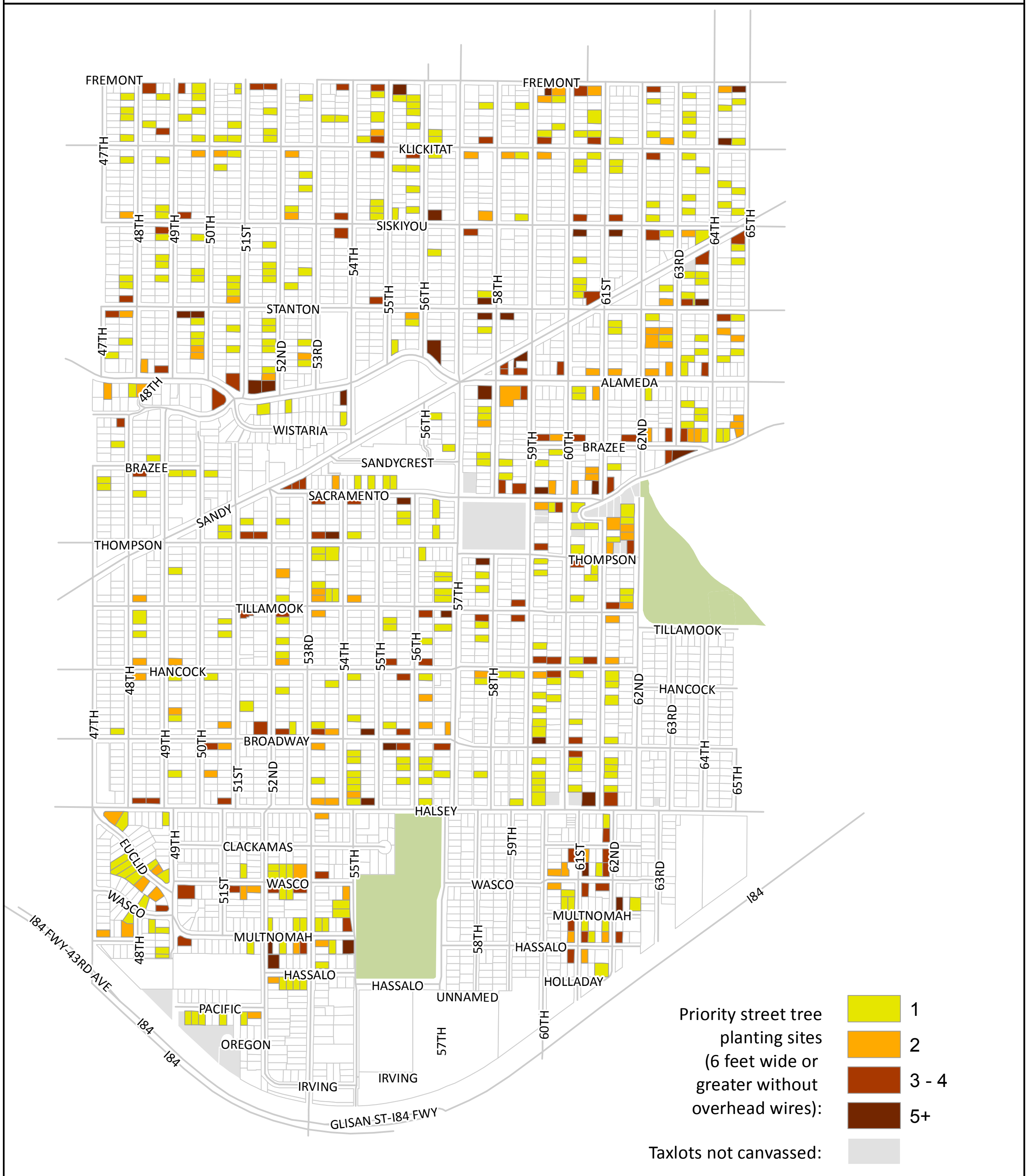
Appendix J: Available street tree planting sites



Appendix K: Priority street tree planting sites

Rose City Park Street Tree Inventory 2016

Priority street tree planting sites



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1,000 Feet

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