

TACOMA MALL

STRATEGIC URBAN FOREST ACTION PLAN

TACOMA, WA
APRIL 2020



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PREPARED FOR

The City of Tacoma, WA

INVENTORY PERFORMED

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STRATEGIC URBAN FOREST ACTION PLAN OVERVIEW

Having a healthy, diverse community forest in urbanized areas such as downtown cores and shopping centers can provide many benefits to residents, visitors, and the ecosystem. In addition to being aesthetically pleasing, trees also scrub the air of pollutants, slow the release of stormwater runoff into the watershed, filter stormwater, provide oxygen, reduce energy costs, provide shade, and offer habitat and food for wildlife. In fact, many studies have shown that people “are happier, experience significantly greater well-being, and show significantly lower mental distress when they live in areas with greater amounts of green space” (Wolf, K.L., et al. *Outside Our Doors, The Nature Conservancy, 2016*). Trees in busy city centers such as the Tacoma Mall regional growth center are particularly valuable to incorporate into larger planning efforts so that their benefits can continue to grow as the region continues to develop over time.

The key to maintaining a sustainable and healthy urban forest in the Tacoma Mall region is species and age diversity, proper tree maintenance, risk management, and community support, which can be accomplished with this strategic Urban Forest Action Plan (“Action Plan”). The information in this Action Plan is provided to guide future maintenance and management, aligned with the Citywide Urban Forest Management Plan (2019), to better plan for the health and longevity of the Tacoma Mall’s urban forest. By monitoring the urban forest for potential risks such as exotic tree pests and diseases, impacts of climate change, storm damage reduction and response, compacted soils, construction damage, vandalism, and improper pruning etc., the City, its partners, and the community can maintain and enhance the many benefits that trees provide within the Mall area and the City as a whole.

PROJECT AREA

The Tacoma Mall neighborhood includes approximately 575 (recently expanded from 485) acres in southwestern Tacoma. The Tacoma Mall has been designated as a Regional Growth Center (RGC) by the City of Tacoma and the Puget Sound Regional Council and is anticipating rapid growth and development in upcoming years.

As such, the Tacoma City Council approved the [Tacoma Mall Neighborhood Subarea Plan](#) in May of 2018 with the goal of establishing “innovative planning and policy actions to help the area achieve its potential as a thriving, livable, walkable and transit-ready urban neighborhood” (Tacoma Mall neighborhood website). This Action Plan can be used as a tool for the City to strategically incorporate tree canopy into its planning processes as the Tacoma Mall RGC undergoes extensive development.

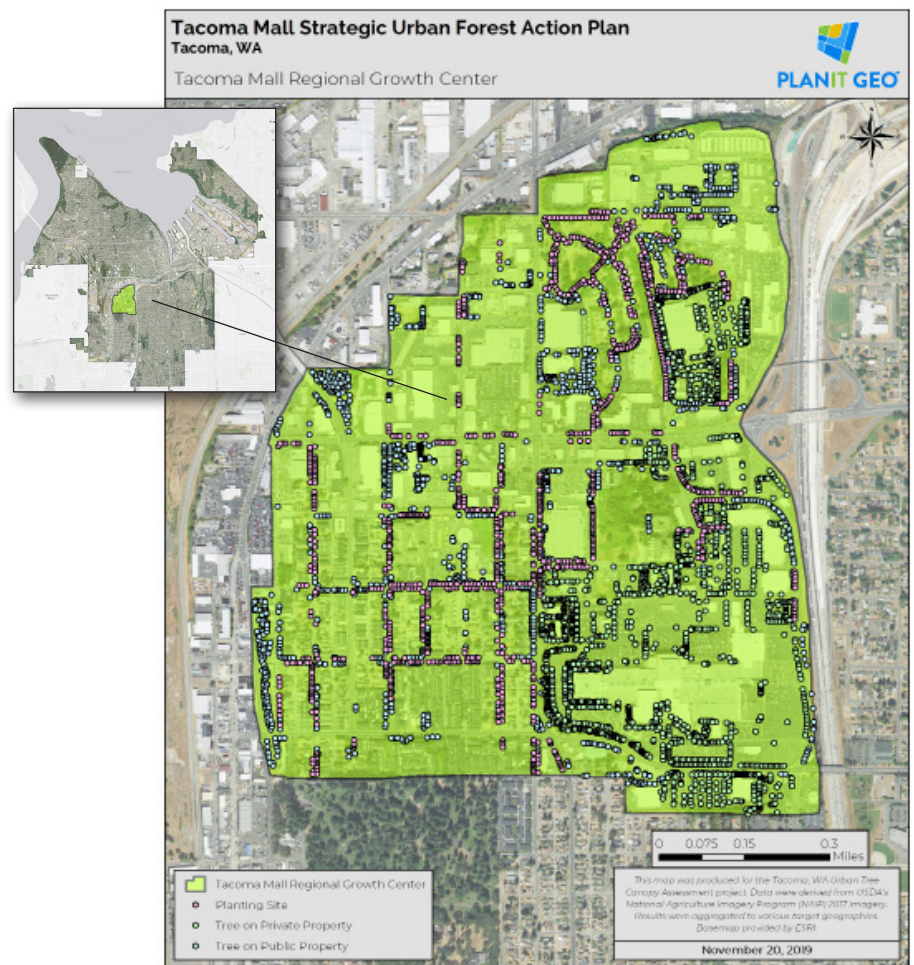


Figure 1. | Tacoma Mall boundary and inventory locations.



1,599 PUBLIC TREES
2,069 PRIVATE TREES
1,081 PLANTING SITES
58 ACRES OF CANOPY

DATA COLLECTION METHODOLOGY

This Action Plan synthesizes data from several different sources clipped to the Mall boundary for analysis. The analyses in this report include all trees within the Mall boundary on both public and private property and potential planting sites on public property, inventoried as part of the 2019 Citywide Urban Forest Management Plan project; land cover data from the 2018 Urban Tree Canopy Assessment; and stormwater data from the 2018 Puget Sound Urban Tree Canopy & Stormwater Management Report.

The inventory data include 3,667 trees and 1,081 planting sites that were inventoried by Certified Arborists accredited by the International Society of Arboriculture. The arborists recorded the tree species, size, occupied land use, growing space, maintenance needs, and other observations. The inventory data were analyzed in Microsoft Excel, ArcGIS, and the City of Tacoma’s TreePlotter™ tree inventory software

application (<https://pg-cloud.com/TacomaWA/>). Using the inventory data, the state of the urban forest within the Tacoma Mall area was analyzed and summarized to identify characteristics and trends relating to the health and diversity of trees within the 575-acre RGC. These results are presented in the Tree Inventory Summary section.

The data also include full land cover mapping of the Mall area. This spatial dataset was derived using an object-based image analysis (remote sensing) of a high-resolution 2018 aerial image from the National Agriculture Imagery Program. Metrics for existing tree canopy, possible planting area, and unsuitable area for planting were calculated within the Mall area. The land cover data were also incorporated into an assessment of stormwater benefits of tree canopy in Tacoma, where metrics were also calculated for the Tacoma Mall area. The land cover and stormwater results are discussed in the Urban Tree Canopy Assessment section.

Table 1. | Data sources analyzed for the 2019 Tacoma Mall strategic Urban Forest Action Plan.

| Source | Date Completed | Use in Action Plan |
|---|----------------|---|
| Tacoma Mall Tree Inventory | April 2019 | Inventory of all public (ROW) and private trees and planting sites |
| Tacoma Urban Tree Canopy Assessment | December 2018 | Full land cover classification, planting space and urban tree canopy metrics, and stormwater benefits |
| Puget Sound Urban Tree Canopy and Stormwater Management Report | March 2019 | Benefits of tree canopy to mitigate stormwater |
| City of Tacoma | March 2019 | Mall boundary, tax parcels, Councilmanic districts, addresses, land use, and Equity Index |

RELATIONSHIP TO OTHER CITY EFFORTS

This Urban Forest Action Plan is supported by and reinforces City policies outlined in the elements of the City of Tacoma's Comprehensive Plan, One Tacoma; the Citywide Urban Forest Management Plan; the Environmental Action Plan; the Tacoma Mall Subarea Plan; and other planning documents that establish broad policies for the physical character of Pierce County. Goals and objectives within these other plans will be supported by a strategic urban forest management approach for the Tacoma Mall area.

One Tacoma: Comprehensive Plan (updated 2015)

One Tacoma guides Tacoma's development over the long term, addresses the entire community, and describes how the community's vision for the future is to be achieved. It is a blueprint for the future character of the City by guiding decisions on land use, transportation, housing, capital facilities, parks, and the environment. This Plan's strategies align with the goals and objectives of One Tacoma.

City of Tacoma Urban Forest Management Plan (2019)

In coordination with the City's Environmental Services Department, partners, and the community, the 2019 Urban Forest Management Plan was developed to achieve goals of urban forest sustainability, management, and equity for all Tacomans and future generations. The Citywide Urban Forest Action Plan provides a road map for actions that move towards a goal of a healthy, thriving 30% overall tree canopy coverage by 2030 by creating greater efficiencies in City operations; standardizing levels of service; and responding to the challenges of climate change as well as other environmental factors. The strategic urban forest action plan for Tacoma Mall supports the following Citywide urban forest goals, strategies, and actions:

Table 2. | Goals and actions in the Tacoma Citywide Urban Forest Action Plan that relate to the urban forest.

| | |
|------------------------------------|---|
| Funding and Authority Goal | City resources and authority enable equitable urban forest management for the preservation and enhancement of tree benefits. |
| Strategy 3D | Public tree maintenance responsibility is shared by the City and its residents by City obtaining maintenance responsibility of public trees in priority areas including major arterials, business districts, regional growth areas, and historically underserved neighborhoods. |
| Action 3D.7 | <i>In coordination with the Management Policy actions, establish and sustain efforts with Neighborhood Business Districts, Neighborhood Council District, neighborhood organizations, and civic groups in all Tacoma neighborhoods by 2022 to implement young tree maintenance approaches for the care of 10,500 trees planted annually.</i> |
| Inventory and Planning Goal | A comprehensive understanding of the urban forest ensures data-driven decisions, sustainable and equitable planning, and amplifies the benefits received from trees. |
| Strategy 4B | Develop a strategic tree planting and maintenance plan(s). |
| Action 4B.3 | <i>Develop a strategic urban forest management plan for one priority neighborhood or area per year similar to the 2020 Tacoma Mall Strategic Urban Forest Management Plan (in progress) and the 2010 Neighborhood Business Districts Urban Forest Management Plan. Address best practices, species diversity, and tree pest and disease resiliency.</i> |
| Strategy 4C | Encourage and support other City policies and plans through the lens of urban forestry. |
| Action 4C.4 | <i>Continue to align tree planting and canopy goals with the watershed assessment, green stormwater infrastructure plans, and subarea planning efforts by providing technical assistance for the goals of stormwater management and improved water quality.</i> |
| Strategy 4E | Understand urban forest trends and risks on private land and utilize the partnership network for improved urban forest management. |
| Action 4E.5 | <i>Utilize partners to provide at least one annual workshop or event and provide resources to private landholders to support sustainable urban forest management and planting practices with an emphasis in priority areas.</i> |

Table 2. (ctd.) | Goals and actions in the Tacoma Citywide Urban Forest Action Plan that relate to the urban forest.

| | |
|--|---|
| Risk and Disaster Management Goal | Proactively manage tree-related risk throughout the urban forest and equip urban forest leaders with resources to address risks and disasters. |
| Strategy 5A | Effectively monitor threats from urban forest disturbances such as pest and disease outbreaks. |
| Action 5A.6 | <i>Use Citywide tree inventory data and best available science for long-term planning and management of existing and future tree pests and diseases impacting Tacoma's urban forest...</i> |
| Strategy 5C | Risks to the urban forest are properly planned for and appropriately addressed or mitigated with adequate resources to maintain public health and urban forest sustainability. |
| Action 5C.2 | <i>Work with environmental non-profit organizations and other partners to provide resources and annual training regarding tree pest and disease management as well as invasive species management. Provide resources to private landholders on an as-needed basis.</i> |
| Community Engagement Goal | Sustainable urban forest management and equity is achieved through a partnership with the City and its residents resulting in improved well-being, human health outcomes, and stronger local economies. |
| Strategy 6A | Continue to build trust and strong partnerships between the City, partners, and the community. |
| Action 6A.1 | <i>Support and sustain partnerships with local and regional participatory organizations. Encourage and support horizontal volunteer collaboration between organizations. Increase the number of community volunteers annually from 275 recorded in 2018.</i> |
| Strategy 6C | Include the community in the decision making process for urban forestry efforts throughout Tacoma's neighborhoods. |
| Action 6C.2 | <i>Conduct biannual community surveys (starting in 2021) to gauge public viewpoints and receive feedback on Plan implementation and program success. Survey responses should inform future urban forest decision making.</i> |
| Strategy 6D | Seek inclusive outlets for City members to actively steward and value their urban forest. |
| Action 6D.5 | <i>Establish a young adult job training, urban forest stewardship program to facilitate the planting and/or care of 10,500 trees annually (City-led and partnership plantings).</i> |
| Strategy 6E | Secure non-conventional partners in urban forestry, including public health, tribes, and transportation sectors. |
| Action 6E.9 | <i>Establish non-conventional partnerships that serve single and/or multiple Tacoma neighborhoods. All 8 neighborhoods should be supported.</i> |
| Strategy 6F | Provide equitable access to urban forest resources for all Tacomans, ensuring all residents and visitors alike share the benefits of trees. |
| Action 6F.8 | <i>Identify appropriate parks, rights-of-way, and other public spaces in Tacoma that feasibly can support healthy and safe fruit trees for gleaning initiatives. Initiate feasibility study in supportive low-income neighborhoods in 2023, progressing to other supportive neighborhoods by 2025. Consider the use of vacant City lots and brown-fields for community-oriented orchards in supportive neighborhoods.</i> |

The City of Tacoma Environmental Action Plan (2016)

The Environmental Action Plan (EAP) is a list of meaningful, high-priority actions that the City of Tacoma and the community will take between 2016 and 2020 to meet the environmental goals outlined in the Tacoma 2025 Strategic Plan. The long-term goals for Tacoma's "natural systems" described in the EAP related to urban forestry include: 1) Sustain and improve Tacoma's natural environment; 2) ensure that all Tacomans have access to clean air and water, can experience nature in their daily lives, and benefit from low-impact development; 3) foster appreciation and stewardship of wildlife and natural resources; and, 4) restore damaged shorelines and marine ecosystems and protect salmon habitat along the many rivers and streams that flow into Commencement Bay.

Tacoma Mall Neighborhood Subarea Plan (2018)

The Subarea Plan initiates innovative planning and policy actions to help the area achieve its potential as a thriving, livable, walkable, and transit-ready urban neighborhood.

Table 3. | Goals and actions in the Tacoma Mall Neighborhood 2018 Subarea Plan that relate to the urban forest.

| Chapter 3 - Urban Form | |
|--------------------------------|---|
| Goal UF-1 | Establish a more coherent, cohesive and accessible neighborhood structure by implementing the six foundational elements of neighborhood urban form. ¹ |
| Action UF-7 | <i>Design and implement the Subarea Plan area-wide stormwater management, parks and open space and tree canopy cover strategies.</i> |
| Chapter 7 - Environment | |
| Goal E-1 | Enhance water quality and flow control conditions through implementation of an area-wide stormwater strategy with both centralized and dispersed BMPs that infiltrate runoff, provide flood storage, and reduce effective impervious surface coverage. |
| Action E-5 | <i>Preserve existing mature trees and green spaces in association with City actions when feasible, and encourage retention of mature trees when properties are developed.</i> |
| Goal E-3 | Achieve 25% tree canopy coverage in the Tacoma Mall Neighborhood Subarea by 2040. |
| Action E-9 | <i>Target 25% tree canopy coverage in the Madison District and 20% coverage in other Districts by 2040.</i> |
| Action E-10 | <i>Work with property owners such as WSDOT to increase tree cover on the neighborhood perimeter, focusing on opportunities to provide large swaths of green, mitigate freeway noise and air pollution, and make the neighborhood attractive and inviting.</i> |
| Action E-11 | <i>To increase the identity, canopy cover and green infrastructure value of the Loop Road linear parkway consider planting the largest street trees feasible and appropriate to the design.</i> |
| Action E-12 | <i>Coordinate with parks and open space services providers to strive to meet tree canopy targets within their facilities.</i> |
| Action E-13 | <i>Seek ways to promote Garry Oaks as a signature native tree species.</i> |
| Action E-14 | <i>Encourage private property owners to plant trees, particularly when there are opportunities to beautify and promote pedestrian connections between large paved areas.</i> |
| Chapter 8 - Community Vitality | |
| Goal CV-1 | Foster an identity for the Tacoma Mall Neighborhood that instills pride in a strong community of diverse residents and businesses. |
| Action CV-3 | <i>Rebrand the neighborhood as a "green neighborhood," celebrating planned improvements in green stormwater infrastructure, parks and tree cover..."</i> |
| Goal CV-6 | Collaborate with Metro Parks Tacoma, the Tacoma School District, civic partners and the community to plan and implement the community's parks and open spaces vision in the Tacoma Mall Neighborhood. |
| Action CV-27 | <i>Explore acquisition of any surplus public properties as well as further joint use of publicly owned facilities as recreational amenities, locations for public art or wayfinding, tree planting and passive open spaces.</i> |

1. Dempsey, Nicola & Brown, Caroline & Raman, Shibu & Porta, Sergio & Jenks, Mike & Jones, Colin & Bramley, Glen. (2009). Elements of Urban Form. 10.1007/978-1-4020-8647-2_2.

BENEFITS PROVIDED BY TREES

The quality of life of the citizens in any community depends on the urban forest, as trees make a vital and affordable contribution to the sense of community, pedestrian-friendly neighborhoods, energy savings, and air quality. The urban forestry program is critical to meeting the City's commitment to climate change mitigation and adaptation, carbon sequestration, stormwater reduction, wildlife habitat enhancement, and water conservation. Trees are one of the few infrastructure investments that grow in value over time.

Note: The following data was derived from the Alliance for Community Trees. A review of the specific benefits of the Tacoma Mall's public and private trees based on inventory data is provided in the Inventory Summary section.

Clean the Air and Breathe Easier



Shade trees reduce pollution and return oxygen to the atmosphere. In addition to carbon dioxide, trees' leaves or needles absorb pollutants, such as ozone, nitrogen dioxide, sulfur dioxide, and some particulate matter.

Calm Traffic and Make Neighborhoods Safer, Quieter



People drive more slowly and carefully through tree-lined streets, because trees create the illusion of narrower streets. One study found a 46% decrease in crash rates across urban arterial and highway sites after landscape improvements were installed. The presence of trees in a suburban landscape reduced the cruising speed of drivers by an average of 3 miles per hour. Faster drivers and slower drivers both drove at decreased speeds in the presence of trees. Trees reduce noise pollution, buffering as much as half of urban noise. By absorbing sounds, a belt of trees 100 feet wide and 50 feet tall can reduce highway noise by 6 to 10 decibels. Buffers composed of trees and shrubs can reduce 50% of noise.

Raise Property Values



Trees are sound investments, for campuses, businesses and residents alike, and their value increases as they grow. Sustainable landscapes can increase property values up to 37%. The value of trees appreciates over time, because the benefits grow as they do. For businesses, trees have added value, including higher revenues. Shoppers seek out leafy promenades that frame storefronts. Research shows that shoppers spend more—between 9 and 12% more—on products in tree-lined business districts.

Save Energy and Lower Energy Costs for Buildings



As natural screens, trees can insulate buildings from extreme temperatures, keep properties cool, and reduce air conditioning utility bills. A 20% canopy of deciduous trees over a house results in annual cooling savings of 8 to 18% and annual heating savings of 2 to 8%. By planting shade trees on sunny exposures, residents and businesses can save up to 50% on hot-day energy bills.

Reduce the Need for Street Maintenance



Shaded streets and parking lots last longer and require far less pavement maintenance, reducing long-term costs. Canopy diminishes pavement fatigue, cracking, rutting, and other damage. A study from University of California, Davis found that 20% shade cover on a street improves pavement condition by 11%, which is a 60% savings for resurfacing over 30 years.

Reduce Stress and Improve the Quality of Life



Neighborhoods and campuses with generous canopies of trees are uplifting and good for public health. Greater contact with natural environments correlates with lower levels of stress, improving performance. Students' concentration levels go up when they are able to look out onto a green landscape. Studies show that children with attention deficit disorder function better after activities in green settings. A green environment impacts worker productivity. Workers without views of nature from their desks claimed 23% more sick days than workers with views of nature. Residents of areas with the highest levels of greenery were 3 times as likely to be physically active and 40% less likely to be overweight than residents living in the least green settings.

Build Safe Communities and Decrease Crime



Police and crime prevention experts agree that trees and landscaping cut the incidence of theft, vandalism, and violence by enhancing campus neighborhoods. Thriving trees on

well-maintained streets indicate pride of ownership. Public housing residents with nearby trees and natural landscapes reported 25% fewer acts of domestic aggression and violence. Apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees. Buildings with medium amounts of greenery had 42% fewer crimes.

Conserve Water and Soil



A tree's fibrous roots, extending into the soil, are premier pollution filtration and soil erosion prevention systems. Intensely urbanized areas are covered with a

large number of impermeable surfaces. In contrast to an impervious hardscape, a healthy urban forest can reduce annual storm water runoff up to 7%. Highly efficient trees also utilize or absorb toxic substances such as lead, zinc, copper, and biological contaminants. One study estimated that eliminating the need for additional local stormwater filtration systems would result in savings exceeding \$2 billion.

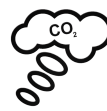
Cooler Pavement Diminishes Urban Heat Islands



Broad canopy trees lower temperatures by shading buildings, asphalt, and concrete. They deflect radiation from the sun and release moisture into the air. The urban

heat island effect is the resulting higher temperature of areas dominated by buildings, roads, and sidewalks. Cities are often 5° to 10°F hotter than undeveloped areas, because hot pavement and buildings have replaced cool vegetated land. In addition, high temperatures increase the volatility of automobile oil and oil within the asphalt itself, releasing the fumes into the atmosphere. Shade trees can reduce asphalt temperatures by as much as 36°F, which diminishes the fumes and improves air quality.

Positively Influence Climate to Ensure Sustainability



Trees absorb carbon dioxide and store carbon in wood, which helps to reduce greenhouse gases. Carbon emissions from vehicles, industries, and power plants are a primary

contributor to increased air temperatures in metropolitan areas. Trees in the United States store 700 million tons of carbon valued at \$14 billion with an annual carbon sequestration rate of 22.8 million tons per year valued at \$460 million annually.

Protect Wildlife and Restore Ecosystems



Planting and protecting trees can provide habitat for hundreds of birds and small animals. Urbanization and the destruction of valuable ecosystems have led to the decline of many of species. Adding trees, particularly native trees, provides valuable habitat for wildlife.



Figure 2. | A healthy urban forest will provide the Tacoma Mall with benefits such as shade, stormwater regulation, aesthetics and a sense of community as the neighborhood continues to develop.

INVENTORY AND CANOPY RESULTS AT-A-GLANCE

The following section provides the characteristics of Tacoma Mall’s existing public trees, private trees, and potential planting sites, organized by Structure, Management, and Risks. The summary results presented below are discussed in greater detail in the following section and were used to inform this Action Plan’s recommendations. Note that the following summaries consist of all trees (on both public and private property).

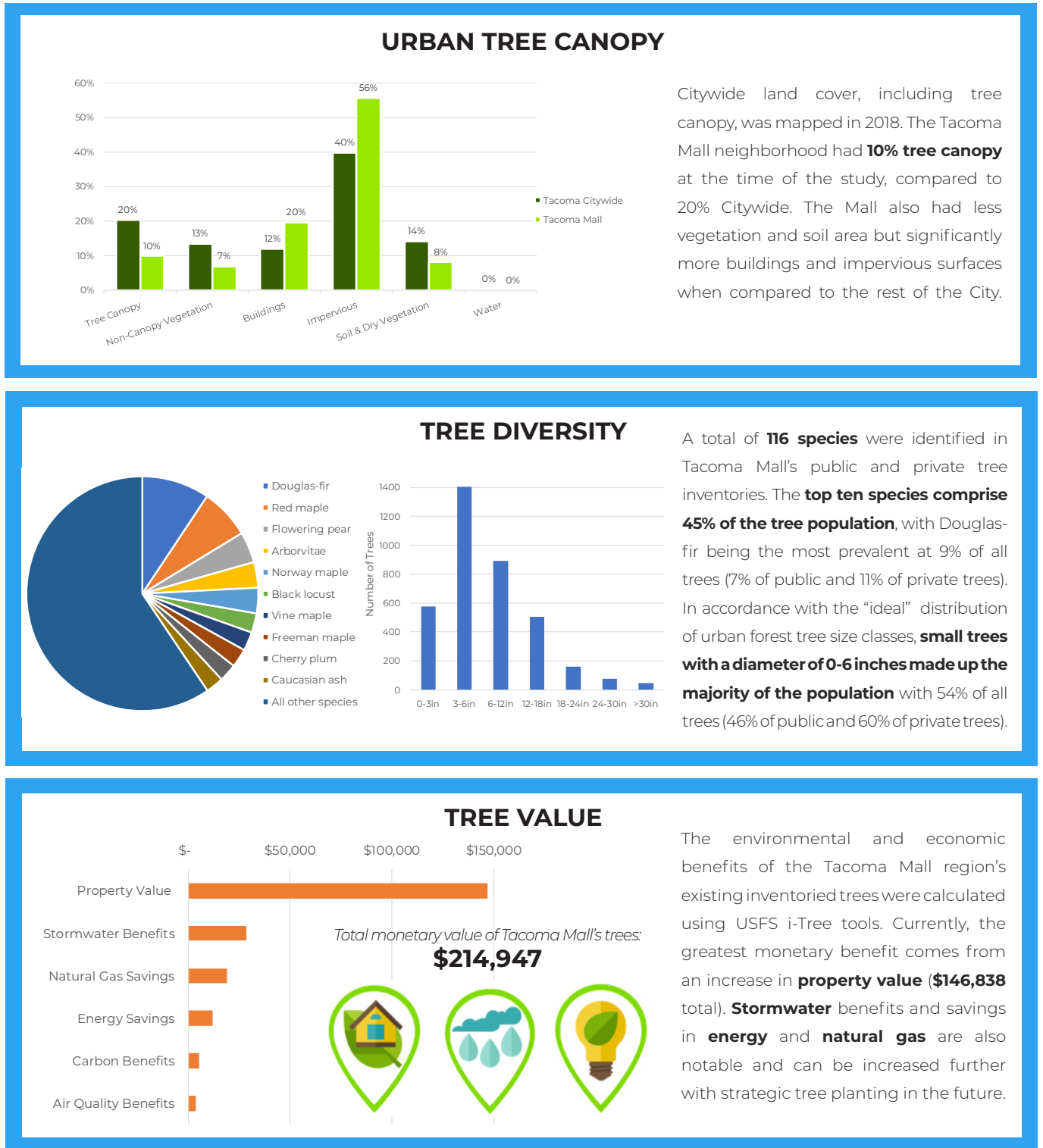


Figure 3. | Tree canopy (top), tree species diversity and size distribution (middle) and tree value (bottom) results for Tacoma Mall at-a-glance.

OVERVIEW OF URBAN TREE CANOPY

In 2018, Tacoma’s Citywide urban tree canopy (UTC) was assessed for a better understanding of the extent of trees and available planting space, not just within City-maintained areas, but in all land uses. Using 2018 high resolution aerial imagery from the USDA’s National Aerial Imagery Program (NAIP) for Washington, remote sensing and GIS techniques were used to map and measure land cover types across several geographic scales. The intent of this assessment was to analyze canopy and other land cover metrics in developing an Urban Forest Management Plan for the City of Tacoma and assess stormwater benefits for the Puget Sound Tree Canopy and Stormwater Report project. While the tree canopy assessment was initially prepared of the full City of Tacoma boundary, tree canopy was clipped to the mall boundary and reassessed for this Strategic Urban Forest Action Plan.

METHODOLOGY

An initial land cover dataset was created prior to mapping tree canopy. This land cover data set is the most fundamental component of an urban tree canopy assessment. A remote sensing process used the NAIP imagery to derive five initial land cover classes. These classes are shown below.



Figure 17. | Land cover classes identified in the 2018 Tacoma, WA urban tree canopy assessment.

Table 4. | Land cover classes for the Tacoma Mall regional growth center and full City of Tacoma (acres and percent).

| Tacoma, WA Land Cover | Total Area | Tree Canopy | Impervious Surfaces | Non-Canopy Vegetation | Soil & Dry Vegetation | Water |
|------------------------------------|------------|-------------|---------------------|-----------------------|-----------------------|-------|
| Tacoma Mall (Acres) | 589 | 58 | 443 | 41 | 48 | 0 |
| Tacoma Mall (% of Total) | 100% | 10% | 75% | 7% | 8% | 0% |
| City of Tacoma (Acres) | 31,607 | 6,406 | 16,344 | 4,257 | 4,469 | 132 |
| City of Tacoma (% of Total) | 100% | 20% | 52% | 13% | 14% | >1% |

In addition to quantifying Tacoma’s existing tree canopy cover, another metric of interest in this assessment was the area where tree canopy could be expanded. To assess this, all land area in Tacoma that was not existing tree canopy coverage was classified as either possible planting area (PPA) or unsuitable for planting. Possible planting areas were derived from the Non-Canopy Vegetation class. Unsuitable areas, or areas where it was not feasible to plant trees due to biophysical or land use restraints (e.g., airport runways, golf course playing areas, and recreation fields), were manually delineated and overlaid with the existing land cover data set. The final results were reported as PPA and Unsuitable Vegetation, Unsuitable Impervious, Unsuitable Soil, and Total Unsuitable. The key findings of the tree canopy assessment can help inform a strategic approach to identifying existing canopy to preserve and future planting areas.

KEY FINDINGS

Refining and re-assessing the 2018 Tacoma, WA UTC assessment data to the Mall boundary determined that the Mall has a total of 10% tree canopy cover, or 58 acres. Possible Planting Area (PPA), or areas that aren't canopy-covered, impervious, water, soil and dry vegetation, and/or Unsuitable, comprises 7% of the Mall or 41 acres. Unsuitable areas comprise the remaining 83%, or 490 acres, of the Mall.

Prior to summarizing tree canopy and PPA data for the Tacoma Mall, the data was summarized for the full City of Tacoma. The figure below shows that the Mall area differed from the full City in several ways. Most significantly, there was less tree canopy (10% compared to 20% Citywide), less non-canopy vegetation, less soil, and less possible planting area (7% compared to 13% Citywide). However, there was more total impervious area (76% compared to 52% Citywide) and more total unsuitable areas (83% compared to 67%). This indicates that it will be even more important for the Tacoma Mall region to be strategic with its future tree plantings in this limited space.

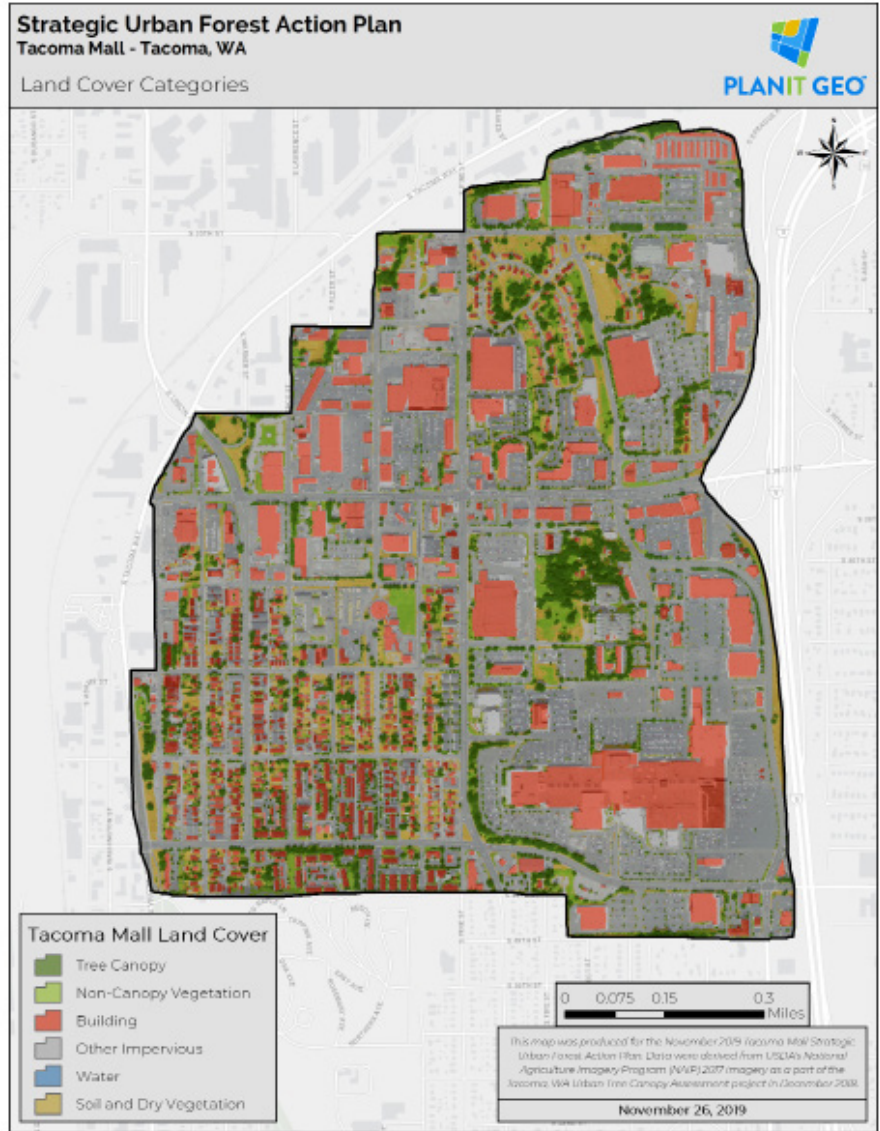


Figure 4. | Tacoma Mall's 2018 land cover classes, derived by remote sensing.

Tacoma Mall Land Cover Classes and Urban Tree Canopy Potential

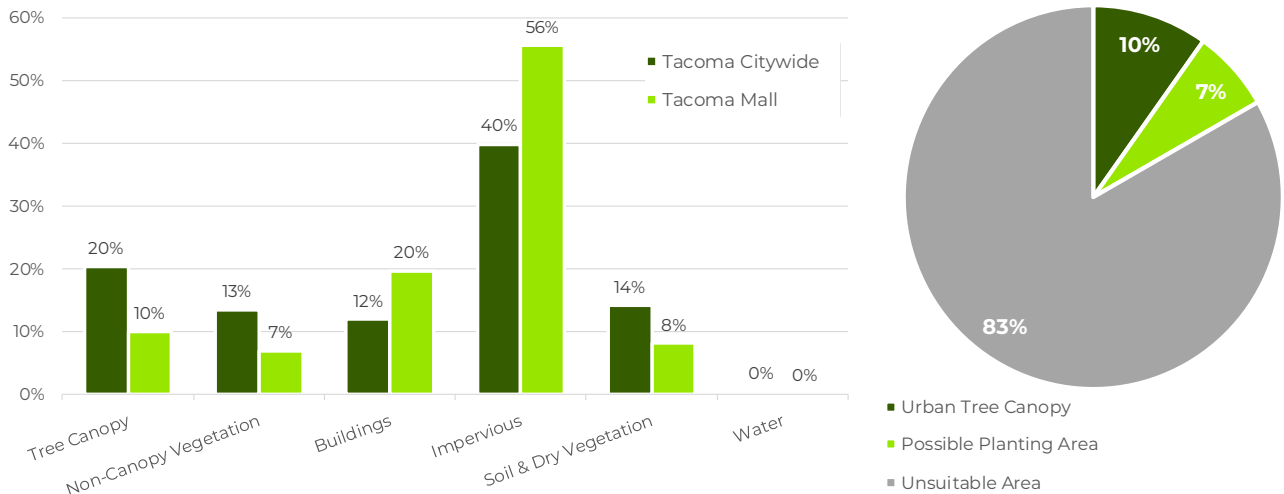


Figure 5. | Land cover classes (left) and urban tree canopy potential for the Tacoma Mall area (right).

SUMMARY OF TREE INVENTORY

INVENTORY STRUCTURE

Urban forest structure describes the tree population in the Tacoma Mall neighborhood in terms of its species composition, number of trees, age classes, and tree distribution. Summaries are presented for public trees (within the right-of-way), private trees (on private property, such as parking lots), all trees, and all potential planting sites on public property. These summaries assist tree managers in proper tree management and planting to ensure long-lasting canopy and benefits distributed equally throughout the Regional Growth Center.

TREE DIVERSITY AND COMPOSITION

Tree species composition data are essential since the types of trees present in neighborhoods and commercial centers greatly affect the tree maintenance activities, required budgets, and amount of benefits provided.

The 1,599 trees on public/right-of-way property (“public trees”) inventoried are comprised of 116 different species classifications. The top 10 species comprise 45% of the tree population. The highest percent consists of Douglas-fir with 7% (118 trees) of the public tree population.

On private property within the Tacoma Mall, the 2,068 trees (“private trees”) inventoried are comprised of 90 different species classifications. The top 10 species comprise 47% of the tree population. The highest percent, again, consists of Douglas-fir with 11% (228 trees) of the private tree population.

In total, 3,667 trees inventoried in the Tacoma Mall comprised 140 species classifications. The top 10 species comprised 40% of the total tree population (indicating that different species were more prevalent on public versus private property). The highest percent of all trees was also Douglas-fir with 9% (346 trees).

Tacoma Mall Total Tree Species Diversity

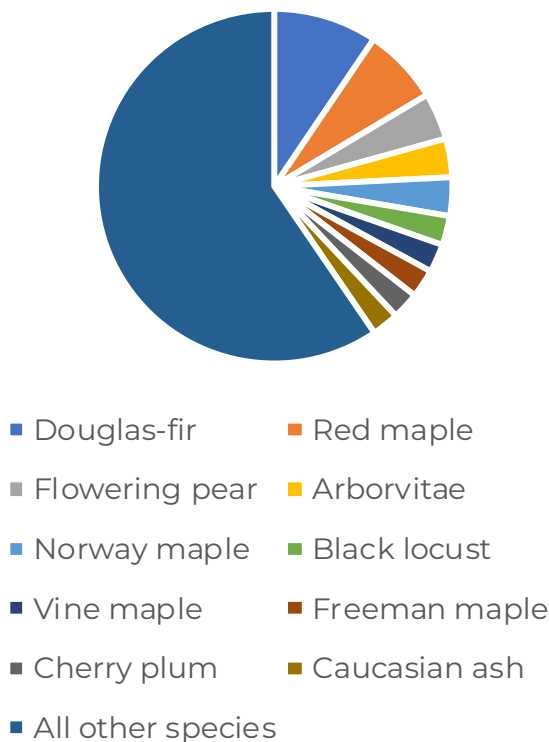
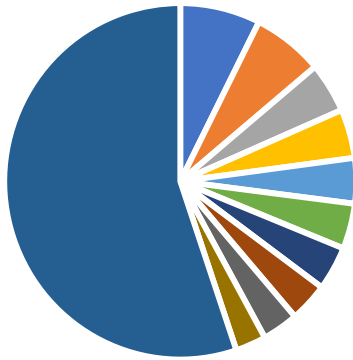


Figure 6. | Tacoma Mall total tree species composition.

Table 5. | Tacoma Mall total tree species composition.

| All Tree Species Diversity | # of Trees | % of Top 10 | % of All Species |
|----------------------------|--------------|-------------|------------------|
| Douglas-fir | 346 | 23% | 9% |
| Red maple | 255 | 17% | 7% |
| Flowering pear | 157 | 11% | 4% |
| Arborvitae | 129 | 9% | 4% |
| Norway maple | 129 | 9% | 4% |
| Black locust | 98 | 7% | 3% |
| Vine maple | 95 | 6% | 3% |
| Freeman maple | 95 | 6% | 3% |
| Cherry plum | 91 | 6% | 2% |
| Caucasian ash | 90 | 6% | 2% |
| All other species | 2,182 | -- | 60% |
| Top 10 Subtotal | 1,485 | 100% | 40% |
| Total | 3,667 | -- | 100% |

Tacoma Mall Public Tree Species Diversity



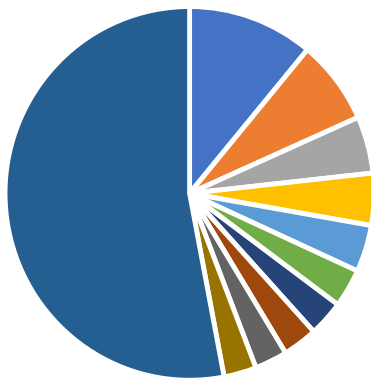
- Douglas-fir
- Red maple
- Cherry plum
- American sweetgum
- Norway maple
- Freeman maple
- Flowering pear
- Oregon white oak
- Port Orford cedar
- Kwanzan cherry
- All other species

Figure 7. | Tacoma Mall public tree species composition.

Table 6. | Tacoma Mall public tree species composition.

| Public Tree Species Diversity | # of Trees | % of Top 10 | % of All Species |
|-------------------------------|--------------|-------------|------------------|
| Douglas-fir | 118 | 16% | 7% |
| Red maple | 104 | 15% | 7% |
| Cherry plum | 73 | 10% | 5% |
| American sweetgum | 71 | 10% | 4% |
| Norway maple | 66 | 9% | 4% |
| Freeman maple | 66 | 9% | 4% |
| Flowering pear | 64 | 9% | 4% |
| Oregon white oak | 57 | 8% | 4% |
| Port Orford cedar | 53 | 7% | 3% |
| Kwanzan cherry | 45 | 6% | 3% |
| All other species | 882 | -- | 55% |
| Top 10 Subtotal | 717 | 100% | 45% |
| Total | 1,559 | -- | 100% |

Tacoma Mall Private Tree Species Diversity



- Douglas-fir
- Red maple
- Arborvitae
- Flowering pear
- Black locust
- Vine maple
- Shore pine
- Norway maple
- Caucasian ash
- Katsura
- All other species

Figure 8. | Tacoma Mall private tree species composition.

Table 7. | Tacoma Mall private tree species composition.

| Private Tree Species Diversity | # of Trees | % of Top 10 | % of All Species |
|--------------------------------|--------------|-------------|------------------|
| Douglas-fir | 228 | 23% | 11% |
| Red maple | 151 | 16% | 7% |
| Arborvitae | 102 | 10% | 5% |
| Flowering pear | 93 | 10% | 4% |
| Black locust | 84 | 9% | 4% |
| Vine maple | 69 | 7% | 3% |
| Shore pine | 64 | 7% | 3% |
| Norway maple | 63 | 6% | 3% |
| Caucasian ash | 59 | 6% | 3% |
| Katsura | 59 | 6% | 3% |
| All other species | 1,096 | -- | 53% |
| Top 10 Subtotal | 972 | 100% | 47% |
| Total | 2,068 | -- | 100% |

GENUS DIVERSITY

As noted above, the Tacoma Mall’s urban forest is heavily comprised of only a few species. The top 10 most prevalent species make up 40% of the total tree population. In addition to species diversity, genus diversity (the next-broadest taxonomic rank) is also of interest. According to the USDA’s Agricultural Research Service, the urban forestry standard is the “30-20-10 rule,” which states that we should plant no more than 30% of any one family; 20% of one genus; or 10% of one species. Doing so ensures a more resilient forest by preventing the large-scale devastation of one dominant species by an emergent pest or disease.

In the Tacoma Mall, the *Acer* genus currently exceed its recommended frequency. These trees include the maples, such as the red maple, Norway maple, Freeman maple, and vine maple species, and in total, comprise 20% of the total tree population (21% of private trees). Unfortunately, these trees are threatened by pest and diseases that pose a threat to the Tacoma Mall’s urban forest. The *Acer* genus is threatened by the spotted lanternfly, bacterial leaf scorch, and the widely dreaded Asian Longhorned Beetle (ALB), all of which can kill maples and require the removal of large, mature trees. If any of these pests or diseases were to reach the Tacoma Mall, a huge proportion of its trees could be lost very quickly and it would be difficult for the region to recover. Therefore, it is recommended that species and genus diversity be a top priority when deciding on future trees to be planted.

Table 8. | Tacoma Mall total tree genus composition.

| All Tree Genus Diversity | # of Trees | % of Top 10 | % of All Genera |
|--|--------------|-------------|-----------------|
| Acer (maples) | 720 | 30% | 20% |
| Pseudotsuga (Douglas-fir) | 346 | 14% | 9% |
| Prunus (cherry, plums) | 288 | 12% | 8% |
| Pinus (pines) | 196 | 8% | 5% |
| Thuja (i.e. arborvitae, western red cedar) | 175 | 7% | 5% |
| Fraxinus (ash) | 164 | 7% | 4% |
| Pyrus (pear) | 157 | 6% | 4% |
| Quercus (oaks) | 147 | 6% | 4% |
| Chamaecyparis (i.e. Port Orford cedar) | 136 | 6% | 4% |
| Robinia (black locust) | 98 | 4% | 3% |
| All other genera | 1,240 | -- | 34% |
| Top 10 Subtotal | 2,427 | 100% | 66% |
| Total | 3,667 | -- | 100% |

Tacoma Mall Tree Genus Diversity

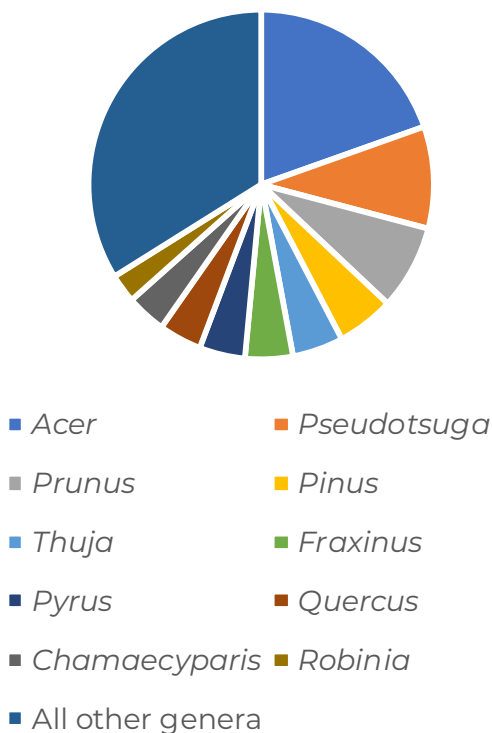


Figure 9. | Tacoma Mall total tree genus composition.

Tacoma Mall Public Genus Species Diversity

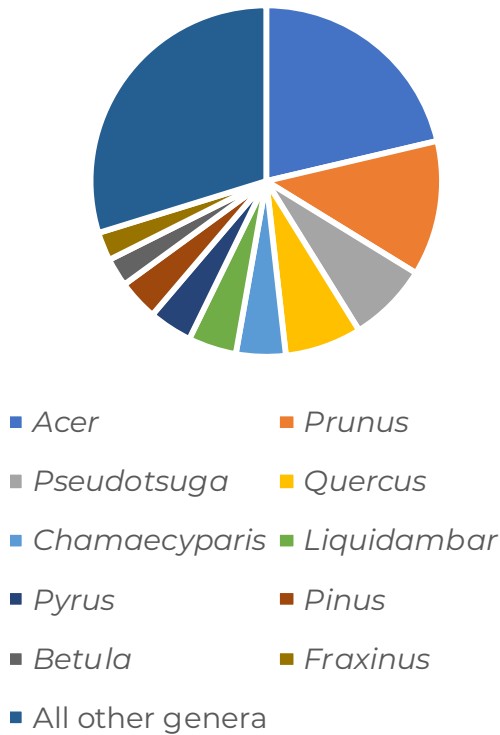


Figure 10. | Tacoma Mall public tree genus composition.

Table 9. | Tacoma Mall public tree genus composition.

| Public Tree Genus Diversity | # of Trees | % of Top 10 | % of All Genera |
|-----------------------------|--------------|-------------|-----------------|
| Acer | 341 | 30% | 21% |
| Prunus | 199 | 18% | 12% |
| Pseudotsuga | 118 | 11% | 7% |
| Quercus | 113 | 10% | 7% |
| Chamaecyparis | 73 | 7% | 5% |
| Liquidambar | 71 | 6% | 4% |
| Pyrus | 64 | 6% | 4% |
| Pinus | 60 | 5% | 4% |
| Betula (birch) | 42 | 4% | 3% |
| Fraxinus | 42 | 4% | 3% |
| All other genera | 476 | -- | 30% |
| Top 10 Subtotal | 1,123 | 100% | 70% |
| Total | 1,599 | -- | 100% |

Tacoma Mall Private Tree Genus Diversity

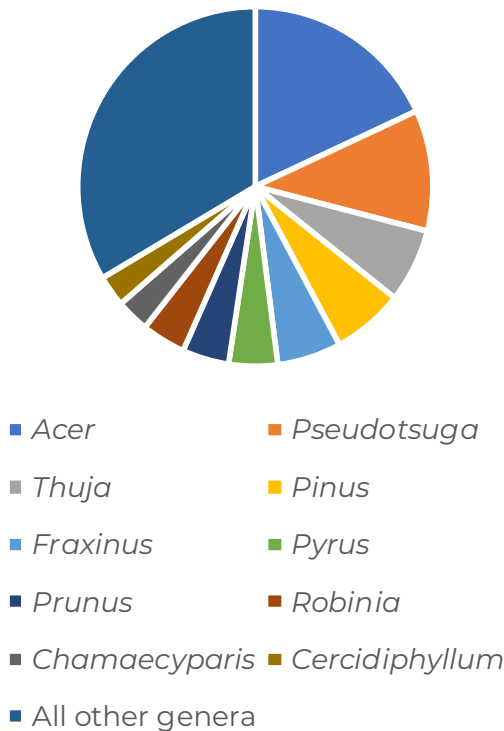


Figure 11. | Tacoma Mall private tree genus composition.

Table 10. | Tacoma Mall private tree genus composition.

| Private Tree Genus Diversity | # of Trees | % of Top 10 | % of All Genera |
|--------------------------------------|--------------|-------------|-----------------|
| Acer | 379 | 27% | 18% |
| Pseudotsuga | 228 | 16% | 11% |
| Thuja | 139 | 10% | 7% |
| Pinus | 136 | 10% | 7% |
| Fraxinus | 122 | 9% | 6% |
| Pyrus | 93 | 7% | 4% |
| Prunus | 89 | 6% | 4% |
| Robinia | 84 | 6% | 4% |
| Chamaecyparis | 63 | 5% | 3% |
| Cercidiphyllum (i.e. katsura) | 59 | 4% | 3% |
| All other genera | 676 | -- | 33% |
| Top 10 Subtotal | 1,392 | 100% | 67% |
| Total | 2,068 | -- | 100% |

SIZE AND AGE DISTRIBUTION

The distribution of tree ages influences the structure of the urban forest as well as the present and future costs. An unevenly-aged urban forest offers continued flow of ecological benefits and a more uniform workflow allowing managers to more accurately allocate annual maintenance schedules and budgets. To optimize the value and benefits of the neighborhood’s trees, the urban forest in Tacoma Mall should have a high percentage of large canopy trees which provide greater ecosystem benefits. On the other hand, there must be a suitable number of younger, smaller trees in the urban forest to account for the loss of large and mature trees in decline. Having a healthy percentage of young trees in the urban forest will ensure a sustainable tree population as well as age distribution in future years. The majority of trees in the Tacoma Mall region are in the youngest age class, with private trees being slightly larger than public trees within this age class and public trees being slightly larger and more mature overall.

Tacoma Mall Tree Size Distribution

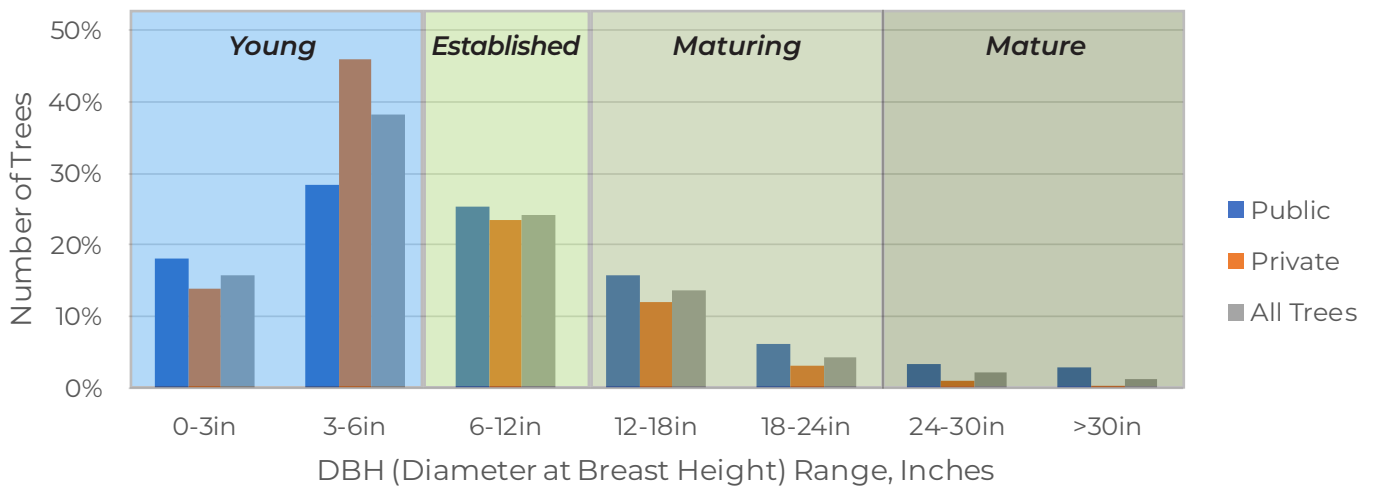


Figure 12. | Comparison of size/age ranges for Tacoma Mall’s public, private, and total tree population.

DISTRIBUTION OF LAND USES

Trees located in different types of urban settings face different threats and have unique management needs. During the inventory, the surrounding land use was recorded for each tree (not related to City land use or zoning). Five land uses were recorded in Tacoma: industrial/large commercial, small commercial, single-family residential, multi-family residential, and park/vacant/other. The majority of all trees in this region were found in industrial areas, comprising 67% of all trees (50% of public trees and 81% of private trees). 17% of public trees were each found in multi-family areas and parks, while private trees included some multi-family areas (14%) but hardly any parks (3%). Small commercial areas made up a small portion of the total tree population’s land uses (10% of public trees, 4% of private trees, and 7% overall). Single-family residential areas made up just 3% of all trees (7% of public trees and 0 private trees at all). This indicates that planting trees in a greater diversity of land uses, such as single-family and multi-family residential areas, would be a valuable priority moving forward.

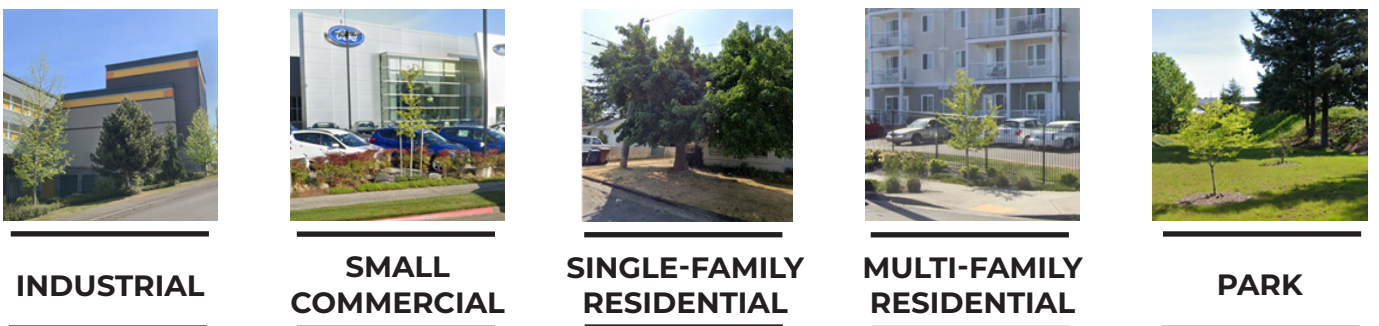


Figure 13. | Examples of the land use classes in Tacoma Mall where inventoried trees could be located.

Table 11. | Comparison of trees by land uses for Tacoma Mall's public, private, and total tree population.

| Land Use | All Trees | | Public Trees | | Private Trees | |
|------------------------------|--------------|-------------|--------------|------------|---------------|------------|
| | # of Trees | % | # of Trees | % | # of Trees | % |
| Industrial/ Large Commercial | 2,465 | 67% | 798 | 50% | 1,667 | 81% |
| Multi Family | 531 | 14% | 271 | 17% | 260 | 13% |
| Park/ Vacant/ Other | 324 | 9% | 272 | 17% | 52 | 3% |
| Small Commercial | 242 | 7% | 153 | 10% | 89 | 4% |
| Single Family | 105 | 3% | 105 | 7% | - | 0% |
| Grand Total | 3,667 | 100% | 1,599 | 44% | 2,068 | 56% |

URBAN FOREST CONDITION

Tree characteristics and outside forces affect the management needs for urban trees. An analysis of the condition and maintenance requirements assists managers in planning the Tacoma Mall's urban forest. Tree condition indicates how well trees are managed and how well they perform given site-specific conditions. Tree maintenance needs are assigned for public safety reasons and for the health and longevity of the trees. Understanding the maintenance needs assists tree managers in establishing daily work plans and maintaining public safety. The inventory data were analyzed to identify potential trends in tree condition and management needs. Information on the condition of trees plays an important role in the region's planning, budgeting, and use of resources. Each inventoried tree's health was evaluated by ISA Certified Arborists based on the condition of the wood and the foliage.

Figure 14 below summarizes the 3,667 trees that were assigned a condition rating and shows the distribution of trees by condition class. The data show that a majority of the trees inventoried are classified as being in "Good" condition, comprising 51% of all trees, followed by those in "Fair" condition comprising 31%. Private trees tended to be in better condition than public trees, having a higher percentage of "Excellent" and "Good" condition trees and a lower percentage of "Fair" and "Poor." Note that 1% trees are classified as dead, and 6% are noted as poor condition. The dead trees and trees in poor condition should be addressed and planned for immediately to avoid risks to public safety and assist in the planning for replacement trees.

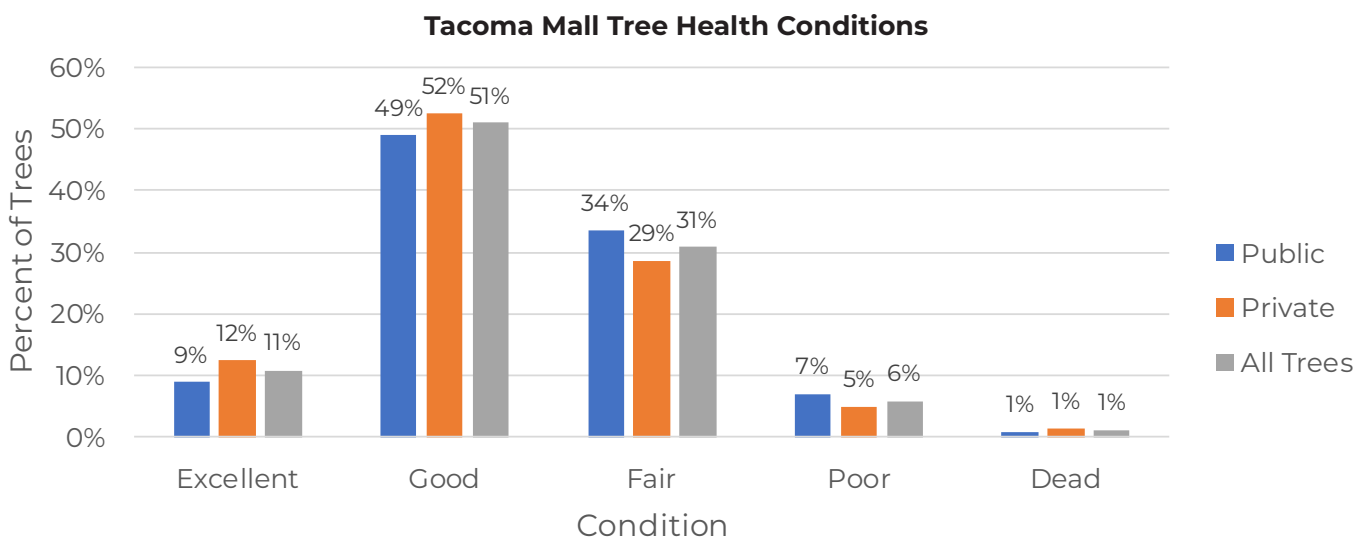


Figure 14. | Tacoma Mall tree health conditions.

RELATIVE PERFORMANCE INDEX OF TOP SPECIES

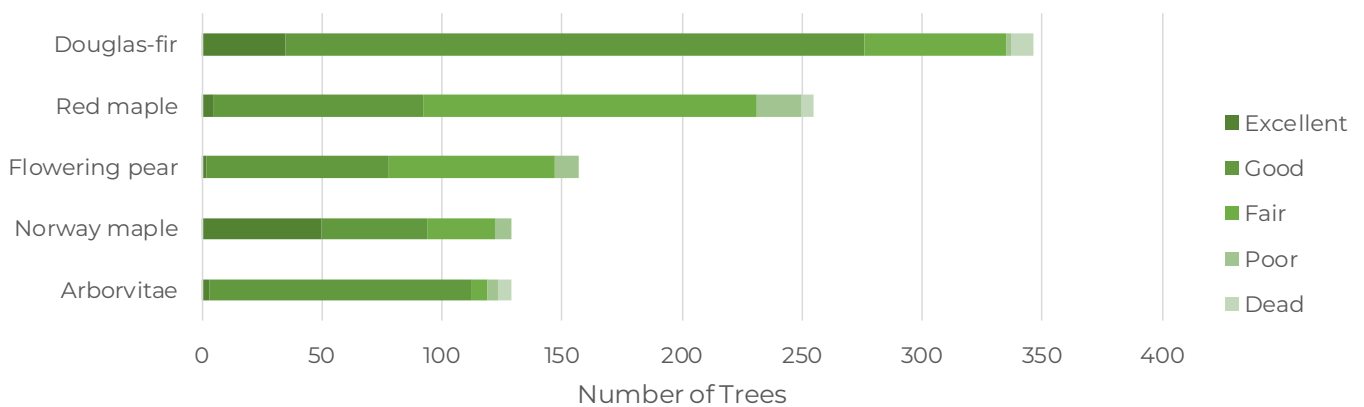
The Relative Performance Index (RPI) is a comparison of a species' condition rating of "Good" and the tree population's "Good" rating. Using the percent of Good trees for a given species divided by the tree population percentage of Good trees gives a value of equal to 1, less than 1, or greater than 1. A value equal to 1 means the particular species is as healthy as the overall tree population. A value less than 1 means the species isn't as healthy as the overall tree population. A value greater than 1 means the species is healthier than the overall tree population. RPI answers the question of how well a species is performing in terms of health compared to the entire inventoried population.

Table 12. | Relative Performance Index of top 5 species.

| Common Name | Total Counts | Total "Good" | Species % "Good" | City % "Good" | RPI |
|----------------|--------------|--------------|------------------|---------------|------|
| Douglas-fir | 542 | 394 | 73% | 52% | 1.41 |
| Red maple | 255 | 85 | 33% | 52% | 0.65 |
| Flowering pear | 157 | 76 | 48% | 52% | 0.94 |
| Norway maple | 147 | 54 | 37% | 52% | 0.71 |
| Arborvitae | 144 | 116 | 81% | 52% | 1.56 |

The table provides a summary of the RPI's in order of abundance in the tree population. Douglas-fir are most abundant and have a higher RPI (1.41) than all other common species except Arborvitae, which had the highest RPI (1.56). This demonstrates that hardier evergreen species tend to do better in this region than more delicate ornamental trees such as maples and pears, which are also abundant but offer much lower RPI's. A key issue is that 55% of red maples are only in "Fair" condition and will need to be monitored and improved. Young trees should be targeted since they can be more easily remediated.

Tree Health Conditions of Top Species



Relative Performance Index of Top Species

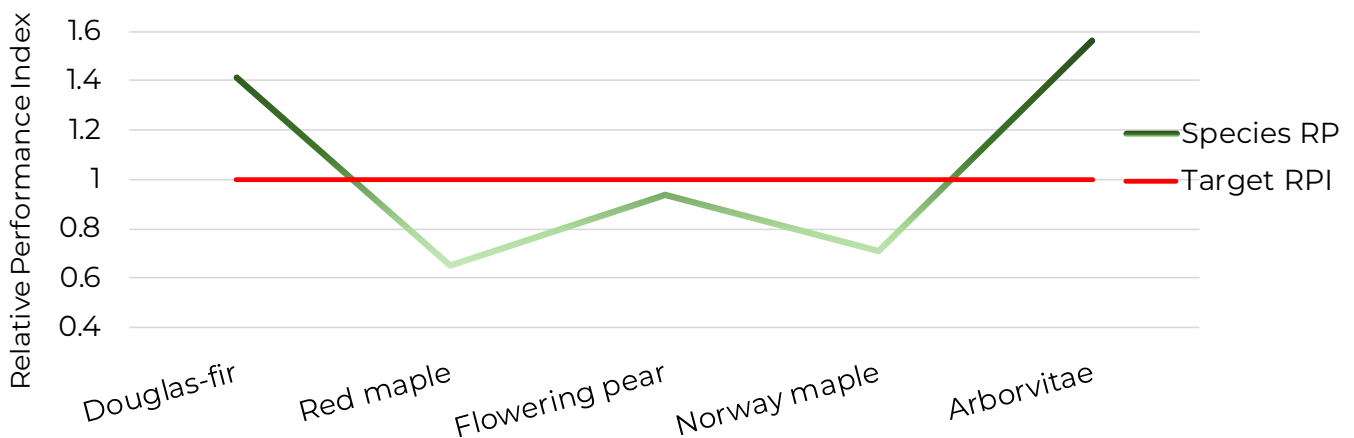


Figure 15. | Health conditions (top) and relative performance index (bottom) of the most prevalent tree species in the Tacoma Mall.

TREE DEFECTS OBSERVED

Tree observations were recorded during the 2019 inventory to further describe a tree’s health, structure, or location when more detail was needed. A total of 7,873 observations were recorded. Figure 16 below provides a summary of the observations recorded during the inventory. Note that trees may have more than one observation (or none). These observations can be used in combination with the condition and maintenance data to assist in the management of the Tacoma Mall’s urban forest.

A total of 2,445 trees (67%) are noted with at least one observation while 1,222 trees (33%) have no observation recorded. Private and public trees had similar proportions of trees with observations (67% compared to 68%) though the types of most common observations reported differed. “Co-dominant stems” was the most common observation of both public (37%) and private

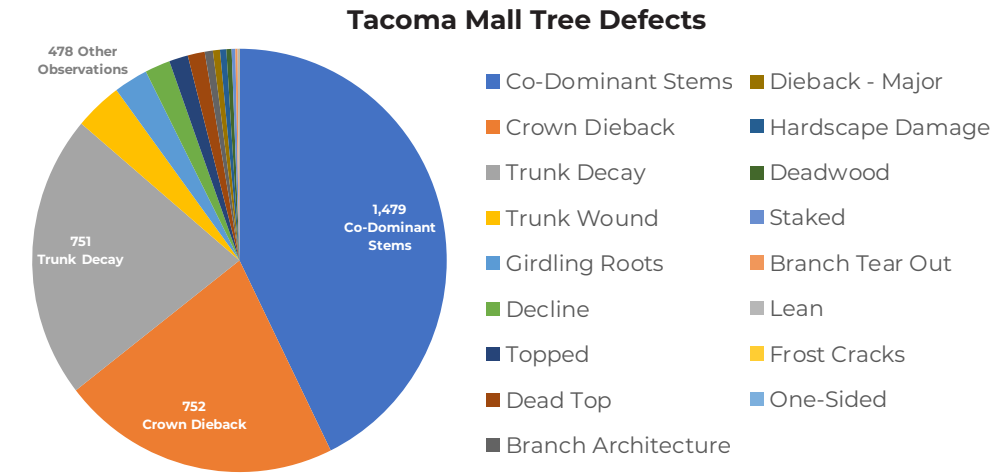


Figure 16. | Tacoma Mall tree defects observed. (Not all trees received an observation.)

(43%) trees, affecting 40% of all trees. Co-dominant stems result when a young tree is not properly pruned, allowing more than one large stem to emerge from the trunk. This gives the tree poor structural integrity and may eventually lead to tree failure. The prevalence of this observation in all Tacoma Mall trees indicates that establishing a routine pruning cycle and ensuring that young trees receive the structural pruning needed to properly train them should be top priorities when planting and maintaining new trees. The next most frequent observation was trunk decay in public trees (34%) and crown dieback in private trees (31%), which both could have resulted from multiple causes.

It should be noted that observations such as “co-dominant stems,” “trunk decay,” “trunk wound,” “girdling roots,” “topped,” “hardscape damage,” and “staked” are likely human-caused and could have potentially been avoided or are treatable. This is 2,436 of the 7,873 observations (31%). 1,222 trees had no defects observed, although all trees should be routinely observed to assess for any new maintenance issues.

MAINTENANCE NEEDS OF PUBLIC TREES

The inventory also required an assessment of the maintenance needs, if any, for each tree managed by the City (public trees). Table 13 on the right provides a summary of the primary removals required as well as pruning recommendations for Tacoma Mall’s public trees. A total of 535 of Tacoma Mall’s 1,599 public trees (33%) received a tree work task recommendation.

Table 13. | Tree work needed for public trees.

| Public Tree Work Tasks* | # of Trees | % of Top 10 | % of All Trees |
|-------------------------------|--------------|-------------|----------------|
| Prune-Clearance | 400 | 75% | 25% |
| Remove | 124 | 23% | 8% |
| Utility | 70 | 13% | 4% |
| Sidewalk Damage | 32 | 6% | 2% |
| Crown Cleaning | 12 | 2% | 1% |
| Remove-Stake | 20 | 4% | 1% |
| Remove Hardware | 25 | 5% | 2% |
| Remove-Girdling Root | 8 | 1% | 1% |
| Monitor | 27 | 5% | 2% |
| Not Specified | 1,064 | 0% | 67% |
| Trees Needing Any Work | 535 | 100% | 33% |
| Grand Total | 1,559 | -- | 100% |

*Definitions of tree work tasks available in Appendix.

Clearance pruning was the most prevalent task, recommended for 400 trees, or 25% of all public trees and 75% of all trees with any recommended task. Clearance pruning involves the removal of dead, dying, diseased, broken, poor structured, or attached limbs, often corrected or prevented during a recommended routine pruning cycle. Removal was recommended for 124 trees (8%). These trees are dead or dying and will pose a threat to public safety if not addressed, and should therefore be a top priority. Trees with other maintenance tasks or observations that are treatable should be addressed next. For example, trees with “girdling roots” have a structural root(s) that is encircling the trunk of the tree, and if these roots are not amended, they will eventually prevent the flow of water and nutrients through the cambium and kill the tree.

Tacoma Mall Public Tree Growing Spaces

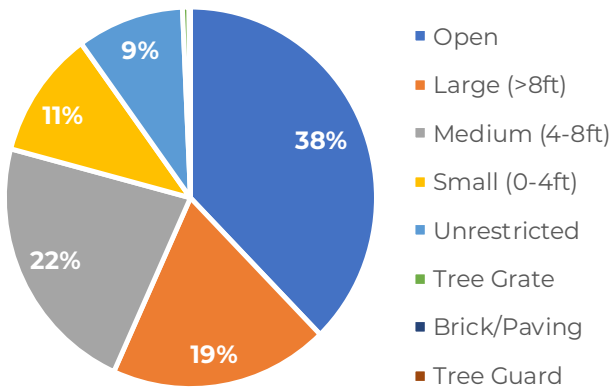


Figure 17. | Tacoma Mall tree public tree growing spaces.

Growing space was also recorded for public trees. This is important because the location a tree is planted can impact its ability to grow to its full potential. Trees in open environments are able to grow larger than those in restricted sites. Inappropriately placed trees also create avoidable conflicts with residents, developers, and hardscapes - creating costly maintenance. For this reason, growing space should be considered when locating and prioritizing potential new planting sites. 38% of public trees were found in an open space, and 9% were entirely unrestricted. The remainder could be found in small (11%), medium (22%) or large (19%) restricted spaces. 9 trees (1%) were found in a tree grate, along with 1 tree guard and 1 brick or paving site, which can all severely restrict growth over time and even kill mature trees if not addressed.

POTENTIAL PLANTING SITES

Since increasing canopy in the Tacoma Mall region is a high priority, vacant sites, also referred to as “potential tree planting sites”, were inventoried. These inventoried sites are not meant to be fully stocked within the planning horizon of this Action Plan but are meant to provide information for the City to utilize in all tree planting planning. Potential tree planting sites within public rights-of-way (ROW) were recorded based on their size/available growing space, possible wire conflicts, and adjacent land use.

A total of 1,081 possible planting sites were located. 459 were small sites (42%), 346 were large sites (32%) and 276 were medium sites (26%). Most sites (634 or 59%) did not have any potential wire conflicts, but 383 had a live wire overhead (35%) and 64 had a communication wire overhead (6%). In terms of surrounding land use, more than half of proposed

sites were found in residential areas, with 352 sites located in single-family residential areas and 207 sites in multi-family residential areas (33% and 19% of sites respectively, or 52% total). Small commercial areas contained 397 sites or 37%, followed by industrial/large commercial sites and parks.

Table 14. | Tacoma Mall proposed planting site sizes.

| Proposed Planting Sites | # of Sites | % |
|--------------------------------|--------------|-------------|
| Small Proposed Planting Sites | 459 | 42% |
| Medium Proposed Planting Sites | 276 | 26% |
| Large Proposed Planting Sites | 346 | 32% |
| Grand Total | 1,081 | 100% |

Table 15. | Tacoma Mall planting site wire conflicts.

| Planting Site Wire Conflicts | # of Sites | % |
|--------------------------------|--------------|-------------|
| No Overhead Lines | 634 | 59% |
| Overhead Lines - Live | 383 | 35% |
| Overhead Lines - Communication | 64 | 6% |
| Grand Total | 1,081 | 100% |

Tacoma Mall Public Planting Sites by Land Use

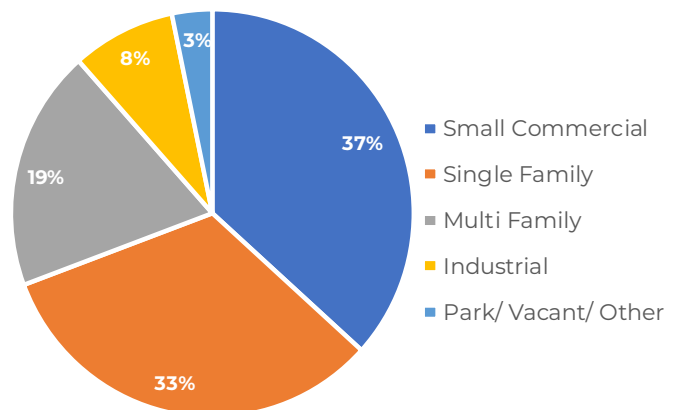


Figure 18. | Tacoma Mall planting site land uses.

VALUE AND BENEFITS OF INVENTORIED TREES

The community forest plays an important role in supporting and improving the quality of life in urban areas. A tree's shade and beauty contribute to a community's quality of life and soften the often hard appearance of urban landscapes and streetscapes. When properly maintained, trees provide communities abundant environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal. The trees growing along the public streets in particular constitute a valuable community resource. They provide numerous tangible and intangible benefits such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, education, and aesthetics. The services and benefits of trees in the urban and suburban setting were once considered to be unquantifiable, but with extensive scientific studies and practical research, these benefits can now be confidently calculated using tree inventory information.



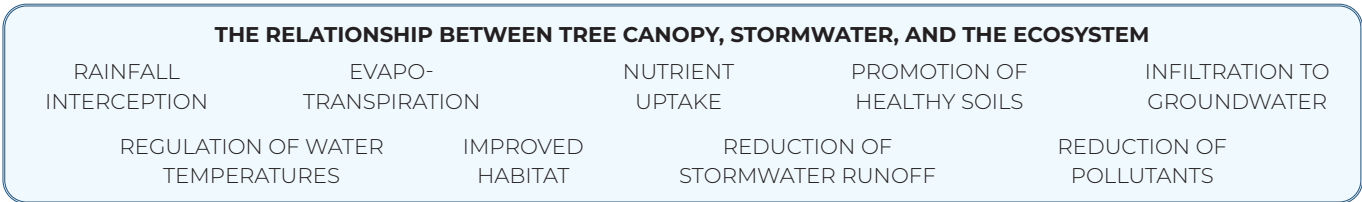
The results of applying a proven, defensible model and method that determines tree benefit values for the Tacoma Mall's public and private tree inventory data are summarized below. Using the Tacoma, WA TreePlotter™ INVENTORY application, all public and private trees within the Mall boundary were filtered and benefits were calculated based on U.S. Forest Service's i-Tree's data. The results of the tree inventory provide insight into the overall health of the Mall's public and trees and the management activities needed to maintain and increase the benefits of trees into the future. Currently, the greatest benefit of trees to the Tacoma Mall is coming from increased property value. Increasing the environmental benefits of trees from stormwater reduction, natural gas and energy savings, and carbon storage should be a top priority when deciding where to plant new trees.

Table 16. | Value and benefits of Tacoma Mall's existing public and private trees. Benefits were calculated using the Tacoma, WA TreePlotter™ INVENTORY app and based on USFS i-Tree research. (All values are reported in \$USD unless otherwise noted.)

| Benefit | Public Tree Value | Private Tree Value | Total Value |
|-------------------------------------|-------------------|--------------------|------------------|
| Stormwater Monetary Benefit | \$15,380 | \$12,981 | \$28,361 |
| Runoff Prevention (Gallons) | 1,424,100 | 1,201,950 | 2,626,050 |
| Property Value Total | \$69,081 | \$77,757 | \$146,838 |
| Energy Savings | \$6,336 | \$5,703 | \$12,039 |
| Energy Saved (kWh) | 99,626 | 89,673 | 189,299 |
| Natural Gas Savings | \$9,353 | \$9,438 | \$18,791 |
| Heat Prevention (Therms) | 10,317 | 10,410 | 20,727 |
| Air Quality Monetary Benefit | \$1,992 | \$1,475 | \$3,467 |
| Pollutants removed (lb) | 1,026 | 784 | 1,810 |
| Carbon Monetary Benefit | \$2,769 | \$2,680 | \$5,449 |
| Carbon Stored (lb) | 369,217 | 357,363 | 726,580 |
| Carbon Sequestered (lb) | 179,412 | 180,686 | 360,098 |
| Carbon Avoided (lb) | 219,687 | 197,739 | 417,426 |
| Total Monetary Benefit: | \$104,912 | \$110,035 | \$214,947 |

TREE CANOPY TO REDUCE STORMWATER

Urban tree canopy provides many benefits on stormwater for the Tacoma area. Tree canopy helps to reduce runoff from storm events at the site level and landscape scale by intercepting and evapotranspiring rainfall before it becomes runoff. In Western Washington, tree canopy intercepts an estimated 18–25% of the annual rainfall falling onto it (Herrera 2008), in turn reducing the amount of polluted runoff that makes its way into bodies of water such as Puget Sound. Average annual interception value varies depending on storm intensity. Small storms are characterized by high relative interception, and large storms are characterized by low relative interception. Adding tree canopy can mitigate the impacts of stormwater, such as flooding and degraded water quality. Decreasing tree canopy in favor of impervious surfaces can have the opposite effect, increasing runoff and water-delivered pollutants. The Puget Sound Urban Tree Canopy and Stormwater project for King County provided resources to fuel productive conversations between the urban forestry and stormwater communities about the role of tree canopy in mitigating stormwater- and runoff-related issues.



METHODOLOGY

The Puget Sound Urban Tree Canopy and Stormwater project fueled these discussions between urban foresters and stormwater communities by comparing analyses from the modeling tools used by King and Pierce county communities — the first-ever direct comparison of stormwater models applied to urban forests in the Pacific Northwest. The two models were:

- **i-Tree Hydro**, designed to inform forestry managers of the effects of urban tree canopy and impervious cover on changes in streamflow
- **The Western Washington Hydrology Model (WWHM)**, designed to inform planners, engineers, developers and managers on best management practices for meeting stormwater regulatory requirements

The project involved four pilot communities (the cities of **Kent, Kirkland, Snohomish, and Tacoma**), and four spatial scales (**city, drainage basin, neighborhood, and parcel**) to demonstrate the practical applications of the two models. The Tacoma Mall was used at the Neighborhood scale for the Tacoma pilot community analysis. The land cover percentages for the area are shown in Table 4 in the previous section. Land cover percentages for each city and scale were entered into each model along with precipitation, topology and stream gage data and run in six different scenarios. The six scenarios modeled focused on analyzing increase or decrease (percent change) in stormwater runoff over a six-year period, and based on three variables: loss of tree canopy; changes to tree canopy and impervious area resulting from development; and increases in tree canopy from current canopy levels

Table 17. | Descriptions of the models used in the Puget Sound Tree Canopy and Stormwater Project.

| i-Tree Hydro | WWHM |
|---|---|
| <i>i-Tree is a suite of tools developed and supported by the United States Department of Agriculture (USDA) Forest Service and the Davey Institute. i-Tree Hydro is the first vegetation specific hydrology model, which predicts stream flows and water quality at a landscape scaled based on changes in impervious surfaces and urban tree cover. It is meant to inform forestry managers and communities of the benefits of their urban forest. Other i-Tree software tools that include stormwater-related benefit analysis are i-Tree Eco and i-Tree Landscape.</i> | <i>The Western Washington Hydrology Model (WWHM) is used to evaluate mitigation practices, primarily stormwater flow control and treatment facilities for runoff generated from development in the western region (west of Cascade Mountain Range) of Washington. WWHM is designed to inform planners, engineers, developers and managers on best management practices for meeting stormwater regulatory requirements when implementing different land use changes in a project area.</i> |

KEY FINDINGS

Overall, the results of the project showed that increasing canopy has a positive impact on stormwater runoff. The decrease in stormwater runoff varied with the different amounts of different land cover types such as impervious. After the analysis of all cities at all scales, there were some key findings that could apply to all results:

- In nearly all modeled scenarios, **i-Tree Hydro** yielded lower runoff volumes, and therefore a lower benefit of tree canopy than **WVHM**.
- **Increase in tree cover over impervious surfaces results in decreased runoff volumes.**
- Development that includes **tree retention results in reduced runoff volume** compared with development without tree retention.
- Scenarios where tree canopy is replaced with any other land cover type, including herbaceous layers or impervious area, result in **increased runoff volume**.
- Areas with **higher existing tree canopy coverage** experience a lower magnitude of runoff volume when tree canopy is reduced.

Table 18. | Results (Scenario 1A) of two stormwater runoff models in relative change (volume: ft³ and %) in four Pacific Northwest communities.

| City | Neighborhood | Area (Acres) | i-Tree Hydro Runoff Avoided | WVHM Runoff Avoided | Avoided Runoff Range |
|-----------|-------------------|--------------|-----------------------------|---------------------|----------------------|
| Kent | Lower Mill Creek | 138 | 2.0 million | 1.4 million | 1-2% |
| Kirkland | Wolff | 13 | 0.3 million | 0.4 million | 4-14% |
| Snohomish | Historic District | 77 | 0.4 million | 0.2 million | 1-5% |
| Tacoma | Tacoma Mall | 589 | 1.0 million | 5.0 million | 0-2% |

Tacoma Mall Stormwater Runoff Scenario Results

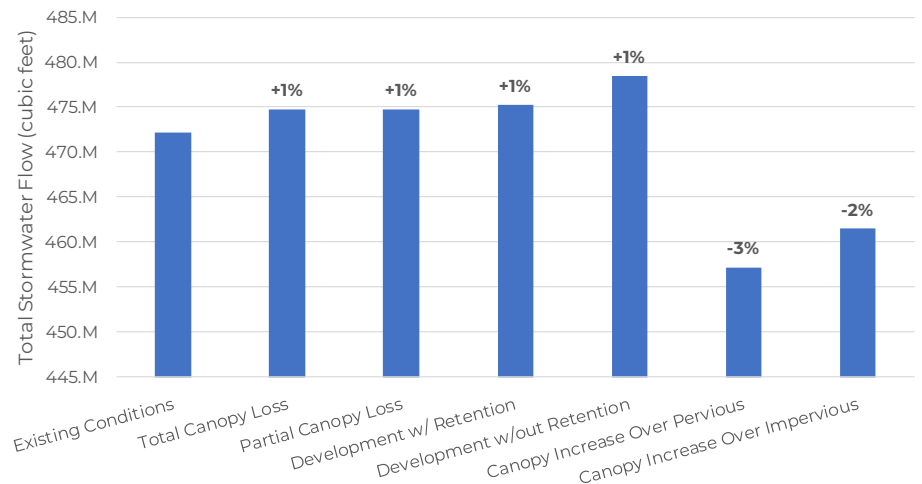
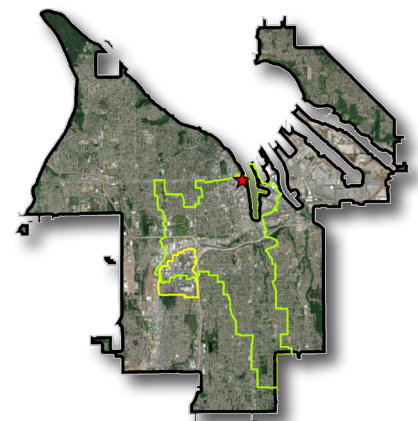


Figure 19. | Results of the six potential future scenarios for the Tacoma Mall.

Figure 20. (right) | Map showing the City of Tacoma, used as a pilot community in the 2019 Puget Sound Tree Canopy and Stormwater Project. Results were calculated at several scales: the full City area, the nearest drainage basin (green outline), the Tacoma Mall neighborhood (yellow outline), and parcels.



Generally, an increase in tree canopy in the Tacoma Mall area resulted in a decrease in stormwater runoff, while a decrease of tree canopy resulted in an increase of stormwater runoff. However, the Tacoma Mall results varied in some ways compared to other cities and geographic scales. The high amounts of impervious surface in the Tacoma Mall area were reflected in both model's results when each Scenario was run, demonstrating higher increases in runoff (even when the scenario involved tree retention during development). With the very high percentage of impervious surfaces (76%) in the Tacoma Mall area, an increase in canopy over those impervious surfaces (and increase in tree canopy in general) would have great benefit to the stormwater runoff volumes and water quality for the surrounding area.

CONCLUSION AND RECOMMENDATIONS

Street trees are a defining and valued characteristic of any neighborhood that make communities a desirable place to live, work, shop and play. The urban forest is also one of the only infrastructural resources that will continue to offer increasing benefits to its community over time. As the Tacoma Mall neighborhood prepares for widespread planned development, planting and maintaining a healthy urban forest should be a top priority of City departments, developers, property owners and managers, residents and community members alike. The Mall region should strive to achieve a routine monitoring and maintenance schedule of all trees and continue to plant trees, especially alongside new commercial and residential developments, to enhance the beauty of the area and the benefits that trees provide. Achieving the recommendations set forth in this Action Plan will maintain a healthy and sustainable urban forest valued by its constituents.



OVERVIEW OF RECOMMENDATIONS FOR TACOMA MALL

Tree Program Recommendations

- *Ensure industry standards and **best management practices** are followed during the planting and care of trees.*
- *Clearly establish, define, and communicate the maintenance responsibility of trees in the **public rights-of-way**.*
- *Continue to track maintenance, plantings, and removals in the **TreePlotter application**.*
- *Conduct a complete inventory of the Mall's tree population **5-10 years** from the 2019 inventory.*

Tree Maintenance Recommendations

- *Maintain or establish a cyclical, routine tree **monitoring and maintenance schedule** and conduct **routine tree maintenance** to address needs identified by the inventory results.*
- *Address the **high risk** trees (e.g. removals) accordingly, and evaluate lower risk trees and address accordingly (e.g. prune, remove girdling roots, etc.).*
- *Monitor trees less than **fair** condition, especially young red maples which are prevalent and disproportionately "fair."*

Tree Planting Recommendations

- ***Plant** new trees in proposed planting sites and wherever dead trees are removed.*
- *Prioritize planting sites in areas that have **low existing canopy, high impervious area**, and plenty of available planting spaces.*

Outreach and Education Recommendations

- ***Educate** the residents, businesses, and community about the tree inventory population, the associated benefits, and the City's urban forestry program.*
- *Consider **engaging the community members** in the care of young trees (watering, structural pruning, mulching, etc.) under supervision and instruction by trained staff.*

TREE PROGRAM RECOMMENDATIONS

The maintenance responsibility of trees in public areas varies throughout the Tacoma Mall area. Responsibility may be of the City, adjacent property owner, City partner, organization, or a combination of these entities. The following recommendations should be applied regardless of the responsible individual(s).

A healthy urban forest is strategically planned to contain a diverse distribution of tree species that are properly managed to reduce potential risks to the public. Programmatic recommendations to be implemented by the City, its partners, and trained individuals such as “tree stewards” should include the tracking of tree maintenance activities and plantings in the TreePlotter™ software application. This data will provide the information to monitor the urban forest’s diversity and manage potential tree risk.

Newly planted and existing trees should be protected during construction by adhering to City policies and standards as described in the Tacoma Municipal Code, Tacoma’s Urban Forest Manual, and as updated by the Citywide Urban Forest Action Plan. Examples of these industry standards include the American National Standards Institute’s (ANSI) A300 Pruning Standards and the International Society of Arboriculture’s (ISA) Best Management Practices (BMPs).

A tree management program in the Tacoma Mall area should be established that defines the appropriate tree maintenance cycles, tree inventory and assessment methods, maintenance responsibility, and other measures to maintain the urban forest.

The program should consider outreach and education to the residents and business owners in the Tacoma Mall area for the care and enhancement of trees on private property. Tree assessments on both public and private property should include the monitoring of exotic tree pests and diseases that pose threats to individual trees and the urban forest.



TREE MAINTENANCE RECOMMENDATIONS

As stated above, the maintenance responsibility of trees varies within the public rights-of-way. Established and newly planted trees require proper tree maintenance practices to maintain a healthy, safe, and thriving urban forest.

Trees across the Tacoma Mall area vary in species, size, age, condition, and maintenance need that necessitates a strategic maintenance approach to effectively care for trees in public areas. Using the City's tree inventory management software, maintenance should be planned, prioritized, and scheduled by the following categories:

- 1) Trees requiring **removal**;
- 2) Trees requiring **clearance pruning**;
- 3) Tree **pest** and/or **disease** treatment;
- 4) Trees requiring **monitoring** (e.g. fair condition trees);
- 5) **Routine pruning** of established trees; and
- 6) **Training pruning** of newly planted trees.

An overview of recommended maintenance activities for public trees recorded during the inventory is provided in the Tree Inventory Maintenance section.

Using these recommendations as a guide, the City should have qualified staff evaluate the recommended removals and amend issues, if possible, or remove the tree if necessary (removal timing based on priority and available budget). The urban forestry program in the Tacoma Mall area should also budget and prepare for natural tree mortality, hence the need for continued monitoring of the urban forest. Trees in a highly urbanized region such as the Tacoma Mall face many threats and will need continuous monitoring and care.

Following the mitigation of the identified priority tree maintenance and removals as a systematic and routine pruning cycle of established and mature trees is recommended. To establish a cycle that effectively manages every public tree in the Tacoma Mall area, grid or planning areas should be established based on tree maintenance responsibility (i.e. City vs. property owner), geographic location, tree density, and tree species. Effectively maintaining trees in public areas to reduce clearance issues, improve tree structure and health, enhance ecosystem benefits provided, and maintain public safety can be achieved by properly pruning every tree on a 5-year cycle.

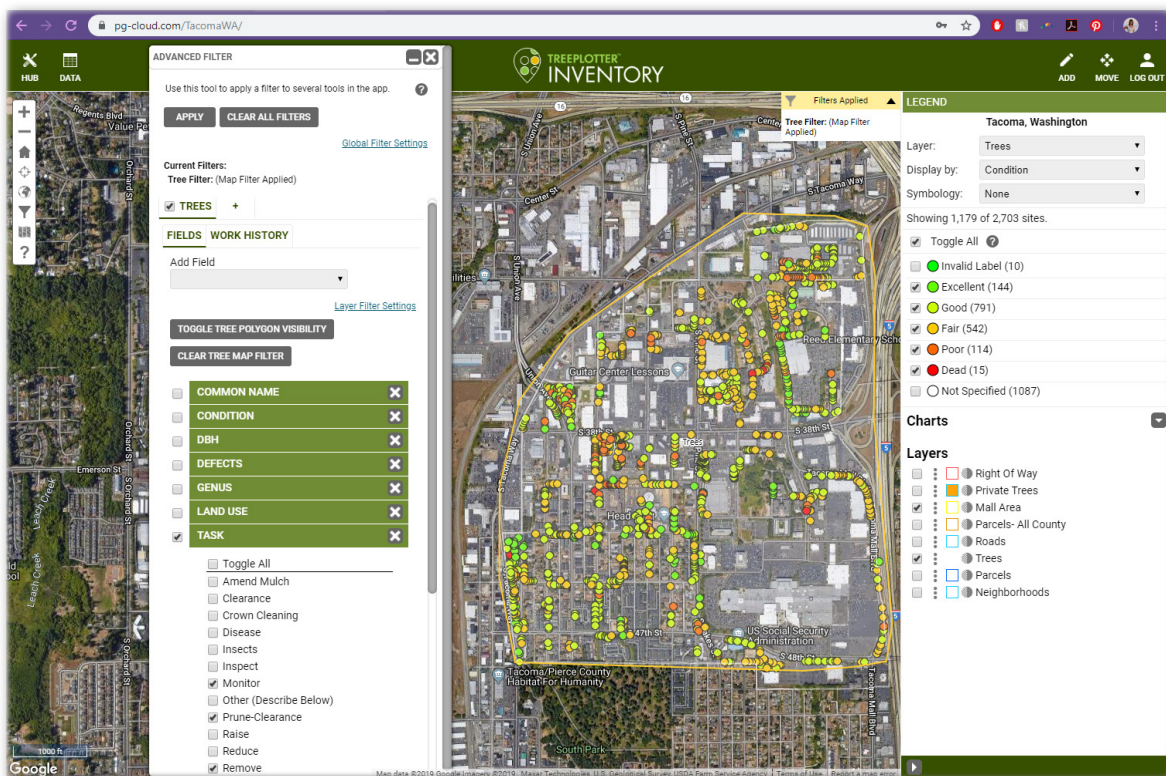


Figure 21. | An example of how the Tacoma, WA TreePlotter™ custom software application can be used to filter the Tacoma Mall region's public trees to track and prioritize maintenance scheduling. In this screenshot, all public trees are displayed by condition (legend, right). Once applied, the filter would display only the trees with maintenance tasks to monitor, prune, or remove (advanced filter, left). Trees can be filtered by any field.

Routine pruning consists of clearance pruning (clearance from signs, sidewalks, roads, buildings, infrastructure), cleaning (removing of dead/dying/diseased/decayed branches), structural (removal of weakly attached limbs with included bark and removal of co-dominant stems), and aesthetics (based on natural growth and flowering habits) by adhering to the ANSI A300 Pruning Standards and ISA BMPs. Young and newly planted trees should be maintained on a shorter cycle than established and mature trees because of their rapid growth, in general, and response to maintenance. Proper young tree pruning and training pruning can establish a tree with a healthy, strong stature reducing future maintenance needs and costs.

It is recommended that every tree planted in the Tacoma Mall area be monitored within 6 months of planting to assess watering, staking, mulching, and plant health care needs. After establishment to the planting site (~3 years), each tree should be pruned to “train” the shape and growth habits according to the ANSI A300 Standards and ISA BMPs. Generally, trees less than 6-inches in diameter are young trees to be included in this tree maintenance regime. Due to the rapid growth of young trees, it is recommended that this cycle—possibly using the same grid system as established tree cycles—occur on a 3-year basis (i.e. every young tree pruned within 3 years until established and/or greater than 6-inches in diameter).

TREE PLANTING RECOMMENDATIONS

To achieve the Citywide canopy goal of 30%, Tacoma Mall established its own localized and specific canopy goal of 25% canopy coverage by 2040, detailed in the Tacoma Mall Subarea Plan. It is recommended that the tree programs (City and partners) in the Tacoma Mall area establish an aggressive tree planting schedule to achieve Citywide tree canopy goals, enhance the ecosystem benefits, and complement its new planned development. In this way, the urban forest can grow with the neighborhood and provide many ecological, economic, and social benefits to the community.

All private and Capital Projects shall adhere to City policies and at a minimum, every tree that is removed in a public area should be replaced with a new tree appropriate for the site and overall program objectives. New trees should be planted in empty planting sites according to priority as identified in the 2019 inventory and in coordination with other Citywide projects. For example, the Madison District is undergoing major infrastructure improvements which may require the removal of existing trees. Tree plantings should not occur without the cooperation of all parties involved and the timing should align with planning and construction efforts to enable mutual agreements, accomplishment of objectives, and tree survival. The streets in Madison District will be completely replanted which presents a unique opportunity for the City to design its urban forest.

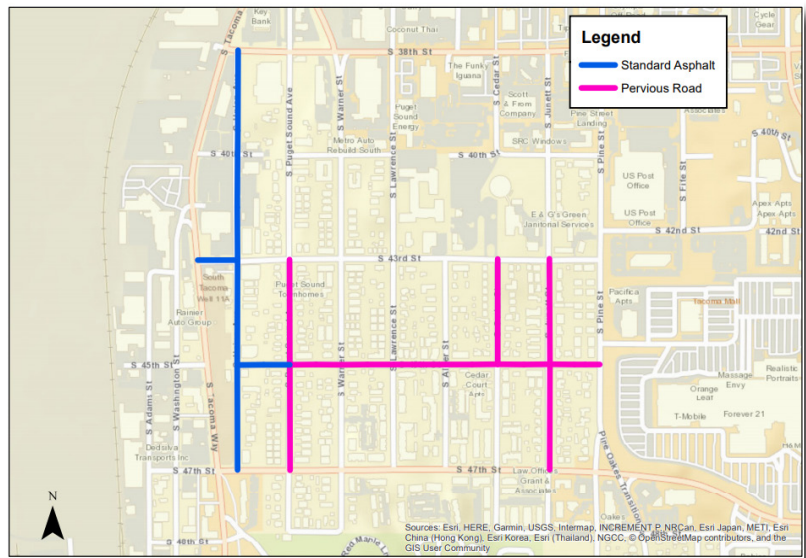


Figure 22. | Map showing a planned green infrastructure project in the Madison District that will require removal and replanting of all trees.

When planning for new trees, attention must be given to ensure a proper tree species, location, and timing (based on the inventory data) are selected to help create a diverse urban forest in terms of species composition and age structure. Newly planted trees must be properly cared for (mulching, watering, training prune, plant health care).

It is recommended that more trees be planted than replaced, but the future costs of these additional trees must also be considered. These future costs can potentially be reduced by conducting young tree training as described above—establishing the lowest permanent branch, proper scaffolding of branches, healthy branches and limbs, and a central stem without competing co-dominant and/or poorly attached stems.

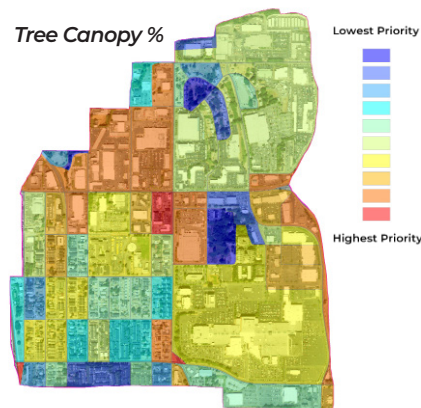
When selecting species for new and/or replacement plantings, the landscape architecture and building architecture of the Mall area can be incorporated to achieve a cohesive vision for the region. These tree plantings in public areas should be based on the City’s recommended tree species list, tree diversity targets, community and adjacent property owner’s interests, goals for equity and enhancement of ecosystem benefits, and sustainability of the urban forest.

PLANTING SITE PRIORITIZATION

A planting site prioritization ranking was calculated based on several possible canopy goals. This analysis was conducted at the census block scale to provide recommendations using a common planning boundary that is easily identifiable. Using the results from the 2018 Tree Canopy Assessment, a planting priority rank for each census block in the Mall was determined from lowest to highest. Prioritization scores were calculated for the following planting themes:

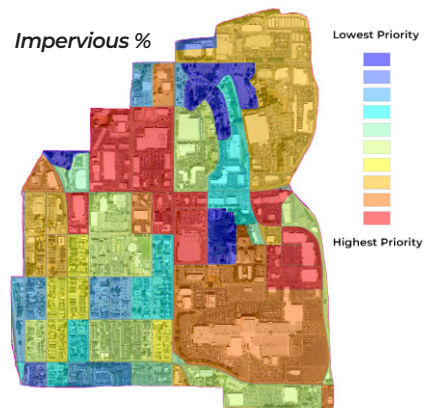
Areas with low existing canopy

To promote environmental equity and ensure an even distribution of the many benefits of trees, census blocks with the lowest existing percentage of urban tree canopy by area were selected. Planting trees in these areas will not only increase the overall urban tree canopy throughout the Tacoma Mall neighborhood, but also help to bring the most canopy-deficient blocks to canopy cover levels similar to the surrounding area.



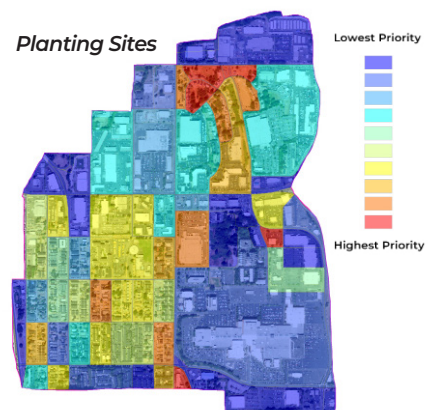
Areas with high impervious area

The Puget Sound Tree Canopy and Stormwater Project describes how tree canopy is most influential in reducing stormwater when trees are planted in areas with a high percentage of impervious surface areas (i.e. parking lots, buildings, and roads), particularly when canopy overhangs these surfaces. To promote stormwater benefits, census blocks with the most impervious surfaces by area were selected.



Areas with the most available planting sites

An important consideration when deciding where to plant new trees is also, simply, where there is available space to plant them. To provide an assessment of this theme, the number of possible planting sites in each census block was counted, and the blocks with the most planting sites per-acre were selected.



Overall priority ranking

To achieve one simplified “master” prioritization ranking, a composite priority ranking was determined from the sum of scores of the three priority planting themes described above. Results of the master prioritization are presented on the next page.

Figure 23. | Census block prioritization maps by theme.

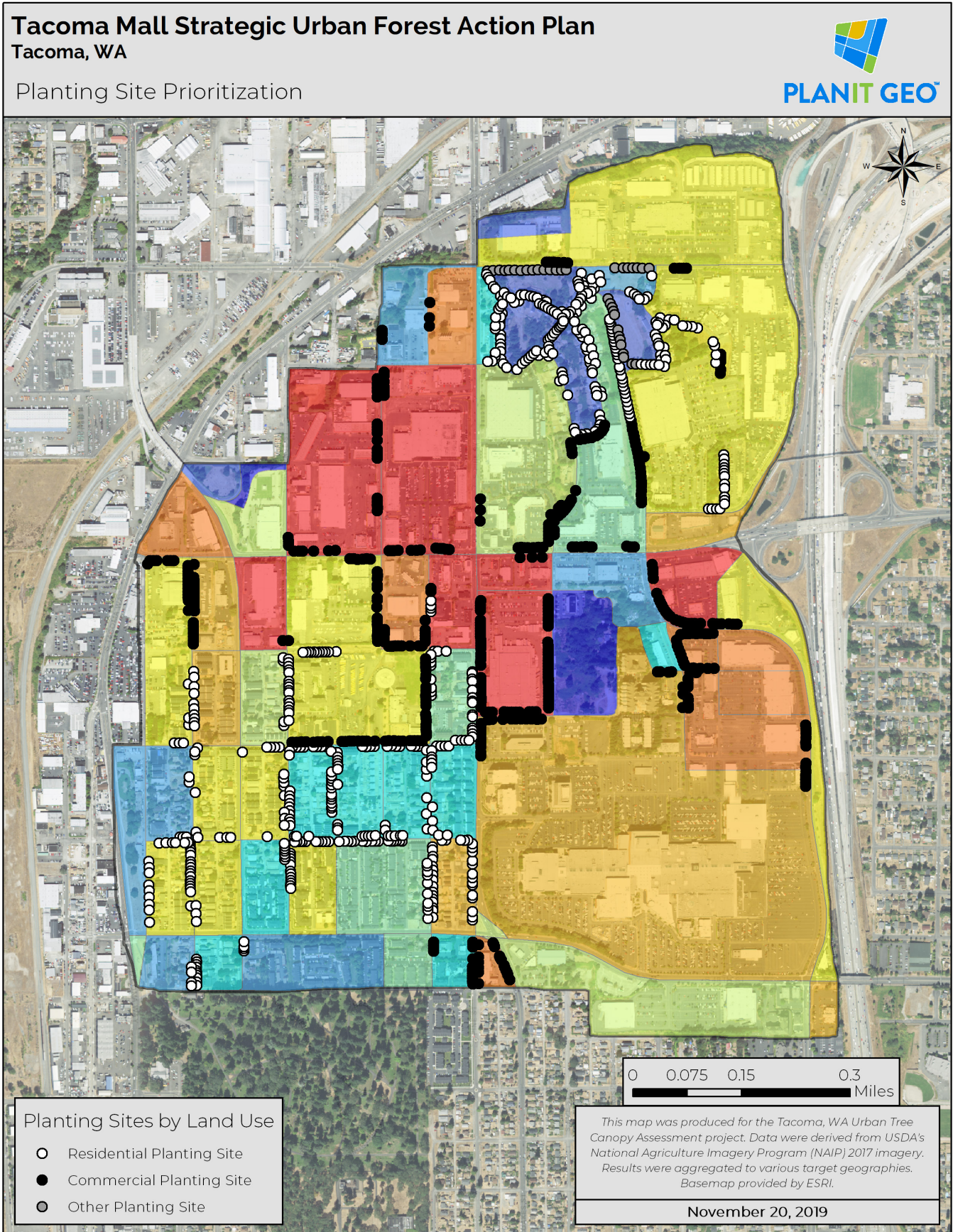


Figure 24. | Master census block prioritization map, which considers areas with low existing tree canopy, high impervious land cover, and high possible planting sites identified in the inventory.

OUTREACH AND EDUCATION RECOMMENDATIONS

The City of Tacoma’s Urban Forestry Program has the authority to plant trees in public areas of the Tacoma Mall Neighborhood but these plantings should be a shared effort between the City, its partners, and the residents. Achieving canopy goals and a healthy urban forest can only be achieved through this partnership, especially important because of the shared maintenance responsibility of public trees across the neighborhood. The City should look for opportunities to partner with property managers, business owners, developers, landscapers, homeowners, local residents, and community groups in order to achieve urban forestry goals for the Tacoma Mall area. The following section includes specific tools that can be used to approach target audiences in residential and commercial land use areas that can be used to strategically engage the right people and inspire stewardship action for Tacoma Mall’s urban forest.

Residential areas contain the most available planting space in the Tacoma Mall Regional Growth Center, but commercial areas contain the most high-priority sites.

STRATEGIES FOR RESIDENTIAL AREAS

Residential areas contain more than half of all proposed planting sites identified during the 2019 Tacoma Mall public tree and planting site inventory. 52% of all sites are found in Single-Family (33%) or Multi-Family (19%) residential land uses. Residential areas offer additional opportunities to promote the planting and maintenance of trees that their commercial counterparts may not because people live in these areas, and residents, families and community organizations tend to be most interested in supporting the communities where they personally live. To promote the value, protection, and expansion of the urban forest in the Tacoma Mall neighborhood’s residential areas (on private property and public rights-of-way), the City should take steps to engage the surrounding community members who live in these areas and incentivize private tree planting and stewardship.

RESIDENTIAL AREA TARGET AUDIENCES



**Homeowners
& Local Residents**



**Neighborhood Organizations/
Community Groups**



**Housing
Developers**



**The City of Tacoma
and Its Partners**

The key messages to local families and community groups in residential areas should focus on the ways that trees improve the residents’ quality of life. Parents will be happy to know that areas with higher urban tree canopy cover have been correlated with lower rates of childhood asthma, heart disease, and other human health indicators. Tree canopy also improves neighborhoods by providing aesthetic benefits and providing an increased sense of well-being by making streets more attractive, improving walkability due to shade, and inviting local wildlife such as birds. For homeowners, property managers, and residential developers, trees can decrease energy costs due to their ability to regulate temperatures and have even been linked with increased property values and decreased crime rates. These messages can be tailored to both the owner-occupied and renter-occupied properties.

Activities that encourage residents to plant trees on their own property, such as tree giveaways or property tax benefits, will help to increase canopy in the Tacoma Mall’s residential areas; however, strategic planning must occur for pre- and post-planting processes and procedures. Tree species and age diversity planning should be a priority to promote continuous, shared benefits. This information can be distributed by publishing a street tree list based on the data in this Action Plan to the general public. For example, Douglas-fir trees have a higher RPI (relative performance indices), meaning they perform well in the Tacoma Mall area compared to other common species such as red maples. This does not imply an increased planting of Douglas-firs but should be a consideration among other factors when choosing tree species for planting sites. Following the planting of trees, continued maintenance is crucial. The maintenance regime and responsibility should be established prior to planting and effectively implemented. Establishing a routine pruning and monitoring schedule for all trees will help to reduce the possibility of human-caused and structural tree defects, reduce exotic tree pest and disease issues, maintain public safety, and ensure the longevity of the trees. The City can share this role by identifying local community groups to engage in tree planting and stewardship, with an emphasis on engaging and training youth, under the supervision of trained arborists.

STRATEGIES FOR COMMERCIAL AREAS

Commercial land use contain 45% of the available planting sites identified during the 2019 inventory. Sub-categories within commercial land use consist of small commercial (37% of the planting sites) and large commercial or industrial areas (8% of the planting sites). Most of the proposed planting sites identified in the highest-priority census blocks according to the map on page 25 were also located in commercial areas. These areas also tend to have less existing canopy and other vegetation (like grass or shrubs) and more impervious surfaces (like parking lots and large buildings) than the adjacent residential areas. To leverage the greatest potential benefits of new trees, many trees should be planted in commercial areas. To promote the planting and maintenance of trees in commercial areas, the City should focus on communicating with those who manage and work in these areas.


COMMERCIAL AREA TARGET AUDIENCES




**Commercial
Developers**



**Business Owners &
Property Managers**



**Landscaping
Companies**



**The City of Tacoma
and Its Partners**

The key messages to commercial developers, property managers, and business owners should emphasize the economic benefits of planting and caring for trees. These conversations and messages should include the potential costs of not maintaining trees properly. Aside from the more obvious tree benefits mentioned previously, such as their ability to conserve energy and reduce building cooling costs, trees can even boost consumerism in commercial areas by making the surrounding environment more inviting to visit, linger, and shop. Most notably, these desired habits of potential consumers are achieved by providing shade over parking lots and sidewalks. The City of Tacoma’s design standards requiring trees for lots and shading over lots should be adhered to. In these highly industrialized, impervious regions, the stormwater benefits of trees are also especially pronounced and can be leveraged by property owners to gain stormwater credits where applicable.

Just like in residential areas, the greatest challenge in achieving a higher canopy coverage in the Tacoma Mall’s commercial areas will not be simply planting trees, but planting the right trees with attention to species and size and maintaining them over time. For example, when selecting trees to plant, it should be considered that small trees will remain in conflict with views of business signs while large trees will surpass sign heights and improve views with proper care. Tree maintenance for clearance, including young tree training and mature tree pruning, is essential to prevent human-caused and structural tree defects, outbreaks of pests or diseases, and threats to public safety. Businesses can assure these maintenance needs are met by hiring competent and certified tree and landscaping companies that follow industry standards and best management practices. It is recommended that workshops and educational materials be provided to the commercial property audience regarding proper tree planting and maintenance. These practices should be demonstrated by the Tacoma Mall tree program in all public areas as a model for other sectors to follow.

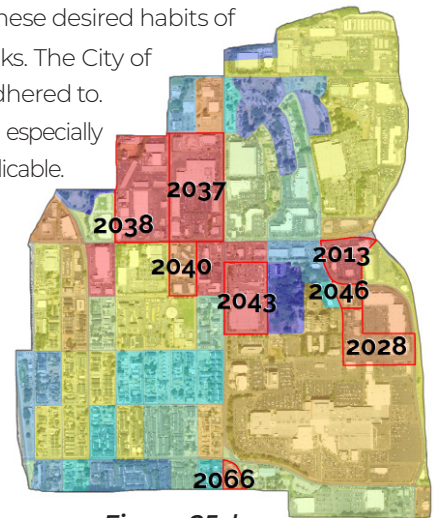


Figure 25. | High overall priority census blocks with at least 20 commercial planting sites.

CONCLUSION

Tacoma Mall’s trees are a valuable asset that, if planned and cared for, will continue to add to the health and well-being of the residents, businesses, and visitors. Everyone benefits from the proper care and enhancement of the urban forest. This Action Plan serves as a road map outlining meaningful, high-priority actions that the City of Tacoma and its partners should take to strive towards the vision of a healthy, thriving urban forest in the up-and-coming Tacoma Mall regional growth center. This means addressing maintenance needs, continually monitoring the urban forest, planting more trees than removed, responding to the challenges of climate change and other environmental factors, and engaging the community. This Plan functions both as a management tool for tree managers and provides transparency to the public regarding the future of the Tacoma Mall neighborhood. The City should begin to implement recommendations in this Plan as soon as possible to ensure a healthy, thriving, and sustainable urban forest.

APPENDIX

TREE WORK TASK DEFINITIONS:

Prune-Clearance: The pruning of tree branches for appropriate clearance from sidewalks, roadways, signs, and utilities using best practices.

Prune-Routine: The regularly-scheduled pruning of established trees to preserve existing mature canopy and reduce potential risk.

Prune-Training: The pruning of newly-planted and young trees to help “train” their growth for optimal structure.

Remove: The removal of a tree due to a decline in tree health or a irreparable tree issue posing a potential or existing risk.

Monitor: Tree may need continued assessments to determine the maintenance need.

Utility: Tree maintenance typically including the trimming of branches or limbs for clearance of utilities i.e. service wires.

Not Specified: Tree was not given a tree work task.

TREE CANOPY ASSESSMENT DEFINITIONS:

Total Acres: Total area, in acres, of the assessment boundary.

Land Acres: Total land area, in acres, of the assessment boundary (excludes water).

Urban Tree Canopy (UTC): The “layer of leaves, branches and stems that cover the ground” (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of Tacoma’s urban forest. Tree canopy was generally taller than 10-15 feet tall.

Non-Canopy Vegetation: Areas of grass and open space where tree canopy does not exist.

Possible Planting Area - Vegetation: Areas of grass and open space where tree canopy does not exist, and it is biophysically possible to plant trees.

Possible Planting Area - Impervious: Paved areas void of tree canopy, excluding buildings and roads, where it is biophysically possible to establish tree canopy. Examples include parking lots and sidewalks.

Possible Planting Area - Total: The combination of PPA Vegetation area and PPA Impervious area.

Sidewalk Damage: The upheaval and/or cracking of sidewalks due to tree roots and/or tree trunk and not due to other causes. Remediation is based on a case-by-case, tree-by-tree basis.

Crown Cleaning: The pruning of established and mature trees to remove dead, diseased, decayed, dying, or poorly structured branches while adhering to industry standards and best practices.

Remove-Stake: Newly planted trees often receive stakes for stability that need to be removed once established or stake is impeding growth or health.

Remove Hardware: Hardware may include ties for the tree stakes that need removed to not impede growth or health.

Remove-Girdling Root: Roots may encircle the trunk of a tree due to poor soils, excessive watering, poor mulching practices, and/or poor nursery quality and the girdling root needs to be severed and/or removed if it will not affect the health of the tree. This will prevent the tree from “choking” itself as it grows into the root, cutting of nutrient and water uptake.

Shrub: Low-lying vegetation that was classified based on interpretation of shadows and texture in vegetation. Shrubs produce little to no shadow and appeared smooth in texture compared to tree canopy.

Soil/Dry Vegetation: Areas of bare soil and/or dried, dead vegetation.

Impervious: Paved areas such as roads, sidewalks, buildings, parking lots, trails, and swimming pools.

Unsuitable Planting Area: Areas where it is not feasible to plant trees. Airports, ball fields, golf courses, etc. were manually defined as unsuitable planting areas.

Unsuitable Impervious: Areas of impervious surfaces that are not suitable for tree planting. These include buildings and roads.

Unsuitable Soil: Areas of soil/dry vegetation considered unsuitable for tree planting. Irrigation and other modifiers may be required to keep a tree alive in these areas.

Unsuitable Vegetation: Areas of non-canopy vegetation that are not suitable for tree planting due to their land use.

Water: Areas of open, surface water not including swimming pools.

Strategic Urban Forest Action Plan

Urban Tree Canopy

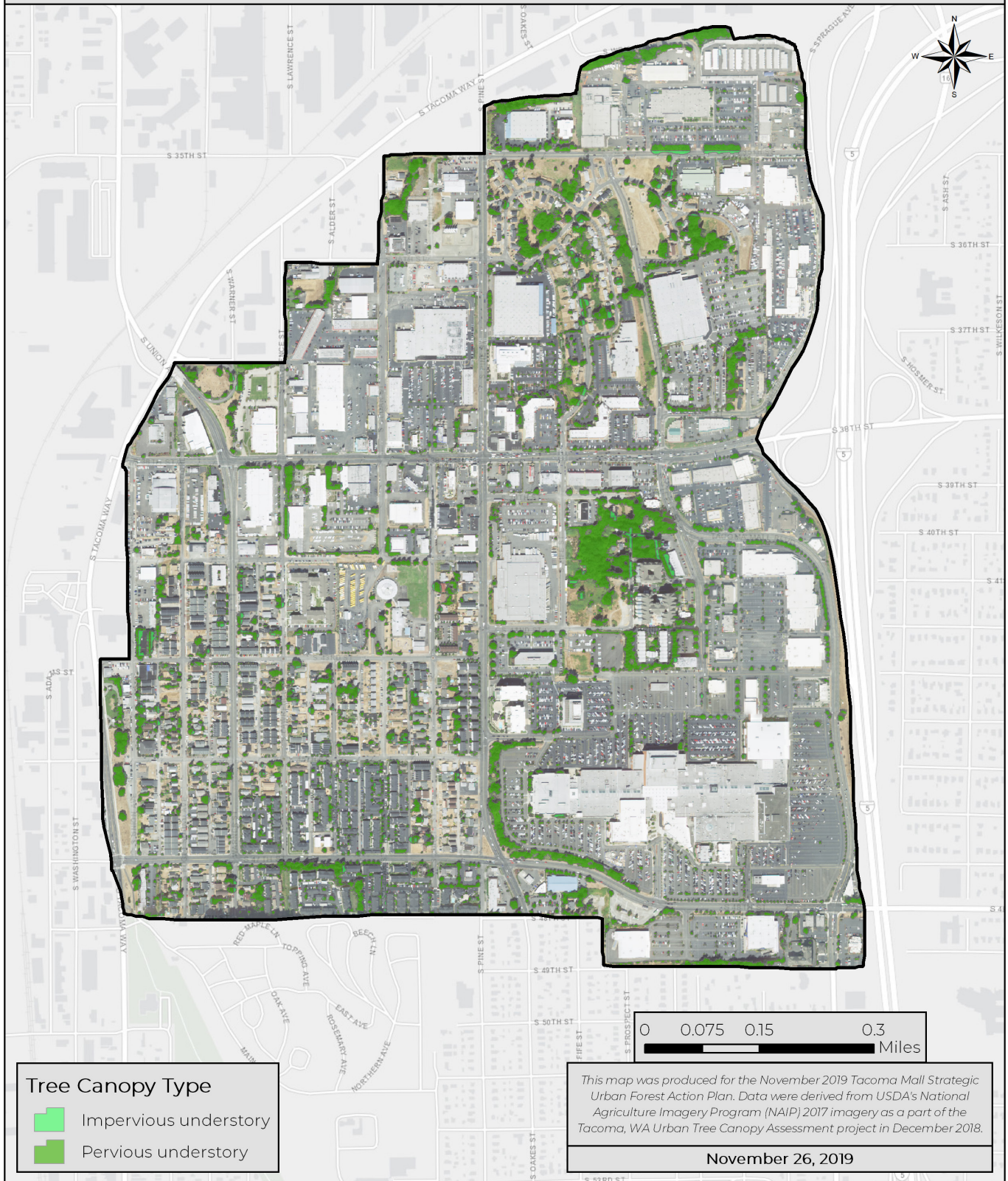


Figure A1. | Map of existing urban tree canopy in the Tacoma Mall Regional Growth Center.

APRIL 2020

TACOMA MALL

STRATEGIC URBAN FOREST
MANAGEMENT PLAN

