

The Seattle Department of Transportation

# Trees and Sidewalks Operations Plan

DRAFT FOR PUBLIC REVIEW - December 2014



## ACKNOWLEDGMENTS

The Trees and Sidewalks Operations Plan is a product of the Seattle Department of Transportation, working together with planners, landscape architects, engineers, arborists, and those with tree management and regulatory responsibilities. The plan provides a framework for the actions and responsibilities that will help preserve, maintain, and enhance the condition of Seattle's urban forest.

### Seattle Department of Transportation:

Jennifer Wieland, Project Manager  
Barbara Gray, SDOT Interim Deputy Director  
Darren Morgan, Urban Forestry Manager  
Elizabeth Sheldon, Interim Street  
Maintenance Director  
Shane Dewald, Senior Landscape Architect  
Joshua Erickson, Field Operations Manager  
Shannon Glass, Public Space Management  
Program  
Jinny Green, Pedestrian Lead  
Ben Hansen, Pavement Lead  
Jane Rebelowski, Crew Project Inspector  
Ben Roberts, Arboriculturist  
Nolan Rundquist, City Arborist  
Lou Stubecki, Arboriculturist

### Special Thanks:

Urban Forestry Commission  
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### Project Team:

SvR Design Company  
GeoEngineers  
Harrison Design  
Norton-Arnold & Company  
Ribeiro Consultants  
Stenn Design  
Tree Solutions

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# SEATTLE DEPARTMENT OF TRANSPORTATION

## Mission

Delivering a first-rate transportation system for Seattle

## Vision

A vibrant Seattle with connected people, places, and products

## Core Principles

1. Keep it Safe—Improve safety for people of all ages and abilities so they are comfortable moving around the city, regardless of what travel mode they choose
2. Focus on the Basics—Keep our transportation system in good condition in a way that promotes long term fiscal and environmental stewardship
3. Build Healthy Communities—Develop an equitable transportation system that focuses on neighborhoods, offers healthy travel choices and great public spaces
4. Support a Thriving Economy—Move people and goods efficiently to keep our economy thriving and provide efficient and practical transportation choices that enhance our quality of life, draw new businesses and visitors to our city
5. Provide Great Service—Sustain an innovative and engaged workforce who strongly value public service, strive to be good financial stewards, deliver services equitably, and engage all parts of the community in our work



# PURPOSE & INTENT OF OPERATIONS PLAN

Street trees and sidewalks both play vital roles in Seattle's public realm, helping to make our city more livable and sustain our quality of life. It is not uncommon for conflicts to arise between trees and sidewalks, particularly in locations where they were installed some time ago. These conflicts can compromise pedestrian access to the sidewalk and/or tree health.

## Purpose

The purpose of the Trees and Sidewalks Operations Plan is to clarify responsibilities and work processes and to provide guidance on installation, repair, and maintenance of sidewalks and street trees in public places in Seattle. (The term *public place[s]* is used in this Operations Plan to mean areas in the public right-of-way, as defined in Seattle's Street Tree Manual.)

## Intended Audience

This plan is intended primarily for internal use by the Seattle Department of Transportation (SDOT). It will be particularly relevant to operations within SDOT Urban Forestry and SDOT Street Maintenance, as well as within other divisions working with streetscape elements that relate to trees and sidewalks. Other City departments may also use the plan as a resource to help manage trees in the city's public right-of-way, including Seattle Public Utilities (SPU), Seattle City Light (SCL), and the Department of Parks and Recreation (Parks).

This plan is also intended to clarify to the broader public the processes and procedures that SDOT uses to manage street trees and sidewalks.



**PALM  
TAROT CARD  
READINGS**  
1706 227-0508

**NO PARKING**  
FROM 11:30 AM  
TO 3:00 PM  
TOW-AWAY AREA  
PHONE: 504-5444  
NATIONAL NUMBER: 204-521-4045

City of Dallas  
Public Works  
Regulation Department

500-584

500-584

# INTRODUCTION

## Plan Goals and Objectives

The goals of this Operations Plan are supported in existing city policies and plans as well as by Seattle residents.

- **Accessibility and Health:** To provide a safe, accessible, and inviting walking environment, following universal design principles
- **Environment:** To protect and expand a healthy urban forest
- **Equity:** To thoroughly consider the needs of all communities in accordance with the City's Race and Social Justice Initiative
- **Efficiency:** To preserve existing assets—both street trees and sidewalks—and use resources wisely

These goals will be met by achieving the following objectives.

- Explore strategies that enhance neighborhood aesthetic, reduce lifecycle costs, and allow sidewalks and substantial trees to coexist
- Repair sidewalks damaged by street trees with sustainable solutions
- Retain healthy, mature, and appropriately-sited trees whenever possible, while ensuring mobility
- Assess the appropriateness of street trees based on established criteria, including species, location, planting space, maintenance, past and current conflicts, and proximity to public and private structures and infrastructure
- Explore and implement alternative and/or innovative sidewalk repair approaches to preserve trees where feasible
- Evaluate sidewalk repair approaches across a range of criteria, including lifecycle costs and benefits as well as community costs and benefits
- Implement tree removal, when no other practicable alternatives exist, in phases to enable continued canopy coverage
- Increase the urban canopy by planting new street trees in vacant locations
- Communicate to property owners the importance of proper tree maintenance to address implementation of the revised Street Tree Ordinance and the walkable zone (as defined in the Pedestrian Master Plan)



are accessible, continuous, and unobstructed for use by all people, including people with disabilities. The Americans with Disabilities Act (ADA) and the US Access Board Public Right-of-Way Accessibility Guidelines (PROWAG) provide guidance and regulation for sidewalks in the public right-of-way.

While sidewalks do not need to be perfectly straight, curves that direct the pedestrian away from the natural path of the roadway should not be introduced solely for aesthetic reasons. Sidewalks shall provide a minimum four-foot wide clear zone along the path of travel (per PROWAG Sections R302.3 and R302.4). Pedestrian facilities shall be designed to allow all users to logically connect to other pedestrian facilities. They shall be in compliance with current ADA requirements. Sidewalks and walkways should be constructed

with accompanying curb ramps, including companion ramps, as required by current ADA standards.

### Related Documents

Many City documents provide policy guidance for this Operations Plan. The Pedestrian Master Plan (2009), Right-of-Way Improvements Manual (2012), Urban Forest Stewardship Plan (2013) and Street Tree Ordinance (2013) have recently been adopted by City Council. These documents highlight the importance of the tree canopy along streets as well as the requirements for sidewalk construction and maintenance to provide pedestrian access for all people in Seattle.



### *Pedestrian Master Plan*

The Pedestrian Master Plan (PMP) includes an issue paper on the topic of trees and sidewalks as well as targeted implementation actions to address the “walkable zone,” including conflicts between trees and sidewalks. The walkable zone is a clear pedestrian zone that is a minimum of six feet wide by eight feet tall, wherever possible. In the Pedestrian Master Plan Implementation Actions, Strategy 2.4 deals specifically with trees and sidewalks, calling for policy and programmatic actions “to support the dual benefits of tree canopy coverage and walkability.”

### *Urban Forest Stewardship Plan*

The Urban Forest Stewardship Plan (UFSP) provides a policy framework that guides decision-making and identifies principles, priorities, goals, and strategies that will help Seattle preserve, protect, maintain, and restore its urban forest over the next 24 years. The UFSP provides the foundation to direct and integrate management of the many issues and opportunities of Seattle’s urban forest resources. One of the four goals of the UFSP is to expand Seattle’s forest canopy cover to 30% by 2037. The “Environment” goal of this Operations Plan supports the UFSP canopy cover goal by providing solutions to maintain and grow healthy trees in public places and reduce conflicts with sidewalks and other infrastructure.





### ***Right-of-Way Improvements Manual***

The Right-of-Way Improvements Manual (ROWIM) guides property owners, developers, architects, landscape architects, and engineers involved with the design, permitting, and construction of improvements to Seattle's streets.

The ROWIM attempts to balance the access and mobility needs of all street users.

SDOT is updating the ROWIM in 2015.

### ***Street Tree Ordinance & Street Tree Manual***

On April 29, 2013, the City of Seattle amended Seattle Municipal Code (SMC 15.43), the Tree and Vegetation Management in Public Places Ordinance (Street Tree Ordinance), to expand SDOT's regulatory authority to protect, maintain, and preserve trees in the public right-of-way.

SDOT's Street Tree Manual clarifies the intent and scope of the Street Tree Ordinance. It includes information about tree planting, maintenance, and preservation.

SDOT is updating the Street Tree Manual in 2015.



# BACKGROUND & RESEARCH

## Seattle's Urban Forest: Street Trees

Seattle's urban forest includes all trees and understory plants on public and private property. The urban forest includes a diverse mix of vegetation, managed by both individuals and groups and located in natural areas, parks, other City-owned property, rights-of-way, and private property.

The urban forest provides important ecosystem services through stormwater retention, air and water pollution reduction, climate change mitigation, and heat island effect reduction. Seattle's urban forest is home to diverse wildlife and provides food, shelter, and nesting opportunities that are essential to supporting this wildlife. The presence or absence of trees can define a neighborhood, and studies show that people enjoy trees and are more comfortable in the presence of trees than they are without them in a landscape.

SDOT is responsible for the management of trees in the right-of-way (street trees), including design, installation, and stewardship of trees and landscapes in the right-of-way and permitting of actions that could impact these trees. SDOT maintains over 40,000 street trees and regulates planting and maintenance of another 100,000 street trees. Since 2007, SDOT has planted an average of 1,200 trees per year. The department must balance canopy cover goals with the need to minimize tree conflicts with surrounding infrastructure and transportation safety requirements.

A permit is required for any work in a public place including, but not limited to, tree planting, tree removal, and tree pruning of limbs greater than two inches in diameter.

Throughout Seattle, there are locations where the existing planting strip or tree pit is too small to accommodate the tree that has been planted. In many cases this has caused adjacent sidewalks to heave and break, creating potential hazards for pedestrians. This condition typically occurs because the tree species needs a larger volume of soil to achieve its mature canopy size or has an aggressive root system or a trunk character that spreads at the base but is constrained by its planting



area. Root upheaval may also occur because the subgrade soils are severely compacted or dense and do not allow root penetration. The City has developed an Approved Street Tree List (2000) to clarify which species are appropriate in certain locations as well as standards for locating trees near other infrastructure.

SDOT estimates that about 20% of street trees could be considered for removal due to improper location (e.g., large trees under utility lines, conflicts with underground utilities or sidewalks, insufficient growing space) or structural and health issues. SDOT currently removes trees only if they pose an imminent hazard or if removal allows the City to take advantage of opportunities to replace trees as part of a larger planting project. SDOT also removes privately-maintained street trees when they become imminent hazards.

## Street Tree Governance

### *Permitting & Jurisdiction*

**SDOT Urban Forestry** has arborist and landscape architect services that permit and inspect tree management activities in public places under Seattle Municipal Code (SMC) 15.43. Urban Forestry also conducts plan review and inspection of street trees and related urban forestry infrastructure for Department of Planning and Development (DPD) and/or SDOT Street Improvement Permit (SIP) projects to ensure compliance with land use code, drainage code, and the Seattle Green Factor ordinance.

**Department of Planning and Development (DPD)** is responsible for permitting and inspections of tree management activities on private property under SMC 25.11.



### *Street Tree Management*

SDOT maintains certain street trees throughout Seattle. SDOT's Urban Forestry division also oversees work on street trees that SDOT does not actively manage and maintain.

Other departments also manage trees in Seattle. The Department of Parks and Recreation manages trees in parks as well as some trees along park boulevards. Seattle City Light prunes trees planted under power lines. Seattle Public Utilities works with SDOT in managing street trees to avoid conflicts with underground utilities.

### **Seattle's Sidewalks**

Seattle has over 2,000 miles of sidewalks and pathways with a replacement value of \$2.8 billion.

About 72% of Seattle's blocks have sidewalks. Most of the existing sidewalks were built when the parcels were first developed. SDOT's Pedestrian Program and other capital projects install and replace sidewalks. New sidewalks are also built or replaced when required by the land use code for private development projects.

SDOT's Sidewalk Repair Program oversees maintenance of the city's sidewalks and curbs. The program's goal is to ensure that sidewalks are safe and accessible for all pedestrians.



### **Sidewalk Governance**

#### *Permitting & Jurisdiction*

SDOT Street Maintenance manages the Sidewalk Repair Program. The program's goal is to ensure that all sidewalks are safe and accessible for all pedestrians. Street Maintenance also monitors the maintenance and performance of City streets and establishes multi-year repaving priorities.

SDOT Street Use manages sidewalk replacement and repair by other city departments and private property owners by issuing permits, inspection, project coordination, public outreach, utility record keeping, and plan review.

#### *Sidewalk Management*

As stated in Client Assistance Memo (CAM) 2208: "SMC 15.72 requires property owners to keep the sidewalk adjacent to their property fit and safe for the purposes of public travel.

As such, property owners must repair cracks and other damage to the sidewalk as well as ensure that snow and ice do not pose a hazard to pedestrians. If the sidewalk is determined to be unfit or unsafe, SDOT must direct the abutting property owner to fix their sidewalk. However, in the case of sidewalks damaged by street trees that are managed by SDOT, the City maintains adjacent sidewalks and repairs damage."

## Research Summaries & Links to Other Cities' Street Tree Management Documents

### **Chicago Department of Transportation**

(CDOT) builds and maintains hundreds of miles of sidewalks each year, working with local aldermen to determine locations for repair. CDOT also operates the Shared Cost Sidewalk Program, in which property owners and the City share the cost of a new sidewalk. The Bureau of Forestry trims thousands of trees a year, plants new trees, addresses insect and disease problems, and otherwise promotes tree health throughout the City.

<http://www.cityofchicago.org/city/en/depts/streets/provdrs/forestry.html>

**San Francisco, CA** has a Better Streets Plan that identifies street tree specification and maintenance requirements for adjacent property owners.

<http://www.sfbetterstreets.org/find-project-types/greening-and-stormwater-management/greening-overview/street-trees/>

The Better Streets Plan identifies sidewalk design requirements...

<http://www.sfbetterstreets.org/design-guidelines/>

... as well as maintenance requirements for constrained sidewalks.

<http://www.sfbetterstreets.org/learn-the-process/maintenance/>

As part of its Urban Forest Plan, San Francisco identified key findings and recommendations for financing of San Francisco's Urban Forest.

[http://www.sf-planning.org/ftp/files/plans-and-programs/planning-for-the-city/urban-forest-plan/UFP\\_Financing\\_Study\\_Exec\\_Sum\\_131216.pdf](http://www.sf-planning.org/ftp/files/plans-and-programs/planning-for-the-city/urban-forest-plan/UFP_Financing_Study_Exec_Sum_131216.pdf)

**Minneapolis, MN** has an Urban Forestry Policy that outlines actions around trees in sidewalk zones.

[http://www.minneapolismn.gov/www/groups/public/@cped/documents/webcontent/convert\\_282934.pdf](http://www.minneapolismn.gov/www/groups/public/@cped/documents/webcontent/convert_282934.pdf)

**Portland, OR** details its Sidewalk Maintenance Repair Program, identifying property owner responsibilities.

<http://www.portlandonline.com/auditor/index.cfm?c=27478&a=472303>

Portland also has a sidewalk repair manual that identifies sidewalk repair methods and materials needed to maintain the adjacent sidewalk.

<http://www.portlandoregon.gov/transportation/article/443054>

**Sacramento, CA** requires property owners to repair the sidewalk regardless of who owns the tree.

<http://portal.cityofsacramento.org/Public-Works/Maintenance-Services/Sidewalks-Curbs-Gutters>

**Spokane, WA** has Guidelines for Infilling Street Trees. This document identifies allowable sidewalk adjustments that can be made to accommodate trees.

[http://spokaneurbanforestry.org/uploads/forestry\\_page\\_content\\_body/Street%20Tree%20Infill\\_11\\_1\\_10\\_FINAL.pdf](http://spokaneurbanforestry.org/uploads/forestry_page_content_body/Street%20Tree%20Infill_11_1_10_FINAL.pdf)

**Bellevue, WA** takes responsibility for maintenance of trees and sidewalks within the right-of-way in the downtown core.

[http://www.bellevuewa.gov/street\\_maintenance.htm](http://www.bellevuewa.gov/street_maintenance.htm)

## City Research

Management of street trees and sidewalks varies across the country. Research on various cities' related policies and programs informed the decision process and comparison of Seattle practices. In most cities, healthy street trees are not removed solely for the purpose of repairing a sidewalk. Similar to Seattle, most cities expressed challenges identifying solutions that would meet accessibility requirements for a sidewalk.

Page 16 lists the Street Tree/Sidewalk programs researched as part of this project, including links to selected best practices. More findings from the research are included in Appendix A.

## Seattle Practices

Seattle's Street Tree Manual clarifies practices around trees. The current status of Seattle practices informed the development of the solutions toolkit included in this Operations Plan.

### *Trees*

Seattle provides a great deal of publicly accessible information about tree selection, pruning, and maintenance through such resources as SDOT's Urban Forestry website, SDOT's Approved Street Tree List, a Tree Pruning Guide for Seattle Residents, and the Seattle reLeaf website.

Seattle currently maintains a two-for-one tree replacement policy, as directed by Executive Order in 2005 by Mayor Nickels, and identified in the 2013 Urban Forest Stewardship Plan. City departments plant two trees for each tree they remove from City property or the right-of-way.

## Best Practices Research Topics

- Trees
- Street Edge / Hardscape
- Roots
- Nutrients & Subbase Soils
- Irrigation & Aeration of Existing Trees
- Failures
- Utilities
- Transportation
- Education / Outreach
- Design Standards
- Easements

Seattle is similar to Chicago where the transportation department maintains both trees and sidewalks. In many other large cities including Los Angeles, New York, and Bellevue, the Parks Department maintains street trees. SDOT maintains approximately 40,000 trees in Seattle's right-of-way, with responsibility for maintenance of other right-of-way trees falling to the abutting property owners. The industry standard tree pruning cycle is five to seven years; SDOT currently has two tree crews and is operating on a 20+ year pruning cycle.

Inspection services for all street trees (including approximately 100,000 privately maintained street trees) is shared among approximately 11 positions within SDOT Urban Forestry. However, many more staff within Urban Forestry and other SDOT divisions interact with trees regularly.

## Street Edge / Hardscape

Seattle allows a variety of pavement materials in the right-of-way. Not all of the standard pavement sections work well where there are existing trees. Some required installation depths for pavers are greater than eight inches, which can be problematic for trees with shallow root systems.

Researchers have found that a washed gravel layer under the sidewalk pavement may reduce damage by tree roots.<sup>1</sup> The open-graded gravel does not hold water, and the lack of soil and nutrients in the voids discourages root growth while supporting the pavement.

## Roots

SDOT has arborists and arboriculturists on staff that coordinate tree root evaluation and pruning. Currently, Seattle has no standard specification or guidance for tree root evaluation and pruning.

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<sup>1</sup> Smiley, E. Thomas. 2008. "Comparison of Methods to Reduce Sidewalk Damage from Tree Roots," in *Arboriculture & Urban Forestry* 34(3):179-183.

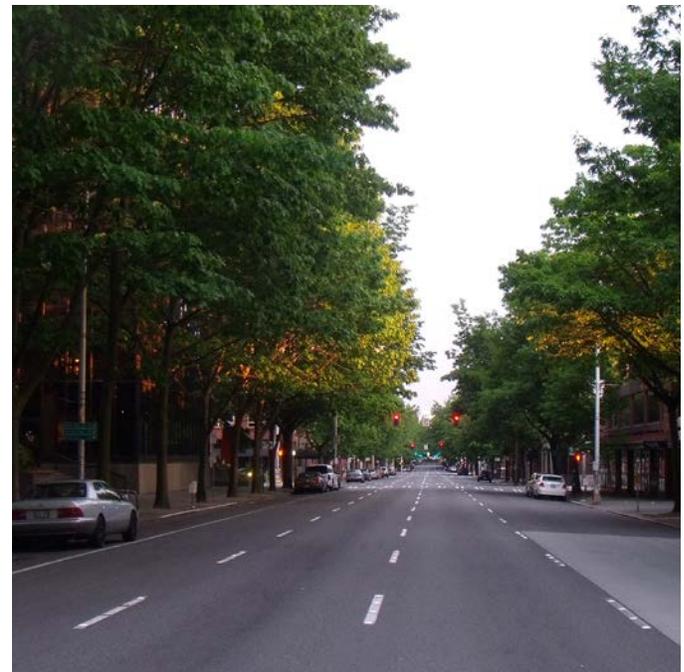


## Nutrients & Subbase Soils

There is little review or preparation of the subbase soil at locations where existing trees were removed when new (replacement) trees are installed there. Once a tree is planted, it receives short-term maintenance, primarily watering.

For new tree installation, mulch and compost mixes are identified in Seattle's Standard Specifications for Road, Bridge, and Municipal Construction. These materials are typically approved by a landscape architect or engineer for compliance. Soil tests are not typically performed. City standards are in place to improve consistency through procurement as an alternative to onsite testing upon delivery.

SDOT currently does not give guidance or specifications for structural soil or appropriate soil volumes for tree plantings based on mature sizes of trees. Nationwide best practices for tree planting include the provision of certain minimum volumes of soil that are useable by the tree for root growth (e.g., the soils contain nutrients/organic matter and some degree



of void space to accommodate air, water, and root growth; see, for example Washington, DC Department of Transportation's 2014 Green Infrastructure Standards). Future Seattle construction projects will likely follow current best practices for soil volume and use structural soils (among other means) to increase soil volumes for trees.

### ***Irrigation & Aeration of Existing Trees***

Providing water and/or aeration for street trees during establishment and mature trees during periods of weather stress can help to maintain and establish a healthy urban forest. SDOT does routinely water and aerate street trees.

### ***Failures***

Two common reasons for tree failures in Seattle are impacts from construction activity and poor pruning. Seattle has updated standard details and specifications for work near existing trees. Construction contractors are required to submit and adhere to a Tree, Vegetation, and Soil Protection Plan (TVSPP). Responsibility for field inspections is shared between SDOT and



the Department of Planning and Development (DPD), depending on tree location. However, field inspections to ensure that the standards and the TVSPP are followed are limited due to the number of inspectors available.

### ***Utilities***

Seattle is a developed city, and there are very few locations where trees could be installed without coordinating with existing utilities. The ROWIM and the Standard Details identify setbacks of trees from utilities and other infrastructure. These setbacks are similar to the standard requirements found in other jurisdictions.

### ***Transportation – Trees at Intersections & Along Corridors***

Trees at planting do not indicate the visibility problems that might occur when they mature. Mature trunk diameter is not necessarily considered when locating street trees near intersections and when siting bus stops. SDOT standards require trees to be located a minimum of 30 feet from the extension of the cross street's curb line at intersections (see Standard Plan 030). The City does not currently provide guidance on placement of trees in relation to bus stop clearances for visibility, safety, and exposure to the elements in the standard plans or ROWIM.

### ***Education & Outreach***

SDOT coordinates with Seattle Public Utilities and the Office of Sustainability and Environment on the ReLeaf Program to educate people in Seattle about trees (<http://www.seattle.gov/trees>). SDOT has information regarding trees and sidewalks on the Urban Forestry, Street Maintenance, and Sidewalk Repair Program websites.



The public can also call 206-684-TREE (8733) to find answers to tree questions in Seattle. Rules and regulations differ depending on the location of the tree. This number provides a menu of options or allows the caller to connect directly to the appropriate person and City department.

The City passed Ordinance 123052 in August 2009 establishing an Urban Forestry Commission to advise the Mayor and City Council concerning the establishment of policy and regulations governing the protection, management, and conservation of trees and vegetation in the City of Seattle. The Urban Forestry Commission holds meetings twice a month that are open to the public.

### ***Design Standards & Specifications***

The City of Seattle has design standards and specifications in the Standard Specifications and Standard Plans for Road, Bridge, and Municipal Construction. These standards are also referenced in the ROWIM. Existing standards provide information about tree

planting, soils, and tree establishment. There is currently no standard plan or specification for minimum soil volume required for various tree species. Minimum tree pit sizing is fairly small compared to other cities. Some other jurisdictions, such as Washington, DC, list recommended soil volumes for trees in their standard construction details (e.g., for green infrastructure) and/or plant lists. The ROWIM is under revision and there is an opportunity to review and revise the standards as part of this process.

### ***Easements***

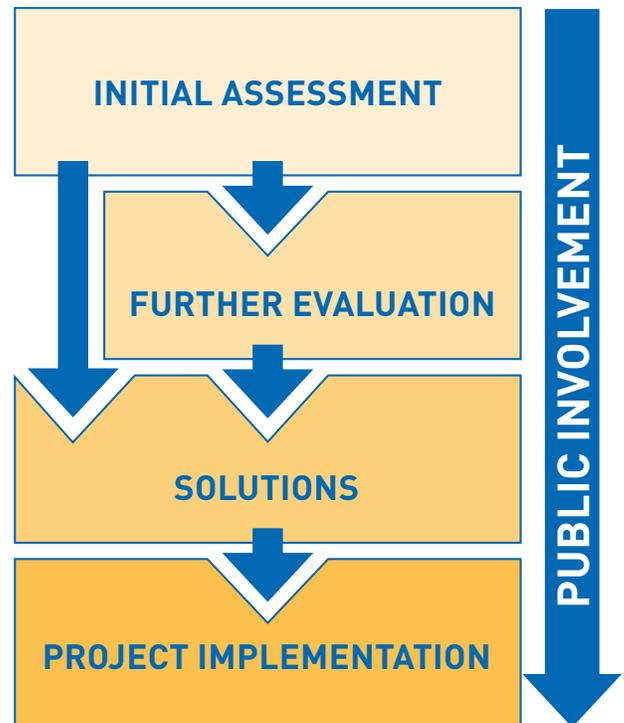
Established procedures for dedications of rights-of-way or easements are outlined in CAM 2203. Typically SDOT does not pay for sidewalk easements to maintain access along a street frontage.

# DECISION PROCESS

During the development of this Operations Plan, the need to clarify the decision process to address tree and sidewalk conflicts became apparent. SDOT has used checklists and forms internally, but these traditionally have not been available to the public. To make the decision process around the retention or removal of trees more transparent and consistent, SDOT has clarified the typical process and has developed diagrams to highlight the key decision points. A summary diagram of the refined process is shown to the right, and a more detailed process diagram is on the following page.

This decision process was developed for the Sidewalk Safety Repair Program (SSRP), which is coordinated between SDOT's Street Maintenance and Urban Forestry divisions. The SSRP focuses on repairs around SDOT-managed trees and adjacent sidewalks. However, this process can be adapted and used by other divisions in SDOT. The decision process is intended to work on projects of many scales, ranging from a spot location where there is only one tree being affected to a corridor project over several blocks or more.

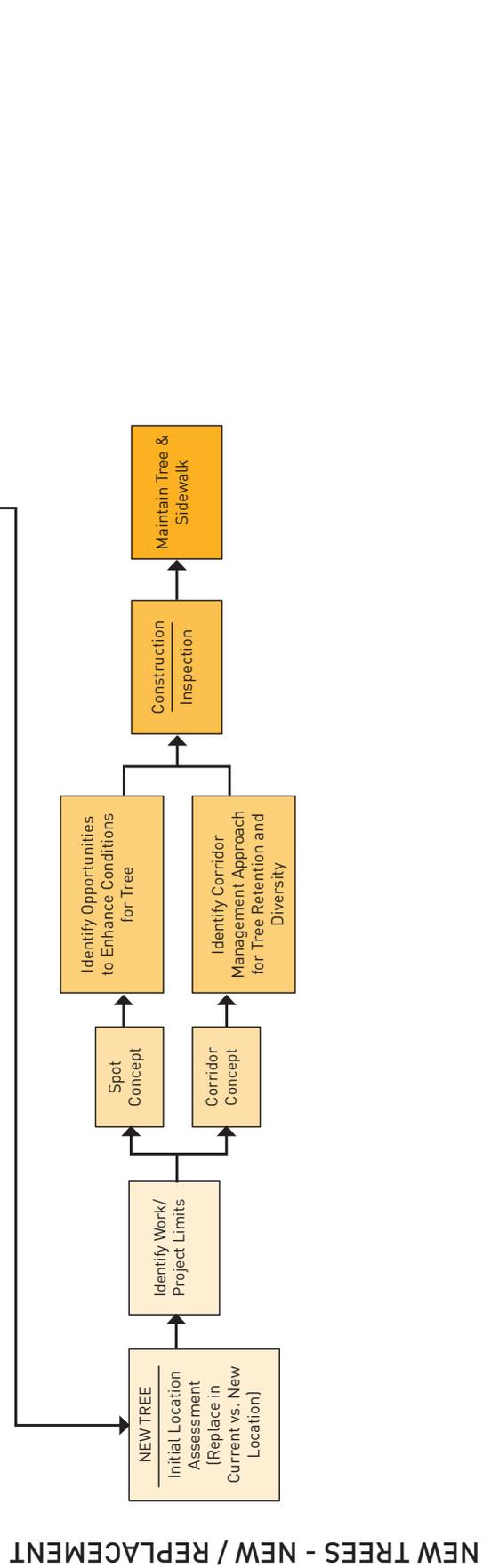
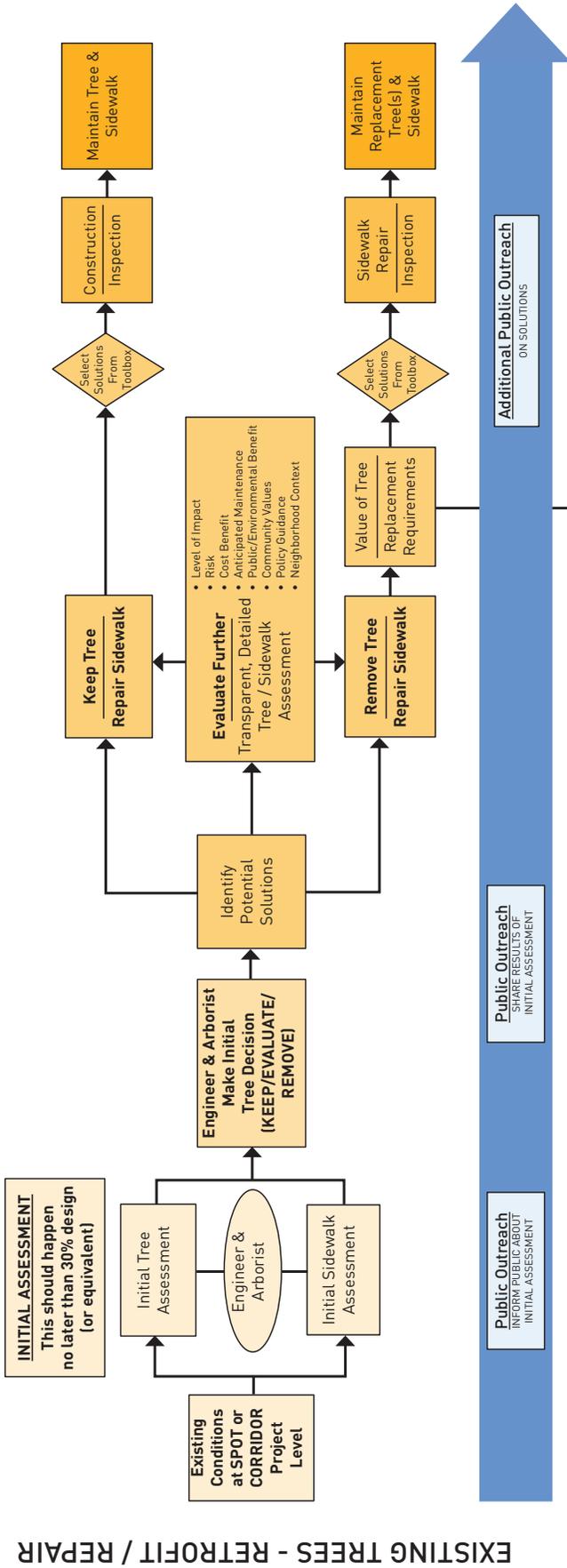
The decision process considers existing trees and sidewalks as well as opportunities to plant new trees within the public right-of-way.



This process will help project and program managers understand the amount of time and type of resources that must be allocated toward a project to provide and promote tree canopy growth and accessible sidewalks.

The processes for selecting and confirming a project that involves trees and sidewalks vary depending on the SDOT division leading the effort, the funding source and the street classification and/or street typology.

# TREE/SIDEWALK ASSESSMENT & WORK PROCESS



## Initial Assessment

SDOT strives for consistency and predictability in the initial assessment of trees and sidewalks at potential project locations. The initial assessment allows the project manager to collect information, including:

- **Tree Preservation Potential.** What is the tree quality or health, and is it worth preserving?
- **Tree Mitigation Exploration.** If a tree exhibits poor health or vigor, can that be mitigated by any means other than removal?
- **Public Safety Risk.** Is the tree a potential hazard that cannot be mitigated by any means other than removal? This includes any tree or tree part that poses a high risk of damage to persons using or property located in public places (as determined by the Director, according to the tree hazard evaluation standards established by the International Society of Arboriculture [Defined in SMC15.02.044.E]).

The initial assessment should occur no later than 30% design or an equivalent level of design effort. A draft Initial Assessment Form is located in Appendix C.



## Initial Tree Decision

### *Engineer & Arborist/Landscape Architect Coordination*

For the initial assessment to be successful, both an engineer and arborist/landscape architect will visit the potential project location and assess the tree and sidewalk conditions together. This will allow for better coordination between divisions as the project moves forward. The engineer and arborist/landscape architect will review the information collected and identify one of the following actions at each tree location within the project area:

- **Remove Tree and Replace Sidewalk.** A tree is identified to be removed if it is unhealthy or if it is hazardous, as identified in the Street Tree Ordinance.
  - **Tree is Removed.** Replace the removed tree with the minimum 2:1 replacement ratio. Identify if the replacement trees can be located in the same location or on the same street as the removed tree. If not, replacements should be planted as close to the removal as geographically feasible. Identify the estimated cost to remove the tree(s), repair the sidewalk, and plant replacement trees.
- **Keep Tree and Maintain Sidewalk.** A tree will be kept and the sidewalk will be maintained if a sidewalk of standard width and a tree pit of standard width (at a minimum) can be installed or retained.
  - **Tree is Kept.** Identify targeted sidewalk maintenance cycle to maintain public safety. Estimate the cost of the sidewalk repair that would achieve the desired lifecycle for the repair. Estimate



sidewalk and tree maintenance needs/ costs and any maintenance to the tree that is being retained (e.g., root pruning, branch pruning, soil amendments).

- **Evaluate Sidewalk and/or Tree Further.** There are limitations to the initial assessment. It is not the appropriate time for extensive explorations of pavement, soils, or evaluation of the tree's root system; additionally the project may not have survey information to identify the adjacent grades. The purpose of the initial assessment is to identify where these future actions are required so that the appropriate schedule and funding for the project can be determined.

SDOT views trees and sidewalks as important public infrastructure assets. SDOT strives to keep healthy trees and have accessible sidewalks. If standard



widths cannot be met then SDOT will take the time and resources to evaluate if alternative approaches (such as sidewalk width reduction, alternative sidewalk materials, adjustments to the tree pit and/or tree root pruning) can be used to retain a tree and provide an accessible sidewalk at problem locations.

### Further Evaluation

The team conducting further evaluation may include a civil engineer, arborist, landscape architect, urban designer, geotechnical engineer, traffic engineer, or other professionals with expertise relevant to the project details.

In addition to collecting technical information about the trees and sidewalks, SDOT will consider the following:



- **Level of impact** if the tree were to be removed or to remain.
- **Any risks** for the city or the public as the project moves forward.
- **Cost/benefit** of keeping the tree versus continually maintaining the sidewalks. This is a complex issue that is being evaluated based on public safety, tree species, and budget projections.
- **Anticipated maintenance** of the sidewalk if the tree were to be kept.
- **Public/environmental benefit** the tree is providing in terms of shade, view screening, stormwater interception, etc, and how well those benefits could be replaced with new trees.
- **Community values** placed on for either the sidewalk or the tree.
- **Policy guidance** from a neighborhood plan, urban design framework, or other guiding document that exists for the project area.
- **Neighborhood context.** The tree provides or contributes to defining character of the neighborhood and/or a sense of place for the block or corridor where it is planted.
- **Historic Districts.** Seattle has established seven historic districts: Ballard Avenue; Columbia City; Fort Lawton; Harvard-Belmont; International District; Pike Place Market; and Pioneer Square. The appearance of public spaces within each district is regulated by a public review board and/or the Landmarks Preservation Board. Special coordination and review is required in these districts.

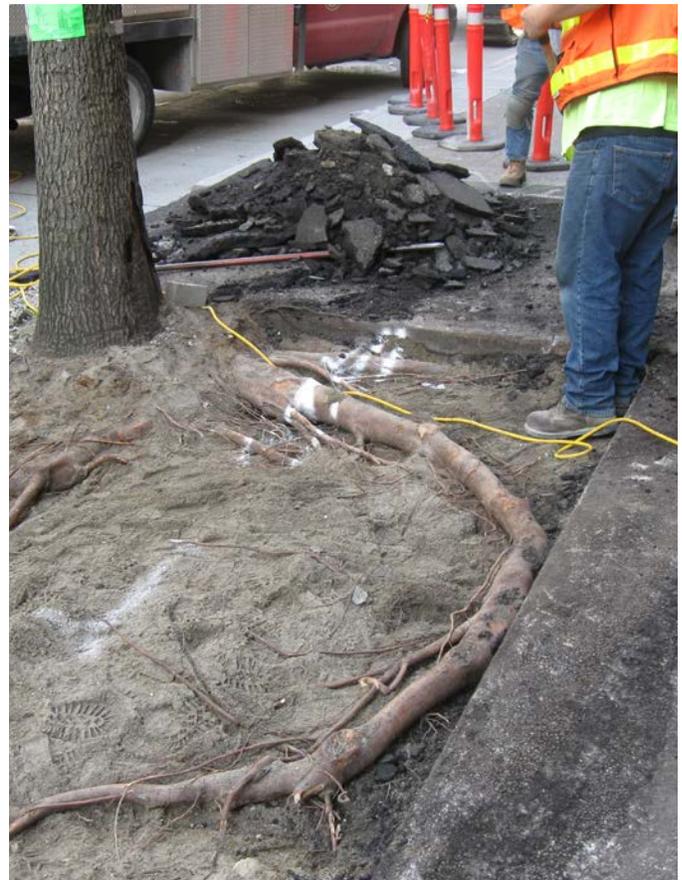
SDOT will periodically review and refine these criteria and ensure that emerging best practices are continually incorporated and addressed in the process.

## Solutions

### *Identify Potential Tree Solutions: Keep, Evaluate Further, or Remove*

As a result of the initial assessment and further evaluation, SDOT will document the decision process for individual trees and sidewalks. The engineer and arborist/landscape architect will discuss the potential solutions as part of the process of determining whether to keep or remove the tree.

- **If Remove, Valuation of Tree.** If the tree must be removed, SDOT will provide options to replace the tree with a minimum 2:1 ratio. Ideally, the tree would be replaced at the same location. If this is not possible due to space constraints or other safety concerns, the replacement trees will be planted along the corridor first. If the corridor does not offer planting opportunities, SDOT will plant trees on adjacent residential streets near the project area.
- **If Keep, Corridor Management Approach.** Many corridors, especially along arterials, have one tree species that was planted at the same time. These corridors are aesthetically appealing and often provide a consistent view down a corridor. During the initial assessment, SDOT



will identify the opportunity or need to diversify the corridor by planting new, younger trees and/or different species along the corridor. There could also be an opportunity to manage the trees with corrective actions to provide clearance from the sidewalk and vehicles and maximize beneficial tree canopy.

### *Identify Potential Sidewalk Solutions*

The Solutions Toolkit in this Operations Plan includes the range of sidewalk materials that Seattle allows within public places. This range provides flexibility for SDOT to construct and/or approve sidewalk repair plans in a variety of conditions. Information gathered during the initial assessment and subsequent site visits will support the selection of the surface type at the project location.

### *Identify Opportunities to Improve Conditions for New Trees*

When new trees are planted, SDOT will select an appropriate tree for the location and follow best practices in site and tree pit preparation to provide enough soil volume to support the tree root growth and minimize future pavement damage by roots.

## Project Implementation

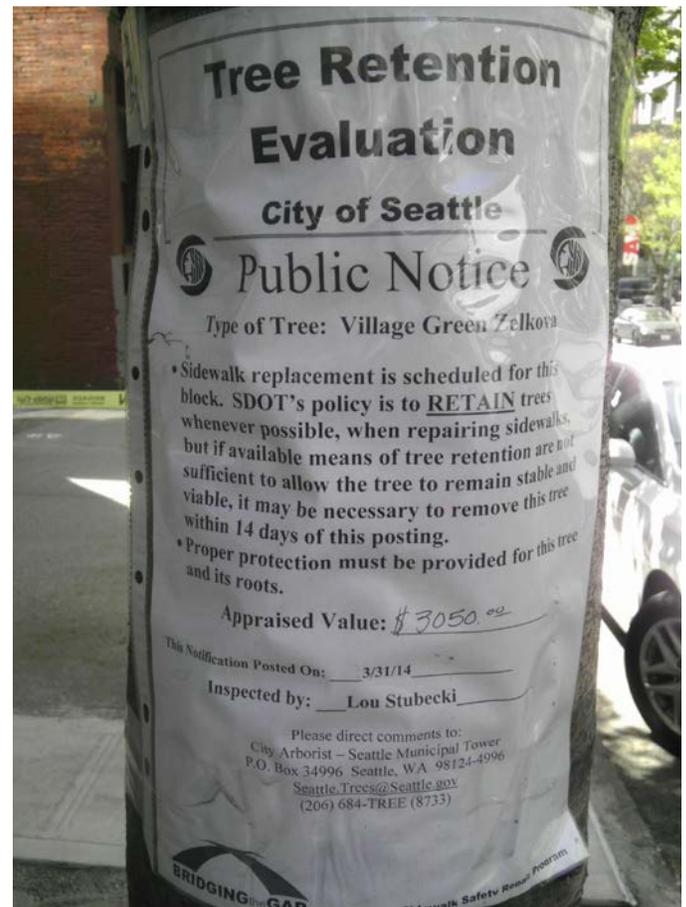
### *Sidewalk Repair / Inspection*

Whether the sidewalk repair is occurring at a location where the tree is retained or removed, SDOT must meet ADA requirements. The minimum width for a sidewalk in the City of Seattle is 6 feet. The minimum width of a public sidewalk to meet ADA requirements is 4 feet.

## Public Involvement

SDOT will provide three main public involvement opportunities when tree and sidewalk work occurs.

- The **first opportunity** is when SDOT is performing the initial tree/sidewalk assessment. This outreach may be posting a public notice about the process (on affected trees and/or in nearby public places). This should occur at the beginning of the project during scoping but could happen up to 30% design. It is important that the initial public contact be early so the community understands the purpose and scope of the proposed project. SDOT funds projects through a variety of sources that have different



scope and project requirements. This is the opportunity to let the community know that an initial assessment is occurring.

- The **second opportunity** for public outreach is following the completion of the initial assessment. SDOT can share the results of the assessment completed by the engineer and arborist/landscape architect, discuss potential solutions, and consider any public feedback in the design.
- The **third opportunity** to reach out to the public is following the selection of the solutions. At this point, SDOT can present the proposed design and confirm the timeline for the project.

The amount of time between these public outreach opportunities will vary depending on the SDOT program responsible for the project, the funding source, whether SDOT

or contracted crews are performing the construction, and if the trees need to be evaluated further before a solution can be confirmed.

## Maintenance

Trees and sidewalks need to be maintained. Like most cities, Seattle has a backlog of maintenance activities. The process and tools outlined in this Operations Plan provide solutions that support efficient use of SDOT resources and staff to maintain sidewalks and street trees at an ideal frequency.

The Seattle Pedestrian Master Plan prioritizes projects and proactive maintenance across the city. The priority areas include many key pedestrian destinations and areas that have a great need for pedestrian facilities.

Both new and repaired sidewalks must be maintained and potentially repaired in the future. Maintenance of the sidewalk is the responsibility of the adjacent property owner. However, SDOT must track and document maintenance of SDOT-managed trees and adjacent sidewalks. Tracking this maintenance will provide information about the durability of materials and lifecycle of repair methods and will help SDOT allocate staff and material resources for future maintenance. These records will also provide information to the public about when infrastructure was installed, who should maintain it, and which types of repair may be the most effective.



# SOLUTIONS TOOLKIT

The purpose of this toolkit is to identify solutions that may be employed to plant and retain healthy trees and provide accessible, walkable surfaces. This toolkit was created as part of the SDOT Trees and Sidewalks Operations Plan for use by SDOT Urban Forestry and Street Maintenance. However, this toolkit may also be used as a resource for other Seattle departments and private developers or property owners seeking guidance on installation and maintenance of trees and sidewalks adjacent to their property.

This toolkit includes both tree-based and infrastructure-based techniques and materials to guide design, construction, and maintenance activities related to trees and sidewalks. The toolbox is organized into the following four categories and identifies each as:

**P** **proactive** (at new installations and major reconstruction)

**R** **responsive** (as part of maintenance)

**MATERIAL** **Paving and Other Surface Materials**  
These materials can be used to create a walkable surface or to delineate space for people and/or the tree.

**DESIGN** **Infrastructure-Based Design Solutions**  
These design considerations can be employed to support a tree and/or sidewalk.

**ROOT** **Rootzone-Based Materials**  
These tools can support tree health and guide tree growth below the ground.

**TREE** **Tree-Based Solutions**  
These solutions are focused on tree selection and tree maintenance.

For most projects, multiple solutions will be required to resolve existing conflicts between

trees and sidewalks. Each solution includes the following information as applicable:

- Description of the solution
- Application for the solution
- When the solution should be applied and when it should not be applied
- Cost
- Expected useful life
- If the solution is currently in the standard plans, specifications, or ROWIM.

Many of these solutions are currently used by SDOT but have been updated in the toolbox with information collected during the best practices research. However, some of solutions are not currently part of SDOT's ROWIM or Seattle's Standard Plans and Specifications and will require further review and approval, potentially on a project-by-project basis. The use of some non-standard solutions may require the following actions by SDOT:

- engineering review;
- asset ownership agreements;
- maintenance regiments; and/or
- standardization.

There is a note on the left side of each tool summary page that indicates whether or not there is a City of Seattle standard or guidance for that tool.

The following pages contain a table of contents for the solutions toolkit.

# TOOLKIT OVERVIEW

CATEGORY	TOOLS	PROACTIVE	RESPONSIVE	COST*				EXPECTED USEFUL LIFE			
				\$	\$\$	\$\$\$	\$\$\$\$	Month	Year	Decade	Century

## PAVING AND OTHER SURFACE MATERIALS

MATERIAL		PROACTIVE	RESPONSIVE	COST*	EXPECTED USEFUL LIFE
Asphalt	P	R		\$-\$\$\$	M Y D C
Expansion Joints	P	R		\$	M Y D C
Pavers	P	R		\$\$-\$\$\$	M Y D C
Pervious Concrete	P	R		\$\$\$-\$\$\$\$	M Y D C
Reinforced or Thicker Slab	P	R		\$\$-\$\$\$	M Y D C
Rockery / Wall	P	R		\$\$-\$\$\$\$	M Y D C
Beveling	P	R		\$-\$\$	M Y D C
Porous Asphalt	P	R		\$-\$\$\$	M Y D C
Shims	P	R		\$	M Y D C
Tree Guards and Tree Rails	P	R		\$\$-\$\$\$	M Y D C
Decomposed Granite	P	R		\$-\$\$	M Y D C
Mudjacking (Concrete Leveling)	P	R		\$\$-\$\$\$\$	M Y D C

## INFRASTRUCTURE-BASED DESIGN SOLUTIONS

DESIGN		PROACTIVE	RESPONSIVE	COST*	EXPECTED USEFUL LIFE
Monolithic Sidewalk	P	R		\$\$\$	M Y D C
Pavement Thickness	P	R		\$\$\$	M Y D C
Tree Pit Sizing	P	R		\$	M Y D C
Bridging	P	R		\$\$\$\$	M Y D C
Curb Bulbs	P	R		\$\$\$-\$\$\$\$	M Y D C
Curb Realignment	P	R		\$\$\$-\$\$\$\$	M Y D C
Curving or Offset Sidewalk	P	R		\$\$-\$\$\$	M Y D C
Easement	P	R		\$-\$\$\$	M Y D C
Suspended Pavement Systems	P	R		\$\$\$-\$\$\$\$	M Y D C
Lowered Sites	P	R		\$\$\$-\$\$\$\$	M Y D C
Soil Volume	P	R		\$-\$\$\$	M Y D C

CATEGORY	TOOLS	PROACTIVE	RESPONSIVE	COST*				EXPECTED USEFUL LIFE			
				\$	\$\$	\$\$\$	\$\$\$\$	Month	Year	Decade	Century
ROOT	<b>ROOTZONE-BASED MATERIALS</b>										
	Mulch	P	R			\$		M	Y	D	C
	Root Barriers	P	R			\$		M	Y	D	C
	Continuous Trenches	P	R			\$\$\$		M	Y	D	C
	Foam Underlay	P	R			\$-\$\$		M	Y	D	C
	Modified Gravel Layer	P	R			\$		M	Y	D	C
	Root Paths	P	R			\$-\$\$		M	Y	D	C
	Soil Modification	P	R			\$-\$\$		M	Y	D	C
	Steel Plates	P	R			\$\$-\$\$\$\$		M	Y	D	C
	Structural Soils	P	R			\$\$-\$\$\$\$		M	Y	D	C
Subsurface Aeration / Irrigation	P	R			\$\$		M	Y	D	C	
TREE	<b>TREE-BASED SOLUTIONS</b>										
	SDOT Street Tree List	P	R			\$		M	Y	D	C
	Corrective Pruning	P	R			\$-\$\$		M	Y	D	C
	Root Pruning	P	R			\$-\$\$		M	Y	D	C

\*General cost notes:

- Sidewalk material costs, when given in linear feet, assume 6-foot sidewalk width
- Costs are 2014 3Q planning-level costs and will vary for actual construction
- Costs do not include design, permitting, or other “soft” costs
- Costs not included in tool costs but which would be necessary with use of some solutions include:
  - Drainage structure and connection = approximately \$5,650 / location
  - Curb ramps = approximately \$5,000 / ramp

# ASPHALT



Asphalt is not typically used as a standard sidewalk material in Seattle; however, it may be used as a short- to medium-term pavement solution for sidewalk repair or replacement. It has less initial cost, is more flexible, and can more easily be repaired than concrete pavement. However, asphalt has a much shorter expected useful life and requires a higher level of ongoing maintenance than concrete.

## BEST USED IF

- A shorter-term repair solution is needed in an area with existing concrete sidewalks.
- A lower-cost option is appropriate for a new sidewalk.
- A flexible paving material is desirable until specific existing trees are replaced.

## DON'T USE IF

- Sidewalk segment is short and between existing concrete sidewalk (typically replace with concrete instead).

## EXPECTED USEFUL LIFE



## COST

\$-\$\$\$



Tool addressed in  
COS Standard Plans

## PROACTIVE / RESPONSIVE

- Proactive - May be used for new sidewalks in areas where concrete sidewalks are not feasible.
- Responsive - Replace sidewalk with asphalt in situations outlined above.

## NOTE

- Useful life of asphalt pavement can vary greatly with site conditions.

## ESTIMATED COST

- \$22 / linear foot

## REFERENCES

- City of Seattle Standard Plan 425
- Seattle Right-of-Way Improvements Manual

# EXPANSION JOINTS



Photo Credit: Philadelphia Water Department

Expansion joints are transverse joints used to control the location of cracking and allow movement of concrete due to temperature and subgrade moisture variation. The standard interval for expansion joints in Seattle sidewalks is 28 or 30 feet. When sidewalk is being replaced, these joints may be strategically located in relation to new or existing adjacent trees and existing root conditions.

## BEST USED IF

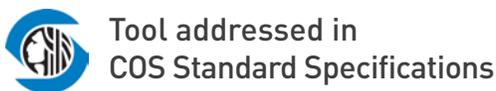
- Existing roots can be pruned to accommodate the installation and significant future root growth is not anticipated (e.g., tree is mature and/or roots have been provided with space to grow in subgrade through other applied solutions).
- There is adequate soil volume in areas the roots are intended to grow.

## EXPECTED USEFUL LIFE



## COST

\$



## DON'T USE IF

- Tree root growth is vigorous and the monolithic construction is unlikely to provide more than a short-term solution.

## PROACTIVE/RESPONSIVE

- Proactive – When installing a new sidewalk, consider locating expansion joints near trees to reduce potential for differential lifting of slabs.
- Responsive – Expansion joints may be used on replacement slabs, following removal of damaging roots (root pruning) or application of other subgrade solutions. This approach may confine future damage from new roots to a smaller area.

## ESTIMATED COST

- n/a (adjust locations during pavement design)

## REFERENCES

- City of Seattle Standard Specifications, Section 8-14
- Costello, L. R. and K. S. Jones. 2003. Reducing Infrastructure Damage By Tree Roots: A Compendium of Strategies. Western Chapter of the International Society of Arboriculture.

# PAVERS



Many types of unit pavers are available, including several varieties made from materials such as rubber or composite plastics. When properly installed and maintained, pavers may provide accessible surfaces that are more flexible than concrete, providing room for continued tree root growth under the sidewalk.

### BEST USED IF

- There are existing pavers or panels.
- Urban design guidelines recommend alternative paving surfaces.

### DON'T USE IF

- There are a large number of utility structures, such as water meters or maintenance holes, and the pavers would have to be cut around the structures.

### EXPECTED USEFUL LIFE



### COST

\$\$-\$\$\$\$



Tool addressed in  
COS Standard Plans

### PROACTIVE / RESPONSIVE

- Proactive – Pavers installed at the same time as trees can provide an accessible walking surface.
- Responsive – This application is typically used when a small section of sidewalk needs to be replaced. Rubber or plastic panels could be used as a temporary solution until a larger section of sidewalk can be reconstructed.

### NOTE

- The depth of installation varies greatly depending on the paver type and material. As a result, some pavers will not work at locations with existing trees with shallow root structures.
- Maintenance needs and durability will vary by type.
- See specific manufacturers' product information for installation details and recommendations.

### ESTIMATED COST

- \$10 - \$50 / square foot

### REFERENCES

- City of Seattle Standard Plan 425
- Seattle Right-of-Way Improvements Manual

# PERVIOUS CONCRETE



Pervious concrete allows air and water to pass through to the bedding and soil layers below. If designed and installed properly, it may deter shallow root growth (and reduce root damage to the sidewalk) by allowing water to infiltrate more deeply into the soil profile and providing air contact just below the pavement.

### BEST USED IF

- There is adequate space for installation of the pervious concrete and necessary subbase layers without excessive impact to existing roots.

### DON'T USE IF

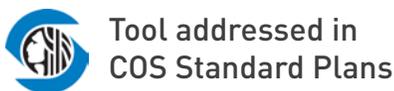
- Adjacent properties are below surface grade of sidewalk.

### EXPECTED USEFUL LIFE



### COST

\$\$\$-\$\$\$\$



### PROACTIVE / RESPONSIVE

- Proactive - May be used to provide better growing conditions in structural or other soils below the sidewalk bedding material.
- Responsive - May be used to encourage deeper root growth and/or discourage rooting near surface to deter further sidewalk damage.

### NOTE

- Requires more maintenance than standard concrete pavement.

### ESTIMATED COST

- \$35 / linear foot

### REFERENCES

- City of Seattle Standard Plan 425
- Seattle Right-of-Way Improvements Manual

## ROCKERY / WALL



Private properties are not always at the same elevation as the adjacent public rights-of-way. A wall or rockery can be used to transition from the property to the sidewalk if the grade of the sidewalk needs to be adjusted to accommodate roots.

### BEST USED IF

- The maximum wall height at the front of the wall is 4 feet.
- Space is needed to re-align a sidewalk or increase width.

### DON'T USE IF

- Wall height is greater than 4 feet or the ground surface above the wall slopes up more steeply than 3H:1V (would require a geotechnical and/or structural engineer).

### EXPECTED USEFUL LIFE



### COST

\$\$-\$\$\$\$



Tool addressed in  
COS Standard Plans

### PROACTIVE/RESPONSIVE

- Responsive – Typically installed to provide a grade break.

### NOTE

- Depending on height and direction of grade change, a hand rail / guard rail may be required.
- Consider drainage impacts of grade changes.
- For private property owners: from Seattle DPD TIP 321 - You don't need a construction permit if you meet all of the following conditions:
  1. The rockery or retaining wall will be 4 feet or lower in height.
  2. The wall is not located in an environmentally critical area (ECA) or near an ECA.
  3. You will not damage adjoining properties or structures during or after construction of the wall.
 If these three conditions are not met, you need a new construction permit.

### ESTIMATED COST

- \$25 / square face foot

### REFERENCES

- City of Seattle Standard Plan 141
- City of Seattle Standard Plan 801
- DPD Tip 321

## REINFORCED OR THICKER SLAB



Photo Credit: University of Florida

A reinforced or thicker (than standard 3-1/2" concrete thickness) sidewalk can be used to help resist uplift of tree roots. Reinforcing may include the use of steel rebar or wire mesh. The use of thicker pavement is similar to the design of sidewalks at driveways, which employ a thicker sidewalk section (6" to 8" concrete thickness) to support vehicular traffic.

### BEST USED IF

- Minimal future root growth is anticipated and existing roots can be pruned to accommodate the installation.
- There is adequate soil volume in areas the roots are intended to grow.

### DON'T USE IF

- Tree root growth is vigorous and the reinforced or thicker sidewalk is unlikely to provide a lasting solution.

### PROACTIVE/RESPONSIVE

- Proactive – Used along new installations to prevent future root uplift.
- Responsive – To correct uplift of the sidewalk and provide resistance from future uplift after corrective actions have been taken.

### NOTE

- Reinforced pavement may not be allowed in areas where future utility installation is required.

### EXPECTED USEFUL LIFE



### COST

\$\$ - \$\$\$



Tool addressed in  
COS Standard Plans

### ESTIMATED COST

- \$60 / linear foot for reinforced slab
- \$40 / linear foot for 4" thickness

### REFERENCES

- City of Seattle Standard Plan 430 (see sidewalk section at back of driveway ramp)

## BEVELING



Beveling involves cutting down the raised edge of a concrete panel to make a smoother transition and reduce tripping hazards.

### BEST USED IF

- A short-term solution is required.

### DON'T USE IF

- Uplift is greater than 1".

### PROACTIVE / RESPONSIVE

- Responsive - Provides a relatively short-term solution to raised concrete edges.

### NOTE

- There is a limit to how much beveling/grinding can be done at each point on a concrete sidewalk based on pavement thickness and severity of uplift.
- Longevity of fix will depend on how rapidly additional damage (uplift/subsidence of concrete) occurs.

### EXPECTED USEFUL LIFE

M	Y	D	C
YEARS			

### COST

\$-\$\$



Tool addressed in  
Seattle ROWIM

### ESTIMATED COST

- \$200 / location

### REFERENCES

- Seattle Right-of-Way Improvements Manual
- SDOT Client Assistance Memo (CAM) 2208 - Sidewalk Maintenance and Repair



# POROUS ASPHALT



Porous asphalt is similar to regular asphalt but will allow water to pass through the pavement. It may be appropriate to use in cases where infiltration in the sidewalk pavement area is desirable.

### BEST USED IF

- There are long corridors where concrete sidewalks cannot be constructed.

### DON'T USE IF

- Only short segments of repairs are needed.
- Site soils will not allow for infiltration of stormwater.
- Adjacent properties are below surface grade of sidewalk.

### PROACTIVE/RESPONSIVE

- Proactive - May be used for new sidewalks in areas where infiltration is desirable (adjacent to bioretention).
- Responsive - May be used for replacement sidewalks in areas where infiltration is desirable (adjacent to bioretention).

### EXPECTED USEFUL LIFE



### COST

\$-\$\$\$



Tool addressed in  
Seattle ROWIM

### NOTE

- Due to manufacturing constraints (can't be produced in very small quantities), porous asphalt should only be used for longer sidewalk segments such as multiple blocks.

### ESTIMATED COST

- \$30 / linear foot

### REFERENCES

- Seattle Right-of-Way Improvements Manual

## SHIMS



Shims, also called wedges, are temporary or interim measures to treat cracked or lifted sidewalks to reduce tripping hazards and improve accessibility. Asphalt is typically used to construct a shim.

### BEST USED IF

- Immediate solution to problem is needed.
- Problem is minor enough to address with shim (generally 1" or less lift) and space is available to install shim at 4H:1V max slope.

### DON'T USE IF

- Uplift is too significant to address with shim.

### PROACTIVE / RESPONSIVE

- Responsive - Shims are used in response to an issue that must be immediately addressed.

### EXPECTED USEFUL LIFE

M	Y	D	C
---	---	---	---

YEARS

### COST

\$



Tool addressed in  
Seattle ROWIM

### NOTE

- In general, shims are considered a temporary measure and will require more frequent repair or replacement than a fully-repaired sidewalk.

### ESTIMATED COST

- \$200 / location

### REFERENCES

- Seattle Right-of-Way Improvements Manual
- Seattle Client Assistance Memo (CAM) 2208 - Sidewalk Maintenance and Repair

# TREE GUARDS AND TREE RAILS



A tree guard around a tree’s trunk can help protect the trunk from damage. A tree rail around an entire tree pit/ planting area can help protect the tree as well as prevent soil compaction around it.

## BEST USED IF

- Tree planting is in area of high pedestrian traffic.

## DON'T USE IF

- Tree planting is in low-traffic area.
- Periodic maintenance of tree guard or railing is unlikely (tree guards near trunk can damage the tree if left in place too long as the tree grows).

## PROACTIVE/RESPONSIVE

- Proactive - Best put in place with new plantings in areas where high foot traffic in the tree planting area is anticipated.
- Responsive - May be installed in areas where damage to trees and compaction of planting area is a problem, if reasonable alternative travel areas exist.

## EXPECTED USEFUL LIFE



## COST

\$\$ - \$\$\$



Tool addressed in Seattle ROWIM

## NOTE

- Consider whether there is enough space outside of the planting area to accommodate pedestrian volumes; if not, then consider other solutions, such as relocation of trees, replacing tree pit surface with walkable surface (such as fine crushed gravel), or a tree grate.
- Could be used to help accommodate grade changes between tree planting area and adjacent sidewalk.

## ESTIMATED COST

- \$50 - \$100 / linear foot (rails)
- \$250 - \$500 / tree (guards)

## REFERENCES

- Seattle Right-of-Way Improvements Manual
- City of New York Parks & Recreation. February 2014. Tree Planting Standards. <http://www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf>

## DECOMPOSED GRANITE



Decomposed granite, or small crushed gravel, may be used as a path / walkway surface in residential areas. It may also be used as a finished surface on top of planting soil in tree pits in areas of high pedestrian traffic (see 'Mulch').

### BEST USED IF

- Pedestrian volume is relatively low.
- Pathway creates a new pedestrian route (e.g., no sidewalk previously existed on route to be paved with gravel).

### DON'T USE IF

- No other ADA-compliant route is available.
- Location is an arterial, business district street, or otherwise busy pedestrian corridor.

### EXPECTED USEFUL LIFE

M	Y	D	C
YEARS			

### COST

\$ - \$\$



Tool NOT addressed  
in Seattle standards

### PROACTIVE/RESPONSIVE

- Proactive - May be used for a new pathway or section to provide a flexible but walkable surface adjacent to trees and other plantings.
- Responsive - May be used as a temporary surface in root zones where damaged pavement has been removed.

### NOTE

- Binders and regular maintenance may be required to meet ADA.
- Consider who will provide maintenance once material is installed. It will require more regular maintenance than asphalt or concrete pavement materials.

### ESTIMATED COST

- \$12 / linear foot

### REFERENCES

- Seattle Department of Parks and Recreation
- Mann, Gordon, RCA. Sidewalk and Root Conflicts: Mitigating the Conflict - An Overview

# MUDJACKING (CONCRETE LEVELING)



Mudjacking, or concrete leveling, is used to lift concrete panels when they have sunk or collapsed. Usually a cement and soil mixture is pumped under pressure below the existing concrete panel; the practice may also be performed using a foam fill material. The mixture fills the void beneath the surface and adds additional support under the concrete panel.

### BEST USED IF

- There is no tree or if the existing tree is being removed.
- A small section of sidewalk needs to be replaced.
- The concrete panel(s) remain in good condition.

### DON'T USE IF

- The concrete panel is not in good condition.
- If there is an existing tree (casing the roots in the mixture could cause damage to the tree).

### PROACTIVE/RESPONSIVE

- Responsive – This application is typically applied to an existing sidewalk panel section that has settled.

### NOTE

- Mudjacking is not a typical maintenance activity in the City of Seattle. This activity would not be performed within the dripline of an existing tree.

### EXPECTED USEFUL LIFE

M	Y	D	C
---	---	---	---

DECADES

### COST

\$\$-\$\$\$\$



Tool NOT addressed in Seattle standards

### ESTIMATED COST

- \$10 / linear foot

### REFERENCES

- Costello, L. R. and K. S. Jones. 2003. Reducing Infrastructure Damage By Tree Roots: A Compendium of Strategies. Western Chapter of the International Society of Arboriculture.

## MONOLITHIC SIDEWALK



A monolithic sidewalk is where the roadway curb and sidewalk are constructed as one continuous concrete installation as opposed to two separate installations with an expansion joint separating curb and sidewalk. As one continuous installation there is more concrete weight (mass) to resist the uplift of tree roots. The elimination of the expansion joint at the back of curb also eliminates a potential future weakness in the paving infrastructure.

### BEST USED IF

- Future root growth is not anticipated and existing roots can be pruned to accommodate the installation.
- There is adequate soil volume in areas the roots are intended to grow.

### EXPECTED USEFUL LIFE



### COST

\$\$\$



Tool addressed in  
COS Standard Plans

### DON'T USE IF

- Tree root growth is vigorous and the monolithic construction is unlikely to provide more than a short-term solution.

### PROACTIVE/RESPONSIVE

- Proactive – Monolithic sidewalks can be used along new installations where the sidewalk is located adjacent to the street to prevent future root uplift.
- Responsive – To correct uplift of the sidewalk and provide resistance from future uplift after corrective actions have been taken and root integrity can be maintained.

### NOTE

- Consider impacts from drainage flow paths for monolithic sidewalks as it is not desirable to convey surface runoff along the face of curb if there is a joint present.

### ESTIMATED COST

- \$60 / linear foot

### REFERENCES

- City of Seattle Standard Plan 421

# PAVEMENT THICKNESS



In some cases, thicker pavement may minimize future root damage by providing greater strength and resistance against root pressure. In other cases, thinner (reinforced) pavement can provide more space for existing tree roots.

### BEST USED IF

- Additional excavation to accommodate thicker pavement section will not cause unacceptable damage to existing tree roots or infrastructure.
- Thinner pavement will better accommodate existing tree roots.

### DON'T USE IF

- Root structure does not allow for desired pavement thickness.
- Vehicular or other anticipated loads will damage thinner pavement.

### EXPECTED USEFUL LIFE



### COST

\$\$\$



Tool addressed in COS Standard Plans

### PROACTIVE / RESPONSIVE

- Responsive - A thicker pavement section would be used in response to an existing issue; new trees should be planted with adequate space and root barrier (per City of Seattle Standard Plans) so as to not require a thicker pavement section.

### NOTE

- This applies to concrete sidewalks only.

### ESTIMATED COST

- \$40 / linear foot for 4" thickness

### REFERENCES

- City of Seattle Standard Plans 420-425

## TREE PIT SIZING



Tree pits are typically used as an alternative to planting strips in business districts where additional sidewalk width is important to accommodate pedestrian volumes. In Seattle, when permitted as an alternative to planting strips, tree pits shall be constructed per Standard Plan 424, dimensioned to meet or exceed the minimum size required. The minimum square footage for a tree pit is 24 square feet of open area (typically 4' x 6' or 5' x 5'). Any proposed variations shall be subject to site-specific review to ensure that (1) conditions justify the variation; (2) the design meets public safety standards; and (3) the design provides adequate conditions, including soil volume, to support trees.

### BEST USED IF

- A continuous planting strip is not a good option for the site (e.g., in a busy/pedestrian setting, or adjacent to curbside parking with frequent turnover).

### DON'T USE IF

- Continuous planter strips are more appropriate for the site.

### PROACTIVE / RESPONSIVE

- Proactive - Tree pits for new plantings should allow adequate room for trunk and root growth for the species of tree being planted.
- Responsive - In some cases tree pits may be enlarged to alleviate constrained root or trunk space and provide better growing conditions for an existing tree.

### EXPECTED USEFUL LIFE



### ESTIMATED COST

- Proactive - No added cost if included in design
- Responsive - \$15 / square yard

### COST

\$



Tool addressed in  
COS Standard Plans

### REFERENCES

- City of Seattle Standard Plan 424
- City of New York Parks & Recreation. February 2014. Tree Planting Standards. <http://www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf>

## BRIDGING



Bridging can provide grade separation between a sidewalk and the root zone of a tree. Various bridging techniques exist, including pier and beam bridges, cantilevered sections, and boardwalks. Bridging techniques are used to provide space for tree roots to grow in soil without lifting or otherwise damaging the adjacent sidewalk. The “bridge” section of the sidewalk supports itself, from the ends, on piers, without the need for compacted subgrade below it. Various deck materials may be used, including concrete, or steel panels (such as in photo to left) with appropriate non-slip finish.

### BEST USED IF

- To preserve a high-value tree and also meet sidewalk accessibility requirements.

### DON'T USE IF

- Cannot work within grading requirements for site-specific conditions.

### EXPECTED USEFUL LIFE



### COST

\$\$\$\$



Tool addressed in  
Seattle ROWIM

### PROACTIVE / RESPONSIVE

- Responsive - May be used to replace a damaged sidewalk if other measures (such as root pruning) would not allow for a more basic sidewalk repair and continued root damage would be likely.

### NOTE

- If drop to adjacent grade is greater than 18”, then bridge would require handrail.
- If bridge deck is metal, a non-slip texture or surface treatment must be provided.

### ESTIMATED COST

- \$225 / linear foot

### REFERENCES

- Seattle Right-of-Way Improvements Manual

## CURB BULBS



A curb bulb is a radial extension of a sidewalk at an intersection used to shorten the crossing distance for pedestrians. Curb bulbs may be landscaped and provide additional root growth area for trees, and can improve pedestrian crossings. Designs that include trees and landscaping must ensure proper sight lines are maintained.

### BEST USED IF

- Additional planting space would likely reduce further sidewalk damage by tree roots.
- Existing planting strip does not have enough space for desired tree species.
- Parking restrictions already exist at location (e.g., within 30' of a crosswalk).

### DON'T USE IF

- Relocating the curb will not work due to drainage or other infrastructure conditions.
- Curb bulb will not work due to traffic conditions.
- Other street uses may be planned for the existing roadway width (such as bicycle facilities, etc).

### PROACTIVE / RESPONSIVE

- Proactive - Curb bulbs may be used to create a larger planting area for a new tree.
- Responsive - Curb bulbs may be used to give an existing tree more space to grow.

### NOTE

- Certain conditions must be in place, including curbs, drainage, and proper location of utilities.
- Curb bulbs are generally a costly solution, but may be particularly appropriate where they serve other purposes (such as traffic calming/pedestrian improvements).

### ESTIMATED COST

- \$50 / linear foot (excludes drainage and ramps)

### REFERENCES

- Seattle Right-of-Way Improvements Manual

### EXPECTED USEFUL LIFE



### COST

\$\$\$ - \$\$\$\$



Tool addressed in  
Seattle ROWIM

# CURB REALIGNMENT



Curb realignment involves shifting the curb location for a significant distance (e.g., along an entire block) in order to widen the planting strip and provide more space for trees.

**BEST USED IF**

- There is space in the right-of-way to create additional width in the planting strip (generally taking space from the street).

**DON'T USE IF**

- There is not street width that could be used for planting.
- Shifting the curb would cause conflicts with other existing infrastructure.

**PROACTIVE / RESPONSIVE**

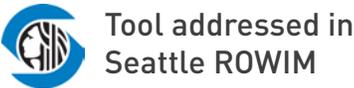
- Proactive - May be done as part of a large-scale street repair/reconstruction (e.g., capital improvement project) to provide additional space for new trees.
- Responsive - May be done as part of a large-scale street repair/reconstruction (e.g., capital improvement project) to provide additional space for existing trees.

**EXPECTED USEFUL LIFE**



**COST**

\$\$\$-\$\$\$\$



**NOTE**

- Curb realignment will require traffic studies and engineering.
- Must consider impacts to parking, transit, and other transportation facilities.

**ESTIMATED COST**

- Proactive - Minimal cost change if part of design
- Responsive - \$50 / linear foot (excludes drainage modifications and ramps)

**REFERENCES**

- Seattle Right-of-Way Improvements Manual

## CURVING OR OFFSET SIDEWALK



Curving (or offset) sidewalks may be used to meander around planting areas to give trees more space to grow.

### BEST USED IF

- An existing tree is of high value.
- Curving the sidewalk around one or multiple planting areas can provide a significantly better area for new tree planting.

### DON'T USE IF

- Space is limited in the right-of-way.

### PROACTIVE / RESPONSIVE

- Proactive - May be used to provide increased planting space where larger species of trees will be used.
- Responsive - May be installed in conjunction with sidewalk repair or larger-scale development in order to help preserve mature trees and protect new infrastructure from root damage.

### EXPECTED USEFUL LIFE



### COST

\$\$-\$\$\$



Tool addressed in  
Seattle ROWIM

### NOTE

- Can potentially be combined with an easement to locate the sidewalk on private property adjacent to the right-of-way.

### ESTIMATED COST

- \$38 / linear foot

### REFERENCES

- Seattle Right-of-Way Improvements Manual

## EASEMENT



An easement may allow construction of a sidewalk on private property in order to provide more space for existing or new trees. The width of easements is site specific.

### BEST USED IF

- Adequate planting space is not available in the right-of-way.

### DON'T USE IF

- Topography requires new structures, such as walls, in the right-of-way.

### PROACTIVE / RESPONSIVE

- Proactive - Can provide a larger planting area for new trees, particularly if larger species are desired.
- Responsive - May provide larger root zone for existing trees, to prevent future damage after any repairs and potentially prolong life of the tree.

### NOTE

- This requires coordination between the property owner and SDOT.

### ESTIMATED COST

- Market value or dedication from property owner

### REFERENCES

- Seattle Right-of-Way Improvements Manual

### EXPECTED USEFUL LIFE

M	Y	D	C
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CENTURY

### COST

\$-\$\$\$



Tool addressed in  
Seattle ROWIM

# SUSPENDED PAVEMENT SYSTEMS



Suspended pavement systems may be used in new tree plantings where there is not an adequate volume of soil available for tree root growth. These systems provide structural support for pavement while allowing the use of planting soil as fill, which provides space for roots to grow, promoting healthy trees and preventing pavement damage by roots near the surface.

## BEST USED IF

- Adequate soil volume for the size of intended tree species is not available within the tree pit and adjacent planting strip.
- An area below pavement between the planting strip and back of sidewalk is desired for root growth while avoiding pavement damage.

## EXPECTED USEFUL LIFE



## COST

\$\$\$-\$\$\$\$



Tool addressed in  
Seattle ROWIM

## DON'T USE IF

- Cannot work within grading requirements for site-specific conditions.

## PROACTIVE / RESPONSIVE

- Proactive - Should be used for new tree plantings, particularly in urban conditions with limited planting area within the streetscape.

## ESTIMATED COST

- \$15 - \$25 / cubic foot (depending on depth)

## REFERENCES

- Seattle Right-of-Way Improvements Manual

## LOWERED SITES



Photo Credit: IRONSMITH

### EXPECTED USEFUL LIFE



### COST

\$\$\$-\$\$\$\$



Tool NOT addressed  
in Seattle standards

Lowered sites may be used to provide spatial separation between the finished grade of the tree planting pit and the surrounding sidewalk or other pavement. Pavement over lowered sites requires reinforcement for support. Tree grates or other materials may provide a walkable surface level with adjacent grades over the lowered tree pit area. Trees should be provided with adequate soil volume per the species selected, either within the lowered tree pit or by using other solutions under adjacent pavement such as structural soil and subsurface aeration/irrigation.

### BEST USED IF

- Trees are desired in an area with high pedestrian volumes and little available planting space but few underground infrastructure conflicts.

### DON'T USE IF

- Space is available for planting trees at grade.
- Underground infrastructure in nearby areas is extensive and would limit available soil volume or present likely conflicts with tree roots.

### PROACTIVE/RESPONSIVE

- Proactive - This approach will prevent compaction of soil around the tree pit.

### NOTE

- Maintenance can be an issue with lowered tree planting sites, as the lowered sites tend to accumulate trash and debris and may be more difficult to access.
- Planting techniques and details may be similar to tree planting in bioretention planters or using bridging.
- Design must provide drainage in lowered planting area to avoid prolonged soil saturation.

### ESTIMATED COST

- \$50 - \$100 / square foot

### REFERENCES

- Costello, L. R. and K. S. Jones. 2003. Reducing Infrastructure Damage By Tree Roots: A Compendium of Strategies. Western Chapter of the International Society of Arboriculture.

## SOIL VOLUME

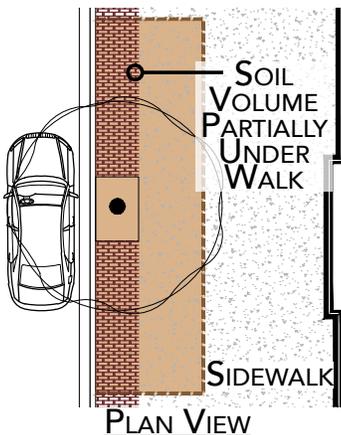


Photo Credit: District of Columbia Dept. of Transportation

### EXPECTED USEFUL LIFE



### COST

\$-\$\$\$



Tool NOT addressed  
in Seattle standards

All street trees should have an adequate volume of soil of a type and depth that promotes healthy tree and root growth. Many tree and sidewalk conflicts arise due to tree roots growing directly under sidewalks, with compacted fill and other poor soils below. Providing adequate volume and depth of appropriate soils will help grow healthier trees and reduce tree and sidewalk conflicts. Soil volume requirements vary by tree species and location, but a general guideline is two cubic feet of soil per one square foot of area within the tree's mature drip line. Generally the following volumes should be provided:

- small tree = 600 cubic feet of soil
- medium tree = 1,000 cubic feet of soil
- large tree = 1,500 cubic feet of soil

### BEST USED IF

- New tree plantings are being planned and installed.
- Opportunity exists to augment the planting soil available to existing trees without adversely impacting the roots.

### DON'T USE IF

- Adding soil volume would require cutting or damaging critical roots on an existing tree.

### PROACTIVE/RESPONSIVE

- Proactive - Require adequate tree pit size and/or provide soil under adjacent pavement for new tree plantings.
- Responsive - Increase tree pit size and provide soils that promote healthy root growth to extent possible when repairing sidewalks around existing trees.

### NOTE

- Planting soils under or at back of sidewalk may count towards soil volume if appropriate soils are provided for tree root growth.
- Actual soil volumes needed for optimum tree health will vary with location, tree species, and other conditions.

### ESTIMATED COST

- Varies based on required soil volume

### REFERENCES

- District of Columbia Department of Transportation. 2014. Green Infrastructure Standards.
- Casey Trees. 2008. Tree Space Design: Growing the Tree Out of The Box. <http://caseytrees.org/resources/publications/treespacedesign/>

# MULCH



Mulch may be used at the surface to promote tree health, suppress growth of weeds and grasses that compete with a tree for moisture, and encourage root growth in appropriate areas. Arborist wood chip mulch helps prevent soil compaction and allows water to infiltrate into soils in planting areas. Arborist wood chip or other mulch containing compost can contribute beneficial humic acid to the tree’s root zone. Crushed gravel may be used as mulch in higher-traffic areas as a means of providing a walkable but flexible surface in the tree pit.

## BEST USED IF

- Any soil would be left exposed in the planting area; areas that would otherwise not be planted should be mulched.
- Top of soil in the tree pit is lower than adjacent sidewalk.
- Gravel mulch is typically used in tree pits only in neighborhood commercial areas and downtown Seattle.



## DON'T USE IF

- Gravel mulch should not be used if the intention is to deter people from walking in the tree pit.

## PROACTIVE/RESPONSIVE

- Proactive – New tree plantings should be mulched with a mulch type appropriate to the location.
- Responsive – Mulch should be applied to an existing tree zone where the soil has settled or the mulch layer has become depleted and there is exposed bare soil.

## NOTE

- Existing soil should be loosened/aerated if it is extremely compacted (as possible without root damage) prior to mulch application (see also Soil Modification tool).
- Keep mulch away from trunks; mulch should be avoided in the root crown area for some tree species.

## EXPECTED USEFUL LIFE

M	Y	D	C
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YEARS

## COST

\$



Tool addressed in  
COS Standard Plans

## ESTIMATED COST

- \$5 - \$10 / square yard at 3” depth

## REFERENCES

- City of Seattle Standard Plan 100a
- City of Seattle Standard Specifications

# ROOT BARRIERS



Root barriers are physical barriers (commonly plastic sheeting or interlocking panels) installed from surface level to a depth of 12”-24” or more at the interface between a tree zone and adjacent paving or other infrastructure. They are intended to deter root growth near the surface that may damage pavement. Typical placement is vertical, although horizontal root barriers also exist.

## BEST USED IF

- A new tree is being installed and there is pavement nearby that may be damaged by future root growth.
- There is adequate soil volume in areas the roots are intended to grow.

## PROACTIVE/RESPONSIVE

- Proactive - Root barriers are best used for new tree plantings to prevent future damage to adjacent sidewalks and other infrastructure.
- Responsive - Root barriers may be added in specialized retrofit conditions.

## NOTE

- Note that root barriers are required adjacent to sidewalks (18” depth) and curbs (24” depth) for new tree plantings per detail in City of Seattle Standard Plan 100a.

## ESTIMATED COST

- \$8 / linear foot

## REFERENCES

- City of Seattle Standard Plan 100a
- Smiley, E. Thomas. 2008. “Comparison of Methods to Reduce Sidewalk Damage from Tree Roots,” in *Arboriculture & Urban Forestry* 34(3):179-183

## EXPECTED USEFUL LIFE



## COST

\$



Tool addressed in  
COS Standard Plans

# CONTINUOUS TRENCHES



Photo Credit: Casey Trees, Tree Space Design Report

Continuous trenches may be used to provide extra soil volume for root growth underneath pavement. The trench area (typically 6’ wide by 3’ deep) is excavated and filled with loosely compacted planting soil. Pavement above the trench area must be engineered and self-supporting, spanning the trench area with adequate support on both sides. The trench may connect several tree pits.

### BEST USED IF

- Poor native soil conditions and lack of space for tree pits limit soil volume available for healthy tree roots.

### DON'T USE IF

- Adequate structural support for pavement above trench cannot be achieved.

### PROACTIVE/RESPONSIVE

- Proactive - May be used to provide adequate soil volume for new tree plantings.
- Responsive - May be added in extensive retrofit or repair work if possible without extensive damage to existing root systems.

### NOTE

- Pavement (sidewalks, step-out zones, etc) above the trench must be supported structurally, either by bridging to appropriate supports on either side of the trench or by the inclusion of structural support elements (such as DeepRoot SilvaCells or Citygreen Strata Cells) that can accommodate planting soil and root growth within the trench.

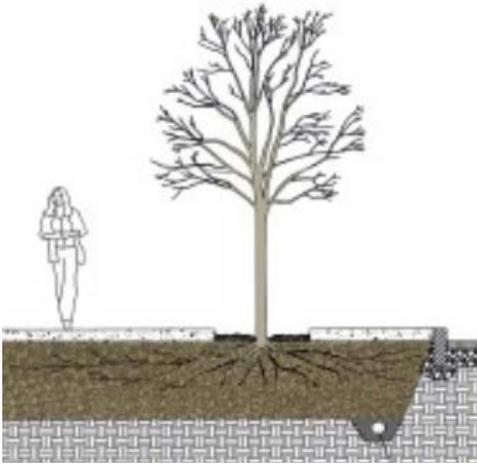


Photo Credit: Casey Trees, Tree Space Design Report

### EXPECTED USEFUL LIFE



### COST

\$\$ - \$\$\$\$



Tool NOT addressed in Seattle standards

### ESTIMATED COST

- Varies - if pavement necessary see Structural Soils and Suspended Pavement Systems

### REFERENCES

- City of New York Parks & Recreation. February 2014. Tree Planting Standards. <http://www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf>

# FOAM UNDERLAY

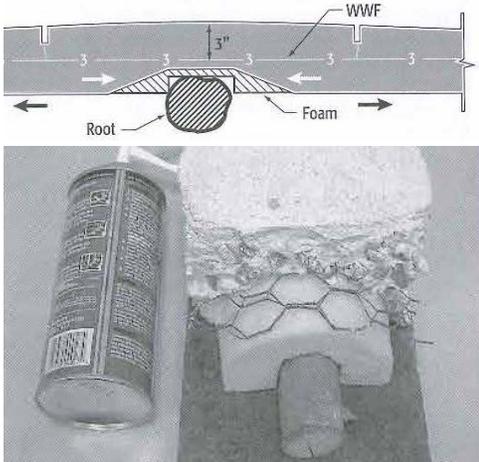


Photo Credit: Costello and Jones, 2003. *Reducing Infrastructure Damage by Tree Roots*

A foam layer is added between existing roots and new concrete pavement to support the pavement and help prevent movement or damage. Radial root growth compresses the foam to some degree before affecting the pavement slab.

## BEST USED IF

- Site is a repair at a mature tree (slower root growth).
- Installation is combined with concrete sidewalk replacement.
- Existing roots that cannot be pruned are left near bottom surface of replacement sidewalk pavement.

## DON'T USE IF

- Tree (root) growth is expected to be rapid.

## PROACTIVE/RESPONSIVE

- Proactive - Rigid foam may be used below the sidewalk pavement to prevent future root damage; may be more effective combined with other tools, such as root barriers.
- Responsive - May prevent or slow further damage to pavement by existing roots when replacing the pavement.

## EXPECTED USEFUL LIFE

M	Y	D	C
YEARS			

## COST

\$-\$\$



Tool NOT addressed in Seattle standards

## NOTE

- Use of foam underlay under sidewalks is non-standard in the City of Seattle and installation must be reviewed and approved by SDOT.
- Further research or testing of this tool may be necessary. Compare to use of modified gravel layer. May be used where depth available for modified base course is limited (e.g., under 4").

## ESTIMATED COST

- \$150-\$250 / location

## REFERENCES

- Smiley, E. Thomas. 2008. "Comparison of Methods to Reduce Sidewalk Damage from Tree Roots," in *Arboriculture & Urban Forestry* 34(3):179-183
- Costello, L. R. and K. S. Jones. 2003. *Reducing Infrastructure Damage By Tree Roots: A Compendium of Strategies*. Western Chapter of the International Society of Arboriculture.

# MODIFIED GRAVEL LAYER



An open-graded gravel base course may be applied under the sidewalk pavement to discourage root growth directly under the pavement and reduce likelihood of sidewalk damage.

### BEST USED IF

- Depth is available in the pavement profile to include at least 4" of modified gravel layer.

### DON'T USE IF

- Extra depth of excavation to install modified gravel layer would damage critical existing roots.

### PROACTIVE/RESPONSIVE

- Proactive - Use as a compacted base course below new sidewalk pavement.
- Responsive - Use as a compacted base course below new pavement for sidewalk repairs, as grades allow.

### EXPECTED USEFUL LIFE



### COST

\$



Tool NOT addressed in Seattle standards

### NOTE

- Thickness of gravel layer can be adjusted around existing tree roots.

### ESTIMATED COST

- \$0.70 / square foot (at 4" depth of gravel)

### REFERENCES

- Smiley, E. Thomas. 2008. "Comparison of Methods to Reduce Sidewalk Damage from Tree Roots," in *Arboriculture & Urban Forestry* 34(3):179-183

# ROOT PATHS



Photo Credit: Arlington, VA, Department of Community Planning, Housing and Development

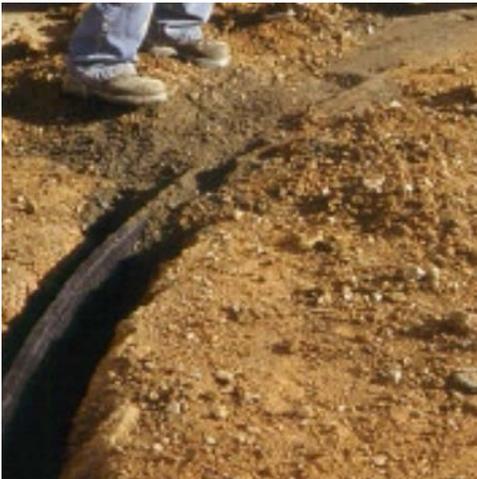


Photo Credit: Casey Trees, Tree Space Design Report

Root paths are narrow trenches, roughly 4” wide by 1’ deep, installed in compacted subgrade before the gravel base for pavement is added. A commercially available strip drain material could be added to the trench to support drainage, and the remaining space backfilled with planting soil. Root paths extend radially from tree pit locations, and may connect to adjacent tree pits, and/or other nearby planting areas (lawns, etc.).

### BEST USED IF

- Underlying (native) soil supports some rooting even when it is somewhat compacted.

### DON'T USE IF

- Positive drainage out of / away from root path cannot be achieved.

### PROACTIVE/RESPONSIVE

- Proactive - Root paths should be installed for new plantings during construction, at the time of subgrade preparation (before paving).

### NOTE

- Root paths may be most applicable in urban areas where tree roots need to be directed around utilities and planting space is limited.

### ESTIMATED COST

- \$600-\$800 per tree [Costello & Jones 2003]

### EXPECTED USEFUL LIFE



### COST

\$-\$



Tool NOT addressed in Seattle standards

### REFERENCES

- Casey Trees. 2008. Tree Space Design: Growing the Tree Out of The Box. <http://caseytrees.org/resources/publications/treespacedesign/>
- Costello, L. R. and K. S. Jones. 2003. Reducing Infrastructure Damage By Tree Roots: A Compendium of Strategies. Western Chapter of the International Society of Arboriculture.

# SOIL MODIFICATION



Photo Credit: Organic Soil Solutions

Soil modification includes improvements and amendments to site soils, or the use of specific beneficial soils to replace existing soils, to improve conditions for root growth in desirable locations. One recommended amendment is humic acid, an organic soil treatment that can loosen tightly packed soils to improve water infiltration and help foster root growth deeper in the soil horizon. The addition of a high-quality, biologically-active and pathogen-free compost in soil areas where root growth is desirable is also recommended.

## BEST USED IF

- Tree roots are staying largely near the soil surface and soils are hard and difficult to penetrate.

## DON'T USE IF

- Proposed soil modification would cause excessive root damage.

## PROACTIVE/RESPONSIVE

- Proactive - Humic acid may be used with new plantings at the surface of any prepared subgrade where roots may develop.
- Proactive - Soils should be improved in any planting bed areas adjacent to tree plantings to encourage root growth in planted areas rather than under pavement.
- Responsive - Humic acid should be used around any exposed roots and at the base of any excavation to encourage deeper root development and discourage pavement damage.

## NOTE

- Also ensure adequate soil volume is available (see Soil Volume tool).

## ESTIMATED COST

- \$100 / tree minimum for biological treatments

## REFERENCES

- Penn State College of Agricultural Sciences. 2008. Planting and After Care of Community Trees. [http://www.dec.ny.gov/docs/lands\\_forests\\_pdf/planttree.pdf](http://www.dec.ny.gov/docs/lands_forests_pdf/planttree.pdf)

## EXPECTED USEFUL LIFE



## COST

\$-\$\$



Tool NOT addressed in Seattle standards

# STEEL PLATES



Photo Credit: Gordon Mann

Steel plates are placed above existing roots and anchored into place to prevent upward root expansion. Pavement is placed over the steel plates.

### BEST USED IF

- An existing root should not be pruned but needs to be constrained to prevent or slow further sidewalk damage.

### DON'T USE IF

- Steel plate would be placed above an underground utility.

### PROACTIVE/RESPONSIVE

- Responsive - Steel plates should be used in response to an issue that has developed. Proactive measures should be used to prevent pavement damage for new plantings.

### EXPECTED USEFUL LIFE



### COST

\$\$-\$\$\$\$



Tool NOT addressed in Seattle standards

### NOTE

- Use of steel plates under sidewalks is non-standard in the City of Seattle and their installation must be reviewed and approved by SDOT.
- The City should develop and implement a method to track locations where steel plates are installed and alert individuals who may be doing construction work near them to their presence.

### ESTIMATED COST

- \$500-\$1000 / site

### REFERENCES

- Mann, Gordon, RCA. Sidewalk and Root Conflicts: Mitigating the Conflict - An Overview



# STRUCTURAL SOILS



Structural soils are soils that are specially designed to provide nutrients, space, and porosity to accommodate root growth while also allowing for compaction to support pavement without settling. There are proprietary structural soil mixes available as well as various non-proprietary mixes that have been used in many municipalities.

### BEST USED IF

- Structural soil can be placed in adequate depths to allow for root growth away from the bottom of the pavement.

### DON'T USE IF

- Depth of at least 12" of structural soil cannot be achieved for a new tree planting (shallow depths will encourage root growth near the bottom of the pavement).

### EXPECTED USEFUL LIFE



### COST

\$\$-\$\$\$



Tool NOT addressed in Seattle standards

### PROACTIVE/RESPONSIVE

- Proactive - May be placed under new pavement areas or under planting soil in planting beds to provide soil volume for root growth.
- Responsive - May be used as fill material around existing roots in areas where sidewalk will be replaced above, if adequate structural soil depth can be placed.

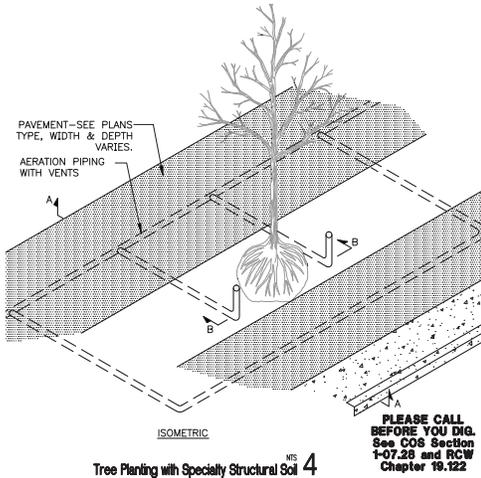
### ESTIMATED COST

- \$60 - \$80 / cubic yard (or \$1.85 - \$3 / cubic foot)

### REFERENCES

- Urban Horticulture Institute, Cornell University. "Using CU-Structural Soil in the Urban Environment" and related documents. See <http://www.hort.cornell.edu/uhi/outreach/index.htm>
- Casey Trees. 2008. Tree Space Design: Growing the Tree Out of The Box. <http://caseytrees.org/resources/publications/treespacedesign/>
- Penn State College of Agricultural Sciences. 2008. Planting and After Care of Community Trees. [http://www.dec.ny.gov/docs/lands\\_forests\\_pdf/planttree.pdf](http://www.dec.ny.gov/docs/lands_forests_pdf/planttree.pdf)

# SUBSURFACE AERATION & IRRIGATION



Aeration piping may be installed to help encourage deeper root growth by providing some air to deeper layers of soil, particularly where covered by pavement. In some cases the addition of an irrigation system (typically drip tubing) within the perforated aeration piping can further aid in desirable root growth.

## BEST USED IF

- Placement of structural soil or other fill allows for installation of aeration piping at least 12” below finished grade.
- Aeration piping may be added under paved areas.

## DON'T USE IF

- Installation of piping would require damage to critical existing roots.
- Piping cannot be installed at adequate depth or in areas where encouraging root growth would be beneficial.

## PROACTIVE/RESPONSIVE

- Proactive - Aeration piping and subsurface irrigation may be installed during subgrade preparation under pavement adjacent to tree plantings.
- Responsive - If pavement is to be replaced or added adjacent to existing trees the addition of subsurface aeration piping may help maintain adequate growing conditions for existing roots.

## NOTE

- Aeration piping may become defunct (due to root intrusion or other causes) within 5-10 years, which is acceptable if the tree(s) have become established in their growing conditions.

## EXPECTED USEFUL LIFE

M	Y	D	C
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YEARS

**COST**  
\$\$



Tool NOT addressed in Seattle standards

## ESTIMATED COST

- \$750 - \$1,500 / tree for proactive installations
- Cost varies for responsive (retrofit) installations

## REFERENCES

- Penn State College of Agricultural Sciences. 2008. Planting and After Care of Community Trees (see pg. 14). [http://www.dec.ny.gov/docs/lands\\_forests\\_pdf/planttree.pdf](http://www.dec.ny.gov/docs/lands_forests_pdf/planttree.pdf)



# CORRECTIVE PRUNING



Corrective pruning involves above-ground pruning to establish good structural form (proactive), and to remove dead or diseased material and weakly attached parts, and provide clearance for surrounding conditions (such as street traffic, overhead utilities, or adjacent buildings). Trees will typically achieve best form if pruned three times in the first seven years.

All pruning maintenance performed on street trees shall be in accordance with current tree industry standards and supervised by an ISA-certified arborist or an ISA-certified tree worker.

## EXPECTED USEFUL LIFE

M	Y	D	C
---	---	---	---

YEARS

## COST

\$-\$\$



Tool addressed in  
SDOT Street Tree Manual

## BEST USED IF

- Tree is in good health and vigor and is worthy of preservation.

## DON'T USE IF

- Tree is not worthy of preservation or is in poor health to the degree that corrective pruning would not improve its condition.

## PROACTIVE/RESPONSIVE

- Proactive - Used to establish good structural form and proactively address potential future clearance issues.
- Responsive - Used to remove dead, diseased, weakly attached parts and to provide clearance.

## ESTIMATED COST

- \$200-\$500/tree depending on size of tree

## REFERENCES

- SDOT Street Tree Manual



# ROOT PRUNING



Root pruning is a responsive treatment in which tree roots that are causing issues, such as sidewalk uplift, are removed, typically in conjunction with repair of damaged sidewalks or other infrastructure. The amount of root pruning that a tree can handle varies by tree size, species, condition, age, and root distribution, and must be supervised by a qualified arborist.

### BEST USED IF

- A minimal amount of root pruning can prevent or defer future damage caused by the tree’s roots.
- Removal of specific roots makes space available for an appropriate repair (e.g., allows proper sidewalk width and/or grading).

### EXPECTED USEFUL LIFE

M	Y	D	C
YEARS			

### DON'T USE IF

- Arborist determines that root pruning would significantly impact health or structural integrity of the tree.
- Qualified arborist has not been consulted.

### COST

\$-\$\$

### PROACTIVE/RESPONSIVE

- Responsive - This practice is used to address tree roots that are directly contributing to an infrastructure issue.



Tool addressed in SDOT Street Tree Manual

### NOTE

- SDOT Urban Forestry must approve removal/pruning of roots greater than 2” in diameter within the dripline of a street tree.
- All root pruning within the critical root zone of a street tree must be supervised or directed by a representative from SDOT Urban Forestry.

### ESTIMATED COST

- \$500 - \$2,000 per tree

### REFERENCES

- SDOT Street Tree Manual



# CASE STUDIES

Three different case studies were performed to test the draft decision process. The case studies represent a diverse set of conditions throughout the city, with one low-density corridor, one medium-density corridor, and one

high-density corridor. For the corridor locations, a conceptual plan was developed as a test case for resolving issues at this scale. The concept plans and results of the initial assessments for these corridors can be found in the appendix.

## **CASE STUDY #1: LOW-DENSITY CORRIDOR 34th Avenue, Madrona (see Appendix D)**

The Madrona case study limits include 34th Avenue from E Union Street to E Cherry Street. Most of the trees along the corridor are species of maples (*Acer*). There are overhead wires on both sides of the street, but live electrical wires are on the east side of the street. This corridor is served by a bus line that requires trolley wires. Key destinations accessed from the corridor—including Madrona Elementary, St. Therese School, Madrona Playground, Alvin Larkins Park and several neighborhood

commercial businesses and other services—are located on 34th Avenue.

Most of the trees along the corridor are lifting the sidewalk with their roots. The sidewalks along this corridor have been beveled and shimmed in the past. Many of these trees will need to be evaluated further to identify if root pruning and grade adjustments are enough to make sidewalk replacement feasible. Since this corridor is an arterial with bus service and provides access to neighborhood services, it is recommended that concrete sidewalks be installed. If trees need to be removed after further evaluation, new tree pits must be larger.



**CASE STUDY #2:**  
**MEDIUM-DENSITY CORRIDOR**  
**Lake City (see Appendix E)**

The Lake City case study limits include 35th Avenue NE from NE 125th Street to NE 130th Street and NE 130th Street from 35th Avenue NE to 32nd Avenue NE. This corridor contains a mature tree canopy that is predominantly ash (*Fraxinus*) trees. The sidewalk damage is minor but the width of the sidewalk is limited by the adjacent properties and the location of the trees. In some locations, the topography limits the ability to widen the sidewalk. At many locations, the current sidewalk is less than 4 feet wide.

This corridor is within the Lake City Hub Urban Village and is adjacent to Lowrise, Commercial and Single Family zoning. There are two private schools along the corridor, and it is identified as a school walking route for Cedar Park elementary. There is also a transit route which provides a key connection to downtown Seattle.

The concept plan recommends that the shims and bevels be used to improve the minor sidewalk damage along the corridor. Over time, the sidewalks may be improved and widened as properties redevelop along the corridor. In other locations, it may be necessary to obtain easements from adjacent properties to provide an accessible sidewalk and keep the large canopy trees.





**CASE STUDY #3:**  
**HIGH-DENSITY CORRIDOR**  
**Rainier Beach (see Appendix F)**

The Rainier Beach case study limits include Rainier Avenue S from S Henderson Street to Seward Park Avenue S. Almost all trees showed some signs of damage from vehicles, with several recently planted trees that were destroyed. Planting conditions along this corridor vary between tree wells and continuous planter strips. The sidewalk damage is minor in most areas along Rainier Avenue S with only a few locations that require more intensive repair. Several tree pits on the north end of Rainier Avenue S have recently been improved with larger tree wells and adjustments to the edge of the sidewalk to allow for a clear path of travel.

Rainier Beach is a Residential Urban Village. Rainier Avenue South is adjacent to Lowrise and Neighborhood Commercial zoned property. Key destinations are accessed from the corridor including Rainier Beach High School, South Shore K-8, Rainier Beach Public Library, Beer Sheva Park and Atlantic City Boat Ramp. Several transit stops line the corridor and provide connections for the neighborhood and larger community. The recently updated Neighborhood Plan and the Southeast Transportation Study both identify a community desire to increase tree canopy along this section of Rainier Avenue.

The concept plan identifies locations where trees should be retained and shows opportunities to increase the tree canopy along the corridor.



# ACTION ITEMS & CONSIDERATIONS

## Internal Action Items and Broad Considerations

The process of developing this Operations Plan led to the identification of a number of areas where additional efforts should be made to support SDOT tree and sidewalk management. The actions listed below are not detailed in this Operations Plan. These recommendations for further and ongoing work are for SDOT to improve upon its operations pertaining to trees and sidewalks.

Actions that may be addressed internally within SDOT's Urban Forestry and Sidewalk Repair divisions:

- Confirm evaluation criteria for trees and sidewalks
- Request budget for staff resources for tree and sidewalk management and operations
- Update street tree list
  - Soil volume
  - Rooting and trunk characteristics
  - Minimum allowable tree pit size
- Update tree inventory and other tree and sidewalk information accessed by public
- Discuss systematic approach to tree and sidewalk maintenance

Additional considerations that will require broader coordination within SDOT and other city departments:

- Integrate tree assessment with complete streets checklist
- Integrate tree assessment with asphalt paving program, Capital Improvement Program, Street Improvement Permits, and other right-of-way permits
- Update standard plans and specifications to align with current tree and sidewalk best practices
  - Tree pit size
  - Soil composition and amendments
  - Soil volume
  - Additional guidance on accessibility requirements for public places
- Coordinate with other departments that maintain trees, including Seattle City Light and Seattle Parks and Recreation
- Allocate additional funding for sidewalk repair and tree planting

The Seattle Department of Transportation  
700 5th Avenue, Suite 3800  
PO Box 34996  
Seattle, WA 98124-4996  
(206) 684-ROAD (7623)  
[www.seattle.gov/transportation](http://www.seattle.gov/transportation)



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# APPENDIX A

## BEST PRACTICES COMPILATION - CITY RESEARCH



# APPENDIX B

## BEST PRACTICES RESEARCH SUMMARY FOR IDT MEETING - TECHNICAL RESEARCH



# APPENDIX C

## INITIAL ASSESSMENT FORM



# APPENDIX D

## MADRONA CASE STUDY CONCEPT PLAN



# APPENDIX E

## LAKE CITY CASE STUDY CONCEPT PLAN



# APPENDIX F

## RAINIER BEACH CASE STUDY CONCEPT PLAN



# APPENDIX G

## PUBLIC OUTREACH LEAD