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Photograph courtesy of Don Wilson

October 2019
Seattle-Tacoma International Airport Flight Corridor Safety Program

ANCHOR QEA

Implementation Plan

Prepared for Port of Seattle

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October 2019
Seattle-Tacoma International Airport Flight Corridor Safety Program

Implementation Plan

Prepared for
Port of Seattle
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ABBREVIATIONS

BMP	best management practice
Burien	city of Burien
Des Moines	city of Des Moines
FAA	Federal Aviation Administration
LiDAR	Light Detection and Ranging
Port	Port of Seattle
Program	Flight Corridor Safety Obstruction Management Program
ROW	right-of-way
SeaTac	city of SeaTac
SEPA	State Environmental Policy Act
SR	State Route
STIA	Seattle-Tacoma International Airport
WSDOT	Washington State Department of Transportation

1 Introduction

The Port of Seattle (Port) is implementing a Flight Corridor Safety Obstruction Management Program (Program) to maintain navigable airspace at Seattle-Tacoma International Airport (STIA). The Program ensures compliance with the requirements of the Federal Aviation Administration (FAA) for safe operation of aircraft during takeoff and landing at STIA by removing objects identified as hazardous obstructions to air navigation.

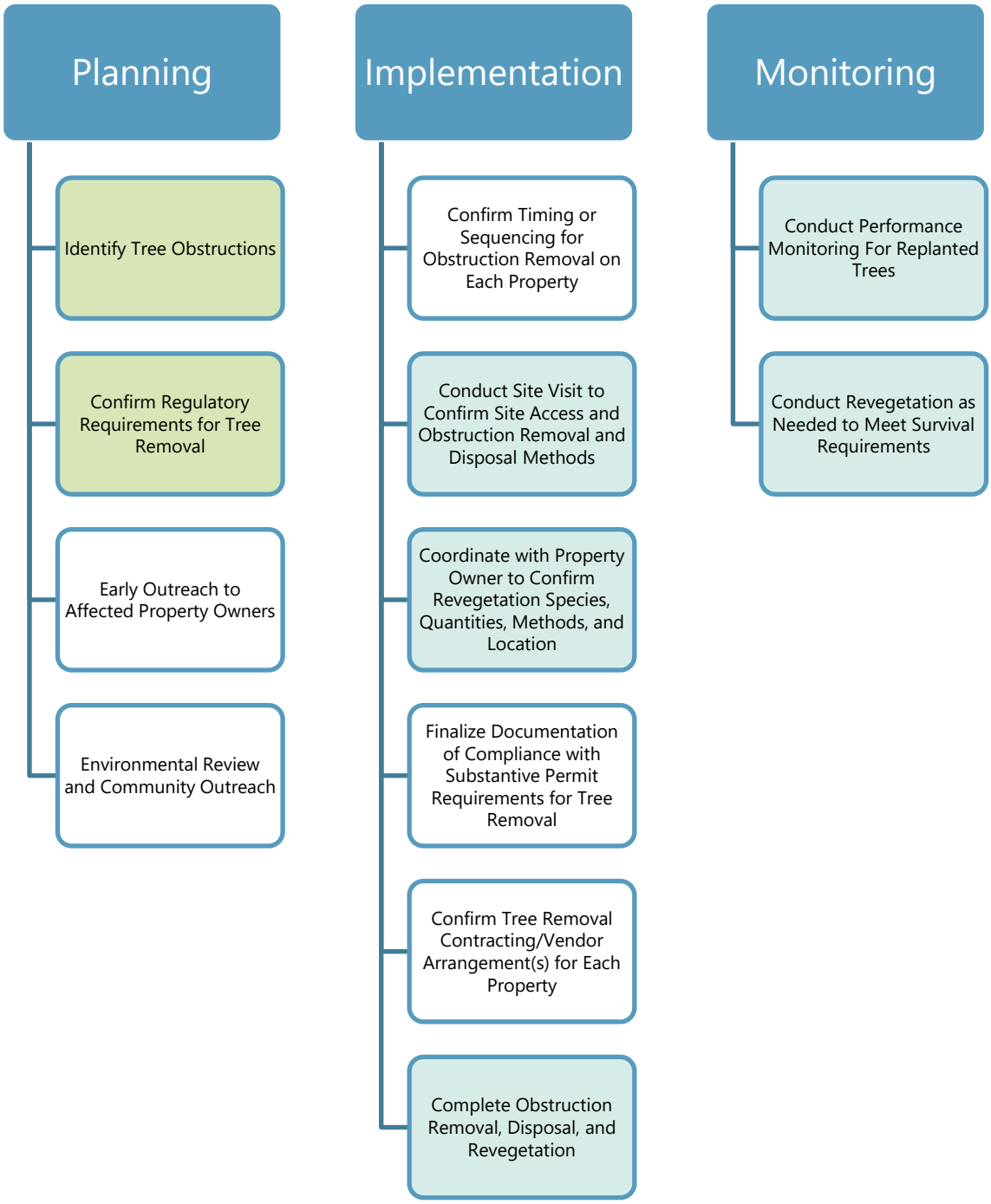
In 2014, the Port completed a Light Detection and Ranging (LiDAR) survey to identify objects penetrating flight safety surfaces, including their relative elevation. In 2016, the Port completed a State Environmental Policy Act (SEPA) checklist, issued a Mitigated Determination of Non-Significance, and removed obstructions on Port property. A Regulatory Approach Memorandum and Implementation Plan were also developed to support the SEPA review and associated permitting.

In 2018, the Port conducted a new LiDAR analysis and identified obstruction points on Port, public, and private property. Based on field verification of the LiDAR data, all the obstructions currently under review are trees (174 total). The Port intends to remove these obstructions as soon as late 2020 and will meet all applicable laws and regulations.

The Port will follow existing precedent for tree replacement on Port property, comply with critical areas ordinances for trees in wetlands and buffer areas, provide tree replacement consistent with jurisdictional standards to the extent practicable, and implement actions according to the environmental review process.

The purpose of this report is to provide a detailed methodology and timeline for removal of obstructions on Port, public, and private properties surrounding STIA. The report is a companion document to the *Regulatory Approach Memorandum* (Anchor QEA 2019), which identifies anticipated environmental requirements and permits needed to remove the obstructions as well as additional local standards with which the Port has chosen to comply to the extent practicable. Figure 1 provides an overview of planning, implementation, and monitoring components of the Program.

Figure 1
Flight Corridor Safety Obstruction Management Program Overview



Green squares: Refer to *Regulatory Approach Memorandum* (Anchor QEA 2019)
Light blue square: Components provided in Implementation Plan

1.1 Components of Implementation Plan

This report provides an inventory of the tree obstructions by jurisdiction and property ownership type, a characterization of obstructions, a discussion of obstruction management methods, a description of how these methods should be applied to each obstruction by jurisdiction, preliminary cost estimates that can be used for budget planning, and a detailed schedule for implementing the Program.

1.2 Overview of Jurisdiction and Property Ownership

Obstructions occur on parcels under the jurisdiction of the Port, Washington State Department of Transportation (WSDOT), the city of Burien (Burien), the city of Des Moines (Des Moines), and the city of SeaTac (SeaTac). Obstructions are under private and public ownership. See Figure 2 for a site vicinity and location of obstructions and Figure 3 for obstructions and critical areas.

Local jurisdictions are generally the primary source of standards for tree removal and replacement. Each jurisdiction has unique requirements that inform obstruction management methods, specifically tree removal and replacement. Comprehensive obstruction removal and site management methods are included as Appendix A. For obstruction located in WSDOT jurisdiction, the Implementation Plan refers to the WSDOT Roadside Policy Manual.

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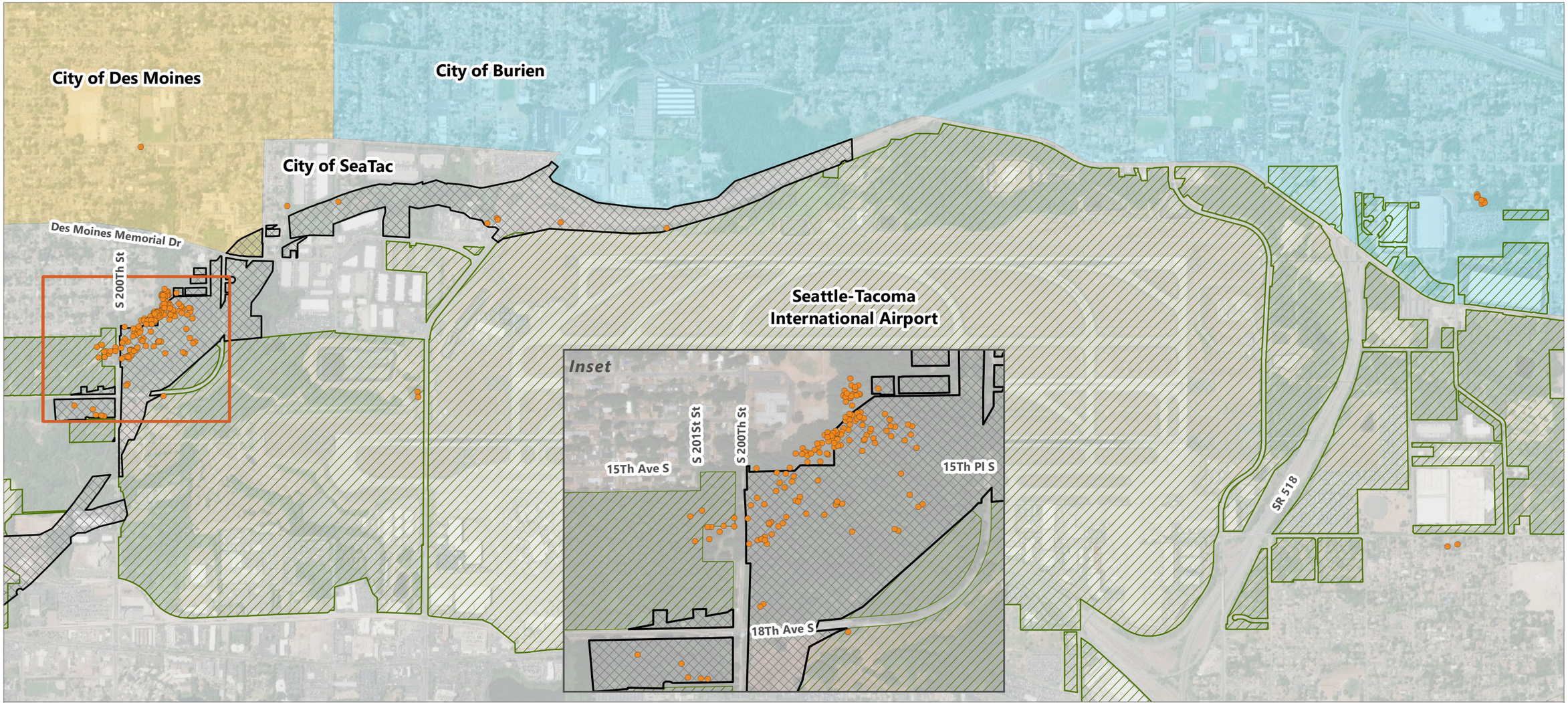

LEGEND:

- Obstruction
- Port of Seattle Ownership
- WSDOT SR 509 Right-of-way

Jurisdiction

- City of Burien
- City of Des Moines
- City of SeaTac

NOTE:
1. Obstruction locations and ownership information provided by Port of Seattle

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Figure 2
Site Vicinity and Locations of Obstructions
Draft Implementation Plan
Seattle-Tacoma Airport Flight Corridor Safety Program
Port of Seattle

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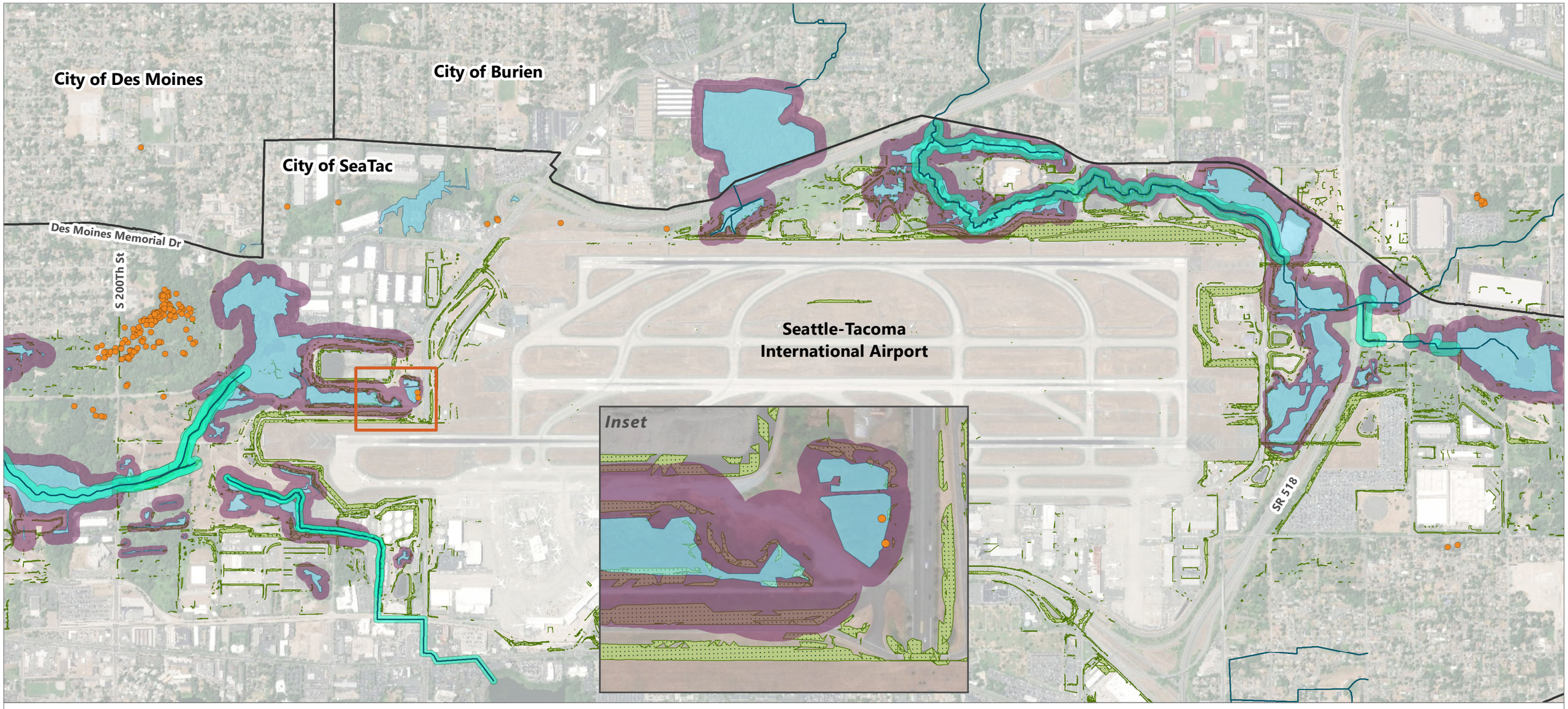

LEGEND:

- Obstruction
- Stream
- Stream Buffer
- Wetland
- Wetland Buffer
- Steep Slope (>40%)

NOTE:
1. Obstruction locations and ownership information provided by Port of Seattle

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Figure 3
Location of Obstructions and Critical Areas
Draft Implementation Plan
Seattle-Tacoma Airport Flight Corridor Safety Program
Port of Seattle

2 Obstruction Inventory

Table 1 summarizes the quantity of obstructions to be removed by jurisdiction. The table provides additional information for the obstructions located in SeaTac, Burien, or Des Moines jurisdiction, breaking down whether the obstruction is on public or private property. A detailed list of obstructions and their attributes is provided in the *Regulatory Approach Memorandum* (Anchor QEA 2019).

Table 1
Obstruction Removal Summary

Jurisdiction/ Property Ownership	Number of Obstructions	Notes
Port	**6**	Includes two obstructions in critical areas (one in a wetland and one in the wetland buffer).
WSDOT	**104**	Obstructions are located on WSDOT ROW for the planned SR 509 extension project.
City of SeaTac		
Public	46	This category includes 27 obstructions located on Highline School District Property.
Private	10	Obstructions in this category are located on Hillgrove Cemetery and residential properties.
Subtotal	**56**	
City of Burien		
Public	0	
Private	7	Obstructions are located on a single vacant property zoned residential.
Subtotal	**7**	
City of Des Moines		
Public	1	Obstruction is located on the border of a residential property and City street ROW.
Private		
Subtotal	**1**	
Total	**174**	

Figure 2 demonstrates that approximately 60% of tree obstructions lie in the State Route (SR) 509 right-of-way (ROW) administered by WSDOT, which administers its own tree management standards. Remaining obstructions fall under SeaTac and Port jurisdiction with a limited number of trees ranging more broadly into Des Moines (one obstruction) and Burien (seven obstructions) city limits.

Two obstructions occur on Port property in critical areas (e.g., streams, wetlands, and steep slopes). Figure 3 identifies the location of critical areas, indicating that the two obstructions are within a wetland and wetland buffer areas located on Port property.

3 Obstruction Removal and Revegetation Plans

This section outlines methods for specific obstruction removal and replacement by jurisdiction and ownership type (public or private). Table 2 summarizes the quantities of removal and revegetation for the different jurisdictions and ownership types. The tree planting planned quantities are based on the ratios presented in the *Regulatory Approach Memorandum* (Anchor QEA 2019).

Table 2
Summary of Tree Removal and Replacement Quantities – All Sites

Jurisdiction/ Property Ownership[1]	Total Obstructions (Total Trees Removed)[2]	Planned Tree Replacement
Port		
Outside of critical areas	4	16
Within critical area	2	8
WSDOT[3]	104	
Category 2 trees (4 to 30 inches in diameter)[4]	41 (1,022 inches total trunk diameter)	511–1,022
Category 1 trees (greater than 30 inches in diameter)[5]	63 (2,294 inches total trunk diameter)	1,658–3,316
City of SeaTac		
Public	46	138
Private	10	10
City of Burien		
Public	0	0
Private	7	7
City of Des Moines		
Public	1	3
Private		
Total	**174**	**2,351–4,520**

Notes:

1. Required tree replacement quantities are based on mitigation ratios established by the Port. Actual tree replacement quantities may exceed the required ratios.
2. The total does not include potential understory tree removal. If understory trees are removed, the replacement requirement may be as large as a 3:1 ratio (to be confirmed with WSDOT).
3. For obstructions in WSDOT ROW, the replacement ratio varies depending on the size of the tree removed. The replacement ratio is a minimum of 25:1 per WSDOT Roadside Policy Manual (WSDOT 2015, Chapter 2).
   i. Obstructions considered Category 2 trees (moderate-size coniferous and other late successional species trees between 4 and 30 inches in diameter, measured 4.5 feet from the ground) will be replaced at a ratio of one 1-gallon replacement tree for each 1-inch of trunk diameter. Or, if larger container sizes are used, the plant quantity will be adjusted down. For example, if 2-gallon container plants are used, only half the number of plants will be required.
   ii. Obstructions considered Category 1 trees (mature, old-growth, large specimen, or heritage trees greater than 30 inches in diameter, measured 4.5 feet from the ground) require consultation with the WSDOT HQ Design Landscape Architect to determine appropriate project-specific restoration. It is assumed that the ratio would be at least that of the Category 2 trees.

This section is complemented by Appendix A, Obstruction Removal and Site Management Methods, which provides specifications and best management practices (BMPs) that will be applied during implementation, including the following:

1. Obstruction removal preparation
2. Obstruction removal and material disposal methods
3. Revegetation methods
4. Monitoring
5. Erosion and sediment control BMPs

3.1 Port Properties

Within Port properties, six obstructions require removal. These obstructions are south of STIA. Access to three obstructions is actively controlled by the Port as they occur within Port property that is restricted from public use and fenced. The remaining three obstructions on located in an area that is publicly accessible for recreational use.

Two obstructions occur within critical areas. One obstruction is in a wetland, and the second obstruction is within the same wetland's buffer. Figure 3 identifies the location of critical areas and indicates the two obstructions within critical areas.

Access and Construction Staging

The obstructions located in areas actively controlled by the Port will need Port authorization and coordination for access. Access is as follows:

- The two obstructions located within critical areas can be access from the north via S 188th Street, which is a four-lane road with a center turning lane.
- One obstruction is located along 18th Avenue South and can be accessed from the edge of the roadway. Access will require fence removal and replacement.
- The three obstructions located in the publicly accessible area south of STIA can be accessed from the north via S 200th Street. Access will require fence removal and replacement to avoid impacting vegetation and public walking/biking trails.
- There is a moderately sized area (20,000 square feet) suitable for construction staging located on the southern side of S 188th Street. Truck turn-around in this area must protect the stormwater retention basin and the wetland complex. All staging areas would need to be restored to pre-project conditions following obstruction removal work.

Site Condition Review

1. Hazards include non-critical slopes at the north portion of the site (16 degrees or 28.7%) and steep slopes (greater than 24 degrees or 44.5%), dense Himalayan blackberry brambles,

congestion hazards while working near trails used for mountain biking, and potentially biohazards (syringes).
2. Critical areas that will be encountered in the site or while accessing the site include wetlands, wetland buffers, and steep slopes.
3. A concrete diversion dam at the wetland complex must be protected.
4. Other STIA-related infrastructure to be protected includes one stormwater retention basin.

Site Preparation

1. Critical area protection: Install sediment controls downstream of the work area and outside of the wetland boundary.
2. Infrastructure protection: Protect Port infrastructure by ensuring sediment control measures are in place prior to commencing obstruction removal site work, and by placing flagging or high-visibility fencing materials around features to alert operators from damaging them with their equipment. Biodegradable silt fencing is recommended as it can be left in place, further minimizing wetland impacts following projection completion.
3. Public safety protection: Fence off work that abuts publicly accessible roads and trails.
4. Fence removal: Obstruction removal area can be accessed directly off S 200th Street but two to three panels of chain-link fencing will need to be removed (and replaced following completion of site work).

Obstruction Removal and Material Disposal

1. Selectively remove and grind stumps of all obstruction trees (six obstructions).
2. Clear invasive species (English ivy, common holly, Scotch broom, and Himalayan blackberry) within clearing limits defined by obstruction removal work area.
3. Dispose of material off site, or chip and mulch material and place processed material on site (outside of the wetland). Dispose of all invasive vegetation debris in an approved off-site location.

Treatment

The objective of treatment measures is to control establishment of future obstructions, stabilize slopes and soil disturbed by obstruction removal, and replace trees on site to the extent possible.

1. Install geotechnical fabric (jute) in all cleared areas with slopes greater than 4:1 (4 horizontal to 1 vertical) prior to revegetation efforts.
2. Revegetate cleared areas. The planting categories allow for the following maximum heights for installed vegetation, though species selected for each category were selected to grow far below the following thresholds:
    a. Short height upland planting: 100 to 140 feet
    b. Shrub upland planting: 80 to 100 feet
    c. Groundcover planting: 40 to 80 feet

3. The required tree replacement quantity associated with obstruction removal is 12 trees planted on Port sites or another location within the drainage basin.
4. The estimated planting quantities will include the following:
    a. Trees planted: 12

Monitoring

1. Monitor stumps and treat with broad-spectrum glyphosate or fungus (mycilia) tablets to control resprouting. While black cottonwood sprouts from remaining stumps are unlikely to exceed 100 feet in height, these sprouts may still become future obstructions within the higher topography areas of the site.
2. Monitor for future obstructions.
3. Monitor to ensure revegetation areas meet the following performance standards:
    a. Performance Standard 1: Average survival of all native planted stock will be 100% at the end of Year 1 and at least 80% at the end of Year 2.
    b. Performance Standard 2: Invasive plant species are maintained at levels below 20% cover averaged over the entire obstruction removal area.

3.1.1 Best Management Practices

The BMPs listed in Table 3 are suitable measures for controlling sediment and erosion on Port sites.

Table 3
Port Site Best Management Practices

BMP Category	BMP Numbers and Titles
Preserve Vegetation/Mark Clearing Limits	• BMP C101: Preserving Natural Vegetation • BMP C102: Buffer Zones • BMP C103: High Visibility Plastic, Metal, or Biodegradable Fence • BMP C103: Silt Fence
Establish Construction Access	• BMP C105: Stabilized Construction Entrance/Exit • BMP C107: Construction Road/Parking Area Stabilization
Install Sediment Controls	• BMP C235: Wattles • BMP C233: Silt Fence
Stabilize Soil and Protect Slopes	• BMP C120: Temporary and Permanent Seeding • BMP C121: Mulching
Maintain BMPs and Manage the Project	• BMP C160: Certified Erosion and Sediment Control Lead • BMP C162: Scheduling

3.2 Public Properties

Public properties with obstructions include state-, city-, and school district-owned lots, some of which span multiple cities properties. The largest group of obstructions on public land are on WSDOT ROW that is slated for redevelopment through the SR 509 extension project.

3.2.1 WSDOT Right-of-Way

There are 104 obstructions on WSDOT SR 509 ROW that require removal. These obstructions are south and west of STIA. One obstruction within the WSDOT SR 509 ROW is privately owned; the remaining 103 are publicly owned. There are no critical areas on these sites. In addition to tree obstructions, the WSDOT ROW contains invasive species including Himalayan blackberry, common holly, and hawthorn. The south area has signs of encampments and illegal dumping, as well as informal hiking trails.

The Port has met with WSDOT regarding the need for removal of obstructions on WSDOT property. WSDOT does not have objections to removal of trees from either of these locations for the purposes of meeting STIA's flight corridor safety requirements. WSDOT has provided the Port with the relevant sections of the WSDOT Roadside Policy Manual so the Port can determine requirements for tree replacement within the WSDOT ROW. Because the obstructions are within the future SR 509 development area, tree replacement associated with WSDOT parcels may occur off site.

The Port will provide payment to WSDOT for revegetation costs. Table 4 provides an opinion of probable construction cost for the procurement and installation of replacement trees. The costs provide two scenarios:

- **Scenario 1:** Higher ratio, smaller revegetation stock—replacement ratio of 1-inch-diameter removed to a single 1-gallon container tree
- **Scenario 2:** Lower ratio, revegetation larger stock—replacement ratio of 2-inch-diameter removed to a single 2-gallon container tree

Costs assume the replacement ratio for Category 1 and Category 2 trees is the same. Costs do not include construction mobilization (such as preparing construction access), planting preparation, maintenance, or monitoring. Costs are only for the replacement trees and do not include cost for any additional plantings associated with a revegetation effort (installing groundcover or shrubs within the clearing limits). Costs do not include markups (such as sales tax and construction contingency).

Table 4
Opinion of Probable Construction Costs for Procurement and Installation of Trees

Item	Quantity	Unit	Unit Cost	Subtotal
Scenario 1: Higher ratio, smaller revegetation stock				
1-gallon tree	3,163	EA	$21.00	**$66,423.00**
Scenario 2: Lower ratio, revegetation larger stock				
2-gallon tree	1,582	EA	$38.00	**$60,116.00**

3.2.2 SeaTac

There are 46 obstructions on public property within SeaTac that require removal. These obstructions are south, west, and north of STIA. Most obstructions are located on Highline School District Property. There are no critical areas on these sites.

Access and Construction Staging

Access and staging areas to be determined following coordination with property owners.

Site Condition Review

1. Utility locates will be required for all obstruction and potential obstruction removal areas.

Site Preparation

1. Public safety protection: Fence off work and staging areas that abut publicly accessible roads and recreation areas.
2. Verify trees for removal: Mark all trees for removal to be inspected by engineer prior to commencing removal activities.

Obstruction Removal and Material Disposal

1. Clear and grub all obstructions.
2. If conditions are found that prohibit full grubbing (e.g., protection of existing facilities), cut and grind stumps to meet finished grade and treat with broad-spectrum glyphosate or fungus (mycilia) tablets. Grinding stumps can lead to sinkholes and grade irregularities when the remaining root systems decompose overtime; therefore, grinding stumps should be a last resort over grubbing and only used where grubbing would damage facilities (e.g., structural foundations).
3. Dispose of material off site.

Site Treatment

1. Parcel owners may choose from the plant list in Appendix B for landscape vegetation replacement.

Monitoring

1. Monitor for future obstructions.

3.2.3 Des Moines

There is one obstruction on the boundary of the Des Moines ROW and a residential property. Refer to Section 3.3 (private properties) for direction on obstruction removal.

3.3 Private Properties

Private properties with obstructions are primarily found in residential areas, though SeaTac includes several obstructions within Hillgrove Cemetery.

3.3.1 SeaTac

There are 10 obstruction located at the Hillgrove Cemetery and residential properties. There are no critical areas in areas with identified obstructions.

Access and Construction Staging

Access and staging areas to be determined following coordination with property owners.

Site Condition Review

1. Utility locates will be required for all obstruction removal areas.

Site Preparation

1. Public safety protection: Fence off work and staging areas that abut publicly accessible roads and parking areas.
2. Verify trees for removal: Mark all trees for removal to be inspected by engineer prior to commencing removal activities.
3. Place steel plates or mats to provide access while protecting the ground: Provide barricades between structures and/or resident access routes and obstruction removal areas for safety and structure protection.

Obstruction Removal and Material Disposal

1. Clear and grub all obstructions.
2. Selectively remove and grind stumps at cemetery, Do not fully grub or remove stumps at cemetery.

3. If conditions are found that prohibit full grubbing, cut and grind stumps to meet finished grade and treat with broad-spectrum glyphosate or fungus (mycilia) tablets. Grinding stumps can lead to sinkholes and grade irregularities when the remaining root systems decompose overtime; therefore, grinding stumps should be a last resort over grubbing and only used where grubbing would damage facilities (e.g., structural foundations).
4. Dispose of material off site.

Site Treatment

1. Parcel owners may choose from the plant list in Appendix B for landscape vegetation replacement.

Monitoring

1. Monitor for future obstructions.

3.3.2 Burien

There are seven obstructions located on a single vacant property zoned residential. There are no critical areas on the property.

Access and Construction Staging

Access and staging area to be determined following coordination with the property owner.

Site Condition Review

1. Utility locates will be required for all obstruction and potential obstruction removal areas.

Site Preparation

1. Public safety protection: Fence off work and staging areas that abut publicly accessible roads and parking areas.
2. Verify trees for removal: Mark all trees for removal to be inspected by engineer prior to commencing removal activities.
3. Place steel plates or mats to provide access while protecting the ground: Provide barricades between structures and/or resident access routes and obstruction removal areas for safety and structure protection.

Obstruction Removal and Material Disposal

1. Clear and grub all obstructions.
2. If conditions are found that prohibit full grubbing, cut and grind stumps to meet finished grade and treat with broad-spectrum glyphosate or fungus (mycilia) tablets. Grinding stumps can lead to sinkholes and grade irregularities when the remaining root systems decompose overtime;

therefore, grinding stumps should be a last resort over grubbing and only used where grubbing would damage facilities (e.g., structural foundations).

3. Dispose of material off site.

Site Treatment

1. Parcel owner may choose from the plant list in Appendix B for landscape vegetation replacement.
2. Site restoration may include grading, seeding, replacing and installing plants to compensate for damaged landscape areas, and filling ruts caused by equipment.

Monitoring

1. Monitor for future obstructions.

3.3.3 Des Moines

There is one obstruction on the boundary of the Des Moines ROW and a residential property. There are no critical areas in the areas with the identified obstruction.

Access and Construction Staging

An access and staging area to be determined following coordination with the property owner.

Site Condition Review

1. Utility locates will be required for the obstruction removal area.

Site Preparation

1. Public safety protection: Fence off work and staging areas that abut publicly accessible roads and parking areas.
2. Verify trees for removal: Mark the tree for removal to be inspected by engineer prior to commencing removal activities.
3. Place steel plates or mats to provide access while protecting the ground: Provide barricades between structures and/or resident access route and obstruction removal area for safety and structure protection.

Obstruction Removal and Material Disposal

1. Clear and grub obstruction.
2. If conditions are found that prohibit full grubbing, cut and grind the stump to meet finished grade. Grinding stumps can lead to sinkholes and grade irregularities when the remaining root systems decompose overtime; therefore, grinding stumps should be a last resort over grubbing and only used where grubbing would damage facilities (e.g., structural foundations).

3. Dispose of material off site.

Site Treatment

1. Parcel owner may choose from the plant list in Appendix B for landscape vegetation replacement.

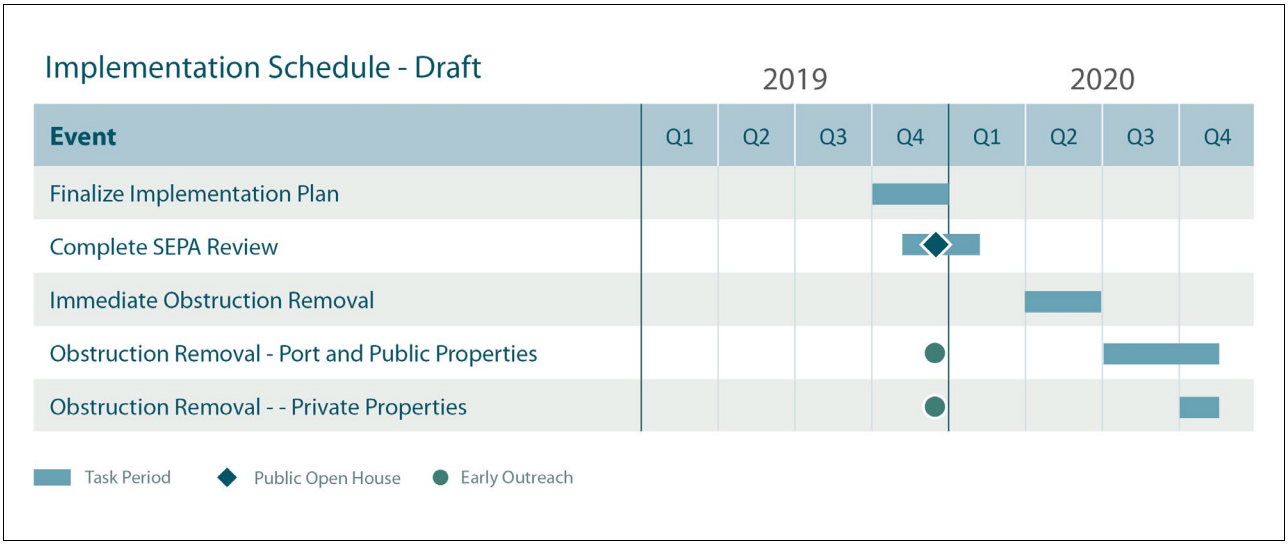
Monitoring

1. Monitor for future obstructions.

4 Schedule

4.1 Overall Schedule

The schedule for the overall Program is presented below. The process will include permitting obstruction removal for the entire project, coordination with public agencies and outreach and coordination with private property owners, and implementation of obstruction management.



4.2 Sequencing by Site

Sequencing of obstruction management will begin with obstruction requiring immediate removal. A total of 28 obstructions are identified for immediate removal. This includes trees topped in 2018 and identified obstructions that are penetrating the operations surface. None of the obstruction identified for immediate removal are within Burien or Des Moines and none are within critical areas. Table 5 identifies these obstructions by jurisdiction. Immediate removal will take place in spring 2020. The removal of all other obstructions shall be completed as soon as late 2020.

Table 5
Obstructions Requiring Immediate Removal

Jurisdiction/ Property Ownership	Number of Immediate Obstructions	Notes
Port	**0**	
WSDOT	**16**	
City of SeaTac		
Public	6	
Private	6	All private trees are located on Hilltop Cemetery property.
Subtotal	**12**	
Total	**28**	

5 References

Anchor QEA (Anchor QEA, LLC), 2019. *Regulatory Approach Memorandum*. Seattle-Tacoma International Airport Flight Corridor Safety Program. Prepared for Port of Seattle. October 2019.

WSDOT (Washington Department of Transportation), 2015. WSDOT Roadside Policy Manual. M 3110.03. August 2015. Available at: https://www.wsdot.wa.gov/Publications/Manuals/M3110.htm.

Appendix A
Obstruction Removal and Site Management Methods

A-1 Obstruction Removal Preparation

Obstruction removal preparation activities include verifying/inspecting site conditions and could include identifying and installing access barriers, access routes, and staging areas; identifying and installing erosion and sediment control measures; salvaging vegetation; and marking obstructions and other features to be removed. For obstructions located in Washington State Department of Transportation (WSDOT) jurisdiction, The WSDOT clearing standards will apply as described in Section 3 of the Implementation Plan.

A-1.1 Sequencing

Before any work commences, the contractor will develop a proposed sequencing plan for obstruction removal. This plan must be confirmed by the Port of Seattle (Port) engineer.

A-1.2 Site Visit

Before any work commences, site visits will be held with both the contractor and Port engineer in order for the contractor to verify the following:

- **Hazardous features:** Permanent features should be marked/flagged to protect site personnel and biological hazards (e.g., unsanitary conditions, discarded syringes) should be identified and removed.
- **Access issues:** Traffic control measures may be required for obstruction removal along busy or congested public rights-of-way (ROWs).
- **Utilities in need of protection:** Stormwater and electrical utilities, including large stormwater ponds, will likely be the main utilities that will require protection. However, any areas that will require excavation for obstruction removal will also require a utility location/verification through the Utility Notification Center.
- **Existing facilities in need of protection:** These features could include Seattle-Tacoma International Airport (STIA) features such as the Air Operation Area (AOA) perimeter fence, the Port's west side office, or supports for runway approach lighting systems with flashing lights (ALSF). Existing facilities on private sites include structures, grounds, and landscaping outside of the obstruction removal area. Additional steel plates or mats and barricades will likely be required to safely remove obstructions on private sites without impacting existing structures.
- **Critical areas in need of protection:** These features could include steep slopes, wetlands, streams, and their buffers. In addition, topographic swales/ditches that could direct additional stormwater or sediment-laden runoff to these critical areas, and areas of potential erosion, should also be identified.

A-1.3 Access and Safety

Access barriers are necessary to control the removal area from trespass or unintentional entrance by unauthorized personnel during construction activities. While most Port sites have adequate access control from existing fencing, publicly accessible sites, such as the WSDOT ROW parcels near Highline School, will need to be barricaded. Temporary chain-link fencing, with 20-foot-wide lockable gates along the construction equipment access route(s), can provide a suitable barrier. Small public or private sites, or those along roadways, may require additional signs, barricades, or competent flaggers to ensure the public is protected from hazards associated with tree removal.

Access and exit points should be limited to one route, if possible. The route should be a truck or equipment driveway and should be stabilized to avoid tracking sediment on adjacent roadways. Stabilization can include placing a minimum 12-inch layer of 4- to 8-inch-sized quarry spalls over geotextile fabric, for a length of 25 feet and width of at least 15 feet. Longer access routes into a site may be required depending on the substrate/groundwater site characteristics and the size and weight of equipment used; pads of quarry spalls and geotextile can also be used for this application.

A-1.4 Clearing Limits and Tree Marking Confirmation

Prior to obstruction removal, clearing limits will be marked with fencing. The trees that will be removed should be confirmed and marked in multiple places on the trunk. This process is an important due diligence step to make sure that only the intended trees are removed.

A-1.5 Erosion and Sediment Control

Prior to obstruction removal, erosion and sediment controls will need to be planned and installed. Planning items will include development of a spill prevention, control, and countermeasures plan and consideration of overall site layout during construction. Fuel storage should be segregated from other materials and located at least 20 feet from streams and wetlands. The fuel storage area must be graded to ensure containment of any leaks or spills.

A-1.6 Plant Salvage – Optional Action

Through community service events, or partnering with native plant organizations, the Port may salvage native shrub and groundcover plant materials within the obstruction removal clearing limits for reuse. Plant materials should be carefully stockpiled for later relocation, exercising care when moving the plant materials to avoid breaking branches or roots. Salvaged vegetation may be used within cleared areas during the site treatment step in the process. This vegetation may also be used on other Port properties or provided for restoration work by other agencies (e.g., King County, EarthCorp).

A-2 Tree Obstruction Removal and Material Disposal

A-2.1 Tree Removal and Clearing Methods

Obstruction removal methods and equipment vary depending on site characteristics, the distribution and characteristics of obstructions on a site, and the type of disposal method or sale of the cleared material. The range of tree removal and clearing methods, and their suitability, are summarized in Table A-1, followed by a more detailed discussion.

Table A-1
Summary of Obstruction Removal and Clearing Methods

Method Description	Suitability
Clearing and Grubbing	
Clearing involves removal of trees and vegetation, including invasive species, as well as other understory and groundcover vegetation above the soil surface as necessary to access and fell the obstruction. Fell and limb trees using mechanical equipment such as a feller buncher; harvester equipment may also buck the logs into smaller pieces. Grubbing a cleared area entails removing organic matter in the soil, often to a minimum of 12 inches in depth. There is an opportunity for stripped topsoil to be salvaged for later use. Topsoil with any invasive vegetation is not suitable for salvaging. Salvaged topsoil can be segregated and stockpiled separately from other cleared material. It can be spread over disturbed areas upon completion of obstruction removal activities as part of the restoration planting effort.	Suitable for areas with dense obstruction groupings where adjacent areas are not congested or major traffic corridors
Tree Removal (excludes stump grubbing)	
Fell, limb, and buck trees using mechanical means and/or chain saws (manual) as needed. Remove invasive species, and retain, as practical, the remaining understory.	Suitable for areas with dense obstruction groupings where adjacent areas are not congested or major traffic corridors, and where full stump removal (grubbing) is not required
Selective Clearing and Tree Removal (manual work)	
Fell, limb, and buck trees using chain saws. Remove invasive species but retain remaining understory.	Suitable within or near critical areas, and/or where isolated obstructions occur, particularly on congested sites
Retain Stumps	
Follow tree removal or selective removal of trees, which leaves a 1- to 2-foot stump above the ground surface. To inhibit resprouting, stumps can be treated using broad-spectrum glyphosate or fungus (mycilia) tablets that encourage fungus to eat away at the remaining structure.	Suitable where isolated or small groupings of obstructions occur, and retaining stumps is used to protect critical areas like steep slopes or wetlands

Method Description	Suitability
Remove Stumps	
Cut or grind and mulch stumps, and the associated root mass below the ground level, using a stumper or stump grinder attachment. Another option is to use a grubbing blade mounted on the front of a carrier vehicle or cut a tree part-way down and push it over (clearing and grubbing operation).	Suitable on areas outside of critical areas

Tree removal could take the form of selectively removing trees with a chain saw or using mechanical means. Manual removal involves felling, limbing, and bucking trees using chain saws. A tree removal area that is congested and/or contains many existing facilities or grounds to be preserved, or is inaccessible to large equipment, will require manual methods of removal.

Mechanical felling has worker safety, productivity, and efficiency benefits compared to manual removal; however, this method is infeasible for certain sites where equipment cannot fit, or where equipment would damage existing facilities or impact critical areas. Where feasible, mechanical felling is the best option for preparing timber for sale, which is an obstruction "disposal" option for many of the Port and WSDOT sites for this Flight Corridor Safety Obstruction Management Program (Program).

Common equipment used for large mechanical felling operations includes the following:

- Feller buncher, which has motorized vehicle base (tracked or wheeled) with a head that can cut and gather several trees at once; the most common tracked feller bunchers in the western United States are 12 feet wide, with excavator bases and swing booms with a 25-foot reach (USDA 2016)
- Delimber, which is used to remove branches from felled trees
- Harvester, which consolidates felling, delimbing, and bucking (cutting tree into appropriate lengths) into one machine
- Skidder, which is used to bundle and pull logs out of a forest
- Forwarder, which is a vehicle that uses a boom arm to load and carry logs out of the forest clear of the ground

Stump removal can occur using a grubbing blade (for clearing and grubbing operations) that can be mounted on the front of a carrier vehicle. Using this method, or cutting a tree part-way down and pushing it over, is an option to harvest material for large woody debris applications for restoration projects. Another option for stump removal is to cut or grind and mulch stumps, and the associated root mass below the ground level, using a stumper or stump grinder attachment. Grinding stumps can lead to sinkholes and grade irregularities when the remaining root systems decompose overtime. These grade irregularities are not an issue within natural forested areas, but they do have moderate

safety implications on sites used by the public. Within private sites and recreation areas, grubbing, rather than grinding of stumps, is recommended.

Grubbing a clearing area (i.e., removing organic matter in the soil, often to a minimum of 12 inches in depth), provides an opportunity for stripping topsoil to be salvaged for use in future restoration planting efforts. Salvaged topsoil should be segregated and stockpiled separately from other cleared material; it can be spread over disturbed areas upon completion of obstruction removal activities. If a site will not support future planting, topsoil can alternatively be transported to other sites for use in restoration and revegetation efforts.

Areas within sites that are on steep slopes or in wetlands will benefit from retaining stumps after tree removal to stabilize soils and minimize impacts to these critical areas. To inhibit resprouting, stumps can be treated using broad-spectrum glyphosate, or using fungus (mycilia) tablets that encourage fungus to eat away at the remaining structure.

Erosion and sediment control measures will need to be actively managed during the obstruction removal phase of the Program. If monitoring or inspection shows that the control measures are ineffective, repairs should be made, or replacement measures should be installed. If sediment reaches one-third of the exposed height of the control measure, the sediment should be removed and disposed of properly.

A-2.2 Material Disposal Options

Options for disposal of obstructions, and associated vegetation (e.g., invasive species, vegetation impacted during removal) are summarized in Table A-2, followed by a more detailed discussion.

Table A-2
Summary of Material Disposal Methods

Method Description	Suitability
On-Site Disposal (including chipping and mulching)	
Leave cleared materials on site with minimal processing, though cutting large tree pieces into manageable log segments may be required. Alternatively, material may be processed into wood chips/mulch, which can provide benefits to the site through invasive species control and soil nutrient inputs. On-site disposal cannot be used for invasive vegetation.	Suitable for most sites (with owner's permission), outside of wetlands. Not suitable for invasive material.
Off-Site Disposal	
Remove material from site and dispose at an approved location, or to a beneficial reuse site identified by the Port. Invasive vegetation must be disposed of off-site in an approved location.	Suitable for wetland areas where on-site disposal is not feasible, or other sites at owner's discretion. Required for invasive vegetation.

Method Description	Suitability
Timber Sale	
Establish board foot volumes, market, and prepare trees for sale.	Large, forested tracts with merchantable timber

A-2.3 On-Site Material Disposal

Cleared materials may be left on site with minimal processing, though cutting large tree pieces into manageable log segments may be required. Alternatively, material may be processed into wood chips/mulch, which can provide benefits to the site through invasive species control and soil nutrient inputs. For small diameter trees, this mulching option can be combined with the obstruction removal step through the use of a mechanical mulcher. Invasive vegetation cannot be disposed of on site. Disposing of material on site is not suitable for non-Port sites unless permission for this disposal method is approved by the owner. Disposing of material within wetland areas is also prohibited as this material could be interpreted as wetland fill.

A-2.4 Off-Site Material Disposal

Cleared material may be disposed of off site through the contractor taking ownership of the material and disposing of it at an off-site, permit-compliant location of their choosing. Alternatively, the Port may wish to take ownership of some of the cleared obstruction material for beneficial uses in other Port locations as restoration (e.g., large woody debris) or site furnishings (e.g., log edging, seating, or art features). This Port beneficial reuse option can be facilitated by identifying this material on site and specifying a location where the contractor can deliver the material to be stockpiled. Invasive vegetation must be disposed of off site in an approved location.

A-2.5 Marketing and Selling Timber

The Port and WSDOT may consider a timber sale as another option for material disposal. This option could provide significant revenue, but it also requires additional planning steps. Generally, the timber selling process would include the following:

- Researching the timber market condition and trends as they relate to desired species, minimum quantities, sizes, and material quality
- Refining a tree inventory to project the available timber volumes
- Developing a marketing strategy, guided by the following questions:
  - What are the products and when will they be available?
  - How will products be sold (stumpage [i.e., standing timber] or as logs)?
  - What is the current market value for these products?
  - Who are the potential buyers?

- Clearly laying out property lines of sale area and marking timber
- Promoting the products through actively contacting potential buyers and providing a prospectus
- Evaluating offers and drawing up a timber sale contract, and a logging contract for log products
- Actively monitoring the operation

A-3 Revegetation

Revegetation following obstruction removal will involve stabilizing soils using vegetation and, in certain instances, geotechnical methods. Closeout of the work will include removing temporary facilities and erosion/sediment control measures and cleaning up the site.

A-3.1 Revegetation Preparation

Soil preparation and the installation of erosion control fabrics (if warranted) will precede plant installation tasks. Soil amendment may be needed for areas with compacted soil or areas where an excessive amount of topsoil was removed through obstruction removal operations. Soil amendment can be placed in planting areas and rototilled into the existing subgrade.

The installation of jute matting is recommended for sites with slopes greater than 4:1 (4 horizontal to 1 vertical) to control slopes during plant establishment. This material consists of unbleached, single jute yarn woven into a mat. Jute matting is installed by rolling out the fabric and, where multiple strips of mat are required, overlapping adjacent mats by a minimum of 4 inches. The upslope end of the mat is secured by burying and staking the ends in a trench and then backfilling the trench. The matting is further secured with wooden stakes spaced every 2.5 feet along the length of the material.

A-3.2 Revegetation Plant Installation

Plant installation should be performed within the wet season if possible (between October and May) unless an irrigation system is available and utilized. Appendix B provides a list of recommended replacement tree species with mature tree heights that are well below obstruction levels.

Plant materials for understory restoration can be supplemented with salvaged material removed during site preparation activities. Purchased plant materials can include both container grown stock and livestake cuttings. Container grown stock should be inspected prior to installation to ensure plants meet the following standards:

- Neither overly loose in the container with underdeveloped root systems, nor container bound
- Free of weeds, disfiguring knots, injuries/abrasions, and all forms of infestation

Trees that are installed in public spaces and ROWs are generally larger planting stock and must meet location jurisdiction requirements (Burien Code Chapter 19.25, Interlocal Agreement Landscape Design Standards, SeaTac Development Standards Chapter 15.445). Within applicable sites in the cities of SeaTac and Burien, these requirements include the following:

- Deciduous trees shall have a caliper of at least 1.75 inches (Burien) or 2 inches (SeaTac).
- Evergreen trees shall be at least 6 feet (Burien) or 8 feet in height (SeaTac).

Additional requirements may include the following:

- Conifer trees should have only one leader (growing apex).
- Deciduous trees that have a solitary leader shall have only lateral branches thinned by pruning.
- Pruning requirements for low branches for accessibility on sidewalks and clear sight distances (branches typically pruned 5 to 8 feet above ground level).

Container plants should be installed according to the following requirements:

- Remove plants from containers in a manner that prevents damage to their root system. Containers may require vertical cuts down the full depth of the container to accommodate removal. All circling roots shall be loosened to ensure natural directional growth after planting.
- Install plants within pits that are sized at least twice the diameter of the root system or container, with scarified sides and bottom.
- Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set the crown of plant material at the finish grade. No filling will be permitted around trunks or stems or above grafts on grafted trees.
- After plants are set, water in soil mixture around bases of root balls and fill all voids.
- Mulch shrub beds immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface. Mulch shall be feathered back from base of trees and shrubs to reduce potential plant rot.

Livestake cuttings are live plant materials without a previously developed root system. This type of material is often used for willow installations within moist areas; livestake installation is not suitable for non-irrigated, dry soils. The source material for livestakes should be dormant when the cuttings are made and cut from material on a plant that is 1 to 2 years old. Cuttings can only be stored for 2 weeks (kept moist and shaded) before installation. Installation during fall to early spring (October 15 to March 15) is recommended. The top cut for the stake should occur immediately above a bud. The lower root end shall be cut at about a 45-degree angle. Livestake cuttings should be cut and installed with the bark intact, but with no other branches or stems included. Prior to installation, the stakes should be soaked continuously.

Livestake plants should be installed according to the following requirements:

- Pound livestakes into the ground with a mallet or create a hole using a pilot bar in firm soils.
- Plant at least 80% of the stake length within the ground and ensure that two to five bud scars are present above the ground.
- Tamp soil around the stake.
- Mulch the livestake planting area and thoroughly water mulched areas.

A-4 Monitoring

Where black cottonwood or maple stumps remain (steep slopes and wetlands), they should be monitored to ensure resprouting does not lead to future obstructions. Sprouts from stumps can rarely achieve heights above 80 feet, but in certain areas near STIA, these sprouts may still reach obstruction levels. Stumps can be treated using broad-spectrum glyphosate or using fungus (mycilia) tablets that encourage fungus to eat away at the remaining structure.

A-4.1 Performance Monitoring

Long-term monitoring will be required to document potential future obstructions and provide regular maintenance of areas with low-height obstructions. Monitoring will occur for 2 years on all revegetation areas to ensure mitigation measures meet the performance standards below. If monitoring reveals that the revegetation mitigation measures are not meeting the performance standards, corrective action will occur in accordance with SeaTac Municipal Code 15.700.120 as follows:

- **Performance Standard 1:** Average survival of all native planted stock will be 100% at the end of Year 1 and at least 80% at the end of Year 2.
- **Performance Standard 2:** Invasive plant species are maintained at levels below 20% cover averaged over the entire obstruction removal area.

A-4.2 Revegetation As Needed

It is recommended to include a 1-year plant warranty requirement within the contract specifications. This will require the contractor to warrant plant materials to remain alive and be in healthy, vigorous condition for a period of 1 year after the date of physical completion. The warranty will require replacement of plants that are dead or in unhealthy conditions. Typically plant warranties do not include damage or loss of plants caused by fires, floods, freezing rains, lighting, or windstorms; extreme winter weather conditions; vandalism; or negligence on the part of the Owner. Following the 1-year warranty, the Port may conduct revegetation as needed to meet the survival requirements described in the above performance standards.

A-5 Erosion and Sediment Control Best Management Practices

A construction stormwater pollution prevention plan and erosion and sediment control measures will be required to control the quantity and quality of stormwater that may pass through the obstruction management sites. In accordance with Chapter 90.48 Revised Code of Washington and the U.S. Clean Water Act, a Construction Stormwater General Permit (CSWGP) for National Pollutant Discharge Elimination System compliance is anticipated for sites (e.g., WSDOT ROW area) where clearing and grading will exceed 1 acre.

This section outlines the most appropriate best management practices (BMPs) that can be used during obstruction management implementation. More detail on the BMPs identified here is available through the *Stormwater Management Manual for Western Washington* (Ecology 2012).

A-5.1 Preserve Vegetation/Mark Clearing Limits

Natural vegetation and the duff layer/native topsoil outside of the obstruction removal zones should be protected as these materials not only provides long-term ecological function, but also control stormwater erosion. Clearly marking the limits of clearing will ensure this material is not mistakenly removed during construction activities. Appropriate BMPs for this element include the following:

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High Visibility Fence

A-5.2 Establish Construction Access

Constructing a clear construction access and exit location provides safety benefits (e.g., clear understanding of vehicle traffic), and provides an opportunity to control sediment from being tracked outside of the construction site. Appropriate BMPs for this element include the following:

- BMP C105: Stabilized Construction Entrance/Exit
- BMP C107: Construction Road/Parking Area Stabilization

A-5.3 Install Sediment Controls

Earth moving on a construction site increases the risk of sediment being washed "downstream" and, in turn, impacting adjacent sites and/or critical areas such as wetlands or streams. Sediment control measures trap sediment on site where it can be managed. Appropriate BMPs for this element include the following:

- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles

A-5.4 Stabilize Soils and Protect Slopes

Soil that has been worked can be protected from erosion and sedimentation by soil stabilization measures. Soils must not remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30), or for more than 2 days during the wet season (October 1 to April 30). Appropriate BMPs for this element include the following:

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering

A-5.5 Maintain Best Management Practices and Manage the Project

Managing the project will include accounting for the dry and wet seasons as they relate to the construction schedule. During construction, a designated Certified Erosion and Sediment Control Lead person will lead the inspection and monitoring of BMPs and will work with the contractor to improve BMP performance over the life of the project. Appropriate BMPs for this element include the following:

- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling

A-6 References

Ecology (Washington State Department of Ecology), 2012. *Stormwater Management Manual for Western Washington*. Publication Number 12-10-030. August.

USDA (U.S. Department of Agriculture), 2016. Danger Tree Mitigation Guidelines for Managers. Cited February 15, 2016. Available from: http://www.fs.fed.us/t-d/pubs/htmlpubs/htm11512815/page05.htm.

Appendix B
Approved Vegetation List

Appendix B
Approved Vegetation List

Common Name	Scientific Name	Maximum Height (feet)	Canopy Width (feet)	Preferred Site Conditions
Moderately Tall Conifer Trees				
Northern Japanese hemlock	*Tsuga diversifolia*	35–60	25	Moist but well-drained soils; shade to part shade (not in sun)
Weeping giant sequoia	*Sequoiadendron giganteum 'Pendulum'*	45–60	4	Sun; well-drained soil
Korean fir	*Abies koreana*	30–50	5	Full sun; well-drained soil; slower growing
Golden Japanese cedar	*Cryptomeria japonica 'Sekkan-sugi'*	25–40	10	Full sun to dappled shade; prefers well-drained soils, but will tolerate clay
Serbian spruce	*Picea omorika*	45–60	10	Grows best in full sun; prefers well-drained soils, but will tolerate clay
Limber pine	*Pinus flexilis 'Vanderwolf's Pyramid'*	25–40	10	Grows best in full sun; prefers well-drained soils; tolerates restricted root zones (good near patios)
Shore pine	*Pinus contorta var. contorta*	40–50	25	Grows best in full sun; prefers well-drained soils; tolerates restricted root zones (good near patios)
Irish yew	*Taxus baccata 'Fastigiata'*	30–50	4	Full sun or shade; prefers well-drained soils; works well as a hedge
Moderately Tall Deciduous Trees				
Trident maple	*Acer buergerianum*	30–50	30	Full sun to open shade in well-drained soil
Japanese maple	*Acer palmatum*	30–40	30	Full sun to open shade; tolerant of many soil conditions
Pagoda dogwood	*Cornus alternifolia*	30–40	30	Prefers light or open shade sites with moist or well-drained soils
Kobus magnolia	*Magnolia kobus*	30–50	15	Easy to grow; plant in sheltered areas to protect flowers
Hybrid white dogwood	*Cornus 'Eddie's White Wonder'*	40–50	20	Prefers rich, well-drained soil, but tolerant of clay; prefers full sun to light shade and good circulation
Sweet bay magnolia	*Magnolia virginiana*	30–40	18	Easy to grow; plant in sheltered areas to protect flowers
Persian ironwood	*Parrotia persica 'Vanessa'*	40–50	20	Grows in full sun to dappled shade; fall color is best in sun; grows best in well-drained soils, but will tolerate moisture and clay
Orangebark stewartia	*Stewartia monadelpha*	50–60	15	Grows best in light to open shade in rich, well-drained or sandy soils; prefers irrigation in summer
Japanese stewartia	*Stewartia pseudocamellia*	50–60	12	Grows best in light to open shade in rich, well-drained or sandy soils; prefers irrigation in summer
Hybrid serviceberry	*Amelanchier × grandiflora 'Autumn Brilliance'*	30–40	25	Prefers full sun, but tolerates light shade; prefers well-drained soils, but tolerates clay
Goldenrain tree	*Koelreuteria paniculata*	30–40	25	Prefers full sun and well-drained soils, but tolerant of clay
Black gum	*Nyssa sylvatica*	50–60	20	Prefers full sun to light or open shade; adaptable to many soil conditions from wet to well-drained