Longfellow Creek
Brandon to Findlay trail

Site Design

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Introduction

The Longfellow Creek Brandon to Findlay trail is a restoration project focusing on a one-block section of the Legacy Trail. The site is located on land owned by Seattle Parks and Recreation, west of 26th Avenue NE and bound to the north and south by SW Brandon Street and SW Findlay Street. The Legacy Trail is a community-based effort to build a continuous trail from Roxhill Park to SW Andover Street along Longfellow Creek (Shapiro 2003). There is an existing trail through this park but improvements to the trail bed will be installed within the next year by the Seattle Parks Department (Stannard 2004). A consultant has been hired to design the three-mile length of trail and this is one of the last sections be improved.

Many years ago the site was logged and subsequently used for housing. Some evidence of foundations remain at the site. Previous community groups have planted cedars and possibly other natives in one patch but the site is largely infested with a variety of invasive species (Stannard 2004).

Goals

Community groups such as Longfellowcreek.org and The Delridge Neighborhood Development Association (DNDA) are very interested in restoring this section of the Legacy Trail. The parks department will help to clear invasive species and improve the trail. DNDA is interested in recommendations for the trail alignment in order to best protect the existing wetlands and habitat. Community volunteers are eager to plant native species along the trail to further improve habitat for native species. They intend to focus their first efforts on the corridor within fifty feet of the trail. The primary focus of our design will be to provide a plan to remove and control invasive weeds, make suggestions for the best trail alignment, and address local issues such as vandalism.

Site Analysis

To provide a proper design for this site, it is important to understand what currently exists. The primary focus of our design will be to provide a plan to remove and control invasive weeds, make suggestions for the best trail alignment, and address local issues such as vandalism. Below are current issues on the site that we will address in our final design.

Hydrology

The hydrology of the area must be considered in plant selection. As shown in Figure 1, "A" are typical moist woodland soils. The areas labeled "B", "C", and "D" are wet for at least a part of the year to varying extents. The "C" areas contain small creeks or drainage channels that empty into Longfellow creek that keep the soil saturated year round. Clay is very much a part of the soil make-up throughout the site, and the water holding capacity appears to be relatively high in soils, especially around areas B through D. The existing plants are those typically found in a wet area and, since many of them are invasive, they must be removed. In planting this area, emergent and wetland shrubs and trees that are tolerant to saturated soils have been chosen in order to maintain plant health and create a streamside ecosystem.

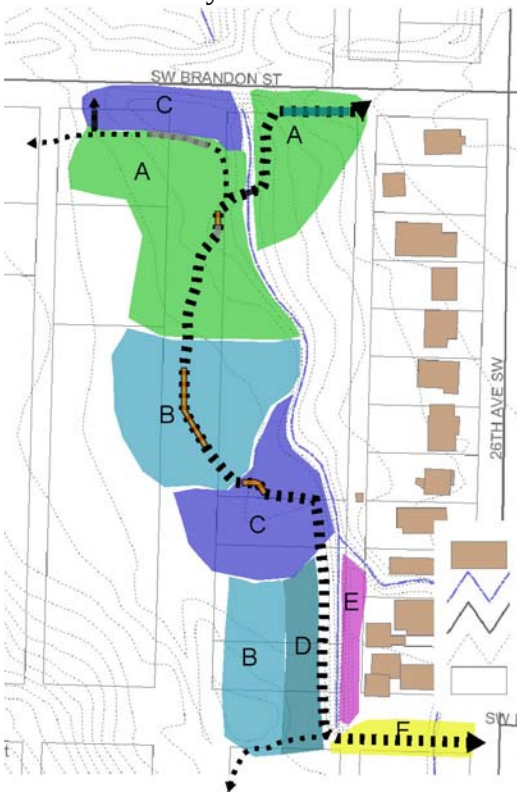


Figure 1. Site hydrology by area

Soil Analysis

Soils greatly affect plant growth and plant health physically through soil structure, depth of soil, water infiltration, bulk density, and water holding capacity. Soils affect plant growth chemically through pH, and through the ability for soil particles to hold positively

charged ions that can serve as nutrients for plants. The soil's ability to function in an ecosystem can contribute to water quality, nutrient cycling, and biodiversity, as well as plant growth (Brady, 24).

The existing soils at Longfellow creek between Brandon and Findlay were tested for macronutrient and micronutrient levels, cation exchange capacity (the ability for soils to hold positively charged ions), pH, and levels of organic matter. Three soil samples were taken within 50 feet of either side of the trail. These are numbered samples that correspond with three main areas of the site:

1. Close to the corner of Brandon and 26th, just off the main trail, on the east side of the creek.
2. Close to the corner of Findlay and 26th and probably fill brought in for the trail, just off the main trail on the west side of the creek
3. The area close to Brandon and 27th, about 50 feet from the main trail on the west side of the creek

Soil Texture and Cation Exchange Capacity

The texture of the soil was examined to better understand the soil's ability to retain moisture and nutrients. In samples #1 and #3, the soil texture is a silty clay loam, and in sample #2, it is silty clay. Silt particles are very small (0.002mm-0.05mm) and are often made up of minerals weathered down to feel like flour. Clay is an even smaller particle (<.0.002), with a very large surface area. The surfaces of clay particles are charged and are able to hold on to large amounts of water and positively charged nutrients.

The Cation Exchange Capacity (CEC) is a measure of the ability of the soil to bind and retain positively charged nutrients. The cation exchange capacities from the site soil samples are listed below in Table 1.

sample number	**Cation Exchange Capacity (meq/100g)**
1	18.4 meq/100g
2	10.4 meq/100g
3	17.9 meq/100g

Table 1. Cation Exchange Capacity at different areas within the site.

An adequate CEC is usually within the range of 10-15 meq/100g. In samples taken from the site, we see adequate CEC, with the possible exception of sample #2. The higher this value, the more sites available on soil particles for nutrients to bind.

Soil acidity, and pH

Testing for acidity levels in soil can give us an idea of nutrient availability for plant uptake. The ideal pH for most plants is from 5.5-7.5 (University of Massachusetts, 2004), allowing for beneficial microbial activity to take place, which can aid in nutrient uptake through the plant's roots. If the soil pH is too low or too high, the CEC can be affected, and many nutrients may become unavailable to plants. In samples #2 and #3, the soil pH levels are higher then optimal.

Soil Level pH

Sample number	soil pH
1	5.9
2	6.8
3	6.7

Table 2. pH levels at various areas of the site.

Nutrients

Samples were tested for key macronutrient and micronutrient levels to find deficiencies and to be aware of possibly toxic levels of heavy metals or nutrients. The micronutrient levels of all three samples were in adequate amounts (see Table 3). The macronutrients tested were Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg), the results are noted in the table below in parts per million.

Macronutrient levels (parts per million)

sample number	NO_3^-	NH_4^+	P	K^+	Ca^{++}	Mg^{++}	
1	12	6	8	250	1318	217	
2	4	2	8	94	1711	330	
3	3	4	9	154	2341	341	

Table 3. Macronutrient levels.

Nitrogen is a common nutrient deficiency in soils and is essential for plant growth. It is taken up for use by the plant as either nitrate (NO_3^-) or ammonium (NH_4^+). The nitrogen levels can fluctuate with soil and weather conditions and this test only measures the levels at the time the sample was taken. The test should be treated as a guideline to get a feel for extremely high and extremely low levels of nitrogen, rather then as the basis for fertilizing recommendations.

Phosphorous is rarely lacking in our urban soils. However, the levels of phosphorous from the samples taken are actually in the low to medium range. Potassium is readily abundant in all three samples, and in sample #1, the level of potassium is very high. Calcium and magnesium are both plentiful in all samples taken.

Recommendations

To prepare the site for planting, the pH should be adjusted for the area on the west side of Longfellow creek. Broadcast sulfur on the area to reduce the pH and make the soil more hospitable to native plant species. Sulfur can be added at 2 cups per 100 sq ft to the soil surface (University of Massachusetts, 2004). Northwest soils are naturally acidic and native plants are well adapted to acid soils. Lowering the pH will allow new plantings to grow much more vigorously.

The organic matter in sample #1 is high and considered adequate in samples #2 and #3 (University of Massachusetts, 2004). This should allow for a healthy growing environment for young plants. Once invasive removal of an area is completed, the area should be mulched with wood chips at a depth of 1 foot. The source of the wood chips should be considered to be sure that the chips are free from contaminants such as salts and other chemicals, which may be harmful to plants as the chips biodegrade. The addition of the wood chips will slowly release nutrients into the soil for plants over time

and act as a barrier to weeds. The mulch will also retain water in the areas where new transplants may be susceptible to drying out. By increasing the organic matter in the soil as the wood chips biodegrade, the cation exchange capacity may improve to some degree.

Existing Plant Assessment

The existing plants on the site consist of native and non-native trees, shrubs, and herbaceous species. Overall, deciduous native trees, *Alnus Rubra* and *Acer macrophyllum* dominate the canopy, with some large *Thuja plicata* and *Pseudotsuga menziesii* scattered across the site. There are also several young *Thuja plicata* in the mid-canopy but this shrub layer is dominated largely by the invasive *Rubus discolor*. Ground covers vary across the site but *Hedera Helix* is common as is *Phalaris arundinacea* in some areas. *Polystichum munitum* and *Oemleria cerasiformis* have also done well in many areas of the site.

Figure 2. Existing plant assessment

The following is a list of plants according to location as indicated on Figure 1:


Area #2


Area #4


Area #8


Tree #11


Area #12

Location	Plants
1	**Invasive** *Buddleia davidii* Butterfly bush
2	Canopy: somewhat open with *Thuija plicata* Western red cedar Mid-canopy: *Oemleria cerasiformis* Indian plum Ground cover: **Invasive** *Hedera Helix* English ivy, some bank erosion, bare soil
3	Canopy: *Thuja plicata* western red cedar, *Acer macrophyllum* big leaf maple, *Psuedotsuga menziesii* Douglas fir, *Alnus rubra* red alder Ground cover: little vegetation, leaves
4	Canopy: *Alnus rubra* red alder Mid-canopy: *Oemleria cerasiformis* Indian plum Ground cover: **Invasive** *Hedera Helix* English ivy dominate, *Polystichum munitum* swordfern landscape fabric under ivy
5	Canopy: *Alnus rubra* red alder, *Acer macrophyllum* big leaf maple, Mid-canopy: **Invasive** *Rubus discolor* Himalayan blackberry Ground cover: **Invasive** *Ilex aquifolium* English holly, **Invasive** *Hedera Helix* English ivy
6	**Invasive** *Hedera Helix* English ivy, grassy swale
7	Canopy: *Thuja plicata* western red cedar, *Alnus rubra* red alder Ground cover: **Invasive** *Ilex aquifolium* English holly, *Polystichum munitum* swordfern
8	Canopy: *Alnus rubra* red alder, *Thuija plicata* Western red cedar Mid-canopy: **Invasive** *Buddleia davidii* butterfly bush Ground cover: **Invasive** *Hedera Helix* English ivy, **Invasive** *Phalaris arundinacea* reed canary grass,
9	Canopy: *Alnus rubra* red alder, *Thuja plicata* western red cedar Mid-canopy: *Oemleria cerasiformis* Indian plum **Invasive** *Rubus discolor* Himalayan blackberry, **Invasive** *Ilex aquifolium* English holly, Rubus ursinus trailing blackberry Groundcover: *Polystichum munitum* swordfern
10	Mid-canopy: *Salix spp.* willow overgrowing trail **Invasive** *Rubus discolor* Himalayan blackberry
11	Leaning/dying *Thuja plicata*
12	Canopy: open *Alnus rubra* red alder, *Acer macrophyllum* big leaf maple Mid-canopy: *Thuja plicata* western red cedar saplings, **Invasive** *Rubus discolor* Himalayan blackberry,


Area #16

Rubus ursinus trailing blackberry,
Invasive *Buddleia davidii* butterfly bush
Ground cover: **Invasive** *Phalaris arundinacea* reed canary grass, other grasses

13 Canopy: *Alnus rubra* red alder,
Populus trichocarpa black cottonwood,
Acer macrophyllum big leaf maple
Mid-canopy: Salix spp. willow,
Invasive *Rubus discolor* Himalayan blackberry
Ground cover: muddy

14 Mid-canopy: *Salix spp.* willow
Invasive *Buddleia davidii* Butterfly bush
Invasive *Convolvulus sepium* hedge bindweed

15 Canopy: *Alnus rubra* red alder,
Populus trichocarpa black cottonwood

16 Mid-canopy: *Arbutus unedo* strawberry tree
Ground cover: grass


Area #20

17 Ground cover: **Invasive** *Phalaris arundinacea* reed canary grass

18 Mid-canopy: **Invasive** *Rubus discolor* Himalayan blackberry

19 Mid-canopy: **Invasive** *Buddleia davidii* butterfly bush

20 Ground cover: **Invasive** *Phalaris arundinacea* reed canary grass

21 Canopy: *Salix spp*. willow, *Alnus rubra* red alder
Mid-canopy: *Cornus sericea* red twig dogwood **Invasive** *Rubus discolor* Himalayan blackberry

22 Groundcover: grasses

Hazard Trees
There are two trees at the site that have the potential to be hazardous.

Tree 1
Species: *Thuja plicata*
Location: This tree is just to the north of the bridge on the east bank of the creek.
Diameter: 2 feet
Height: approximately 50 feet
Potential Target: Trail on opposite side of the creek
Assessment: This tree does not require immediate action however, it should be monitored due to a few factors that may have compromised its stability. The base of the trunk is hollow and has previously had ivy grow up through the center of the trunk and emerge through a crack higher up. The ivy has been removed and further invasions should be controlled to avoid adding extra weight to the trunk. The tree is also leaning at an angle of 20 degrees towards the creek. There is no evidence of root heaving or soil disturbance at the base however about 50% of the area to the east of the trunk is compacted from the trail. Despite these factors, the crown is quite vigorous and there is little evidence of other compromising factors. Since the trail does not have a high

frequency of use during storms, our recommendation is to monitor the tree every few months to evaluate if there is increasing lean or further deterioration of the trunk.

Tree 2
Species: *Thuja Plicata*
Location: This tree is just north of the bridge on the west bank between the west bank trail and the stream.
Diameter: 1.5 feet
Height: approximately 25 feet
Potential Target: Trail on opposite side of the creek
Assessment: This tree may need further evaluation from a certified arborist for possible removal. The base of the trunk is decayed and appears to be hollow. The bark is split on the east side of the trunk to a height of 4 feet. The crown of the tree is 80% dead. The main leader is completely dead and a lateral branch on the west side has grown vertically to become the leader. The trunk is leaning to the east approximately 10 degrees. The root zone is compromised on the west side by the trail and on the east side by the under cutting of the creek bank. The overall impact is about 70% of the root zone. A possible solution to avoid complete removal of the tree is to reduce its height and remove the remaining living branch. This will reduce the weight and area that the tree threatens if it were to fall. The tree could also potentially be supported with guide wires to add stability.

Invasive Plant Removal

Our analysis finds that five major invasive plants are dominating the site and need to be removed. These invasive plants are *Buddleia davidii, Ilex aquifolium, Hedera helix, Rubus discolo*r, and *Phalaris arundinacea*. Identification techniques, images, and methods for removal are outlined in the following pages.

Buddleia davidii (butterfly bush)

History and Use
Introduced as an ornamental plant, the butterfly bush is an aggressive self-seeder and a common invasive on roadsides, empty lots, and natural areas.

Method of Spread
This plant spreads primarily by seed and rapidly colonizes disturbed areas (Starr 2003).

Identification
We found two incidents of *Buddleia davidii*. One along Brandon near the northeast entrance to the trail (top image) and one towards the southern end of the park along the trail. This deciduous shrub has slim opposite leaves and purple cone-shaped flowers.

Recommended Methods Of Control
If cut *Buddleia davidii* will resprout (Starr 2003). These individual shrubs can be removed by cutting but long term monitoring will be required to watch for sprouts. Seed production is prolific. The plant should not be dug out as soil disturbance is likely to result in new seedlings (Starr 2003). If long term monitoring is possible to repeatedly cut new sprouts the bush will eventually die. An alternative to this is to paint stumps with a weed killer such as round up to prevent sprouting.

The plant should be removed before developing seeds in the early fall. Take care to watch for new seedlings and future outbreaks as these two shrubs will have left behind ample seeds from past seasons. Seedlings are most likely to develop in newly disturbed areas. A layer of mulch over disturbed areas and established plants will deter new seedlings of *Buddleia davidii.*

Ilex aquifolium (English Holly)

History and Use

The English Holly has been introduced for ornamental purposes and heralds from Europe, East Asia, and North Africa. Often grown for Christmas decorations, and sometimes recommended for use in gardens to provide bird habitat.

Method of Spread

Birds are fond of the berries, and are the primary dispersers of this invader. English Holly can also spread by suckering or layering. If uncontrolled, a dense thicket will displace native trees and understory alike.

Identification

- Thick, glossy, dark green leaves, *very* spiky
- Large shrub or small tree, may grow up to 50’ tall
- Small white flowers, separate male and female plants
- Bunches of poisonous red berries in the winter on female plants

Recommended Methods of control

Because birds disperse seed from nearby ornamentals, keep in mind that removal will be a long-term maintenance commitment as new seedlings grow. For young individuals,

hand pulling is the easiest method of removal. Older shrubs can be killed by cutting off at the base during the summer. Holly tends to sprout from the base, so it may need to be cut back several times before its reserves are exhausted. (*Weeds of the Blue Mountain Brushland)*

Hedera helix (English Ivy)

History and Use
English ivy is an evergreen vine. It was introduced as an ornamental plant, and it's often used as a ground cover for gardens, urban landscape, roadsides, slopes, and erosion control. It's highly invasive. It spreads aggressively, disturbs natural areas, and competes with native plants. It also climbs trees, and when it snows, the weight increases and breaks branches. It damages plants and can be hazardous for humans and animals.

Method of Spread
English ivy reproduces vegetatively and by seeds. Root fragments can produce more plants. Seeds are eaten by birds, especially introduced species, and dispersed in other areas. It spreads by growing aerial roots at nodes and also climbs trees or structures and attaches itself with holdfasts. It grows fast and can climb to 90 feet (Dirr 375). The roots go down deep in the ground and hold tightly.

Identification
The leaves are waxy and withstand pollution. Water-soluble herbicides do not penetrate the waxy layer (Bergendorf 98). English ivy has two phases in its lifecycle. When it's juvenile, the leaves are 3 to 5 lobed, and mature leaves become ovate (Dirr 375).
During the juvenile period, it grows like a vine. When it matures, it becomes woody and shrub-like. Mature plants bloom and bear fruits in autumn. The fruit is a black drupe that contains 2 to 5 seeds (Dirr 375-376). English Ivy can produce thousands of seeds per year (Bergendorf 98). Both leaves and fruits contain toxic compounds such as Saponins and Cyanogenic glycosides to protect from herbivores, and large amount of consumption can cause a burning sensation in throat, upsetting stomach, vomiting, and diarrhea, but some birds can eat the fruit (Foster 190). English ivy grows well in moist but well-drained, organic soil. It tolerates heavy shade, acid and alkaline soil, and salt (Dirr 376).

Recommended Methods Of Control
Because there is a creek, herbicides cannot be applied. Mechanical control such as mowing and pulling is most effective although it's labor-intensive. Thick vines create a habitat for rodents, so mowing is recommended when it can be applied. Also, it makes easy to pull and dig vines out. When pulling out plants, it's important to remove all the roots because root fragments can reproduce plants. Twisting vines when pulling can remove the entire plants without snapping off. If there are native plants, shearing vines

around them and minimize to disturb the native plants' roots as much as possible when digging out the vines.
Mature English ivy produces fruits; therefore, it has to be controlled before setting seeds. To remove vines from trees, cut off the vines above the ground so that they cannot take water and nutrients. Eventually, the vines die and fall off. No need to climb trees to remove them.

Continuous monitoring and management are necessary.

Rubus Discolor (Himalayan Blackberry)

History and Use
Himalayan blackberry is considered an obnoxious weed on the King County Noxious Weed List, meaning that the King County Weed Board recognizes blackberry as invasive and widespread, but there is no mandatory control of blackberry (King County Noxious Weeds List, 2004). It was introduced from England, but originated in India.

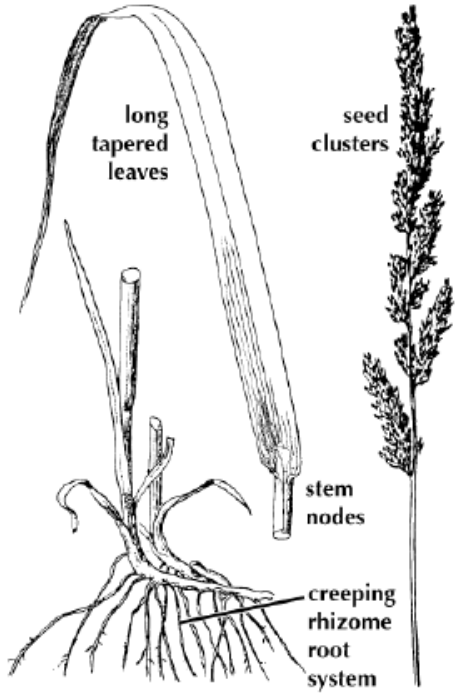
Method of Spread
Himalayan blackberry is a strong competitor and the thickets formed by them can easily shade out existing natives. Reproduction is accomplished in several ways; most commonly through seed, which are mature in late summer. Blackberry thickets can produce huge amounts of seeds each season, which many species of birds and mammals disperse. Blackberries also spread vegetatively through lateral roots producing new vegetative shoots and through vegetative rooting through cane tips. Canes of Himalayan blackberry can grow to twenty-three feet (7 m) long in a single season (University of California, Davis), given ideal conditions. It is an unpleasant plant to come across, due to its thorny and impenetrable habit.

Identification
An erect to arching, and even trailing shrub, blackberry is often armed with recurved prickles along its four-sided stems. The leaves are alternate and tri-foliate on reproductive shoots, and 5-foliate on vegetative shoots. The oval leaflets are toothed, and covered with white hairs on the undersides. It is probably most recognizable by its fruit; a black aggregate berry which is ripe in late summer and, which may not be present if the plant is growing in too much shade.

Recommended Methods of Control
Himalayan blackberry should be removed mechanically. The canes should be cut down or mowed if possible, then the roots removed by (gloved) hand. This is a time consuming process, but it has been shown to be effective. If the roots are not removed, new plants may be generated. The canes should be removed from the site as they may root if left there for any length of time.

Once the plants have been removed, new plants should be put in as quickly as possible to attempt to shade out seedlings that may be present. Mulching will also aid in repressing blackberry seedlings from sprouting. Birds, mammals, and streams are able to carry the seeds long distance, and the risk of continued infestation of blackberry is high with blackberry remaining on the slopes of the site. Until the area has been successfully replanted and a dense enough canopy is present, the probability of blackberry returning to the site is fairly high and restored areas should be observed to maintain blackberry populations.

(Phalaris arundinacea) Reed Canary Grass *Class C Noxious Weed*



History and Use

Reed canary grass was probably introduced from Europe and Asia as were most of our weedy grasses. The seed is used for birdseed and the plant is considered a good forage plant in for pasture, silage, and hay as well as filtration for water pollution control.

Method of Spread

The King County Department of Natural Resources website describes reed canary grass method of spread as follows: "[It] an aggressive invader of moist areas, meadows and lake shores. Reed canary grass is a generally competitive, persistent and vigorous perennial grass that grows in poorly drained areas and along stream and canal banks. Its creeping rhizomes force out other grasses and thus reduce biodiversity by sucking up all of the water and nutrients in the soil. Although reed canary grass has been valuable for forage, it has become a threat to some of our native wetland plant communities. The grass is widely distributed in Idaho, Oregon, Nevada, Utah and Washington."

Methods of control

Reed canary grass can be hand-pulled, but because it does not tolerate shade the best control method is selective planting of favorable species. Because the roots of reed canary grass can be up to 24" in depth, hand removal can be difficult. Another removal method can be to mow it down in the winter and cover it with a thick mulch layer.

Once shaded or mowed, the remains can be covered with cardboard, mulched deeply with 18" of wood chips and replaced by sedges, rushes, willow, red osier dogwood and chokecherry. In particular, there is some evidence to suggest that salmonberry phyto-toxins might have an inhibiting effect on reed canary grass. Because reed canary grass provides such great cover from aerial predators, rodent populations can be fairly high. This can effect restoration since rodent foraging can inhibit the success of seedlings

Identification

- a coarse but attractive perennial, reed canary grass grows as tall as six feet
- long leaves are flat, green with a sooty-gray hue, about 1/2 inch wide, and spread out from the stem at tight right angles
- light green to straw colored stems have swollen stem nodes
- flowers and grains grow in dense but branched clusters, which commonly turn purplish as the plant matures in spring and fade to straw color in late summer
- roots spread extensively by creeping rhizomes and runners (Sandelin, 2003)

Wildlife and Beaver

Local residents and stewards of the site have pointed out evidence that a beaver is active near the creek. Much information is available on the Internet for how to cope with the typical impacts of Beaver. The following is a summary of information available from Animal Protection of New Mexico and the King County Water and Land Resources Division.

Beavers can greatly alter hydrology at a site and take down trees, but removal is usually only a temporary solution. It is more practical and humane to come up with a solution that allows the beaver to stay where they are (APNM 2004). In addition, beaver make many beneficial contributions to creek habitat. "Beavers maintain wetland systems in the landscape. Their activities may change watercourses, raise water tables, and create new habitats for plants, fish, and other wildlife. In the Pacific Northwest, beaver ponds are critical for slowing stormwater runoff, trapping sediments, and maintaining summer base flows among other ecological benefits. Recent studies indicate that coho that are reared in beaver ponds find more food, refuge from floods and predators, and may be twice the size of juveniles that are not reared in beaver ponds. To date, artificial structures and "restored" wetlands do not provide comparable levels of ecological functions as wetlands created and maintained by beavers. In addition, beavers maintain wetlands at a significantly lower cost than humans have been able to achieve" (King County 2004)

Flooding

Beavers build dams to raise the water level in order to build their lodges. The lodge is built on what is effectively an island with an underwater entrance, providing protection from predators (APNM 2004). Beavers are attracted to the sound of flowing water and

will seek out that spot to dam. Products are available to prevent beavers from blocking culverts and flooding private property or roads such as the Beaver Deceiver (see below) which uses wire mesh to let water flow through culverts. The Beaver Baffler is made of perforated pipe and wire mesh that allows water to flow through beaver dams (APNM 2004). In Washington, a Hydraulic Permit Approval is required from the Washington Department of Fish and Wildlife to use either device and there may be local county or city permits required as well.

Beaver Deceiver available from:
Skip Lisle, Wildlife Biologist
Penobscot Indian Nation
Dept. of Natural Resources
6 River Rd.
Old Town, ME 04468

Protecting Trees

Beavers are most interested in trees that are within 100 feet of the stream bank. The APNM suggests several methods for protecting trees. For highly valued trees, cages made of hardware cloth or 2x4" welded wire fencing encircling the trunk to a height of 4 feet will protect the tree. Cut every other horizontal wire and bend into hooks to close the cage leaving space between the cage and trunk. The cage can be anchored with stakes (APMN 2004). A less visible and less expensive method is to paint trunks with a paint and sand mix. Add 8 ounces of fine sand (30 mil, 70 mil, or mason sand) to one quart of exterior latex paint. Stir often and paint the bottom four feet of the trunk. The paint can even be color-coded to match the trees. Avoid painting young trees less than six feet tall. The sand will discourage beavers from gnawing on the trunk (APNM 2004). Low fences can protect groups of trees such as young trees installed for restoration. Chicken wire or similar material staked into the ground to a height of 3 or 4 feet will deter beavers from entering an area. Bend the bottom of the fence into an L to prevent burrowing (King County 2004).

Trail/Circulation

An approximately 800-foot trail segment currently runs the length of the project site along Longfellow Creek. Once this site is restored, this portion of the trail will be officially be considered part of the Longfellow Creek Legacy Trail, which links several miles of open space along one of Seattle's last salmon spawning streams.

Trailheads

Several unmarked trailheads connect the site from the Greg Davis Park to the north and the rest of the Longfellow Creek Legacy Trail to the south.

On the north side of the site along Brandon Street, three entrance points currently create a confusing entrance to this trail segment along Longfellow Creek. The following issues create a confusing mix of trails, which must be addressed through our design:

- The need for establishing a main entrance that connects across the street to Greg Davis Park. In the future, this main access point will be strengthened as the Longfellow Creek Legacy Trail is extended to the north beyond Greg Davis Park..


Proposed main entrance

- Removal of at least one of the trail access points from Brandon Street, specifically the east-most trail that is directly behind the residences.
    - Maintaining and developing the trail access from the west, while removing social trails. This western trail access connects across a newly-constructed wooden bridge and Brandon Street to a side-loop of Greg Davis Park, as well as, from a heavily-traveled "social trail" that will eventually connect to the new High Point mixed-income housing community.
- The lack of signage is a contributing factor to the confusing trail hierarchy and connectivity across Brandon Street.

On the south of the project site, another confusing mix of trail entrance points must be addressed through the design. These are as follows:

- The need for a strong trailhead link from 26th Avenue SW.
- The need for a coherent T-intersection in the trailhead (while traveling southbound) that would discourage use of the grassy wet strip behind the residences.


Current trailhead on 26th Ave SW

- The need for a clear and passable connection to the gravel utility road so that it can serve as the southbound connection to the Longfellow Legacy Trail.

Trail Location
See Appendix 4 for a figure that shows the existing and recommended routes of the trail through the project site. With the exception of the aforementioned trailhead recommendations, we recommend that the alignment of the main trail through the project remain as it currently exists.

Our analysis also finds that two social trails and two social "areas" should be removed with re-vegetation and limited access. These are identified on the "Trail Analysis" graphic and are described as follows:

Social Trails to be Removed:
- The aforementioned social "side" trail on the northwest side of the creek
- The aforementioned lesser trailhead that is close to the residences on the northeast side of the creek.

Social Areas to be Removed:
- The broad flat area north*east* of the Longfellow Creek bridge crossing.
- The broad flat area north*west* of the Longfellow Creek bridge crossing.

Trail Size
Currently the trail width varies from approximately 3' to 6' wide. The trail should be widened to 6' to allow for two people to walk alongside each other or pass each other. See the "Trail Analysis" graphic for the locations of where trial widening should occur.

Trail Surface
See Appendix 4 for the locations of where each of the following trail surfaces exists:

- Compacted earth
- Boardwalk
- Exposed landscape fabric and wood chips
- Gravel
- Wooden bridges


Landscape fabric and wood chips

Based on our analysis of trail surfaces and usage patterns, we recommend the following trail surface improvements:

- Remove gravel trail surfaces as they can be easily eroded and be deposited in the creek
- Remove landscape fabric, regrade, and resurface portions of the trail with compacted earth
- Maintain boardwalks and bridges and potentially plan for resurfacing as the boards age.

Trail to Longfellow Creek Relationship
The "Trail Analysis" graphic illustrates that the creek is a major organizing element for the project site and thus the trail. At the north entrance of the project site, the trail parallels and crosses the creek. Thus the creek can be viewed from the trail for approximately 350 feet. In the middle of the project site, the trail pulls away from the creek and is enclosed by a thick, marshy riparian area on the both sides of the trail. At the south end of the project site, the trail merges and parallels the stream, in a filled and vegetated area that disconnects the trail somewhat from the creek, even though it can be seen from the trail.

Opportunities for Creek-viewing, trailside seating, and Interpretation
Based on the above analysis, we have identified several opportunities for creek-viewing, trailside seating, and interpretation of the trail with signage. These are identified in Appendix 4.

Grading
Only minor grade changes in the following areas of the project site will be necessary for trail development and enhancement and improved drainage:

- Main Trailhead connecting from Greg Davis Park.
  This portion of the site must be graded so that the main trailhead is located just to the south of the road visually connected across from the Greg Davis Park trail. A flat area must be cleared and graded that then gently slopes and blends into the existing trail that leads down to the creek and bridge.

- Stairs Mitigation.
  To create universal access, the stairs to the southwest of the bridge should be removed and the trail grade should be built into the slope so as to lower the trail grade to a gentle slope of >5%.

- Trail Bed Build-up by the Social Area.
  To the south of the aforementioned area, the trail bed must be built up so as to level and separate it from the social area to the east.

- Marshy Area between Boardwalks.
  Between the two stretches of boardwalk, the trail bed must be raised and approximately three equally spaced 6" culverts must be embedded in the subgrade in order to permit drainage and clear access across this wet area.

- Access to Utility Road at the proposed T-intersection at the south end of the project site, clearing and regarding of this area must accommodate for access to the utility road beyond it. A winding trail would accommodate the grade while a small foot bridge would allow for underneath passage of water.

Privacy, Safety, and Vandalism Issues

Privacy

Privacy can be an issue for some residents. There is no screen between the houses and a trail, so many of the properties are exposed and visible from the trail. Close proximity to buildings may also detract from the feeling of solitude that might be experienced when walking on a greenbelt trail. The design will need to take views of the creek and the need for privacy into consideration.

Dumping

Dumping is a serious problem. Trash is often dumped in the brush and in the creek, especially close to Brandon St. and Findlay St. Educating the public about the creek and wildlife is necessary, and a warning sign at the entry may be effective. Occasional cleanup by volunteers may be necessary to maintain the site. Setting up garbage cans would not be a good idea because people may bring more garbage.

Vandalism

Graffiti and vandalism can be a problem for the trail and trees. A tree nearby the bridge over the creek has been severely damaged by knife throwing. Neighborhood children may be using the area for unsuitable activities, such as skateboarding. Vandalism may be difficult to stop but can be minimized by creating an open environment or by installing structures to help contain visitors to the trail.

Safety

Dim and bushy areas give a “creepy” impression. It could be unsafe after dark, and there are possible criminal activities. Caution signs may be necessary. Visibility on the trail also needs to be considered, and balanced with the need for privacy.

Site Design

Summary of Site Design

Trail
While the overall placement of the trail is good, we have a few recommendations.

- Several social trails will need to be revegetated (see Appendix 4).
- The trail that connects with Greg Davis Park should be widened and improved to provide better connection between the parks and reduce the use of nearby social trails.
- The trail should be widened to 6' along its entire length.
- Gravel and landscape fabric should be removed and replaced with compacted earth.
- Widen areas of the boardwalk to incorporate benches and encourage people to stay on the path (see Appendix 4).

Privacy
Residents along the creek are concerned that improvements will increase traffic on the trail. Many yards are clearly visible from the trail, so privacy is an issue. Additionally, it is important to give visitors to the area a sense of being apart from the city, to make the trail a place to experience nature. To create a visual barrier for residents and visitors alike, the following steps should be taken.

- Install vegetation that acts like a screen (see Appendix 1)
- Locate benches to encourage visitors to linger or congregate is areas not visible to nearby buildings (see Appendix 4)

Vandalism
Currently, this section of the trail is occasionally used in a destructive manner. To reduce the amount of damage to the existing and newly installed plants:

- Clearly display signs that describe the value of the restoration to visitors.
- Designate areas for people to gather, so that they are less likely to go off of the trail.
- Include railings along sections of the trail that people are more likely to leave the trail (see Appendix 4).

Signage
While the exact content and design of the signs are up to you, we recommend three basic categories of signage, see Appendix 4 for possible locations.

- 1) Orientation: clear marking of trailheads.
- 2) Educational
- 3) Management: address the harmful effects of trash dumping, mark closed social trails so that new plants will not be walked on.

Growing Conditions
Based on the hydrology, soil conditions, and light availability on the site, the following subdivisions will be planted with different pallets. See Appendix 1 for plant selections for each section.

- A: upland understory
- B: moist to saturated understory
- C: saturated for much of the year, understory
- D: Moist, full sun

Invasive Species Control
Five invasive species were identified in our site analysis. To revegetate this site, we selected assertive species that can compete with aggressive invasives. This will reduce the amount of long-term maintenance the site will require to prevent the exotic species from taking over again.

Wildlife
By returning native plant species and structural complexity to this site, it is hoped that wildlife can benefit from the restoration. The resident beaver will hopefully serve as an amenity of the area. In removing Himalayan blackberry and other plants from the site, we will be compromising some food and habitat that birds and other wildlife may have relied on. In our plan, these invasives have been replaced with other species that should provide higher quality habitat in the long run.

Installation

Installation Instructions

Timing

Fall is the best season for plant installation for the best plant establishment. Do not install in summer because new plants suffer from heat and drought. Later winter and spring are acceptable for planting, but it's not the best time.

Location

Group the same species together in a mass planting rather than putting one of each type in the same area. Mass plantings are better at competing with weeds.

Proper Installation techniques

Pull mulch away from the spot. Dig a hole twice as wide as but no deeper than the root ball of the plant.

If plants are balled and burlapped, all the wrapping materials should be removed. Wrapping materials block root growth. Then, remove the soil gently from all the plant materials for optimal plant establishment in the native soil. Soil in the root ball can be easily removed in a bucket of water. When removing the soil, be careful not to damage the roots as much as possible.

If there are circling roots, straighten or remove them. When circling roots become large, they can choke the plant to death. Circling roots greater than 1/4 in. diameter are difficult to correct; therefore, it's better not to install plants with large circling roots. Plants with poor root system should not be planted as well because they establish poorly.

Next, make a mound in the planting hole, spread the roots on the mound, and position the plant at the same soil level or slightly above than it was grown (Figure 3).

Fill the hole with the native soil and add water. After the soil settles around the roots, add more soil to fill completely and make a ridge around the hole (Figure 4). Then, add water again in the basin to settle the soil. Be sure that the soil level is proper. No amendment, compost, or fertilizer should be added because native plants are adapted to the native soil and limited nutrients.

Pull mulch back over the soil. Allow the mulch thickness to drop as it gets closer to the base of the plant. There should be no mulch in direct contact with the newly installed plant.

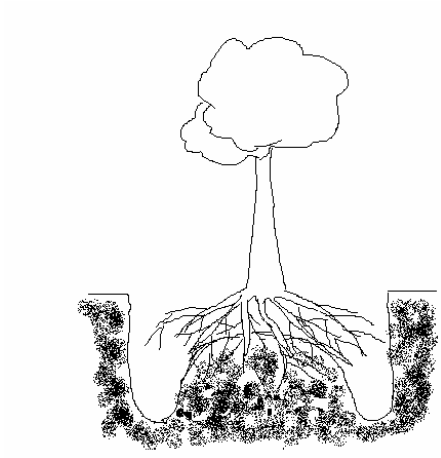


Figure 3

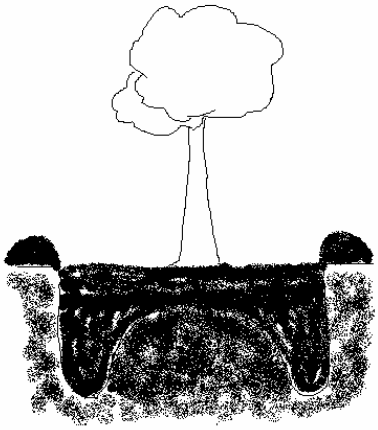


Figure 4

Spacing
General rule:
Spacing of trees = (mature height of tree A + mature height of tree B) / 2
Spacing of shrubs = (mature height of shrub A + mature height of shrub B) / 3

Trees and shrubs need large space for extending the roots and the canopy when they mature, so do not plant them close together. Plants for screening can be planted closer. Large herbaceous plants are planted 1 ft. to 1 1/2 ft. apart. Small or slow growing plants can be planted closer for faster establishment.

Mass planting works well for better competition with weeds.

Mulching
Add 6 inches to a foot of wood chip mulch to retain moisture, suppress weeds, and reduce compaction. Mulch also helps build a good soil structure. Small wood chips are desirable for good decomposition. Bark is not recommended because it may contain high salt levels. Do not mulch around the trunk or the main stem because it could cause disease and rot problems.

Staking
Tall trees and bare root trees need staking. The tree should be loosely tied, allowing it to sway gently in the wind. It helps the tree develop trunk taper and strong root system. Tie materials should be broad, smooth, and elastic. Remove the staking as soon as the plant has established a year after. If the tree can stand up on its own, it is best to avoid staking it.

<u>Installation Specifications</u>

Because dealing with smaller plots is easier to work with and more motivating to volunteer workers, we recommend restoring this site according to the vegetation subdivisions labeled A through D on the map. When one section is completed, the group can move on to the next. If large equipment or weekend projects are needed, these plans may need to be altered to treat several sections at once.

Phase I: Trail and Grade improvements

- Improve grading at trailhead near Greg David Park
- Remove gravel and landscape fabric from the Northwestern area A
- Raise grade of the trail near social trails
- Extend boardwalk or raise grade in muddy areas
- Create gathering areas and railings along the boardwalk (See Appendix 4)
- Redirect trail at the south end of the site to the utility road
- Install educational, management, and orientation signage

Phase II: North End Trailhead, Northeast "A" area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.
- In areas marked "G" on the map, concentrate *Mahonia aquafolium* and other spiny or thorny species to discourage use of social trails.

Phase III: Wet grassy area, Northern "C" area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.
- In areas marked "g" on the map, concentrate *Mahonia aquifolium* and other shiny or thorny species to discourage use of social trails.

Phase IV: English Ivy, Northwest "A" area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.

- In areas marked “G” on the map, concentrate *Mahonia aquafolium* and other spiny or thorny species to discourage use of social trails.

Phase V: Alder grove, Northern “B” area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.
- In areas marked “i”, concentrate *rosa piesocarpus* and *rosa nootkaensis* and other spiny or thorny species to encourage people to stay on the path.

Phase VI: Southern “C” area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.

Phase VII: “D” area and Southern “B” area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.

Phase VIII: Screening “E” area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.
- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the *soil*, not just the mulch.

Phase IX: Southern Trailhead, “F” area

- Remove invasive species from the area
- Broadcast 2 cups of Sulfur per 100 square feet onto the soil
- Mulch entire area to be treated, taking care not to smother desirable species. Do not let the mulch touch the base of desirable species.

- Install plants from Appendix 1, keeping spacing considerations in mind (see Appendix 2 for specific plant spacing needs). Clump the same species together, rather than interspersing them evenly throughout the zone.
- Be sure plants are planted in the soil, not just the mulch.

Aftercare and Maintenance

Water installed plants well once a week and keep the soil moist for a year until plants establish. Too much water or too little water can cause physiological problems, so check moisture levels regularly.

Monitor and control weeds regularly because they grow faster and earlier in the season than native plants. Fragments of the plant such as a stem or a root can produce more plants readily, and there are viable seeds in the soil; therefore, it's the best way to remove weeds is before they become big and spread in the planting areas. When controlling weeds, do not injure or remove native plants by mistake. Do not leave removed weeds on the site.

Add mulch every two to three years until persistent weeds are suppressed and new plants are well established to compete with weeds.

Remove hazardous branches or trees along the trail. When pruning, do not leave a stub nor make a flush cut. Prune just above the branch collar so that the plant can seal the wound well.

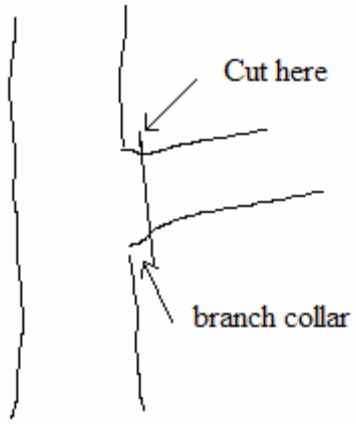


Figure 5. Proper pruning cut.

Remove stakes and ties one year after the installation. Staking the tree for too long could cause problems such as a weak trunk and a small root system. Tying for too long causes girdling and interferes water uptake in the xylem.

Appendix 1: Plant List by Area

Northern "C" area		Number
Cornus stolinifera	red osier dogwood	132
Fraxinus latifolia	Oregon ash	3
Rosa pisocarpa	clustered wild rose	124
Salix lucida (lasiandra)	pacific willow	5
Salix sitchensis	sitka willow	31
Symphocarpus Alba	snowberry	155
Carex obnupta	slough sedge	310
Eleicharis palustris	common spikerush	310
Glyceria grandis	Reed mannagrass	310
Juncus acuminatus	tapered rush	620

Northeastern "A" area		Number
Acer circinatum	vine maple	11
Amelanchair alnifolia	serviceberry	29
Corylus cornata	beaked hazelnut	174
Gaultheria shalon	salal	29
Holodiscus discolor	oceanspray	58
Mahonia aquifolium	shiny oregon grape	7
Rhamnus purshiana	Cascara	3
Ribes sanguinium	red-flowering currant	194
Ribes lacustre	Black gooseberry	116
Dicentra formosa	bleeding heart	582
Fragaria vesca	wild strawberry	233
Maianthemum dilatatum	false lily of the valley	194
Thalictrum occidentale	western meadowrue	174
Tolmiea menziesii	piggy back plant	582

Northwestern "A" area		Number
Amelanchair alnifolia	serviceberry	95
Corylus cornata	beaked hazelnut	239
Gaultheria shalon	salal	575
Holodiscus discolor	oceanspray	95
Mahonia aquifolium	shiny oregon grape	191
Rhamnus purshiana	Cascara	25
Ribes lacustre	Black gooseberry	959
Rosa nutkana	nootka rose	383
Sambucus racemosa	red elderberry	319
Dicentra formosa	bleeding heart	639
Fragaria vesca	wild strawberry	959
Maianthemum dilatatum	false lily of the valley	767
Polystichum minutum	sword fern	639
Tolmiea menziesii	piggy back plant	575
Vancouveria hexandra	inside out flower	582

Northern "B" area		Number
Acer circinatum	vine maple	9
Amelanchair alnifolia	serviceberry	24
Cornus stolinifera	red osier dogwood	60
Malus (Pyrus) fusca	pacific crabapple	3
Rhamnus purshiana	Cascara	9
Ribes lacustre	Black gooseberry	8
Rubus spectabilis	salmonberry	161
Rosa nutkana	nootka rose	38
Rubus parvifolus	thimbleberry	96
Sambucus racemosa	red elderberry	48
Tsuga heterophylla	western hemlock	12
Carex obnupta	slough sedge	193
Dicentra formosa	bleeding heart	64
Fragaria vesca	wild strawberry	96
Glyceria grandis	Reed mannagrass	242
Hydrophyllum tenupes (?)	pacific waterleaf	388
Polystichum minutum	sword fern	24
Tellima grandiflora	fringecup	193
Thalictrum occidentale	western meadowrue	193
Tolmiea menziesii	piggy back plant	129
Vancouveria hexandra	insideout flower	193

Southern "C" area		Number
Cornus stolinifera	red osier dogwood	5
Fraxinus latifolia	Oregon ash	1
Rosa pisocarpa	clustered wild rose	17
Ribes divaricatum	wild gooseberry	
Rubus spectabilis	salmonberry	86
Salix lucida (lasiandra)	pacific willow	11
Salix sitchensis	sitka willow	13
Thuja plicata	western red cedar	1
Tsuga heterophylla	western hemlock	1
Carex obnupta	slough sedge	259
Eleicharis palustris	common spikerush	259
Glyceria grandis	Reed mannagrass	259
Juncus acuminatus	tapered rush	259

Southern "B" area		Number
Acer circinatum	vine maple	4
Cornus stolinifera	red osier dogwood	23
Ribes lacustre	Black gooseberry	28
Ribes divaricatum	wild gooseberry	28
Rubus spectabilis	salmonberry	191
Rosa nutkana	nootka rose	92
Rubus parvifolus	thimbleberry	46
Salix sitchensis	sitka willow	3
Tsuga heterophylla	western hemlock	2
Carex obnupta	slough sedge	153
Glyceria grandis	Reed mannagrass	69

Hydrophyllum tenupes (?)	pacific waterleaf	388
Maianthemum dilatatum	false lily of the valley	153
Polystichum minutum	sword fern	57

"D" area		Number
Cornus stolinifera	red osier dogwood	58
Fraxinus latifolia	Oregon ash	2
Rubus spectabilis	salmonberry	116
Salix lucida (lasiandra)	pacific willow	14
Salix sitchensis	sitka willow	14
Symphocarpus Alba	snowberry	140
Thuja plicata	western red cedar	7
Tsuga heterophylla	western hemlock	7
Carex obnupta	slough sedge	875
Eleicharis palustris	common spikerush	350
Glyceria grandis	Reed mannagrass	350
Juncus acuminatus	tapered rush	350

"E" area		Number
Acer circinatum	vine maple	62
Salix lucida (lasiandra)	pacific willow	20
Maianthemum dilatatum	false lily of the valley	333
Polystichum minutum	sword fern	31

"F" area		Number
Symphocarpus alba	snowberry	10
Polystichum minutum	sword fern	6

Appendix 2: Species Information

Acer circinatum **Vine maple**
Exposure: partial shade to deep shade, full sun if ample soil moisture
Soil moisture: moist to dry
Transplanting success: high
Growth rate: moderate
Form: deciduous small tree or large shrub to 20 ft; moderately deep root system

Vine maple is relatively slow to establish, especially in the full sun, but it usually is a survivor. Provide mulch and/or irrigation for best results.

Alnus rubra **Red alder**
Exposure: full sun to light shade
Soil moisture: wet to moist
Transplanting success: medium
Growth rate: rapid
Form: deciduous tree to 90 feet; branching, fibrous, moderately deep root system with taproot

One of the best species for high-speed revegetation--alder will grow several feet a year, even in poor soil. Alder roots are associated with nitrogen-fixing bacteria that improve the soil. If there are mature red alder near the site, we suggest not planting alder because seedlings will usually move in on their own.

Amelanchier alnifolia **Serviceberry**
Exposure: full sun to shade
Soil moisture: moist to dry
Transplanting success: medium
Growth rate: moderate, may be slow to establish
Form: deciduous large shrub or small tree to 20 feet; tap root, may spread by suckers

Berries and foliage are favored by wildlife; it is common along woodland margins and is drought tolerant

Cornus sericea (stolonifera) **Red osier dogwood**
Exposure: full sun to partial shade
Soil moisture: saturated to moist
Transplanting success: high for container-grown, low or medium for live stakes
Growth rate: rapid
Form: deciduous large shrub or small tree, 5-20 feet depending on site conditions; fibrous, shallow root system, spreads by layering and suckers

Typically found in wet sites, in ditches or over-hanging water. It can tolerate fairly dry conditions if shaded or mulched. Fast growing, vigorous, and spreading. May not be a good choice for areas with hungry deer since we've seen it get chomped at our nursery. Red osier dogwood can be grown from live stakes and other cuttings with variable success; we've heard that installing them in shade or part shade gives the best results.

Corylus cornuta **Beaked hazelnut**
Exposure: sun to deep shade
Soil moisture: moist and well-drained to dry
Transplanting success: medium-high
Growth rate: moderate
Form: deciduous shrub 4-12 feet; branching, roots, suckers occasionally

This species grows on moist but well-drained soils, typically in shade to part sun. Can be transplanted into full sun if irrigation is provided during first few years. Nuts are coveted by wildlife.

Fraxinus latifolia **Oregon ash**
Exposure: full sun to partial shade
Soil moisture: wet to very moist; will tolerate standing water early in growing season
Transplanting success: high
Growth rate: rapid given adequate moisture
Form: deciduous tree to 80 feet; branching, moderately deep root system

We select this hardy, fast growing tree for plantings on flood plains and wet meadows. It is also found on the banks of lakes and streams on highly organic substrate. It prefers saturated soil, making it one of our wettest trees.

Gaultheria shallon **Salal**
Exposure: partial shade to deep shade
Soil moisture: moist to dry
Transplanting success: medium to high if shaded, low if not
Growth rate: slow until established
Form: evergreen shrub 2-5 feet, sometimes more; very shallow and fibrous root system, spreads vigorously by underground stems once well established

We've all seen salal growing in the full sun, but *transplanting* salal into full sun on bare mineral soil is a recipe for failure. It is not a pioneer species and suffers from severe transplant shock. If it survives, it generally takes at least a few years before its typical, rampant growth begins. For somewhat better results, plant into shade or partial shade and add woody mulch. It can survive full sun if irrigated and mulched, but growth is usually meager.

Holodiscus discolor **Oceanspray**
Exposure: full sun to shade
Soil moisture: moist to dry
Transplanting success: high
Growth rate: rapid
Form: deciduous large shrub to 12 feet; branching, fibrous, moderately deep root system, sometimes spreads by root suckers

Oceanspray tolerates a wide range of environmental conditions and generally does well on all but very wet or very hot and dry sites. It is widespread across the Puget Sound lowlands in habitats ranging from ocean bluffs to forest understory. Oceanspray can be a good choice for erosion control plantings.

Lonicera involucrata **Black twinberry**
Exposure: full sun to partial shade
Soil moisture: saturated to moist
Transplanting success: high
Growth rate: rapid
Form: deciduous shrub to 10 feet; branching, fibrous, shallow roots

This hardy species will grow like gangbusters in the right situation; with plentiful moisture it will put on several feet a year; it is less vigorous in drier spots, but tends to be a survivor. Berries are favored by birds.

Mahonia (Berberis) aquifolium **Tall Oregon grape**
Exposure: full sun to partial shade
Soil moisture: moist to dry
Transplanting success: medium to high
Growth rate: moderate
Form: evergreen shrub to 8 feet; moderately deep taproot, spreads by underground stems

Tall Oregon grape is typically found on rocky soil in the open sun or partial shade. It can suffer from transplant shock, but is very drought tolerant and may survive on sites that will not be irrigated. Birds love the berries.

Malus fusca **Western crabapple**
Exposure: full sun to shade
Soil moisture: wet to moist
Transplanting success: high
Growth rate: moderate to rapid
Form: deciduous tree or shrub up to 35 feet

Western crabapple provides excellent cover and food for wildlife. It has dense, thicket-like growth that deters predators and produces abundant crabapples. Twigs are also favored by browsing animals, so much so that you may need to use a deer-repellant or other protection to avoid losing young plants. Transplants are tolerant of a relatively wide range of soil and light conditions

Rhamnus purshiana **Cascara**
Exposure: full sun to shade
Soil moisture: wet to dry
Transplanting success: high
Growth rate: rapid
Form: deciduous tree to 30 feet; fibrous, moderately deep root system with taproot

Cascara transplants well, thrives in a range of conditions, and grows fairly quickly, making it useful for revegetation in a variety of situations. It is a small tree with relatively open growth and may be a good choice for slope plantings where view preservation is important. It is not a good species for sites with bad air quality as it is sensitive to pollution. Cascara is very common in western Washington, often mistaken for red alder--they look very similar when full-grown.

Ribes divaricatum **Straggly gooseberry**
Exposure: partial shade to shade
Soil moisture: wet to moist
Transplanting success: medium
Growth rate: moderate
Form: thorny, deciduous shrub to 8 feet; branching root system

Gooseberries are important for wildlife as hedgerows or individual plantings. The berries provide food and the dense, prickly growth is excellent cover. This species is also called wild gooseberry and wax currant (usually "currants" are thornless).

Ribes lacustra **Black gooseberry**

Exposure: partial shade to shade
Soil moisture: wet to moist
Transplanting success: medium
Growth rate: moderate
Form: thorny, deciduous shrub to 6 feet; branching root system

Similar to *R. divaricatum*. Thorns can cause an allergic reaction.

Ribes sanguineum **Red-flowering currant**
Exposure: sun to part shade
Soil moisture: dry
Transplanting success: medium
Growth rate: moderate
Form: deciduous shrub to 10 feet; branching root system

The trick with red-flowering currant is not *over* watering, as it is susceptible to root rot. Make sure it is planted in well-drained soil and do not irrigate unless the soil is very dry. This species is scattered in many dry habitats throughout western Washington; it is widely planted for its sun and drought tolerance and its

ornamental qualities. The flowers are magnets for hummingbirds, and the fruit food for many other birds and mammals.

Rosa nutkana **Nootka rose**
Exposure: full sun to partial shade
Soil moisture: wet to moist, dry okay if shaded
Transplanting success: high
Growth rate: rapid
Form: deciduous shrub to 10 feet; branched, fibrous, shallow roots, spreads vigorously by suckers

Nootka rose is a workhorse of a plant. It is successful in a range of sun and moisture conditions and spreads easily. We have monitored harsh restoration sites where Nootka rose was not only surviving but spreading. It is also one of the few species that can compete with Himalaya blackberry. Nootka rose likes it wetter than bald-hip rose but not as wet as swamp rose.

Rosa pisocarpa **Swamp rose**
Exposure: full sun to partial shade
Soil moisture: saturated to moist
Transplanting success: high
Growth rate: rapid
Form: deciduous shrub to 8 feet; branched root system, spreads vigorously by suckers

In wet soils, swamp rose grows quickly and spreads to create thickets, even holding its own against the aggressive Douglas spirea. It transplants well and is one of the most dependable plants for wetland revegetation. It prefers the wettest conditions of our three native roses. It will do okay in merely moist soils as long as they don't dry up entirely during the summer.

Rubus parviflorus **Thimbleberry**

Exposure: full sun to shade
Soil moisture: moist
Transplanting success: high
Growth rate: rapid
Form: deciduous shrub 3-8 feet; spreads vigorously by suckers

This common species grows very well planted into moist soils--it quickly becomes established, spreading to form thickets. It also can do well in relatively dry soil if initial irrigation, shade, or mulch is provided. Wet soils are fine, if well drained. Thimbleberry is often a good choice for erosion control plantings, since it is drought tolerant and spreads by underground stems. We have found this species to be a good survivor!

Rubus spectabilis **Salmonberry**
Exposure: partial shade to shade
Soil moisture: wet to moist
Transplanting success: medium to high
Growth rate: moderate to rapid
Form: deciduous shrub to 12 feet; fibrous shallow roots, spreads by suckers

Salmonberry is a frequent choice for mitigation sites, but some practioners have reported high mortality. This may be due to droughty conditions that salmonberry seedlings cannot tolerate. In our experience, given adequate moisture or shade during establishment, this species grows vigorously and spreads to form thickets. May be planted in full sun if soil remains moist through the summer.

Salix lucida (lasiandra) **Pacific willow**
Exposure: full sun to partial shade
Soil moisture: saturated to moist
Transplanting success: high (both container-grown & live stakes)

Growth rate: rapid
Form: multi-stemmed deciduous tree to 60 feet; fibrous, moderately deep and widespread root system

Pacific willow is the tallest of the native willows. Given ample moisture, it grows abundantly and can quickly become established to anchor soil at the base of a slope. Pacific willow grows very well from cuttings, although the wood is somewhat brittle and live stakes may split if pounded vigorously.

Salix sitchensis **Sitka willow**
Exposure: full sun to partial shade
Soil moisture: saturated to moist
Transplanting success: high (both container-grown & live stakes)
Growth rate: rapid
Form: deciduous shrub to 25 feet; fibrous, moderately deep and widespread roots

Sitka is the most common native willow in south Sound wetlands. This species is a shrubby willow, but can still attain heights of twenty-five feet or more. To maintain a view, you can cut them down by half their height without significant harm to the plants. Sitka willow is our favorite choice for live stakes, because it has a very high success rate and the wood stays sound when pounded with a mallet.

Symphoricarpos albus **Snowberry**
Exposure: full sun to shade
Soil moisture: very moist to dry
Transplanting success: high
Growth rate: rapid
Form: deciduous shrub to 2-6 feet; fibrous, shallow root system, spreads vigorously by suckers

Snowberry is an incredible survivor, flourishing in situations that would slay a lesser plant. It transplants well, tolerates sun or shade, withstands drought and/or occasional flooding, and spreads quickly even in poor soil or on steep hillsides. Another plus for snowberry is that it is one of the few native shrubs that stays small--it averages three or four feet tall--and thus is a good choice for areas where view corridors are important. Hooray snowberry!

Thuja plicata **Western red cedar**
Exposure: partial shade to deep shade
Soil moisture: wet to moist, tolerates seasonal flooding
Transplanting success: medium
Growth rate: moderate
Form: coniferous evergreen tree to 200 feet with buttressed base; shallow, widely spreading root system

Western red cedar does not do well planted in open sites; the foliage sunburns easily and transplants often do not survive. With mulch and ample moisture, success in the sun will be higher, but this species is better suited to shady, nutrient rich sites. If the site is somewhat dry, provide mulch and shade. If the site is wet, plant the cedar where it will not be saturated during the growing season

Tsuga heterophylla **Western hemlock**
Exposure: partial shade to deep shade
Soil moisture: wet to moist
Transplanting success: medium
Growth rate: moderate
Form: coniferous evergreen tree to 200 feet; shallow, slow-growing roots becoming wide-spread

Like western red cedar, western hemlock transplants best into shaded sites; seedlings are often dried up by sun. This species is not tolerant of drought after transplanting, but will accept a fairly wide range of soil moisture if mulch and/or shade are available. At the nursery, we have seen best root growth with very low levels of fertilization

Carex obnupta **Slough sedge**
Exposure: full sun to shade
Soil moisture: moist to wet
Transplanting success: high
Growth rate: rapid
Form: dense tufts to 60 inches on long, fleshy rhizomes

Slough sedge is the superstar of emergent revegetation. It transplants very well, grows and spreads quickly, tolerates wide seasonal water level fluctuations, and is one of the few shade-tolerant sedges. If project conditions are at all suitable, it will perform impressively. It is one of our most competitive emergents against invasive species; established swards may resist even reed canarygrass. Slough sedge is very common and is found in wet woods, ditches, meadows, lakeshores, streambanks, and marshes.

Eleocharis palustris **Common spikerush**
Exposure: full sun
Soil moisture: wet to shallow water
Transplanting success: medium
Growth rate: unknown
Form: small clusters to 40 inches along rhizomes

Common spikerush is found in wet meadows, tidal marshes, and shorelines. It can spend much of the year in shallow water, but needs to dry out for at least a few months during the growing season. Tolerates some salt water.

Juncus acuminatus **Tapered rush**
Exposure: full sun
Soil moisture: wet to shallow water
Transplanting success: high
Growth rate: medium to rapid
Form: mostly tufted to 30 inches, sometimes with short rhizomes and in dense mats

Tapered rush prefers to be wet throughout the year, frequenting the shallow water of lakeshores, ditches, meadows, and marshes. This species matures quickly and produces prolific seeds that may aid in your revegetation efforts

Dicentra formosa **Bleeding heart**
Exposure: partial shade to shade
Soil moisture: moist, dry in shade okay
Transplanting success: high
Growth rate: rapid
Form: soft herbaceous perennial to 20 inches, from slender, fleshy rhizomes

Bleeding heart needs soil rich in organic matter to really shine--given moist , fluffy soil, this plant will spread rapidly. In poorer soil, bleeding heart will do reasonably well, as long as it is protected from the sun. Bleeding heart can provide food and nectar for wildlife.

Fragaria vesca **Woodland strawberry**
Exposure: full sun to shade
Soil moisture: moist
Transplanting success: high
Growth rate: rapid
Form: herbaceous perennial to 12 inches, spreads by runners

Woodland strawberry will accept a fairly wide range of soil and light conditions, from dry soil in shaded areas to moist soil in the open sun. It spreads very quickly, and if the soil is rich, it will grow lushly to provide good cover and weed competition. Fruit is eaten by birds and small mammals (and humans if they're quick enough).

Hydrophyllum tenuipes **Pacific waterleaf**
Exposure: partial shade to shade
Soil moisture: moist
Transplanting success: high
Growth rate: moderate to rapid
Form: herbaceous perennial to 30 inches, from short, thick rhizome and fleshy roots

Waterleaf is common in moist, open forests in the lowlands. We have seen it spread copiously, once established. This species must be planted in shade and will benefit from light organic mulching (not more than an inch).

Maianthemum dilatatum **False lily-of-the-valley**
Exposure: partial shade to shade
Soil moisture: moist, dry in shade okay
Transplanting success: high
Growth rate: rapid
Form: herbaceous perennial (somewhat evergreen) to 12 inches, from slender, branching rhizomes

False lily-of-the-valley does not like being in a pot, but once released into the soil, it spreads abundantly. For best results, with this species and many other native perennials, plant in at least partial shade and top-dress lightly with organic mulch.

Polystichum munitum **Sword fern**
Exposure: partial shade to shade
Soil moisture: moist to dry
Transplanting success: high
Growth rate: moderate
Form: evergreen fern with fronds to 5 feet, woody rhizomes

We often see sword fern planted in full sun, but transplants usually don't survive in the open unless there is ample soil moisture. However, with suitable conditions this plant will thrive with little or no care after planting; it is highly successful when planted in partial or full shade and mulched. Sword fern is also tough and competitive against invasive species once established.

Tellima grandiflora **Fringecup**
Exposure: partial shade to shade
Soil moisture: moist
Transplanting success: high
Growth rate: moderate
Form: herbaceous perennial to 30 inches, with short rhizomes

One of our customers says that this is the toughest flowering upland herb he knows: it competes with invasive species and tolerates disturbed soil and drought. For best results in full sun, provide an inch of mulch and some irrigation. This species transplants well and spreads well from seed.

Thalictrum occidentale **Western meadowrue**
Exposure: full sun to shade
Soil moisture: moist
Transplanting success: high
Growth rate: rapid
Form: herbaceous perennial to 2 feet, from fleshy rhizomes, separate male and female plants

Our native meadowrue grows and spreads vigorously in fluffy, rich soil, but it also will tolerate less ideal soil as long as some moisture and an inch of mulch are available through the summer.

Tolmiea menziesii **Piggyback plant**
Exposure: partial shade to shade

Soil moisture: moist to wet
Transplanting success: high
Growth rate: rapid
Form: herbaceous perennial to 30 inches, well-developed rhizomes

Piggyback plant is very common along streamsides, wetland edges, and moist forests. It requires plentiful moisture and some shade. Given these conditions, it can establish itself quickly and spread.

Vancouveria hexandra **Inside-out flower**
Exposure: partial shade to shade
Soil moisture: moist
Transplanting success: high
Growth rate: moderate
Form: herbaceous perennial to 10 inches, from rhizomes

Inside-out flower spreads extensively in fertile, mature soils. We advise planting it in at least partial shade and, if soils are poor in organic matter, mulching lightly with wood chips.

All plant descriptions courtesy of soundnatives.com except description of Ribes lacustre

Appendix 3: Budget

Plant Budget

Almost all plants should be available through Sound Natives Nursery (http://soundnativeplants.com/index.htm), any others can be supplemented from Woodbrook Nursery (http://www.woodbrook.net/) at varying costs (prices below are from Sound Native) *Delivery from Sound Native Nursery in Olympia is around $80 per delivery

Latin Name	Quantity	Price per Unit	Total
Acer circinatum	86	$3.00	$258.00
Amelanchair alnifolia	148	$3.00	$444.00
Carex obnupta	1790	$0.75	$1,342.50
Cornus stolinifera	278	$2.75	$764.50
Corylus cornata	413	$3.25	$1,342.25
Dicentra formosa	1285	$1.25	$1,606.25
Eleicharis palustris	919	$0.75	$689.25
Fragaria vesca	1288	$1.50	$1,932.00
Fraxinus latifolia	6	$3.00	$18.00
Gaultheria shalon	604	$3.50	$2,114.00
Glyceria grandis	1230	$0.75	$922.50
Holodiscus discolor	153	$3.00	$459.00
Hydrophyllum tenupes	776	$1.50	$1,164.00
Juncus acuminatus	1229	$0.75	$921.75
Mahonia aquifolium	198	$3.00	$594.00
Maianthemum dilatatum	1447	$1.75	$2,532.25
Malus (Pyrus) fusca	3	$3.00	$9.00
Polystichum minutum	757	$3.00	$2,271.00
Rhamnus purshiana	37	$2.75	$101.75
Ribes divaricatum	28	$3.00	$84.00
Ribes lacustre	1111	$5.50	$6,110.50
Ribes sanguinium	194	$4.00	$776.00
Rosa nutkana	513	$3.00	$1,539.00
Rosa pisocarpa	141	$3.00	$423.00
Rubus parvifolus	142	$2.75	$390.50
Rubus spectabilis	554	$3.00	$1,662.00
Salix lucida (lasiandra)	50	$2.75	$137.50
Salix sitchensis	61	$2.75	$167.75
Sambucus racemosa	367	$3.00	$1,101.00
Symphocarpus alba	305	$2.75	$838.75
Tellima grandiflora	193	$1.50	$289.50
Thalictrum occidentale	367	$1.50	$550.50
Thuja plicata	8	$3.00	$24.00
Tolmiea menziesii	1286	$1.25	$1,607.50
Tsuga heterophylla	22	$3.00	$66.00
Vancouveria hexandra	775	$1.50	$1,162.50

Total	**$36,416.00**

Site Prep Budget
Ammonium Sulfate 1 bag (50 lb) $3.58
Mulch: Mulch should be acquired for free from the city.

Trail Budget
Because our trail analysis was a recommendation only and another entity will be administering this portion of the project, no budget was created for the trail or grading.

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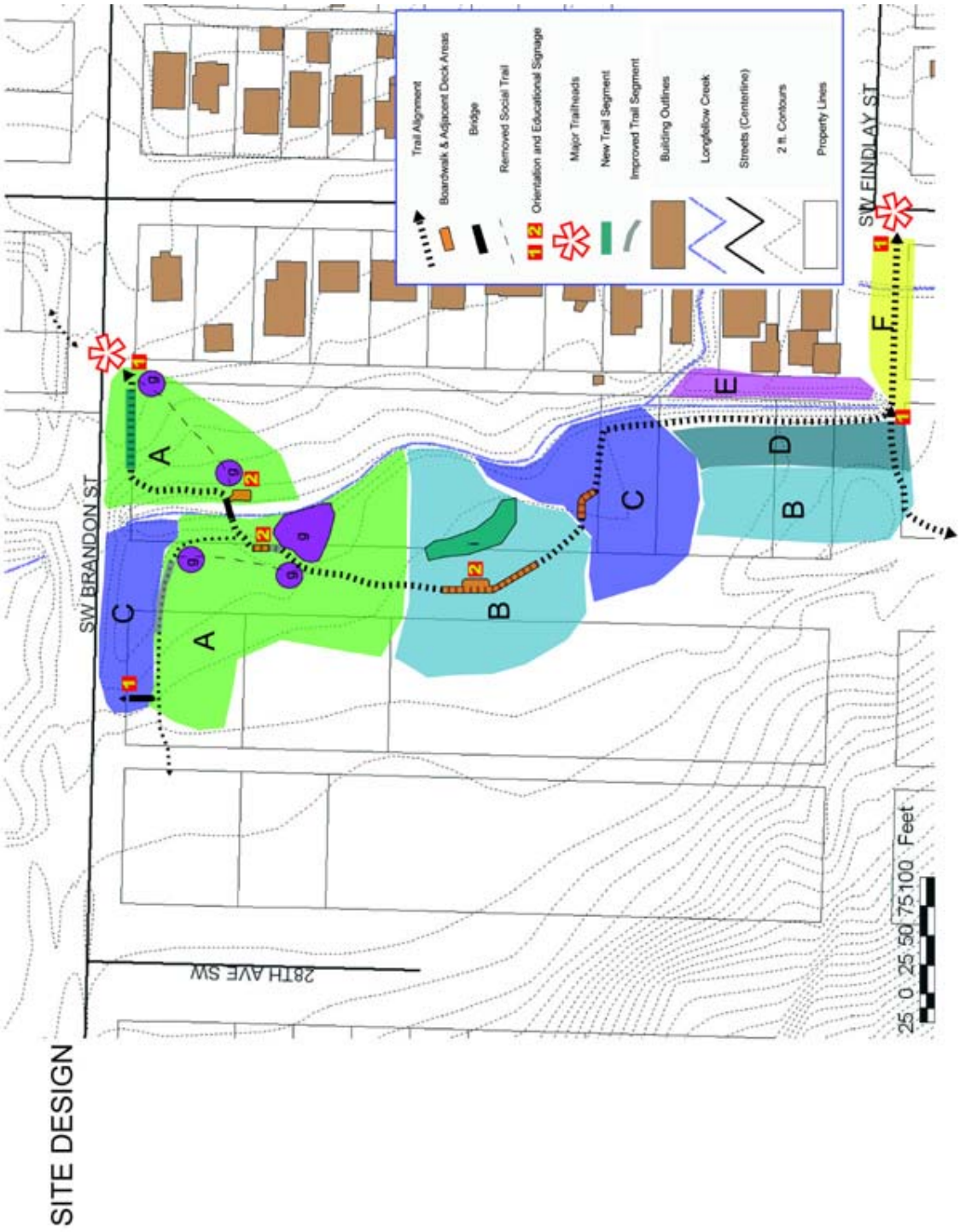
Appendix 4: Site Design Graphic



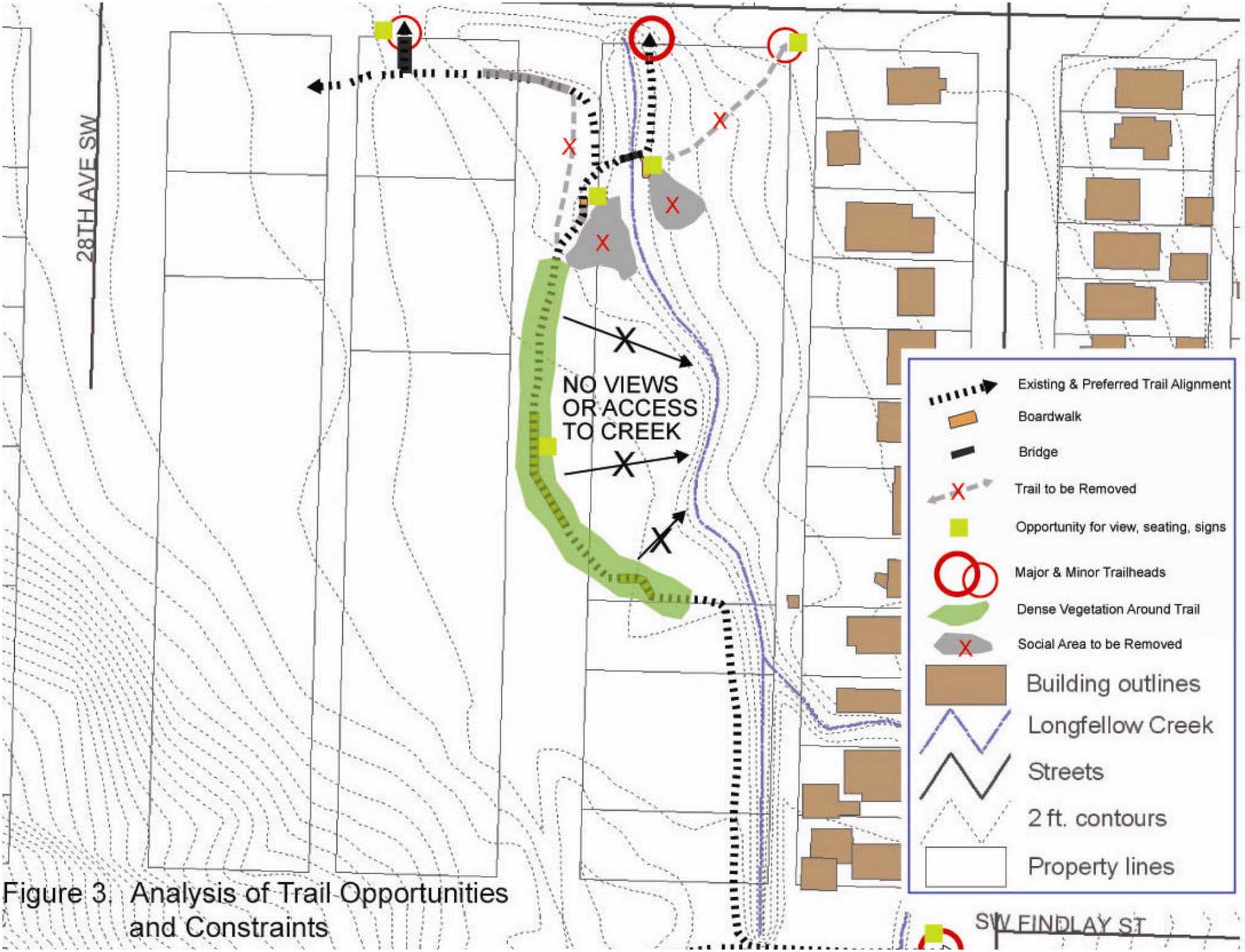
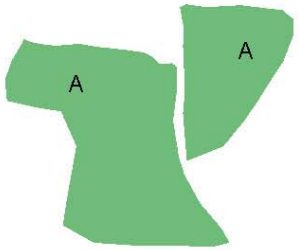


Figure 3. Analysis of Trail Opportunities and Constraints

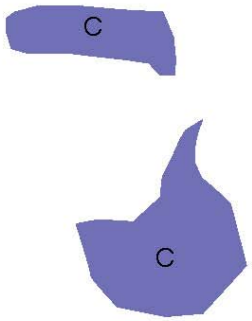
DESCRIPTIONS OF PLANTING AREAS

Based on Hydrology, soil conditions, and light availability on the site, the following areas A through I, will be planted with different palletes



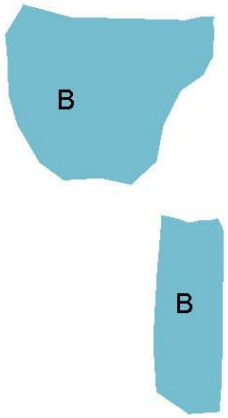
A:

This area consists of upland understory plantings, responding to relatively well-draining acidic soils. Plants for this area include beaked hazelnut (*Corylus cornuta*), Oregon grape (*Mahonia aquilifolium*), nootka rose (Rosa nutkana).



C:

This area consists of understory plants that prefer year-round saturated soil conditions. Plants for this area include salmonberry (*Rubus spectabilis*), Oregon ash (*Fraxinus latifolia*), Slough sedge (*Carex obnupta*) and black twinberry (*Lonicera involucruta*).



B:

This area consists of plants that prefer moist to saturated understory conditions. Higher clay content in the soils retains more moisture while providing a rich source of nutrients. Plants for this area include red osier dogwood (*Cornus sericea*) and bleeding heart (*Dicentra formosa*).

D:

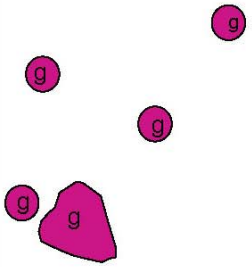
This area consists of plantings that prefer moist conditions and thrive in full sunlight. Plants for this area include reed mannagrass (*Glyceria grandis*),Slough sedge (*Carex obnupta*), and red osier dogwood (*Cornus sericea*).

DESCRIPTIONS OF PLANTING AREAS (continued)

Based on Hydrology, soil conditions, and light availability on the site, the following areas A through I, will be planted with different palletes

E:

This area consists of compacted fill soils that lie adjacent to Longfellow Creek. To provide privacy screening for nearby residences, plants for this area include vine maple (*Acer circinatum*) and pacific willow (*Salix lucida*).



G:

This area consists of disturbed soils in the vicinity of social trails and hangouts. To reduce compaction and human access, plants for this area include Oregon grape (*Mahonia aquifolium*), and nootka rose (*Rosa nutkana*).

F:

This area consists of compacted fill soils that provide trailhead access. Plants for this area include snowberry (*Symphocarpos alba*) and sword fern (*Polystichum munitum*).

I:

This area consists of disturbed soils with little canopy cover and full sun exposure. To provide pleasant plantings for trailside benches while prevent access, plants for this area include vine maple (*Acer circinatum*), Oregon grape (*Mahonia aquifolium*), and nootka rose (*Rosa nutkana*).

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