Cotton Hill Park

Final Report

University of Washington Restoration Ecology Network Capstone Course 2008-2009

Location:
110th Ave NE & NE 98th Street
Kirkland, WA 98033
NW ¼ of NE ¼, Section 5, Township 25N, Range 5W.

Clients:
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Karen Story, Highlands Neighborhood Association

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Section 1: Project Summary

1.1: Project Overview

This document summarizes and explains the restoration project completed at Cotton Hill Park within Kirkland, Washington. The project was conducted for Sharon Rodman and the City of Kirkland Parks and Community Services, as well as Karen Story and the Highlands Neighborhood Association. The project was conducted from September 2008-June 2009 by six University of Washington Restoration Ecology Network Capstone students.

This project was the pioneer restoration project within Cotton Hill Park. In accordance with the goals of the Green Kirkland Partnership (the City of Kirkland and the Nature Conservancy), the ultimate goal was to increase community stewardship, leading to the eventual ecological restoration of the entire park.

Cotton Hill Park is an undeveloped, 4.1 acre natural area, located within the Forbes Creek Watershed in Kirkland. The park is bordered on three sides (north, east, south) by residential housing. Along the western edge of the park there is a railroad track, which will eventually be converted to a walking trail. Due to the extent of urbanization, and logging of Kirkland in the early 1900's, Cotton Hill Park is fragmented from other natural areas and is dominated by invasive plant species. Within the park itself, there are two main public access trails that were constructed by the local community. One is a raised gravel path beginning at the south entrance of the park and running north up the center of the park, through the forested wetland. This trail meets another gravel trail that runs east to west approximately 15 meters from the northern border of the park. The east-west trail starts at the east edge of the park, runs down a staircase on the east hill, by a wetland on the north side of the trail, and continues to the west end of the park

Figure 1: *Site conditions before restoration: high level of invasive species, suppressed native species, and limited wildlife habitat. October 20, 2008.*

Figure 2*: Site conditions after: invasives removed, mulch installed, native plants, and woody debris. June 5, 2009.*

1.2: Pre-restoration Site Conditions

The 2008-2009 restoration site that was selected is near the northern edge of the park, at the junction of the east-west and north-south paths, and lies to the south and east of them. Since the site is bordered on the west and north sides by the paths, it is highly visible to the public. The site is fairly large, and it covers approximately 6500 ft^2. The topography is fairly level, but has a slight upward slope of about 10-15% on the eastern edge where it meets the base of the eastern hill slope. Due to the slight grade, down by the north-south path, the ground is lower and water accumulates at the base of the raised gravel path.

In addition, the site was dominated by well-established invasive species, occupying about 75%-85% groundcover; predominantly *Rubus armeniacus* (Himalayan blackberry), *Hedera helix* (English ivy), *Phalaris arundinacea* (reed canary grass), *Ranunculus repens* (creeping buttercup), *Geranium robertianum* (herb Robert), and a concentrated patch of *Polygonum cuspidatum* (Japanese knotweed). Existing canopy cover was approximately 45-50%, consisting of *Alnus rubra* (red alder), *Populus balsamifera* (black cottonwood), *Acer macrophyllum* (big-leaf maple), and *Rubus spectabilis* (salmonberry). Throughout the site, thick patches of *R. armeniacus* were dominant, with 1-2 meters tall thickets, especially along the eastern edge of the site where it blanketed the understory and inhibited the successional emergence of native species. *H. helix* was also well established in some areas, growing vigorously on dead *A. rubra*, hastening canopy decline.

One of the most significant disturbances within the site is the storm-water runoff coming down Cotton Hill Park's east hill, especially because the site lies at the base of the steepest part, below where an erosion trench exists. Due to the urban residential surroundings, the storm-water may contain chemical and biological contaminants associated with landscaping and pet waste. Off-leash dogs are also a frequent problem within the park; dogs that run through the forested areas and stray from the path deposit excrement within the site, which negatively impacts wildlife, plants, and especially water sources through increased levels of fecal coliform.

1.3: Reference Ecosystem

The site chosen for reference was Bridle Trails State Park within Kirkland, WA. This park is a few miles south of Cotton Hill Park, and has a very similar ecology, that of a forested wetland in an urban area. Bridle Trails is 400x the size of Cotton Hill, and there are many places within the park that are wetlands with canopy gaps, emerging understory vegetation, and ample wildlife habitat (Bridle Trails Park Foundation). Bridle Trails is primarily a conifer dominated forest, but also has numerous interspersed deciduous trees (most notably *A. macrophyllum*). Bridle Trails currently resembles what Cotton Hill Park will probably look like in 50 years.

1.4: Project Goals

The ultimate goal of the project was to reinstate the successional emergence of a mixed conifer-deciduous forest, with a relatively diverse understory and increased wildlife habitat. In response to the prevalence of invasive species, sparse canopy cover, and lack of wildlife habitat we established four main project goals.

Project Goals:

1. To promote forest succession and dominance of appropriate native vegetation by installing conifers, deciduous trees, and a wide variety of understory species.

2. To increase and create hospitable conditions for native amphibians on site.

3. To improve habitat for native birds by planting overwintering fruit species and increasing the amount of snags onsite.

4. To promote ecological education and long term stewardship through community involvement in the restoration project.

1.5: Approaches

The first goal was to enhance the stability and diversity of the native, lowland Puget Sound riparian forest. To begin, we assessed the site and subsequently manually removed the invasive plant species present within the site boundary, including *R. armeniacus*, *H. helix, P. arundinacea*, and *R. repens*. To help control and suppress the re-growth of invasive plants, we used a 4-6" layer of arborist mulch over the entire site. This phase was very labor intensive, but we were able to get it completed efficiently and quickly with the help and effort of enthusiastic community volunteers. Unfortunately, there is a large stand of *P. cuspidatum* in the middle of the site, which cannot be effectively controlled by physical removal due to hardy, underground rhizomatous roots. We collaborated with the Kirkland Parks Department, and formulated a maintenance plan to use herbicide to attempt to eradicate the *P. cuspidatum*, which may take several years. The Parks Department will use a 2% solution of glyphosate, an herbicide that has been proven effective in controlling *P. cuspidatum* over an extended period of time (IPSAWG 2006). Glyphosate was chosen because it is effective, is not toxic to animals when a low dose is used, it binds to the soil so it does not leech into water, and it has an average half life of 47 days (EXTOXNET 1996).

After invasive removal and mulching, we installed native plants based upon specific criteria: we installed conifers per the clients request; deciduous trees that would grow fast and shade out the invasive species; any fruiting shrubs we planted could not be poisonous due to the kids who walk through the park daily; and all the plants had to have fairly high wet-tolerance since our site receives a lot of water. The conifers posed a challenge because they are quite wet-intolerant and our site is saturated during winter months. We built hummocks to facilitate the growth of conifers, including *Pseudotsuga menziesii* (Douglas-fir), *Tsuga heterophylla* (western hemlock), Thuja *plicata* (western red cedar) and *Picea sitchensis* (Sitka spruce) (Pojar & MacKinnon 2004). Hummocks are used to create a drier microclimate and increase growth and survival rates for conifers, aiding in their establishment within wetland microenvironments and ecosystems. We made the hummocks by forming a triangular base out of woody debris on site, staking them together, and filling them with soil from the vernal pool we dug and some additional topsoil we received from the Parks Department. We made three hummocks; one large 3 feet by 5 feet, and two smaller hummocks about 3 feet by 2 feet. After the trees were planted, mulch was put on top of the hummocks to help stabilize the soil, retain moisture, and provide nutrients.

The second goal was to build and improve amphibian habitat to attract frogs, newts, and salamanders. This goal also posed a problem because even though our site is very wet, it is flat and has minimal amphibian habitat features (i.e. snags, rocks, hibernation habitat, feeding, etc). There is a large vernal pool fifteen feet south of our site, which provides substantial water habitat for amphibians. However, the vernal pool is dominated by *P. arundinacea*, which reduces the availability of nutrients and food. We created a corridor between our site and the vernal pool by placing woody debris and rocks to provide protection for amphibians along the migration route. We also dug a four by seven foot hole on the wettest portion of the site with the hopes of creating an additional water source. The hole began to fill with water immediately after we dug it and is now completely full; it will be surprising if a lot of water remains in it at the end of summer because it is the nature of vernal pools to have annual variation in water volume. The large vernal pool south of the site usually dries up and decreases drastically in size by the end of summer. We have high hopes for the increase of amphibian life on our site and the park as a whole; we can already hear a few frogs croaking in the nearby vernal pool and have found a couple *Ambystoma macrodactylum* (long-toed salamanders) on our site.

The third goal was to improve the quantity and quality of bird habitat. There are a few birds that can be heard within the entire park itself, yet there is limited bird nesting habitat and food sources on the site. We created snag trees by using a post-hole digger to dig holes, in which we installed 5-10 foot tall dead trees (woody debris from on site) for bird perches. We also planted species that will grow tall to provide additional perches, including *T. plicata* and *P. sitchensis*. We planted many native species with summer and overwintering fruit so that birds would have food available year round. Overwintering fruit species include *Pyrus fusca* (Pacific crab apple), *Symphoricarpos albus* (snowberry), and *Rosa nutkana* (Nootka rose). Summer fruiting species include *Oemleria cerasiformis* (Indian plum), *Crataegus douglasii* (black hawthorn), *Gaultheria shallon* (salal), and *Frangula purshiana* (cascara) (Pojar & MacKinnon 2004).

The fourth goal was to promote ecological education, community volunteering, and continued stewardship of both our restoration site and Cotton Hill Park as a whole. To accomplish this goal, at every work party we would have a brief introduction to educate volunteers about the ecological significance of native plant communities and basic restoration methods. A majority of the volunteers were very interested in the concept of restoration and asked many questions about the negative impacts of invasive species. It was encouraging to work with volunteers who not only gave their time, but who truly cared and wanted to learn about the practice of restoration ecology.

1.6: Major Accomplishments

- Removed 75 cubic yards of invasive plant biomass
- Installed approximately 371 native plants
- Put down 100 cubic yards of mulch
- Created a vernal pool for amphibian habitat
- Created three hummocks to facilitate conifer growth
- Hosted numerous work parties
    - Had 35 volunteers on December 7, 2008
    - Had 65 volunteers show up on Martin Luther King Jr. Day 2009
- Wrote maintenance plan for entire site
    - Includes herbicide treatment for *P. cuspidatum*
- Interviewed and broadcasted on KIRO 7 News (January 19, 2009)

1.7: Team Contact Information

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Figure 3*: The restoration team and clients at the UW REN Poster Symposium, UW Seattle Campus. Front row, L-R: Karen Story, Sharon Rodman. Back row L-R: Josh Jackson, Marian Hanson, Robyn Mushkin, Kelley Govan, Kinsey Burke, and Reed Keagle. June 4, 2009.*

1.8: Acknowledgments

First of all, we would like to thank our dedicated, hard working volunteers, who helped make this project possible. We would also like to thank our clients, Sharon Rodman and the City of Kirkland for providing us with this great restoration project. Thank you to Karen Story of the Highlands Neighborhood Association, for helping recruit and organize people for volunteer work parties. Also, Collins Klemm and his crew, who provided us with a continual supply of mulch and took away vast amounts of removed plant biomass.

We greatly appreciate the expertise and guidance of the UW REN professors, Kern Ewing, Jim Fridley, Warren Gold, and John Banks. Special thanks to Rodney Pond, the most helpful TA and exemplary source of input; his patience and extensive knowledge truly made this project possible.

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Section 2: As-Built Report

2.1: Tasks and Approaches

Goal 1*: Enhance the stability and diversity of the native wet to mesic, lowland Puget Sound, riparian forest located within Cotton Hill Park.*

Objective 1-1: Remove and suppress invasive plant species to allow establishment and growth of native tree, shrub, and groundcover species.

Task 1-1a: Remove all *R. armeniacus* above and below ground biomass.

Approach: Make sure thick gloves and long sleeves are used in *R. armeniacus* removal to protect skin. Trim above-ground biomass until stems are approximately 12" long, this will enable easier identification for root wad removal. Then use shovels, hoes, or other tools to grub out and remove all root crowns and underground runners to decrease re-growth. Remove plant material from site and pile up in on-site compost pile. (Soll 2004).

AD1: The team decided against creating an on-site compost pile over concerns the pile would be an eyesore to park visitors. Instead, a debris area was designated near the mulch pile for Parks Department pick-up.

Task 1-1b: Remove all *H. helix* above and below ground biomass.

Approach: Cut *H. helix* stems where they have grown over trees, and remove root wads, underground runners, and any offshoots on, under, and near the ground. Leave the post-cut foliage on the trees to die (can remove later to increase tree health). *H. helix* vines and leaves can be wound up (like a cable), making it easier to tell where the below-ground roots are. Make sure ALL *H. helix* plant material is removed from the site and discarded correctly; add to plant material pile for Parks Department to remove. (Reichard 2008 Nov 4).

Task 1-1c: Remove all aboveground *P. arundinacea* biomass.

Approach: *P. arundinacea* should be hand pulled to remove the aboveground biomass. Cardboard should be placed on top of the soil, and 4-6" of arborist's mulch placed on top of the cardboard to better suppress re-growth. Small trees and shrubs (that are wet-tolerant) will

later be planted directly through 'existing' patches of *P. arundinacea* to provide more of a deterrent to re-growth. (Reichard 2008 Nov 4).

AD2: The team decided against placing a cardboard layer under the mulch since reed canary grass density is low in this area, and the threat of re-invasion is low due to shady conditions. Eliminating the cardboard layer will also allow the native seed bank to emerge.

Task 1-1d: Cordon off *P.cuspidatum* stand for late summer stem-injection by City of Kirkland.

Approach: It is critical nobody enters the *P. cuspidatum* patch because in order for the Parks Department to effectively kill it with herbicides (25% glyphosate solution), the stems must have a chance to grow, and the stems have to be cut immediately before application of herbicide. Use wooden stakes and rope (or excess ivy vines) to clearly delineate where people should not go. Monitor during volunteer events to make sure everyone understands not to go in there. Invasive removal of *R. armeniacus* and *H. helix* on the edges should be conducted by UW REN students only. (Reichard 2008 Nov 6).

Task 1-1e: Cover and condition soils with arborist mulch for invasive control areas after removal.

Approach: Ensure all invasive plant material is fully removed from the soil before mulch is applied. Cardboard only needs to be installed over *P. arundinacea* patches since root mass will not be removed. Arborist mulch should be transported in wheelbarrows from the mulch pile to the site along the north to south path. Mulch should be applied evenly over the entire site, 4-6" deep.

See AD2.

Task 1-1f: Develop invasive control guidelines for client and volunteers.

Approach: Research the best management practices for each invasive plant species, for both removal and post-restoration monitoring and maintenance. Be prepared for any questions clients or volunteers may have about: the different ecological impacts each invasive species has, their methods of spread, and also how control methods are chosen and how plants are prioritized for control. Educate volunteers on work party days to ensure safety and correct removal of invasive plants. Before each work party, create an outline of things to address that day; for example,

for blackberry removal, go over safety and methods with the volunteers and then supervise them to ensure everything is going smoothly.

Objective 1-2: Install site-appropriate native conifers that will eventually replace short-lived deciduous canopy species.

Task 1-2a: Build hummocks in wet areas to create more ideal planting conditions for conifers (Polygons 2&3, Figure 4).

Approach: Research successful implementation of hummocks and model the construction after those. All construction will be completed by UW REN students, yet volunteers can be educated on the details and purpose of hummocks. In wetland areas hummocks are natural formations that rise above surrounding areas, resembling small mounds. In restoration, hummocks are used to create a drier microclimate that facilitates conifer establishment within wetland microenvironments and ecosystems. The woody-debris on site can be used to create the hummock base by engineering the wood to form a base (either triangular or square), which should be staked to secure. Coir logs can be used to form a circular base (called a Renfrow Hummock), but the type of hummock built depends on available material. The hummock will be filled with a mixture of compost material and sandy soil. Then appropriate species will be planted in the hummocks, with a layer of arborist mulch on top (3-5”), which gives nutrients to the seedlings and helps to retain water. (Earthcorps 2003).

AD3: Hummocks were also installed in the dryer polygon 3 to provide a variation of conditions for trees in that area as well. This was decided by the team upon consultation with instructors.

Task 1-2b: Plant *T. plicata* in moist, shady areas.

Approach: Plant after invasive plants have been removed and 4-6” of mulch has been laid out. To plant bare-root trees in mulch, clear a 12-15” diameter hole in the mulch down to the soil. Dig 8-10” deep (enough to adequately cover the roots). Then gently place tree in hole and cover and ‘hug’ with soil. Replace mulch around base of tree at a slightly sloped angle with less towards the base of the tree, and leave a 1” gap around trunk to allow more water to get to tree. (Powell 1996). *T. plicata* should be installed in polygons 2 & 3.

AD4: *T. Plicata* was also planted in the largest hummock in polygon 2b because the team felt it would do well in the open canopy of that location.

Task 1-2c: Plant *P. sitchensis* and *P. menziesii* on hummocks located in moist and sunny areas of polygons 2 & 3.

Approach: See approach for Task 1-2a. The hummock should be 6-18" tall, leaning towards the taller side to account for soil settling and hummock sinking.

Task 1-2d: Plant *T. heterophylla* on hummocks in partly shaded areas of polygons 2 & 3.

Approach: See approach for Task 1-2b.

Objective 1-3: Install native shrubs and herbaceous perennial groundcovers to replace the invasive plant species

Task 1-3a: Plant the shrubs *Gaultheria shallon* (salal), *Aruncus diocius* (goat's beard), *Oemleria cerasiformis* (Indian plum), *Physocarpus capitatus* (Pacific ninebark), *Frangula purshiana* (cascara), *Lonicera involucrata* (black twinberry), *Acer circinatum* (vine maple), *Vaccinum parvifolium* (red huckleberry), *Symphoricarpos albus (snowberry),* and *Rubus parviflorus (thimbleberry)* in polygon 2.

Approach: Plants should be installed after invasive plant removal is complete and mulch has been applied on the site. Plants should be spaced far enough away from each other to reduce competition between native species; however, the plants will be young enough to tolerate some initial clumping and overplanting. Also, more shrubs should be planted than are actually desired in order to establish early shade for invasives competition and to account for plant mortality.

AD4: *A. diocius* was not planted as this was meant to replace the knotweed after removal. Since the knotweed will not be removed until late summer, A. diocius could not be planted yet.

Task 1-3b: Live-stake *Cornus sericea* (red-osier dogwood) and *Rosa pisocarpa* (clustered wild rose), in polygon 2.

Approach: Tools needed for obtaining cuttings: gloves, clean pruners or hand saw, goggles (if needed), and a bucket or bag filled with water to place cuttings in. Before cutting stakes, mature and healthy *C. sericea*

trees will need to be found to help reduce cost (however, if not they may need to be purchased). Stakes should be taken off the shrubs in late winter or early spring when the tree is dormant, before budding. Cuttings should be 18-24" in length and at least 3/8th" in diameter, and taken from upright branches. The cuttings should be stored in water or wrapped in wet burlap sacks in a cool place to prevent them from drying out. (Buza, no date).

Task 1-3c: Plant groundcover plants *Tellima grandiflora* (fringecup), *Athyrium filix-femina* (lady fern), *Tolmia menziesii* (piggyback plant), *Carex obnupta* (slough sedge), and *Scirpus microcarpus* (small-fruited bulrush) in polygon 1. Plant *Elocharis palustris* (common spike rush) only in the sunniest areas of polygon 1.

Approach: See approach for Task 1-3a.

AD5: Planted 5 *Dryopteris erythrosora* (autumn fern) and 15 *Polysticum polyblepharum* (tassel fern) as a substitute for the *A. filix-femina* that was unavailable at the time per team member Marian's decision.

AD6: Removed the 5 *D. erythrosora* and replaced them with 5 *P. munitum*, and removed the 15 *P. polyblepharum* and replaced them with 15 *Dryopteris expansa* (shield fern) as the former ferns were not native plants. This was suggested by instructors.

Goal 2: Improve herpetalogical habitat at this site to attract such species as *Pseudacris regilla* (Pacific tree frog), *Rana aurora* (red-legged frog), *Plethodon vehiculum* (Western red-backed salamander), *Ensatina eschscholtzii* (ensatina salamander), *Elgaria coernulea* (Northern alligator lizard), and *Thamnophis ordinoides* (Northwestern garter snake).

Objective 2-1: Create new and preserve existing amphibian and reptile breeding and hibernation features.

Task 2-1a: Create a series of micro-depressions and ponds in sunny areas.

Approach: Choose appropriate areas (in wetter areas of the site) to dig 20" (minimum) depressions with shallow slope edges. This depth is indicated to accommodate many amphibian activities such as egg-laying

by frogs and salamanders, and the development of the young tadpoles and salamander larvae. The shallow slopes allow for easier access by these small animals. The width of the depressions will vary depending on available space and hydrology (Cates et al. 2002).

AD7: One larger depression (4ft x 7ftx 6ft) was created instead of many smaller ones. This was decided by the team because the areas on the site that were both sunny *and* wet were limited. It was installed in an area that tended to pooling and it filled itself in shortly after it was dug. It is hoped that the larger size will prevent frequent drying, remaining at an appropriate water level throughout breeding season

Task 2-1b: Plant *S. microcarpus* (small-fruited bulrush) and *E. palustris* (common spike rush) around depressions and ponds for shade and shelter (Cates et al. 2002).

Approach: See approach for Task 1-3a.

AD8: *Carex stipata* (sawbeak sedge) was planted instead of *S. microcarpus*. At the time the plants were installed around the pond, a source for *S. microcarpus* had not been found and *C. stipata* was deemed a reasonable substitute due to its preference for sunny, wet spots. When *S. microcarpus* was obtained, there was no longer space for it around the pond and it was needed in another area to help shade out *P. arundinacea*.

Task 2-1c: Plant *Elodea canadensis* (elodea) and *Lemna minor* (duckweed) in depressions and ponds that have a good chance of persisting throughout the seasons to provide oxygen, shelter, and egg-laying sites. These plants will also attract insects for food. (Cates et al. 2002).

Approach: Install *E. Canadensis* and *L. minor* at the base of water-filled (or very wet) depressions; a few can be installed in the vernal pool to attempt to increase the habitat value. They should be planted fairly close together to account for mortality, but far enough away to reduce intraspecies competition.

AD9: *E. canadensis and L. minor* were not installed. This was decided by the team on advice from instructors. These aquatic plants require year round water that may not be available at this site, and the hope is for the pool to dry up by mid- to late June.

Task 2-1d: Install small brush piles and rock walls near ponds for shelter and basking.

Approach: For both brush piles and rock walls, start with larger logs or rocks on the bottom layer. Some can be slightly buried. Leave spaces and fill them in somewhat with soil and/or leaves. Make sure there are entrances for the amphibians to use. These can be natural entrances or contrived with some kind of tubing. Continue adding layers, as high as deemed appropriate. Make sure structure is stable. (Cates et al. 2002)

AD10: Although some rock piles were installed in and near the pond, brush piles and more rock piles were installed away from the pond in order to establish hibernation and breeding habitat for snakes and salamanders that will not use the pond. This was decided by the team upon advice from instructors.

Task 2-1e: Create a travel corridor from the vernal pond (south of the site) to the restoration site.

Approach: Find an appropriate route from the vernal pond that will remain undisturbed (not close to the gravel paths) and make sure the vegetation around it remains tall enough to protect traveling amphibians. (Cates et al. 2002). If the corridor is sparse in vegetation in certain spots, live stakes can easily be installed to provide cover.

AD11: A travel corridor was not explicitly established because the vegetation between the vernal pool and the restoration site was deemed too thick and impenetrable for us at this time. However, this does not mean it will be impassable for amphibians. Rock piles and woody debris throughout the site, and placed along route to the vernal pool, will serve as refuge and resting sites.

Goal 3: Improve the quality of the bird habitat

Objective 3-1: Create new and preserve existing bird resting features

Task 3-1a: Locate existing snags and check for stability.

Approach: Any existing snags to be preserved should be positioned in the Interior of the site, away from foot traffic to avoid accidents involving falling debris (Unknown 2008). Make sure that existing snags near the path are stable. Any that are not should be taken out carefully.

Task 3-1b: Create new snags to supplement existing snags.

Approach: Select trees that are clearly senescing. If the selected trees are not dead already, they should be girdled no lower than 14” above the

ground. Gouges and slits may be cut into the tree to create roosting sites. Proper measurements for slits and gouges begin at least 8' deep and 2' wide. They must enter into the cambium layer at sharp angles. (Unknown 2008).

AD12: Enough snags of varying degrees of decay existed on site that the team did not deem it necessary to girdle any live trees. New snags were created from downed woody debris found on site. Snags near the path were moved to the interior.

Task 3-1c: Plant trees that will grow tall for perching and provide food and shelter for various bird species. See Tasks 1-2b through c.

Approach: Trees chosen for this purpose are *T. plicata* (provides sap for Yellow-bellied sapsucker, cavity nesting for woodpeckers, and seeds for various bird species), *P. sitchensis* (provides seeds for chickadee and crossbill), *P. menziesii* (provides nesting and perching for osprey and eagles, and seeds for various bird species), and *T. heterophylla* (provides seeds for crossbill, junco, chickadee, flicker, and grouse). (King County Wildlife Program, no date). See approach for Tasks 1-2b through c.

Objective 3-2: Install native species with summer and overwintering fruit

Task 3-2a: Plant *O. cerasiformis* (berries eaten by cedar waxwing), *Pyrus fusca* (Pacific crab apple)(overwintering fruit eaten by most fruit eating wildlife), *Crataegus douglasii* (black hawthorn) (fruits eaten by band-tailed pigeon, evening grosbeak, hermit thrush, flicker, robin and more), *S. albus* (overwintering fruits eaten by robin, thrush, towhee and more), and *Rhamnus purshiana* (cascara) (fruits eaten by bushtit, robin, thrush chickadee, nuthatch and more). (King County Wildlife Program, no date).

Approach: See approach for Task 1-3a.

AD13: *P. fusca* was not planted because one tree already existed on site and the team decided there was not room for another. In addition to the above species, *P. capitatus*, *Rosa pisocarpa* (swamp rose), *R. parviflorus*, *R. nutkana*, *G. shallon*, *L. involucrata* and *Cornus* "Eddie's white wonder" were planted to provide fruit for birds (King County Wildlife Program, no date). This was decided by the team because plants were obtained free of charge and extra space was available due to expanded site borders.

Task 3-2b: Plant live stakes of *Cornus sericea* (red-osier dogwood) (provides fruit for warbler, thrush, robin, bluebird and more) and

clustered *Rosa nutkana* (Nootka rose) (provides overwintering fruit for bluebird, junco, thrush and more). (King County Wildlife Program, no date).

Approach: See approach for Tasks 1-3b and c.

Goal 4: Promote ecological education, community volunteerism, and continued stewardship of the project site.

Objective 4-1: Educate work party volunteers in the ecological significance of native plant communities and the importance of stewardship

Task 4-1a: Prepare short presentations for pre-work party pep talks.

Approach: Work party facilitator should prepare an outline of critical information to make presentation short and informative. Briefly discuss how invasive species suppress the successional emergence of native vegetation, especially specific affects of species to be worked with that day; i.e. how *R. armeniacus* out-competes other plants and inhibits plant growth, and how ivy contributes to canopy decline and also inhibits plant regeneration. We also will discuss safety guidelines and methods of invasive species removal. The goal of these talks is to increase community knowledge of basic ecological principles, and to ensure all actions during a work party are safe.

Task 4-1b: Train stewards and other work party leaders to be prepared to answer questions and provide guidance during work parties.

Approach: All team members present at work parties should be well-informed of the methods for tasks being performed and the general plan for the site, including ecological reasoning behind the plan. We will have a meeting before the work party, either a few days before and/or the day of.

AD14: We did not do any training specifically for other work party leaders because our team was always the one leading it. There was always enough of us there at any given work party to oversee and aid volunteers in the acts of restoration, and any subsequent questions they had or help they required.

Objective 4-2: Construct and install signs at the site that explain to park visitors the value of native plant communities and the ecosystem services they provide

Task 4-2a: Write short summaries of plant communities and ecosystem s ervices.

Approach: Make information concise and understandable to a broad audience, including children. Base answers upon research and group decision of topics for the signs.

AD15: Due to budget and time constraints, the signs have not been constructed yet. The sign information was also not written due to time constraints, but if the parks department still wants us to, we will be more than glad to create the sign templates. Topics that can be included in the signs are the benefits of restoration, impacts of invasive species, and subsequent native plant communities. Other sign information topics could be the importance and reasons for installed site features, including the hummocks and vernal pool.

Task 4-2b: Determine best locations for sign placement.

Approach: Choose locations that are visible to passers-by. Work with client for suggestions.

AD16: Even though the signs were not created, we know the approximate locations they will be placed. One can go at the "T" intersection of the paths, and the other near the frog pond, both to educate people about it, and to help assist in keeping people and dogs out of the pond. However, once the signs are printed, their exact locations may vary slightly.

Task 4-2c: Construct signs

Approach: Research to discover the best signage material appropriate for the park. Work with the City of Kirkland and the Parks Department to obtain materials, and possibly have assistance in construction. Install the signs within the site.

AD17: As previously stated, due to budget, and some time constraints, we were not able to construct the signs. But we are available to write the material for the signs any time in the future. The best material to make signs out of is to get the signs printed on aluminum sheets and posted on a wooden base. This will ensure the signs are durable and last a long time, while remaining structurally sound and the words readable.

2.2: Description of Polygons, Site Treatment, and Planting Scheme

The restoration site is divided into three polygons in terms of soil type and moisture (see Figure 2). Polygon 1 is the lowest and wettest area of the site and has an area of 615 ft². It is 3 feet wide and runs along the entire west side of the site next to the elevated gravel foot path. In the northwest corner it then turns and heads east along the northern border and the gravel foot path for 33 feet and widens to 18 feet. Here the soil is very wet and consists of grayish-brown, silty clay, with blue-gray gleyed soil or rust-colored mottling in gray silty sand beneath (Mitsch and Gosselink 2007). There are very few soil macroinvertebrates except in the southwest corner where there are many large and small worms. Water accumulates along the west side path, and the path is used frequently by the neighborhood residents. The vegetation was primarily *R. repens* and mixed nonnative grasses, with *P. arundinacea* invading the margins and *Juncus effusus* (common rush) found scattered near soil sample site 2 (Pojar et al. 1994). Site preparation included covering with mulch (Task 1-1e) once the nearby *R. armeniacus* and *H. helix* were removed (Tasks 1-1a and b), and then plants were added to the site. 5 *R. nutkana* live stakes were planted on 3 foot centers in the northern areas that receive more sunlight (Task 1-3b). 2 *T. grandiflora* were planted along the west side at 18-inch centers, as well as 15 *T. menziesii* at 9-inch centers and 60 *C. obnupta* at 1-foot centers (Task 1-3c). These plant species were spaced to help shade out the *P. arundinacea* found along the west side (Shaw 2008, Pond 2009). 20 *E. palustris* and 20 *S. microcarpus* were added along the north side at 1-foot centers (Task 1-3c) (Pond 2009). These plant species were chosen for their compatibility with the growing conditions of this area as well as their lower height. This area is next to the neighborhood trail and larger plant species could pose a safety problem, block the view of the site and interfere with travel through the park (Gold 2008). Due to a lack of availability of *A. filix-femina* in May, *P. polyblepharum, D. erythrosora,* and *G. shallon*

were substituted for the herbaceous layer. However since the *P. polyblepharum and D. erythrosora* were not native plants, they were later replaced by *P. munitum* and *D. expansa.* Since the *C. obnupta* was purchased in 4-inch pots rather than 1 gallon size we also obtained some *S. microcarpus*. Since many shrubs and groundcovers were obtained for free, we were able to add more to the site than originally planned. Along the border next to the path, the client will place educational signs according to the client's specifications (Tasks 4-2a through c).

Polygon 2 is the largest polygon of the restoration site at 3995 ft². It is situated in the center of the site and includes the southern border. It is slightly elevated from polygon 1 and includes some slight mounded areas. The soil is moist but not wet due to groundwater moving down the slight slope. The soil texture is predominantly sandy clay, grayish-brown to a lighter tan-brown in color and contains very few macroinvertebrates which are present along the south side. Vegetation consisted of *R. armeniacus*, *Rubus ursinus*, *H. helix,* the stand of *P. cuspidatum*, numerous *P. munitum,* and a patch of *Chamaerion angustifolium* (fireweed) (Pojar et al. 1994). Here site preparation involved removing *H. helix* and *R. armeniacus* plants including root wads (Tasks 1-1a and b). Per acceptable invasive control methods, the *H. helix* was cut around the trees, pried off and the remainder including the roots pulled out of the ground (Shaw 2008). The *R. armeniacus* was also cut back and root wads removed (Shaw 2008). The area was covered with mulch (Task 1-1e), and then plants were added (see Figure 4). On 12 foot centers, 5 *F. purshiana*, 3 *L. involucrata*, and 1 *C. douglasii* were planted (Task1-3a). On 6 foot centers, plants included 3 *T. plicata* (Task 1-2b), 8 *A. circinatum,* 1 *Picea sitchensis* (Sitka spruce), 2 *Pseudotsuga menziesii* (Douglas-*fir)* and 9 *O. cerasiformis* (Task 1-3a). On 4 foot centers, 6 *C. sericea* (Task 1-3b) were planted, as well as 5 live stakes (Task 1-3b). 2 *V. parvifolium (*Task 1-3a) were planted on decaying wood found on the site. 12 *P. capitatus,* 3 *S. albus* 5 *R. parviflorus*, 5 *R. pisocarpa*, were planted on 3 foot centers (Task 1-3a). The *S. albus* was planted in the south area where it is sunnier. On 18 inch centers, 19 *G. shallon (*Task 1-3a), 2 *T. grandiflora,* 5 *P. Munitum,* 1 *Berberis nervosa* (Oregon grape) and 12 *Dryopteris expansa* (shield ferns) (Task 1-3c) were planted, and

on 9-inch centers 3 *T. menziesii* were planted. The tree and shrub combinations were chosen not only for their suitability of growing conditions, but for the food, shelter and nesting sites they will provide for the local birds (King County Wildlife Program, no date and Pojar et al. 1994). The availability of free plants enabled us to add more tree and shrub varieties to this section. The plant spacing was determined by plant sizes at maturity to allow appropriate room for growth (Pond 2009). The patch of *P. cuspidatum* in the center of this polygon was roped off and left alone. The *R. armeniacus* in this area was removed (using the same method as mentioned above) but done very carefully to decrease disturbing the *P. cuspidatum* roots as little as possible as root disturbance can cause *P. cuspidatum* to spread (Shaw 2008). The *P. cuspidatum* will be left for the Parks Department to inject with glyphosate herbicide next August or September (Task 1-1d) (Shaw 2008). 15 *A. diocius* can be planted on 4 foot centers in its place (Task 1-3a).

Polygon 3 is the driest polygon on site, and is slightly elevated on the northeast and southeast corners of the site. Polygon 3 consists of the section along the eastern border and covers an area of 790 ft². The soil here is slightly damp to dry, light tan to brown in color, silty sand in texture and contains very few invertebrates. Soil sample 3 was very coarse, consisting mostly of 1-2 inch pebbles mixed with a little brown, loamy sand. There are 3 large downed trees coming from the east extending into the center of this polygon. The vegetation was dominated by *H. helix*, *R. armeniacus,* and *P. munitum* (Pojar et al. 1994). Here site preparation involved removing *H. helix* and *R. armeniacus* plants including root wads (Tasks 1-1a and b). Per acceptable invasive control methods, the *H. helix* was cut around the trees, pried off and the remainder including the roots pulled out of the ground (Shaw 2008). Larger pieces of woody debris were removed to get to the *H. helix* plants. The 3 largest pieces of wood debris, the downed trees, were left in place. The *R. armeniacus* was also cut back and root wads removed (Shaw 2008). The area was covered with mulch (Task 1-1e) and trees added (see Figure 4). On 12-foot centers 3 *F. purshiana* were planted. On 6-foot centers, 4 *T. heterophylla* (Task 1-2d), 5 *P. menziesii* (Task 1-2c), 10 *P. sitchensis*, 1 Cornus 'Eddie's White Wonder", 4 *T. plicata*, and 5 *A. circinatum* were planted (Task 1-2c). On 3-foot centers, 5 *P. capitatus,* 2 *P.*

lewisii, 1 *R. pisocarpa,* and 1 *R. parviflorus* were planted. On 18-inch centers 15 *G. shallon* were planted. Due to the availability of free shrub and tree plants, we were able not only to expand the eastern margins of the site, but add plants to the understory of the trees. Conifers were planted here to provide seeds, cover, insects, and nest sites for birds (King County Wildlife Program, no date). Large and small woody debris can still be found throughout the entire restoration site.

2.3: Maintenance and Monitoring

Task 1-1a: Remove all *R. armeniacus* above and below ground biomass.

M&M Approach: Realistically, *R. armeniacus* cannot be fully eradicated, but re-sprouts can be controlled. Over summer, the re-growth should be cut or dug up. Then in fall all root wads should be dug up (Shaw, 2008) (the moist soil will make it easier), and re-apply mulch in affected areas (spread to about 1 meter diameter around removed wads). Biomass can be composted on site if a suitable compost site is available.

AD18: The Parks Department determined a suitable composting site at the southern park entrance and is willing to take biomass waste away when given proper notice.

Task 1-1b: Remove all *H. helix* above and below ground biomass.

M&M Approach: *H. helix* will also not be completely eradicated after initial restoration. The site should be monitored for re-growth year round. Small ground growth should be immediately removed, making sure to remove any root bundles or runners. The ivy stems should be cut back from around any trees they may re-grow upon, and the vines should be removed once dry and dead. Biomass should be removed from the site because live ivy vines readily re-sprout if given a chance.

Task 1-1c: Remove all aboveground *P. arundinacea* biomass.

M&M Approach: *P. arundinacea* will also probably re-sprout, especially in the wet areas of the site with less canopy cover. During the fall or winter, all re-sprouts should be hand-pulled (since mowing is not feasible for the site) and cardboard and mulch should be applied thickly over the area in which it occurs (plus a 1 meter buffer zone). If there has been any seedling mortality around that

area, new species of fast growing, hardy plants should be installed to shade out the *P. arundinacea.*

AD19: The highest density stands of *P. arundinacea* in Cotton Hill Park are actually beyond the boundaries of the restoration site, so re-invasion may not occur in large patches. Cardboard may be difficult to apply to small patches with so many surrounding native plants, so thick layers of mulch may suffice.

Task 1-1d: Cordon off *P. cuspidatum* stand for late summer stem-injection by City of Kirkland.

M&M Approach: During the late summer (August-September), the stems of the *P. cuspidatum* should be injected with a glyphosate (herbicide) solution. Before the herbicide is injected, the stems should be cut to about 2 inches above the ground; to be effective the herbicide must be applied *immediately*. The herbicide to be used is a 25% glyphosate solution (Roundup® or Rodeo®), which is the safest for use in wetland areas. The glyphosate will most likely have to be re applied, either using the cut-stem method again, or carefully implementing a foliar spray on the re-growth (Remaley, 2007).

Task 1-1e: Cover and condition soils with mulch in invasive control areas after removal.

M&M Approach: Mulching will be completed during current restoration project; it may need to be repeated in a few years when new plantings are installed; otherwise only use as needed on extensive re-growth of invasive plants.

Task 1-1f: Develop invasive control guidelines for client and volunteers

M&M Approach: Compose an in-depth description and step-by step process of the above-mentioned control methods for specific invasive plant species, into a stewardship plan. Update processes as new methods are innovated, and as new invasive species arrive, into the stewardship plan, so stewardship efforts are well-informed and effective, to the greatest extent possible.

Task 1-2a: Build hummocks in wet areas (polygons 1 & 2) to create more ideal planting conditions for conifers.

M&M Approach: This aspect will be more assessment than maintenance to determine the success of the hummocks. However, monitoring should include making sure the trees are growing straight (adjust or change stakes as necessary, i.e. replace stakes if tree needs more support). During the summer the trees

should be manually watered bi-weekly since soil in the hummocks will be drier than the rest of the site. While installed plants establish, soil in the hummocks is likely to be overly dry, during the dry season. Mulch on the hummocks will help the soil retain water. If trees planted in the hummocks have low survival, more seedlings should be planted in the hummocks and elsewhere to better determine how successful the hummocks are.

Task 1-2b: Plant *T. plicata* in moist, shady areas.

M&M Approach: Remove any invasive plants strangling seedlings to increase chance of survival. It may need watering during the summer if the ground is very dry. If there has been high seedling mortality, more should be planted the following winter.

Task 1-2c: Plant *P. sitchensis* and *P. menziesii* on hummocks located in moist and sunny areas of polygons 2 & 3.

M&M Approach: Same as Task 1-2a.

Task 1-2d: Plant *T. heterophylla* on hummocks in partly shaded areas of polygons 2 & 3.

M&M Approach: Same as Task 1-2a; high likelihood of needing manual watering.

Task 1-3a: Plant the shrubs *G. shallon*, *A. diocius*, *O. cerasiformis*, *P. capitatus*, *F. purshiana*, *A. circinatum*, *V. parvifolium*, *L. involucrata* and *R. lacustre* in polygon 2.

M&M Approach: The shrubs should be treated much like the trees, manual watering during the summer if needed and new seedlings planted during winter if there was high mortality. If seedling mortality is high, similar native species should be considered, to replace dead seedlings.

Task 1-3b: Live-stake *R. nutkana* and *C. sericea* in polygon 2.

M&M Approach: Same as Task 1-3a.

Task 1-3c: Plant groundcover plants *T. grandiflora*, *A. filix-femina*, *T. menziesii*, *C. obnupta*, and *S. microcarpus* in polygon 1. Plant *E. palustris* only in the sunniest areas of polygon 1.

M&M Approach: These should be maintained by ensuring they are not out-competed by invasive plants (especially *R. armeniacus* and *P. arundinacea*); invasives present in groundcover should be removed (easy to hand-pull while wandering through site). Groundcover plants experiencing mortality should be replaced with plants of the same species, in a clump; otherwise, if the majority of the species did not survive, a more site-appropriate species should be installed. Also, if *R. repens* and *G. robertianum* are still dominating the groundcover (especially bordering the paths), they should be hand removed and mulched over if the new species are not surviving well, and then new plants installed through the mulch that are already semi-mature.

Task 2-1a: Create a series of micro-depressions and ponds in sunny areas

M&M Approach: Maintaining amphibian habitat will require monitoring the site and replacing habitat features as needed. The goal is to attract amphibians; however, there is no guarantee that it will be effective. If it is, the hope is that it will not require a lot of on-going maintenance. However, if amphibians are observed, documentation of the number and species present can help determine how successful amphibian habitat enhancements have been. As conditions change, invasive species like *P. arundinacea* are likely to sprout up. The recommended solution is manually removing invasive vegetation from the amphibian pond and continuing to reinforce population levels of beneficial wetland species.

Task 2-1b: Plant S*. microcarpus* and E*. palustris* around depressions and ponds for shade and shelter.

M&M Approach: See M&M for Task 2-1a (above).

AD20: *C. Stipata* was planted in place of *S. microcarpus*. Same monitoring and maintenance approaches apply.

Task 2-1c: Plant *E. canadensis* and *L. minor* in depressions and ponds that have a good chance of persisting throughout the seasons to provide oxygen, shelter, and egg-laying sites. These plants will also attract insects for food. (Cates et al. 2002).

M&M Approach: If *E. canadensis* and *L. minor* mortality is high, they should be re-introduced unless a pattern of high mortality emerges, in which case a more site-appropriate native species should be considered. These aquatic plants must be submerged, so monitoring data on the water level of the pond and the nearby micro-depressions is helpful. See maintenance and monitoring approach for Task 2-1a.

AD21: Neither of these plants were planted on the site. No maintenance or monitoring will be necessary.

Task 2-1d: Install small brush piles and rock walls near shrubs and ponds for shelter and basking.

M&M Approach: See maintenance and monitoring approach for Task 2-1a.

Task 2-1e: Create a travel corridor from the vernal pond (south of the site) to the restoration site.

M&M Approach: Once the corridor has been created, plants should be installed in high densities and placed so they prevent people from entering that area. See maintenance and monitoring approach for Task 2-1a.

Task 3-1a: Locate existing snags and check for stability.

M&M Approach: Check the stability of existing snags and installed bird habitat features every couple of months (especially after instances of extreme weather). Watch out for dead *A. rubra*; they fall easily and could be a hazard to children and anybody walking through the park. Whenever one is found that endangers park visitors walking on the path, secure the area and carefully knock it over; try not to topple the tree onto seedlings. Snags that are not close to the trail should be left standing and allowed to fall over naturally.

Task 3-1b: Create new snags if there are not sufficient structures existing on site.

M&M Approach: If the number of snags for bird habitat falls below the number of snags observed at the start of the restoration project, create new snags by digging a hole with a shovel or post-hole digger and placing a log in the hole, standing upright. Make sure to fill in the hole sufficiently so the snag is stable and not a danger to park visitors.

Task 3-2a: Plant *O. cerasiformis*, *P. fusca*, *C. douglasii*, and *R. purshiana* (see task 1-3a).

M&M Approach: See maintenance and monitoring approach for Task 1-3a

Task 3-2b: Plant *C. sericea* and *R. nutkana* and clustered wild rose (see Tasks 1-3b).

M&M Approach: See maintenance and monitoring approach for Tasks 1-3b.

Task 4-1a: Prepare short presentations for pre-work party pep talks.

M&M Approach: A short, precise description of restoration work will be written up to provide an educational tool for any future work party leaders; describes basic ecology of site and plant-specific control methods and why that plant is bad. This will be given to Karen Story at the conclusion of this year's UW REN capstone so it will be at her discretion who to appoint lead-informer for the project (i.e. school teachers who bring kids to work on the park, local volunteers, etc). This document probably will evolve and be expanded on, as knowledge increases among volunteer stewards, and the needs of the public change, making it an ongoing work.

Task 4-1b: Be prepared to answer questions and provide guidance during work parties.

M&M Approach: The document prepared can help answer future work-party volunteer questions (see M&M for Task 4-1a, above).

Task 4-2a: Write short summaries that describe plant communities and ecosystem services typical of a suitable target reference site.

M&M Approach: The templates for the summaries to go on the signs will be given to Karen Story.

Task 4-2b: Determine best locations for sign placement.

M&M Approach: If a different spot is deemed better for the sign in the future, then it may be moved at the discretion of the clients, Karen Story, Sharon Rodman, and the Kirkland Parks Department.

Task 4-2c: Construct signs

M&M Approach: Ensure signs are lasting through weather, human intervention, and time; replace if desired or needed. Templates will be written for the signs and given to Karen Story in case replacement is needed due to damage or loss. Any sign removal or replacement will be at the discretion of the clients.

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Section 3: Site Maps

3.1: Map of Site Location

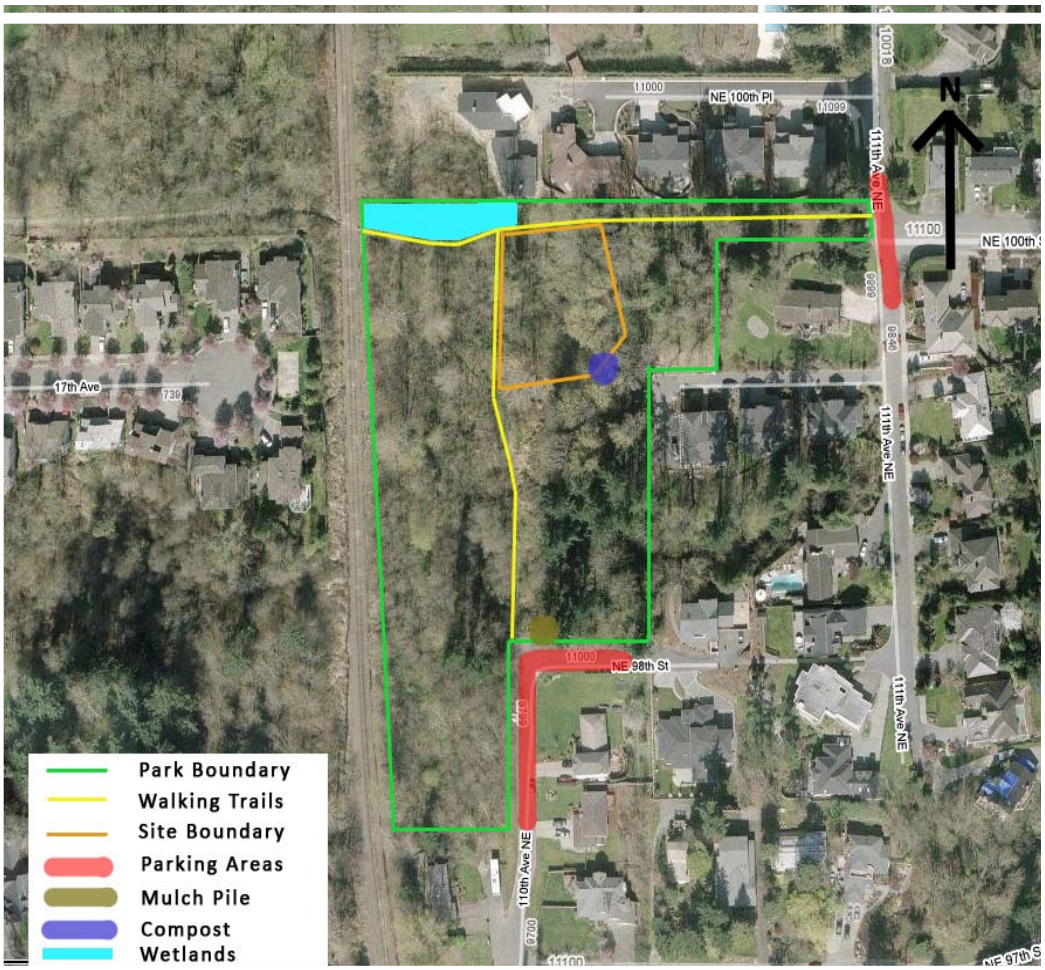


Figure 4. *Site Location with relevant features*

3.2: Original Site Conditions

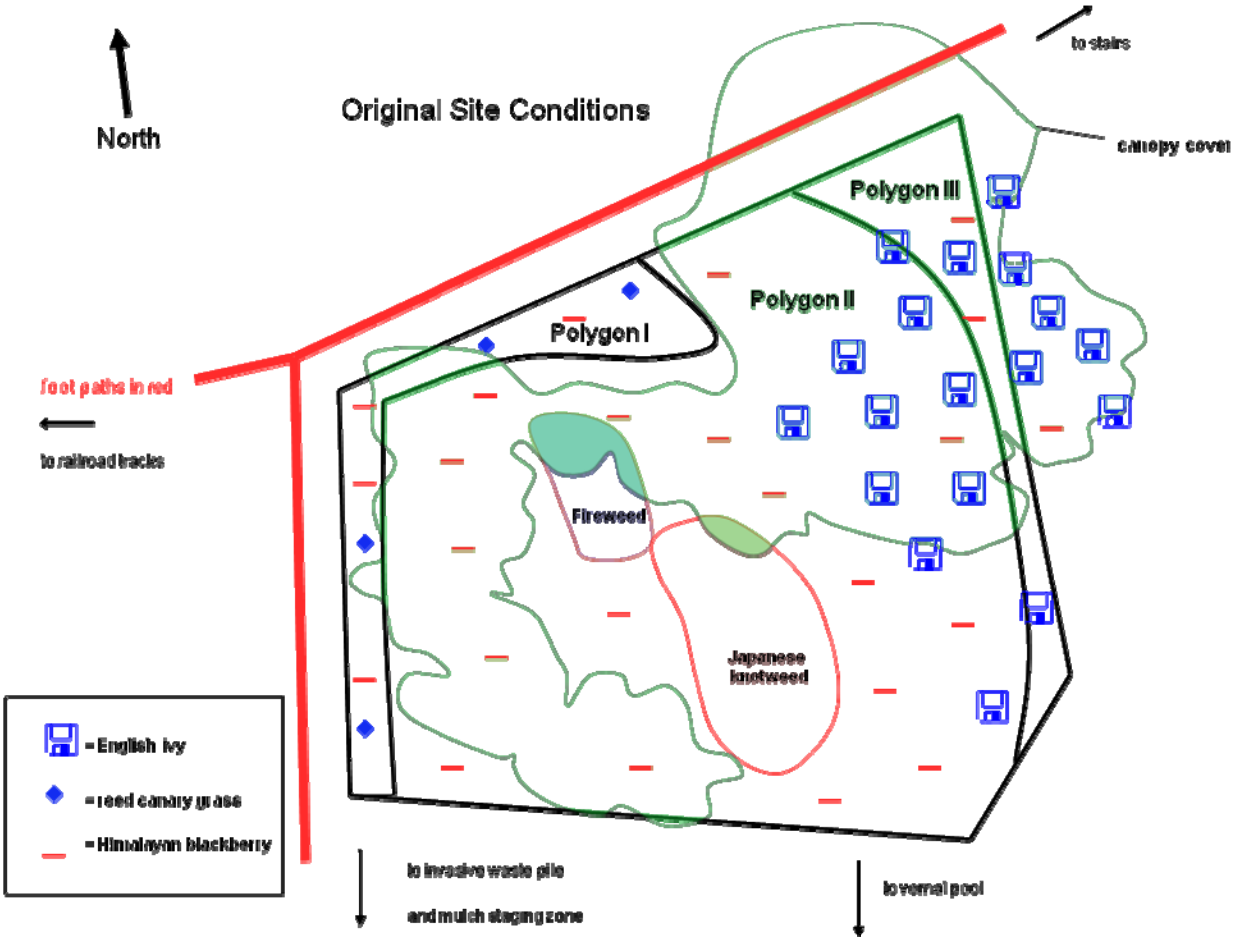


Figure 5. Original Site Conditions

3.3: Site Preparation by Polygon

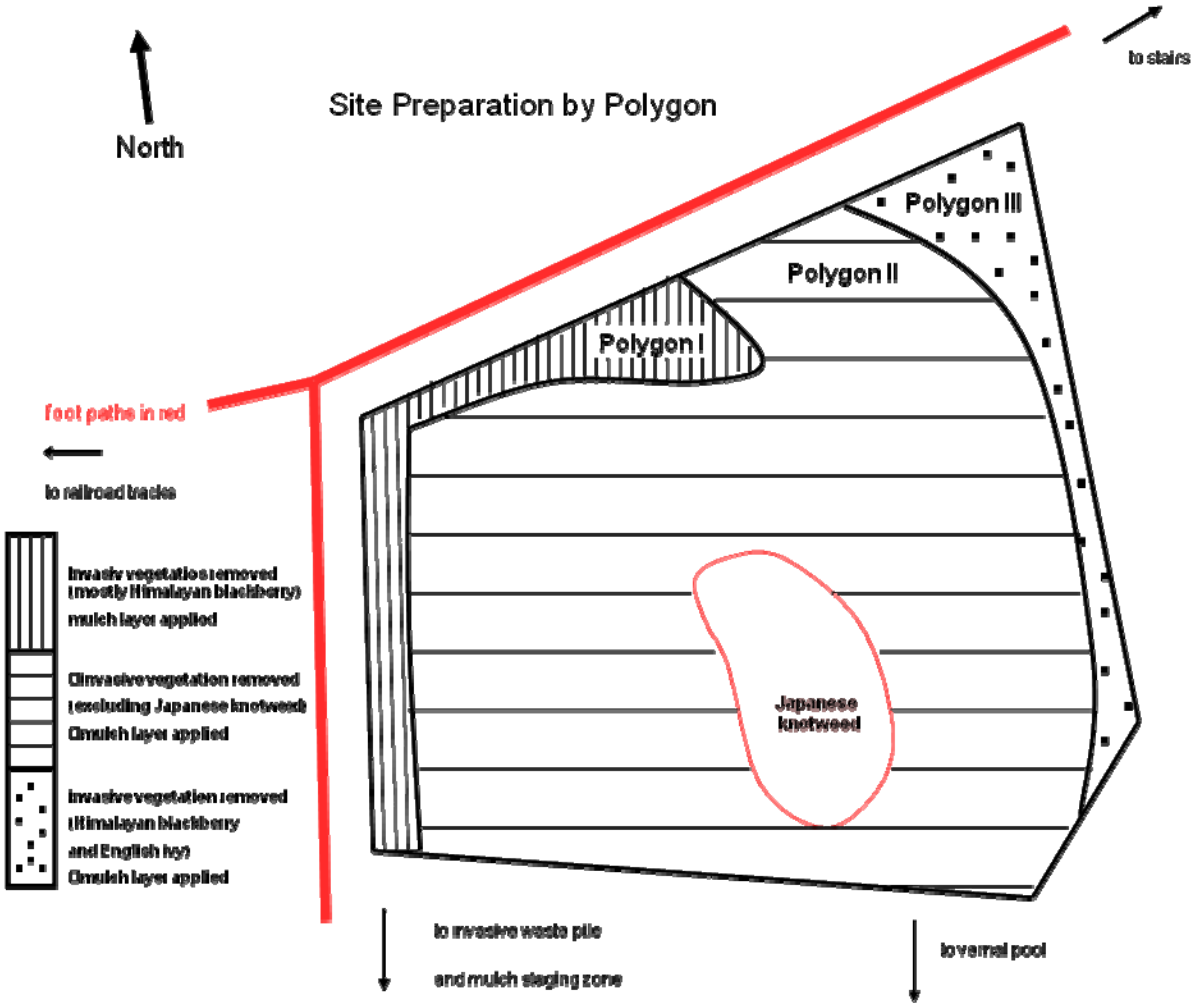


Figure 6. *Site Preparation by Polygon*

3.4: Planting Plan by Polygon

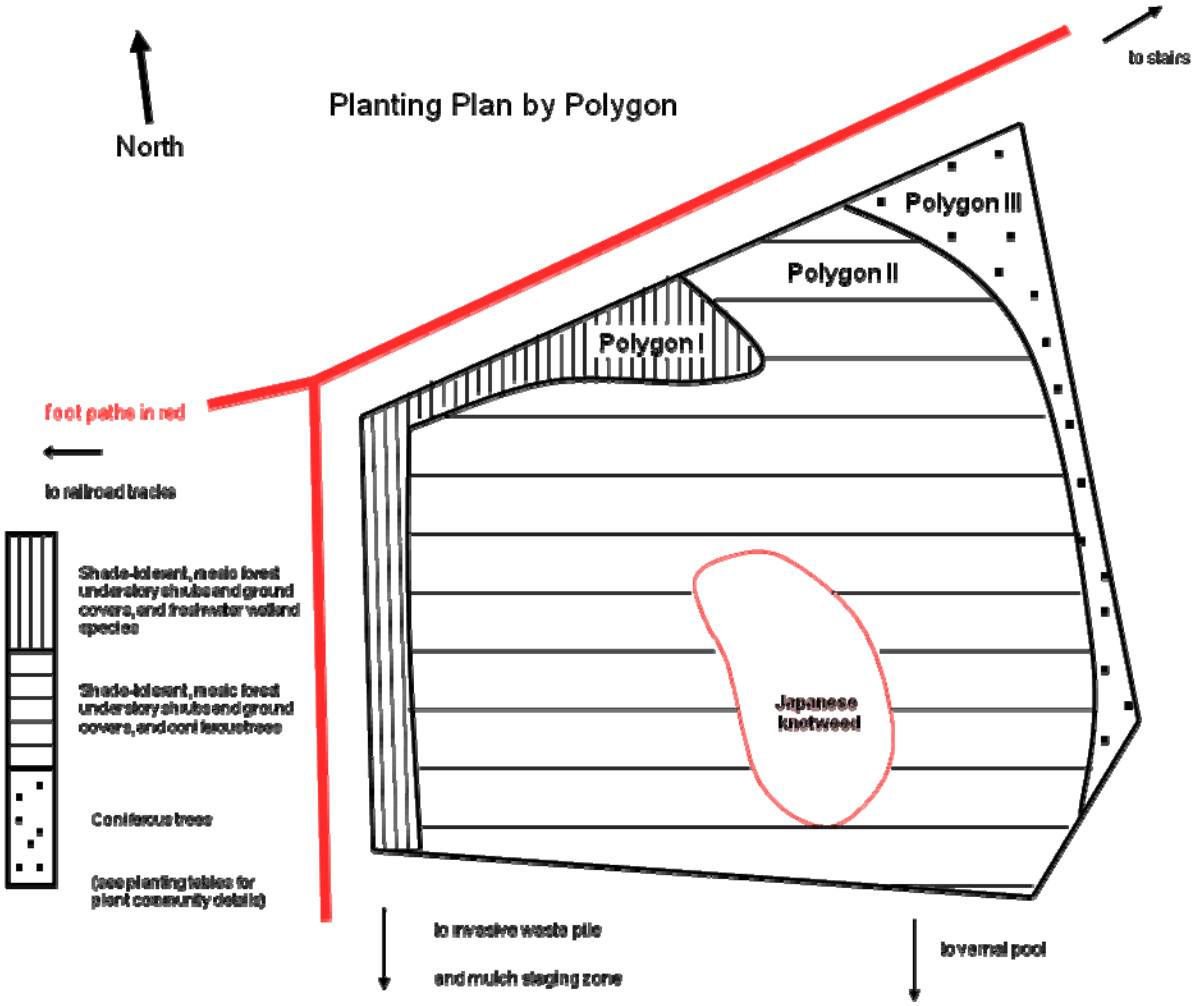


Figure 7. *Planting Plan by Polygon*

3.5 As-Built Map

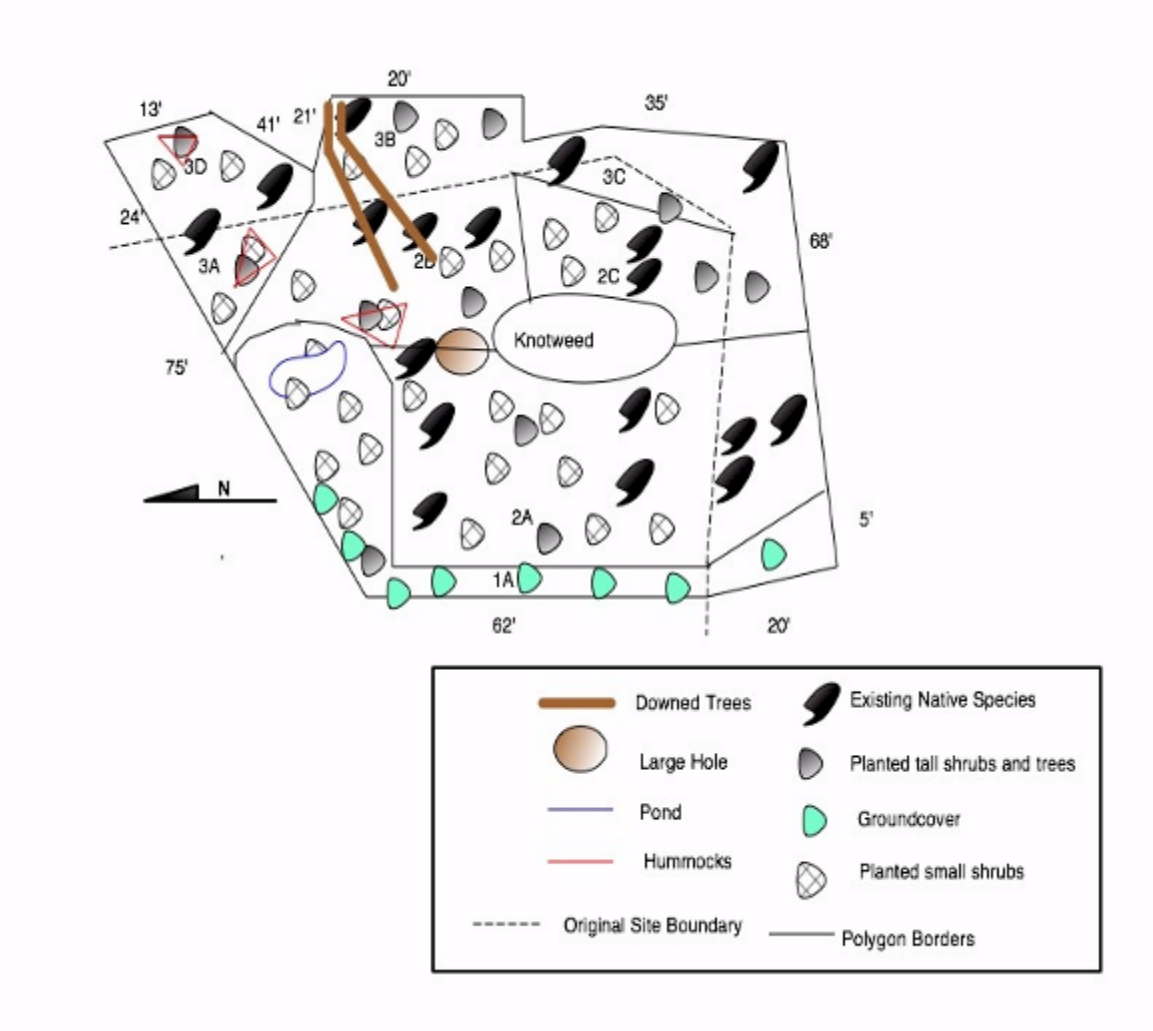


Figure 8. *As-Built Map*

Section 4: As-Built Tables

4.1: Plant Table

Table 1. Plant Species Planted, by Polygon

Polygon #1	Quantity	Form	Centers	Source*
Slough sedge (*Carex obnupta*)	60	~~1 gallon container~~ **4" pots**	1 ft.	~~THNP/SNP~~ **SLG**
Common spike rush *(Elocharis palustris)*	~~20~~ **30**	plugs	1 ft.	SNP
Sawbeak sedge *(Carex stipata)*	30	plugs	1 ft	SLG
Small-fruit bulrush *(Scirpus microcarpus)*	~~20~~ **40**	**plugs**	1 ft.	~~THNP~~ **SLG**
Fringecup *(Tellima grandiflora)*	~~30~~ 2	4" pot	18"	MG
Piggyback plant *(Tolmiea menziesii)*	~~15~~ **7**	4" pot	9"	~~MG~~ **SLG**
~~Lady fern *(Athyrium filix-femina)*~~	~~5~~	~~1 gallon container~~	~~18"~~	~~SNP~~
Shield fern *(Dryopteris expansa)*	**5**	**4" pot to 1 gallon**	**18"**	**Marian**
~~**Tassel fern *(Polystichum polyblepharum)***~~	~~**3**~~	~~**1 gallon container**~~	~~**18"**~~	~~**SLG**~~
Alaska violas (*Viola langsdorfii*)	**7**	**4" pot**	**9"**	**Karen**
Sword fern *(Polystichum munitum)*	**1**	**1 gallon container**	**2 ft**	**MG**
Swamp Rose *(Rosa pisocarpa)*	**5**	**1 gallon container**	**3 ft.**	**Rodney**
Salal *(Gaultheria shallon)*	**4**	**1 gallon container**	**18"**	**SLG**
Pacific ninebark *(Physocarpus capitatus)*	**3**	**1 gallon container**	**3 ft.**	**Amy**
Mock orange *(Philadelphus lewisii)*	**1**	**1 gallon container**	**3 ft.**	**Amy**
Nootka rose *(Rosa nutkana)*	**5**	**live stakes**	**3 ft.**	**Karen**
Nootka rose *(Rosa nutkana)*	**1**	**1 gallon container**	**3 ft.**	**SCD**

Polygon #2	Quantity	Form	Centers	Source*
Salal *(Gaultheria shallon)*	~~15~~ **19**	bare root	18"	KCD & MG
~~Lady fern *(Athyrium filix-femina)*~~	~~5~~	~~1 gallon container~~	~~18"~~	~~SNP~~
~~**Tassel fern *(Polystichum polyblepharum)***~~	~~**12**~~	~~**1 gallon container**~~	~~**18"**~~	~~**SLG**~~
~~**Autumn fern *(Dryopteris erythrosora)***~~	~~**5**~~	~~**1 gallon container**~~	~~**18"**~~	~~**SLG**~~
~~Goat's beard *(Aruncus diocius)*~~	~~15~~	~~bare root~~	~~4 ft.~~	~~P Dept.~~
Black twinberry *(Lonicera involucrata)*	~~10~~ **3**	bare root	12 ft.	KCD
Indian plum *(Oemleria cerasiformis)*	~~10~~ **9**	bare root	12 ft.	KCD
Cascara *(Rhamnus or Frangula purshiana)*	~~8~~ **5**	1 gallon container	12 ft.	Rodney
Red huckleberry *(Vaccinium parvifolium)*	~~6~~ **2**	**2** ~~5~~ gallon container	4 ft.	MG
Thimbleberry *(Rubus parviflorus)*	~~7~~ **5**	1 gallon container	3 ft.	MG
Snowberry *(Symphoricarpos alba)*	~~10~~ **3**	~~bare root~~ **1 gallon container**	3 ft.	SCD~~/MG~~ **SLG**
Western redcedar *(Thuja plicata)*	~~10~~ **3**	bare root	6 ft.	KCD
Red-osier dogwood *(Cornus sericea)*	**1**	**2 gallon container**	**4 ft.**	**MG**
Red-osier dogwood *(Cornus sericea)*	10	bare root	4 ft.	KCD
Red-osier dogwood *(Cornus sericea)*	5	live stakes	4 ft.	Rodney
~~Nootka rose *(Rosa nutkana)*~~	~~5~~	~~live stakes~~	~~3 ft.~~	~~Karen~~

Swamp Rose *(Rosa pisocarpa)*	**5**	**1 gallon container**	**3 ft.**	**Rodney**
Vine maple *(Acer circinatum)*	~~5~~ **8**	bare root	6 ft.	KCD
~~Pacific crabapple *(Pyrus fusca)*~~	~~1~~	~~2 gallon container~~	~~12 ft.~~	~~SLG~~
Black hawthorne *(Crataegus douglasii)*	1	2 gallon container	12 ft.	SLG
Sitka spruce *(Picea sitchensis)*	**1**	**bare root**	**6 ft.**	**SCD**
Douglas-fir *(Pseudotsuga menziesii)*	**2**	**1 gallon container**	**6 ft.**	**Amy**
Fringecup *(Tellima grandiflora)*	**2**	**4" pot**	**18"**	**MG**
Piggyback plant *(Tolmiea menziesii)*	**3**	**4" pot**	**9”**	**SLG**
Oregon grape *(Berberis nervosa)*	**1**	**bare root**	**18"**	**MG**
Pacific ninebark *(Physocarpus capitatus)*	**12**	**1 gallon container**	**3 ft.**	**Amy**

Polygon #3	Quantity	Form	Centers	Source*
Western hemlock *(Tsuga heterophylla)*	~~10~~ **4**	bare root	6 ft.	KCD
Vine maple *(Acer circinatum)*	5	bare root	6 ft.	KCD
Cornus ‘Eddie’s White Wonder’	**1**	**2 gallon container**	**6 ft.**	**SLG**
Sitka spruce *(Picea sitchensis)*~~-poss.substitution~~	~~10~~ **2**	bare root	6 ft.	~~KCD~~ **SCD**
Western redcedar *(Thuja plicata)*	**4**	**bare root**	**6 ft.**	**KCD**
Douglas-fir *(Pseudotsuga menziesii)*	5	bare root	6 ft.	MG
Salal *(Gaultheria shallon)*	**15**	**4” pots & bare root**	**18”**	**KCD/MG**
Pacific ninebark *(Physocarpus capitatus)*	**5**	**1 gallon container**	**3 ft.**	**Amy**
Mock orange *(Philadelphus lewisii)*	**2**	**1 gallon container**	**3 ft.**	**Amy**
Swamp Rose *(Rosa pisacarpa)*	**1**	**1 gallon container**	**3 ft.**	**Rodney**
Thimbleberry *(Rubus parviflorus)*	**5**	**1 gallon container**	**3 ft.**	**MG**
Snowberry *(Symphoricarpos alba)*	**6**	**1 gallon container**	**3 ft.**	**SLG**
Indian plum *(Oemleria cerasiformis)*	**6**	**bare root**	**12 ft.**	**Amy**
Cascara *(Rhamnus or Frangula purshiana)*	**3**	**1 gallon container**	**12 ft.**	**Rodney**

*Source codes:
Karen - Karen Story will let us take cuttings
KCD - King Conservation District
MG - Master Gardeners
P Dept. - Parks Department after they kill the knotweed
SCD - Snohomish Conservation District
SLG – Storm Lake Growers
SNP - Sound Native Plants
THNP - Tadpole Haven Native Plants

4.2: Materials and Tools Table

Table 2. Materials Needed

Task	Materials	Quantity	Source	Tools	Quantity	Source
1-1a	none			Loppers	15	Parks
				Hand Pruners	10	Parks
				Shovels	20	Parks
				Tarp	2	Parks
				Gloves	20 pairs	Parks
1-1b	none			Lopers	15	Parks
				Hand Pruners	10	Parks
				Shovels	20	Parks
				Tarp	2	Parks
				Gloves	20 pairs	Parks
1-1c	none			Brush cutter	1	Parks
1-1d	Stakes	10	Marian	Hammer	1	Marian
	Rope	50'	Marian			
1-1e	Mulch	100 yards	Parks	Shovels	10	Parks
				Rakes	10	Parks
				Wheelbarrows	5	Parks
				Gloves	20 pairs	Parks
1-1f	Paper	10 sheets	Josh	Computer	1	Josh
1-2a	Small logs	~~3~~ **3-5**/hummock	On site	Hammer	2	Josh
	Stakes (small branches)	9/hummock	On site	Hatchet	1	Josh
	Soil	.5 yard/hummock	Parks	Gloves	10	Parks
1-2b	*Thuja plicata*	10	KCD	Shovels	1	Parks
1-2c	*Picea sitchensis*	10	KCD	Shovels	1	Parks
	Pseudotsuga menziesii	5	MG			
	Thuja plicata	**2**	**KCD**			
1-2d	*Tsuga heterophylla*	10	KCD	Shovels	1	Parks
1-3a	*Gaultheria shallon*	15	KCD	Shovels	5	Parks
	Aruncus diocius	15	P-Dept			
	Oemleria cerasiformis	10	KCD			
	Physocarpus capitatus	10	KCD			

	Frangula purshiana	8	Rodney			
	Lonicera involucrata	10	KCD			
	Acer circinatum	10	KCD			
	Vaccinum parvifolium	6	MG			
	Symphoricarpos albus	10	SCD/MG			
1-3b	*Cornus sericea*	15	KCD/Rodney	Shovels	5	Parks
	Rosa nutkana	5	Karen	Gloves	5	Parks
1-3c	*Tellima grandiflora*	30	MG	Shovels	5	Parks
	Athyrium filix-femina	10	SNP			
	Tolmia menziesii	15	MG			
	Carex obnupta	60	THNP/SNP			
	Elocharis palustris	20	SNP			
	Scirpus microcarpus	20	THNP			
2-1a	none			Shovel	4	Parks
2-1b	~~*Scirpus microcarpus*~~ ***Carex stipata***	20	THNP	Shovel	1	Parks
	Elocharis palustris	20	SNP			
2-1c	~~*Elodea canadensis*~~	~~5~~	~~THNP~~	~~Shovel~~	~~1~~	~~Parks~~
	~~*Lemna minor*~~	~~5~~	~~THNP~~			
2-1d	Brush/small branches/twigs	1 yard	On Site	Wheelbarrow	1	Josh
	Rocks (2"-5")	1 yard	Josh **&** **Marian**			
2-1e	~~Mulch~~	~~1 yard~~	~~Parks~~	~~Loppers~~	~~2~~	~~Parks~~
				~~Shovels~~	~~2~~	~~Parks~~
				~~Gloves~~	~~2~~	~~Parks~~
3-1a	Woody Debris	10 pieces	On Site	Rope	50"	Josh
3-1b	None			None		
3-1c	None			None		
3-2a	None			None		
3-2b	None			None		
4-1a	None			None		
4-1b	None			None		
4-2a	None			None		

4-2b	None			None		
4-2c	~~Wood~~	~~TBD~~	~~TBD~~	~~Saw~~	~~1~~	~~Josh~~
	~~Nails/Screws~~	~~TBD~~	~~TBD~~	~~Hammer~~	~~1~~	~~Josh~~
	~~Metal Sign~~	~~TBD~~	~~TBD~~	~~Tape measure~~	~~1~~	~~Josh~~

4.3 Work Timeline

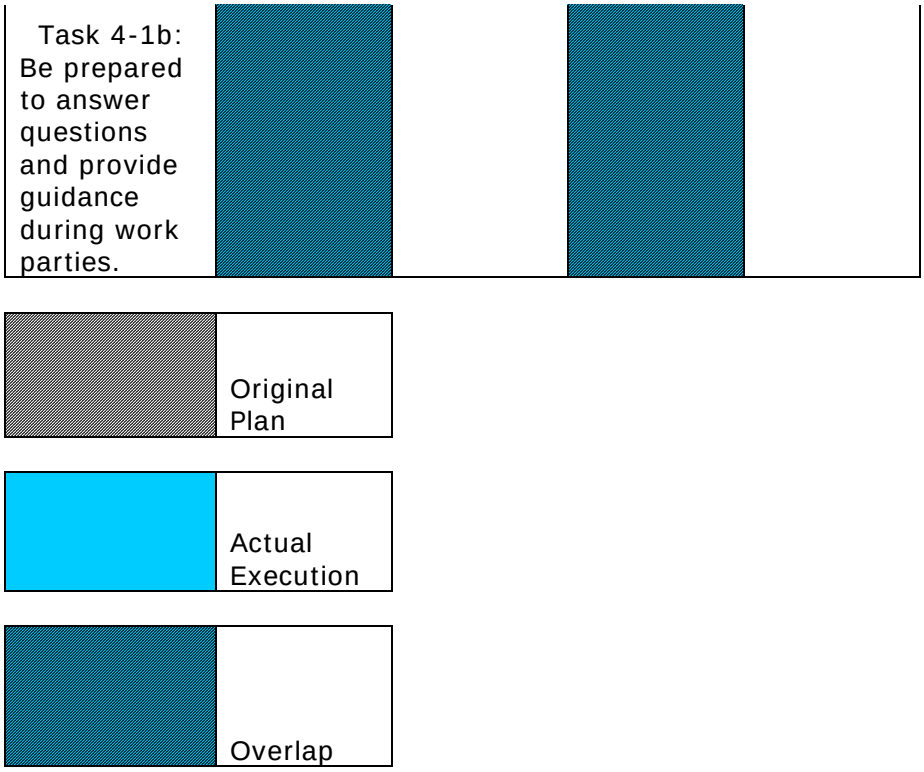
Table 3. Revised Timeline of work Completed

	Jan-09	Feb-09	Mar-09	Apr-09
Task 1-1a: Remove *Rubus armeniacus*				
Task 1-1b: Remove *Hedera helix*				
Task 1-1c: Remove all aboveground *Phalaris arundinacea*				
Task 1-1d: Cordon off *Polygonum cuspidatum*, stand for late summer stem-injection by City of Kirkland				
Task 1-1e: Mulch				
Task 1-1f: Invasive control guidelines				
Task 1-2a: Build hummocks				
Task 1-2b: Plant *Thuja plicata*				

Task 1-2c: Plant *Picea sitchensis* on hummocks.				
Task 1-2d: Plant *Tsuga heterophylla*				
Task 1-3a: Plant *Gaultheria shallon, Aruncus diocius*, *Lonicera involucrate*, *Oemleria cerasiformis*, *Frangula purshiana*, *Acer circinatum*, *Vaccinum parvifolium*, and *\Ribes lacustre*				
Task 1-3b: Live-stake *Physocarpus capitatus* and *Cornus stolonifera*				
Task 1-3c: Live-stake *Rosa pisocarpa*, and *Rosa nutkana*				

Task 1-3d: Plant *Tellima grandiflora, Athyrium filix-femina, Tolmia menziesii, Carex obnupta, Elocharis palustris*, and *Scirpus microcarpus*				
Task 2-1a: Create a series of small depressions and ponds in sunny areas				
Task 2-2b: *Plant microcarpus* and *Elocharis palustris* around depressions and ponds for shade.				
Task 2-2c: Introduce elodea (Elodea canadensis) and duckwe (Lemna minor) to the depressions and ponds.				
Task 2-2d: Install small brush piles and rock walls near shrubs and ponds.				

Task 2-2e: Create a travel corridor from the vernal pond (south of the site) to the restoration site				
Task 3-1a: Increase stability of existing snags using woody debris.				
Task 3-1b: Plant trees that attract birds and that will grow tall (see tasks 1-2b through c).				
Task 3-2a: Plant Indian plum and cascara (see task 1-3a)				
Task 3-2b: Plant red-osier dogwood and clustered wild rose (see tasks 1-3b and c).				
Task 4-1a: Prepare short presentations for pre-work party pep talks.				


Task 4-1b: Be prepared to answer questions and provide guidance during work parties.
Original Plan
Actual Execution
Overlap

UW REN Restoration of Cotton Hill Park
Stewardship Plan

Prepared for: Sharon Rodman and Karen Story
Kirkland, Washington
May 2009

Kinsey Burke: UW Bothell, Environmental Studies
Kelley Govan: UW Seattle, Environmental Studies and English
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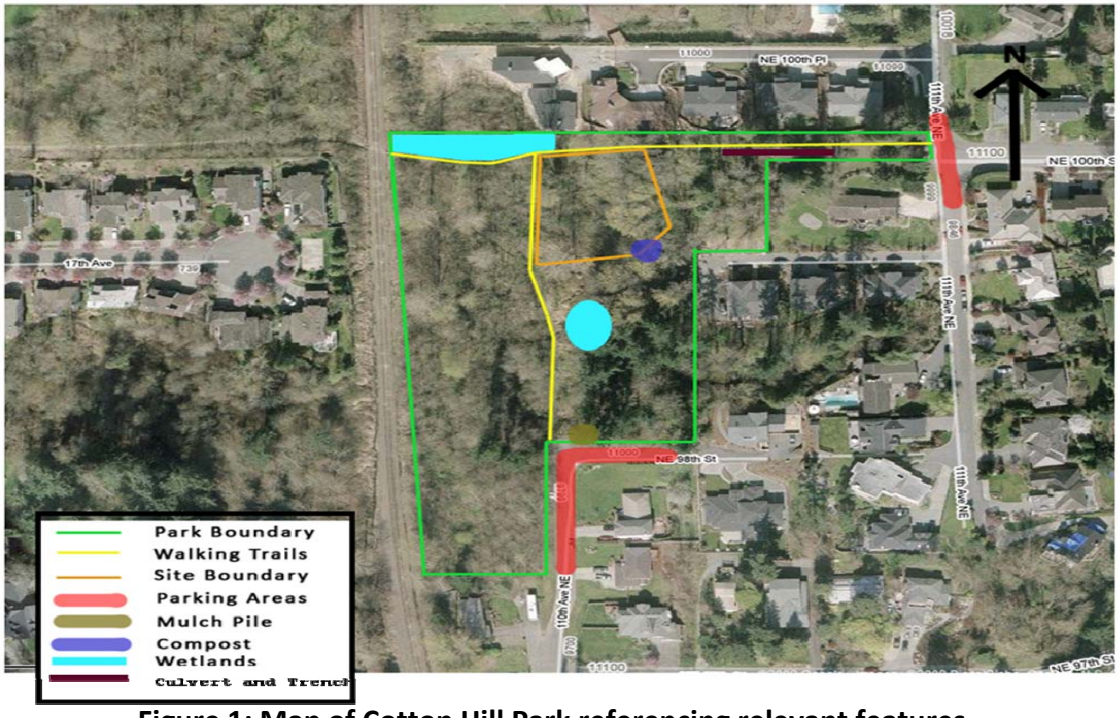

Figure 1: Map of Cotton Hill Park referencing relevant features

Project Description

Cotton Hill Park is an undeveloped 4.1 acre natural area, located within the Forbes Creek Watershed in Kirkland, Washington. The restoration site covers an area of approximately 7500 ft² near the northern edge of the park (Fig. 1). It lies to the southeast of the junction where the east-west and north-south paths meet. The park is bordered on three sides (north, east, south) by residential housing, some of which can be seen quite clearly to the north from the restoration site. The park is owned by the City of Kirkland, and they oversee the park's maintenance with volunteer assistance from the Highlands Neighborhood Association. Both groups have planned and conducted numerous improvement projects within the park, including removal of invasive species, mulching, native species planting, and the installation of the raised gravel paths that run through the park.

The pre-restoration conditions at the designated site were fairly degraded; the site was dominated by deciduous trees with sparse canopy cover and non-native, invasive species were well-established and dominant. The declining deciduous canopy allowed non-natives to invade and persist, which out-competed most native understory plants and prevented conifers from seeding within the site. The invasive species dominating the site included Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), Japanese or Bohemian knotweed (*Polygonum spp.*), and reed canary grass (*Phalaris arundinacea*). The most prominent native deciduous trees at the site were red alder (*Alnus rubra*), with a few big-leaf maples (*Acer macrophyllum*), black cottonwood (*Poplar balsamifera*), common hawthorn (*Crataegus monogyna*), and Pacific crabapple (*Pyrus fusca*). The pre-restoration site conditions did not resemble the historical site conditions, which would have been that of a lowland conifer forest. There are a few conifers in the surrounding areas of the park, but none pre-existed at the restoration site. The site was severely degraded by the invasive plants, threatening the health of the deciduous canopy, and hindering succession of a mixed conifer-deciduous stand.

For the restoration project within Cotton Hill Park, we established four goals in accordance with the objectives of the Green Kirkland Partnership:

- Promote forest succession and dominance of appropriate native vegetation

- Create hospitable conditions for native amphibians
- Improve habitat for native birds
- Promote ecological education and stewardship at the site

As-Built Site Description

(See As-built map, Figure 2)

Initially, the site was divided into 3 polygons based on soil type (polygons 1, 2, 3). Later the polygons were further sub-divided based upon existing canopy coverage, light availability, and to simplify communications about our planting plan (polygons 1a, 1b, 2a, 2b, 2c, 3a, 3b, 3c, 3d).

Starting at the northwest corner of the site where the paths converge, polygon 1a extends south 82 ft along the western edge of the site (bordering the north-south raised gravel path) in a strip about 3 ft wide, and gradually widens to 5 ft towards the end. This polygon extends about 20 ft south beyond the original southern border of the site. A few young red alders were growing in this area, along with invading reed canary grass and numerous sword ferns (*Polystichum munitum*). This polygon is the shadiest of all the polygons, and the soil remains saturated throughout the year. After the reed canary grass above-ground biomass was removed, the area was heavily mulched and planted with slough sedge (*Carex obnupta*) and small-fruit bulrush (*Scirpus microcarpus*) to shade out future re-growth of reed canary grass. Other species planted in this polygon include Alaska violet (*Viola langsdorfii*) and tassel fern (*Polystichum polyblepharum*); both these species like moist soil and are shade tolerant.

Polygon 1b starts in the same northwest corner and extends east 50 ft along the northern edge of the site, adjacent to the east-west gravel path. The area is narrow on the western edge of the polygon and gradually widens eastward, extending in to the site about 18 ft. This polygon has the least canopy cover and, as a result, is one of the sunniest spots within the site. Despite the inundation of sunlight, the soils are still very saturated throughout most of the year. Existing vegetation in this area consisted of creeping buttercup (*Ranunculus repens*), common horsetail (*Equisetum arvense*), common rush (*Juncus effusus*), trailing blackberry

(*Rubus ursinus*), and several sword ferns and lawn grass. The buttercup and lawn grass were removed before the area was heavily mulched. After site preparation, sawbeak sedge (*Carex stipata*), Nootka rose (*Rosa nutkana*), and clustered wild rose (*Rosa pisocarpa*) were planted closer to the trail. Piggyback plant (*Tolmiea menziesii*), fringecup (*Tellima grandiflora*), and salal (*Gaultheria shallon*) were planted in the interior of the polygon, where there is a slight rise so the soil is slightly less saturated there. One Oregon ash (*Fraxinus latifolia*)) was also planted in the western portion of the polygon. About 36 ft east of the T-intersection of the paths, a pond was dug to increase amphibian habitat. It measures about 7 ft long by 4ft wide at the southern end of the pond, and 6 ft wide to the north. The location for the pond was chosen due to its higher exposure to sun, as well as its tendency to collect water draining from the hill above. The perimeter of the pond was planted with sawbeak sedge, and common spike rush (*Elocharis palustris*) to provide shade for frogs and salamanders. Rock piles were added to provide sunning spots and hiding places. The Nootka and clustered wild rose species mentioned above will eventually provide some protection for the pond from trail users and their dogs.

Polygon 2a extends from the edge of 1a east for 35 ft and south of 1b for approximately 75 ft (including about 13-18 ft beyond the original border). The terrain is variable with one small ditch at the northeast section of the polygon and several small rises throughout. The soil is less wet than 1a and 1b, and is more claylike. This area was heavily dominated by Himalayan blackberry and a large, 24 ft x 28 ft patch of Japanese knotweed (the knotweed patch also extends into polygons 2b and 2c). Also present in this area were Pacific crabapple, red alder, common hawthorn, black cottonwood, hazelnut (*Corylus cornuta*), swordfern, trailing blackberry, salmonberry (*Rubus spectabilis*), and a large stand of fireweed (*Chamerion angustifolium*). Himalayan blackberry above- and below-ground biomass was manually removed and the area mulched. The knotweed was cordoned off for later herbicide treatment by the City of Kirkland. The polygon was subseqently planted with mostly native shrub species and a few conifers. Species include autumn fern (*Dryopteris erythrosora*), tassel fern, salal, clustered wild rose, vine maple (*Acer circinatum*), red-osier dogwood (*Cornus sericea*), fringecup, Indian plum (*Oemleria cerasiformis*), black twinberry (*Lonicera involucrate*), snowberry (*Symphoricarpus alba*), red huckleberry (*Vaccinium parvifolium*), Douglas-fir

(*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*). Species were chosen for partial shade tolerance and varying soil moisture in the polygon due to micro topography.

Polygon 2b extends east from 2a for about 26 ft. From the northern path, it forms a small spur that angles southeast into the site, then widens and extends south for 56 ft. It is partly sunny in the northern end and partly shady in the interior. The soil is less wet than 1a and 1b, and tends to be more claylike. This area was covered in Himalayan blackberry, with English ivy clambering into it from the east. Some of the Japanese knotweed patch extends into this polygon as well. Pre-existing native vegetation included red alder and a large patch of salmonberry. Himalayan blackberry and English ivy above- and below-ground biomass was manually removed and the area heavily mulched. One large hummock was built to provide drier conditions for some species, including some shrubs and conifers. Species planted within the polygon include clustered wild rose, Pacific ninebark (*Physocarpus capitatus*), red-osier dogwood, salal, cascara (*Frangula purshiana*), vine maple, twinberry, Indian plum, western red cedar, western hemlock (Tsuga heterophylla), and Douglas-fir. Species were chosen for forest succession as well as partial-sun and partial-shade tolerance.

Polygon 2c moves south from 2b to the southern border for 40 ft (including an 8 ft buffer beyond the original border), and about 10 ft east from the knotweed patch. This polygon has little to no canopy and is mostly full sun, with areas of partial sun. The soil is also claylike, but less so than polygons 2a and 2b. Pre-restoration, the polygon contained Indian plum and an abundance of native salmonberry patches, which were intertwined with Himalayan blackberry and English ivy. Much of the knotweed patch extended into this area as well. Himalayan blackberry and English ivy above- and below-ground biomass were manually removed and the area heavily mulched. Due to the strong presence of native salmonberry here, not many plants were needed. However, one black hawthorn (*Crataegus douglasii*) and some Sitka spruce (*Picea sitchensis*) were planted here to promote forest succession.

The original polygon 3 was fairly small and covered the northeast and southeast corners, but it was expanded during work parties to create a buffer zone. On the northeastern most part of the original site, polygon 3a, the ground slopes up slightly at about 10-15% and has drier, sandier soil conditions than polygons 1 and 2. The polygon extends along the northern path for

20 ft and into the interior of the site for 43 ft in a triangular shape. The area is partly sunny and has a large deciduous canopy, created by mature big-leafed maple and red alder, which were ringed by Himalayan blackberry. After the Himalayan blackberry above-and below-ground biomass was manually removed, the area was mulched and a small hummock was built. Species planted in this area include Pacific ninebark, salal, vine maple and clustered wild rose.

Polygon 3b starts 43 ft south of the northern boundary, extending all the way down to the southern border and stretches east 30 ft at its widest point. This polygon was not included in the original polygon 3, and it was created to act as a buffer between the site and the non-restored areas to the east. This section is partly shady, slightly elevated, with drier, sandier soil. It was nearly impenetrable due to extensive English ivy blankets and some interspersed Himalayan blackberry; these were removed, as above, to form a buffer zone around the site. One prominent feature of this section is a large willow (*Salix spp.)* lying on its side that continues to grow. It takes up considerable space and adds character to the site, as well as bird perches. Species planted in this polygon were mainly conifers with some shrubs and groundcover to discourage re-growth of English ivy and promote forest succession. Most were planted in the northern part of the polygon, leaving the southern part as an unplanted buffer. They include salal, vine maple, Indian plum, cascara, western red cedar, and western hemlock.

Polygon 3c is a sunny, small triangle in the southeast wedged between 2c and 3b. It was originally the southeast border. The section had some Himalayan blackberry growing amongst the native salmonberry. It was removed and the area mulched and planted with snowberry, Sitka spruce and thimbleberry (*Rubus parviflorus*) to promote forest succession.

Polygon 3d extends 24 ft east of our original border, along the northern boundary, and about 43 ft into the interior of the site. It lies on a slope of a 20-25% grade, and is sunny with the dryer, sandy soil. A large patch of Himalayan blackberry was removed from this area. A hummock was constructed and many shrubs were planted with a few conifers. Species planted were Pacific ninebark, mock orange (*Philadelphus lewisii*), a hybrid flowering dogwood (*Cornus X Eddie's white wonder*), salal, vine maple, Indian plum, western red cedar, and western hemlock. Species were chosen to promote forest succession.

As-Built Map

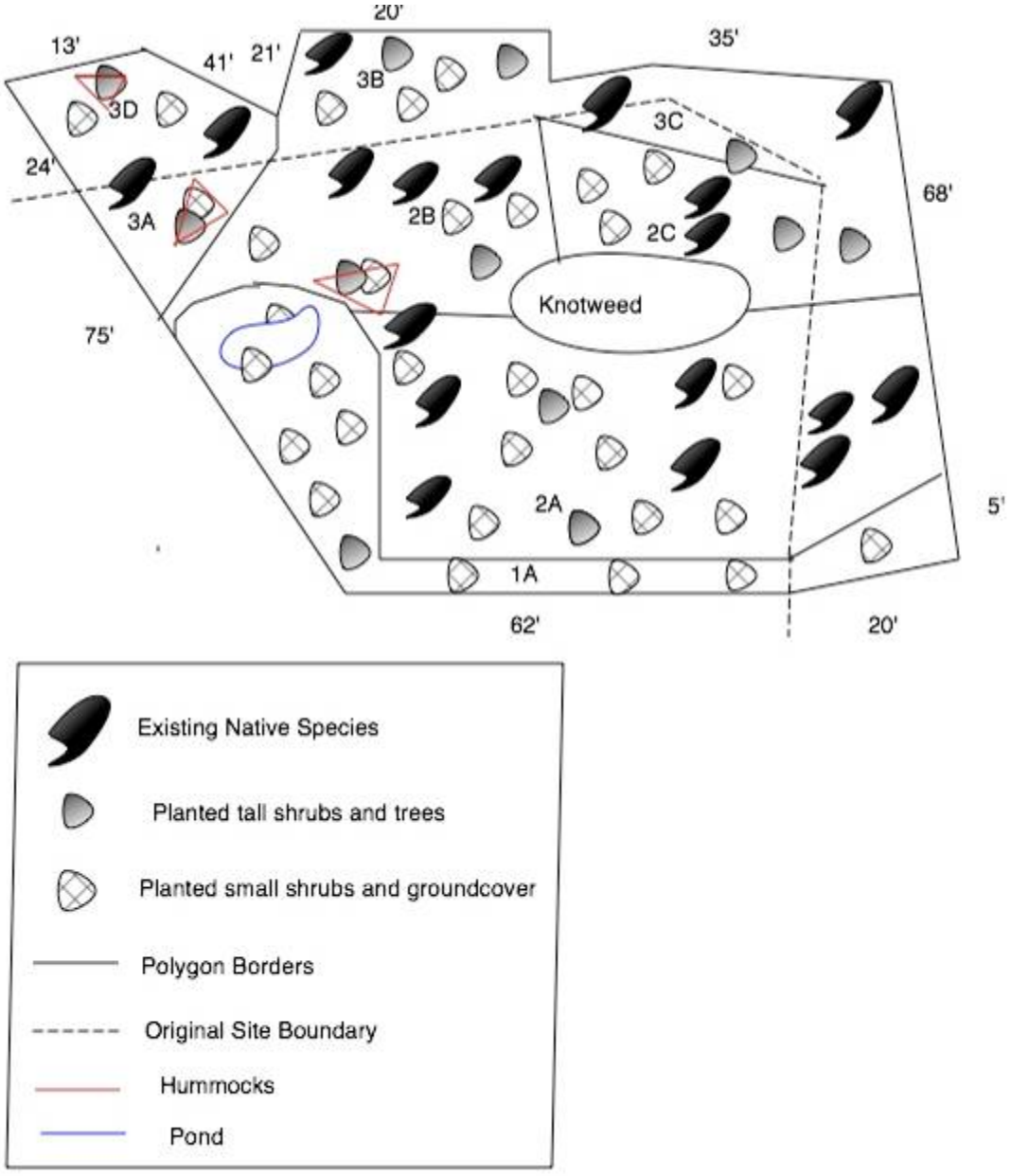

Figure 2: As-built map showing existing vegetation pre-restoration, and post-restoration installation locations of shrubs, trees, hummocks, and the vernal pond.

Maintenance tasks

Plant Care

Watering

Why: Young or transplanted plants have small root systems. It will take them time to establish well-developed root systems that can provide the nutrients they need. Until that time, they need some assistance in the form of watering.

Where: During the summer months, many of the installed plants may need watering. Focus on polygon 3, as it will be the driest. Elevated hummocks may also require special attention and extra watering.

When: During the summer (~June – September), an assessment of the site should be made every week or two by just one or two volunteers. Check for wilting leaves. If a plant is found with wilting leaves, check the soil at the base of the plant. If the soil is dry, the plant needs water. During the fall and spring months, check during dry periods of more than 4 days.

Resources and tools: There is no usable water available on site. The vernal pools dry up during the summer, and any water in the pond should be left as habitat. Water will have to be brought in from offsite to water the plants.

How: Using a bucket, pour ½ to 1 gallon of water at the base of the plant. This should be enough to moisten the root zone. Do not pour water over the entire plant. If time does not allow the watering of all plants in need, water the driest ones first. These plants are most likely to be the ones along the trails, since that is where the most sunlight gets through the canopy.

Plant Replacement

Why: There will be some mortality among the plants we installed, due to transplant stress and difficulty of cuttings establishing. Replacing dead plants will help to suppress the re-growth of invasive species, provide wildlife habitat, and lead to the eventual development of the targeted mixed evergreen-deciduous forest.

Where: Throughout the site, with special attention to polygon 3. It is the driest and may be the most likely to incur mortality.

When: During the winter months, over the next three to five years.

Resources and tools: Tools include shovels, spades, and wheelbarrow to transport dead trees to the plant material pile for removal. Contact the Kirkland Parks Department to obtain these tools and replacement plants.

How: Inspect all plants throughout the site at the end of summer or beginning of fall. Check for dead or dying plants and note their location with a flag. In winter, remove the dead trees and replace them. If it was a single plant of a species that died, replace it with the same species and of a similar size. However, if an entire species is experiencing high mortality, then they should be replaced with a different native species that is tolerant of the site conditions.

Invasive Control

Invasive removal

Why: Removing invasive plants from the site will aid in the growth and establishment of native species by eliminating competition for resources.

Where: Check the entire site, paying special attention to the south and east borders. Blackberry and ivy will likely come in at these borders due to the yet to be controlled invasives adjacent to the site.

When: Check the site every spring to catch new plants as they are just emerging and again in the fall or winter to catch any missed during the spring cleanup.

Resources and tools: For blackberry, you will need a pair of gloves, pruners, and a shovel. The ivy will require a pair of pruners. A wheelbarrow is handy for carrying removed plants off of the site. Buttercup can be removed with a small trowel. These tools can be obtained from the Kirkland Parks Department. Any Japanese knotweed will have to be removed by the parks department. Contact them to arrange that.

How: To remove blackberry, first cut the stalk about 1 foot above the ground. Remove any loose vines by pulling them out. Next, dig around the stalk to remove as much of the root mass as possible. Ivy can be removed by pulling it out of the ground. The roots can be very long, but they are buried shallow and gently pulling will bring them out of the ground. If the ivy is growing up a tree, cut a 1 foot section out of the ivy all the way around the tree. Pull off and remove the ivy below the cut. The ivy above the cut can be allowed to die, making it easier to remove later. To remove buttercup, just dig under the roots with a small trowel and remove the plant.

Mulching

Why: A thick layer of mulch is important in preventing re-establishment of invasive species. It also helps to retain moisture in the soil, prevents erosion, and eventually provides nutrients to the plants as it breaks down.

Where: Check the entire site, especially where reed canary grass is growing nearby (polygon 1). After removing any blackberry or ivy, apply mulch to any areas where invasives were found or the mulch is less than 4 inches thick. If any area is experiencing a high mortality rate, then that section should be targeted for increased mulching to increase moisture retention.

When: This should be done at the same time as the invasive removal to help prevent invasives from coming back.
Resources and tools: You will need a shovel, rake, and wheelbarrow. Mulch and tools may be provided by the Kirkland Parks Department and delivered to the site. Two weeks notification is needed for mulch delivery.

How: If mulching in an area where invasive species were growing, mulch should be applied after any invasives were removed. Shovel mulch from the pile at the south entrance of the park into a wheelbarrow. Dump the wheelbarrow in the area needing mulch. Take care not to dump the mulch onto any plants in the area. A five gallon bucket can also be used to transport mulch if the area to be mulched does not need a lot, or if it is difficult to get to with a wheelbarrow. Spread the mulch evenly with the rake to a thickness of 4 to 6 inches.

Habitat feature maintenance

The On-Site Frog Pond

Why: Amphibians have specific breeding and living condition requirements to thrive in the park, such as: water, places to sun themselves, places to hide, plants that attract insects for food, places to lay eggs, easy access from one pond to another.

Where: The frog pond located at the northern edge of the site.

When: during the semiannual invasive removal check in the spring and fall/winter as well as early summer.

Resources and tools: Woody debris can be found throughout the park. Rocks will need to be brought in to the site by volunteers. Ask the Kirkland Parks Department for gravel or rock.

How: Ensure that there are multiple ways for frogs to move easily in and out of the pond. Maintain the slopes at a shallow angle. Lay branches part in the water and part on the shore. Ensure that there are piles of rocks around the pond to provide shelter and sunning. Restack some rocks if the piles have fallen over. Allow crevices that amphibians can crawl in and out of. The water should dry up no sooner than late June to protect the habitat from invasive bullfrogs. Allow this to happen. If the pond is drying up sooner or not maintaining hydrology during the wet season, consult with Kirkland Parks about site hydrology and what may be done to remedy the situation.

Bird snags

Why: Snags create good habitat for birds in the park, but rotten snags could pose a danger to people.

Where: Snags are located throughout the site. Look for trees that are tall and no longer producing leaves. Other signs include bark that is coming loose from the trunk.

When: Snags should be checked in the fall before winter storms can bring them down.

Resources and tools: A hammer and a flat screwdriver

How: Pound the screwdriver into the snag with the hammer. If the wood is solid, it will not go in easily. If the snag has decayed significantly enough to be a potential hazard, the screwdriver should easily penetrate into the middle of the trunk. A snag that has sound wood may be unstable in the soil. Give it a light push, if the soil at the base of the snag lifts up as it sways it is also a potential hazard. If the snag is found to be unstable and within reach of the trails it is potentially hazardous and will need to be removed. Contact the Kirkland Parks department to alert them to tall and large diameter snags and hazard trees. These should be removed by certified arborists. For small diameter (<6”) and shorter (<10’) hazardous snags, make sure everyone in the area knows that the snag is coming down and is out of the way. Gently push the snag over in a direction that will not harm any existing plants. The resulting hole can be used to install a new tree or shrub. Fallen snags should be left where they lie to provide surface habitat.

Signage Care

Cleaning

Why: A clean sign will look nicer in the park and will be easier for people to read.

Where: Signs will be located along the existing trails on the north and west sides of the site.

When: Check signs whenever you are in the park.

Resources and tools: A bucket of warm water with some environmentally safe soap and a rag. Another bucket of clean water is needed for rinsing the signs.

How: Gently wipe down the signs with the soapy water to clean off dirt. Use as little soap as possible to clean with. Rinse the signs off with clean water. If signs are damaged, illegible, or missing, contact the Kirkland Parks Department for a replacement.

Community outreach

Maintenance Work Parties

Why: To keep the community interested in the site and to maintain a healthy ecosystem of the park as a whole.

Where: At the park.

When: Twice a year.

Resources and tools: The Kirkland Highlands Neighborhood Association and the City of Kirkland maintain large volunteer databases from which to invite people to the maintenance work party on the site. The Kirkland Parks Department can supply all of the necessary tools for the work party.

How: Send out emails and post flyers at the park several weeks before the event. Contact the Kirkland Highlands Neighborhood Association for these resources. Plan to have people work from 10 am to 2 pm. Request RSVP's from everyone coming so that you are sure to have enough tools for everyone. Also send out a reminder email a week before the event, which may also get you more volunteers who had not previously sent an RSVP. All work party participants must sign a release form from the City of Kirkland before work begins.

Maintenance Timetable

Maintenance Task	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Watering					X	XX	XX	XX	X O			
Plant Replacement									X		X	
Blackberry Removal			X							X		
Ivy Removal		X		X		X		X		X		X
Reed Canary Grass Removal						X				X		
Mulching		O	O	O		O		O	O	O	O	O
Habitat Maintenance				X		X			X			
Educational Signage					O						O	
Work Parties				X		O				X		

Key:

Required:

X=Once a Month

XX=Twice a Month

Casual:

O=Recommended

Monitoring Methods

Goal 1*: Enhance the stability and diversity of the native wet to mesic, lowland Puget Sound, riparian forest located within Cotton Hill Park.*

Objective 1-1: Remove and suppress invasive plant species to allow establishment and growth of native tree, shrub, and groundcover species.

Benchmark1-1a: <40% groundcover (from original level of 90% ground-cover) in the first year following Himalayan blackberry biomass removal, application of arborist mulch layer and installation of native plant species.

Monitoring method 1-1a: Visually estimate percent cover in 5% increments of Himalayan blackberry in the spring, in each of the three 2 m x 2 m monitoring plots. Compare estimates to baseline data, based on original site conditions. See monitoring form, Appendix A.

Benchmark1-1b: <20% groundcover biomass (from original level of 50% ground-cover) and <5% new canopy biomass in the first year following English ivy biomass removal, application of arborist mulch layer and installation of native plant species.

Monitoring method 1-1b: Visually estimate percent cover in 5% increments of English ivy in the spring, in each of the three 2 m x 2 m monitoring plots. Compare estimates to baseline data, based on original site conditions. See monitoring form, Appendix A.

Benchmark1-1c: <5% groundcover from original level of 10% ground-cover, in the first year following reed canary grass biomass removal, application of arborist mulch layer and installation of native plant species.

Monitoring method 1-1c: Visually estimate percent cover in 5% increments of reed canary grass in the spring, in each of the three 2 m x 2 m monitoring plots. Compare estimates to baseline data, based on original site conditions. See monitoring form, Appendix A.

Benchmark 1-1d: 90% reduction in knot weed population in the first year following herbicide treatment by City of Kirkland restoration practitioner. >90% reduction in knotweed population by the second year following herbicide treatment.

Monitoring method 1-1d: Visually estimate percent cover in 5% increments of knotweed in the spring, in the roped-off plot. Compare estimates to baseline data, based on original site conditions. See monitoring form, Appendix A.

Objective 1-2: Install site-appropriate native conifers that will eventually replace short-lived deciduous canopy species.

Benchmark 1-2: >45% survival in two years of all conifers planted: western red cedar, Douglas-fir, Sitka spruce, and western hemlock.

Monitoring method 1-2: Count the number of conifer trees that have died in the spring and compare that number to the baseline data (original number planted), then the conifer population levels following installation can be determined. See monitoring form, Appendix A.

Objective 1-3: Install native shrubs and herbaceous perennial groundcovers to replace the invasive plant species

Benchmark 1-3: At least 90% of the planted woody shrub species will survive after 1 year of planting.

Monitoring method 1-3: Count the number of woody shrubs that have died in the spring and compare the number to the baseline data, which is based on shrub population levels after installation. See monitoring form, Appendix A.

Goal 2: Improve amphibian and reptile habitat at this site to attract such species as Pacific tree frog, red-legged frog, western red-backed salamander, ensatina salamander, northern alligator lizard, and northwestern garter snake.

Objective 2-1: Create new and preserve existing amphibian breeding and hibernation features.

Benchmark 2-1a: Constructed pond should maintain some standing water through at least mid-June at which time drying is expected and beneficial for native frog species.

Monitoring method 2-1a: Assess and note the water level of the amphibian pond in the spring, and check for frog eggs and tadpoles.

Benchmark 2-1b: Vegetation planted around pools should achieve approximately 80-90% cover by year 4.

Monitoring method 2-1b: Visually estimate percent cover in 5% increments of vegetation surrounding the pond. Compare to baseline data of original levels after installation. See monitoring form, Appendix A.

Benchmark 2-1c: Installed amphibian habitat features (brush and rock piles) should remain at least 90% intact.

Monitoring method: Estimate how intact amphibian habitat features are compared to baseline data on original conditions of installed habitat features. See monitoring form, Appendix A.

Goal 3: Improve the quality of the bird habitat

Objective 3-1: Create new and preserve existing bird resting features

Benchmark 3-1a: >30% increase in snags on site within the next 2-3 years.

Monitoring method 3-1a: Take inventory of the number of snags present in the restoration site and compare to baseline data, based on original site conditions. See monitoring form, Appendix A.

Benchmark 3-1b: >45% survival in two years of all conifers planted: *T. plicata, P. menziesii, P. sitchensis,* and *T. heterophylla.*

Monitoring methods 3-1b: see monitoring method 1-2.

Benchmark 3-2: >70% survival rate after one year of fruit-bearing trees and shrub species: *P. fusca* (Pacific-crab apple), *C. douglasii* (black hawthorn), *R. purshiana* (cascara), *C. nuttallii* (Pacific dogwood), *S. albus (common snowberry), C. sericea* (red-osier dogwood) and *R. nutkana* (Nootka rose). >50% increase in fruit production that persists into winter months by year three.

Monitoring method 1-3: Count the number of fruit-bearing trees and shrubs that died, in the spring, and compare to baseline data based on population levels following plant installations, in June 2009. See monitoring form, Appendix A.

Goal 4: Promote ecological education, community volunteerism, and continued stewardship of the project site.

Objective 4-1: Educate work party volunteers in the ecological significance of native plant communities and the importance of stewardship.

Benchmark 4-1a: Pre-work party presentations will increase volunteer knowledge of native vegetation of the site and techniques for removing invasive species and/or proper site maintenance by at least 50%.

Monitoring method 4-1a: Hand out surveys to volunteers before and after pre-work-party presentations so comparisons can be made to assess volunteer knowledge and the effectiveness of educational efforts.

Benchmark 4-1b: Enhanced training received by the team leaders will enable them to answer 75% of simple questions posed by volunteers on the native vegetation and techniques.
DellaSala, et al.(2003), said that the scientists, forest practitioners, environmentalists, restoration workers, and other "team leaders" can be models of what to do and what not to do when restoring forests to assist with the volunteer citizen workforce.

Monitoring method 4-1b: Collect questions from volunteers about native vegetation and ecological restoration techniques, to use for training volunteer team leaders and other interested volunteers.

Objective 4-2: Construct and install signs at the site that explain to park visitors the value of native plant communities and the ecosystem services they provide

Benchmark 4-2a: The constructed educational signs should last at least 10 years.

Monitoring method 4-2a: Check signs for damage and replace as needed.

Benchmark 4-2b: Volunteer participation in stewardship activities will increase by at least 20 percent in terms of increased numbers of work-party volunteers in the next year.

Monitoring method 4-2b: Compile volunteer sign-up form data to estimate levels of volunteer participation in stewardship efforts.

Successional Management

The restoration work we conducted within Cotton Hill Park is leading the site toward a mixed conifer-deciduous forest. Our actions were in response to the eventual senescence of the deciduous canopy, the presence of invasive species, and the subsequent need for a long-term, ecologically stable ecosystem. On the UW REN 2008-2009 restoration site, we removed invasive plant species, installed a thick layer of mulch, and planted a diverse selection of native sedges, shrubs, deciduous, and coniferous trees. We chose species to satisfy our design criteria: successional transition to a mixed conifer-deciduous canopy; increased shade to suppress invasive species; increase of fruiting species palatable to birds; and tolerance of seasonally saturated soils.

To achieve a mixed conifer-deciduous forest, we had to successfully plant conifers within the site so they can eventually become established and reproductively functional within the larger forested ecosystem. However, the conifers posed a challenge because they are variably tolerant of saturated soils, especially as saplings, and our site is saturated during winter months. We built three hummocks on the north-eastern half of the site to facilitate the growth of conifers, including Douglas-fir, western hemlock, western red cedar and Sitka spruce. The hummocks create a drier microclimate that increases growth and survival rates for conifers, aiding in their establishment within wetland microenvironments and ecosystems (Porter 2003). The hummocks were placed on the north-eastern half of the site (in polygons 2B, 3A, and 3D) because it is drier and slightly elevated than the rest of the site, which is conducive to conifer growth; conifers would most likely not have survived if we planted them along the western edge, which is very wet. We also chose to plant conifers in the eastern half of the site because they cannot be planted too close to the amphibian habitat, especially the vernal pool, because they will shade out some understory species crucial for amphibian habitat. Some additional conifers were planted without hummocks along the eastern side of the site where it is driest; this will test the success of the hummocks by comparing survival rates of hummock grown and non-hummock grown conifers. Monitoring should be done to determine the success of the hummocks, and more conifers should be planted using hummocks if that method was more successful than planting directly into the ground, and vice versa.

A significant component of the project was to increase and improve both avian and amphibian habitat on the site. To enhance the quality and quantity of bird habitat, we planted native shrubs and trees that have both overwintering and summer fruit, so there would be a year-round food supply. Bird presence and populations within the park should increase as time goes on, especially as further restoration actions occur within the park. More fruiting trees, and especially shrubs, should be planted over the next few decades to ensure the quantity and quality of bird habitat is maintained and even increased. Birds will enhance the value of the forest ecosystem at Cotton Hill Park by reinstating viable avian populations and increasing numbers of native plant species installed on the site through propagation of seeds. Birds will also provide aesthetic and educational benefits to neighbors and park visitors by allowing them to watch and listen to birds. However, it is important to note that the increased presence of birds within the site (and the park as a whole), will cause more invasive plant species seeds to be deposited on the site through their excrement. In turn this will lead to a higher chance of re-

invasion of invasive plants. Nevertheless, with continued invasive species management, control, and increasing canopy cover to shade out some invaders, the benefits of having birds in the park will outweigh this disadvantage. Additionally, to amplify amphibian habitat, we created a small, 4 by 7 foot vernal pool on our site. The pool has already successfully filled and maintained a high water level for the last few weeks; it will probably be empty by the end of summer, but thus is the nature of vernal pools. We also found two long-toed salamanders on the site in April 2009, near the vernal pool, and tadpoles in the pool at the end of May 2009, which are good signs that amphibians do, and can, live within the park. We also released a dozen Pacific chorus frogs within the site, so there are high hopes that there will be an increase of native amphibian life.

A mixed conifer-deciduous forest was chosen as the target ecosystem for several reasons. First of all, there is existing deciduous canopy cover throughout the entire park. However, the existing deciduous canopy will not be around in 50 to 100 years due to the shorter life spans of deciduous trees, so we planted conifers so there will be adequate, long-term canopy over this time span. In addition, we also planted more deciduous trees to supplement the existing canopy, mainly because they will be able to provide canopy cover when the older, existing deciduous trees begin to die off. For our site and the park as a whole, the mixed conifer-deciduous canopy ecosystem will maximize ecological benefits because the mixed forest is both productive and fairly stable. Both coniferous and deciduous trees will provide canopy cover, shade, and wildlife habitat; however the existing deciduous canopy will dominate while the conifers are growing. Conifers will provide habitat and canopy cover during the winter months when the deciduous trees have dropped their leaves. In addition to habitat benefits, the diversity of plants will allow the mixed conifer-deciduous forest to provide aesthetic benefits to the community around the park. The mixed canopy cover will allow for a higher diversity of species, especially in the next 50 years, because it will take that long for the conifers we planted to become dominant. With a mixed dominance forest, park visitors and neighbors adjacent to the park will be able to gaze into the forest to see birds and the trees and not have their view blocked by large conifers. Compared to a monoculture of conifers or deciduous trees, the plant diversity of groundcover, shrubs, and both coniferous and deciduous trees will be the most aesthetically pleasing forest ecosystem to look at; the mixture of deciduous and coniferous trees is important because conifer dominated ecosystems are less productive and dramatically reduce understory diversity.

If the ecosystem follows the developmental trajectory we initiated, in about 20 years the conifers will begin to become physically dominant, produce seeds, and provide shade. The seeds will hopefully lead to more conifers, and the branches will provide shade to control and inhibit invasive plant re-growth. In 20 years the understory of shrubs and groundcover will be well-established, providing much needed wildlife habitat and food sources, especially for birds. Then in 50 to 100 years, the site will have a canopy dominated by conifers with deciduous trees dominating the margins along the trails. The conifers will be reaching maturity, producing more cones, and providing even more shade to control invasive plants. There will be a fair variety of shrubs and groundcover species, but these will be shaded out in the areas under the conifer canopy, which will decrease understory diversity.

To ensure the long-term attainment of the mixed deciduous-conifer forest, further restoration activities will need to be conducted on the site. First of all, more species will need to be planted, especially to account for mortality rates among seedlings and transplanted species. The conifers we planted will provide a solid foundation for future growth; however if they are not adequately watered or cared for their survival may be limited (though they may die from lack of sufficient ideal growing environments). More conifers will need to be planted within the next 5 to 10 years along the eastern half of the site to ensure the eventual establishment of a conifer canopy within 50 to 100 years. Additionally, more deciduous trees and shrubs should be planted over the next few decades throughout the site to maintain canopy cover and understory diversity over the long term. Once the Japanese knotweed is successfully eradicated, deciduous trees and shrubs should be planted in there to prevent further establishment of invasive species (especially if bird populations do increase). Groundcover species and small shrubs should be planted along the trails bordering the site; taller species should be planted in the interior of the site to maintain the aesthetic benefit of being able to look into the forest. Planting small shrubs and groundcover by the gravel trails will also create buffer zones between the human-use areas and the mixed conifer-deciduous forest. These small shrubs will also protect wildlife habitat from dogs and off-trail walkers by forming a barrier. If the site is managed and maintained on a regular basis, over time it will become a forested urban wetland with a mixed deciduous-conifer canopy, adequate diversity of understory species, and viable habitat for birds and amphibians. Not only will the site be ecologically functional, but it will be aesthetically and personally beneficial to humans who use and visit the park.

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Appendices

Appendix A: Restoration Site Monitoring Form

PLOT	**SPECIES**	**#LIVE**	**#DEAD**	**%COVER**	**RECRUIT?**	**LAYER**
1-A	TEGR	1				G
	ROPI	1				S
	POPO	2				G
	EQAR	3				G
	CAOB	5				G
	SCMI	2				G
totals	**natives**	14	0	100%		
	invasives	0	0	0%		
1-B	PHLE	1				S
	DREX	1				G
	PHCA	1				S
	TOME	1				G
	RARE	2 patches		25%		G
totals	**natives**	4	0	75%		
	invasives	2	0	25%		
2-A	COSE	1				S
	SYAL	1				S
	DRER	1				G
	POPO	1				G
	GASH	1				G
	EQAR	3				G
	TOME	2				G
totals	**natives**	10	0	100%		
	invasives	0	0	0%		
2-B	ALRU	3				C
	ACCI	1				C
	RHPU	1				C/S
	RUSP	1				S
	RUUR	3		10%		G
	POMU	1				G
	EPAN	3 patches		15%		G
totals	**natives**	13	0	100%		
	invasives	0	0	0%		
2-C	PISI	1				C
	SYAL	2				S

	OECE	1		50%		S
	POMU	1				G
	RUUR	4		25%		G
	POCU	1 patch		20%		S
totals	**natives**	9	0	80%		
	invasives	1	0	20%		
3-A	OECE	1		100%		S
	EQAR	12		50%		G
	RUUR	4		10%		G
totals	**natives**	17	0	100%		
	invasives	0	0	0%		
3-B	TSHE	1				C
	ACCI	1				C
	OECE	1				S
	GASH	1				G
total	**natives**	4	0	100%		
	invasives	0	0	0%		
3-C	PISI	1				C
	RUSP	1		30%		S
	OECE	1		20%		S
	EQAR	8		30%		G
totals	**natives**	11	0	100%		
	invasives	0	0	0%		
3-D	PHCA	1				S
	PHLE	1				S
	OECE	4		30%		S
	POMU	1				G
totals	**natives**	7	0	100%		
	invasives	0	0	0%		
Pond						
	CAST	12		70%		G
	ELPA	10		30%		G
total	**natives**	22		90%		
	invasives	0		0%		
Rock piles		4				
Snags				15%		

Appendix B: Plant codes for monitoring sheets

PLANTS PRESENT AT COTTON HILL SITE

COMMON NAME	SCIENTIFIC NAME	CODE	POLYGON	INSTALLED OR NATIVE
Big leaf maple	*Acer macrophyllum*	ACMA	3	native
Black cottonwood	*Populus balsamifera*	POBA	2,3?	native
Red alder	*Alnus rubra*	ALRU	2,3	native
Western redcedar	*Thuja plicata*	THPL	2,3	installed
Douglas-fir	*Pseudotsuga menziesii*	PSME	2,3	both?
Sitka spruce	*Picea sitchensis*	PISI	2,3?	installed
Western hemlock	*Tsuga heterophylla*	TSHE	2,3?	both?
Hazelnut	*Corylus cornuta*	COCO	2	
Black hawthorn	*Crataegus douglasii*	CRDO	2	installed
Common hawthorn	*Crataegus monogyna*	CRMO	2	native
Pacific crab apple	*Malus fusca*	MAFU	2	native
Cascara	*Rhamnus purshiana*	RHPU	2,3	installed
Pacific ninebark	*Physocarpus capitatus*	PHCA	2,3	installed
Vine maple	*Acer circinatum*	ACCI	2,3	installed
Dogwood	*Cornus x 'Eddie's White Wonder*	COEW	2,3	
Nootka rose	*Rosa nutkana*	RONU	2	installed
Swamp rose	*Rosa pisocarpa*	ROPI	2.3	installed
Red-osier dogwood	*Cornus sericea*	COSE	2?	installed
Snowberry	*Symphoricarpos albus*	SYAL	2,3	installed
Thimbleberry	*Rubus parviflorus*	RUPA	2,3	installed
Black twinberry	*Lonicera involuncrata*	LOIN	2?	installed
Cascade Oregon grape	*Mahonia nervosa*	MANE	2,3	installed
Indian plum	*Oemleria cerasiformis*	OECE	2,3	installed
Red huckleberry	*Vaccinium parvifolium*	VAPA	2	installed
Salmonberry	*Rubus spectabilis*	RUSP	2,3	installed
Bleeding heart	*Dicentra formosa*	DOFP	2	installed
Common rush	*Juncus effusus*	JUEF	1,2	native
Salal	*Gaultheria shallon*	GASH	1,2,3	installed
Slough sedge	*Carex obnupta*	CAOB	1	installed
Trailing blackberry	*Rubus ursinus*	RUUR	1,2,3	native
Western sword fern	*Polystichum munitum*	POMU	1,2,3	native
Fringecup	*Tellima grandiflora*	TEGR	1,2,3	both
Piggyback plant	*Tolmia menzieii*	TOME	1,2,3,	installed
Common spike rush	*Elocharis palustris*	ELPA	1	installed
Fireweed	*Epilobium angustifolium*	EPAN	2	installed
Tassel fern			1, 2	installed
Autumn fern			2	installed
Sawbeak sedge	*Carex stipata*	CAST	1	installed
Small-flower bulrush	*Scirpus microcarpus*	SCMI	1	installed
Japanese knotweed	*Polygonum cuspidatum*	POCU	2	invasive

Appendix C: Map of monitoring plots and photo points

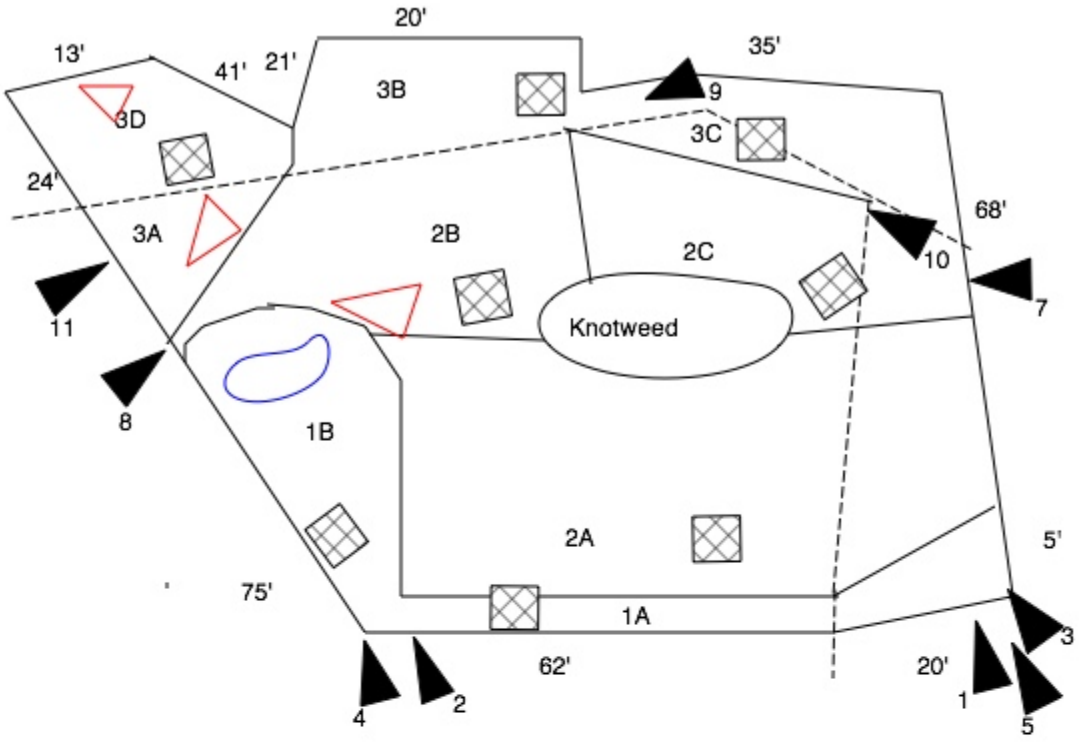

Photo Point

Monitoring Plot

Polygon Borders

Original Site Boundary

Hummocks

Pond

Photo Points

1. 350 degrees NWW at 5' height
2. 40 degrees NNE at 5' height
3. 320 degrees NW at 5' height
4. 40 degrees NNE at 5' height
5. 0 degrees N at 5' height
6. 140 degrees SE at 5' height
7. 300 degrees WNW at 5' height
8. 110 degrees ESE at 5' height
9. 340 degrees NWW at 5' height
10. 0 degrees N at 5' height
11. 130 degrees at 6' height

Appendix D: Pictures of the monitoring photo points

PHOTO POINTS: Cotton Hill Park Overall Site

1. Looking 350 degrees NWW from the SW corner of the site at a 5 foot height

2. Looking 40 degrees NNE along the northern border of the site from the NW corner at a 5-foot height

PHOTO POINTS: Restoration Site by Polygons

3. Polygon Section 1-A: Looking 320 degrees NW at a 5-foot height

4. Polygon Section 1-B: Looking 40 degrees NNE at a 5-foot height

5. Polygon section 2-A: Looking 0 degrees North at a 5-foot height

6. Polygon section 2-B: Looking 140 degrees SE at a 5-foot height

7. Polygon section 2-C: Looking 300 degrees WNW at a 5-foot height

8. Polygon section 3-A: Looking 110 degrees ESE at a 5-foot height

9. Polygon section 3-B: Looking 340 degrees NWW at a 5-foot height

10. Polygon section 3-C: Looking 0 degrees N at a 5-foot height

11. Polygon section 3-D: Looking 130 degrees ESE at a 6-foot height

Appendix E: Contact Information

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