North Creek Forest Stewardship Plan

University of Washington-Restoration Ecology Network

Capstone Course 2017-2018

Prepared for Friends of North Creek Forest and the City of Bothell

Sarah Witte - Friends of North Creek Forest Stewardship Coordinator

Tracey Perkosky - City of Bothell Parks Department Interim Director

Scott Purdy - City of Bothell Parks Maintenance Supervisor

Prepared by:

Rebecca Bruemmer - Environmental Science; University of Washington Seattle

Mahleah Grant - Environmental Studies; University of Washington Bothell

Candice Magbag - Environmental Science; University of Washington Bothell

Kendra Potoshnik - Environmental Science; University of Washington Seattle

Johnathon Rutledge - Environmental Studies; University of Washington Bothell

Table of Contents

List of Figures & Tables

Project Description

North Creek Forest is located in Bothell, Washington in the lowland forest of the Puget Sound region (Figure 1). Roughly 18 miles northeast of Seattle, the forest is situated just west of Interstate 405 and can be accessed via a 1.3-mile walk north from the University of Washington Bothell and Cascadia College campuses. Project Site 7 is located on the southeastern portion of North Creek Forest and is 0.27 acres (1093 m^2) in total area. The northern boundary of the project site is adjacent to the former property line of the neighboring household while the eastern boundary runs parallel along 112th Avenue NE, approximately 4 m from the edge of street that serves as the only access road to the project site.

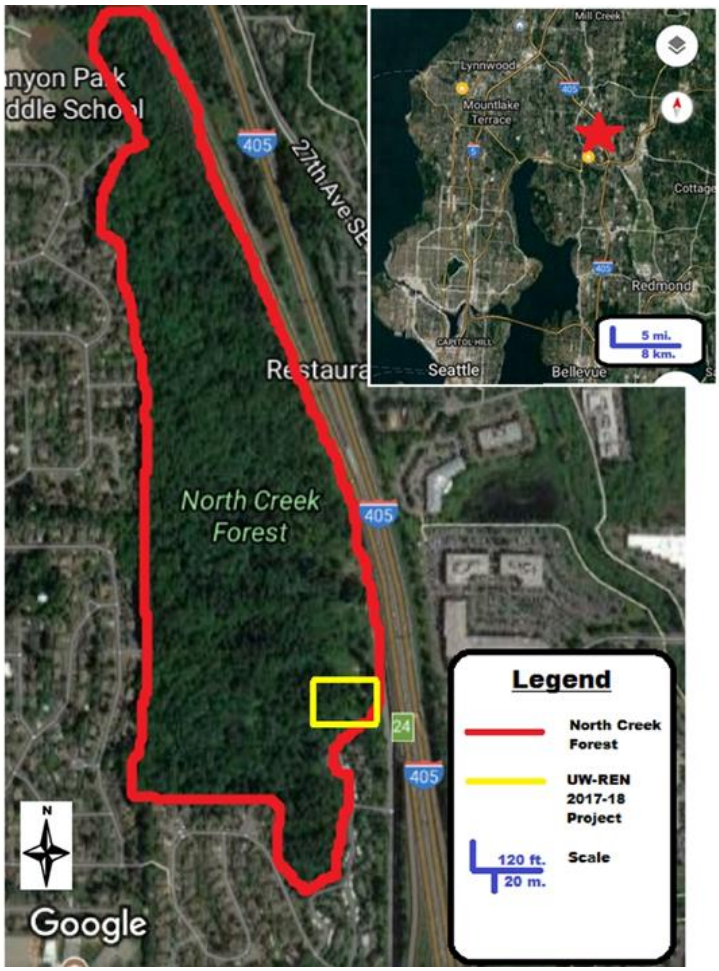

Figure 1. North Creek Forest in Bothell, WA with UW-REN 2017-18 Project Site 7 boundaries. Inset: Regional map of North Creek Forest in Puget Sound, Washington. Images: Google Maps

The UW-REN 2017-18 team is partnered with the City of Bothell and a community group, the Friends of North Creek Forest (FNCF), to restore Project Site 7. The Friends of North Creek Forest is a non-profit organization dedicated to improving the ecological function of North Creek Forest through conservation, education, and stewardship (FNCF). The City of Bothell is the landowner and ultimate authority over North Creek Forest. The ecological functions of Project Site 7 were impaired by a dominance of structurally and biologically-depauperate non-native vegetation. Ecological restoration of the site was needed to increase biodiversity and wildlife habitat, improving forest function by the renewal of the ecosystem's health (Higgs 1997). Restoration activities can provide opportunities to foster relationships between the surrounding communities and the forest, thereby building stewardship capacity for the North Creek Forest.

We had four main goals, or functional requirements, to address in order to successfully restore project site 7.

- **Goal 1:** Promote the establishment and dominance of native vegetation that reflects the surrounding upland forest and later matures into a typical Puget Sound region upland coniferous forest
- **Goal 2:** Improve habitat functions at North Creek Forest
- **Goal 3:** Improve forest resistance and resilience to human and natural disturbance
- **Goal 4:** Build stewardship capacity at North Creek Forest

With the assistance of our community partners and many dedicated volunteers, we removed almost all Himalayan blackberry (*Rubus armeniacus*) and English Ivy (*Hedera helix)* from project site 7. To prevent invasive species from returning, we planted native species that will shade out invasive species and provide habitat for wildlife. We spread roughly six (6) inches of wood chip mulch throughout the site and installed wood chip buffers to deter encroachment of Himalayan blackberry from the western and southern boundary.

Post-Installation Site Description with As-Built Maps

The restoration project site has been divided into five distinct polygons initially based on the most abundant vegetative species and vertical structure upon the initial site assessment conducted in October of 2017. The slope ranges from 12 % in the northwest corner and 9 % in the southwest corner, to a -1 % in the northeastern corner. Preliminary soil assessments conducted in the field suggest similar soil conditions throughout the project site and were initially noted as being sandy loam with some clay deposits.

Figure 2. Location of Project Site 7 within North Creek Forest
Images: Environmental Systems Research Institute (esri)

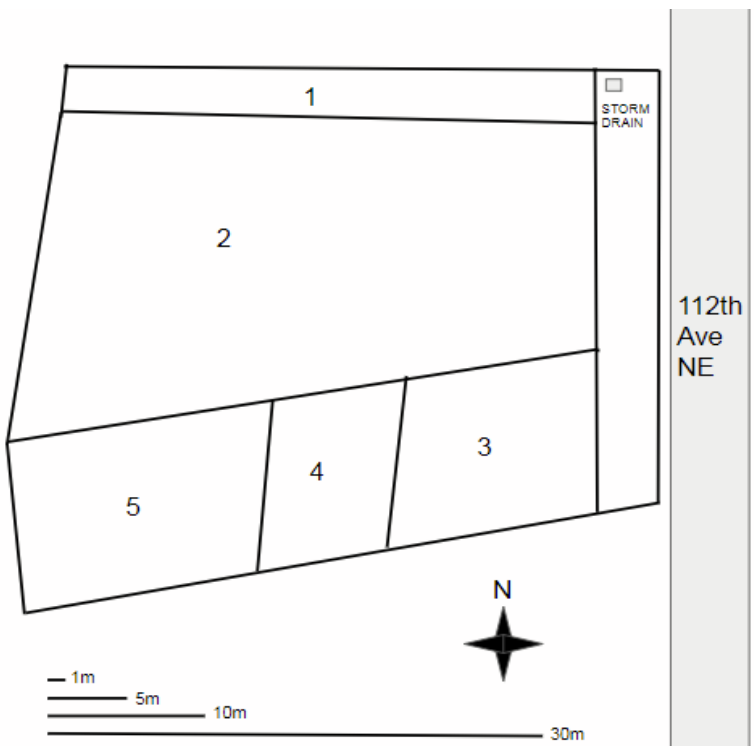

Figure 3. Map of polygons within the project site

Polygon 1

Polygon 1 (88.5 m^2) is the northernmost polygon and runs adjacent to the neighboring monoculture grass lawn. This polygon serves as a weak buffer between the aforementioned lawn and the forest of mixed deciduous trees of Polygon 2. The soil texture is of sandy clay loam that is well-drained, with the polygon resting on a 0-12% slope. There are no pre-existing trees rooted in Polygon 1; however, the canopy in this polygon is created by two Norway spruce (*Picea abies*) and two Bigleaf maple (*Acer macrophyllum*) just north of the project site boundary.

During the fall and winter seasons, the ground is covered by approximately 2 ft of leaf litter due to accumulated fallen leaves from the Bigleaf maples and elm (*Ulmnus* species) tree located on the adjacent lawn being leaf-blown by human activity onto the polygon. Some native Trailing blackberry (*Rubus ursinus*) was observed in a relatively low density coming in from the western edge of the polygon. Approximately 70% of this polygon was covered by non-native English ivy with the low presence of Himalayan blackberry, also non-native, protruding inward from the southern boundary of the polygon.

During restoration, the English ivy vines were pulled and the Himalayan blackberry removed completely by the roots. The area not covered by leaf litter has been mulched with coarse wood chips to about 4-6 inches deep. Three species of trees, Bigleaf maple, Western redcedar (*Thuja plicata*), and Sitka willow (*Salix sitchensis*), were planted in the polygon in the form of ½ gallon pots and livestakes (Figure 1, Table 1). 15 Indian plum (*Oemleria cerasiformis*) livestakes were also installed randomly throughout the western portion of the polygon (Figure 1, Table 1).

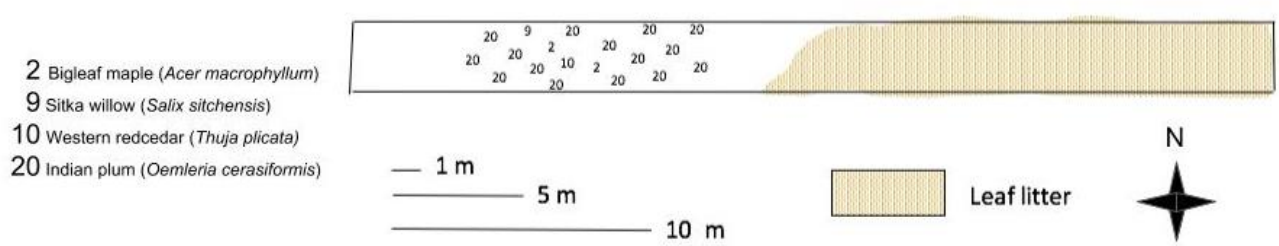

Figure 4. As-built map of Polygon 1

Table 1: Plant inventory - Polygon 1

Polygon 1				
Common name	**Latin name**	**#**	**Form**	**Planted/Existing**
Trees				
Bigleaf maple	*Acer macrophyllum*	2	½ gal pot	P
Western redcedar	*Thuja plicata*	1	½ gal pot	P
Sitka willow	*Salix sitchensis*	1	livestake	P
Shrubs				
Indian plum	*Oemleria cerasiformis*	15	livestake	P

Polygon 2

Polygon 2 (562 m^2) is situated between Polygon 1 and Polygons 3-5. It has an easterly slope aspect ranging from 2-12%. The soil texture is characterized as loamy sand and is well drained. This polygon contains an upper and lower canopy layer due to the slope gradient. Bitter cherry (*Prunus emarginata*) trees dominate the polygon and are accompanied by Pacific crabapple (*Malus fusca*), the remnants of a planted orchard. These factors result in 0-25% insolation at the ground level for Polygon 2, increasing in winter months with the loss of the Bitter cherry leaves. Bracken fern (*Pteridium aquilinum)* are native ferns found in relatively low abundance in this polygon. Himalayan blackberry was observed with high presence across the polygon, which grew into the canopy layer. Some English ivy crept in from Polygon 1. Himalayan blackberry was removed by the roots and pulled from the canopy, along with the English ivy from the ground and around the Bitter cherry tree trunks.

The polygon was heavily mulched, up to six (6) inches in depth. After heavy mulch was applied to Polygon 2, 174 plants were installed over five volunteer work parties in a mixture of live-stakes, bare-root and potted plants. A mixture of 62 trees, 89 shrubs and 23 herbaceous plants have been installed to initiate natural succession (Clewell and Aronson 2013).

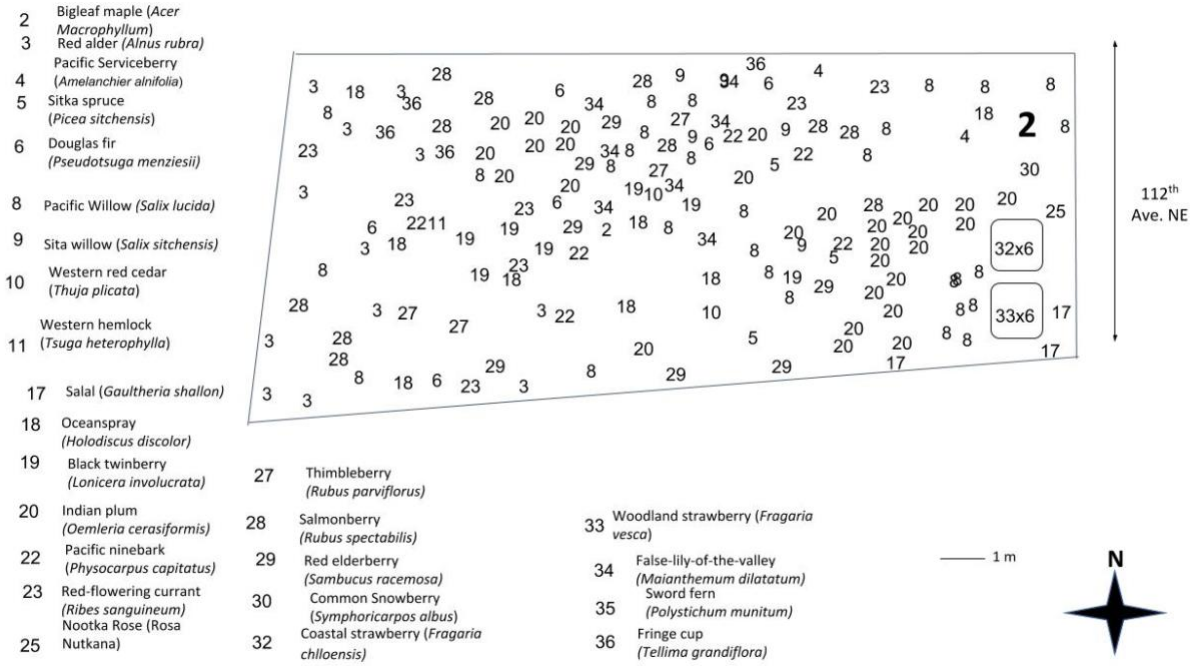

Figure 5. As-built map of Polygon 2

Table 2: Plant inventory - Polygon 2

Polygon 2				
Common name	**Latin name**	**#**	**Form**	**Planted/Existing**
Trees				
Red alder	*Alnus rubra*	12	1-gal	P
Pacific serviceberry	*Amelanchier alnifolia*	2	1-gal	P
Sitka spruce	*Picea sitchensis*	3	1-gal	P
Douglas-fir	*Pseudotsuga menziesii*	6	salvage/ 3-gal	P
Pacific willow	*Salix lucida*	30	livestakes	P
Sitka willow	*Salix sitchensis*	5	livestakes	P
Western redcedar	*Thuja plicata*	2	½ gal	P
Western hemlock	*Tsuga heterophylla*	1	1-gal	P

Shrubs				
Coastal strawberry	*Fragaria chiloensis*	6	salvage	P
Woodland strawberry	*Fragaria vesca*	6	salvage	P
Salal	*Gaultheria shallon*	3	½ gal	P
Oceanspray	*Holodiscus discolor*	8	1-gal	P
Black twinberry	*Lonicera involucrata*	7	1-gal	P
Indian plum	*Oemleria cerasiformis*	30	livestakes/ 1-gal	P
Pacific ninebark	*Physocarpus capitatus*	7	½ gal	P
Red-flowering currant	*Ribes sanguineum*	7	½ gal	P
Nootka rose	*Rosa nutkana*	1	½ gal	P
Thimbleberry	*Rubus parviflorus*	4	1-gal	P
Salmonberry	*Rubus spectabilis*	14	livestakes/ 1-gal	P
Red elderberry	*Sambucus racemosa*	2	1-gal	P
Common snowberry	*Symphoricarpos albus*	1	½ gal	P
Forbs				
False-lily-of-the-valley	*Maianthemum dilatatum*	7	4-in	P
Fringe cup	*Tellima grandiflora*	4	½ gal	P

Polygon 3

Polygon 3 (144.5 m^2) is located at the south-eastern edge of Site 7 adjacent to 112th. It has 0% slope; however, water flows downhill from the rest of the site. The soil is a well-drained sandy loam that remains fairly moist most of the year due to drainage from uphill. It has 75-100% ground insolation, making it the part of our site with the most sun exposure. This polygon was 100% covered by Himalayan Blackberry prior to restoration. There is a wall of Himalayan Blackberry (already growing over the telephone wires) bordering the southern edge of Polygon 3 that presents a threat of spreading. Along the eastern edge between Polygon 3 and 112th Ave, there is Reed Canary Grass (*Phalaris arundinacea*) that could potentially invade the polygon. Several piles of asphalt were discovered in Polygon 3.

Since Polygon 3 was previously a Himalayan blackberry monoculture, there were no plants left in the polygon after removal was completed. Due to the lack of canopy cover, sun-loving native shrubs such as Nootka rose and Oceanspray were installed. These species have been successful at other restoration sites nearby. Once the shrub layer is well established, we hope that more shade-loving understory species will spread from the other polygons. Polygon 3 was primarily planted with shrubs to prevent entanglement with power lines above, but we also wanted plants that would grow big enough to outcompete the encroaching Himalayan blackberry. On the western side of the polygon, which does not have power lines above it, we planted large shrubs and early successional trees that can tolerate drier, high-light conditions, such as Red alder, Douglas-fir, and Garry oak to create a canopy. Increased canopy cover will help shade out invasive species, in addition to creating more diverse habitat structure.

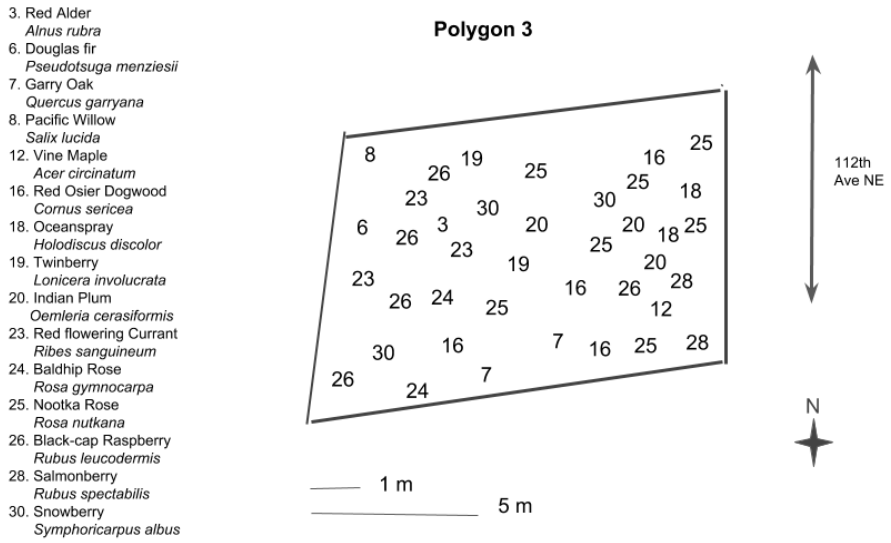

Figure 6. As-built map of Polygon 3

Table 3: Plant inventory - Polygon 3

Polygon 3				
Common name	**Latin name**	**#**	**Form**	**Planted/Existing**
Trees				
Red Alder	*Alnus rubra*	1	1-gal	P
Douglas-fir	*Pseudotsuga menziesii*	1	Bareroot	P
Shrubs				
Vine Maple	*Acer circinatum*	1	Bareroot	P
Red Osier Dogwood	*Cornus sericea*	4	1-gal	P
Oceanspray	*Holodiscus discolor*	2	1-gal	P
Twinberry	*Lonicera involucrata*	2	1-gal	P
Indian Plum	*Oemleria cerasiformis*	3	Livestakes	P
Red flowering Currant	*Ribes sanguineum*	3	Bareroot	P
Salmonberry	*Rubus spectabilis*	2	Bareroot	P
Garry Oak	*Quercus garryana*	2	1-gal	P
Baldhip Rose	*Rosa gymnocarpa*	2	Bareroot	P
Nootka Rose	*Rosa nutkana*	7	Bareroot	P
Blackcap Raspberry	*Rubus leucodermis*	5	1-gal	P
Pacific Willow	*Salix lucida*	1	livestake	P
Snowberry	*Symphoricarpos albus*	3	1-gal	P

Polygon 4

Polygon 4 (101.8 m^2) is located at the southern end of the site within Polygon 5. It contains a canopy composed of red alder trees. It has a 2-3% slope, a few rodent channels, and originally a surface organic material of leaf litter and woody detritus. The soil is of a clay loam texture and contains numerous pebbles up to three inches in diameter. *Pteridium aquilinum* (bracken fern) was observed in low abundance in Polygon 4 before restoration began, but it was damaged during the removal of Himalayan blackberry and subsequently died. Himalayan blackberry was present as a mid-tall shrub canopy layer that prevented other species from establishing. The Himalayan blackberry plants and roots were removed, and native plants were installed. These included two species of ferns, many native shrub species, and four tree species to create a canopy when the red alder trees die (Table 4).

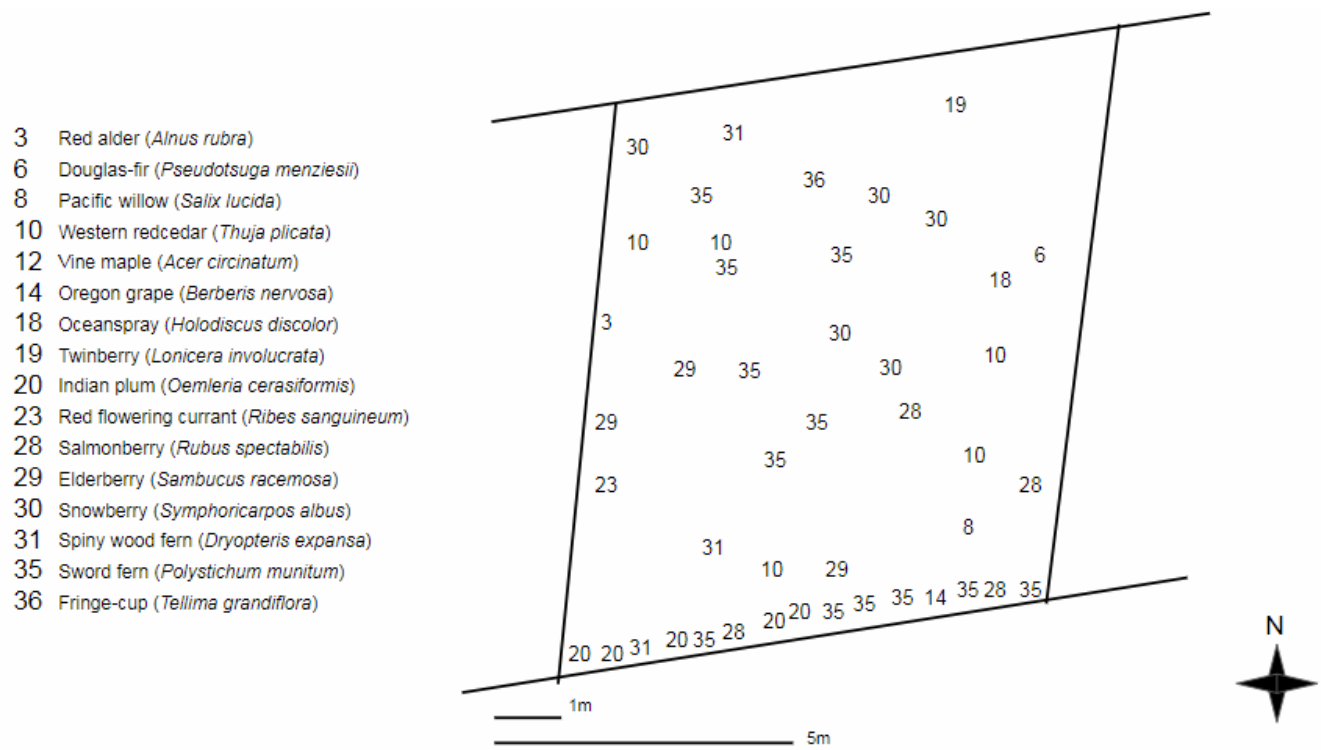

Figure 7. As-built map of Polygon 4

Table 4: Plant inventory - Polygon 4

Polygon 4				
Common name	**Latin name**	**#**	**Form**	**Planted/Existing**
Trees				
Red alder	*Alnus rubra*	10	--	E
Red alder	*Alnus rubra*	1	1-gal	P
Douglas-fir	*Pseudotsuga menziesii*	1	salvage	P
Pacific willow	*Salix lucida*	1	Livestakes	P
Western redcedar	*Thuja plicata*	5	½-gal	P
Shrubs				
Vine maple	*Acer circinatum*	1	Bareroot	P
Oregon grape	*Berberis nervosa*	1	½ gal	P
Oceanspray	*Holodiscus discolor*	1	1-gal	P
Twinberry	*Lonicera involucrata*	1	1-gal	P
Indian plum	*Oemleria cerasiformis*	5	Livestakes	P
Red flowering currant	*Ribes sanguineum*	1	Bareroot	P
Salmonberry	*Rubus spectabilis*	4	Livestake/ 1-gal	P
Elderberry	*Sambucus racemosa*	2	1-gal	P
Snowberry	*Symphoricarpos albus*	5	1-gal	P
Forbs				
Fringecup	*Tellima grandiflora*	2	½-gal	P

Ferns				
Spiny wood fern	*Dryopteris expansa*	2	1-gal	P
Sword fern	*Polystichum munitum*	12	1-gal	P

Polygon 5

Polygon 5 (196.3 m^2) had the highest occurrence of rodent burrows which contributed to the uneven terrain. It has the steepest slope of all the polygons (9%), the largest gap in the canopy layer and there was some large woody debris. The soil there has been characterized as sandy clay loam, and retains moisture well. Initial site assessments showed that both Sword fern and Bracken fern were present in low abundance. No trees were present and non-native Himalayan blackberry was found to be in high abundance throughout this polygon. As such, our approach was to remove the invasive both above and below ground, and then apply a six (6) inch layer of coarse wood chip mulch. We worked towards the goal of shading out Himalayan blackberry by planting to create an upper, middle, and shrub canopy layer. Additional planting considerations included provisions for soil stabilizing, wildlife habitat, cover, concealment, and native food resources.

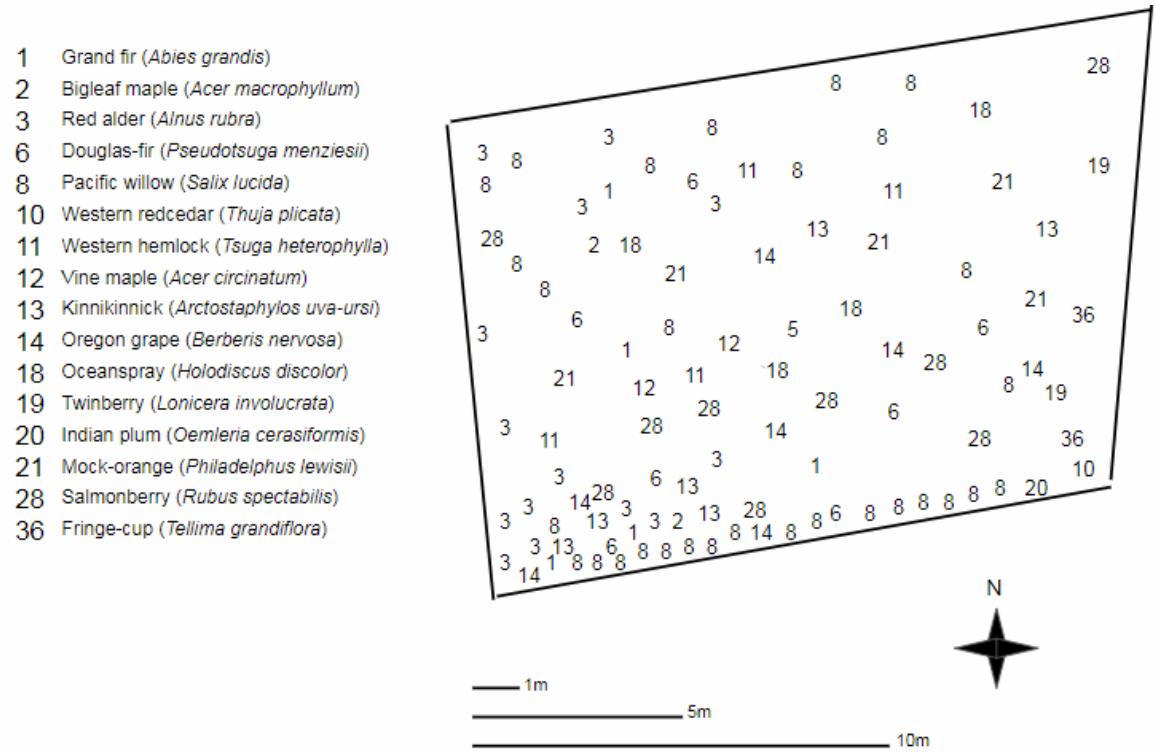

Figure 8. As-built map of Polygon 5

Table 5: Plant inventory - Polygon 5

Polygon 5				
Common name	**Latin name**	**#**	**Form**	**Planted/Existing**
Trees				
Grand fir	*Abies grandis*	4	1 gal	P
Bigleaf Maple	*Acer macrophyllum*	4	½ gal	P
Red Alder	*Alnus rubra*	12	½ gal	P
Sitka Spruce	*Picea sitchensis*	1	1 gal	P
Douglas-fir	*Pseudotsuga menziesii*	6	1-gal/ salvage	P
Western hemlock	*Tsuga heterophylla*	4	1 gal	P
Shrubs				
Dull Oregon grape	*Berberis nervosa*	7	½ gal	P
Oceanspray	*Holodiscus discolor*	4	½ gal	P
Twinberry	*Lonicera involucrata*	2	bareroot	P
Mock-orange	*Philadelphus lewisii*	6	bareroot	P
Salmonberry	*Rubus spectabilis*	8	livestakes	P
Pacific willow	*Salix lucida*	30	livestakes	P
Indian Plum	*Oemleria cerasiformis*	1	livestakes	P
Forbs				
Kinnikinnick	*Archtostaphylos uva-ursi*	10	Plugs	P

Maintenance Plan

Approach

As our time with Project Site 7 comes to an end, we must consider the future of our efforts. Restoring historic potential to the North Creek Forest will depend heavily upon the selfless endeavors of our Community Partners, future stewards, and volunteers alike. Each stage of ecological succession will undoubtedly present its own unique challenges and opportunities, but the maintenance approach will be vital to our overall success. One of the most essential components of our maintenance plan will be the assurance of adequate watering, as appropriate for each species. Although water is important, there are many other aspects to consider.

In support of *Functional Requirement 1*, Photo Monitoring and Vegetation Surveys will be used to visually assess plant growth, regeneration, and mortality. With the passing of each growth season, we plan to see increased presence among planted native vegetation. Ensuring its dominance will continue to promote the structural and biological diversity of the surrounding upland coniferous forest.

By monitoring the site for wildlife and pollinators, community partners will have the ability to assess the effectiveness of our habitat provisions in support of *Functional Requirement 2*. An additional component of the wildlife and pollinator monitoring will be the assessment of herbivory by any number of organisms. Our hope is that an increasing presence of organisms will utilize our site for migration stops, hibernation, nesting and cover or concealment. As the increased presence of native species decreases available microsites for those which are invasive, Project Site 7 will continue to improve the overall resilience of the forest. Enhancing its ability to resist impacts and disturbance will safeguard the efforts of *Functional Requirement 3*. Watching this section of the North Creek Forest develop and regenerate, we hope, will prove invaluable to the fostering of stewardship capacity that we sat out to ensure as per *Functional Requirement 4*.

Maintenance Task List

1. Plant Care

a. Irrigation

Why: Though rainy for much of the year, the Pacific Northwest is known for having warm, dry summers. As climate change continues, longer periods of drought are likely (U.S. Fish & Wildlife 2011). Since the plants we have installed are all relatively young, they do not yet have well-developed root systems that will allow them to access water deeper in the ground. This makes them especially vulnerable to drought, and their inability to take up adequate amounts of water from the soil will lead to desiccation and death. Irrigation during the establishment of our installed plants will greatly increase their chances of survival to maturity (Chalker-Scott 2009).

Where: All installed and pre-existing native plants in Polygons 1, 2, 3, 4, and 5. Polygons 3 & 5 will be the driest in the summer due to minimal shade.

When: Once every two weeks during the dry season from the beginning of May to the end of September for the first 2 years. Watering during the first dry season following spring planting is especially critical. Watering should be done in the morning to allow water to infiltrate the soil before higher midday temperatures cause evaporation, in addition to prevent leaf burn and desiccation.

Resources and Tools: Water totes in the southwest corner of the site will be filled by the City of Bothell. Water will be distributed using hoses and buckets provided by FNCF.

How: Soak the soil surrounding the plants. Look for signs of wilting or leaf scorch to determine which plants need the most water. To minimize water loss through evaporation, it is best to water early in the morning or in the evening when it is cooler.

2. Community Outreach

a. Volunteer Work Parties

Why: Restoration projects such as this rely heavily on the hard-working volunteers attending the work parties. Most of the heavy labor performed during restoration projects are done by volunteers. Work parties aid in the development of a relationship between the community and the forest, thus increasing the level of investment in the forest.

Where: Through the use of the FNCF website, personal and email correspondence, social media, local neighborhoods, or volunteer-engagement networks

When: As often as possible. The site will need regular maintenance for the first few years, and having volunteer work parties would facilitate in spreading mulch, watering plants, and preventing the re-emergence of invasive species.

Resources and Tools: Information from social media and the FNCF website, fliers, recruiters, FNCF representatives, site ambassadors, UW Bothell, and Cascadia College.
How: Information on upcoming volunteer work parties can be distributed via the FNCF website events page, Facebook page, and through emails.

b. Education

Why: Educating the public about the project site and North Creek Forest in general can help spread awareness of the need for restoration. It is through a deeper understanding of the ecological functions and its importance that can foster a sense of pride in the forest. Moreover, educating the younger generation allows younger students to connect with the forest and establish an interest in being outdoors.
Where: Education can take place anywhere- through online postings, at fundraisers, during volunteer work parties, or through partnering with UW Bothell students in Community-based Learning and Research (CBLR) courses.
When: As often as possible. Information is always accessible online, therefore frequent posts about the forest would be beneficial. UW Bothell also offers several CBLR courses throughout the academic school year.
Resources and Tools: FNCF website, presentations, and fliers
How: There are plenty of opportunities for education. As mentioned, posting frequent updates on the forest on social media can reach a broad audience. Organizing fundraisers and presentations can also increase awareness of the forest.

3. Invasive Species Control

The presence of invasive species at our site has prevented the establishment of native plants and degraded the health of the plants already present. Himalayan blackberry has covered almost all of our site, taking resources like light and space away from understory and overstory plants, while not providing much value to native wildlife as a midstory species. Himalayan blackberry was pulled off of Bitter cherry trees (P. emarginata) at our site that were presumed dead or dying, but once the blackberry was removed they leafed out and began to photosynthesize again. English Ivy was observed shading out the understory and even trees in Polygon 1 & 2. Without continued maintenance of the site to prevent the reemergence of invasive species, it is unlikely our site will be able to mature. The surrounding areas of the site provide many threats of invasion. Until the restored forest matures and can shade out invasives, it is likely those areas will spread into our site.

a. **Himalayan Blackberry**

Why: Himalayan blackberry spreads quickly and is a competitive species (Leigh 1999). It can easily grow over and shade out plants competing for light, as well as outcompete them for nutrients and water. When left unmaintained, our site could easily be invaded by the Himalayan blackberry at its south and west borders.

Where: The entire site should be monitored for re-emergence, but special attention should be paid to the southern border of Polygons 3, 4, and 5, as well as the western border of Polygons 2 and 5. On the other side of these borders are large monocultures of Himalayan blackberry which are the most likely source of spread.

When: During regular NCF Work Parties.

Resources and Tools: Shovels, clippers, work gloves. Tarps and wheelbarrows to remove biomass.

How: Cut Himalayan Blackberry stalks using clippers/loppers back to approx. 1 ft. above ground, so they remain visible. Once the stalks have been cut back, remove the crown by digging it out of the ground. Care should be taken to make sure that ALL roots are removed. All biomass from Himalayan blackberry should be transported to a large pile, where it can be removed from the site and disposed of properly.

b. **English ivy**

Why: English ivy is another invasive species that can prevent the growth and success of native plants.

Where: Polygons 1 and 2.

When: During regularly scheduled NCF work parties.

Resources and Tools: Clippers or loppers, hand gloves

How: English Ivy can be pulled out by hand with ease. If it is growing along the ground, it can be rolled up like a carpet. If it is growing on the trees, it should be severed from the roots before it is carefully pulled away from the bark and various limbs. Care should be taken to make sure no biomass is left behind, so it doesn't sprout. All English Ivy biomass should be transported to a large pile, where it can be removed from the site and disposed of properly.

c. **Reed Canarygrass**

Why: Reed canarygrass is considered a Class C noxious weed in Washington state (King County 2016). This grass is aggressive and can overtake areas, which can cause issues in restoration projects. Its dense rhizomatous mats (King County 2016) can prevent native species from growing. We recommend that a future meeting take place between FNCF and the City of Bothell Parks Department to discuss the possibility of a road swale and the replacement of onsite Reed canarygrass.

Where: Eastern edge of Polygon 3.
When: Reed canarygrass can grow up to 6 ft tall, with the largest flower spikes and leaves peaking in June and July. For the project site, it is best to monitor the encroachment of Reed canarygrass onto Polygon 3 as often as possible.
Resources and Tools: Loppers, hand pruners, shovels, mulch
How: Although controlling Reed canarygrass is not required, it could help prevent the overtaking of Polygon 3 by monitoring the boundary. Loppers or hand pruners can be used to trim tall grasses and spread of heavy mulch can help inhibit the growth.

4. Vegetation Thinning

Why: Vegetation thinning refers to selectively removing whole or parts of trees to reduce competition. Doing so can help the remaining species to mature and grow. Vegetation thinning can also aid in maintaining the vegetational structure (NSW Government 2017). In other cases, thinning/pruning can be done if there are noticeable dead or damaged branches that pose danger to the public or surrounding vegetation. Pruning is also practiced for size maintenance, flower and fruit control, root loss compensation, health, and safety (Chalker-Scott 2009).
Where: Throughout the site, particularly in Polygons 1, 2, 4, and 5.
When: In areas like Polygon 2 and 4, thinning/pruning might be needed earlier than in the other polygons. In Polygon 5, it will take several years before the trees are mature enough to be competing with each other for space. The removal of dangerous branches should be done immediately if safe to do so.
Resources and Tools: FNCF can provide tools such as loppers and hand pruners. Any large, dangerous tasks must be fully addressed by the City of Bothell.
How: For ease and safety purposes, this Stewardship Plan will focus on the plant health and public safety necessity of vegetation thinning and pruning instead of aesthetics, flowering control, and root loss compensation. Using loppers or hand pruners, carefully clip any diseased, dead, or decaying branches. If pruning for size control, the pruning must not exceed removal of more than 25% in a growing season (Chalker-Scott 2009). In an effort to provide additional habitat structures and nutrient input, we recommend leaving the pruned woody debris onsite.

5. Replanting

Why: Even with our best efforts, plant die-off is possible due to multiple reasons; for example, drought, herbivory, and competition from invasive species. Replanting may be necessary in the future in order to keep to the original vision for the site.
Where: Throughout the project site

When: As necessary, when plants die. During volunteer work parties, or by FNCF if plant die-off is small.
Resources and Tools: Shovels, watering equipment in dry season, mulch
How: Plants will need to be acquired through a nursery, salvage, donation, or other methods. If the amount of replanting to be done is significant enough, a volunteer work party should occur. If it is possible to see where the plant being replaced was originally located, use the same area to install the new plant. If the area encompassess many plants or it is difficult to determine where the plant originally was, refer to the as-built plant maps (Figures 1-5). After planting, mulch should be applied around the base of each plant to increase water for the plant and deter invasive species encroachment. Depending on the time of year and weather, plants can be watered.

6. Mulching

Why: Spreading a thick layer of coarse wood-chip mulch is essential in preventing soil erosion, retaining moisture in the soil, and inhibiting the re-emergence of invasive species (Chalker-Scott 2009). The mulch also helps in creating an even terrain for walking on the site, especially in Polygons 2 and 5 where rodent burrows pose safety issues.
Where: Polygons 1, 2, 3, 4, & 5.
When: During volunteer work parties, whenever mulch is looking thin or uneven. Mulching is especially critical in spring to retain moisture for the summer, and in summer to maintain mulch depth.
Resources and Tools: Mulch will be provided through Chip Drop (https://getchipdrop.com/). Chip Drop connects arborists who have surplus mulch with community members who want it. Mulch will be distributed using wheelbarrows, pitchforks, buckets, and rakes. Volunteers should wear work gloves for protection.
How: Load wheelbarrows or buckets with mulch using pitchforks and dump the mulch on the thinner areas. Spread with a rake until even. There should be a 4-6” minimum layer of mulch.

7. Preventing On-Site Pollution

Why: Due to the proximity of the freeway, neighboring residences, and recreational use of North Creek Forest, it is likely that that litter will make its way to the site. Trash is detrimental to the health of the forest, especially wildlife that might mistake it for food or get tangled in it. It’s important to prevent trash entering the site when possible, and remove it when present. Over the process of restoring our site, we have found a large amount of trash and there is undoubtedly more to be picked up.
Where: The entire project site and North Creek Forest.

When: During volunteer work parties.
Resources and Tools: gloves for protection, buckets, trash bag, safe sharps disposal.
How: Pick up any trash on the site. Don't pick up anything you don't feel safe touching. Dispose of sharps waste properly e.g. needles, broken glass. Be extremely careful when handling sharps and always wear gloves when touching any trash. Trash should be sorted between garbage and recyclable when possible. It would also be helpful to inform volunteers and neighbors about how their trash impacts the health of the forest, and to always dispose of their waste properly.

8. Pet Waste Management

Why: Human appropriation of the project site is likely to occur. A common problem associated with anthropogenic use of forests is the negligent deposition and failed removal of pet waste. Failure to remove pet waste introduces nutrients, E. coli and other fecal coliform bacteria into the forest and associated watershed (RI Stormwater Solutions, n.d.). The addition of nutrients associated with pet waste can provide advantageous microsites for invasive plant species. With the given slope and hydrology of our project site, the fecal E. coli has the potential to be transported downslope thus spreading over the site and into the watershed where other problems may occur.
Where: The entire project site and North Creek Forest.
When: During volunteer work parties.
Resources and Tools: gloves for protection, trash bag, bucket lined with trash bag, plastic bag to protect the skin and contain the waste.
How: Line the bucket with a trash bag. Pick up any pet waste or pet waste bags left on the site. Do not pick up anything you do not feel safe or comfortable touching. Be extremely careful when handling pet waste. Place pet waste bags into the lined bucket and properly dispose of the trash bag once the site is clear. It may also be useful to inform volunteers and neighbors about how their actions can impact the health of the forest.

Resources

Table 6: Resources and tools for site maintenance actions

Maintenance Task	Resources	Supplies
Irrigation	Water totes filled by City of Bothell	Buckets Hose
Community Outreach	FNCF website Social Media Work Parties	Fliers Event postings
Invasive Control	City of Bothell truck	Gloves Shovels Loppers Wheelbarrows Tarps
Vegetation Thinning	FNCF	Loppers Hand pruners Gloves Wheelbarrows
Replanting	Local nurseries	Gloves Shovels Selected Plants
Mulching	Chip Drop (https://getchipdrop.com/) Chip Drop is a service that connects arborists who have surplus mulch with community members	Gloves Wheelbarrows Pitchforks Buckets Rakes
Preventing On-site Pollution	FNCF	Garbage bag/bin Gloves

Maintenance Schedule

Table 7: Maintenance schedule Gantt chart

Task	Week	January	February	March	April	May	June	July	August	September	October	November	December
Irrigation	1												
	2												
	3												
	4												
Volunteer Work Party	1												
	2												
	3												
	4												
Education	1												
	2												
	3												
	4												
Himalayan blackberry control	1												
	2												
	3												
	4												
English Ivy control	1												
	2												
	3												
	4												
Reed Canary grass control	1												
	2												
	3												
	4												
Vegetative thinning	1												
	2												
	3												
	4												
Replanting	1												
	2												
	3												
	4												
Mulching	1												
	2												
	3												
	4												
Removing on-site pollution	1												
	2												
	3												
	4												

Monitoring Plan

Restoration is a process that continues long after the initial project is completed. To ensure that our project goals are being met in the future, we are leaving the important task of monitoring our project site to our community partners and volunteers. Using photo comparison and vegetation sample plots, we will be able to know if our performance standards are being met and the site is on its way to becoming a self-sustaining mature forest. Without monitoring and analyzing the data collected on our site, there is no way of knowing how our goals are being achieved. The information collected through regular monitoring will determine the success of the project and help inform future restoration practices, particularly at North Creek Forest. Monitoring will help FNCF and the City of Bothell track and evaluate the progress of the restoration site and allow an adaptive management approach to address issues along the way, such as invasive species reemergence of pest issues. Monitoring is also valuable for documenting wildlife usage, the effects of climate change, and other ecosystem changes.

Our approach will use effectiveness monitoring or, according to the *Ecological Restoration Guidelines for British Columbia*, "the process of identifying and measuring key indicators of ecosystem response to a restoration treatment". Routine evaluations using quick, low-cost data collection will consist of mainly qualitative photo monitoring. Quantitative monitoring will be more time-intensive, since it will be done through vegetation assessments.

Quantitative Monitoring

Approach

Quantitative monitoring at our site will assess vegetation using transects and a simple assessment (Monitoring forms found in Appendix 1) in July of each year. Our methods are designed to provide consistent, quality data and reduce subjectivity. We will collect information on species composition, plant vigor, percent vegetative cover. Surveying will occur in July, when most plants will have flowers and leaves, which are needed to make accurate estimations of plant cover and vigor.

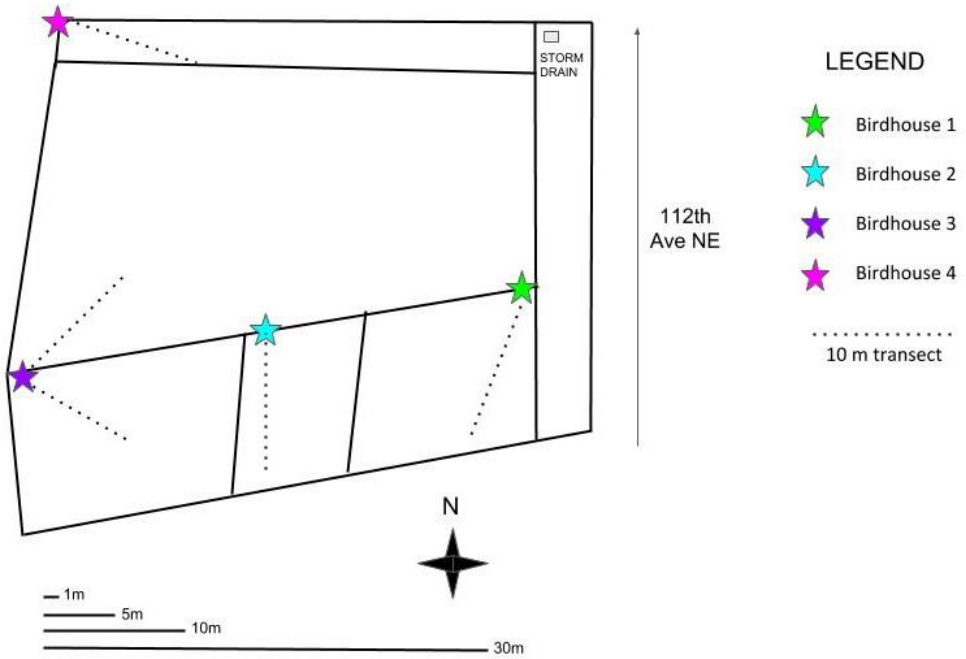

Figure 9. Map of monitoring transects

Monitoring Methods

Setting Up Point-Intercept Transects

Each polygon has one 10 m transect, beginning at the nearest birdhouse & photo monitoring point. This location was requested by FNCF volunteers to make finding the transects easier. Fasten the meter tape to the origin of the transect and stretch to the opposite endpoint, which will be marked physically with a stake as well as labelled on the map. The meter tape should be taught, not overstretched.

Vegetative Cover & Species Composition

Starting at the origin (0.0 M), walk along the transect. Record only the plant species that fall directly under or above the transect tape on the monitoring form. Record the species code and the intercept length. The species code is a 4-letter abbreviation of the species name, using the first 2 letters of the genus and species (eg. *Holodiscus discolor* = HODI). This is meant to make recording easier, but it is also fine to use the full name. The intercept length is the distance to the nearest centimeter from where the species is first encountered to the point it ends on the tape. Visualize the transect as a vertical wall to the sky, and any species that touches the wall should be recorded. Percent cover can then be calculated based on the proportion of the entire transect length that is covered by a species. Make a note of any individuals that were not planted. This will help us learn which species are spreading, colonizing, and/or naturally regenerating. In the first few years, there won't be many plants that intersect since they are still small. As they grow and spread, there will be more intersects.

Plant Vigor

In addition to recording species occurrence and cover along the transect, the health of each plant should be recorded. For each species that intercepts the transect (should be the same species as recorded for vegetative cover), record whether the plant is thriving, alive, stressed, or dead using the following code (Snohomish County Surface Water Management 2003):

1= Thrive Evidence of vigorous growth includes: new green leaders, flowers, developing fruits, evidence of last year's fruits, etc.

2= Alive No evidence of above, but plant is green and shows no signs of damage or stress.

3= Stressed Plant color poor, desiccated leaders, withering leaves, signs of herbivory. Record type of damage if possible.

4= Dead No sign of life. Scratch bark to check for green cambium layer.

If plants are stressed or damaged, it is important to make a note of type of stress and potential causes. Disease tends to appear in plants uniformly, whereas pest problems are more random. Some signs of herbivory include: bite marks on leaves, shredded bark, or evidence of stems and leaves being bitten off/torn. If a plant is a live stake, make note. This will help inform future use of live stakes.

Table 8: Description of transect lines

Transect	Size	Polygon location	Description	Latitude	Longitude
1	10 m	Polygon 1	-Place a stake at GPS point. This marks the end of the transect (10 m). -Start at Birdhouse 4 (0 m), at the NW corner of Polygon 1. -Lay 10 m diagonal transect 95°E	47.7737°N	122.19152°W
2	10 m	Polygon 2	-Place a stake at GPS point. This marks the end of the transect (10 m). -Start at Birdhouse 3 (0 m), at the SW corner of Polygon 2. -Lay 10 m diagonal transect 42°NE	47.77353°N	122.19149°W
3	10 m	Polygon 3	-Place a stake at GPS point. This marks the end of the transect (10 m). -Start at Birdhouse 1 (0 m), at the NE corner of Polygon 3. -Lay 10 m diagonal transect 170°S	47.77343°N	122.19118°W

4	10 m	Polygon 4	-Place a stake at GPS point. This marks the end of the transect (10 m). -Start at Birdhouse 2 (0 m), at the NW corner of Polygon 4. -Lay 10 m North-South transect 162°S	47.77347°N	122.19142°W
5	10 m	Polygon 5	-Place a stake at GPS point. This marks the end of the transect (10 m). -Start at Birdhouse 3 (0 m), at the NW corner of Polygon 5. -Lay 10 m diagonal transect 85°E	47.77341°N	122.19144°W

Management Response

Proposed benchmarks are observable or measurable attributes that can be used to determine if a project is on track to meet its objectives. Since restoration is not just a year-long project, but an ongoing process of ecological succession, meeting proposed benchmarks will help us know that our project has been successful.

Table 9: Proposed benchmarks and considerations

Proposed Benchmark	Considerations for Implementation	Other Relevant Findings
Percent Native Vegetative Cover		
90% by year 8		Vegetative cover should steadily increase until around year 8, the begin to slow
Plant Vigor and Mortality		
70% survival after 1st year. 80% thriving by year 3.	Regular watering will be needed the first two summers to survive drought	-Monitor any pest and disease problems -Replace dead plants when possible
Vegetation Layer Establishment		
Canopy emergence by year 5 Shrub layer establishment by year 2	-It may take longer for a canopy to emerge -Regular watering will help ensure shrub establishment	-Layers should grow more distinct as more time passes

Abundance of Nonnative Invasive Species		
Maintain abundance below 5%	-Removal should be done during regular work parties -More than 5% invasive cover will threaten the health and success of the site -Control of an invasive species population is easier when it is present in low abundance	-As plants grow, it will become harder for invasive species to spread because they will be shaded out

As the dry summer months approach, water will become increasingly important. Knowing the ideal times to water will assist with its conservation. It is recommended that you water the vegetation between the hours of 6pm and 10am in an effort to reduce evapotranspiration (Chalker-Scott 2009). An additional method of water-stress prevention is to provide a deep watering of 18-20 inches 1-3 times per month throughout July and August (Chalker-Scott 2009). If vegetation begins to show scorch marks on the leaves, or if the leaves appear wilted, water stress could be the problem. Check to ensure that the soil is not being over or under-watered but gently exposing the surface beneath the mulch. Inspecting for signs of disease or infestation can also prove beneficial. Although wildlife encroachment is a target, these species can also create problems for the vegetation. Since the site was covered with approximately 6 inches of course wood chip mulch, newly formed rodent burrows should be easily spotted. Many of the newer vegetation species can serve as a food source in the wild, so be sure to inspect plantings for signs of chewing or being dug-up from below.

Disease & Pests- Any individual that is hosting a disease or pest should be placed in a plastic bag, removed from the site, and properly discarded. DO NOT compost these plants, as it will spread the problem further. Investigate possible sources for the problem. If many plants are hosting disease and pests, removal may not be helpful. Possible solutions may be to attract more beneficial insects or change watering regimens.

Herbivory- Identify the herbivore first. Is it possible to remove the herbivore? If not, develop solutions based on the extent of damage and vulnerable species. For certain herbivores such as deer, temporary solutions can be found until the plants grow above the browse line. Fences and deterrents may help for the short term until the site is well established, but at some point the site must become self-sustaining. Herbivory is a natural process and cannot be prevented indefinitely

Invasive Species Reemergence- Ideally, all invasive individuals would be removed as soon as they are discovered. However, it is unlikely that there will be time and resources available to do this. If there is over 5% invasive species cover, a work party should be held to remove them from the site. Potential sources of invasive species should be investigated and if possible, eradicated.

Resources

Table 10: Equipment for quantitative monitoring

Equipment	Qty	Purpose
50 m Tape Measure	2	Creating transects for sampling
Field Notebook	1	Record data for future monitoring purposes
Plant ID Book (Recommended: *Plants of the Pacific Northwest Coast* by Pojar & MacKinnon)	1	Plant identification
Data sheets provided in Appendix 1 (3 pages)	1	Record information
Clipboard	1	Provide a stable writing surface

Logistical Considerations

Monitoring should be done in July, when most plants have leaves and flowers/fruit. Watering prior to monitoring is ideal, so leaves are not wilted when measuring vegetative cover. We recommend printing out the monitoring forms (Appendix 2) for taking notes, since they provide guidance on the monitoring process. Plastic slipcovers for data sheets may be helpful for monitoring on days with rainy weather.

Baseline Data Collection

Site: 7	Observer(s): Candice Magbag, Kendra Potoshnik	Date: 05/10/18
Transect ID: 1 (Polygon 1)	Transect length: 10m	

Line Intercept				Vigor Assessment		
	Species 4-letter code	Start (m)	End (m)	Class 1-4 1=thrive, 2=alive, 3=stressed, 4=dead	Livestake Y/N	Any damage?
1	TEGR	2.13	2.35	2	N	
2	HEHE	4.0	4.6	3	N	
3	RUAR	4.74	4.77	2	N	
4	CRMO	9.10	9.95	1	N	
5	ACMA	8.8	10	1	N	

Site: 7	Observer(s): Candice Magbag, Kendra Potoshnik	Date: 05/10/18
Transect ID: 2 (Polygon 2)	Transect length: 10m	

Line Intercept				Vigor Assessment		
	Species 4-letter code	Start (m)	End (m)	Class 1-4 1=thrive, 2=alive, 3=stressed, 4=dead	Livestake Y/N	Any damage?
1	SALU	0.9	0.95	1	Y	
2	SYAL	3.10	3.60	3	N	
3	PHCA	6.22	6.28	1	N	
4	PSME	6.90	7.3	1	N	
5	SALU	7.47	7.5	1	N	

Site: 7	Observer(s): Candice Magbag, Kendra Potoshnik	Date: 05/10/2018
Transect ID: 3 (Polygon 3)	Transect length: 10m	

Line Intercept				Vigor Assessment		
	Species 4-letter code	Start (m)	End (m)	Class 1-4 1=thrive, 2=alive, 3=stressed, 4=dead	Livestake Y/N	Any damage?
1	HODI	2.0	2.11	1	N	
2	HODI	3.10	3.32	1	N	
3	ACMA	6.95	7.0	3	N	
4	QUGA	8.87	8.95	2	N	
5	BEPA	9.5	10	2	N	

Site: 7	Observer(s): Candice Magbag, Kendra Potoshnik	Date: 05/10/18
Transect ID: 4 (Polygon 4)	Transect length: 10	

Line Intercept				Vigor Assessment		
	Species 4-letter code	Start (m)	End (m)	Class 1-4 1=thrive, 2=alive, 3=stressed, 4=dead	Livestake Y/N	Any damage?
1	ALRU	0.0	10 canopy	1	N	
2	POMU	5.80	6.18	2	N	
3	POMU	9.11	9.26	2	N	

Site: 7	Observer(s): Candice Magbag, Kendra Potoshnik	Date: 05/10/18
Transect ID: 5 (Polygon 5)	Transect length: 10m	

Line Intercept				Vigor Assessment		
	Species 4-letter code	Start (m)	End (m)	Class 1-4 1=thrive, 2=alive, 3=stressed, 4=dead	Livestake Y/N	Any damage?
1	RUSP	0.54	0.64	2	N	
2	SALU	1. 95	2.0	2	N	
3	LOIN	2.9	3.1	2	N	
4	PSME	4.95	5.15	1	N	
5	ABGR	8.42	8.73	1	N	

Qualitative Monitoring

Approach

Qualitative monitoring will be done using established photo points to show visual changes in structural complexity, species composition, and density at the project site (Smith-Caggiano and Goodman 2012). These photos will document the establishment of the native vegetation we installed, as well as showing the amount of reestablishment of invasive species. Following FNCF's protocol for past project sites, photographs will be taken in July and October (Carpenter et al. 2016).

Photo Monitoring Methods

To standardize the photos, each photo will be taken from a height of 5 ft. A Canon DSLR camera was used to take the baseline photos. A majority of monitoring photos at North Creek Forest are taken by citizen volunteers who use the cameras they have in their possession (S. Witte, personal communication, 2018 May 05). If possible, a camera of similar quality to a Canon DSLR should be used; however, a high-quality smartphone camera is acceptable if a professional camera is not available.

Baseline Photos

Five permanent photopoint locations have been selected, four within the project site and one across 112th Ave from the project site. From these 5 locations, 10 photopoints have been selected, and the positions of the photos are indicated on the photopoint map (Figure 7). The location across the street is unmarked, since the photographer will need to stand at the edge of the street, but detailed instructions have been provided for the exact location. The photography locations for the remaining photopoints will be marked with birdhouses on 6-ft poles in order to indicate the specific location permanently. These birdhouses are marked on the photopoint map (Figure 7).

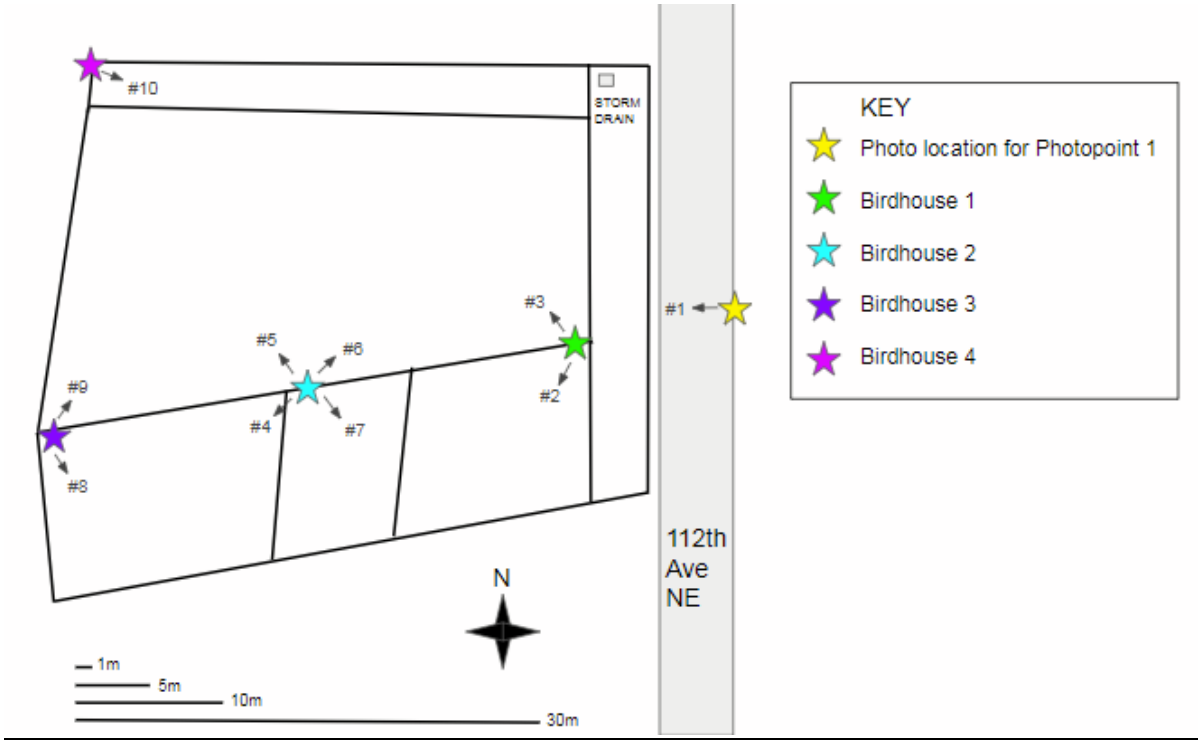

Figure 10. Photopoint locations and directions

To ensure that the photographs taken match the baseline photographs, the photographer should carry printed baseline photos or have access to the photos via a smartphone, tablet, or other device. As the photographer takes each photo, they should ensure that their photo matches up with the corresponding baseline photograph.

Begin across the street from the project site, at approximately the north-south midpoint of the site's east boundary. Stand where the grass changes to asphalt and face the site to take the photo for Photopoint 1. You should be next to the pole on the left of the wall's height change (the pole pictured at the center of Figure 8).

Figure 11. Wall between 112th Ave NE and highway

Figure 12. Photopoint 1*

*an updated photo will be provided in the As-Built Report without the pile of Himalayan blackberry on the left, which has yet to be removed

Next, walk across the street, and continue into the site approximately 5m to Birdhouse 1 (the easternmost birdhouse). Standing at the birdhouse, face SW for Photopoint 2.

Figure 13. Photopoint 2

Remaining at the same birdhouse, face NW for Photopoint 3.

Figure 14. Photopoint 3

Walk west into the site to Birdhouse 2. Stand at the birdhouse and face SW for Photopoint 4.

Figure 15. Photopoint 4

Remaining at the birdhouse, face NW for Photopoint 5.

Figure 16. Photopoint 5

Face NE for Photopoint 6.

Figure 17. Photopoint 6

For the final photopoint at this location (Photopoint 7), face SE.

Figure 18. Photopoint 7

Continue west to Birdhouse 3 at the western edge of the site. Standing next to it, face SE for Photopoint 8.

Figure 19. Photopoint 8

Turn NW for Photopoint 9.

Figure 20. Photopoint 9

To reach the location for Photopoint 10, walk north to Birdhouse 4, at the NW corner of the project site. If the site becomes impassable due to plant growth, it may be necessary to walk east toward the road and around. From the road, walk west on the lawn to Birdhouse 4. Face SE for Photopoint 10.

Figure 21. Photopoint 10

In order for the photos at each point through time to be taken from the exact same location, all photos will be taken from a height of 5ft.

Resources

Table 11: Photopoint locations and descriptions

Photo point #	GPS Coordinates	Description	Direction
1		Across 112th Ave NE	W
2	47.77353°N, 122.19115°W	Birdhouse 1 (easternmost)	SW
3		Birdhouse 1	NW
4	47.77355°N, 122.19136°W	Birdhouse 2	SW
5		Birdhouse 2	NW
6		Birdhouse 2	NE
7		Birdhouse 2	SE
8	47.77343°N, 122.19165°W	Birdhouse 3 (westernmost)	SE
9		Birdhouse 3	NE
10	47.77353N, 122.19115 W	Birdhouse 4 (NW corner of project site)	SE

Table 12: Equipment for qualitative monitoring

Equipment	Qty	Purpose
Digital camera or device with camera (e.g. smartphone)	1	Take photos
Tape measure	1	Position camera/smartphone 5 ft above ground
GPS or device with GPS capabilities (e.g. smartphone)	1	Locate GPS coordinates of photo points
Baseline photos (printed or viewed on a device)	1	Refer to baseline photos for accurate monitoring photos

Logistical Considerations

For photo monitoring, the resources and abilities of North Creek Forest volunteers should be considered. As previously mentioned, much of the photo monitoring at the project site will be done by citizen volunteers who may not have DSLR cameras or the knowledge to make use of azimuth data. Therefore, we recommend that a high-quality smartphone camera be used if a DSLR is not available. In addition, we have foregone azimuth and clinometer readings for each photopoint in favor of general directions (e.g. SW) and the recommendation to match the baseline photos as closely as possible.

Monitoring schedule

Table 13: Monitoring schedule Gantt chart

Task	January	February	March	April	May	June	July	August	September	October	November	December
Vegetation Assessment												
Monitor plant vigor												
Check for signs of herbivory (e.g. chewing)												
Monitor for pests and disease												
Monitor for reemergence of invasives												
Take basline photos at photo points												

Long Term Site Management Plan

Through continued maintenance by forest stewards and the City following our long-term maintenance plan, invasive plants at this site will be controlled before they can repopulate. This will allow reintroduced native species to proliferate. The mature deciduous trees currently present and in decline will be replaced with faster-growing sun tolerant conifers such as Douglas-fir, which we have planted. The deciduous trees will create snags and large woody debris, functioning as important habitat and nutrient sources. The initial Douglas-fir canopy will also shade out invasive species and contribute to their control. Once the sun-tolerant canopy has been established, propagules will naturally be introduced from the surrounding forest. Sun-intolerant conifers like Western redcedar will emerge, as well as a mix of native shrubs and shade-loving understory plants found in later succession forests. If the long term plan is followed, the resulting forest will have plants in multiple successional stages that should be able to reproduce on their own. By starting with sun-loving conifers and then progressing to more shade-tolerant species and understory plants, the forest will have diverse vertical and horizontal structure. The increased biodiversity and structure will make the forest more resilient, however there will be challenges to controlling invasive species. The project site is bordered at its east and south boundaries by Himalayan blackberry. North Creek Forest recently opened to the public as a park, which has increased ground compaction and the presence of dogs, known contributors to invasive colonization. Over the long term, we believe our site will be maintained by community members. 100 years from now, we hope to have a diverse, mixed-succession native conifer forest.

As discussed with our Community Partners, FNCF will monitor the project site up to three (3) years after the “completion” of the team’s restoration. Frequent replenishment of wood chip mulch will be needed to suppress the growth of invasive species (Chalker-Scott 2009) as well as monitoring and possible watering of the plants during the summer dry seasons. We expect continued work on the project site through more volunteer work parties involving the surrounding community organized and led by FNCF. After three (3) years, the plant material should be well established and the need for maintenance activities greatly diminished. Periodic monitoring for invasive species encroachment and adaptive management will be necessary as in any urban park setting and this will be accomplished following the stewardship plan as a guide.

The design of this project has been modeled with the intent for the project site to mature and become established using limited resources and minimal maintenance. With these parameters in mind, the team focused on planting drought-tolerant species that can flourish in drier

seasons with extended periods between watering. High-density planting can help combat plant mortality, and incorporating species of later succession will jump start the shift of the surrounding plant communities through successional development. Since the site is still bordered by Himalayan blackberry, six (6) inches of mulch have been applied to reduce reinvasion and the need for weeding. The insertion of evergreen species will create shade, which will also inhibit the re-establishment of invasive species. The team wants a successful project and therefore designed the project site to survive despite limited resources, using the above incorporated ideas to reduce the maintenance burden.

The project was created with a vision of a mixed deciduous-conifer forest that provides wildlife habitat through its diverse understory. We hope that runoff from uphill, whether natural or through impervious surfaces, will be filtered by the increase of diverse plant life before entering North Creek. As the plants in our site become more established and mature, we hope to be a successful reference for future UW-REN teams at North Creek Forest; eventually restoring the impaired sections of North Creek Forest into a self-sustaining ecosystem utilized by the local public for educational and recreational purposes.

Literature Cited

Bruemmer R, Grant M, Magbag C, Potoshnik K, Rutledge J. 2017. North Creek Forest Proposal. Fall Quarter 2017 University of Washington Restoration Ecology Network.

Bruemmer R, Grant M, Magbag C, Potoshnik K, Rutledge J. 2017. North Creek Forest Site Assessment. Fall Quarter 2017 University of Washington Restoration Ecology Network.

Carpenter E, Farmer K, Radon T, Tuvshinjargal B, Vradenburg N. 2016. North Creek Forest Stewardship Plan. Spring Quarter 2016. University of Washington Restoration Ecology Network. [accessed 2018 May 09]: https://www.friendsnorthcreekforest.org/uwren-site-5-2015-2016.html

Chalker-Scott L. 2009. Sustainable Landscapes & Gardens: Good Science--practical application. Yakima, WA: GFG Pub. Print.

Clewell A. and Aronson J. 2013. Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. 2nd ed. Covelo: Island Press.

Douglas, T. Ecological restoration guidelines for British Columbia. Biodiversity Branch: Ministry of Water, Land, and Air Protection. Victoria, B.C. [accessed 2018 April 29]: http://www.env.gov.bc.ca/fia/documents/restorationguidelines.pdf

Friends of North Creek Forest. [accessed 2018 May 09]. http://www.friendsnorthcreekforest.org/

Google Maps: North Creek Forest. [Internet]. c2017. DigitalGlobe: U.S.Geological Survey. USDA Farm Service Agency. [updated 2017; cited 2018 May 09]. Available from: https://www.google.com/maps/NorthCreekFores t

Higgs, E. 1997. What is good ecological restoration? Conservation Biology. 11(2): 338-348. [accessed 25 Jan 2018]. http://www.jstor.org.offcampus.lib.washington.edu/stable/pdf/2387608.pdf?refreqid=excelsior%3A92df6a1c0a8d24ca0df7275ffec0b20f

King County Noxious Weed Control Program. 2016. Weed Control: best management practices. Seattle (WA): King County, WA; [accessed 2018 May 09]. https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-control-practices/bmp.aspx

Leigh, M. 1999. Grow Your Own Native Landscape: a guide to identifying, propagating and landscaping with western Washington native plants. WSU Cooperative Extension Publication.

NSW. 2013. Landholders Guide: Guidelines for Thinning of Native Vegetation under the NSW Native Vegetation Regulation, [Internet]. Available: http://www.environment.nsw.gov.au/resources/vegetation/140273DraftThinningGde.pdf

Rhode Island Stormwater Solutions. Do you scoop the poop? [accessed 2018 May 15]: https://cfpub.epa.gov/npstbx/files/Pet%20Care%20Fact%20Sheet.pdf

Smith-Caggiano M, Goodman D.H. 2012. Photograph monitoring of channel rehabilitation sites on the Trinity River, California, 2007-10. U.S. Fish and Wildlife Service. [accessed 2018 May 2]: https://www.fws.gov/arcata/fisheries/reports/dataSeries/Report_TR%20Photomonitoring_Revision%203%2030%202012%20Final.pdf

Snohomish County Surface Water Management. 2003. 2003 vegetation monitoring manual. [accessed 2018 April 29]: https://snohomishcountywa.gov/DocumentCenter/View/7291/Vegetation-Monitoring-Manual

United States Fish & Wildlife Service. 2011. Climate change in the pacific region. [accessed 2018 May 7]: https://www.fws.gov/pacific/Climatechange/changepnw.html

Appendix 1

Monitoring and Survey Forms

Site:	Observer(s):	Date:
Transect ID:	Transect length:	

Line Intercept				Vigor Assessment		
	Species 4-letter code	Start (m)	End (m)	Class 1-4 1=thrive, 2=alive, 3=stressed, 4=dead	Livestake Y/N	Any damage?
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Site Condition and Maintenance Assessment

Site Name: Date of Visit:
Observers: Time on Site:

This form is intended to be filled out while observing and walking through the site. It should be used to gain a sense of the overall site condition and guide maintenance implementation. It is not a detailed quantitative assessment.

Native Plant Health
Indicate # or % of species individuals that are stressed, damaged, or dead.

Species	Stressed	Damaged	Dead	Suspected Cause

Do you see any evidence of what is causing poor plant health? (e.g. rodent pathways)

Plant Vigor: List species that are exhibiting vigorous growth by producing new leaders or flowers.

Regeneration: List the species and location of any seedlings.

Structural Diversity: Circle layers present.

Understory Shrub Sub-Canopy Canopy Emergent

Wildlife: List wildlife observed at the site, including insects, to the best of your ability. Include evidence of wildlife, such as tracks.

Invasive Plants: List any invasive species, such as Himalayan Blackberry, and the approximate amount of area they cover.

Natural Disturbances: List any natural disturbances and their location, such as tree fall, standing water, plant disease, etc.

Human Disturbances: Note the location and amount of human disturbances such as trash, vandalism, and trampling.

Overall Site Evaluation: Summarize the overall plant health and site condition based on the assessment above.

Site Maintenance Priority: Write in the code based on the need for maintenance. Use the comments sections to provide further details.
Priority Code:
High+ Immediate Need, project at risk
Medium= immediate need, sometime during current year
Low= Some need, could pass over current season

Maintenance Type	Priority Code	Comments
Mulching		
Invasive Species Control		
Watering		
Plant Replacement		
Cleanup		
Other		

Appendix 2

Project contact information

UW REN Team

Rebecca Bruemmer	rab713@uw.edu
Mahleah Grant	grantm52@uw.edu
Candice Magbag	cmagbag@uw.edu
Kendra Potoshnik	potosk@uw.edu
Johnathon Rutledge	jr57@uw.edu

Friends of North Creek Forest

Sarah Witte	switte@friendsnorthcreekforest.org

City of Bothell - Parks Department

Tracey Perkosky	tracey.perkosky@bothellwa.gov
Scott Purdy	scott.purdy@bothellwa.gov

Appendix 3

Sources for Materials

Material	Source
Water for plant irrigation	City of Bothell
Wood chip mulch	ChipDrop: https://getchipdrop.com/
Tools (e.g. loppers, shovels, rakes)	FNCF
Quantitative monitoring form	Appendix 1
Digital camera or device with camera (e.g. smartphone)	Personal device
Tape measure	FNCF
GPS or device with GPS capabilities (e.g. smartphone)	Personal device
Baseline photos	Personal device