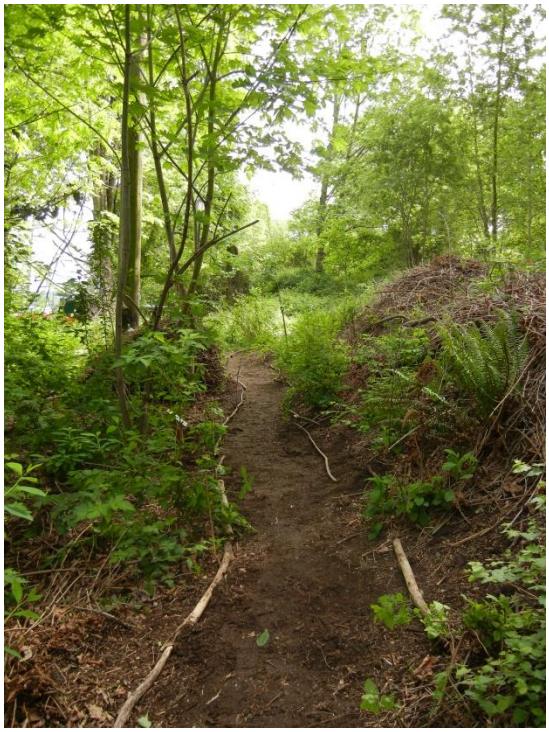
Kincaid Ravine Restoration Project: A Two Year Progress Report with a Focus on Hydrology Improvements and Place Making

July 2016

By: Daniel Hintz



In partial fulfillment of a Master's of Environmental Horticulture degree
University of Washington, School of Environmental and Forest Sciences

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List of Abbreviations (in order of appearance in paper)

KR – Kincaid Ravine
UW – University of Washington
PM – Student Project Manager
EC –EarthCorps
CSF – Campus Sustainability Fund
SP – Stewardship Partners
SER-UW – Society for Ecological Restoration UW Chapter
UW-REN – University of Washington – Restoration Ecology Network
UWBG – University of Washington Botanic Gardens
RSO – Registered Student Organization
VMP – Vegetation Monitoring Point
PP – Photo Point
POE – Project of the Environment
BMP's – Best Management Practices
IPM – Integrated Pest Management
CUH – Center for Urban Horticulture
KCD – King Conservation District
SEFS – School of Environmental and Forest Sciences
ESRM – Environmental Science and Resource Management
GSP – Green Seattle Partnership
CWD –Coarse Woody Debris
DBH – Diameter at Breast Height
RCG – Reed Canarygrass
EPA – United States Environmental Protection Agency
BGT – Burke-Gilman Trail
CWA – Clean Water Act
CFS – Cubic Feet per Second
ART – Attention Restoration Theory
MLA – Masters of Landscape Architecture
PANAS – Positive and Negative Affect Schedule

I. Introduction

Kincaid Ravine (KR) is a roughly 4 acre, forested open space located in the northeast corner of the University of Washington (UW) campus (Figure 1-A). As the largest open space on the central portion of the UW campus, KR has endured a long history of neglect and ecological degradation until student led work began at KR in 2013. Prior to 2013, trash and homeless encampments were prevalent throughout KR and a suite of invasive species had severely limited biodiversity and conifer regeneration.

Figure 1-A: Location of Kincaid Ravine (outlined in red)

In an attempt to restore KR back to a healthy urban forest and an asset for the UW community, Martha Moritz (Moritz, 2014) developed the "Kincaid Ravine Restoration and Stewardship Plan" in 2014. This report laid the foundation for restoration efforts and goals at KR. While the report was created, initial funding from the Campus Sustainability Fund (CSF) was secured to support work at KR. On the ground restoration work at KR began in February of 2014. The following academic year Matthew Schwartz (Schwartz, 2015) took over as student project

manager (PM) from Moritz. In his 2015 report, "Transforming Science into Best Practice: Restoring Process in Kincaid Ravine" (Schwartz, 2015) he focused on improving pollinator habitat at KR and understanding the role of urban forests in the mitigation of climate change.

The purpose of the current report, "Kincaid Ravine Restoration Project: A Two Year Progress Report with a Focus on Hydrology Improvements and Place Making", is to further elaborate on the progress in achieving restoration goals set forth by Moritz and Schwartz while also taking a slightly new direction. I focus on characterizing and improving the hydrology in KR and enhancing the human connection to KR through the process of "place making". In an effort to avoid redundancy with previous reports on KR, I focus primarily on themes original to this paper, except where project progress was made relative to goals and plans set forth in previous reports. Examples of themes previously reported on will include project management activities (project history, funding, outreach, partner development etc.) and vegetative monitoring data collected.

As an intern at KR from December 2014 – May 2015 and as the KR student PM from June 2015 – June 2016, my goals were to fulfill and build on the established responsibilities of the PM (Chapter II), continue ecological restoration work and increase monitoring efforts at KR (Chapter III), work to characterize hydrology in KR and develop and implement projects to increase infiltration and enhance wetland habitat (Chapter IV) and finally, to analyze the benefits of urban green spaces in relationship to human health and develop ways to foster this connection at KR (Chapter V).

II. Project Management

Project management at KR during the 2015-2016 academic year has focused on maintaining and expanding restoration efforts, coordinating with project partners, student groups and stakeholders, managing budgets, securing funding to allow expansion of restoration efforts into the final unrestored areas of KR, developing stronger outreach and project awareness and managing volunteer and contractor work at KR.

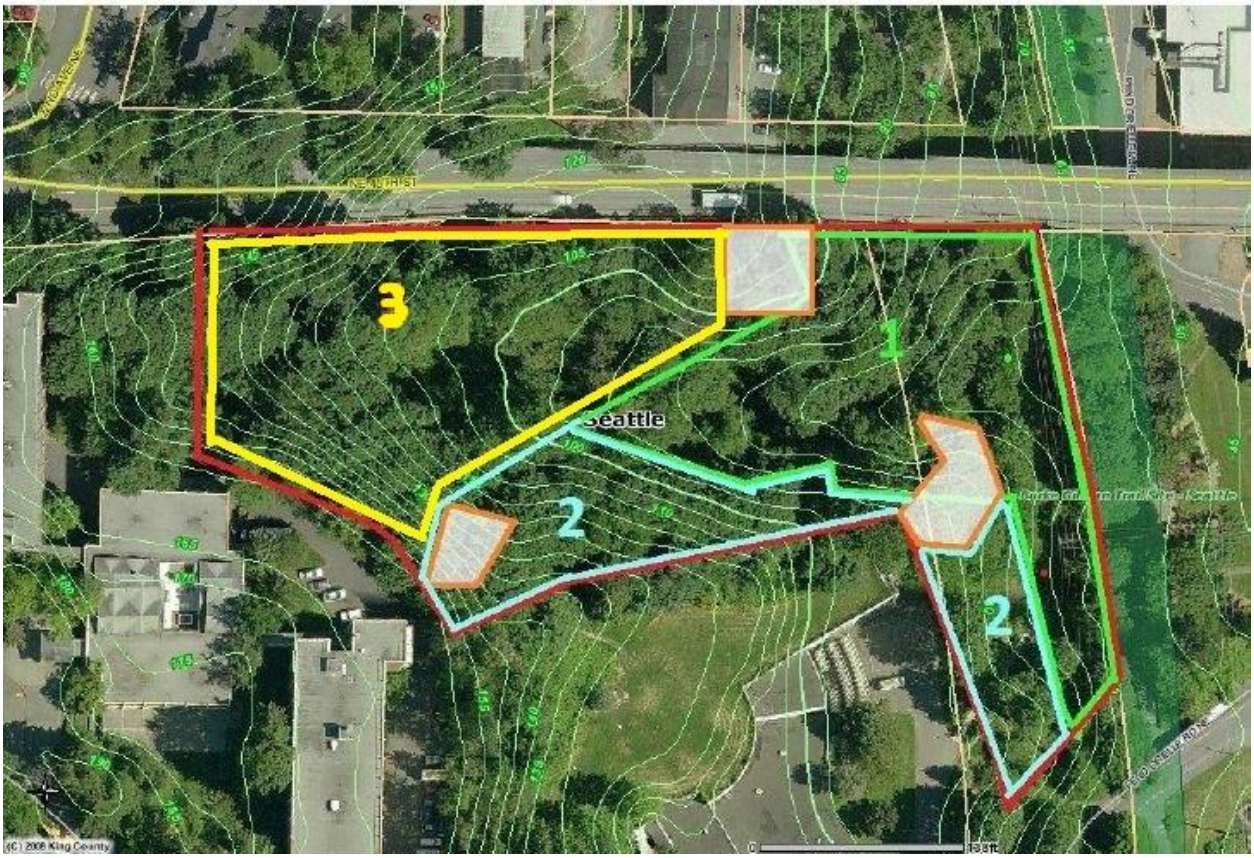

Figure 2-A: Work Area, January 2014 – June 2016. *Original Map credit: King County 2008*

Key to Figure 2-A Polygons:
Red → Kincaid Ravine perimeter boundary
Area 1 Green → Phase I restoration February – June 2014, has received four rounds of invasive species removal; invasive trees injected; initial and supplemental plantings
Area 2 Blue → Phase I restoration November 2014 – November 2015, has received two rounds of invasive species removal; invasive trees injected; initial plantings
Area 3 Yellow → Phase I restoration March 2016 – present, invasive species knockdown and removal; invasive trees injected
Orange → UW-REN Capstone Sites

Updated Project Timeline

The timeline and project history in the following sections are updated versions of the timeline and project history presented in "Transforming Science into Best Practice: Restoring Process in Kincaid Ravine" (Schwartz 2015).

1. Planning phase - This occurred for all areas in KR from May-Dec of 2013. During that time, initial partnerships were formed, a restoration design was created, and baseline monitoring and site inventories were established.

2. Phase I - This occurred in area 1 from Jan-June 2014; in area 2 from Nov 2014 -Nov 2015; and began in area 3 in March of 2016 with an expected completion by June of 2017. Phase I work involves: removal of the encampment areas, removal of debris and hazardous materials, major removal of invasive species, initial installation of native plants, and other restoration work (e.g. slope stabilization, installing mulch, and creating maintenance access).

3. Phase II - This work began in area 1 in Nov 2015 and is currently ongoing; will take place in area 2 beginning in fall of 2016; and in area 3 during 2017/2018. Phase II involves two years of maintenance, including ongoing monitoring which will guide continued removal of invasive species regrowth, care for planted native species, supplemental planting, and the implementation of specialty projects (i.e.: pollinator patches, educational nook, hydrological improvements, climate change adaptation, trails). This phase will be performed in partnership with UW Grounds, EarthCorps (EC), the Society for Ecological Restoration-UW chapter (SER-UW), Stewardship Partners (SP), and academic units (i.e. student project managers, REN Capstone).

4. Phase III – This will occur upon completion of phases I and II. The work during this time is anticipated to be minimal. While it is still uncertain who will oversee long term stewardship, there are tentative plans for SER-UW to take this over with some support from UW Grounds. The primary tasks will be continued invasive species maintenance and ecological monitoring. Ongoing support from volunteer groups, students, and community members can be integrated as part of a long-term stewardship plan.

Project History and Accomplishments

Planning Phase

1. March 2013

- Original Letter of Intent submitted to Campus Sustainability Fund (CSF) by Justin Hellier (UW alumni)

2. April 2013
   - Student project manager position created for Martha Moritz, UW graduate student
   - Approval for KR restoration from UW Grounds, UW campus Landscape Architect Kristine Kenney, and UW Botanic Gardens (UWBG) faculty advisors received

3. May 2013
   - Project proposal, authored by Martha Moritz and Justin Hellier, approved by CSF
   - Initial project funding from CSF of $70,179

4. June-July 2013
   - Partnership secured with SER-UW regarding long-term project stewardship
   - Project approval and site access confirmed with adjacent landowner, SDOT
   - Initial site vegetation, habitat feature, wildlife, and hydrology inventory complete

5. August 2013
   - Baseline monitoring plot established using Green Seattle Partnership protocol

6. October 2013
   - Approval confirmed of EC Scope of Work and contract by UW Purchasing

7. October – December 2013
   - Restoration design planned and coordinated between EC project manager Kym Foley and student PM Martha Moritz- installation plant list, prioritizing work areas, and restoration tasks

8. December 2013
   - Role finalized as Community Partner for Restoration Ecology Network (REN) Capstone
   - Role finalized as Internship Advisor for Project on the Environment (POE) Capstone

<u>Phases I and II</u>

9. February- April 2014
   - Phase I initial invasive species removal work was completed by EC, SER-UW, and REN Capstone group. The bulk of the green waste (Approximately 42 c.y) produced during

this first phase of the work was hauled to UW managed Cedar Grove compost bins in order to reduce potential eyesores in the trail buffer area. EC crews injected 908 non-native woody trees with herbicide (Imazapyr) using an EZ Ject lance throughout the entire site. Targeted trees included cherry laurel (*Prunus laurocerasus*) and English holly *(Ilex aquifolium*)

- EC role was defined: (a) set the stage for volunteer events, (b) tackle the areas that are too steep or too sensitive for volunteers to work in, and (c) complete restoration activities in as great an area as possible. EC provided expertise in erosion control, working in wetlands, and invasive weed best management practices (BMP's) in accordance with Integrated Pest Management (IPM) principles. EC crews spent a total of 21 crew days from Feb - April 2014 in KR. Five of these crew days were the management of volunteer work parties.
- Eight total volunteer work parties, led by EC, SER-UW, and REN

10. March – April 2014
    - Erosion control by EC, SER-UW, and REN of exposed soils following invasive species removal- jute netting, mulch, and wood straw were used in different areas of the site
    - Installation of native trees and shrubs throughout area 1 by EC, SER-UW, REN = combined 2,317 plants installed on site
    - Martha Moritz begins transition of student PM to Matt Schwartz
11. June 2014
    - Student PMs Martha Moritz and Matt Schwartz are awarded supplementary funding ($29,945.44) from CSF
    - EC PM Kym Foley awarded King Conservation District Seattle Community Partnership Grant ($38,696) for an additional 12 crew days for new restoration expansion, 12 crew days for maintenance, and 3 volunteer stewardship events through December 2018
12. Summer 2014
    - SER-UW hosts 3 work parties, removing invasive plants
13. Sept-Dec 2014
    - Phase I work begins for area 2, phase II work begins for area 1

- POE Intern Andrew Jauhola secured as Plant Manager for winter quarter 2015
- SER-UW hosts 4 work parties removing invasive plants, installing 2 pollinator patches

14. Feb 2015

- Student PM Matt Schwartz and POE Intern Andrew Jauhola awarded CSF grant ($3,385) for educational signage and bench production
- Student PM Dan Hintz awarded CSF grant ($5000) for KR Hydrological Assessment

15. Feb- September 2015

- SER-UW hosts 5 work parties removing invasive plants, installing 5 pollinator patches
- Memorandum of Agreement drafted, reviewed, edited and signed by project partners
- Educational signage and benches designed, produced and installed

16. September – December 2015

- Kincaid Ravine Hydrological Assessment Report finished in collaboration with Aaron Clark of Stewardship Partners (Appendix A)
- MLA graduate student Jeni Chan joins project as intern to focus on place making and design in KR to include better human access
- 7 EC crew days focusing on Phase II work in area 1 and phase I planting in area 2, one EC volunteer event and one SER-UW volunteer event
- 400 native plants installed, 1.5lbs of native seed mix spread for erosion control
- Installation of “picket fence” check dams in incised portion of stream channel
- Promoted infiltration of ground and stormwater into trail side ditches to avoid flooding of Burke-Gilman trail and water entering storm sewers (Figures 4-E and 4-F)

17. January – March 2016

- Final CSF budget amendment request ($35,000) approved to support Phase I work in area 3 and to supplement plantings throughout KR with large conifers
- EC begins Phase I invasive knockdown in area 3 (north slope of KR)
- 2 year vegetative monitoring data collected
- Presentation of work at KR to SER-NW regional conference in Portland, OR

18. April – June 2016

- Interpretive trail built connecting “educational nook” along Burke Gilman trail to stairs heading to North Physics building parking lot
- 6 mini-native species identification signs installed along interpretive trail
- Phase I invasive removal begins in area 3
- Phase II maintenance continues in area 1

Project Management Responsibilities

Grant Funding and Budget Management

The grant funding for restoration work at KR has included initial project funding from CSF, 2 budget amendments from CSF, funding for two specialty projects from CSF, and funding for maintenance work and volunteer events from King Conservation District.

Funding for Restoration Work:

1. **May 2013 - $70,179.** Awarded by CSF to Martha Moritz and Justin Hellier for initial project funding (detailed in Kincaid Ravine Restoration and Stewardship Plan (Moritz 2014).

2. **June 2014 - $29,455.** CSF award for additional Restoration Crew Days to student PMs Martha Moritz and Matt Schwartz. Funds added to existing UW-KR budget ($99,634 total). Budget administrator: Carrie Cone, Center for Urban Horticulture (CUH).

3. **June 2014 - $38,696.** KCD Seattle Community Partnership Grant awarded to EC PM Kym Foley for an additional 12 crew days for new restoration expansion, 12 crew days for maintenance, and 3 volunteer stewardship events through December 2018. Funds are maintained by EC separate from the UW-KR budget. Budget administrator: EarthCorps.

4. **February 2016 - $35,000.** CSF award for additional Restoration Crew Days to student PM Dan Hintz. Scope of work outlined in Figure 2-B. Funds are added to existing UW-KR budget ($134,634 total). Budget Administrators: Carrie Cone and Patricia Chinn-Sloan, CUH.

Funding of Specialty Projects:

1. **February 2015 - $3,385.** CSF award for Educational Signage + Benches to student PM Matt Schwartz and POE Intern Andrew Jauhola. Funds are maintained separate from original UW-KR budget. Budget administrator: Wendy Starr, School of Environmental and Forest Sciences SEFS.

2. **February 2015 - $5,000.** CSF award for Hydrological Assessment to student PM Dan Hintz. Funds are maintained separate from original UW-KR budget. Budget administrator: Carrie Cone, CUH.

Between CSF and KCD there has been $173,330 awarded for restoration work at KR. On May 30, 2016 there is approximately $35,000 dollars remaining for restoration work at KR in the CSF budget and $20,280 remaining in the KCD budget. On top of the $35,000 left in the CSF budget going directly to restoration services and materials, there is another $9,500 left to create outreach materials, pay student management stipends and support long term site maintenance with SER-UW.

Narrative Scope of Work: Since February of 2014, EarthCorps has partnered with the University of Washington Campus Sustainability Fund in the effort to restore Kincaid Ravine, an ecologically and socially valuable urban forest in the northeast corner of campus. Primary goals of the project include control of invasive vegetation, re-establishment of appropriate native plant communities, erosion control, and community engagement. This scope of work reflects the need for adaptive management based on recent site expansion and learnings from previous work accomplished. EarthCorps will provide a crew of 5-6 including a WA State pesticide licensed crew supervisor, project management, materials acquisition, and all tools necessary to accomplish the following tasks: Task 1 - Surface Water Drainage Improvements: Re-direct storm water flow away from the Burke-Gilman trail and into pre-existing draining ditches to minimize flooding and promote groundwater recharge. Task 2 - Tree Planting: Install 500 large stock (2-5 gal) trees throughout the 1.75 acres already under active restoration to accelerate regeneration of the tree canopy. Task 3 - North Slope Invasive Removal: A combination of manual, mechanical, and chemical methods will be used to control a complex area of dense Western clematis, Himalayan blackberry, and English ivy. Task 4 - Site Maintenance: Continued monitoring and invasive removal to tackle regrowth through the end of the calendar year, 2016. In addition, watering of dry and exposed planting sites will occur once per month during the summer of 2016 to enhance survivorship during dry months.

	Crew Days or Hours	Crew Day Rate	Project Manager Rate	Materials Cost	Subtotals
Task 1: Surface Water Drainage Improvements					
Days in field:	2	$ 1,220.00			$ 2,440.00
Project Management	4		$ 75.00		$ 300.00
Materials					$ -
Parking ($15/day)				$ 30.00	$ 30.00
					$ 2,770.00
Task 2: Conifer Tree Planting					
Days in field:	4	$ 1,220.00			$ 4,880.00
Project Management	8		$ 75.00		$ 600.00
Materials					$ -
Plants (500 @ $7.00 ea, $75 delivery)				$ 3,575.00	$ 3,575.00
Parking ($15/day)				$ 60.00	$ 60.00
					$ 9,115.00
Task 3: North Slope Invasive Removal					
Days in field:	6	$ 1,220.00			$ 7,320.00
Project Management	12		$ 75.00		$ 900.00
Materials					$ -
Parking ($15/day)				$ 90.00	$ 90.00
					$ 8,310.00
Task 4: Site Maintenance					
Days in field:	4	$ 1,220.00			$ 4,880.00
Project Management	20		$ 75.00		$ 1,500.00
Parking ($15/day)				$ 60.00	$ 60.00
					$ 6,440.00
	Total of Sub-Totals				$ 26,635.00
	TOTAL FEE				$ 26,635.00
Sales Tax: 9.60%	**Location Code:**	1726			$ 2,556.96
	TOTAL PAYABLE				**$ 29,191.96**

Figure 2-B. Budget Amendment (2016) Scope of Work

The budget amendment secured in February of 2016 will very likely be the last funding from CSF (besides the potential for other specialty projects separate from restoration work). Discussions with CSF about one last round of funding began in the summer of 2015. Since funding from the first two awards from CSF was dwindling, this last amendment was requested to support work in Area 3 (Figure 2-A) of KR, which had yet to receive Phase I restoration.

Before this final budget amendment, it was determined with CSF and EC that there was not enough remaining funding to conduct thorough restoration work in Area 3 without one last budget amendment. The budget amendment will also support planting of larger, more established conifers since conifer canopy recovery is a primary goal of restoration work at KR. The amendment will also provide extra funding for maintenance (Phase II) work and future work in wetland/hydrology improvements. While $29,200 of the budget amendment will go to EarthCorps services, the remaining $5,800 will go to cover student project management stipends and funding for SER-UW to coordinate long-term stewardship at KR.

Outreach Activities

Since the restoration work at Kincaid Ravine has continued to gain momentum over the past two years, efforts to increase project outreach and awareness have been a major focus of the student PM during the 2015-2016 academic year. Outreach activities have included a quarterly electronic newsletter, presentations, use of social media, posters and better utilization of SER-UW to promote events and news at KR through their website and email blasts. The target audience continues to be students, faculty, the ecological restoration community and the general public. Below is a list of outreach activities carried out by the PM during the 2015-2016 school year. This list is intended to catalog outreach materials currently available for KR and to inform future students working at KR about opportunities available to promote the work at KR.

1. **Internet Presence**

- Kincaid Ravine Restoration Project Facebook page (https://www.facebook.com/krrestoration/?ref=aymt_homepage_panel). As for May 30, 2016 the KR Facebook page has 157 likes and an average reach of just over 100 people per post.
- SER-UW website (https://society4ecologicalrestorationuw.wordpress.com/current-projects/kincaid-ravine/). This page has links to academic reports and background on KR along with the SER-UW calendar where volunteer events can be listed.
- seruw@uw.edu and kincaidravine@gmail.com email accounts. The SER-UW account is used for email blasts to advertise volunteer events, while the KR Gmail is a contact for the public to reach with questions and comments.

2. **Posters and Presentations**

- Society for Ecological Restoration NW Regional Conference in Portland, April 4-8, 2016. Poster on display, "Restoration of a Degraded Urban Forest in a Campus Setting: A Two Year Review of Work at Kincaid Ravine". (Appendix B)
- Elizabeth Miller Library: 6th Annual UWBG Student Mini-poster exhibit, May of 2015 and 2016. Poster on display, "Restoring Kincaid Ravine" (2015) and "A Two Year Review of Work at Kincaid Ravine" (2016).
- Campus Sustainability Fund Poster Presentation, October 29, 2015 at Odegaard Library. Poster on display, "Restoring Kincaid Ravine Version 2".
- Campus Sustainability Fund Project Panel Presentation, November 12, 2015.
- Power point presentation to UW-REN capstone class, October 2, 2015.
- UW Sustainability Earth Day Tabling, April 22, 2016.

3. **Outreach Materials**

- KinRav quarterly electronic newsletter created using MailChimp
- KR "fact sheets" with SER-UW contact information created

Project Partners and Volunteer Development

Maintaining and developing new project partnerships has been another main focus of the student PM during the past year. This includes working with stakeholders at the UW such as University Landscape Architect (Kristine Kenney), UW Environmental Planner (Jan Arnst), UW Grounds (Sara Shores, arborist has been main point of contact), UW Transportation Services and CSF. These stakeholders have been crucial for project support and ensuring the restoration goals at KR fit in with UW policy, goals and future plans for development on campus (i.e. North Campus Residence Hall construction and future re-routing of Burke-Gilman Trail). Faculty members in SEFS have also been vital in guiding the work at KR. In the 2014-2015 and 2015-2016 academic years that has included Dr. Kern Ewing, Dr. James Fridley, Dr. Susan Bolton and Dr. Kathy Wolf.

Since using the work at KR to educate the campus community about ecological restoration is a major goal, working with student groups and classes has been another priority for partnership development. 2015-2016 has seen the KR and SER-UW partnership continue to develop with volunteer events at KR being advertised at SER-UW meetings and through emails and website postings. KR has also entered into its third year as a Community Partner and work site for the REN capstone course. REN has now helped restore roughly 0.75 acres at KR and established monitoring plots and protocol. ESRM 100 volunteers are also recruited for work parties at KR. This year 8 ESRM 100 students participated in work parties during the 2015 fall quarter. KR has also hosted field trips for Introduction to Restoration Ecology (ESRM 362/SEFS 530). Lastly, the past year has focused on creating partnerships with other campus Registered Student Organizations (RSO). This has entailed hosting volunteer work parties at KR with Society for Ethnobotany ("harvested" reed canarygrass for a basket weaving project) and with Sustainability and Stewardship for Northwest Women. Looking into the future, there are many campus RSOs wanting to participate in service projects on campus, yet they do not have sites to work on. KR can serve as a host for work parties that foster service and opportunities for different RSO's to interact and share their missions.

While partnerships with CSF, UW administrators, faculty members and students have been critical to the success at KR, the project would not be where it is at now without essential partnerships with local non-profits EarthCorps and Stewardship Partners and from King Conservation District. EarthCorps is the "engine" of the restoration work at KR and will continue to have conservation corps crews work on site through 2018. Former KR student PM Matt Schwartz now works as the project manager at EarthCorps for KR so the technical support, continuity and familiarity EarthCorps has with the work at KR is irreplaceable. KCD has greatly increased the amount of Phase II maintenance work that will occur at KR through 2018. Lastly, Stewardship Partners and consultant Aaron Clark have been instrumental in analyzing the hydrology and making plans for wetland improvements at KR. Clark and EarthCorps PM Kym Foley have also consulted on wildlife habitat and bird surveys at KR.

Future Project Management

Continued student involvement for project management and coordination at KR is vital to the long term success of the project. With the CSF budget amendment scoped to fund work through the summer of 2017, coordinating EC and UW-REN work, managing budgets, recruiting volunteers and grant reporting will be essential roles for student management during the 2016-2107 academic year. Master of Landscape Architect student Jeni Chan will work at the site for her practicum project and continue to focus on site design as it relates to education opportunities and access for visitors. Undergraduate student Ceci Henderson has been offered the position as SER-UW student officer at KR and would work to coordinate quarterly volunteer events and develop outreach materials. In the autumn 2016 quarter I also plan to meet with incoming MEH students to gauge interest in someone taking over as student PM. There is the potential for a $1,200 a quarter stipend ($3,600 total). Requirements for this stipend would include: quarterly grant reports to CSF; budget management; quarterly electronic newsletters updating stakeholders on work at KR; coordination and prioritization of work with EC and UW-REN; collection of monitoring data and photo points; continued work on hydrology improvements; maintenance of signs and bench areas and coordination of quarterly volunteer events with SER-UW.

III. Vegetation Management and Monitoring

List of Plants Installed

As of June of 2016, 4,100 native plants and 74 different species (20 tree species, 27 shrub species and 27 herbaceous species) have been installed at KR since work began in January of 2014. Plant installation numbers and species are detailed below in Table 3-1. Plants have been installed by EC, SER-UW volunteers and three UW-REN capstone groups. Plant stock has included bare roots, 1 and 2 gallon pots, live stakes and plants directly transplanted from King County Native Plant Salvage events. Continued coordination with the SER-UW nursery is recommended for acquisition of plant materials and identifying species desired for planting at KR that can be propagated at the SER-UW nursery.

Trees

Abies grandis	Grand Fir	14
Acer circinatum	vine maple	137
Arbutus menziesii	Pacific madrone	3
Corylus cornuta	beaked hazelnut	68
Acer macrophyllum	bigleaf maple	40
Alnus rubra	red alder	13
Fraxinus latifolia	Oregon ash	10
Picea sitchensis	Sitka spruce	46
Pinus contorta	shore pine	20
Prunus emarginata	Bitter cherry	10
Prunus virginiana	Chokecherry	20
Pseudotsuga menziesii	Douglas fir	162
Rhamnus purshiana	cascara	25
Salix hookeriana	hooker's willow	50
Salix lasiandra	Pacific willow	10
Salix scouleriana	Scouler's willow	14
Salix sitchensis	Sitka willow	100
Taxus brevifolia	Pacific yew	1
Thuja plicata	western red cedar	307
Tsuga heterophylla	western hemlock	75
TOTAL		**1125**

Shrubs

Amelanchier alnifolia	serviceberry	1
Cornus sericea	red osier dogwood	542
Fragaria chiloensis	Coastal strawberry	5
Gaultheria shallon	salal	40
Holodiscus discolor	oceanspray	136
Lonicera ciliosa	Orange honeysuckle	1
Lonicera involucrata	black twinberry	59
Lonicera hispidula	Hairy honeysuckle	1
Berberis aquifolium	Tall Oregon grape	31
Berberis nervosa	dull Oregon grape	283
Oemleria cerasiformis	Indian plum	173
Oplopanaz horridus	Devil's club	17
Philadelphus lewisii	Mock orange	10
Physocarpus capitatus	Pacific ninebark	65
Ribes lacustre	Swamp gooseberry	5
Ribes sanguineum	red flowering currant	37
Rhododendron macrophyllum	Pacific rhododendron	2

Rosa gymnocarpa	Woods rose	29
Rosa nutkana	nootka rose	92
Rubus leucodermis	Black cap raspberry	4
Rubus parviflorus	thimbleberry	125
Rubus spectabilis	salmonberry	154
Sambucus racemosa	red elderberry	189
Symphoricarpos albus	snowberry	186
Vaccinium ovatum	evergreen huckleberry	29
Vaccinium parvifolium	Red huckleberry	11
Viburnum edule	Highbush cranberry	7
TOTAL		**2234**

Herbaceous

Achillea millefolium	yarrow	29
Aquilegia formosa	red columbine	5
Asarum caudatum	wild ginger	2
Athyrium filix-femina	lady fern	73
Blechnum spicant	Deer fern	20
Carex hendersonii	Henderson's sedge	10
Carex obnupta	Slough sedge	2
Carex sitchensis	Sitka sedge	7
Claytonia sibirica	Siberian miner's lettuce	2
Dicentra formosa	bleeding heart	12
Eriophyllum lanatum	Oregon sunshine	2
Erythranthe guttata	seep monkey flower	4
Gaultheria shallon	Salal	29
Geum macrophyllum	largeleaf avens	24
Juncus ensifolius	Swordleaf rush	1
Lilium columbianum	tiger lily	2
Lupinus latifolius	broadleaf lupine	3
Maianthemum dilatatum	false lily-of-the-valley	34
Oxalis oregana	Redwood sorrel	2
Penstemon serrulatus	Cascade penstemon	5
Polystichum munitum	sword fern	372
Pteridium aquilinum	bracken fern	5
Solidago canadensis	Canada goldenrod	52
Stachys chamissonis var. colleyeae	coastal hedge nettle	2
Tellima grandiflora	fringecup	12
Tolmiea menziesii	Piggyback plant	24
Trillium ovatum	Western trillium	6
TOTAL		741

Table 3-1. Plant Installation List, Jan. 2014 – May 2016

Vegetation Monitoring

Baseline monitoring data in KR was collected in August of 2013 by student PM Martha Moritz in collaboration with the Green Seattle Partnership (GSP). The Vegetation Monitoring Plot A (VMP A) was laid out using the GSP forest monitoring protocol (http://greenseattle.org/wp-content/uploads/2015/05/GSP-Forest-Steward-Field-Guide.pdf). After marking the center of VMP A (location shown in Figure 3-A) with a 3 foot piece of rebar and an orange cap, the circular plot was laid out by extending two measuring tapes 37.5 feet in each cardinal direction from the center marking. This method produces a circular plot with a 75 foot diameter and an area of 4,415 square feet, or just over 1/10th of an acre (which represents about 3% of KR). The location of VMP A was selected since it was within Area 1 (receiving the first round of Phase I restoration work in February of 2014) and represented both wetland and upland habitat. The field monitoring data collection form for March 25, 2016 can be found in Appendix C.

Figure 3-A. Location of VMP A and Photo Points

A detailed summary of the data collected during baseline monitoring can be found in Moritz's 2014 report along with the *Baseline Monitoring Report* written by Dylan Mendenhall, EarthCorps' Forest Monitoring Program Coordinator. While monitoring did not occur during

the 2014/2015 academic year, data collection was replicated by student PM Dan Hintz on March 25, 2016; just over two years after Phase I restoration work began in and around VMP A.

The main purposes of the monitoring efforts were to identify how successful restoration work was at achieving four primary goals at KR. These goals are:

1) Increasing Native Tree Regeneration with a Focus on Conifers
2) Increasing Shrub and Understory Plant Diversity
3) Reducing Invasive Species Cover
4) Improving Habitat through Presence of Snags and Coarse Woody Debris (CWD)

Native Tree Regeneration

Increasing native tree regeneration was done through Phase I planting since there has been no evidence of natural native conifer recruitment at KR. The monitoring data collected in March of 2016 measured stems per acre (number of stems in VMP A multiplied by 10) of all tree species present at VMP A along with tree mortality rates for each conifer species planted in 2014. As of March 2016, there were 150 stems/acre of conifer tree seedlings with *Thuja plicata (*100 stems/acre) and *Picea sitchensis* (50 stems/acre) as the two species present. No broadleaf deciduous trees were planted in VMP A, but there is one *Alnus rubra* (7" DBH) and one *Acer macrophyllum* (24" DBH) within VMP A. These trees represent the mature canopy cover at VMP A, which has decreased from roughly 75% in 2013 to 60% in 2016 as one large *A. rubra* (16" DBH) had uprooted in the middle of VMP A during December of 2014. For *T. plicata*, there was an average seedling height of 19" with a mortality rate of 10%. For *P. sitchensis*, there was an average seedling height of 34" with a mortality rate of 29%. For all conifers planted at VMP A there was a mortality rate of 17%.

Shrub and Understory Diversity

Shrub and understory diversity was also improved through initial Phase I planting in February of 2014 along with supplemental plantings in January of 2015. Restoration targets, species richness and percent cover in the shrub and groundcover strata are outlined in Tables 3-2 and Table 3-3. *Rubus spectabilis* and *Oemlaria cerasiformis* were the only shrub species present in 2013 and are still the dominant shrub species, but there are now seven shrub species present in

VMP A. Newly established species include *Salix lucida, Physocarpus capitatus, Ribes lacustre, Cornus sericea* and *Oplopanax horridus*. The groundcover species diversity has not increased significantly since 2013 (5 species in 2013 and 6 in 2016), with *Equisetum hyemale* and *Lysichiton americanus* still the dominant two groundcover species present at VMP A. Other groundcover species occurring at VMP A include *Athyrium filix-femina, Polystichum munitum, Dryopteris expansa* and *Tellima grandiflora*. All of these species occur at less than 5% cover and would be good candidates to use to further increase groundcovers not only at VMP A, but along the sloped edges throughout the central wetland in KR.

Category	Parameter	Targets	8/19/2013	3/25/2016
Native Tree Regeneration	Evergreen Density	100 stems/acre	20 stems/acre	150 stems/acre
	Diversity	4 species	3	4
Native Shrubs	% Cover	75%	98%	72%
	Diversity	6 species	2	7
Native Groundcovers	% Cover	50%	100%	74%
	Diversity	8 species	5	6
Invasive Species	Trees (ILAQ and PRLA)	<20 stems/acre	20 stems/acre	160 stems/acre
	Shrubs (RUAR)	<10% cover	11%	4%
	Groundcovers (HEHE and CASE)	<10% cover	101%	9%
CWD and Snags	CWD	20% cover	15%	25%
	Snags	30 stems/acre	30 stems/acre	40 stems/acre

Table 3-2. Monitoring Data and Restoration Targets for VMP A

Category	8/19/2013	3/25/2016
Trees (stems)	THPL: 1 (seedling) ACMA: 1 ALRU: 3	THPL: 10 (mean height = 19") PISI: 5 (mean height = 34") ALRU: 1 (DBH = 7") ACMA: 1 (DBH = 24")
Shrubs (% cover)	RUSP: 80% OECE: 5%	RUSP: 35% OECE: 25% SALU: 8%
Groundcovers (% cover)	EQHY: 85% LYAM: 60% ATFI: 5%	EQHY: 50% LYAM: 22% ATFI: 5%
Invasive Species	ILAQ: 1 (mature tree) HEHE: 90% RUAR: 11%	ILAQ: 16 (mean height = 12") HEHE: 6% RUAR: 4%

Table 3-3. Number of Stems and Percent Cover of Dominant Species within VMP A

Invasive Species Cover

Invasive species cover was dramatically reduced and has stayed below target cover goals (<10% cover for shrub and groundcover) since Phase I restoration was conducted in 2014. There was also one EC crew day of Phase II invasive species maintenance performed at VMP A during the fall of 2015. The most notable change is that the cover of *Hedera helix* has gone from 90% in 2013 to just 6% in March of 2016. This is a positive sign that manual removal of *H. helix* in KR has been effective, although continued maintenance will be key to keeping cover within target ranges. While ivy cover has been dramatically reduced due to restoration efforts, the number of invasive *Ilex aquifolium* tree stems have increased significantly since the start of restoration. 2013 baseline monitoring only reported one mature tree at VMP A that was then treated with herbicide injection in the spring of 2014. That tree looks to be mostly dead, but many (16 in VMP A) seedlings have emerged either from rhizomes from the mature *I. aquifolium* tree or from its seeds. These seedlings are very small and average only 12" in height so injection is not currently an option for treatment though their growth and spread should continue to be monitored. One last observation from the data collected in March of 2016 shows some establishment of invasive groundcover *Lactuca muralis* which was not recorded during 2013 baseline monitoring. While cover of *L. muralis* is still below 5%, it is worth monitoring since it has been observed growing in much higher density in other areas of KR.

Coarse Woody Debris and Snags

Coarse Woody Debris (CWD) and Snags are primarily a measurement of wildlife (bird and macroinvertebrates) habitat and an attempt to analyze if and to what extent nutrients are re-entering the soil (Harmen et. al 1986). Due to the early successional nature of the canopy existing at KR and VMP A (primarily *Alnus rubra* and *Acer macrophllum*) there have been lots of trees and branches that have dropped during wind storms at KR. These downed branches and trees (including an uprooted *A. rubra* tree with 16" DBH) have increased the ground cover of CWD at VMP A from 15% in 2013 to 25% in 2016 with the amount of snags increasing from 3 to 4 over that same time span. Both of these parameters meet the targets established in Moritz's 2014 *KR Restoration and Stewardship Plan* and in Mendenhall's 2014 *KR Baseline Monitoring Report*. While wildlife monitoring protocols have not been established at KR, during monitoring efforts at KR in March of 2016 bird species *Cyanocitta stelleri* (Steller's jay), *Melospiza melodia* (song sparrow), *Corvus brachyrhynchos* (American crow), *Turdus migratorius* (American robin) and *Calypte anna* (Anna's hummingbird) were identified at VMP A. EC project manager Kym Foley has kept a running list of bird species identified at KR which is located in Appendix D.

Recommendations for Restoration Based on Monitoring Data

In VMP A there seems to be a tradeoff between planting faster growing *Picea sitchensis* with a higher mortality rate or slower growing *T. plicata* with a lower mortality rate. In 2014 about 2/3 of the conifers planted at VMP A were *T. plicata* with the other 1/3 being *P. sitchensis*. Although *P. sitchensis* has a higher mortality rate, it could be justified to plant a higher ratio of *P. sitchensis* in the future since they seem to grow well in the wetter conditions found in VMP A and the central wetland area of KR. There is also a major need to focus on *I. aquifolium* re-sprouts. While the re-sprouts are very small and cannot be injected, other herbicide applications such as "cut and paint" are recommended to limit the regrowth and spread of invasive trees in KR. As for invasive groundcovers and shrubs, regrowth was often found in or on the edges of compost piles leftover from Phase I restoration. These piles should be targeted during Phase II maintenance and it is likely brush piles were over stacked on their platforms and invasive plant material was able to make contact with soil and re-establish. Lastly, there is still a need to increase the amount of groundcover species at VMP A and on the edges surrounding

the central wetland. Many of the edges along the wetland are relatively bare and steep, increasing the potential for erosion. Species like *Polystichum munitum* and *Berberis nervosa* have done well in similar areas of KR and would provide more cover and slope stabilization.

Potential Inconsistencies with Monitoring Data

It is important to note a few discrepancies between monitoring data collected at VMP A in 2013 and again in 2016. The first and most important difference being the season data was collected. Baseline data was collected in August of 2013, well into the growing season, while in 2016 it was collected in late March, only a month or so into the growing season. This may have led to a relative underestimation of percent cover for both native, and non-native species during 2016 monitoring. Ideally monitoring data would be collected in both March and August going forward, though since August is not during the academic school year, continuing data collection in March might be most feasible.

As mentioned before, it is also important to point out that a large *A. rubra* tree uprooted in the central wetland which has noticeably broadened the flow and ponding of water at VMP A. This can be seen as a positive feature since it has reduced channelization of flow and created broader wet habitat, but it is also important to consider the effect the more broadly wet site might have on invasive species regrowth. Since *H. helix* is not known for growing in anaerobic conditions, the fact that its cover has been reduced dramatically over 2 years could be due to a combination of restoration efforts and change in soil moisture at VMP A.

Photo Point Monitoring

Photo Points (PP) for monitoring were established in 2013 and their locations can be seen in Figure 3-A. The recreation of PP 1, 3 and 5 are below. PP give a good visual example of how sites change over time in response to restoration and are helpful at tracking general changes in vegetative cover. They are also extremely useful tools for outreach and presentations as the visual comparisons are often much more powerful to a general audience than measurements of percent cover.

Figure 3-B. PP 1, October 3, 2013

Figure 3-C. PP 1, March 13, 2014

Figure 3-D. PP 1, March 25, 2016

Figure 3-E. PP 3, October 3, 2013

Figure 3-F. PP 3, March 13, 2014

Figure 3-G. PP 3, March 25, 2016

Figure 3-H. PP 5, March 13, 2014

Figure 3-I. PP 5, March 25, 2016

Kincaid Ravine Tree Inventory

During April and early May of 2016, a mature tree inventory (DBH > 5") was conducted at KR in Areas 1 and 2 (Figure 2-A). The inventory was carried out using equipment borrowed from UW Grounds and the data was added to the UW Grounds Interactive Tree Map application (http://depts.washington.edu/grounds/arboriculture/interactive.php). An Ipad with the ArcGIS Collector application was used to record GPS locations of trees, including data on tree species, DBH and estimated tree height. Since no formal tree inventory for KR has been done in the past, this will serve as valuable baseline monitoring data to be able to compare and track the development of mature canopy (species richness, density etc.) at KR over the next several

decades in response to restoration efforts. Tree tags with numbers were also nailed to each tree so individual trees can be located and monitored easily going forward using the UW Tree Map application.

The ArcGIS attribute table with individual tree data and the UW Grounds Interactive Tree Map for KR can be found in Appendix E. In total 67 trees were inventoried in approximately 2 acres of KR (density of 33.5 trees/acre). There was only one native conifer (*Pinus monticola*) which was located at the very southeast edge of KR. The four deciduous tree species present included dominant species *Acer macrophyllum* (42 trees) along with *Alnus rubra* (9 trees), *Populus trichocarpa* (5 trees) and non-native *Prunus avium* (10 trees). This data only confirms previously stated needs to re-establish conifer canopy while also highlighting the need to track and possibly treat the non-native *Prunus avium* trees with herbicide.

Reed Canarygrass (RCG) Treatment

In April 2015, a cultural control experiment of reed canarygrass (*Phalaris arundinaceae*) located in the lower portion of wetland E (under the power lines along the Burke-Gilman Trail) was implemented by creating three 12 x 12 plots. The purpose of the experiment is to compare three control methods over a timeline of two years. The three treatments were:

1) Burlap coverage: RCG mowed (using machetes and loppers); area covered in 3 ply burlap sacks; not planted
2) Live stake shading: RCG mowed (using machetes); area planted with live stakes (*Cornus sericea* and *Salix lucida*) at a density of12-18" on center
3) Grub and mulch: RCG grubbed (root material removed as completely as possible); area planted at a density of 6" on center with herbaceous plants; mulched 4" thick

After an initial mowing of all RCG during Phase I restoration in February of 2014, RCG cover was measured at roughly 90% across all three treatment plots when they were established in April of 2015. However, due to poor demarcation and incomplete grubbing and removal during the previous year, Treatment 3 was removed from consideration during the follow up data collection on April 28, 2016. As seen in Figure 3-J, mowing and covering of RCG with 3 layers of

burlap sacks overlapping at the margins was fairly successful at hindering RCG growth in year 2 of the experiment. Percent cover was reduced to 30%, although this likely would not hold true long term.

Figure 3-J. Treatment 1 in April 2016

Figure 3-K. Treatment 2 in April of 2016

As for Treatment 2 (mowing and planting of dogwood and willow stakes), RCG regrowth (figure 3-K) was more vigorous when compared to mowing and covering with burlap sacks. Percent cover was estimated at 65% for Treatment 2, which was down from initial cover of 90% measured in April of 2015.

While this experiment is very anecdotal and short term, it does give some evidence for the usefulness in using burlap sacks to suppress RCG during the phase of restoration when you are trying to get native plants established. It is very likely that between the seed bank present on site and the ability of RCG to sprout from rhizomes that it will re-establish as the burlap sacks continue to biodegrade. However, RCG was mowed again in the locations of both Treatments 1 and 2 and two layers of burlap sacks were re-applied in the area of Treatment 1 during April of 2016. Follow up data and observations should be collected in spring of 2017 to see if burlap

sack coverage still suppresses the growth of RCG in year 3. If so, this will continue to be a relatively cheap and easy method to "knock back" RCG while live-stakes and other native plant installations continue to grow and take hold at KR.

Garlic Mustard in Kincaid Ravine

Garlic mustard (*Alliaria petiolata)* is listed as a Class A noxious weed in King County that is required by law to be controlled. It can be found along the access path that heads west from the Burke-Gilman Trail about 100' S of NE 45th St overpass. The infestation continues in scattered patches along the overpass and up the hill towards McCarty Hall (Figure 3-L). UW Grounds and King County Noxious Weeds have been monitoring the infestation. Manual removal of garlic mustards plants has been performed by Campus Grounds and EarthCorps. However, as seen in Figures 3-L and 3-M, the spread of garlic mustard has continued to increase from 2015 to 2016. Monitoring and removal efforts will continue with a heightened focus on limiting the spread of seeds by using boot brushes and cleaning of tools used by crews and volunteers working in KR.

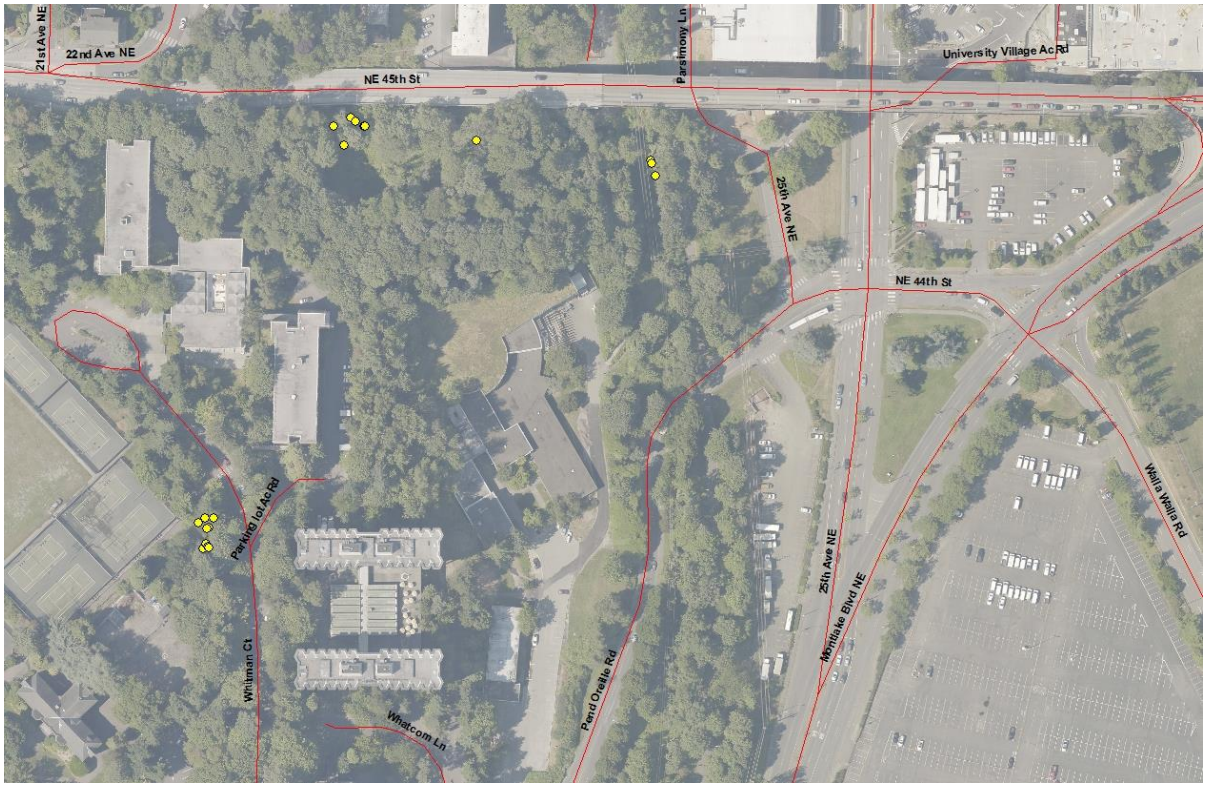

Figure 3-L. Garlic Mustard Locations 2015. *Map Credit: Karen Peterson, King County Noxious Weed Control Program*

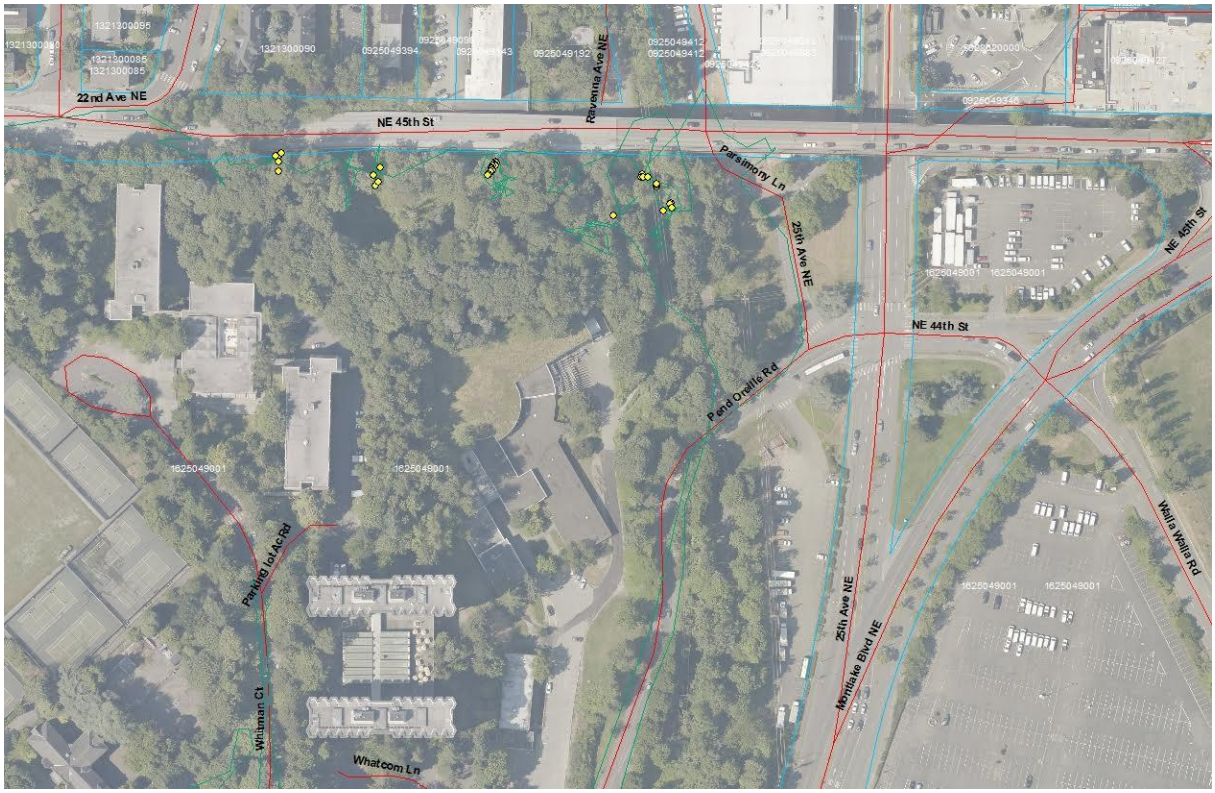

Figure 3-M. Garlic Mustard Locations 2016. *Map Credit: Karen Peterson, King County Noxious Weed Control Program*

IV. Wetland Restoration and Hydrology Improvements

Assessment of Hydrology in Kincaid Ravine

The existing topography and hydrology of Kincaid Ravine includes two delineated wetlands and a small stream that are fed by 3 small groundwater seeps (seeps mapped in Figure 4-A). Two of these seeps flow out of the south slope of KR, one occurring roughly at the northeast corner of McCarty Hall (Figure 4-A), and the other sits about midway through the ravine, near the northeast corner of the North Physics Laboratory (Figure 4-A) building. The last and the biggest of the three seeps is located on the north side of KR, under the 45th Street Viaduct, roughly across the viaduct from the building located at 2221 NE 46th Street (Figure 4-A).

Figure 4-A. Locations of Groundwater Seeps feeding central Wetland and Stream. *Map Credit: King County Imap 2013.*

At the lower (east) end of KR the creek area spreads into a flatter area and creates a 2,087 square foot category III Palustrine emergent wetland (delineated "Wetland 2" in Raedeke Associates, Inc. report March 2014—see Figure 4-B) (Cowardin 1979). The stream exits the ravine via infiltration along an existing ditch that becomes a 2,980 square foot category III wetland flowing north along the west side of the Burke Gilman (BG) Trail under the 45th Street viaduct (delineated "Wetland 1" in Raedeke Associates, Inc. report March 2014—see Figure 4-B). Where the stream turns north and enters the northbound ditch, it is filled with fine sediments allowing water to overtop the BG Trail and also to flow south into a previously dry ditch and infiltrate into the native soils. Flooding of the BG trail is common during fall and winter months and often inundates half of the trail's width at the location where the stream reaches the trail. The north ditch (Wetland 1) used to be maintained and regularly had sediment removed by UW Grounds, but since this trail ditch was delineated as wetland in 2014 by Raedeke Associates, Inc. the ditch has been left alone and has slowly filled with sediment, causing water to flood the BG Trail and begin to flow south into the previously dry trailside ditch that runs towards Pend Oreille Road (location shown in Figure 1-A).

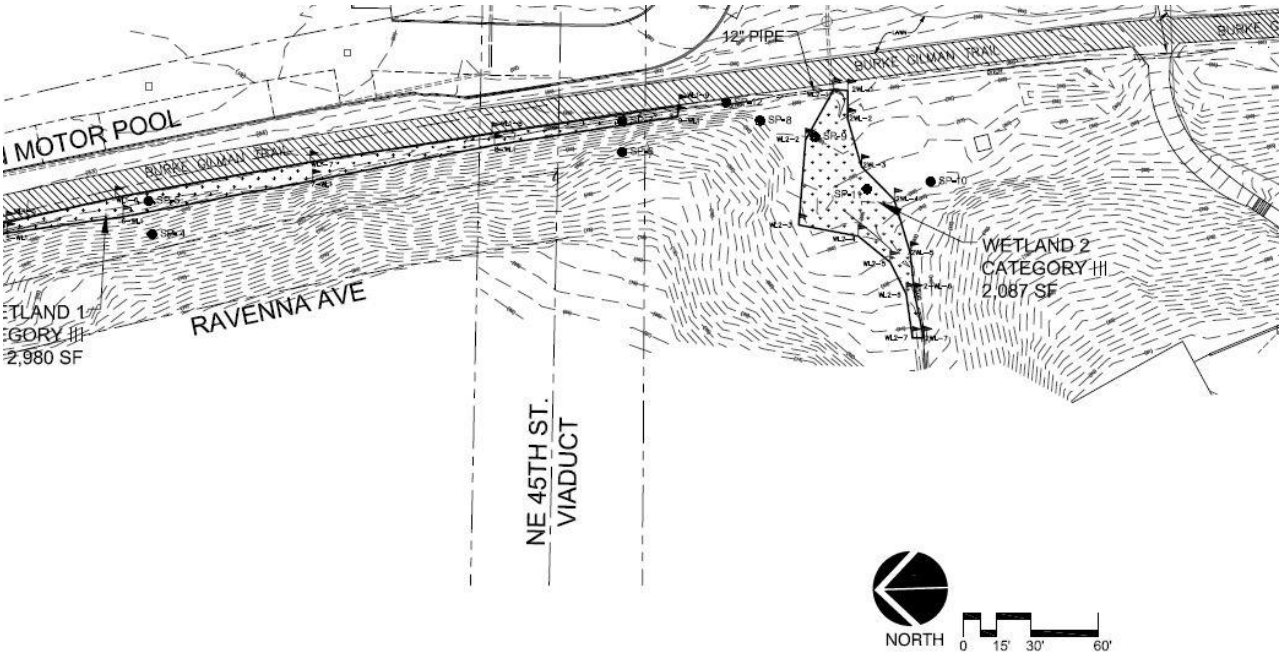

Figure 4-B. 2014 Raedeke Associates, Inc. Wetland Delineation of Eastern Portion of KR

Within the interior of KR, along the stream course uphill of the BG Trail, there are areas of erosion and stream incising that were identified as locations that could be mitigated with check dams and/or coarse woody debris (CWD) to slow flows and decrease erosive force and further reduce sediment loads in the stream. The wetland that drains into this stretch of incised channel is delineated as "Wetland E" by ESA Adolfson in their report prepared for Exeltech Consulting Inc. and SDOT in January of 2013. Wetland E has both Palustrine forested and scrub/shrub vegetation classes and is categorized as a slope wetland by Hydrogeomorphic (HGM) classification (Brinson 1993). Wetland E (Figure 4-C) is 14,228 square feet (approximately 1/3 of an acre) and is located on the "floor" of KR between the slopes to the north and south that feed the wetland with groundwater seeps (ESA Adolfson 2010). Water moves through Wetland E slowly and due to already existing downed CWD and dense vegetation, hydrology modifications were not considered necessary in this portion of KR and instead the focus would continue to be on invasive species maintenance, increasing conifer canopy and groundcover and shrub species richness.

Water Quality Testing

While much time was spent characterizing the hydrology of KR and coming up with ideas for hydrology and wetland enhancements, water chemistry was also tested from a sample

collected on 4/21/15 (Appendix F). This sample was considered a "dry" sample since there was no rain that day or for 6 days before the sample was taken. The sample was tested by the King County Environmental Lab. The results showed non-detectable levels of oil, relatively low levels of copper (0.0197 mg/L) and high levels of lead (0.0916 mg/L). According to the EPA Table of Regulated Drinking Water Contaminants, the levels of copper are only at 1.5% of allowable drinking water levels, but the lead levels are 6.1 times the allowable level for drinking water (EPA 2016). While the source of contamination is unknown, EPA cites corrosion of household plumbing systems and erosions of natural deposits as potential sources. It is also possible that lead and especially copper used in brake pads (heavy traffic on the steep 45th St. Viaduct) could contribute to these levels at KR. Inorganic chemicals like lead and copper can be harmful to humans in consumed through drinking water and can also be detrimental to fish and other aquatic species. Fish and amphibians are likely not present at KR, but these contaminants can travel downstream and water (ground and surface water) from KR does end up in Lake Washington. Future monitoring of water quality at KR is recommended.

Actions Taken

Installation of Picket Fence Check Dams and CWD

Picket fence check dams are an inexpensive, low-tech stream restoration technique designed to enhance bed and bank stability in small stream systems (EarthCorps 2015). These small picket fence check dams are also commonly used to enhance fish habitat in small streams since they will produce hydraulic diversity with aggradation of sand and sediment upstream of the check dams and scouring of pools below the check dams. However, since there are no fish species present at KR, the primary purpose of installing Picket Fence check dams and CWD throughout the incised portions of stream channel at KR was to reduce sediment transport, limit channel incision by increasing bank and bed stability and slowing down stream flows in an attempt to promote infiltration and reduce flooding of the Burke-Gilman Trail.

Between Wetland E and Wetland D (Figure 4-C) there is an incised stretch of stream channel that runs approximately 80 feet in length before broadly spilling out under the power lines and into the trail ditch (Wetland D) flowing north along the BG Trail. Stretches of this channel are

incised anywhere from 1 to 3.5 feet from the top edge of the stream bank. In October of 2015, seven oak stake Picket Fence check dams were installed by student PM Dan Hintz and EarthCorps throughout the portion of incised channel with two more CWD installations where channelization begins to decrease towards the BG Trail. The Picket Fence check dams were spaced approximately 10 feet apart, with a few in closer proximity in the more severely incised portions of the stream. While the Picket Fence check dams were installed primarily for bank stability and to reduce sediment transport, the CWD was installed in an attempt to broaden the flow of water leaving the channel and promote infiltration into soils within KR instead of flowing across the BG Trail or into the Wetland 1 ditch (Figure 4-B).

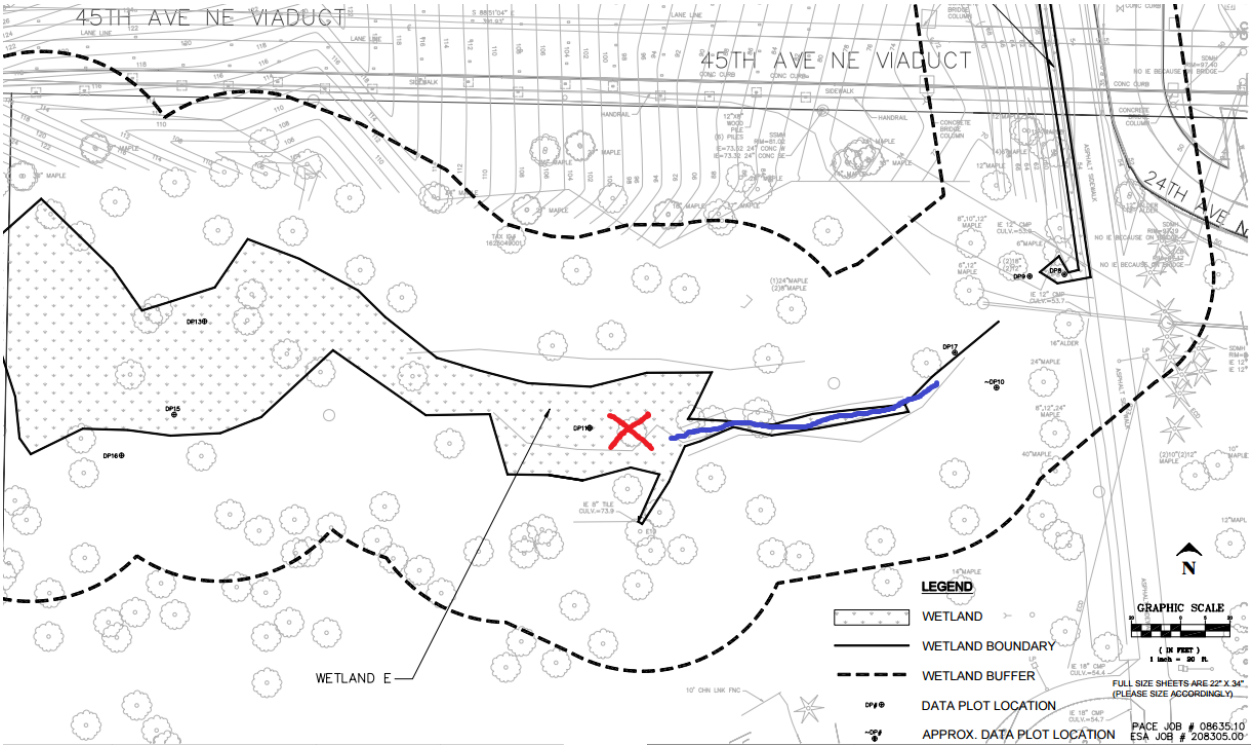

Figure 4-C. Red X marks start of stream channelization where Red Alder tree has uprooted and blue line represents stretch of incised stream channel where Picket Fences and CWD were installed. *Map Credit: ESA Adolfson, prepared for Seattle Department of Transporation*

The actual construction of the Picket Fence check dams required pounding 3 foot long oak stakes approximately 2.5 feet into the stream banks and bed. Stakes installed into the stream bank were hammered perpendicular to the angle of the stream bank and stakes hammered into the stream bed were angled approximately 15-20 degrees upstream. At each Picket Fence stakes were installed at a rate of 4 stakes per foot of channel width and stakes were staggered

from one to another with a 4” offset. This offset allowed for coir fabric to be weaved in between the oak stakes and then fastened to the top of the stakes with twine. Sketches and instructions for Picket Fence construction were provided by Natural Systems Design and can be found in Appendix G.

Figure 4-D. Picket Fences 2 months after installation shown increasing sediment deposition

Use of Trailside Ditches as Infiltration Galleries

The trailside ditch that the stream began to overflow into in 2015 (south of the delineated Wetland 1 ditch) also has a parallel ditch approximately 12 feet further west and slightly uphill. These areas were identified during the KR Hydrological Assessment to have the potential to infiltrate significant volumes of surface water and were assessed for bioretention capacity (see Appendix H for bioretention concept design). Both ditches are approximately 100 feet in length. Infiltration tests were conducted in March of 2015 at two locations in each ditch yielding variable, but generally high infiltration rates of 2.9-6 inches per hour. Simulated saturation conditions were achieved by conducting successive saturation and infiltration tests in the same holes. Each hole was dug 24” deep and filled full once before infiltration rates were measured to mimic soil saturation. After the initial filling of water had infiltrated, holes were

filled two more times each and the time it took for water to infiltrate soils and empty from the holes was recorded.

The use of these parallel trailside ditches to improve infiltration on site and limit flooding of the BG Trail was the first consideration of the hydrology assessment since it would be a relatively low tech, easy solution that would not require excavation or fill in wetlands. However, after consulting with project stakeholder and UW Landscape Architect Kristine Kenney, it was determined that long term she would prefer the ditches be filled in to improve safety along the BG-Trail and better access to the "Educational Nook" sign and bench area in KR. Kenney supported the use of ditches in the short term to alleviate flooding of the BG Trail and so in November of 2015, very minor excavation using shovels was conducted to remove some fine sediments that had accrued and to promote flow of water into the trailside ditch flowing south towards Pend Oreille Road.

Figure 4-E. Trail Side Ditch flowing south used for infiltration. Photo taken 1/8/2016

While some storm water still flowed north into the Wetland 1 trailside ditch, the majority of water after mid-November of 2015 was flowing and infiltrating into the south ditches. This reconfiguration of flows at KR had immediate short term success in terms of limiting flooding on the BG Trail. Student PM Dan Hintz checked the site every Friday from November through February and Stewardship Partners consultant Aaron Clark monitored the ditches almost every weekday during that same span as a commuter on the BG Trail. During the winter of 2015/2016, the BG Trail was never observed to have flooded due to flows from KR. The closest the ditches came to breaching the trail occurred on January 22, 2016 after 1.15 inches of precipitation was recorded in the previous 24 hours at SeaTac and 1.91 inches in the previous 72 hours (National Weather Service Daily Climate Data). This heavy amount of rain in a 3 day period caused the ditches to fill within 2 inches of the trail grade.

Although the trailside ditches have so far been very effective at preventing flooding of the BG Trail, it would be a stretch to say this project improved any wetland habitat or would be successful long term without regular maintenance. Reducing flooding of the BG Trail was and still is a major priority when assessing the hydrology at KR. However, visual evidence suggests that without regular removal of sediment, the south ditches could begin to fill in and increase the likelihood of trail flooding, similar to what happened to Wetland 1 after sediment removal ceased. In observations recorded in early May of 2016, the south ditches had already accumulated 2-3" of muddy, silty sediment from being used as infiltration galleries since November 2015. EC will remove sediment in the short term (fall of 2016), but due to the need for long term maintenance, project input from the UW Landscape Architect, and goals to retain and infiltrate water further up in KR in and around wetlands, other options for hydrology and wetland improvements are being developed and are outlined in the next section.

Future Options for Hydrology Improvements

A major consideration for any wetland hydrology improvement projects at KR is to minimize the amount of impact within delineated wetlands. This is partly to avoid triggering permits (which UW environmental planner Jane Arntz-Richards has recommended unless needed as a last resort) and to protect existing wetland habitat and restoration work at KR. Under Section 404

of the Federal Clean Water Act (CWA), excavation or fill within a wetland is regulated and subject to a permit review to prove practicable alternatives do not exist. Similar permitting processes for work in wetlands exist through the state (Department of Ecology enforces CWA Section 404) and county (King County Critical Area Ordinances). Initial ideas during the KR Hydrological Assessment were to use a berm (fill) or excavation to promote infiltration further up in the ravine before water leaves through the trailside ditches. For permitting reasons, and because these sorts of projects would require more technical design and construction, they have been scrapped for simpler, low tech options. These options include the previously described Picket Fence check dams and use of trail side ditches for infiltration, but further use of coarse woody debris and minor excavation on the edge of Wetland 2 could be used to divert the flow of water, slowing it down by allowing it to meander and potentially infiltrate over a greater area before exiting KR.

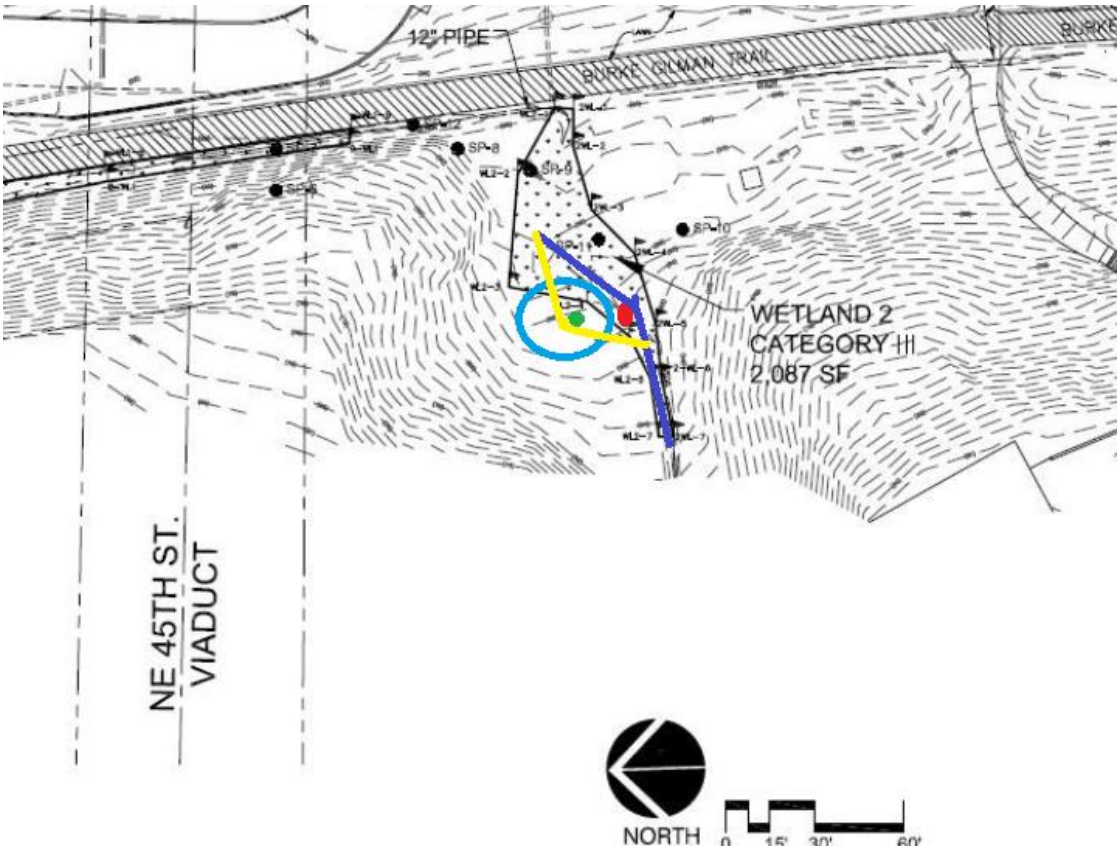

Figure 4-F. Proposed location for expanded infiltration (Area marked by Blue circle, Red dot is location of flow measurements and Green dot is location of infiltration test. Blue line marks existing water course and Yellow line is proposed redirection of flow). *Map Credit: Raedeke Associates, Inc. 2014*

The light blue circle marked in Figure 4-F shows the location that has be chosen to potentially expand infiltration and convert to slightly wetter habitat. This site was selected since it is out of the delineated wetland, the elevation gradient is close to the exisiting stream course (as seen by contour lines in Figure 4-B and ground truthed elevation data collected located in Appendix I) and because this area has experienced little to no restoration work that would be undone (it is currently covered in reed canarygrass and bittersweet nightshade). The area was also tested for infiltration on February 22, 2016 (assumed soil saturation since it was middle of winter) and yielded a good infiltration rate of 2.1 inches/hour. This site was identified during a site visit with Aaron Clark (Stewardship Partners) and Kristine Kenney (UW Landscape Architect). The one major impediment to this design is a large *Acer macrophyllum* tree that's base forms a mound which diverts water away from the proposed area of infiltration. Flow could potentially be diverted around this tree, but removal has been recommended by Kenney and discussions have begun with UW Campus Grounds about removing the tree. Wood from the downed maple tree could then be used as CWD to help direct flows and form small infiltration pools before water re-joins with its original water course and exits KR through the trailside ditches.

This project is still being planned with EarthCorps, Kenney, Stewardship Partners and UW Campus Grounds, but tentative plans for building this area are set for early fall of 2016 (before the 2016-2017 rainy season) when EarthCorps will be working frequently at KR. Some minor excavation using shovels will be required and monitoring of volumes and directions of flows should be closely tracked during winter of 2016/2017.

Flow Data Collection

To better track the future reduction in flows in response to the previously described plan and to determine the potential size for this proposed infiltration area at KR, approximate flow measurements were recorded at the location (marked with red dot in Figure 4-F) where the incised channel begins to "spill out" into Wetland 2. This area was chosen since it has been identified as a potential location to divert flow and promote infiltration before water exits KR through the trailside ditches. Flow measurements were recorded every Friday from January 22, 2016 through March 4, 2016. Flow was measured using the "float method" which is a simple

method for estimating flow by measuring the cross sectional area of the stream (A) and the velocity (V) of water by using a ping pong ball and recording the time it takes to float a measured distance. The distance floated was 12 feet. To get more representative data for velocity, five float trials were measured and averaged each Friday. Once velocity was determined and area measured, flow (Q) was calculated by multiplying velocity by area (Q=VA). Q was calculated in cubic feet per second (cfs). Table 4-1 shows flow for each data collection date along with precipitation amounts in the 24 and 72 hours leading up to each day data was collected.

Date	Flow (Q=VA)	Precipitation (previous 24 hours)	Precipitation (previous 72 hours)
1/22/2016	0.42 cfs	1.15 inches	1.91 inches
1/29/2016	0.36 cfs	0.61 inches	1.73 inches
2/5/2016	0.21 cfs	0.33 inches	0.87 inches
2/12/2016	0.19 cfs	0.48 inches	0.61 inches
2/19/2016	0.18 cfs	0.12 inches	0.60 inches
2/26/2016	0.13 cfs	0.00 inches	0.02 inches
3/4/2016	0.18 cfs	0.03 inches	1.12 inches

Table 4-1. Stream Flow Data at point of potential infiltration gallery

V. Place Making

Since KR has such high visibility due to its location on the UW campus and being adjacent to the Burke-Gilman trail, focusing on the human and community benefits of creating a healthy green space in an urban setting is an essential project goal. This includes providing access to explore, opportunities to learn about restoration and forest ecology, and creating an environment for relaxation and respite which have been shown to positively affect mood and mental health.

Health Benefits of Urban Green Spaces

Over the past several decades the fields of environmental sociology, landscape architecture and public health are continuing to build more evidence about the value of urban green spaces as they relate to public health. As more and more people continue to choose to live in cities; 80.7% of U.S population according to 2010 Census which was up 2% from 2000 and 11% since 1960; the need for access to green space is both an issue of human health and equity. Urban green spaces can provide avenues for recreation (physical health), opportunities to socialize

and build social cohesion and can improve mental health through restorative experiences. These health benefits are on top of already documented benefits associated with urban green spaces such as improved air and water quality, energy savings, heat mitigation and increased property values.

In his 2015 report, student PM Matt Schwartz already outlined some of the benefits urban green spaces provide in terms of air quality and climate change mitigation. This section will focus more on the cognitive and mental health benefits that are associated with urban green spaces and how some of the theories about landscape design as they relate to health have and will continue to be incorporated at KR.

The three major ideas/theories that will be outlined in this section are:

1. Landscape Preferences
2. Stress Reduction Theory
3. Attention Restoration Theory (ART)

Landscape Preferences

One of the more simple and well-studied ideas in environmental psychology is that people have two basic needs in natural environments; the need to understand and to explore. A very commonly used model to describe the landscape features that satisfy these needs is the "complexity/coherence/mystery/legibility' model put forth by Rachel and Stephen Kaplan (1989). These ideas about landscape preference theory suggest that a landscape should be coherent, which means a space has visual connectedness and a sense of relatedness across elements (Kaplan and Kaplan 1989). A coherent place is understandable and wayfinding is guided by repeated patterns and features (Wolf 2016). This appeals to people's need to understand. Complexity is more related to people's need to explore. If a place is too monotonous and lacks variation (i.e. grass fields) people might find it boring. If a place is too complex, people might find it uncomfortable and unwelcoming. Finding the right mixture of complexity and coherence is what seems to really make a green space desirable for human use and interaction. While mystery (the idea that more is to be revealed as you move through a

site) and legibility (ability to find one's way around) are the other two landscape preference ideas, the focus at KR has been more on finding the right balance of complexity and coherence.

Since KR is designated as an open space and is being restored as close to a native forest as possible, complexity is fairly abundant across the site. By nature, natural areas are complex and goals for restoration include biodiversity (both wildlife and plants) and enhancement of different habitats (i.e. both forested and emergent wetlands, upland forest, shade vs. sun areas etc.). Now that restoration work is well on its way at KR, finding the right balance between conserving the site for ecological value (complexity) and also bringing in people to explore, learn and walk around (coherence and legibility) is a major consideration going forward as interpretive areas and trails continue to be developed. During the 2015/2016 academic year student PM Dan Hintz partnered with Master's in Landscape Architect (MLA) student Jeni Chan to work together on ideas to make KR more welcoming to people while also keeping sensitive areas (like wetlands) off limits. A site sketch designed around the idea of human access was created by Chan for the east portion of KR (along the BG Trail) and is available in Appendix J.

Other fairly obvious but crucial ideas to human landscape preferences include safety and accessibility. Work at KR has really focused on removal of trash, homeless encampments, student "party pits" and hypodermic needles. UW Recycling Services have provided small dumpsters and recycling totes to dispose of trash and debris from KR and hypodermic needles are disposed of in "sharps" containers. Educational signage, benches, interpretive trails and ditch crossings have all been installed to make KR more accessible, coherent and safe. The development of these landscape features are described in the following section.

Stress Reduction Theory

While preferred landscape features themselves do not contribute directly to human health, they are the essential part of the equation that make people more likely to interact with nature. In restoring a degraded ravine to a healthy urban forest with a focus on sustainable landscape features that attract people to visit you are not only designing for ecological benefits, but also co-benefits that can include stress reduction and attention restoration which are essential to long-term mental health. Stress reduction as a product of interactions with nature is a theory

first proposed in depth by Ulrich (1991). Ulrich used a lab setting and measured responses of people with heightened stress levels to urban images and images of nature. It was overwhelmingly found that the responses to nature were stress reducing while responses to urban settings often hampered stress recuperation (Ulrich 1991). This is very applicable to people living in busy cities that have to deal with stressors of a busy urban environment on top of common stressors such as jobs, families or schoolwork. Many other studies in environmental psychology have since been conducted that demonstrate how interactions with nature can provide stress reduction and lessen the likelihood of the negative health effects from chronic stress.

Attention Restoration Theory (ART)

Attention Restoration Theory (ART) is similar to Stress Reduction Theory, but focuses on stress reduction and the cognitive benefits of interactions with nature. The idea originally put forth by R. Kaplan and S. Kaplan (1989) describes how due to the many stimuli (or hard fascinations) people regularly experience in daily life living in an urban environment, the brain can experience a state of attention fatigue. Attention fatigue can lead to mental fatigue, irritability and in the long term, chronic stress (Wolf 2016). Interacting with nature is one way to remedy attention fatigue. Nature provides "soft fascinations" which can restore directed attention abilities. This idea is shown by Berman et al. (2008) when measuring participants mood (using Positive and Negative Affect Schedule, PANAS) and subjecting them to "backwards digit span" tests (a measure of cognitive ability) prior to and after walks through urban green spaces. Cognition was shown to be improved after experiences with nature for participants scoring poorly (indicating poor mood and stress) on the PANAS test.

While the exact features of the natural landscape, the "dose" of nature and any causal relationships between health and interactions with nature are still difficult to define, there is still a substantial (and growing) field of literature about the positive effects of nature on human health. For that reason, and the fact that KR has such high visibility and potential to draw in students and commuters along the BG-Trail, considering how landscape features are designed and implemented at KR is vital for project management going forward.

Development of Landscape Features at KR

Interpretive Trail

In April of 2016 an approximately 120 foot trail was constructed to connect the "Educational Nook" area along the BG Trail to the path leading up to the parking lot at the North Physics laboratory. This "cut through" trail site was selected since it would further develop the Educational Nook area and since it was regularly observed that walkers on the BG Trail would use the path to the N. Physics Building parking lot as a shortcut to campus. This way people on the BG Trail can now cut that corner while walking through an area of KR with interpretive signs on pollinator habitat, climate change and native species identification and descriptions. Access from the BG Trail across the infiltration ditch to the Educational Nook area and interpretive trail has also been improved from a single wooden plank to a 4-foot wide crossing structure with concrete footings that was built in the Gould Hall Woodshop by student PM Dan Hintz and Jeni Chan.

Figure 5-A. Interpretive Trail (left) and one of 6, mini native species ID signs installed along the trail (right).

Educational Nook

The Educational Nook area continues to be developed and remains a focal point for maintenance work such as weeding and pruning since it is currently the primary gathering spot in KR. Two cedar benches and interpretive signage were installed in September of 2015. Since then workers from the nearby Plant Facilities building and student and non-student BG Trail users have been observed using the spot to eat lunch or take a break from their day. This area not only provides opportunities to learn about ecological restoration and the work at KR, but also provides mental respite and breaks that are the foundation of the Stress Reduction and Attention Restoration Theories. As mentioned in the previous section, accessibility through the building of a ditch crossing and small trail are also improving the ability and likelihood of people passing through the Educational Nook area. Weeding and selective pruning has also been a focus in the spring of 2016 to provide better view of the ravine and improve the noticeability of the benches from the BG Trail since one bench was fairly obscured by Indian Plum.

Plans to develop a similar, small seating area along the path to the 45th street Viaduct (north of the entrance to the Educational Nook) are also in the works with MLA intern Jeni Chan. This area (pictured in Figure 5-B) would use existing remnant concrete slabs for terraced seating and would be right above the area proposed for infiltration (Chapter IV). With remaining funds in the CSF "Signs and Benches" budget an interpretive sign on the benefits of wetland habitat could also be installed in this area.

Figure 5-B. Proposed site for seating and educational signage on value of wetland habitats

Maintenance of Welcome to Kincaid Area

Figure 5-C. Welcome to Kincaid Ravine sign area

The last spot that has been a focus for Place Making is the Welcome to Kincaid Ravine (Figure 5-C) sign spot along the BG Trail. Since the site serves as the "Welcome" spot to KR it should be a high priority area for weeding, mulching and planting if already installed plants do not survive. The more neglected this area looks, the more it feels like the ravine does not have an active human presence. In order for people to want to enter KR and feel safe doing so, it is necessary that it looks like it is being cared for, especially at the entrance.

VI. Conclusion

Over two years into the restoration work at Kincaid Ravine there has been significant progress made in restoring ecological functions in the ravine, building partnerships and engaging students in the work taking place. The purpose of this report is to detail the progress accomplished in building on goals laid out by student project managers Moritz (2014) and Schwartz (2015) while also identifying areas where improvements can be made and energy should be focused. While restoration work is ongoing at Kincaid Ravine and will be funded into 2018, it is becoming more of an urgent priority to plan for the transition from project management to long term site maintenance. What exactly this entails is still unclear, but it is necessary that there be some sort of long term stewardship and maintenance work (i.e. invasive species, hydrology, trails, signs etc.) to ensure that the trajectory towards a healthy urban forest and campus/community asset continues. Future student management should focus on building partnerships with groups (i.e. SER-UW, UW Grounds, UW classes) who can help coordinate long term site maintenance. This long term planning could also include working to restore surrounding habitats (like Ravenna Woods) and partnering with the City of Seattle to leverage resources for restoration work in the area. There is still much restoration work to coordinate and work to be done with hydrology, trail construction and project outreach, but the focus of the next student PM should be on developing a long term maintenance plan for KR.

From a personal standpoint, the project offered me the opportunity to build on my skills in ecological restoration and knowledge of restoration ecology while also learning a great deal

about project management, managing budgets, prioritizing work, coordinating volunteers and working with stakeholders and project partners to accomplish collective goals. These experiences have already led to securing a position in the field as a Restoration Specialist. Similar efforts carried out over the next few years by current and future students, along with project partners and stakeholders, should ensure that Kincaid Ravine will continue to add ecological and community value to the UW campus.

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Appendices

Appendix A – KR Hydrology Assessment Report

The Kincaid Ravine Hydrology Assessment Report can be found at:

https://society4ecologicalrestorationuw.files.wordpress.com/2015/06/kincaid-ravine-hydrology-assessment.pdf

Restoration of a Degraded Urban Forest in a Campus Setting: A Two Year Review of work at Kincaid Ravine

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Project History

Kincaid Ravine is a 4-acre forested open space with two delineated wetlands located in the northeast corner of the University of Washington campus. Until student led restoration work began at the ravine in the spring of 2014, the site was covered with a suite of invasive species, trash and lacked any conifer canopy. With the help of funding from the Campus Sustainability Fund, contract work from EarthCorps and SER-UW led student volunteer events, over 3 acres of the ravine are now in active restoration and 4,000 native trees and shrubs have been planted.

Project Location

Focused Objectives

1. Increase plant biodiversity, conifer canopy and wildlife habitat.
2. Enhance wetland habitat and limit erosion and flooding on the Burke-Gilman Trail through increased infiltration of stormwater into soils on site.
3. Engage students in stewardship, research and educational opportunities.
4. Transform Kincaid Ravine into an amenity on campus that students and the broader community can enjoy for education, exploration and mental respite.

Place Making

Development of "Educational Nook" that includes:

- Two cedar benches
- Interpretive signs on the importance of urban forests for pollinator habitat and climate change mitigation
- Small trail with mini native plant identification signs

Kincaid Ravine's proximity to the Burke-Gilman Trail gives the project excellent visibility which has attracted many visitors.

Vegetation Monitoring

*Monitoring data collected for 1/10 acre plot partially located in central wetland

Parameter	8/19/2013	3/25/2016
Trees (stems)	THPL: 1 (seedling) ACMA: 1 ALRU: 3	THPL: 10 (ave. height = 19") PISI: 5 (ave. height = 34") ALRU: 1 (7" DBH)
Shrubs (% cover)	RUSP: 80% OECE: 5%	RUSP: 35% OECE: 25% SALU: 8%
Groundcovers (% cover)	EQHY: 85% LYAM: 60% ATFI: 5%	EQHY: 50% LYAM: 22 % ATFI: 5 %
Invasive Species	ILAQ: 1 (mature) HEHE: 90% RUAR: 10%	ILAQ: 16 (ave. height = 12") HEHE: 6% RUAR: 5%

Photo Point Monitoring

Photo Point pictures taken in October, 2013 (above) at entrance to Kincaid Ravine before restoration work began and again in March of 2016 (left) two years into active restoration.

Notes on Monitoring Data

- Invasive removal and planting at monitoring plot occurred in Feb. of 2014 with one maintenance crew day in 2015.
- 83% tree planting survival (71% for PISI and 90% for THPL)
- Only dominant species listed in above table. Other species present (< 5% cover) PHCA, RILA, COSE, OPHO, POMU, DREX, TEGR and invasive species CASE and LAMU.
- Timing of monitoring may have skewed % cover estimates.
- Large ALRU in plot uprooted in Dec. 2014 which broadened the flow of water, possibly favoring wetland species.
- Invasive species regrowth concentrated around brush piles.

Wetland Improvements

- Development of Kincaid Ravine Hydrological Assessment report documenting the groundwater seeps and channels in the ravine with a goal of improving wetland habitat and limiting flooding on the Burke-Gilman Trail.
- Use of trail side ditch for infiltration gallery which has greatly reduced the frequency of trail flooding this past winter and limited amount of water entering storm sewers (below right).
- Installation of "Picket Fence" check dams (below left) to limit channel incision and slow down transport of water and sediments.
- Planting of willow and dogwood live stakes treated with natural "willow water" rooting hormone.
- Reduction of reed canarygrass cover when cut and covered with 2-3 layers of burlap sacks as compared to just mowing.

Student Involvement

- 3rd year of MEH student project management
- 3rd year of UW-REN capstone class working on site
- SER-UW coordinated volunteer events and other RSO partnerships
- Interns from ESRM and MLA
- Class field trips in ESRM 362

Thanks to our Project Partners!

CSF Campus Sustainability Fund, University of Washington

King Conservation District

Stewardship Partners – Helping Landowners Preserve the Environment

Earth Corps

W Grounds Management

University of Washington Botanic Gardens

Appendix C – VMP A Monitoring Data Sheet

Dan Hintz
monitored on 3/25/16

Monitoring Data: Plot A

		#	3/30 stems/acre	Ave. height
Trees:	Picea Sitchensis	5 (2 dead)	50	34"
	Thuja plicata	10 (1 dead)	100	18.5"
	Alnus rubra	1	10	7" DBH

Mortality rate = 15/18 = 83% → 17%; 71% for PISI, 90% for THPL but small

		% cover	
Shrubs:	Rubus spectabilis	35%	
	Oemleria cerasiformis	24%	
	Salix sp. (Live stakes?)	8%	
	Physocarpus capitatus	1%	1-2 plants of each
	Ribes lacustre	1%	
	Cornus sericea	1%	
	Oplopanax horridus	2%	
		% cover	
Ground covers:	Equisetum hyemale	48%	
	is some arvense too?	15%	
	Lysichiton americanus	↓	
	Athyrium filix-femina	5%	
	Polystichum munitum	4%	
	Dryopteris expansa	<1%	→ 1 plant
	Tellima grandiflora	1%	

			#/or %	stems/acre	Ave Height
Imazapyr injection; no cherry laurel	Invasives:	Ilex aquifolium	16	160	12"
		Hedera helix	6%		
		Rubus armeniacus	4%		
		Calystegia sepium	3%		
		Lactuca muralis	1%		

Nov/Dec. 2014

CWD: Alder (16" DBH) down, branches from snags. CWD = 25% cover. willow stakes that didn't take, maple branch, 4 snags (6-12")

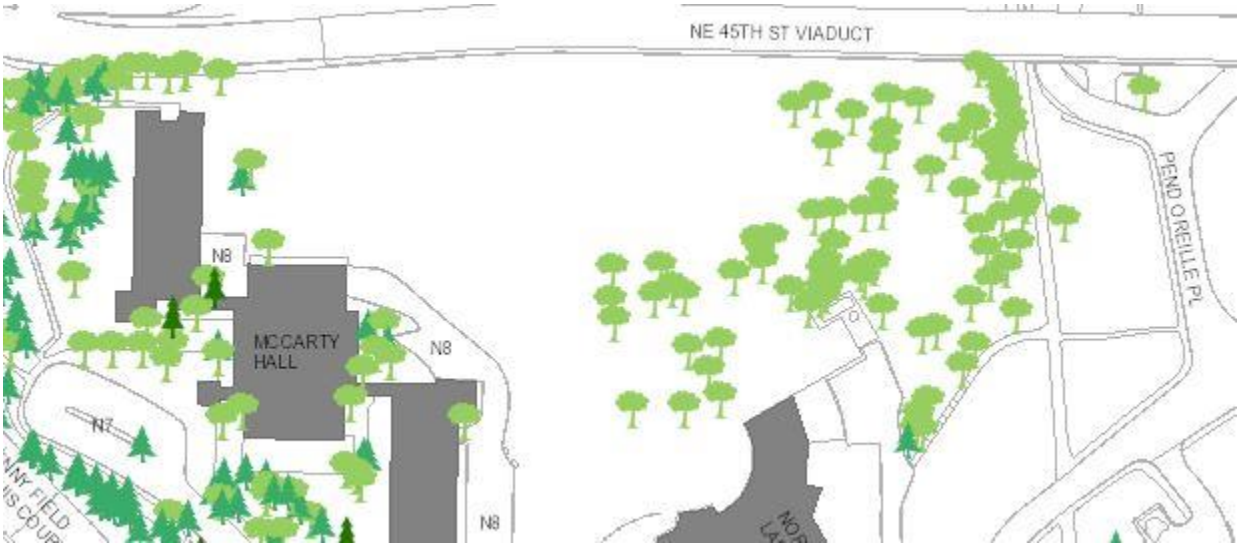
* invasives (BB, Bweed & ivy around brush piles
* Alder tree down altered hydrology, broadened the flow
* % cover maybe slightly underestimated since early in growing season

compare to 8/13

Appendix D- List of Bird Species Identified at KR

Species	Notes/observations
American crow	
American goldfinch	
American robin	nesting
Anna's hummingbird	
bewicks wren	
black-capped chickadee	
brown creeper	
bushtit	nesting
cooper's hawk	
downy woodpecker	
golden-crowned kinglet	
lincoln sparrow	
northern flicker	
Pacific wren	
pileated woodpecker	
red-breasted nuthatch	
ruby-crowned kinglet	
rufus hummingbird	
song sparrow	nesting
Stellar's jay	
wilson's warbler	
wood duck	nesting

Appendix E – Tree Inventory Map and Data Table



FID	Shape *	TREE_NUMBE	SPECIES_NA	DBH	HEIGHT
0	Point	11880	Acer macrophyllum	21.8	80
1	Point	11881	Acer macrophyllum	32.8	90
2	Point	11882	Acer macrophyllum	21.1	70
3	Point	11883	Acer macrophyllum	8.4	60
4	Point	11884	Acer macrophyllum	14.7	75
5	Point	11885	Acer macrophyllum	17.8	60
6	Point	11886	Acer macrophyllum	19.2	65
7	Point	11887	Acer macrophyllum	22	50
8	Point	11888	Acer macrophyllum	13.6	65
9	Point	11889	Populus trichocarpa	5.8	35
10	Point	11890	Populus trichocarpa	7.3	45
11	Point	11891	Pinus sp	5.5	40
12	Point	11892	Acer macrophyllum	23.4	70
13	Point	11893	Acer macrophyllum	26.3	80
14	Point	11894	Acer macrophyllum	31.8	75
15	Point	11895	Acer macrophyllum	26	80
16	Point	11896	Alnus sp	11.3	50
17	Point	11897	Alnus sp	13.6	60
18	Point	11898	Populus trichocarpa	40.7	80
19	Point	11899	Populus trichocarpa	38.4	80
20	Point	11900	Alnus sp	9.8	55
21	Point	11902	Acer macrophyllum	8.5	40
22	Point	11903	Alnus sp	6	35
23	Point	11904	Acer macrophyllum	10	50
24	Point	11905	Acer macrophyllum	36.5	75
25	Point	11906	Acer macrophyllum	13	60
26	Point	11907	Acer macrophyllum	16.5	65
27	Point	11908	Acer macrophyllum	26	80
28	Point	11909	Acer macrophyllum	14.5	50
29	Point	11910	Acer macrophyllum	34	80
30	Point	11911	Acer macrophyllum	40	85
31	Point	11912	Prunus sp	5.5	35
32	Point	11913	Acer macrophyllum	9.5	50
33	Point	11914	Acer macrophyllum	22.5	75
34	Point	11915	Prunus sp	4	25
35	Point	11916	Acer macrophyllum	9.5	45
36	Point	11917	Prunus sp	6.5	45
37	Point	11918	Acer macrophyllum	23	70
38	Point	11919	Prunus sp	7	45
39	Point	11920	Prunus sp	4	40

39	Point	11920	Prunus sp	4	40
40	Point	11921	Acer macrophyllum	18	75
41	Point	11922	Prunus sp	6.5	50
42	Point	11923	Acer macrophyllum	17	70
43	Point	11924	Acer macrophyllum	19.5	70
44	Point	11925	Prunus sp	7	50
45	Point	11926	Prunus sp	6	45
46	Point	11927	Acer macrophyllum	22	40
47	Point	11928	Thuja plicata	37	90
48	Point	11929	Acer macrophyllum	28	70
49	Point	11930	Acer macrophyllum	10.5	45
50	Point	11931	Acer macrophyllum	17.3	65
51	Point	11932	Acer macrophyllum	28.4	75
52	Point	11933	Acer macrophyllum	32.6	70
53	Point	11934	Acer macrophyllum	21.2	65
54	Point	11935	Acer macrophyllum	26.5	55
55	Point	11936	Acer macrophyllum	26	70
56	Point	11937	Populus trichocarpa	20	90
57	Point	11938	Acer macrophyllum	29	90
58	Point	11939	Prunus sp	6.5	50
59	Point	11940	Acer macrophyllum	26	75
60	Point	11941	Acer macrophyllum	17.7	75
61	Point	11942	Alnus sp	10.5	50
62	Point	11943	Alnus sp	16	55
63	Point	11944	Alnus sp	18.5	70
64	Point	11945	Alnus sp	11	55
65	Point	11946	Alnus sp	12.5	55
66	Point	11901	Acer macrophyllum	8.5	40

**Alnus sp* = *Alnus rubra* and *Prunus sp.* = non-native *Prunus avium* and *Pinus sp. = Pinus monticola*

Appendix F – Water Quality Test Results

King County Environmental Lab Analytical Report

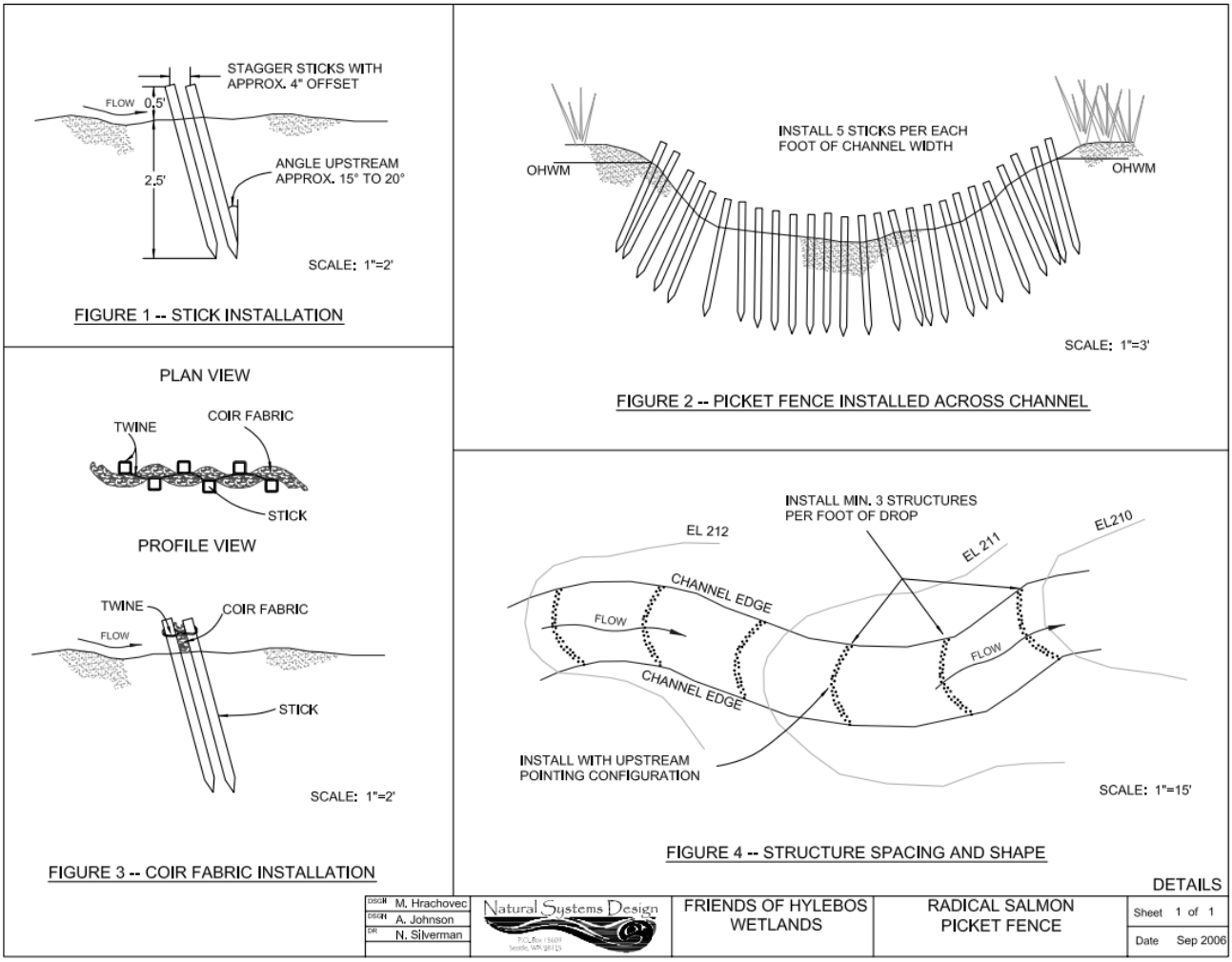
	Project: 421874-984 Locator: NONE Descrip: UNKNOWN LOCATOR Sample: L61949-4 Matrix: LG STORM WTR ColDate: 4/21/15 20:30 TimeSpan: TotalSolid: ClientLoc: SampDepth: **WET Weight Basis**					Project: 421874-984 Locator: NONE Descrip: UNKNOWN LOCATOR Sample: L61949-5 Matrix: LG STORM WTR ColDate: 4/21/15 20:30 TimeSpan: TotalSolid: ClientLoc: SampDepth: **WET Weight Basis**					Project: 421874-984 Locator: NONE Descrip: UNKNOWN LOCATOR Sample: L61949-9 Matrix: LG STORM WTR ColDate: 4/21/15 20:30 TimeSpan: TotalSolid: ClientLoc: SampDepth: **WET Weight Basis**				
Parameters	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**
ES NONE															
Sample Information	Kincaid Ravine				none	E1 Detention Pond				none	Kincaid Ravine				none
MT EPA 200.8*SW846 6020A															
Copper, Total, ICP-MS											19.7		0.2	2	ug/L
Lead, Total, ICP-MS											91.6		0.1	0.5	ug/L
OR EPA 1664B															
Hem (oil, total)		<MDL	1.6	5.6	mg/L		<MDL	1.5	5.2	mg/L					
SGT-Hem (oil, nonpolar)		<MDL	1.6	5.6	mg/L		<MDL	1.5	5.2	mg/L					

Qualifier Definitions:
<MDL = Less than the method detection limit
<RDL = Less than the reporting detection limit. Quantitative accuracy may be limited due to low response.

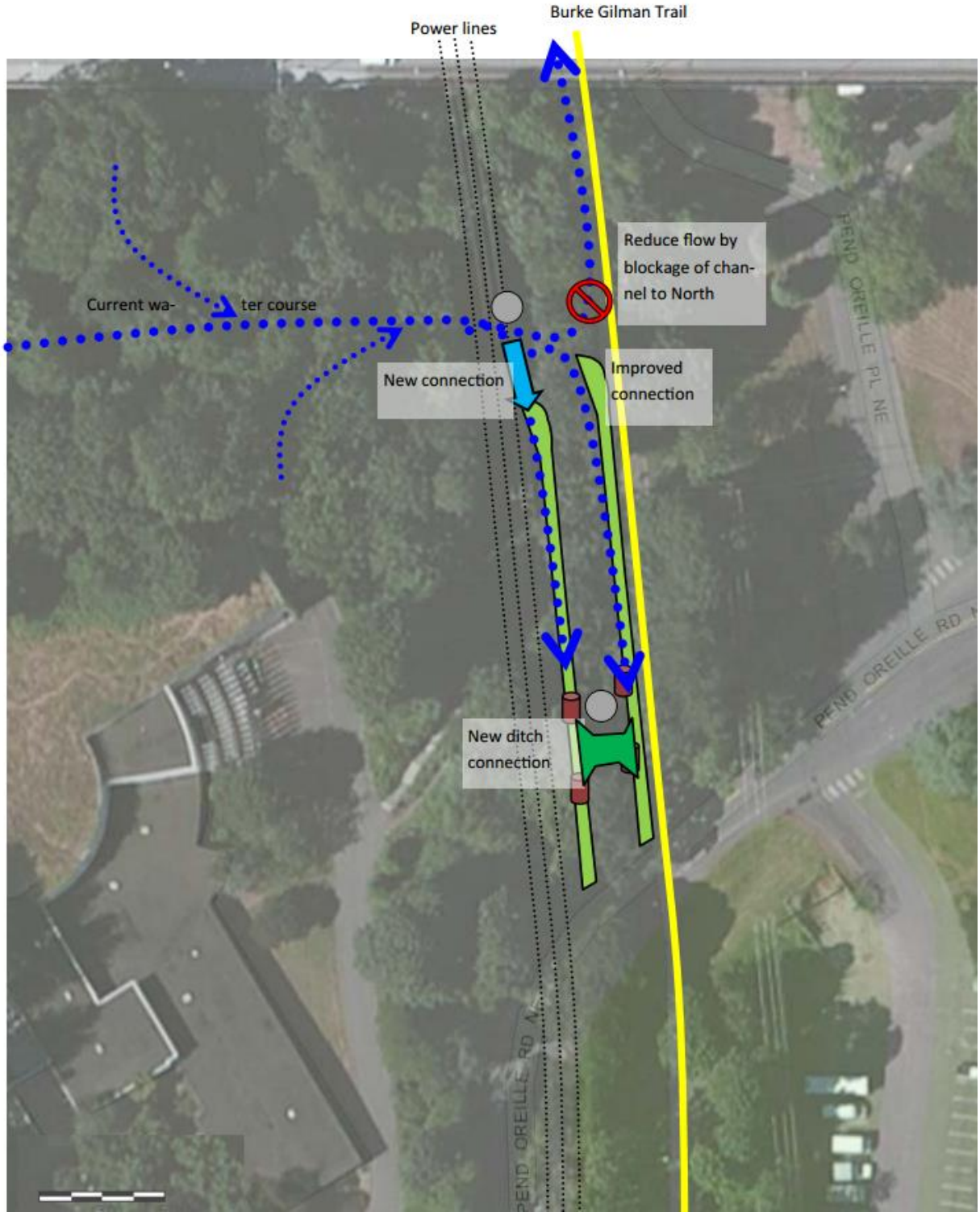
	Project: 421874-984 Locator: NONE Descrip: UNKNOWN LOCATOR Sample: L61949-10 Matrix: LG STORM WTR ColDate: 4/21/15 20:30 TimeSpan: TotalSolid: ClientLoc: SampDepth: **WET Weight Basis**				
Parameters	**Value**	**Qual**	**MDL**	**RDL**	**Units**
ES NONE					
Sample Information	E1 Detention Pond				none
MT EPA 200.8*SW846 60					
Copper, Total, ICP-MS	0.48	<RDL	0.2	2	ug/L
Lead, Total, ICP-MS	0.14	<RDL	0.1	0.5	ug/L
OR EPA 1664B					
Hem (oil, total)					
SGT-Hem (oil, nonpolar)					

Qualifier Definitions:
<MDL = Less than the m
<RDL = Less than the re

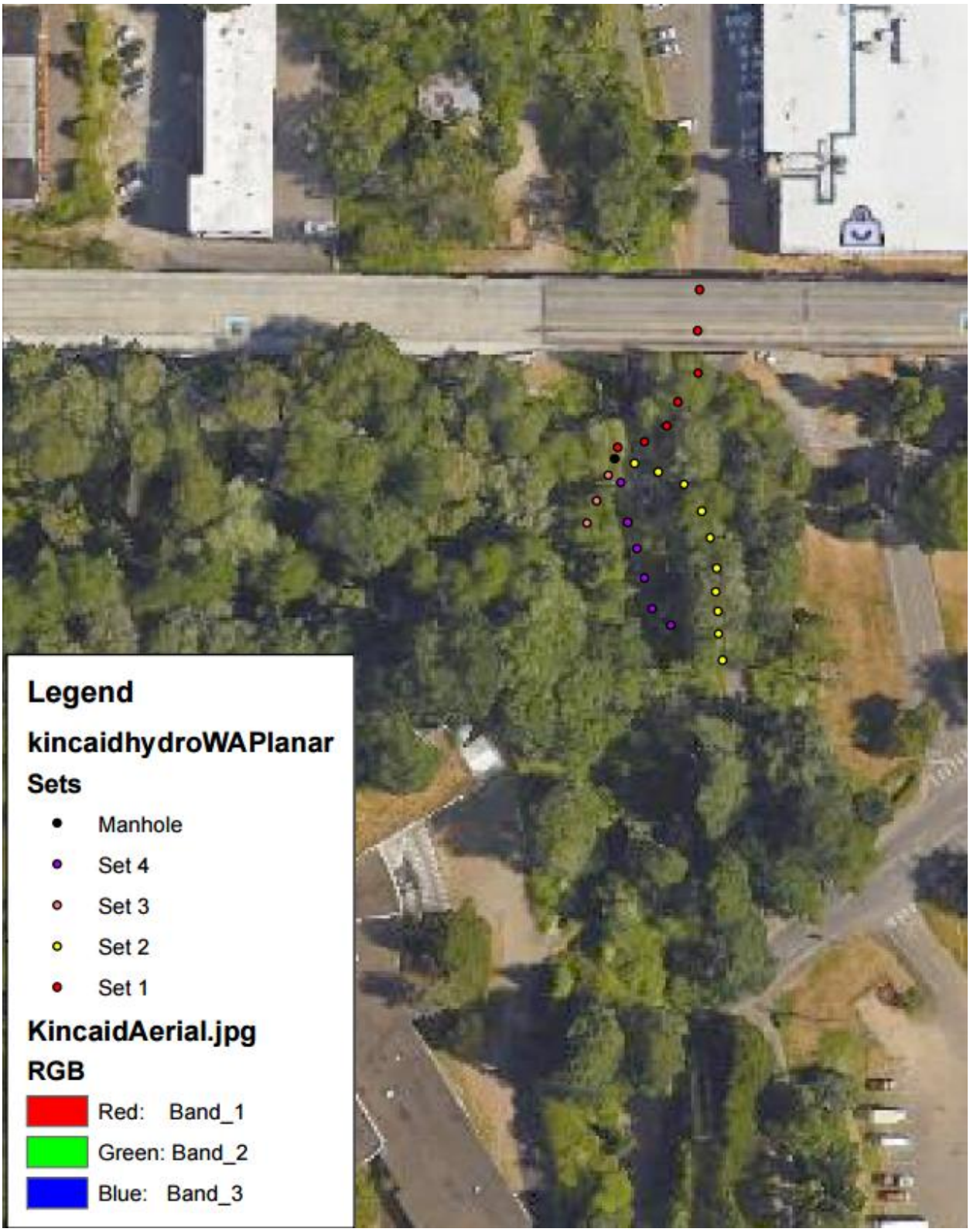
Appendix G – Picket Fence Check Dam Installation Instructions



Appendix H – Trailside Ditch Infiltration Design



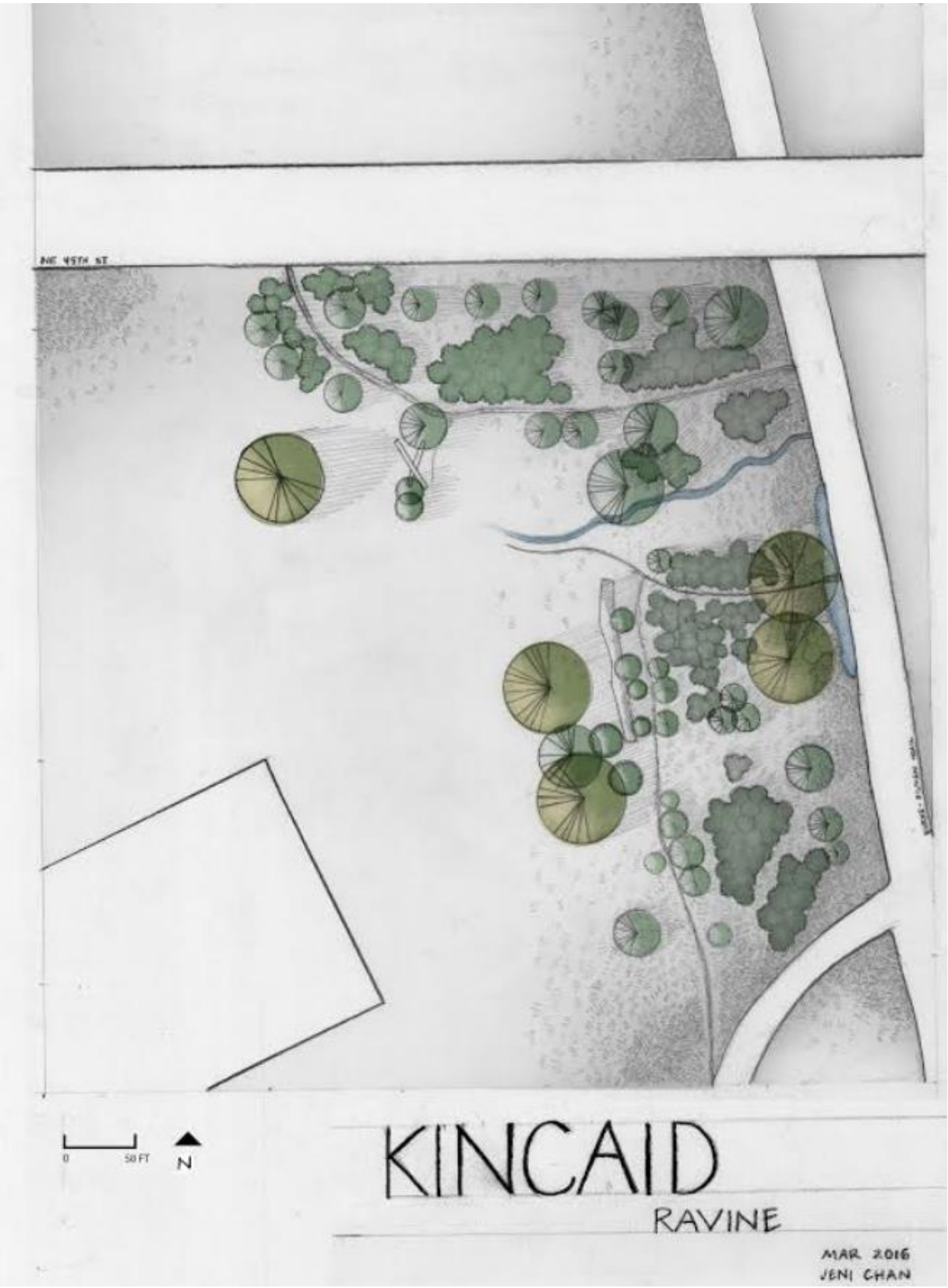
Appendix I – Elevation Map and Data for Existing Stream Course and Ditches



Line vectors for Kincaid ravine surveyed on 8/3/15 (aaron clark and Dan hintz)

Waypoint	elevation change	elevation relative to manhole (mm)
Set 1 MANHOLE TO NORTHBOUND DITCH/WETLAND		
	0	0
88	-250	-250
89	-330	-580
90	-500	-1080
91	-110	-1190
92	-26	-1216
93	-50	-1266
94	-30	-1296
Set 2 MANHOLE TO SOUTHBOUND TRAILSIDE DITCH (DITCH 1)		
manhole	0	0
95	-295	-295
96	-265	-560
97	-300	-860
98	-180	-1040
99	-190	-1230
100	30	-1200
101	-122	-1322
102	-100	-1422
103	-30	-1452
104	65	-1387
Set 3 MANHOLE TO NEXT UPHILL BEND IN CREEK		
manhole	0	0
105	140	140
106	265	405
107	455	860
Set 4 MANHOLE TO POWERLINE TO DITCH #2		
manhole	0	0
108	65	65
109	40	105
110	-75	30
111	-170	-140
112	-160	-300
113	-510	-810

Appendix J – Landscape Design: Sketch of Existing Plan



Appendix K – List of Project Contacts

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