LOUISA BOREN RESTORATION PLAN

Abstract

The project restoration site is located in Louisa Boren Park just south of Interlaken Boulevard on Capitol Hill. It comprises a ravine basin and the surrounding slopes, characterized by wetland and upland habitats. Currently, invasive plant species are widespread at the site and are compromising the integrity of the native vegetation community. Site assessments provided information on soils, hydrology, climate, and existing vegetation that allowed for informed decisions regarding site preparation, plant selection, and installation. The main goal of our project is to develop a strategy to re-instate a self-sustaining upland and wetland ecosystem that will harmonize with site usage. The plan includes recommendations on removing invasive plants, controlling erosion, removing hazard trees, installing and establishing appropriate native vegetation, and devising proper management and monitoring strategies to ensure the best chances for restoration success.

Site History

Louisa Boren Park was established in 1913 when six acres of Interlaken Park were set aside and renamed by the Seattle Park Commissioners in honor of Louisa Boren Deny, the last survivor of the original pioneers to the Seattle area (Seattle Parks and Recreation 2002). In honor of Louisa Boren, a memorial, constructed by the Washington Women's Pioneer Auxiliary on June 1, 1914, marks the northwestern edge of the park. The landscape of Louisa Boren Park and the surrounding area has seen many changes since being settled in 1851.

The entire area of Interlaken Park and Louisa Boren Park was preserved on the advice of the Olmstead Brothers. The area was used as a bicycle trail to get from Lake Washington to Capitol Hill in the late 1800's. Bicyclists, joggers and vehicle traffic still frequently use the path that was once the most traveled bicycle route in Seattle; it is now known as Interlaken Boulevard. As recommended by the Olmstead brothers, the bicycle path, ravines and surrounding bluffs were turned into a park "to head off ill-advised attempts to sub-divide" by private landowners (Sherwood 1980).

Originally, the park was covered with tall, thick conifer stands and the area that was known as Broadway Hill, now Capitol Hill, was logged and prepared for development. Louisa Boren Park is situated in the area that was logged, but most likely was not immediately considered for development due to the steep slopes. Since the original logging, the undeveloped areas were replaced with hardwoods and second-growth conifers.

In the later part of 1903 houses were built in the local area and on the edges of the park. The excavations, fills and trenches that were part of the building process of the houses and their utilities, resulted in changes to the natural soil and drainage patterns, aggravating a condition described by the Olmsted brothers in 1903 as "liable to slides" (Sherwood 1980). As the Olmsted brothers predicted, this land has proven to be active and unpredictable. Over time there have been numerous small landslides and one large, deadly slide in the area in December of 1942, which killed an entire family. The slopes of Louisa Boren have continued to slump over the years; this is apparent due to the

change in slope, the curve in the older mature trees and the lean of younger trees on the restoration site.

Since the development of the park in 1913, it has served the purpose of providing the public a pleasant environment in which to experience nature and escape the city hard-scape. Over the years, a trail has formed in Louisa Boren Park leading from the top (the south) to the bottom (the north) of the park. This trail borders the current restoration site and serves as a corridor between the upper part of Capitol Hill and Interlaken Boulevard.

Site Description

The project restoration site runs adjacent to Interlaken Boulevard and is marked on its northwest corner by the Louisa Boren memorial stone. The site comprises a ravine basin wetland and its surrounding slopes. It is bordered by a recreational trail to the west, a residential fence to the east, and Interlaken Boulevard to the north. Two streams run through the site from the southwest, and merge in the north-central part of the wetland. The forest canopy is dominated by deciduous species such as *Acer macropyllum* and *Alnus rubra*, and the shrub layer is dominated by *Rubus spectabilis.* The understory is dominated by invasive *Hedera helix*. Invasive species are abundant at the site; this fact may be attributed to edge effects and location of the site relative to surrounding neighborhoods. Current impacts to the site include foot traffic and cyclists around the periphery, car exhaust fumes from Interlaken Boulevard, and off leash pets.

Project Goals

Successful implementation of the designed restoration project at Louisa Boren will accomplish many goals. Firstly, the plan emphasizes the need to eradicate invasives, the main current problem at the site. Invasive plants can harm natural ecosystems in a number of ways, for example, out-competing native vegetation, altering nutrient cycles, and changing site hydrology dynamics. In this way, their control is imperative to the success of the restoration project. With the removal of invasives, especially *Hedera helix*, the integrity of the soil will likely be compromised, and, therefore, erosion control is critical at the site, another main objective of the project. An essential and obvious goal is the establishment of a diverse native plant community, in both the wetland and upland

habitats, that will serve to increase wildlife habitat. Finally, an important objective of this project is to provide education about the importance of restoration and the way it has been implemented at the site to the public that uses Louisa Boren.

A) Existing Plant Community

As expected after logging, the forest canopy is now dominated by mature, deciduous pioneer species such as *Alnus rubra* and *Acer macrophyllum*. The mature canopy species are beginning to decline and few juvenile conifer species exist, hindering the natural stages of succession. Although few in number, isolated mature conifers left by loggers remain along the periphery of the east and western areas of the site. The mid-forest stratum is dominated by monoculture stands of *Rubus spectabilis*, some of which will need to be removed to create a more diverse habitat. Common woodland shade species such as *Polysticum munitum* and *Mahonia nervosa* are abundant at the site. However, shade-loving, native herbaceous plants are virtually non-existent, and with an increase in canopy gaps, the understory has been taken over by *Hedera helix*, a more adaptable invasive species. *Hedera helix* is the most prolific invader at the site, dominating the entire understory both within the wetland and upland areas. The Existing Vegetation Plan visually represents the various plant assemblages at the site (Map 1, Appendix I), while the following table shows the location and invasive status the different species.

Species	**Common Name**	**Location: Wetland**	**Location: Upland**	**Invasive**
Acer circinatum	vine maple		X	
Acer macrophyllum	big leaf maple		X	
Alnus rubra	red alder	X	X	
Athyrium filix-femina	lady fern	X	X	
Carex sp.	sedge	X		
Clematis vitalba	evergreen clematis	X	X	X
Convolvulus arvensis	morning glory	X	X	X
Equisetum arvense	common horsetail	X		
Hedera helix	English ivy	X	X	X
Ilex aquifolium	English holly	X	X	X
Mahonia nervosa	low Oregon grape		X	
Polysticum munitum	sword fern		X	
Prunus laurocerasus	cherry laurel	X	X	X
Pteridium aquilinum	bracken fern	X	X	
Ranunculus uncinatus	little buttercup	X	X	
Rubus discolor	Himalayan Blackberry	X	X	X
Rubus spectabilis	salmonberry	X	X	
Rubus ursinus	trailing blackberry	X	X	
Thuja plicata	western red cedar		X	
Tsuga heterophylla	western hemlock		X	
Urtica dioica	stinging nettle		X	
Vinca minor	common periwinkle	X	X	

B) Hazard Tree Assessment

Tree #1:

Location: Roughly 50 yards up the trail on left.

Species: Big leaf maple (*Acer macrophyllum*)

DBH: 60”

Roots: Exposed structural roots across pathway

Health / Vigor: Poor health 30% dead wood

Dominance: Dominant

# of Trunks: One main leader with large laterals

Comments: There is a large cavity at the base of the tree with approximately 4-6 inches of holding wood for the entire circumference. No presence of fruiting bodies was detected, though rot is evident. The tree has a westerly lean of 20-30^{o} toward the wetland.

Tree #2

Location: Roughly 60 yards up the trail on the right

Species: Big leaf maple (*Acer macrophyllum*)

DBH: 12”; 34”; 41” Combined 87”

Roots: Exposed absorbing and structural roots

Health / Vigor: Fair-poor

Dominance: Co-dominant

# of Trunks: Three leaders are present, one completely dead, two intact.

Comments: Due to the under mining that is caused by the heavy runoff, half of the root ball has been exposed, weakening both the structure and health of the tree. The leader that is entirely dead hangs over the trail posing a threat to pedestrians; furthermore, the larger of the two living leaders is leaning at roughly 30-35^{o} over the trail imposing more weight on the unstable root ball.

Tree #3:

Location: The southwest corner of the site next to the road.

Species: Big leaf maple (*Acer macrophyllum*)

DBH: 37”

Roots: No exposed roots

Health / Vigor: Poor 60 – 70% dead

Dominance: Dominant

# of Trunks: One main leader with a large lateral

Comments: The tree has a 25^{o} lean over the road with numerous pieces of deadwood that can easily fall on the road below creating hazards for motorists and pedestrians. It is my recommendation that this tree be removed immediately.

C) Soil Assessment

In October of 2002, soil samples were collected for lab analysis of soil moisture, nutrient content, pH, organic matter, cation exchange capacity, and percent base saturation. They were extracted at the site using a soil corer at a depth of 6-8 inches. Samples were placed in air-tight ziplock bags, the excess air was removed, and they were kept frozen until sent away for analysis.

Samples for soil moisture were taken from three different areas of the site: on the north, east, and west slopes because these are the areas that may have water availability issues during drier parts of the year (the rest of the site is wetland). Gravimetric soil moisture analysis was performed at the Center for Urban Horticulture.

Site	% moisture
N slope (top)	9.28
N. slope (middle)	9.83
N. slope (base)	19.59
W. slope (top)	24.45
W. slope (middle)	19.64
E. slope (top)	16.67
E. slope (middle)	18.19

Table 1. Gravimetric soil moisture results

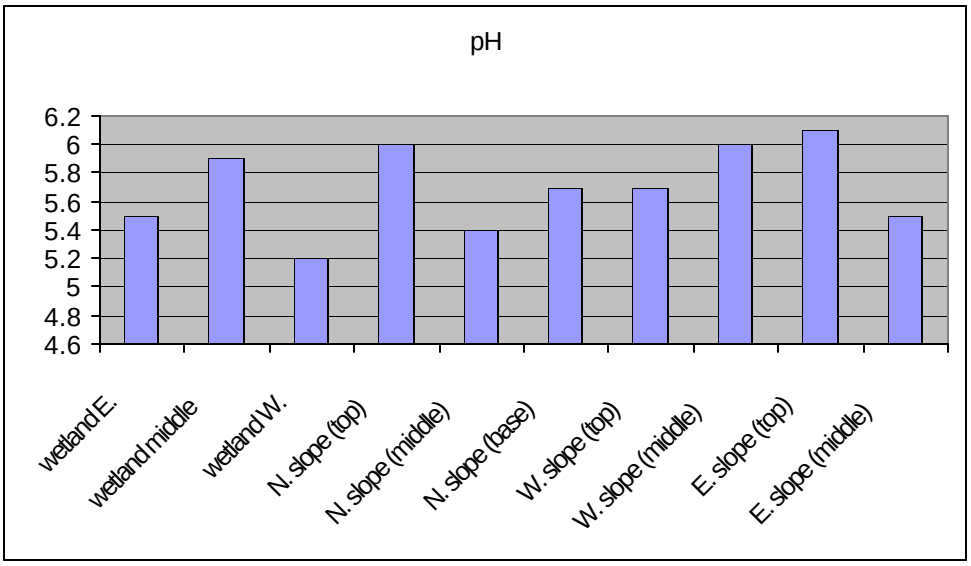
The top and middle of the north slope, adjacent to the road, has the lowest soil moisture and will be where water availability is of greatest concern (Table 1). The lack of soil moisture in this area can most likely be attributed to extensive compaction, (resulting in decreased water holding capacity of the soil), along the road from pedestrians and cars. In order for vegetation to survive on this portion of the site, the compaction in this area must be alleviated. This could potentially be accomplished by tilling or hoeing on the top of the slope, but such a method should not be employed on the downgrade since it could likely lead to erosion. Mulch should be applied to this area (especially on the slope) as soon as possible to prevent further compaction and promote development of soil structure. Given that sampling occurred during one of the driest times of the year, all other sampled locations of the site exhibited a decent amount of soil moisture (approx. 17-24%), and water availability will most likely not be an issue for restoration vegetation. However, plantings in the upland in compacted areas near the road or path may face water deficiencies, and plant selection and management should plan accordingly.

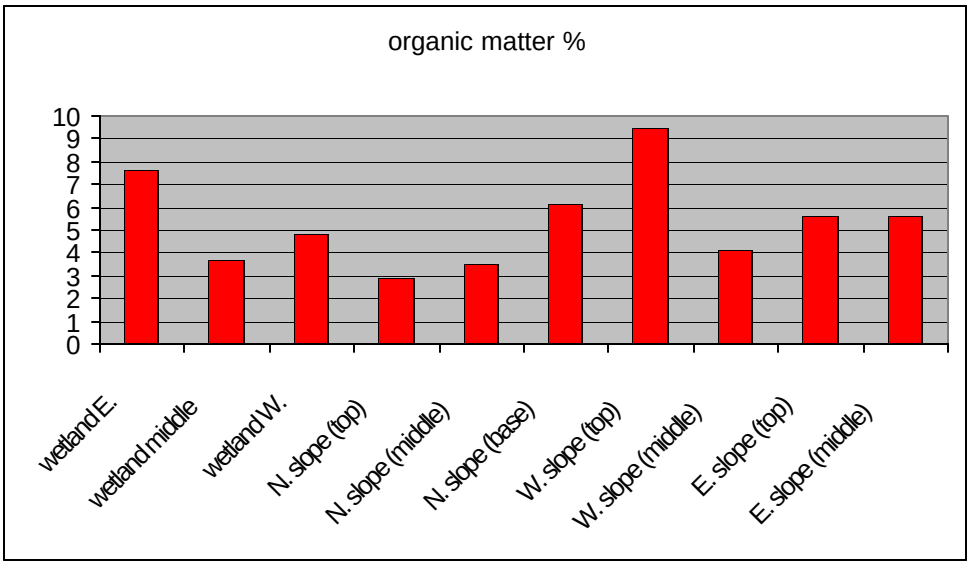
Samples for nutrient analysis and remaining tests were collected from ten locations within the site. Three were extracted from the wetland area; one from the west, one from the middle, and one from the east. On the east and west slopes, samples were

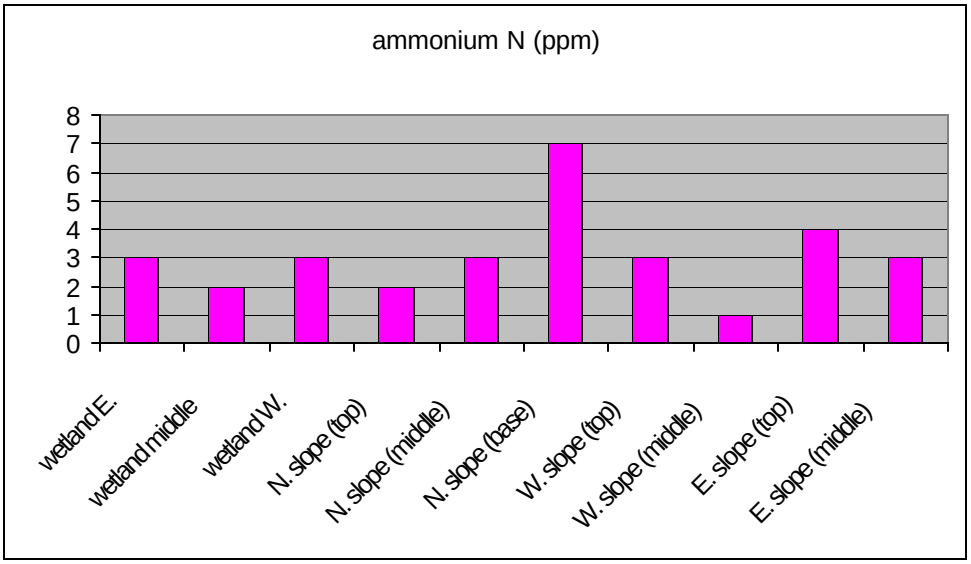
taken from the top and the middle of the slope. Samples were also collected from the top, middle, and base of the north slope. Analysis was performed at the University of Massachusetts Soil and Plant Tissue Testing Laboratory.

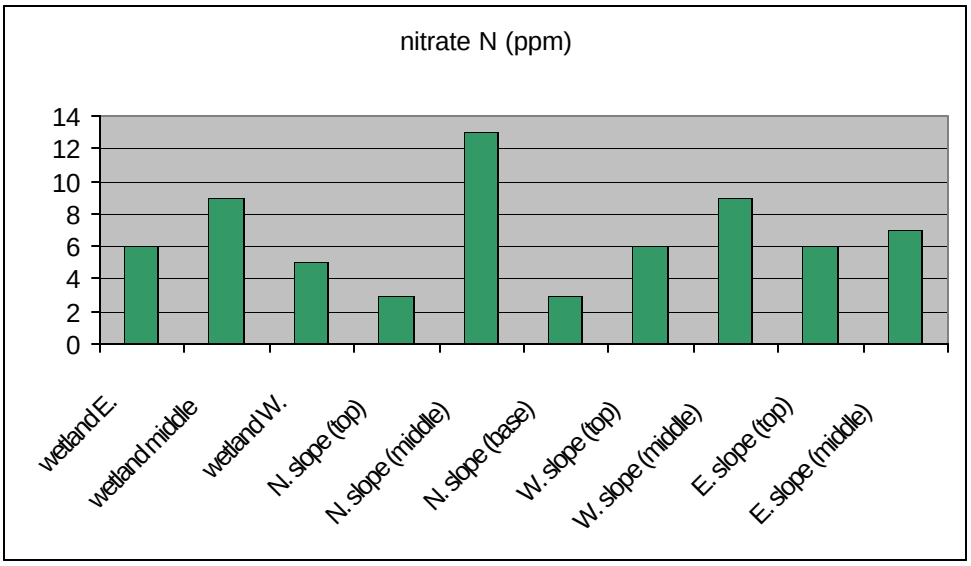
site	pH	organic matter %	ammonium N	nitrate N	P	K	Ca	Mg
wetland E.	5.5	7.6	3	6	8	61	1439	610
wetland middle	5.9	3.7	2	9	6	73	918	364
wetland W.	5.2	4.8	3	5	8	79	1100	467
N. slope (top)	6	2.9	2	3	9	94	1233	241
N. slope (middle)	5.4	3.5	3	13	11	88	905	190
N. slope (base)	5.7	6.1	7	3	7	46	1349	379
W. slope (top)	5.7	9.5	3	6	7	91	1804	357
W. slope (middle)	6	4.1	1	9	8	46	1195	411
E. slope (top)	6.1	5.6	4	6	9	97	1626	405
E. slope (middle)	5.5	5.6	3	7	6	34	1182	433
site	B	Mn	Zn	Cu	Fe	Al	Pb	
wetland E.	0.9	17.4	3.2	0.8	84	28	73	
wetland middle	0.4	11.9	3.6	0.7	72	27	187	
wetland W.	0.5	20.6	4.7	0.8	135	35	88	
N. slope (top)	0.3	2.7	6.3	0.8	11	40	128	
N. slope (middle)	0.3	6.3	4.4	0.5	14	70	81	
N. slope (base)	0.3	7	3.3	0.7	40	27	50	
W. slope (top)	0.3	4.4	4.1	0.9	46	78	77	
W. slope (middle)	0.3	3.6	1.1	0.8	36	40	46	
E. slope (top)	0.3	2.9	1.4	0.8	22	43	53	
E. slope (middle)	0.2	3	2	0.8	70	47	63	

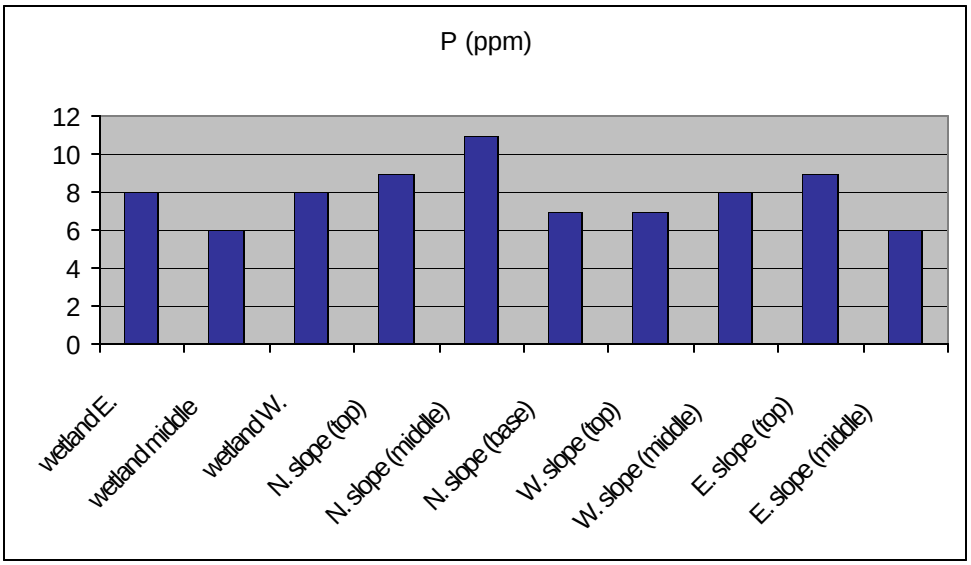
Table 2. Soil analysis results (units are ppm unless otherwise noted)

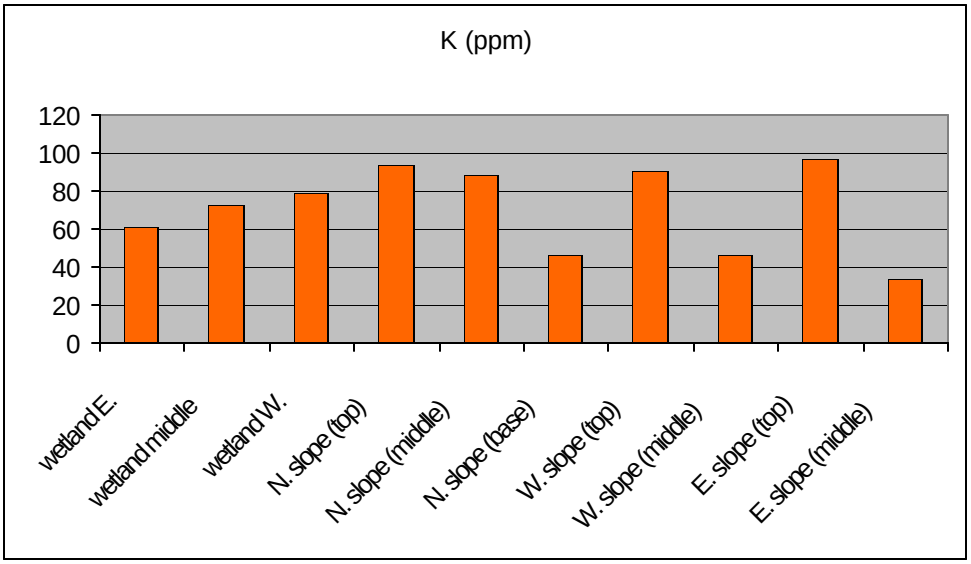

pH
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

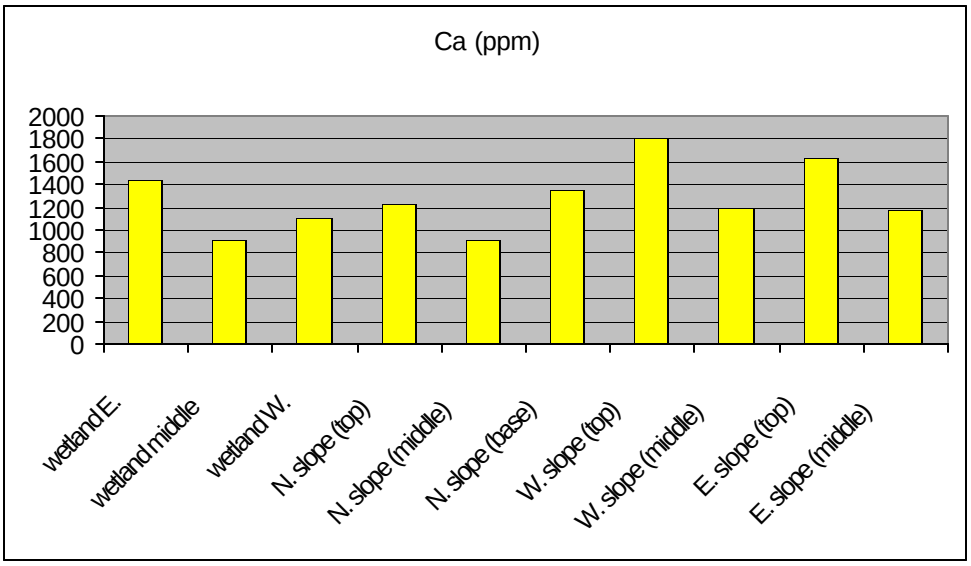

organic matter %
10
9
8
7
6
5
4
3
2
1
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

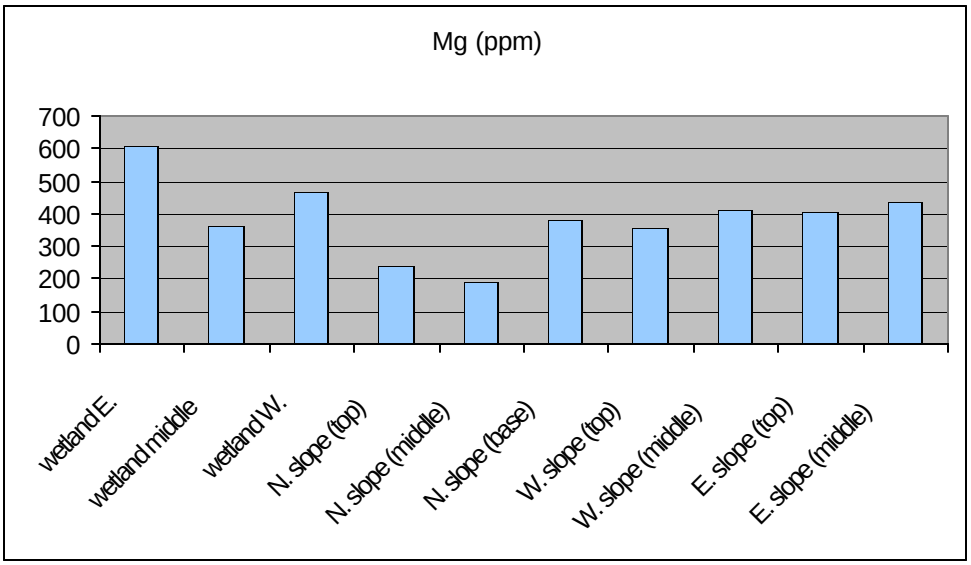

ammonium N (ppm)
8
7
6
5
4
3
2
1
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

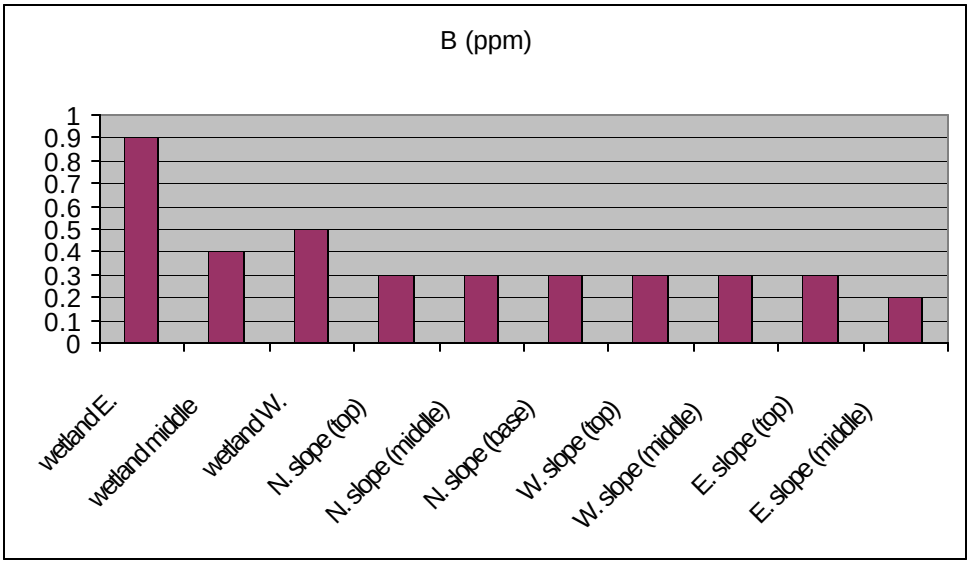

nitrate N (ppm)
14
12
10
8
6
4
2
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

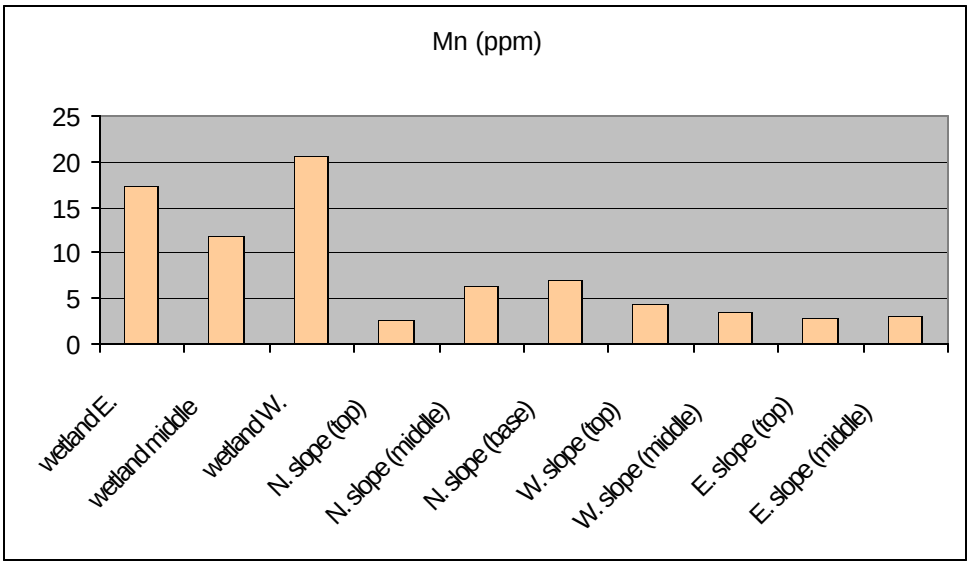

P (ppm)
12
10
8
6
4
2
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

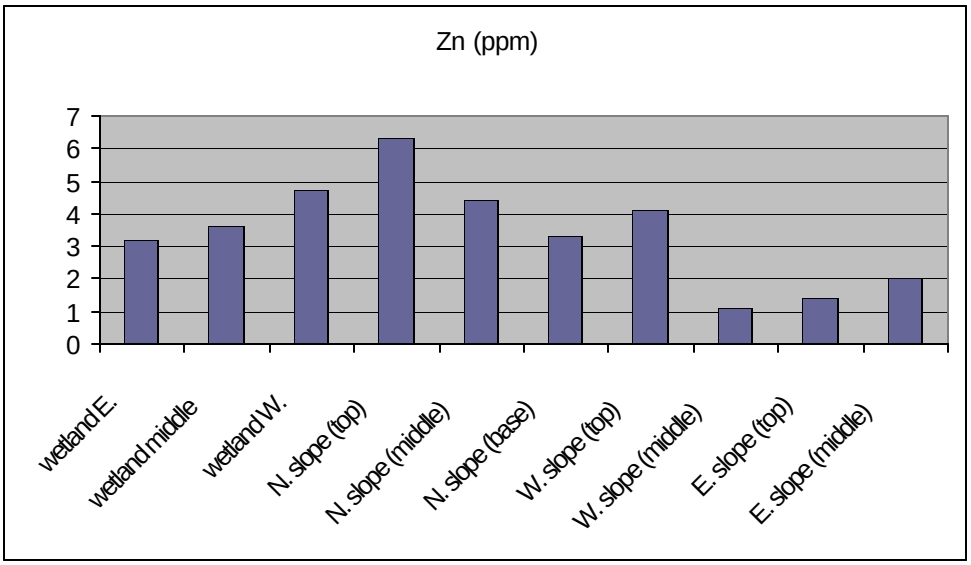

K (ppm)
120
100
80
60
40
20
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

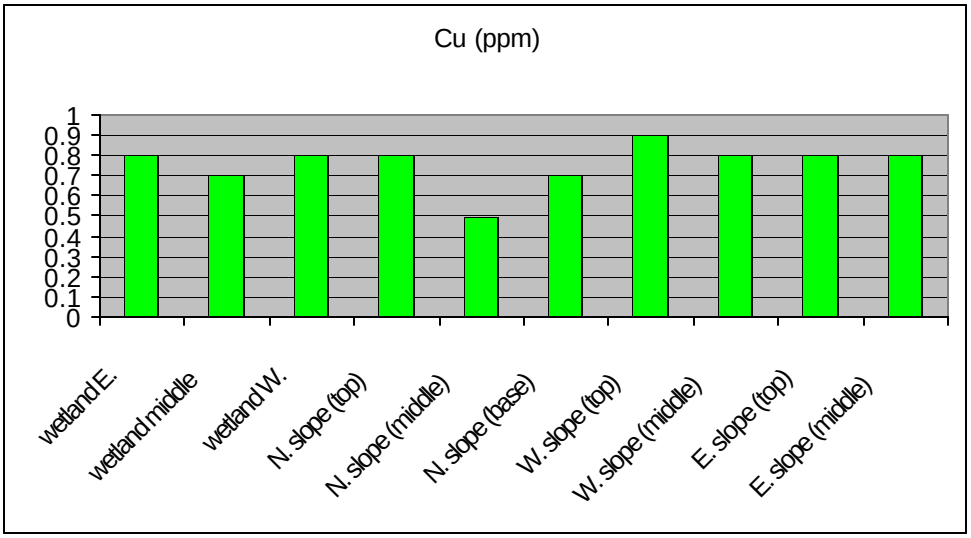

Ca (ppm)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

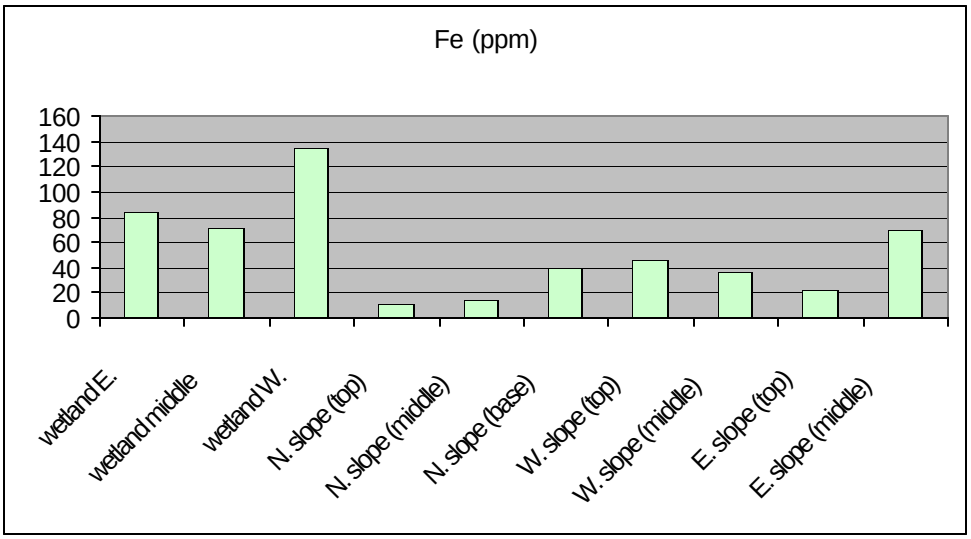

Mg (ppm)
700
600
500
400
300
200
100
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

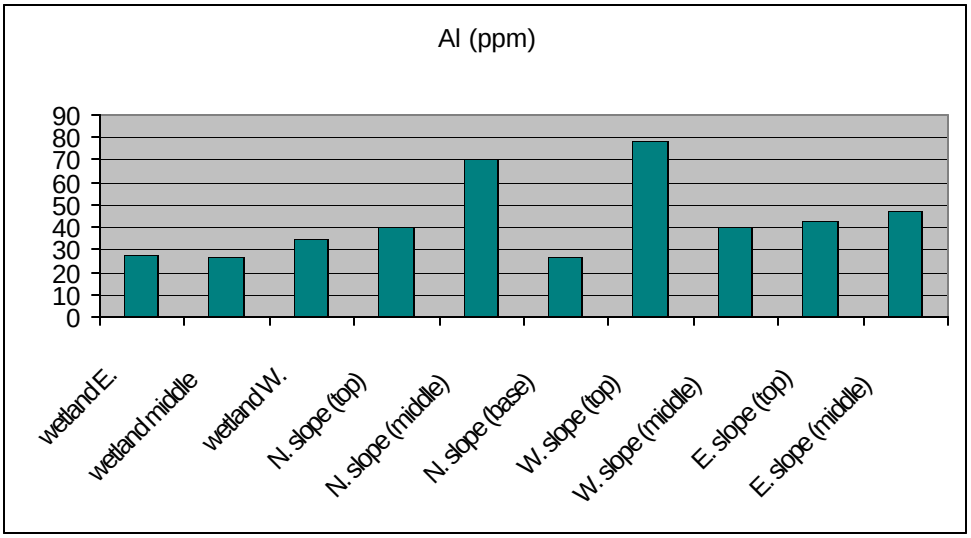

B (ppm)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

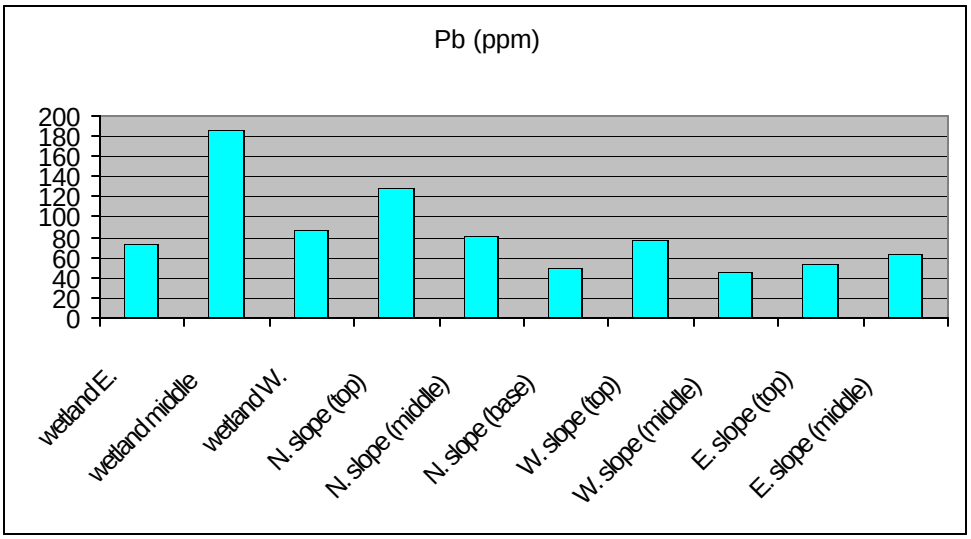

Mn (ppm)
25
20
15
10
5
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)


Zn (ppm)
7
6
5
4
3
2
1
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)


Cu (ppm)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)


Fe (ppm)
160
140
120
100
80
60
40
20
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)


Al (ppm)
90
80
70
60
50
40
30
20
10
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)


Pb (ppm)
200
180
160
140
120
100
80
60
40
20
0
wetland E.
wetland middle
wetland W.
N. slope (top)
N. slope (middle)
N. slope (base)
W. slope (top)
W. slope (middle)
E. slope (top)
E. slope (middle)

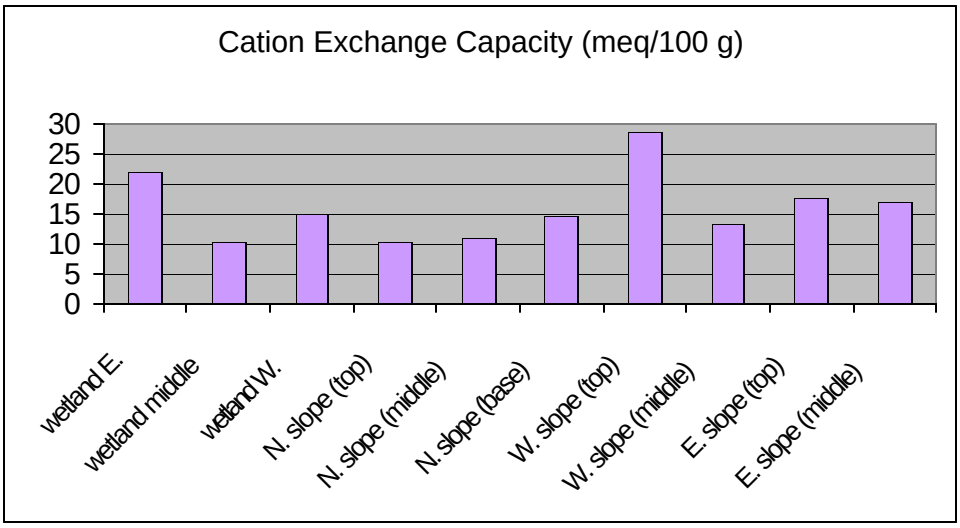


Figure 1. Graphic representation of soil analysis results (factor assessed is given at the top of each graph)

Nutrient Content

The vegetation on-site did not exhibit nutrient deficiency symptoms, so we have no reason to believe that nutrient availability will be a limiting factor at the site. For the most part, the soil results bolstered this conclusion, and most nutrient analyses revealed normal to high values. Interestingly, the soil from the base of the north slope displayed relatively high ammonium levels compared to the rest of the site (Fig. 1). The high nitrogen levels in this area could perhaps be attributed to the fact that all of the run-off from the above ravine, potentially being laden with fertilizers from the surrounding residences, collects here and flows through the drain, affecting the soil as it passes through.

pH

The soil from the west part of the wetland exhibited the lowest pH of anywhere on the site. This result makes sense because this area is the most saturated, mucky area of the site, and highly organic wetlands tend to be characterized by low pH (Mitsch and Gosselink 2000). Excluding extremely low pH systems, such as bogs, the optimal pH range for freshwater wetland plants is 6.5-7.0, which could explain why not many plants are growing in this area, since the pH was 5.2.

Organic Matter

In terms of organic matter, the north slope tended to exhibit the lowest values for the site. This is not surprising given that this area borders the road, is highly compacted, and most likely had a parent substrate with a high mineral composition that was artificially introduced by road construction.

On the other hand, the relatively low results for organic matter in the wetland were quite surprising because it was expected that this area of the site would exhibit high values because decomposition is suppressed in the anoxic conditions of saturated soils found in wetland. Also, the mucky nature of the wetland suggested that it was high in organic matter.

The west slope displayed the highest organic matter content. This result means that this area will have a solid, latent cache of nutrients to support planted vegetation in the future. This is encouraging given that this location is adjacent to the path and will be where much of the revegetation occurs.

Bulk Density

The bulk density of a soil reveals how much compaction it has endured, and it is defined as the mass of a unit of dry soil. The effect of bulk density on the ability of roots to penetrate soil depends on soil moisture and texture, with maximum values ranging from 1.45 g/cm3 (moist clay) to 1.85 g/cm3 (moist loamy sand) (Brady and Weil 2002).

At the Louisa Boren site, bulk density was tested at three areas were compaction was perceived to potentially be a problem to installed plant establishment. The bulk density at the top of the north slope (adjacent to road) was 1.15 g/cm3, while it was 1.08 g/cm3 at the middle of the slope. The area next to the trail on the top of the west slope had the highest bulk density, and it was 1.35 g/cm3. Compaction does not seem like it will be a major issue in terms of plant establishment at the site, but these areas should, nonetheless, be tilled to a certain degree to remove the smooth soil surface that may decrease water absorption.

Textural and Color Analysis

Soil pits were dug in four locations on the site to assess soil texture, color (using a Munsell soil color chart), and horizon composition. On the west slope, an organic horizon (O-horizon) with a dark color of 10YR 2/2 comprised the first two inches of depth, and from 2-18 inches, the soil was mineral, sandy loam in texture, and exhibited a color of 10YR 3/1. In the wetland area below the west slope, the top eight inches was a dark, mucky, saturated organic horizon with a color of 10YR 2/2. From 8-18 inches depth, the soil matrix was a mineral clay loam (successful 2" ribboning), with a gleyed color of 5Y 4/1 containing oxidized iron concretions lining root channels. On the east slope, an organic horizon with a color of 10YR 2/1 characterized the first two inches of soil. From 2-18 inches depth, the soil was a sandy clay loam exhibiting a color of 10YR 3/1. The soil of the wetland area at the base of the east slope was characterized by a 3 inch O-horizon with a color of 10YR 2/1. From a depth of 3-8 inches, it became a mineral soil with a sandy loam texture and a color of 10YR 3/2. The soil became a clay loam from 8-18 inches, with a gleyed color of 5Y 4/1.

D) Hydrology Assessment

The majority of the site is comprised of a wetland basin into which water drains off from adjacent upland slopes, and it is characterized by a number of seeps and two major streams. In terms of topography, this site is part of a ravine base that exhibits a gentle downward grade toward the north; it is surrounded to the north, east, and west sides by steeper slopes. During periods of high precipitation (peak flows), the volume of water that runs off the surrounding upland slopes and into this wetland area must be considerable. The north slope was created by the building of Interlaken Boulevard, and at its base is a grated drain that collects the runoff from the ravine above, as well as run-off from the street. With this, the drain must accommodate a significant amount of water during the rainy season, and maintenance plans should emphasize the importance of keeping the drain free of debris to ensure proper flow.

The seeps are generally not well defined, and they stem mostly from the west, and southeast. One major, defined seep on the west drains off the hillside above the path, and appears to be compromising the integrity of the trail. Application of a thick layer of

mulch or coarse gravel could help to ameliorate this problem by bringing the path back up to grade for the benefit of pedestrians, while allowing water flowing down the hillside to continue across the path (under the applied substrate) and down into the wetland. Many of the west seeps drain into a particularly wet and mucky area in the northwest corner of the site that is distinguishable as being fairly bare and deficient in vegetation compared with the rest of the site. The soil in this location was completely saturated in November of 2002, even following an extended dry period, and an 18-inch soil pit filled with water in one minute. Another bare area similar to this one was located in the middle of the site adjacent to the stream, but the substrate was not as mucky, and it took over five minutes for soil pits to fill with water. In the salmonberry thickets at the south of the site, soils continued to be saturated by widespread seeps flowing from the south.

The two "major" streams at the site are actually quite small and located toward the west, with one flowing from the southwest and another from the south. It seems that many of the seeps on the southwest side of the site feed these streams, and that flow varies greatly with precipitation and runoff. The two streams merge toward the middle of the site and empty into the drain, flowing under the road and discharging on the other side.

Maintaining the water quality at the site needs to be a major concern of future restoration projects. Given that the major watercourses are small, they can be highly impacted by disruption of soil along their banks. Input of soil particles will greatly increase the turbidity, temperature, and decrease dissolved oxygen of the water, having negative implications for downstream ecosystems. Therefore, revegetation efforts need to take care to minimize such disturbance.

E) Climate Analysis: Light and Wind

The site primarily consists of deciduous trees, such as *Acer macrophyllum* and *Alnus rubra*, creating a dense canopy cover. During the spring, summer, and early fall seasons, this site is heavily shaded, with low-moderate levels of light actually reaching the forest floor. Even when the trees are in leaf, however, the wetland area in the center of the site and a small spot near the north entrance, receive more light due to canopy gaps creating an opportunity for light to reach the forest floor. After observing the site

following leaf drop of the deciduous trees, most of the site receives ample sunlight, excluding the slopes that are characterized by a higher density of conifers. The southern part of the site that is not on the slope is also slightly shaded even in the winter because of a group of about ten conifers directly south cast shade in that section of the site year-round. There are many factors changing the light intensity, but overall the site would be classified as low to moderate light, year-round.

Most of the wind affecting the Seattle area comes from the southwest. Since this site is located at the base of three slopes and, for the most part, exhibits a northern aspect, it is protected from wind quite well. The minimal presence of wind at our site is also due to the fact that it is characterized by fairly dense tree cover, as is the surrounding area of Interlaken Park. These ideas have been supported by personal observation during site visits, where wind has never had a noticeable presence.

F) Local Ordinances and Regulations

Several Seattle Ordinances and Regulations pertain to the site. Since a road runs along the Northern border of the site, planting regulations must be followed for any planting near the road, as well as any standards which regulate the minimum distance between a bench and a roadway.

According to the Seattle Municipal Code, planting along near streets must meet the following guidelines (COS 2001).

- All trees or shrubs should be set back by at least three feet from the street curb or edge.
- All trees must be maintained to provide an eight-foot clearance under the tree canopy.

These guidelines are important for determining proper plant installation and pruning management.

Since Seattle Parks Department requested a bench, researching the ordinances pertaining to safe bench placement was essential. According to the Seattle Municipal Codes Section SMC 23.60.160, “public amenities appropriate to the usage of the public access space such as benches . . . shall be selected and placed to ensure a usable and

comfortable public area," (COS 2001). To ensure a usable and comfortable public area, visibility to the bench is absolutely crucial, as to not encourage criminal activity.
It must also not be too close to the road, in order to keep the bench users safe from passing traffic. While no ordinance was found specifying a minimum required distance the bench and road, sidewalk width regulations can be used to estimate. These require a minimum of 10-12 feet for newly constructed sidewalks (COS 2002). Therefore, a minimum distance of 12 feet from the road is recommended.

Since soil properties and microclimates vary throughout the site it was crucial to research plant characteristics and ecology before selecting material. Selecting plants that are suitable for their intended environment is of utmost importance to the success of this restoration project. Plants that are adapted to site conditions will require less immediate aftercare and continued maintenance. To accommodate the different conditions found at Louisa Boren, the area has been divided into re-vegetation zones that represent similar microclimates. Plants were selected for each re-vegetation zone based on the following criteria: adaptability to conditions of designated zone; rate of establishment; and low maintenance requirements, since little aftercare will be provided.

Zone One

Zone One is situated in the NW corner of the site and is bordered by Interlaken Boulevard. The lower portion of the zone borders the wetland and is currently dominated by a monoculture of *Rubus spectabilis*. Removal of the *Rubus spectabilis* and replacement with *Cornus stolonifera* and *Physocarpus capitatus* throughout the more moist section of the zone is recommended.

Zone Two

Zone Two is situated adjacent to Zone One and is bordered by Interlaken Boulevard. The site is highly visible to pedestrians and for this reason, the more ornamental native species such as *Acer circinatum*, *Philadelphus lewisii*, and *Rhododendron macrophyllum* are recommended.

Zone Three

Zone Three is adjacent to Interlaken Boulevard and comprises a view point. The area is highly visible to pedestrians and overlooks the entire ravine. Soil moisture levels are relatively low and therefore, more drought resistant species have been selected for this area. The selected species must be able to tolerate drier soil conditions and enhance

aesthetics. Recommended species include *Gaultheria shallon, Dicentra Formosa, Philadelphus lewisii, Rhododendron macrophyllum* and *Acer circinatum*.

Zone Four

Zone Four is located on the northern slope. The slope is steep and highly susceptible to erosion. Soil moisture conditions vary from the middle to the base of the slope. Selected species for Zone four must be able to tolerate moist to dry soil conditions and stabilize the slope. Recommendations include *Gaultheria shallon, Polystichum munitum, Mahonia nervosa, Acer circinatum, Cornus stolonifera* and *Physocarpus capitatus*.

Zone Five

Zone Five is located on the NE corner of the site and encompasses a slope. Slope stabilizing species such *Acer circinatum, Mahonia nervosa, Polystichum munitum* and *Gaultheria shallon* are recommended for this area.

Zone Six

Zone Six is located at the base of the northern slope. The zone is comprised of both wetland soils and drier soil conditions. Species recommendations include *Thuja plicata* and *Polystichum munitum* for the drier soil conditions and *Cornus Canadensis, Lysichiton americanum, Cornus stolonifera* and *Carex obtnusa* for the wetland area.

Zone Seven

Zone Seven is located within the eastern portion of the wetland. The soils stay wet throughout the year and therefore wetland species such as *Lysichiton americanum, Cornus Canadensis* and *Carex obtnusa* are appropriate choices for this area.

Zone Eight

Zone Eight is the largest revegetation zone located in the western portion of the wetland. Suggested plantings for the periphery include *Cornus stolonifera* and

Physocarpus capitatus. Recommended wetland species such as *Carex obtnusa*, *Lysichiton americanum* and *Cornus Canadensis* are appropriate choices.

Zone Nine

Zone Nine is situated in the sloped, western portion of the site and is bordered by the trail. The area is currently dominated by a monoculture of *Rubus spectabilis*, which should be removed before planting. The zone is partially shaded with large open gaps. Soil conditions vary from moist to dry. Limiting the open canopy is a consideration at this site and Thuja plicata would be a good choice of plant species. Due to the location aesthetically pleasing natives should also be selected.

Zone Ten

Zone Ten is adjacent to Zone Nine and is bordered by the trail. The zone is completely shaded and is currently dominated by *Rubus spectabilis*, which should be thinned or removed before planting. An understory of *Polystichum munitum* is also present and this should be left intact. *Vaccinium parvifolium* and *Acer circinatum* would be good choices for this zone as they would add more structural diversity and enhance aesthetics.

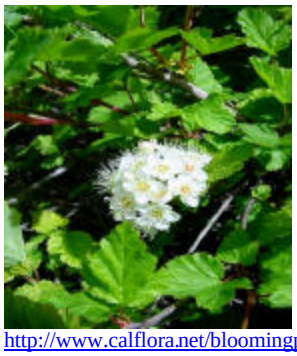
Zone Map (refer to Appendix I: map 2)

The designated revegetation zones have been placed on a site map for ease of reference.

Plant Descriptions

A total of fifteen native species have been selected to suit the varying conditions of the restoration site. The following descriptions include explanations of plant form, habitat preference and ecology.

***Physocarpus capitatus* (Pacific ninebark)**



http://www.calflora.net/bloomingplants/pacificninebark.html

This deciduous species is a flowering plant from the *Rosaceae* family, the preferred habitat for this species is on moist banks usually north facing, indicating that this is a more shade tolerant species. This multi-stemmed species forms dense thickets when mature; furthermore, this species has excellent soil-binding qualities as well as the ability to provide cover for both small mammals and nesting sites for birds. For propagation purposes this species can be germinated from seed, though it grows best from hardwood cuttings.

***Cornus stolonifera* (red osier dogwood)**

http://www.wsu.edu:8080/~wsherb/images/Cornaceae/cornusstolonifera.jpg

This multi-stemmed deciduous shrub can reach a height of 15 feet, creating a very tall thicket like screen. The dense clusters of greenish-white flowers accompanied by bluish-white berries in the fall makes this an aesthetically pleasant plant. The preferred habitat of this shrub is in moist sites, usually along stream banks or swamps with full sun to partial shade. The advantage of this plant is its ability to bind soil, along with its attractive appearance that makes it a popular choice for foraging wildlife. Propagation of

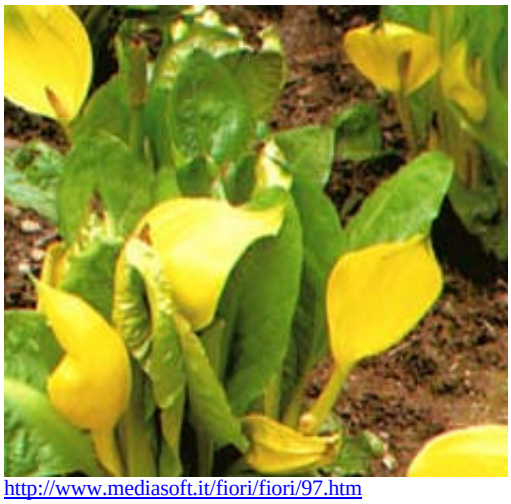
this shrub is easiest using hardwood cuttings that grow quite rapidly; moreover, this shrub can be propagated from seed though the process is far more intensive.

***Rhodedendron macrophyllum* (Pacific rhodedendron)**

http://www.cnr.vt.edu/dendro/dendrology/syllabus/rmacrophyllum.htm

This native shrub can grow up to eight meters tall and its branched form can vary from erect to spreading (Pojar and MacKinnon 1994). Its evergreen leaves are oblong (8-20 cm long) and leathery, while its flowers are bell-shaped and pink to purple. Flowers are 5-lobed, 2-4 cm long, and occur in terminal clusters in late spring, while the fruits are woody capsules. This plant sprouts well after fires, and flowers are usually most prolific on those individuals located in gaps or on forest edges. Pacific rhododendron often forms a dense shrub layer in fairly dry coniferous forests from Southern British Columbia to Northern California, and the range of this plant extends from shoreline up to middle mountain elevations. In terms of pests, Pacific rhodedendron tends to often be inflicted by powdery mildew in moist areas with poor circulation (Dreistadt et al. 1994). Also, root weevils and root rot fungi (such as Phytopthora) can sometimes be a problem. At our site at Lousia Boren Park, Pacific rhodedendron should be planted in the driest upland areas, in canopy gaps if possible to promote flowering.

***Lysichiton americanum* (skunk cabbage)**



http://www.mediasoft.it/fiori/fiori/97.htm

This perennial native forb is characterized by large, erect leaves that sprout from underground stem crowns (Guard 1995). The leaves are often extremely large (up to 150 cm), fleshy, and lance-shaped to oval. The central flowering stalk, the spadix, is surrounded by a large, yellow bract, the spathe, which tends to be an obvious distinguishing characteristic of this species. The flowers on the spadix are tiny, yellowish-green, and have an extremely pungent odor, attracting flies and beetles as pollinators. Skunk cabbage blooms in the early spring before its leaves appear, and it can be found in a variety of freshwater wetlands throughout Washington and Oregon from sea level to mountain elevations. This plant grows best in canopy shade, and remains small when it is in exposed areas. It is an obligate wetland plant, and thrives in muddy, saturated conditions, often co-occurring with sedges. The stem crowns of skunk cabbage can be vegetatively propagated, making this plant a good choice for wetland restoration projects. In terms of pests, skunk cabbage is eaten by a variety of woodland animals, and can often be ravaged by slugs if conditions permit. At Louisa Boren, skunk cabbage is found in a part of the wetland adjacent to our site and will be an excellent choice for planting in the mucky, sparsely-vegetated, extremely high soil moisture areas of our site.

***Vaccinium parvifolium* (red huckleberry)**

http://www.wsdot.wa.gov/eesc/environmental/programs/culres/ethbot/t-z/VacciniumPar.htm

Vaccinium parvifolium is a deciduous shrub with an upright, graceful growth habit extending to 4m tall at maturity. Leaves are alternate, oval and approximately 3cm in length. The flowers are urn shaped range from pink to white in color and the attractive, edible, bright red berries provide a source of food for wildlife (Pojar and McKinnon 1994). This species thrives in canopy gaps and along forest edges. For maximum success plant in partial to full shade, with moist to dry soils and use a substrate of decayed wood, which can include either decaying logs or mulch (Leigh 1999). Disease and pathogen problems include tar spots and blueberry rust (Dreistadt, Clark and Flint 1999). Although slow to establish *Vaccinium parvifolium* is a good choice for the site, because it is adapted to edge effects and will do well planted along the top of the northern slope in the abundance of fallen debris.

***Acer circinatum* (vine maple)**

http://www.laspilitas.com/plants/767.htm

Acer circinatum is a deciduous tree or shrub growing to a height of 7m tall. Leaves are opposite with 7-9 lobes and turn a striking shade of gold or red during the autumn (Pojar and McKinnon 1994). This species thrives along forest edges or in canopy gaps where it

can gain access to light. Ideal growing conditions include moist to dry soils and exposure to full sun, with adequate moisture, or partial shade (Leigh 1999). Disease and pathogens include tar spots, verticillium wilt and aphids. *Acer circinatum* is a good choice for the site, because it adds an attractive mid canopy structure and is tolerant of edge effects. For these reasons, this species should be used on the edge of the northern slope to frame the viewpoint and along the western edge of the site adjacent to the path to enhance aesthetics and add structural diversity.

***Dicentra Formosa* (Pacific bleeding heart)**

http://www.rainyside.com/features/plant_gallery/nativeplants/Dicentra_formosa.html

Dicentra Formosa is a herbaceous, upright perennial ranging in height from 6-20cm. This species produces pink, drooping, heart shaped flowers that form attractive terminal clusters. The leaves are fan shaped with deeply divided lobes, originating from rhizomes. Reproductive methods include seed production and vegetative spread from brittle rhizomes (Leigh 1999). This species is commonly found in ravines, forest environments and along moist sreambanks (Pojar and McKinnon 1994). Optimum growing conditions include full to partial shade and moist to dry soil conditions. Disease and pathogens are not common in this species. *Dicentra Formosa* is a good choice for the site, because it is adapted to a variety of soil moisture conditions, adds an attractive herbaceous understory and attracts beneficial insects such as butterflies. For these reasons, this species can be planted in any upland zone.

***Cornus canadensis* (bunchberry)**

http://www.orst.edu/dept/ldplants/coca1.htm

Cornus canadensis is a rhizomatous perennial ranging in height from 5-25cm (Pojar and McKinnon 1994). Leaves are evergreen and arranged in a terminal whorl below cream colored bracts. The fruits are bright, sweet, red berries and they are a good source of food for wildlife. This species thrives in bogs, moist forest edges, partial and full canopy openings and is often found growing on decayed logs. Optimum growing conditions include exposure to partial or full shade and moist soils (Leigh 1999). Disease and pathogens are not common among this species. *Cornus canadensis* is a good species choice for our site, because it adds structural diversity to the wetland area currently dominated by *Rubus spectabilis* and will further increase diversity in the upland areas.

***Mahonia nervosa* (dull Oregon grape)**

http://www.orst.edu/dept/ldplants/mane1.htm

Mahonia nervosa is an evergreen, erect, rhizomatous, stiff branched, and small shrub that is native to the Northwest and found in many shaded, woodland settings. It thrives in dry

to fairly moist soil conditions at both low and middle elevations, and it cannot tolerate swampy, waterlogged soil conditions (Pojar and McKinnon 1994). Rarely reaching above 60 cm tall with prickly, holly like leaves, *Mahonia nervosa* is a prime selection for creating a physical barrier along pathways while preserving views into adjacent areas. Leaf spot and rust can be an aesthetic problem, especially if the plants are located near a high traffic area, which increases Sulfur dioxide exposure (White 2002).

***Carex obtnupta* (slough sedge)**

http://elib.cs.berkeley.edu/cgi/img_query?where-genre=Plant&where-taxon=Carex+obnupta

Carex obtnupta has dense tufts of grass blades emerging from long and fat rhizomes. The stems are purplish, stiff, have rough sheaths, and average between 60 and 150 cm tall. It thrives in marshes, swamps, bogs, stream-banks, lake shores, wet open forests, meadows, and clearings, making it a versatile and unique plant selection to use in the waterlogged areas of our site (Pojar and McKinnon 1994). While fungal and bacterial problems rarely affect this species, waterfowl, pintails, mallards, and grouse are known to feed on slough sedge (USGS 2002). However, the likelihood of these species feeding on the *Carex obtnusa* at Louisa Boren is slim.

***Gaultheria shallon* (salal)**

http://www.orst.edu/dept/ldplants/gash4.htm

Native to the Northwest, *Gaultheria shallon,* commonly known as salal, is a creeping to erect evergreen shrub. It has alternate, leathery, dark green, glossy leaves that can be two to four inches long (WSDOT 2001). The amount of light it receives affects its growth habit. In full sun, it grows low to the ground and makes a good ground cover, but in shady conditions, salal will grow much more spindly, reaching 10 feet (Virginia Tech Dendrology 2002). It does grow in both full sun and full shade, but does best in partial shade to sun (OSU 2002). *Gaultheria shallon* does well in most well drained moist soils. This would help cover the ground and keep invasives from re-establishing and taking over the site.

Symphoricarpos albus (snowberry, waxberry)

http://www.borealforest.org/shrubs/shrub50.htm

Symphoricarpos albus is a deciduous shrub that grows 3-5 ft. in height and spread, usually freely branching and suckering with broad round suckers. (OSUH 2002). This

plant is native to North and Central America and China and prefers the environment of sun to partial shade and can withstand neglect. Snowberry is a very dense plant that also grows well in shade and tolerates clay (MSUE 1996). This plant grows rapidly and has a vigorous, suckering root system making it a useful plant on steep banks. Snowberry produces its signature white fruits that persist into the winter.

***Polystichum munitum* (sword fern)**

http://www.orst.edu/dept/ldplants/pomu1.htm

Native to the Northwest, *Polystichum munitum* is a relatively fast-growing, evergreen fern. It usually ranges from 2-4 ft in height and has long fronds arching from many stems. It has evergreen narrow, lance-shaped pinnate dark green fronds. Sword fern grows best in moist forests at low to middle range elevations, these usually include all Western Coastal regions (WSDOT 2001). Part to full shade and well drained moist soils are included in its best natural growing environments (OSU 2002). Sword fern is an abundant understory plant in moist coniferous forests at low elevations here in the Northwest. The thick fibrous root system of *Polystichum munitum* makes it an excellent plant for erosion control and for stabilization of steep slopes. This would be a great plant choice for our site because the slopes of our site will have high potential to erosion after the removal of *Hedera helix*.

***Thuja plicata* (Western red cedar)**

http://www.orst.edu/dept/ldplants/thpl1.htm

Thuja plicata is a large, evergreen conifer in the Cupressaceae family that is native to the Northwest. It has an open pyramidal shape with frond-like branches, and it is often buttressed at the base (Pojar and MacKinnon 1994). These trees have been known to reach heights of over 200 ft, but are most often found in the 80-100 ft range. Its optimal growing conditions include sun to partial shade with moist, but usually well-drained soil. Western red cedar performs best when protected from high winds. This plant has a tolerance of anaerobic soil conditions allowing it to grow in some waterlogged sites. With the high soil moisture and the low light intensity of Louisa Boren, and since there are already some individuals growing there, *Thuja plicata* would be an excellent choice for restoration planting.

***Philadelphus lewisii* (mock orange)**

http://www.orst.edu/dept/ldplants/phle5.htm

Philadelphus lewisii is a deciduous shrub, with an open branching habit that grows to a height of 3m. The leaves are opposite, oval and light green in color. The most striking feature are the extremely fragrant, white, showy flowers. This species thrives in a variety of habitats from forests canopies and edges to rocky outcrops (Pojar and McKinnon 1994). Optimum growing conditions include moist to dry soils and full sun to partial shade. Disease and pathogens are not common among this species. *Philadelphus lewisii* is an excellent species choice for our site, because it is able to tolerate a range of soil and light conditions, will enhance the mid canopy layer and enhance aesthetics. For these reasons, *Philadelphus lewisii* can be planted in any upland area and should be placed in areas that are visible to pedestrians during spring flowering.

State of purchased plant material

Use of containerized vegetation material is recommended because of the versatility it provides in terms of planting times: it can be installed nearly any time of year. Bare root material, on the other hand, must be installed in the fall or winter while the plants are still dormant. This potentially precludes the use of bare root vegetation at Lousia Boren, because the late summer (driest part of the year) is the recommended planting time, so as to minimize soil impacts in the wetland. The benefits of bare root material, however, are that root problems can be readily identified, the material is cheaper, and handling of plants is logistically easier (less space required for storage, material is lighter in weight, etc.). Most reliable local native plant suppliers sell their

plants in containers or plugs. But, it is common to find some trees, such as *Thuja plicata,* sold as bare root material.

Plant Selection Guide (refer to appendix II)

The plant selection guide lists the full plant selection chosen for this site, the appropriate planting zones and spacing considerations.

Planting Plan (refer to Appendix I: map 3)

The detailed planting plan shows vegetative composition of the site after installation of the selected species.

As discussed earlier, major goals of this project are to restore a self-sustaining native vegetation community and to provide a means of public education about restoration at the site. In order for this to be achieved, the site must be prepared appropriately, and the plants must be installed properly. This includes the removal of invasive species (by the means delineated below in the individual plant sections), erosion control, hazard tree removal, mulching, construction of bench and informational sign, and plant installation. The following section is devoted to describing each of these tasks in detail.

A) Invasive Plant Species Removal

***Hedera helix* (English ivy)**

http://www.floridata.com/ref/h/hedera_h.cfm

Hedera helix is an evergreen vine in the Araliaceae family, and its leaves are dark green, waxy, somewhat leathery, and are arranged alternately. Leaf shape is variable depending on the maturity of the vine and the amount of sunlight the leaves receive (PCA 2002). Commonly, the leaves are 3-5 lobed with a heart-shaped base. This plant usually thrives in dark, moist forests, but it is also known to grow in just about any conditions, even in full sun (HYGP 2002).

English ivy has recently been put on Washington State's Noxious Weed list with a class C Status (WPA 2002). It has become a major problem in the Pacific Northwest, as well as many other parts of the world due to its invasive tendencies. This plant, which is widely used for home landscapes and as an erosion control groundcover, is being quickly spread into the native forests of Washington. In addition to its ability to easily grow in most local environmental conditions, invasive characteristics include quick

vegetative spread, adventitious rooting, and seed dispersal via birds and other animals. English ivy lacks natural biological control agents in this area, further contributing to its proliferation. This plant can take over entire forests, covering understory species and climbing into trees, and shading-out natives, sometimes resulting in an "ivy desert". The suspended ivy also adds extra weight to tree branches, making them susceptible to breakage and wind-throw.

Many different methods of control have been devised and tested in attempt to eradicate English ivy from local forests. A widely accepted tactic is to cut the stems of climbing vines near the base of trees and remove all of the ivy around the tree base through mechanical control methods. This eventually kills the ivy above the cut, and it can be removed later. Sprayed chemical herbicides are generally not a recommended form of control, because they often cannot penetrate the waxy cuticle of the leaves. On the other hand, a highly effective method is to paint herbicide on ivy cut at its base. If applying to the stems, a 15-30% mixture of triclopyrester (Garlon 4) and water may be used, but this may harm surrounding plants if used improperly (PCA 2002). Because *H. helix* is an evergreen vine, and grows year-round, herbicides can be applied at any time, but it is usually best to administer this treatment in the drier months to keep rain from diluting the chemicals and spreading the herbicide. If the affected site is characterized by streams or other water-courses, such as at Louisa Boren, use of chemicals is not advised, and mechanical removal (e.g. hand pulling or weed-whacking) is the recommended tactic. Given that English ivy is such an aggressive invader, mechanical control must be repeated on a regular basis to successfully eradicate the plant.

***Clematis vitalba* (traveller's joy)**

http://www.dipbot.unict.it/orto/0473-1.html

This invasive species is a semi-woody climber, which climbs 30 feet or more. The stems are furrowed, and the leaves are pinnately compound. Its flowers are white, two inches in diameter, and bloom in the late summer. Numerous tufts of long, white, velvety, and curling seedpods are exposed in the autumn (Burras and Griffith 1994).

Many nurseries sell this *Clematis* species for the unique seed heads that bear wind dispersed seeds, thus facilitating extensive distribution to neighboring properties and resulting invasive spread (Cronk and Fuller 1995). Also adding to its invasibility is the fact that it can regenerate from broken fragments. Older stems have better water retention and hold more nutrients, increasing the chances of new climbers emerging from older fragments. This plant also reaches reproductive maturity early, especially if exposed to ideal, full-sun conditions.

There are three forms of control for this species, although not all three are appropriate for our site. Chemical control can be utilized treating it with Tordon Brushkiller and Garlon 520, and bioloical control can be implemented by introducing insects into the garden. The third approach is mechanical control, which involves pulling small seedlings early, or completely eradicating larger plants via complete removal of all roots (Cronk and Fuller 1995). This method should also involve cutting the plant down just before flowering as to severely hinder its nutrient source and prevent seeding. Mechanical control is the best method of eradication of *Clematis vitalba* for Louisa Boren Park, given the constraints of the site (e.g. preserving water quality).

***Ipomoea purpurea* (morning glory)**

http://www.museums.org.za/bio/plants/convolvulaceae/ipomoea_purpurea.htm

Although this vine is native to tropical regions in Asia and Africa, it has the versatility to survive anywhere from coastal areas to inland climates in Washington. It can be found in habitats ranging from fallow pastures to natural areas, and it thrives in disturbed areas (Pojar and MacKinnon 1994). Morning glory is a profuse climber with a sprawling, twining habit, and if it is not maintained with aggressive control, it can take-

over large areas in a short period of time. The creeping and climbing nature of this vine allows it to successfully cover other plants, thereby out-competing them for light, eventually leading to their decline. Morning glory is characterized by a solid leaf with 3-5 rounded lobes, and its showy, funnel-like flowers range in color from white to pink and can appear year-round. This plant produces adventitious roots that emerge from leaf nodes along the stem. This feature makes eradicating morning glory extremely difficult, and care has to be taken to remove all of the roots, which often must be done by hand. Mechanical control is the recommended eradication strategy for this species at Louisa Boren, which should most likely be a combination of clipping and hand-pulling. Although this plant is not considered a noxious weed, its invasive tendencies are obvious, as is the fact that it is a detriment to local native ecosystems.

***Rubus discolor* (Himalayan blackberry)**

http://www.cnr.vt.edu/dendro/dendrology/syllabus/rdiscolor.htm

Rubus discolor is an introduced species native to India, but introduced from Europe. The growth habit is firstly upright and firm, then arching and trailing with maturity (Pojar and McKinnon 1994). The leaves are oval in shape, 3 – 5 in number, have toothed margins and are pubescent underneath. The canes are covered with sharp recurved thorns. Flowers are pinkish white and produce black fruits considered valuable to wildlife and favored by humans. This species is an aggressive invader able to reproduce both vegetatively and by seed. The seeds are eaten by wildlife, scarified in the

gut and dispersed in the animal's feces. Vegetative reproduction is efficient, because although the canes originate from one main root ball this species is able to root again as soon as a mature stem tip touches the ground forming another root ball; this process eventually forms dense thickets (Shaw 2000). *Rubus discolor* can be devastating to native habitat as it is able to outcompete native plants for water, nutrients and forms dense thickets eventually shading out its competitors. Optimal habitat includes disturbed areas, moist soil conditions and ample light. At Louisa Boren *Rubus discolor* is found in the exposed wetland portions of the site and along the streamside where ample light and moisture are available. Herbicides are not permitted on King County property and therefore, manual removal is the preferred method. Cut stems to ground and dig out the main root ball. Do not replant in the area until the procedure has been repeated the following season to ensure eradication.

***Prunus laurocerasus* (English laurel)**

http://www.planteopformeringsstationen.dk/dansk/traerbuske/prunuslaurocerasus.htm

Prunus laurocerasus is an evergreen shrub/tree that grows approximately 10'-20' in height and is native to Southeastern Europe and Asia Minor (OSUH 2002). Leaves of English laurel are alternate and simple, 5-15 cm long, and oblong or obovate in shape. The leaves may also be described as glossy and medium-dark green in color. In spring, *Prunus laurocerasus* produces 3"-5" racemes of white fragrant flowers, and the purple/black fruit develops in summer, facilitating seed spread via birds. This plant prefers to grow in moist soils in either sun or shade. Its growth habit is wide-spreading, dense, coarse textured, and vigorous, making it a favorite hedge plant locally, but these characteristics also lend to its ability to invade. Removal of *Prunus laurocerasus* is best

done by mechanical means. Pulling-up or digging-out the plant in the spring, during the process of new growth while nutrient storage is at a minimum, but before fruiting, is the best tactic. Caution should be taken during removal and disposal, however, as the wilted leaves, stems, and seeds of English laurel are poisonous (NCSU 1997).

***Ilex aquifolium* (English holly)**

http://www.anbg.gov.au/images/photo_cd/732131822178/058.html

This plant is a widely used ornamental woody shrub or tree that is non-native to Western Washington and has invaded many natural areas in this region (KCWB 2002). Growing to a maximum height of ten meters, it is able to exploit the relatively open sub-canopy niche, and can displace native forest species. English holly is characterized by attractive evergreen leaves that are stiff, shiny, and exhibit spines along their margins. The optimum light condition for growth of this plant is partial shade, but it is able to tolerate situations ranging from full sun to shade (Reichard 2002). It does best in well-drained soils. In terms of reproduction, English holly is often dioecious, and the females develop small, fragrant, white flowers in the spring. Pollination and fertilization is required for fruit maturation, so a male plant must be nearby for the characteristic red berries to develop in winter on the female plants. These berries are subsequently dispersed by birds, explaining their often random appearance in urban parks.

King County's Weed Board has labeled English holly as an "obnoxious weed", meaning that the plant is recognized as invasive, but there are no regulations that govern its required control (King County 2002). The board does, however, discourage people from installing the plant, and they also recommend containing populations and eradication when possible.

Eradication of English holly can be achieved by either chemical or mechanical means. The most effective chemical method involves herbicide injection. This is executed by drilling holes (angled downward) into the trunk of the plant, and applying 1.5 mL of a 20% glyphosphate solution (or another herbicide, such as Tordon Brushkiller®) to the wound in spring or summer (Reichard 2002). An alternative control method using herbicide involves cutting the plant off at its base and painting the trunk immediately with an herbicide such as Tordon® or Roundup®. Even though these two techniques are effective and individual specific, their use is not recommended at Louisa Boren because of the extremely wet conditions at the site and the danger of water contamination. Mechanical control, or hand-pulling, is the recommended strategy for controlling English holly at the site. The younger plants can be uprooted fairly easily by this mechanism, but the older shrubs may require use of a weed wrench for removal (Reichard 2002).

B) Removal of Native and Non-Invasive Vegetation

In order to reduce the existing *Rubus spectabilis* monoculture and create more structural diversity within the site, it is recommended that the salmonberry be removed from Zones One, Nine and Ten before planting. Zone Six comprises a monoculture of *Vinca minor*, which should also be removed prior to re-vegetating.

C) Erosion Control

Erosion, as interpreted by the Random House College Dictionary, is the process by which the surface of the earth is worn away by the action of water, glaciers, wind and waves (Stein et al. 1973). In this case, there is no presence of glaciers, waves or wind, but the presence of water is very apparent. The natural flow of precipitation run-off has been accelerated by the construction of houses and roads atop the bluff. This construction began roughly during the 1920's and has had a profound affect on the current evolution of the landscape. Historical records of the site show evidence of massive slides that can be attributed to the urban development, in particular there was a major slide in the 1940's not more than 30 yards from the site that claimed a couple of homes in the wake of its destruction.

The present condition of the site shows little alteration since the 1940's, but the surrounding slopes are slowly beginning to slump toward the center of the site; this is evident by the diagonal growth of the surrounding trees. Erosion of the site is further enhanced by the invasive species that rapidly and seriously degrade the quality of wild-lands by altering natural processes and reducing biodiversity (WSDOT 2002). Invasive species compose a large percentage of the biota present at the site and once the restoration plan is implemented all invasives will be removed from the site. The removal of invasives will cause a tremendous amount of soil disturbance and subsequently sediment will be flushed into the stream when combined with seasonal run-off. To prevent sediment accretion, reconstruction of the site will be implemented; this will include the installation of native plants combined with soil bioengineering. Bioengineering combines the use of structural practices and live vegetation to provide erosion protection for hill-slopes, streambanks and lake shores. Advantages of bioengineering solutions are: 1) low cost and lower long-term maintenance cost than traditional methods; 2) low maintenance of live plants after they are established; 3) environmental benefits of wildlife habitat, water quality improvement and aesthetics; 4) improved strength over time as root systems develop and increase structural stability; and 5) compatibility with environmentally sensitive sites or sites with limited access (Franti 1996).

There are many designs that can be implemented into the bioengineering process, all of which have validity and are structurally sound when placed in the correct environment. Some of those designs are live staking, coir matting, and contour wattling. For sites that are highly susceptible to erosion live staking is found to be the most appropriate measure; the directions for live staking use and benefits are as follows:

Live Staking

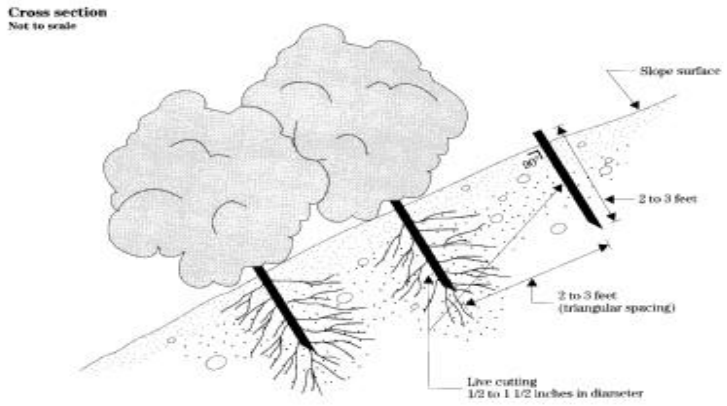


Figure 1.

Live staking is a process that involves the installation of woody plant whips that are cut into lengths and placed into the slope. These woody plants root easily and should be planted in the fall or spring when they are dormant. When mature they will reinforce the soil structure of the slope, as seen in figure 1. Considerations that need to be taken when planting these species are size of the cuttings, appropriate species selection and correct installation. Hardy species such as pacific ninebark (*Physocarpus capitatus*) and red osier dogwood (*Cornus sericea*) are excellent candidates since they are durable and easy to propagate. The stakes should be cut into 2 to 3 foot lengths and have a diameter of ½ to 11/2 inches. For proper installation the stakes need to be cut flat on top, diagonal at the bottom and inserted into the slope with a minimum angle of 10 degrees.

Contour Wattling

This practice of erosion control, known as live fascines, can be used in accordance with live staking as seen in figure 2. This method of control involves packaging woody plant material into bundles or cables 8 - 10 inches in diameter. The bundles are installed into trenches that run parallel to the slope and should be installed approximately 2 inches above the soil line; this will divert the excess run-off laterally and trap sediment, preventing further degradation to the slope. This installation process is shown in Figure 3.

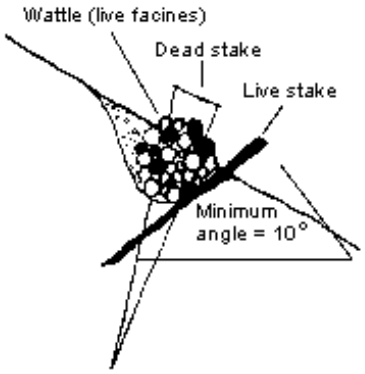


Figure 2.

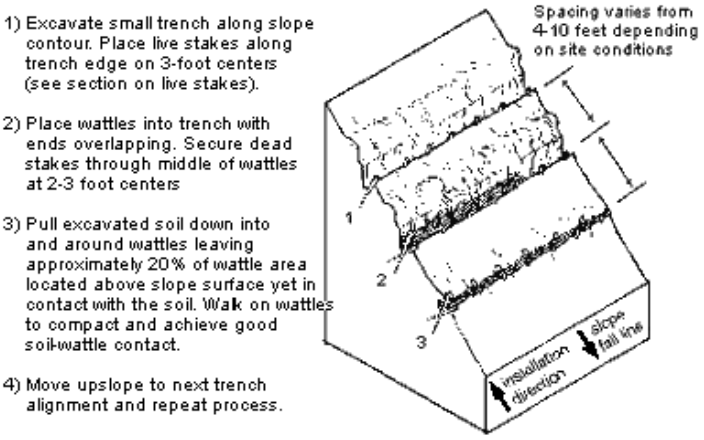


Figure 3.

To ensure that erosion is completely controlled coir matting may be installed on the steeper slopes to provide top soil support. Installation of the matting is relatively simple by comparison to other methods. Sections of this coarse net are laid across the slope and staked into place; plants can be installed through the material and mulched.

Slope stabilization is required in zones 4 and 5. Suggested methods for erosion control at this site should include contour wattling followed by a layer of coir matting, which will help stabilize the slopes and keep sediment from running into the stream. Native vegetation will subsequently be added to the slopes for increased stability.

D) Hazard Tree Removal

Hazard trees identified in Section II: Site Assessment should be removed by a qualified arborist.

E) Mulch

The use of mulch on the site is crucial to the health of existing plant material and will aid in the establishment of new plantings. Mulch will help to increase beneficial soil organisms, which aerate the soil, thereby reducing compaction and contribute to nutrient cycling, among many other functions. Mulch acts as a slow release fertilizer, adding nutrients to the soil over time. Irrigation will be a problem at this site and, therefore, a layer of mulch will help retain soil moisture during the drier months, reducing the chance of drought stress. The insulation provided by the mulch will protect plant roots from extreme temperature changes, thereby providing a more stable environment with less stress. Adding a layer of mulch six to eight inches in depth is an effective method of weed control, which is an important consideration at this site. For these reasons, it is recommended that a six-inch layer of mulch be applied to all slope and upland areas of the site before installation.

E) Sign and Bench Design

At the request of the Seattle Parks Department, this project includes a bench near the trail entrance. In order to minimize materials, the design of this bench is combined with a interpretive sign that our group felt was important to add in order to teach park users the importance of wetland restoration. This bench and sign combination is a custom design, derived from the railings of the Old Faithful Inn at the Yellowstone National Park. Detailed drawings and step-by-step instructions for its construction are found in Appendix III.

Because Louisa Boren Park has a limited budget, it is extremely important to minimize the cost of the bench. The prices for the bench materials are listed, but retail companies such as Dunn Lumber in Seattle or even Home Depot could potentially contribute donations. Both companies are active in their community and have an application process before determining where they donate materials. The wetland restoration and park improvement goals defined in this project meet their general pre-requisites for application, but does not guarantee any donated materials. Check Appendix V for the application requirements and information.

F) Plant Installation

Proper plant installation is crucial to the successful establishment of vegetation. The following are summary guidelines of the detailed plant installation specifications that are given in Appendix IV.

1. Storage:
   - Keep all plant material moist.

2. Preparing Plant:
   a. Remove all tags, staking, or any other foreign material from the plant.
   b. To remove from container, place hand over potting material, turn plant upside down, and gently lead plant out of container.
   c. Remove all potting material, thereby exposing all roots.
   d. Prune off any dead, damaged, diseased roots.
   e. Remove or straighten out circling roots, and cut any kinked or girdling roots back.

3. Hole Preparation:
   a. Dig the hole so that it will be two – three times the width of the root mass. If glazing occurs on the side of the hole, take a planting fork and lightly drag it along glazed areas, or poke the sides with the fork.
   b. Remove organic matter such as mulch, roots, and weeds, along with large stones, or any other objects that will interfere with optimal root establishment.
   c. Build a small soil mound in the middle of the hole.

4. Plant Placement
   a. Place the plant on top of the mound, arranging the roots evenly and radially. Position the plant with respect to slope and wind conditions on site, and to the plant's structure.
   b. Fill the remaining hole with backfill, and gently firm using hand pressure.
   c. Stake the plant, if plant is unstable to the point of toppling over. Avoid staking them, otherwise.
   d. Water in the hole, and fill with more native soil if subsidence occurs.

5. Immediate Aftercare
   a. Spread a mulch layer 4 – 6 inches deep around newly planted area, being sure to not cover plant's root crown.
   b. Irrigate regularly at least for the first year, and as necessary after a year has passed.

Maintenance

Lack of proper maintenance and monitoring can often be the demise of a restoration and for this reason, it is crucial to develop and follow a management plan to ensure the best chances for project success. The following section is devoted to describing the components of this strategy at the restoration site at Louisa Boren Park. Here, emphasis is placed on control of invasive species, establishment of new plantings, and erosion prevention. Since invasives are the main problem at the site it is anticipated that control will be a major component of the management plan. Also, new plants will need proper care, especially in their first year for establishment, in order to be successful on the site. Since much of the site is wetland and characterized by watercourses, prevention of erosion is essential, so that water quality is maintained. It is recommended that the site be managed intensely for at least three years, to provide the best chance for restoration success and the establishment of a self-sustaining ecosystem

1. Invasive Control

   Preventing the return of invasives that currently have such a strong presence at Louisa Boren is extremely important to the success of this restoration project. Fast growing and competitive weedy species, especially vines (ivy and morning glory), will re-establish quickly if their suppression is not routinely maintained, especially given their prominence in the area surrounding the site. The most suitable techniques for eradication of the various invasive species are mentioned in the individual descriptions, but continued mechanical removal is the only form of control suitable for this site. Continued weed control will provide healthier growing conditions for the newly planted vegetation. It is advised to monitor the site for invasives on a monthly basis. Priority control should concentrate on keeping invasive vegetation away from new plantings.

2. Irrigation

   Regular irrigation is an important step to the help ensure survival of new plants. All of the new plantings should be watered immediately following installation, with the exception of the wetland plants. Regular irrigation should continue for

the first three years especially throughout the drier summer months. The plants chosen to re-vegetate this site are adapted to Northwest environmental conditions, and will not need any added irrigation after they fully establish and their roots and start to mature.

3. Mulch

   New plantings should receive regular applications of mulch until established. Re-mulching new plantings every four to six months would be sufficient. The slopes and upland areas should be re-mulched annually until native diversity has been restored and the abundance of invasives has been reduced.

4. Pruning

   Newly planted trees should be observed on an annual to biannual regimen and pruned of any branches that would disrupt the proper structure of the tree. To maintain the health and aesthetics of existing trees as well as the safety of both motor and pedestrian traffic it is crucial to perform regular pruning. A good rule of thumb to follow is to prune a tree for dead, diseased or crossing branches every 2 – 5 years. This will assure good growth, proper structure and prevent any major problems in the future. Roughly thirty percent of the trees located at the Louisa Boren site are big leaf maples (*Acer macrophyllum*), all of which are in dire need of maintenance. The problems in question are as follows: All of the *Acer* species have a minimum of twenty percent dead wood in the canopy and mid-bole. Apart from being aesthetically displeasing, this will weaken the health and structure of the tree as well as pose a serious safety issues. Some of the maples located along Interlaken Boulevard have snapped out deadwood, suspended on other branches that are hanging over the road, these are also known as "Widow Makers". Along with the regularly scheduled maintenance of these species, attention should also be given to hazard trees that pose a greater safety issue. By inspecting the base, main bole and canopy of all the trees on site for rot or decay there can be an avoidance of dangerous trees by removing the hazard in a timely manner.

5. Staking Maintenance

   The stakes should remain attached to the tree for roughly one year or until the tree can exhibit strong root stability. Maintenance of these staked trees should include checking root stability and monitoring for exposed roots. To check for stability gently shake the tree to check the resistance level. If the resistance is strong this indicates appropriate root formation and the stake may be removed. It is imperative that staking not be removed until after the seasonal winds have died down.

6. Erosion Control Maintenance

   For the first year of installation it is imperative to maintain the installation of these control methods. It is important to make sure that the matting has not slipped in any direction, since this can cause damage to plants that may have been installed through the net. It is also good practice to check the structural integrity of the contour wattling for signs of undermining or sediment build up. The live-staked material, if installed correctly, should begin rooting quickly, so, a gently shaking of the stakes to check for stability should be performed annually.

Monitoring

Monitoring at Louisa Boren will be essential to the success of the project. Since the restoration will be a dynamic process, it makes sense to have a management and monitoring plan that is flexible, interconnected, and is able to accommodate on-site change. Such a scheme is called adaptive management. This method makes use of contingency plans, devices that lay-out what/when/how improvements must be made to management strategies when monitoring determines that performance standards are not being achieved. Utilization of this practice will greatly increase the success of individual restorations by encouraging mid-course corrections and ensuring that the funding is set-aside for this purpose. Idealistic goals and objectives set at the beginning of a restoration project will have to be modified as actualities and limitations of specific sites reveal themselves. Management and monitoring practices should constitute an interconnected, evolving feedback loop: monitoring should determine whether management procedures

are successful, and then management practices should be adjusted accordingly, with follow-up monitoring to evaluate the results of any implemented changes.

At Louisa Boren, it will be crucial to monitor the health of newly installed vegetation. Vegetation should be checked regularly, especially in the first year, for signs of decline due to environmental factors (such as drought or flooding) or human/domestic animal induced problems (such as trampling), and management practices or plant selection should be changed accordingly. Replanting should occur as necessary. On-site pests should also be monitored. Also, closely watching the activity of invasives, and implementing and changing control tactics as necessary, will be of paramount importance to the success of the site.

Watching for changes that will be required to the other components of the aftercare plan, such as mulching and erosion, is also essential, and changes to the management strategy should be made as necessary.

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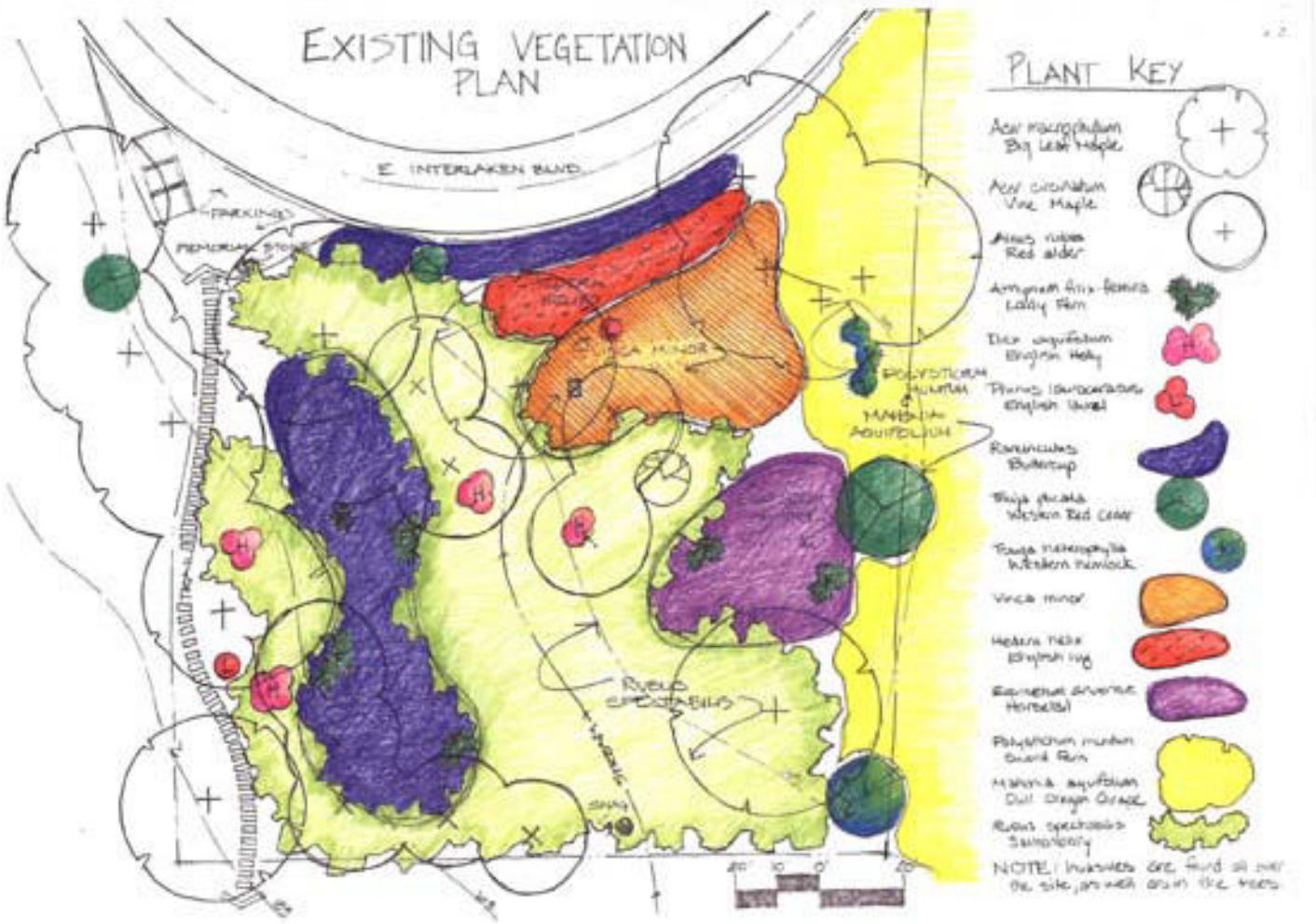
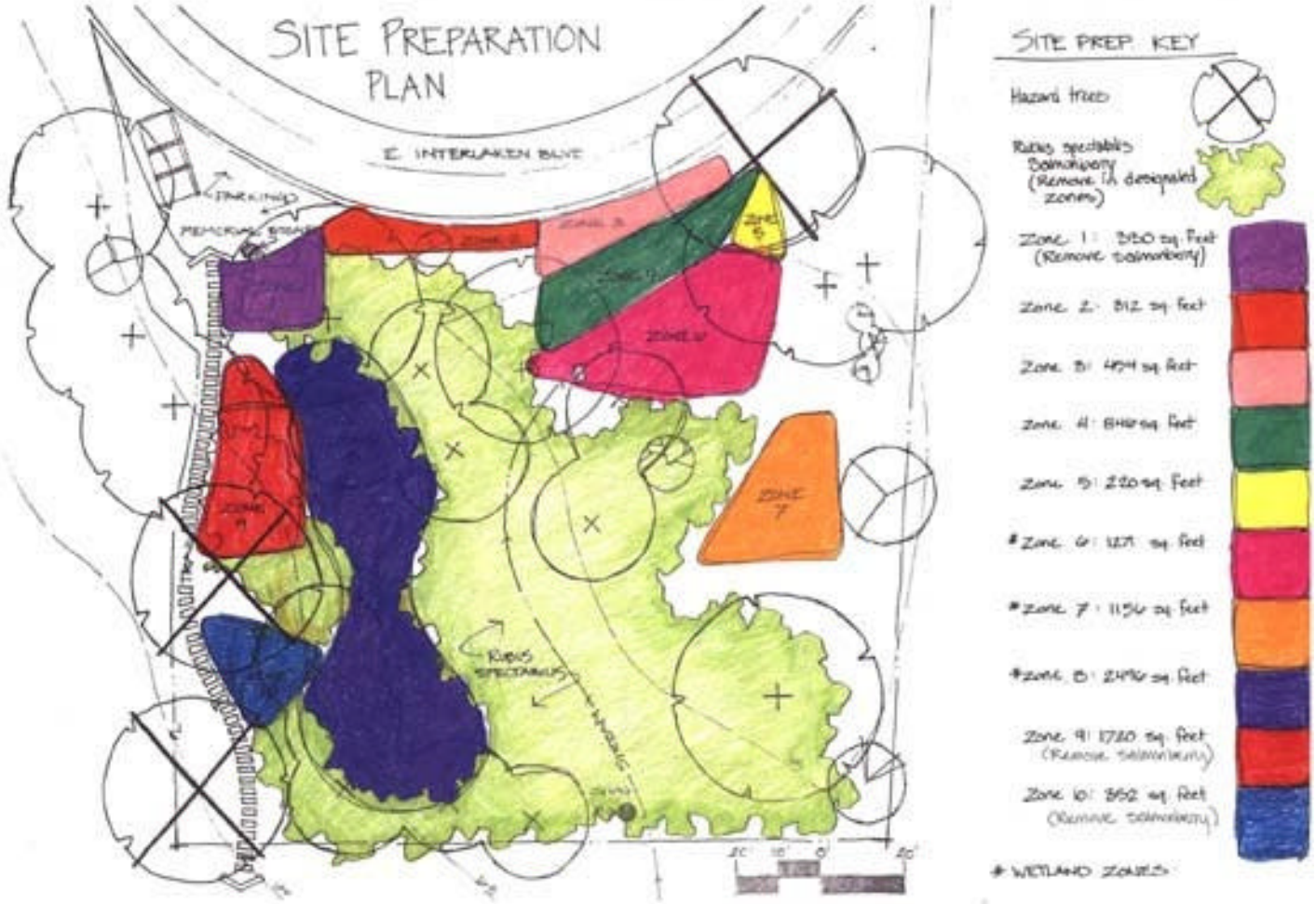
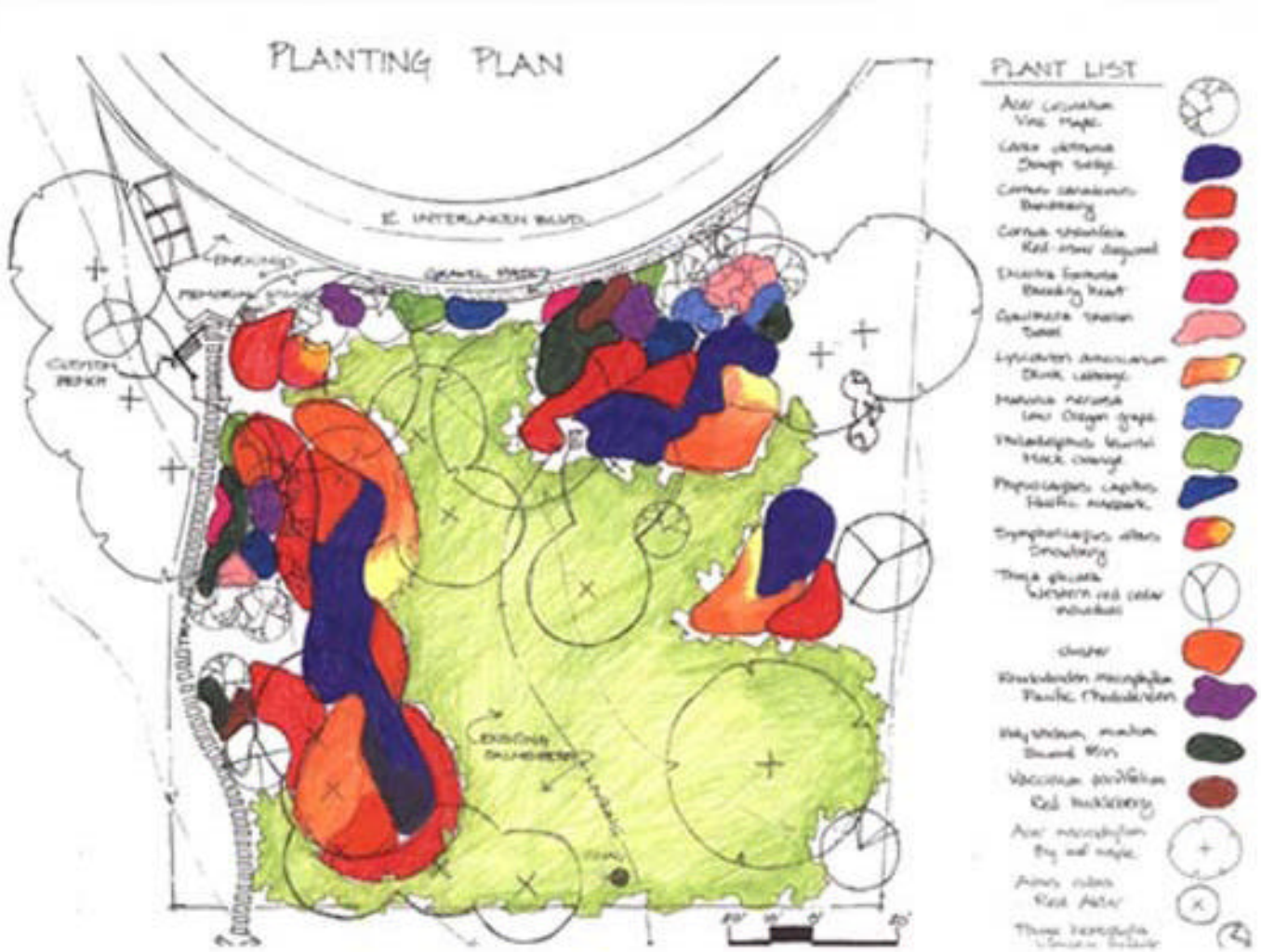

EXISTING VEGETATION PLAN
E. INTERLAKEN BLVD.
PARKING
MEMORIAL STONE
VINCA MINOR
POLYSTICHUM MUNITUM
MAHONIA AQUIFOLIUM
RUBUS SPECTABILIS
SIGN
0' 10' 20'
PLANT KEY
Acer macrophyllum
Big leaf Maple
Acer circinatum
Vine Maple
Alnus rubra
Red alder
Athyrium filix-femina
Lady Fern
Ilex aquifolium
English Holly
Prunus laurocerasus
English laurel
Rhamnus Buckthorn
Thuja plicata
Western Red cedar
Tsuga heterophylla
Western Hemlock
Vinca minor
Hedera helix
English ivy
Polystichum munitum
Sword Fern
Mahonia aquifolium
Oregon Grape
Rubus spectabilis
Salmonberry
NOTE: Invasives are found all over the site, primarily along the trees


SITE PREPARATION PLAN
E. INTERLAKEN BLVD
ZONE 7
RUBUS SPECTABILIS
SITE PREP KEY
Hazard trees
Rubus spectabilis Salmonberry (Remove in designated zones)
Zone 1: 350 sq Feet (Remove salmonberry)
Zone 2: 812 sq Feet
Zone 3: 454 sq Feet
Zone 4: 8480 sq Feet
Zone 5: 220 sq Feet
Zone 6: 127 sq Feet
Zone 7: 1134 sq Feet
Zone 8: 2496 sq Feet
Zone 9: 1720 sq Feet (Remove salmonberry)
Zone 10: 862 sq Feet (Remove salmonberry)
WETLAND ZONES


PLANTING PLAN
E. INTERLAKEN BLVD.
EXISTING
PLANT LIST