Restoration Options for Bowker Creek:
Demonstration Segment Downstream of Haultain Street

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July 4, 2002

ACKNOWLEDGEMENTS

The purpose of this report is twofold. While fulfilling graduation requirements for the Environmental Technology Program at Camosun College, it provides local government and community groups with options for the enhancement of urban streams. We would like to extend a sincere thank you to everyone that provided support and guidance to us throughout the duration of this project.

Dianne Humphrey

Barry Weaver

David Blundon

Russ Frith

Anna Colangeli

Dave Thomas

Linda Grimm

Paul Harder

Friends of Bowker Creek Society

District of Saanich Planning Department

District of Saanich Public Works Department

Family and friends

We would also like to thank everyone at Camosun College that has supported us in our journey through the Environmental Technology Program.

EXECUTIVE SUMMARY

A demonstration restoration plan for a segment of Bowker Creek has been prepared for the Municipality of Saanich and Friends of Bowker Creek Society, with the purpose of guiding future restoration efforts along the creek. Bowker Creek is 8 kilometres in length and runs through the municipalities of Saanich, Victoria and Oak Bay. Modifications to the creek have accompanied urban development, and have been carried out with the exclusive objective of storm water management; all sections of the waterway have been significantly altered either by enclosure in a storm drain or by channelization of open segments.

Challenges discussed in the report expand on the review of environmental issues in the Municipality of Saanich's Environmental Concept Plans for Bowker Creek: Trent Street to Pearl Avenue report. Additional challenges were determined by surveying the vegetation, soils and other features of the site, and through input from representatives from Friends of Bowker Creek Society, Municipality of Saanich, Capital Regional District, and residents living close to the creek.

The field component of this project included a site survey to determine dimensions of the study area, a vegetation inventory to determine which native and non-native plant species were dominant, and a soil survey to determine the pH, texture and nutrient content of the soil. The results from these surveys were used to ascertain challenges, which included concerns with respect to safety, bank stabilization, hydraulic capacity and vegetation management.

Recommendations for restoration methods were determined through a compilation of comprehensive literature and web-based research as well as through conversations with various biologists, consultants and representatives from the Municipality of Saanich Planning, Public Works and Parks Departments.

The recommendations for restoration in this report suggest multi-objective strategies to manage storm water while enhancing the natural and visual character of the neighbourhood and can be used to guide future restoration efforts throughout the watershed.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This demonstration restoration plan has been prepared by Mine Bieller, Katia Gauvin, Gagan Leekha and Regan Walker of the Camosun College Environmental Technology program. It is intended to provide the Municipality of Saanich and the Friends of Bowker Creek Society with a tool to guide future restoration efforts along Bowker Creek in Victoria, BC. The plan includes recommendations for restoration methods that focus on improving bank stability and hydraulic capacity while enhancing natural habitat and the visual character of the neighbourhood. The recommendations expand on ideas put forth in the Municipality of Saanich's Environmental Restoration Concept Plans for Bowker Creek: Trent Street to Pearl Avenue, and refer specifically to Zone 3 as defined in this report.

2.0 NEED FOR THE PROJECT

Past modifications to Bowker Creek have been carried out with the exclusive objective of stormwater management. This single-objective approach to planning has lead to the loss of the natural features and functions of the creek, eliminating habitat and increasing problems such as flooding and erosion. There are a number of concerns around safety, bank stabilization, hydraulic capacity, and vegetation management, which must be addressed in the restoration plan for this site. Safety issues include the proximity of the footpath to the gabion wall, as well as portions of the path close to the bank that become especially hazardous during winter months and after following periods of heavy rain. The root systems of the Golden Willows at the project site restrict the hydraulic capacity of the stream channel by trapping floating debris such as branches and refuse. There is no current vegetation management plan to encourage the replacement of invasive species with native plants. Invasive species dominate this area, reducing biological diversity and native riparian habitat.

3.0 PROJECT OBJECTIVES

This proposal will provide recommendations for the restoration of a segment of Bowker Creek for the Municipality of Saanich and the Friends of Bowker Creek. The plan will address the needs of local government and community groups. It will focus on restoring the natural features and functions of the creek, thereby reducing rainfall impact and erosion potential as riparian habitat and biological diversity are enhanced.

a) To recommend a sustainable vegetation management plan that replaces invasive species with native riparian vegetation and decreases the need for long-term in-stream maintenance.
b) To recommend structural and vegetative methods of improving the stability of the creek's banks and facilitating its hydraulic functions.
c) To prepare a proposal to acquire funding for an information sign to raise public awareness on restoration efforts.
d) To prepare a plan for the ongoing maintenance of project site.
e) To incorporate Saanich's Green/Blue Spaces strategies into the restoration of the project site.

4.0 DESCRIPTION OF STUDY AREA

4.1 Bowker Creek Watershed

The headwaters of the Bowker Creek watershed are located at the University of Victoria, the McKenzie Avenue area and the Cedar Hill Golf Course (Appendix 13.1). The outfall is located in Oak Bay, near Cranmore Road and Beach Drive. The watershed is 1028 hectares in area, with 613 hectares located in Saanich, 236 hectares in Victoria and 170 hectares in Oak Bay. It is heavily developed and predominantly residential (Crowther, 2000).

4.2 Bowker Creek

Bowker Creek is approximately 8km in length, and as a result of development, all sections have been significantly altered either by enclosure in a storm drain or by channelization of open segments. Most of the creek north of Knight Avenue has been enclosed, while slightly less than half of the southerly portion is open (Crowther, 2000).

4.3 Zone 3 of Bowker Creek

Zone 3, as defined in the District of Saanich's Environmental Restoration Concept Plans for Bowker Creek: Trent Street to Pearl Avenue, is 55 meters long and extends downstream from the outlet of the Haultain Road box culvert (Appendix 13.2). A concrete sill extends across the outlet and slopes downstream. The average wetted width is approximately 2.5 m and a shallow run habitat typifies this segment (Harder, 2002). For sampling purposes, Zone 3 has been divided into four areas based on homogeneity of the vegetation within each area (Appendix 13.3).

A. Grass Field
B. East Bank
C. West Bank
D. Blackberry Thicket

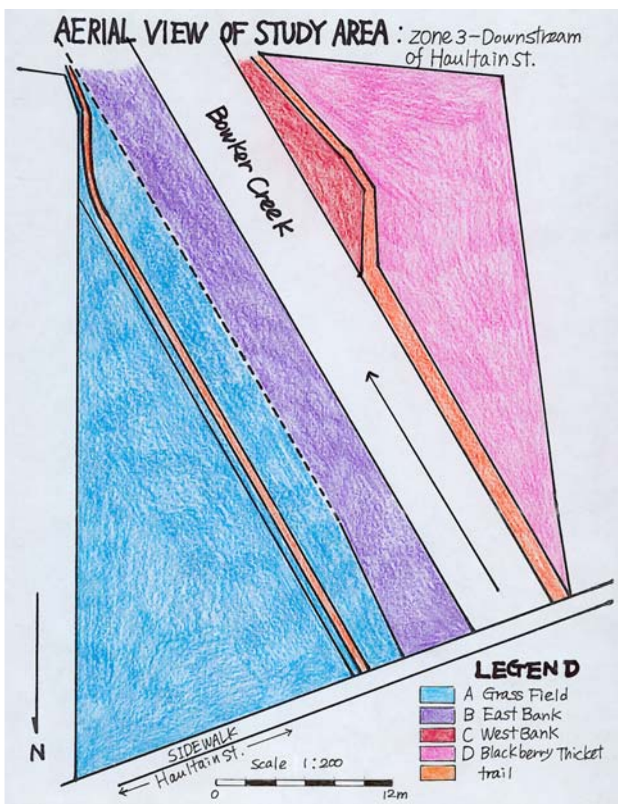
5.0 SITE SURVEY

A site survey was carried out to measure distances and bearings in order to determine the dimensions of the study area[1] (Appendix 13.3).

5.1 Methodology

A tape measure was used to measure the length and width of the creek, banks, trails, and the east and west property lines. To obtain measurements for the preparation of a map that depicts the area of study divided into four smaller areas, compass bearings were taken and recorded at each directional change within each of the four areas. The map was drawn at a scale of 1:200 (Figure 1).

Figure 1: Aerial View of Study Area



[1] Data were collected on May 16 and 18, 2002.

5.2 Results

The east bank of the creek was 45 meters long, with an average width of 4.5m. Its area was approximately 191m^2 including the 11 m^2 occupied by the gabion. The grass field located adjacent to the east bank was 342 m^2 and extended from the property line of 1875 Haultain Street to the east bank of the creek.

The west bank of the creek was 55 meters long, with an average width of 4.5m. Twenty-six metres of this length south from Haultain Street were reinforced with rock-filled gabions that were 2.2 meters in height. The area of the west bank, including the gabion, was approximately 188 m^2. The blackberry thicket extended from the footpath on the west bank to the property line of 1851 Haultain Street and its area was approximately 225 m^2.
The downstream bearing of the creek runs at 150^o from Haultain Street.

5.3 Quality Assurance / Quality Control

- The magnetic declination for Victoria, BC, was set at 20^{o}50'E.
- In plotting a field traverse of the site, measurement and bearing errors resulted in the traverse not closing. The error was corrected "mechanically" when the map was drawn.
- Bearings and measurements were taken twice.

6.0 SOIL SURVEY

A soil survey investigating pH, texture, and essential nutrients was undertaken to determine which native plants were best suited for re-introduction in the study area[2].

6.1 Methodology

There were two types of soil survey. One survey was carried out in order to determine the topsoil characteristics for establishing plant roots. The other survey used a soil pit to look at the soil profile as it relates to plant growth.

6.1.1 Soil Collection

The samples were collected from topsoil in five different locations within each area of the site (i.e. the Grass Field, East Bank, Blackberry Thicket, and West Bank). For each area, the five samples were well mixed and tested in order to determine the average topsoil characteristics. Since the vegetation survey for each area was homogeneous, one soil pit survey was conducted for each of the four areas. All four pits measured approximately 30cm x 30cm. The depth of each pit varied depending on where the solid clay layer was found. The maximum depth was approximately 45cm. No attempt was made to dig beyond the clay layer, since doing so would have created too much disturbance. Within each pit, a sample was collected and placed in a labelled plastic bag, to be taken to the laboratory for analysis.

6.1.2 pH Measurement

The soil pH determined by analysis of a slurry which was made at a 1:1 ratio of soil to distilled water. The slurry was tested with the pH meter. The following steps outline the method that was used:

1. Mix well 20g soil and 20ml of distilled water in a beaker.
2. Let the slurry stand for 15 minutes while stirring occasionally.

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[2] Samples were collected May 19, 28 and 29, 2002. Data were collected May 20 and 21, and June 3 and 4, 2002.

3. After calibration of the pH meter, probe was placed in slurry.
4. Read pH scale.

6.1.3 Soil Texture

To determine the soil texture, the soil was separated into three different particle sizes: sand (0.05 ~ 2mm), silt (0.002 ~ 0.05), and clay (< 0.002). Texture refers to the relative proportions of sand, silt, and clay particles in the given soils. The following procedure outlines the method of soil texture analysis that was used:

1. Place the soil sample in tube "A" up to line 15 and add 1ml of Soil Dispersing Reagent.
2. Fill tube "A" to line 45 with tap water and gently shake for 2 minutes.
3. Allow to stand undisturbed for 30 seconds. After 30 seconds decant liquid solution into tube "B".
4. Allow tube "B" to stand undisturbed for 30 minutes then decant liquid solution into tube "C".
5. Read the lines of each tube. "A" contains sand residue and "B" contains silt residue.
6. Calculate the clay fraction from the sand and the silt if the clay remaining in tube "C" cannot be accurately read.

6.1.4 Nitrogen Test

The steps associated with this test are described below:

1. Fill a test tube to line 7 with Nitrogen Extracting Solution and add 1g of the soil sample.
2. Shake 1 minute and allow the soil to settle.
3. Transfer the clear liquid to line 3 of a second tube.
4. Add 0.5g of Nitrogen Indicator Powder to the second tube.
5. Shake to mix and wait for 5 minutes for pink colour to develop.
6. Match test colour with Nitrogen Colour Chart.

6.1.5 Potassium Test

The steps associated with this test are described below:

1. Fill test tube to line 7 with Potassium Extracting Solution and add 2g of the soil sample.
2. Shake 1 minute and allow soil to settle.
3. Transfer the clear liquid to line 5 in a second tube.
4. Add one Potassium Indicator Tablet to the second tube.
5. Shake to dissolve the tablet until a purple colour develops.
6. Add Potassium Test Solution two drops at a time until colour changes from purple to blue.
7. Use End Point Colour Chart as a guide in reading the changed colour.

6.1.6 Phosphorus Test

The steps associated with this test are described below:

1. Fill test tube to line 6 with Phosphorus Extracting Solution and add 1.5g of the soil sample.
2. Shake 1 minute and allow soil to settle.
3. Transfer the clear liquid to line 3 of a second tube.
4. Add six drops of Phosphorus Indicator Reagent to the second tube.
5. Shake to mix contents and add one phosphorus Test Tablet.
6. Shake to dissolve tablet until a blue colour develops.
7. Match test colour with Phosphorus Colour Chart.

6.2 Results

6.2.1 Topsoil Survey

According to the topsoil survey (Appendix 13.4), the soil pH for the East and West Bank were 5.2 and 5.4. In the Grass Field and Blackberry thicket, soil pHs were 6.1 and 6.2. The two banks were more acidic.

The topsoil texture in the Grass Field was dissimilar to that in the other areas. Topsoil in the Grass Field contained more sand, i.e. 83%, while the other areas ranged from 60% to 63% sand (Table 1). The textural triangle was used to determine the soil types. The Grass Field was loamy sand while the others were sandy loam.

In terms of essential plant nutrients, nitrogen levels were low and potassium levels were high to medium in all four areas. Each of the banks had low phosphorus levels, and in the Grass Field and Blackberry Thicket, phosphorous levels were high (Table 1).

Table 1: Soil Test Results—Topsoil Averages for Four Areas

TEST	**RESULT**				**INTERPRETATION**
Layer/Depth	GRASS FIELD	EAST BANK	BLACKBERRY SITE	WEST BANK	
pH /meter	6.1	5.2	6.2	5.4	Acidic
Soil Texture	83% Sand	60% Sand	63% Sand	60% Sand	Texture of topsoil in Grass Field dissimilar to that in remainder of study area; topsoil in Grass Field contains more sand.
	13% Silt	27% Silt	37% Silt	40% Silt	
	4% Clay	13% Clay	0% Clay	0% Clay	
Soil Type	Loamy sand	Sandy Loam	Sandy Loam	Sandy Loam	
ESSENTIAL PLANT NUTRIENTS					
Nitrogen	Trace/ no color	Trace ~low/ light pink	Trace/ no color	Trace/ no color	Low nitrogen levels. High Potassium levels. Creek banks low in phosphorous.
Potassium	Medium high / 12 drops	Medium/ 14 drops	High/ 10 drops	Medium / 14drops	
Phosphorous	Medium ~ high/ dark blue	Trace/ light blue	Very high/ dark blue	Low/ light blue	

Field Comments: The samples were collected from topsoil in five different locations within each site shown above. For each site the five samples were mixed well and were tested in order to get an average. The amount of clay in these samples is very small because they contain topsoil only.

6.2.2 Soil Pit Survey

In the soil pit survey (Appendix 13.4), soil pH ranged from 4.5 to 5.8. The Blackberry thicket was the most acidic area with a pH of 4.9 on average for the three layers. The West Bank was the least acidic area with a pH of 5.7.

The Soil type varied between loam, sandy loam, and loamy sand. However, the dominant type was sandy clay loam; it was found in seven out of twelve portions. Sandy clay loam soil has at least 45% sand with the remainder silt and clay. Abundant sand was found at each layer in all four areas. The sand content of soil at the West Bank was notably high at 73%. In both banks, approximately 30% clay was found, which was higher than the other zones.

In terms of essential plant nutrients, there was a lack of nitrogen in all zones. Potassium levels were medium low to medium high. Phosphorous levels were low except in the Blackberry Thicket, which was medium on average for the three layers.

6.3 Quality Assurance / Quality Control

6.3.1 pH Measurement

- Calibrated pH meter using known pH 4 and pH 8 solutions.
- Rinsed probe well with distilled water before and after measurements.
- Placed probe in the slurry until the reading settled.

6.3.2 Soil Texture

- Continued to gently shake for 2minutes for the first separation.
- Accurately read the line and monitor time.

6.3.3 Essential Plant Nutrient Tests

- A numbering system was used to identify samples and to avoid confusion as test reagents looked very similar.

7.0 VEGETATION SURVEY

A vegetation survey was undertaken to determine which plants were growing in the study area[3].

7.1 Methodology

The study area was divided into four zones based on homogeneity of vegetation: Grass Field, East Bank, West Bank, and Blackberry Thicket. There were two sample designs – one for the Grass Field and Blackberry Thicket and the other for the creek banks.

In the Grass Field, two transects parallel to the adjacent property were laid out. The first transect was set 3.7 m from the property line. The second was set 9.8 m away from the property. The survey areas were one-meter square quadrats set out at four-meter intervals starting at Haultain Street.

In the Blackberry Thicket, two transects parallel to the adjacent property were laid out one meter from the property line. The survey areas were one-meter square quadrats at six-meter intervals. The third transect was set out parallel to the trail from Haultain street and situated 0.5 meters from the trail. The survey areas on this transect were also one-meter square quadrats, but they were set out at 10-meter intervals (Appendix 13.5).

The second sample design for the west and east banks involved setting out one-meter square quadrats at the top, middle, and bottom of the bank. Three different layers were selected because the vegetation differed significantly, especially in the bottom layer where plants such as horsetail and water parsley were common.

Quadrats were laid out on the banks at four-meter intervals; the placement and number of quadrats varied between the two banks. On the west bank, there were three quadrats. The top quadrat was set one meter from the end of the gabion. The middle quadrat was set at 1.75 m from both the top and bottom of the bank. The bottom quadrat was set out at water level.

[3] Data were collected on May 18, 23, and 24.

On the East bank, the first bottom quadrat was set out two meters from the culvert, and middle and top quadrats were laid out in four-meter intervals. The other three quadrants were set out in the same pattern, moving south (Appendix 13.6).

7.2 Results

In the Grass Field, 19 species were found, including 8 grass species (Appendix 13.7). The dominant plants were grasses, particularly Kentucky bluegrass (*Poa pratensis*), which covered 66% of the quadrats on average. Quadrat 5 in the Grass Field was 100% Kentucky bluegrass. In terms of other grasses, on average, Orchard grass (*Dactylis glomerata*) at 23% and Perennial ryegrass (*Lolium perenne*) at 22% also were prevalent. In terms of predominant flowering plants, Bicknell's geranium 34% (*Geranium bicknellii*), White clover (*Trifolium repens*) 27%, and Common salsify (*Tragopogon porrifolius*) 23% were common.

In the Blackberry Thicket, 20 species were found (Appendix 13.7). The dominant plants were Himalayan Blackberry (*Rubus discolor*), which was 100% in two quadrats and covered 64% of the area on average. The two other dominant plants were Orchard Morning Glory (*Convolvulus arvensis*), covering on average 33% of the quadrats, and Orchard Grass (*Dactylis glomerata*), covering 23%. It should be noted that the majority of this area was densely covered by Himalayan Blackberry, which limited the growth of other plants.

Vegetation varied significantly on the east and west bank depending on whether the quadrat was at the top, middle or bottom of the creek. Given this and the small sample size, averages for the each of the banks in their entirety are thus somewhat misleading.

In the East Bank, 22 species were found (Appendix 13.7). The dominant plants were Tall Oatgrass (*Arrhenatherum elatius*), which covered 48% on average, Scotch Broom (*Cytisus scoparious*) at 41%, Common Horsetail (*Equisetum arvense*) at 28% and Himalayan Blackberry (*Rubus Discolor*) at 23%.

In the West Bank, 9 species were found (Appendix 13.7). The dominant species were Himalayan Blackberry (*Rubus discolor*) at 75% on average, Common Snowberry (*Symphoricarpos albus*) at 38% and Orchard Morning Glory (*Convolvulus arvensis*) at 23%.

7.3 Quality Assurance / Quality Control

- If a selected area was not suitable for sampling due to disturbance, the quadrat was moved forward until the area was no longer disturbed.

8.0 VISUAL ESTIMATE OF VEGETATION

A visual estimate of the percent cover of vegetation was undertaken for the two banks (Appendix 13.8). This was done because of the variation in plant species, especially at different levels of the banks, and the small number of sample quadrats. The visual estimate is a useful tool to better understand the vegetative patterns on the banks. Visual estimates were not done for the other two zones due to the homogeneity of the plants in those areas, i.e. blackberries and grasses[4].

8.1 Method

The area of the East Bank was determined using the length gabion subtracted from the length of the entire bank, (40 m) multiplied by the height of the bank (4.5 m). From this it was calculated that the area of the bank was 180 m^2 and that one percent of the bank was equivalent to 1.8 m^2. The square root of the area of one percent of the bank (1.3 m) is equivalent to the length of one side of the area that was used to estimate vegetation cover.

The area of the West Bank was determined using the length of the bank, with the length of the gabion subtracted, (29 m) and the height of the bank (4.5 m). From this it was calculated that the area of the bank was 130.5 m^2 and that one percent of the bank was equivalent to 1.3 m^2. The square root of the area of one percent of the bank (1.1 m) is equivalent to the length of one side of the area that was used to estimate vegetation cover.

Based on the size of a square representing one percent of the total area, percent cover of the dominant plants was visually estimated.

[4] Visual estimate of vegetation was done May 18, 2002.

8.2 Results

In terms of the East Bank, the dominant plants species were the Himalayan Blackberry (*Rubus discolor*) at 52%, Scotch Broom (*Cytisus scoparius*) at 40% and Golden Willow (*Salix alba* L. var.*vitellina* Stokes) at 20%. On the West Bank, the dominant plants were Himalayan Blackberry (*Rubus discolor*) at 44%, Scotch Broom (*Cytisus scoparius*) at 20% and Common Snowberry (*Symphoricarpos albus*) at 20% (Table 2). Let it be noted that this assessment of vegetation cover was done by eye from the opposite side of each bank; therefore, there may be small inaccuracies in the estimates.

Table 2: Percent Cover of East and West Banks Based on Visual Estimate

SCIENTIFIC NAME	COMMON NAME	WEST BANK	EAST BANK
TREES			
Salix alba L. var. *vitellina* Stokes	Golden Willow	0.11	0.2
SHRUBS			
Cytisus scoparius	Scotch Broom	0.2	0.4
Rubus discolor	Himalayan Blackberry	0.44	0.52
Symphoricarpos albus	Common Snowberry	0.2	0.06
FLOWERING PLANTS			
Equisetum arvense	Common Horsetail	0.04	0
Oenanthe sarmentosa	Pacific Water-Parsley	0.12	0

9.0 DISCUSSION OF RESULTS

The field survey consisted of four parts: a site survey, soil survey, plant survey and visual estimate of vegetation.

9.1 Site Survey

The study area was shaped like a parallelogram (Appendix 13.3). The southern end of the study zone narrowed considerably near the footpath due to the property lines on the west and east side of the site.

9.2 Soil Survey

The second part of the survey was the soil survey. It included an analysis of pH, texture, and essential nutrients. In the four areas, soil pH ranged from 4.5 to 5.8. The blackberry thicket was the most acidic area with a pH 4.9 on average for the three layers (top, middle, and bottom) sampled. The west bank was the least acidic area with pH 5.7. Soil with high clay content also tends to be acidic (Colangeli, 2002).

The soil was mostly sandy clay loam except in the grass field where it was loamy sand. The topsoil survey results in Table 5 were based on the average of 5 samples in each area and determined that topsoil of the grass area was 83% sand. The high sand content is believed to be the result of flood control measures. Research established that sandbags were used in 1975 (Kent, 1975) and it is reasonable to assume that this occurred in other years as well.

In the two banks, the clay content was 30%. This was higher than the other areas. It is not uncommon for banks to have a high clay content as it is less likely than sand and silt to be washed away by the stream or precipitation

The soil pit survey found that nitrogen was lacking in the entire zone. Phosphorous was also low, except in the blackberry thicket. Potassium levels were medium to high throughout the zone except in the east bank where it was very low. This latter finding was contrary to the literature that suggests that soils high in clay have high potassium content (LaMotte, 1994).

However, the potassium level was based on only one sample and may not be indicative of the entire east bank.

In terms of the topsoil survey, it found that nitrogen was low throughout the four areas, potassium was medium to high throughout, and phosphorus ranged from very high to very low. Notwithstanding, the level of nutrients was sufficient to support vigorous plant growth throughout most of the area.

9.3 Vegetation Survey and Visual Estimate of Vegetation

Vegetation surveys were conducted individually for the four areas (Appendix 13.7). In addition, a visual estimate of vegetation was undertaken for the east and west banks due to their greater variation in plant species, to help determine the degree of plant invasiveness, and to compensate for the limited sample size in the bank vegetation surveys (Appendix 13.8).

The four areas differed significantly in their vegetation. The grass field, as the name implies, was largely composed of grasses and, to a lesser extent, flowering plants. It is unknown if the grass field had been planted at some time or was the result of self-seeding. The grass is cut several times a year by the District of Saanich. This prevents other species, and especially taller plants, from establishing themselves in this area. The thickness of the grass also impedes the growth of other plants as seeds carried by wind or birds cannot reach the soil.

The east and west banks had similar vegetative patterns, not including the gabion, although the east bank had more grasses due to its proximity to the grass field. There were three highly invasive plants in the banks. Scotch Broom (*Cytisus scoparius*) was very prevalent in the top and middle of the banks but was not present at the bottom. This is because the plant prefers drier soils. The Himalayan Blackberry (*Rubus discolor*), on the other hand, grew at all levels of the banks but was more common on the west bank which borders the blackberry thicket. This suggested that this plant thrives regardless of soil moisture levels. The Golden Willow (*Salix alba* L. var.*vitellina* Stokes) was also very common at the bottom of the banks and even grew within the creek. (The Golden Willow was not part of the vegetation survey due to small sample size but was noted in the visual estimate of vegetation segment.). This suggested that the plant thrives in very moist conditions. The bottom of both banks contained Pacific Water-

Parsley (*Oenanthe sarmentosa*), which also requires very moist conditions. The Common Horsetail (*Equisetum arvense*) was also common in the lower and middle areas of the bank, indicating that it prefers moister soil.

The blackberry thicket was largely comprised of Himalayan Blackberry (*Rebus discolor*). This exotic plant often thrives on disturbed sites and streamside areas. Orchard Morning-Glory (*Convolvulus arvensis)* was also prevalent in this area as it, like Himalayan Blackberry, grows well in disturbed, sunny sites.

10.0 CHALLENGES AND RECOMMENDATIONS

10.1 East Bank

10.1.1 Golden Willow

Figure 2: Golden Willow in Stream

Challenge:

Networks of Golden Willow roots encroach into the active channel (Figure 2), collecting debris and impeding the drainage of storm water. These networks can displace the natural channel bed and its dependent invertebrate populations. During storm events and high flows, there is potential for root networks to be pulled from the bed and block culverts. Willows are also responsible for significant removal of stream water during periods of low flow due to their high rates of transpiration. Finally, Golden Willow out-competes native willows as well as other native species (Crowther, 2000).

Recommendations:

i) Remove the Golden Willow by cutting the tree, leaving a stump half of a metre to one metre in height. Make vertical cuts in the top of the freshly cut stump. This will leave the tree vulnerable to pathogens. Continue to make vertical cuts every two months for about six months, or until the tree dies from stress methods. The root systems are left intact to ensure bank stability while newly planted native vegetation becomes established (Dept. of Land & Water Conservation, 2002).

To efficiently manage Willow along the stream, a more thorough Willow removal program can be undertaken. This requires a coordinated and sustained effort along the entire length of the creek, working from the headwaters to the mouth to prevent the spread of seeds and cuttings downstream.

10.1.2 Footpath

Challenge:

There is a well-used footpath on the east side of the creek, running from Haultain Street to St. Patrick's School. A section of this unofficial footpath, which is bordered by residential property, passes directly over an unstable area of the bank (Harder, 2002); the bank is especially unstable during winter months and after heavy periods of rain. This is a major safety concern as students attending St. Patrick's school, as well as other members of the community, regularly use the footpath.

Recommendations:

i) Approach the landowners of 1875 Haultain Street about purchasing the southwest corner of the property. Move the path away from the bank and plant vegetation in its place; this vegetation can serve as a buffer between the path and the creek. Recognition of the footpath and the surrounding area as an official green space would satisfy objectives outlined in Saanich Blue/Green Spaces: A Framework for Action including:
    - providing outdoor recreation and cultural opportunities for people of all ages and abilities to experience and enjoy green/blue spaces;
    - linking major green/blue spaces with greenways;
    - enhancing the natural and visual character and diversity of green/blue spaces

10.1.3 Invasive Vegetation

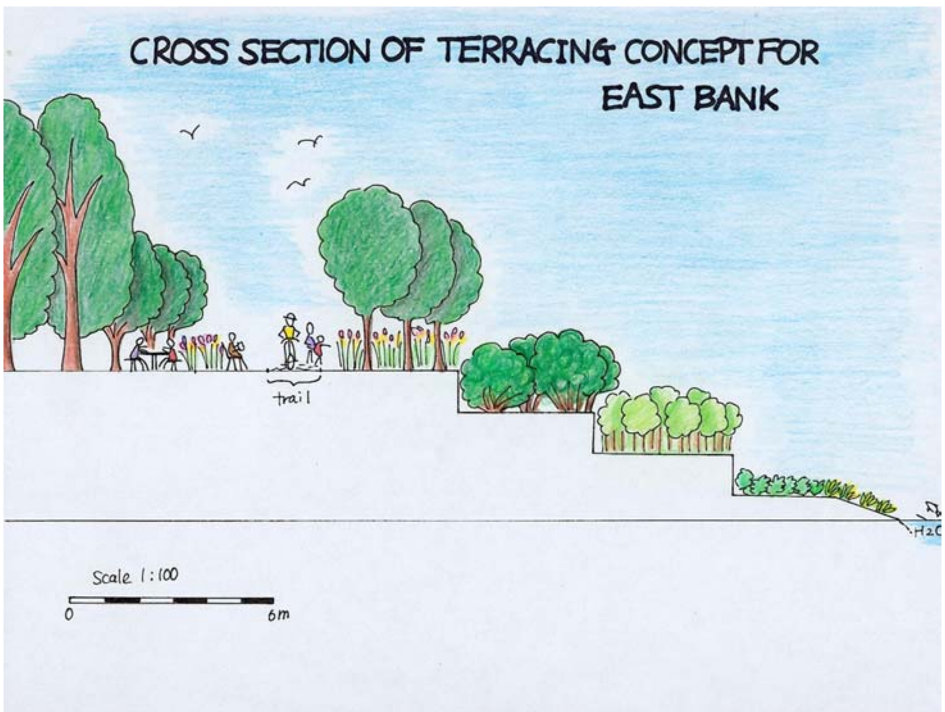
Challenge:

Non-native, invasive species such as Scotch Broom and Himalayan Blackberry dominate the bank, precluding natural riparian habitat and resulting in a reduction in biological diversity.

Recommendations:

i) Create terraces on the east bank, removing soil and vegetation, and conserve any natives plants removed for replanting (Figure 3). Terracing removes soil that contains seeds and root systems of invasive plants, greatly reducing their chances of re-establishment. The flatter slopes of a terraced bank enhances vegetation establishment, and terracing reduces erosion potential by decreasing runoff velocities, promoting infiltration, and trapping sediment (CA Dept. of Transportation, 2000).

Figure 3: Terracing Concept for East Bank



Stabilize the terraces with landscape fabric and apply a layer of mulch before planting native riparian vegetation (Appendix 13.9). Landscape fabric seeded with a blend of native grasses initially stabilizes the terraces through root growth and inhibits weed growth. Planting nitrogen-fixing forbs, such as Giant Vetch and Nootka Lupine, together with the native grasses improves the condition of the soil, further discourages weed growth, and promotes bank stabilization until trees and shrubs are established and able to assume this function.

Transplant native trees and shrubs in autumn, when root establishment is most successful. Trees and shrubs serve numerous functions; they stabilize the bank, increase native habitat, discourage growth of photophilic invasive vegetation, shade the channel, and supply food sources, such as leaf litter, for aquatic life.

Encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required. This can take the form of a day or weekend-long community semi-annual event that focuses on cutting re-growth and pulling shoots and can incorporate a neighborhood barbeque or picnic (Appendix 13.16).

ii) If terracing is not an option, cut Scotch Broom and Himalayan Blackberry just above the soil surface. Leave root systems intact to maintain bank stability and to prevent disturbance of the seed bank. The most effective time to cut Scotch Broom is in the spring when its energy reserves are low due to flowering and the spread of seeds is prevented.

Stabilize the bank with landscape fabric and apply a layer of mulch before planting native riparian vegetation (Appendix 13.9). Landscape fabric seeded with a blend of native grasses initially stabilizes the bank through root growth and inhibits weed growth. Plant nitrogen-fixing forbs, such as Giant Vetch and Nootka Lupine, to improve the condition of the soil and further discourage weed growth, and to promote bank stabilization until trees and shrubs are able to assume this function.

Transplant native trees and shrubs in autumn, when root establishment is most successful. Trees and shrubs serve numerous functions; they stabilize the bank, increase native habitat, discourage growth of photophilic invasive vegetation, shade the channel, and supply food sources, such as leaf litter, for aquatic life.

Encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required (Appendix 13.16).

10.2 Grass Field

10.2.1 Riparian Vegetation

Challenge:

The lack of tall shading trees and shrubs near the east bank results in increased water temperature and limited food sources, such as leaf litter, for aquatic life.

Recommendations:

i) Move the footpath away from the east bank in order to plant tall, fast-growing trees such as Red Alder and shrubs such as Red Osier Dogwood and Snowberry (Appendix 13.10) along the bank. This will also provide space for terracing of the east bank.

10.2.2 Invasive Vegetation

Challenge: Non-native grass species dominate.

Recommendations:

i) Incorporate terracing of the east bank and planting of a variety of native species on the restructured bank and field into the creation of a green space on the east side of the creek. Erect an information sign to create awareness of these restorative efforts (Appendix 13.15). This would satisfy objectives outlined in <u>Saanich Blue/Green Spaces: A Framework for Action</u> including:
    - maintaining biological diversity by protecting and enhancing a variety of ecosystems and habitat in contiguous units;
    - linking major green/blue spaces with greenways;
    - restoring damaged or altered ecosystems and habitat;
    - educating the community about the value and interconnectedness of green/blue spaces;
    - enhancing the natural and visual character and diversity of green/blue spaces.

10.3 West Bank

10.3.1 Golden Willow

Challenge:

Networks of Golden Willow roots encroach into the active channel, collecting debris and impeding the drainage of storm water (Figure 4). These networks can displace the natural channel bed and its dependent invertebrate populations. During storm events and high flows, there is potential for root networks to be pulled from the bed and block culverts. Willows are also responsible for significant removal of stream water during periods of low flow due to their high rates of transpiration. Finally, Golden Willow out-competes native willows as well as other native species (Crowther, 2000).

Figure 4: Golden Willow Shoots in Stream

Recommendations:

i) Remove the Golden Willow by cutting the tree, leaving a stump half of a metre to one metre in height. Make vertical cuts in the top of the freshly cut stump. This will leave the tree vulnerable to pathogens. Continue to make vertical cuts every two months for about six months, or until the tree dies from stress. The root systems are left intact to ensure bank stability while newly planted native vegetation becomes established (Dept. of Land & Water Conservation, 2002).

10.3.2 Footpath

Challenge:

The proximity of the footpath to the edge of the gabion wall is a potential hazard.

Recommendations:

i) Move the footpath several metres away from edge of the gabion wall, with the exception of the first three metres downstream of Haultain Street, where the fence of the adjacent property borders the gabion. A short length of fence can be installed here.

10.3.3 Riparian Vegetation

Challenge:

Riparian vegetation is not present on the portion of west bank that is reinforced with rock-filled gabions; the thin layer of heavily compacted soil on top of the gabion wall does not accommodate vegetation (Figure 5).

Figure 5: West Bank—Gabion Wall

Recommendations:

i) Reduce the length of the gabion wall, blending it into the bank by tapering the end (Appendix 13.13). Leave enough intact to ensure stability of the modified bank near the bridge at Haultain Street. The restructured bank should be sloped back to a two-to-one ratio in order to facilitate the introduction of native plants, as the steep banks limit the quantity and variety of riparian vegetation that can exist along the creek (Crowther, 2000).

Stabilize the bank with landscape fabric and apply a layer of mulch before planting native riparian vegetation (Appendix 13.11). Landscape fabric seeded with a blend of native grasses will initially stabilize the bank through root growth and inhibit weed growth. Planting nitrogen-fixing forbs, such as Giant Vetch and Nootka Lupine, together with the native grasses will improve the condition of the soil, further discourage weed growth, and promote bank stabilization until trees and shrubs are able to assume this function.

Transplant native trees and shrubs in autumn, when root establishment is most successful. Encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required.

ii) Remove the top third of the gabion wall, leaving the portion near the bridge at Haultain Street intact to ensure stability. Build up the bank on top of the gabion with soil, sloping it gently to the elevation of the adjacent property.

Cover the bank with landscape fabric and apply a layer of mulch before planting with native shrubs that have strong, shallow, lateral root systems such as Red-Osier Dogwood and Indian Plum (Appendix 13.11). These shrubs serve a variety of functions; they stabilize the bank, shade the channel, increase native habitat, and supply food sources, such as leaf litter, for aquatic life. Landscape fabric seeded with a blend of native grasses initially stabilizes the bank through root growth and inhibits weed growth. Planting nitrogen-fixing forbs, such as Giant Vetch and Nootka Lupine, together with the native grasses improves soil conditions, further discourages weed growth, and promotes bank stabilization until the shrubs are able to assume this function.

Transplant native shrubs in autumn, when root establishment is most successful, and encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required (Appendix 13.16).

iii) After lining the top of the gabion wall with a permeable barrier, construct a retaining wall at its outer edge and fill with soil up to the elevation of the adjacent property.

Plant native trees and shrubs that shade the channel, increase native habitat, and supply food sources, such as leaf litter, for aquatic life. Plant nitrogen-fixing native forbs, such as Giant Vetch and Nootka Lupine, among the trees and shrubs to raise soil quality and discourage weed growth.

Transplant native trees and shrubs in autumn, when root establishment is most successful, and encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required (Appendix 13.16).

10.3.4 Invasive Vegetation

Challenge:

Non-native, invasive species such as Scotch Broom and Himalayan Blackberry dominate the bank, precluding natural riparian habitat and resulting in a reduction in biological diversity.

Figure 6: Scotch Broom

Recommendations:

i) Cut Scotch Broom and Himalayan Blackberry just above the soil surface. Leave root systems intact to maintain bank stability and to prevent disturbance of the seed bank. The most effective time to cut Scotch Broom is in the spring when its energy reserves are low due to flowering and the spread of seeds is prevented. Remove the Golden Willow by cutting the tree and leaving a stump half of a meter to one meter in height. Make vertical cuts in top of the freshly cut stump. This will leave the tree vulnerable to pathogens. Continue to make vertical cuts every two months for about six months or until the tree dies from stress methods, leaving the root system intact (Dept. of Land & Water Conservation, 2002).

Lay down bank-stabilizing landscape fabric and apply a layer of mulch before planting native riparian vegetation (Appendix 13.11). Landscape fabric seeded with a blend of native grasses initially stabilizes the bank through root growth and inhibits weed growth. Further discourage non-native plant growth and raise soil quality by planting nitrogen-fixing forbs, such as Giant Vetch and Nootka Lupine, along with the native grasses.

Transplant native trees and shrubs in autumn, when root establishment is most successful. Trees and shrubs serve numerous functions; they stabilize the bank, increase native habitat, discourage growth of photophilic invasive vegetation, shade the channel, and supply food sources, such as leaf litter, for aquatic life.

Encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required (Appendix 13.16).

10.4 Blackberry Thicket

10.4.1 Invasive Vegetation

Challenge:

Non-native species dominate.

Recommendations:

i) Mechanically cut Himalayan Blackberry before digging up the large roots. Cover the bank with landscape fabric and apply a layer of mulch before planting with native vegetation (Appendix 13.12).

Use Red Alder, which grows tall quickly, to increase levels of nitrogen in the soil and to shade out the competing blackberry, and include a variety of shrubs to ensure a biologically diverse habitat. To discourage weed growth and increase soil quality, plant nitrogen-fixing native herbs such as Giant Vetch and Nootka Lupine among the trees and shrubs (Appendix 13.12).

Transplant native trees and shrubs in autumn, when root establishment is most successful. Encourage growth of newly planted vegetation with a regular watering regime. In order to prevent significant re-growth of invasive, non-native plants, maintenance is required (Appendix 13.16).

11.0 CONCLUSION

Challenges investigated during development of the restoration options for this demonstration site are representative of challenges observed throughout the length of the creek. The positive impacts of restoration efforts, including the re-introduction of native species, improvement of bank stability and enhancement of visual character, will be more significant when applied to larger portions of the creek. The recommendations put forth in the report can be useful tools to guide future restoration efforts throughout the watershed. They contrast with the existing management practices, as each address multiple objectives rather than focusing on stormwater management. These objectives include reducing rainfall impact and erosion potential, decreasing the need for long-term in-stream maintenance, and increasing public awareness of the restoration efforts and encouraging community involvement. Restorations efforts along Bowker Creek can be a collaborative effort between the District of Saanich, Friends of Bowker Creek and post-secondary students. Useful research to be undertaken by students in the future includes determining sources of pollution in the watershed, studying impermeable surfaces within the watershed as they relate to high water flows, and investigating the status of maintenance of oil and gas interceptors.

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13.0 APPENDICES

Appendix 13.1 Map of the Bowker Creek Watershed

Appendix 13.2 Map of Zone 3

Appendix 13.3 Aerial View of Study Area

Appendix 13.4 Results Tables for Soil Survey

Appendix 13.5 Sample Design I

Appendix 13.6 Sample Design II

Appendix 13.7 Results Tables for Vegetation Survey

Appendix 13.8 Visual Estimate of Vegetation

Lateral View of West and East Banks
Percent Cover of East and West Banks Based on Visual Estimate

Appendix 13.9 Planting Guide for East Bank

Appendix 13.10 Planting Guide for Grass Field

Appendix 13.11 Planting Guide for West Bank

Appendix 13.12 Planting Guide for Blackberry Thicket

Appendix 13.13 Concept Drawing for West Side of Zone 3

Appendix 13.14 Drawings of Terracing Concept for East Bank

Appendix 13.15 Sign Proposal

Appendix 13.16 Reference Tools for Restoration Activities and Maintenance

Methods for Removal of Invasive Plant Species
Timeline for Restoration Activities
Timeline for Ongoing Maintenance of Restoration Efforts