Bowker Creek

URBAN WATERSHED RENEWAL INITIATIVE

BOWKER CREEK BLUEPRINT

A 100-year action plan to restore the Bowker Creek Watershed

August 2012
VICTORIA BC

Prepared by the Bowker Creek Initiative with support from
Westland Resource Group Inc., Kerr Wood Leidal Associates Ltd., and Murdoch de Greeff Inc.

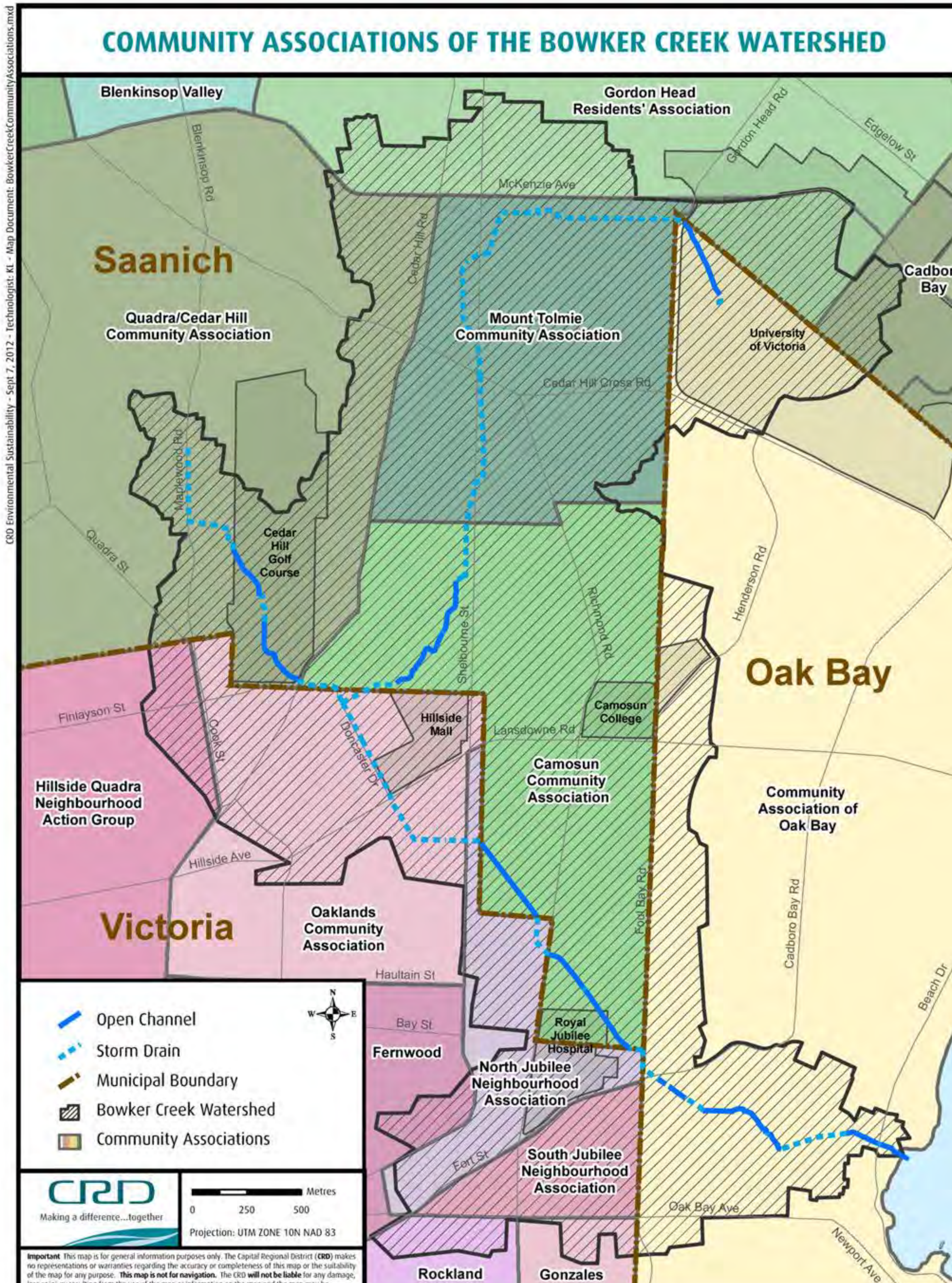
Bowker Creek Blueprint endorsed by:

City of Victoria
ENDORSED, September 22, 2011

District of Saanich
ENDORSED, October 17, 2011

District of Oak Bay
ENDORSED, July 23, 2012

Facilitated and Chaired by:



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BOWKER CREEK BLUEPRINT

EXECUTIVE SUMMARY

The Bowker Creek Initiative (BCI) has developed this *Bowker Creek Blueprint: A 100-year action plan to restore the Bowker Creek Watershed* to provide member municipalities, the Capital Regional District, the community and other land stewards with information and guidance to manage and restore the watershed and creek corridor over the long term (e.g., 50 to 100 years). This blueprint is to be implemented over a period of decades in recognition that change can be slow in the urban environment. Having a plan in place will ensure that positive changes can happen incrementally, and that opportunities for major improvements can be achieved as they arise. The recommendations in this blueprint support the vision and the four goals described in the Bowker Creek Watershed Management Plan, adopted by BCI members in 2003:

BOWKER CREEK WATERSHED MANAGEMENT PLAN (2003) VISION

The varied human uses and natural areas in the Bowker watershed are managed to minimize runoff and pollution, making Bowker Creek a healthy creek that supports habitat for native vegetation and wildlife, and provides a community greenway to connect neighbourhoods.

2003 WATERSHED MANAGEMENT PLAN GOALS

1. **Individuals, community and special interest groups, institutions, governments, and businesses take responsibility for actions that affect the watershed.**
2. **Manage flows effectively.**
3. **Improve and expand public areas, natural areas, and biodiversity in the watershed.**
4. **Achieve and maintain acceptable water quality in the watershed.**

Flooding, water pollution and habitat loss are significant concerns for Bowker Creek. Despite the degradation it has suffered, Bowker Creek offers connections with the natural environment to the 30,000 residents in the watershed, and provides an opportunity to restore islands of nature within the urban environment. It also offers a focus for a greenway corridor through the urban core of Greater Victoria, and the potential to create more vibrant communities and neighbourhoods while reducing greenhouse gas emissions and adapting to climate change. Bowker Creek is important to the community and has become a pilot project for urban watershed management in the Capital Region.

This blueprint was developed with significant input from municipal staff and community members, and is based on work undertaken since the BCI was established in 2004. This document builds on the Bowker Creek Master Drainage Plan (Kerr Wood Leidal, 2007), greenways mapping, creek habitat assessments, water quality data and other information to create a plan of action.

Recommendations are provided at two scales:

- watershed management activities and policies, and
- site-specific actions for each of the 17 creek sections.

As the blueprint was developed, all recommendations were rated on how well they addressed environmental, social and economic considerations, and the committee assigned a priority to each recommendation. This approach highlighted the actions with the greatest environmental and social benefits versus costs.

The following **watershed management principles and actions** are summarized in this blueprint (see Section 4 and Appendix A for details):

- Use creek-friendly management approaches wherever possible
- Adopt requirements to reduce effective impervious area for new developments
- Construct infiltration and retention features in boulevards
- Incorporate Bowker Creek goals into municipal plans
- Maintain effective communication of the Bowker Creek vision, goals and actions
- Plant trees and shrubs and protect existing trees
- Purchase and protect key land in the watershed
- Incorporate proposed greenways into land use planning
- Include climate change adaptation and mitigation in all activities

Recommended **reach infrastructure upgrades or specific actions** (see Section 5 and Appendix B) range from small restoration efforts such as invasive species removal, to large changes such as day-lighting buried creek sections and/or channel re-alignment and riparian restoration. Some reach-specific actions can proceed immediately while others will need to wait until opportunities arise. Opportunities will occur with changing land uses, as funding comes available, as infrastructure needs to be upgraded, and as societal priorities change.

Ten key actions have been identified as important first steps for municipalities and other land stewards in the next three to five years, as follows (see Section 6 for details):

1. Review and revise municipal plans to include Bowker Creek goals and actions.
2. Adopt requirements to reduce effective impervious area for new developments.
3. Remove specific invasive species beginning to colonize the watershed.
4. Complete a pilot project to locate and build a demonstration rainwater infiltration/retention structure in each municipality.
5. Support development of an urban forest strategy in Oak Bay to complement those underway in Saanich and Victoria.
6. Develop a strategy to acquire key properties as they come available.
7. Work with Oak Bay High School to design and implement creek restoration on school district property.
8. Participate in the Shelbourne Valley Action Plan process to identify current and future opportunities for creek restoration, rainwater infiltration and/or greenway development.
9. Work with creek-side landowners between Pearl and Trent Streets to achieve the long-term vision.
10. Continue with restoration at Browning Park.

A **monitoring program** has been developed in order to provide periodic feedback on the effectiveness of actions undertaken by the BCI partners. Monitoring indicators include percent effective impervious area, percent urban tree cover, the extent of creek restoration and kilometres of greenway trail development, improvements in water quality and overall watershed health (see Section 7 and Appendix D).

This document is a blueprint for implementing long-term change along the creek corridor and throughout the watershed, to achieve the vision and goals of the Bowker Creek Watershed Management Plan. Continuing efforts and cooperation will be required by Bowker Creek Initiative members, decision-makers and the wider community, with the rewards of cleaner water, healthier ecosystems, less flooding and new greenways throughout the watershed.

GLOSSARY

Bioswales: Landscaped elements designed to remove silt and pollution from surface runoff water that consist of a swaled drainage course with gently sloped sides (less than six percent) and filled with native vegetation and soil. The water's flow path, along with the wide and shallow ditch, is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt. Depending upon the geometry of land available, a bioswale may have a meandering or almost straight channel alignment. Biological factors also contribute to the breakdown of certain pollutants. A common application is around parking lots and or street curbs where substantial automotive pollution is collected by the pavement and then flushed by rain. The bioswale, aids in treating the runoff before releasing it to the watershed or storm sewer.

Climate adaptation: Is making adjustments and preparing for observed or expected change in climate, in order to moderate harm and to take advantage of new opportunities.

Climate Change: Any long-term significant change in the “average weather” that a given region experiences. Average weather may include average temperature, precipitation and wind patterns. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. These changes can be caused by dynamic process on Earth (ocean processes, volcanoes), external forces including variations in sunlight intensity, and more recently by human activities.

Climate mitigation: Is action to reduce the emissions of greenhouse gasses (GHGs)—primarily carbon dioxide from combustion.

Creek restoration: A set of activities that help improve the environmental health of a creek. Improved health may be indicated by expanded habitat for diverse species, reduced stream bank erosion, improved water quality (i.e. reduction of pollutant levels and increased dissolved oxygen levels) and achieving a self-sustaining, functional flow regime in the stream system that does not require periodic human intervention, such as dredging or construction of flood control structures. Restoration activities may range from a simple removal of a disturbance which inhibits natural stream function, to stabilization of stream banks to riparian zone restoration.

Daylighting: The act of removing streams from underground pipes and culverts, restoring some of the form and function of historic streams. Daylighting is the most profound form of stream restoration, recreating a surface waterway.

Detention pond: Is a low lying area that is designed to temporarily hold water while slowly draining to another location. They are generally used for flood control when large amounts of rain could cause flash flooding if it all entered the stormwater system at the same time. When a detention pond is used, the total amount of discharge is the same, but the discharge happens over a longer amount of time. A hydrologist will design a water detention pond to temporarily detain the water and keep the runoff to the desired rate. When the rain ends the water detention pond will be empty shortly afterwards.

Greenbuilding: Is a systems approach to building design and construction that employs techniques that minimize environmental impacts and reduce ongoing energy consumption while contributing to the health and productivity of its occupants.

Green Infrastructure: Uses vegetation, soils and natural processes to manage runoff from impervious surfaces and rainwater to create healthier urban environments. At a neighbourhood or site specific level, it is an approach to managing runoff and rainwater that imitates the natural hydrology (or movement of water) on site by using existing site characteristics, engineered and landscaped features to promote infiltration and evapotranspiration. Green infrastructure aids in reducing the total volumes, slowing the rate and cleaning runoff entering into the traditional stormwater infrastructure.

Green Roofs: Are building roofs that are purposefully covered with vegetation. Green roofs can store significant volumes of rainwater, prevent runoff in small storm events, and delaying peak runoff for larger storms. The plants also return some of the moisture to the atmosphere through evapotranspiration. Green roofs can reduce the heat island effect in the summer, and provide valuable habitat for birds and insects.

Green Streets: Are streets that are designed to be part of a sustainable stormwater strategy that uses a natural systems approach to manage stormwater, reduce flows, improve water quality and enhance watershed health. Trees and shrubs are an integral component of the stormwater strategy and visual amenity of green streets, ideally located at the side of streets between the street and the sidewalk or in center median plantings. Green streets provide for traffic calming, improved pedestrian and bicycle safety, reduced demand on the city’s sewer collection system with attendant reduction in the need for costly infrastructure / pipe system construction, diversion of stormwater from sewer system, reduced impervious surfaces so stormwater can infiltrate to recharge ground water and surface water, increased urban greenspace and enhanced community and neighborhood livability.

Greenways: Are linear corridors that connect green spaces to provide wildlife habitat and recreational and alternative or passive transportation opportunities. The potential greenways proposed in the Bowker Creek Blueprint would perform an important, safe alternative transportation function through busy neighbourhoods as well as providing habitat corridors and (in some cases) enhancing and restoring Bowker Creek aquatic and riparian habitat. Some of the proposed greenway would be shared use on existing roadways (cars, pedestrians and bicycles), while some would be multi-use trails for non-motorized transport, and some areas would provide for pedestrian traffic separate from nearby cycle routes. The ideal greenway would provide tree canopy and habitat.

Impervious surfaces: Are mainly artificial structures—such as pavements (roads, sidewalks, buildings, driveways and parking lots) that are covered by impenetrable materials such as asphalt, concrete, brick, and stone and rooftops. Soils compacted by urban development are also highly impervious.

Invasive Species: Are plants and animals introduced to an environment where they are not native and which they become a nuisance, often to the detriment of native species. Invasive species have the ability to establish quickly and spread rapidly, often displacing native plants, because their new environment has few natural competitors. Many invasive plants are difficult to remove due to deep taproots, high production and longevity of seeds and ability to thrive in unfavorable conditions. Invasive species are increasingly difficult and expensive to control.

Low Impact Development: See Green Infrastructure.

Permeable Pavement: Also known as pervious or porous paving, is a type of hard surfacing that allows rainfall to percolate to an underlying reservoir base where rainfall is either infiltrated to underlying soils or removed by a subsurface drain. Types of pervious pavements include permeable concrete or asphalt, unit pavers, interlocking bricks, grass pavers or gravel pavers.

Rain Gardens: Also known as vegetated infiltration basins and bioretention areas, are landscape features designed to treat and detain stormwater runoff from hard surface areas such as roofs, roads and parking lots. They consist of depressed garden spaces where runoff can pond and infiltrate into deep constructed soils and then into the native soils below. Components of a rain garden usually include an inlet pipe or sheet flow, compost amended soils, native plants that are appropriate for the moisture conditions, and an overflow drain or outlet.

Retention pond: A pond designed to hold a specific amount of water indefinitely. Usually the pond is designed to have drainage leading to another location when the water level gets above the pond capacity, but still maintains a certain capacity. The pond level may go up and down, but ordinarily the pond has some water in it at all times.

Stewardship: Is an ethic that embodies cooperative planning and management of environmental resources with organizations, communities and others to actively engage in the prevention of loss of habitat and facilitate its recovery in the interest of long-term sustainability.

Stormwater: Is the component of runoff that is generated by human activities. Stormwater is created when land development alters the natural Water Balance. When vegetation and soils are replaced with roads and buildings, less rainfall infiltrates into the ground, less gets taken up by vegetation and more becomes surface runoff that picks up pollution from surfaces, mainly roadways, and carries it into the creeks, lakes and nearshore marine receiving environments via stormwater infrastructure.

1.0 INTRODUCTION

The Bowker Creek Urban Watershed Renewal Initiative is a pilot project that is leading the way in watershed management in the Capital Region. This *Bowker Creek Blueprint: A 100-year action plan to restore the Bowker Creek Watershed* (Blueprint) is developed to support the multiple jurisdictions and land stewards within the Bowker Creek Watershed in taking a watershed perspective to improving the health of Bowker Creek and supporting restoration and greenway development along the creek corridor.

1.1 BACKGROUND

The Bowker Creek Initiative (BCI) is a unique multi-jurisdictional effort to improve watershed management efforts in the Capital Region on Vancouver Island, British Columbia. In 2003, a watershed management plan was completed for Bowker Creek with the aim of protecting and improving the overall health of the watershed and the creek corridor. The Bowker Creek Watershed Management Plan (BCWMP) defined a watershed vision, goals, objectives, and actions. To guide the implementation of the BCWMP, a steering committee was formed in 2004 that included representatives from the three municipalities in the watershed (Saanich, Victoria and Oak Bay), the Capital Regional District (CRD), and community groups.

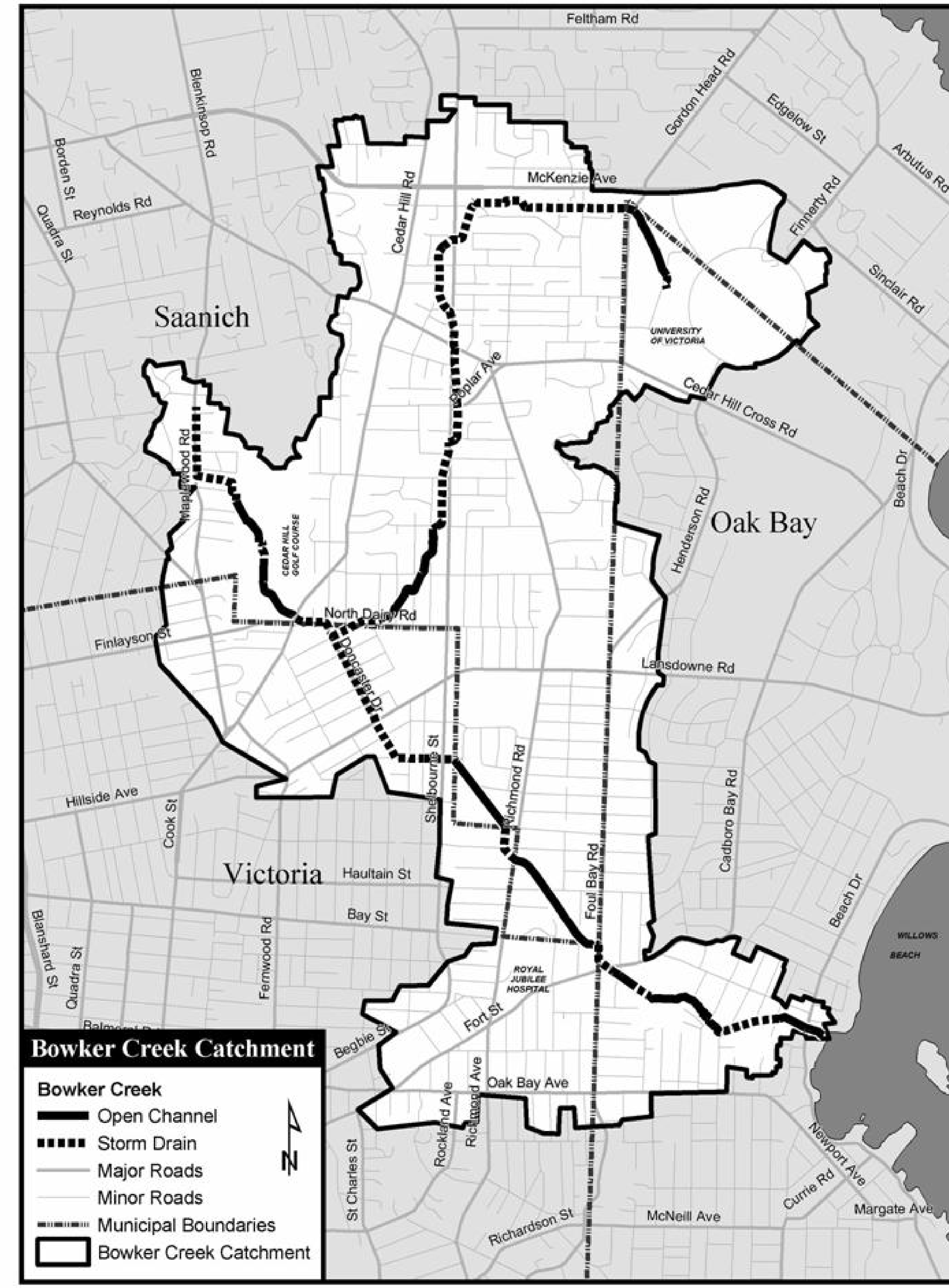
Since 2004, the Initiative has made considerable progress in implementing the BCWMP. In a 2008 progress review, the municipal partners and community groups confirmed that an action plan that provided detailed, watershed wide and reach-specific actions was needed to continue to move forward with implementing the BCWMP. Westland Resource Group was hired in 2009 to work with committee members to draft the *Blueprint*.

The *Blueprint* was developed to assist municipalities, land stewards and community groups in meeting the goals of the BCWMP. Many of the recommended actions can take place in the short- and medium-term, and others will need to occur opportunistically or through long-term efforts. The time horizon for completing actions in this plan can be as long as 50–100 years from now, recognizing the time required for significant change in the urban environment. This plan will allow the three municipalities and other land stewards to coordinate their efforts to manage the watershed so that over the long term the watershed vision can be achieved.

1.2 DESCRIPTION OF THE WATERSHED

The Bowker Creek watershed (Map 1) covers an area of 1,028 hectares (2,540 acres). The total creek, including the main tributary, measures 9.4 kilometres (km) long; of that 3.4 km remain as open channel and the remaining length flows underground through pipes and culverts (Reid Crowther & Partners Ltd. and SHIP Environmental Consultants Ltd., 2000). The creek mainstream (7.9 km) flows northwest from its headwaters at the University of Victoria, west and then south through Saanich in the Shelbourne Valley, and generally southeast through Victoria and Oak Bay to the outlet in Oak Bay. A major tributary (1.5 km) of Bowker Creek flows southeast through the Cedar Hill Golf Course and enters the main channel near Doncaster Drive and North Dairy Road.

The majority of the underlying soil in the watershed is clay with some areas of sand and gravels, and bedrock outcrops (Kerr Wood Leidal, 2007)—see Map 2. The ground is generally flat (gradients less than 5%) with a few isolated steep areas such as Mount Tolmie (Kerr Wood Leidal, 2007).



Map 1. Bowker Creek Watershed municipal boundaries and above- and below-ground creek sections

Historically, Bowker Creek was a meandering, low gradient creek with numerous small tributaries and wetland areas. The watershed supported extensive Garry Oak meadows and woodlands, and the creek would have supported coho and chum salmon and cutthroat trout. Local First Nations derived food and fresh water from the creek, and nutrients transported from the watershed helped support a rich marine ecosystem in Oak Bay (Westland Resource Group, 2003). As agricultural and urban development spread, the mainstem and tributaries were altered and buried, with 63% of the channel now confined to culverts—see Map 1. These culverts now form the backbone of the municipal stormwater drainage system.

Today, the Bowker Creek watershed is highly urbanized, predominantly with residential, commercial and institutional land uses—see Map 2. An estimated 50% of the Bowker Creek watershed is composed of impervious surfaces such as roads, parking areas and roofs (Kerr Wood Leidal, 2007). Surfaces that are covered with roads, buildings, and pavement prevent rainwater from naturally filtering into the ground. Instead stormwater runs off into the storm drain system and rapidly enters Bowker Creek, picking up pollutants on the way. Impervious surfaces, the elimination of wetland and floodplain areas, and the piping of most of the mainstem and tributaries have led to an increase in the volume of peak flows during storm events, exacerbating flooding along the open channels and flooding upcreek of some of the underground sections. Impervious surfaces also cause low summer base flows, and reduced water quality for aquatic habitat (Westland Resource Group, 2003).

Despite the changes that have occurred in the watershed, Bowker Creek is still used by people and wildlife. Open portions and the adjacent riparian area provide habitat for plants and animals. The local community values these areas for recreation and for their intrinsic value. The Cedar Hill Park and Golf Course, the headwaters at the University of Victoria, Browning Park in Saanich, the Bowker Creek Park in Oak Bay, and the vacant BC Hydro property near the Royal Jubilee Hospital are popular recreation areas (Westland Resource Group, 2003). Although the watershed probably won't be restored to its pre-European contact condition, some natural characteristics remain that can be protected and enhanced. Sections of the creek that are currently underground or in poor condition can also be improved. Across the watershed, pollution and flooding can be minimized by bringing in 'low impact development' measures to mimic the pre-development hydrology.

1.3 Scope of the Study

Starting in 2006, the Bowker Creek Initiative steering committee worked towards the development of an Integrated Stormwater Management Plan (ISMP) to advance the goals and objectives in the BCWMP. The Bowker Creek Master Drainage Plan, completed in 2007, was the first phase of this work. In 2008, the ISMP terms of reference were developed and the plan was later renamed to the *"Bowker Creek Blueprint: A 100-year action plan to restore the Bowker Creek Watershed"* to better reflect its intent.

This Blueprint builds on the vision, goals, objectives, and actions in the BCWMP. It builds on the technical recommendations in the Bowker Creek Watershed Assessment (Reid Crowther & Partners Ltd. and SHIP Environmental Consultants Ltd., 2000), the Bowker Creek Master Drainage Plan (Kerr Wood Leidal, 2007), and other work done to date, including a creek restoration assessment (Appendix C) (Gower, 2009), the Bowker Creek Proper Functioning Condition Assessment (Barraclough, et al., 2007), and proposed greenways routing.

The purpose of the Blueprint is to:

- recommend watershed management policies, planning and other stewardship actions to improve watershed health.
- recommend reach-specific actions for each creek section.
- provide support and information to municipalities and other land stewards to achieve the goals and objectives in the Bowker Creek Watershed Management Plan.

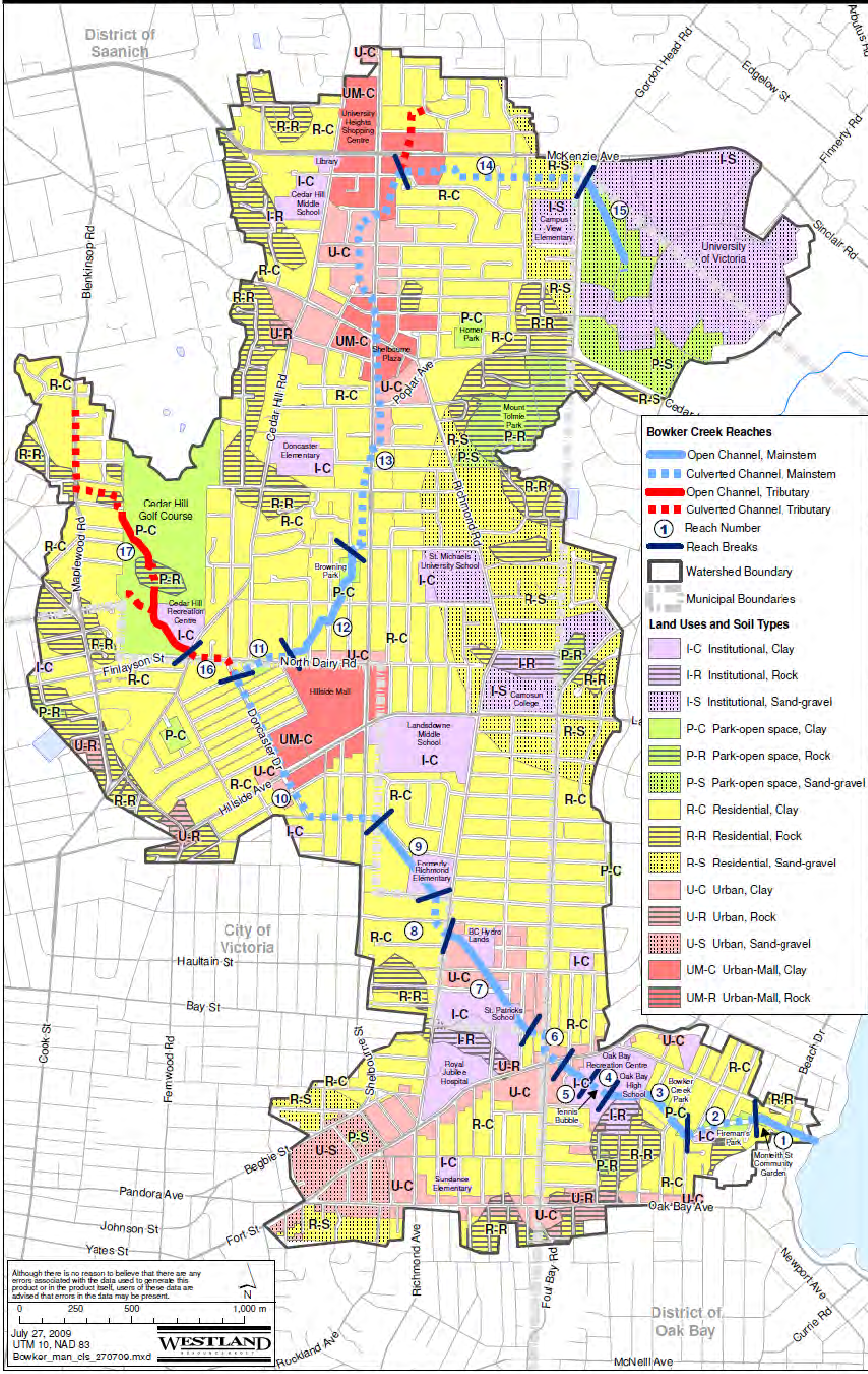
This Blueprint includes:

1. Recommendations for watershed management actions and supporting policy and planning approaches to advance the implementation of the BCWMP.
2. Recommendations for reach-specific actions along the creek corridor that describe:
    - mitigation strategies for flooding, erosion and climate change;
    - protection and restoration of riparian and aquatic habitats through site-specific actions; and
    - a multi-use greenway corridor, public greenspace, and habitat connectivity in accordance with the regional greenway system.
3. Key actions for short-term implementation.
4. Priorities, budget categories, and responsibilities.
5. A description of the methods used to develop the plan.
6. Relevant background information and data that is not already available in existing documents.
7. A recommended monitoring program that will allow for adaptive management over time.

Figure 1. Watershed tour with municipal elected representatives, May 2009

Figure 2. Blueprint public consultation, February 2010

Bowker Creek Watershed Land Uses and Soil Types



1.4 PROJECT TEAM

Bowker Creek Initiative Steering Committee and subcommittee members and municipal staff that contributed to plan development are as follows:

FIRST NAME	LAST NAME	ORGANIZATION	POSITION
Natalie	Bandringa	Bowker Creek Initiative	Co-ordinator
Tanis	Gower	Bowker Creek Initiative	Co-ordinator (2006-2009)
David	Blundon	Camosun College	Professor
Andrea	Gleichauf	Camosun Community Association	Outreach Committee member
Steven	Fifield	City of Victoria	Manager, Underground Utilities
Jamie	Ramsay	Community Association of Oak Bay	
Jody	Watson	CRD	BCI Chair
Richard	Ding	District of Oak Bay	Design Engineer
Dave	Marshall	District of Oak Bay	Director, Engineering Services
Dwayne	Halldorson	District of Saanich	Manager, Underground Services
Adriane	Pollard	District of Saanich	Manager, Environmental Services
Anne	Topp	District of Saanich	Manager, Community Planning
Lise	Townsend	Environmental Consultant and community member	
Ian	Graeme	Friends of Bowker Creek Society	
Chris	Jensen	Friends of Bowker Creek Society	
Jim	Kirby	Friends of Bowker Creek Society	
Soren	Henrich	North Jubilee Neighbourhood Association	Outreach Subcommitte member
Ken	Whitcroft	Quadra-Cedar Hill Neighbourhood Association	
Gerald	Harris	Resident	Outreach Subcommitte member
Carolyn	Knight	Resident	Outreach Subcommitte member
Sarah	Webb	University of Victoria	Campus Sustainability Co-ordinator
Ian	Swan	University of Victoria	Outreach Subcommitte member

In addition to the Bowker Creek Initiative representatives, the following individuals contributed to key studies and plans that were incorporated into the Blueprint:

FIRST NAME	LAST NAME	ORGANIZATION	POSITION
Dalia	Hull-Thor	Capital Regional District	Environmental Technician
Barri	Rudolph	Capital Regional District	Environmental Science Officer
Gary	Darrah	City of Victoria	Manager, Park Development
Joe	Daly	City of Victoria	Manager, Parks Services
Ed	Robertson	City of Victoria	Assistant Director, Public Works
Ken	Silvester	City of Victoria	Manager, Water & Environment
Grace	Esposito	District of Oak Bay	Engineer Assistant
Lorne	Middleton	District of Oak Bay	Manager, Parks Services
Stuart	Pitt	District of Oak Bay	Municipal Engineer
Roy	Thompson	District of Oak Bay	Planner
Gerald	Fleming	District of Saanich	Manager, Park Planning and Design
Becky	Goodall	District of Saanich	Park Planner/Designer
Rob	Miller	Downstream Environmental Consulting Ltd.	Biologist
Sara	Stallard	Fish Kissing Weasels Environmental	Biologist
Jeff	Howard	Kerr Wood Leidal Associates Ltd.	Project Engineer
Dave	Murray	Kerr Wood Leidal Associates Ltd.	Project Engineer
Scott	Murdoch	Murdoch and de Greeff Inc.	
Lehna	Malmkvist	Swell Environmental Consulting	Biologist/Previous BCI Coordinator
David	Harper	Westland Resource Group	Project Manager
Tara	Lindsay	Westland Resource Group	Assistant Environmental Planner
Steve	Young	Westland Resource Group	Geographical Information Systems Specialist

1.5 REPORT FORMAT

This report has the following format:

- Section 1 provides the background, describes the geography of Bowker Creek and scope of study and describes the report.
- Section 2 describes the methods used to develop the Blueprint.
- Section 3 summarizes vision, goals, and objectives of the Bowker Creek Watershed Management Plan.
- Section 4 presents a summary of watershed principles and actions.
- Section 5 presents a summary of recommended actions to improve the entire creek corridor.
- Section 6 presents key actions for short-term implementation (three to five years).
- Section 7 outlines the monitoring program and presents 2009 Baseline data.
- Section 8 contains references.
- Appendix A presents a detailed list of actions for watershed management.
- Appendix B presents detailed, reach specific actions to improve the creek corridor.
- Appendix C presents detailed restoration prescriptions for the open sections of Bowker Creek.
- Appendix D presents detailed methodology of the Blueprint Monitoring Program.

Figure 3. The Bowker Creek committees at work on the draft Blueprint

2.0 DEVELOPMENT OF THE BOWKER CREEK BLUEPRINT

This section presents the methods used in the development of the Bowker Creek Blueprint.

2.1 INTEGRATING FACTORS IN WATERSHED MANAGEMENT

The Bowker Creek Steering Committee felt that it was important to integrate environmental, social, and economic considerations for the recommended actions in the plan. Westland Resource Group met with the Bowker Creek Steering Committee and the Blueprint subcommittee on January 22, 2009, to draft a set of criteria for evaluating and integrating actions in the Blueprint. The criteria were designed to ensure environmental, social, and economic considerations were considered in the recommended actions, and that the engineering information from the Master Drainage Plan (Kerr Wood Leidal, 2007) was incorporated. The criteria make it possible to evaluate actions or sets of actions. The criteria and scoring system are presented in Table 1. Higher environmental and social scores mean a project or activity would be worthwhile, while economic scores and scores for how 'fundable' a project is often reflect the ease of implementation.

Table 1. Blueprint action evaluation criteria

CRITERION	CONSIDERATIONS	SCORING SYSTEM
Environmental	➢ water quality or quantity ➢ retention or infiltration ➢ riparian or creek habitat values ➢ intact upland habitats ➢ habitat connectivity ➢ biodiversity ➢ creek function ➢ adaptation to climate change ➢ mitigate climate change ➢ bank stability ➢ flood risk	0 to +3
Social	➢ linkages among communities ➢ Smart Planning principles ➢ recreational use ➢ public connection to and enjoyment of the creek ➢ public awareness (education) ➢ individual stewardship actions ➢ public health and safety ➢ flood damage ➢ neighbourhood disruption	0 to +3
Economic	➢ operating cost ➢ capital cost ➢ fundability through grants or synergy with existing programs	-3 to 0 -3 to 0 0 to +3

2.2 DATA COLLECTION AND ANALYSIS

Data were collected and evaluated from existing Bowker Creek publications, maps and environmental datasets, municipal plans and policies and other relevant publications, including:

- The Bowker Creek Master Drainage Plan (MDP) (Kerr Wood Leidal, 2007) was the first phase of work for the Blueprint and describes engineering requirements to address flooding and erosion issues.
- The Bowker Creek Watershed Assessment (Reid Crowther, 2000) provides useful background data.
- The Bowker Creek Watershed Management Plan (Westland Resource Group, 2003).
- The Bowker Creek Initiative Potential Greenways map (Bowker Creek Initiative Greenways Subcommittee, 2007).
- Bowker Creek Channel Restoration Needs and Prescriptions (Gower, 2009) (see Appendix C.
- Bowker Creek Proper Functioning Condition Assessment (Barraclough, et al., 2007).
- Urban Forest Stewardship Mapping and Analysis (Caslys Consulting, 2008).
- Environmental restoration concept plans for Saanich open channel sections (Harder, 2002).
- Capital Regional District water sediment quality data collected since 1993.
- Benthic invertebrate data and Benthic Index of Biotic Integrity scoring (Fish-Kissing Weasels Environmental, 2009).

Base maps of the Bowker Creek watershed were developed, and include watershed and municipal boundaries, land use, soils, creek channels, and storm drain alignments. The base maps and information from the *Bowker Creek Watershed Proper Functioning Condition Assessment* (PFCA) (Barraclough, et al., 2007) and the *Bowker Creek Master Drainage Plan* (MDP) (Kerr Wood Leidal, 2007) were used to define reaches for the creek. The PFCA delineates 16 open sections of the creek based on segments of the creek that share common processes and attributes, while the MDP defines 103 reaches based on storm catchment. To keep the number of reaches to a manageable number for developing actions, and to include both open and closed sections, the entire length of the creek was sectioned into 17 reaches.

The upland areas outside the creek corridor were classified into distinct "upland units"—areas of similar land use—and mapped: see Map 2. A set of actions could then be applied to each of the upland units to improve the overall condition of the watershed. Five main land use units were defined, as follows:

1. **Institutional:** Areas (excluding parks) owned by public institutions such as local government, regional districts, crown corporations, and the provincial government, including Royal Jubilee Hospital, BC Hydro lands, Oak Bay Recreation Centre, and Lansdowne Secondary School
2. **Parks and open space**: Recreational and nature parks and some open space areas including Fireman's Park, Bowker Creek Park, and Browning Park
3. **Residential:** Areas of predominantly detached housing
4. **Urban:** Areas of mixed commercial, attached and detached residential. These areas are more densely developed than residential areas and include the Shelbourne Street, Fort Street, and Oak Bay Avenue corridors
5. **Urban mall:** Retail malls with large paved parking lots including Hillside Mall, University Heights Shopping Centre, and Shelbourne Plaza. Large impervious areas such as parking lots increase the volume of peak flows in the creek. Increasing infiltration and detention in these areas can improve water quality and reduce flooding

Clay, rock, and sand-gravel soil subunits were overlain with the land use units in Map 2, in order to provide the information needed to develop detailed green infrastructure measures. While various green infrastructure measures can be taken irrespective of soil type, infiltration measures will need to be designed to suit the infiltration ability of the native soils.

Figure 4. Bowker Creek volunteers after completing a bank stabilization project

2.3 DEVELOPING RECOMMENDATIONS FOR THE CREEK CORRIDOR AND THE WHOLE WATERSHED

A long list of potential recommendations was drafted based on available information as well as ideas from the steering committee and Blueprint subcommittee. This list of potential actions was refined to develop watershed-wide management and reach-specific recommendations that address the goals and objectives in the Bowker Creek Watershed Management Plan.

The actions were refined and integrated to remove repetition and to ensure that actions worked together, and that any impacts resulting from the actions were considered and minimized. Where appropriate, alternatives and options to the preferred action were developed. The actions were rated using the environmental, social, and economic criteria developed by the BCI Steering Committee and Blueprint subcommittee. It was decided that no summed ratings would be given, due to the difficulty of weighting environmental, social and economic criteria against each other, and also because it was felt that summed scores were overly arbitrary.

Committee feedback to the actions and their rating and relative priority levels was given at a June 18, 2009 joint meeting of the committees. Further committee feedback was given to the actions and other report sections at the August 13 and October 8, 2009 joint committee meetings, and the suggested revisions were incorporated into the final plan. The result of this work is found in Appendices A and B.

2.4 PUBLIC CONSULTATION

Public consultation for the Blueprint has been an inherent part of the development of the document from the beginning of the process, with diverse individuals and groups (i.e. community associations) represented on the BCI Steering Committee, Integrated Stormwater Management Plan sub-committee and Greenways sub-committee. Various approaches to public consultation were taken in order to receive input from a wide group of people and to raise support of the Blueprint. The following is a list of public consultations conducted by BCI Steering committee, Outreach sub-committee, Chair and Coordinator:

- Hosted tour of the watershed for municipal politicians (May 2009)
- Presented a preview of draft Blueprint to municipal politicians, half-day session (November 2009)
- Posted *Bowker Creek Blueprint: a 100-year action plan to restore the Bowker Creek Watershed (Draft January 2010)* on the BCI website for comment (January – August 2010)
- First public open house held at Hillside Mall, day-long drop-in attended by more than 350 people (January 2010)
- Blueprint display at Shelbourne Corridor open house attended by approximately 250 people
- Launched public consultation feedback survey, gathered 46 forms (January 2010)
- Convening for Action on Vancouver Island (CAVI) held a forum on the Blueprint (February 2010)
- Hosted tour for University of Victoria of the Bowker Creek Watershed (March 2010)
- BCI and Blueprint featured as a case study on the "Waterbucket: Sustainable Approaches to Watershed Management" Internet site, www.waterbucket.ca (Spring 2010)
- Held second public open house at World Health Organization (WHO) and Shelbourne Corridor Celebration event, day-long drop-in (May 2010)
- BCI is an attending member of the public consultation/planning committees of the Oak Bay High School renovation and Royal Jubilee Hospital (RJH) regarding integration of the Blueprint into their Master Plan 2010–2030 and the District of Saanich's Shelbourne Corridor process
- BCI and Blueprint featured as a case study in the Fraser Basin Council (FBC) Water and Watershed Planning Guide, www.fraserbasin.bc.ca, and the upcoming edition of the university textbook *Our Environment: A Canadian Perspective*, 5th edition by Dianne Draper
- BCI and Blueprint featured as a case study with the Environmental Law Clinic, University of Victoria's report *Re-inventing Rainwater Management: a Strategy to Protect Health and Restore Nature in the Capital Region* (February 2010)
- Display at and discussion with attendees of the following community events: Bowker Creek Pennant Workshops, Shelbourne Corridor History Celebration, 12th annual Duck Race, Bowker Creek Brush-Up
- BCI Annual Reports featured the Blueprint

3.0 WATERSHED ISSUES, VISION, GOALS, AND OBJECTIVES

3.1 ISSUES

To prepare the 2003 Bowker Creek Watershed Management Plan, a forum was convened that included all interested stakeholders and levels of government. This group worked by consensus to develop a draft plan. Public input was then sought through an open house and by posting the draft plan on the CRD's website. The most common topics discussed by the public were:

- water quality
- flooding and flow management
- creating greenways, natural areas and more greenspace
- providing for biodiversity and habitat protection (both plant and animal) (Westland Resource Group, 2003)

Additional concerns raised included:

- reducing the length of piped sections and increased creek daylighting.
- watershed development and redevelopment.
- bank erosion, stability, and treatment.
- government coordination and planning (Westland Resource Group, 2003).

3.2 VISION, GOALS AND OBJECTIVES

This section presents the vision, goals, and objectives of the Bowker Creek Watershed Management Plan. The watershed management actions presented in Appendix A and the detailed reach-specific actions presented in Appendix B were developed to help achieve these goals and objectives.

THE BOWKER CREEK WATERSHED MANAGEMENT PLAN VISION

The varied human uses and natural areas in the Bowker watershed are managed to minimize runoff and pollution, making Bowker Creek a healthy creek that supports habitat for native vegetation and wildlife, and provides a community greenway to connect neighbourhoods.

THE BOWKER CREEK WATERSHED MANAGEMENT PLAN GOALS AND OBJECTIVES

Goal 1. Individuals, community and special interest groups, institutions, governments, and businesses take responsibility for actions that affect the watershed

Objective 1A. Ensure all interest holders understand the values of Bowker Creek and the watershed so they can act responsibly.

Objective 1B. Foster long-term community stewardship of Bowker Creek and celebrate accomplishments.

Objective 1C. Plan and manage land in the Bowker watershed in ways that create compact and attractive communities, increase areas of greenspace, reduce stormwater runoff, and improve water quality in Bowker Creek.

Goal 2. Manage flows effectively

Objective 2A. Base watershed management decisions on a comprehensive understanding of the hydrological characteristics of the watershed; manage the risk of flood damage to property near Bowker Creek; and coordinate flow management decisions among jurisdictions.

Objective 2B. Encourage onsite retention and infiltration of stormwater to reduce the area of effective impervious surfaces in the watershed.

Goal 3. Improve and expand public areas, natural areas, and biodiversity in the watershed

Objective 3A. Prepare a comprehensive inventory of watershed values.

Objective 3B. Protect and enhance existing natural areas (or areas with restoration potential) in the watershed, particularly adjacent to Bowker Creek.

Objective 3C. Create a multi-use greenway corridor from the headwaters to the ocean, in accordance with the Regional greenway system.

Goal 4. Achieve and maintain acceptable water quality in the watershed

Objective 4A. Identify water quality problems and causes.

Objective 4B. Meet or exceed provincial water quality guidelines for aquatic life.

Objective 4C. Establish and maintain stable naturalized banks to protect water quality and public safety.

3.3 A 100-YEAR VISION FOR THE BOWKER CREEK WATERSHED

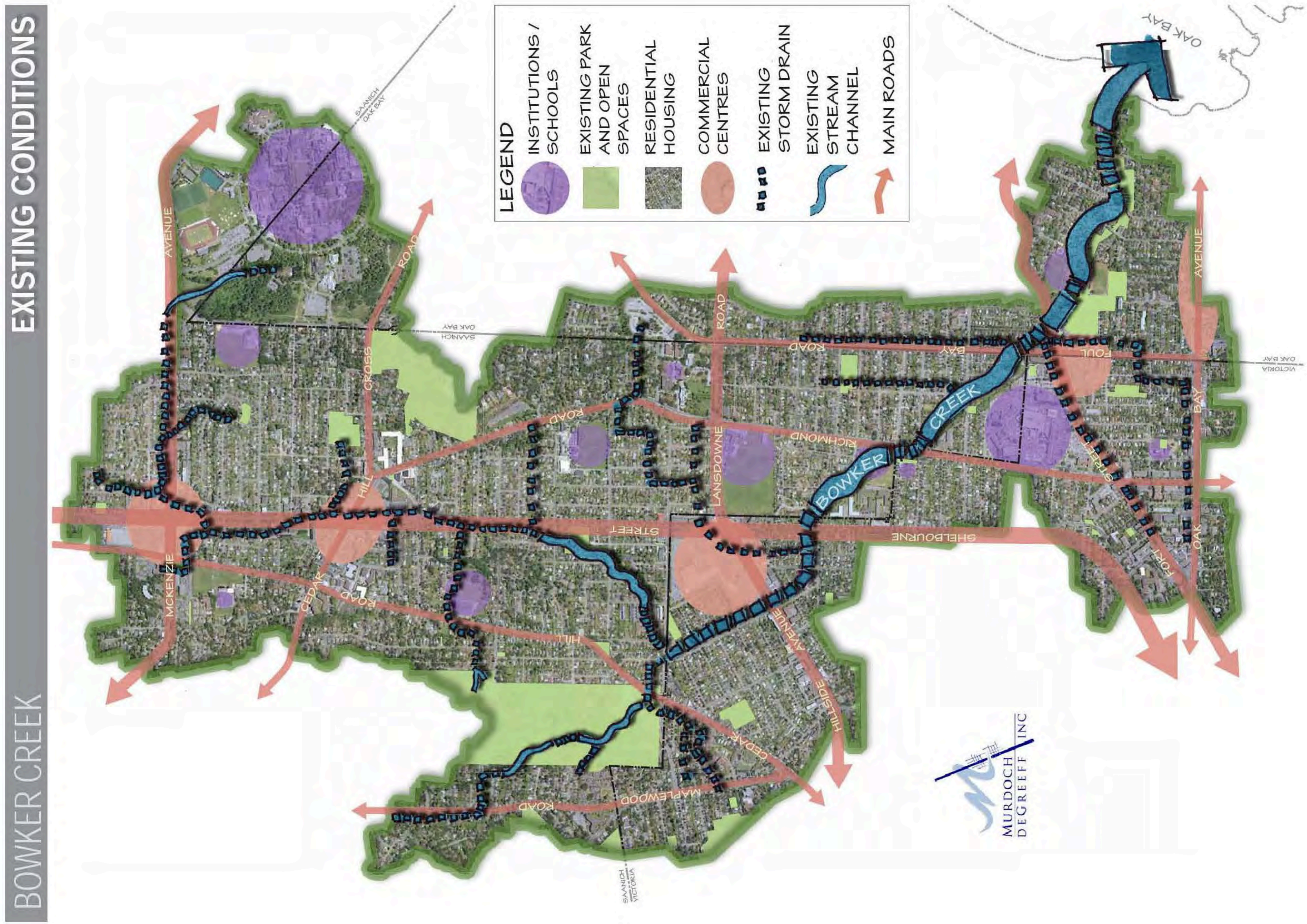
A series of conceptual images were created to help provide a tangible view of what the watershed could look like once the Blueprint is implemented. Map 3 "Existing Watershed Conditions" illustrates the ratio of the creek above and underground, roads and social context of the current conditions of the watershed. Map 4 "100 Year Vision for the Bowker Creek Watershed" illustrates the desired outcomes of the Blueprint. The ribbon of blue running the length of the watershed represents the daylighted creek. The greening of the watershed is portrayed by a green grid of green streets and greenways.

WHAT IS A GREEN STREET?

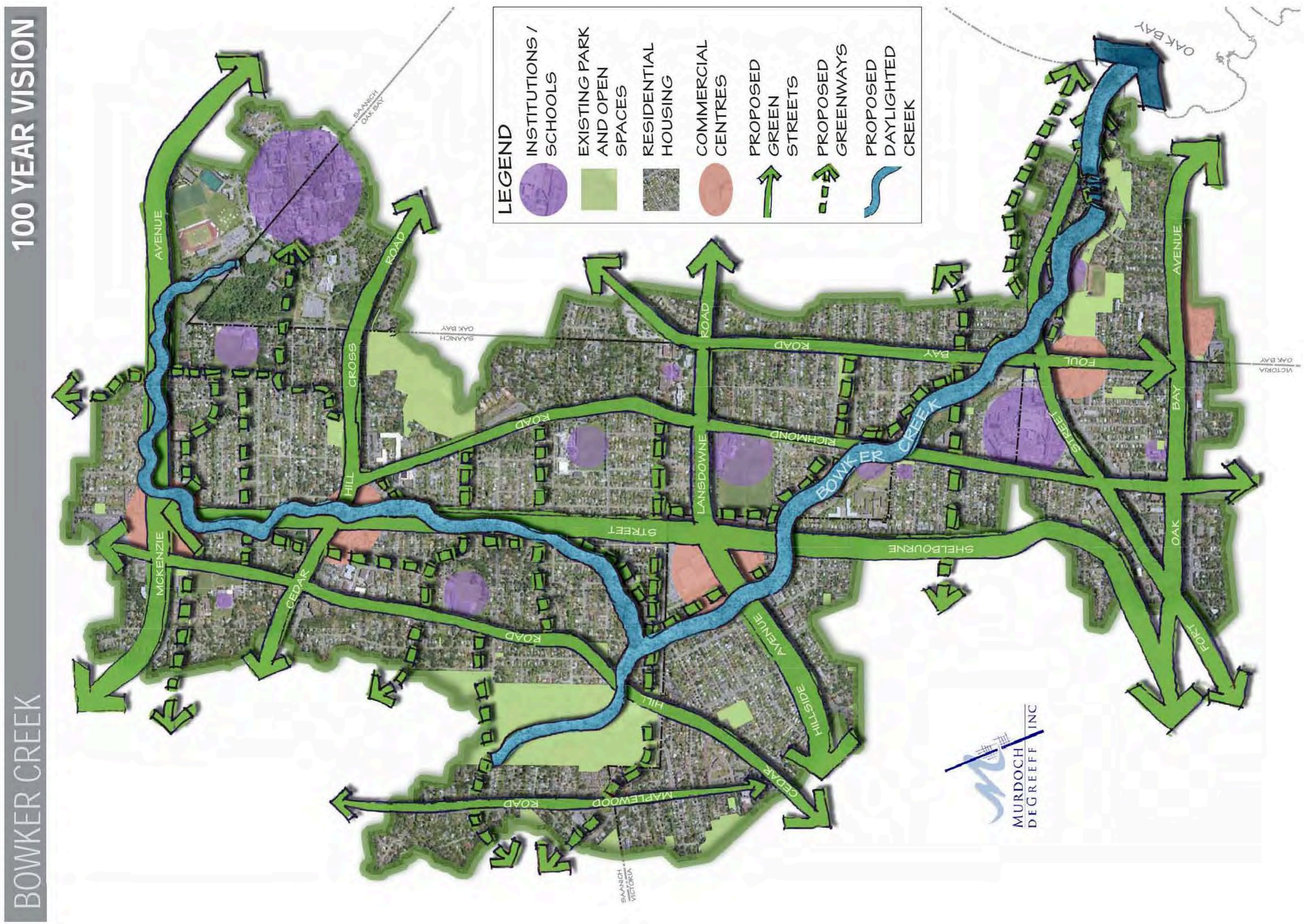
Green streets and parking lots are part of a sustainable rainwater management strategy that manages rainwater, reduces storm flow peaks, improves water quality and enhances watershed health. Green streets and parking lots:

- contribute to traffic calming
- improve pedestrian and bicycle safety
- reduce demand on city stormwater infrastructure
- reduce impervious surfaces, allowing rainwater to infiltrate
- recharge groundwater
- deliver cleaner water to Bowker Creek
- increase urban green space
- enhance community and neighbourhood livability

Map 3. Existing Watershed Conditions



Map 4. 100-year vision for the Bowker Creek Watershed



4.0 PRINCIPLES AND ACTIONS FOR WATERSHED MANAGEMENT—SUMMARY

4.1 PRINCIPLES

There are many specific watershed actions proposed in Appendix A. The most important themes are summarized here as principles. If these basic watershed management principles are considered in all development, land use and operational decision making, it will lead to improved watershed health.

The following watershed-wide approaches are essential to achieving the vision in the Bowker Creek Watershed Management Plan:

1. USE CREEK-FRIENDLY MANAGEMENT APPROACHES WHEREVER POSSIBLE

The Bowker Creek watershed has been significantly altered from its natural state. While it may not be possible to completely restore the watershed, there are many opportunities to create a more naturally functioning system. Creek-friendly management approaches should include the following, which are all appropriate for inclusion into Official Community Plan policies:

- When replacing hydraulic structures in the watershed or during significant re-development, consider the feasibility of daylighting the creek.
- Use natural methods such as bioengineering as solutions to soil erosion and to increase bank stability.
- Use low impact development approaches to manage rainwater runoff – see principles 2 and 3 for specific recommendations.
- When land along the creek corridor is for sale or is to be redeveloped, ensure that opportunities to improve creek conditions and to create greenways are considered – see principles 7 and 8 for specific recommendations.
- Use watershed-friendly approaches on municipally owned land, including eliminating the use of pesticides (except in special cases, e.g. managing high priority invasive species), using native plant species and planting trees, installing infiltration and retention areas, and creating a healthy riparian buffer around Bowker Creek.

2. ADOPT REQUIREMENTS TO REDUCE EFFECTIVE IMPERVIOUS AREA FOR NEW DEVELOPMENTS

Impervious area—the area covered by roofs, roads, and other hard impenetrable surfaces—in the Bowker Creek Watershed is 50% (Kerr Wood Leidal, 2007). Imperviousness is an important determinant of creek health and is one of the main reasons urban creeks are degraded by problems of flooding, erosion, and poor water quality. The 'effective' impervious area can be lowered over time using green infrastructure features such as raingardens, permeable pavement and other forms of retention and filtration to approximate more natural watershed hydrology (Table 2). It is recommended that the municipalities in the Bowker Creek watershed adopt a green infrastructure approach to new development including adopting specific standards for minimizing Effective Impervious Area (EIA).

A 30% EIA target is recommended as it represents a significant improvement in creek and watershed health for the Bowker Creek Watershed. This improvement can be measured using the watershed health tracking system (see Section 7 and Appendix D). Together with some riparian restoration, achievement of 30% EIA would improve watershed health from 'poor' to 'fair'.

About Green Infrastructure

The green infrastructure approach to managing rainwater imitates the natural hydrology (or movement of water) during the land development process by using existing site characteristics and engineered or landscaped features that allow infiltration, and that filter, store, evaporate and detain runoff close to its source. Green infrastructure:

- **can help protect the environment**. Green infrastructure techniques remove pollutants from stormwater, reduce the overall volume of stormwater, manage high storm flows, and replenish streams and wetlands and aquifers.
- **can help reduce flooding and protect property.** Reducing impervious surfaces, increasing vegetation, and dispersing and infiltrating rainwater results in less runoff, reducing the likelihood of flooding from storms.
- **helps protect human health by removing pollutants from stormwater.** Untreated stormwater can be unsafe for people to swim in.
- **is good for the economy.** Green infrastructure can help protect water quality and marine sediment quality. This ensures that our resources remain clean, and taxpayers don't have to pay for expensive cleanup efforts for polluted waters and sediments. Developers and builders can also save money because green infrastructure projects in many cases are less expensive to build, saving money on overall development costs.
- **provides cost-effective alternatives to systems upgrades.** Land developed prior to the 1990s usually provides little, if any, stormwater treatment. In many cases, green infrastructure systems, such as bioretention, are much less expensive to use than costly stormwater vaults or land-consuming stormwater ponds.
- **can increase the appearance and aesthetics of communities.** Green infrastructure projects leave more trees and plants and have less impervious surfaces, which makes for greener developments and communities.
- **can increase public safety.** One of the hallmarks of green infrastructure is narrower streets. Studies show that when vehicle traffic is slowed, there are fewer pedestrian accidents and fatalities.

Key green infrastructure strategies include:

- Conservation measures
  - Maximize retention of native forest cover or revegetate if already cleared.
  - Protect native soils that drain well, and restore the draining capacity of soils compacted during construction.
  - Protect topographic site features that slow, store and infiltrate stormwater.
  - Protect natural drainage patterns and features.
- Site planning
  - Use a multi-disciplinary approach that includes planners, engineers, architects, and landscape architects.
  - Place buildings and roads away from critical areas and well-draining soils.
  - Minimize impervious surfaces and completely disconnect them from engineered storm drain infrastructure.
- Distributed management practices
  - Manage rainwater as close to its origin as possible by using many, small scale green infrastructure techniques.
  - Create a site design that slows surface flows and increases the amount of time stormwater flows over the site.
  - Integrate stormwater controls into the design of the site and use the controls as site amenities.
  - Reduce the reliance on traditional collection and conveyance stormwater practices.
- Maintenance and education
  - Develop reliable, long-term maintenance programs with clear and enforceable guidelines.
  - Educate homeowners, building owner/operators, local government staff and others as needed on proper operation and maintenance of practices, and protection of all surface waters.

Each municipality would need to adopt an approach suited to their individual needs, and this approach would include effective impervious area targets for the re-development of the differing land uses in the watershed, to achieve an overall average reduction to 30% EIA over time. The creation of supporting information and bylaws would be necessary to enable this new policy, as would the development of ways to measure compliance—e.g. through hydrological modeling. Incentives could also be provided to encourage green infrastructure on properties (e.g. residences) that are not undergoing development.

Table 2 shows different green infrastructure techniques appropriate for different urban land uses such as, institutional, park/open space, urban, residential, mall and roads and boulevards

A visual depiction of possible green infrastructure approaches for residential, commercial, institutional and urban areas is shown in Figure 6. Aside from roads and boulevards, these land uses are defined in Section 2.2, and shown in Map 2. While all of the approaches or features in Table 2 can be undertaken regardless of native soil type, features will have to be designed based on native soil type. Therefore, Map 2 also delineates the locations of clay, rock, and sand-gravel substrates in the watershed.

The 30% EIA target and its effects on the creek should be examined over time as green infrastructure is successfully implemented. While creek degradation varies in direct relation to human disturbance, 10% impervious area has been suggested as a number beyond which creeks show obvious signs of degradation (Booth and Jackson 1997). It is theoretically possible to reduce EIA to as low as 2% using extensive green infrastructure features (Walsh et al., 2005). At some point in the future, 10% EIA may become a feasible target for the Bowker Creek watershed and meanwhile 30% EIA is a worthy goal.

Table 2. Appropriate rainwater and stormwater management features for different land uses

RAINWATER/ STORMWATER MANAGEMENT FEATURE (Green Infrastructure)	LAND USE (See Map 2, Page 3)						
	INSTITU-TIONAL	URBAN	RESI-DENTIAL	PARK/ OPEN SPACE	MALL	BOULE-VARD	ROAD
Downspout disconnect	X	X	X				
Harvesting and using roof runoff	X	X	X				
Raingardens	X	X	X	X	X	X	X
Infiltration basins / tree wells	X	X			X	X	
Detention/Retention ponds	X	X		X		X	
Pervious pavement	X	X	X	X	X	X	X
Constructed wetlands	X	X		X	X	X	
Floodwater storage areas	X	X		X	X	X	
Green roofs	X	X	X		X		
Wide riparian buffer zones for filtration and flood storage	X	X	X	X	X	X	X
Maintenance and restoration of natural channels with floodplains	X	X	X	X	X	X	X
Plant and maintain trees	X	X	X	X	X	X	
Prevent soil compaction	X	X	X	X	X	X	
Uncompacted topsoil (30cm+) for lawns	X	X	X	X	X	X	
Swales instead of curb and gutters						X	
Street sweeping							X
Minimize road width							X

3. Construct infiltration and retention features in boulevards

There are significant opportunities for rainwater/stormwater management in boulevards, to reduce runoff volumes and improve water quality. It is recommended that municipalities establish standards and policies for stormwater management in boulevards. This will complement improvements to stormwater management on private land as described above, and will also provide demonstration structures and learning opportunities. Infiltration and retention features in boulevards also present opportunities for planting trees to meet other objectives, for example urban forest goals and climate change adaptation and mitigation. Such actions will significantly contribute to achieving a green streets approach and will improve watershed health (Figure 6).

4. Incorporate Bowker Creek goals into municipal plans

For the Bowker Creek Watershed Management Plan and the Bowker Creek Blueprint to be effective, relevant goals and details must be incorporated into other plans. Where this has not already occurred, appropriate wording should be included in Official Community Plans, Greenway Plans, Park Plans and any other relevant plans such as local area plans and community plans. As appropriate, related items should be incorporated into annual operation plans and budgets.

5. Maintain effective communication of the Bowker Creek vision, goals, and actions

Many of the recommendations outlined in the action tables in Appendices A and B are opportunistic, so it is important that municipal staff, politicians, and community groups are aware of the contents of this plan to take advantage of opportunities when they arise. Effective communication is the responsibility of steering committee members as well as the Bowker Creek Initiative Coordinator. Effective communication includes dialogue both within and between organizations, particularly with respect to organizational initiatives that can be aligned with the Bowker Creek Initiative's goals and objectives. Pro-active contact should be made with new municipal staff members to ensure they are aware of the goals and objectives of the watershed management plan and the existence of the Bowker Creek Blueprint. Council members should also be kept apprised of issues, opportunities and progress, to ensure decisions are made in support of the blueprint.

6. Plant trees and shrubs and protect existing trees

In 2008, the Urban Forest Stewardship Initiative commissioned a report that mapped and analysed the urban forest canopy cover in the CRD from 1986 to 2005. Over the 19 year time period studied, there was a 13.2% increase in impervious surface and an 8.3% decrease in the amount of tree cover (Caslys Consulting Ltd. 2008). Urban Forest Stewardship data shows that the Bowker Creek Watershed has tree cover of 20.6%, and impervious cover of 50%. Victoria, Oak Bay and Saanich are among the municipalities with the lowest total tree cover (as a percentage of total area) in the region.

The main recommendation of the Urban Forest Stewardship Initiative report is to develop an urban forest strategy for the region, to address declines and pressures caused by ongoing increases in population in the CRD. Several municipalities have begun this process, including Victoria and Saanich.

Trees provide valuable services in a watershed, such as:

- reduced stormwater volume because of greater rainfall interception and evapotranspiration,
- reduced infrastructure costs by decreasing total stormwater volume,
- increased water quality by filtering surface water and preventing erosion,

- increased air quality by absorbing and filtering air pollution,
- carbon storage through biological processes, and
- provision of habitat and aesthetic values.

If municipalities have not already done so, they should consider the development and implementation of an urban forest strategy that includes: public education, protection of existing trees through the development of tree protection bylaws, and development of municipal policies to encourage native tree planting on private land, and in school yards, parks, boulevards, and medians. Policies should also be explored for requiring a minimum amount of vegetated greenspace on developments and redevelopments. The requirement would depend on land use. Twelve percent is an average target that is in line with provincial targets for ecosystem preservation. Wherever possible, native trees should be planted together with native shrubs, in order to restore the original ecosystem. Selecting a diversity of plants will help with climate change adaptation.

7. Purchase and protect key land in the watershed

In order to meet watershed plan goals for greenways and the protection and enhancement of natural areas, a targeted, long term (e.g. 50+ years) plan to purchase key properties needs to be in place. Key properties may include specific streamside lots that would allow for significant creek restoration and/or greenway development, and also for expansion of the floodplain to address flooding concerns. Each municipality should consider adopting a strategy and operational budgets for property purchases, to take advantage of opportunities as they arise.

8. Incorporate proposed greenways into land use planning

Greenways and greenspace make neighbourhoods more liveable. As the population in the region increases and land use becomes more dense, more greenspace will be needed. Developing greenways along the Bowker Creek corridor is an important part of the Bowker Creek Watershed Management Plan. In 2007, a proposed greenways routing map was developed by the Bowker Creek Greenways subcommittee, as input to the greenways planning processes in the three municipalities, and is included in this document as Map 5. If they have not already done so, municipalities should review these recommendations for incorporation into municipal greenway plans, official community plans, local areas plans, and parks plans. Any development or redevelopment in the watershed should be used as an opportunity to create greenways. In addition to being depicted on Map 5—Bowker Creek Initiative Potential Greenways, these routes are also shown on a reach-by-reach basis in Appendix B.

Public greenways within riparian corridors should serve a number of uses, but passive activities such as hiking, nature viewing and access to water should be emphasized. If a trail is located within 10 m of Bowker Creek, it can be assumed to be within the Streamside Protection and Enhancement Area (SPEA) under the Riparian Areas Regulation. These trails should be located as far from the high water mark as possible. They should be narrow (1 m is optimal) and avoid the need to remove native vegetation. Surfaces should be made of porous/pervious materials when runoff has the potential to enter the creek untreated. Best Management Practices (such as sediment and erosion control, re-vegetation, planting buffers, etc.) should be used during construction to protect the riparian vegetation and the creek itself. Best Management Practices related to the Water Act and Fisheries Act, as well as possible notifications to the Ministry of Environment and the Department of Fisheries and Oceans, should be used to gain approval and advice.

9. Include climate change adaptation and mitigation in all activities

There are many areas where good urban watershed management overlaps with climate action. For example, changes to precipitation patterns are expected to increase peak flows, and thus affect channel and pipe infrastructure—worsening floods and erosion. Climate mitigation efforts such as tree planting can be concentrated along creek corridors, while low impact development measures provide a no-regrets strategy to reduce flood peaks during smaller storms. The development of greenways (such as proposed in this plan) enables self-propelled transportation and the reduction of carbon pollution.

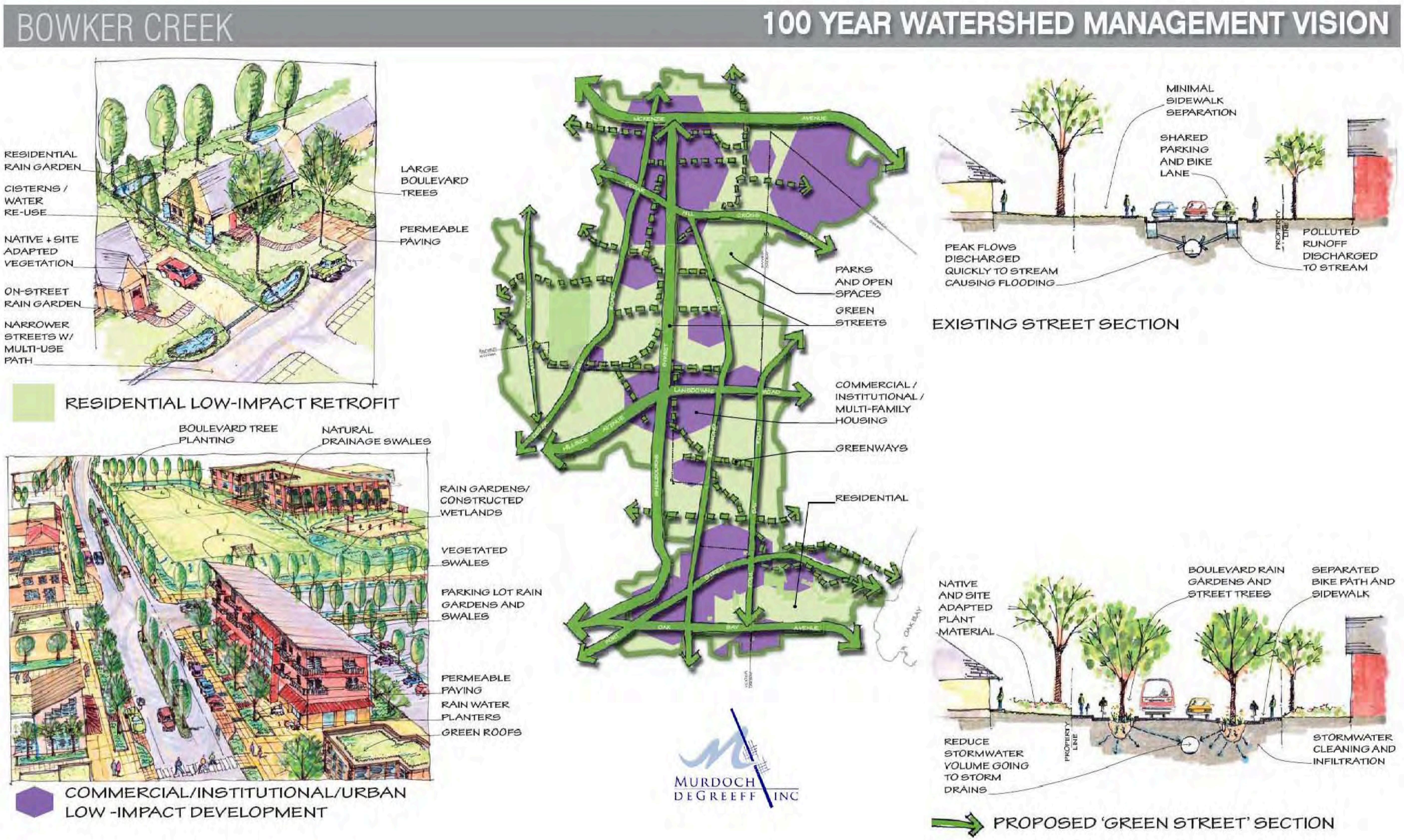
Watershed efforts should be aligned with climate change efforts wherever possible. This includes using the Master Drainage Plan (Kerr Wood Leidal, 2007) information about increased flood flows to design future infrastructure upgrades modeled at a future scenario of a 15% increase in duration and frequency of rainfall. Thus all the hydrotechnical recommendations are for a future climate. Synergistic watershed management and climate change efforts also include riparian restoration and other measures to provide ecosystems with the resilience required for climate change adaptation. Addressing climate change is a major focus of governments and related funding sources, and by aligning with climate change action, watershed efforts can achieve synergies and also have a higher chance of receiving funding.

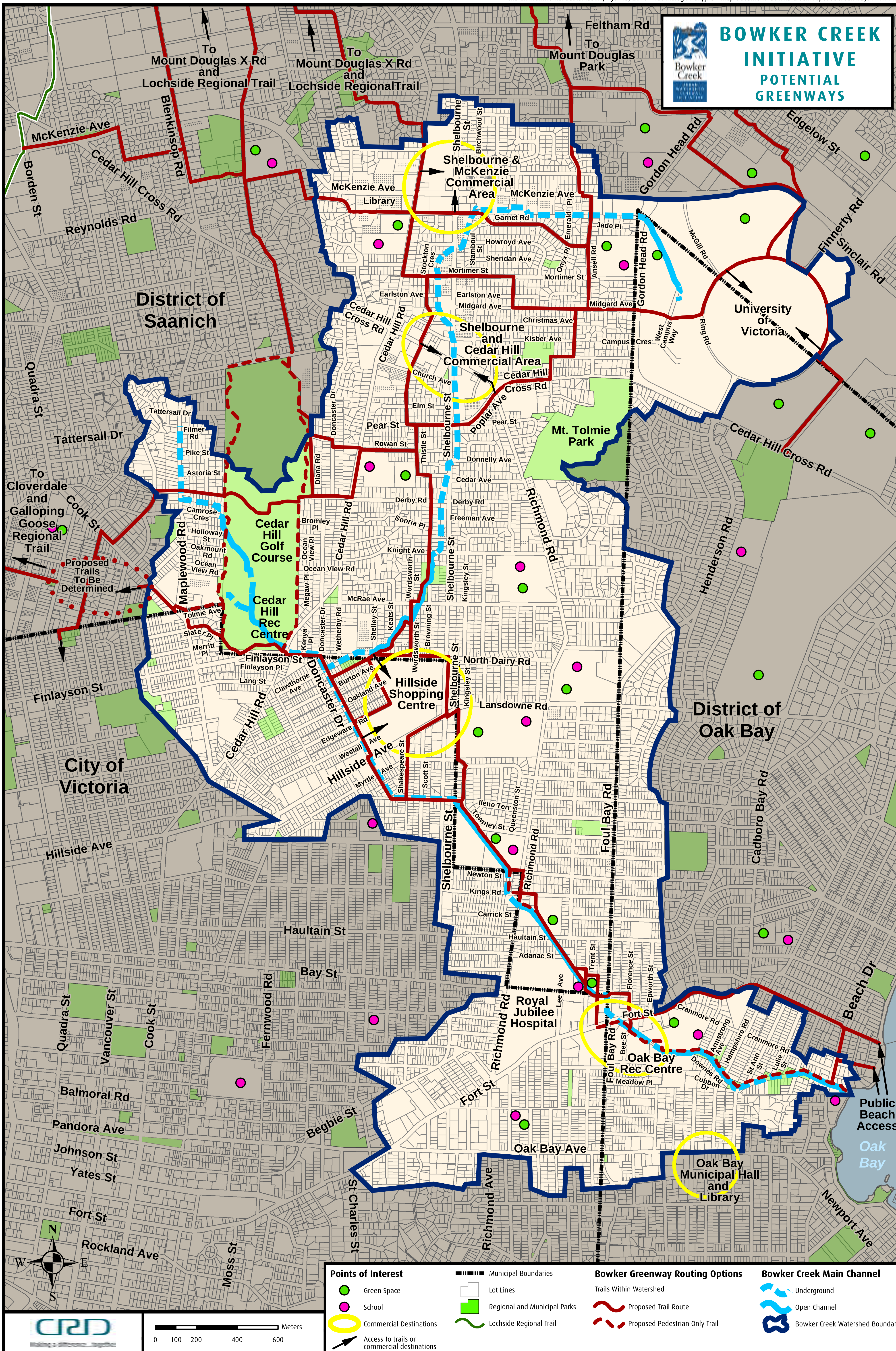
4.2 Detailed Watershed Management Actions

Detailed watershed management actions 1 through 33 are found in Appendix A. Municipalities, community groups and land owners can use the actions in this appendix to incorporate into organizational plans and operating budgets. The general intent of many recommended actions is to improve infiltration and retention so that flooding and erosion is reduced, impacts on the creek channel are lessened, and water quality is improved. Some actions are also directed at improving community involvement and stewardship, removing invasive species, and planting trees. The development of a greenway is another important watershed management action.

Figure 5. Benthic Sampling in Bowker Creek

Figure 6. 100-Year Vision for Watershed Management





The purpose of this map is to provide the Bowker Creek Initiative's input to municipal planning processes for future Greenways (multi-use trails (commuting and recreation) and wildlife corridors) in the Bowker Creek watershed and connections to surrounding areas. The map identifies several routes that may be feasible, which support the long term goals of the Bowker Creek Watershed Management Plan.The Greenways presented on this map are representative only of the existing or potential Greenways for the Bowker Creek corridor. For all other existing or potential Greenways, please contact the respective Municipalities.

Roads based on May 2010 data
Lot lines based on 2008 data

MAP 5. POTENTIAL GREENWAYS

5.0 Actions to Improve the Creek Corridor—summary

5.1 Current Creek Corridor

Each of 17 creek reaches are described in Appendix B, and options for creek restoration and greenway development are provided. Detailed recommendations to improve the Bowker Creek corridor for the specific reaches are found in Appendix B, and land managers and watershed stewards should refer to this appendix for the necessary details. Municipalities, community groups and land owners can use the actions in this appendix to incorporate into organizational plans and operating budgets.

The recommendations range from small restoration efforts such as invasive species removal that can begin immediately, to large changes such as creek daylighting or channel re-alignment that can be undertaken as land uses change, as funding comes available, or as infrastructure needs to be upgraded. These actions form a blueprint for change along the creek corridor, and are expected to be implemented over time as opportunities arise. Timeframes for completing this work could range from 50 to100 years, with some opportunities arising in the short term.

In general, restoration of above-ground sections would require widening the creek corridor to create more gradually sloped banks and an expanded riparian area, as well as the removal of invasive plant species and planting of native trees and shrubs. A widened creek corridor with gradual banks will expand the floodplain and reduce flooding in surrounding areas. If space is available, the creek channel can be made more sinuous to approximate its former pattern. Detailed restoration designs would be based on the available land and the ongoing land uses. Greenways (public paths for walking and in some cases cycling) should be incorporated wherever possible (Map 5). Figure 7 shows one major demonstration restoration project undertaken to date.

If creek daylighting occurs it will displace established land uses. Therefore, daylighting is expected to happen only with re-development or with changing priorities for land use. In some locations, daylighting could occur with the purchase of key properties.

5.2 Envisioning the future of the Creek Corridor

A vital part of the Blueprint is illustrating the future possibilities to the public, municipal staff and municipal politicians. Figure 8 provides a vision of possible designs for key areas such as the Shelbourne Corridor and other potential urban creek streets and natural creeks in greenways or parks. Large open areas that have not been developed represent the most likely potential for major restoration efforts that would significantly improve the creek corridor and overall watershed health as well as providing significant community amenities and natural areas in an otherwise fully developed watershed. Figures 9 through 12 show potential future visions for specific creek sections in Fireman's Park (Figure 9), Oak Bay High School and Recreation Centre (Figure 10), various properties from Richmond Road to Trent Street (Figure 11), and the former Richmond Elementary School (Figure 12). In many cases, existing land uses mean that this type of restoration cannot occur in the short term. However as this Blueprint is made for the long term (50–100 years), these maps are included as a vision of one potential future.

Figure 7. A demonstration restoration project at St. Patrick's Elementary School.
Before, during and after photographs. The project was completed in 2005. Final pictures were taken in 2008.

Figure 8. 100-Year Vision for the Creek Corridor

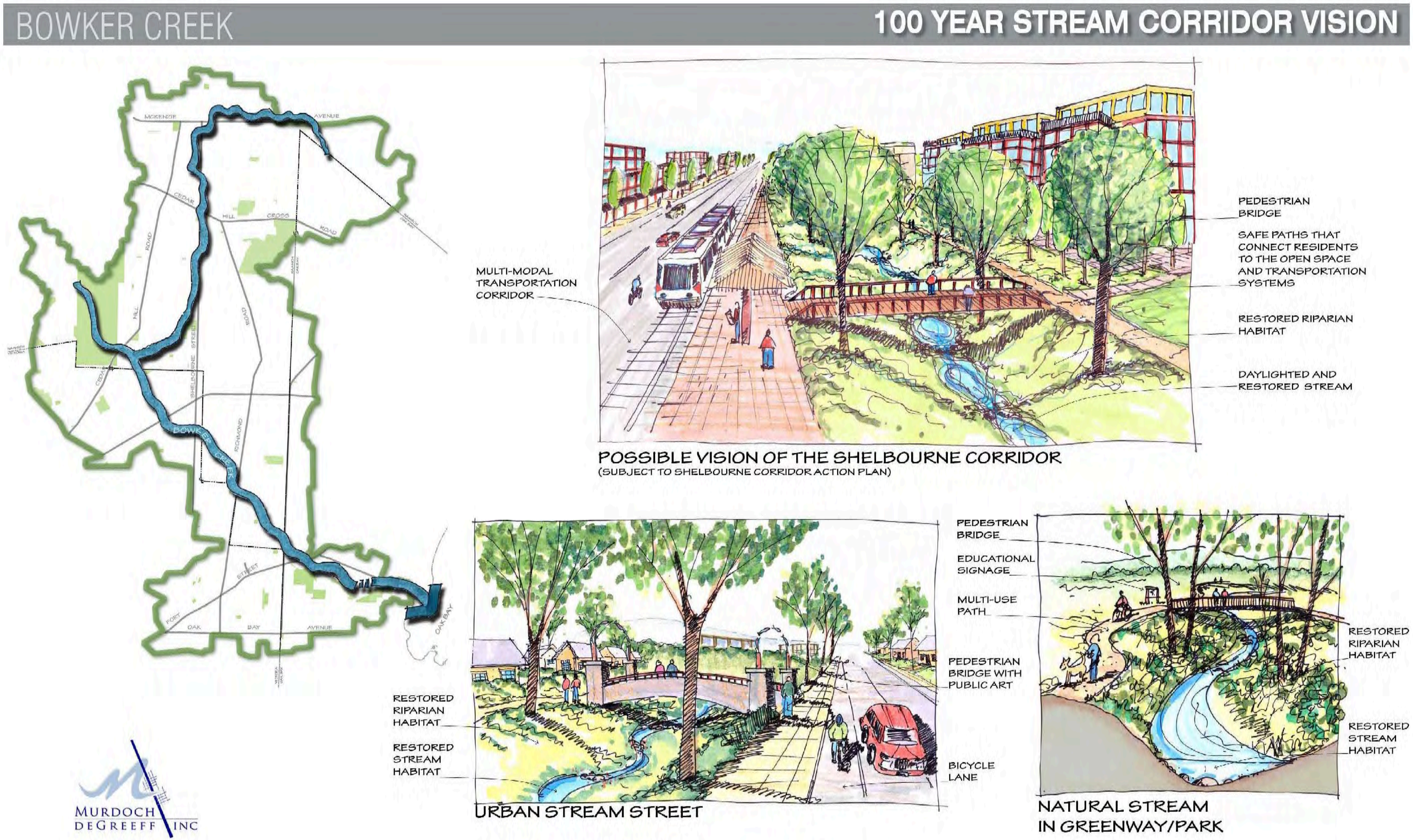


Figure 9. A Possible Long-Term Vision for Fireman's Park in Oak Bay (Reach 2)

Figure 10. A Possible Long-Term Vision for Oak Bay High and Oak Bay Recreation Centre (Reaches 3, 4 & 5)

Figure 11. A Possible Long-Term Vision for Richmond Road to Trent Street (Reach 7)
(Including properties by St. Patrick's Elementary School, Royal Jubilee Hospital, and BC Hydro)

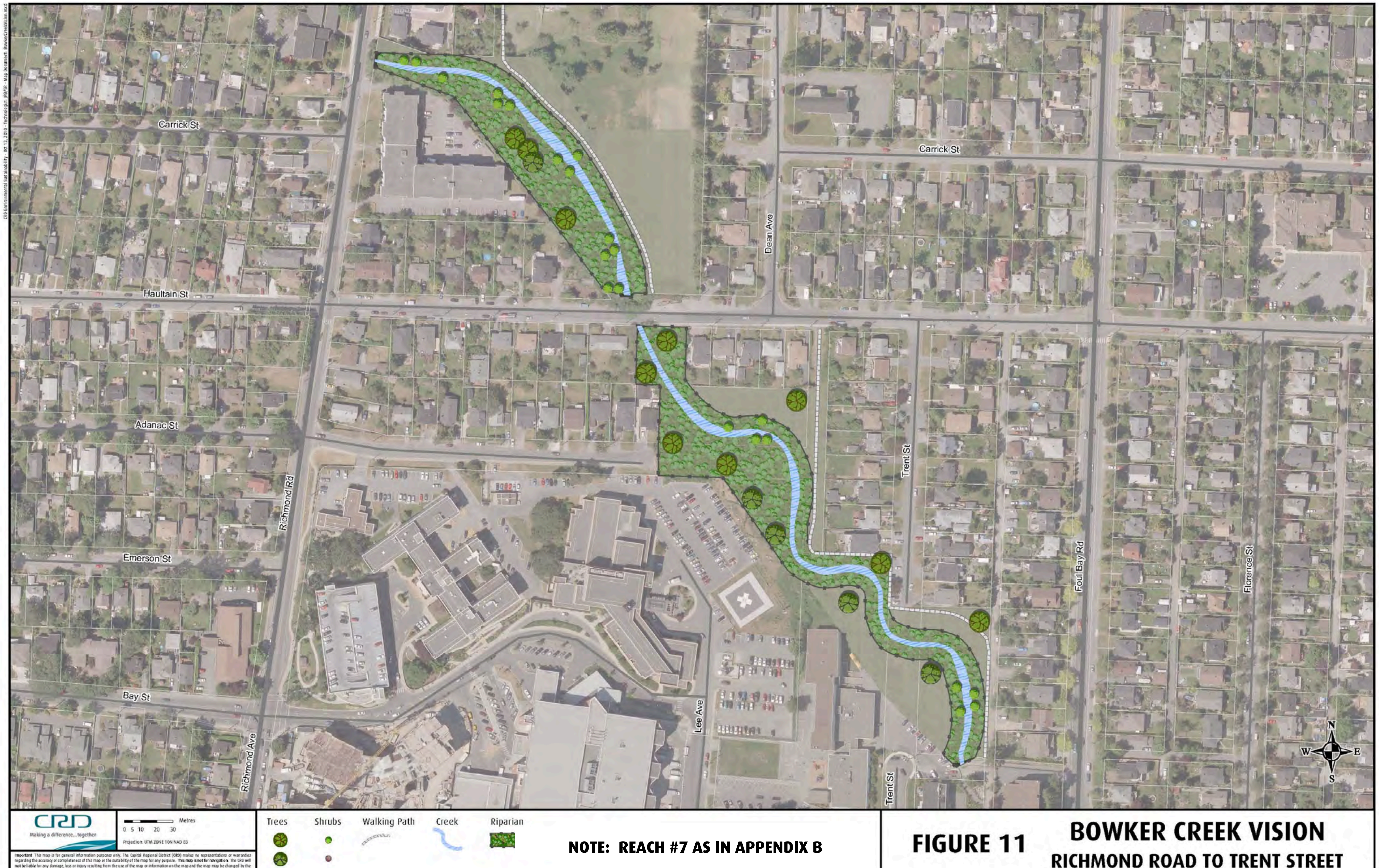


Figure 12. A possible long-term vision for the former Richmond Elementary School location (Reach 9)
(Note that the creek no longer bisects the property.)

6.0 KEY ACTIONS FOR SHORT-TERM IMPLEMENTATION

This plan contains extensive detail about actions to be taken over varying time frames and in different locations—see Appendices A and B. Therefore, it is important to highlight the areas where we can make progress in the next three to five years. The following list gives recommendations for actions that can begin immediately and which will have significant positive benefits for Bowker Creek.

6.1 TEN KEY ACTIONS FOR SHORT-TERM IMPLEMENTATION

All of the actions listed below are high priority. Watershed-wide actions are listed first, followed by reach-specific actions.

1. REVIEW AND REVISE MUNICIPAL PLANS TO INCLUDE BOWKER CREEK GOALS AND ACTIONS

Where this has not already occurred, wording to include Bowker Creek goals and actions should be included in Official Community Plans, Greenway Plans, Park Plans and any other relevant plans such as local area plans and community plans. As appropriate, related items should be incorporated into annual operations plans and budgets. This action is important, as it will ensure that municipalities can be efficient and effective in implementing the Bowker Creek Watershed Management Plan and the Bowker Creek Blueprint.

2. ADOPT REQUIREMENTS TO REDUCE EFFECTIVE IMPERVIOUS AREA FOR NEW DEVELOPMENTS

A goal of reducing Effective Impervious Area (EIA) to a maximum of 30% across the watershed can be achieved incrementally if supported by new policies. A key recommendation is to develop municipal policies for maximum EIA on new developments and re-developments, along with appropriate supporting guidelines, incentives, information, by-laws, and ways to measure compliance. Each municipality should tailor the details of this approach according to their internal processes and needs, with support from the BCI. A likely approach would be to assign specific EIA targets and guidelines to different types of land uses, to achieve a watershed-wide reduction in EIA over time.

3. REMOVE SPECIFIC INVASIVE SPECIES BEGINNING TO COLONIZE THE WATERSHED

Invasive species are an issue throughout the watershed, as they displace native species that provide important ecosystem functions. Bowker Creek is lined with invasive species, particularly blackberry, ivy and yellow willow, and removing all invasive species in the watershed would be a daunting task. However there are two species: invasive knotweed (*Polygonum spp*.) and policeman's helmet (*Impatiens glandulifera*) that should be removed before they become widely established (Figure 13). This effort should include outreach to residents regarding removing these from private property, as well as targeted removal efforts by municipalities in known locations along the creek corridor. To date, all known occurrences along the creek corridor are found in the District of Oak Bay east of Oak Bay High School.

4. COMPLETE A PILOT PROJECT TO LOCATE AND BUILD A DEMONSTRATION RAINWATER INFILTRATION/RETENTION STRUCTURE IN EACH MUNICIPALITY

Green infrastructure is increasingly recognized as an important and effective approach to rainwater and stormwater management. Saanich and Victoria have recently planned and built some green infrastructure features such as raingardens, and Oak Bay is also making changes such as allowing gravel driveways. These efforts are important, and as municipalities learn about and implement more green infrastructure, they can demonstrate effective approaches and raise awareness about doing business differently.

The BCI has been offered LIDAR (light detecting and ranging) technology to locate the most appropriate and effective locations for installing green infrastructure features such as raingardens and swales. This laser-based technology has already generated location and elevational data during flights over the watershed, and these data can be used to determine a location for a green infrastructure feature in each municipality. A pilot project should be completed using LIDAR to determine appropriate locations, and operational budgets or grant money should be used to allow each municipality to construct one or more demonstration raingardens or other infiltration/retention structures in municipal boulevards.

Figure 13. Policeman's helmet (left) and invasive knotweed (right)
These two probematic invasive species (*Impatiens glandulifera* and *Polygonum spp*, respectively) getting established in the watershed should be eradicated before they spread.

Figure 14. Trent Street Rain Garden, City of Victoria
Photo Credit: Murdoch de Greeff Inc.

5. Support development of an urban forest strategy in Oak Bay to complement those underway in Saanich and Victoria

Recognizing the importance of the urban forest and their aging stock of trees, Saanich and Victoria are working on urban forest strategies to ensure healthy tree populations into the future. It is important that this happen watershed-wide, and Oak Bay should consider initiating a similar strategy. All three strategies should recognize the importance of native trees for riparian restoration, for stormwater management, and for climate mitigation/adaptation.

6. Develop a strategy to acquire key properties as they come available

Creek restoration and greenway development often require land acquisition, to make sufficient room for public pathways, a healthy creek channel and floodplain, and native streamside vegetation. Key creek-side properties have been identified to each municipality for potential acquisition. Each municipality will need to develop its own strategy and priorities for these properties, so that when they come on to the market or make application for redevelopment, action can be taken as appropriate. For example, municipalities might ask for first right of refusal on key properties.

7. Work with Oak Bay High School to design and implement creek restoration on school district property

Oak Bay High school is undergoing redevelopment, with two aging buildings being replaced by one building on a different part of the property. The school district is willing to dedicate a limited amount of land—outside of their requirements for the building, parking and sports fields—to widen the creek corridor and allow for creek restoration. The Bowker Creek Initiative and the District of Oak Bay will need to apply for funding and work with the school district to realize this opportunity.

8. Participate in the Shelbourne Valley Action Plan process to identify current and future opportunities for creek restoration, rainwater infiltration, and/or greenway development

The District of Saanich has initiated a consultative planning process to create a more balanced transportation corridor along Shelbourne Street—including walking, biking and transit—complemented by mixed-use residential and commercial development. The terms of reference include objectives to protect and enhance the natural environment and recognize and integrate the Bowker Creek Watershed Management Plan. The Bowker Creek Initiative should participate in the planning process for the Shelbourne Valley Action Plan, to ensure that opportunities for creek restoration, rainwater infiltration (i.e. low impact development), and/or greenway development can be realized over time.

9. Work with creek-side landowners between Pearl and Trent Streets to achieve the long-term vision

The creek section between Pearl and Trent Streets is mainly above ground, and has several institutional landowners including: School District 61, BC Hydro, Bishop of Victoria, Saanich (for road rights-of-way), the Royal Jubilee Hospital, and St. Patrick’s School. The Bowker Creek Initiative should work with these landowners to achieve creek restoration—see Figures 11 and 12 for a long-term vision for this section. Restoration in some locations can only happen with future changes in land use or ownership, while in other locations restoration could proceed with the landowners’ permission and cooperation.

10. Continue with restoration at Browning Park

The District of Saanich is creating a greenway path through Browning Park and the Wordsworth Street right-of-way, and will be doing a limited amount of riparian restoration at that time. A park redesign is also occurring and these changes will improve some of the riparian buffer. After these projects are complete, potential opportunities for more restoration should evaluated, and interpretive signage should also be considered. Funding applications for further restoration work can be made, or restoration can be included in Saanich operational budgets as appropriate.

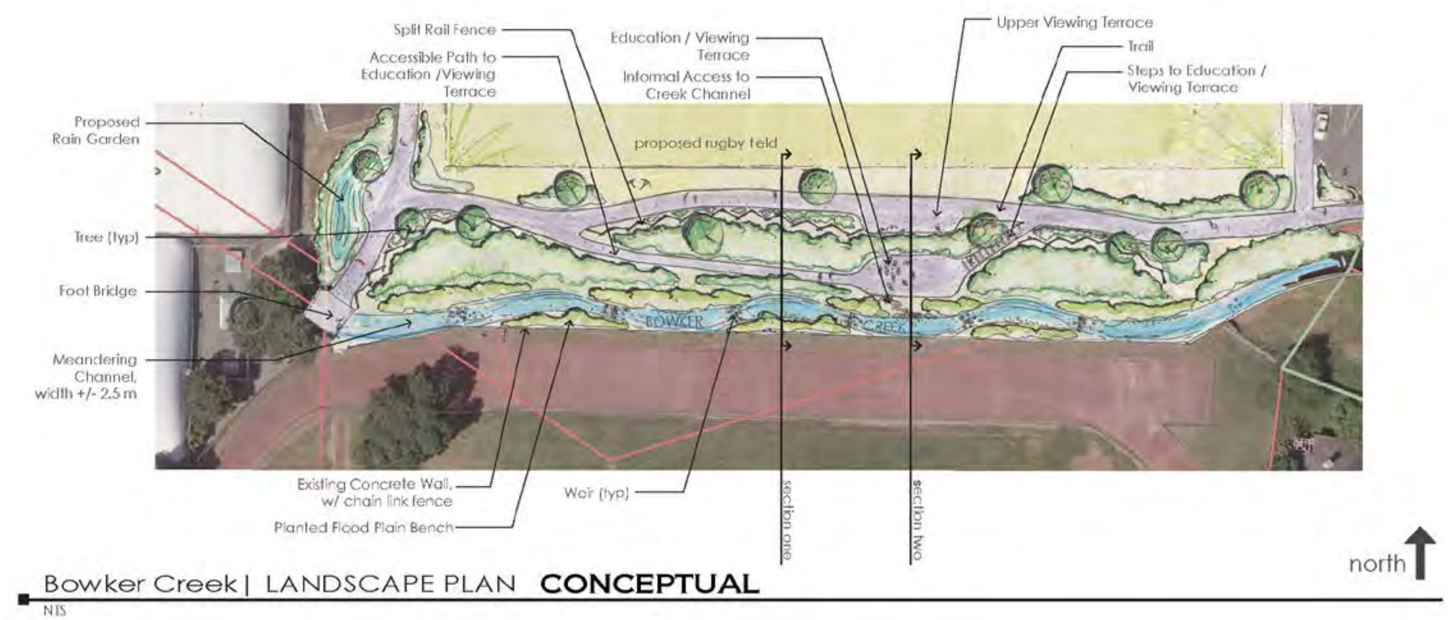


Figure 15. Conceptual Landscape Plan for restoration of Bowker Creek at Oak Bay High School
Conceptual Plan Credit: Kerr Wood Leidal Associates Ltd. and Murdoch de Greeff Inc.

7.0 MONITORING PROGRAM

A monitoring program will provide feedback on the effectiveness of ongoing actions in meeting the Bowker Creek Watershed Management Plan goals and objectives. It will also allow for adaptive management opportunities as the Blueprint is implemented.

7.1 MONITORING VARIABLES

The health of Bowker Creek and its watershed, and the successful implementation of the Bowker Creek Blueprint, will be monitored over time using the variables below. Baseline (2009) data is presented in section 7.2. The methodology for each monitoring variable is outlined in Appendix D.

A. WATERSHED WIDE MONITORING VARIABLES

1. **Watershed Health Tracking System**: This system uses the measures of riparian forest integrity, benthic index of biotic integrity, and total effective impervious area to track overall watershed health. This is a reproducible, low-cost system that can be used to track improvements to Bowker Creek and provide a framework for understanding how future changes to these factors can improve or degrade watershed health. Using this system also allows comparisons between Bowker Creek to other creeks in the region and to creeks in other jurisdictions such as the Lower Mainland and Washington State that also use the Watershed Health Tracking System. More information is found in Kerr Wood Leidal (2005).

   a) ***Total Impervious Area*:** (%TIA) a measurement of the area of the watershed that is covered by impervious surfaces expressed as a percent of total watershed area. It is the area within a watershed that is comprised of hardened surfaces resisting infiltration (i.e. roads, parking lots/driveways and rooftops.). The amount of impervious surface is a direct measure of the degree of urbanization, and it strongly affects both water quality in urban peak flow areas and replenishment of groundwater. In general, the negative impact on creeks increases as the percentage of impervious surface in a watershed increases (Page, 1999).

   b) ***Effective Impervious Area*:** (%EIA) a measurement of the impervious area that is connected directly to the drainage network through stormwater systems or surface runoff expressed as a percent of total watershed area. It is the impervious area calculated in the same manner as percent total impervious area (TIA), minus the areas that drain to terrain where rainwater infiltrates (Page, 1999). As re-development that employs Low Impact Development (green infrastructure) techniques (i.e. permeable pavement, green roofs, green streets, etc.) takes place and other low impact development measures are implemented, effective impervious area will need to be calculated. For these baseline values it is assumed there is no difference between percentage of impervious area and effective impervious area as the data was not available. More information can be found in Kerr Wood Leidal, (2005)

   c) ***Riparian Forest Integrity*:** (%RFI) a measurement of the forested area with 30m on either side of the creek (with the middle of the creek as the centre line) expressed as a percent of riparian forested area over the entire length of the creek. Riparian trees provide large organic debris for fish habitat, bank stabilization to reduce erosion, shading to moderate water temperature, and food for aquatic life. More information is found in Page (1999).

   d) ***Benthic Index of Biotic Integrity*:** (B-IBI) is a score that reflects the health of the benthic microinvertebrate (bottom dwelling, spineless organisms ranging from midge larva at 1 mm to an adult crayfish of 15 cm) communities within the creek. The invertebrates found are an effective measure of a creek's year-round ecological health (biological integrity), as influenced by water quality and habitat quality issues caused by human activities. B-IBI is a biological indicator providing insight into a creeks ability to provide a healthy place for aquatic organisms to live. More information is found in (Stallard, 2007), Kerr Wood Leidal (2005), Karr and Chu (1998), and EVS (2003). NOTE: it is recommended that an alternative to this variable is used due to the high cost of conducting this variable. A possible alternative could be fish box monitoring.

2. **Urban Tree Cover:** (ha and %) a measurement of the estimated area of tree cover within the entire watershed, not just riparian area, and thus does not include other vegetative areas such as shrubs, grass/lawns or gardens, etc. expressed in hectares and as percentage of total watershed. Tree cover density can also be measured (i.e. 0>5% in increments to >75% per hectares). There are numerous benefits to a healthy urban tree cover, including reduced surface flood water run-off, habitat for wildlife, shade and reduced ambient temperature, lower levels of noise and dust, oxygen production and reduced carbon dioxide, and a sense of place and community. More information can be found in Urban Forest Canopy Cover Mapping and Analysis in the Capital Regional District, British Columbia 1986-2005 (Caslys Consulting Ltd., 2008).

3. **Length of greenway developed:** (m) a measurement of total length of paths (bike, pedestrian, multiuse) that runs within the watershed expressed in meters. "Greenways" are defined as linear corridors that connect green spaces to provide wildlife habitat and recreational and transportation opportunities. The greenways proposed (Map 5) may perform an important, safe alternative transportation function through busy neighbourhoods, connecting major growth centers, as well providing habitat corridors and (in some cases) enhancing and restoring Bowker Creek aquatic and riparian habitat. Some parts of the greenway would be shared use on existing roadways (cars, pedestrians and bicycles), some parts would be multi-use trails for non-motorized transport, and some areas would provide for pedestrian traffic connections to the creek separate from nearby cycle routes. (BCI, Greenways Subcommittee, 2007).

B. CREEK CORRIDOR MONITORING VARIABLES

4. **Creek length above ground:** (m and %) a measurement of the total length of creek course that flows on the surface (above ground) expressed in meters and as a percent of total creek length. This variable can change by daylighting (opening) or culverting (closing) sections of the creek. There are numerous benefits to creek daylighting. The higher the percentage of the creek that flows above ground (not culverted), the better the creek performs its natural functions as an artery of natural drainage, absorbing peak flows and reducing the risk of flooding, and providing a natural amenity for the community. Economic benefits include increased property values and commercial activity in the area and decreased stressors on storm drain infrastructure.

5. **Restoration of open creek sections:** (m and m^2) a) the measurement of the linear length (m) of creek banks restored expressed in meters of creek bank improved (banks on each side of creeks are measured independently); b) the measurement of amount (m^2) of riparian area that has been restored expressed in square meters of total area of restoration within the riparian area (30 m on either side of creek). Restoration could include wattle fencing or other means of improving bank slopes, removing invasive species and planting native species and increasing riparian buffer widths. Some above-ground sections of the creek are narrow concrete channels or banks, and buffer areas are covered with mainly invasive plant species or may not have a vegetated buffer, preventing those creek sections from performing all of their natural functions: infiltration, slowing of storm event flows, filtering and bioremediation of pollutants by soil and plants, and reducing impervious surfaces. Restoration of creek banks and buffer areas (where land is available) enable the creek to better perform its natural functions, especially in both peak and low flows, and become a greater natural community amenity.

C. Water and Sediment Quality Variables

6. **Water quality:** a measurement of key parameters including, fecal coliforms, temperature, dissolved oxygen, pH, specific conductance, turbidity, nitrate/nitrogen. The CRD samples for these water quality parameters in Bowker Creek starting as part of their larger stormwater monitoring program. Water quality in the urban environment reflects the various pollutants washed off roads and private property into the storm drain system. It may also reflect cross connections to sanitary sewer lines or leaky sanitary sewer lines that infiltrate into the storm drain system. Pollutants washing off roadways include metals from vehicle wear and leakage (e.g. copper, zinc, cadmium and lead), and fuels and other petroleum products. Elevated levels of nutrients such as phosphorus and nitrogen are also commonly found in urban runoff, as is sediment from construction activities and soil erosion (NCHRP 2006). When untreated stormwater runoff is discharged directly to receiving waters, pollutant loadings can be much higher than those attributed to domestic sewage (USEPA 2002 in NCHRP 2006), and have been found to cause significant impacts to aquatic life in receiving waters (NCHRP 2006). Stormwater runoff and pollutant discharges increase steadily with urbanization because of the increase in impervious surfaces, which reduces infiltration of rainfall and runoff (NCHRP 2006).

   Sediment Quality: a measurement of certain contaminants that adhere to the sediment in the creek bottom and will accumulate over time. The CRD initiated a sampling sediment program in 1993 to better assess certain types of contaminants found in stormwater. These include metals and polycyclic aromatic hydrocarbons (PAHs). The CRD samples for eight metals and for low and high molecular weight PAHs (LPAH and HPAH). PAHs are a group of chemicals which naturally occur in coal, oil and gasoline, and as combustion by-products of these substances. PAHs are also a result of incomplete combustion of wood and tobacco. Examples of substances containing LPAHs include gasoline and diesel fuel, and HPAHs are found in substances like asphalt and tar. HPAHs are more toxic than LPAHs, which can more easily evaporate or break down.

7.2 Monitoring Frequency

It is proposed that the monitoring variables in section 7.1 be reviewed every five years to determine whether there has been any change and to determine any trends. This will require a Geographical Information Systems (GIS) exercise and a review of where channel restoration has occurred and greenways have been constructed. Water quality and benthic invertebrate data are collected on an annual or periodic basis by the CRD and these data should be reviewed as collected and also analyzed in the five-year reviews.

The cost for five-year review of key monitoring variables should be minimal but will require staff time.

7.3 Baseline Conditions, 2009

This section provides the baseline results of the Bowker Creek Watershed monitoring program as of December 2009. Baseline results for watershed variables such as the watershed health tracking system score and benthic invertebrate analysis (Table 4), urban tree cover (Table 5), greenways (Table 6) and for stream corridor variables such as creek length above ground, length and area of creek restoration (Table 7) and water and sediment quality results (Table 8) are provided.

Map 6 Bowker Creek Snapshot Conditions 2009 shows the location of creek restoration sites, completed greenways and green streets, and the locations of Bowker Creek interpretive signs, major commercial centres and areas of green space. This map also shows the location of several green infrastructure features (i.e., detention/retention ponds, green roofs, permeable pavement, swales and raingardens, underground retention tanks and green streets) that have been installed at municipal, commercial and institutional lands throughout the watershed. These features are depicted on this map because the effective impervious area, for which a 2009 baseline result was not possible, can be lowered over time using green infrastructure features to approximate more natural watershed hydrology. As technology improves, this information is needed to start calculating the Effective Impervious Area percentage, therefore known locations of these technologies have been mapped here.

A. Watershed Wide Monitoring Variables Results

Table 3. Watershed health tracking system score (2009 Baseline)

(See Map 5.)

MONITORING VARIABLE	VALUE	METHODOLOGY & DATA SOURCE
1. Watershed Health Tracking System score	Poor	Template for Integrated Stormwater Management Planning 2005 (Kerr Wood Leidal, 2005)
a) Total Impervious Area (TIA)°(%)	50%	Bowker Creek Master Drainage Plan (Kerr Wood Leidal, 2007) & Urban Forest Canopy Cover Mapping and Analysis in the Capital Regional District, British Columbia 1986-2005 (Caslys Consulting Ltd., 2008)
b) Effective Impervious Area (EIA)°(%)	*50%	Suggested methodology is found in Kerr Wood Leidal (2005).
c) Riparian Forest Integrity (%) (entire creek length) • Grass/Lawns (within riparian buffer, but % of entire creek length) • Pavement, rooftops, etc. (within the riparian buffer, but % of entire creek length)	**15.6% ***11.5% 8.2%	BCI Coordinator (2010) in-part based on GIS work from, Bowker Creek, An Assessment of Riparian Habitat & Biological Species Diversity (Camosun Students Rogers & Soloducha, 2008) NOTE: data had to be calculated on GIS to include entire length of creek with buffer
d) Benthic Index of Biotic Integrity score	15 (critically impaired)	Bowker Creek Benthic Invertebrate Pilot Project (Stallard, 2009)

NOTES: *for 2009 baseline data (%), EIA is assumed the same as TIA

** this Riparian Forest Integrity (RFI) is mostly vegetation counted in this statistic is non-native, shrubby vegetation. If a more detailed inventory were taken to include only healthy, treed riparian buffers, the RFI score would be much lower.

*** These areas within the riparian buffer and could be identified for restoration (i.e. native tree planting), thus increasing the RFI with potentially minimally intensive efforts.

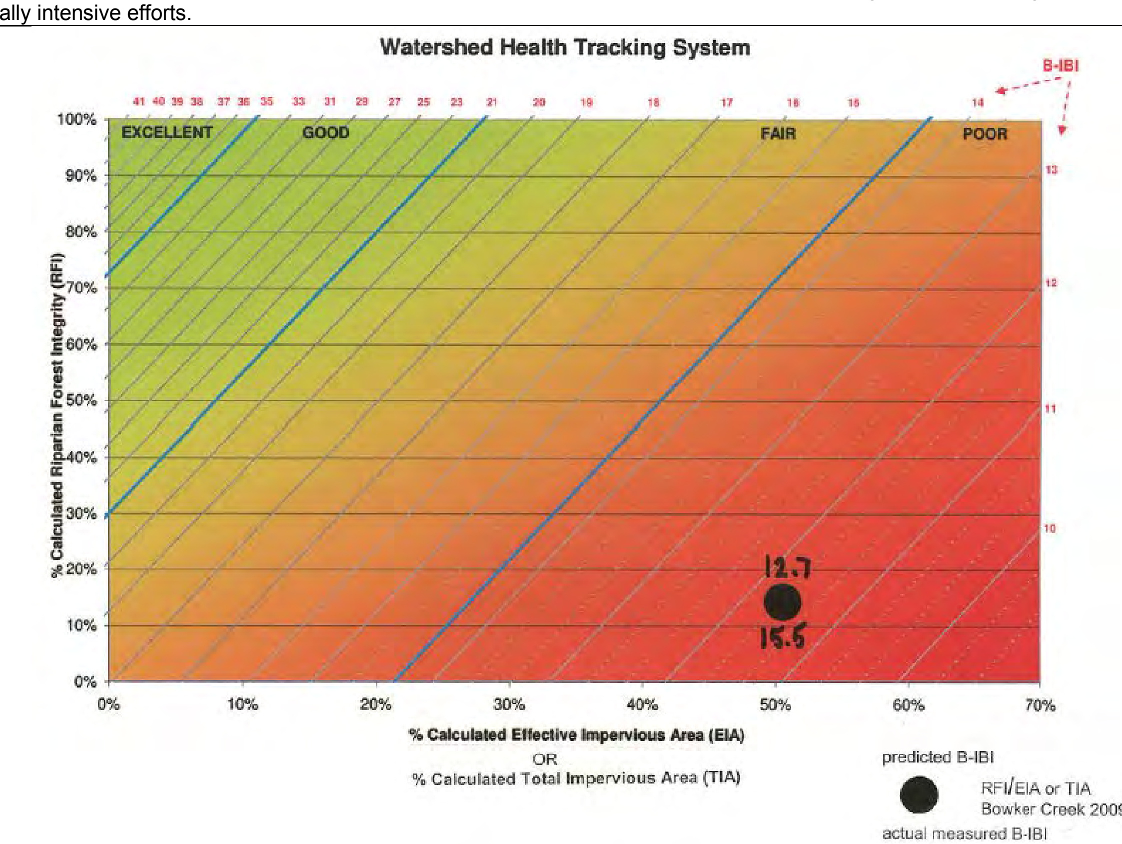


Table 3, continued: Bowker Creek B-IBI creek ratings 2007 Baseline

Metric	Site 1 value	Site 1 B-IBI score	Site 2 value	Site 2 B-IBI score	Site 3** value	Site 3** B-IBI score	Site 4 value	Site 4 B-IBI score
Taxa richness and composition								
Total number of taxa	*19*	3	*15*	1	*19*	1	*11*	1
Number of Ephemeroptera (mayfly) taxa	*0*	1	*0*	1	*0*	1	*0*	1
Number of Plecoptera (stonefly) taxa	*0*	1	*0*	1	*0*	1	*0*	1
Number of Trichoptera (caddisfly) taxa	*0*	1	*0*	1	*0*	1	*0*	1
Number of long-lived taxa	*0*	1	*0*	1	*1*	1	*0*	1
Tolerance								
Number of intolerant taxa*	*2*	1	*2*	1	*2*	1	*1.3*	1
% of individuals in tolerant taxa*	*54%*	1	*53%*	1	*60%*	1	*67%*	1
Feeding ecology								
% of predator individuals	*7.8%*	1	*6.5%*	1	*30%*	5	*2.6%*	1
Number of clinger taxa	*1*	1	*1.3*	1	*0*	1	*0%*	1
Population attributes								
% dominance (top 3 taxa)	*32%*	5	*32%*	5	*41%*	5	*35%*	5
Total Reach Scores (of possible 10-50)	**16**		**14**		**18**		**14**	
Average Score ~ Bowker Creek	**15.5** **10-16 = Critically Impaired**							

*Chironomids are not included in these metrics.
**1 sample only, no replicates at this site

NOTE: for sampling site locations see Appendix D: Methodology

Table 4. Urban tree cover (2005 Baseline)

MONITORING VARIABLE	VALUE		METHODOLOGY and DATA SOURCE
2. Urban Tree Cover (%) (2005)	20.6%		Urban Forest Canopy Cover Mapping and Analysis in the Capital Regional District, British Columbia 1986-2005 (Caslys Consulting Ltd., 2008)
	DENSITY CLASSES WITHIN URBAN TREE COVER (%)	**DENSITY OF TREE COVER (HA)**	
	0-5%	79	
	>5-10%	138	
	>10-25%	585	
	>25-50%	293	
	>50-75%	56	
	>75-100%	8	

Further information on the Bowker Creek Watershed from the Urban Forest Canopy Cover Mapping and Analysis in the Capital Regional District, British Columbia 1986-2005 (Caslys Consulting Ltd., 2008)

LAND COVER	AREA (M^2)	AREA (HA)	PERCENTAGE (%)
agriculture	0.0	0.0	0.0
exposed soil	84,627	8.5	0.8%
grass	2,764,446	276.4	27.1%
gravel	0.0	0.0	0.0
impervious	5,090,529	509.1	49.9%
marsh	0.0	0.0	0.0
shadow	137,502	13.8	1.3%
shrubs	25,824	2.6	0.3%
trees	2,106,091	210.6	20.6%
water	1,906	0.2	0.0

Table 5. Length of Greenway Developed

MUNICIPALITY	PROPOSED LENGTH OF GREENWAY (metres)	COMPLETED LENGTH OF GREENWAY (DEC. 2009) (metres)	LOCATION OF GREENWAY COMPLETED	METHODOLOGY & DATA SOURCE
City of Victoria	3,360	92	Path between Newton St. and Kings Rd.	City of Victoria
District of Oak Bay	2,980	460	Path from Oak Bay Tennis Bubble to St. Anne's Pond at Monterey Ave.	District of Oak Bay
District of Saanich	16,750	390	Path from Knight Ave south through Browning Park across McRae Ave. aling the Wordsworth right of way to the dead end section of Wordsworth	District of Saanich

B. Creek Corridor Variables Results

Table 6. Creek corridor variables (2009 Baseline)

(See Map 5.)

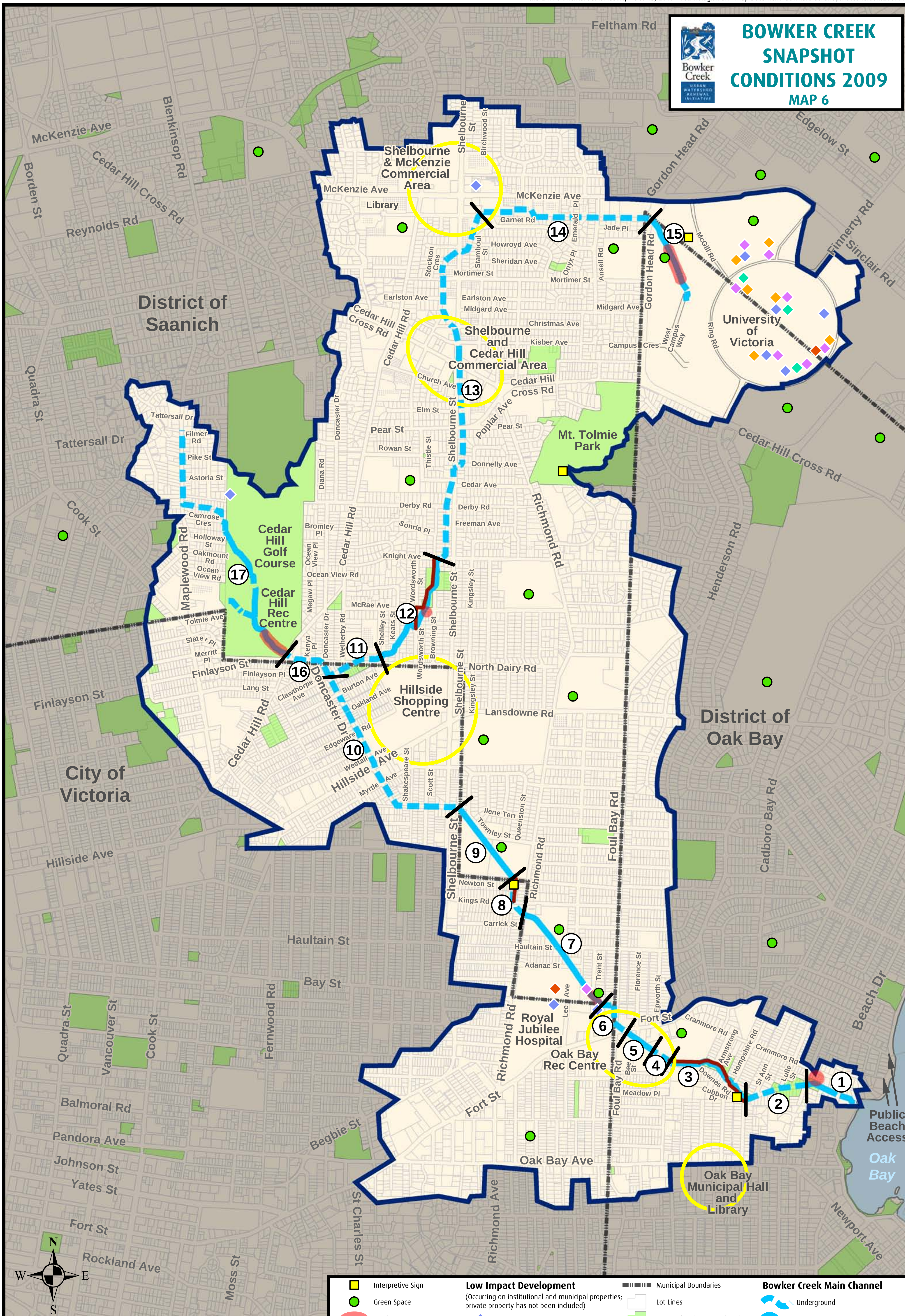
MONITORING VARIABLE	VALUE	METHODOLOGY & DATA SOURCE
3. Creek Length Above Ground (%, km) baseline + new daylighting		
a) Main channel	a) main channel 37% or 2.9 km	a) 7.9 km is the length of the main channel, above and below ground, from UVic Faculty Club to outlet (as defined in the Bowker Creek Master Drainage Plan, Kerr Wood Leidal, 2007)
b) Cedar Hill tributaries	b) tributaries 33% or 0.5 km	b) 1.5 km is the length of the tributaries, above and below ground, running mainly through the Cedar Hill Golf Course. (BCI Coordinator/CRD GIS, 2010)
c) Total creek (a+b)	c) 36.1% or 3.4 km	c) Total creek length is 9.4 km
4. Restoration of Open Creek		
a) Area of Open Creek Riparian Buffer Improved (m^2) baseline + new restoration	a) 492 m	Respective Municipalities & BCI Coordinator (2009)
b) Length of Open Creek Banks Improved (m)* baseline + new restoration	b) 2166 m2	

NOTE:* banks on each side of creek measured independently

Table 7. Corridor Variables Baseline

BLUEPRINT REACH NUMBERS (& jurisdiction)	STREET LOCATION	REACH LENGTH & STATUS* (M)	LENGTH OF RESTORED BANKS** (M)	RESTORED RIPARIAN FORESTED AREA (M^2)	DESCRIPTION
1 Oak Bay	Monteith St. to creek mouth	Open 254.9	40 m	120 m^2	Bioengineering by mean of willow wattle was installed in 2005. That winter was blown out and reinstalled in 2006. Approx 3 m wide.
2 Oak Bay	St. Ann St. to Monteith St.	Enclosed 311.7			
3 Oak Bay	Downstream of Oak Bay Tennis Bubble to St. Ann St.	Open 462.9			
4 Oak Bay	Oak Bay Tennis Bubble	Enclosed 101.2			
5 Oak Bay	Cadboro Bay Rd. to Oak Bay Recreation Centre	Open 149.4			
6 Victoria & Oak Bay	Trent St. to Cadboro Bay Rd.	Enclosed 236.0			
7 Saanich	Richmond to Trent (St. Patrick's School)	Open 574.3	210 m	630 m^2	3 meter wide bioengineering by Saanich PW in 2007 (30-40m south bank); 2006 (50 m north bank), 2005 (15-20m south bank); 48 m (x 2) by Community Group and BCI Coordinator; golden willow removal and thinning occurred on some of the area already included in 2009. In 1998, the PCC gave some money to Hydro to plant some shrubs and trees along the greenway.
8 Victoria	Newton St. to Richmond Rd.	Enclosed 204.0			
9 Saanich	Pearl St. to Newton St.	Open 420.6			
10 Victoria	Clawthorpe Ave. To Pearl St. (@ Hillside)	Enclosed 1015.2			
11 Saanich & Victoria	North Dairy Rd. to Clawthorpe Ave.	Enclosed 272.8			
12 Saanich	Knight to North Dairy (Browning Park)	Open 615.1	20 m	60 m^2	Bioengineering by Saanich PW 2004 at 1607 McCrae Road; 2003 at 1607 McCrae Road
13 Saanich	Garnet to Knight (@ Shelbourne)	Enclosed 1858.5			
14 Saanich	Gordon Head Rd. to Garnet Rd. (Mackenzie)	Enclosed 864.8			
15 Saanich	University Club of Victoria to Gordon Head Rd.	Open 447.7			
16 Saanich & Victoria	Cedar Hill Golf Course to Clawthorpe (@ Finlayson)	Enclosed 265.3			
17 Saanich	Cedar Hill Golf Course	Open 1540.8	222 m	666 m^2 960 m^2	Saanich Public works removed cattails and planted vegetation in 2000 Community tree planting began in 1995 Tree Appreciation Day from near the intersection where the culvert begins to the trail over the second bridge at the back NW corner of the rec centre. Over three events led by Saanich Parks, we planted most heavily both sides from the culvert to the first bridge on the North Dairy side and then along the creek on west side of the centre, the easterly side closest to the building.
		TOTAL	492 m	2166 m2	

Notes
*enclosed = underground, in culvert; open = runs on surface, may have earthen banks or channelized (open culvert, cement, etc.);daylighted = taken out of underground culvert so that it runs on surface
**each bank is measured separately



Interpretive Sign	**Low Impact Development** (Occurring on institutional and municipal properties; private property has not been included)	Municipal Boundaries	**Bowker Creek Main Channel**
Green Space	Detention/Retention Pond	Lot Lines	Underground
Creek Resoration Areas	Green Roof	Regional and Municipal Parks	Open Channel
Commercial Destinations	Permeable Pavement	Existing Greenways	Bowker Creek Watershed Boundary
	Swale or Rain Garden		Reach Number
	Underground Retention Tanks		Reach Breaks
	Green Street (none currently exist)		

Roads based on May 2010 data
Lot lines based on 2008 data

0 100 200 400 600 Meters

Projection: UTM ZONE 10N NAD 83

CRD Making a difference...together

C. WATER AND SEDIMENT QUALITY RESULTS

6. Water and sediment quality sampling results

Water sampling results show that Bowker Creek is usually within the BC-Approved Water Quality Guidelines for aquatic life, though as noted above this will not be the case throughout the year. The sampled values for temperature and dissolved oxygen are often within limits that can support salmon habitat. pH varies, and is almost always within the BC-Approved Water Quality Guidelines. The location of Bowker Creek Sediment and water sampling sites are show on Map 8 (Appendix D).

The longest set of water quality data for Bowker Creek is for fecal coliforms. Over time, the trend is for decreasing but variable levels of fecal coliforms. Nevertheless, coliform levels usually exceed those deemed safe for swimming (200 fecal coliforms per 100 mL), with levels highest at the creek mouth, and dropping upstream.

There are less data points for 316-5 (6 measurements) as monitoring was initiated later (in 2005). As a result percentage data are very sensitive. For example, one measurement was in exceedence of the turbidity guideline results in a 17% exceedence rate (1/6).

Parameters of most concern are fecal coliform, phosphorus, and turbidity. Fecal coliform and phosphorus concentration indicate contamination from sewage and high turbidity is likely a result of development that reduces impervious area increasing creek flow rates. Lack of vegetation can also increase phosphorus levels.

Exceedences of the fecal coliform and phosphorus guideline tend to increase from upstream to downstream. Elevated turbidity occurs at all stations without a trend from upstream to downstream.

Sediment sampling has indicated that copper and zinc levels were elevated above the marine sediment water quality guidelines (CRD 1992) in 2005, and LPAHs and HPAHs were elevated above the guidelines in 2008. Upstream investigations to date have not determined the source. LPAHs and HPAHs are assumed to come from street runoff, and correspond to repeated observations of hydrocarbons in the creek by the Bowker Creek Coordinator, Saanich staff, and volunteers.

Table 8. Water and sediment quality: percentage of samples in exceedence of guidelines 1997–2007 Baseline in Bowker Creek

(See "sampling results" for more information.)

WATER QUALITY	PERCENTAGE OF SAMPLES IN EXCEEDENCE OF GUIDELINES*			
***CRD Stations # (upstream to downstream)	316-5	316-4	316-3	316-1
Fecal Coliform	33	67	88	100
Temperature	0	0	0	0
pH	0	5	0	5
Dissolved Oxygen	33	0	0	0
Conductivity	0	0	0	0
Turbidity	17	17	38	31
Nitrate/Nitrogen	0	0	0	0
Phosphorous	0	38	56	56
SEDIMENT QUALITY				
Percentage of sediment samples that received h high contaminant rating (n=22) from 2003-2008	13.6			

NOTES

* Data compared to BC or CCME Guidelines for protection of aquatic life, with the exception of fecal coliform data which was compared to SHWP guideline for protection of public health (200 FC/100mL). Values above the SHWP guideline indicate contamination is likely from sewage rather than wild or domestic animals and birds.

** Quantity of data differs between parameters: Monitoring was initiated for fecal coliform in 1997; temperature, pH and dissolved oxygen in 1999; conductivity in 2000; turbidity in 2003 and nitrate and phosphorus in 2005.

*** For the location of CRD station sampling sties see Appendix D: Methodology

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APPENDIX A

APPENDIX A—ACTIONS FOR WATERSHED MANAGEMENT

A list of detailed watershed management actions are presented in this appendix. These actions are designed to achieve the vision, goals, and objectives put forward in the Bowker Creek Watershed Implementation Plan (2003). Municipalities, community groups and land owners can use the actions in this appendix to incorporate into organizational plans and operating budgets. This plan is a guide to action and cannot mandate any group to carry out the actions.

RATING CRITERIA

Environmental, social, and economic factors need to be integrated into the implementation plan actions. To ensure that these factors were considered for each action, a set of criteria was developed. Each action or set of actions were rated using the criteria presented in Table 7. The ratings were not summed to show a total score as the committee believed that it was difficult to compare actions based on the sum alone.

GOALS ADDRESSED BY THE ACTION

The action tables specify which of the following Bowker Creek Watershed Management Plan goals the actions meet:

Goal 1. Individuals, community and special interest groups, institutions, governments, and businesses take responsibility for actions that affect the watershed

Goal 2. Manage flows effectively

Goal 3. Improve and expand public areas, natural areas, and biodiversity in the watershed

Goal 4. Achieve and maintain acceptable water quality in the watershed

LEAD AGENCY (SUPPORTING ORGANIZATIONS)

The action tables define which organization is responsible for implementing the action and any potential supporting organizations.

TYPE

Each action is assigned one or more of the following categories:

- capital—is a capital cost action
- operational—should be integrated into operational work programs
- opportunistic—should be implemented as opportunities come up, such as when funding is available or during redevelopment of the area

FUNDING SOURCE

Potential funding sources are identified. Some funding sources are more specific than others, and further research into specific funding sources for some of the actions is needed. Funding sources will change with shifting government priorities and this column should be re-evaluated on a regular basis.

PRIORITY

The Bowker Creek Initiative Steering Committee assigned each action a high, medium, or low priority.

Table 9. Criteria for rating actions in the Bowker Creek Blueprint Baseline

CRITERION	CONSIDERATIONS	RATING	RATING DEFINITION
Environmental	✓ water quality or quantity ✓ retention or infiltration ✓ riparian or creek habitat values ✓ intact upland habitats ✓ habitat connectivity ✓ biodiversity ✓ creek function ✓ adaptation to climate change ✓ mitigate climate change	0	No net environmental benefits.
		1	Environmental benefits from this action(s) are limited. Adverse environmental impacts are possible.
		2	Environmental benefits will occur from this action(s). Few adverse environmental impacts are anticipated.
		3	Significant environmental benefits can accrue from this action(s).
Social	✓ linkages among communities ✓ Smart Planning principles ✓ recreational use ✓ public connection to and enjoyment of the creek ✓ public awareness and education ✓ individual stewardship actions ✓ public health and safety ✓ flood damage ✓ neighbourhood disruption	0	No net social benefits.
		1	Social benefits from this action(s) are limited. Some adverse social impacts are possible.
		2	Social benefits will occur from this action(s). No adverse social impacts are anticipated.
		3	Significant social benefits can accrue from this action(s).
Capital Cost	✓ capital cost	0	Costs are negligible
		-1	Less than $100,000
		-2	$100,000 to $1 million
		-3	More than $1 million
Operating Cost	✓ operating cost	0	Costs are negligible
		-1	Less than $25,000 per year
		-2	$25,000 to $100,000 per year
		-3	More than $100,000 per year
Fundability	✓ known funding sources ✓ chance of obtaining funding	1	Few funding sources. Difficult to obtain funding.
		2	Some funding sources. Reasonable chance of obtaining funding.
		3	Many funding sources or secure funding sources. Good chance of obtaining funding.

ACTION LIST FOR WATERSHED MANAGEMENT

ACTION NO.	ACTIONS	TOPIC	RATING					GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TIMING			FUNDING SOURCE	PRIORITY (H, M, L)
			Environmental	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
1	Review and revise relevant official community plans, and community and local area plans to include goals, objectives, and actions from the Bowker Creek Watershed Management Plan and Bowker Creek Blueprint. Incorporate Blueprint actions into annual municipal operation plans and budgets.	Land use, greenway, and associated plans	2	2	0	-1	3	1	Municipalities		X		Municipal operating budgets	H
2	Incorporate the Bowker Creek greenway plan into municipal greenway plans, parks plans, transportation plans, and other relevant plans.	Land use, greenway, and associated plans	2	2	0	-1	3	1, 3	Municipalities		X		Municipal operating budget	H
3	Designate a creek flood plain or zone on either side of the creek, through zoning bylaws to prevent any new construction of buildings below the 200-year flood elevation. Flood mapping should include climate change assumptions.	Land use, greenway, and associated plans	2	2	0	-1	3	1, 2, 3, 4	Municipalities		X		Municipal operating budgets, grants	H
4	Establish policies that require minimum vegetated greenspace on developments and redevelopments, depending on type of land use. 12% is an average target, based on provincial standards and is within the range recommended by the Urban Forest Stewardship Initiative.	Land use, greenway, and associated plans	2	2	0	-1	3	3	Municipalities		X		Municipal operating budget	H
5	Align watershed efforts with climate change adaptation and mitigation measures and strategies, including tree planting, greenways planning and rain/stormwater infrastructure	Land use, greenway, and associated plans	3	3	0	-1	3	2, 3	Municipalities		X	X	Municipal operating budgets, grants	H
6	With land use changes, use amenity bonusing or other mechanisms to fund or construct greenways, greenspace, or to daylight the creek.	Land use, greenway, and associated plans	3	2	0	-1	3	3	Municipalities		X	X	Developer	M-H
7	Encourage and pursue daylighting and greenways projects as part of changes to land use or when replacing hydraulic structures	Land use, greenway, and associated plans	3	2	0	-1	3	3	Municipalities (BCI)			X	Municipal operating budget	H
8	Develop municipal policies to acquire key streamside parcels for use as flood storage, greenway, parklands, and for creek daylighting.	Land acquisition	3	3	0	-1	3	3	Municipalities (BCI)		X		Municipal operating budget	H
9	Purchase key properties affected by flooding, as appropriate	Land acquisition	3	3	-3	0	2	2, 3	Municipalities	X		X	Grants, acquisition fund	M
10	Revise municipal policies and regulations to permit and encourage low impact development to ensure that developments and redevelopments have an effective impervious area of no more than 30%.	Runoff and water quality (green infrastructure)	3	2	0	-1	3	1, 2, 3, 4	Municipalities		X		Municipal operating budgets, grants	H
11	Establish requirements for rainwater/stormwater management in boulevards. Change municipal policies to use alternate street and sidewalk design and maintenance standards to reduce runoff volumes and improve water quality. For example, use bioswales before catch basins on streets.	Runoff and water quality (green infrastructure)	2	2	-1	-1	3	1, 2, 4	Municipalities		X		Municipal operating budget	H
12	In urban areas, ensure appropriate maintenance of oil interceptors and sediment traps on private property through a municipally-coordinated maintenance program funded by a fee-for-service program.	Runoff and water quality (green infrastructure)	2	2	0	-2	2	4	Municipalities		X		Fee-for-service or utiltity	M-H
13	Provide appropriate frequency of catch basin cleaning and street sweeping practices	Runoff and water quality (green infrastructure)	2	1	0	-2	2	4	Municipalities		X		Municipal operating budget	M

ACTION LIST FOR WATERSHED MANAGEMENT

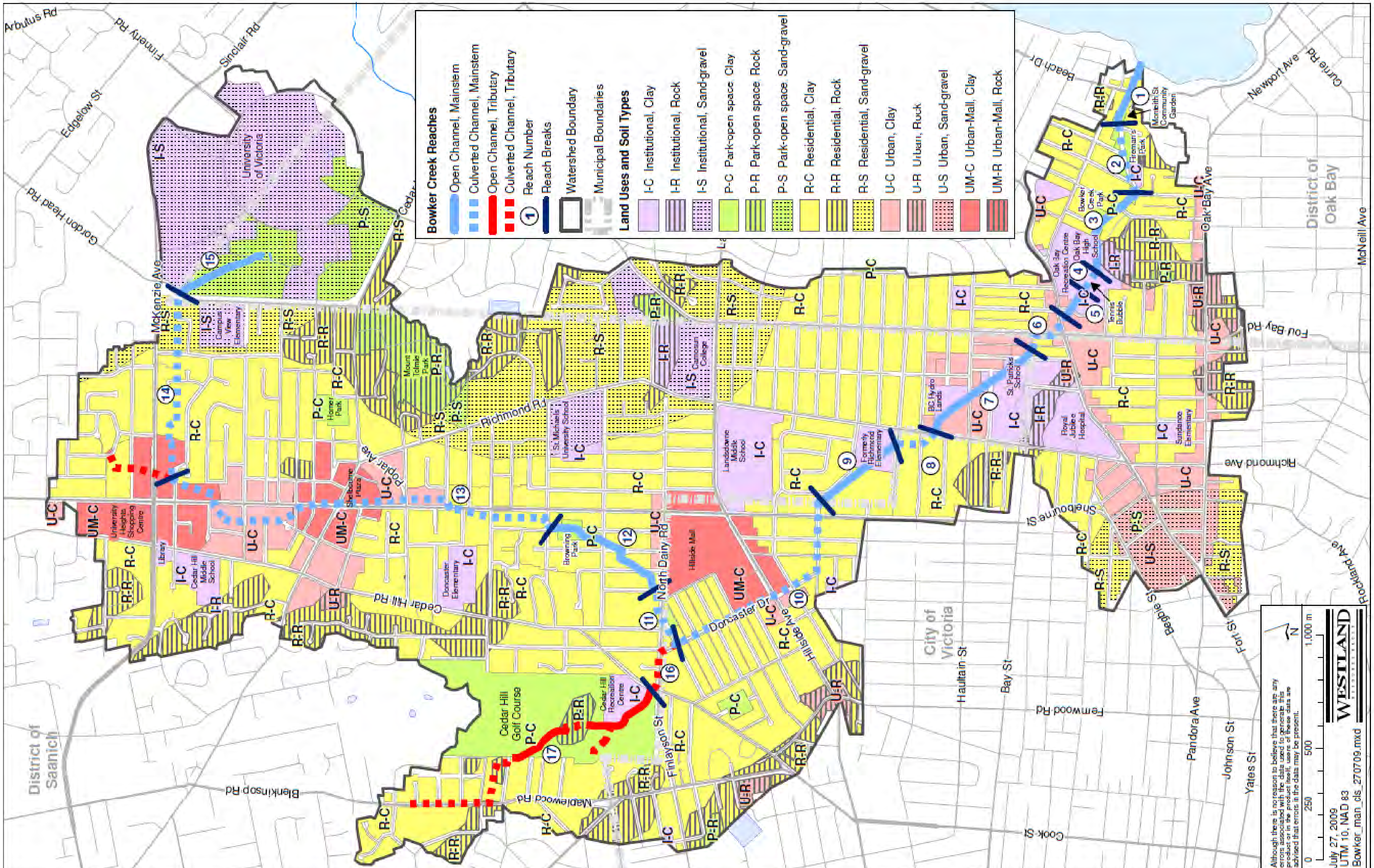
ACTION NO.	ACTIONS	TOPIC	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TIMING: Capital	TIMING: Operational	TIMING: Opportunistic	FUNDING SOURCE	PRIORITY (H, M, L)
14	Develop policies to require commercial and institutional property owners to install oil interceptors and sediment traps in parking lots before stormwater reaches the creek.	Runoff and water quality (green infrastructure)	2	2	-1	-1	2	4	Municipalities (developers, institutions)		X		Municipal operating budget	M-H
15	Create a utility to fund stormwater management projects.	Runoff and water quality (green infrastructure)	2	2	0	-2	3	1	Municipalities		X		Municipal operating budget	H
16	Work on a pilot project to use LIDAR to identify key areas for raingarden or swale installation on public land, and determine if this approach is useful for wider application	Runoff and water quality (green infrastructure)	3	1	0	-1	2	2, 4	BCI			X	Grants	M
17	Identify opportunities and install neighbourhood scale stormwater retention facilities, to reduce flood discharges and to improve water quality.	Runoff and water quality (green infrastructure)	3	2	-2	-2	2	1, 2, 4	Municipalities (BCI, developers)		X		Grants, municipal budgets	H
18	Implement permeable asphalt or concrete in a highly visible area for demonstration purposes; eventually require it for certain types of streets and locations (e.g. low-volume streets immediately adjacent to the creek).	Runoff and water quality (green infrastructure)	3	2	-1	0	2	2, 4	Municipalities (BCI)	X		X	Grants	H
19	Adjust Municipal Development Cost Charges (DCC) to provide incentives for low impact development.	Runoff and water quality (green infrastructure)	3	2	0	-1	3	2, 4	Municipalities		X		Municipal operating budget	H
20	Discourage the sale of invasive exotic plant species at garden centres through education and policy. Encourage landowners to cease using cosmetic herbicides and pesticides through a public education program.	Vegetation management	2	3	0	-1	2	3	BCI (municipalities, public groups)		X		Grants	M
21	If municipalities have not already done so, develop and implement an urban forest strategy that includes the following actions: ✓ develop educational materials describing the links between the trees and creeks, ✓ protection of existing trees through the development (as appropriate) of tree protection bylaws, ✓ plant and maintain street trees and boulevards throughout the watershed, including using a diversity of species, ✓ establish municipal policies that require a minimum of 12% vegetated greenspace on developments and redevelopments, ✓ encourage private landowners to plant native trees and vegetation on their properties, and ✓ encourage schools to add tree planting to school yards.	Vegetation management	3	3	-1	-2	3	1, 2, 3, 4	Municipalities		X	X	Trees for tomorrow, province, CRD, grants, municipality, parks budget	H
22	Develop a strategy and coordinate invasive species eradication for the creek and riparian area, based on eradicating a few key species. May require some research or trials.	Vegetation management	3	2	0	-1	3	3	Municipalities (BCI)		X		Grants	M
23	Where action is needed to control streambank erosion, use bio-engineering measures rather than hard engineering whenever feasible.	Creek corridor and riparian area management	2	2	-1	-1	2	2, 4	Municipalities (streamside property owners)		X	X	Property owners, municipalities	M-H
24	Pursue channel conveyance and stability improvements as possible during development and redevelopment, such as, channel maintenance or restoration, daylighting, and removing invasives and replanting with native vegetation. When replacing hydraulic structures that are inadequate or are nearing the end of their service life, use the opportunity to daylight and naturalize the creek, as possible.	Creek corridor and riparian area management	3	2	-2	-1	2	2, 3, 4	Municipalities		X	X	Developer	M

ACTION LIST FOR WATERSHED MANAGEMENT

ACTION NO.	ACTIONS	TOPIC	RATING: Environmental	Social	Capital cost	Operating cost	Fundability	GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TIMING: Capital	Operational	Opportunistic	FUNDING SOURCE	PRIORITY (H, M, L)
25	In institutional areas, request that schools, hospitals, and other institutions in the watershed develop stormwater management plans and include green infrastructure actions into the plan.	Education and outreach	3	2	-1	0	2	1	BCI (institutions)		X		Institutions	H
26	Identify and contact landowners with streamside properties and provide information on what is happening in the creek and ways they can contribute to creek health.	Education and outreach	3	3	0	-1	3	1	BCI (community groups)		X		Grants	H
27	Encourage voluntary action by developing and delivering workshops and educational materials on various subjects and needs including: ✓ best on-site stormwater management practices for builders and developers, ✓ low impact development (stormwater management) for municipal managers and councils and the public ✓ workshops and/or educational materials for residential land owners on topics that include: ✓ rain gardens, ✓ installation of rain barrels, ✓ disconnection of roof leaders, ✓ protecting streamside vegetation, ✓ planting native species, ✓ lawn and garden management to maximize infiltration, ✓ installation of pervious areas, ✓ car washing, oil leaks and paint disposal, and ✓ eliminating deposition of deleterious substances into the drainage system.	Education and outreach	3	3	0	-1	3	1	BCI (public groups)		X	X	Grants	M
28	Identify and contact owners of properties with large impervious surfaces and provide information on pervious surface technology and stormwater detention and infiltration.	Education and outreach	2	2	0	-1	2	2	Municipalities (BCI)		X	X	Grants	M-H
29	Continue to increase awareness and encourage action in the Bowker Creek watershed by: ✓ organizing and profiling community events such as walking tours, educational exhibits, the Annual Bowker Creek Rubber Duck Race and Clean-up, and community celebrations. ✓ maintaining good media relations including relationship building with key media contacts, media releases, promotion of special events, and updates on achievements. ✓ providing information on the watershed, the plans, and community efforts to the public and local media through marketing materials, displays, advertisements, the Bowker Creek Initiative website, and television.	Education and outreach	2	3	0	-1	3	1	BCI		X		Grants, BCI operating budget	M-H
30	Provide regular updates to elected officials and partners through annual reports, staff reports and updates, and presentations.	Education and outreach	0	3	0	-1	3	1	Municipalities		X		Municipal operating budget	M-H
31	Provide regular updates and outreach to residents and other watershed users through websites, Bowker Creek list serve, other list serves, community newsletters, other media, displays at community events, and presentations to community associations and groups.	Education and outreach	0	3	0	-1	3	1	BCI		X		Grants, BCI operating budget	M
32	Incorporate public art in rain-gardens and key locations, to highlight creek and watershed attributes.	Education and outreach	0	3	-1	0	2	1	Municipalities (community groups)			X	Grants, developers	M
33	Establish a list of potential student restoration projects and liaise with UVic, Camosun, and high schools.	Education and outreach	0	3	0	-1	3	1	Community groups		X		Grants	M

APPENDIX B

BOWKER CREEK REACH MAP FOR APPENDIX B



BOWKER CREEK REACH MAP FOR APPENDIX B

APPENDIX B—ACTIONS TO IMPROVE THE CREEK CORRIDOR

A list of detailed, reach-specific actions is presented in this appendix. These actions are designed to achieve the vision, goals, and objectives put forward in the Bowker Creek Watershed Implementation Plan (2003). Municipalities, community groups and land owners can use the actions in this plan to incorporate into organizational plans and operating budgets. This plan is a guide to action and cannot mandate any group to carry out the actions.

Reach-specific action items were developed for the 17 Bowker Creek reaches. See Reach Map on the opposite page and the Reach Characteristic Table on the next page. The recommended actions range from small restoration efforts such as invasive species removal, to large projects such as daylighting sections of the creek. The suggested hydraulic upgrades were adopted mainly from the Master Drainage Plan. Actions related to greenways were based on the 2007 Bowker Creek Proposed Greenways map (Map 5 in this document). Creek restoration recommendations were based on the more detailed information found in Appendix C: Bowker Creek Channel Restoration Prescriptions; developed in March 2009 by the Bowker Creek Initiative Coordinator.

REACH NUMBERS

The base maps and information from the *Bowker Creek Watershed Proper Functioning Condition Assessment* (PFCA) (Barraclough, et al., 2007) and the *Bowker Creek Master Drainage Plan* (MDP) (Kerr Wood Leidal, 2007) were used to delineate reaches for the creek and the main tributary that flows through Cedar Hill Golf Course. The MDP defines 103 creek reaches, while the PFCA delineates 16 open sections of the creek. To keep the number of creek reaches to a manageable amount for developing actions and to include both open and closed sections, the creek was sectioned into 17 reaches for the Blueprint (See Reach Map on the opposite page). Integrated, location specific actions were developed for each reach. The location and description of each reach is presented in maps and photographs on the page before the action table.

ACTION NUMBERS

The numbering system for the creek reach actions includes the Blueprint reach number, a hyphen, and then an action number; for example, the first action in reach 1 is numbered 1-1. The numbering system for the watershed-wide actions is assigned sequentially (Appendix A).

RATING CRITERIA

Environmental, social, and economic factors need to be integrated into the implementation plan actions. To ensure that these factors were considered for each action, a set of criteria was developed. Each action or set of actions were rated using the criteria presented in Table 9 (see Appendix A). The ratings were not summed to show a total score as the committee believed that it was difficult to compare actions based on the sum alone.

GOALS ADDRESSED BY THE ACTION

The action tables specify which of the following Bowker Creek Watershed Management Plan goals the actions meet:

Goal 1.	**Individuals, community and special interest groups, institutions, governments, and businesses take responsibility for actions that affect the watershed**
Goal 2.	**Manage flows effectively**
Goal 3.	**Improve and expand public areas, natural areas, and biodiversity in the watershed**
Goal 4.	**Achieve and maintain acceptable water quality in the watershed**

LEAD AGENCY (SUPPORTING ORGANIZATIONS)

The action tables define which organization is responsible for implementing the action and any potential supporting organizations.

TYPE

Each action is categorized as:

- capital—is a capital cost action,
- operational—should be integrated into operational work programs, or
- opportunistic—should be implemented as opportunities come up, such as when funding is available or during redevelopment of the area.

FUNDING SOURCE

Potential funding sources are identified. Some funding sources are more specific than others, and further research into specific funding sources for some of the actions is needed. Funding sources will change with shifting government priorities and this column should be re-evaluated on a regular basis.

PRIORITY

The Bowker Creek Initiative Steering Committee assigned each action a high, medium, or low priority.

CHARACTERISTICS OF BOWKER CREEK REACHES

BLUE-PRINT REACH	LOCATION	DESCRIPTION	RIPARIAN VEGETATION	ISSUES: Invasive species	Channelized	Conveyance	Flooding	Erosion
1	Monteith St. to creek mouth	**Open**. Flows in an open channel east and southeast from Monteith Street along the Monteith Street Community gardens, through private property to the ocean. The creek is entirely armoured below Beach Drive and has patches of armouring above Beach Drive.	**Mainly dominated by invasive (yellow willow, English ivy) and non-native vegetation and grass.** Native species: cottonwood, cedar, Garry oak, bigleaf maple, Douglas-fir, poplar, alder, mock orange, rose, red-osier dogwood, oceanspray, snowberry, vine maple, bracken fern, water parsley. Bioengineering stakes of pacific/sitka/scouler's willow are also present. Non-native and invasive species: yellow willow, English ivy, cherry, laburnum, weeping willow, Himalayan blackberry, knotweed, buttercup, daphne, morning glory, laurel, holly, thistle, policeman's helmet, lawn variety grasses	X	X	X	X	X
2	St. Ann St. to Monteith St.	**Enclosed.** Flows eastward through a pipe under Fireman's Park to St. Ann Street.	N/A			X	X	
3	Downstream of Oak Bay Tennis Bubble to St. Ann St.	**Open.** Flows east and southeast in an open armoured channel through part of the Oak Bay Recreation Centre property, Oak Bay High School and Bowker Creek Park.	**Mainly invasive species and grass with isolated pockets of landscaped native and non-native trees and shrubs. Some non-native shrubs overhang the channel and provide cover.** Native species: cedar, cottonwood, Garry oak, birch, , red-osier dogwood, mahonia, alder, bigleaf maple, snowberry, oceanspray Non-native and invasive species: Himalayan blackberry, yellow willow and European nightshade, tulip tree, buddlea, lawn variety grasses, Japanese knotweed in the channel at one location	X	X	X	X	X
4	Oak Bay Tennis Bubble	**Enclosed.** Flows southeast through a pipe beneath the Oak Bay Tennis Bubble.	N/A			X	X	
5	Cadboro Bay Rd. to Oak Bay Recreation Centre	**Open.** Flows in an open channel southeast from Cadboro Bay Road, through the Oak Bay Recreation Centre to the culvert beneath the tennis bubble. The creek is entirely armoured between Bee Street and Cadboro Bay Road and partially armoured downstream.	**Mature trees such as bigleaf maple and cottonwood, no vegetation in armoured sections.** Native Species: Douglas-fir, cottonwood, bigleaf maple, alder, red-osier dogwood, snowberry, rose, water parsley, cattails Non-native and invasive species: laburnum, yellow willow, English hawthorn, Scotch broom, Himalayan blackberry, European bittersweet, English ivy, daphne, grass	X	X	X	X	X
6	Trent St. to Cadboro Bay Rd.	**Enclosed.** Flows east through a pipe from Trent Street, south along Foul Bay Road, and southeast to Cadboro Bay Road.	N/A			X	X	
7	Richmond Rd. to Trent St.	**Open.** Flows in an open armoured channel southeast through the BC Hydro property, St. Patrick's School and the Royal Jubilee Hospital.	**Mainly invasive species (80%+) except for 45 m restored section of native riparian vegetation at St. Pat's school and the large native trees on the BC Hydro lands**. Native species: cottonwood, black hawthorn, pine, Douglas-fir, hemlock, cedar, spruce, native willows, alder, red-osier dogwood, snowberry, rose, mock orange, red-flowering currant, swordfern, scirpus Non-native and invasive species: yellow willow, reed canary grass, Himalayan blackberry, broom, English ivy, buttercup, cherry, holly, daphne, grass, daffodil, fennel	X	X	X	X	X
8	Newton St. to Richmond Rd.	**Enclosed.** Flows south and southeast through a pipe from Newton Street to Richmond Street including under the Spirit Garden right-of-way.	N/A			X	X	
9	Pearl St. to Newton St.	**Open.** Flows southeast in a deep eroding open channel beside the Townley Street right-of-way and through the former Richmond Elementary to Newton Street.	**Mainly invasive (>90%) trees (yellow willow) and shrubs (Himalayan blackberry).** Native species: cottonwood, black hawthorn, red-osier dogwood Non-native and invasive species: yellow willow, Himalayan blackberry, broom, English ivy, holly, laurel	X	X	X	X	X

BLUE-PRINT REACH	LOCATION	DESCRIPTION	RIPARIAN VEGETATION	ISSUES: Invasive species	ISSUES: Channelized	ISSUES: Conveyance	ISSUES: Flooding	ISSUES: Erosion
10	Clawthorpe Ave. to Pearl St.	**Enclosed.** Flows southeast through a pipe along Doncaster Ave., and east along Pearl St. to just before Townley Street.	N/A			X	X	
11	North Dairy Rd. to Clawthorpe Ave.	**Enclosed.** Flows west through a pipe along North Dairy Rd., and southwest along Clawthorpe Ave. to Doncaster Dr.	N/A				X	
12	Knight Ave. to North Dairy Rd.	**Open.** Flows southwest in an open partially armoured channel through Browning Park, private residences and road right-of-ways to Shelley St. and North Dairy Rd.	**Narrow riparian of mainly invasive species (yellow willow, Himalayan blackberry) and some larger deciduous trees sections, lawns abut creek in many areas** Native species: bigleaf maple, native willows in bioengineering, snowberry, Indian-plum, cottonwood, Douglas-fir, grand fir Non-native and invasive species: Himalayan blackberry, yellow willow, English hawthorn, English ivy, holly, ornamental trees, daphne, lamium, cedar hedge	X	X	X	X	X
13	Garnet Rd. to Knight Ave.	**Enclosed.** Generally flows south through a pipe from Garnet Rd. to Knight Ave. along Shelbourne St., a highly developed, commercial and transportation corridor.	N/A			X	X	
14	Gordon Head Rd. to Garnet Rd.	**Enclosed.** Flows west through a pipe just south of Mackenzie Ave. to Garnet Rd.	N/A			X	X	
15	University Club of Victoria to Gordon Head Rd.	**Open.** Flows in an open channel from the headwaters at the University Club of Victoria through the University of Victoria to Gordon Head Road.	**Variable riparian buffer consisting of mainly native (.75%) deciduous and coniferous trees with mostly native shrub understory.** Native Species: Douglas-fir, alder, trembling aspen, bigleaf maple, cottonwood, grand fir, willow, alder, garry oak, cedar, red-osier dogwood, snowberry, salmonberry, trailing blackberry, salal, Oregon grape, birch, bracken fern, swordfern, piggyback plant, skunk cabbage, cattail, pacific water parsley Non-native and invasive species: rhododendron, English hawthorn, Himalayan blackberry, ivy, holly, buttercup, reed canary grass	X				
16	Cedar Hill Golf Course to Clawthorpe Ave.	**Enclosed.** Flows through a pipe beginning immediately south of the Cedar Hill Recreation Centre east along North Dairy Rd. and southeast along Doncaster Dr. to Clawthorpe Ave.	N/A				X	
17	Cedar Hill Golf Course	**Mainly open.** Flows southeast, mainly in an open channel, through the Cedar Hill Golf Course to Cedar Hill Rd.	**Variable riparian buffer of mainly native trees and shrubs in some areas with golf course grass abutting the creek in other areas. More invasives in the lower section.** Native species: Western red cedar, Douglas-fir, Oregon ash, cottonwood, native willow, alder, grand fir, Indian-plum, Nootka rose, snowberry, thimbleberry, equisetum, red-osier dogwood, red-flowering currant, hardhack, equisetum, skunk cabbage, pacific water parsley, rushes, water-plantain, watercress Non-native and invasive species: Cherry cultivar, Laburnum, holly, Himalayan blackberry, reed canary grass, poison hemlock, purple salsify, curly dock, cleavers, creeping buttercup, thistle, morning glory, lawn variety grasses		X		X	X

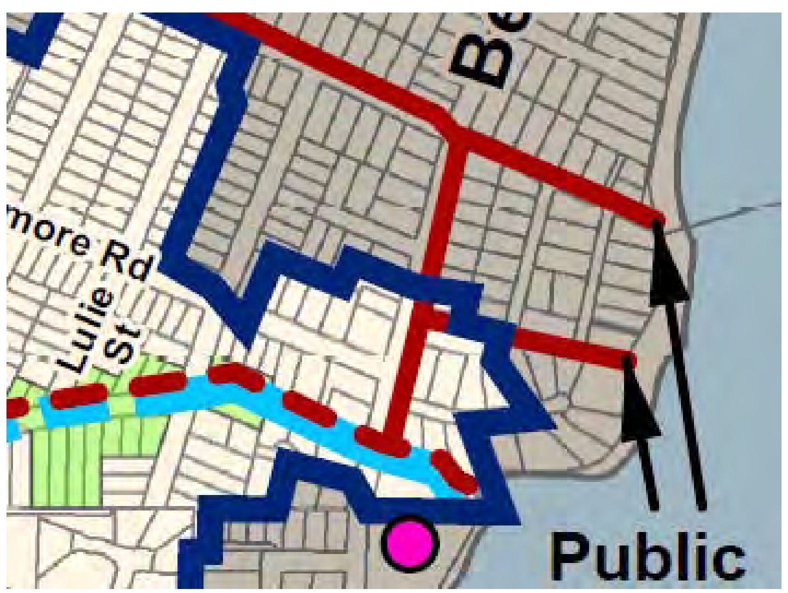
REACH 1: MONTEITH STREET TO CREEK MOUTH

Reach 1 flows in an open channel east and southeast from Monteith Street along the Monteith Street Community Gardens, through private property to the ocean. The riparian vegetation includes trees, shrubs, and grass. Invasive species include ivy and yellow willow and policeman's helmet. This reach has issues with invasive species, channelization, conveyance, flooding, and erosion. It has also been identified as having archaeological significance. The creek is entirely armoured below Beach Drive and has patches of armouring above Beach Drive. The uppermost section has one of the more natural creek channels in the watershed.

Reach location

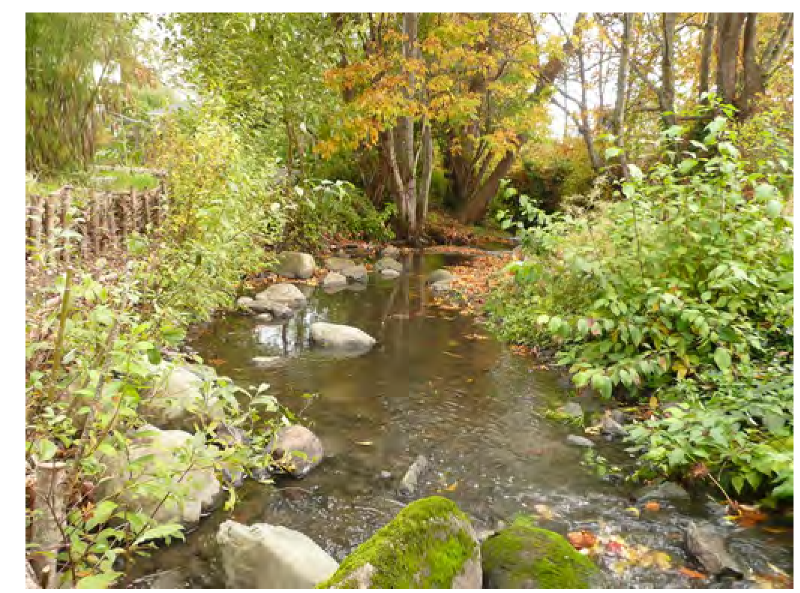

The creek mouth where it discharges to the ocean


View of the rock wall showing proximity of the apartment building to the creek



Proposed greenways


South-west corner of the Kachan property. Much of this corner has eroded away in recent years.

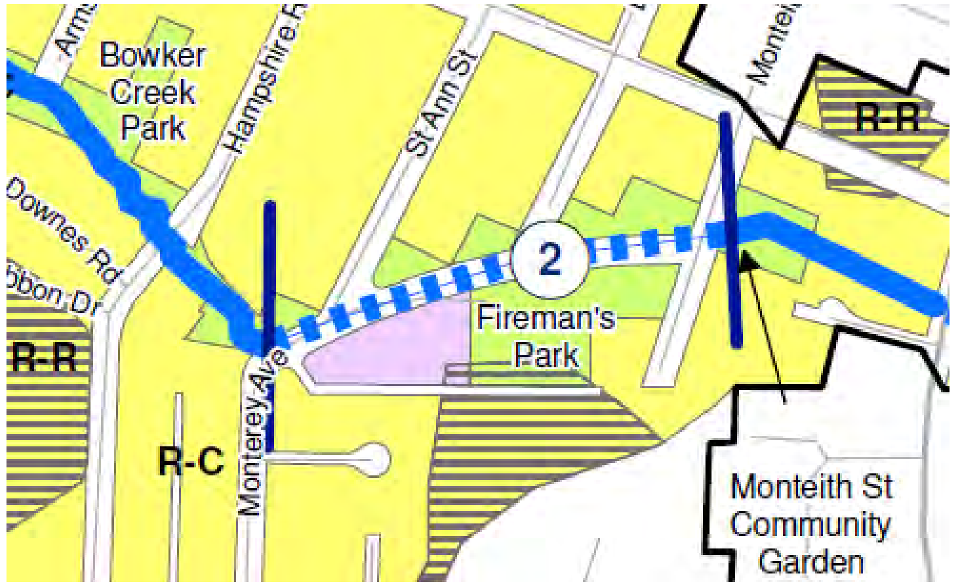

Downstream view of Reach 1 showing bioengineering on the left and a relatively new 'bar' in centre, created by an artificially dug channel.

Action List for Reach 1: Monteith Street to creek mouth

REACH-ACTION NO.	LOCATION	ACTIONS	RATINGS					WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE			FUNDING	PRIORITY (H, M, L)
			Environmental	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
1-1	Eastern edge of Monteith community gardens property to above Beach Dr.	If property owners agree, relocate or remove fences and remove fill to re-slope channel banks further back into the private property, on the steep north bank in particular. The south bank is less steep and in better condition but could still use a widened riparian buffer. Remove invasive species and plant native trees and shrubs. If the space available is limited, the north bank could be terraced using willow wattles. If possible, include space for a greenway.	3	2	-1	-1	1	2, 3, 4	Oak Bay (BCI, community groups, property owners)		X	X	Property owners, Oak Bay, grants for buying native vegetation, grants for channel restoration	M
1-2	Monteith Street Community Gardens	Remove policeman's helmet (*Impatiens glandulifera*) from the community gardens on an annual basis until eradicated. Note: this is an archaeological site.	3	2	0	-1	3	3	Oak Bay (BCI, community groups)		X		Oak Bay Parks staff time	H
1-3	Monteith Street Community Gardens	On the south bank, funding is in place to purchase native plants to improve the riparian buffer (10-15 m wide strip) and remove invasive species. Note: this is an archaeological site.	3	3	-1	0	3	2, 3, 4	Oak Bay (BCI, community groups)		X		TD Friend of the Environment Fund	H
1-4	Monteith Street Community Gardens	On the north bank, reclaim riparian area with native plants, re-slope the bank and relocate affected garden plots. Install in-stream structures to improve in-channel conditions if other improvements are completed. Note: this is an archaeological site.	3	1	-1	-1	2	2, 3, 4	Oak Bay (BCI, community groups)			X	Grants, Oak Bay for relocating garden plots	M
1-5	Monteith St. to creek mouth	Create a greenway along this reach that connects to Fireman's Park and Beach Drive greenway (refer to Map 5). Partial or full acquisition of land or a right-of-way would be required from the creek mouth to the community gardens. Complete extensive creek restoration as part of this work, including reducing bank slopes, increasing riparian buffer width, removing invasive species and planting native vegetation.	3	2	-3	-1	1	1, 3	Oak Bay (BCI)			X	Large grant program and municipality, provincial funding	M
1-6 preferred	Beach Drive culvert	Replace undersized Beach Drive culvert with a bridge. The underside of the bridge should be above the 25-year water level and the asphalt creek bottom should be removed and reshaped to eliminate this fish barrier. Maintain existing upstream channel dimensions under roadway.	2	2	-2	-1	1	2	Oak Bay	x			Municipality, grants, provincial funding	M
1-6 alternative	*Beach Drive culvert*	*Replace undersized Beach Drive culvert with a 7.0 x 1.8 m box culvert with the bottom lowered to eliminate fish barrier. See Master Drainage Plan.*	2	2	-2	-1	1	2	Oak Bay	x			Municipal operating budget	L
1-7	Below Beach Drive to creek mouth	Remove invasive knotweed (*Polygonum* spp.) in the channel (and on land if property owners agree).	3	1	0	-1	3	3	Oak Bay (BCI)		X		Small grants, municipal operating budget	H
1-8	Below Beach Drive to creek mouth	Control erosion at 1725 Beach Drive apartment building by installing bioengineering terraces if the property uses allow. With redevelopment or landowner involvement, the concrete and rock walls can be removed or set back and the creek banks sloped back and planted with native vegetation. Changes on the south bank could only occur with redevelopment, while changes on the north bank are possible with landowner involvement. If possible, include space for a greenway.	3	2	-2	-1	2	2, 3, 4	Oak Bay, (property owners, BCI)			X	Property owners, Oak Bay, grants for buying native vegetation, grants for channel restoration	M

REACH 2: ANN STREET TO MONTEITH STREET

Reach 2 flows eastward from St. Ann Street through a pipe under Fireman's Park to Monteith Street. This reach has conveyance and flooding issues.



Reach location

Proposed greenways

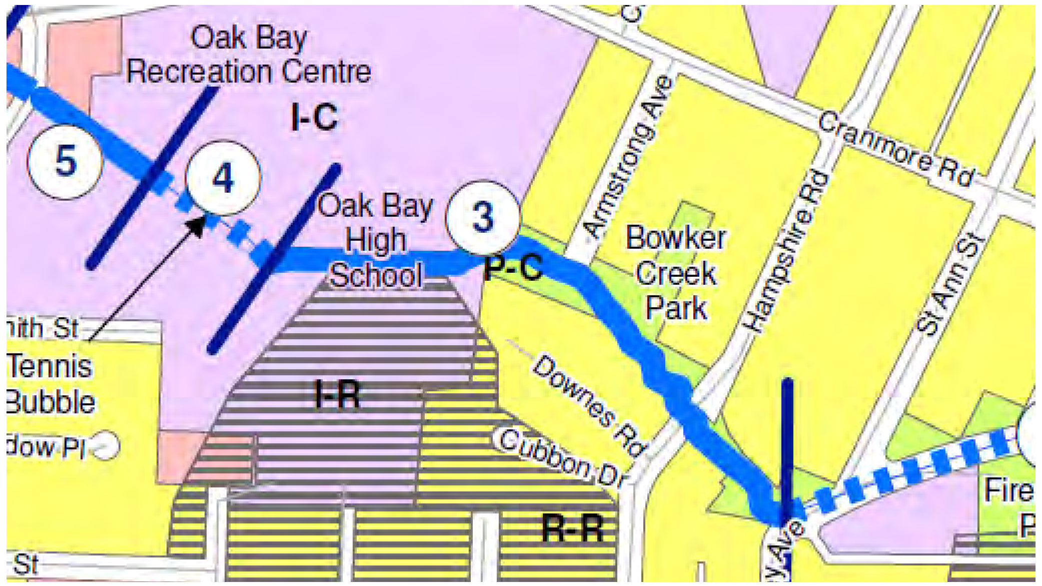
Fireman's Park, during a May 2009 watershed tour for municipal councillors

ACTION LIST FOR REACH 2: ST. ANN STREET TO MONTEITH STREET

REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	TYPE: Operational	TYPE: Opportunistic	FUNDING	PRIORITY (H, M, L)
2-2	Fireman's Park	Install a berm along the east side of Fireman's Park to protect property on Monteith Street from flooding by directing overland flow back to the creek.	1	2	-1	-1	3	2	Oak Bay		X		Oak Bay	M
2-3 preferred	Fireman's Park	Daylight creek and create a greenway from Monterey Avenue to Monteith Street (parking may need to be reconfigured). Retain existing storm drain as high flow bypass. Detailed design of this action is needed. To reduce impacts to the community, if possible, relocate eastern Fireman's Park baseball field to another location in Oak Bay. See Figure 9 for a restoration concept for this location.	3	2	-3	-1	1	1, 2, 3, 4	Oak Bay		X		Assistance to make changes at Fireman's park - daylighting, greenway, from federal/provincial sources. Cost of new baseball diamond to Oak Bay	H
2-3 alternative	*Fireman's Park*	*To address inadequate hydraulic capacity of existing storm drain, add 3.1 m x 2.44 m box culvert. See Master Drainage Plan for more details.*	0	2	-2	0	1	2	Oak Bay		X		Oak Bay operating budget	L

REACH 3: DOWNSTREAM OF OAK BAY TENNIS BUBBLE TO ST. ANN STREET

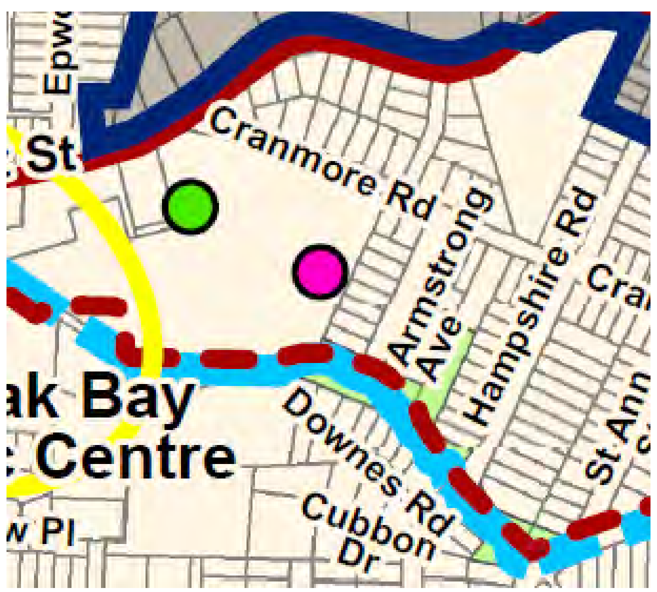
Reach 3 flows east in an open armoured channel through Oak Bay High School and southeast through Bowker Creek Park to St. Ann Street. The riparian vegetation includes young native trees, yellow willow and blackberry in the high school section, and grass with isolated pockets of landscaped native and non-native trees and shrubs through Bowker Creek Park. This reach has issues with invasive species Japanese Knotweed, channelization, conveyance, and flooding.



Reach location

Culvert exiting from under the tennis bubbles at the top of Reach 3

Narrow creek corridor between athletic track (left) and school property (right)



Proposed greenways

Typical concrete channel wall.

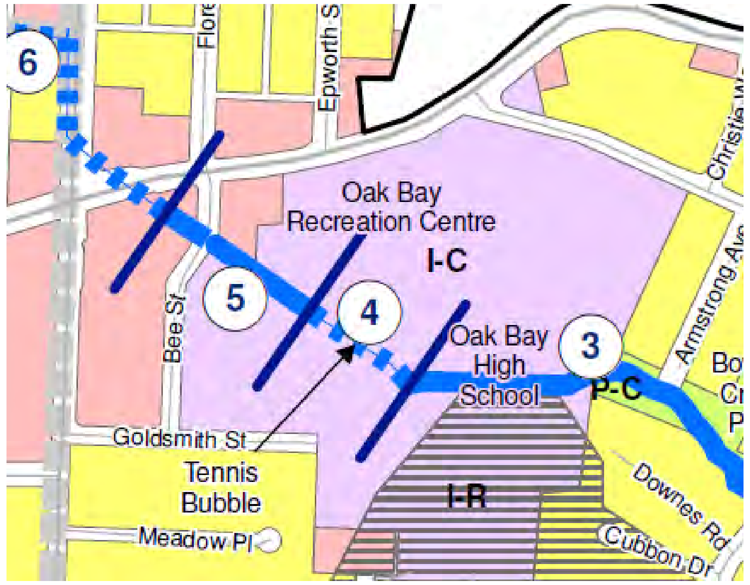
Natural sediments accumulate in the lower part of this reach

ACTION LIST FOR REACH 3: DOWNSTREAM OF OAK BAY TENNIS BUBBLE TO ST. ANN STREET

REACH-ACTION NO.	LOCATION	ACTIONS	RATING					WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING AGENCIES)	TYPE			FUNDING SOURCE	PRIORITY (H, M, L)
			Environmental	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
3-1	Downstream of Oak Bay Tennis Bubble to St. Ann St.	Create a greenway along this reach.	2	3	-1	-1	2	1, 2, 3, 4	Oak Bay		X	X	Provincial funding plus municipal operational budget	H
3-2	Downstream of Oak Bay tennis bubble to Oak Bay High School	Downstream of tennis bubble, remove box culverts and construct a foot bridge above the 25-year high water level between the athletic track and Oak Bay High School. Seek opportunities to reconfigure the channel. Move the north bank further into Oak Bay High School property by at least 10 m. Re-grade the north bank and vegetate with native species. Create earth-filled terraces against the existing concrete wall on the south bank to create a naturally vegetated streambank (leaving the adjacent athletic track intact). Install large rocks in the creek to create structure and to dissipate creek flow energy, and if the bottom is concrete lined, remove to create a naturalized bottom. Install a new greenway along the improved reach. See Figure 10 for a restoration concept for this location.	3	3	-2	-1	1	1, 2, 3, 4	Oak Bay (School District, BCI)		X	X	School District, Provincial, and smaller grants for plants	H
3-3	Oak Bay High School	Become involved in the planning or public input process to redevelop Oak Bay High School, so that improvements to Bowker Creek can be incorporated into the changes. Possible opportunity for an outdoor classroom creekside.	3	3	0	0	3	1, 2, 3, 4	BCI (Oak Bay)			X		H
3-4	Bowker Creek Park	Remove invasive knotweed (*Polygonum* spp.).	3	2	0	-1	3	3	Oak Bay		X		Oak Bay operations budget	H
3-5	Bowker Creek Park	Use more native plants in landscaping along channel edge. Replace grassed areas along channel with overhanging vegetation. Plant more native vegetation such as spirea and cattail in the backwater of the large pond.	2	2	-1	0	2	2, 3, 4	Oak Bay		X		Oak Bay Parks budget	M
3-6	Bowker Creek Park	Recreate a natural-bottomed creek bed using the current channel footprint. Remove the concrete lined bottom and sides, and grade the banks back or use terraces to support native vegetation along the banks. In locations where space is tighter, use the existing concrete walls to create planting benches. Plant native vegetation.	3	2	-1	0	1	3, 4	Oak Bay, BCI		X	X	Provincial and federal	H
3-7	Hampshire Road culvert	Increase hydraulic capacity at Hampshire Road by raising road by approximately 1.2 m and constructing a bridge with an underside above the 25-year water level. Maintain the existing channel dimensions through the road right-of-way.	1	2	-2	-1	1	2	Oak Bay		X	X	Grants, municipal operating budget	M

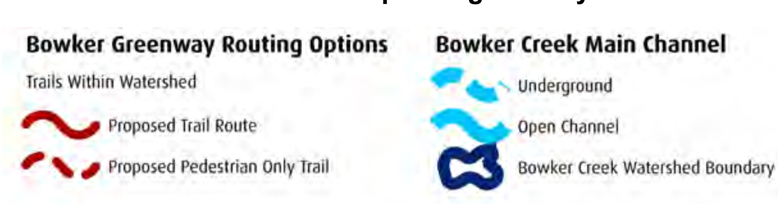
REACH 4: OAK BAY TENNIS BUBBLE

Reach 4 flows southeast in a pipe beneath the Oak Bay Tennis Bubble. This reach has conveyance issues.



Reach location

Proposed greenways



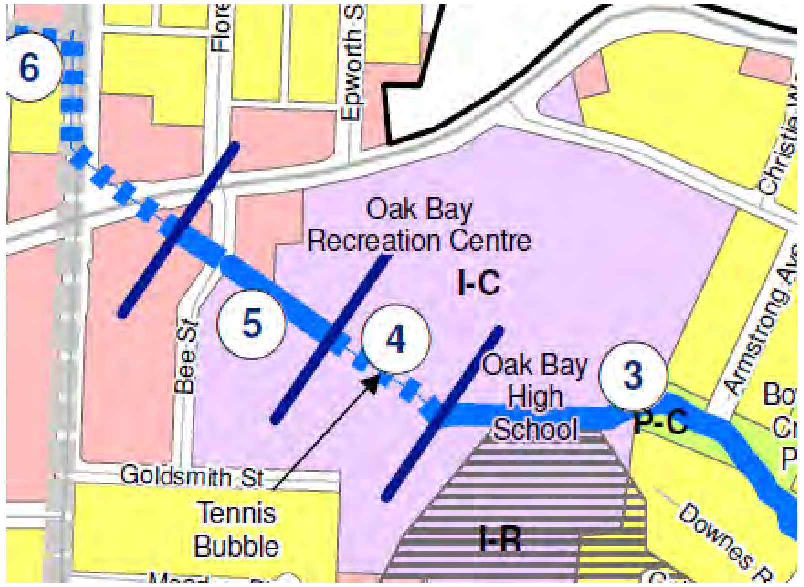
Bowker Creek emerging from under the tennis bubble

ACTION LIST FOR REACH 4: OAK BAY TENNIS BUBBLE

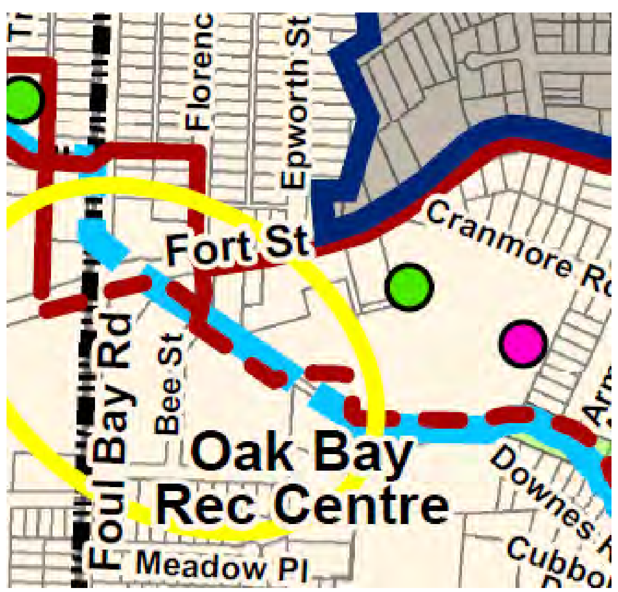
REACH-ACTION NO.	LOCATION	ACTIONS	RATING					WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE			FUNDING SOURCE	PRIORITY (H, M, L)
			Environmental	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
4-1	Oak Bay Tennis Bubble	Improve by adding native trees pedestrian and bike access through this area as part of regional greenways planning.	2	3	-1	-1	1	3	Oak Bay		X	X	Municipal budget and provincial grants	H
4-2 preferred	Oak Bay Tennis Bubble	If the tennis bubble is relocated (e.g., in concert with changes at Oak Bay High School), daylight the creek and improve the channel geometry and sinuosity to create more natural conditions and opportunities for a riparian buffer. Create a greenway along this reach. See Figure 10 for a restoration concept for this location.	3	2	-3	-1	1	2, 3, 4	Oak Bay		X	X	Municipal budget and provincial grants	H
4-2 alternative	*Oak Bay Tennis Bubble*	*During redevelopment, to increase hydraulic capacity, lower channel and add 2 – 2.44 m by 3.66 m box culverts.*	0	2	-2	0	1	2	Oak Bay		X	X	Municipal budget and provincial grants	L

REACH 5: CADBORO BAY ROAD TO OAK BAY RECREATION CENTRE

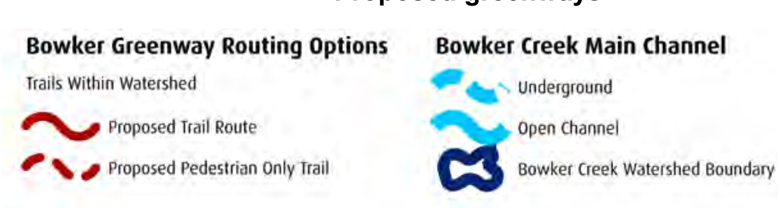
Reach 5 flows in an open channel from Cadboro Bay Road southeast to the Oak Bay Recreation Centre where it enters a pipe under the Oak Bay Tennis Bubble. The riparian vegetation at this reach includes trees, such as big leaf maple and cottonwood, blackberry, and an armoured section with no vegetation. The creek is entirely armoured between Bee Street and Cadboro Bay Road and partially armoured downstream. This reach has issues with invasive species, channelization, conveyance, flooding, and erosion.



Reach location



Proposed greenways



Reach 5 beside the Oak Bay Recreation Centre, looking downstream from Bee Street. Note the steep banks and mix of invasive and native vegetation.

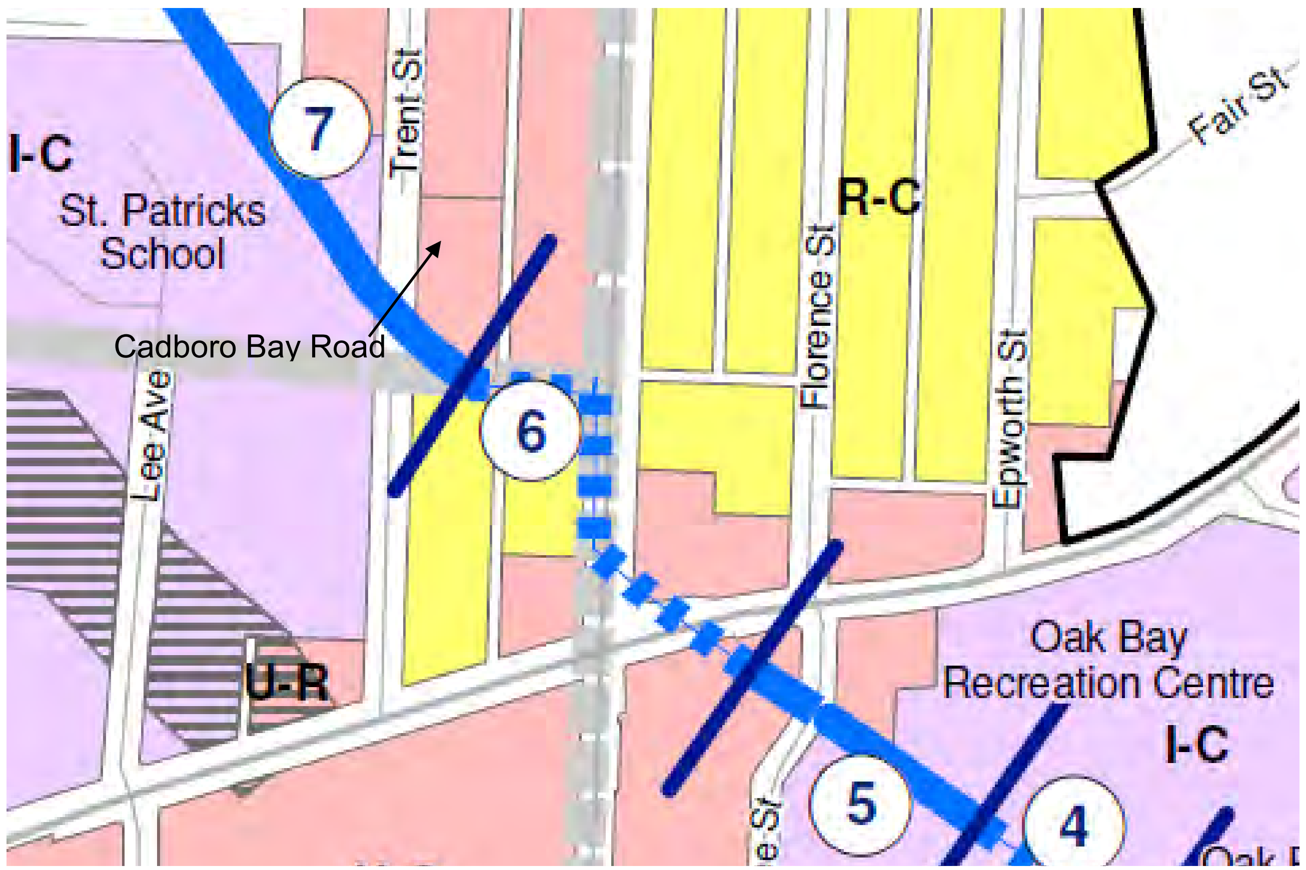
Looking upstream from Be Street. Few options exist to improve this reach. One possibility is installing in-stream baffles for complexity and aeration.

ACTION LIST FOR REACH 5: CADBORO BAY ROAD TO OAK BAY RECREATION CENTRE

REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	TYPE: Operational	TYPE: Opportunistic	FUNDING	PRIORITY (H, M, L)
5-1	Cadboro Bay Road to Bee Street	Widen channel and/or install baffle or boulders for in-channel complexity. Review potential for relocating creek to create a more meandering, wider corridor if adjacent land is proposed for redevelopment.	2	2	-2	-1	1	2, 3, 4	Oak Bay (BCI)		X	X	Provincial related to greenways, climate	M
5-2	Bee Street	To increase hydraulic capacity, install a bridge with same width as proposed upstream channel and with underside above 25-year water level which includes the climate change projections.	2	2	-1	-1	1	2	Oak Bay		X		Oak Bay operating budget	M
5-3	Bee Street to Oak Bay Recreation Centre upstream of Tennis Bubble	Changes to Oak Bay High School create opportunities to improve the creek on the north side of the existing channel. Widen channel and create more gradual side slopes (slope will be based on detailed design and site constraints). Plant native vegetation along banks. Create a greenway along the south side of the creek. This action would require at least 10 m of additional space along the creek corridor, and would affect parking at the Oak Bay Recreation Centre A detailed design is needed that could include a strategy to replace the lost parking. See Figure 10 for a restoration concept for this location.	3	3	-2	-1	1	2, 3, 4	Oak Bay (BCI)		X	X	Provincial related to greenways, climate	M-H
5-4	Cadboro Bay Road to Oak Bay Recreation Centre	Create a greenway along the creek and greenways along Bee Street, Florence Street, and Cadboro Bay Road (refer to Map 5 for more details).	2	3	-2	-1	1	3	Oak Bay	X		X	Provincial funding plus municipal operational budget	H

REACH 6: TRENT STREET TO CADBORO BAY ROAD

Reach 6 flows east in a pipe from Trent Street, south along Foul Bay Road, and southeast to Cadboro Bay Road. This reach has conveyance issues.



Reach location

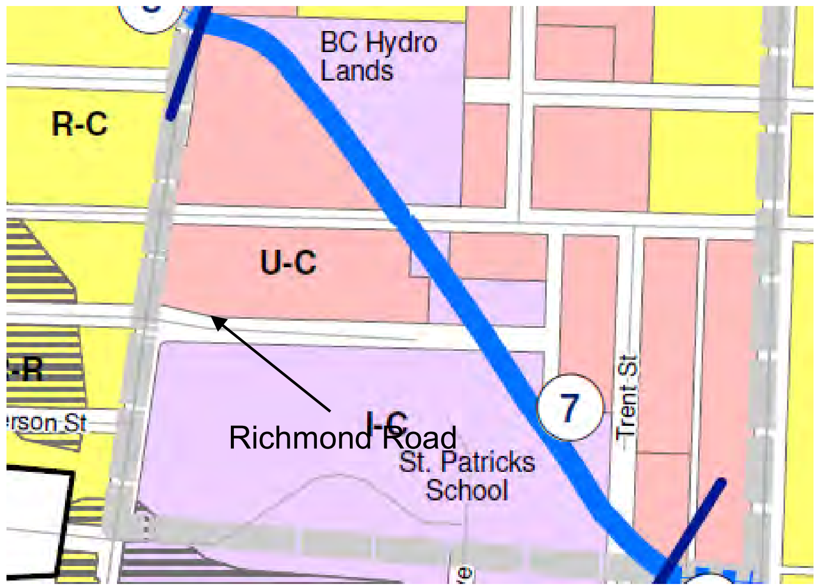
Proposed greenways

ACTION LIST FOR REACH 6: TRENT STREET TO CADBORO BAY ROAD

Reach-Action no.	Location	Actions	Rating					WMP GOALS ADDRESSED	Lead Agency (possible supporting partners)	Type			Funding	Priority (H, M, L)
			Environ-mental	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
6-1	Trent St. to Cadboro Bay Rd.	Create greenways in this corridor between Trent Street and Foul Bay Road, Florence Street, and through an unnamed road off Florence Street to the culvert west of Foul Bay Road (refer Map 5 for more details).	2	3	-2	-1	1	3	Oak Bay, Victoria, BCI		X	X	Grants, parks budget	M-H
6-2 preferred	Trent St. to Cadboro Bay Rd.	If major redevelopment occurs, seek opportunity to relocate, meander, and daylight creek, and increase capacity to deal with flooding issues. A detailed design is needed.	3	2	-3	-1	1	2, 3, 4	Oak Bay, Victoria, BCI		X	X	Developer	H
6-2 alternative	*Trent St. to Cadboro Bay Rd.*	*To increase hydraulic capacity, lower and upgrade to 2 - 3.66 x 3.66 box culverts.*	0	2	-2	0	1	2	Oak Bay, Victoria		X	X	Municipal operating budget	L

REACH 7: RICHMOND ROAD TO TRENT STREET

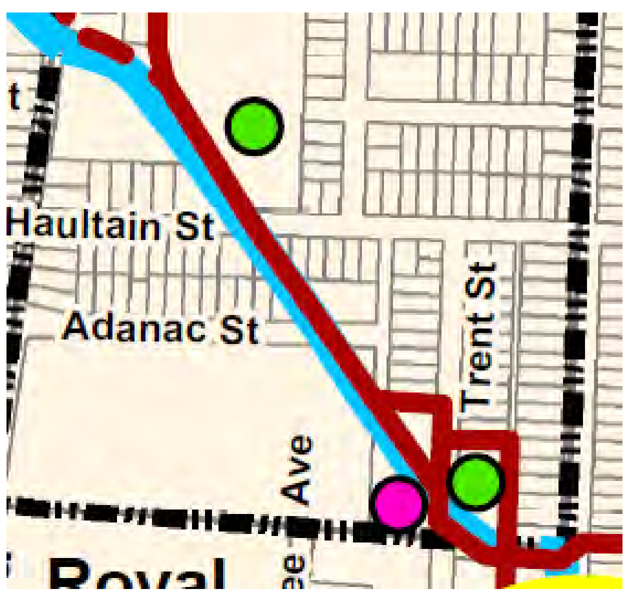
Reach 7 flows in an open partially armoured channel southeast through the BC Hydro property, the Royal Jubilee Hospital and St. Patrick's school. Creekside property is also owned by Saanich and the Bishop of Victoria. The riparian vegetation includes deciduous and coniferous trees, grass, blackberry, yellow willow, and native shrubs. This reach has issues with invasive species, channelization, conveyance, flooding, and erosion.



Reach location

The path along the BC Hydro portion of this reach is popular with neighbours The mature conifer trees that line the path are important to the community.

View across the creek toward the west bank. Bowker Creek is constrained along the west side of the Hydro property and restoration would entail expansion to the east.



Proposed greenways

View from the west bank across the creek to the triangle of land south of Haultain on the east bank. This area provides potential for widening the creek corridor.

The portion of the reach alongside the Royal Jubilee Hospital has some native vegetation and other areas of eroding grassy banks.

ACTION LIST FOR REACH 7: RICHMOND ROAD TO TRENT STREET

REACH-ACTION NO.	LOCATION	ACTIONS	RATING					WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE			FUNDING	PRIORITY (H, M, L)
			Environmental	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
7-1	BC Hydro property (1837 Kings Rd)	Meet with BC Hydro to discuss the future use and ownership of the BC Hydro land between Kings Road and Haultain Street. Discuss the possibility of turning all or part of the property into a park and greenway through a gift from BC Hydro, or if necessary, a land purchase.	3	3	0	0	3	1,2,3,4	BCI, Saanich		X		Regular operating budget	H
7-2 preferred	BC Hydro property (1837 Kings Rd)	If BC Hydro agrees, move and meander the channel eastward a minimum of 10 m to create a floodplain and riparian area. Re-slope the banks to a gentle grade. Create some slow moving off-channel areas as a public amenity and to improve water quality (some mature conifers would need to be removed and extensive public education and consultation would be needed; retain as many of these trees as possible). Create crayfish habitat and salvage crayfish from current creek location. Plant native riparian species in buffers 5-15 m wide, with key points for public viewing of the creek. As possible, create flood storage by locating the new channel in a floodplain (depression) that would retain some flood flows. Create a greenway path outside the riparian buffer with seating and interpretive signs. See Figure 11 for one possible restoration concept for this location.	3	3	-2	-1	1	1, 2, 3, 4	Saanich (BCI, BC Hydro)			X	BC Hydro provide land. Funding provincial or federal for works	H
7-2 alternative	*BC Hydro property (1837 Kings Rd)*	*In the short-term, re-slope the bank and plant with native vegetation 25 m downstream of Richmond Road culvert to control bank erosion.*	*2*	*1*	*-1*	*-1*	*2*	*4*	*Saanich (property owner)*		*X*		*Saanich operating budget*	*M*
7-3 preferred	Haultain Street Culvert	To increase hydraulic capacity of Haultain Street culvert, install a bridge with an underside above the 25-year water level.	1	2	-2	-1	1	2	Saanich		X	X	Saanich operating budget	H
7-3 alternative	*Haultain Street Culvert*	*To increase hydraulic capacity of Haultain Street culvert, lower and upgrade the Haultain Street culvert to a 4.00 x 3.60 m box culvert.*	0	2	-1	0	1	2	Saanich		X	X	Saanich operating budget	L
7-4	Haultain Street and lots immediately south of Haultain	In concert with changes to the BC Hydro property (Action 7-2), change the location of the creek crossing under Haultain Street to take advantage of the vacant triangle of land immediately south of Haultain Street and the residential lot to the east (if it comes on the market). Remove the gabions, widen the creek corridor, reduce bank slopes, and plant native vegetation. Create a greenway.	3	1	-2	-1	1	2,3	Saanich, BCI			X	Provincial or federal	M
7-5	Haultain Street to Trent Street	In the short-term, conduct ongoing management of yellow willow. Repair willow wattle structure 190 to 201 m downstream of Haultain Street culvert.	2	2	0	-1	3	3	Saanich		X		Saanich operating budget	M
7-6 preferred	Haultain to Trent Street (RJ Hospital and St. Patrick's School, Bishop of Victoria, Adanac Street ROW).	On an opportunistic basis, reshape the channel and create meanders, create a floodplain, gradual side slopes and a healthy riparian area. Build small off-channel wetlands as space permits. VIHA is interested in options that improve the creek running through their property, especially options that include the Adanac Street right-of-way and the Bishop of Victoria property. Include the St. Patrick's School property in this work as possible. Create a greenway (refer to Map 5 for more details). See Map 10 for an illustration of a restoration concept for this location.	3	3	-2	-1	1	2, 3, 4	Saanich (VIHA, Bishop of Victoria, BCI)			X	Provincial, federal	H
7-6 alternative	*St. Patrick's School only*	*If widening, meandering and relocating the creek corridor through St. Patrick's School is not feasible, create retaining walls and a small riparian area within the current bounds, or widen the creek corridor as much as possible to allow for yellow willow removal and bank slopes that will support native vegetation*	*2*	*1*	*-1*	*-2*	*1*	*2, 3, 4*	*Saanich (School Board, BCI)*			*X*	*Property owners, Saanich*	*L*
7-7	Trent to Pearl St.	Work with landowners between Trent and Pearl streets to achieve the long term vision (Blueprint action #9)						9	BCI					

REACH 8: NEWTON STREET TO RICHMOND ROAD

Reach 8 flows south in a pipe from Newton Street to Kings Road under the Spirit Garden right-of-way, and then southeast to Richmond Street. This reach has conveyance issues.

Reach location

Proposed greenways

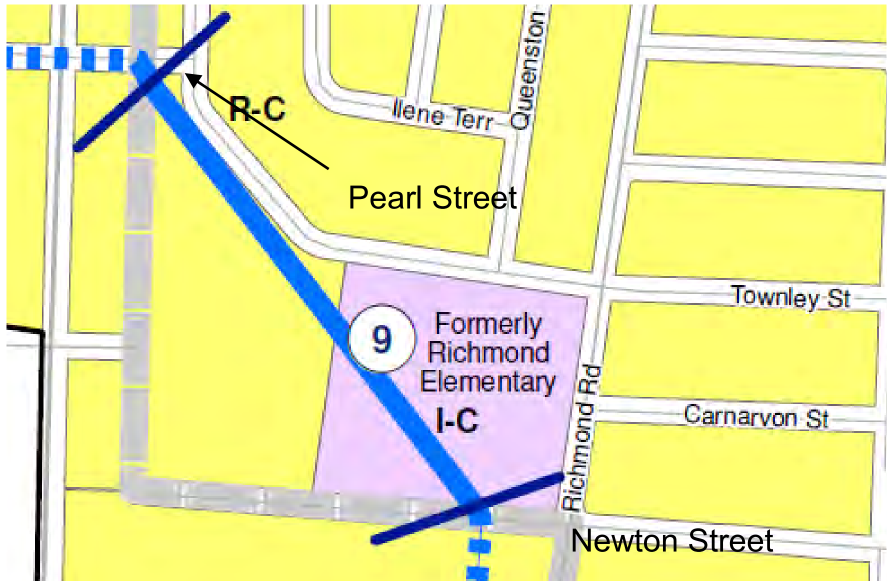
Walking through the Spirit Garden during the 2008 Bowker Creek Celebration

ACTION LIST FOR REACH 8: NEWTON STREET TO RICHMOND ROAD

REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	TYPE: Operational	TYPE: Opportunistic	FUNDING	PRIORITY (H, M, L)
8-1	Between Trent & Pearl streets	Work with landowners between Trent St. & Pearl St. to achieve the long term vision (Blueprint action #9)						9	BCI					
8-2	Newton Street to Richmond Road (including the Spirit Garden and Victoria right-of-way)	Create a greenway along the creek (refer to Map 5 for more details).	3	2	-2	-1	2		Saanich & Victoria (BCI)		X	X	Provincial or federal. Victoria	M
8-2 preferred	Newton Street to Richmond Road (including the Spirit Garden and Victoria right-of-way)	As possible or feasible, daylight and improve the creek along the greenway to increase its hydraulic capacity and environmental value. This could include property acquisition and the creation of a small park at the corner of Richmond and Newton Streets, extending south to Kings Road.	3	2	-3	-1	1		Saanich & Victoria (BCI)			X	Provincial or federal. Victoria	
8-2 alternative	*Newton Street to Richmond Road*	*To increase hydraulic capacity, upgrade to 2 - 3.10 x 2.44 m box culverts.*	0	1	-3	0	1	2	Victoria & Saanich		X	X	Saanich & Victoria operating budgets	L
8-3	Newton Street to Richmond Road (including the Spirit Garden and Victoria right-of-way)	Consider placing this area into a Development Permit area to enhance the creek when development takes place.	3	2	0	-1	3	3	Victoria & Saanich			X	Victoria policy decision	H

REACH 9: PEARL STREET TO NEWTON STREET

Reach 9 flows southeast in an open channel from Pearl Street, beside the Townley Street right-of-way, and through the former Richmond Elementary to Newton Street. The riparian vegetation includes trees and shrubs, mostly mature yellow willow, blackberry, scotch broom, red osier dogwood, black hawthorne, and snowberry. This reach has issues with invasive species, channelization, conveyance, flooding, and erosion.



Reach location

The right-of-way along Townley Street is relatively narrow, but still allows an opportunity to widen the creek corridor.

The west bank is constrained in the upper two-thirds of the reach by an extensive apartment complex at 1702 Newton Street.

Proposed greenways

Bowker Creek cuts through the former Richmond Elementary school grounds and is surrounded by fencing and fields on both sides

Erosion is an issue through the school grounds. The fence footings have been eroding and public access is worsening the issue.

ACTION LIST FOR REACH 9: PEARL STREET TO NEWTON STREET

REACH-ACTION NO.	LOCATION	ACTIONS	RATING						WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TIMING			FUNDING SOURCE	PRIORITY (H, M, L)
			Environmental	Social	Capital cost	Operating cost	Fundability	Total			Capital	Operational	Opportunistic		
9-1	Between Trent and Pearl streets	Work with landowners between Trent St. & Pearl St. to achieve the long term vision (Blueprint action #9)							9	BCI					
9-2	Pearl Street to Newton Street	Create a greenway along the creek (refer to Map 5 for more details). Most of this proposed greenway is through the former Richmond Elementary school grounds, which already has a right-of-way for this purpose, and the remainder could be created on the Townley Street right-of-way. If channel relocation occurs (see 9-4), the greenway location could be modified as appropriate.	3	3	-2	-1	1	4	3	Saanich (School District, BCI)			X	Provincial, federal, Saanich	H
9-3	Former Richmond Elementary	Replace and reposition fence that is falling over.	1	2	-1	0	2			School District		X		School District budget	M
9-4 preferred	Former Richmond Elementary School property only	On this site there is an opportunity to create a wider, healthier channel in the triangle to the west of the current alignment. See Figure 12 for a restoration concept in this location. Moving the channel west may accommodate different land uses by removing the channel that currently bisects the property. The new, relocated channel should have gently sloping banks and be planted with native species to create a riparian buffer. Opportunities for an outdoor classroom. The existing channel may provide opportunities to install an overflow pipe to accommodate the peak flows, while having the separate constructed channel providing more habitat and amenity values. The detailed design and site constraints will determine what occurs. A greenway should be created as part of these changes, and can follow the existing right-of-way, or be relocated alongside the new channel location.	3	3	-2	-1	2	5	2, 3, 4	Saanich, School District, (BCI, land developer)			X	Federal, provincial	H
9-4 alternative	*Former Richmond Elementary School property only*	*Widen the creek corridor within the current alignment. If the width is constrained, a retaining wall could be installed on the east bank to create a planting bench. Create a more gently sloping west bank and increase the width of the riparian areas. Remove invasive species and plant native species. Create a greenway along the creek in the current right-of-way alignment.*	2	2	-2	-1	1	0	2, 3, 4	Saanich (School District 61)			X	Saanich, School District 61	M

REACH 10: CLAWTHORPE AVENUE TO PEARL STREET

Reach 10 flows southeast from Clawthorpe Avenue in a pipe along Doncaster Drive, and east along Pearl Street to just before Townley Street. This reach has conveyance issues.

Reach location

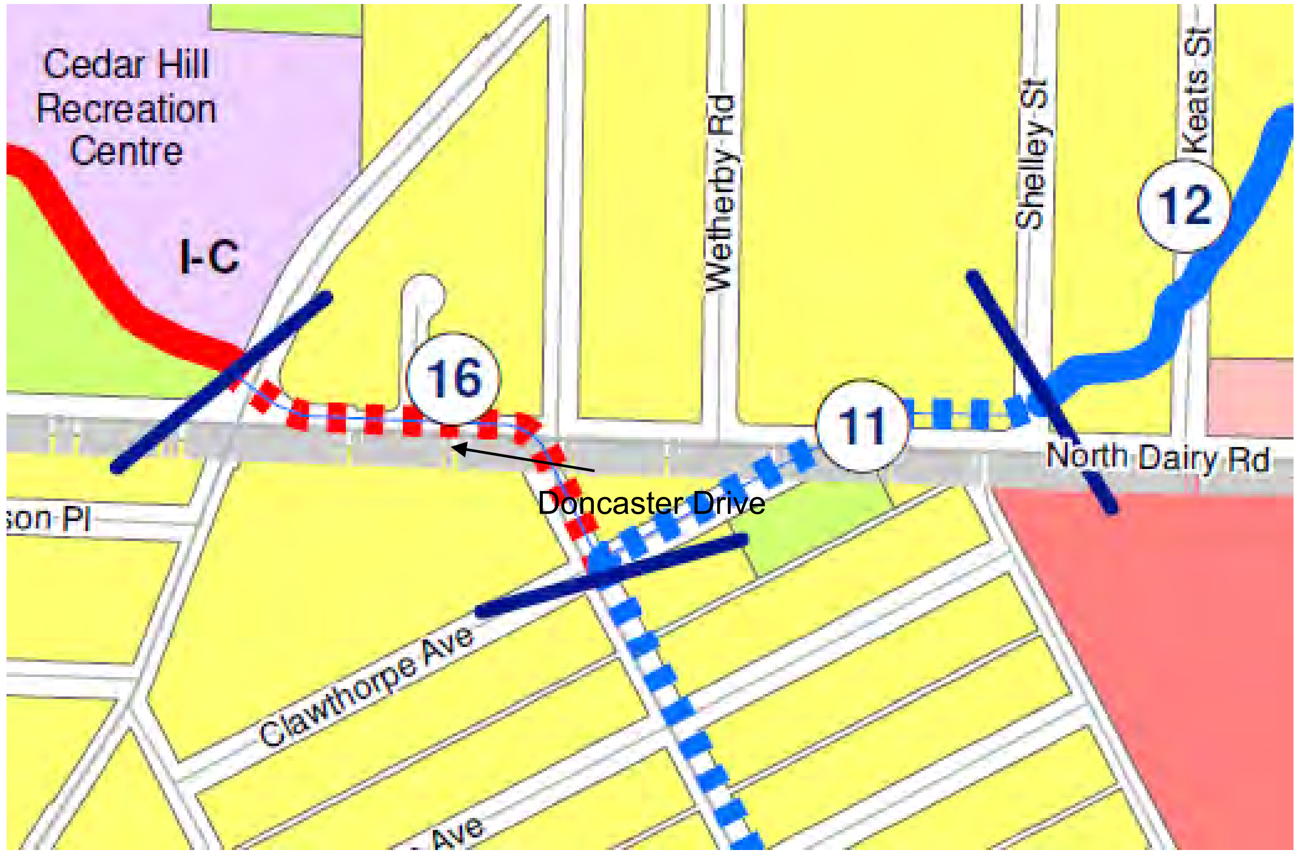
Proposed greenways

ACTION LIST FOR REACH 10: CLAWTHORPE AVENUE TO PEARL STREET

REACH-ACTION NO.	LOCATION	ACTIONS	RATING					WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE			FUNDING	PRIORITY (H, M, L)
			Environmen-tal	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunis-tic		
10-1	Between Trent & Pearl St	Work with landowners between Trent St. & Pearl St. to achieve the long term vision (Blueprint action #9)						9	BCI					
10-2	Clawthorpe Ave. to Pearl St..	Create a greenway along Doncaster Drive (refer to Map 5 for more details). Depending on greenway design, this may require partial or full acquisition or right-of-ways along certain properties.	2	2	-2	-1	1	3	Victoria	X			Victoria, Provincial, federal	M
10-3	Clawthorpe Ave. to Pearl St.	During redevelopment, further increase onsite storage and green infrastructure features at Hillside Mall, by working cooperatively with the developer.	3	3	-3	-1	1	1, 2, 3, 4	Victoria (BCI)			X	Provincial, federal, developer	H
10-4 preferred	Clawthorpe Ave. to Pearl St.	During significant redevelopment, determine the feasibility of daylighting Bowker Creek along the periphery of Hillside Mall, or along the Doncaster Dr. ROW.	3	2	-3	-1	1	1, 2, 3, 4	Victoria			X	Victoria operating budget, grants	H
10-4 alternative	*Clawthorpe Ave. to Pearl St.*	*To increase hydraulic capacity on Pearl Street, add 3.66 x 1.83 m box culvert. On Doncaster Drive add 1.52 m round storm drain.*	*0*	*1*	*-2*	*-1*	*1*	*2*	*Victoria*			*X*	*Victoria capital budget*	*M*

REACH 11: NORTH DAIRY ROAD TO CLAWTHORPE AVENUE

Reach 11 flows west in a pipe along North Dairy Road, and southwest along Clawthorpe Avenue to Doncaster Drive.



Reach location

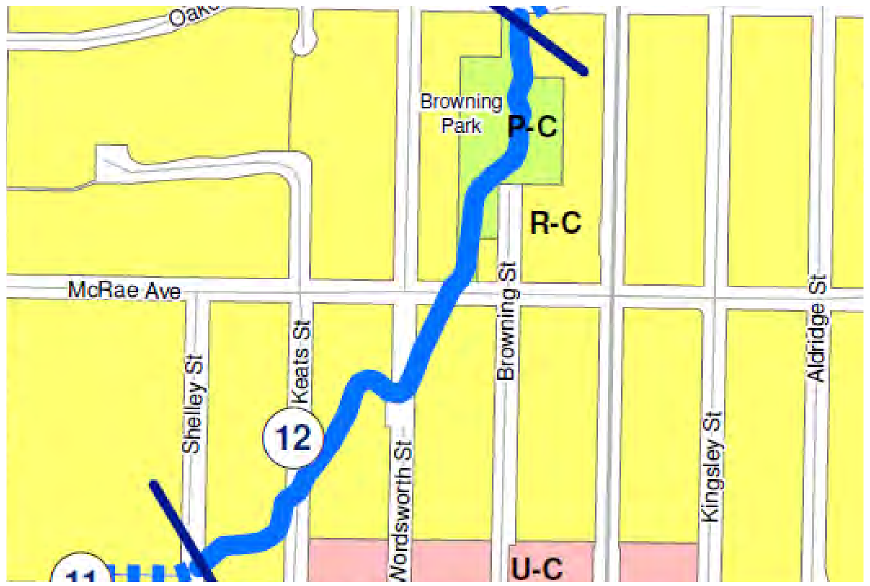
Proposed Greenways

ACTION LIST FOR REACH 11: NORTH DAIRY ROAD TO CLAWTHORPE AVENUE

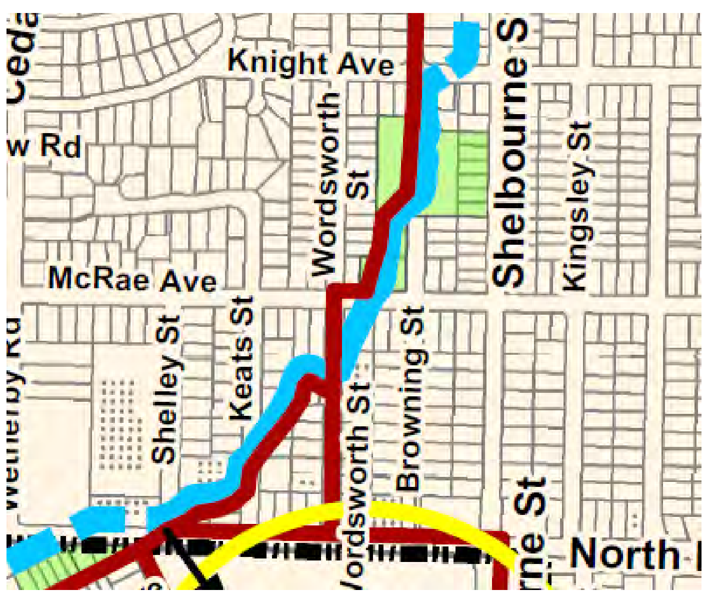
REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	Social	Capital cost	Operating cost	Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	Operational	Opportunistic	FUNDING	PRIORITY (H, M, L)
11-1	North Dairy Rd. to Clawthorpe Ave.	Create a greenway near the creek between Clawthorpe Avenue and Burton Avenue through Clawthorpe playlot (refer to Map 5 for more details).	2	3	-2	-1	1	3	Victoria		X	X	Grants, provincial	M
11-2	North Dairy Rd. to Clawthorpe Ave.	Relocate and daylight the creek through the Clawthorpe playlot. Review daylighting options with Victoria Parks department due to concerns over daylighting the creek near a busy traffic corridor. Consider purchasing properties in this area to create more space for the creek and greenways.	2	2	-2	-1	1	2, 3, 4	Victoria	X		X	Provincial, Victoria capital budget	H

REACH 12: KNIGHT AVENUE TO NORTH DAIRY ROAD

Reach 12 flows southwest in an open partially armoured channel from Knight Avenue through Browning Park, private residences, and road rights-of-way to Shelley Street and North Dairy Road. The riparian vegetation is variable and includes Himalayan blackberry, native and introduced deciduous trees and shrubs, and sections that abut lawns. This reach has issues with invasive species, channelization, conveyance, flooding, and erosion.



Reach location



Proposed greenways

Looking across to an armoured east bank at the north end of Browning Park. The creek is highly incised at this point.

Grassy area in Browning Park along the west bank that is a candidate for riparian planting

The section between McRae and North Dairy is constrained between private lots and has erosion issues.

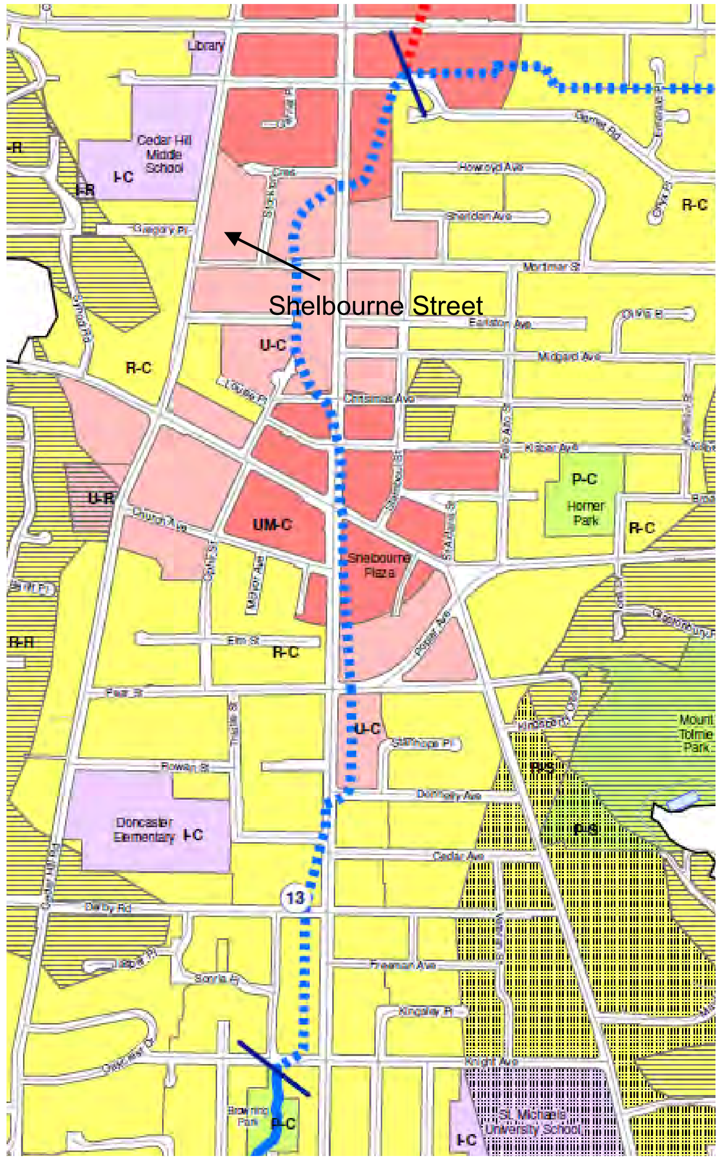
This reach frequently experiences hydrocarbon pollution from upstream sources

ACTION LIST FOR REACH 12: KNIGHT AVENUE TO NORTH DAIRY ROAD

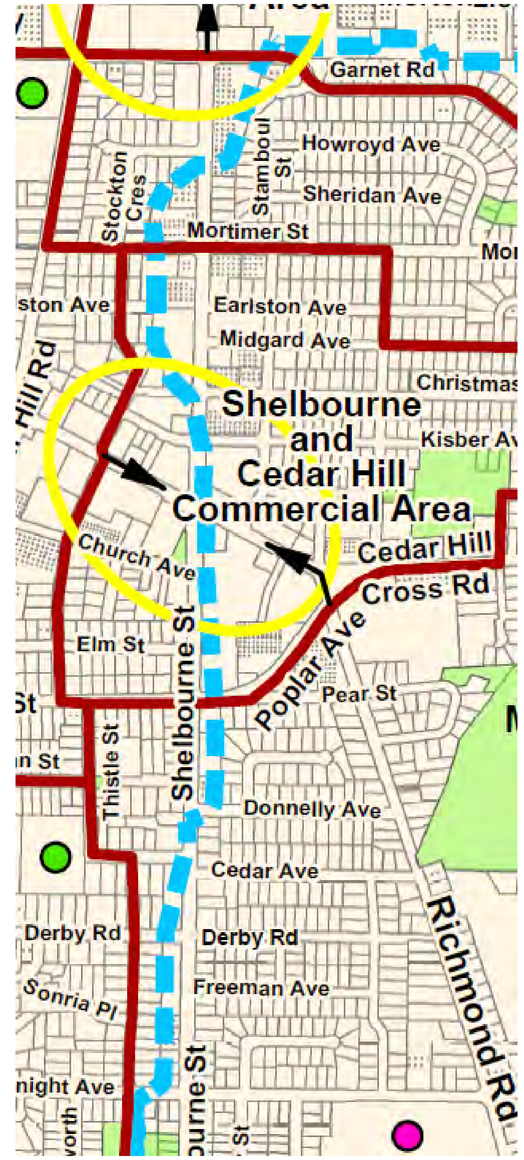
REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TIMING: Capital	TIMING: Operational	TIMING: Opportunistic	FUNDING SOURCE	PRIORITY (H, M, L)
12-1	Browning Park only	**Operational actions for Browning Park**—Combine greenway and park improvements with the following Bowker Creek restoration activities: ✓ Move encroaching paths back from the creek and close off informal trails on east bank. ✓ Vegetate grassy areas or areas with a limited riparian fringe, in particular, the west bank between the footbridge and McRae Avenue, and along the east bank where the path encroaches and where housing has been removed. ✓ Re-slope the banks, particularly the west bank alongside 1621 Knight Avenue and 60 m and 265 m downstream of Knight Avenue culvert. ✓ Address house drainage coming through the west side of the park by building a demonstration rain garden for retention. ✓ Determine the source of hydrocarbons and if necessary, create an oil capture device. ✓ Remove invasive species and replant with diverse native species.	3	2	-1	-1	2	2, 3, 4	Saanich, residential property owners		X	X	Trees for Tomorrow, Local Motion, Saanich operational	H
12-2	Browning Park only	**Opportunistic actions for Browning Park**—If the actions listed in 12-1 for park renewal do not fully achieve creek restoration, improve creek conditions on an opportunistic basis. All long-term changes to this reach should consider bank armour removal and bank re-sloping. Ensure that the creek has a diverse riparian buffer throughout the park and maximize public outreach opportunities and public connection with the creek corridor. Consider moving the channel further east (at the south end near McRae Street) to allow space for a greenway and a riparian buffer adjacent to the west bank. Alternatively, re-grade the east bank, remove the rock wall and plant with native trees and shrubs. Remove the asphalt chunks and paving from the entire channel bottom. Create engineered rock groins and riffles. Implement a program to purchase properties to expand the park to the north and south, as they come available.	3	2	-2	-1	2	2, 3, 4	Saanich (BCI), residential property owners			X	Local Motion, Trees for Tomorrow, Saanich Parks	H
12-3	McRae Avenue to Keats Street	To increase hydraulic capacity, add a 1.83 x 1.52 m box high flow bypass along Keats Street and McRae Avenue. See Master Drainage Plan (Kerr Wood Leidal, 2007).	0	1	-1	-1	1	2	Saanich, residential property owners			X	Saanich	L
12-4	Keats Street	Expand the riparian buffer into the existing rights-of-way along Keats Street, remove the gabions, re-slope the banks, remove invasive species, and plant native species.	3	2	-3	-1	1	2,3,4				X	Provincial, federal	
12-5	North Dairy Road to McRae Avenue	Create a greenway along this reach and improve creek conditions, particularly as relates to bank slope, bank erosion, floodplain creation, and planting of native riparian vegetation. This effort would require rights-of-ways or acquisition of creekside properties. Acquisition would be done opportunistically when properties come onto the market: rights-of-way could be created with landowner involvement (refer to Map 5 for details on the greenway portion of this work).	3	2	-3	-1	1	2,3,4	Saanich, residential property owners			X	Provincial, federal	M
12-6	McRae Ave. to North Dairy Rd. (including Wordsworth right-of-way)	In the short-term, improve the riparian buffer (remove invasives and plant native species) and re-slope the bank on the publicly owned land on the Wordsworth right-of-way, as part of greenway improvements. Remove the small patch of invasive lamium along the bank just downstream of the pedestrian bridge.	3	2	-3	-1	1	2, 3, 4	Saanich, residential property owners		X	X	Saanich operational and parks, Local Motion, Trees for tomorrow	M-H

REACH 13: GARNET ROAD TO KNIGHT AVENUE

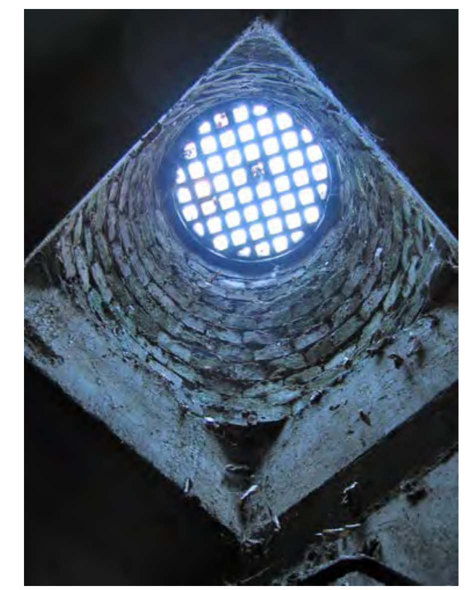
Reach 13 generally flows south in a pipe from Garnet Road to Knight Avenue along Shelbourne Street, a highly developed commercial and transportation corridor. This reach has conveyance issues.



Reach location



Proposed greenways



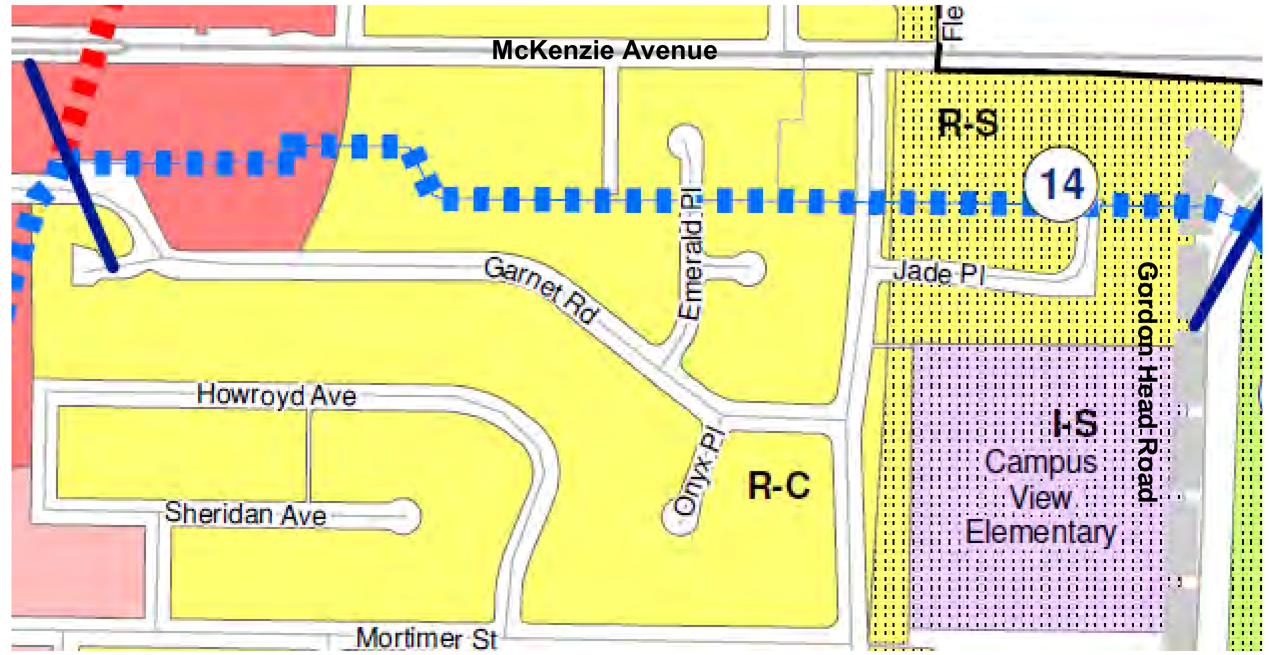
Reach 13 is entirely below ground, beneath a busy transportation corridor

ACTION LIST FOR REACH 13: GARNET ROAD TO KNIGHT AVENUE

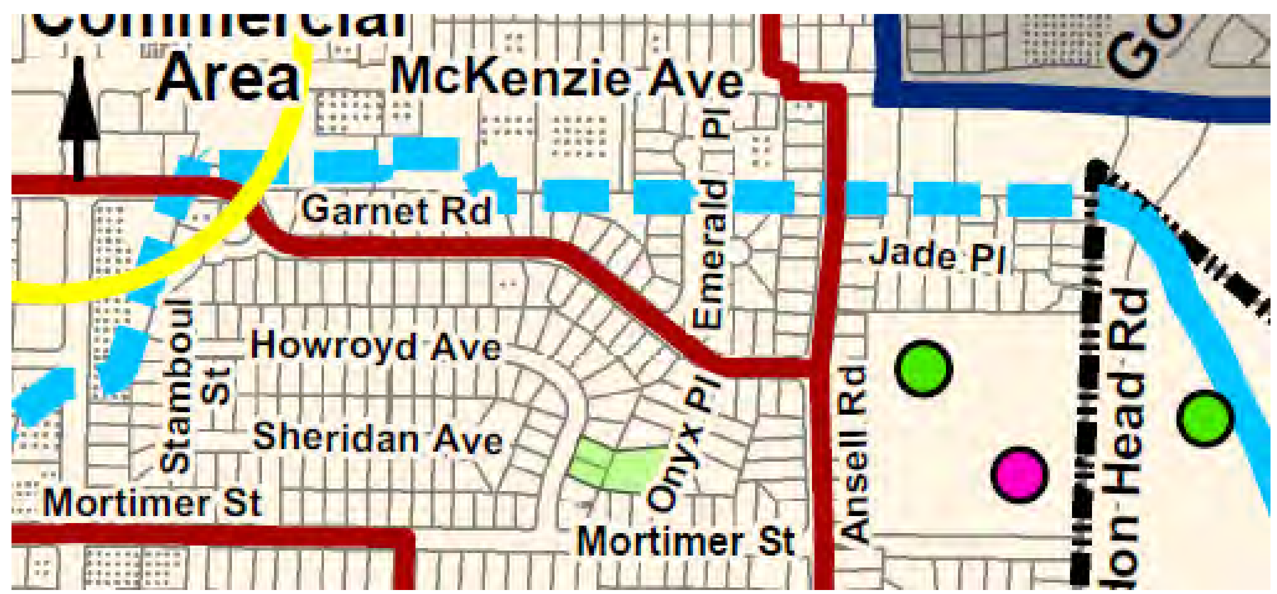
REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	Social	Capital cost	Operating cost	Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	Operational	Opportunistic	FUNDING	PRIORITY (H, M, L)
13-1	Garnet Rd. to Knight Ave. (includes the Shelbourne Corridor)	Saanich is currently in the process of creating a Shelbourne corridor plan. The Bowker Creek Initiative will be involved in developing and giving feedback to this plan.	3	3	0	-1	3	1, 3	BCI		X		BCI	H
13-2 preferred	Garnet Rd. to Knight Ave. (includes the Shelbourne Corridor)	Relocate and daylight Bowker Creek and create a greenway corridor generally to the west of Shelbourne Street from Knight Street and Donnelley Street, to the east from Donnelley Street to Christmas Avenue, and to the west from Christmas Avenue to Stockton Avenue. Detailed design of this project would include a list of properties to acquire, greenway alignments (Map 5), and measures to create a healthy creek channel and riparian buffer. The existing pipe could continue to be used during high flow periods.	3	3	-3	-2	1	2, 3, 4	Saanich (BCI)			X	Saanich, developers	H
13-2 alternative	*Garnet Rd. to Knight Ave. (includes the Shelbourne Corridor)*	*To increase hydraulic capacity, upgrade to:* ✓ *a 3.66 x 1.83 m box culvert from Donnelly Avenue to Knight Avenue,* ✓ *a 3.10 x 1.52 m box culvert from Rowan Street to Donnelly Avenue,* ✓ *a 3.66 x 1.52 m box from Cedar Hill Cross Road to Rowan Street,* ✓ *a 3.10 x 1.22 m box from Gamet Road to Cedar Hill Cross Road.*	0	0	-3	-2	1	2	Saanich			X	Saanich	L
13-3	Garnet Rd. to Knight Ave. (includes the Shelbourne Corridor)	Detention and infiltration opportunities should be implemented during redevelopment and as part of the Shelbourne corridor plan. Install rain gardens, encourage property owners to use green infrastructure methods, and install infiltration boulevards planted with native trees and shrubs. These actions will address downstream water quality issues in Browning Park.	3	1	-1	-1	2	1,2,4	Saanich	X	X	X	developers	M

Reach 14: Gordon Head Road to Garnet Road

Reach 14 flows west in a pipe from Gordon Head Road, just south of Mackenzie Avenue, to Garnet Road. This reach has conveyance issues.



Reach location



Proposed greenways

Bowker Greenway Routing Options

Trails Within Watershed

Proposed Trail Route

Proposed Pedestrian Only Trail

Bowker Creek Main Channel

Underground

Open Channel

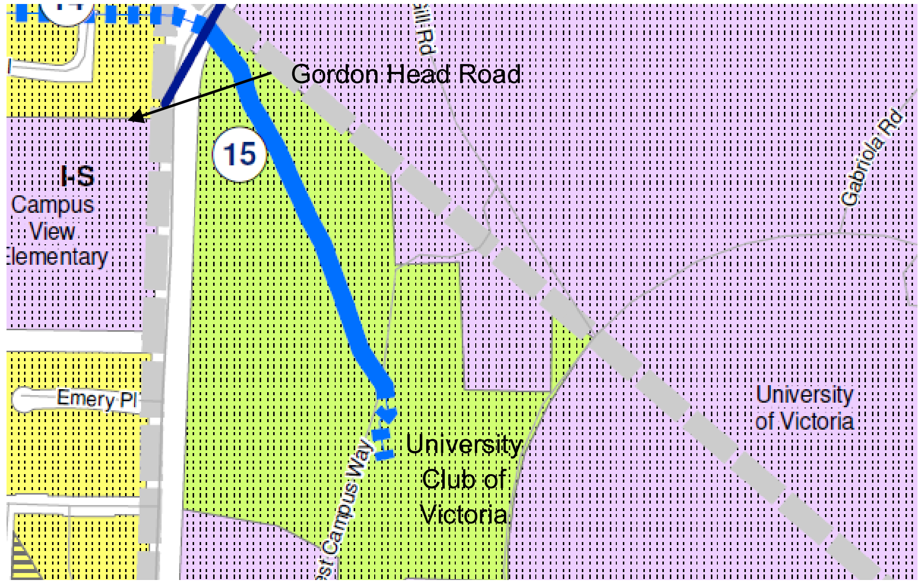
Bowker Creek Watershed Boundary

ACTION LIST FOR REACH 14: GORDON HEAD ROAD TO GARNET ROAD

REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	Social	Capital cost	Operating cost	Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	Operational	Opportunistic	FUNDING	PRIORITY (H, M, L)
14-1 preferred	Gordon Head Rd. to Garnet Rd.	During repair of infrastructure or re-development, daylight the creek and use existing storm drain as a high flow bypass. Include pedestrian access and greenways.	3	3	-3	-1	1	2, 3, 4	Saanich (developer)			X	Saanich, developer	M-H
14-1 alternative	*Gordon Head Rd. to Garnet Rd.*	*Increase hydraulic capacity by upgrading to:* ✓ *a 3.1 x 1.22 m box from Cedarwood to Gamet,* ✓ *a 1.83 x 1.22 m box culvert from Gordon Head to Cedar Wood,* ✓ *a 1.37 m round culvert at Gordon Head Road.*	0	0	-3	-1	1	2	Saanich			X	Saanich	L

REACH 15: THE UNIVERSITY CLUB OF VICTORIA (THE HEADWATERS) TO GORDON HEAD ROAD

Reach 15 flows in an open channel from the headwaters at the University Club of Victoria through the University of Victoria to Gordon Head Road. The riparian vegetation includes widely spaced native deciduous and coniferous trees with a shrub understory, and this reach has the only remaining natural floodplain in the watershed. This reach has invasive species issues.



Reach location

The pond at the Faculty Club. The perimeter is landscaped and native plantings could be increased.

Blackberry patches within the forested area are an obvious target for invasive species removal efforts

Proposed greenways

Much of Reach 15 is inaccessible within a forested floodplain

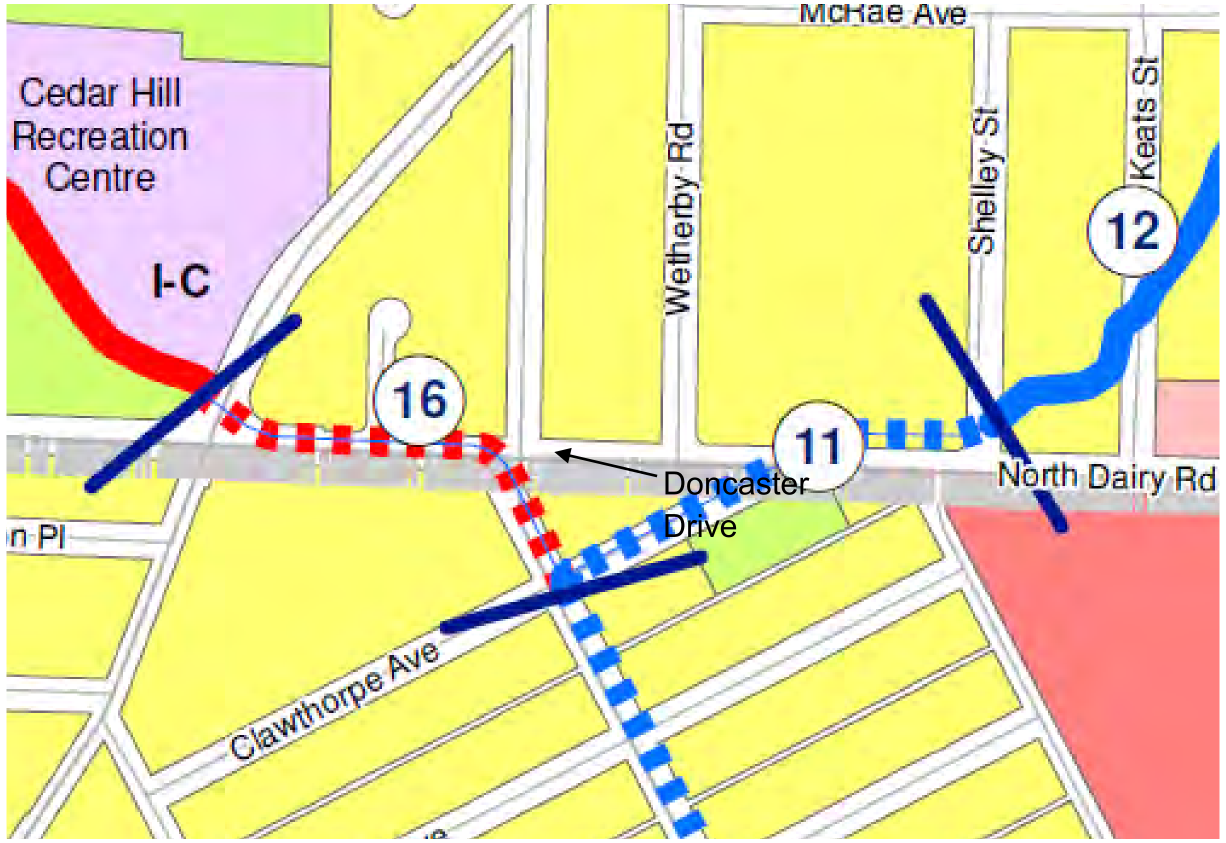
This feeder channel coming from the stadium is a good candidate for riparian restoration and for widening the riparian buffer

ACTION LIST FOR REACH 15: THE UNIVERSITY CLUB OF VICTORIA (THE HEADWATERS) TO GORDON HEAD ROAD

REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	TYPE: Operational	TYPE: Opportunistic	FUNDING	PRIORITY (H, M, L)
15-1	University Club of Victoria to Gordon Head Road	Remove invasive species. Install interpretive signs about Bowker Creek and stormwater management in the parking lot to the south. Extend riparian buffer into blackberry and grass lined swale beside the parking lot to the south. Plant more native species around Faculty Club pond edge and outlet channel, including dispersed willow stakes. In the creek section east of the Fraser Building parking lot, widen the riparian buffer into the grassy and blackberry-covered areas.	3	3	-1	0	2	1, 2, 3, 4	UVic Facilities Management (BCI)			X	UVic, student projects, small grants for plant purchase and signage	M-H
15-2	University Club of Victoria to Gordon Head Road	Approach the University to obtain the perpetual protection of this reach beyond 2011.	3	3	0	0	3	1, 2, 3, 4	UVic Facilities Management (BCI)		X		Not applicable	H
15-3	University Club of Victoria to Gordon Head Road	Continue to implement campus-wide stormwater management as per the University of Victoria Integrated Stormwater Management Plan (2004).	3	3	-2	-1	3	1,2,3,4	UVic Facilities Management	X	X		UVic	H

REACH 16: CEDAR HILL RECREATION CENTRE TO CLAWTHORPE AVENUE

Reach 16 is a main tributary to Bowker Creek. It flows in a pipe beginning immediately south of the Cedar Hill Recreation Centre, east along North Dairy Road, and southeast along Doncaster Drive to Clawthorpe Avenue.



Reach location

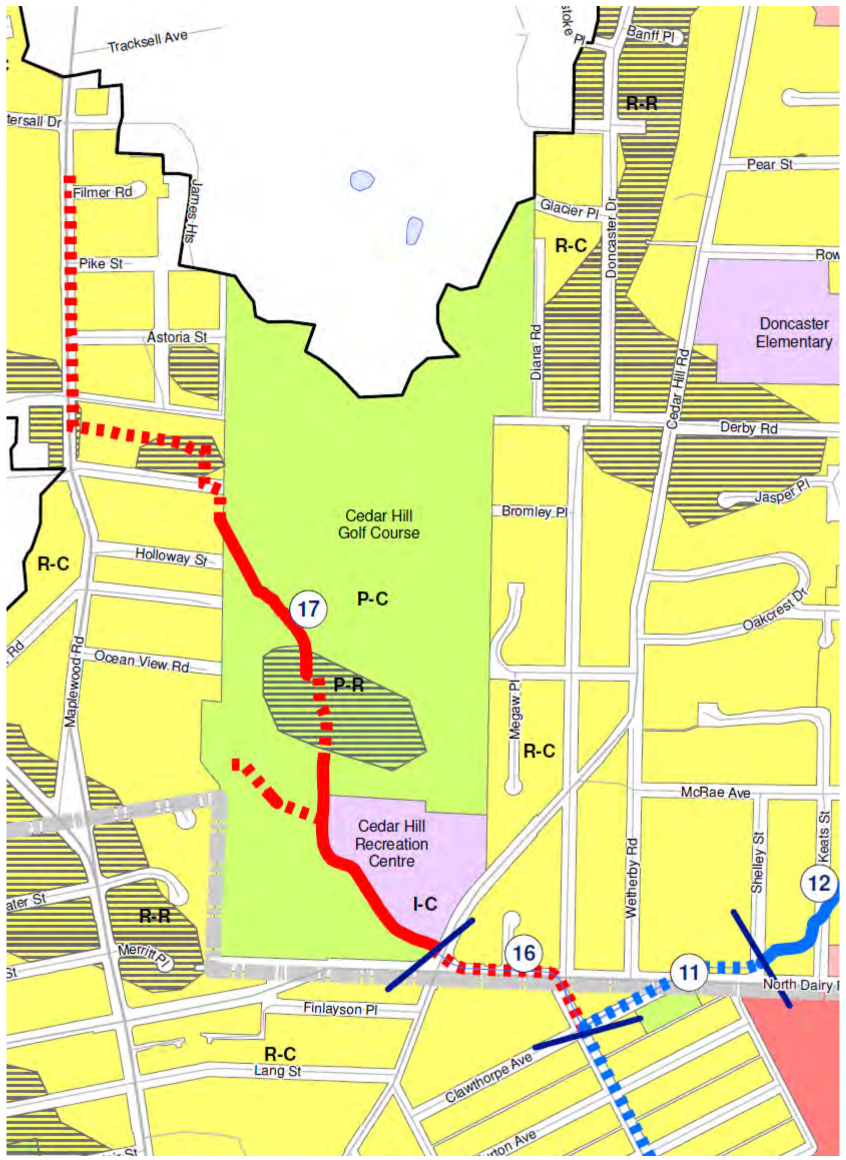
Proposed greenways

ACTION LIST FOR REACH 16: CEDAR HILL RECREATION CENTRE TO CLAWTHORPE AVENUE (TRIBUTARY)

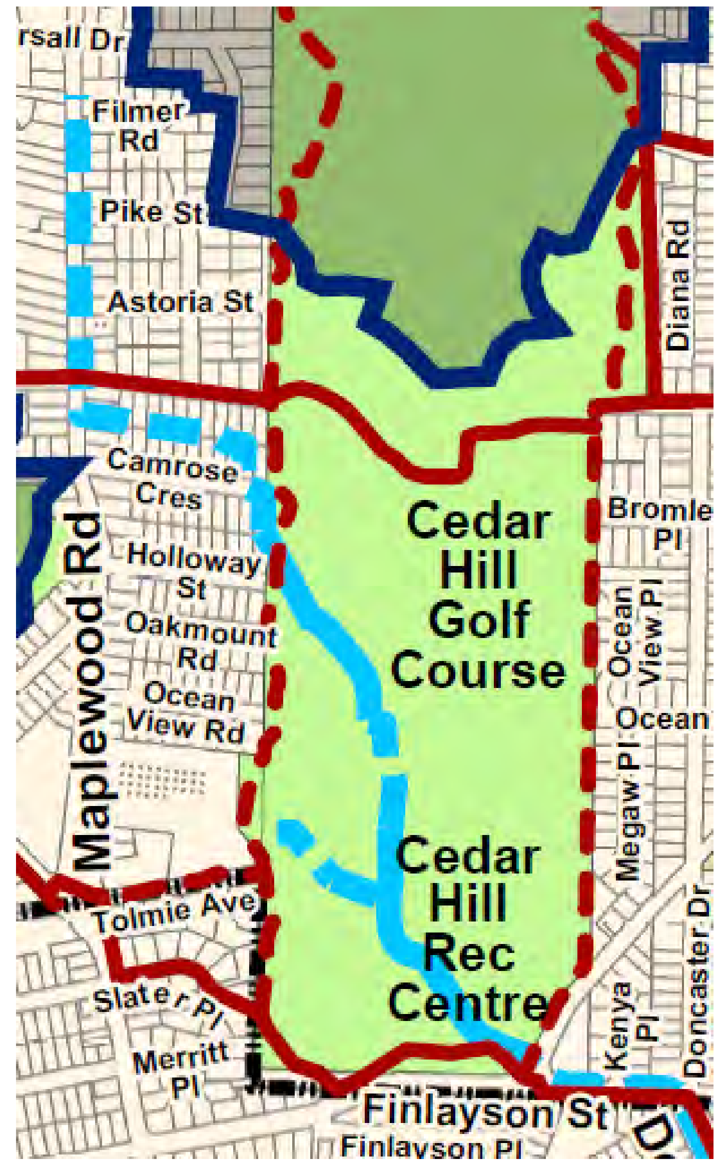
REACH-ACTION NO.	LOCATION	ACTIONS	RATING					WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE			FUNDING	PRIORITY (H, M, L)
			Environmen-tal	Social	Capital cost	Operating cost	Fundability			Capital	Operational	Opportunistic		
16-1	Cedar Hill Golf Course to Clawthorpe Ave.	Create a greenway along North Dairy Road (refer to Map 5 for more details).	2	3	-1	-1	2	2, 3, 4	Saanich	X			Provincial, municipal operational & capital budgets	M-H
16-2	Cedar Hill Golf Course to Clawthorpe Ave.	During redevelopment, consider daylight the creek and create a greenway along the creek.	3	2	-3	-1	1	2,3,4	Victoria, Saanich			X	Provincial, developer	M-H
16-3	Cedar Hill Golf Course and Cedar Hill Recreation Centre	Removal of invasives (see Appendix C, reach #15 &16 for identified invasives) Plant native trees along riparian												

REACH 17: CEDAR HILL RECREATION CENTRE AND CEDAR HILL GOLF COURSE (TRIBUTARY)

Reach 17 is a main tributary to Bowker Creek, it flows southeast, mainly in an open channel, through the Cedar Hill Golf Course and Cedar Hill Recreation Centre to Cedar Hill Road. The riparian vegetation includes grass, coniferous trees, and red osier dogwood. This reach has issues with channelization and erosion.



Reach location



Proposed greenways

Downstream view from footbridge showing conifers, blackberry, and red osier dogwood

Planted conifers need ongoing care to thrive among reed canary grass and blackberry

Action List for Reach 17: Cedar Hill Recreation Centre and Cedar Hill Golf Course (Tributary)

REACH-ACTION NO.	LOCATION	ACTIONS	RATING: Environmental	RATING: Social	RATING: Capital cost	RATING: Operating cost	RATING: Fundability	WMP GOALS ADDRESSED	LEAD AGENCY (POSSIBLE SUPPORTING PARTNERS)	TYPE: Capital	TYPE: Operational	TYPE: Opportunistic	FUNDING SOURCE	PRIORITY (H, M, L)
17-1 preferred	Cedar Hill Golf Course and Cedar Hill Recreation Centre	Install a detention basin to the southwest of Cedar Hill recreation centre and naturalize the creek as much as feasible (the greens and fairways may need to be reoriented). Remove invasive species and care for planted conifers. Re-slope banks to a gentler angle and re-vegetate with native species. Ban the use of pesticides and herbicides on the golf course and at the recreation centre or take the pesticide-free pledge	3	2	-2	-1	2	2, 3, 4	Saanich		X	X	Saanich parks, volunteers, Quadra Cedar Hill Neighbourhood Assn.	M
17-1 alternative	*Cedar Hill Golf Course and Cedar Hill Recreation Centre*	*Downstream of 600 mm culvert on Cedar Hill Golf Course, immediately west of the baseball diamond, reduce erosion at outlet caused by high velocity by protecting banks with rock.*	1	0	-1	-1	2	2	Saanich		X	X	Saanich	M
17-2	Maplewood Road to Cedar Hill Golf Course	Examine the feasibility of creek daylighting when infrastructure needs upgrading or when the area is being redeveloped.	3	2	-3	-1	2	2,3	Saanich		X	X	Saanich, developer	M
17-3	Cedar Hill Golf Course and Cedar Hill Recreation Centre	Removal of invasives (see Appendix C reach# 15& 16 for identified invasives) Plant native trees along riparian												

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APPENDIX C

APPENDIX C—BOWKER CREEK CHANNEL RESTORATION NEEDS AND PRESCRIPTIONS

By Tanis Gower, RPBio

INTRODUCTION

This assessment and recommendations were prepared in between October 2008 and November 2009 by the Bowker Creek Initiative Coordinator, to feed into the Bowker Creek Blueprint under preparation by the Bowker Creek Initiative Steering Committee and supporting consultants. The same reach breaks are used as defined by the Bowker Creek Watershed Proper Functioning Condition Assessment (Barraclough et al., 2007), and more detail is provided regarding current and potential vegetation conditions and restoration opportunities. This assessment addresses only those sections of Bowker Creek that are currently above ground

The original Watershed Assessment (Reid Crowther, 2000) and specific recommendations for sections in Saanich (P.A. Harder and Associates, 2002) were also reviewed in developing this document.

Please refer to chart below for reach numbers.

BLUEPRINT REACH NUMBERS	APPENDIX C
1	1A,1B and 1C
2	enclosed
3	3A and 3B
4	enclosed
5	5A and 5B
6	enclosed
7	7A and 7B
8	enclosed
9	9
10	enclosed
11	enclosed
12	12A and 12B
13	enclosed
14	enclosed
15	15A, 15B and 15C
16	enclosed
17	17A and 17B

GENERAL RESTORATION RECOMMENDATIONS

In general, the open sections of Bowker Creek are deeply incised with two to four meters elevation difference between top of bank and creek bottom. The incised (excavated) channel corridor typically measures between 5 to 13 meters from top of bank to top of bank, with the narrower sections supported by retaining walls. The average wetted channel width under low to moderate flow conditions is two to four meters. The natural floodplain has been removed or altered in all but the uppermost sections of the creek located on the UVic campus. In most locations without retaining walls or concrete sandbags/gabions, the banks are steeply sloping (ranging from an engineered 1:1 grade to vertical) and consist mainly of a clay substrate. The steep clay banks are unsuitable for the establishment of a diverse community of native vegetation (Reid Crowther, 2000), and where riparian vegetation exists it is often dominated by invasive species, particularly blackberry, ivy and yellow willow. In-stream habitat is extremely poor. The habitat type is mostly shallow runs, with little to no pool habitat, and short and infrequent riffle habitats. Substrates vary and where the creek bottom is not hardened with cement or asphalt, small gravels, sand, silt or and cobble overlay clay or bedrock substrates. In some areas the creek bottom consists of exposed clay. In many areas, root mats from the invasive yellow willow are seen on the channel bottom.

General restoration prescriptions that can be adopted in any open channel area, on an opportunistic basis as land use changes or as property owners decide to get involved are:

- Increase floodplain area by creating more gently sloping banks and/or removing fill to create a wide bench and lower the top of bank. Where benches are created, they should be one meter or less above the creek bed, as possible, to maximize floodplain area and the potential to plant floodplain vegetation.
- Remove invasive species;
- Plant native species; and,
- In selected appropriate areas, increase channel diversity by installing engineered rock weirs and groins. This is particularly recommended for those reaches with significant improvements and changes to the channel configuration and floodplain extent.

With respect to removing invasive species, yellow willow (*Salix lutea)* is not possible to remove without major channel reconstruction that includes excavating the root masses. For this reason most yellow willow should remain intact when short term restoration actions are taken.

For larger properties that may come available, the creek channel could be further restored by creating a new channel configuration with meanders of appropriate amplitude. The bankfull width, depth, channel and bank slope can be designed based on existing flows and desired flow conveyance (e.g. Keir Wood Leidal, 2007) as well as on the site conditions and the principles of natural channel configurations as found in Newbury and Gaboury (1994). Depending on design considerations and the site in question, the original channel could be maintained as an overflow channel for peak flows.

In areas where the ability to expand the floodplain is limited, retaining walls can be used on one or both sides of the creek, to enable the creation of a lower riparian bench alongside the creek. In addition to enabling the development of healthy riparian vegetation and a limited floodplain, this option will allow for increased flood conveyance. This option is less desirable than the development of a more natural floodplain, but represents a good compromise in areas where a significantly wider creek corridor will never be logistically feasible due to existing infrastructure.

Any significant changes to the creek and riparian area should be accompanied by interpretive signage and by points of visual access to the creek. Physical access to the creek is not required but is desired in some cases.

Detailed restoration prescriptions including the exact number and type of riparian plants should be prepared as restoration opportunities present themselves. A list of native plants that can be used as a starting point for detailed restoration planning is found in Addendum 1.

REACH SUMMARIES AND PRESCRIPTIONS

REACH 1A

— creek mouth to Kachan property above Beach Drive (one property above Beach Drive)

Width of riparian buffer each side (slope distance) and estimated slope

90 degrees slope, variable height (1–2+ m) concrete/rock retaining walls. As such there is no riparian buffer however there is a strip of vegetation on the north bank in particular, that is one tree/shrub wide. Yellow willow has colonized a short segment of deposited fine soil/sand within the concrete walls. Ivy covers parts of the concrete walls.

Streambank erosion issues (Y/N and H,M,L)

Y, M, on south bank just downstream of Beach Avenue. High, steep eroding bank, approx 7 meters long and up to 3 meters high, sparsely vegetated with blackberry

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Trees, shrubs, grass. Dominant species: ivy, yellow willow,

Species list of all plants covering >5% of the area within vegetated streamside zone (see Addendum 2 for latin names)

Ivy, garry oak, blackberry, knotweed, daphne, poplar, yellow willow, ornamental trees (e.g. cherry, laurel, laburnum), morning glory, snowberry, big-leaf maple, weeping willow, cedar, fir, policeman's helment.

Percent coverage of invasive vs. native species

Approx 20% invasive, probably 80% non-native in total.

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

Strip of trees/shrubs above retaining wall on north bank is 0–2 meters wide. Potential width with landowner involvement and removal of concrete wall could be ~5 meters wide.

On the south bank little change can be made with the current building footprint. Currently the vegetation along the concrete wall is mostly grass, ivy and ornamentals.

Short term riparian restoration potential and techniques

Remove knotweed growing from concrete wall on south bank below Beach Drive—<u>high priority</u>.

Remove ivy growing on private property along the south bank above and below Beach Drive. This would be particularly useful above Beach Drive where there is space for native plantings above the retaining wall. Remove blackberry and ivy along the Kachan property particularly where there is no bank hardening (no cement sand bags) and replace with native shrubs.

Use native tree and shrub species in landscaping

Address erosion just below Beach Ave by installing bioengineering terraces (willow wattles) if the property uses allow. This would require resloping the bank to a gentler angle and the existing land use in this area (front yard of an apartment building) would need to be assessed.

Short term channel restoration potential and techniques

Channel bed below Beach Drive is mainly bedrock and cobble with some sandy deposits. Good channel complexity (see Plate 5) as a result.

Long term channel and riparian restoration potential

Long term restoration will require redevelopment, particularly on the south bank. The current building footprint on the south bank is too close to the creek for any changes to be made to the creek channel. On the north bank, changes could be made if the property owners were willing to give some of their property to the creek.

In the long term with redevelopment and/or landowner involvement, the concrete/rock walls can be removed and the creek banks sloped back and planted with native vegetation. The ultimate configuration will be determined by the amount of space made available—ideally the entire creek corridor should be 15+ meters in width. If redevelopment constraints require the creek corridor to remain relatively narrow, parts of the relocated creek bank could be stabilized by developing bioengineering terraces as necessary. Bioengineering is best for shorter stretches of creek rather than extended creek sections, as the willow forms dense, tall stands of a kind not typically found in such abundance in nature. Another option for the south bank in particular is to move the concrete retaining walls back from the creek to allow a natural riparian area within these bounds.

Observations/Notes

The creek bed under and adjacent to Beach Drive is asphalt. This presents the first fish barrier in Bowker Creek, due to high velocities and shallow depths—fish passage would be possible only with high flows.

On north bank homeowners discard yard waste into channel.

North bank rock wall has a sinkhole behind it near the creek mouth.

Tidal influence extends up into this reach, and CRD water quality sampling is done just above the limit of tidal influence.

Reach 1A photographs

Plate 1: View of the creek mouth where it enters the ocean

Plate 2: Knotweed growing from south bank retaining wall in Reach 1A

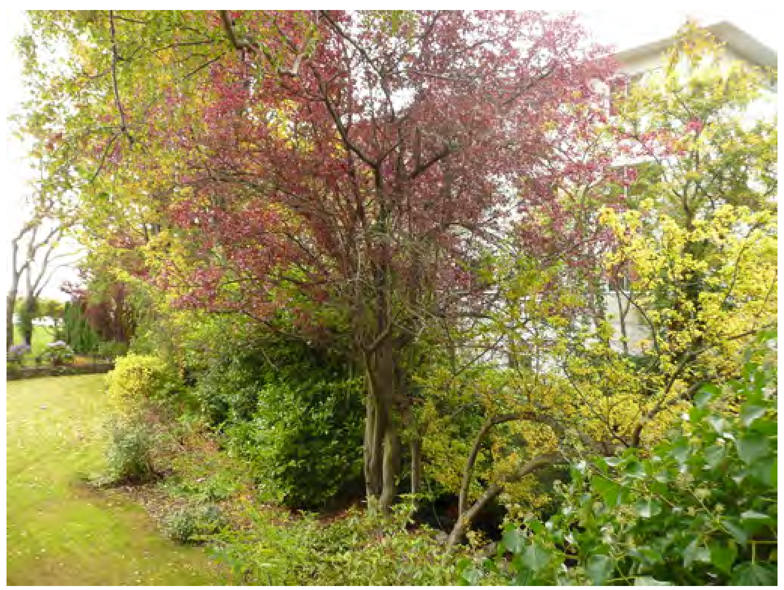

Plate 4: View looking downstream from Beach Drive. Note the narrow riparian 'strip' on north bank, apartment building on south bank

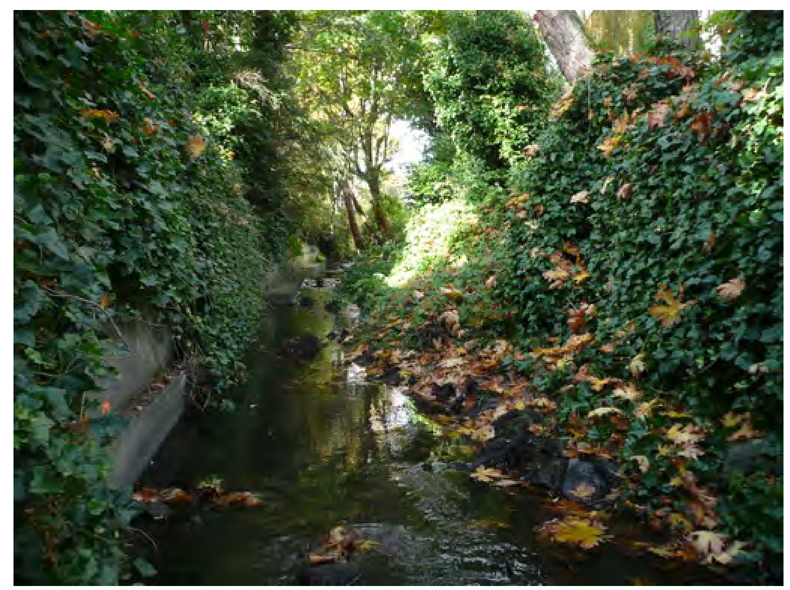

Plate 5: Reach 1A above Beach Drive. The Kachan property at 1776 Beach Drive is on the right hand side. Ivy and adjacent blackberry can be removed and native shrubs planted above the retaining wall on the south bank and in space on the north bank made available by blackberry removal.

Plate 3: Natural cobble line providing complexity in Reach 1A. Reddish substrate on the left is yellow willow root mats commonly found in Bowker Creek.

REACH 1B

— one property above Beach Drive to eastern (downstream) edge of Monteith community gardens property

Width of riparian buffer each side (slope distance) and estimated slope
Concrete/rock walls are absent in part b of Reach 1. On part of the north bank the riparian 'buffer' consists of a steep (approx 2:1) blackberry-covered bank leading up to a fence at the slope break. Other areas have fences set further back or no fences. The south bank has up to a few meters of vegetation with significant native trees and shrubs present, and is lower elevation and more natural in some areas.

Streambank erosion issues (Y/N and H,M,L)
Y – M (fill known to have been lost to the creek at Kachan property)

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species
Trees, shrubs – mix of species including dominant blackberry on the north bank and native trees and shrubs on the south bank.

Species list of all plants covering >5% of the area within vegetated streamside zone
Big leaf maple, alder, poplar, cottonwood, ivy, blackberry, morning glory, snowberry, laurel, mock orange, holly, rose, oceanspray, red-osier dogwood, vine maple, bracken fern, buttercup, water parsley, Daphne

Percent coverage of invasive vs. native species
40/60 with some fairly natural areas and others completely dominated by blackberry and morning glory

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)
There is up to a few meters of vegetated area on either side of the creek, with a buffer width up to 5 meters currently possible on the south bank. With private landowner involvement the creek corridor could be significantly improved via resloping the banks (north side), widening the riparian buffer and planting more native trees and shrubs. The current building footprints appear to leave enough room for this to occur.

Short term riparian restoration potential and techniques
Removing ivy and other invasives on south bank, and maintaining and improving the native plant mix in that area. Short-term action not recommended on the blackberry and morning-glory covered north bank.

Short term riparian restoration potential and techniques
Removing ivy and other invasives on south bank, and maintaining and improving the native plant mix in that area. Short-term action not recommended on the blackberry and morning-glory covered north bank.

Short term channel restoration potential and techniques
As in Reach 1A, the channel has a bedrock base, though it is less obvious in places. The substrate is bedrock/cobble/gravel/sand. No short term channel improvements suggested.

Long term channel and riparian restoration potential
Relocating or removing some fences, and removing fill in order to reslope channel banks further back into the private property. This applies particularly to the north bank but both banks will benefit from removal of invasives and planting native trees and shrubs. If the space available is limited, the north bank could be terraced using willow wattles (bioengineering). Any work of this sort should tie in with the erosion issues happening at the Kachan property.

Observations/Notes
As in many (if not most) places along the creek, streamside properties are built up with fill. The erosion problems at the Kachan property (1776 Beach Drive) are a result of a corner of the filled lot extending into the creek channel and causing a narrowing and a slight bend in the creek (Fig. 7). According to Lisa Kachan (pers. comm.), she would like to stabilize the property using 'soft' techniques like bioengineering if affordable, though it currently appears to be too expensive to accomplish without outside support. Lisa Kachan's two upstream neighbours also have some interest in doing something for the creek where it runs past their properties. Any action taken by the Kachans would be best accompanied by action by their upstream neighbours as well.

Reach 1B photographs

Plate 8: **Kachan property at 1776 Beach Drive. The fence in the far distance marks the location where the creek narrows and bends around the fill that was historically used to create/extend the side yard on this property.**

Plate 7: **The steep north bank on reach 1B, covered in blackberry and morning glory. Fence shown is from panhandle of property at 1790 Cranmore Road.**

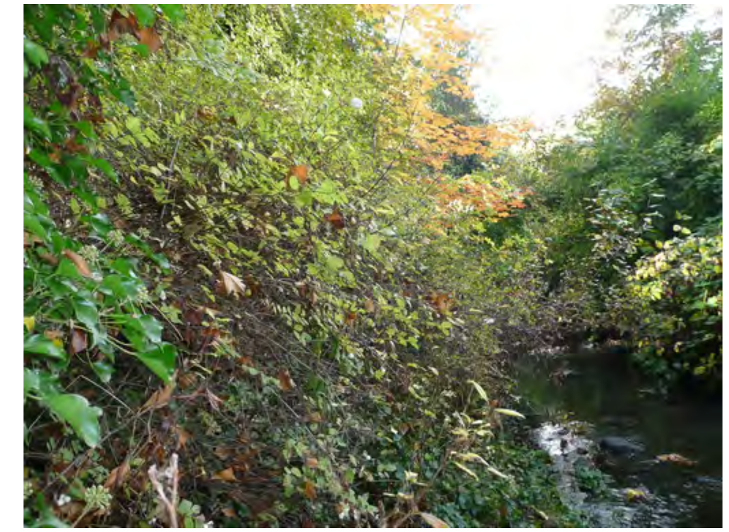

Plate 6: **The more natural south bank of reach 1B is shown at left.**

REACH 1C

— Monteith street community gardens and Oak Bay municipal lot

Width of riparian buffer each side (slope distance) and estimated slope

The buffer on the north (community garden) bank is approx. 1 meter wide and consists primarily of bioengineering completed in March 2007, with dominant individual yellow willow and cottonwood trees at either end and a concrete sandbag section at downstream end. The bioengineered area consists of a steep short (approx 1.5 m high) slope consisting of two tiers of willow wattles, with variable growth and survival. The buffer on south bank is variable in width (10-20 meters of unmanaged native/invasive vegetation), has a gentle slope and is dominated by red osier dogwood and ivy.

Streambank erosion issues (Y/N and H,M,L)

Y, M **–** addressed with bioengineering in March 2007. New creek braid artificially induced (see Plates 10 and 11)

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Trees/Shrubs: Yellow willow, cottonwood, red osier dogwood, willow stakes, snowberry

Species list of all plants covering >5% of the area within vegetated streamside zone

Cottonwood, weeping willow, pacific/sitka/scouler's willow (bioengineering stakes), bigleaf maple, snowberry, ivy, water parsley, thistle, blackberry, Daphne, policeman's helmet

Percent coverage of invasive vs. native species

Approx 30% invasive. There is little to no blackberry currently along streambanks but the newly disturbed in-channel area (Plates 11 and 12) has blackberry shoots as well as low numbers of thistle/daphne.

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

Oak Bay is the landowner. If community gardens were relocated from the north bank a buffer could be created that would be 10–25 meters in width (based on lot constraints) as compared to the current < 1 m buffer.

On the south bank, Oak Bay wishes to create community gardens. A currently planned project includes community gardens at a maximal distance from the creek, and a restored riparian buffer of 10–15 meters.

Short term riparian restoration potential and techniques

Remove occasional occurrences of policeman's helmet (*Impatiens glandulifera)* (Plate 12) from the community gardens on an annual basis until eradicated—high priority

For the south bank, funding is in place to purchase native plants to improve the riparian buffer (10–15 meter wide strip) and remove invasives. No short term riparian restoration is possible on the north bank unless community garden plots can be removed along the streambank. Note: the bioengineering treatment is not thriving as previously, particularly in the central section. Some areas have been clipped by the gardeners to control shade and in certain locations it is possible this may have affected the viability of the stakes.

Short term channel restoration potential and techniques

In-channel conditions have been altered (Fig. 11 and 12). The resultant 'point bar' needs to be treated to remove invasive species. Currently, the channel throughout the reach has some diversity with cobble, some boulders, and gravel in pockets.

Long term channel and riparian restoration potential

South bank as per previously prepared plans. North bank via relocating the community gardens elsewhere, resloping the bank (as appropriate) and reclaiming the riparian area with native plants. As per the proper functioning condition assessment, in-channel conditions could be improved with rock groins.

Observations/Notes

Aside from the wetland conditions at UVic, this is the only reach that has any significant amount of floodplain. Invasive species are less predominant here than in many reaches, though ivy is prominent on the south bank. This is a high profile location and restoration treatment on the south bank will be beneficial for the creek and the Initiative. Additionally, contact should be made with the community gardeners to ensure that willow wattle pruning is done appropriately. The overall structure of the bioengineering is holding up very well but as the dead parts decay erosion problems may resume.

Note: the Fireman's Park culvert is undersized and the resultant high flow velocities have caused channel widening at the top of the reach.

Reach 1C photographs

Plate 9: Downstream view of Reach 1C showing bioengineering on the left and a relatively new 'bar' in centre, created by an artificially dug channel.

Plate 10: Upstream end of point bar showing top end of excavated channel, and looking towards Fireman's Park culvert exit.

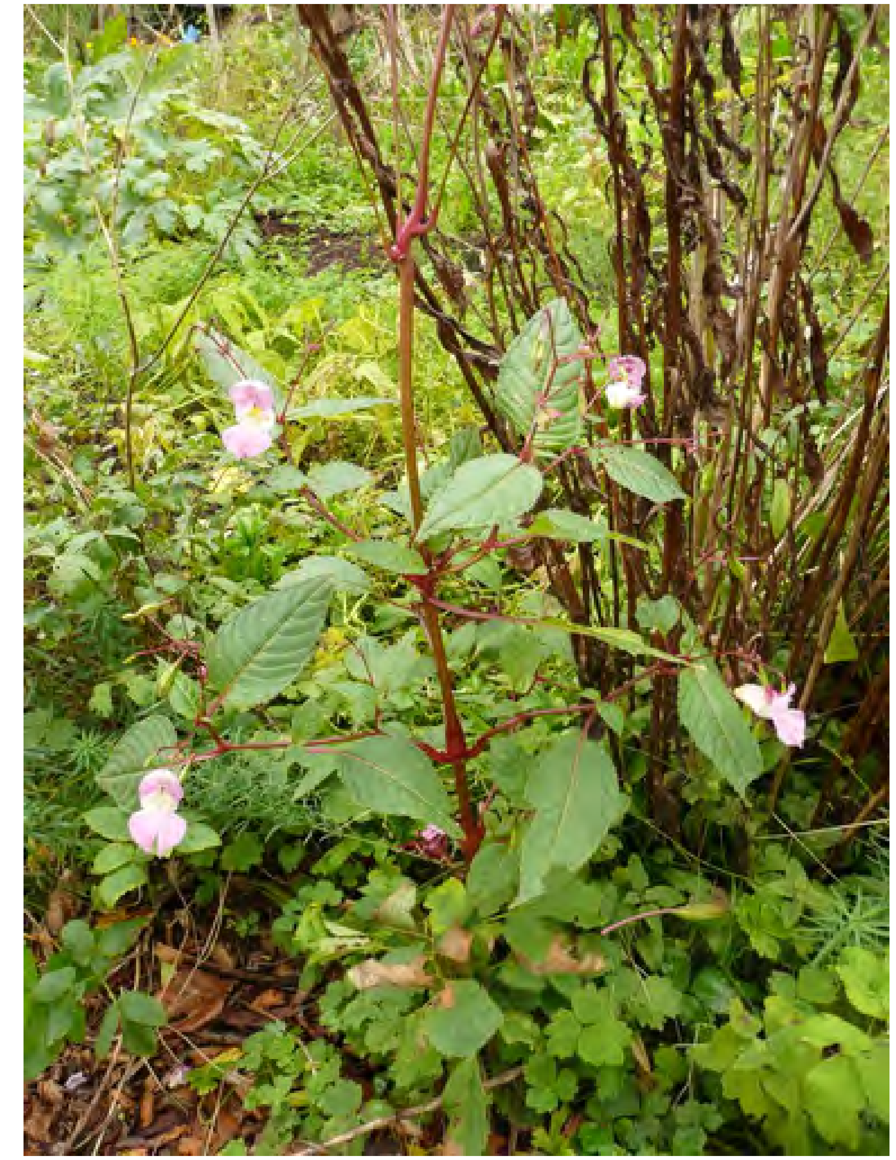

Plate 11: Policeman's helmet (Impatiens glandulifera) is an invasive annual plant that needs to be controlled before it establishes in the watershed. A few plants were found along Bowker Creek in the Monteith Street community gardens

Plate 12: Artificially created 'side channel'. This channel has been stable since its creation sometime in the winter of 2007/2008, presumably by an individual concerned about erosion and flooding at the community gardens. Invasive vegetation on the bar should be addressed.

REACH 3A

— Monterey Street to Oak Bay High School

Width of riparian buffer each side (slope distance) and estimated slope

N/A riparian area not connected due to vertical concrete walls

Streambank erosion issues (Y/N and H,M,L)

N

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Concrete and rock-lined channel surrounded by grass with isolated pockets of landscaped native and non-native trees and shrubs. Some non-native shrubs overhang the channel and provide cover . There are some pockets of native landscaping but with no channel connectivity.

Species list of all plants covering >5% of the area within vegetated streamside zone

Scattered vegetation outside the channel includes: cedar, cottonwood, garry oak, birch, tulip tree, buddlea, red osier dogwood, mahonia, alder, big leaf maple, snowberry, oceanspray, and lawn variety grasses. Some Japanese knotweed occurs within the channel in one location (Plate 14), and another alcove location harbours some limited in-channel vegetation (Plate 15).

Percent coverage of invasive vs. native species

90% + invasive and non-native if lawn variety grasses included

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

While there is little or no riparian connectivity, there are variable widths of land alongside the concrete armoured channel. This land is owned by the District of Oak Bay and was 'beautified' to support its current public use back in the 1980s. There is space to redevelop the channel without concrete walls and bottom, and to reconnect a riparian area, should there be the political will and public support.

Short term riparian restoration potential and techniques

High priority: remove Japanese knotweed spotted in two locations (see Plate 13 and 14).

Replace some grassed areas with overhanging vegetation.

In the one widened pond area within the concrete lined channel, plant more native vegetation such as spirea or cattails (Plate 15)

Over time increase the amount of native landscaping.

Short term channel restoration potential and techniques

n/a

Long term channel and riparian restoration potential

In some or all areas, remove the concrete lined bottom and sides, and grade the banks back and/or use terraces to support native vegetation along the banks. In locations where space is tighter, use setback retaining walls to create planting benches. Plant native vegetation. Recreate a natural-bottomed meandering creek bed. As per the PFC assessment (Barraclough et al., 2007), the general alignment and footprint of the channel and ponds can remain. Note: one area in particular that is not currently used by the public (west bank at south end of reach) has potential as a pilot project to create a naturalized bank and riparian area (Plate 16).

Observations/Notes

It is very important to eradicate knotweed from this reach. This is the largest occurrence seen to date.

Reach 3A photographs

Plate 13: Knotweed intermixed with other vegetation on the west bank south of Hampshire Road.

Plate 14: Partially vegetated in-channel area that could be enhanced with plantings of Spirea and/or other water-loving plants.

Plate 15: Typical concrete channel wall.

Plate 16: Large knotweed patch found within the channel boundaries, on the west bank north of Hampshire Road. All knotweed should be removed and monitored to ensure it is eradicated.

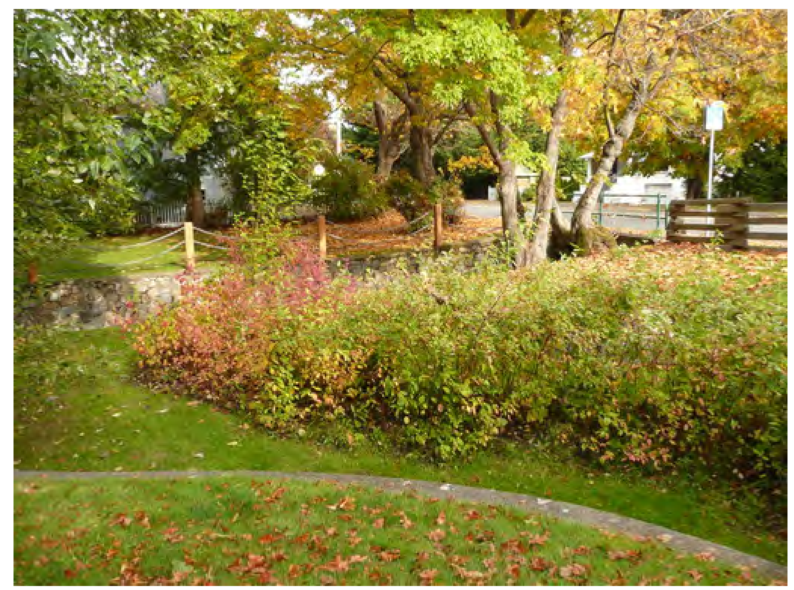

Plate 17: The area on the far bank (west bank north of Hampshire Road) is a potential candidate for a pilot project to create a more natural channel bank and riparian area due its lower public use and available space.

REACH 3B

— Oak Bay High School to tennis bubble

Width of riparian buffer each side (slope distance) and estimated slope

The channel is very narrow and deep. The south bank is a vertical retaining wall and the north bank is steep and vegetated. The vegetated width on the north bank is minimal (<2 m).

Streambank erosion issues (Y/N and H,M,L)

N (streambank not visible)

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

On the vegetated bank the dominant vegetation is young trees with some shrubs. Cottonwood, blackberry, yellow willow and European nightshade are predominant.

Species list of all plants covering >5% of the area within vegetated streamside zone As above.

Percent coverage of invasive vs. native species 50/50

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

The entire creek corridor is very narrow, perhaps 5–6 meters wide. With redevelopment the north bank along the high school property could be set back and regraded to create a more gradual streambank and a riparian buffer, by reclaiming a minimum of 10 metres of the school property.

Short term riparian restoration potential and techniques

The vegetation on the north bank could be improved (remove invasives and plant more diverse native plants) but with great difficulty due to the steepness of the bank and the fencing. This is a relatively low priority and longer term channel restoration is preferred.

Short term channel restoration potential and techniques n/a

Long term channel and riparian restoration potential

As described above and in the PFC assessment, the channel conditions could be greatly improved by moving the north bank further into Oak Bay High School property by at least 10 meters. The channel itself would be widened and meanders created, and the current concrete-lined bank on the south side could have an earth-filled terrace installed alongside it to create a naturally vegetated streambank while leaving the adjacent property (athletic track) untouched. The creek bed may currently be concrete lined. If so, the concrete would need to be removed as part of the work. Appropriate sediments will likely colonize the reach, and larger rocks can be installed to create structure.

As part of the work, the north bank would be regraded (e.g. maximum 1:1) and vegetated with native species, and a new trail installed alongside the improved reach. This would greatly improve conditions and would be a high profile restoration site. This work could be accomplished as part of a redevelopment of the school property.

Observations/Notes

The school facility will be completely rebuilt due to the need for seismic upgrades and other issues. The School District is willing to work with the BCI to allow for restoration on their property.

Reach 3B photographs

Plate 18: Narrow creek corridor between athletic track (left) and school property (right). Tennis bubble is in the background.

Plate 19: The narrow band of streamside vegetation on the north bank is a mix of blackberry and young cottonwood and yellow willow.

REACH 5A

— Tennis bubble to Bee Street.

Width of riparian buffer each side (slope distance) and estimated slope

In the lower reach on the north side, the slope is approx. 1.5:1. On the south side and in the rest of reach it is approx 2:1. The riparian corridor is narrow and entrenched as per Reach 3B but it is less steep-sided and the creek is more accessible.

Streambank erosion issues (Y/N and H,M,L) Y, L. Small unvegetated patch on lower north side of reach.

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

As described in the PFC Assessment, the reach is different in upper and lower halves. In the lower half there is more species diversity and trees are dominant. In the upper half blackberry is dominant. Tree species in the lower half are big leaf maple and cottonwood. There is an unhealthy age structure – mostly mature trees with no replacements in the understory – and a lack of a vigorous and healthy riparian community.

Species list of all plants covering >5% of the area within vegetated streamside zone

Cottonwood, bigleaf maple, snowberry, Douglas-fir, ivy, blackberry, Daphne, alder, red-osier dogwood, scotch broom, yellow willow, English hawthorne, European bittersweet, laburnum, rose, water parsley, grass. Part of the reach is armoured.

Percent coverage of invasive vs. native species 50/50

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

Narrow corridor currently—approx 5–8 meters. With Oak Bay involvement the creek could be given more room on the south side where the Oak Bay Rec Centre parking lot currently is.

Short term riparian restoration potential and techniques

Remove invasives and plant natives. It may be difficult to remove blackberry from this steep reach but this is a very accessible area where equipment could be brought in—and this could be instructive for other reaches affected by blackberry. If removing blackberry is not feasible, the Daphne, broom, hawthorne and European bittersweet could be removed and native shrubs planted in the lower half of the reach. However these short term actions are a low priority if any larger-scale actions are planned.

Short term channel restoration potential and techniques N/A

Long term channel and riparian restoration potential

This reach is behind the Oak Bay Recreation Centre and is high profile. People walk along the bank even in the absence of a safe trail. If the parking lot could be changed to make more room along the creek corridor (made into a two-tier structure) then the reach could be improved and a greenway trail installed. This would require at least 5 more meters of space along the creek corridor, and potentially more to incorporate a public walkway (detailed design required).

Observations/Notes

The District of Oak Bay is interested in treating this reach for bank stability but is waiting to see integrated recommendations from the BCI.

Reach 5A photograph

Plate 20: Reach 5A beside the Oak Bay Recreation Centre, looking downstream from Bee Street. Note the steep banks and mix of invasive and native vegetation.

REACH 5B

— Bee street to Cadboro Bay Road

Width of riparian buffer each side (slope distance) and estimated slope No buffer, vertical concrete walls
Streambank erosion issues (Y/N and H,M,L) N
Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species The only vegetation is that which can colonize inside the concrete walled (and bottomed) channel. Water parsley and cattails are two species which occur depending on recent flows.
Species list of all plants covering >5% of the area within vegetated streamside zone N/A
Percent coverage of invasive vs. native species N/A
Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment) No riparian corridor as this is a concrete channel. There is little opportunity to improve this short reach, given the land use constraints.
Short term riparian restoration potential and techniques N/A
Short term channel restoration potential and techniques Install baffles/boulders for in-channel complexity.
Long term channel and riparian restoration potential Install baffles/boulders for in-channel complexity. Review for restoration potential if major redevelopment occurs.
Observations/Notes This short (approx 45 m) reach is a low priority for treatments as little improvement can be realized without drastic land use changes.

Reach 5B photograph

Plate 21: Reach 5B looking upstream from Bee Street. Few options exist to improve this reach. One possibility is installing in-stream baffles for complexity and aeration.

Reach 7A

— Trent Street to Haultain

Width of riparian buffer each side (slope distance) and estimated slope

Above a restoration demonstration section which encompasses the lower 45 meters of the reach, there is a narrow buffer on each side—on the east bank it is 2+ meters and for the west bank 2–3 meters. The creek is incised 2+ meters throughout this section. Aside from the lower restoration demonstration section and small areas of the west bank, the banks are steep (e.g. 1:1 to vertical).

Streambank erosion issues (Y/N and H,M,L)

Y, M. There are short sections of eroding bank on the west bank across from the heliport, and at the Bishop of Victoria or Adanac ROW property.

Other erosion issues have been dealt with, with the restoration demonstration section and with bioengineering. However extensive sections of bioengineering are composed of dead willow stakes and will need to be observed over time to determine whether erosion will reoccur.

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Upstream of the treated (restoration demonstration) section:

Deciduous trees (yellow willow and cottonwood) with grass and blackberry/shrubs. Yellow willow are very well established, and occupy the periphery of the channel bottom, particularly alongside St. Patrick’s school (see Plate 24).

Species list of all plants covering >5% of the area within vegetated streamside zone

Yellow willow, grass (reed canary), cottonwood, blackberry, broom, ivy, black hawthorne, snowberry, rose, buttercup, cherry, holly

Native willows in bioengineering

In treated section: native willows, cottonwood, alder, red-osier dogwood, mock orange, red-flowering currant, rose, scirpus, swordfern, and others.

Percent coverage of invasive vs. native species

Approximately 80% invasives not including the restoration demonstration section.

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

The riparian and creek corridor is approximately 9 meters.

With permissions of the landowners and some changes to land use, the corridor could be at least 15 to 20 meters wide. This would require a change in the school use plus involvement by VIHA, the District of Saanich, and the Bishop of Victoria.

Short term riparian restoration potential and techniques

Remove invasives on the west bank, and plant with a diversity of native trees and shrubs.

Monitor the areas with dead bioengineering wattles to determine whether problems with erosion will develop over time.

Plant native shrubs and trees on the upper reach east bank where no riparian vegetation currently exists (on triangle south of Haultain and on Bishop/Adanac ROW property).

Improve the water quality running off the hospital property, by improving their stormwater infiltration/channel design (see Plate 25).

Short term channel restoration potential and techniques

The following could be done in the short term or combined with longer term/larger scale actions: Use the triangle of land immediately south of Haultain, and the informal path on the west bank, to widen the creek corridor (Plate 27). This effort can result in a 15 meter wide corridor, even at the most narrow point. With the exception of the location where a fenceline comes directly to the streambank (see Plate 28), this would allow an opportunity to remove the gabions and create a terraced creek bank with native vegetation. This may require a retaining wall on the west bank and at the corner of the lot at 1875 Haultain—a detailed design would be required.

Long term channel and riparian restoration potential

With land use changes (i.e, if St. Patrick’s school ever relocates and their land is taken over by the hospital or is otherwise redeveloped), and with involvement by VIHA, Saanich, and the Bishop of Victoria in the areas they currently own, the channel could be significantly reshaped to create a floodplain, to remove the yellow willow, and to create a healthy riparian community. This would entail creating a wider riparian corridor and more gradual banks (e.g sloped at 0.5 to 1 and less in places), a meandering channel (where possible) and potentially some small off-channel wetlands as space permits. Channel meanders should be designed based on land use constraints as well as for the appropriate amplitude for Bowker Creek flows (see Newbury and Gaboury 1994).

If the land use at St. Patrick’s remains unchanged, there is still opportunity to improve the upper part of the reach as per suggestions above.

If widening the corridor is not feasible (e.g. through the St. Patrick’s school property), the channel could be reconstructed within retaining walls as described in P.A. Harder and Associates Ltd. (2002), keeping within the same footprint but providing a small riparian area within the bounds of the retaining walls.

The upper part of the reach is constrained between lots. A long term option is to purchase the lot at 1875 Haultain Street (and/or at 1860 Adanac), to allow more room for the creek.

Any changes such as the above should be accompanied by interpretive signage and by points of visual access to the creek.

Observations/Notes

The above descriptions do not relate to the 45 m section that forms the lower part of Reach 7A. This restoration demonstration section was done opportunely when the north-east sewer trunk was upgraded, and improved conditions by resloping the banks, narrowing the channel, planting the riparian area terrace with wattles (willow and cottonwood) and with various native shrubs. The shrubs and willows are doing extremely well, and periodic blackberry removal is the only further maintenance required. This section is much improved with respect to riparian conditions, bank stability, and appropriate creek width, but still lacks in-stream complexity and a natural floodplain. If the area is ever redeveloped this section could be improved further by creating a reshaped, more complex channel in a wider floodplain, as described above.

Bioengineering done by Saanich above the footbridge has variable survival. On the east bank, little has survived. On the west bank, survival is moderately good, with the middle section having poor survival. The key section below the corner of the school gym is thriving. Immediately above the footbridge on the west bank, there is a rock retaining wall. This wall appears to be leaning and there is some erosion behind it.

The creek throughout this reach is shallow and lacking complexity, with the exception of large woody debris from a fallen yellow willow (see Plate 26), which is the only significant LWD seen in Bowker Creek outside of UVic. The creek substrate in this reach is variable, with exposed clay and small gravels, extensive yellow willow root mats, areas with cobble, and areas with a silty/sandy soft bottom.

VIHA at Royal Jubilee is interested in options that improve the creek running thorugh their property, and are most interested in options that also include the Adanac Street right-of-way and the Bishop of Victoria property, so that the entire triangle of land above St Patricks's school could be treated as a unit.

VIHA engineered the Royal Jubilee drainage so that no pipes drain directly from the property into the creek. However, their infiltration channel/area is not treating water quality sufficiently, and does not allow for significant infiltration. The original design of these features should be compared to their current functioning.

Reach 7A photographs

Plate 22: The 45-m long restoration demonstration section completed in 2005 is doing well and the willow/cottonwood wattles are thriving along with a variety of native shrubs (Photo October 2008).

Plate 23: One of two 'topped' cottonwood next to the hospital heliport

Plate 24: Upstream of the demonstration restoration section showing dead bioengineering along the east bank, behind thriving yellow willow growing on the channel bottom.

Reach 7A photographs, continued

Plate 25: Runoff from the hospital includes hydrocarbons. There is an opportunity to improve VIHA's Royal Jubilee stormwater runoff facilities next to Bowker Creek.

Plate 26: looking from the west bank to the triangle of land south of Haultain on the east bank. This area provides potential for widening the creek corridor.

Plate 27: Eroding unvegetated banks on the Bishop of Victoria and Adanac right-of- way property provide an opportunity for short and/or long term restoration actions.

Reach 7A photographs, continued

Plate 28: This fallen yellow willow offers rare large woody debris in Bowker Creek.

Plate 29: The property at 1875 Haultain comes to a point at the edge of Bowker Creek and is stabilized by gabions.

Plate 30: Gabions are controlling erosion at the top end of this reach, allowing for a streamside footpath on the west bank.

REACH 7B

— Haultain to Richmond: BC Hydro property

Width of riparian buffer each side (slope distance) and estimated slope

Vegetated 'buffers' are to top of bank, where vegetation exists. Banks are steep in most areas, with a height of up to three meters.

Streambank erosion issues (Y/N and H,M,L)

Y, H. Steep unvegetated and eroding banks in places, particularly in the top half of the reach, on the east bank where public access has eroded the vegetation, and on the west bank near the apartment building. One area on the east bank actually has a hole eroded into the streambank.

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Blackberry and exposed soil with occasional trees, yellow willow and cottonwood, with a set-back row of coniferous trees along the streamside path.

Species list of all plants covering >5% of the area within vegetated streamside zone

Blackberry, yellow willow, cottonwood, grass, ivy, Daphne, holly, cherry, snowberry, daffodil and fennel.

A double row of planted conifers along the streamside trail, which include pine, fir, hemlock, cedar, spruce and other species.

Percent coverage of invasive vs. native species

95% invasive, non-native or unvegetated

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

If the distance to the inner row of conifers along the path is included, the creek corridor is approximately 11 meters wide. With BC Hydro involvement, the creek corridor could be widened as much as necessary to create a meandering channel with appropriately sloped banks. On the west bank there is currently a chainlink fence at top of bank. To improve the channel, the expansion would need to be done to the east.

Short term riparian restoration potential and techniques

No short term actions recommended

Short term channel restoration potential and techniques

No short term actions recommended aside from removing yellow willow growing against the Richmond Road culvert, that could potentially pose issues during flood flows.

Long term channel and riparian restoration potential

Completely re-make the channel by moving it eastwards a minimum of 10 meters. Reslope the banks to a gentle grade (e.g. 0.5 to 1). Create some channel sinuosity at the appropriate amplitude (Newbury and Gaboury 1994). Plant native riparian species in buffers 5 to 15 meters wide (width can be variable), with key points for public viewing of the creek channel. Create a greenway path outside the riparian buffer. Create interpretive signage. Create one or two small off-channel wetland pockets with diverse emergent/riparian vegetation. These should be planted with adjacent shade trees so as not to create creek temperature issues.

Salvage harvest some of the abundant crayfish that live in this reach, and relocate them to the new channel. Provide woody materials to ensure crayfish habitat can develop in the new channel. Create artificial riffle habitat (rock groins) with rocks of sufficient size to withstand peak flows (Slaney and Zaldokas 1997)

Observations/Notes

This is one of the best locations for making significant changes to the creek channel.

Yellow willow currently growing against the culvert under Richmond Rd could pose issues during flood flows.

This section has a healthy population of crayfish.

Moving the channel would require removing the row of coniferous trees along the eastern creek bank, and community education to create support for these changes. Currently these trees are host to bird species (i.e. barred owl) not commonly seen in the watershed.

On the lower west bank there are gabions which extend upstream for approximately 25 meters, and the section below the apartment building on the west bank also has some concrete sandbags.

There are some minimal riffle habitats in this section, and this reach is one of the areas for benthic invertebrate sampling.

Substrates in this reach consist of gravel and cobble with sand and silt.

Reach 7B photographs

Plate 31: This reach is typified by steep, sparsely vegetated eroding banks and by blackberry on the west bank. It also has more riffle habitat than many sections of Bowker Creek.

Plate 32: The path along this reach is popular with neighbours and the mature conifer trees that line the path are important to the community.

Plate 33: Typical view of the east bank, with the row of conifer trees visible at the top of bank.

Plate 34: Looking toward the west bank. Bowker Creek is constrained along the west side of the Hydro property and restoration would entail expansion to the east.

REACH 9

— Newton to Pearl Street (Richmond school and Townley Street ROW)

Width of riparian buffer each side (slope distance) and estimated slope

The vegetated area extends only to the top of bank. The west bank is steeper and is approximately 2.5 meters wide. The east bank is approximately 4.5 meters wide.

Streambank erosion issues (Y/N and H,M,L)

Y, H

Erosion is extensive on both banks, particularly on the steeper west bank.

Additionally, the streamside fence is falling over due to erosion around its footings. See Plates 38 and 42

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Trees and shrubs: mature yellow willow, blackberry, snowberry

Species list of all plants covering >5% of the area within vegetated streamside zone

yellow willow, blackberry, broom, cottonwood, red osier dogwood, black hawthorne, English ivy, holly, laurel. The west bank along the apartment complex has a short retaining wall with a laurel hedge.

Percent coverage of invasive vs. native species

90% invasive

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

The entire, deeply entrenched creek corridor is approximately 13 meters wide. With school board involvement, the creek corridor and riparian buffers could be widened to an extent that would support a healthy creek channel.

Short term riparian restoration potential and techniques

There are serious erosion issues, but it is preferable to create a longer-term solution that involves resloping the banks, rather than attempting bioengineering on these steep banks.

Short term channel restoration potential and techniques

Fencing that is falling over could be replaced and set back further from the top of bank to avoid future issues.

Long term channel and riparian restoration potential

Redesign the creek channel by moving/widening the creek corridor to the west. It can also be moved east by a certain amount to reduce the east bank slope as necessary, but the distance the channel corridor can be moved east is constrained by the right of way above the sewer pipe line parallel to the east bank. Access for sewer maintenance needs to be maintained.

Design options will depend on the amount of land available in the triangle of land to the west of the current creek channel. If this entire area comes available for use, a meandering channel with a significant pond/wetland can be created. See specific design suggestions as per Reach 7B. If the land available is limited the creek corridor should be widened and its original alignment maintained, and the following options are possible:

Create a retaining wall along the east bank, to enable a planting bench 3–5+ meters wide along the east side of the channel, OR regrade the channel within the constraints of the right of way (detailed design required).

Regrade the west bank and remove volumes of fill in order to create a gently sloping bank. If space is limited this bank can be created in two tiers. Changing the west bank slope will require expanding the creek corridor at least X meters from the current top of bank.

There is currently a designated right of way along the east bank of the channel, above the north east trunk sewer line. The School Board has signed an agreement to create this right of way. Design options should use this corridor for greenway development.

At the top of the reach, options become more limited due to the apartment buildings on the west bank and the narrower right of way beside Townley street, which would need to incorporate a greenway path. In this section, the sewer line runs mainly below the street, but there is a Saanich water line in the road right of way. On the east bank, a retaining wall could be built set back from the creek to allow for a planting bench as described in Harder (2002).

Observations/Notes

This section has the worst erosion anywhere along the creek, and is the most entrenched. Working with the school district to restore this section will create excellent PR.

Substrate in this reach is variable and ranges from cobble and gravel to sand to silt to clay. Willow mats cover significant sections. There were two sinkholes encountered, one with an unknown depth.

Fish were seen in this reach. They appear to be sticklebacks but the species has not yet been identified.

There were hydrocarbons stirred up by walking in this reach, as well as gas from decaying leaves and sediment. On the day the reach was walked, Saanich had a single absorbent oil boom below the Pearl Street outlet.

At the top of the reach, there are some native shrubs planted as part of work done to control erosion. These require further maintenance.

Reach 9 photographs

Plate 35: The upper part of the reach below Pearl Avenue is the healthiest in terms of substrate, channel configuration and riparian vegetation. Benthic invertebrate sampling is done here.

Plate 36: The west bank is constrained in the upper two-thirds of the reach by an extensive apartment complex at 1702 Newton Street.

Plate 37: Extensive blackberry is a major feature of this reach.

Plate 38: Erosion is an issue through the school grounds. The fence footings have been eroding and public access is worsening the issue.

Plate 39: The school district has put extra fencing around eroding sections as a public safety measure.

Plate 40: The right-of-way along Townley Street is relatively narrow, but still allows an opportunity to widen the creek corridor.

REACH 12A

— North Dairy Road to McRae

Width of riparian buffer each side (slope distance) and estimated slope

Vegetated 'buffer' is narrow—to top of bank or with a narrow row of vegetation at top of bank. The bank height is up to two meters and ranges from 1:1 to vertical

Streambank erosion issues (Y/N and H,M,L)

Y, M. There are a few spots of significant erosion on the west bank between the two footbridges.

A significant portion of the reach has concrete sandbags, gabions, or rock walls, particularly the lower part of the reach.

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Variable. It is mainly blackberry dominated with treed sections, and with sections that abut directly to lawns with and without armoured banks.

Species list of all plants covering >5% of the area within vegetated streamside zone

Blackberry, snowberry, yellow willow, native willows in bioengineering, hawthorne, ivy, holly, ornamental trees, big leaf maple, Indian plum, cottonwood, lamium, douglas fir, grand fir, cedar hedge.

Percent coverage of invasive vs. native species

95% invasive or unvegetated.

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

Corridor width is approximately 8 meters or less, with a very narrow to no riparian buffer. The creek winds between residential properties, and without redevelopment significant restoration will be impossible. However, some worthwhile work could be done if certain property owners agree. The Wordsworth Street right-of-way also offers opportunity.

Short term riparian restoration potential and techniques

Remove the small patch of lamium on the west bank downstream of the upper footbridge.

Vegetate the west bank riparian zone along the Wordsworth Street right of way accessed from McRae Avenue. Reslope the bank to the degree possible while leaving room for a greenway path.

Work with the private property owner across from the right of way (1607 McRae Avenue), to vegetate the grassed terrace below their upper rock wall, and to reslope the bank as necessary. Part of the lower terrace is also armoured and part is a bare clay bank. See Plate 41.

Short term channel restoration potential and techniques

If the property owners at 1599 McRae Avenue agree, grade the bank back, and plant with native species to a buffer distance agreeable with the property owners. The backyard at this address is quite large and extends to the top of bank of Bowker creek with a cedar hedge and fence. The property comes to an angle here and this area is likely not much used. There is erosion all along this section. See Plate 42.

Long term channel and riparian restoration potential

Aquire several properties and/or rights-of-way along properties to create floodplain and a riparian buffer.

Move the creek into the right-of-way along Keats Street. This would depend on requirements for the electricity line currently in this space. The creek could gain four to five meters of space if this right of way could be made available. The gabions would be removed and the bank resloped, blackberry removed, and planted with native species.

There is a fenced property at the south end of Shelley Street, which is part of the lot at 1564 North Dairy. See Plate 46. This area is isolated and unused, and the concrete wall could be removed and a riparian buffer installed. The new streambank would have to be engineered however (e.g. with terraces), as the space is limited and the bank is high. It is unclear whether the city cares for this property or if it is the responsibility of the homeowner at 1564 North Dairy. This action could be taken in the shorter term but would make the most sense as part of a larger program.

Observations/Notes

The substrate in this reach is variable. Below McRae is a gravel/cobble section, followed by sandy substrate, then by a clay bottom with occasional cobble and extensive willow root mats, then by a gravel cobble section. In the cobble section there is more riffle habitat and the section above Keats Street is another possibility for benthic sampling.

The upper end of this reach has had bioengineering completed by the District of Saanich. The section nearest McRae is thriving but a significant portion, particularly on the east bank, is now dead.

Currently, the District of Saanich is planning limited riparian restoration on the Wordsworth ROW as part of their greenway creation.

Reach 12A photographs

Plate 41: Reach 12A looking north. The patch of grass on the left is the Wordsworth Street right of way accessed from McRae street. The lawn below the rock wall on the right has potential for riparian restoration if the property owner agrees. This could entail some bank resloping.

Plate 42: Erosion behind 1599 McRae Avenue. If the property owner agrees, the section along this property is a candidate for bank and riparian restoration.

Plate 43: Discrete areas on both banks, particularly the west bank, have erosion problems.

Plate 44: Upstream view. The creek does a sharp turn around this property. This would be a key property to acquire for creek restoration as the house footprint is very close to the creek.

Plate 45: Looking south along the right of way on Keats Street. Depending on whether the power line could be moved, the creek could be extended into the right of way, allowing the gabions on the east bank to be removed and natural riparian vegetation planted.

Plate 46: This streamside property appears to be part of the lot at 1564 North Dairy. It could be reconfigured as part of short or long term restoration plans

REACH 12B

— McRae to Knight – Browning Park

Width of riparian buffer each side (slope distance) and estimated slope

The upper and lower halves of the reach differ (above and below footbridge).

In the lower half on the west bank, grass extends to the creek bank in many places; in other areas the riparian vegetation is one tree or shrub deep. The bank on the west side is low (~ one meter). On the east bank the vegetated buffer is wider (0 to 5 meters) and the height of bank increases moving north. The east bank slopes back at approximately 1:1.

In the upper half of the reach, the riparian buffer consists of one row of trees on both sides, with shrubby undergrowth and ivy. The east bank is high and near vertical. The west bank is low and transitions to high and steep at the upper end of the reach. At the upper end, the creek is very incised, with tops of bank four or more meters above the creek.

Streambank erosion issues (Y/N and H,M,L)

Y, L. There is one patch of erosion on the east bank above the footbridge, where the bank is not armoured. Parts of the steep west bank are also unvegetated where there are access points to the creek.

In the upper reach the creek edge is armoured with one row of rocks set in concrete or asphalt, and the upper east bank is armoured with concrete blocks. In the bottom part of the reach, there is a low (one meter) rock retaining wall on both sides. In the middle reach the armouring varies.

The creek bottom is armoured with asphalt, though in the upper reach (below the culvert) this has been eroded into large chunks.

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Deciduous trees (alder, cottonwood, yellow willow), shrubs and ivy with grassy areas in the mid/lower reach

Species list of all plants covering >5% of the area within vegetated streamside zone

North end: alder and ivy are dominant, with snowberry, blackberry, big leaf maple, cottonwood, holly, daphne

South end: yellow willow and cottonwood are dominant, with grass, Garry oak, snowberry, blackberry, Indian plum, alder, laurel

Percent coverage of invasive vs. native species

Approximately 40% invasive

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

The vegetated riparian corridor is up to 13 meters wide, but width varies.

This park is owned by the District of Saanich and changes can potentially be made. At the north end the east bank is at residential property lines, is near vertical and, and is armoured. Assuming it is stable, it should remain as is. For the uppermost 38 meters of this reach (one property deep), options are limited due to limited available space. Below this point, the riparian buffer can be widened and changes can be made to the banks and to the creek location and/or configuration.

Short term riparian restoration potential and techniques

Vegetate the grassy riparian patches below the footbridge on the west bank with native shrubs and trees. However if changes to the channel are possible this action should be postponed.

Widen the riparian buffer along the east bank:

In the southern part of the reach where housing formerly stood (if longer term action not planned as per below)

In the area just south of the footbridge, by moving the footpath further east

On the east bank above the footbridge, install a delta loc system or bioengineering, to stabilize the bank at the corner of the property line at 1637 Knight Avenue (as per park plans)

Remove invasive species in all possible locations

Increase species and age class diversity with native plantings

Remove the mature yellow willow in the lower reach as feasible (together with a planting plan)

Vegetate open areas on the east bank (lower reach) and close off the informal trails

Short term channel restoration potential and techniques

Address house drainage coming through the west side of the park by building a demonstration rain garden for infiltration.

Create an upcreek oil capture device and/or determine the source of hydrocarbons to this reach.

Remove the concrete walls and asphalt bottom from the lower reach and reconfigure the banks at a stable slope.

Long term channel and riparian restoration potential

Parallel with the southern end of the lot line for the house at 1621 Knight Avenue (38 meters from top of reach), begin grading the west bank back to a gentler angle (1:1 at minimum), and move the footpath further west. Re-vegetate the bank with native trees and shrubs. Move the channel as far westward as practicable while still allowing space for a greenway and public use. Determine whether this move would allow the east bank to be reconstructed, or whether it should remain as is (if stable) or have a retaining wall constructed.

At the south end of the reach near McRae St., consider moving the channel further east, to allow space for both a greenway and a riparian buffer (there is a narrow point where the distance between the creek and the edge of the park is approximately 10 meters). The east bank in this area consists of former housing lots that were purchased by the District of Saanich to add to the park. These lots are likely on fill and the creek bank slopes down from the level fill. While there is some riparian vegetation here, there is also an opportunity to move the channel further east to make room for a greenway and a riparian buffer on the west bank. However there are a few mature cottonwoods and one mature Garry oak that would need to be considered. These are approximately 5 meters away from the east bank. Regardless of whether the channel is moved, there is an opportunity to regrade the east bank and remove the rock wall, and plant with native trees and shrubs.

Remove the asphalt chunks and paving from the channel bottom. Create engineered rock groins/riffles.

All longer term changes to the channel need to consider removal of bank armour and creation of a diverse riparian buffer.

Observations/Notes

The east bank above the footbridge to the top of the reach is covered in ivy but has limited restoration potential due to its steepness.

In general, the riparian trees (particularly the alder in the upper reach) are even-aged with no younger trees in the understory.

Discussions are ongoing with Saanich about making some of the above changes as part of greenway implementation and with Trees for Tomorrow funding.

Reach 12B photographs

Plate 47: Grassy area along west bank that is a candidate for riparian planting

Plate 48: The top of the reach looking across to the armoured east bank. The creek is highly incised here.

Plate 49: Looking south from the top of the reach. The current path curves towards the creek and with park redevelopment will be moved west to provide space for a riparian buffer, including a resloping of the creek bank.

Plate 50: looking across to the east bank where homes have been removed to expand the park. Even if the creek is not moved further east to accommodate a wider riparian buffer on the west bank, the east bank can be re-graded and have riparian buffer on the west bank, the east bank can be re-graded and have riparian vegetation planted, and the rock wall removed.

REACH 15A
— UVic Faculty Club pond and outlet channel
Width of riparian buffer each side (slope distance) and estimated slope Variable buffer width around pond. Narrow buffer width around outlet channel. Gentle slopes
Streambank erosion issues (Y/N and H,M,L) N
Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species Pond: Trees and shrubs (Douglas fir, alder, bigleaf maple, cottonwood, cedar, dogwood, cattail Exit channel: shrubs and groundcover (ornamental and native). Bark mulch.
Species list of all plants covering >5% of the area within vegetated streamside zone Douglas fir, alder, bigleaf maple, cottonwood, cedar, dogwood, cattail, Oregon grape, birch, swordfern, garry oak, pacific water parsley, rhododendron, salal, cattails
Percent coverage of invasive vs. native species 80 % native
Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment) The landscaped buffer zone around the pond is a few meters wide, more in spots. The buffer around the outlet channel is less than a meter wide. The configuration of this reach is unlikely to change, until such time as the building is demolished or redesigned.
Short term riparian restoration potential and techniques Plant more native species around pond edge and outlet channel. In particular, introduce dispersed willow stakes in a few pondside areas.
Short term channel restoration potential and techniques N/A
Long term channel and riparian restoration potential If the building is ever removed, this site could be converted into wetland
Observations/Notes Dam downstream of pond has been repaired. Some water pollution visible on pond surface. The pond area evidently used to be smaller and/or potentially not a year round feature. Currently, a stormwater pipe from across campus discharges into this pond.

Reach 15A photographs

Plate 51: The pond at the Faculty Club, Reach 15A. The pond edge is somewhat landscaped and native plantings could be increased.

Plate 52: The pond edge is the concrete patio at the Faculty Club. Looking downstream to beginning of outlet channel.

Plate 53: Pond outlet channel

Plate 54: Pond outlet channel as it goes into a culvert below parking and access roads

REACH 15B
— Faculty club to Gordon Head Road (description also includes the forested section of Reach 15C, Section B)
Width of riparian buffer each side (slope distance) and estimated slope Low gradient extensive buffer/floodplain
Streambank erosion issues (Y/N and H,M,L) N
Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species Widely spaced deciduous and coniferous trees with a shrub understory: Grand fir, douglas fir, bigleaf maple, cottonwood, alder, blackberry, rose, red-osier dogwood, salmonberry
Species list of all plants covering >5% of the area within vegetated streamside zone In addition to the above: bracken fern, ivy, holly, buttercup, snowberry, sword fern, piggyback plant, trailing blackberry, grass (reed canary?), trembling aspen, skunk cabbage, English hawthorne
Percent coverage of invasive vs. native species 60/40 native/invasive
Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment) This is the only section of the creek with abundant existing floodplain
Short term riparian restoration potential and techniques Remove ivy, starting with ivy covered trees. Remove the large blackberry patches. Remove the blackberry from the drainage channel coming from the parking lot (lot #10) to the south (see Plate 57) and install interpretive signage here about Bowker Creek and stormwater management. Identify and map epicentres or concentrations of invasive species and work from these outwards over a period of years until minimal maintenance is required. The section of creek beside the parking lot could have its riparian buffer extended out into the ROW. See Plate 56.
Short term channel restoration potential and techniques N/A
Long term channel and riparian restoration potential Same as short term

Observations/Notes
Note: the above description applies to Reach 15C as well, from the Fraser Parking lot to its confluence with reach 15B. This forested area is protected until 2011 in the existing UVic campus plan and may be included in new sustainability planning. This is a very wet area, with soft ground and silty fine soils. There are various dead trees—maple and grand fir—which may relate to changes in hydrology due to parking lot construction south of this forested area. A long term strategy to remove invasives in this area would be welcome and would ideally come from students and faculty members and be supported by UVic Facilities Management.

Reach 15B photographs

Plate 55: Creek channel behind Faculty Club parking lot

Plate 56: Location of creek channel beside Faculty Club parking lot. The riparian buffer could be extended into the grass ROW.

Reach 15B photographs, continued

Plate 57: Blackberry lined drainage channel from parking lot 10 (near Visual Arts building) to vicinity of Reach 15B. This presents an opportunity to create a more natural channel with native plants and interpretive signage about runoff and Bowker Creek.

Plate 58: ivy covered trees and blackberry mixed with native vegetation. This is in the area where the forested section of Reach 15C joins with Reach 15B.

Plate 59: Some pure blackberry patches (in the area of confluence between Reach 15B and 15C, close to the Fraser Building parking lot) are obvious targets for invasive species control

Plate 60: Much of the channel in Reach 15B and the forested area of Reach 15C is impenetrable and inaccessible, and its course has not been accurately mapped.

Reach 15C

— Tributary from Mackenzie/Stadium Section A. There are two very different sections:

Section A: Mackenzie to the Fraser Building Parking Lot, and Section B: Fraser Building Parking lot to Reach 15B. The below deals only with Section A as Section B has the same conditions as Reach 15B

Width of riparian buffer each side (slope distance) and estimated slope

Variable width, from 0 to 10 meters. Slope is very gradual and banks are low – the creek is unconfined in this reach.

Streambank erosion issues (Y/N and H,M,L) N

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

Deciduous trees and shrubs, grass and herbs. Cottonwood is dominant, with some alder. Dominant shrubs are salmonberry, native willow (likely pacific and sitka) and blackberry Some patches with a high water table are dominated by herbs especially buttercup.

Species list of all plants covering >5% of the area within vegetated streamside zone

Cottonwood, alder, salmonberry, native willow spp, blackberry, snowberry, red osier dogwood, reed canary grass and lawn grasses, sword fern, lodgepole pine, thistle, water parsley.

Percent coverage of invasive vs. native species

Approximately 70% native if grassed area is not included. Buttercup and blackberry are responsible for the greatest extent of invasive plant cover.

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

The current corridor is 3 to 15 meters wide, and it could easily be extended without altering existing land uses.

Short term riparian restoration potential and techniques

Widen riparian buffer by planting diverse native vegetation up to a distance of 15 meters on each creek bank. Remove the invasive thistle and large blackberry thicket at the north end. Provide interpretive signage about the project and the reason for the changes.

Short term channel restoration potential and techniques

Add more structure with placement of large logs. Sediment trapping has been suggested (Barraclough, et al., 2007) to deal with fine sediments coming off the road system. At the time of inspection the problem of sediments was not evident. This area should be revisited to determine whether water quality and sediment inputs are issues here.

Improve the quality and quantity of runoff from the Fraser parking lot into the channel. This parking lot offers further opportunities for infiltration. Improvements could be made including a swale along the parking lot edge and infiltration features within the lot itself. This may allow the current ditch draining the lot to be returned to a naturally vegetated state.

Long term channel and riparian restoration potential

The short and long term options are similar, as there are no significant barriers to restoration in Section A of Reach 15C.

Observations/Notes

Flow emerging from the upstream blackberry thicket indicates that pipes are feeding into this reach. However the extent and location of this drainage network is not obvious, and would require more information from Facilities Management to determine.

Reach 15C photographs

Plate 61: Reach 15C, Section A, has no apparent barriers to restoration. The main restoration action is to increase the width of the riparian buffer.

Plate 62: The riparian buffer is quite narrow in some locations, due to mowing near to the creek edge.

Plate 63: Looking south down Reach 15C (Section A). Stormwater (or groundwater) emerges from inside the blackberry patch to water the reach.

Plate 64: Invasive buttercup occupies a significant area, in some cases mixed with pacific water parsley.

Plate 65: Runoff comes from the Fraser parking lot and is delivered to the channel both overland and through this ditch.

REACH 17A

— Tributary from Cedar Hill Golf course, lower section

Lower = A (Cedar Hill to 1st footbridge); Upper = B (Between 1st & 2nd footbridges)

NOTE: above the 600 mm pipe was not explored

Width of riparian buffer each side (slope distance) and estimated slope

Incised excavated channel with steep banks

Lower reach A: similar bank heights of 3-4 metres on each side. Slopes 1:1–1:2. Vegetated buffer 5–8 m wide.

Upper reach B: Very high banks ~5 m high on SW side; slopes 2:1–1:1; width of SW vegetated riparian buffer up to 12 m. Banks decrease on NE bank travelling upstream from 1.5–3 m; slope 1:3; vegetated buffer ~5 m wide.

Streambank erosion issues (Y/N and H,M,L) N

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

A: Canopy of western redcedar and Douglas-fir with thick Nootka rose and red-osier dogwood shrub layer.

B: Cottonwoods and red-osier dogwood at upper and lower ends of reach; Nootka rose throughout; middle section of Himalayan blackberry, reed canary grass and equisetum.

Species list of all plants covering >5% of the area within vegetated streamside zone

Note: all invasives (*) seen are listed, whether >5% or not, in order to target for removal.

A: western redcedar, Douglas-fir, Indian-plum, Nootka rose, *Himalayan blackberry, *reed canary grass, equisetum, red-osier dogwood, Pacific water parsley, *(bull?) thistle, *morning-glory, snowberry, hardhack, *poison hemlock, cherry cultivar (non-native), curly dock (non-native), *creeping buttercup, agricultural grasses.

B: : western redcedar, Douglas-fir, cottonwood, Oregon Ash, willow (likely native), red alder, grand fir, various mature and immature conifers, Indian-plum, Nootka rose, thimbleberry, red-flowering currant, *English hawthorn, *Himalayan blackberry, *reed canary grass, equisetum, red-osier dogwood, Pacific water parsley, *(bull?) thistle, *morning-glory, snowberry, hardhack, skunk cabbage, *golden chain tree (*Laburnum* sp.), *purple salsify/oyster plant (*Tragopogon* sp.), curly dock (non-native), *creeping buttercup, cattail (*Typha* sp.), *holly, agricultural grasses.

Percent coverage of invasive vs. native species A: 20% invasive:80% native

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

Buffer varies. Pathways closely parallel creek on alternating sides. Vegetated corridor includes mown grass areas that could be utilized. This reach is on public (Saanich) golf course property and there is potential to reshape the banks and create a wider riparian buffer.

Short term riparian restoration potential and techniques

Plant more red-osier dogwood and native shrubs to shade out invasives in middle section of B. Remove invasive species, especially poison hemlock to prevent spreading. Remove invasive species and care for planted conifers. Increase plantings by adding cottonwood stakes.

Short term channel restoration potential and techniques

Coarse woody debris could add more creek complexity

Long term channel and riparian restoration potential

A has mature native trees on banks, thus banks are fine. Plant more native species. Consider sloping SW bank of B and planting increased native trees throughout this section. Consider Garry oak and associated meadow species for very dry and sunny area at top of bank on SW of B. Consider native-planted COIR-type logs for bio-engineering of SW bank of B. If necessary create a terrace and use bioengineering with willows to stabilize it.

Observations/Notes

There is a long and deep vegetated ditch between Cedar Hill Rd and the Recreation Centre parking lot that discharges into the lower end of Reach 17A just before the creek flows underground at Cedar Hill Rd. While mostly filled with invasive species currently, there is room to complex this section to create sinuosity. In the short term it could be planted with native trees and shrubs to create shade.

Note: the Quadra Cedar Hill Neighbourhood Association has hosted invasive species removal parties in this reach in 2007 and 2008.

Reach 17A photographs

Plate 67: Reach 17A downstream view from footbridge several years after removal of blackberry

Plate 68: downstream end of Reach 17A-A looking west from Cedar Hill

Plate 69: Map of Reach 17A-AB and 17B-CD

Reach 17B

— Upper part of tributary from Cedar Hill Golf course (past footbridge to baseball diamond)

Lower = C (2nd footbridge to north of baseball diamond and before footpath where creek channel is entrenched); Upper = D (entrenched channel to 600 mm pipe)

Width of riparian buffer each side (slope distance) and estimated slope

Lower portion of reach C is an unconfined, low-gradient floodplain with minimal slopes of mainly less than 1 m in height. Vegetated riparian buffer varies greatly from 2-5 m wide (NE bank) to up to 10 m (SW bank) with a large cattail/willow marsh of ~2500 m^2 and up to 60 m across.

Upper reach D: Creek consists of a linear ditch ~1 m wide and 0.5 m deep in a low-gradient field. W bank is manicured golf course to within <1 m of channel, E bank is infrequently/roughly mowed to 1 m the channel. Creek source discharges into a shallow, ~3-5 m wide pool from 600 mm concrete pipe emerging from steep hillock.

Streambank erosion issues (Y/N and H,M,L)

Y, low

Dominant vegetation structure (trees, shrubs or ground cover) and dominant and co-dominant plant species

C: Mainly mature willow (most likely native) marsh with portions of open cattail/reed canary grass marsh.

D: Mature cottonwoods tapering off to Himalayan blackberry and Scotch broom with open sections of creeping buttercup and Pacific water parsley.

Species list of all plants covering >5% of the area within vegetated streamside zone

Note: all invasives (*) seen are listed, whether >5% or not, in order to target for removal.

C: willow (likely native), cottonwood, *English hawthorn, immature Douglas-fir, mature alder, western redcedar, red-osier dogwood, hardhack, thimbleberry, cherry (maybe native), hawthorn (maybe native), equisetum, cleavers or bedstraw (*Galium* sp.), *(bull?) thistle, *reed canary grass, *Himalayan blackberry, cattail (*Typha* sp.), Pacific water parsley, *morning-glory, Nootka rose, *creeping buttercup, Scouler's willow (maybe), *holly, skunk cabbage, curly dock (non-native), agricultural grasses.

D: willow (likely native), cottonwood, immature conifers, *Himalayan blackberry, *holly, *Scotch broom, Pacific water parsley, *European bittersweet, equisetum, cleavers or bedstraw (*Galium* sp.), *creeping buttercup, cattail (*Typha* sp.), *morning-glory, *climbing rose (?), rush (*Juncaceae* family), mint (*?),curly dock (non-native), water-plantain (*Alisma plantago-aquatica*?), agricultural grasses, + 2 water plant (non-native) watercress (Rorippa micropylla) and American brooklime (Veronica beccabunga ssp. americana)

Percent coverage of invasive vs. native species

If willow = (Pacific?) willow, C: 5% invasive:95% native. D: 30% invasive:70% native

Current width of vegetated riparian corridor and potential width of riparian buffer with private landowner involvement/redevelopment (comment)

C: Riparian corridor ~2–10 m wide around marsh, <1 m at times in linear section adjacent to golf fairway (W side). Potential for expansion of corridor is limited only by the baseball diamond on the NE side and by the golf course layout. Both are publicly (Saanich) owned.

D: Riparian corridor currently is only 1 tree/shrub wide and has been mowed to the trench margin in some locations. Potential expansion is limited only on W side by gold green layout.

Short term riparian restoration potential and techniques

Remove invasive species immediately, especially at headwaters (Scotch broom, Himalayan blackberry, European bittersweet, creeping buttercup). Plant native shrub species in open trench section of D for shade.

Short term channel restoration potential and techniques

Coarse woody debris could add more creek complexity and sinuosity of linear section in D. Examine erosion at 600 mm pipe pool and armour bank with native willow wattling or native-planted COIR logs.

Long term channel and riparian restoration potential

D could be graded to reduce trenching and create more marsh habitat for water retention as at C, or narrow channel could be retained with added sinuosity, coarse woody debris and increased canopy coverage to prevent increased water temperatures.

Observations/Notes

The creek bed substrate is fine silty mud along all sections of the reach. Depending on the source of the water in the 600 mm pipe, gravel may make a good substrate at this small headwater pond for added complexity. There is a small tributary flow into the west end of the willow/cattail marsh in C immediately adjacent to a golf fairway. This flow emanates from a spring or, more likely, a buried pipe that has silted in. This tributary could potentially be daylighted and planted with native species.

Reach 17B photographs

Plate 70: Cattail marsh looking north to baseball diamond

Plate 71: Top of Reach 17B linear section, looking south

Plate 72: Pool at head of 600 mm culvert

Plate 73: Willow marsh at top of Reach 17B

Plate 74: Source flow from west tributary into cattail marsh

APPENDIX C-1: RECOMMENDED PLANT SPECIES FOR RIPARIAN RESTORATION PROJECTS ON BOWKER CREEK

Detailed restoration prescriptions including the exact number and type of riparian plants will be prepared as restoration opportunities present themselves. Plants should be spaced two to four meters apart (trees should be four meters apart). A list of native plants that can be used as a starting point for detailed restoration planning is as follows:

Wetter locations/bottom of bank

Tree species:

black cottonwood (*Populus balsamifera* ssp.*tricocarpa)*

western redcedar *(Thuja plicata)*

bigleaf maple (*Acer macrophyllum)*

Shrub species:

native willows (Scouler's, Pacific, Sitka, Hooker's). Note that depending on environment these species can grow into small trees, Pacific willow in particular. (*Salix* spp.*)*

Pacific ninebark (*Physocarpus capitatus)*

hardhack (*Spirea douglasii)* (wet floodplain sites only)

red-osier dogwood (*Cornus stolonifera)*

Indian-plum (*Oemleria cerasiformis)*

salmonberry (*Rubus spectabilis)*

Drier locations/top of bank:

Tree species:

bigleaf maple (*Acer macrophyllum)*

grand fir (*Abies grandis)*

Douglas-fir (*Pseudotsuga menziesii)*

Shrub species:

snowberry (*Symphoricarpos albus)*

nootka rose (*Rosa nutkana)*

oceanspray (*Holodiscus discolor)*

Indian-plum (*Oemleria cerasiformis)*

Recommendations:

In areas that are high visibility/high use, the following further species can be planted to increase the aesthetic appeal. These species are not typical riparian species and are more suited to the top of bank:

- Mock-orange (*Philadelphus lewisii)*
- red-flowering currant (*Ribes sanguineum)*

Planting should occur in fall, timed with the onset of first rains. Ideally, the plants should be irrigated over two summers. If this is not possible, deep mulching should be used instead, with emergency watering in very dry periods as needed. Removal of invasive species should be done until the plants are established (two to three years). Removal of problem species like blackberry and knotweed should be done on an ongoing basis as required.

The banks of Bowker creek often consist of clay. As the channel is modified based on restoration prescriptions, it may be necessary to import mulch or topsoil to support native plant growth, and/or fertilizers may be employed when planting.

APPENDIX C-2: COMMON AND LATIN NAMES FOR COMMONLY-OCCURRING BOWKER CREEK RIPARIAN VEGETATION

A star (*) indicates non-native vegetation, and two stars (**) indicates invasive non-native vegetation

Herbs/groundcover

bracken fern (*Pteridium aquilinum*)

buttercup (*Ranunculus repens*) **

Canada thistle (*Cirsium arvense)*

cattail (*Typha latifolia)*

English ivy (*Hedera helix)* **

horsetail *(Equisetum* spp.*)*

European bittersweet (*Solanum dulcamara)* **

morning-glory (*Ipomoea* spp.) **

Pacific water-parsley (*Oenanthe sarmentosa)*

policeman's helmet (*Impatiens glandulifera)* **

poison hemlock (*Conium maculatum)***

reed canary grass (*Phalaris arundinacea)*

skunk cabbage (*Lysichiton americanum)*

sword fern (*Polystichum munitum)*

trailing blackberry *(Rubus ursinus)*

yellow pond lily (*Nuphar polysepalum)*

Shrubs

dull Oregon-grape *(Mahonia nervosa)*

English hawthorne (*Crataegus laevigata)* **

English holly (*Ilex aquifolium)*

Himalayan blackberry (*Rubus discolour)* **

Japanese knotweed (*Polygonum cuspidatum)* **

laburnum (*Laburnum* spp.) *

laurel-leaved daphne (*Daphnea laureola)* **

laurel spp. (Lauraceae*)* *

mock-orange (*Philadelphus lewisii)*

Nootka rose (*Rosa nutkana)*

oceanspray (*Holodiscus discolour)*

salal (*Gaultheria shallon)*

Scotch broom (*Cytisus scoparius)* **

snowberry (*Symphoricarpos albus)*

red-osier dogwood (*Cornus stolonifera)*

rhododendron (*Rhododendron* spp.)

vine maple (*Acer circinatum)*

Trees

alder (*Alnus rubra)*

bigleafed maple (*Acer macrophyllum)*

birch (*Betula* spp.)

black cottonwood (*Populus balsamifera* ssp. *tricocarpa)*

black hawthorn *(Crataegus douglasii)*

cherry (*Prunus* spp.) *

Douglas-fir (*Pseudotsuga menziesii*)

Garry oak (*Quercus garryana)*

hemlock *(Tsuga heterophylla)*

Indian plum *(Oemleria cerasiformis)*

Oregon ash *(Fraxinus latifolia)*

pacific willow *(Salix lucida)*

poplar (*Populus balsamifera)*

shore pine (*Pinus contorta)*

trembling aspen *(Populous tremuloides)*

weeping willow (*Salix* x *sepalcralus)* *

western redcedar (*Thuja plicata*)

willows (*Salix* ssp.)

yellow willow (*Salix lutea)* **

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APPENDIX D

APPENDIX D—METHODOLOGY OF THE BLUEPRINT MONITORING PROGRAM

Further to the defined monitoring variables in 7.0 *Monitoring Program*, this appendix outlines the methodologies for conducting the monitoring program every five years. It is imperative that the monitoring program can be repeated with consistency so that the results are comparable. Outlined below is the methodology for each monitoring variable as well as any specific notes on mapping or calculations.

Notes

1. For original baseline data methodologies and calculations, please refer directly to the original document.
2. In preparation for assessing the baseline data surface type in the Riparian Forest Integrity (RFI) analysis, the centerline of Bowker Creek had to be adjusted to accurately reflect its position on the map. Extensive editing was required to place the center of the creek in position on the orthophoto. The scale at which the center line was redrawn was 1:500. It is important to integrate this more accurately delineated creek into all analysis of the various monitoring variables.
3. The baseline of the blueprint, the CRD mapping has these measurements at:
   - total length of the creek (main channel + tributaries): 9.4 km
   - total length open channel: 3.4km (36%)
   - total length contained in storm drains: 6.1km (64%)

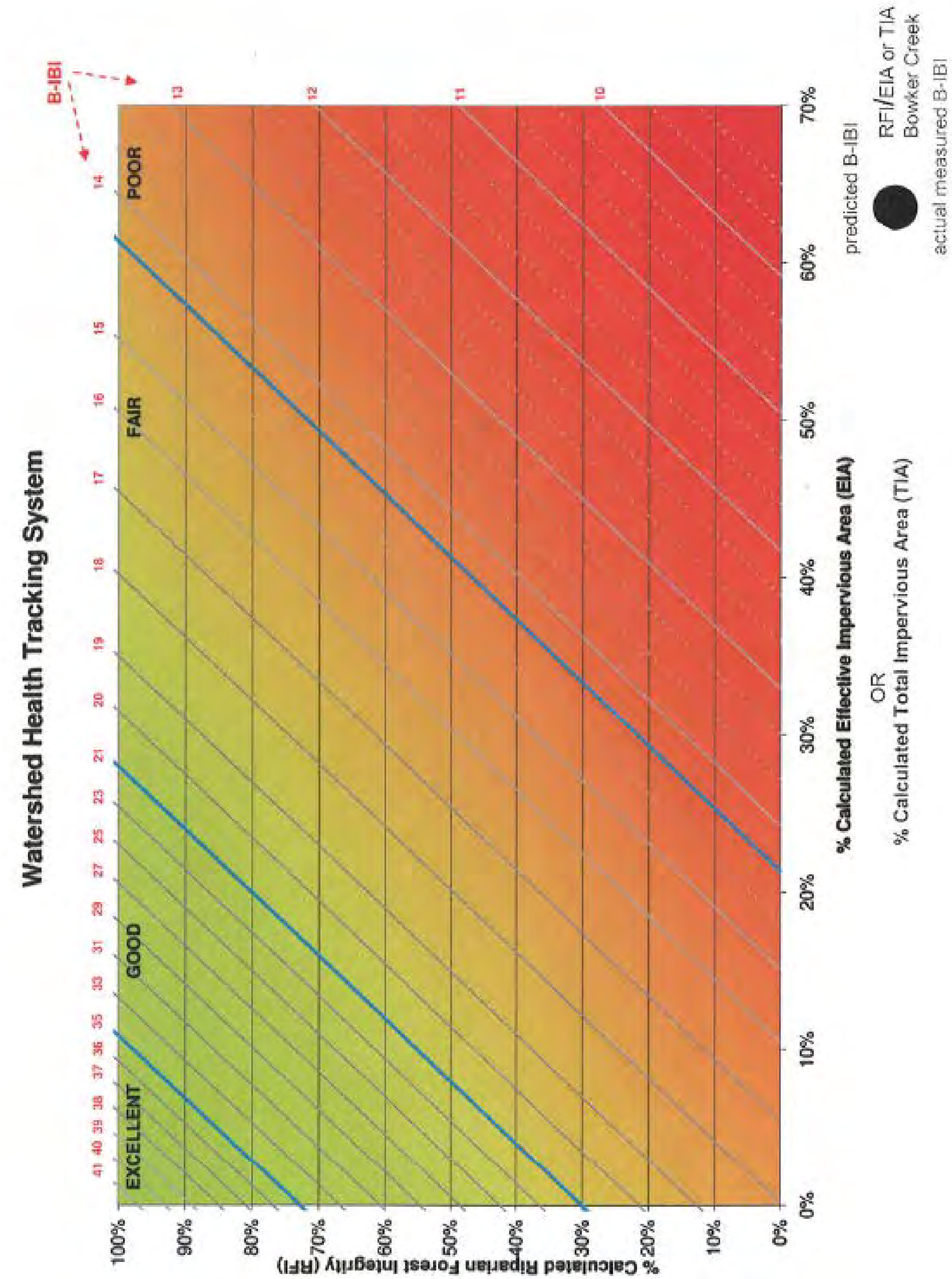
WATERSHED WIDE VARIABLES METHODOLOGIES

1. WATERSHED HEALTH TRACKING SYSTEM

source: Template for Integrated Stormwater Management Planning 2005 (Kerr Wood Leidal, 2005)

See "Watershed Health Tracking System" chart (adjacent):

- Y- axis is the Riparian Forest Integrity (RFI) [% of watershed]
- Lower X- axis is the Effective Impervious Area (EIA) [% of watershed], however until technology allows it is suggested that lower X-axis be Total Impervious Area (TIA) [% of watershed]
- Top x-axis is the Benthic Index of Biotic Integrity score B-IBI



Variables Needed for the Watershed Health Tracking System

MAPPING AND CALCULATION NOTE: As technology allows, it would be ideal to distinguish land cover/surface type in the riparian area from the current "Pervious" which is currently identified as "grass", and "Canopy Cover" which is "trees and shrubs" (which may be mostly invasive species).

A. Total Impervious Area (TIA) (% of watershed)

source methodology: Master Drainage Plan (Kerr Wood Leidal, 2007)

Computer analysis was conducted using the most resent colour orthophotos (1:7500) maps supplied by the CRD. It is important to note the following from the Master Drainage Plan (pg 3-1) in order to conduct the orthophoto interpretation in subsequent years.

"In order to determine the imperviousness (hardened surfaces resisting infiltration) of each of the sub-catchments within the watershed, the software Feature Analyst produced by Visual Learning Systems was used. Once manually trained, this software was used to automatically delineate impervious areas based on the air photos provided by CRD. In manually checking the software's delineation of impervious areas it was found that it slightly overestimated the impervious areas. For sample areas the impervious areas were manually delineated and compared with the automatically delineation. Based on the sample areas, the impervious areas automatically delineated were reduce by 7%. It was found that the entire Bowker Creek watershed is approximately 50% impervious."

B. Effective Impervious Area (EIA) (% of watershed)

source methodology: Master Drainage Plan (Kerr Wood Leidal, 2007)

Effective Impervious Area (EIA) was not successfully measured for baseline data and was thus assumed to be roughly equivalent to TIA. The Mater Drainage Plan states (pg 3-2), "During the flow-monitoring period no storm events of significant precipitation intensities occurred (i.e. not significant enough to generate measureable runoff from pervious areas). Therefore, stormdrain monitoring was not useful in generating the Green Ampt Equation parameters for pervious areas." Please refer to the Master Drainage Plan for further information.

EIA is somewhat reflected in the baseline conditions map (Map 3), which contains all known municipal and institutional Low Impact Development (green infrastructure), raingardens, swales and etc. Until calculation of the EIA becomes more easily measureable and mapped, this figure is difficult to use as a variable. For the time being it is recommended that TIA be used rather than EIA.

NOTE: The municipalities and institutions have recently completed some of the first urban raingardens and green infrastructure within the Bowker Creek watershed; it is suggested that these be mapped as they are an important variable in calculating EIA, and need to be encouraged as re-development occurs. In the future, it is also encouraged to include private property locations of green infrastructure, raingardens, and etc.

C. Riparian Forest Integrity (RFI) (% of 30 m buffer on either side of creek for above and below ground)

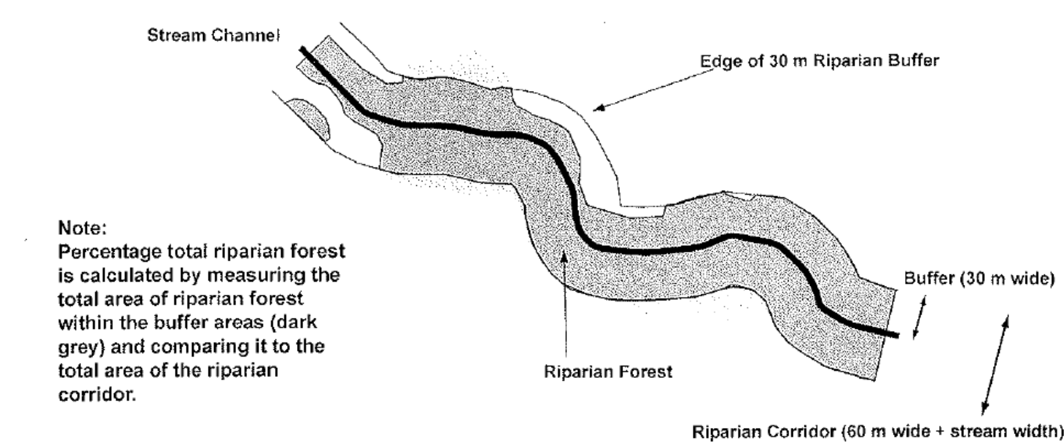
source methodology: Proposed Watershed Classification System for Stormwater Management in the GVS & DD Area (Page, 1999)

RFI can be derived using GIS analysis (utilizing the land classifications data set developed from the Urban Forest Stewardship Initiative), on the newest orthophotos. Percentage total riparian forest is calculated by measuring the total area of riparian forest within the total 30 m. buffer (area on each side of the centre line of the creek), and comparing it to the total area of the riparian corridor. It is important to note that these measurements can be made only to the open section of the creek, but the percentage must be applied to the entire buffered length (total ha) of the creek above and below ground.

For the baseline data, buffer surface features categories included: Impervious Surface (roof tops, parking lots, roads, etc.), Open Channel (creek visible), Canopy Cover (tees and shrubs), and Pervious Surface (grass/lawn). As technology improves it would be valuable to expand these categories to delineate degraded riparian such as blackberry and yellow willow. It is very important to note that the baseline data for the RFI does not reflect the health of the RFI (i.e. the "canopy cover" classification includes all shrubs and trees, of which a high percentage is invasive shrubs and other invasive in the understory).

MAPPING NOTE: For the baseline data the CRD provided a digital orthophoto in .tif format with which to digitize the surface features, as well as providing shape (.shp) files with all pertinent layers included. In preparation for assessing the baseline data surface type, the centerline of Bowker Creek had to be adjusted to accurately reflect its position on the map. Extensive editing was required to place the center of the creek in position on the orthophoto. The scale at which the center line was redrawn was 1:500. The four subcategories of Surface Type were created using ARCCatalog and the Domain function. The default category is Canopy Cover. Statistics were generated in the attribute tables using the summarize function.

Percentage Total Riparian Forest



D. Benthic Index of Biotic Integrity (B-IBI score)

source: Bowker Creek Benthic Invertebrate Pilot Project (Stallard, 2009)

The following methodologies were used: the Greater Vancouver Regional District (GVRD, now Metro Vancouver) Benthic Macroinvertebrate B-IBI Guide (EVS 2003), Restoring Life in Running Waters (Karr and Chu 1999) and the video Biological Monitoring Protocol (Cedar Films 1998). Some adaptations were made due to the difficulty in finding suitable lengths of riffle substrate in this highly modified urban watercourse. Karr/SalmonWeb protocols were used in place of EVS methodology for determining the number of replicates and sub-sampling, and the duration of substrate disturbance.

NOTE: the sample collection date (October) falls outside of the generally recommended sampling window in the Pacific Northwest of August-September (Karr and Chu 1999, EVS 2003, Beatty et al., 2006).

Four sample sites were chosen following a previous inspection of the creek to search for suitable locations (see map below). The BMI sampling protocol recommends avoiding creek sections with different substrates and locations immediately downstream of modifications such as bridges, culverts and other control structures (EVS 2003, Beatty et al., 2006). However, these types of modifications make up the majority of Bowker Creek. The sampling sites were chosen primarily based on riparian canopy, substrate and riffle characteristics, where a suitable length of reach allowed three Surber sampler placements within approximately 20-30 metres. At three sites (Beach Drive, BC Hydro lands, Browning Park) samples were collected in three individual riffle sections not less than 10 metres apart for each creek section, with some riffles as far as 27 metres apart. This was due to the lack of continuous riffle habitat as described in both EVS (2003) and Karr and Chu (1999). Most riffle habitats in Bowker Creek were less than 1 m in length. At the Pearl Street location (site 3), there was only riffle habitat for one sample; however, a sample was collected to provide information on the creek health as a large portion of the creek is underground immediately upstream of the site.

METRIC	DESCRIPTIONS
Total Taxa Richness	The total number of unique taxa identified in each replicate. The numbers from the three replicates are then averaged for this metric.
Ephemeroptera Taxa Richness	The total number of unique mayfly (Ephemeroptera) taxa identified in each replicate. The numbers from the three replicates are then averaged for this metric.
Plecoptera Taxa Richness	The total number of unique stonefly (Plecoptera) taxa identified in each replicate. The numbers from the three replicates are then averaged for this metric.
Trichoptera Taxa Richness	The total number of unique caddisfly (Tricoptera) taxa identified in each replicate. The numbers from the three replicates are then averaged for this metric.
Number of Long-Lived Taxa	The total number of unique long-lived taxa identified in each replicate. The numbers from the three replicates are then averaged for this metric.
Number of Intolerant Taxa	The total number of unique intolerant taxa identified in each replicate. Chironomids are not included in this metric. The numbers from the three replicates are then averaged for this metric.
Percent Tolerant Individuals	The total number of tolerant individuals counted in each replicate divided by the total number of individuals in that replicate, *multiplied by 100*. Chironomids are not included in this metric. The numbers from the three replicates are then averaged for this metric.
Percent Predator Individuals	The total number of predator individuals counted in each replicate divided by the total number of individuals in that replicate, *multiplied by 100*. The numbers from the three replicates are then averaged for this metric.
Number of Clinger Taxa	The total number of unique clinger taxa identified in each replicate. The numbers from the three replicates are then averaged for this metric.
Percent Dominance	The sum of individuals in the three (3) most abundant taxa in each replicate, divided by the total number of individuals in that replicate, *multiplied by 100.* The numbers from the three replicates are then averaged for this metric.

Species-Level 10 Metric B-IBI Scoring Criteria

The Species-Level 10 Metric Scoring Criteria is calibrated for organisms identified to the following taxonomic specifications:

- Aquatic insects to lowest practicable level, most to Species
- Rhyacophilids (caddisfly larva) to Sub-group
- Chironomids to Genus
- Non-insects to Order or Family

SPECIES-LEVEL 10 METRIC B-IBI	SCORING CRITERIA		
METRIC	1	3	5
Taxa richness and composition			
Total number of taxa	[0, 20)	[20, 40]	> 40
Number of Ephemeroptera (mayfly) taxa	[0, 4]	(4, 8]	> 8
Number of Plecoptera (stonefly) taxa	[0, 3]	(3,7]	> 7
Number of Trichoptera (caddisfly) taxa	[0, 5)	[5, 10)	≥ 10
Number of long-lived taxa	[0, 2]	(2, 4]	> 4
Tolerance			
Number of intolerant taxa*	[0, 2]	(2, 3]	> 3
% of individuals in tolerant taxa*	≥ 50	(19, 50)	[0, 19]
Feeding ecology			
% of predator individuals	[0, 10)	[10, 20)	≥ 20
Number of clinger taxa	[0, 10]	(10, 20]	> 20
Population attributes			
% dominance (top 3 taxa)	≥ 75	[50, 75)	[0, 50)

Square braces indicate the value next to the brace is included in the range; rounded parentheses indicate the value is *not* included.
*Chironomids are not included in these metrics.

B-IBI Score Interpretation

Conversion of metric totals into the three scoring criteria categories (1, 3, 5) enables comparisons between sampling locations, whether within the same creek, or across watersheds and regions, as well as comparisons over time. As explained by SalmonWeb, category 5 represents the expected range of results for an “undisturbed” site, category 3 for a “somewhat degraded” site, and category 1 for a “severely degraded” site (2001).

Summing of the category scores gives the total B-IBI score from a possible 10-50 points and an associated rating indicating the biological health of the creek. The following 10 metric B-IBI score interpretation table contains recent amendments (Chadd 2004) agreed to by James Karr, with changes to terminology in order to be more effective in portraying the ecological status of creek health.

10 Metric B-IBI Score Interpretation for Creek Health

PREVIOUS SCORE	PREVIOUS GRADE	AMENDED SCORE	AMENDED GRADE	DEFINITION
50-46	Excellent	50-46	Healthy	Ecologically intact, supporting the most sensitive life-forms.
44-38	Good	44-36	Compromised	Showing signs of ecological degradation. Impacts expected to one or more salmon life-stages.
36-28	Fair	34-28	Impaired	Healthy ecosystem functions demonstrably impaired. Cannot support self-sustaining salmon populations.
26-18	Poor	26-18	Highly Impaired	Highly adverse to salmon and various other life-forms.
16-10	Very Poor	16-10	Critically Impaired	Unable to support a large proportion of once-native life-forms.

Adapted from Chadd 2004.

Benthic Sample Sites Locations

Sample Sites 1

Location: South of 1776 Beach Drive, upstream (west) of Beach Drive. Roughly corresponding to creek segment 1+00 to 2+00 from Reid Crowther (2000).

1a 4.5 m upstream of staff gauge at concrete box culvert under Beach Drive & adjacent to square orange spray paint and pink flagging tape.

1b 14.5 m upstream of staff gauge & 1 m downstream of start of horizontal concrete edge of retaining wall & adjacent to fence post in concrete base. 10 m upstream of 1a.

1c 25.5 m upstream of staff gauge & 19.5 m downstream from bedrock 'cascade' & opposite black pvc in 100 mm clay pipe imbedded high in wall. 11 m upstream of 1b.

Sample Sites 2

Location: BC Hydro reserve lands, between Haultain Street and Richmond Road. Roughly corresponding to creek segment 19+00 to 20+00 and water quality station WQ11 from Reid Crowther (2000).

2a 71 m upstream (north) of white fence at Haultain Street & 1 m upstream of a big willow at treehouse or chicken coop across from bare earth on northeast bank.

2b 92-94 m upstream (north) of white fence at Haultain Street & 21 m upstream (north) of 2a. 4 m upstream of corner of chainlink fence on southwest bank. Second clearing from Haultain & 7 m downstream of first log/tree over creek.

2c 124-125 m upstream (north) of white fence at Haultain Street & 27 m upstream (north) of 2b. At a big willow on southwest bank 1 m south of 3rd clearing at spot where apartment building corner is closest to creek (~5 m upstream).

Sample Site 3

Location: Downstream of Pearl Street where creek emerges from underground section. Roughly corresponding to creek segment 26+00 to 27+00 and downstream of water quality station WQ15 from Reid Crowther (2000).

3 21.5 m downstream of Pearl Street box culvert & 2 m upstream of a large willow.

Sample Sites 4

Location: Browning Park between McRae and Knight Avenue. Roughly corresponding to creek segment 45+00 to 46+00 and downstream of water quality station WQ19 from Reid Crowther (2000).

4a 60-70 m downstream of wooden footbridge & 2 m upstream of large alder on west bank & 1 m downstream from small exotic conifer held by 2 support posts at edge of clearing.

4b Upstream of wooden footbridge & 42 m downstream of Knight Ave box culvert.

4c 26 m downstream of from Knight Ave box culvert and 16 m upstream of 4b.

CRD Environmental Sustainability - Oct 14, 2010 - Technologist: SR - Map Document: BowkerCreekBenthicSamp.mxd

Meters
0 100 200 400 600

Projection: UTM ZONE 10N NAD 83

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Benthic Samping Site Locations

Municipal Boundaries

Lot Lines

Regional and Municipal Parks

Bowker Creek Main Channel

Underground

Open Channel

Bowker Creek Watershed Boundary

Roads based on May 2010 data
Lot lines based on 2008 data

2. URBAN TREE COVER (% OF WATERSHED)

source methodology: Urban Forest Canopy Cover Mapping and Analysis in the CRD 1986-2005 (Urban Forest Stewardship Initiative, 2008)

CITYgreen software was used in the baseline data analysis. Subsequently, land cover classes and attributes have been developed specifically for the baseline data source and are available to in-house Geographic Information System (GIS) mapping, making it possible for CRD staff to generate the urban tree cover data. Moreover, as orthophoto resolution improves, the data will have greater accuracy. NOTE: baseline data was derived from multiple sources and displayed on air photos at 1:5000 and classified at a grid of 1 ha cells.

Future urban tree cover percentage and other land cover classes (i.e. grass, impervious shrub, trees, etc.) can be derived using the developed database, thus allowing GIS analysis to be run on the newest air photos available. At this time it is also suggested that new classifications be added (when technology allows) to identify areas such as blackberry, and green infrastructure. There is also the potential that LIDAR (**Li**ght **D**etection **a**nd **R**anging) technologies can be used when they become cost effective.

NOTE: Other data presented in 7.2 *2009 Baseline Conditions* was generated from the data in Urban Forest Canopy Cover Mapping and Analysis in the CRD 1986–2005 (Urban Forest Stewardship Initiative, 2008).

CREEK CORRIDOR VARIABLES

3. CREEK LENGTH ABOVE GROUND

a) main channel (meters and %)
b) Cedar Hill tributaries (meters and %)

source: (original creek lengths above and below ground) Bowker Creek Master Drainage Plan (Kerr Wood Leidal, 2007) & any new sections daylighted the respective municipality

As new sections are daylighted, their measurements need to be documented and reported by the authority doing the restoration. This new measurement would be added to the previous measurements, growing accumulatively.

Note: New above ground creek length needs to be added to GIS mapping.

4 RESTORATION OF OPEN CREEK SECTIONS

a) Length of improved creek bank (meters of open creek, each side of bank measured independently)
b) Size of improved riparian area (meters squared, within 30 m buffer around open creek)

source: (baseline data) BCI Coordinator (2009)

The measurement of the a) linear length of open creek bank improvements, measured in meters (m), measuring each side of the bank independently, and b) improvement to riparian areas, including restoration activities that occur within the 30 meter riparian area, measured in squared meters (m^2), need to be recorded. Improvements in both a) and b) include activities such as invasive plant removal, native plantings, removal of hardened banks, wattle fencing, creation of in-stream and streamside tabling, re-routing of creek with meanders and other means of bank restoration and improvements and expansion of the forested riparian area.

Note: Improved lengths and areas need to be added to the GIS mapping. Any new restoration needs to be documented by respective municipalities or other group doing the restoration, and reported to the BCI coordinator. Measurement of b) can be used for data in tracking Riparian Forest Integrity (RFI%) under Watershed Wide Variables.

5. LENGTH OF GREENWAY DEVELOPED

(meters within watershed)

source: (original Greenways length) BCI Coordinator (2009)

Based on the definition of "greenways" in sections 4 and 7 of the Blueprint, as new sections of the greenway are developed, the respective municipality needs to report the measurement of the sections. This new measurement would be added to previous measurements, growing accumulatively. As the greenways have multiple routing and are on roadways as well as creek side, the length will be longer than the creek itself.

In the future, as "greenstreets" develop, it may be of interest to have a measurement of total length within the watershed. Greenstreets are defined on page 7 of the Blueprint.

NOTE: New length of greenway developed needs to be added to GIS mapping, distinguishing the "green" greenways. Any newly developed greenways within the watershed need to be documented by respective municipalities and reported to the BCI coordinator. All potential greenways are based on the greenways outlined on Map 5, Bowker Creek Initiative Potential Greenways.

WATER AND SEDIMENT QUALITY VARIABLES

6. WATER AND SEDIMENT QUALITY

(various scores of various parameters measured)

source: Stormwater Quality Report, Core Area (CRD, 2007 and annually)

Baseline data used for this report ranges from 2000 to 2009 CRD monitoring results. Sampling is conducted by the CRD Stormwater, Harbours and Watersheds Program (SHWP) at four locations along Bowker Creek—see Map 8. Water quality sampling is done by the CRD twice yearly under wet and dry weather conditions, to help municipalities understand which creeks under their jurisdiction may need to receive remedial measures. It is not done during 'first flush' events (i.e., rainfall after an extended dry period) where pollutants are expected to reach their highest levels. This means that short duration pollution events are not typically included in sampling results, though these events will have a significant impact on aquatic life. The CRD takes sediment samples on a scheduled basis, and more frequent follow-up sampling is done when high contaminant levels are found, in conjunction with detailed investigations to determine the source(s) of contamination.

Sampling and analysis methods are described in the Stormwater Quality Report, Core Area, 2007, which also explains criteria for determining the chemical contaminant ratings and is available on the internet and in hard copy by request to the SHWP.

The CRD has been monitoring the following water quality variables in the Bowker Creek. Fecal coliform counts per 100 millilitres have been sampled since 1982. Temperature, pH and dissolved oxygen have been sampled since 1999, and specific conductance since 2000. Turbidity measurements have been taken since 2003, and nutrient levels (nitrate/nitrogen and phosphorus) have been sampled since 2005.

Sources of Typical Stormwater Pollutants*

POLLUTANT	POTENTIAL SOURCES
Sediment and Floatables	Streets, lawns, driveways, roads, construction activities, atmospheric deposition, drainage channel erosion
Pesticides and Herbicides	Residential lawns and gardens, roadsides, utility right-of-ways, commercial and industrial landscaped areas, soil wash-off
Organic Materials	Residential lawns and gardens, commercial landscaping, animal wastes
Metals	Automobiles, bridges, atmospheric deposition, industrial areas, soil erosion, corroding metal surfaces, combustion processes
Oil and Grease/Hydrocarbons	Roads, driveways, parking lots, vehicle maintenance areas, gas stations, illicit dumping to storm drains
Bacteria and Viruses	Lawns, roads, leaky sanitary sewer lines, sanitary sewer cross-connections, animal waste, septic systems
Nitrogen and Phosphorus	Lawn fertilizers, atmospheric deposition, automobile exhaust, soil erosion, animal waste, detergents

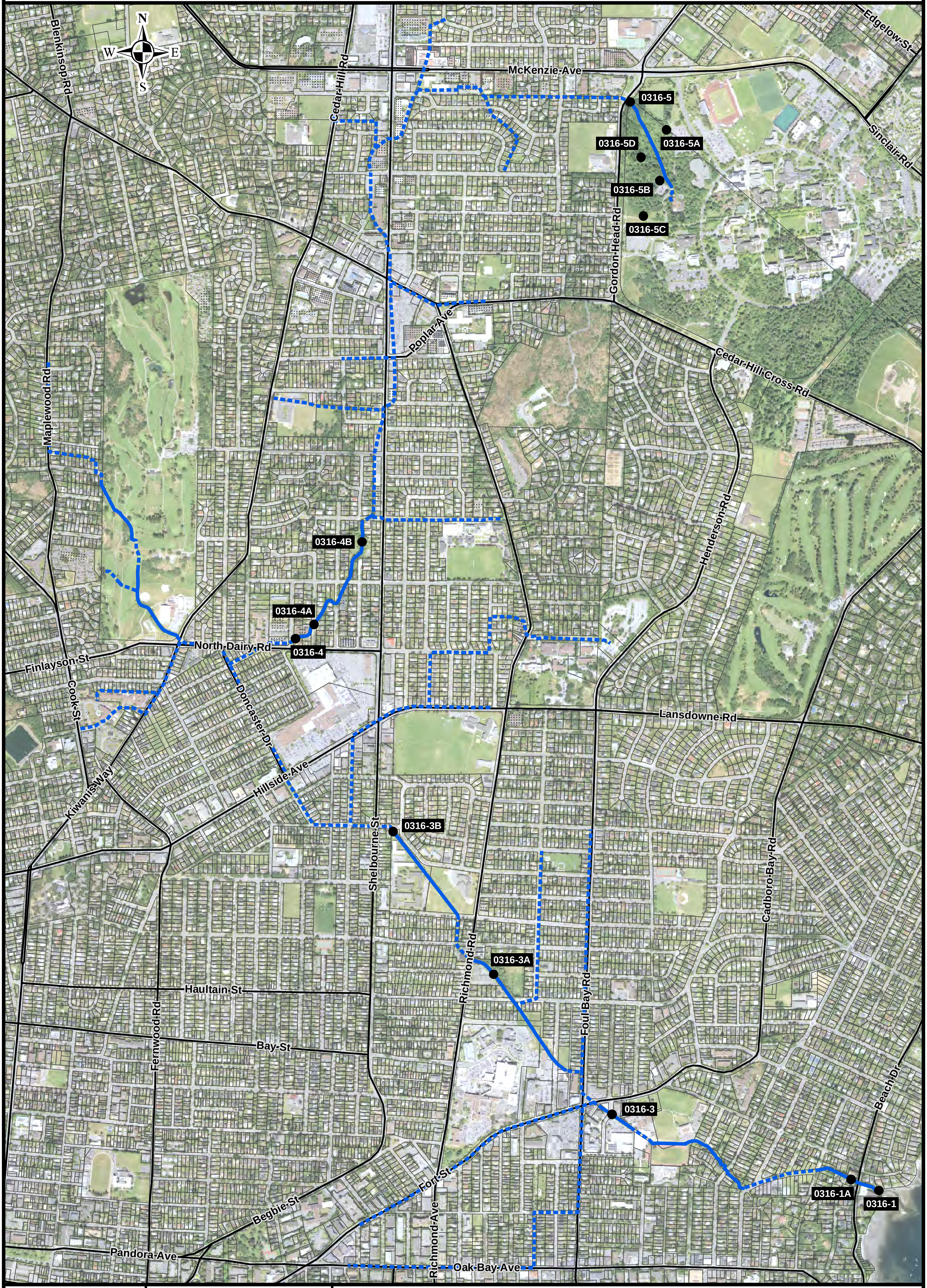
***Adapted from USEPA 1999**

NOTE: As the CRD's annual Stormwater Quality Report (Core Area) will be the source of data for this variable, it is important to ensure that the program keeps monitoring Bowker Creek into the future.

Water Quality Variables Monitored in Bowker Creek by the CRD

WATER QUALITY VARIABLE	WHAT IT MEASURES OR INDICATES
Fecal Coliforms	An important measure of water quality from a human health perspective as they are an indicator of the presence of sewage and associated harmful bacteria.
Temperature	An indicator of habitat quality for some aquatic species such as salmon, and it also has an effect on dissolved oxygen levels, with levels diminishing as temperature rises. In the urban environment, impervious surfaces such as parking lots can contribute heated water to creeks.
Dissolved Oxygen	Must be present in sufficient quantities to support high quality habitat for certain aquatic species. Oxygen levels can be diminished with high temperatures or with elevated nutrient levels that act to increase the biological oxygen demand.
pH	A measure of acidity, and will vary to some degree under natural conditions due to variations in the local watershed geology. In the urban environment, pH could be altered by various chemicals – either of industrial or residential origin - washing into the creek. The BC-Approved Water Quality Guidelines (Province of BC 2006) state that pH must be between 6.5 and 9.0 to support aquatic life.
Specific Conductance	A measure of the ability of water to conduct an electrical current. It provides an indication of dissolved solids (such as salt, metals or nutrients) in the water and changes to specific conductance may indicate changing pollution levels.
Turbidity	Measurements provide an indication of the amount of suspended sediments, which in the urban environment could be a result of erosion from construction activities or erosion from exposed creek banks.
Nitrate/Nitrogen and Phosphorus	Provides information about these two common and important nutrients, which can have negative effects on aquatic ecosystems when out of balance. Levels of these nutrients are often elevated in urban environments.

BOWKER CREEK SEDIMENT AND WATER SAMPLING LOCATIONS



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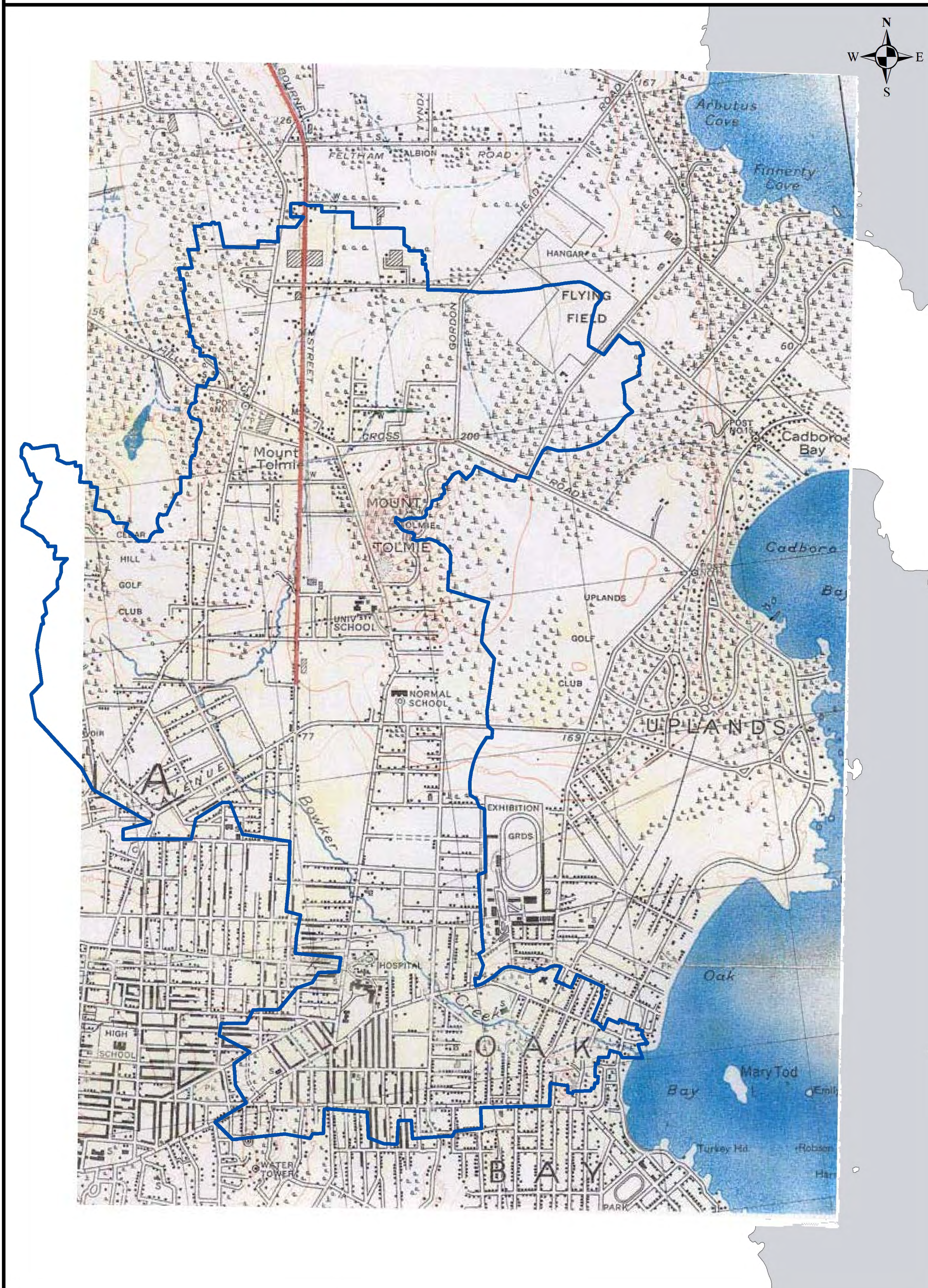
MAP 8. WATER AND SEDIMENT SAMPLING LOCATIONS

CRD Environmental Sustainability - Sept 10, 2012 - Technologist: JPB - Map Document: BowkerHistorical1930.mxd

BOWKER CREEK WATERSHED AREA
HISTORICAL CONTEXT - 1930



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0 100 200 300 400 500 Meters

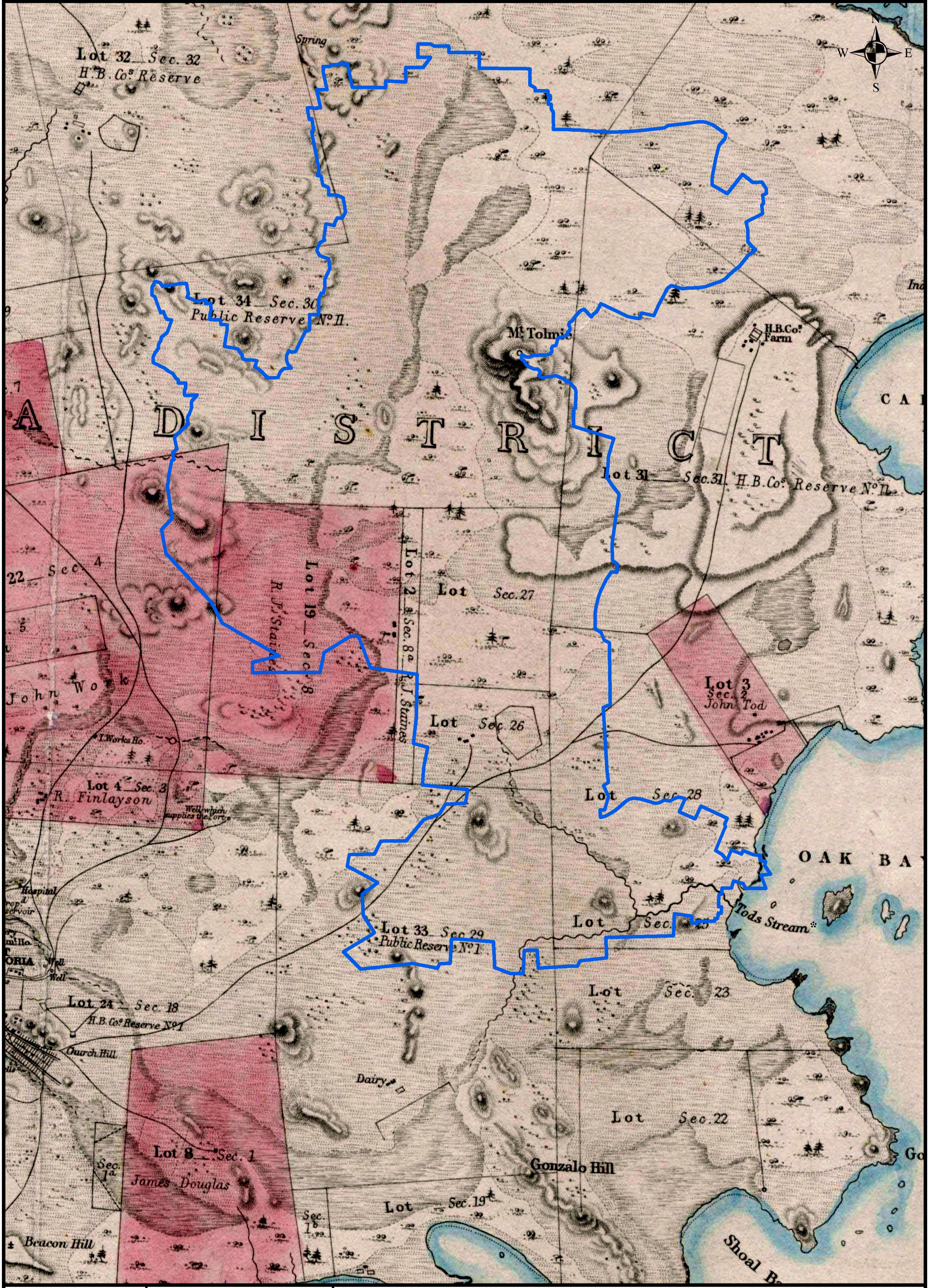
Projection: UTM ZONE 10N NAD 83

Current Bowker Creek Watershed Area

CRD Environmental Sustainability - Sept 10, 2012 - Technologist: JPB - Map Document: BowkerHistorical1854.mxd

BOWKER CREEK WATERSHED AREA

HISTORICAL CONTEXT - 1854



CRD
Making a difference...together

Meters
0 100 200 300 400 500

Projection: UTM ZONE 10N NAD 83

Current Bowker Creek Watershed Area

Base Map Shows a Portion of:
Map of the Districts of Victoria and Esquimalt in Vancouver Island. Published 1854, by John Arrowsmith. 2 inches to 1 mile.
The National Archives of the UK (TNA): Public Record Office (PRO), CO 700/BRITISH COLUMBIA2
* In this representation Bowker Creek is referred to as Tods Stream