the partnership
for water sustainability in bc

Assessing the Worth of Ecological Services Using the *Ecological Accounting Process* for Watershed Assessment

Brooklyn Creek Demonstration Application in the Comox Valley

September 2018

The Ecological Accounting Process (EAP) is a program deliverable for
"Sustainable Watershed Systems, through Asset Management",
Georgia Basin Inter-Regional Education Initiative

What the Reader Will Learn

Readers will find in this report a demonstration of the Ecological Accounting Process (EAP) as it was applied to the Brooklyn Creek watershed in the Comox Valley on Vancouver Island.

Brooklyn Creek is a small creekshed whose hydrology and ecological services have been altered and degraded by decades of land use impacts. Of three local governments with management authority over land use and conservation in the creekshed, only the Town of Comox has acted strategically for more than a decade to maintain (prevent degradation) and manage (enhance) the stream corridor and the available ecological services.

The report offers three big ideas. *The first is that local government, First Nations, and community, businesses and other stakeholders have divergent views about what the ecological services of the creekshed may be worth.*

The Town's actions through the parks, public works and planning departments in concert with the Brooklyn Creek Watershed Society reflect that these stakeholders understand the worth (value in use) of the package of ecological services provided by the creekshed:

> ***They appreciate the insoluble connection between the condition of entire creekshed hydrology and the extent of ecological services available in their catchment.***

This realization has led to investment of more than $4 million to acquire, maintain and manage lands harbouring ecological systems and aesthetically-connected parks, greenways, trails and other recreational assets.

The second big idea is that the Water Balance Methodology *provides an accurate analysis of the condition of the hydrology. As the engine that powers ecological services, impaired hydrological functions result in a diminished package of ecological services.*

The third big idea concerns financial value of lands *occupied by the stream corridor, riparian areas and wetlands. In the Town of Comox many residential properties abut the stream corridor on each side. Property owners may not build on the portion of their parcel that is in the set-back area. The ribbon of setback areas on each side of the stream together with the stream bed area itself comprises a* ***commons asset****. The final section of the report proposes a method to calculate the financial value of the commons.*

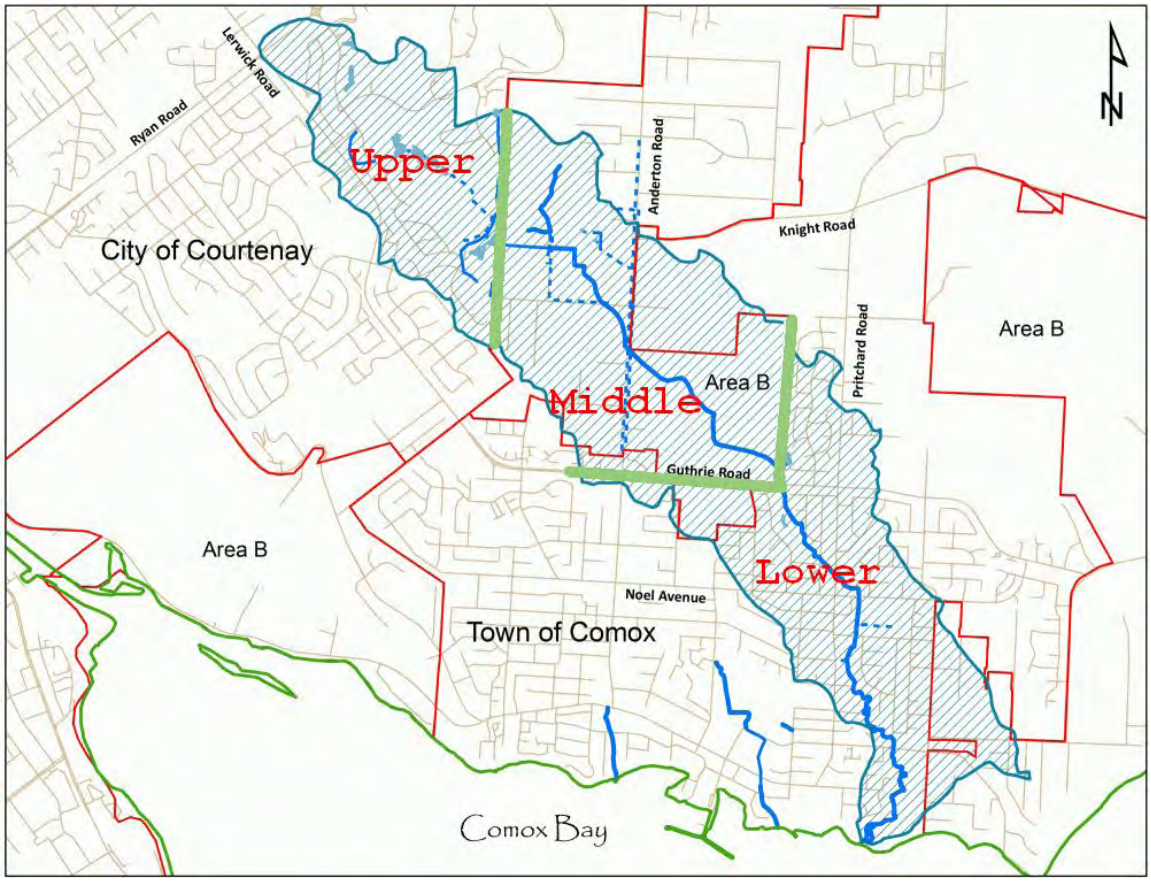
Tim Pringle, Chair
Ecological Accounting Process (EAP) Initiative
September 2018

EAP is a deliverable for the "Sustainable Watershed Systems, through Asset Management" program,
Implemented under the umbrella of the Georgia Basin Inter-Regional Education Initiative

EXECUTIVE SUMMARY

REGIONAL CONTEXT: The Brooklyn Creek watershed lies within the bounds of three local governments; Town of Comox, City of Courtenay, and the Comox Valley Regional District. Historical land use changes and on-going urbanization have degraded hydrological systems and dependent ecological services throughout the creekshed (stream of the 1st order).

The Ecological Accounting Process (EAP) considered these impacts. It assessed the current functioning condition of the stream and riparian areas of the creekshed and reviewed the actions of authorities and collaborators to manage and maintain its ecological services.



CONTEXT FOR EAP DEMONSTRATION APPLICATION: Selection of Brooklyn Creek as an "EAP Demonstration Application" was made possible by the willingness of the Town of Comox to participate in a program funded by the governments of Canada and British Columbia. EAP is one of the twin pillars of the "Sustainable Watershed Systems, through Asset Management" program. The other pillar is the Water Balance Methodology.

The insights and understanding gained through this demonstration application will be shared with other local governments participating in the *Georgia Basin Inter-Regional Educational Initiative*.

EXECUTIVE SUMMARY

The companion document for this technical report is a document titled **Vancouver Island Demonstration Applications of the Ecological Accounting Process (EAP): Valuing the 'Water Balance Services' Provided by Nature**, released separately by the Partnership for Water Sustainability. The companion document elaborates on the purpose of EAP; and the guiding philosophy that has influenced the genesis, evolution and application of the EAP Methodology. It is best that the two documents be read together for maximum understanding.

CHANGES IN HYDROLOGY: The research applied the Water Balance Methodology as the tool to assess the current functioning condition of the hydrology. Decades of constructing engineered drainage infrastructure to collect and convey away rainfall has **caused the creekshed to lose much of its capacity to spread, retain and infiltrate rainwater**.

As a result, flooding has increased as has erosion, sedimentation, debris blockages and loss of aquatic and terrestrial habitat.

CREEKSHED MANAGEMENT: Three local government jurisdictions have some management capacity concerning the creekshed. Each reflects different views of the worth of available ecological services. "Worth" refers to the present and future uses that the community derives from the hydrology and ecological services of the creekshed.

The Town of Comox is the management authority in the lower catchment of the Creekshed. During the past eleven years, the Town has made considerable investment in maintenance (prevent degradation) and management (enhancement). The managers in the middle and upper creekshed have made scant investments in maintenance; and, none in enhancement.

In the Lower Catchment Area: The Town of Comox strategy began with the Master Drainage Plan (1999) which confirmed the loss of capacity to retain and infiltrate rainwater throughout the creekshed. In the early 2000s flooding pushed the Town to construct a diversion facility (2005) at the cost of $1.98 million.

At this juncture the Public Works Department, Parks Department and Brooklyn Creek Watershed Society collaborated to devise and adopt **a long-range strategy to maintain and enhance the creek corridor and riparian areas**. Since that time about $780,000 has been invested in annual projects with funding provided by the Town of Comox, external sources, and donated labour and expertise by the Watershed Society and others.

This enhancement work has been invested in lands owned and/or acquired by the Town for parks and greenway purposes (including 2.46 acres at the former Brooklyn Elementary in 2013 at a declared value of $292,375).

Overall, **the investment secures ecological services:** the stream corridor, riparian areas, fish habitat, portions of the urban woodlands, as well as natural areas to enhance parks, trails, etc. **The investment also maintains the conveyance capacity of the creek which is part of the municipal drainage systems**.

EXECUTIVE SUMMARY

In the Middle & Upper Catchment Areas: In contrast to the Town of Comox, the middle and upper creekshed areas have no management plans for the creek corridor or riparian zone, although in each catchment, the creek is used for conveyance as part of the local government rainwater drainage system.

This reality means that **Town of Comox enhancement work is subject to the downstream impacts of decisions made by middle and upper creekshed managers**.

THE "COMMONS ASSET" CONCEPT: The EAP introduced a strategy to place a financial value on the land underlying the creek corridor and riparian area. This approach defines the "commons asset" as the land under the creek and in the set-back areas of residential properties that abut the creek.

BC assessment values for the residential properties are used to obtain a dollar amount for the portion of the parcel in the set-back area. The width of the stream at a nominal 3 metres is included at the same value as adjoining properties. In the test calculation involving 8 properties, the value of the commons asset was $2,705,000 per kilometre or $2705 per metre.

This commons asset approach **provides a consistent method to place a financial value on ecological assets of this kind; that is, ecological services dependent on creekshed hydrology.** As well, it indicates the amount of annual expenditure (say 1%) for maintenance that might be expected to protect the asset.

OVERVIEW ASSESSMENT OF CREEKSHED CONDITION: Finally, the EAP review confirms that the Town of Comox has managed and improved the functioning condition of Brooklyn Creek (lower creekshed catchment) though its long range plan and strong collaboration with community partners and external funders.

Unfortunately, in the mid and upper catchments of the creekshed, the hydrologic conditions remain threatened and degraded. Without improvements there, the permanence of the work in the lower catchment will remain limited.

LIST OF CONTRIBUTORS

This Brooklyn Creek demonstration application of the *Ecological Accounting Process* was carried out by the project team and assisted by many individuals who contributed information and responded to requests for advice. The Partnership for Water Sustainability in British Columbia thanks the following individuals:

- **Project team:**
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The educational goal of the IREI is to build practitioner capacity within local government to implement a whole-system, water balance approach branded as ***Sustainable Watershed Systems, through Asset Management***.

Inter-governmental collaboration and funding enable the Partnership to develop approaches, tools and resources; as well as provide teaching, training and mentoring.

Regional Districts supporting the IREI

C·V·R·D

Comox Valley Regional District

Regional District of Nanaimo

CRD Making a difference...together

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About the Partnership for Water Sustainability

The Partnership for Water Sustainability in BC is a legal entity, incorporated in 2010 as a not-for-profit society, and delivers services on behalf of government. It originated as an inter-governmental partnership, formed in 2002 to fund and develop the Water Balance Model as a web-based decision support tool.

When the **Water Sustainability Action Plan for British Columbia** *(Action Plan) was released in 2004, the Water Balance Model for BC was the centrepiece initiative. Action Plan experience informed development of* **Living Water Smart, British Columbia's Water Plan***, released in 2008, as well as the parallel* **Green Communities Initiative***.*

The Partnership for Water Sustainability embraces shared responsibility, is the hub for a "convening for action" network in the local government setting, and is responsible for delivering the Action Plan program through partnerships and collaboration. This program includes the **Georgia Basin Inter-Regional Education Initiative***.*

The Partnership for Water Sustainability plays a bridging role between Province, local government and community; and is the steward for **Stormwater Planning: A Guidebook for British Columbia***, a provincial guidance document released in 2002.*

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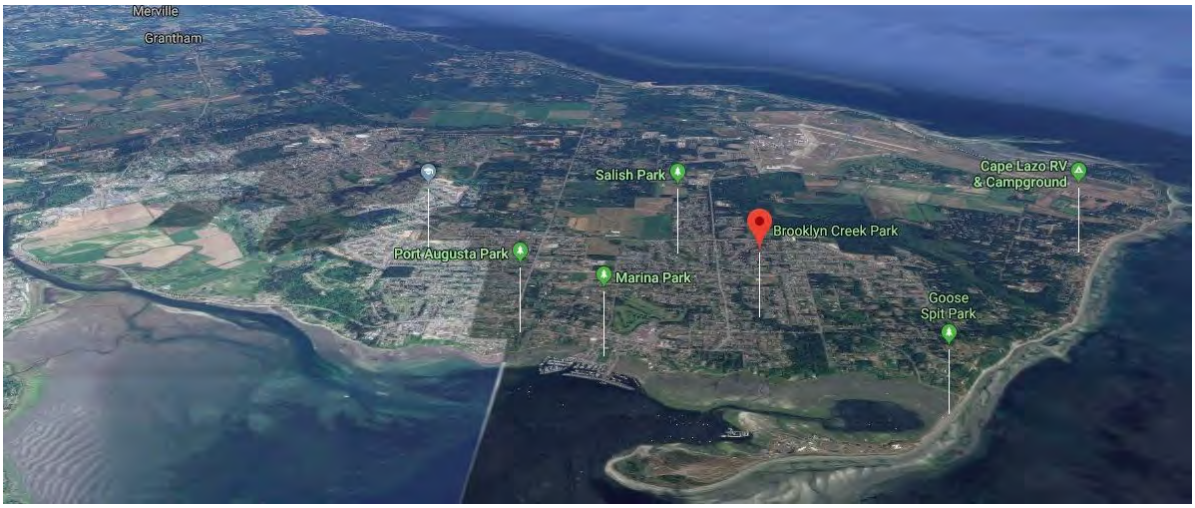
1. INTRODUCTION

Creekshed Context

Like many small creeksheds, Brooklyn Creek lies in more than one authority with jurisdiction within the watershed, namely: City of Courtenay (upper), Comox Valley Regional District (middle), and Town of Comox (lower). This results in three distinctively different land management strategies:

- In the upper zone, the headwaters catchment has been altered and made subordinate to engineered drainage design and construction.
- In the middle zone, large lot as well as dense rural subdivision has cut up the top metre of the landscape, thereby impairing natural hydrology.
- In the lower zone, the Town of Comox and collaborators have adopted and executed a long-range strategy to enhance and maintain the stream corridor and riparian zone.



View looking north: An aerial impression of the different land uses in the creekshed

The Brooklyn Creek watershed provides a variety of services which include, but are not restricted to; drainage, agricultural production, forestry, transportation, both terrestrial and aquatic habitat for flora and fauna, recreation, flood relief, and numerous others.

The monetary value of these services is not included in any formal accounting process. At the present time there is a lack of understanding of the methods and procedures required to establish the value of the hydrology as well as the ecological systems in a natural watershed. Can we therefore conclude that these services are deemed to have no value?

Established Accounting Protocols

Canada Treasury Board, and Public Service Accounting Board (PSAB) have established accounting protocols that are to be used by the public service including local government. Key features of the established protocols used in preparation of financial statements can be stated simply as:

- Capital Assets which are tangible assets that are purchased, constructed, developed or acquired.
- Land, buildings and infrastructure assets
- Buildings and other assets acquired more than 40 years ago where no betterments have been undertaken should be carried at zero cost

Established protocols include neither natural assets nor intangible assets such as easements and rights-of-way.

Asset Management: A different set of protocols have been established for Asset Management where more emphasis is based upon the monetary value of the assets which:

- Can include Net Present Value
- Are limited to Capital, operating, maintenance, replacement, and removal costs

Currently expenditures related to services from natural assets are not included within the formal asset management accounting protocols.

We see a need to establish a more sustainable service delivery protocol that recognizes the worth of the natural assets and the services that they provide in a community. We envision this to be an **Ecological Accounting Process** (EAP).

Ecological Accounting Process (EAP)

The Ecological Accounting Process (EAP) assesses an entire watershed at the creekshed[1] scale. It focuses on ecological services supported by hydrological realities.

EAP considers what the watershed was, what it is now, and what the community would like it to be, and uses this “current state” analysis to determine the activities that concerned parties could undertake to improve its ecological services through management, enhancement and maintenance.

By choosing an option, or mix of options, stakeholders (key intervenors) would decide to invest time, expertise and dollars. Their actions form the *measure of worth*[2] that characterises the creekshed.

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[1] SOURCE: Fin Donnelly, Chair of the Rivershed Society of BC: watershed areas, from smallest to largest, are described as stream reach, creekshed, rivershed, and basin.

Conceptual Framework for Analysis: The EAP analysis deals with a basic question: what is the creekshed worth, now and in the future, to the community and various intervenors[3]? The success of the EAP analysis depends on:

- a description and understanding of the ecological services (uses) supplied by the creekshed which support natural systems and human settlement activities; this is the current condition;
- an analysis of the potential to improve (and possibly increase) uses through enhancement activities, management and maintenance; and
- an understanding of potential worth to concerned and involved parties based on past and possible future investment of time and resources in management, maintenance and enhancement of the ecological services of the creekshed.

In reality, key intervenors who have responsibilities to implement or support objectives of official community plans, regional growth strategies and sustainability strategies work within an embedded land use context. Rarely, if ever, have past practices and standards prevented degradation of the hydrology of a watershed or creekshed.

Because the hydrology of watersheds is poorly understood, its function is undervalued and poorly managed.

The EAP recognizes that key intervenors ought to cooperate in managing parts of the creekshed to enhance and protect them. Of concern is the lack of consensus of all the parties with an interest in the creekshed concerning a shared management plan which would identify the features, functions, and values of the creekshed.

The lack of a plan can be seen as an obstacle in prioritizing and funding, ongoing maintenance and enhancement of its important features.

Outcomes and So What: The EAP proposes measures to maintain and improve ecological services provided by hydrologic assets and reduce or erase liability caused by degradation.

The EAP approach confirms that realistic management of use and conservation of land (and its natural and constructed assets) in a creekshed, or a larger watershed, deserves a long-term strategy devised and supported by multiple intervenors.

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[2] DEFINITIONS: Worth is *value in use*; whereas market value is *value in exchange* (source: Royal Institute of Chartered Surveyors on Valuation of Real Property Assets).

[3] INTERVENORS: Include local government, First Nations, Ministry of Transportation and Infrastructure, Streamkeepers, Department of Fisheries and Oceans, businesses and other property owners.

Development of the EAP approach is beginning with this study. We have identified a general process and the items for consideration. There is a need for additional information to be included to provide a complete vision of the worth of the creekshed.

This EAP Demonstration Application could be seen as the first step in creating a Creekshed Plan that would identify and provide the value of the components and services provided by the natural features of the creekshed.

The plan would document the consensus of all parties in valuing the components of the creekshed and prioritizing the ongoing maintenance and funding for preservation and enhancement of the creekshed.

An aerial impression of creekshed urbanization, with emphasis on the Brooklyn Creek Park riparian area in foreground

2. METHOD AND OBJECTIVES

A minimum amount of information is required to undertake the watershed assessment and to formulate a mitigation plan. A summary of the scientific and recorded information is provided herein.

2.1 Process

The Ecological Accounting Process (EAP) looks at an entire watershed at the catchment and creekshed (no significant tributaries) level. By reviewing historical land use impacts, it describes changes to the overall hydrology. It applies the Water Balance Methodology (see **Section 4**) as the tool to assess the current conditions of the hydrology. This analysis provides information needed to:

- understand the functioning condition of dependent ecosystems; and
- to propose maintenance and enhancement strategies.

To be useful, EAP must relate these strategies to the views of risk and opportunity expressed by key convenors in official plans, findings and recommendations of research, as well as from experience gained through initiatives to restore, maintain or improve ecological services.

What the Creekshed is Now: Official plan policies, goals and targets express broad social support (values) for preservation and management of ecological services and natural assets. The extent to which intervenors invest in management and maintenance of watershed hydrology reflects how much these assets and services may be worth to them.

EAP is not about engineering practices as the analytical starting point. It is not about managing hydrology through a land use, transportation, or other human settlement framework. Rather, EAP focuses on watershed hydrologic conditions and the dependent ecological services which sustain natural systems and human settlement.

Historically, land use decisions have resulted in parcel by parcel alterations to watershed hydrology. Design and development of drainage infrastructure, roads and other land uses have tended to make natural systems subordinate to engineered systems resulting in degradation that more recent official plans and bylaws attempt to prevent or reduce.

What the Creekshed Could Be: The EAP approach looks at the history of intervenors initiatives the watershed or creekshed as a description of their understanding and management activities concerning its ecological services and what those services may be worth.

This perspective enables the EAP to emphasize what the measures it proposes may offer in terms of environmental stewardship (protecting natural systems), providing drainage functions and other infrastructure needs of human settlement (social and aesthetic), protecting property values, and opportunities to reduce liability (loss of function and capacity) stemming from environmental degradation.

With these possibilities identified, EAP moves on to consider potential costs and benefits related to implementing the proposed maintenance and enhancement strategies. It recognizes that both the intrinsic needs of nature as well as the demands of human settlement share dependence on ecological services related to drainage.

About Worth: EAP focuses on worth (*value in use*) rather than personal and social perceptions of value (inherent, imputed, and assigned) or market value (*value in exchange*). Worth refers to likely returns for expenditures.

When considering ecological services, determining worth is based largely on experience. Intervenors consider past practices that failed to maintain functioning condition and replace them with practices expected to be more effective in maintaining, or restoring, the natural environmental values and functions of the watershed.

Communities and key intervenors express worth about streams and riparian zones in many ways. Official plans state policy, goals and targets concerning protection of streams and riparian areas. Bylaws attempt to direct land use practices to meet goals and targets. These measures result in investments made by key intervenors (local government departments, stream keepers, land owners and developers, funders, etc.) to protect ecological services through management and land use / maintenance practices that maintain site hydrology.

The growing body of literature concerned with “value of natural assets and services” defines the types of services (provisioning, water purification, carbon sequestration, etc.) provided by nature (natural assets) and the value in exchange and substitution (monetized) of those services. EAP accepts this approach and the imputed values.

EAP differs by focusing on worth. EAP encourages intervenors to understand their use and expectations of ecological services from Brooklyn Creek and the worth of maintaining its ecological systems in proper functioning condition.

2.2 The EAP Goal

The goal of EAP is to establish what the definable benefits of ecological services derived from watershed hydrology are, what they may be worth to the community , and how they may be maintained and enhanced to function in near optimal condition.

This goal is completely compatible with official plans such as the following: Comox Valley Regional Growth Strategy, The Regional Sustainability Strategy, City of Courtenay OCP, the Town of Comox OCP, and the Rural Comox Valley Official Community Plan.

The EAP goal also aligns with the *Nature Without Borders, 2013* report as well as the Ministry of Transportation and Infrastructure requirements of the drainage section of the BC Supplement to the TAC Guide 2007.

2.3 EAP Objectives

The objectives of EAP are:

1. Prepare a creekshed profile.
2. Carry out an analysis of creekshed hydrology using the Water Balance Methodology.
3. Identify measures that will reduce or avoid loss and improve the quality and/or amount of ecological services that may be drawn from the hydrology of the watershed.
4. Review community views about risks and opportunities concerning the creekshed ecological systems.
5. Describe and to the extent possible quantify the worth (expenditures, donated labour and expertise, levered funding, etc.) of measures (works and strategies) undertaken by intervenors to protect and enhance creekshed ecological systems.
6. Propose a method to determine a plausible financial value for the land underlying the stream corridor and adjacent riparian areas. This a calculation of the commons value. (see Part Six),
7. Produce a proxy statement (capital and operating amounts), useful for departmental planning and budgeting purposes as well as asset management plans.

2.4 How Intervenors Can Use EAP Findings

The Ecological Accounting Process will contribute to a range of community interests and needs:

- A creekshed or watershed profile.
- A water balance analysis of the watershed or creekshed hydrology.
- An assessment of the condition of ecological services dependent on the hydrology.
- Information that will assist key intervenors in preparing a long-range plan and strategy designed to improve ecological services and support periodic plans for specific projects.
- Adoption of a process whereby intervenors, including local government departments, integrate policy and project initiatives in the creekshed.
- A management and maintenance plan to be undertaken by key intervenors.
- A process to calculate the worth of potential projects and works.
- An accounting of financial expenditures for projects as they are undertaken; and
- A creekshed management strategy which supports the local government Asset Management strategy.

Cited References

Sayce, S., Smith, J., & Cooper, R (2006) Real Estate Appraisal: From Value to Worth; Royal Institute of Chartered Surveyors.

Wilson, S. J. (2010). Natural Capital in BC's Lower Mainland – Valuing the Benefits from Nature, Pacific Parklands Foundation and David Suzuki Foundation.

S. Swanson, D. Kozlowski, R. Hall et al. (2017). Riparian proper functioning condition assessment to improve watershed management for water quality. *Journal of soil and Water Conservation*, vol. 72, no. 2, March/April 2017, pgs. 168-182.

An aerial impression of the Brooklyn Creek headwaters, with emphasis on the Crown Isle development area

3. BROOKLYN CREEK PROFILE

3.1 What was the Brooklyn Creekshed in the Past?

Historically the Comox area was inhabited by the Coast Salish K'ómoks peoples, who relied on its rich sea food and game resources. The region remains in the traditional territory of the K'ómoks First Nation. In the early 1860s the British Columbia colonial government began encouraging settlers to move to the Comox Valley and purchase or pre-empt land under certain conditions.

Brooklyn Creek flowed along the eastern boundary of the settlement that became Port Augusta and later the Town of Comox.

Logging quickly became the primary industry and source of employment in the Comox Valley. A 1929 aerial photograph shows the present-day Comox area cleared of forest with much of the surrounding land under agricultural use. Brooklyn creek watershed occupies a central area in the Town of Comox and has been substantially impacted by decades of population growth and land use demands.

The headwaters area lies in the City of Courtenay and since the late 1980s it has been altered significantly due to resort, residential and commercial development. **Section 4**, the Water Balance Analysis, describes these changes in detail.

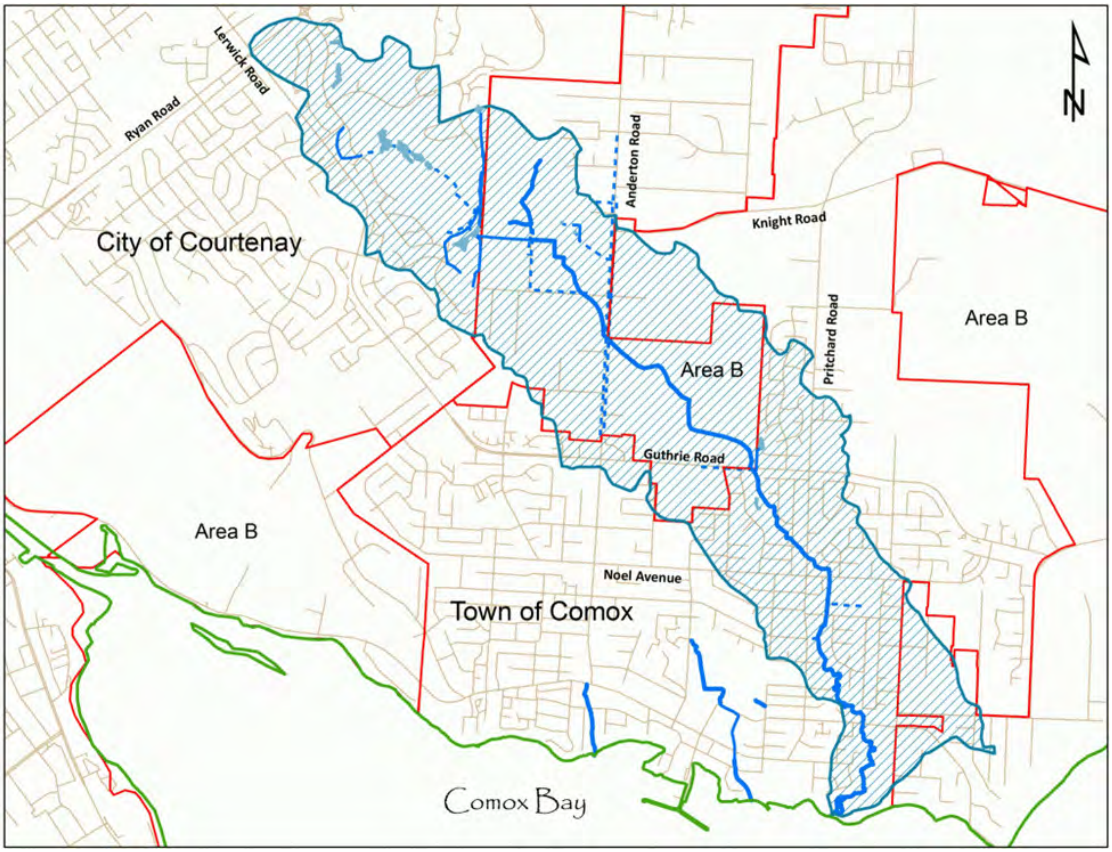


Figure 1 Brooklyn Creekshed

3.2 What is Brooklyn Creek Now?

The historical pattern of development for residential, commercial and other land uses progressed from Comox Bay to the top of the watershed which now lies in the City of Courtenay.

In the Lower Zone: The lower watershed had limited development at the foreshore; however, upland portions to the north boundary of the Town of Comox were developed for residential and other uses. This urban growth accelerated during the 1950s and later. The development practices of the day often allowed homes to be built very near the creek corridor (high water mark).

In the Middle Zone: The mid catchment includes a portion of Area B of CVRD as well as bordering areas of the Town of Comox and the City of Courtenay. This part of the watershed has remained the most rural although a number of large plots were subdivided and occupied decades ago. More recently, residential subdivision and commercial development in the middle watershed has taken place within the Town of Comox. Foxxwood Heights built out from late 1980s through the 1990s is one example.

During the past 40 years, the Brooklyn Creek Hydrology has been the subject of engineering reports for drainage plans concerning development in the upper watershed as well as drainage management in the lower catchments.

Contextual Extracts from Engineering Reports: Three reports – completed in 1991, 1999 and 2016 - are cited as references for this EAP Demonstration Application, and listed at the end of this section. The 2016 report cited analyzed hydrological conditions in the CVRD jurisdiction, including the Brooklyn Creek watershed. Some observations from these reports are summarized as follows:

1. **In 1991, Koers Engineering produced a drainage plan for Silverado Land Corporation**, **owner of the Crown Isle resort and residential development.** The report estimated "a basin area of 193 hectares (477 acres) subdivided into a few large catchments" in Block 72 (more than 800 acres in total owned by Silverado).

   It also noted that *"although considerable ditching has occurred on Block 72 during the course of recent logging and clearing, there is little evidence of historic defined channels crossing the eastern boundary of Block 72."*

   The direction of flow in the catchment area was described as follows: "*the terrain slopes gently from north-west to north-east and drains through two draws or low lying areas along the eastern boundary of Block 72*."

   The report quotes a neighbouring land owner on the eastern boundary observing that *"during the wet season standing water was evident in the low lying areas and that very low velocity west to east flow could be perceived."* It also noted that the site vegetation was *"consistent with non-channelized overland flow and seepage."* Land owners to the east confirmed that winter flooding in low areas of their properties was common.

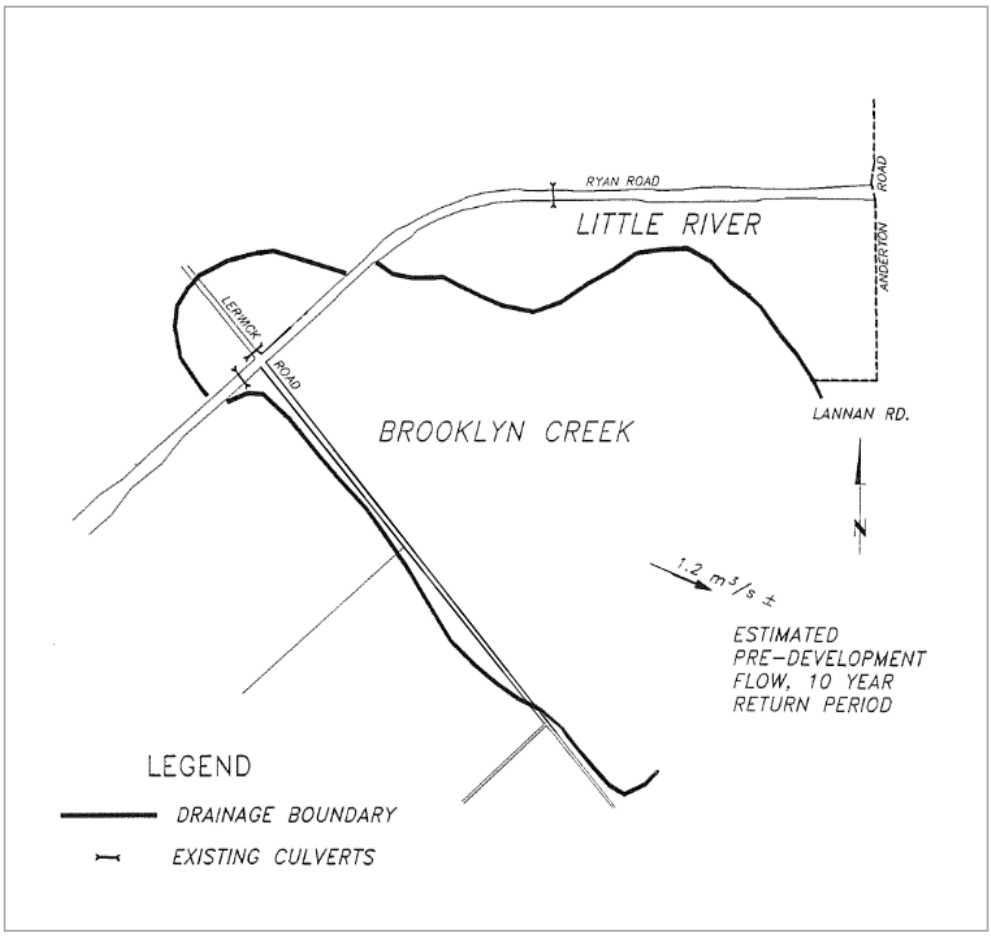


Figure 2 Predevelopment Boundary of the Upper Creekshed

2. **In 1999, Associated Engineering produced the Brooklyn Creek Master Drainage Plan for the Town of Comox**. The report cites a 1959 report on flooding in Comox by the B.C. Department of Lands and Forests, Water Rights Branch:

> *"flooding and concerns regarding increased runoff due to development have been a concern for over 40 years….Peak flows rise in developed areas as a result of reduction in pervious surfaces, reduced depression storage, and the provision of efficient storm drainage connections to receiving waters."*

The report also noted that (referring to Crown Isle and the 1991 Koers & Associates Engineering Ltd. Report):

> "*Currently, Crown Isle is only 12% developed …. all runoff from the development is contained within the bounds of the Crown Isle sub-catchment and released at the control structure located at the outfall of the last detention pond. However, property owners along Brooklyn Creek have reported a marked increase in creek flow and overland flooding since the start of development in 1991."*

3. **In 2016, and in collaboration with the Partnership for Water Sustainability in BC, CVRD published the report, *Establish Water Balance Targets for Water Balance Express.*** This analysis also describes the impairment of watershed hydrology as land development has accumulated over the decades.

> *"As development proceeds there is a very drastic reduction in the shallow soils as building foundations and underground infrastructure is constructed. These disruptions result in large alteration of the shallow superficial soils and the interflow system with the greatest impacts occurring in the denser developments where ground disturbances are contiguous. The (reality that) post-development flow paths for shallow groundwater are disrupted invalidates the assumption that prescriptive approaches are applicable in all locations."*

What These Reports Tell Us: These assessments differ in perspective and hydrological considerations.

The first concerning Silverado Land Corporation was site-specific and proposed a drainage solution in support of proposed development.

- Little consideration was given to the hydrology of the entire watershed.
- Brooklyn Creek and its riparian areas downstream from the Silverado property were to be used for conveyance purposes.
- Thus, the upper catchment became a highly modified drainage devoid of the slow seepage flows it once had.
- Design objectives focused on collecting and moving surface water away.

The Town of Comox commissioned The Brooklyn Creek Master Drainage Plan to investigate options to address concerns about drainage, erosion and sedimentation.

- Necessarily the analysis included land use impacts higher in the watershed and made some recommendations concerning detention in particular.
- Three sites were recommended in the CVRD Area B, as well as an increase in the capacity of the detention pond at the Highwood development, which was done. (Highwood has marginal impact on Brooklyn Creek).
- The third site is Salish Park where linked detention ponds were constructed. The latter two sites are in the Town of Comox.
- The report also recommended that certain work be done to remove gravel bars, debris obstacles, and improve the stream channel. See details in the tables concerning the mid and lower watershed areas.

The third report, *Establish Water Balance Targets for the Water Balance Express*, illustrates the interest of the CVRD in encouraging property owners to take into account site and area hydrology when proposing subdivision and land development. To the extent that this analysis is applied, the negative impacts of land development on the hydrology of watersheds would be reduced.

Cited References

Koers & Associates Engineering LTD. (1991) Crown Isle Development Drainage Report. P.4.

Ibid, p.2.

Associated Engineering (1999) Brooklyn Creek Master Drainage Plan. P. 1-1.

Ibid. p. 2-1.

Comox Valley Regional District (2016). Establish Water Balance Targets for the Water Balance Express. P. ES-2.

3.3 Current Stakeholder Activities in the Creekshed

The following summary covers the "uses" that key intervenors and the community may manage or expect in the creekshed and riparian zone. It begins in the upper catchment and then moves to the mid region and concludes in the lower catchment. Because local government has responsibility for regulation prescribed by local bylaws (in official community plans) as well as the Regional Growth Strategy, each is called the "manager"; these responsibilities may be shared. Other organizations and funders are called collaborators while private land owners comprise another interest group.

The Upper, Middle, and Lower portions of the Brooklyn Creekshed are shown on **Figure 3**.

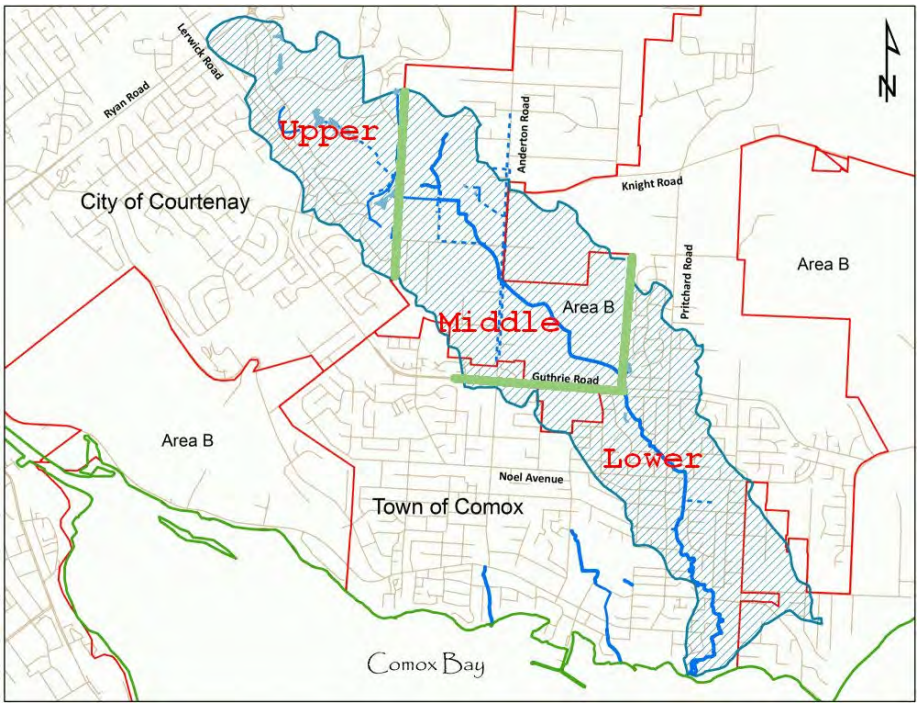


Figure 3 Creekshed Division

In the following two tables, "recognized riparian zone services" means capacity and/or requirement to act under regulations or organizational mission. The verb "act" means to recognize and protect/manage ecological services.

The descriptor "expected riparian zone services" means the uses that intervenors make and intend to continue making of ecological services.

The creekshed has been subdivided into three similar areas based upon a combination of current land use and responsible jurisdiction.

Table 1 – Upper Creekshed	
Intervenors	**Recognized Riparian Zone Services**
City of Courtenay (Manager)	• Approval of drainage plans for land development • Parks, greenways, or trails (one) • Identified conservation areas (none) • Management of Crown Isle drainage infrastructure: still managed by Crown Isle in 2018 • Management of other commercial and residential drainage infrastructure • Shared management of discharge control structure pond 20. • Brooklyn Creek (BC) to be used for conveyance
Crown Isle Development (Silverado Land Corporation - Acting Manager)	• Series of retention ponds for surface water control in golf course design • Management of Crown Isle drainage infrastructure • Shared management of discharge control structure at pond 20. • Ecological services of BC catchment subrogated to engineered drainage. • BC to be used for conveyance
Intervenors	**Expected Riparian Zone Services**
City of Courtenay (Manager)	• Stormwater conveyance to BC
Crown Isle Development (Acting Manager)	• Storm water surface collection and source of landscape water • Storm water conveyance • Continue subrogation of ecological services to engineered design
Brooklyn Creek Watershed Society	• Unsuccessful attempts to work with the City of Courtenay to adopt a trails plan and/or enhancement measures in the creekshed.

Table 2 – Middle Creekshed	
Intervenors	**Recognized Riparian Zone Services**
Comox Valley Regional District (CVRD) (Manager)	• Authority to approve drainage and building plans in Development Permit Areas per bylaws within 30 metres of the highwater mark of the stream • MOU to work with Ministry of Transportation and Infrastructure (MOTI) for approval of rural development (subdivision and amalgamation of properties) • Protect sensitive ecosystems per bylaw policies and objectives concerning natural environment • Support agricultural land users to manage the creek corridor
Town of Comox	• Authorize design and construction of drainage systems • Manage drainage systems serving residential and commercial land uses in the mid-watershed • Manage culverts at strategic locations in the mid-watershed • Enhance retention areas and riparian zones in the mid-watershed (includes Highwood and Salish Park) • Work with collaborators including Brooklyn Creek Watershed Society
Ministry of Transportation and Infrastructure (MOTI) (Manager)	• Authority to approve applications for land subdivision and drainage systems • Maintain roads, ditches & culverts and other drainage works • Implement TAC* standard management • Manage ditch and culvert influences on BC affecting properties and agricultural lands
Brooklyn Creek Watershed Society (BCWS)	• Work with other collaborators to adopt a watershed management plan including maintenance • Work with private landowners to protect the riparian zone and ecosystem services
Private landowners	• Be aware of sensitive natural features in the riparian zone and protect them.
Intervenors	**Expected Riparian Zone Services**
Comox Valley Regional District (CVRD) (Manager)	• Creek used for conveyance of drainage • BC recognized as a natural asset – use Water Balance Methodology for assessment of drainage proposals • Work with MOTI in applying standards for drainage systems
Town of Comox	• Manage BC functioning condition for drainage conveyance; and for healthy riparian zone • Maintain the creek corridor for greenways alignment, trails, and park features • Have the riparian zone support the urban woodlands strategy • Extend the range and quality of fish habitat in BC

Ministry of Transportation and Infrastructure (MOTI) (Manager)	• Creek used for conveyance of drainage from rural development and roadside ditches
Brooklyn Creek Watershed Society (BCWS)	• Work to encourage trails & greenway connections in the middle watershed • encourage the public to appreciate the riparian features of BC • Work with private landowners to protect riparian zone
Private landowners	• Have BC available as an amenity to property enjoyment and value. • Use as a source of water for land uses.

Table 3 – Lower Creekshed	
Intervenors	**Recognized Riparian Zone Services**
Town of Comox (TOC)	• BC (riparian zones) is a major natural asset running through central TOC. • Manage BC in a manner consistent with Regional Growth Strategy Goal 2 concerning ecosystems, natural areas and parks. • Manage BC in a manner consistent with the following TOC Official Community Plan policies: 2.1.8, Parks, Trails and Open Space 2.3.1, Protection of Natural Areas 2.3.3, Greenways and wildlife corridors 2.3.13, Environment policies 2.4.2.6, Storm Drainage System • Manage BC in a manner consistent with TOC Development Permit Areas by laws: No. 7, Riparian Areas No. 11, Wildlife Corridor No. 13, Hazardous Areas • Involve Engineering, Parks & Planning Departments in management process for BC including a multi-year enhancement plan. Implement needed maintenance. • Include urban woodlands objectives with management of BC
Brooklyn Creek Watershed Society (Collaborator)	• Produce mapping of the watershed with sensitive ecosystem inventory locations • Collaborate with TOC to adopt a long-range plan for riparian enhancement (2006-2017) • Help raise funding for annual enhancement projects • Provide volunteer labour for enhancement projects • Support public education and field experiences for parks and greenway users • Support Regional Growth Strategy objectives addressing environmental protection

Funding agencies (collaborators)	• Provide grant funding for annual enhancement projects to meet environmental, fisheries-related, and protection of ecosystems objectives
Private property owners	• Support measures to keep stream healthy and avoid property damage
Intervenors	**Expected Riparian Zone Services**
Town of Comox	• Protect municipally owned parks and natural areas as well as private properties from flooding and erosion • Improvement of the functioning condition of the stream and riparian areas • Add to amenity value of greenways, trails and parks • Enhance / restore salmon spawning and refuge areas • Protect function of storm water conveyance • Add to the appeal of the "natural beauty" of Comox
Brooklyn Creek Watershed Society (Collaborator)	• Enhancement of the riparian zone • Increased public appreciation of BC as an ecological resource • Build trail connections from lower to upper watershed using riparian corridor • Show-case sensitive environmental assets in riparian corridor • Continue the storm water conveyance
Funding Agencies (Western Economic Dev, Pacific Salmon Foundation, Habitat Conservation Trust Fund, Department of Fisheries and Oceans, Ridgeline Excavating Ltd, Fanny Bay Enhancement Society, Current Environmental, Streamside Native Plants)	• Achieve enhancement of the BC riparian zone through multi-party collaboration • Achieve salmon spawning/survival enhancement objectives
Private property owners	• Continued access to the amenity values including positive impact on property prices

What These Tables Tell Us: A summary of this review illustrates the following:

- **In the upper creekshed** the unusual circumstance of one private property owner having gained approval to engineer nearly all of the area of the Brooklyn Creek headwaters resulted in diminished opportunity for the community to access the ecological services of the creekshed in that area. It also affected in unpredicted ways the hydrology downstream from Crown Isle.
- **In the middle creekshed** the decades-old approval of much of the rural subdivision by MOTI resulted in impairment of surface water and interflow conditions due to ditches and roads. In general, retention capacity was greatly diminished and concentrations of the flow of rain water increased.
- **In the lower creekshed**, the impacts of changes in the upland hydrology required actions to reduce degradation of the riparian zone in the Town of Comox. One positive outcome was the adoption of a long-range enhancement strategy for Brooklyn Creek. This was implemented successfully 2006 to 2017.

3.4 What Would Key Intervenors Like the Creekshed to Be in the Future?

For the most part, each of the key intervenors wants and expects Brooklyn Creek to remain capable of supporting human settlement values as well as ecological services. Based on what has happened in each jurisdiction, and strategies contained in current and future plans about the Brooklyn Creekshed riparian zone, the following picture emerges.

In the Upper Creekshed: The City of Courtenay has only one park and no greenway or trail facilities in the Brooklyn Creek watershed; nor are any planned. The area of the upper watershed is primarily within the Crown Isle development; a small part is in an abutting area of commercial development.

Drainage from the two areas combines and moves to the outflow point at the boundary with the CVRD for conveyance down Brooklyn Creek. The headwaters drainage has been made completely subordinate to this urbanization. No changes are planned.

In the Middle Creekshed: The CVRD does not include the Brooklyn Creek in any of its near term plans for parks, trails, or conservation areas. Present status is to respond to subdivision and building proposals that come under development permit area criteria.

The CVRD and the Town of Comox are, however, negotiating an annexation that would see some of Area B of the CVRD transferred to Town of Comox jurisdiction. When the annexation has been completed, the Town will be in a position to execute a strategy for more rainwater detention facilities in the middle watershed area (as recommended in the Mater Drainage Plan).

The Brooklyn Creek Watershed Society will continue to work on its ecological, social and economic goals including:

- extend the Brooklyn Creek trail system (now continuous in the lower watershed) to the top of the watershed, or the boundary with Crown Isle

- advance community engagement in protection of ecological systems.

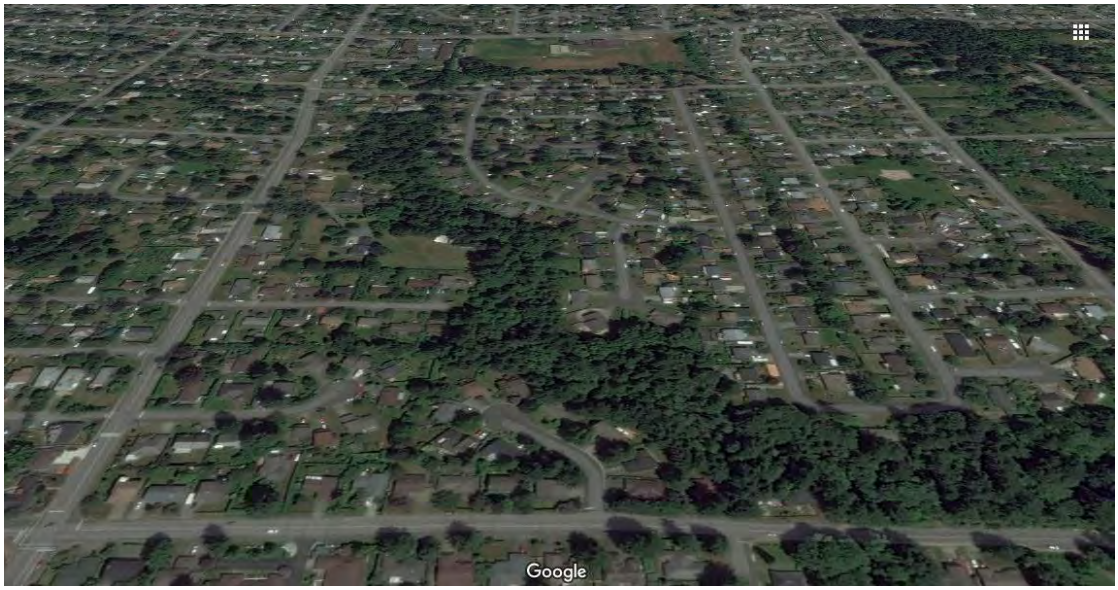
In the Lower Creekshed: In 2017 the Town and collaborators completed the multi-year enhancement plan for Brooklyn Creek within the Town of Comox. More than $700,000 was spent on annual projects that began in 2006. In two of the years much of the work was devoted to maintenance rather than enhancement work. Details of this investment are covered in **Section 6**, Perspectives on Worth.

The future plans for the creekshed include maintenance of the "improvements" (riffles, complexing, spawning beds, stream corridor winds, aids to fish upstream migration, fish refuge areas, plantings and greenway verges, etc.) that have been made. The opportunity to include urban woodland objectives with stream and park maintenance will be pursued. Finally, the Town will work to have more private property owners participate in stream enhancement opportunities.

The earlier mentioned research, *Nature Without Borders (2008)*, was produced by Comox Valley conservation organizations to promote a regional strategy - *"to address the continued loss and fragmentation of sensitive natural areas in the Comox Valley."*

The report was updated in 2013 to “propose a regional approach to biodiversity protection.” These goals concern ecological services dependent, ultimately, on the hydrology of local watersheds.

The Town of Comox realized that on-going degradation of Brooklyn Creek ecological services could not be addressed through remediation alone. .A lasting solutions required a broader strategy. The Town of Comox has progressed to providing its residents with an **ecological services package** based on the hydrology of Brooklyn Creek. **Section 6.1** covers this concept in detail.



4. WATER BALANCE ASSESSMENT

This section applies the Water Balance Methodology[4] to assess the current functioning condition of the creekshed; and identify what enhancements (includes restoring, maintaining and improving) are possible and practical in the Brooklyn Creekshed.

The scope of the analysis encompasses impacts and mitigation. This leads into consideration of mitigation system criteria and analysis, including an introductory discussion of what computer modelling involves and how to verify the results. The discussion is methodical. A technical background is helpful (but not essential) when reading this section.

A Starting Point

The functioning condition of the watershed hydrology is complex and often subject to gross simplifications that bias our view of the potential problems and solutions associated with maintaining or enhancing the ecological functioning of a watershed.

A very simple view of the water balance would include precipitation, infiltration into the ground and potential evapo-transporation of water from the surface and plants. This oversimplification is totally inadequate in forming the basis for watershed planning to protect the ecological functioning of the watershed.

An Introduction to Complexity: The next level of complexity includes a simple view of the hydrologic cycle and is also inadequate in describing the ecological functions of the watershed. This simplified view of the hydrologic cycle assumes all rainfall in a natural watershed is infiltrated into the ground then flows vertically until the water enters an aquifer prior to discharging to a stream. This view of the model must make two assumptions: that soils are homogeneous, and that there is no topographic relief across the landscape. **Both of these assumptions are incorrect**.

This simplified view is often the basis of watershed plans that do not include any assessment of streams and their discharges when creating a watershed plan. Plans prepared using these assumptions may not provide the correct direction or recommendations necessary to protect the natural assets within a watershed.

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[4] SOURCE: Stormwater Planning: A Guidebook for British Columbia, 2002
http://waterbucket.ca/rm/sites/wbcrm/documents/media/242.pdf

and

http://waterbucket.ca/wp-content/uploads/2012/05/Primer-on-Water-Balance-Methodology-for-Protecting-Watershed-Health_February-2014.pdf

Recent research by the United States Geological Survey has found that a more complex view of the hydrologic cycle is required to adequately describe the flow paths of water in a watershed and to identify how precipitation reaches a stream.

An accurate representation of groundwater flow can be found in research and publications that introduce shallow horizontal flow through unsaturated soils driven by gravity and affected by differences in the soil properties.

A graphical representation of the hydrologic cycle can be seen in the Figure 4 which includes the **shallow zone of interflow** which is responsible for a significant proportion of the water balance.

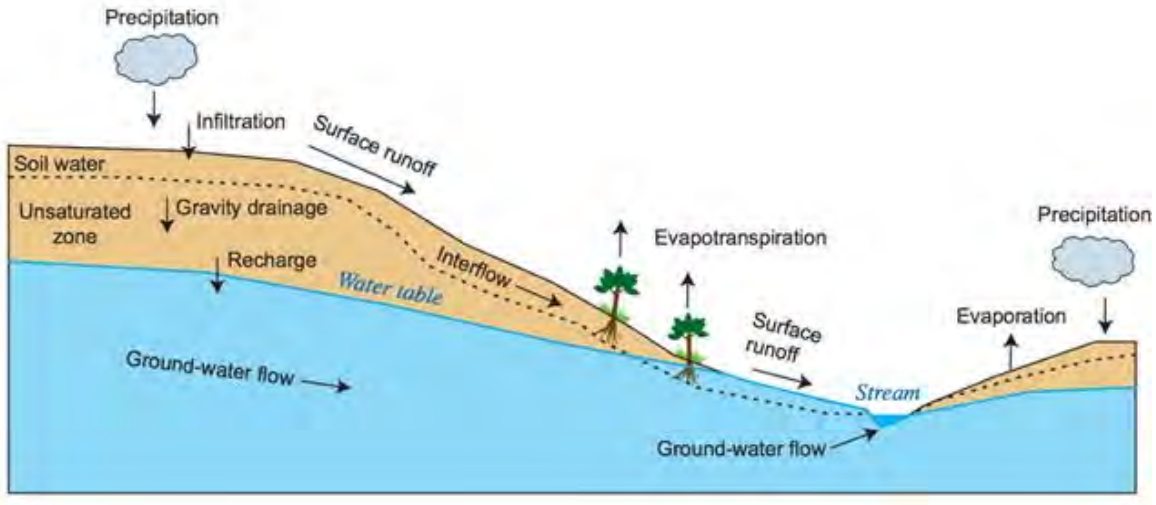

Figure 4 Rainwater Flow Paths

The image is from USGS research and groundwater models that can be found at https://water.usgs.gov/ogw/gsflow/ which leads to this publication https://pubs.usgs.gov/tm/tm6d1/pdf/tm6d1.pdf

Another international research publication documenting these phenomena can be found at https://www.ajol.info/index.php/wsa/article/download/81041/71266

This view of the hydrologic cycle is supported by several additional sources. An early view of the hydrologic cycle that includes the concept of interflow was presented in “Dynamic Hydrology,” by P. S. Eagleson, published in 1970 by McGraw-Hill and as shown in Figure 5.

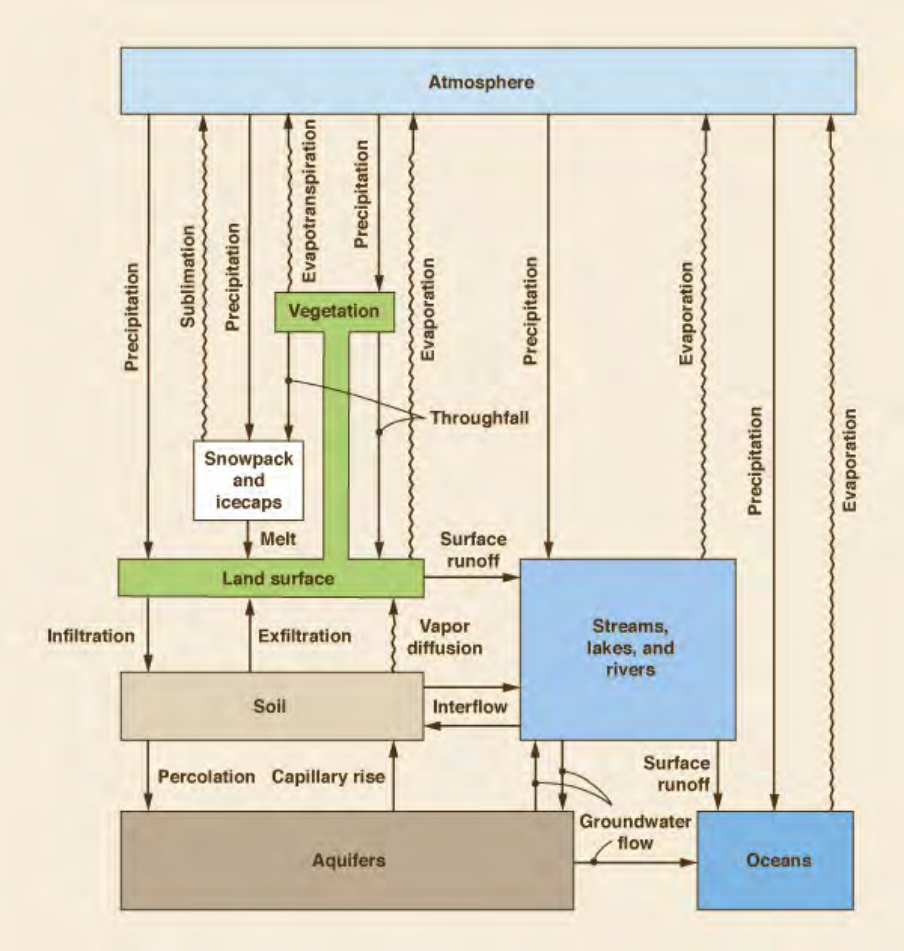

Figure 5 Hydrologic Cycle

Interflow Zone and the Water Balance

Further support of the importance of interflow can be seen in the physical evidence provided by examination of the soil formation processes. Information in this section of this report has been derived from the Soils of Southern• Vancouver Island, MOE Technical Report 17, J.R. Jungen, P.Ag., B.C. Ministry of Environment, August 1985. The soil great groups that are present within the watershed are Podzols, Brunisols, and Gleysols.

The Brunisolic soils are considered to be a transitional stage between the original parent geological material and given time and additional weathering they will become Podzols. In fact these soils are very similar to the Podzolic Soils within the region in that they have developed under the influence of a coniferous forest.

A major factor in soil genesis is the midsummer drought in July and August, which brings about dehydration and chemical precipitation processes and a slight decrease in the acidity of the soil.

Chemical precipitation centers in the formation of iron oxides that are indicated may be a red or rust color in the in the first foot or more of the soil horizon. The lack of the iron oxides in the lower soil horizons is indicative of very limited flow of water into the lower soil horizons as the water would readily transport the dissolved iron oxides if it were to continue to flow downward. The colours of the soils beneath the layer of forest litter range from reddish brown to yellowish brown.

The reddish brown colour due to unhydrated iron oxide (hematite) is most distinct when exposed during cultivation or excavation. The entire weathered soils layer seldom extends beyond a depth of 600 mm or 750 mm (two or two and a half feet).

Poorly drained Gleysolic soils are found on level to very gently sloping terrain, usually on marine and fluvial deposits where moisture accumulation and/or seepage exert a significant role. Soil profiles are strongly gleyed and mottled, and saturated for long periods.

Typical vegetation in gleysolic areas include red alder, cottonwood, willow, skunk cabbage and sedges. Gleysolic soils develop In the presence of excessive moisture which results in permanent or periodic reducing conditions. As a result, the gleyed subsoil is bluish-gray to greenish-gray and reddish-brown mottles usually occur in the profile.

These soils occur where the water table is high because of proximity to bodies of water (e.g. floodplains) or in depressional sites, or on materials with low hydraulic conductivity.

As described earlier there are two major subsurface flow paths and one surface flow path through which rainwater will travel to the stream. The flow paths and time periods associated with the flow paths within the watershed can be visualized in the **Figure 6**.

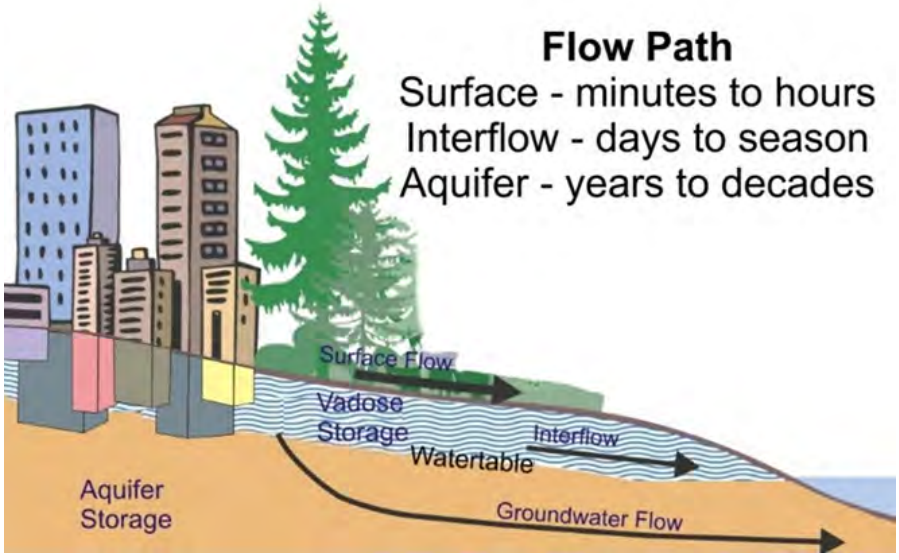

Figure 6 Rainwater in Watersheds

Hydrologic Assessment: As described above, the creekshed has undergone significant change from its natural state. These changes include:

- Clearing of forests
- Conversion of the land into farms and urban areas
- Increasing impervious cover with roads and buildings
- Drainage improvements with roadside ditches and storm sewers.

As a result, the hydrologic function of the watershed has changed and there is an:

- Interrupted and intercepted interflow system which has led to:
  - Less water retained in the watershed
  - Higher winter peak flows
  - Reduced summer base discharges

One readily identifiable alteration involves the drainage of wetlands for the purpose of urban development and of agriculture. **An area immediately north of Guthrie Road to the west of Pritchard Road is subject to sustained ponding.** While this is adverse to the intended use of the lands the flooding is now likely to be exacerbated by ongoing urban development in the upper watershed.

The area has been described in the Brooklyn Creek Master Drainage Plan, Associated Engineering, July 1999. The area is shown on **Figure 7** as extracted from that report.

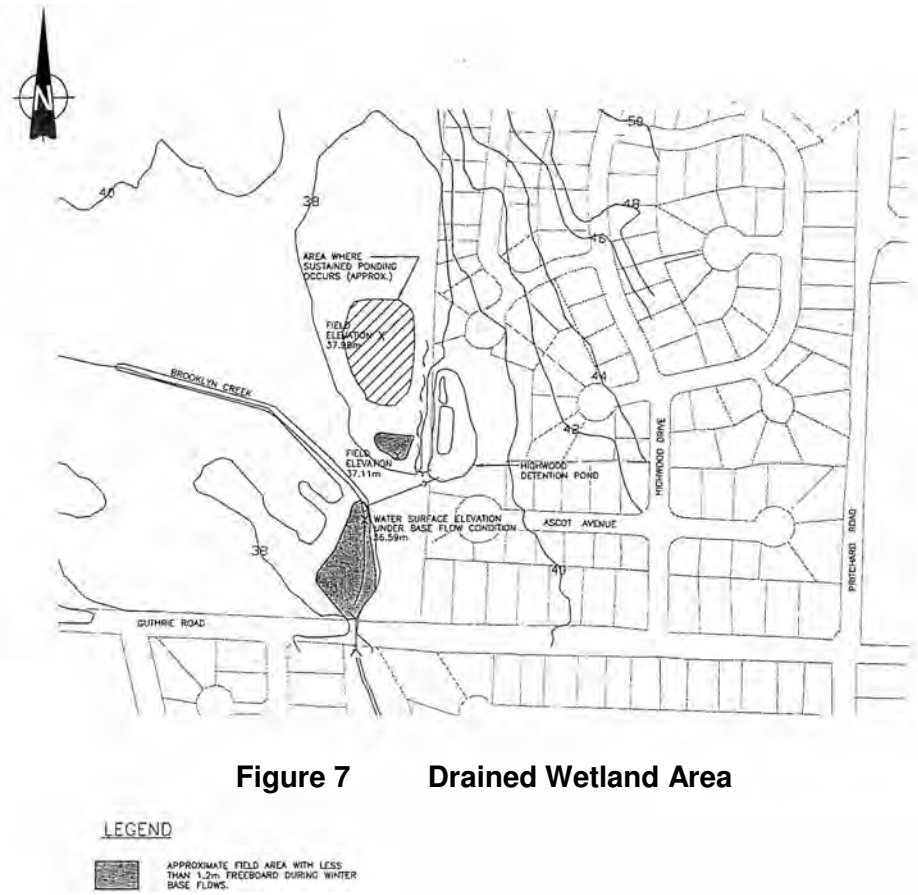

Figure 7 Drained Wetland Area

It is anticipated that alteration of the hydrology of the creekshed is responsible for alterations of the stream, resulting in reduced aquatic habitat and fish populations.

Of greater concern to the developments within the watershed are the:

- Greater volumes of discharge during flood events
- Increased potential for flooding and flood damages

Computer Modelling

A continuous simulation model was established to assess the alterations of hydrology within the watershed. The model was verified using available regional data and the model is capable of predicting the flood frequency associated with the existing conditions as shown in the Figure 8.

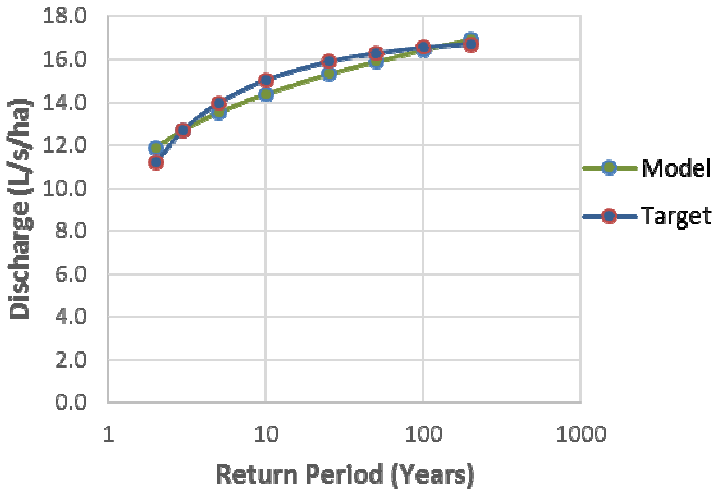

Figure 8 Flood Frequency

The importance of the interflow component of the stream discharge was established by turning off the “soilwater” routines within the model with the resultant surface runoff being the only discharge reported.

A flood frequency comparing the surface runoff and the total discharge which includes both surface runoff and “soilwater” is shown in **Figure 9** on the page following.

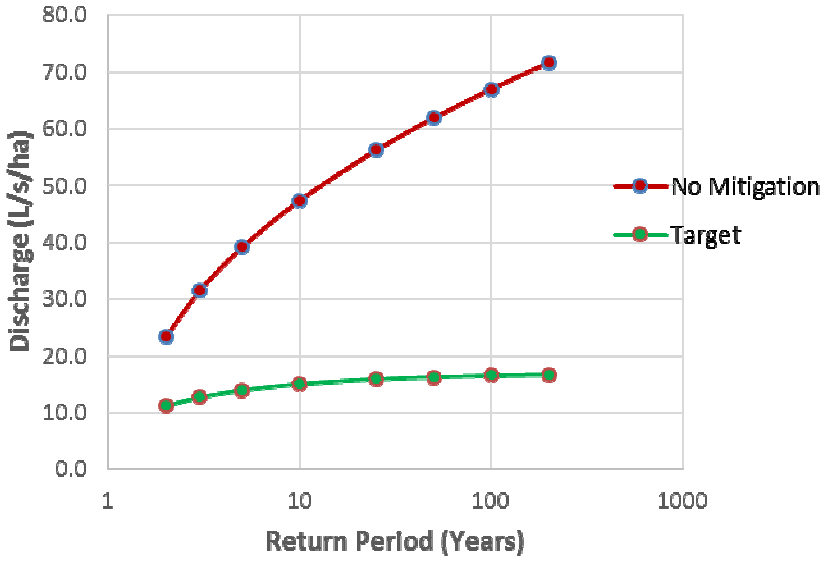

Figure 9 Importance of Subsurface Flows

As can be seen a vast majority of the stream discharge is from the "soilwater" and a small proportion, less than one quarter of the flood discharge is comprised of surface runoff.

This represents the importance and the effect of the interflow system in the hydrologic cycle. Therefore any disruption of the interflow system will dramatically alter the hydrologic cycle and water balance within the watershed.

The model was then used to simulate the pre-development conditions and potential future conditions within the watershed as can be seen in **Figure 10.**

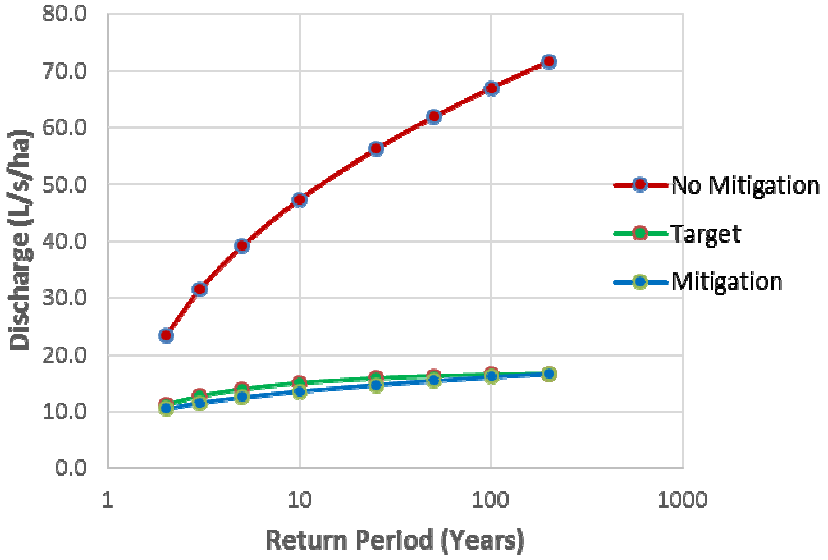

Figure 10 Effect of Development

As can be seen the majority of the projected impacts to increased flood frequency and magnitude have already taken place within the creekshed.

There are additional alterations in the creekshed that could include improvements to drainage infrastructure that would increase the more frequent and smaller flood events.

The mitigation of the increased flood risks and increasing of the flow duration during the summer months can be achieved by a number of infrastructure types depending upon configuration of the development that is causing the impact.

Existing urban residential and commercial/industrial areas are increasing flood peaks because they directly discharge into the stream with no attempt to limit the increases in flood discharge.

Farm lands have had an impact due to two different aspects which include:

- Reduction of tree cover and cultivation through the small ephemeral streams that were once within the treed areas, and

- Increased discharges resulting from the road ditches that intercept the interflow and more rapidly direct the “soilwater” to the stream combined with the drainage of natural wetland areas.

Sizing of the Mitigation Infrastructure

Mitigation of the impacts to the creekshed hydrology would restore the function and ultimately, the form of the natural stream channel of Brooklyn Creek.

At this time there are no simple and easy fixes that can be applied, rather the road to restoring the function will be long and results will rely on taking advantage of development and redevelopment of the existing land to construct mitigation measures.

One component of rainwater management, often referred to as stormwater management, is the inclusion of detention facilities or ponds and potentially of wetlands.

The design of the wetlands and retention ponds would provide a dual benefit in provision of environmental enhancements and flood risk reduction. Therefore a traditional stormwater design process cannot be used and a modified process that accounts for the environmental aspects and objectives is required.

Consequences of Cumulative Effects: As indicated earlier, the dual problem of increased flood peaks and volumes has a cumulative effect on the stream that results in excess and unnatural erosion in the upper reaches and deposition in the lower reaches. The erosion is caused by both the discharges and the duration of those discharges.

Ponds and wetlands only manage the magnitude of the discharge while allowing an increase in the duration of the erosion causing flows. The simplest method of returning the creekshed hydrology is to also return the natural water balance and utilize all of the flow paths as described earlier.

The analysis that has been undertaken and described above included the criteria of maintaining the flow paths of surface runoff, interflow, and aquifer flow so as to limit the duration and magnitude of the surface discharges in Brooklyn Creek.

The analysis developed a set of creekshed targets that, if implemented over time as opportunities arise, would return the natural hydrologic function of the creekshed.

Water Balance Targets for Creekshed Restoration

The mitigation works would be applied primarily in urban development as the watershed use shifts to meet the vision of the development plans of the CVRD, Town of Comox, and the City of Courtenay. The three physical characteristics of the mitigation works would include:

1. **Volume of retention** which stores rainwater for controlled release to deep groundwater / aquifer or to the stream through the municipal drainage system;
2. **Infiltration system area** in contact with the subsurface which will allow retained water volumes to infiltrate to deep groundwater / aquifer; and
3. The **base flow release rate** which can be used to augment small stream discharges through release of retained rainwater.

The size of the mitigation works can be summarized in the three target values for the study area and include:

1. **Retention Volume** on site at 164 m^3/ha of development, with neighbourhood detention facilities having a 1 in 100 year volume of 420 m^3/ha of contributing area
2. **Base Flow Release Rate** 1.0 L/s/ha from on-site systems, and maximum controlled release rate of 11.2 L/s/ha of developed area for neighbourhood facilities. Overflows are allowed from all facilities.
3. **Infiltration Area** 100 m^2/ha of development area for on-site facilities.

Implementation of these simple works can yield, over time, a restored and natural Brooklyn Creek.

5. RISKS & OPPORTUNITIES

Broadly, all parties want to prevent further degradation of the creekshed and reduce the impact of periodic high flow volumes moving to the lower creekshed.

Intervenor Viewpoints

The discussion of methodology (in Section 2) noted that general (social) views about the value of creekshed ecological services are not the same as perspectives on the worth of these systems.

At the site level, property owners may want to have a stream nearby but resist having to make adjustments in the enjoyment (perceived value) of their property to protect the stream.

Developers will meet regulatory requirements and rely on their consulting engineers to design drainage systems that will be approved.

Local government departments handling approvals know about “proven” designs; however, new methods for drainage design and construction require additional scrutiny before approval. For these reasons, local governments increasingly use development permit areas (DPAs) that provide detail about design and construction methods in order to increase protection of ecological features.

Consequences of Past Practices: Much of the older development of residential, commercial and other land uses in the Brooklyn Creekshed occurred when the regulatory framework concerning riparian areas was less stringent.

In these areas, the condition of the riparian zone often remains altered and degraded. In the lower creekshed, which is under Town of Comox jurisdiction, the impacts of erosion, flooding and other damage have threatened the stream integrity and nearby properties, resulting in remediation and enhancement carried out under the direction of a long-range plan adopted in 2007.

In the middle creekshed, which is under CVRD and MOTI jurisdiction, the nature of rural land subdivision, most of it decades old, has directed the creek into ditches and channels - including about 300 metres in a culvert. But few improvement strategies have been employed. Agricultural uses also have altered the creek.

In the upper creekshed, which is under City of Courtenay jurisdiction, the headwaters area has been subordinated almost completely to engineered drainage systems. These include Crown Isle and nearby commercial development.

Stewardship Sector and Sustainability Initiatives: In view of the history of Brooklyn Creek and other small creeksheds in the Comox Valley, and the ongoing urbanization of the region, conservation organizations undertook research and public education processes to encourage protection of ecological services in the context of official plans.

Nature Without Borders: *The Comox Valley Land Trust Regional Conservation Strategy*, was published by the Comox Valley Land Trust in early 2008. In July, 2008 four local governments passed a motion to protect a network of natural areas as described in *Nature without Borders.*

In two key guidance documents, the Comox Valley community has adopted policy objectives regarding the future of their region and the importance of the environment and ecological services in that future.

- The first is the Comox Valley Regional Growth Strategy (2010) which has as its second goal *"Protect, steward and enhance the natural environment and ecological connections and systems".*

- The second is the Regional Sustainability Strategy (2010). One of its ecosystem goals is that *"100% of sensitive ecosystems and riparian areas are protected and managed to maintain stable health and productivity by 2050.*"

In 2013 the Comox Valley Conservation Partnership published an updated version of *Nature Without Borders*. The Partnership continues working to have local governments and other stakeholders adopt a regional strategy *"to address the continued loss and fragmentation of sensitive natural areas in the Comox Valley."*

The case of Brooklyn Creek illustrates that in a creekshed crossing several jurisdictions, the joint management of the riparian zone is very difficult to put into place. The result for Brooklyn Creek has been continuing degradation.

Intervenor Actions

Earlier in this report, specifically in the Watershed Profile and the Water Balance Analysis chapters, the cumulative changes in the watershed landscape and the resultant condition of the current-state hydrology are described. Thus far, the EAP research has established that:

- **In the upper creekshed,** the ecological services dependent on hydrology have been incorporated into drainage strategies for the golf course and residential development as well as other nearby urban land uses. Few options remain for enhancement and restoration possibilities are limited.

- **In the middle creekshed** under current management responsibility, opportunities for enhancement of riparian features are triggered by applications for subdivision.

  Applications for development of properties already subdivided might provide opportunities for drainage solutions that would protect and cumulatively enhance riparian areas. If enhancement is to occur, the CVRD and MOTI would have to adopt a shared long-range plan to achieve incremental improvements and maintain them in the future. The Town of Comox is a logical collaborator in such strategy.

- **In the lower creekshed,** the Town of Comox and its collaborators already have devised and acted on a long range plan to protect and enhance the ecological services of Brooklyn Creek. As readers will see below, this achievement arose from concerns about risk and conviction that a number of opportunities could be realized.

In order to understand community perceptions of risks and opportunities concerning ecological services in the Brooklyn Creekshed, EAP researchers have reviewed and considered the following:

- policy and strategy content in official plans;
- engineering reports pertaining to drainage concerns;
- other analyses (urban woodlands, fish protection; health of riparian areas);
- regulatory requirements in local government bylaws;
- departmental works and management plans;
- projects dealing with ecological concerns;
- projects dealing with drainage concerns;
- expenditures related to these activities; and
- conversations with individuals involved in the above-noted activities.

The various perspectives about risks and opportunities in the three parts of the Brooklyn Creekshed are summarized in the following tables. The risks refer to area hydrology and ecological services dependent on that hydrology and the creekshed riparian zone.

Table 4 – Upper Creekshed Perceptions of Risks	
Intervenor	**City of Courtenay**
Perceived Risks	**Coping Strategy**
Volume of water conveyed to Brooklyn Creek (BC)	• Under management of Crown Isle drainage
Opportunities	**Actions**
Parks, trails, greenways	• one public park
Intervenor	**Crown Isle (Silverado Land Corporation)**
Perceived Risks	**Coping Strategy**
Conveyance volumes	• None, other than systems already installed

Table 5 – Middle Creekshed Perception of Risks	
Intervenor	**Comox Regional District (CVRD)**
Perceived Risks	**Coping Strategy**
Stream integrity or flooding (CVRD has no authority to intervene in the riparian area of the watershed)	• Refer problems to MOTI (plugged culverts, failed ditches) or Province (stream erosion, flooding)
Subdivision and building permits	• Review plans for approval in Development Permit areas
Agricultural practices	• No authority to intervene
Condition of riparian zone	• None - not a CVRD responsibility
Opportunities	**Actions**
Parks and trails	• None in the strategic plan • Could respond to a collaborator proposal
Intervenor	**Ministry Of Transportation and Infrastructure (MOTI)**
Perceived Risks	**Coping Strategy**
Ditches, culverts, control devices	• Maintenance, respond to calls for repairs
Applications for subdivision	• Review drainage plans; apply standards for approval of design
Condition of BC for conveyance	• Refer problems (debris jams, gravel bars) to the province
Opportunities	**Actions**
Condition of the riparian zone	• May intervene in special circumstances
Trails	• Right of way agreements possible
Intervenor	**Town of Comox**
Perceived risks	**Coping Strategy**
Storm water drainage serving new subdivisions (Foxwood and Highwood)	• Increase capacity of detention ponds at subdivision drainage systems • Maintain collectors and conveyance to
Variable and increased flows from upland areas of BC	• Seasonal detention (ponding above Guthrie Road) • Build a diversion facility to take some peak flow volume out of the creek and pipe it directly to Comox Bay (built 2005) • Master Drainage Plan objectives 1999

Intervenor	Brooklyn Creek Watershed Society
Perceived Risks	**Coping Strategy**
Lack of joint management plan to protect ecological systems throughout the watershed	• Continue to promote the strategy for adoption by local government • Public education
Property owner lack of knowledge about riparian ecological systems	• Public education; respond to property owners' requests for advice/help
Opportunities	**Actions**
Extend trail system along BC from lower watershed to upper catchment	• Propose enhancement and trails projects to potential collaborators (CVRD & MOTI) when right of way work is planned (e.g. Hudson Trunk extension) • Raise grant funding for projects • Provide donated expertise and labour

Table 6 – Lower Creekshed Perception of Risks	
Intervenor	**Town of Comox**
Perceived Risks	**Coping Strategy**
Continued degradation of the creekshed Damage to private and municipal property Risks to the conveyance capacity of the creek and municipal storm drainage Loss of habitat for terrestrial and aquatic species	• BC Master Drainage Plan 1999 • Devise a long-range management plan including strategies to enhance the riparian environment • Collaborate with other intervenors • Acquire properties to advance the enhancement strategies
Reduce or eliminate erosion and sedimentation	• Projects to increase retention areas • Projects to enhance the stream corridor • Stormwater diversion facility 2005
Loss of fish habitat	• Projects to improve fish habitat and movement
Debris jams and invasive plants	• Regular and emergency maintenance program; involve watershed society
Loss of key urban woodland species and specimens (urban forest)	• Include protection in management plan
Opportunities	**Actions**
Implement long-range enhancement plan	• Initiative led by parks department, supported by engineering and in collaboration with watershed society • Parks provides an annual budget, which is supplemented (usually matched) by watershed society fund raising

Attract funding from non-municipal sources	• This strategy supported by the watershed society and TOC
Improve the functioning condition of the creek	• Implement stream corridor and riparian area works designed by biologist and engineer
Protect sensitive ecological flora and fauna	• Refer to provincial sensitive ecological inventory; • Refer to advice from Watershed Society; • include measures in works design
Combine enhancement project work with Town of Comox environmental and public space objectives	• Include greenways, trails, park areas and rest and viewing locations with riparian zone enhancement • Recognize urban woodland objectives as part of the riparian environment
Combine enhancement project work with improvement of salmon and trout habitat, refuge and spawning areas	• Rely on biologist's design • Install riffles, spawning areas, refuge zones, stream complexing, etc. • With Watershed Society, raise funding for this work from Pacific Salmon Foundation and other sources
Encourage private property owners to support the enhancement work along their property lines	• Target key properties and invite participation
Public education about the stream corridor and its functions	• Ensure that the Town of Comox Council receives annual project reports • Parks Department and Watershed Society offer educational programs
In the Town of Comox jurisdiction, establish a management and maintenance plan for the creekshed and all enhanced areas	• Parks Department leads the plan and annual works • Engineering maintains conveyance and engineered features (culverts, headwalls, storm water outfalls, fish ladders, etc.) • Watershed Society assists with periodic projects (removing invasive plants, clearing debris, planting, taking readings, fish counting, etc.)
Intervenor	**Brooklyn Creek Watershed Society**
Perceived Risks	**Coping Strategy**
Continued degradation of the creekshed	• Collaborate in the long-range management plan process and enhancement work
Erosion, sedimentation, debris jams, invasive plants, loss of fish habitat	• Work on annual enhancement projects • Participate in short term maintenance work
Lower BC Watershed not connected to middle and upper areas	• Continue to encourage the City of Courtenay and the CVRD to participate in an integrated watershed management plan.
Opportunities	**Actions**
Stream corridor enhancement	• Support the long-range plan • Volunteer expertise and labour
Riparian zone enhancement	• Support the long range plan • Volunteer labour and expertise
Improve fisheries values	• Volunteer labour and expertise
Public education	• Involvement in programs for school children and adults
Monitor watershed condition	• Co-ordinate with parks department to carry out maintenance

6. PERSPECTIVES ON WORTH

The EAP analysis focuses now on details about key intervenor actions indicating what their priorities have been concerning the hydrology of the Brooklyn Creek watershed and the ecological services supported by the system. **This view of worth, as described in the section about methodology, concerns utility; what does the community expect from the stream and riparian zone?** The following assessment focuses primarily on the lower watershed in the Town of Comox where intervenors have carried out a long-range plan of enhancement and management.

6.1 Water Balance Context

Earlier sections of the research described the extensive urbanization of the Brooklyn Creekshed and the drastically altered hydrology that now exists. The traditional "pipe and pond" design and construction of stormwater infrastructure has neither protected hydrology nor the dependent ecological services.

The Water Balance Methodology analysis identified three measures to improve the degraded functioning condition of Brooklyn creekshed:

- **Volume of retention** which stores rainwater for controlled release to deep groundwater / aquifer or to the stream through the municipal drainage system;
- **Infiltration system area** in contact with the subsurface which will allow retained water volumes to infiltrate to deep groundwater / aquifer; and
- **Base flow release rate** which can be used to augment small stream discharges through release of retained rainwater.

A Synopsis of Creekshed Realities Provides Relevant Understanding: In the upper watershed, the ecology has been subordinated entirely to land development. The intervenors opted for engineered drainage that altered nearly all of the catchment. The natural functioning condition had little worth to them.

Local government and other intervenors primarily manage the stream corridor in the middle catchment as conveyance for local land use drainage. The limited jurisdictional power of the CVRD means that it reacts to applications for subdivision in development permit areas that may, include protection of ecological features.

The Ministry of Transportation and Infrastructure (MOTI) has specific authority related to subdivision approval and maintenance of roads and drainage, which includes technical standards intended to protect the local hydrologic functions of the watershed following development with stated requirements for no increase in l downstream flooding and no adverse impacts on receiving streams.

While the mid-creekshed authorities may cooperate with upper or lower creekshed managers on some management concerns related to hydrology, there is no joint strategy.

Collaborative Efforts to Improve the Lower Creekshed: The lower catchment in the Town of Comox, has suffered obvious negative impacts of more than 125 years of cumulative land use changes throughout the creekshed. By the late 1990s and early 2000s, erosion and sedimentation caused by recurring flooding events compelled the Town of Comox and other intervenors to employ coping strategies.

In 1999 the Town of Comox commissioned and received a master drainage plan. The work on its recommendations progressed year by year. However, between 1999 and 2005 flow volumes led to sedimentation and erosion in the steeper reaches of the creek. As a remediation measure, the Town constructed the Brooklyn diversion facility which takes 20% of the creek's peak flow and pipes it directly to Comox Harbour. The cost was $1,977,953. At this time a wetland complex was constructed in Salish Park to increase stream retention and infiltration capacity.

The second strategy involved adoption in 2006 of a long-range enhancement and management strategy for the creekshed. Since commencing enhancement work in 2008, the Town and the Brooklyn Creek Watershed Society have completed annual enhancement projects based on this plan. The collaborators also understand the need for maintenance work, which has involved periodic repairs to features in the stream corridor as well as on-going clean-up of the riparian zone interface with parks, trails and greenway areas. Most of this work takes place as part of parks and trails maintenance.

6.2 Calculation of the Worth of Brooklyn Creek Ecological Services

Chapter 2 established that EAP focuses on worth (value in use). How do key intervenors and residents use creekshed and riparian zone ecological services and what do they invest in these resources? These expectations were covered in detail in the previous section.

"Intervenors" broadly refers to community or residents. However, those involved directly in the management of the ecological services are Town of Comox departments and council, Brooklyn Creek Watershed Society, Current Environmental Services, and various funders. These collaborators are investing in the enhancement process.

The community or residents confirm the worth of the enhanced creekshed by using its trails, greenways, park areas, fish viewing sites, etc. Council members and other intervenors receive feedback from the community which indicates a strong level of support for the enhancement work.

Key intervenors involved in the enhancement of Brooklyn Creek certainly were motivated by the potential loss of the natural area, the scarce ecological services it provides, and the amenities of the catchment. The cost of remediation already has been indicated by the nearly $2 million outlay for the Brooklyn diversion.

> "Economics as the study of how to allocate limited resources, relies on valuation to provide society with information about the relative level of resource scarcity. The value of ecosystem services and biodiversity is a reflection of what we, as a society, are willing to trade off to conserve these natural resources."
>
> **From:** Pascual U, Muradian R, Bradner L, et al. The Economics of valuing ecosystem services and biodiversity. In *The Economics of Ecosystems and*

Introduction of the Concept of a "Package of Ecological Services": Scarcity simply means that the creek corridor and riparian zone cannot be replaced if they are completely degraded and ecological services fail. Intervenors and residents want this landmark ecological system in their community and they want to continue enjoying the services it provides.

This is an anthropomorphic view of the value of ecological services; it is the worth that the community attributes to having the creekshed and the amenities that it adds to parks, trails, greenways, etc.

The concept of worth in this context might be called a **package of ecological services** which are provided, desired, and valued by the community. Residents want to have the following kinds of amenities available:

1. The underlying hydrology (rainwater interception, retention, infiltration, interflow, etc.) stream corridor (stream complexity, riffles, spawning areas, etc.) riparian zones, wetlands, ponds, habitat for flora and fauna, urban woodland/forest zone, etc.; and,

2. Desired human settlement services dependent on the stream/riparian environment. Examples are natural areas for recreation and parks, greenway corridor, route for pathways and trails, ponds, fish habitat/viewing, outdoor classroom, heritage trees, positive amenity for nearby property values, conveyance for a portion of the Town of Comox storm water system, etc.

The package of ecological services concept refers to the combined range of uses desired by the community. Thus, a strategic plan that supports this diversity will appear worthwhile to the greatest number of interested parties. This is the case for the Brooklyn Creek Enhancement Plan.

Following initial enhancement work in 2005, the long-range plan was devised in 2006 by the Town of Comox Parks and Engineering departments and the Brooklyn Creek Watershed Society. Implementation began in 2008. The following analysis covers expenditures committed for creekshed (stream corridor and riparian zone) work.

6.3 Management and Maintenance Expenditures

EAP defines management as enhancement work, while maintenance involves on-going tasks to prevent degradation of the stream corridor and riparian zone. The creekshed hydrology is natural capital.

EAP accepts the growing body of research about the value of natural capital which concerns the imputed value of *"various services and benefits that ecosystems and biodiversity generate."*

The methodology commonly used is the Total Economic Value (TEV) framework concerning the values occurring (perceived) in the current state of an ecosystem. Presently in Canada the Municipal Natural Capital Initiative (MNAI) is addressing this concern in several projects. The list of references at the end of the report includes several Canadian research papers about valuing natural capital.

As noted earlier, EAP focuses on worth (*value in use*) rather than imputed or assigned calculations of value, which is the objective of the TEV approach.

Worth refers to likely returns for expenditures as perceived by key intervenors and the community. Thus, in the case of Brooklyn Creek, an enhanced riparian area which improves the environment of an adjacent trail or greenway will be an important asset to the Parks Department as well as an aesthetic value prized by community users and the local municipal council members. At the same time, in the case of the Town of Comox, the public works department will consider enhancement of the functioning condition of Brooklyn Creek as management of the local drainage infrastructure.

EAP considers the creekshed (corridor and riparian zone) and the ecological services it provides to be the natural capital asset (see Section 6.6 for a method to calculate the dollar value).

More fundamentally, the hydrology that supports it is a capital asset provided by nature. Works undertaken to improve its current state are management.

6.4 Brooklyn Creek Long-Range Enhancement Plan, 2005 to 2017

The work carried out under this plan has been reported annually since 2008 as the "Brooklyn Creek Channel Enhancement Project." As reported, the project "aims to increase the productivity of wild salmon stocks by improving rearing and spawning habitat and restoring fish passage.

A secondary goal of the project is to "improve pedestrian access within Brooklyn Creek Park and other Municipal Greenways."

The following financial summaries include cash expenditures as well as in-kind dollar amounts for donated labour, equipment and expertise. Examples include some design inputs for annual projects, applications for funding and project reports. Not all communications and educational work was captured in this review. Some of these amounts are based on estimates provided by stakeholders.

Summary of expenditure for enhancement works in Brooklyn Creekshed, Town of Comox, 2005 – 2017.

YEAR,	EXPENDITURES,	SOURCE of FUNDING
2005	$44,000	Western Economic Development, Town of Comox, and TOC in kind
2008	$ 58,000	Pacific Salmon Foundation (PSF), TOC and In-kind
2009	$ 54,000	PSF, TOC and In-kind
2010	$ 82,500	PSF, Habitat Conservation Trust Fund (HCTF), TOC, In-kind
2011	$ 54,400	PSF, TOC, In-kind
2012	$ 50,000	PSF, TOC, In-kind
2013	$ 45,000	PSF, TOC, In-kind
2014	$ 42,500	TOC, School District 71, PSF, In-kind
2015	$ 93,223	PSF, TOC, Department of Fisheries and Oceans, In-kind
2016	$ 45,800	PSF, DFO, TOC, In-kind
2017	$ 82,000	TOC, PSF, In-kind (to be confirmed)
Total	$ 651,423	
Other[5]	$ 145,000	
Total	$ 796,423	

The Town of Comox showed further commitment by acquiring additional sites along the creek corridor for enhancement.

One is 0.92 hectares (2.27 acres) acquired from School District 71 to accommodate greenway construction and creek corridor enhancement. Although the transfer from the school district was at a nominal amount, the land under institutional zoning had a declared value of $292,375.

The other site is 2.56 hectares (6.3 acres) at the mouth of Brooklyn Creek. This is land that includes the Mack Laing property. Purchase cost was $2.1 million in 2013. Town of Comox paid $1.8; the Nature Trust of BC $300,000.

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[5] *"The planning stages, including site assessments, developing restoration prescriptions, public outreach and solicitation of funds of is partially covered by DFO's* Salmon Enhancement Program (SEP), *TOC and fees donated by our firm (Current Environmental)." Annual costs average $6000 and are not covered in the enhancement project summaries. These outlays total $60,000 from 2008 to 2017. (R. Wong, Current environmental*

The annual costs of maintaining these enhanced ecological features as well as the nearby parks, trails, greenway amenities are estimated to be about $8500 per year since 2008. The total for ten years is $85,000. (A. Fraser, TOC Parks Department).

6.5 Protection of the Investment in the Creekshed

The key intervenors have invested a total of about $2,774,000 in remediation (Brooklyn diversion) and enhancement – annual projects in 2005 and 2008 to 2017. Budgeting for maintenance of enhancement and remediation works, (sunk investment) using real property management standards would be at least 1% of total (capital) value per year. At that rate, about $27,100 per year would be required for maintenance work that would protect sunk investment.

In recent years, the Parks Department has spent $7,000 to $10,000 per year for maintenance in the riparian areas that harbour the enhancement investment. The Public Works Department has spent about $4000 per year for maintenance related to the conveyance capacity of the stream. Probably the amounts should be doubled to ensure that the enhanced stream corridor and riparian areas as well as the Brooklyn diversion remain in good functioning condition for protection against flooding and erosion. Environmental mitigation of aquatic and riparian habitat should be considered to require additional resources.

6.6 A Method to Assign a Dollar Value to the Stream Corridor

Stakeholders can go beyond calculating the dollar value of sunk investment in enhancement as a measure of the worth of watershed ecological services and natural area amenities - parks, trails, greenways, urban woodlands, etc. in specific catchments. What about the land that underlies the stream and riparian zone?

Property assessments by BC Assessment Authority provide a land value as well as a value for the improvements (House, garage, or other hard surfaces or structures). Where no improvements exist, the assessment pertains to land only. Natural features are not segregated for assessment purposes. However, because assessments are based on market prices (sales of similar parcels in proximate locations) the value given reflects what buyers may pay when ecological features influence a parcel and the improvements upon it.

The logic of this proposal suggests that there is a monetary value for the land underlying a creek and its riparian zone – let's call it the **ecological area or commons zone**, even though some of the land lies within private property parcels. Whether or not local intervenors have invested in enhancement, a base financial value exists. That value has been determined by an independent authority, BC Assessment.

Under local zoning, residential and other classes of property that have a boundary contiguous to a stream corridor/riparian zone or other sensitive environmental feature have a set-back requirement. No structure may be within 15 metres of the high water mark of the stream (in the case of Brooklyn Creek).

This area cannot be built upon or altered. This restriction is meant to ensure that the stream corridor will remain as a natural feature that all of the community can enjoy as an ecological system. **This is a commons value shared with property owners**.

Both private property owners and the larger community expect the stream, its riparian zone and ecological services to remain in functioning condition, to continue to provide desired ecological services, including those that uplift property values. Management and maintenance is implied.

Thus, the commons asset financial value would be shared. As a somewhat arbitrary measure, using the assessed value of a lot, the percentage in the set-back will have a specific value. As a rule of thumb, the area of the lot in the shared set-back could be given a financial value that is 50% of the assessed value. The land under the stream corridor itself if taken at a nominal width of 3 metres and valued at the same rate as the adjoining parcels.

Consider the following:

There is a measure of the monetary value of the land asset underlying a creek corridor and riparian zone. This is the land that supports the various ecological services that stakeholders perceive as worth managing and maintaining (the **package of ecological services).**

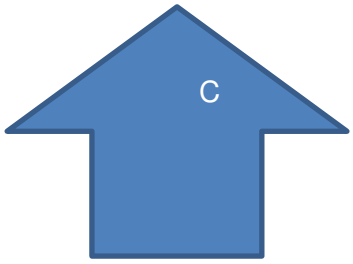
The lines A and B below are the property lines of a residential lot that backs onto a stream. Arrow C indicates the setback zone required under local government regulation; no construction may take place in the set-back area. Imagine the width of the arrow moving toward the top of the photo of the creek / riparian zone.

_____

A

_____

B

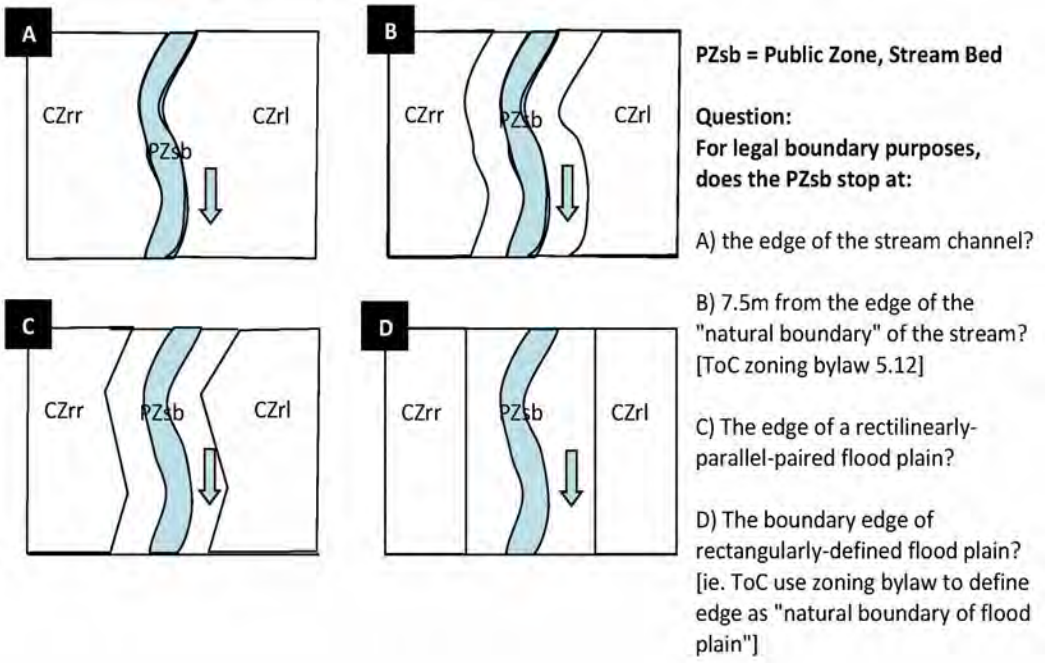


How can the setback area be measured? There are several options as noted below.

For calculating purposes, it may be wise to calculate using (D):

Best accommodates nature

- common sense approach
- accommodates natural movement of stream course braiding over centuries
- lot boundaries ordered geometrically
- location of boundaries will rarely change over time using D
- boundaries will be rarely affected by changes to stream channel (nature does this!)



Ease of calculation = least stress for property owner and local government

- ease of calculation by the landowner and the local government
- No need for constant re-surveying = dramatically reducing need for complex surveying
- No need for survey = removes need to determine who pays for survey

CALCULATION

Using format “D” the area of each parcel to be considered is determined. This information will be available from the local government GIS mapping system. Using civic addresses, the land value of each property in the analyses can be obtained from BC Assessment. The following example concerns eight properties that border Brooklyn Creek.

The land values for the sample lots are:

ADDRESS	SIZE	LAND VALUE	COMMONS Area	WORTH
Pritchard Rd.				
555,	1001 m²	$134,000	TOC Park 100%	134,000
561,	1100 m2	134,000	75%	100,500
Salish St.				
554	780m ²	140,000	75%	105,000
562	821m²	145,000	100%	145,000
568	1051m²	159,000	90%	143,000
576	780 m²	140,000	40%	56,000
577	820 m²	141,000	100%	141,000
1604 Kwakiutl	798 m²	144,000	100%	144,000
Total				$ 968,500

Commons area 50% shared value = $ 484,250

The value of the commons area underlying the stream (at a nominal 3 metres width) and setback areas is approximately $2705 per lineal metre.

The value per kilometre would be $2,705,000. The 2.5 kilometres of stream length in TOC would have an asset value of $6,763,268. Long term maintenance at1% would be $67,630 per year on average.

The value of the portion of Brooklyn Creek enhanced by TOC would be $5,951,000 (based on total length of enhancement of 2200 metres). Long-term maintenance would be $59,951 per year.

Local governments have the GIS capacity to determine more accurate valuation.

The importance of this example is to argue that land with ecological improvements (features put there by nature) have asset value or worth in the same way that land with man-made improvements has financial value calculated in detail for marketing purposes and assessed for management purposes.

Package of Ecological Services

Brooklyn Creek comprises the creek corridor and the riparian zone. Both support ecological systems. The creek itself is a hydrologic system supporting conveyance, flow duration, nutrient transport, aeration, fish habitat (riffles, pools, eddies), stream complexing, etc.

The surrounding zone and interrelated ecological systems work with the hydrology to provide a range of ecological services including moderation of water temperature, habitat for terrestrial and aquatic life, wetlands, ponds, nesting places, woodlands, etc.

From a human settlement point of view Brooklyn Creek is an amenity that can be enjoyed in association with parks, greenways and trails. The creek supports salmon and trout; it is a landscape feature; it is part of the urban woodlands, heritage trees and nesting sites; and it is the focal point of outdoor classroom activities, walking, jogging, cycling, wildlife viewing, etc.

The creek zone adds value to nearby properties and attracts visitors from other local government areas. The Town of Comox also uses the creek for storm water conveyance and attenuation of flooding.

Notes

1. In the Town of Comox zoning bylaw 5.12 states that “no building shall be constructed or located on land above the natural boundary: (1) within 7.5 metres of the natural boundary of Golf Creek, Carthew (Indian) creek, the sea, or a retention pond, or detention pond; or (2) within 15.0 metres of the **natural boundary** of Brooklyn Creek, or a marsh or natural pond.

What does "natural boundary" mean?

2. “In British Columbia, ownership of water and most streambeds is vested in the Crown and the main provincial statute regulating water resources is the Water Act. Section 9 of the Water Act regulates ‘changes in or about a stream.’

   Changes in and about a stream” means:

   (a) any modification to the nature of a stream including the land, vegetation, natural environment or flow of water within a stream, or

   (b) any activity or construction within the stream channel that has or may have an impact on a stream.

   "Stream" includes a natural watercourse or source of water supply, whether usually containing water or not, and a lake, river, creek, spring, ravine, swamp and gulch.

   "Stream channel" means the bed of a stream and the banks of a stream, whether above or below the natural boundary and whether usually containing water or not, including all side channels;”

Definition of the ecological services of the creek corridor (stream bed and adjacent riparian zone).

1. The multi-faceted systems of intercepting, retaining, cleaning, infiltrating, conveying (surface and sub-surface) rainwater to support riparian zones (flora and fauna), supply fish habitat, and hydrate trees are all ecological systems and services.

2. Human settlement (the commons) takes advantage of these systems for a variety of purposes including: conveying drainage from storm-water sewers, providing an environment for trails and greenways, providing features (including ponds) for parks, and riparian zones where flora and wildlife can be viewed. These zones also harbour urban woodlands.

3. Usually values of these ecological systems (services) may be capitalized into the prices of nearby properties which can claim aesthetic advantages of being “on a creek,” near parks and greenways, with waterfront, etc. Such properties command a higher sale price than similar properties distant from ecological assets.

7. WHERE TO FROM HERE

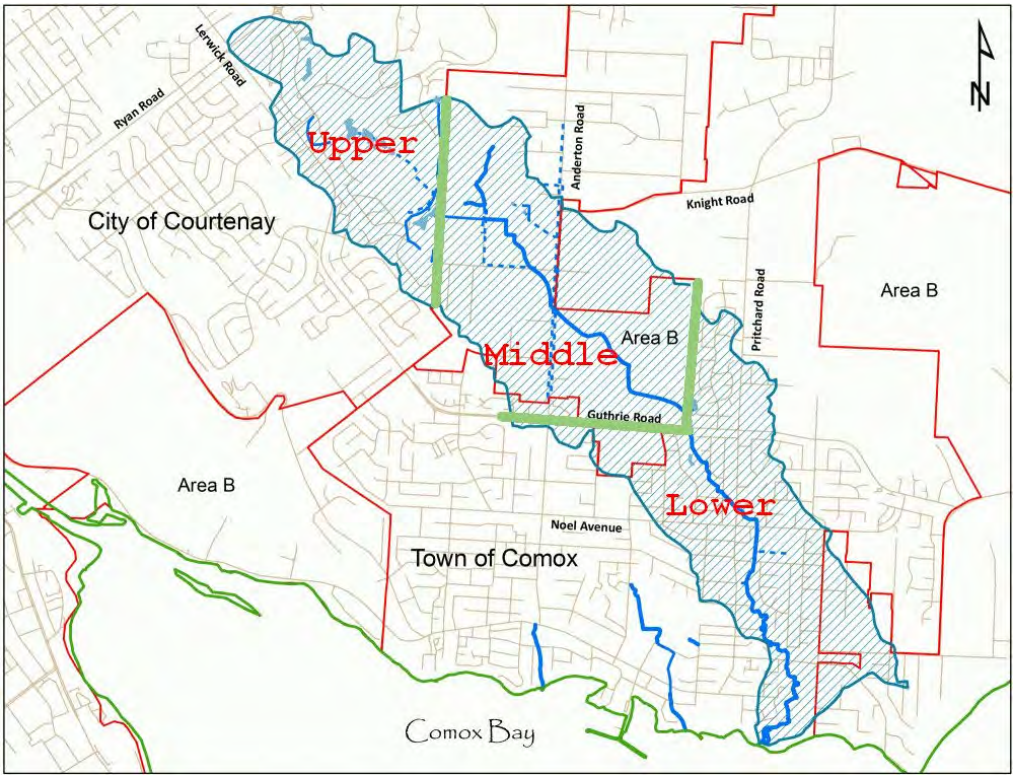
This demonstration application of the Ecological Accounting Process (EAP) has endeavoured to establish what the Brooklyn Creekshed may be worth from the point of view of investments made in the lower catchment by the Town of Comox and other intervenors / managers. As well, this demonstration application of a systems approach provides context for identifying future opportunities to access more ecological services from the middle and upper catchments of the creekshed to serve human demands as well as the intrinsic needs of nature.

Given the foregoing frame of reference, then, this **Brooklyn Creek EAP Demonstration Application** may be viewed as the first step in creating a comprehensive Creekshed Plan that would identify and provide the value of the components and services provided by the natural features of the creekshed.

The insights and understanding gained through the EAP research process - combined with development of a **valuation of worth methodology** that is founded on real numbers - would help intervenors / managers to consider, design and implement strategies and practices to manage and maintain ecological systems in a stream corridor, riparian zone, or other ecological system.

Such a strategy would require assessment of the condition of the creekshed hydrology. Taking action would depend on what they think the creekshed is worth. Participation in a management regime that integrates intervenor / manager effort in all creekshed areas would be a crucial step in enhancement and maintenance efforts.

The Brooklyn Creekshed has 3 distinctive zones



What We Learned

The EAP analysis established that intervenors involved in management of three catchments of the Brooklyn Creekshed have very different views of the worth of its ecological systems.

Past and continuing land use (development) practices have considered hydrology only in a superficial manner which includes the rapid disposal of any water to allow the ground surface to dry as quickly as possible following any rainfall.

The impacts of these practices include increased downstream flooding and increased downstream bed and bank erosion. In contrast, the natural systems contain the rainwater for longer periods and thus attenuate flooding.

What the Water Balance Assessment Revealed

The EAP applied the Water Balance Methodology to describe the current condition of the creekshed hydrology (rain water interception, retention, infiltration, interflow, etc.) which is the engine that supports its ecological systems.

An Overall Perspective on Creekshed Condition: As is the case in most creeksheds, historic standards and regulation of design and construction of drainage systems have failed to prevent degradation of the hydrology of the Brooklyn creekshed and the dependent ecological systems.

Not surprisingly, the Water Balance analysis confirms the loss of the historic creekshed functions that spread, retain and infiltrate rainwater.

The existing urban residential and commercial/industrial areas are increasing flood peaks because they directly discharge into the stream with no attempt to limit the increases in flood discharge.

The farm lands have had an impact due to two different aspects which include:

- Reduction of tree cover and cultivation through the small ephemeral streams that were once within the treed areas, and

- Increased discharges resulting from the road ditches that intercept the interflow and more rapidly direct the stormwater to the stream combined with the drainage of natural wetland areas

In the upper creekshed, the headwaters catchment has been altered and made subordinate to engineered drainage design and construction. The outflow from this catchment occurs at the boundary with the Comox Valley Regional District Area B.

While flow rates may not be greater than historical levels, they occur more frequently and last longer with negative impact on downstream areas.

In the mid-creekshed, Area B and bordering areas, large lot as well as dense rural subdivision has cut up the top metre of the landscape impairing rain water retention, infiltration and inter-flow.

Jurisdictional authority results in a reactive regime: review of drainage plans gets triggered by application for development. No management strategy that includes ecological systems exists, although protective measures are included in Development Permit areas (CVRD) and under MOTI technical standards. Applied maintenance primarily concerns roads and ditches.

In the lower creekshed, the Town of Comox and collaborators have adopted and executed a long-range strategy to enhance and maintain the stream corridor and riparian zone.

This work began in 2005 with the construction of the Brooklyn diversion facility (remediation) and continued as enhancement under a long range strategy carried out as annual projects from 2008 to 2017.

Building on a Foundation for Successful Collaboration

Within the Town of Comox, the combined engineering and biology approach has established features designed to meet eco-system and human settlement needs to:

- improve fish habitat – spawning, refuge, and rearing areas – in the creekshed;
- install retention ponds (Salish Park) to improve infiltration, attenuate erosive flows, and prolong the duration of flows in the creek itself;
- enhance the creek corridor with riffles, gravel beds, complexing, winding pooling and planting of native species;
- combine enhancement with park, greenway, trails and urban woodland amenities;
- increase salmon and trout stocks; make migration and spawning available for public viewing;
- acquire land bordering the creek to increase enhanced and managed areas; and
- maintain the creek as a natural amenity and part of the TOC rain water drainage system.

The key intervenors decided that the creekshed was worth investment in the form of a long-range enhancement plan, raising more than $780,000 over eleven years:

- Town of Comox sources supplied about half of the total, the balance came from outside sources including the Pacific Salmon Foundation.
- Approximately $130,000 of the total was supplied in the form of donated services and labour by Brooklyn Creek Watershed Society members, Current Environmental, businesses and other local contributors.
- The Town of Comox also invested $1,977,953 in the Brooklyn diversion to prevent downstream erosion and to maintain the conveyance capacity of the stream as part of the municipal drainage system.

The 'Worth' of Further Investment

An outcome of the Brooklyn Creek EAP Demonstration Application is a *valuation of worth methodology* that is founded on an understanding of how local governments rely on ecological services for:

- **Aesthetic Purposes:** These cover a range of purposes related to active and passive recreation features and services which local governments offer to their residents.

- **Drainage Functions:** These encompass conveyance, rainwater retention, infiltration, groundwater recharge, and cleansing of surface flows.

EAP refers to these aesthetic and drainage features as a **Package of Ecological Services**. As linked features, the ecological services are part of the **Commons Asset**.

Valuation of Worth Methodology: The systems approach encapsulated in the EAP approach has yielded a method to calculate the value of the land underlying the creek corridor and riparian zone. This requires measuring the width of the stream and setback areas on properties that abut the creek. The essence of the *valuation of worth* methodology is summarized below:

- The setback areas would form a ratio of each property which is "commons." This is land with ecological importance that individual property owners share with the community.

- The value can be calculated from the annual assessments of land value determined by BC Assessment Authority.

- The commons value would be 50% of the assessed value of the land in the setback area (to the high water mark) as well as the area of the stream corridor itself (nominal 3 metres) at the same assessment rate.

The proposed measure provides a financial value for land and ecological assets that parallels the common calculation of land and improvements as the valuation of properties that have been developed. Local government GIS resources can calculate these amounts.

A Value for the Commons Asset: The EAP analysis established a unit value of ~$2700 per lineal metre of stream corridor "commons" zone along the 2.5 km stream length through the Town of Comox.

By establishing a value for the land underlying the stream and riparian zone, stakeholders have a much more realistic idea of the worth of the ecological services supplied by environmental assets. This financial information can be used for strategy related to Asset Management Plans.

Annual Budget: Based on real property management standards, applying 1% of total (capital) value per year would establish an annual budget of ~$67,000 for maintenance and management of Brooklyn Creek ecological services.

Then What?

Finally, the EAP review confirms that the Town of Comox has managed and improved the functioning condition of Brooklyn Creek (lower creekshed catchment) though its long range plan and strong collaboration with community partners and external funders.

Unfortunately, in the mid and upper catchments of the creekshed, the hydrologic condition remains threatened and degraded. Without improvements there, the permanence of the work in the lower catchment will remain limited.

REFERENCES

Associated Engineering. 1999. Town of Comox Master Drainage Plan. Town of Comox.

Carvajal, V. & Janmaat, J. 2017. A Cost-Benefit Analysis of a Riparian Rehabilitation Project on Alderson Creek, Township of Spallumcheen, British Cloumbia. University of British Columbia. 39 pp.

City of Courtenay. 2005. Official Community Plan No. 2387 and amendments (2005 to 2017).

Comox Valley Conservation Strategy. 2013. Nature Without Borders, Second Edition.

Comox Valley Regional District. 2010. Comox Valley Sustainability Strategy.

Comox Valley Regional District. 2011. Regional Growth Strategy: Bylaw No. 120, 2010.

Comox Valley Regional District. 2014. Rural Comox Valley Official Community Plan: Bylaw No. 337, 2014.

Current Environmental. 2015. Channel Enhancement Brooklyn Creek. Power Point Summary.

Department of Lands, Forests and Water Resources. 1962. Preliminary Notes on Ground Water in the Comox Area. Province of BC.

Dumont, J.M. 2016. Establish Water Balance Targets for the Water Balance Express. Comox Valley Regional District.

Kennedy, M. & Wilson, J. 2009. Estimating the Value of Natural Capital in the Credit River Watershed. Pembina Institute. 64 pp.

Koers & Associates Engineering Ltd. Crown Isle Development Drainage Report. 1991. Silverado Land Corporation.

Koers & Associates Engineering Ltd. 2007. Hydrogeological Assessment for Storm Water Infiltration Knight Road Comox BC. Levelton Engineering Solutions.

Koers & Associates Engineering Ltd. 2012. Crown Isle Development Drainage Study Update Brooklyn Creek Tributary Study Area. City of Courtenay.

Molnar, M. 2015. Sound Investment: Measuring the Return on Howe Sound's Ecosystem Assets. David Suzuki Foundation. 77 pp.

Mumby, V. 2012. Town of Comox Urban Forest Management Plan 2012. Town of Comox.

Office for National Statistics. 2017. Principles of Natural Capital. Department for Environment, Food and Rural Affairs, United Kingdom.

Olewiler, N. 2004. The Value of Natural Capital in Settled areas of Canada. Ducks Unlimited, 36 pp.

Partnership for Water Sustainability in BC. 2017. Sustainable Watershed Systems, Through Asset Management. Web document.

Pascual U, Muradian R, Bradner L, et al. 2010. The Economics of valuing ecosystem services and biodiversity. In *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations.* Taylor and Francis Editors. Arizona State University.

Plummer, M.L. 2009. Assessing benefit transfer for the valuation of ecosystem services. In *Frontiers in Ecology and Environment.* 7:38-45.

S. Swanson, D. Kozlowski, R.Hall et al. 2017. Riparian proper functioning condition assessment to improve watershed management for water quality. In *Journal of Soil and Water Conservation.* 72 no. 2: 168-182.

Sayce, S., Smith, J., & Cooper, R. 2006. Real Estate Appraisal: From Value to Worth. Wiley-Blackwell. 356 pp.

Town of Comox and Current Environmental. 2008, 2012, 2013. Brooklyn Creek Channel Enhancement Project.

Town of Comox. 2011. Official Community Plan, Greenways Network Current Plan.

Town of Comox. 2011. Official Community Plan, Bylaw 1685 and amendments (2012, 2013, & 2014)

White, E. M. and Leefers, L. A. 2007. Influence of Natural Amenities on Residential Property Values in a Rural Setting. In *Society and Natural Resources.* 20:659-667.

Wilson, S.J. 2014. The Peace Dividend: Assessing the Economic Value of Ecosystems in B.C.'s Peace River Watershed. David Suzuki Foundation, 2014.

Wilson, S. J. 2010. Natural Capital in BC's Lower Mainland – Valuing the Benefits from Nature. Pacific Parklands Foundation and David Suzuki Foundation.

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