the partnership
for water sustainability in bc

Synthesis Report

on

EAP, the Ecological Accounting Process, a B.C. Strategy for Community Investment in Stream Systems

JUNE 2022

Note to Reader:

Under the umbrella of the Georgia Basin Inter-Regional Education Initiative, this publication is the **Synthesis Report** for a set of nine demonstration applications. These case studies have evolved EAP, the Ecological Accounting Process, a BC Strategy for Community Investment in Stream Systems (Natural Commons).

The EAP program is multi-year (2016-2022) and multi-stage to test, refine and mainstream the EAP methodology and metrics. EAP supports Asset Management for Sustainable Service Delivery: A BC Framework.

To download a PDF copy of this report, as well as any of the others in the series, visit the EAP home page at: www.naturalcommons.ca. This report is the 4th in the *Beyond the Guidebook* series of guidance documents that build on Stormwater Planning: A Guidebook for BC, released in 2002.

ACKNOWLEDGMENTS: Funding and/or in-kind contributions from multiple organizations within five sub-regions of the Georgia Basin made it possible to undertake the project –

Regional District of Nanaimo, Cowichan Valley Regional; Comox Valley Regional District, Capital Regional District, District of North Vancouver, Township of Langley, Town of Comox, District of North Cowichan, City of Nanaimo, Real Estate Foundation of BC, Union of BC Municipalities, BC Ministry of Municipal Affairs, Federation of Canadian Municipalities (through the FCM Municipal Asset Management Program), Mid Vancouver Island Habitat Enhancement Society, Bowker Creek Urban Watershed Renewal Initiative, Island Waters Fly Fishers, Somenos Marsh Wildlife Society, Brooklyn Creek Watershed Society, Partnership for Water Sustainability in BC.

Members of various Project Committees contributed timely input and guidance to select appropriate study areas and parcel sample groups for purposes of EAP analyses. This was invaluable in helping the research team achieve a successful project outcome.

The Partnership also recognizes the valuable support provided by Ariel Verhoeks of the Mount Arrowsmith Biosphere Region Research Institute (Vancouver Island University) in carrying out the foundational GIS analyses.

What the Reader Will Learn

Know your history. Understand the context. These are key thoughts, and they provide perspective for the story of EAP, the Ecological Accounting Process, as told in this Synthesis Report. EAP comprises five cascading concepts (**Figure A**).

The "EAP story" is about a journey, one that began circa 1990 for pioneers working on parallel stream protection and restoration initiatives in British Columbia and Washington State. Three decades later, these parallel tracks have converged in the form of EAP. It has been a building blocks process requiring commitment, patience, and perseverance by many.

EAP provides local governments with the philosophy, methodology and metrics they need to make the financial case for stream systems. Maintenance and management (M&M) of stream systems can now be integrated into a **Local Government Finance Strategy** for sustainable infrastructure funding.

We can draw a direct line between EAP and the Fish Protection Act, passed in 1997 and re-named the Riparian Areas Protection Regulation Act in 2016. Circa 1990, Tim Pringle framed the challenge in terms that are still applicable:

> *"If we know how to do a much better job of protecting ecological features in our communities and on our landscape, then why aren't we doing a better job? Why are streams still being degraded? Why do we still see practices that are embedded in land use policy and regulation that are 50 years old in some cases? How do we change that?"*

The philosophy that **"use and conservation of land are equal values"** launched Tim Pringle on a career trajectory that has culminated with his breakthrough accomplishment in leading the EAP initiative. This 6-year program of applied research to test, refine and mainstream EAP provides local government with a path forward to address the **Riparian Deficit**.

The Riparian Deficit is the environmental equivalent of the **Infrastructure Funding Gap**. It puts the environmental perspective on an equal footing with the engineering and accounting perspectives. This is game-changing.

The Partnership mission is to develop tools and resources to help communities **reconnect hydrology and stream ecology, by design**. This includes a science-informed road map for restoring stream system integrity. Now it is up to communities to operationalize policy objectives spelled out in Living Water Smart, British Columbia's Water Plan.

Kim A. Stephens, M.Eng, P.Eng. (retired)
Executive Director
Partnership for Water Sustainability in BC
June 2022

Figure A – Cascading Concepts

EAP Project Partners and Participants

Organization	Representatives
Partnership for Water Sustainability	Tim Pringle, Kim Stephens
Vancouver Island University	Ariel Verhoeks, Graham Sakaki
Capital Regional District	Jody Watson, Jenn Tyler, Lindsey McCrank
Cowichan Valley Regional District	Kate Miller, Keith Lawrence, Bev Suderman
Regional District of Nanaimo	Murray Walters, Julie Pisani, Michael Wright, Greg Keller
Comox Valley Regional District	Darry Monteith, Vince van Tongren, Alana Mullally, Marc Rutten, Ton Trieu, Myriah Foort, Kevin Douville, Mark Harrison, Daniel May
District of North Vancouver	Richard Boase, Stephen Bridger, Rebecca Bittel
Township of Langley	Jason Chu, Melisa Gunn
Town of Comox	Marvin Kamenz, Shelley Ashfield, Al Fraser, Glenn Westendorp
City of Nanaimo	Rob Lawrance, Kevin Brydges
District of Oak Bay	Daniel Horan
District of Saanich	Adriane Pollard, Lesley Hatch
City of Victoria	Brianne Czypyha, Trina Buhler
Municipality of North Cowichan	David Preikshot, Sarah Grieves, Michelle Gill
Cowichan Tribes	Tim Kulchyski, Tracy Fleming
Bowker Creek Initiative	Soren Henrich, Ian Graeme
Somenos Marsh Wildlife Society	Paul Fletcher, Gina Hoar
Sh-huykwselu Streamkeepers	Kathy O'Donnell
Island Waters Fly Fishers	Bernie Heinrich
Mid Vancouver Island Habitat Enhancement Society	Peter Law
Brooklyn Creek Watershed Society	Christine Hodgson, Robert Deane, Vanessa Scott
Comox Valley Land Trust	Tim Ennis
Ministry of Transportation & Infrastructure	Andy Newall, Sean Wong

Georgia Basin Inter-Regional Education Initiative (IREI)

Educational Goal

Build practitioner capacity within the local government context to implement the whole-system, water balance approach known as ***Asset Management for Sustainable Drainage Service Delivery***

Mandate: Provide value through collaboration and partnerships.

Acknowledgments

The Partnership for Water Sustainability gratefully acknowledges the financial support of the Real Estate Foundation of BC, as well as financial support provided by the Province of British Columbia through both the Ministry of Municipal Affairs and Union of BC Municipalities, and by the federal government through the Federation of Canadian Municipalities.

real estate foundation BRITISH COLUMBIA

BRITISH COLUMBIA Supported by the Province of British Columbia

About the Partnership for Water Sustainability

The Partnership for Water Sustainability in British Columbia has its roots in government – local, provincial, federal. Incorporation of the Partnership as a not-for-profit society, on November 19th 2010, was a milestone moment.

*The Partnership had evolved from a technical committee in the 1990s, to a "water roundtable" in the first decade of the 2000s, and then to a legal entity in 2010. Incorporation enhanced the capabilities of the Partnership to develop tools and resources, and facilitate peer-based learning, to sustain implementation of the vision for **Living Water Smart in British Columbia**.*

*The Partnership vision is to build **bridges of understanding** and pass the baton from the past to the present and future. To bring the intergeneration vision to fruition, the Partnership is growing a network in the local government setting, which encompasses both government and stream stewardship sectors. This network embraces collaborative leadership and **intergenerational collaboration**.*

The Partnership believes that when each generation is receptive to accepting the inter-generational baton and embracing the wisdom that goes with it, the decisions of successive generations will benefit from and build upon the experience of those who went before them.

Five regional districts have endorsed the IREI thru Board Resolutions

Regional District of Nanaimo

Comox Valley Regional District

C·V·R·D

CRD Making a difference...together

METRO VANCOUVER

BEYOND THE GUIDEBOOK SERIES

Released in June 2002, Stormwater Planning: A Guidebook for British Columbia *is the foundation document for the Beyond the Guidebook Series. Each document in the series adds depth to the Guidebook through case study experience.*

	Beyond the Guidebook Title	Publication Date
Beyond the Guidebook 2007	**Context for Rainwater Management & Green Infrastructure in BC**	June 2007
Beyond the Guidebook 2010	**Implementing a New Culture for Urban Watershed Protection & Restoration in BC**	June 2010
Beyond the Guidebook 2015	**Moving Towards Sustainable Watershed Systems, through Asset Management**	November 2015
Beyond the Guidebook 2022	**Ecological Accounting Process, A BC Strategy for Community Investment in Stream Systems**	June 2022
Beyond the Guidebook 2023	**Flowing Towards "Water Reconciliation" within the Georgia Basin / Salish Sea**	TBA

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Beyond the Guidebook 2022

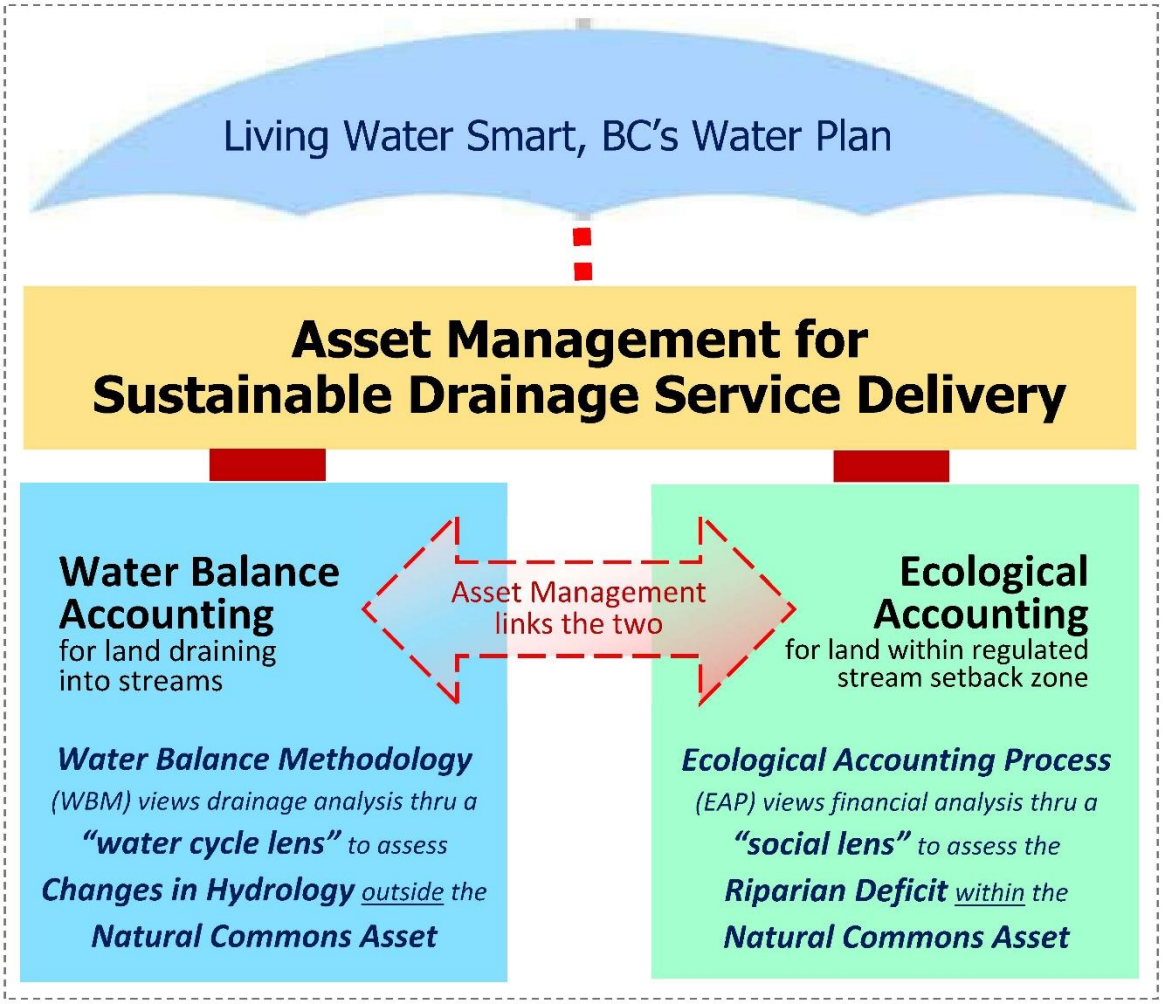
EXECUTIVE SUMMARY

Financial Case for the Stream

The Executive Summary provides a high-level overview for the extremely busy who just wants to understand “what I need to know” about EAP

Figure ES1

Twin Pillars of Stream System Integrity



Hydrology is the Engine that Powers Ecological Services

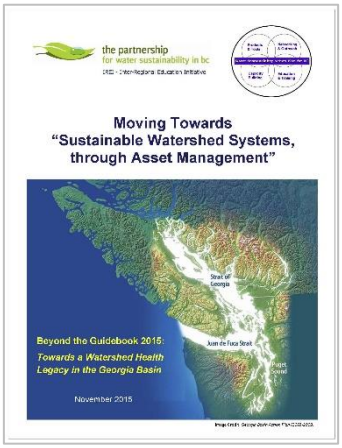
Source: The "road map" introduced as Figure 60 on page 156 in *Beyond the Guidebook 2015: Moving Towards "Sustainable Watershed Systems, through Asset Management"*. Released by the Partnership for Water Sustainability, November 2015

Sustainable Drainage Service Delivery & the Twin Pillars of Stream System Integrity

Drainage Service and the Unfunded Liability

In November 2015, release of Moving Towards "Sustainable Watershed Systems, through Asset Management" launched an educational process built around the twin pillars concept (**Figure ES1)**. Alignment with *Asset Management for Sustainable Service Delivery: A BC Framework,* released a year earlier through Asset Management BC, is the context for including asset management in the title.

Beyond the Guidebook 2015



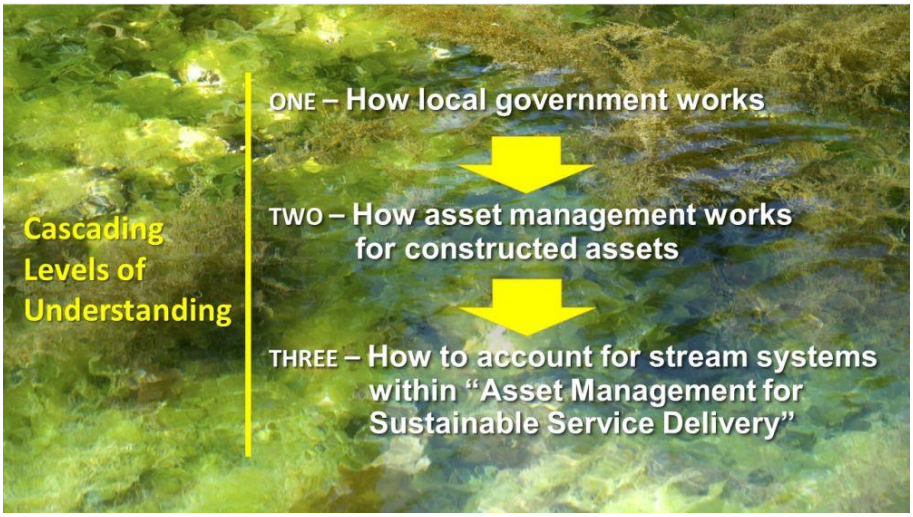
Cascading Levels of Understanding

The educational goal is to encourage local governments to reframe how they look at urbanizing watersheds, and then connect the dots between drainage infrastructure and stream health. What happens on the land does matter to streams. **Getting an unfunded liability under control is their incentive for moving from awareness to action**.

Local governments strive to deliver services sustainably, and work to ensure that current community service needs, and how those services are delivered, do not compromise the ability of future generations to meet their own needs through sound asset management practices.

It takes courage on the part of a Council or Regional Board members to look beyond the short-term, understand what sustainable funding entails over the long-term, and direct staff to get on with the job. This is the local government reality-check.

Three levels-of-understanding provide a frame of reference for EAP analyses and a reality-check for integrating "natural assets" into a local government Asset Management Strategy.



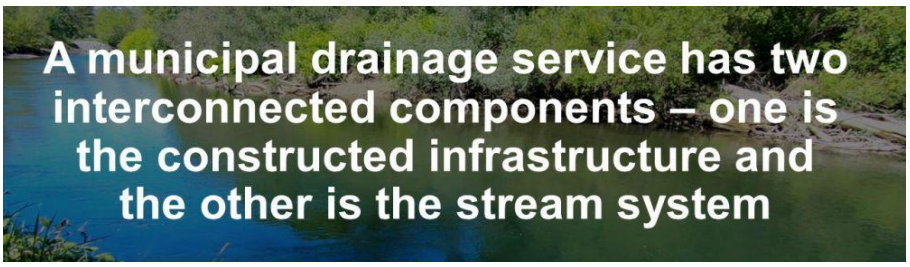
Why Protect Stream System Integrity

When one thinks about asset management, it is often in the context of municipal infrastructure and how this provides the "water service" or the "sanitary sewer service", and so on. **The Drainage Service is the neglected service, and the cost of neglect grows over time**.

The consequence of neglect is an accumulating financial liability to fund creek channel stabilization and riparian corridor restoration in urban and rural settings. Thus, the Partnership mission is to focus attention on this foundational concept:

> **Drainage infrastructure and the stream system together constitute the municipal Drainage Service**.

The urgency of the drainage liability issue spurred the Partnership's analytical process that linked municipal asset management and stream health as "cause-and-effect", for better of for worse. The Asset Management Continuum, included as **Figure ES2**, serves as a road map for local governments wishing to move **from stopgap remediation to long-term solutions**.



Continuum of Steps: The asset management journey for a local government is a "continuum of steps" as illustrated on **Figure ES2**. Step One is to embrace the BC Framework. Step Two is to implement Sustainable Service Delivery. Step Three is to apply EAP, the Ecological Accounting Process.

There is typically no funding mechanism for **stream maintenance and management (M&M)** such as for water and sanitary sewer utilities. So, the unfunded liability caused by drainage impacts grows over time. Once the life-cycle approach is standard practice for constructed assets, getting to Step Three would be so much easier.

Local governments need real numbers to deliver green infrastructure outcomes. It is that basic. Rhetoric is insufficient. EAP metrics are neither hypothetical nor speculative. They are grounded in the BC Assessment database.

Ecological services are core local government services

Ecological services are not intuitively understood by the public, elected representatives, and asset managers. At best, they have been considered as an add-on. To inform and educate, it helps to define ecological services in terms of drainage, recreation, habitat / biodiversity, and enjoyment of property uses. These are core services.

Figure ES2

Integration of Stream Systems into "Asset Management for Sustainable Drainage Service Delivery"

'Continuum of Steps'

Branding logo for
Asset Management for Sustainable Service Delivery: A BC Framework, released December 2014

WHAT is the issue (Ground Zero):
There is no **Asset Management Strategy**. There is an *'unfunded infrastructure (gap, deficit, liability)'*.

SO WHAT can be done (Step One):
Embrace the **BC Framework**. Focus first on constructed assets (pipes & buildings). Implement an *Asset Management Strategy / Program*.

NOW WHAT can we do (Step Two):
Life-cycle approach and **Sustainable Service Delivery** are standard practice for maintenance and management (M&M) of constructed assets.

THEN WHAT will we do (Step Three):
"Twin Pillars" for protection of stream system integrity is standard practice for the drainage service. Apply **EAP, the Ecological Accounting Process,** to quantify *Riparian Deficit* values and establish annual budgets for ongoing stream corridor M&M.

As understanding of the **Local Government Finance Strategy** grows, communities progress incrementally along the Continuum

*At the Partnership's Annual Water Sustainability Workshop held in December 2015, the Chair of Asset Management BC (UBCM's Glen Brown) introduced the Asset Management Continuum in the module titled **Sustainable Service Delivery for Watershed Systems**.*

Integrate Stream Systems into 'Sustainable Drainage Service Delivery'

Unless communities measure the effect of impacts, destabilization of stream channels and degradation of riparian assets and streamside protection areas will continue. EAP helps to quantify the unfunded and growing cost (hence liability) to protect, remediate or enhance stream systems in disturbed urban and rural landscapes. **This is the starting point for a life-cycle approach to M&M of the drainage service**.

Budget Line Items

EAP bridges a gap. While local governments have existing tools in the form of policies and legislation for 'maintenance and management' of ecological assets, they have until now lacked a pragmatic methodology and meaningful metrics to incorporate stream systems as line items in Asset Management Strategies and Budgets.

> **Using numbers generated through application of EAP local governments would have a sound basis for implementing a baseline annual budget for enhancement of the stream system (which is the natural or ecological asset) within a setback zone.**

A Stream is a Land Use: How concepts are explained is crucial. In addition, what is easily understood and can be measured gets implemented. Because the numbers are grounded, EAP puts the environmental perspective on an equal footing with the engineering and accounting perspectives. This alone is a game-changer.

The methodology and metrics recognize the importance of the stream system in the landscape. A stream is a land use because the stream corridor is defined in regulations and has a financial value. EAP uses real numbers from BC Assessment, not hypothetical assumptions, to establish the financial case for the stream corridor system.

Hydrology powers stream ecology. Thus, effective M&M requires an understanding of how water balance pathways connect creekshed hydrology and stream ecology, how changes on the land disconnect them, and how green infrastructure design can reconnect them.

EAP expresses stream system maintenance and management (M&M) as a measurable metric, the **Riparian Deficit**, which is the environmental equivalent of the **Infrastructure Funding Gap**.

Hydrology Powers Stream Ecology

*The flow of rainwater from cloud to stream is comprised of three water balance pathways: **surface runoff, horizontal shallow interflow**, and **deep groundwater**. Yet the latter two are routinely ignored by planners and designers. Time, a critical factor, is also ignored. These omissions have stream health plus financial consequences.*

Why the term 'Riparian Deficit'?

EAP interweaves financial, social, and ecological perspectives within a single number – the Natural Commons Asset Value – to establish the financial case for a stream corridor system.

This foundation has two primary metrics or measures: the NCA financial value is expressed as **$ per km of stream**; the annual M&M budget is **1% of the NCA value** consistent with accepted practice for constructed assets.

The NCA value is a measure of the Riparian Deficit which is a measure of the "loss of riparian integrity" due to land use intrusion into the regulated streamside setback zone.

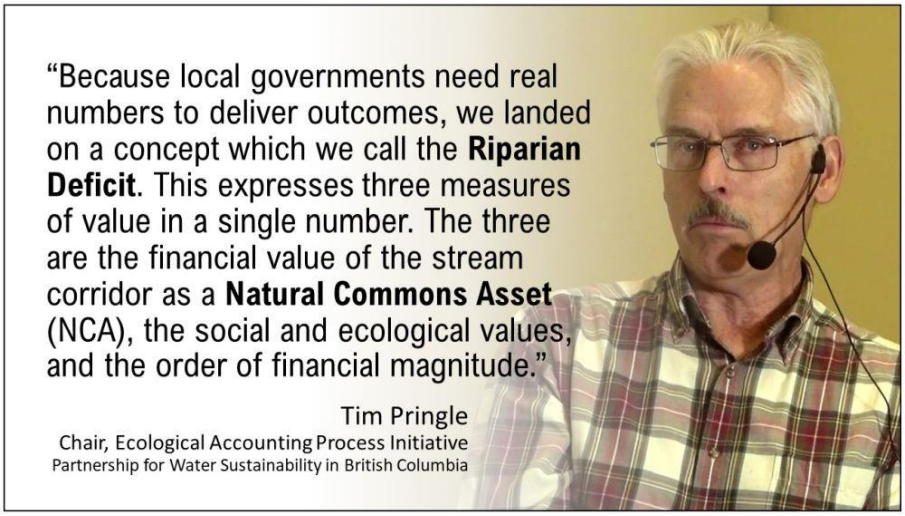
Natural Commons Asset Defined

The NCA is the portion of the stream corridor that lies in the regulated streamside setback zone as defined in the Riparian Areas Protection Act. The NCA width is the sum of the stream width plus the setback distance on each side of the stream.

Local governments need a real number: Riparian Deficit is an effective way of encapsulating the underlying uniqueness of the EAP theory, methodology and metrics. It is used to interpret the full implications of the NCA financial value. Because EAP uses BC Assessment financial values for parcels, the resulting NCA number reflects social and ecological values.

Three values in a single number: When the community wants more development near the stream, more ecological features for trails and parks, aesthetic advantages for parcels abutting the stream, etc., the result is higher financial expectations and increased assessed values. The NCA expresses these expectations in a single number.

The Riparian Deficit refers to the order of financial magnitude of these demands. A high deficit equals a latent need for increased M&M as well as remediation of stream system deficiencies.



EAP Building Blocks & Outcomes

Master drainage planning, integrated stormwater planning, and other processes at best pay lip-service to the role of the streamside protection zone within a stream system context, the condition of native vegetation and woodlands cover, and the need for restoration. Now, EAP provides the reason to ask the question, **why aren't these factors considered and given equal weight to engineering considerations?**

What gets measured gets managed (or could be). The challenge for local governments is how to determine financial values for ecological services and the natural systems that deliver them. The community expectation that these assets will be maintained and managed is the impetus for changes in accounting systems used by local governments.

Applied Research: Stage 3 Mainstreaming

In 2016, the Partnership embarked upon a 6-year program of applied research to evolve EAP through a 3-stage building blocks process of testing, refining, and mainstreaming the methodology and metrics. The program involved 9 case studies and 13 local governments and yielded 19 "big ideas" or foundational concepts. These are described in Part C.

In 2020, five willing local governments stepped up to participate in Stage 3. Each identified local streams for analysis. The capsule summaries in **Table ES1** describe the outcomes for the five projects. The sequencing of projects was fortuitous, resulting in insights which improved the research process.

With the perspective of hindsight, each local government took a leap of faith that EAP would fit into their strategic directions. Every participating local government has benefitted from the building blocks approach to applied research.

Target-based Strategies for Riparian Restoration

Now, with EAP as a foundation piece, these local governments have a rationale and a metric to do business differently via multiple planning pathways to achieve the goal of "natural asset management".

The **Riparian Deficit**, a measurable metric, would allow them to change their internal asset management conversations and begin the process of engendering community support for a target-based strategy for systematic M&M investment over decades, as opportunities arise, to restore riparian woodlands and native vegetation for the full 30m width of the regulated streamside protection setback zone.

Table ES1 – Case Study Outcomes of EAP Mainstreaming

Creek Case Studies and Local Government Collaborators	Where and how EAP fits into a Strategic Direction
Millstone River in the City of Nanaimo & Regional District of Nanaimo	**Corporate Asset Management Planning & Regional Riparian Spatial Analysis:** EAP aligns with Strategic Priorities for environmental stewardship and growth management, and the findings are informing corporate asset management planning as well as how to prioritize investment in riparian and woodland restoration.
Bowker Creek in the municipalities of Saanich, Victoria, and Oak Bay in the Capital Region	**Bowker Creek Blueprint & Daylighting Feasibility Strategy:** EAP provides a financial methodology to approximately value the land within either an existing or potentially recreated stream corridor; and the City of Victoria reports that the EAP analysis and numbers added substance to the City's grant application.
Bings / Menzies Creek in the Municipality of North Cowichan & Cowichan Valley Regional District	**North Cowichan Biodiversity Protection Policy Project:** EAP supports the case for strategic action to strengthen management of environmental assets within North Cowichan; and informs the Regional Collaboration Framework as it pertains to ecosystem stewardship and biodiversity conservation.
Saratoga Miracle Beach Planning Area in the Comox Valley Regional District	**Saratoga Miracle Beach Drainage Service Area:** EAP findings inform the strategy for local area planning of a "settlement node" identified in the Regional Growth Strategy, and also support the case for a Drainage Service Area that would operationalize the "twin pillars" of Water Balance and Ecological accounting.
Bertrand Creek in the Township of Langley	**Langley Ecological Services Initiative:** EAP provides a real number for Payment of Ecological Services to compensate rural parcel owners who are willing to commit areas of their land to riparian and woodland maintenance and/or enhancement to restore stream integrity.

Now What: Train the next generation of land use, GIS and drainage professionals

If we know how to do a much better job of protecting ecological features and stream systems in our communities and on our landscape, then why aren't we doing a better job? Why are streams still degrading? Why do we still see practices embedded in land use policy and regulation that aggravate the situation? How do we change that?

An elephant in the room is the hollowing out of government capacity at all levels and the reliance on outside service providers. The ramifications of this dual concern provide the context for the Partnership's observation that a lack of understanding of the science behind the Twin Pillars of Stream System Integrity (Figure ES1), and that a stream is a system, is widespread.

Following publication of Beyond the Guidebook 2015, the Partnership launched the 4-step process conceptualized on **Figure ES3** to develop and operationalize the EAP methodology and metrics.

Transition Strategy

The process is in motion to operationalize a transition strategy over a 3-year period and initially embed the EAP program in the Mount Arrowsmith Biosphere Region Research Institute (MABRRI). Once the MABRRI precedent is firmly established, a logical next step would be to expand the program to include other university-based hubs.

In broad terms, the concept for moving forward collaboratively is quite simple. One, the Partnership will engage in a conversational process with willing local government partners in 2022. Two, the Partnership will provide guidance and oversight for the first cohort of projects that MABRRI would undertake in 2023.

Continuity and Consistency: The Partnership's objectives in embedding the EAP program with MABRRI are two-fold. First, provide the next generation of land use practitioners with real-world experience. Secondly, elevate the state of practice so that all local governments would know what they need to do to progress along the **Asset Management Continuum** shown on Figure ES2.

This is about building capacity while doing the utmost to ensure continuity and consistency in further evolving application of the EAP philosophy, methodology and metrics. The measure of success will be when local governments have truly reached Step Three, protection of stream system integrity, on the Asset Management Continuum.

Vision for training the next generation

"We believe that incorporating students from Vancouver Island University and other universities will support understanding and experience within municipal governments on the importance of EAP, and simply understanding EAP. Fortunately, most of VIU's Master of Community Planning, and Master GIS students find themselves working within municipal governments."

Graham Sakaki,
Regional Research Institute Manager, MABRRI

Figure ES3 – Build Capacity to Mainstream EAP

A Look Ahead

Figure ES4 distils five key ideas that underpin EAP and is a mind-map for what follows in this Synthesis Report. Because stream setbacks are defined in regulation, a stream corridor is a land use such that a proxy financial value is readily determined from BC Assessment data.

EAP defines the regulated zone as the **Natural Commons Asset** (NCA). This foundation has two primary metrics or measures: the NCA financial value is expressed as **$ per km of stream**; the annual M&M budget is **1% of the NCA value**.

The hope is that the straightforward nature of these metrics would inspire local governments to apply EAP metrics and establish annual budgets for maintenance and management (M&M) of stream systems. Stream M&M would then be a line item within an Asset Management Strategy that accounts for both constructed and natural assets.

A closing perspective on the systems approach that is EAP

"It is amazing that we have been able to produce a methodology that defines what a stream is, can find the value of the stream using impartial BC Assessment data, and add to that a riparian assessment that looks at the 30m zone and a further 200m upland area to evaluate the water balance condition and what is happening to water pathways."

Tim Pringle, EAP Chair

Learning from the Water Balance experience

In the 1990s, the breakthrough in science-informed understanding was the Road Map for Stream System Integrity. For a generation, communities should have known what they ought to be doing. And some have made progress. But, in the big picture, the last two decades have been characterized by an inability to act on the science.

The system context is too hard for most people to visualize. With hindsight, reforming drainage practices requires a provincial authority that provides clear and consistent direction regarding expectations for development of land draining to streams.

On the other hand, most people can visualize what a stream corridor looks like. Thus, local government collaboration with an informed, educated stream stewardship groups may offer the best path forward in the near-term for operationalizing EAP metrics and transitioning drainage practice to **Sustainable Drainage Service Delivery**.

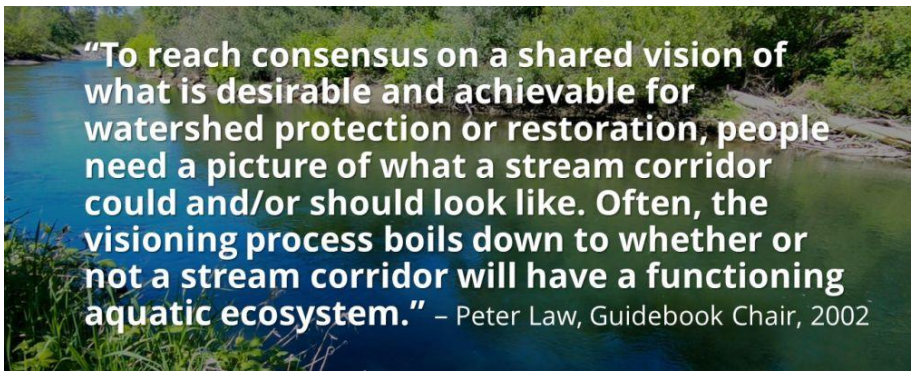


Figure ES4 – Cascading Concepts

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PART A

Synopsis for the Busy Reader

To provide context for application of EAP to stream systems and water assets in nine case studies, this Part A is structured in four parts:

1. ***Use of EAP to establish the 'Financial Case for the Stream System'***
2. ***Riparian Deficit: from Policy to Measurable Metric***
3. ***Historical Context for Twin Pillars Concept***
4. ***Asset Management Context for EAP***

Table A1

THE FINANCIAL CASE FOR A STREAM SYSTEM: A READER'S GUIDE TO UNDERSTANDING "EAP, THE ECOLOGICAL ACCOUNTING PROCESS"	
What is the provincial context for the EAP program?	The context is **Asset Management for Sustainable Service Delivery**, and recognition that a stream system is a **Natural Commons Asset (NCA)**. EAP is a 3-stage program to *Test, Refine & Mainstream* the methodology and metrics for "maintenance and management", or **M&M**, of stream systems. The Partnership for Water Sustainability in BC is collaborating with multiple local governments in five regions within the Georgia Basin to show **how to operationalize EAP within an Asset Management Plan**.
Why is EAP needed?	EAP bridges a gap. It provides local government with a methodology and metrics for integrating natural assets, notably stream corridor systems, into municipal infrastructure. The driver for action is degradation of stream channels and streamside protection areas.
What are EAP core concepts?	A stream is a land use (defined in regulation; can assign a financial value). BC Assessment provides "real numbers" for a proxy financial value. The key metric is "$ per metre of channel length" as a measure of NCA value. Community investment in M&M is a measure of "what the stream is worth".
What would operationalizing of EAP achieve?	**PURPOSE:** Put maintenance and management (M&M) of stream corridor systems on an equal footing with constructed assets (municipal infrastructure). **END GOAL:** Establish an annual budget for stream corridor system M&M as a line item within an Asset Management Budget.
How is EAP a game-changer?	1. EAP interweaves financial, social, and ecological perspectives within a single number to establish the financial case for a stream corridor system. This aggregate number is the **Natural Commons Asset** (NCA) value. 2. The NCA value is a measure of the **Riparian Deficit**. This is the environmental equivalent of the **Infrastructure Liability (Deficit)** for constructed assets such as underground utilities and buildings. 3. The NCA value provides environmental planners with a starting point for a *balanced conversation* with engineers and accountants about the **services** that natural and constructed assets both provide.
Why is EAP important?	EAP adds to the conceptual framework for a riparian area maintenance and management strategy with new insights about financial metrics.

1. Use of EAP, the Ecological Accounting Process, to establish the 'Financial Case for the Stream System'

An Introduction to the EAP Program

The provincial umbrella for EAP, the Ecological Accounting Process, is Asset Management for Sustainable Service Delivery: A BC Framework. The provincial expectation is that local governments would integrate "natural assets" into asset management processes.

EAP shows them how to do it for stream systems and water assets such as wetlands. **Table A1** consolidates key information for the reader's ease of review and absorption.

What is a Natural Asset?

Management of "natural assets" within a local government's **Asset Management Strategy** is an idea whose time has come. This statement sounds good but what does "managing natural assets" actually mean in the local government setting?

It is a vague term that has become a buzz word that is not helpful. Why not use plain language that creates a mental picture? Stream corridor systems, parks, and conservation areas - these are land uses that constitute "natural assets". From a municipal asset management perspective, however, which is the most important, and why?

Why a stream system is the most important natural asset: Stream corridor systems provide a **"package of ecological services"** where people live. In clear language, this phrase means drainage, habitat / biodiversity, recreation, and enjoyment of property. This is wording that Municipal Councils and Regional District Boards understand.

Streams are a major focus for community involvement. Consider how much work stewardship groups do to improve conditions in streams. We can all visualize what a stream looks like. How intuitively obvious is the generic phrase "natural asset"?

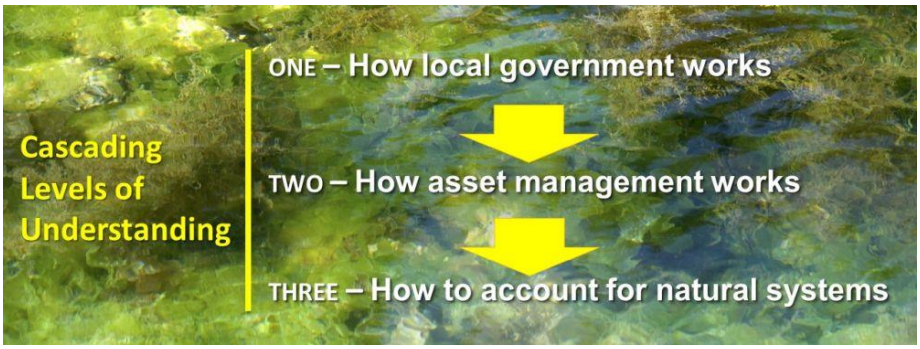
The stream is the natural component of the municipal "drainage service". The elephant in the room is the unfunded liability for urban stream stabilization and restoration. **The "drainage service" is the neglected service and the cost of neglect grows over time**.

Asset Management for Sustainable Drainage Service Delivery

If we know how to do a much better job of protecting ecological features and stream systems in our communities and on our landscape, then why aren't communities doing a better job? Why are streams still being degraded? How do we change that?

EAP Scope

The context for EAP is protection and restoration of stream systems. Two questions set the stage for EAP. First, what is the stream worth to the community? Secondly, how would a municipality operationalize EAP to pay for stream M&M? Three levels-of-understanding then provide a frame of reference for EAP analyses and a reality-check for integrating "natural assets" into a local government Asset Management Strategy.



Communication with elected officials: Visualize a Monday night meeting of a municipal Council and reflect on how Councils make decisions. The mindset and focus of Councillors are on what happens at the parcel scale. Also, how do you get buy-in from a Council for the add-on cost of "natural asset management" when local governments are already grappling with the financial challenges associated with the "infrastructure deficit" for watermains, sanitary sewers and roads?

How concepts are explained is crucial. What is easily understood and can be measured gets implemented. In this *Synopsis of Findings*, we cut through the rhetoric to provide meaningful context and content.

Asset Management for Sustainable Drainage Service Delivery: To help a continuum of audiences come to grips with all the questions posed above, **Figure A1** distils five cascading concepts. These underpin EAP. The visual is a mind-map for what follows.

EAP expresses stream system maintenance and management (M&M) as a measurable metric, the **Riparian Deficit**, which is the environmental equivalent of the **Infrastructure Gap (Deficit)**. The riparian deficit is a measure of "loss of riparian integrity" due to land use intrusion into the regulated streamside setback zone.

EAP puts the environmental perspective on an equal footing with the engineering and accounting perspectives and thus bridges a gap.

Integration of Natural Assets into Local Government Asset Management

The EAP methodology and metrics recognize the importance of the stream system and other water assets in the landscape. A stream is a land use because the stream corridor is defined in regulations and has a financial value.

Figure A1 - Cascading Concepts
Create a Mind-Map for EAP

Asset Management for Sustainable Drainage Service Delivery

Figure A1 distils five key ideas. These underpin EAP, the Ecological Accounting Process. This is a mind-map for what follows.

The context for EAP is protection and restoration of stream systems. Streams are the natural component of the municipal **Drainage Service**.

The desired outcome is that BC local governments would apply EAP metrics to establish annual budgets for maintenance and management (M&M) of stream corridor systems.

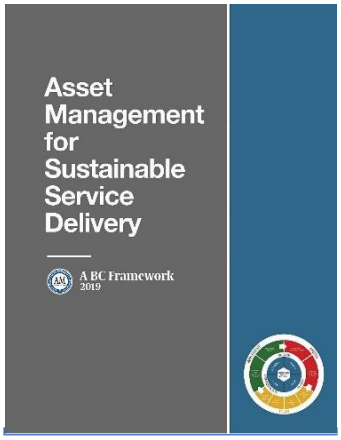
Stream M&M would then be a line item within an Asset Management Strategy that accounts for both constructed and natural assets.

A stream corridor is a land use because stream setbacks are defined in regulation. Also, a proxy financial value is readily determined from the BC Assessment database.

EAP defines the regulated zone as the **Natural Commons Asset** (NCA). This foundation has two primary metrics or measures: the NCA financial value is expressed as **$ per km of stream**; the annual M&M budget is **1% of the NCA value** consistent with accepted practice for constructed assets.

2. Riparian Deficit: from Policy to Measurable Metric

Twin Pillars for Stream System Integrity



The EAP goal for the "drainage service" would be a plan that integrates the Water Balance and Ecological Accounting pillars. ***Asset Management for Sustainable Service Delivery: A BC Framework*** *provides the financial incentive to go down this path.*

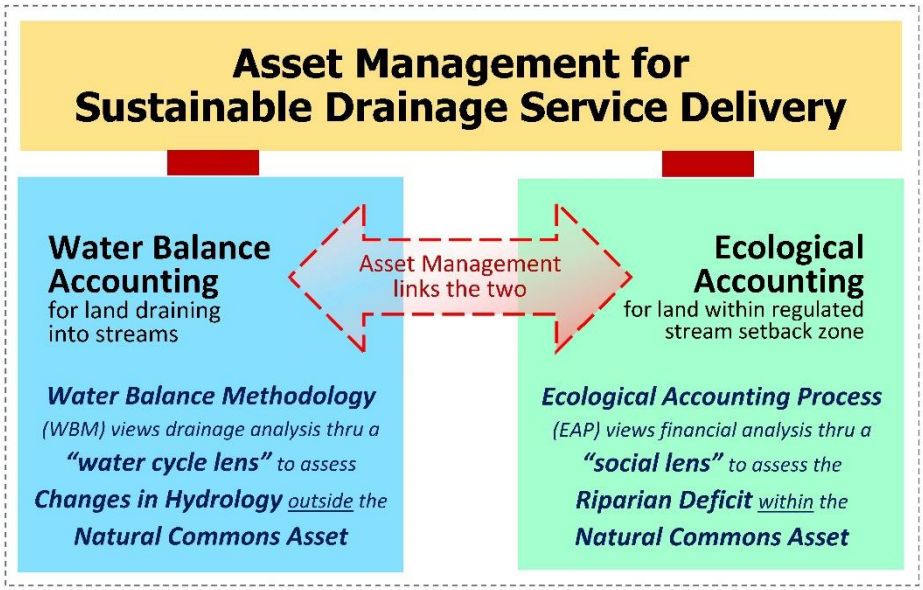
EAP, one of the "twin pillars" for Sustainable Drainage Service Delivery, has evolved through an applied research program involving 12 local governments in southwest BC. The program context is:

> **The EAP program supports local governments that: one, intend to adopt an integrated approach to life-cycle maintenance and management (M&M) of the "drainage service"; and two, recognize that the drainage service comprises two inter-connected components, namely, constructed infrastructure and the stream system.**

Whether constructed or natural, an asset is an asset

In the urban environment, each asset type requires an annual budget for M&M. The power of EAP is that it provides local governments with a tool for tackling the Riparian Deficit within the stream corridor.

This concept is game-changing. It is the ecological equivalent of the Infrastructure Funding Gap (or Deficit). Within local government, having a measurable metric puts the environmental perspective on an equal footing with the engineering and accounting perspectives.



The 5 ways that EAP, the Ecological Accounting Process, addresses stream system integrity

One, what is measured gets managed: What happens on the land matters: After all, what is measured gets managed. EAP provides local governments with a guiding philosophy, method, and metrics to determine the financial value of the land occupied by a stream channel and its adjoining setback zone on each side of the channel. This calculation is defined as the Natural Commons Asset (NCA) value.

Two, what is understood can be implemented: The NCA value is a measure of the Riparian Deficit which quantifies the extent of land use intrusion into the setback zone. A higher dollar value means greater intrusion and reduced riparian area function. This is the environmental equivalent of the infrastructure gap, deficit or liability for constructed assets, such as underground utilities and buildings.

The NCA value provides environmental planners with a starting point for a balanced conversation with engineers and accountants about the services that natural and constructed assets both provide.

Three, what has worth has value: EAP interweaves financial, social, and ecological perspectives within a single number to establish the financial case for a stream corridor system.

EAP adds to the conceptual framework for a riparian area maintenance and management strategy with new insights about financial metrics. For example, a price per metre of channel length as a measure of the NCA value, and the community investment in the maintenance and management as a measure of the stream's worth.

Four, what is considered can be reconsidered: Riparian integrity is more than a regulatory setback width. EAP considers the 200-metre zone beyond the centre of the stream and asks the question: *What is the quality of the riparian and woodland vegetation?*

Five, what benefits one can benefit all: The EAP methodology focuses on the historical and current land use practices that have changed landscapes, modified hydrology, and have led to present-day community perceptions of the perceived worth of a stream and/or other water assets, and the ecological services those assets provide.

The EAP methodology deals with the parcel because this is how communities regulate settlement and growth.

EAP has a philosophy, methodology, and metrics to find natural asset values

Natural assets such as stream systems have a VALUE for the land that they occupy.

EAP finds the asset value of parcels which abut or are adjacent to a stream system. This data leads to calculation of the ***Natural Commons Asset*** *(NCA) value.*

The NCA is the setback zone defined by the Riparian Area Protection Regulation, implemented as of 2004 in BC.

EAP also finds the WORTH of the ecological and social services provided by the stream system, and as measured by the community's investment in the system.

3. Historical Context for Twin Pillars Concept

EAP has its origins in the 1990s "salmon crisis" in the Georgia Basin / Salish Sea / Puget Sound Bioregion. Listing of Coho salmon as an endangered species in Puget Sound was a catalyst for cross-border collaboration between BC and Washington State. The road map for protecting stream system integrity – an outcome of seminal research at the Center for Urban Water Resources Management in Seattle – is the inspiration for the Twin Pillars Concept for linking "water balance accounting" and "ecological accounting" through asset management.

Connecting Dots

The Fish Protection Act was a watershed moment and a call to action. The regulation defined the setback zone as a land use.

*The 1997 workshop led directly to the **SmartStorm Forum Series** (1999 thru 2001). Cross-border in scope and guided by a vision for an ecosystem-based approach to land and water development, the series set in motion a chain of events and associated outcomes.*

*These have rippled through time, resulting in provincial milestones such as: release of **Stormwater Planning: A Guidebook for BC** in 2002; followed by release of **Living Water Smart, British Columbia's Water Plan** in June 2008; and culminating in passage of the **Water Sustainability Act** in 2014.*

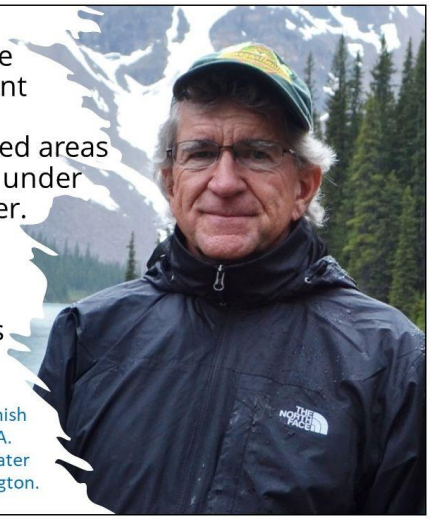
British Columbia Fish Protection Act

When it was enacted in July 1997, the Fish Protection Act established a first in North America. In 2016, the title was changed to the Riparian Areas Protection Regulation Act by the Water Sustainability Act.

Looking back, and in terms of 'green infrastructure' and **the vision for reconnecting hydrology and stream ecology**, much of what has transpired over the past 25 years can be traced back to October 1997 and a focus group workshop convened by the UBCM in Richmond.

The workshop commenced the rollout of the Fish Protection Act. It was the prelude to a "watershed moment" session for local government elected representatives about implementation of streamside setback regulations. Bill Derry shared the Horner and May research and this set-in motion the chain of game-changers described in the sidebar.

For 20 years, Bill Derry chaired the Washington State local government committee that framed eight key questions circa 1990. These defined areas of research by graduate students under the guidance of Dr. Richard Horner. Chris May then pulled together this original research in his PhD dissertation. The BC Partnership for Water Sustainability continues to build on this foundation.



Bill Derry – Inaugural manager (1988) of the Snohomish County Stormwater Utility, one of the first in the USA. Founding Director (1990) of the Center for Urban Water Resources Management at the University of Washington.

Road Map for Protecting Stream System Integrity

In the 1990s, Washington State research correlated land use changes with impacts on **stream system condition**. Richard Horner, Chris May, and others applied a systems approach, examined the interaction of all the variables, and defined four limiting factors. The order-of-priority for the factors is shown in the sidebar. This is the road map for action to protect and/or restore system integrity.

The top two factors are **changes in hydrology** and **loss of riparian integrity** (i.e., "the riparian deficit"). Water Balance Accounting addresses changes on the land draining to the stream. Ecological Accounting addresses changes within a stream corridor. The consequences of changes to the top two factors play out as **degradation of aquatic habitat** and **deterioration of water quality**.

In 2015, the road map for protecting stream system integrity led to the "twin pillars" concept for reconnecting hydrology and stream ecology through asset management, for the "drainage service".

Road Map for Protecting Stream System Integrity

West coast research in the 1990s by Horner et al at the Center for Urban Water Resources Management in Seattle demonstrated that the order-of-priority for factors limiting ecological values of urban streams is:

LIMITING FACTOR 1: ***Changes in Watershed Hydrology –*** *addressed thru the Water Balance Accounting Pillar*

LIMITING FACTOR 2: ***Disturbance and/or Loss of Integrity of Riparian Corridor –*** *addressed through the Ecological Accounting Pillar*

LIMITING FACTOR 3: Degradation and/or Loss of Aquatic Habitat within the Stream

LIMITING FACTOR 4: Deterioration of Water Quality

Cascading Framework for EAP Development

The Partnership for Water Sustainability is responsible for tools, resources and programs developed under the umbrella of the Water Sustainability Action Plan for BC (Action Plan), released in 2004. Action Plan experience informed development of Living Water Smart, British Columbia's Water Plan, released in 2008. Living Water Smart has 45 actions and/or policy objectives.

Reconnect Hydrology and Stream Ecology: A guiding principle for operationalizing each is that action on the ground informs provincial policy through the **shared responsibility model**. Thus, these two Living Water Smart policy objectives drove development of EAP:

> **STREAM SYSTEM INTEGRITY***: "All land and water managers will know what makes a stream healthy, and therefore be able to help land and water users factor in new approaches to securing stream health and the full range of stream benefits."* (p. 43)
>
> **SUSTAINABLE SERVICE DELIVERY:** *"Governments will develop new protocols for capital planning that will look at the life-cycle costs and benefits of buildings, goods and services."* (p. 69)

Framing EAP in terms of the **Riparian Deficit** gives all the players a way to focus on using their time to get the most effective result.

4. Asset Management Context for EAP

Service Delivery & Sustainable Funding

The over-arching context for EAP is whether a local government has a life-cycle lens for looking at its constructed assets. And if so, does it also have a **finance strategy** that embeds a Sustainable Funding Plan? These are prerequisites for a local government embracing "natural" asset management in a meaningful way.

If the foregoing apply, EAP then makes the financial case to put M&M of stream corridor systems and water assets on an equal footing with constructed assets (municipal infrastructure). The essence of EAP is expressed as follows: **What is the environment that supports the package of ecological services?** This is a land use perspective.

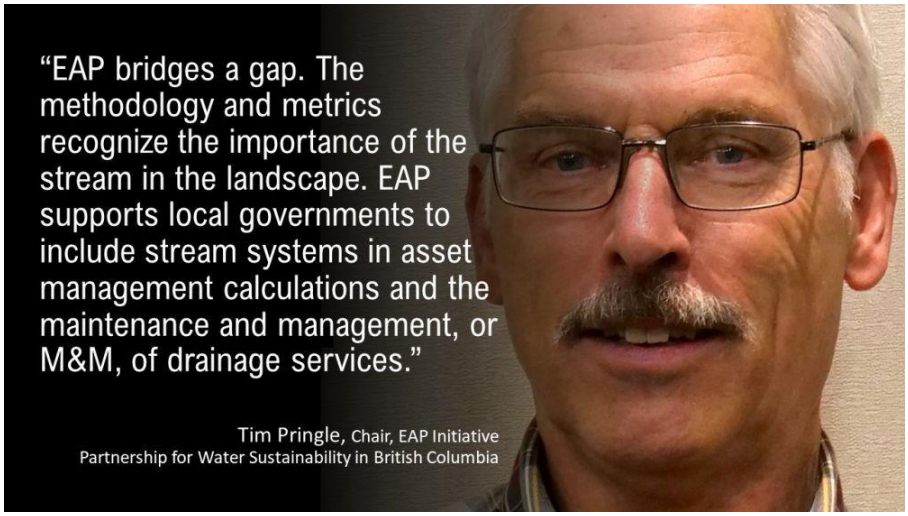
EAP is a Land Use Perspective

The strength of EAP is in how it looks at and values streams as systems and as a land use. A stream corridor is a land use because it satisfies two criteria: it is defined in the Riparian Areas Protection Regulations Act, and it has a financial value.

EAP uses BC Assessment data to find the Natural Capital Asset values of streams. BC Assessment parcel data are accurate, recent, and reflect the motivations of buyers and sellers over time. This means parcel values include social, ecological, and financial trend information.

"The land supports assets that provide services. And decisions are made at the parcel scale. Thus, we are tied to the past through historical subdivision of land. This means we must understand the biology of land use. The human analogy is DNA. Only EAP deals with the parcel."

-Tim Pringle



Building Blocks and Big Ideas

What gets measured gets managed and determines whether a line item is included in a local government Asset Management Strategy. Competing priorities that local governments must constantly reconcile overshadow how one calculates a number. Yet, at the end of the day, it will be all about the number. The number must look right to be right.

Application of the initial EAP methodology through 9 case studies led to refinements and a key finding. Natural systems require a fundamental re-thinking of methodologies for financial valuation, especially for a system such as a stream. The financial value must refer to the physical asset and link it to the land uses that the community expects to enjoy due to the presence of the stream.

What we learned through a building blocks approach to the applied research

Table A2 is a summary of the nine projects comprising the 3-stage EAP program. The table lists the "big ideas" and NCA value associated with each stream system. It is complemented by Table S3 which distils 10 Key Messages.

Context is Everything

Early in the EAP journey, it became clear that **ecological economics theory** does not make sense when applied to the local government setting and asset management. Ecological economics determines general values for natural systems with emphasis on influencing policy and statistical measures. It does not drill down in a way that is helpful to local governments striving, under scrutiny, to make budget decisions.

To provide a relevant solution for local government, one must understand the local government context. EAP is unique because the methodology deals with the parcel. Case studies informed the research and validated the approach. The late John Henneberry was following a similar path in the United Kingdom. It is more than coincidental that he qualified both as a chartered planner and as a chartered surveyor, a rare but important combination. In other words, he understood the importance of the parcel, and this was one of his areas of research.

John Henneberry's pioneering work in the United Kingdom serves as validation of how EAP looks at streams and water assets as a system. His eclecticism produced real insights into the operation of land and property markets, enabling all involved to see things more clearly and differently.

"Nature appears more fragmented because we have to slice it into categories and dice those categories into bits before we can value bits of those bits. The sum of these parts is far short of the whole and does not capture the interconnectedness and holism of nature. In addition, our view of nature is biased to those aspects of it that can be measured and particularly to those that can be valued."

John Henneberry (1952-2021)

Professor of Property Development Studies, University of Sheffield, United Kingdom

The 4Cs for Sustainable Service Delivery:
Collaboration, Capacity, Culture, and Council

It takes courage on the part of a Council or Regional Board members to look beyond the short-term, understand what sustainable funding entails over the long-term, and direct staff to get on with the job.

Unless there is an inter-generational financial vision for sustainable funding, combined with a supporting culture, an incremental erosion of the service levels for constructed assets would inevitably result. This is the local government reality-check for integration of stream systems into asset management strategies and annual budgets.

Three landmark initiatives came to fruition in 2014

These initiatives enable local governments to achieve the vision for "Sustainable Watershed Systems, through Asset Management" as described in Beyond the Guidebook 2015. They provide context for Figure A2 and the process for advancing the Twin Pillars for stream integrity:

***WHAT** – The 'Water Sustainability Act' connects land and water and makes the link to desired water balance outcomes (that would be achieved by integrating watershed systems thinking into asset management).*

***SO WHAT** – 'Develop with Care 2014' makes the link between environmental function and resilience as communities grow.*

***THEN WHAT** – 'Asset Management for Sustainable Service Delivery: A BC Framework' makes the link between local government services, the infrastructure that supports the delivery of those services, and watershed health.*

Timeline Context for EAP

Building on the science-informed foundation in Stormwater Planning: A Guidebook for British Columba, the *Beyond the Guidebook Series* documents the progress of local government leaders in implementing changes in practice. **Figure A2** highlights milestones along the way. Beyond the Guidebook titles reflect incremental progress over time.

The timeline image provides historical perspective for a building blocks process that began in 1992 with publication of guidelines for Liquid Waste Management Plans and continues with EAP.

Reconnecting Hydrology and Stream Ecology: Beyond the Guidebook 2015 introduced EAP as an idea with this statement of intent: "*EAP will address the challenge of determining financial values for goods and services drawn from natural systems"*. The Partnership made this commitment to support of the rollout of Asset Management for Sustainable Service Delivery: A BC Framework.

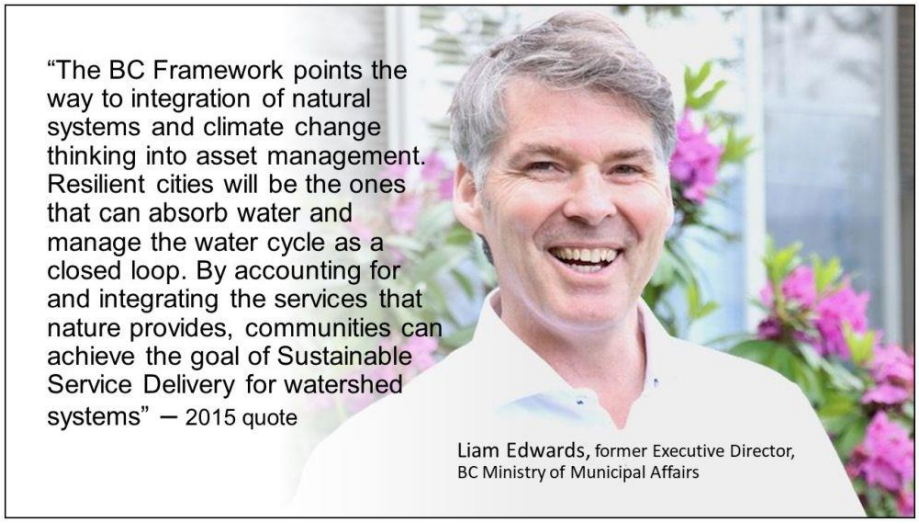
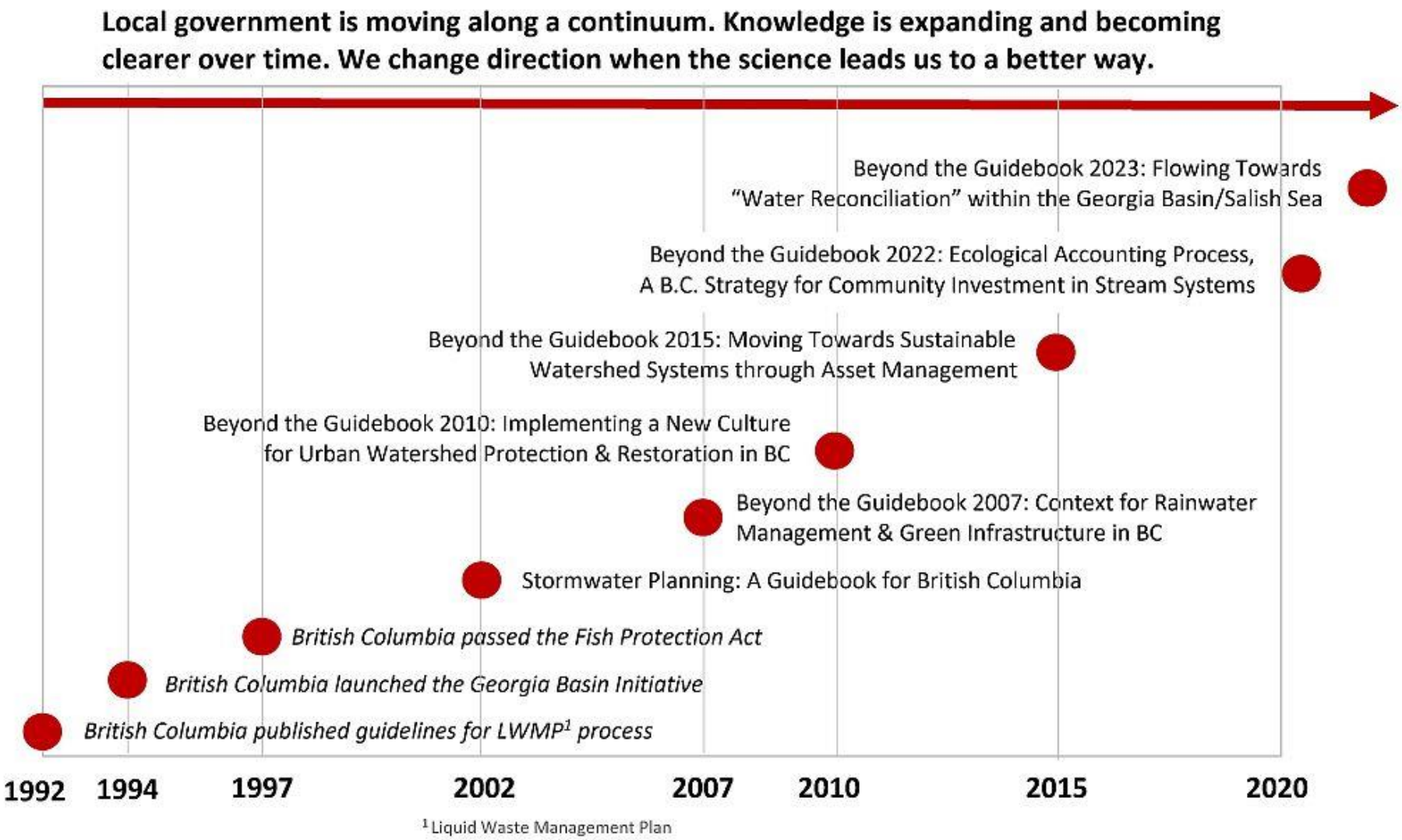


Figure A2 – Historical Context for Reconnecting Hydrology and Stream Ecology



[1] Liquid Waste Management Plan

TABLE A2: What We Learned through the EAP Program

Region	Creek	Big Ideas	NCA Value
STAGE 1 – TEST THE EAP CONCEPT			
Cowichan Valley	**Busy Place Creek -** *CVRD*	**The EAP lens is the *Stream System*** ***Hydrology is the Engine that Powers Ecology***	**$1.2M per km**
Comox Valley	**Brooklyn Creek -** *Comox & Courtenay*	**BC Assessment Data is a proxy for *Financial Value of a Setback Zone*** **Investment in stream restoration is a measure of *Stream Worth*** ***Package of Ecological Services* is the range of community uses**	**$2.7M per km**
STAGE 2 - REFINE THE EAP METHODOLOGY			
Nanaimo Region	**Shelly Creek -** *Parksville*	***Riparian Ecosystems* have been reduced to *Riparian Zones*** **M&M for *Maintenance* (prevent) and *Management* (improve)**	**$1.4M per km**
Metro Vancouver	**Kilmer Creek –** *District of North Vancouver*	***A Stream is a Land Use*** **The concept of the *Natural Commons* underpins EAP** **From *Remediation* to *Restoration***	**$2.9M per km**
STAGE 3 – MAINSTREAM EAP WITHIN AN ASSET MANAGEMENT PLAN			
Nanaimo Region	**Millstone River** *RDN & City of Nanaimo*	***NCA Metric* drives decision-making** ***Framework for Operationalizing EAP, as a Budget Line Item, within an Asset Management Plan***	**$9.6M per km** in urban area **$1.4M per km** in rural area
Capital Region	**Bowker Creek -** *Saanich, Oak Bay, Victoria*	**EAP establishes the *Financial Case for a Stream*** **Streamside parcels have a *Blended Financial Value***	**$11M per km**
Cowichan Valley	**Bings/ Menzies Creek -** *North Cowichan*	**EAP addresses *Loss of Riparian Integrity* as a stream health factor** **NCA Value is a measure of the *Riparian Deficit***	**$2.1M per km**
Comox Valley	**Saratoga Miracle Beach planning area**	**An implementation mechanism would be a *Drainage Service Area***	**$0.74M per km**
Metro Vancouver	**Bertrand Creek** *Langley Township*	**EAP supports *Equitable Urban / Rural Mitigation Investment***	**$11.0M per km** in urban area **$1.6M per km** in rural area

Table A3 - 10 Key Messages to Remember about EAP

How Much to Invest in the Stream System?

EAP focuses on "worth to the community" rather than a theoretical value.

EAP emphasizes both social and financial values.

EAP employs one financial valuation process - that is, calculation of the land value of the Natural Commons Asset (NCA).

In the case of a stream, this is the ribbon of land underlying the stream itself and the adjoining setback area required in bylaws and Riparian Areas Regulations.

BC Assessment land values are used for this calculation, thus reflecting the social commons. Property owners purchase in locations that they think are worth their investment.

Both the calculation of the land value of the NCA and the account of investment in maintenance and management of a stream are reports that can be used for budget strategy and planning as well as for asset management analysis.

1. Every settled creekshed (watershed) comprises a **Constructed Commons** (roads, utilities, etc.) and a **Natural Commons** (streams, riparian corridors, etc.). Each "commons" is a system.
2. **Hydrology is the engine that powers** ecological services derived from the streams system which is the natural asset or Natural Commons.
3. **Impaired hydrological function** results in diminished ecological services caused by land use activities. The **Riparian Deficit** interprets the extent of this alteration.
4. The **worth of a creekshed is a package of ecological services** made possible by the hydrology. EAP focuses on wetlands, ponds, streams, and riparian areas because these natural features provide services desired by communities.
5. **EAP deals with real numbers** which practitioners in local government need to deliver outcomes.
6. **EAP uses the BC Assessment database** regarding land value to calculate the financial value of the Natural Commons Asset (NCA) – that is, the land underlying the stream itself plus the adjacent regulated setback area.
7. View choices through the **Worth Lens** if the goal is to motivate communities to implement strategies that restore stream function.
8. Both the record of expenditures for maintenance and management **(calculation of worth)** and the financial value of the **NCA calculation** provides information about ecological (natural) assets that can be included in local government financial planning and **Asset Management Strategies and Budgets**.
9. The likelihood of a community taking action depends on **what a community thinks** the stream is worth.
10. Distinguish between maintenance and management – because maintenance is about **preventing or avoiding** degradation, whereas management is about **improving** the condition of the ecological asset.

A Guide for the Busy Reader

Table of Contents / Storyline

PART B

Story Behind the Story of Sustainable Drainage Service Delivery

To introduce the reader to core concepts for sustainable funding of the 'drainage service' in the built environment, this Part B is structured in five sections:

1. ***Context for Applying EAP to Establish the 'Financial Case for Stream Systems'***
2. ***Intergenerational Perspective for a 'Local Government Finance Strategy'***
3. ***'Drainage Service' has two Components: Constructed and Natural***
4. ***Operationalizing EAP within Asset Management***
5. ***Urban Watersheds as Infrastructure Assets***

Figure B1

Integration of Stream Systems into "Asset Management for Sustainable Drainage Service Delivery"

'Continuum of Steps'

Branding logo for
Asset Management for Sustainable Service Delivery: A BC Framework, released December 2014

WHAT is the issue (Ground Zero):
There is no **Asset Management Strategy**. There is an *'unfunded infrastructure (gap, deficit, liability)'*.

SO WHAT can be done (Step One):
Embrace the **BC Framework**. Focus first on constructed assets (pipes & buildings). Implement an *Asset Management Strategy / Program*.

NOW WHAT can we do (Step Two):
Life-cycle approach and **Sustainable Service Delivery** are standard practice for maintenance and management (M&M) of constructed assets.

THEN WHAT will we do (Step Three):
"Twin Pillars" for protection of stream system integrity is standard practice for the drainage service. Apply **EAP, the Ecological Accounting Process,** to quantify *Riparian Deficit* values and establish annual budgets for ongoing stream corridor M&M.

As understanding of the **Local Government Finance Strategy** grows, communities progress incrementally along the Continuum

*At the Partnership's Annual Water Sustainability Workshop held in December 2015, the Chair of Asset Management BC (UBCM's Glen Brown) introduced the Asset Management Continuum in the module titled **Sustainable Service Delivery for Watershed Systems**.*

1. Context for Applying EAP to Establish the 'Financial Case for Stream Systems'

An Introduction to the BC Framework

Released in December 2014 by the Union of BC Municipalities (UBCM) and the Ministry of Municipal Affairs through Asset Management BC, Asset Management for Sustainable Service Delivery: A BC Framework marked the dawn of a new era for local government.

Why the BC Framework is a Game-Changer

The BC Framework establishes expectations; it does not prescribe solutions. It is a game-changer because it redefines the context for deciding how infrastructure is planned, financed, implemented, and maintained. It raises questions about how communities would service urbanizing and redeveloping areas in future.

Most importantly, the BC Framework emphasizes the paramount nature of the **services** that constructed infrastructure assets provide. The BC Framework also shines the spotlight on what the **life-cycle costs** are over time to maintain, renew or replace the assets.

The BC Framework recognizes that one size does not fit all: A top-down and bottom-approach drives implementation of the BC Framework. A vision for a 'new business as usual' has emerged. This vision extends beyond traditional municipal infrastructure to encompass services that nature provides, and the implications for hydrologic integrity and creekshed health.

In 2019, UBCM and the Ministry of Municipal Affairs formalized an expectation that local governments applying for provincial grants would integrate "natural assets" into their asset management processes. **EAP shows them how to do it for stream systems and water assets (such as wetlands) within a creekshed.**

Asset Management Continuum: The BC Framework recognizes that asset management for sustainable service delivery occurs alongside associated evolution in community thinking. Incremental in nature, it is a continuous quality-improvement process. **Figure B1** conceptualizes a local government's "asset management journey" as a continuum of steps, with EAP being Step Three.

A vision for fully integrated and sustainable service delivery in BC

The BC Framework points the way to a holistic and integrated approach to asset management. Nature, and the ecosystem services that it provides, are viewed as a fundamental and integral part of a community's infrastructure system. This is not to suggest that all ecosystem services provide a municipal function. The ultimate vision for fully integrated Sustainable Service Delivery is that communities would protect, preserve, restore, and manage "natural assets" in the same way that they manage their engineered assets.

‘Sustainable Service Delivery’ Explained

Glen Brown coined the term **sustainable service delivery** in 2010 when he was an Executive Director with the Ministry of Municipal Affairs. Formal branding came with release of Asset Management for Sustainable Service Delivery: A BC Framework in December 2014, and rollout in 2015. The emphasis on service is a game-changer for local government infrastructure asset management.

At that time, and thanks to the early work of the then newly formed Asset Management BC, chaired by Glen Brown, local governments were just starting to wrap their minds around the **‘20/80 Rule’** and the implications of the 80% as an unfunded liability.

“My inspiration came from Guy Felio, one of the original gurus of asset management nationally. Guy said, ‘It’s all about the service’, because infrastructure/ assets are worthless IF they do not provide a service.”

“That is what resonated with me. Also, for any asset management approach to be successful, it must not focus on the infrastructure/asset by itself. That way-of-thinking applies to nature and the environment as well.”

- Glen Brown, General Manager, UBCM Victoria

A Synthesis of Three Ideas

The Ministry introduced the term to focus local government attention on two desired outcomes that flow from policy objectives in Living Water Smart, BC’s Water Plan:

> Shift the spotlight from the infrastructure itself to the **service** AND the **level-of-service** that the infrastructure asset provides.
>
> Implement a **life-cycle approach** to asset management AND eliminate the **unfunded gap** for infrastructure replacement.

During a curriculum planning session for a local government workshop organized by the Partnership for Water Sustainability, Glen Brown synthesized three themes – *financial accountability, infrastructure sustainability, service delivery* – into a single easy to remember phrase: Sustainable Service Delivery. The rest is history, as they say.

Avoid the Pain, Be Deliberate, Fund the Plan: Sustainable service delivery is how communities can bridge the gap, or disconnect, between short-term and long-term thinking.

“Waiting for municipal infrastructure to fail means that you are forced into one path. And this is probably the most expensive path. And that is not a sustainable way to run a business or a utility. Plan ahead. Put money aside. Minimize risks. Do not wait until things go wrong. Find the right balance between corrective and preventative action” --- Daniel Horan, Director of Engineering and Public Works, District of Oak Bay.

The 4Cs for Sustainable Service Delivery: Collaboration, Capacity, Culture & Council

"After becoming CAO of Courtenay, BC in 2013, we began exploring how to implement an Asset Management Program at the City. Collaborating with external agencies opened our minds to thinking of AM practices in far broader terms, so that they might be applied in any community, regardless of size," states David Allen.

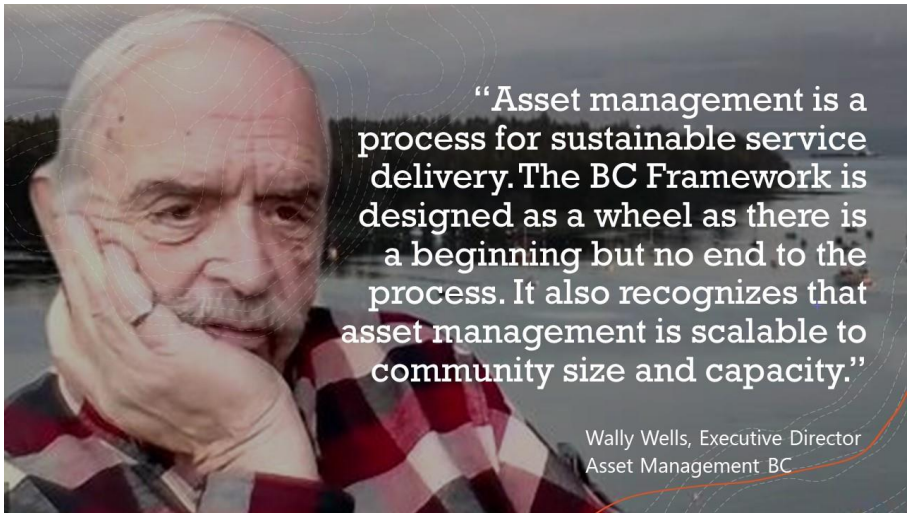
"We didn't realize it, at the time, but it led to us eventually conclude that operationalizing AM would involve four separate, interconnected initiatives that would be the pathway for our journey toward Sustainable Service Delivery: They coalesced into what we locally refer to as *The 4C's - Collaboration, Capacity, Culture, and Council*."

"It is all about building trust between Council and staff, keeping in mind what can realistically be accomplished by an organization, and being clear about the limitations of the current state-of-practice and knowledge and our ability to explain what the numbers mean in that context."

David Allen, Past- Chair (2012-2020)
Asset Management BC Community-of-Practice

"There are many considerations in a local government's budget every year. The questions asked should revolve around service and risk. Are you asking the right questions?"."

-Wally Wells



Adapting Sustainable Service Delivery to Climate Realities

"A constant challenge for planning is not to prevent past events, but instead is to use past experiences to inform and create flexible strategies for the present and the future. Furthermore, this need for flexibility is not restricted to the immediate scope of the problem at hand; but must also consider the broader juggling of evolving local government priorities and service demands," states Robert Hicks.

"This leads to the challenge of assessing problems with sufficient complexity to arrive at flexible and resilient solutions. while at the same time not being overwhelmed and paralyzed by over-analysis. When the climate is changing, an over-arching goal would be to build in resiliency that addresses risk. There is no silver bullet."

"Climate change impacts are risks which can be addressed by aligning asset lifecycles to performance or change thresholds which consider how levels-of-service are likely to deteriorate in response to climate changes impacts. Lifecycles must therefore be considered and re-aligned with the new changing 'normal' conditions."

Robert Hicks
Senior Policy and Process Engineer
City of Vancouver

"The asset management planning and the community planning frameworks resemble each other; planning is planning is planning. Collaboration can strategically and proactively ensure the ongoing essential reliable levels of services."

-Christine Callihoo

"The incorporation of climate change into business as usual is clarified by way of the planning process: Asset Management + Natural Assets + Climate Change Adaptation = Community Resiliency."

Christine Callihoo
Community Climate Resilience / Adaptation Planner

2. Intergenerational Perspective for a 'Local Government Finance Strategy'

Service Delivery & Sustainable Funding

Every local government in British Columbia has aging municipal infrastructure. Currently, the spotlight is on constructed assets (i.e., pipes and buildings). Everyone is challenged with tackling the **infrastructure funding gap** (liability) that grows year-by-year.

The EAP vision is to integrate stream systems into local government asset management processes. But the big picture context for EAP is whether a local government has a strategy for its constructed assets.

This over-arching context is defined by a **local government finance strategy** that produces a Sustainable Funding Plan. "The vision" establishes the reason to embrace EAP. "The plan" is the lynchpin for progressing step-by-step along the Asset Management Continuum.

Success over the long-term depends on local government political commitment to the guiding principles of sustainable service delivery. Next, and with the foregoing as our backdrop, we paint a broad-brush picture of what the **sustainable infrastructure mission** looks like.

Embed a Sustainable Service Delivery Culture

The infrastructure funding gap is a pressing reality, with profound implications for levels of service. It also poses affordability challenges for financing a long-term program of replacement and/or renewal. Once all is said and done, however, the 'sustainable infrastructure mission' has two clear objectives:

Stem the incremental erosion of levels of service in the short-term.

Translate an intergenerational perspective into a life-cycle plan of action for perpetual infrastructure renewal.

The Oak Bay experience, for example, illustrates how to address these objectives: embed a life-cycle lens, along with a sustainable service delivery culture, into the local government finance vision.

It takes courage for a Council or Regional Board to embrace an intergenerational 'Finance Strategy'

To do what is right and necessary to bridge the infrastructure funding gap for constructed assets requires an intergenerational commitment. It takes courage on the part of a Council or Regional Board members to look beyond the short-term, understand what sustainable funding entails over the long-term, and direct staff to get on with the job.

Unless there is a long-term financial vision or strategy for sustainable funding, an incremental erosion of the service levels for constructed assets would inevitably result. This is the local government reality-check for integration of stream systems (natural assets) into asset management plans and annual budgets.

"There is a special type of courage that Council needs to have to say, 'give us the naked truth'. There is not a lot of political up-side to shining a light on infrastructure challenges."

- Christopher Paine, Director of Financial Services, District of Oak Bay

What happens on the land matters to the stream: With all the current talk about integrating natural assets into asset management, we observe that many players either do not know or have a limited appreciation for nature as a system. They focus too much on specific aspects of the system, rather than its interrelated functions.

Land use and drainage servicing practices visibly impact on the **package of ecological services**. The consequences play out as short-circuiting of water balance pathways, erosion and sedimentation within the stream channel, elimination of fish and viable aquatic habitat, and degradation of streamside protection setback zones.

EAP looks at natural assets as a system. It is the system context that must be understood and supported. It is a mistake to focus just on parts of the system. The strength of EAP is in how we look at and value streams as systems and as a land use.

Move from Stop-Gap Remediation to Lasting Restoration: EAP is a leap forward in "addressing the elephant in the room", which is the unfunded liability due to degradation of stream channels and streamside protection areas. An EAP premise is that whole-system action on the landscape would protect stream system integrity.

The goal in having a budget line item for M&M of stream systems would be to move from reactive remediation that is at best stopgap and of limited longevity, to stream enhancement that is effective and lasting.

The **Riparian Deficit** is a new way of defining "loss of riparian integrity". It is an attention-grabber and is explained in **Part E**. The Riparian Deficit is the environmental equivalent of the **Infrastructure Funding Gap (Liability or Deficit)**.

Why communities must focus on 'Service Levels'

District of Oak Bay experience is helpful in gaining perspective on what is involved in building trust and facilitating a process that results in everyone pointing in the right direction strategically. A unique aspect for Oak Bay is that the engineering and finance departments are so much in lockstep on a unified vision for sustainable service delivery.

"In just 3 years, through incremental increases to funding reserves, Council reduced the 100-year gap by $460 million. That's 3 to 4 years of their governance decisions. If they had waited until Chris arrived to develop the financial plan, they'd be $10 million behind just in the current election cycle, let alone how much that translates to over the next 100 years."

-Daniel Horan, Director of Engineering & Public Works, District of Oak Bay

There is no free infrastructure: "Communities that have not embedded sustainable service delivery concepts into their funding structure are playing major catchup. And this is at a cost to the community of foregone investment revenues and debt servicing costs," emphasizes Oak Bay's Christopher Paine.

"In the first phases of a community's development, it feels like you have free infrastructure. When someone moves into a new neighbourhood which has all these wonderful capital services, it feels free because the maintenance costs on those services are so much less than they are at the end of their life cycles."

"We must provide life-cycle information to Council and the community – as to how far we are through the life cycles of assets; what is the cost of replacement; whether we are saving, or not, for that future expense – so that policy makers can provide direction and vision."

"A slow incremental erosion of our capital service levels happens when staff cannot demonstrate the impact in the long-term in a financial way. That is why forward looking long-term financial statements are so important to good decisions. Council is in control. They can choose to accept a slow erosion of service levels and increased risk, or not. But they cannot make that judgement in the absence of information."

"If a community is happy with what it has today, static funding is not going to sustain that. The levels of service are going to decline over time. Unless we increase funding, the negative impacts of system failures are going to be felt by residents," continues Daniel Horan.

"Think about it from a business perspective. Discussion of the service municipalities provide really comes down to whether our customers, our residents, are happy."

"Council and community are always asking questions about why the utility rates are what they are, or why the rates are increasing, what does that get you and so on. Answering these questions comes down to educating them about **levels of service** and their willingness to invest in sustaining a desired level of service."

3. 'Drainage Service' has two Components: Constructed and Natural

Reconnect Hydrology and Stream Ecology by Design, and Restore Stream Integrity

When one thinks about asset management, it is often in the context of municipal infrastructure and how this provides the "water service" or the "sanitary sewer service", and so on. Because the drainage service is the "neglected service", a goal of the EAP program is to focus attention on this foundational concept:

> **Drainage infrastructure and the stream system together constitute the municipal Drainage Service.**

Sustainable Drainage Service Delivery

The statement above can also be used as a guiding principle for operationalizing Asset Management for Sustainable Drainage Service Delivery. Whether constructed or natural, an asset is an asset. And in the built environment, each asset type requires a budget for M&M.

The leap forward implicit in the vision for **"sustainable drainage service delivery"** is recognition of the need for whole-system action on the landscape that would ensure stream system integrity.

Once local governments embrace a guiding philosophy that ecological services and use of land for development are equally important, then the next step is for them to include M&M budgets for stream systems in their Asset Management Budgets. This would begin the process of reconnecting hydrology and stream ecology by design.

Financial case for stream systems: EAP provides communities with a philosophy, pragmatic methodology and metrics to make the financial case for annual investment to prevent degradation and improve the condition of ecological assets that constitute a stream corridor system.

Use of EAP to establish the 'financial case for the stream' would put M&M of stream corridor systems and water assets on an equal footing with constructed assets (municipal infrastructure).

EAP is a land use perspective

The EAP methodology focuses on the historical and current land use practices that have changed landscapes, modified hydrology, and have led to present-day community perceptions of the worth of a stream in a creekshed, and the ecological services the stream system provides.

In a sentence, the essence of EAP is expressed as follows: ***What is the environment that supports the package of ecological services?*** *This is a land use perspective.*

Progressing to Step Three on the 'Continuum of Steps' for Asset Management

Move from Stopgap Remediation to Long-Term Solutions

A goal is to 'get it right', both in the stream channel and on the land draining to the stream.

The challenge in 'getting it right' is to move from stop-gap remediation of problems to long-term restoration of a properly functioning creekshed.

In 2014, three landmark provincial initiatives came to fruition. See below. Together they provide a platform for integrated and coordinated actions.

Introduced on page 15, **Figure B1** is an important communication tool. It illustrates where and how EAP fits into the continuum of steps for restoring stream system integrity. This desired outcome would drive the move from stopgap remediation to long-term solutions.

Continuum of Steps

The asset management journey for a local government is a "continuum of steps" as synthesized below:

- **Step One** – embrace the BC Framework
- **Step Two** – implement Sustainable Service Delivery
- **Step Three** – apply the Ecological Accounting Process

Once the life-cycle approach is standard practice for constructed assets, it would then be much easier to add M&M for stream systems. In Step Three, EAP focuses on the investment of resources already made by many stakeholders, as well as their two-fold aspirations concerning degradation prevention and enhancement of ecological services, respectively.

Benefits to Communities by Designing with Nature: The whole-system approach to protecting stream integrity is founded on the twin pillars of Ecological Accounting and Water Balance Accounting. An implementation plan that reflects the twin pillars would result in multiple desired outcomes:

- **ENHANCE** stream corridors to create high value public assets.
- **AVOID** an unfunded financial liability (by limiting stream erosion, preventing flooding, improving water quality).
- **ADAPT** to a changing climate.
- **REDUCE** life-cycle costs for drainage infrastructure.

Reconnecting hydrology and stream ecology includes adapting to the new climate reality (*longer, drier summers followed by warmer, wetter winters*). This requires effective 'top-down & bottom-up' processes that align and accelerate implementation of reinforcing provincial, regional, and local actions to improve where people live.

The "story behind the story" of the **Asset Management Continuum** as told by Glen Brown is presented next.

Story Behind the Story: "We framed the Asset Management Continuum as a series of three steps, recognizing that most local governments were at Ground Zero in 2015. Our operative phrase was *'as understanding grows'*. We saw this as the key consideration for local governments progressing along the continuum," explains Glen Brown.

"Although it might be possible, we believed it unrealistic to expect anyone to jump directly to Step Three and integrate natural systems into their asset management strategies. We needed a way to illustrate this diagrammatically. This led us to the concept of a continuum."

"The continuum bridges two pieces. One piece is recognition that the asset management process is founded on an incremental approach. The other piece is integration of natural capital, natural assets and watershed systems thinking."

"At the 2015 Water Sustainability Workshop, I explained that implementation of asset management along with the associated evolution of local government thinking is a continuous process, not a discrete task. Some local governments are advanced. Some are just starting out. Our approach is not to dictate or prescribe what to do."

"Over time, capacity and expertise will increase for asset management. We are saying the same thing for integration of natural assets. Local governments, over time, will progress."

"A desired outcome is that they will eventually incorporate natural capital into their asset management processes, and that will recognize the financial value of natural systems."

Watersheds are Infrastructure Assets

Within months of Glen Brown unveiling the Asset Management Continuum, the BC Society of Landscape Architects, invited the Partnership to provide the content for the entire June 2016 issue of Sitelines magazine. Co-authored by Glen Brown and Ray Fung, the last article in the special issue was titled ***Sustainable Service Delivery: Watersheds are infrastructure assets****.*

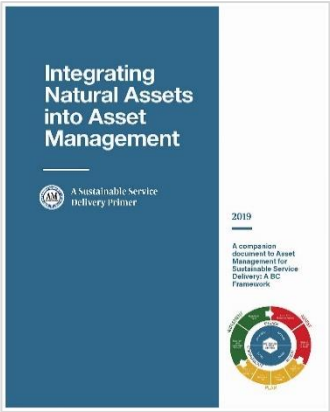
4. Operationalizing EAP within Asset Management

Ecological Services are Core Services

EAP brings a whole-system approach to an understanding of **drainage service** realities. EAP implementation depends on decision-makers understanding that a municipal drainage service has two interconnected components – one is the constructed infrastructure, and the other is the stream system.

There is typically no funding mechanism for stream M&M such as for water and sanitary sewer utilities. Although several local governments in BC do have "stormwater utilities", their main purpose is to fund infrastructure such as pipes and ponds. So, the unfunded M&M liability caused by drainage impacts on stream systems grows over time.

Core services such as utilities, roads, parks, and recreation take up the bulk of a local government budget and are the traditional focus of asset management. Prior to release of the Primer on Integrating Natural Assets with Asset Management in 2019, ecological services were not typically part of the asset management mind-set.



Context for Integration of Stream Systems with Constructed Assets

Released in September 2019 by Asset Management BC, the Primer introduces EAP with this statement:

"Significant strides have been made in natural asset management in British Columbia and across Canada. Several initiatives have built on each other, forming a foundation for local governments to increase their consideration of the potential of natural assets."

Drainage, Recreation, Habitat, and Enjoyment of Property Uses

Ecological services are not intuitively understood by the public, elected representatives, and asset managers. At best, they have been considered as an add-on. To advance uptake of a 'whole-system' way of thinking about the 'drainage service', it helps to define ecological services in terms of drainage, recreation, habitat, and enjoyment of property uses.

Once communities make the mental transition to view ecological services as core local government services, and then look at their budgets differently, the change in mind-set should lead to this question, how can we do things better? This logically leads to the next question:

How do we establish an annual budget for M&M that sustains the 'package of ecological services' in a stream system that humans depend upon for drainage, recreation, habitat, and enjoyment of property uses?

Integration of Stream Systems into 'Sustainable Drainage Service Delivery'

Unless communities measure the effect of impacts, destabilization of stream channels and degradation of riparian assets and streamside protection areas will continue. EAP helps to quantify the unfunded and growing cost (hence liability) to protect, remediate or enhance stream systems in disturbed urban and rural landscapes. **This is the starting point for a life-cycle approach to M&M of the drainage service**.

Budget Line Items: EAP bridges a gap. While local governments have existing tools in the form of policies and legislation for 'maintenance and management' of ecological assets, they have until now lacked a pragmatic methodology and meaningful metrics to incorporate stream systems as line items in Asset Management Budgets.

> **Using numbers generated through application of EAP, local governments have a sound basis for implementing a baseline annual budget for enhancement of the stream system (which is the natural or ecological asset) within a setback zone.**

A Stream is a Land Use: The EAP methodology and metrics recognize the importance of the stream system in the landscape. A stream is a land use because the stream corridor is defined in regulations and has a financial value. EAP uses real numbers from BC Assessment, not hypothetical assumptions, to establish the financial case for the stream corridor system.

Hydrology powers stream ecology. Thus, effective M&M requires an understanding of how water balance pathways connect creekshed hydrology and stream ecology, how changes on the land disconnect them, and how green infrastructure design can reconnect them.

Understanding how hydrology powers stream ecology is the starting point for developing meaningful M&M metrics. Managing the built and natural environments as interconnected systems is a guiding principle.

Over the past six years, a series of "big ideas" emerged during the 3-stage program of testing, refining and mainstreaming EAP. These big ideas are transformative in their implications for local government asset management. They are discussed in **Part C**.

Hydrology Powers Stream Ecology

The flow of rainwater from cloud to stream is comprised of three water balance pathways: ***surface runoff, horizontal shallow interflow****, and* ***deep groundwater****. Yet the latter two are routinely ignored by planners and designers. Time, a critical factor, is also ignored. These omissions lead to stream health plus financial consequences.*

Application of Asset Management Readiness Scale Assessment (AMRS) to EAP

FCM, the Federation of Canadian Municipalities, has developed a spreadsheet tool for evaluating progress by local governments in implementing a life-cycle approach to renewal and replacement of constructed assets. **Table B1** is a simplified version of AMRS. It is included for illustrative purposes.

It is new territory to consider how the **'financial case for stream systems'** would fit into or influence AMRS. The process for understanding how EAP might be applied to AMRS by local governments involved interviews with asset managers.

The Regional District of Nanaimo Board passed this resolution on April 27, 2021:

"That the Millstone River Ecological Accounting Process report be used to inform future Corporate Asset Management Planning."

Local Government Perspectives

Interviews focused on whether and/or how asset managers believed the EAP findings might reasonably fit into or influence AMRS. Conversations revolved around the question of how likely is it that one small study would shift the overall ratings in a 15 x 5 matrix for 5 areas of competency.

Their responses yielded insights into how an EAP case study aligned with and/or fitted into the big picture which is their organization's approach to asset management planning for sustainable service delivery. A selection of quotable quotes is included as **Figure B2**.

"This report has given the RDN, as well as the City of Nanaimo, further insight as we develop our existing framework for the protection and enhancement of our important natural features in our communities, including stream corridors."

Chair Tyler Brown,
Regional District of Nanaimo

Starting Point for Interdepartmental Conversations: The short answer by asset managers is that one small study would not shift the AMRS ratings. However, they said, **EAP does help broaden and balance the asset management conversation**.

This alone achieves the goal of EAP in providing local governments with a methodology and metrics for making the financial case for streams. The intent is that the EAP findings would be used by local governments to establish line items in budgets for M&M of ecological assets in stream corridors.

There is a consensus that Planning and Decision Making is one area of "asset management competency" where an "uptick" would be anticipated as an EAP project outcome. The focus on decision-making is a starting point for inter-departmental conversations that put stream systems and constructed assets on an equal footing. That would be the game-changer.

Figure B2: Local Government Perspectives About EAP

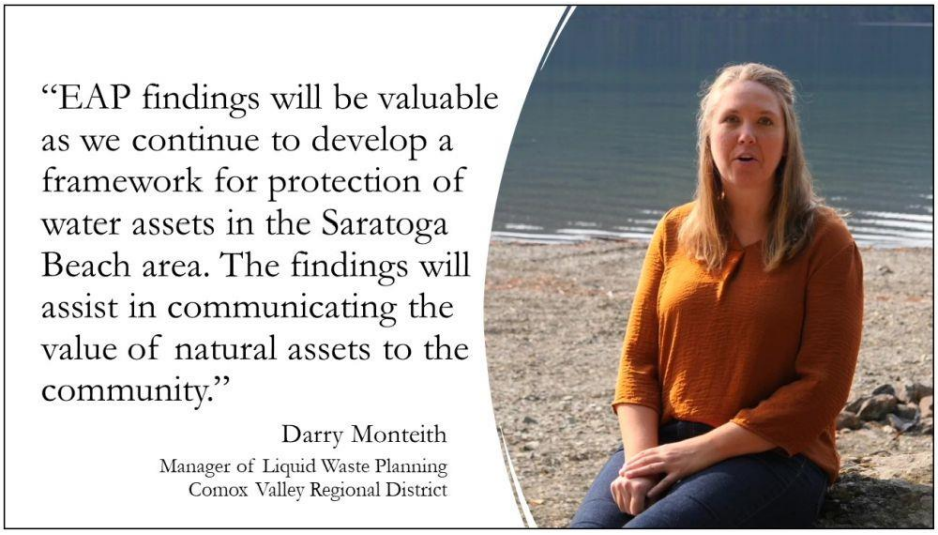


Figure B2: Local Government Perspectives About EAP

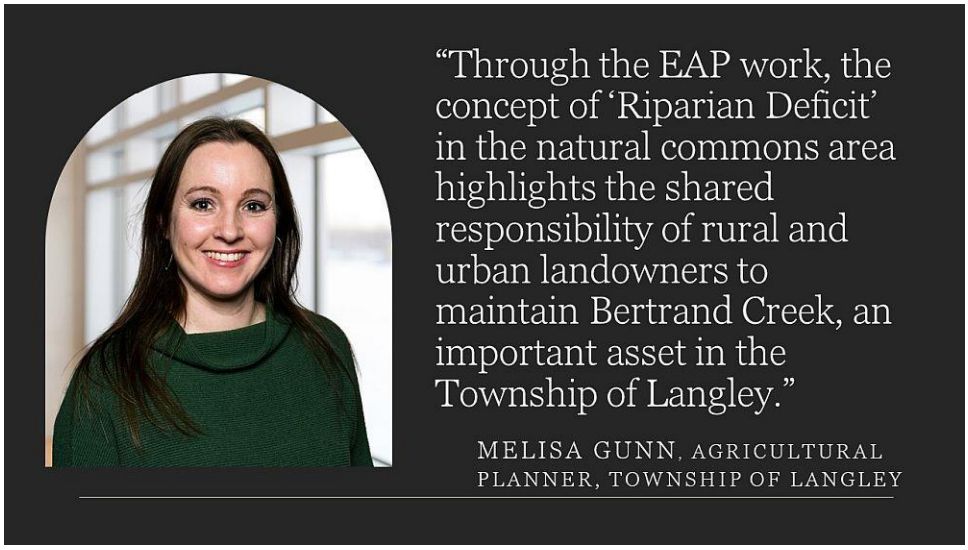


Table B1: FCM Asset Management Readiness Scale Assessment for Constructed Assets (*included for illustrative purposes*)

Competency	Current State	Expected Future State
Policy and Governance	*By developing this competency, the local government is putting in place policies and objectives related to asset management (AM), bringing those policies to life through a strategy and roadmap, and then measuring progress and monitoring implementation over time.*	
A. Policy & Objectives		
B. Strategy & Roadmap	**Intentionally left blank** (typical)	
C. Measurement & Monitoring		
People and Leadership	*By developing this competency, the local government is setting up cross-functional teams with clear accountability and ensuring adequate resourcing and commitment from senior management and elected officials to advance asset management (AM).*	
A. Cross-Functional Teams		
B. Accountability		
C. Resourcing and Commitment		
Data and Information	*By developing this competency, the local government is collecting and using asset data performance data and financial information to support effective AM planning and decision-making.*	
A. Asset Data		
B. Performance Data		
C. Financial Information		
Planning and Decision Making	*By developing this competency, the local government is documenting and standardizing how it sets AM priorities, conducts capital and O&M planning, and decides on budgets.*	
A. Documentation & Standardization		
B. Asset Management Plans		
C. Budgets & Financial Planning		
Contribution to Asset Management Practice	*By developing this competency, the local government is supporting staff in AM training, sharing knowledge internally to communicate the benefits of AM, and participating in external knowledge-sharing.*	
A. Training and Development		
B. Internal Communication & Knowledge-Sharing		
C. External Communication & Knowledge-Sharing		

5. Urban Watersheds as Infrastructure Assets

The New Paradigm

This Section 5 serves as a transition to Part C. It provides historical context for development of EAP.

In November 2015, release of Beyond the Guidebook 2015: Moving Towards "Sustainable Watershed Systems, through Asset Management" launched an educational process to reframe how local governments look at urbanizing watersheds.

The reframing is captured in **Figure B3**. Alignment with the BC Framework is the context. The focus is on the Water Balance Accounting pillar.

Unfunded drainage liability is a driver for action

The Drainage Service is the neglected service. The consequence of neglect is an accumulating financial liability to fund creek channel stabilization and riparian corridor restoration in urban and rural settings.

The urgency of the drainage liability issue spurred the analytical process that linked municipal asset management and stream health as **"cause-and-effect"**, for better of for worse.

Hydrology is the engine that powers ecological services: The three pathways by which rainfall reaches streams --- over the land surface, shallow horizontal interflow through the soil layer, and deep vertical to groundwater --- are **"drainage assets"**. These pathways provide **"water balance services"** that sustain ecological services.

"Sustainable Watershed Systems, through Asset Management" *applies to land uses that local government regulates and is founded on an understanding of how the Water Balance Methodology integrates the Site with the Watershed, Stream, and Groundwater Aquifer*

The Water Balance Methodology is about managing the whole rainfall spectrum and providing benefits to the stream through the wide range of stream needs - from base flow to managing flooding. The Water Balance Methodology bridges all ranges in rainfall and streamflow events.

The Water Balance Methodology incorporates robust and proven calculation techniques and engineering applications to define a watershed and stream as a whole system. In this manner the results can be used to provide a quantitative assessment of both impacts and mitigation effectiveness. It also possible to show benefits that have been long thought as not achievable.

Figure B3 – Creeksheds & Water Balance Services

With release of **Beyond the Guidebook 2015**, an educational goal:

Those who are involved in municipal land use and drainage would understand the vision for.....

"Sustainable Watershed Systems, through Asset Management"

THE NEW PARADIGM –

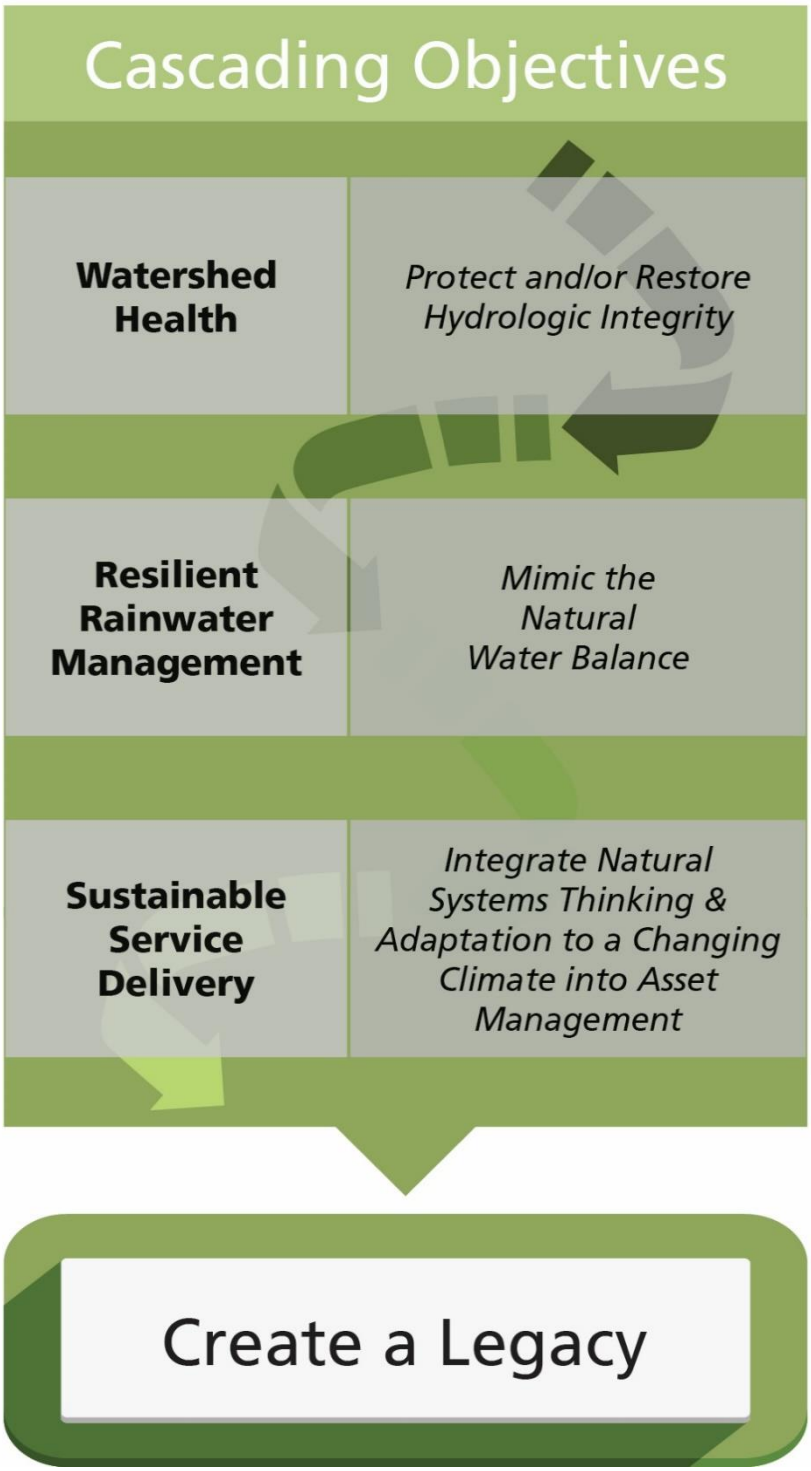
"Creeksheds as Infrastructure Assets"

A creekshed is an **integrated system**.

The **three pathways** by which rainfall reaches streams are 'infrastructure assets'.

The three pathways provide **'water balance services'**.

Figure B4



Cascading Objectives

Figure B4 is the primary branding graphic for Beyond the Guidebook 2015. It illustrates the essence of the three Cascading Objectives for three linked outcomes.

Alignment of efforts – from high level to ground level – is necessary to achieve the **Creekshed Health Goal**, which is defined as:

Implement standards of practice that mimic the natural Water Balance, are affordable and effective, and achieve the desired outcome, which is healthy streams and creeksheds.

Seven years after release of both the BC Framework and Beyond the Guidebook 2015, why and how the three objectives are interconnected is still neither widely known nor fully understood.

Stream health in the built environment is a function of how the landscape is altered by humans. A primary measure is the condition of aquatic ecosystems in stream corridors. Hardening the land surface short-circuits the water cycle. The result: either too much or too little flow in streams. Consequences include expensive fixes in an era when communities are challenged to fund and replace essential infrastructure services.

Sustainable Drainage Service Delivery applies to land uses that local governments regulate and/or can influence.

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PART C

Case Study Building Blocks Process

Part C introduces the nine case studies that are building blocks in the EAP program, and is structured in three sections:

1. ***EAP Program, Processes and Outcomes***
2. ***Capsule Synopses***
   (*a two-page summary for each case study highlights what stands out about the creek system, explains why it was included in the EAP program, elaborates on the context for each "big idea" that emerged from the EAP analysis, and identifies a case study outcome that is defining)*
3. ***Reflections on the EAP Journey***

Table C1: Building Blocks in a Process

Region	Creek	Land Uses	Big Ideas
STAGE 1 – TEST THE EAP CONCEPT (2016-2018)			
Cowichan Valley	**Busy Place Creek -** *CVRD*	Agricultural, residential, industrial	**The EAP lens is the *Stream System*** ***Hydrology is the Engine that Powers Stream Ecology***
Comox Valley	**Brooklyn Creek -** *Comox & Courtenay*	Almost completely urbanized; some agricultural uses	**BC Assessment Data is a proxy for *Financial Value of a Setback Zone*** **Investment in stream restoration is a measure of *Stream Worth*** ***Package of Ecological Services* is the range of community uses**
STAGE 2 - REFINE THE EAP METHODOLOGY (2018 – 2020)			
Nanaimo Region	**Shelly Creek -** *Parksville*	Forest & agricultural areas (90%) drain to urban area	***Riparian Ecosystems* have been reduced to *Riparian Zones*** **M&M for *Maintenance* (prevent) and *Management* (improve)**
Metro Vancouver	**Kilmer Creek** – *District of North Van*	Forested mountain drains into urban area	***A Stream is a Land Use*** **The concept of the *Natural Commons* underpins EAP** **From *Remediation* to *Restoration***
STAGE 3 – MAINSTREAM EAP WITHIN AN ASSET MANAGEMENT STRATEGY (2020 – 2022)			
Nanaimo Region	**Millstone River –** *RDN & Nanaimo*	Agricultural lands drain into urban area.	***NCA Metric* drives decision-making** ***Target-Based Strategy for Riparian Area Restoration*** ***Framework for Operationalizing EAP, as a Budget Line Item, within an Asset Management Strategy***
Capital Region	**Bowker Creek** - *Saanich, Oak Bay, Victoria*	Completely urbanized	**EAP establishes the *Financial Case for a Stream*** **Streamside parcels have a *Blended Financial Value***
Cowichan Valley	**Bings/ Menzies Cr** - *N Cowichan*	Forest, rural and urban zones	**EAP addresses *Loss of Riparian Integrity* as a stream health factor** **NCA Value is a measure of the *Riparian Deficit***
Comox Valley	**Saratoga Miracle Beach planning area**	Rural	**EAP methodology is applicable to all *Water Assets* additionally to the stream corridor** **An implementation mechanism would be a *Drainage Service Area***
Metro Vancouver	**Bertrand Creek** - *Langley Township*	Urban uplands drain to ag lowlands	**EAP quantifies the Riparian Deficit thus supporting *Equitable Urban / Rural Mitigation Investment***

Use and Conservation of Land are Equal Values

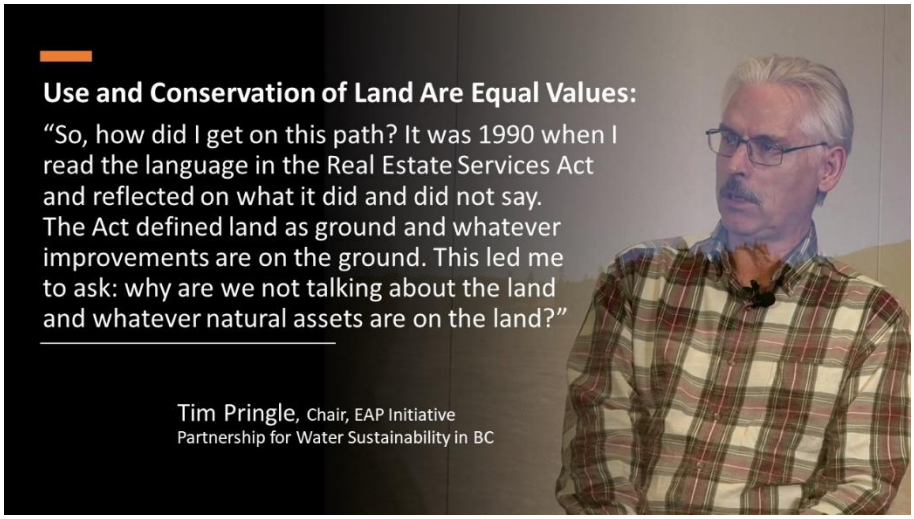
EAP is a major milestone in a journey that had its' genesis in 1991 when Tim Pringle, the Executive Director, convinced his Board of Governors at the Real Estate Foundation of British Columbia (REFBC) to adopt a philosophy that *"use and conservation of land are equal values"*.

From that point forward, the REFBC funded work in the stewardship and conservation sectors applying this guiding philosophy. The notion of *equal values* launched Tim Pringle on a career trajectory that culminated with his pioneering work leading the EAP initiative. This is the context for the case study building blocks process in **Table C1**.

Streams are Still Being Degraded

In the mid-1990s, green infrastructure ideas and practices were just starting to be seeded. And since then, they have evolved. From his current vantage point as EAP Chair, Tim Pringle offers this perspective**:**

"If we know how to do a much better job of protecting ecological features in our communities and on our landscape, then **why aren't we doing a better job?** Why are streams still being degraded? Why do we still see practices that are embedded in land use policy and regulation that are 50 years old in some cases? **How do we change that?**"



Vision for EAP, the Ecological Accounting Process, in 'Beyond the Guidebook 2015'

In 2015, the BC Framework set a strategic direction for local government service delivery because it refocuses business processes on how physical and natural assets are used to deliver services, and support outcomes that reduce life-cycle costs and address risks.

Also in 2015, the Partnership for Water Sustainability released Beyond the Guidebook 2015[1]. It supported the BC Framework by introducing the vision for an Ecological Accounting Process:

> **"The best blend of engineered assets (infrastructure) and natural assets (that provide ecological services) would support a robust long-term asset management plan and the required financial commitments."**

More Than Calculations

EAP is the convergence and synthesis of parallel journeys. Valuing use and conservation of land equally is the financial journey. Reconnecting hydrology and stream ecology by design is the applied science journey. The outcome would be restoration of urban stream integrity in settled areas.

"The vision for EAP set the challenge: develop a practical methodology, one that would be relevant to local government managers and the community, for determining the monetary value of drainage infrastructure and other services drawn (or adapted) to some degree from ecosystems," recalls Tim Pringle.

"Initially, we saw EAP as a tool – that is, the EA Protocol - that would help practitioners **calculate the opportunity cost** of balancing ecological services with drainage infrastructure."

"However, the first demonstration applications revealed that the term EA Process more accurately describes the challenge of working with multiple intervenors to **accurately describe the ecological services made possible by the hydrology**. This comprehensive approach rarely takes place, but it is needed for strategic plans."

[1] http://waterbucket.ca/wp-content/uploads/2017/10/Beyond-The-Guidebook-2015.pdf

Building Blocks and Big Ideas

What gets measured gets managed (or could be). The challenge is how to determine financial values for ecological services and the natural systems that deliver them. These are "commons", assets which produce services that the community desires to use and enjoy. There is an expectation that these assets will be maintained and managed.

This "need" is the impetus for changes in accounting systems used by local government to recognize and place financial values on assets. The change desired would be to include "natural assets" and ecological services.

Applied Research: Test, Refine and Mainstream

The above reality-check is the context for our embarking upon the 6-year program of applied research to evolve EAP through a 3-stage process of testing, refining, and mainstreaming the methodology and metrics. EAP recognizes that land use alters natural assets, basic questions emerge:

- What changes occur where land use (settlement activities) intrude into landscapes where natural assets such as streams once functioned?
- If communities want to balance use and conservation of land, what are the basic metrics to use for maintenance and management?
- What are the capital values as well as the social and ecological values?

While the methodology and metrics are universal, each situation is unique.

Thirteen local governments in five sub-regions of the Georgia Basin / Salish Sea Bioregion participated in the EAP program. The sequencing of the 9 case studies proved consequential and sometimes game changing. While the methodology and metrics are universal, each situation is unique. Understanding what each partner needed as an outcome from the project became a critical consideration in the building blocks process.

Nineteen big ideas power EAP: EAP evolved as one "big idea" led to the next one. We could not have made the leap directly from the first to the last. It required a building blocks process. This is the beneficial outcome of a systematic approach to applied research that tests and refines the methodology and metrics to get them right.

Table C1 consolidates 19 "big ideas" that are transformative in their implications for "why and how" local governments implement Asset Management for Sustainable Drainage Service Delivery.

Mainstreaming means EAP fits into local government Strategic Directions

When the Partnership embarked upon EAP Stage 3 in late 2019, there was no way for anyone to predict either how mainstreaming would unfold over a two-year period or who would be involved. The hope was that there would be sufficient interest for three case studies per year.

By mid-2020, five willing local governments had stepped up to become project partners, representing a consortium of four regional districts and six municipalities. Each identified local streams for analysis.

With the perspective of hindsight, each local government took a leap of faith that EAP would fit into their strategic directions. There was no guaranteed outcome. There was simply a recognition by all of the need to "just do it". The program as a whole and the individual EAP processes have exceeded expectations.

Every participating local government has benefitted from the building blocks approach to applied research. The sequencing of projects was fortuitous, resulting in insights which improved the research process. This energized the collaborative effort.

More than Asset Management

A primary goal of the EAP program is to build support for the idea of operationalizing EAP within an Asset Management Strategy. This was the context for an initial Partnership objective in selecting case studies analyzing streams passing through a range of land use situations – from urban to suburban to rural – and in five South Coast regions.

The unexpected outcome is the realization that local government has multiple pathways to achieve the goal of "natural asset management". These pathways are in the form of planning and environmental initiatives that are challenged to bridge from high-level policy statement to on-the-ground realities.

Ultimately, the success of these initiatives would depend on having a measurable metric, the Riparian Deficit, a real number. This is what starts the conversation with engineering and finance about what must be in an Asset Management Budget if a local government is serious about a strategy for **Sustainable Drainage Service Delivery**.

Table C2 presents capsule summaries which describe the outcomes for EAP projects. These highlight where and how EAP fits into strategic directions which represent a range of pathways.

Insights about making EAP effective – what communities needed

Conversations with communities confirmed streams as the natural asset most in need of analysis.

All agreed that streams are a Natural Commons. Thus, a stream system ought to be comparable to other kinds of commons such as roads and drainage systems. Thus, EAP had to have a methodology to allow such comparison. The elements for analysis are:

A stream is a system and a Natural Commons.

The community uses and enjoys the services (habitat, drainage, recreation, and enjoyment of property) provided by the stream

A stream has a regulated area defined by the Riparian Areas Protection Regulation

This area is a defined land use and must have a specific financial value

The financial value of this area can be determined from BC Assessment data for parcels which abut the stream

The extent of land use (subdivision and development) interference in the stream system is the Riparian Deficit.

Table C2 – Case Study Outcomes of EAP Mainstreaming

Creek Case Studies and Local Government Collaborators	Where and how EAP fits into a Strategic Direction
Millstone River in the City of Nanaimo & Regional District of Nanaimo	**Corporate Asset Management Planning & Regional Riparian Spatial Analysis:** EAP aligns with Strategic Priorities for environmental stewardship and growth management, and the findings are informing corporate asset management planning as well as how to prioritize investment in riparian and woodland restoration.
Bowker Creek in the municipalities of Saanich, Victoria, and Oak Bay in the Capital Region	**Bowker Creek Blueprint & Daylighting Feasibility Strategy:** EAP provides a financial methodology to approximately value the land within either an existing or potentially recreated stream corridor; and the City of Victoria reports that the EAP analysis and numbers added substance to the City's grant application.
Bings / Menzies Creek in the Municipality of North Cowichan & Cowichan Valley Regional District	**North Cowichan Biodiversity Protection Policy Project:** EAP supports the case for strategic action to strengthen management of environmental assets within North Cowichan; and informs the Regional Collaboration Framework as it pertains to ecosystem stewardship and biodiversity conservation.
Saratoga Miracle Beach Planning Area in the Comox Valley Regional District	**Saratoga Miracle Beach Drainage Service Area:** EAP findings inform the strategy for local area planning of a "settlement node" identified in the Regional Growth Strategy, and also support the case for a Drainage Service Area that would operationalize the "twin pillars" of Water Balance and Ecological accounting.
Bertrand Creek in the Township of Langley	**Langley Ecological Services Initiative:** EAP provides a real number for Payment of Ecological Services to compensate rural parcel owners who are willing to commit areas of their land to riparian and woodland maintenance and/or enhancement to restore stream integrity.

Stage 1 (Test) - Busy Place Creek (*Sh-hwuykwselu*) in the Cowichan Valley Regional District

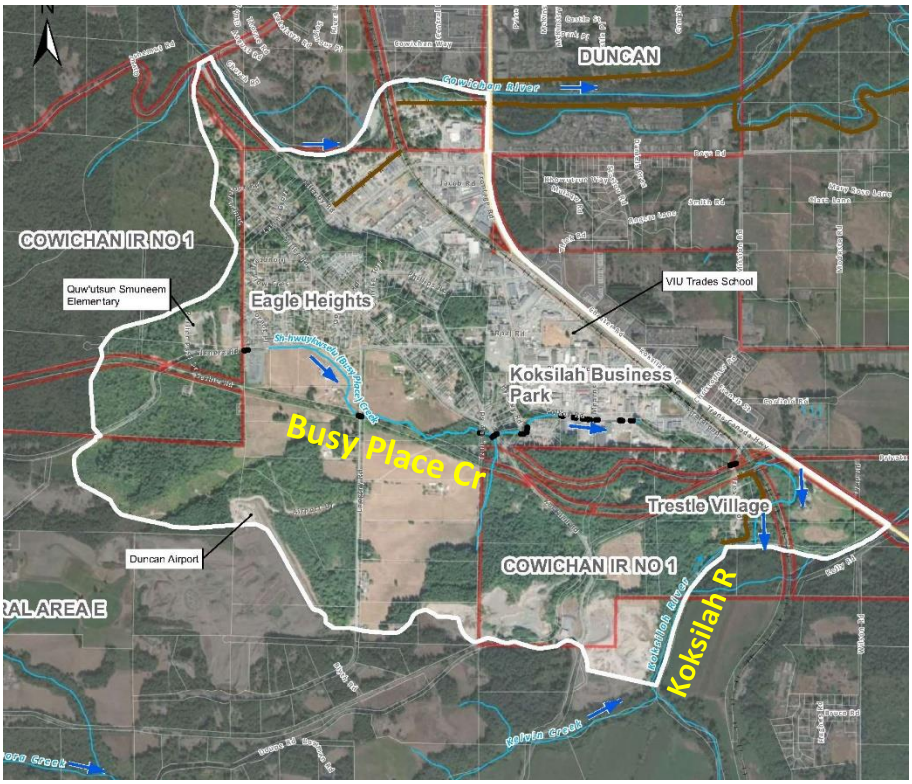
Busy Place Creek (Coast Salish: Sh-hwuykwse) is a small (1st order) stream system in the Cowichan Valley on the east coast of Vancouver Island. It is situated south of the City of Duncan, and discharges to the Koksilah River in the Cowichan Valley Regional District.

Like many small watersheds on the east coast of Vancouver Island, the Sh-hwuykwselu creekshed has been modified by more than 150 years of land uses which ignored its hydrology and dependant ecological services. As a result, much of its hydrological capacity has been compromised or lost.

Key Observations: Due to fragmentation of responsibilities, the "system perspective" is missing. Yet there is an opportunity-in-waiting to interweave Indigenous knowledge and Western science in building a strong collaboration around hydrology.

Watershed Overview

Historically, the location where the main stem of the Sh-hwuykwselu joined the Koksilah River was a meeting place for First Nations trade and exchanges, thus the name Busy Place Creek. Today the creek flows down the hillside from the upland bench area, discharges into a man-made ditch which conveys it south to join the Koksilah River.



Source: Sh-hwuykwselu (Busy Place) Creek Stormwater Management & Mitigation Plan, 2019

Why we selected Busy Place Creek

EAP Stage 1 (Test the Concept) was funded by the governments of Canada and British Columbia during the period 2017-2018 under the *Clean Water and Wastewater Fund* because of the EAP focus on asset management. The Cowichan Valley Regional District (CVRD) acted on behalf of the Partnership for Water Sustainability to obtain the grant.

Because the region had a longstanding interest in Busy Place Creek, CVRD selected it as a priority case study for application of the EAP approach. Significantly, the Busy Place Creek program was carried out in tandem with the Brooklyn Creek case study in the Town of Comox (in the Comox Valley Regional District).

Both projects benefited from cross-fertilization of experience gained and lessons learned during initial development of the conceptual framework, and early testing of the EAP methodology and metrics.

Conceptual framework that guided Stage 1 EAP

Compromised stream systems would trigger substantial remedial costs to protect property and people and restore the functioning of systems.

EAP enables local governments to tackle this unfunded liability by providing a methodology to optimize solutions.

The creekshed defines what goes into EAP. Expressed another way, the creekshed is the driver, not the tool.

To protect creekshed health, constructed infrastructure ought to fit into natural systems, rather than the reverse.

Context for Two Big Ideas

Context is everything. Beyond the Guide 2015, released in November 2015, seeded **"EAP as an idea"** to develop a more complete financial picture for stream systems for asset management. Within the first year, the Partnership had developed a conceptual framework for analysis.

The EAP lens is the stream system *(Big Idea #1)**:*** It is rare that someone takes a true **whole-system view**. Rather, studies and analyses are typically single purpose in scope because the work is viewed through the lens of whichever local government department initiates the work. But does anyone ever point this out?

Hydrology is the engine that powers stream ecology *(Big Idea #2)**:*** It is not universally understood that land development servicing practices disconnect the three pathways by which rainwater naturally reaches streams. **Reframing the relationship** between hydrology and stream ecology in terms of an engine analogy is a foundational idea for initiating a paradigm-shift.

Case Study Outcome

Although not within the EAP scope, potential elements of an affordable and readily implementable water balance restoration strategy soon became apparent. This information helped CVRD move forward with the Sh-hwuykwselu (Busy Place) Creek Stormwater Management & Mitigation Plan, completed in 2019.

Stage 1 (Test) - Brooklyn Creek in the Town of Comox

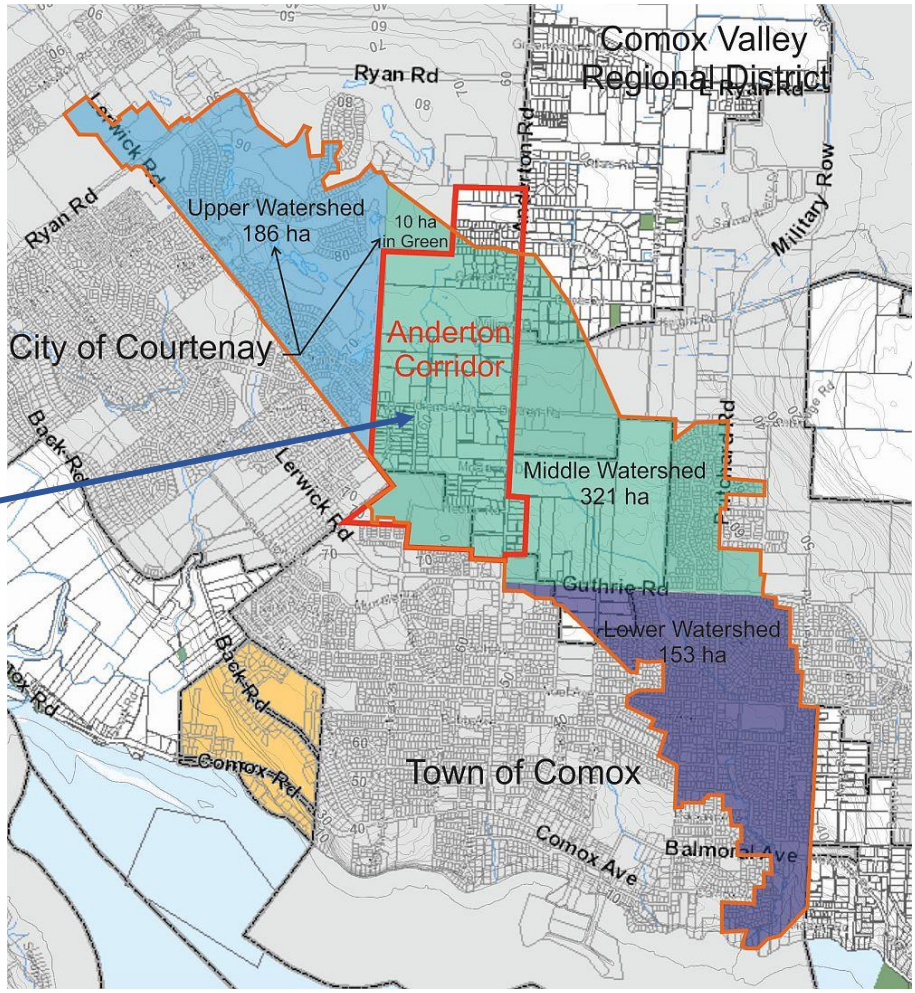
Brooklyn Creek is a small (1st order) stream system in the Comox Valley on the east coast of Vancouver Island. The headwaters originate in the City of Courtenay and the creek flows through the Town of Comox where it discharges into the Salish Sea.

Key Observations: Brooklyn Creek is a **beacon of hope** because the Town's experience shows what is possible when a local government has a strong working relationship with the stewardship sector and leads by example to implement responsible **water balance management**. The Town is reconnecting hydrology and ecology through a combination of regulations, education and training.

Three Building Blocks

*Experience gained and lessons learned through the Lower Brooklyn Creek channel enhancement project and Northeast Comox land development planning process have been integrated into the **Draft Anderton Corridor Neighbourhood Concept Plan** for Middle Brooklyn Creek.*

The Anderton Plan is precedent-setting because it demonstrates how application EAP helps managers change practices and adopt new strategies for protection and enhancement of ecological systems.



Why we selected Brooklyn Creek

Partnership for Water Sustainability interest in Brooklyn Creek dates to 2008, when it was included in the curriculum for the first annual Comox Valley Learning Lunch Seminar Series. The Town of Comox was in the initial stages of implementing the *Brooklyn Creek Channel Enhancement Project*. The 2008 Series was part of the early rollout of peer-based education under the umbrella of Living Water Smart in BC.

Context for Three Big Ideas

The Brooklyn Creek process resulted in a breakthrough in philosophy and approach vis-à-vis valuation of ecological services. Looking through the **worth lens**, to understand how communities decide how much to invest in creekshed restoration, proved transformational.

BC Assessment data is a proxy for financial value of a setback zone *(Big Idea #3):* Local governments need real numbers to deliver outcomes. It is that simple. BC Assessment parcel data are accurate, recent, and reflect the motivations of buyers and sellers over time. This means parcel values include social, ecological, and financial trend information. Use of BC Assessment data eliminates debate over the question of whether numbers are reality-based or hypothetical.

Investment in stream restoration is a measure of stream worth *(Big Idea #4):* Local governments need a metric that is tangible and validates what is a reasonable amount for M&M investment. Because Brooklyn had a decade-long history of community investment in stream restoration, this resulted in a defining moment which revealed why and how valid data build local government confidence. The Town's Glenn Westendorp connected dots and pointed out that the **EAP 1% Benchmark Guideline** matched their actual annual M&M.

Package of ecological services is the range of community of uses *(Big Idea #5):* Local governments need plain language that describes an abstract concept, ecological services, in a way that makes sense to elected representatives and the public. The idea for framing the range of uses desired by the community - **drainage, habitat, recreation, and enjoyment of property** - as a "package of ecological services" clicked when the Town's Marvin Kamenz pointed out that a strategic plan that supports this diversity would appear worthwhile to the greatest number of interested parties.

Case Study Outcome: A rethinking of "core services" in Comox

"Everything was proceeding quite fine until Tim Pringle completed the EAP analysis for lower Brooklyn Creek. That was the moment when we realized that ecological services are not just an add-on. They are, in fact, core services."

"Utilities, roads, parks, and recreation take up the bulk of a municipal budget. Once we made the mental transition to view ecological services as core municipal services, and looked at the municipal budget differently, we then asked ourselves: how can we do things better?"

*"We stopped work on the rainwater management plan and changed the plan focus to the **Package of Ecological Services** – how can we get the best package for them? All plan elements were redesigned; and residential density was concentrated to maximize public access."*

-Marvin Kamenz, 2019

Stage 2 (Refine) – Shelly Creek in the City of Parksville & Regional District of Nanaimo

Shelly Creek is a small (1st order) stream system in the Nanaimo Lowland Ecoregion on the east coast of Vancouver Island. Approximately 6.5 km long, it is a tributary of the Englishman River. The survival of Coho salmon in the Englishman depends on a healthy Shelly Creek because the latter provides habitat for spawning, rearing, and overwintering.

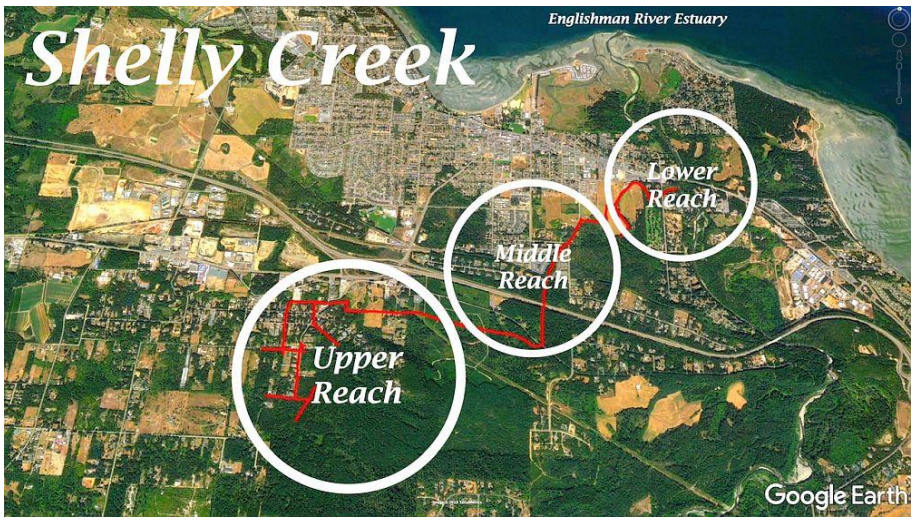
In 1999 the Englishman River was first declared to be one of the most endangered rivers in BC. Extinction of the fisheries resource was viewed as a very real possibility. This was the catalyst for action. An outcome was creation of MVIHES, the acronym for the Mid Vancouver Island Habitat Enhancement Society.

Shelly is the City of Parksville's last fish-bearing creek. With this context in mind, the research question for Shelly Creek was framed in two parts. First, how does the creekshed exhibit the historic impacts of land uses? And secondly, does the stream influence the financial value of parcels that are adjacent to the stream corridor?

Key Observations: The research findings for Shelly Creek suggest that the diminution of stream functions gradually will draw the attention of property owners and the community to the **"no harm"** rule in land appraisal. This means adjacent property owners have an obligation to recognize ecological values and avoid activities on their property that might harm the stream and have a negative impact on parcel values.

Stewards of the Creekshed

MVIHES leads community engagement by recruiting and supporting local volunteers to help with projects. MVIHES helps residents and the community to understand that the Shelly Creek they see today is a riparian system that has been altered by decades of land use activities.



Why we selected Shelly Creek

EAP Stage 2 (Refine the Methodology) was funded by the Union of BC Municipalities under the Asset Management Planning program and completed in 2019-2020. Partnership for Water Sustainability interest in Shelly Creek stems from our respect for MVIHES community-based leadership as **"stewards of the creekshed"**.

Respect for MVIHES is demonstrated by Partnership financial support for several MVIHES-led projects. These contribute to an understanding of the benefits of citizen science at the creekshed scale.

Context for Two Big Ideas

Each EAP case study has resulted in breakthroughs in building an understanding of what matters and what matters most. The Shelly Creek process is characterized by two "big ideas". These are foundational pieces in development of a guiding philosophy for application of the EAP methodology and metrics.

Riparian ecosystems have been reduced to riparian zones *(Big Idea #6):* History shows that the distinction between a "system" and a "zone" is not well understood. **Zones are leftover areas after the landscape is fragmented by human land uses**.

A riparian ecosystem in a pristine setting broadly describes a stream and supporting hydrological pathways. A riparian zone describes the situation where land uses have reduced a stream corridor to the channel width plus regulated setback on each side.

The distinction between system and zone serves as a reality-check for financial valuation of ecological services provided by stream systems in suburban and rural settings. Credit for drawing our attention to the distinction and the implications goes to Jim Dumont, an original thinker.

M&M for "maintenance" to prevent or avoid degradation and "management" to improve stream condition *(Big Idea #7):* The distinction between "maintenance" and "management" goes to the heart of the challenge in helping communities **move from stop-gap remediation of problems to long-term restoration of properly functioning stream systems**.

Holistic M&M refers to application of a whole-system, water balance approach that understands how water reaches a stream and strives to reconnect hydrology and stream ecology by design.

Case Study Outcome: An emphasis on the 'No Harm' Principle

Use of the stream corridor by the community and adjacent parcel owners establishes expectations that its ecological services will continue.

The 'no harm' principle derives from two sources.

One is the process that appraisers, or valuers, use to determine the financial value of a parcel. The valuer will look for both negative and positive impacts.

The second is regulation. For streams, this means the Riparian Areas Regulations and municipal bylaws.

Stage 2 (Refine) – Kilmer Creek in the District of North Vancouver

Kilmer Creek is one of numerous tributaries of Hastings Creek in the Lynn Valley area of the District of North Vancouver. Hastings Creek then discharges into Lynn Creek, a small river system. Over the past century, land development has moved up the mountain slopes and altered the natural drainage.

Kilmer Creek has three distinct zones: 1) forested mountainside; 2) residential development after streamside regulation became provincial law in 1997; 3) residential development prior to streamside regulation.

Where Kilmer flows through the urban area, one-quarter of this length is either enclosed in a pipe or has no riparian zone. The buried section includes the Argyle Secondary School property.

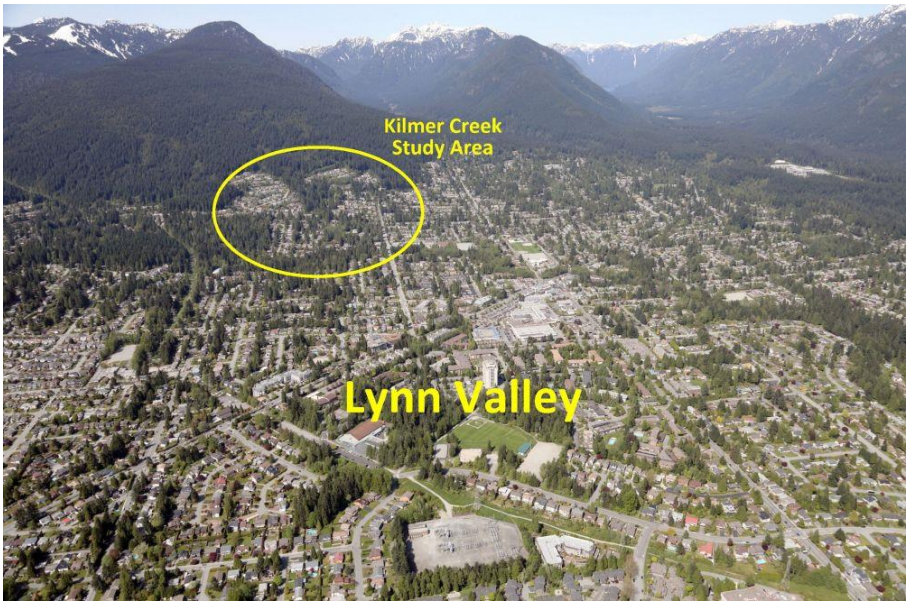
Key Observations: It is the ecological services supplied by the stream that may influence the financial value of parcels. Where there is no riparian zone, parcels abutting a stream will have assessed land values that differ little from nearby parcels that are not adjacent.

The worth of Kilmer Creek is reflected in expenditures of more than $3.6 million since 2014 to remediate damages from flooding and improve maintenance and management of the stream.

Development History

Where pre-1980s subdivision shaped neighbourhoods, the riparian qualities of the stream were subordinated to land use.

Post-1980s subdivision followed streamside protection regulations. The stream's riparian zone in this reach remained intact.



Why we selected Kilmer Creek

Replacement of Argyle Secondary School provided the District of North Vancouver with a timely opportunity to address ecological and conveyance deficiencies in a section of the stream where pre-1960s land use decisions had removed riparian functions.

The municipality envisioned daylighting the creek through the school property and realigning and partially restoring the riparian function upstream in conjunction with land redevelopment. The work is proceeding in phases.

The Kilmer Creek research application was carried out in tandem with the Shelly Creek case study. Although the case studies were a study in land use contrasts, both benefitted from cross-fertilization of insights gained in refining the EAP methodology and metrics.

Context for Three Big Ideas

The Kilmer Creek process is characterized by three "big ideas", each of which was concurrently integrated into the Shelly Creek case study. In addition, we learned that the size of parcels, date of subdivision, proximity to the stream, and neighbourhood character are important considerations related to financial value.

A stream is a land use *(Big Idea #8):* The Kilmer research process crystallized the idea that a stream corridor is a land use. The moment of truth came with the realization that this finding satisfies two criteria: first, the area of the stream corridor is defined in the *Riparian Areas Protection Regulations Act*; and secondly, the corridor has a financial value which is defined as the Natural Commons Asset (NCA) value.

The concept of the "natural commons" underpins EAP *(Big Idea #9):* Kilmer Creek provides a side-by-side contrast of areas with streamside regulation versus none, respectively. Coming to grips with the implications for financial valuation unlocked the train-of-thought that resulted in the **"natural commons"** as an underpinning concept.

From remediation to restoration *(Big Idea #10):* The Kilmer Creek experience shows that a stream may be so altered by land use changes that few "normal" ecological functions are observable. A lesson learned from Kilmer is that a history of flood overflows and damage leads to expensive engineering solutions which remediate problems rather than restore a naturally functioning system.

Case Study Outcome: Kilmer introduced and defined three commons categories

Natural Commons *refers to the stream system that provides ecological services used by nature and the community – drainage, habitat, recreation, and enjoyment of property.*

Constructed Commons *refers to the range of infrastructure services that support lifestyle and property enjoyment; and are maintained and managed through taxation to ensure their availability.*

Institutional Commons *refers to schools and fire protection. The Argyle school project is the reason for defining this category.*

Stage 3 (Mainstream) – Millstone River in the City of Nanaimo & Regional District of Nanaimo

With an area of about 93 km², the Millstone River is the largest system in Water Region 5, one of 7 major basins situated within the boundaries of the Regional District of Nanaimo (RDN). Platting of land parcels began in the watershed 160 years ago evolving into today's farms, rural residential and much denser urban areas.

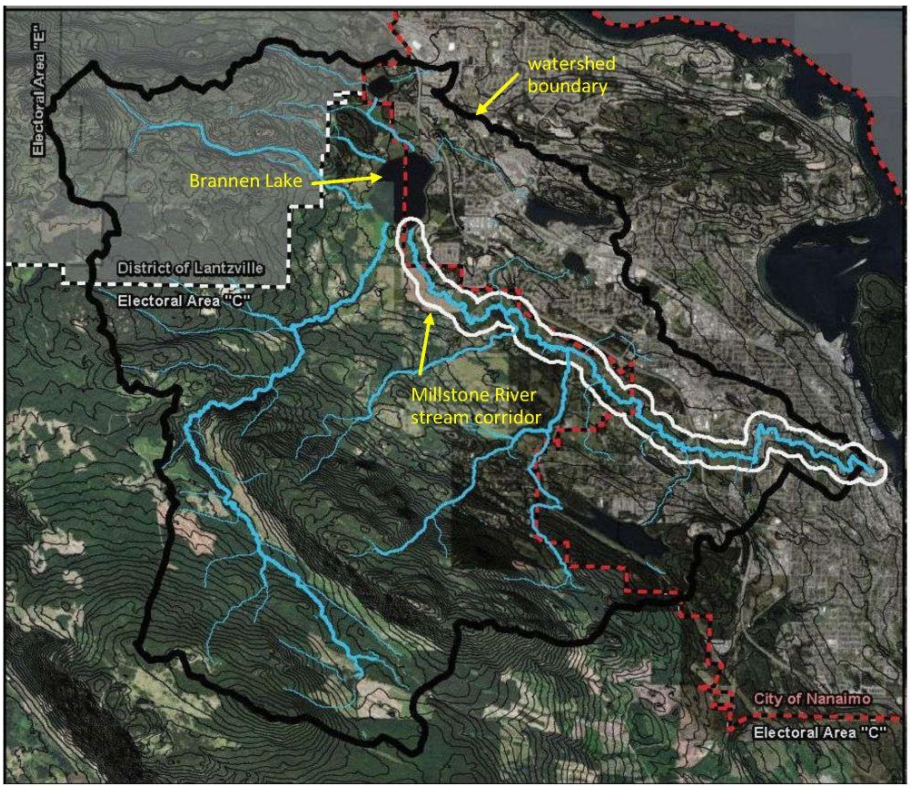
The Millstone is a landmark stream occupying central place in the City of Nanaimo greenway and parks system. In the RDN area, it defines a rural landscape prized for agricultural land uses and rural residential parcels. The watershed accommodates some of the most densely populated areas of the region.

Key Observations: Over the past decade, both the City of Nanaimo and RDN have invested in initiatives to utilize and protect the value of the Millstone stream corridor as a Natural Commons Asset. Their combined investment, especially within the City, is a tangible measure of the worth of the ecological system to the community.

Watershed History

Since time immemorial, the people of the Snuneymuxw First Nation havelived in and used the watershed, imposing few alterations of its natural condition. The village, Sxwuyum, site at the mouth of the Millstone was one of five villages historically occupied by the Snuneymuxw. Following the treaty of 1854, settlers of European descent eclipsed the Snuneymuxw way of life.

The Millstone and its tributaries have lost much of the riparian ecosystems that support the functioning condition of streams.



Why we selected the Millstone River

Co-funded by the Federation of Canadian Municipalities (FCM) and the Real Estate Foundation of BC (REFBC), the purpose in undertaking five EAP Stage 3 (Mainstream EAP within an Asset Management Strategy) case studies was to show how EAP supports the vision for integrating ecological assets in Asset Management for Sustainable Service Delivery: A BC Framework.

The Millstone River and EAP project are a vignette for the bigger mandate of the RDN Drinking Water & Watershed Protection (DWWP) program. Both demonstrate project level partnerships with stewardship groups, as well as partnerships across local government jurisdictions in the case of the Millstone, with RDN Electoral Area C being upstream and the City of Nanaimo downstream.

The Millstone EAP project pulls the thread of collaboration, community outreach and stream stewardship from the first decade of the DWWP through to its second. EAP also adds the new lens of accounting for natural (ecological) assets and ecosystem valuation.

Case Study Outcome: Regional Riparian Spatial Analysis

Having the benchmark assessment of riparian cover helps build support for a target-based strategy for systematic M&M investment to restore riparian woodlands and native vegetation for the full width of the regulated SPEA zone.

To build upon this at the regional level, the RDN commissioned a spatial analysis to inventory current riparian cover levels (functional riparian width) across the region's major watercourses and identify priority areas for restoration of riparian vegetative buffer extent and quality.

Context for Two Big Ideas

The RDN used the Millstone as a pilot to test the EAP methodology and take away learnings for further refinement in future applications. The process highlighted the importance of riparian vegetation and led to an air photo assessment of riparian cover in the river corridor that complemented a previously completed stream survey. The latter had used the Urban Salmon Habitat Program (USHP) methodology.

The resulting **Benchmark Assessment of Riparian Cover** is the starting point for a decision tool. The results provide a high-level basis for strategizing where to prioritize investment in restoration of riparian woodlands to improve the health and functioning condition of the river.

NCA metric drives decision-making *(Big Idea #11):* The NCA, or Natural Commons Asset, is the portion of the stream corridor that lies in the Streamside Protection and Enhancement Area (SPEA - Riparian Areas Protection Regulation). The benchmark for budget planning is 1% of the NCA value.

Framework for operationalizing EAP, as a budget line, within an Asset Management Strategy *(Big Idea #12):* The nature of the Millstone project is applied research to pilot application of the EAP methodology. No recommendations are made. However, the RDN did ask what could be done next. Building on the riparian Benchmark Assessment, four suggestions provide a framework for early action.

Stage 3 (Mainstream) – Bowker Creek in the Capital Regional District

Historical land development has completely urbanized the creekshed. Less than one-third of the 8 km long stream remains as an open channel; the other two-thirds is enclosed in pipes and culverts.

Key Observations: The Bowker Creek EAP project validates the vision driving the 100-Year Action Plan for creekshed restoration. With hindsight, the players knew intuitively what needed to be done, but did not have the numbers to make the case. Now they do.

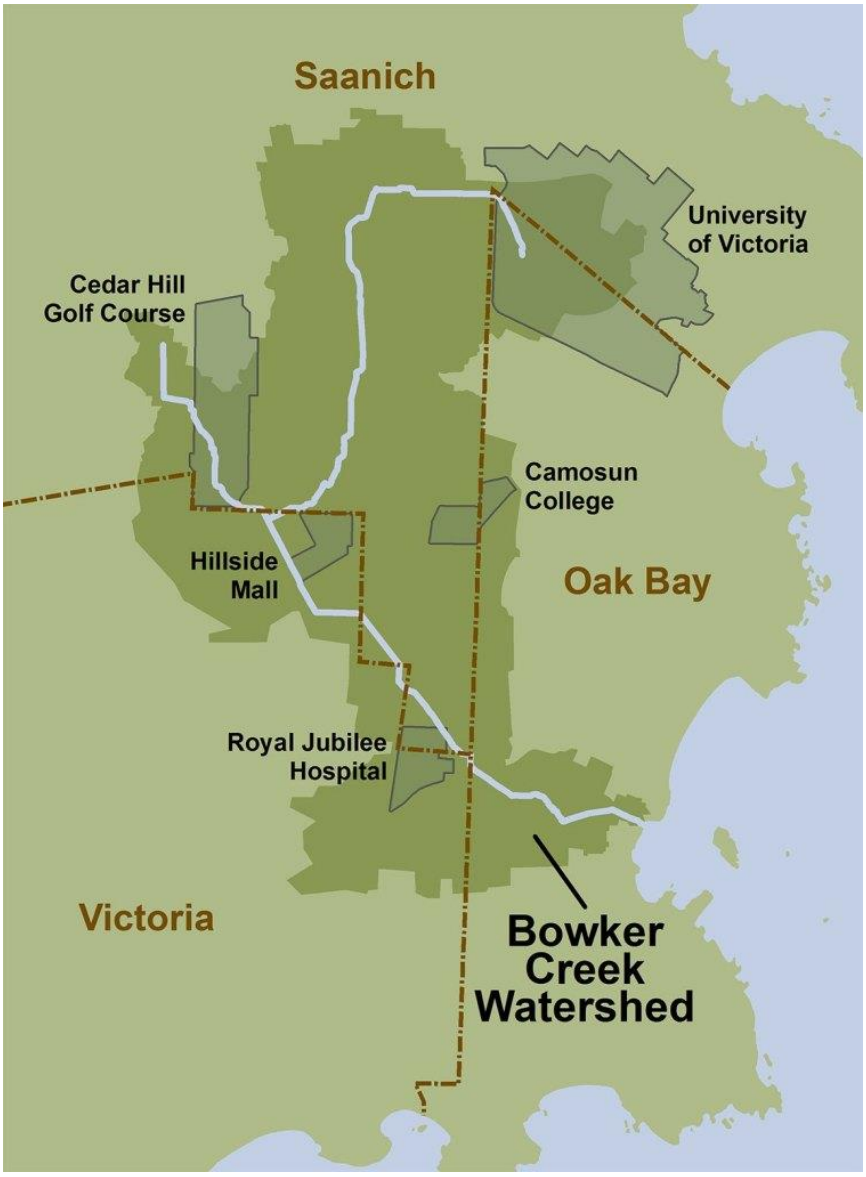
Watershed History

Transformation of the Bowker Creek landscape occurred many decades ago in an era when there was no streamside protection regulation. The EAP study area encompasses the one-third that is open channel.

From the beginning, the Bowker Creek Urban Watershed Renewal Initiative (BCI) naturally evolved as an EAP concept. This dates to 2003 and approval of the Bowker Creek Watershed Management Plan. The restoration vision considered the entire creekshed.

In 2010, the Bowker Creek Blueprint guidance document laid out a 100-year action plan, reach by reach, to restore islands of nature within the urban environment.

In 2019, the Bowker Creek Daylighting Feasibility Study defined a route for future channel and corridor restoration.



Why we selected Bowker Creek

The Daylighting Feasibility Study is a core element in the second decade of the 100-Year Action Plan for restoration of the Bowker Creek stream corridor as a natural commons or ecological system. The daylighting vision provided the point of departure for the EAP project.

Applying EAP added to the conceptual framework for stream daylighting with new insights about metrics for annual maintenance and management (M&M) of a functioning stream corridor system.

The EAP findings for Bowker Creek also added intriguing insights that would potentially inform the long-term strategy for property acquisition, in conjunction with land redevelopment, for stream daylighting.

Context for Two Big Ideas

The daylighting study has broad-brush recommendations for parcel acquisition. The value-added component that EAP provides is a financial methodology to approximately **value the land within either an existing or potentially recreated stream corridor**. EAP helps to frame the right question(s) that would then guide another level of financial analysis by a land economist.

EAP establishes the financial case for a stream *(Big Idea #13):* Getting the choice of language right holds key to effective communication when introducing and explaining a new concept. The Bowker project resulted in a simple yet transformational change in how we describe EAP. Credit for suggesting "establish the financial case" goes to Jody Watson of the CRD. It works because the focus is on the outcome.

Streamside parcels have a Blended Financial Value *(Big Idea #14):* EAP compares assessed financial values of parcels abutting or near to the stream. A core finding of the Bowker EAP project is that the operative or relevant metric for measuring the influence of a stream on parcel value is **$ per square metre** of parcel area.

Further analysis led to an ancillary finding. Parcels abutting the stream have a Blended Financial Value – that is, one value for the developable area of a parcel, and a lesser value for parcel area that cannot be developed due to streamside setback regulations. Purchasers essentially pay a premium for the developable portion.

Case Study Outcome: Metric for measuring influence of stream on parcel values

The Bowker research found that it is all about the "developable area" available for housing; with the $ per m^2 metric being the measure of "developable area value".

The Bowker findings further suggest that it would make sense to base a property acquisition strategy for stream daylighting on a value that blends NCA value and market price.

The question for a land economist is this: How does one separate the component values -- for developable and protected areas -- for a streamside parcel that incorporates a regulated setback zone for riparian ecosystem purposes?

Stage 3 (Mainstream) – Bings / Menzies Creek in the Municipality of North Cowichan

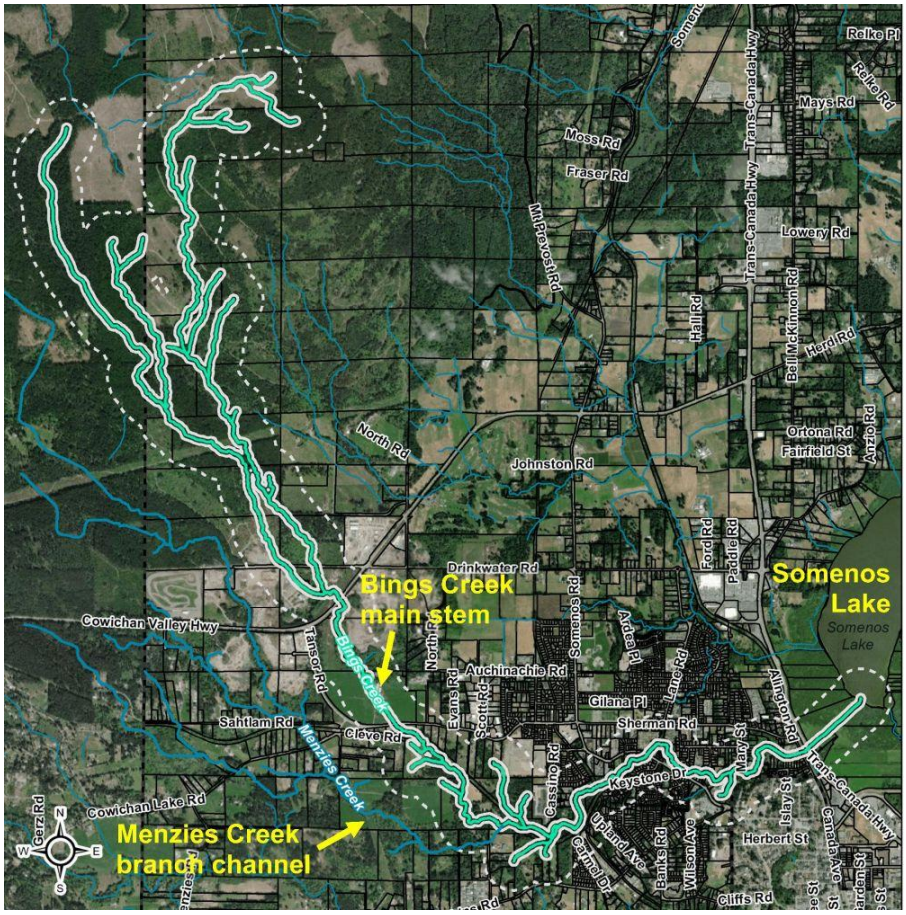
The Bings / Menzies stream system in the Municipality of North Cowichan (MNC), a small (1st order) creek, originates as two parallel channels on the slopes of Mount Prevost. Upstream from the Trans-Canada Highway, the two merge and flow under the highway into Somenos Lake. The stream is a landmark in the community landscape and in the cultural history of the Cowichan region First Nations.

Key Observations: MNC has a robust bylaw for streamside protection. Within the regulated setback zone, only about 9% of the area is impervious. However, the benefits of riparian protection are undermined by the upland strata development because the impervious coverage as a proportion of total strata area ranges from 49% to 75%. The average is 60%. These are extreme percentages.

Watershed History

"The big flowing creek of the past was big enough to hold salmon and canoes. People could travel up the creek into the base of the mountain. And when they got up there, they could take a detour and go up Menzies Creek up into the Hill 60 and Chemainus River area. So, imagine once again, that these creeks were highways from cultural and hunting areas to the village of S'aumna. The base of these creeks, and the whole way up for that matter, would be populated with homes, people, and artifacts."

– Cowichan Tribes oral history



Why we selected Bings / Menzies Creek

Viewed through an environmental lens, the Bings and Bowker case studies are at opposite ends of the land use continuum. The defining difference is streamside setback regulation, or lack thereof.

The Bowker creekshed was fully urbanized in the last century, and well before the *Fish Protection Act* became law in 1997. In stark contrast, the protected stream corridor for Bings Creek is the central feature around which urban development has taken place in this century. Comparison of these contrasting realities adds new insights.

In the Bings creekshed, strata parcel development is a dominant land use. It replaces native vegetation from 60% or more of the parcel area with hard (impervious) surfaces and alters what remains.

This scale of landscape alteration has a material impact because it short-circuits pathways by which water would naturally reach the Bings Creek channel. This conclusion is validated by the streamflow history as recorded by the Bings Creek gauging station.

Case Study Outcome: Why the NCA value is a measure of the Riparian Deficit

The most important finding is that the NCA value for the Bings urban area is relatively low compared to several other EAP case studies. A deeper dive into the analysis led to the observation that MNC policies and regulations - notably ***Development Permit Area 3 – Natural Environment (DPA3)*** *– have prevented subdivision of large parcels abutting the stream.*

Understanding what the numbers are telling us led to a breakthrough in the evolution of the EAP methodology as a tool to support integration of stream systems into Asset Management Strategies. We describe this new concept as the "riparian deficit". In effect, DPA3 has minimized the order-of-magnitude of the deficit when compared to other case studies.

A comparatively low value is a positive indicator of the effectiveness of streamside setback regulation.

Context for Two Big Ideas

Viewed through the EAP lens, the strategic importance of the Bings / Menzies Creek project as a building block is that it culminated in the concept of the **Riparian Deficit** as the environmental equivalent of the **Infrastructure Liability** (gap or deficit). This is a powerful outcome.

EAP is about ensuring that streams survive in an urbanizing setting. The riparian deficit concept adds balance to the asset management conversation by giving equal weight to the environmental protection perspective and associated financial case for stream systems.

EAP addresses loss of riparian integrity as a stream health factor *(Big Idea #15):* All EAP building blocks are important, but Bings is especially significant because it closed the EAP analytical loop vis-à-vis the **Road Map for Protecting Stream System Integrity** (explained in Part C). It allowed us to unequivocally state, this is how communities can reconnect hydrology and stream ecology by design.

NCA value is a measure of the Riparian Deficit *(Big Idea #16):* The NCA financial value alerts communities to the extent of alteration of the riparian features and hydrology of the stream system. This is the Riparian Deficit. The term accounting is key to this process. Simply put, it asks the question: How well are we doing?

Stage 3 (Mainstream) – Saratoga Miracle Beach in the Comox Valley Regional District

Located north of the municipalities of Courtenay and Comox, the Saratoga Miracle Beach study area within the Comox Valley Regional District (CVRD) is defined by its **"water assets"**. The predominant features are Black Creek and two high-value wetland complexes - the Saratoga (Clarkson) wetlands, and the wetlands surrounding the Black Creek slough. Black Creek is a highly productive fish-bearing stream.

The defining nature of these water assets is underscored by the fact that almost half of the existing 603 parcels are within 200 m of a water asset. The presence of wetlands differentiates the Saratoga Miracle Beach EAP Project from the other EAP case studies, and thus adds a new dimension to the EAP analysis.

The CVRD anticipates using this work, together with the Master Drainage Plan and flood mapping work, to inform the development of new regulatory tools and to assist in communicating the value of these natural assets to the public during future community engagement.

Key Observations: CVRD is looking at the impacts of land use changes on natural features, notably water assets. EAP findings would help CVRD understand what is happening at the parcel scale and how the consequences for water assets could play out over time.

EAP findings would support CVRD efforts to inform and educate parcel owners about the need for, and value of, a Drainage Service Area as a mechanism to avoid the future cost of water asset remediation.

Landscape Character and Water Assets

Streams as well as wetlands play a significant role in the location of development of the Saratoga Miracle Beach Area.

Why we selected Saratoga Miracle Beach

Saratoga Miracle Beach is one of three electoral area "settlement nodes" identified in the CVRD Regional Growth Strategy. During planning work undertaken in 2018, the importance of preserving and enhancing the natural function of the drainage systems in the area was identified. The EAP Project builds on that body of work.

Previous EAP case studies looked at a single stream channel and a riparian setback zone. For Saratoga Miracle Beach, the **"water assets"** distinction reflects the need for a slightly modified approach to the EAP analysis. A further distinction is that the EAP analysis is an input to the decision process for land development and proactive environmental protection.

Case Study Outcome: An opportunity to be proactive, not reactive

The other EAP case studies consider the consequences of historical land use decisions, local governments are in reactive mode, and the spotlight is on how to move from stop-gap remediation to lasting restoration.

CVRD, on the other hand, can learn from the mistakes of others, be proactive in protecting the integrity of water assets, and avoid the need for future remediation of water assets.

The unique aspect of the Saratoga Miracle Beach EAP Project is that the research looked at ALL the parcels in the study area. This yields a more complete picture than otherwise might be possible with other approaches to land use analysis.

Context for the Big Idea

The modified approach for Saratoga Miracle Beach involves breaking the study area into the five sub-areas. Because EAP is all about drilling down to the parcel scale, the modified approach allowed us to take a close look at the interplay between parcel conditions and water assets.

The EAP analysis provides the CVRD with metrics to better understand the link between land use practices and impacts on hydrology and woodland/riparian assets. If the community wants to continue accessing the ecological services of the water assets in the area, there must be water balance outcomes as land use (growth) continues. In short, this means that discounting of water assets must cease.

An implementation mechanism would be a Drainage Service Area *(Big Idea #17):* The Saratoga Miracle Beach Master Drainage Plan is a companion to the EAP analysis in three substantive ways: 1) creates a framework that can be applied to future land use decisions to protect the **water assets**; 2) sets out performance targets for replicating hydrologic function by design; and 3) identifies an implementation mechanism (as described below) to operationalize the plan for protecting stream system integrity.

"*Establishing a* **Local Service Area** *for drainage and stormwater management would be initiated with the first development and can be expanded with each subsequent development, whether a subdivision or other type of development. The funding is through an annual parcel tax based upon the costs to operate and maintain the stormwater and drainage infrastructure. In this way any future costs can be recovered by the users of the system without affecting the budgets of the CVRD*."

Stage 3 (Mainstream) – Bertrand Creek in the Township of Langley

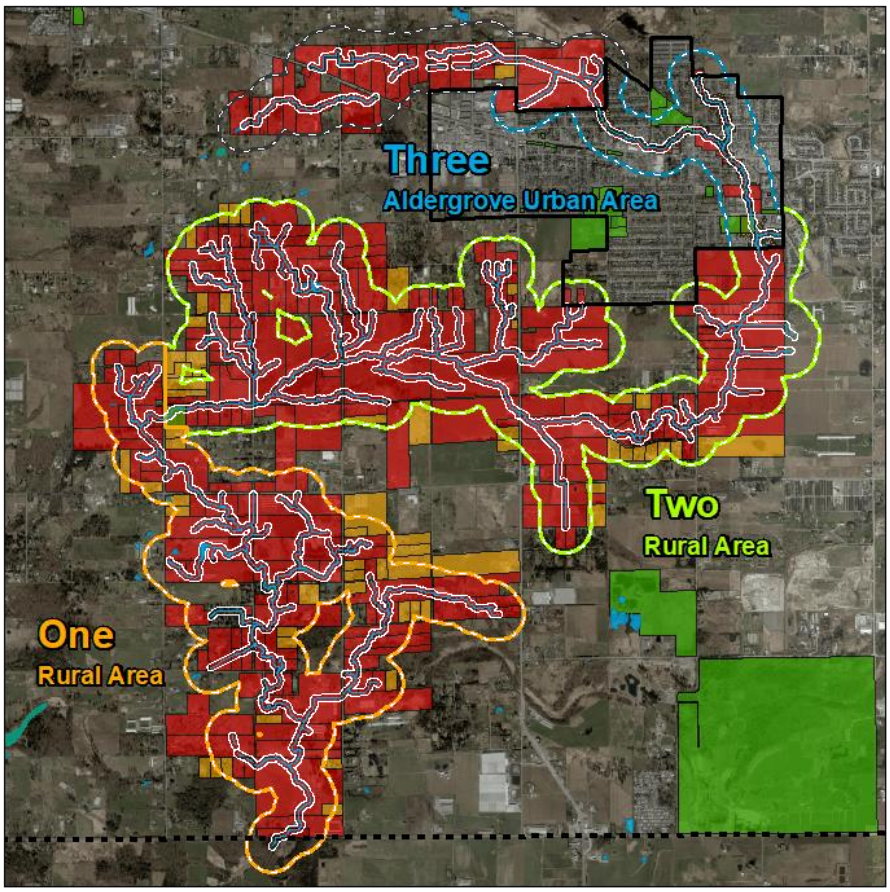
Bertrand Creek and its tributaries drain the southeast quarter of the Township of Langley and is a transboundary watershed. The Bertrand system occupies 14% of the municipality's total land base The main stem originates in a rural area, swings through urban Aldergrove, and flows south through agricultural land into Washington State. There, it discharges into the Nooksack River.

Key Observations: The Township has developed a strategy that would allow it to compensate rural parcel owners for on-parcel M&M and restoration of ecological assets. EAP metrics would support a strategy to increase M&M of riparian assets and woodland assets that are essential for the condition of the stream system. It is therefore a natural alignment of two precedent-setting approaches.

Payment for Ecological Services

Beginning in 2016, the Township of Langley has undertaken a project called the Langley Ecological Services Initiative (LESI) with the goal of applying M&M actions in the Bertrand Creek riparian corridor.

The rationale for payment of such works is two-fold: first, that the opportunities to improve riparian conditions are found in the rural areas; and secondly, that the services provided in the rural areas would then benefit the entire community.



Why we selected Bertrand Creek

The community values the Bertrand Creek landscape. The EAP focus on Bertrand occurs in a framework of policy and actions which protect the environment and natural assets.

The question is, how can EAP support the case for payment? In a nutshell, the answer is that EAP yields data and the understanding that would allow the Township to implement the strategy for Payment of Ecosystem Services in a way that is equitable for all residents.

Context for the Big Idea

Through the case study building blocks, EAP research has proven the validity of using parcel information for quantitative and qualitative analysis of land use impacts on the condition of stream systems.

Moreover, the NCA unit value is a measure of the Riparian Deficit. Thus, it is the lynchpin for Payment of Ecosystem Services. The loss of riparian/woodland assets in urban Aldergrove has created a Riparian Deficit that is 10 times greater than that of the rural area.

EAP quantifies the magnitude of the Riparian Deficit thus supporting equitable urban / rural mitigation investment *(Big Idea #18):* The rural parcel areas offer considerable opportunity to undertake M&M of riparian and woodland assets, whereas opportunity is limited in urban Aldergrove. The Bertrand Creek EAP Project has provided the Township of Langley with information it needs to answer the following research question:

> **What is a fair method to compensate rural parcel owners who are willing to commit areas of their land to riparian and woodland maintenance and/or enhancement to support the condition of Bertrand Creek?**

The concept is to fund riparian restoration in the rural area through a parcel fee on urban parcels. The 1% Guideline for Annual M&M Investment establishes the annual amount to be set aside in a fund. The NCA unit value, expressed as $ per m^2, establishes a Unit Ceiling Rate for compensating rural parcel owners who commit areas of their parcels to maintenance / enhancement of riparian and woodland areas. This work would help offset the Riparian Deficit in urban Aldergrove.

Quantification of riparian & woodland data are measures of assets retained or lost

The Riparian Areas Protection Regulation defines the "streamside protection and enhancement area" ***(SPEA)*** *needed to support stream function and fish habitat. However, it does not address the condition of the riparian and woodlands assets within this zone.*

NCA information enables evaluation of the extent to which development and land use, whether urban or rural, alter streams. EAP uses four variables to describe and quantify the condition of riparian and woodlands assets. These are:

Area of the setback zone

Extent of abutting parcel intrusion into setback zone

Area of woodland cover within the setback zone and adjoining upland area extending 200m beyond the 30m setback zone

Condition of riparian and woodland cover based on type of vegetation and proximity to the stream

Reflections on the EAP Journey

What Will Change?

The 6-year program of case studies is best described as a journey. It took a building blocks process to reach the destination, the Riparian Deficit. This metric enables local government to pose and answer the question: **What will change when EAP analyses provide financial values for natural assets such as streams?**

What is required to integrate "Natural Assets" into *Asset Management for Sustainable Service Delivery: A BC Framework*

Having arrived at the destination, we are able to reflect on the two issues which provided context for the journey: first, engineering measures for stream and riparian protection are insufficient; and secondly, the link to municipal asset management has not been clear.

To reach the destination, we had to address and show how to overcome four challenges: one, a lack of measurable metrics; two, confusion over **what is an asset versus a service**; three, ignorance about how to quantify the financial value of "natural assets" with real numbers; and four, numerous "one-off" projects that fail to build improved asset management practice.

Overarching all this is interdepartmental communication: Simply put, the elephant in the room is the question of how to create a situation where the environmental perspective is on an equal footing with the engineering and accounting perspectives.

Only then can there be an effective conversation about annual budgets for maintenance and management (M&M) of assets, whether those are constructed assets or the natural component of the Drainage Service.

For an inter-departmental conversation to be outcome-oriented, there must be a real number to focus attention on what is at stake. The Riparian Deficit is that metric. By employing it, local government will have a reliable and useful measure for stream M&M within an asset management framework for sustainable service delivery. Moreover, it is the outcome of a collaborative and robust process that benefitted from a range of applied research applications.

"Riparian Deficit" is a measure of land use intrusion

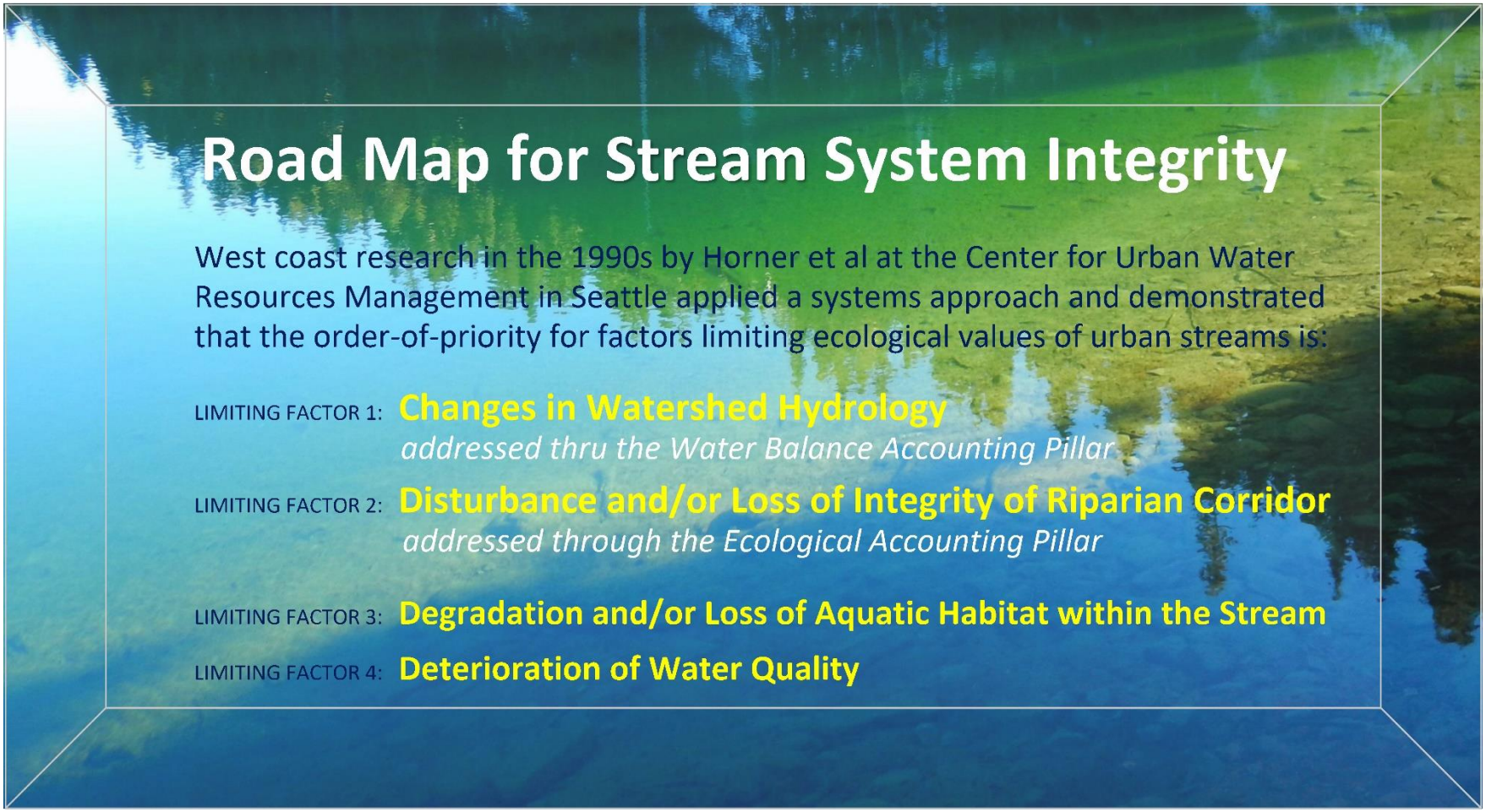
PART D

Hydrology is the Engine that Powers Ecological Services

To provide the reader with an elementary understanding of core hydrology concepts, this Part D is structured in three sections:

1. ***Story Behind the Story of the Water Balance Pillar***
2. ***Water Balance Accounting Pillar Addresses "Changes in Hydrology"***
3. ***Reconnect Hydrology and Stream Ecology by Design, and Restore Stream Integrity***

Figure D1


Road Map for Stream System Integrity
West coast research in the 1990s by Horner et al at the Center for Urban Water Resources Management in Seattle applied a systems approach and demonstrated that the order-of-priority for factors limiting ecological values of urban streams is:
LIMITING FACTOR 1: Changes in Watershed Hydrology
addressed thru the Water Balance Accounting Pillar
LIMITING FACTOR 2: Disturbance and/or Loss of Integrity of Riparian Corridor
addressed through the Ecological Accounting Pillar
LIMITING FACTOR 3: Degradation and/or Loss of Aquatic Habitat within the Stream
LIMITING FACTOR 4: Deterioration of Water Quality

1. Story Behind the Story of the Water Balance Pillar

What Happens on the Land Does Matter!

EAP is the culmination of a 25-year journey. This began with seminal research by Chris May, Richard Horner, and others at the University of Washington in the 1990s. They correlated land use changes with the impacts on stream condition, identified four limiting factors, and ranked them in order of consequence from an ecological perspective.

The ranking shown in **Figure D1** is the road map for science-based action to protect and/or restore stream integrity. The order of priority recognizes that the top two consequences of **changes in land use** are: 1) short-circuiting of water balance pathways, and 2) loss of riparian integrity.

Twin Pillars of Stream System Integrity

The "twin pillars" of stream system integrity, conceptualized as **Figure D2,** build on this science-based understanding. The Water Balance Accounting pillar addresses "changes in hydrology" on the land draining to the stream. The Ecological Accounting pillar addresses "loss of riparian integrity" within a stream corridor.

Linkage of the two pillars would be the over-arching goal of a **Sustainable Funding Plan for the Drainage Service**. Because it determines eligibility for senior government grants, alignment with *Asset Management for Sustainable Service Delivery: A BC Framework* provides local governments with the incentive to go down this path.

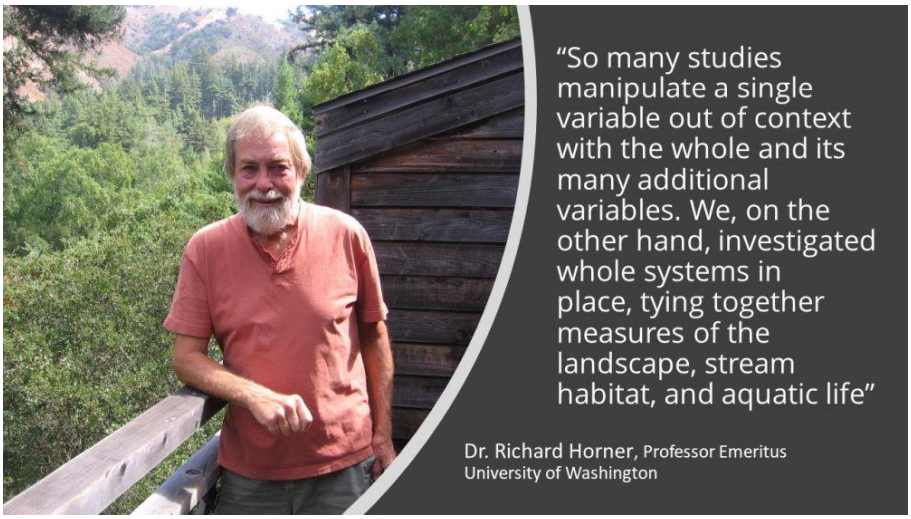
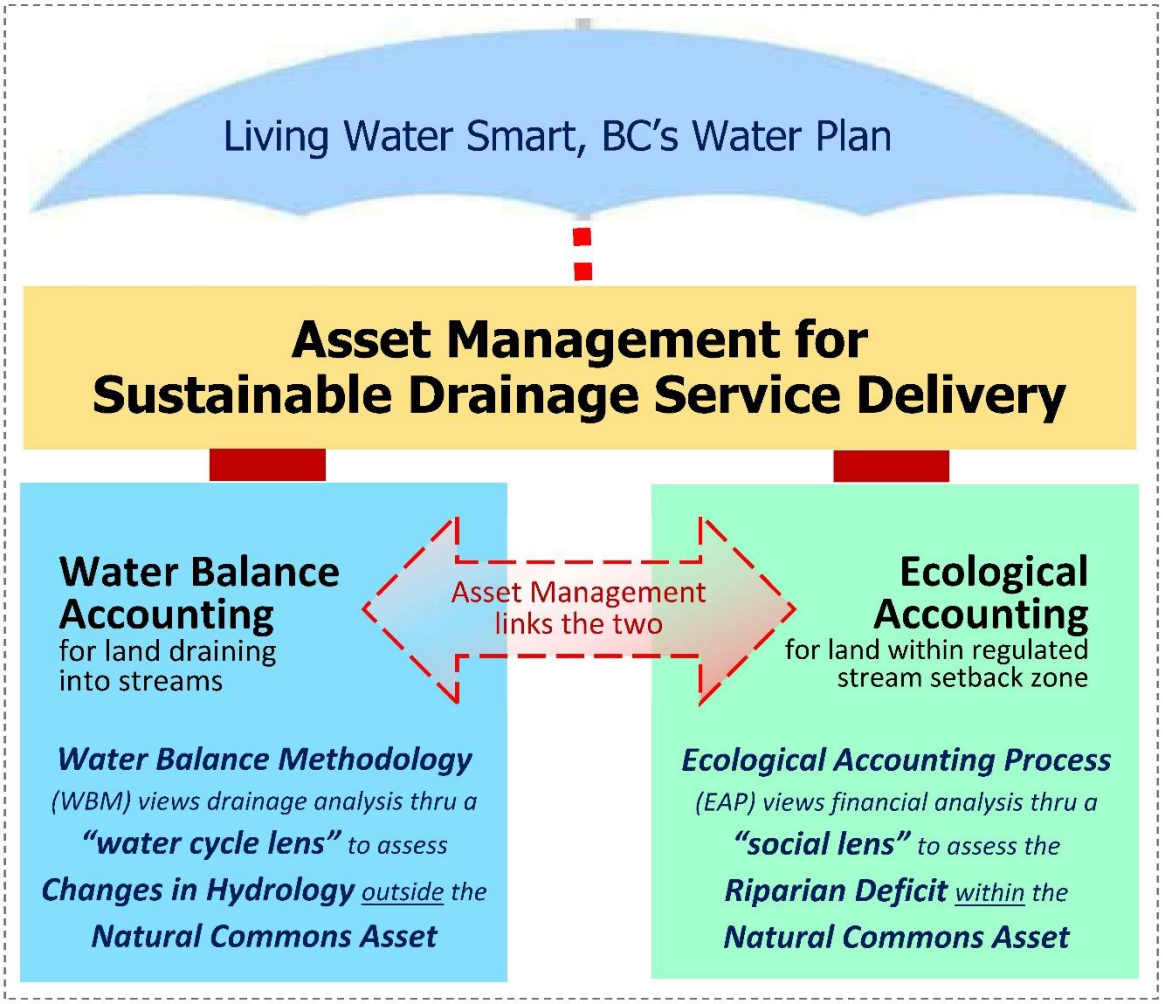


Figure D2

Twin Pillars of Stream System Integrity



Hydrology is the Engine that Powers Ecological Services

Source: The "road map" introduced as Figure 60 on page 156 in *Beyond the Guidebook 2015: Moving Towards "Sustainable Watershed Systems, through Asset Management"*. Released by the Partnership for Water Sustainability, November 2015

Mimic the natural Water Balance

Richard Horner and Chris May had a clear message for land use and drainage practitioners: changes in hydrology, not water quality, must be the primary focus of their efforts. If one gets the hydrology right, water quality typically follows takes care of itself in a residential development.

“Unless and until land development practices mimic the natural water balance, communities cannot expect to restore the biological communities within streams. Simply put, hydrology hits first and hardest - one could pour an equivalent volume of distilled water into a stream, and the consequences for stream health would be the same as if it was urban runoff,” emphasized Richard Horner in an interview.

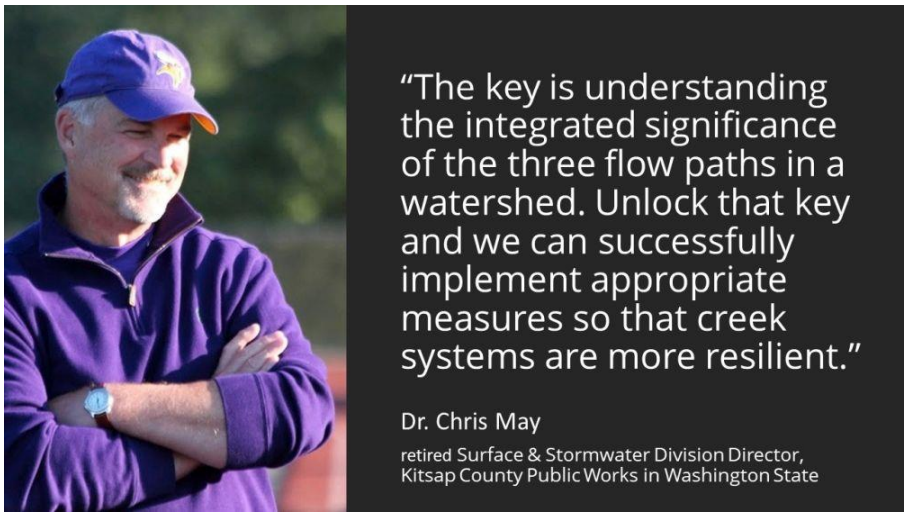
Work at Multiple Scales

“Retrofiting at multiple scales and multiple levels is really key. But, so many people in local government are just too busy these days to even contemplate what needs to be done to repair and restore at multiple scales and levels. As a result, and especially in the big urban cities, it is just too difficult for local government staff to work concurrently at multiple scales,” stated Chris May.

“Kitsap County in Puget Sound is at a manageable scale to effect change and make things better. We have applied the Whole Systems concept to develop our strategy for watershed retrofit and rehabilitation – it is not sufficient to do only a single or even a few things - it is necessary to do everything! We know we need to work at multiple scales and multiple levels to improve conditions in our small stream watersheds – that’s our strategy.”

Understand the Watershed as a System

For two decades, Chris May put science into practice in Kitsap County, his living laboratory for testing a hydrology-based approach at multiple scales to cope with an altered flow regime.



Stormwater Planning: A Guidebook for British Columbia

Released in 2002, Stormwater Planning: A Guidebook for British Columbia built on Washington State science to pioneer a natural systems approach to rainwater management. This resulted in BC achieving international recognition as a leader for **"re-inventing urban hydrology"**. The Guidebook opened the door to implementing a performance target approach to "designing with nature".

Water Balance Accounting Pillar

The Guidebook premise that land development and watershed protection can be compatible represented a radical shift in thinking in 2002. The Guidebook recognized that water volume running off land and into streams is something over which local government has control through its infrastructure policies, practices, and standards.

The Guidebook is also a pioneer application in North America of an adaptive approach to urban drainage. This means learning by doing. The guiding principle is: *"Change direction when the science leads to a better way."* In other words, the adaptive approach is outcome-based.

In addition to **Adaptive Management**, the Guidebook is known for two other concepts which were also landmark innovations. Concept #1 is the **Integrated Strategy** for managing all the 'rainfall-days' that occur each year, rather than just the extreme storms. Concept #2 is the use of **Performance Targets** for replicating flow-duration curves characteristic of natural streams. These concepts are operationalized through application of the Water Balance Methodology and its metrics.

Hydrology Powers Stream Ecology

Part D serves as a hydrology primer so that readers will have a basic understanding of what is important to know.

In this Part D, we elaborate on the Water Balance Accounting pillar.

Then, in Part E, we explain the Ecological Accounting pillar.

"In the United States, too often we see a cookie-cutter approach when guidebooks and manuals are replicated across the country. Not so with the British Columbia Guidebook – it is unique and it is innovative."

Tom Schueler
founder (1992) & former Executive Director,
Center for Urban Watershed Protection, Maryland

Beyond the Guidebook Series

The Beyond the Guidebook Series builds on the Stormwater Guidebook foundation. It exemplifies "adaptive management in action". In 2002, the Guidebook Steering Committee made many decisions, some that were strategic in nature and others where the policy implications were far-reaching.

Historical Context: A strategic decision was to use the word **stormwater** in the guidebook title. In 2002, this plain word provided local governments with a "point of departure" because it was a term they recognized. A goal was to open minds to a paradigm-shift to a landscape/watershed-based approach to community planning. In 2005, this description was simplified to "water-centric planning".

The word stormwater was popularized by the US Environmental Protection Agency, beginning in the 1970s. Use of the word superseded the term drainage in the technical lingo by the 1990s. In BC, the Stormwater Guidebook is the technical and philosophical foundation for evolving a **"water-centric framework"** over time.

The vision for the Beyond the Guidebook Series took shape at an inter-ministry meeting in 2005. Then, it was recognized that it would take time to undertake case studies that would build momentum for a paradigm-shift to "move beyond the guidebook".

Beyond the Guidebook 2007 is the first milestone. It marks the shift in terminology from the narrowly focused *STORMwater* management to the multi-objective *RAINwater* management.

Beyond the Guidebook 2010 is the second milestone. This guidance document illustrates the power of the "regional team approach". It tells the stories of how change is implemented by embedding a stewardship culture. The title says it all: *Implementing a New Culture for Urban Watershed Protection and Restoration*.

Beyond the Guidebook 2015 reports on progress after a decade by local governments on the east coast of Vancouver Island and in the Lower Mainland. It also foreshadows how communities can shift the ecological baseline and replicate a desired condition through **Asset Management for Sustainable Drainage Service Delivery**.

Beyond the Guidebook 2022 springboards from the previous guidance document and is about the Ecological Accounting Pillar. The title says it all in framing a path forward for natural asset management: **A BC Strategy for Community Investment in Stream Systems**.

Story Behind the Guidebook Story

The story behind the story is about the visionary leadership of the Ministry of Environment's Peter Law, Chair of the Guidebook intergovernmental steering committee. Without Peter Law, there would have been no Guidebook. Peter saw the need, garnered support within government, and was hands-on in shepherding the Guidebook from inception to completion.

When the Partnership for Water Sustainability morphed from an intergovernmental technical committee into a non-profit legal entity in 2010, the Ministry of Environment entrusted the Partnership with responsibility as stewards of the Guidebook. Peter Law is a founding Director of the Partnership.

"The Ministry of Environment appreciates that the Partnership for Water Sustainability embraces shared responsibility for *Stormwater Planning: A Guidebook for British Columbia* and is also adding depth to the Guidebook through the *Beyond the Guidebook Series*," stated Wes Shoemaker, former Deputy Minister, in a letter to the Partnership (February 2016)

A stream is a system

Peter Law had a clear and pragmatic vision for developing a Stormwater Guidebook for British Columbia. Guided by a mantra of "affordable and effective", the Guidebook team built on Puget Sound research and validated a "made in BC" approach through case study experience.

A stream is a system, but that is not how land and drainage practitioners treat streams. Moreover, high-level policy statements are often not helpful. To achieve the twin goals of stream stability and aquatic habitat protection, the Guidebook team literally had to re-invent urban hydrology. These one-two drivers resulted in the Water Balance Methodology which transcends the 'voodoo hydrology' and simple equations that characterize standard engineering practice.

How the Guidebook journey began

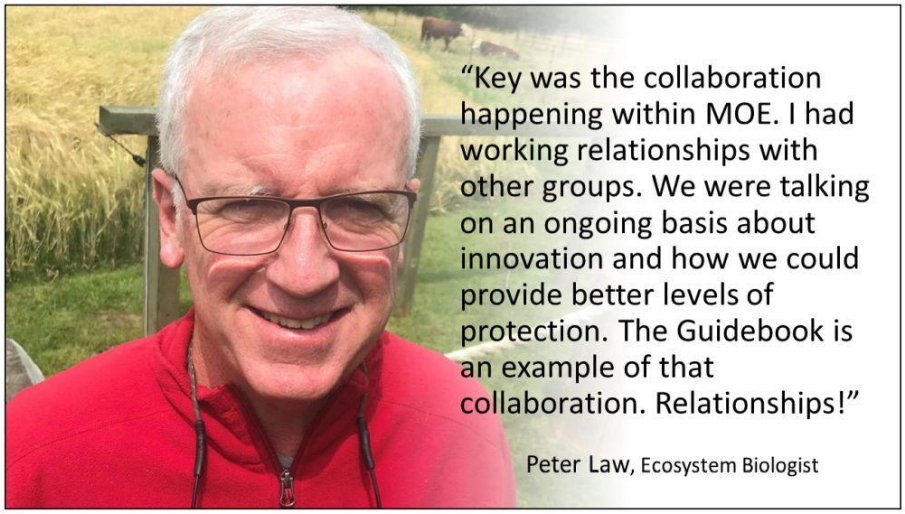
"In 1996, I was a member of an inter-ministry working group tasked with developing the streamside protection regulation to support the Fish Protection Act," recalls Peter Law. "A defining moment was a consultation workshop hosted by the Union of BC Municipalities in October 1997. The presentation on the **science of land use change** by Kim Stephens and Bill Derry helped us realize that we needed more than a setback to protect aquatic habitat."

"The science showed that communities also needed to tackle what was happening on the land that drains to streams. This realization set in motion two parallel paths, the Streamside Protection Regulation which eventually became the Riparian Area Regulation (RAR) and Stormwater Planning: A Guidebook for British Columbia. The focus of streamside setbacks is to protect fish and fish habitat."

"For the Guidebook path, I found the opportunity to 'look beyond the stream' and address poor water quality from drainage runoff in the Waste Management Act. The opportunity resided in the non-point source (stormwater) provision for Liquid Waste Management Plans."

SmartStorm Forums

The action item flowing from the UBCM workshop in 1997 was a series of four events: Vancouver Island (Nanaimo in January 1999), Sunshine Coast (Sechelt in September 1999), and the Fraser Valley (Abbotsford and Pitt Meadows in March 2001). This created momentum to develop the Guidebook.



The Guidebook journey was a 5-year process

"Relationships and collaboration between branches - that is how we moved the Guidebook idea forward within the Ministry of Environment," continues Peter Law. "After the success of the first of the SmartStorm Forums in January 1999, I made a pitch to the Regional Director and Section Head for Waste Management. They saw the utility in the idea. The next step was getting buy-in from a senior manager in Victoria. She thought the idea made a lot of sense."

"Then, out of the blue, Environment Canada stepped up to co-fund the Guidebook and assign a co-chair (Laura Maclean) who was terrific in that role. This was the first game-changer. The second game-changer was a sentence in a letter from the Minister of Environment that **encouraged** the Regional District of Nanaimo to upgrade the stormwater component of its LWMP. The stars had aligned!"

"Stormwater Planning: A Guidebook for British Columbia was developed to provide guidance for the 'stormwater component' of LWMPs. The regulatory significance is that the Minister approves the plan. This creates a legal obligation on the part of local governments."

Water Balance Methodology enables performance targets

"The Guidebook process straddled two provincial government administrations. The potential implication of a change in government is illustrated by what happened to the streamside protection regulation. The previous order-in-council for the Streamside Protection Regulation was rescinded in 2001. It was 2006 before the replacement Riparian Areas Protection Regulation became law," explains Peter Law

"Meanwhile, the Guidebook rolled out smoothly. The Guidebook's reliance on case studies combined with the emphasis on performance targets aligned with the philosophy of the Premier and cabinet."

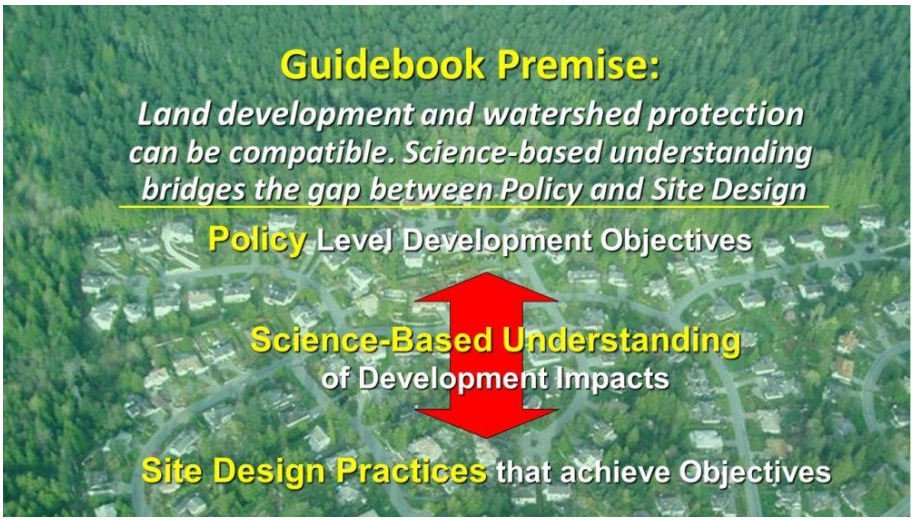
Breakthrough after breakthrough: "In 1997, Washington State science defined and correlated the nature of the land use problem. Their breakthrough was in establishing impervious area thresholds for irreversible impacts on stream ecology."

"Bill Derry believed that BC would leapfrog Washington State. He was proven right. In 2000, the BC breakthrough was development of the Water Balance Methodology. It gave communities a path forward to tackle changes in watershed hydrology at the source - that is, on individual properties."

The Guidebook premise: "The volume-based Water Balance Methodology enables Water Balance Accounting. The methodology allows local governments to establish achievable performance targets to slow, spread and sink rainwater runoff in order to mimic and/or restore the natural flow patterns in streams," emphasizes Peter Law.

"When the Guidebook was released, this capability to set targets gave the steering committee the confidence to be bold and state: **land development and watershed protection can be compatible**. In 2002, this statement represented a radical shift in thinking. It became known as the Guidebook premise."

"If all the players would embrace shared responsibility to **Design With Nature**, communities could move from stopgap remediation to long-term restoration of properly functioning streams. We are not there yet."



Twin Pillars for Stream System Integrity

Restore the natural Water Balance

Communities can embrace the need to move beyond stopgap fixes by applying M&M strategies that further prevent degradation and improve stream condition, respectively.

A generation ago, Washington State science provided the road map for science-based action to protect and/or restore stream system integrity. In 1997, the Fish Protection Act was the point of departure for both the Riparian Areas Protection Regulation and the Guidebook.

By 2002, the Water Balance Accounting pillar was in place, yet implementation has been spotty due to a lack in regulatory oversight. Twenty years later, EAP provides the metrics to operationalize the Ecological Accounting pillar through a local government's strategy for sustainable drainage service delivery. This is potentially game-changing, but only if communities embrace the need to move beyond stopgap fixes and actually restore the natural balance distribution.

2. Water Balance Accounting Pillar Addresses "Changes in Hydrology"

In the 1990s, Puget Sound research in Washington State's part of the Salish Sea was game-changing in nature and yielded the science-based understanding that is the foundation for Stormwater Planning: A Guidebook for British Columbia.

A generation later, the Puget Sound findings have renewed meaning. This section provides the reader with a basic understanding of how the Water Balance Methodology addresses "changes in hydrology".

Water Balance Pathways and Distribution

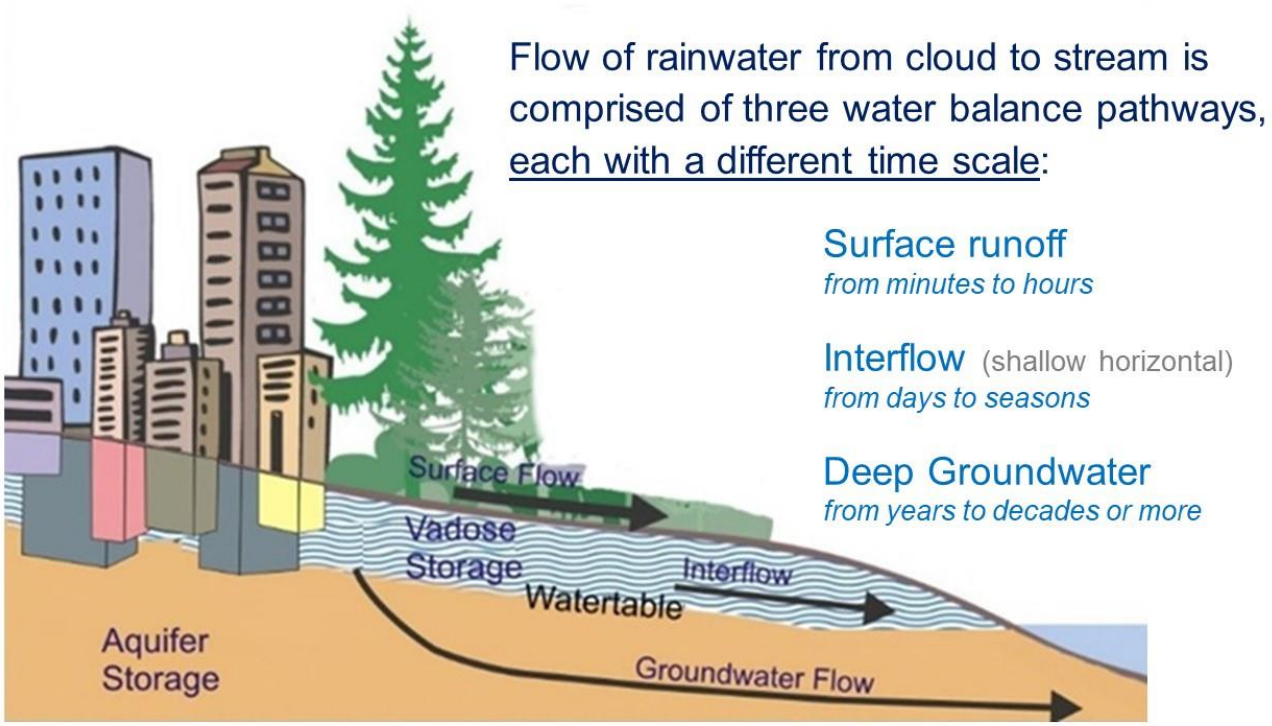
An expanded view of the **water balance pillar** is presented as **Figure D3**. The top image illustrates the three pathways that comprise the water balance. The bottom image provides context for dealing with uncertainty and managing risk.

The guiding principle for application of the Water Balance Methodology is to maintain the proportion of rainwater volume entering the stream via each pathway. The table below provides context.

It underscores the relative magnitude and importance of the interflow component of a properly functioning watershed system in coastal British Columbia. The interflow component has historically been eliminated when land development activities alter the landscape.

	Annual Water Balance by Region				
Flow Paths	Coastal BC	Alberta - Edmonton	Ontario - Ottawa	Nova Scotia	Maryland
Precipitation	**100%**	**100%**	**100%**	**100%**	**100%**
Evaporation	20%	92%	40%	28%	40%
Streamflow	**80%**	**8%**	**60%**	**72%**	**60%**
Surface Runoff	10%	4%	10%	10%	10%
Interflow	**60%**	3%	25%	52%	25%
Aquifer Flow	10%	1%	25%	10%	25%

Figure D3



Stream Integrity

This deceptively simple equation embodies the basic principles and concepts for dealing with uncertainty and managing risk

Climate change is not a driver; rather, it is another variable.

The Water Balance

OUT = IN

IN = *f*unction of climate, season, durations of wet and dry periods, and….

OUT = *f*unction of land uses, integrity of water pathways, volume distribution by pathway, dry-weather recession pattern, and….

and where both sides of equation are variable!

What "Water OUT = Water IN" Means

The equation in the bottom half of **Figure D3** represents the essence of water balance thinking as applied to stream integrity. The **Water OUT = Water IN equation** was developed two decades ago to inform BC's Drought Response Plan for water supply in a changing climate.

As of 2015, Western North America has clearly crossed an invisible threshold into a different hydrometeorological regime. Summers in British Columbia are longer and drier. Winters are warmer and wetter. This new reality has major consequences for all aspects of water security, sustainability, and resiliency.

Context for Whole-System Approach

Both sides of the **Water OUT = Water IN equation** presented on **Figure D3** are variable. This means there are multiple *what if* combinations and permutations to consider. As a result, the inherent variability creates uncertainty which in turn creates risk.

The risk is compounded when local governments and communites fail to anticipate and address disturbance of water pathways when land use changes the hydrology of a creekshed. Whenever rainwater runoff is collected and conveyed away from development sites, it no longer has a role in sustaining interflow.

Building Resiliency on the Landscape: Communities must recognize that stream system condition is a function of water balance integrity and riparian integrity. Subdivision and development alter water pathways. The consequences are **degradation of aquatic habitat** and **deterioration of water quality**. These are the third and fourth limiting factors listed in the road map introduced previously.

The *Water OUT = Water IN equation* will always represent a snapshot in time as its' inputs shift, evolve and change over time. Because many factors are in play, a primary M&M goal for any stream system would be to build in resiliency on the landscape that addresses risk related to water pathways.

Climate change exacerbates vulnerability on the **'IN side'** of the equation. Thus, it makes sense to build in resiliency on the **'OUT side'**. There is no silver bullet. Communities need to do many little things related to land development and servicing practices – for example, preserving the interflow zone to maintain an absorbent soil sponge. Over time the cumulative benefits of doing many things do add up.

3. Reconnect Hydrology and Stream Ecology by Design, and Restore Stream Integrity

Interconnected Components of a System

The Drainage Service requires whole-system M&M strategies because the flow discharges from the constructed infrastructure have consequences for stream integrity due to the "changes in hydrology".

The phrase "changes in hydrology" refers to unbalancing of the natural water balance when alteration of the landscape short-circuits the three pathways (surface, interflow and groundwater) and the timing by which rainfall reaches a stream.

With the passage of time, awareness and understanding have been lost. This is a lesson learned. **Figure D4** conceptualizes how urban drainage infrastructure and a natural stream are interconnected components of a system. The functions of the constructed component are drainage collection, conveyance, and outfall to the stream.

In Section 2, we included a table that presented the water balance distribution by pathway. INTERFLOW is the most important of the three pathways. Yet it is the one most impacted by land use and drainage practices, past and present.

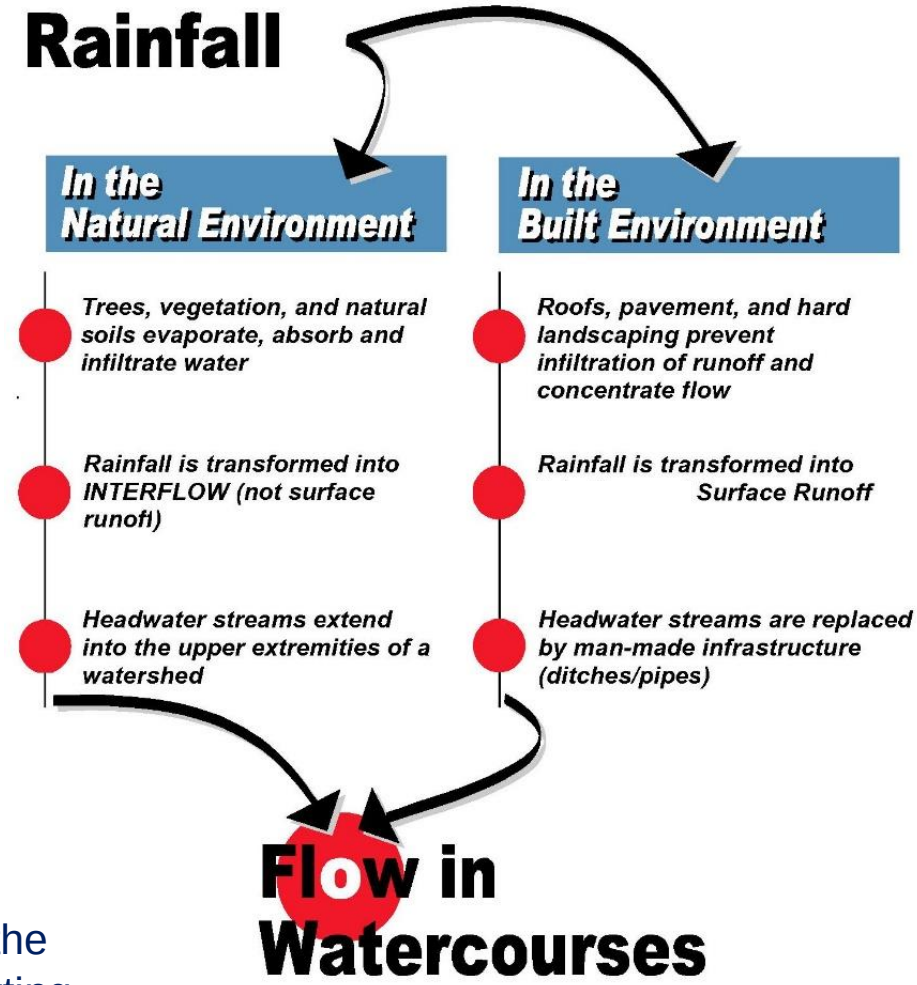
When interflow is eliminated in a fully urbanized creekshed, the previous introduced table shows that **surface runoff volume effectively increases 7-fold, from 10% to 70%**. Two decades ago, the Guidebook outreach program raised awareness of the urgency in protecting interflow.

What / So What / Now What / Then What

Figure D5 is the mind-map for reconnecting hydrology and stream ecology over time. The process starts with requirements and/or accepted practices for use and drainage of land. Hence, the spotlight is on parcels and the neighbourhood building blocks for community development. The opportunity to "get it right" is once in a generation.

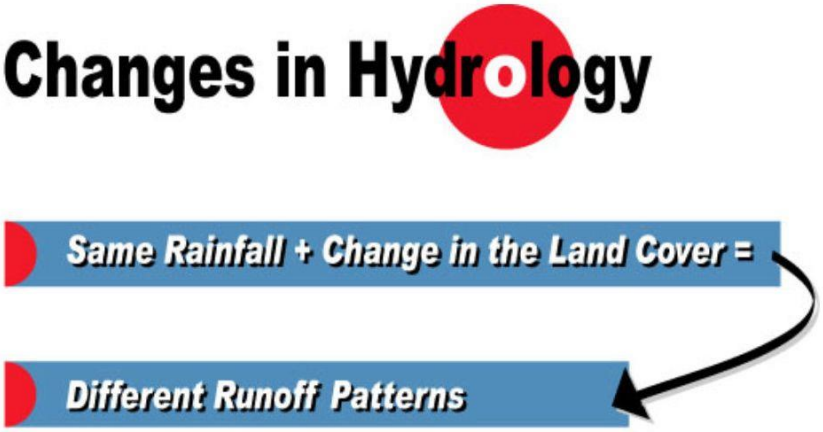
The Ecological Accounting Pillar adds another dimension which is to emphasize the condition and integrity of the riparian setback zone through neighbourhoods. It is often compromised by land use intrusion.

Figure D4



Natural and Built Environments are Inter-Connected in the Urban Drainage Setting

"Changes in Hydrology" refers to unbalancing of the natural water balance when alteration of the landscape ***short-circuits the three pathways*** *(surface, interflow and groundwater)* ***and the timing*** *by which rainfall reaches a stream.*



Source: *Stormwater Planning: A Guidebook for British Columbia*, 2002

Figure D5 - Reconnect Hydrology and Stream Ecology by Design

View the Stream as a System

A changing climate is altering the distribution of the seasonal water balance, and hence seasonal flow patterns (and related processes). This has both high-flow and low-flow consequences for streams. A whole-system approach to Sustainable Drainage Service Delivery that links the Water Balance Accounting and Ecological Accounting pillars would position a community to achieve five policy outcomes:

Water (Cycle) Balance Restored
Riparian Deficit Eliminated
Stream Erosion Prevented
Summer Base Flows Enhanced
Fish Survival Ensured

What the Stream Sees: Key Takeaways

Hydrology powers stream ecology. Core hydrology concepts are consolidated in the notes on **Figure D6**. And water levels corresponding to various flow conditions, both high and low, are superimposed on the image. This is an important visual because it captures so much information in one place.

The image illustrates what a stream cross-section sees at one instant in time. However, the whole-system approach requires that the cross-section view be extended in time like a movie or video. This is the context for two takeaways described next.

Takeaway #1: The stream and its discharges are **dynamic and constantly changing**. The important information in this more complete view of a stream as a system is the duration of flow over time, and how it changes with time.

Takeaway #2: How water gets to a stream, and how long it takes is not well understood, even among land and drainage practitioners. The flow of rainwater from cloud to stream is comprised of three water balance pathways: *overland, horizontal shallow interflow, and deep groundwater*. Yet the latter two are routinely ignored by planners and designers. Time, a critical factor, is also ignored.

Figure D6: What the Stream Sees - At One Instant in Time

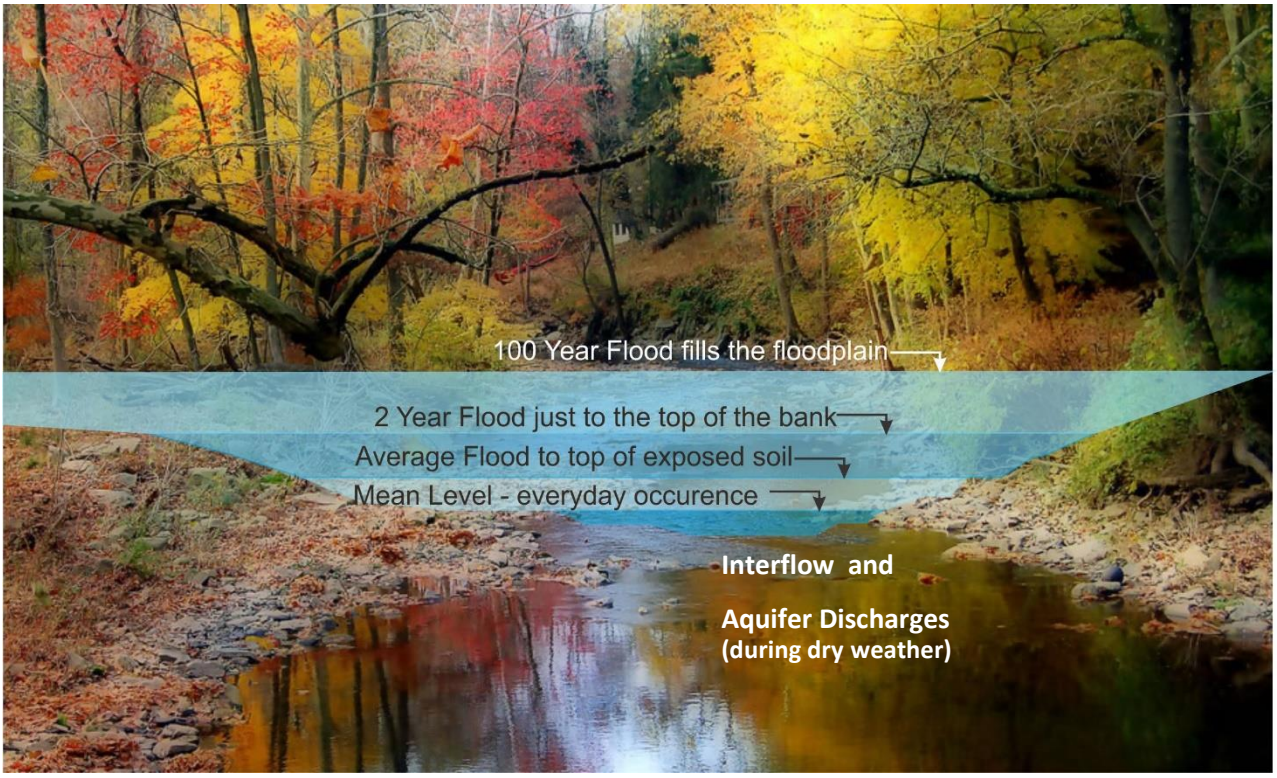


Image Credit: Jim Dumont, P.Eng.

Water levels corresponding to various flow conditions, both high and low, are superimposed on the image.

The complete story requires *the view to be extended in time like a movie or video. The stream and the discharges are dynamic and constantly changing. The important information in this more complete view is the duration of flow over time, and how it changes with time.*

Standard engineering practice is preoccupied *with the peak rates of flow for extreme events. These happen infrequently. This focus is the traditional design mindset for flood conveyance and protection. This single-purpose engineering objective does not account for the cumulative environmental impacts of all the other rainfall-days in a year. Most stream erosion is caused by comparatively small flow rates. These happen frequently and usually range between the mean annual flood and the 2-year flood event.*

A changing climate is altering the distribution of the seasonal water balance*, and hence seasonal flow patterns (and related processes). This has both high-flow and low-flow consequences for streams:*

- ***Warmer, wetter winters & high-flow periods*** *= reduced snowpack / accumulation (in high elevations) and less water in storage = more runoff volume for longer periods of time = stream channels erode = aquatic habitat degrades; and*
- ***Longer, drier summers & low-flow periods*** *= as the landscape dries out, discharges from both interflow and groundwater diminish = little or no flow in streams = streams may be unable to sustain human and/or fish needs.*

Reduced dry weather flows over longer periods of time result in numerous potential impacts, including: elevated water temperatures, isolation from riparian fringe, reduced water quality, discontinuation of channel flow, and habitat isolation.

Integration of the Twin Pillars

Earlier in this Part C, we introduced the 4-step What / So What / Now What / Then What mind-map. Next, we introduce **Table D1**. It illustrates how to apply the 4-step process and complements the Twin Pillars concept for sustainable drainage service delivery. The purpose of the table is to provide the reader with a conceptual framework for reconnecting hydrology and stream ecology over time.

Whole-System, Water Balance Approach

Table D1 conceptualizes considerations that shape a strategy for moving from stop-gap remediation to long-term restoration of stream channel and riparian corridor systems – by connecting land and water by design, and over time restoring water balance in altered landscapes.

Table D1 distills what the Partnership has learned over two-plus decades to populate the boxes in each of the four steps. The result is a synthesis of how to integrate M&M of the constructed and natural components of a drainage system under the umbrella of Asset Management for Sustainable Drainage Service Delivery.

Grow the Restorative Footprint: The essence of Table D1 is further distilled in the table below.

	Cascading Key Messages define "What Really Matters"	"Problem Statements" define Central Issues
WHAT	CALL TO ACTION - resolve problems caused by land use and infrastructure servicing practices	Get engineering and asset management practices right
SO WHAT	CORE BUILDING BLOCKS - protect water pathways that power ecological services	Current practices are source of an unfunded liability
NOW WHAT	DESIRED OUTCOMES – adapt to changing water cycle and reduce life-cycle costs	Sustainable Service Delivery has tangible benefits
THEN WHAT	MAINSTREAMING – grow the restorative footprint to improve where we live	Reverse the decline of the ecological baseline

Table D1 - RECONNECT HYDROLOGY & STREAM ECOLOGY

"Whole-System Approach" (4 Steps) to Integration of Built & Natural Environments

One, WHAT is the issue? **"Call to Action"**	*Two, SO WHAT can be done?* **"Core Building Blocks"**	*Three, NOW WHAT can we do?* **"Desired Outcomes"**	*Four, THEN WHAT? –* **"Mainstreaming"**
Under each step, Cascading Key Messages define "What Really Matters"			
Success in solving 'In your face' problems would mean:	***Integrating Natural Assets into Asset Management relies on understanding that:***	***There are paybacks when a community 'gets it right' with Sustainable Service Delivery:***	***Restorative development results in sustainable stream restoration:***
Less flooding	Hydrology is the engine that powers ecological services	**AVOID** an unfunded and unaffordable financial liability for drainage infrastructure	Require 'design with nature' standards of practice for drainage and servicing of land
Less stream erosion	Three pathways by which rainfall reaches streams are 'infrastructure assets' that provide 'water balance services'	**ADAPT** to a changing climate to restore the water balance and reduce risks	Shrink the destructive footprint while growing the restorative footprint
More streamflow when needed most	Taking action depends on what a community thinks a creekshed is worth.	**REDUCE** life-cycle costs for drainage infrastructure	Demonstrate what is achievable thru a restoration imperative
Below, each "Problem Statement" establishes Context & defines the Central Issues in the 4-Step Process			
Recognize that it is necessary to 'get it right' with respect to planning, engineering and asset management standards of practice – especially as they relate to and impact upon creekshed health and restoration - because "getting it right" would mean the sustainable and cumulative "community benefits" would then ripple through time	**Acknowledge** that there is a problem with current standard practices for servicing and drainage of land - and that these practices are the root cause of degraded urban streams – because 'getting it wrong' results in an unfunded and unaffordable infrastructure liability that is then a financial barrier to restoration of creekshed function	**Re-focus** local government business processes on outcomes so that they align with provincial policy, program and regulatory framework for **Living Water Smart** - which encompasses both the *Whole-System Approach* and *Sustainable Service Delivery* - and thereby achieve desired outcomes that would have tangible community and financial benefits	**Get it right**, across the province. B.C. is one of the last places on the planet where it is still possible to transcend the climate debate and lead by example. B.C. has enough remaining natural capital to protect and restore its way back to true sustainability. Improve where we live.

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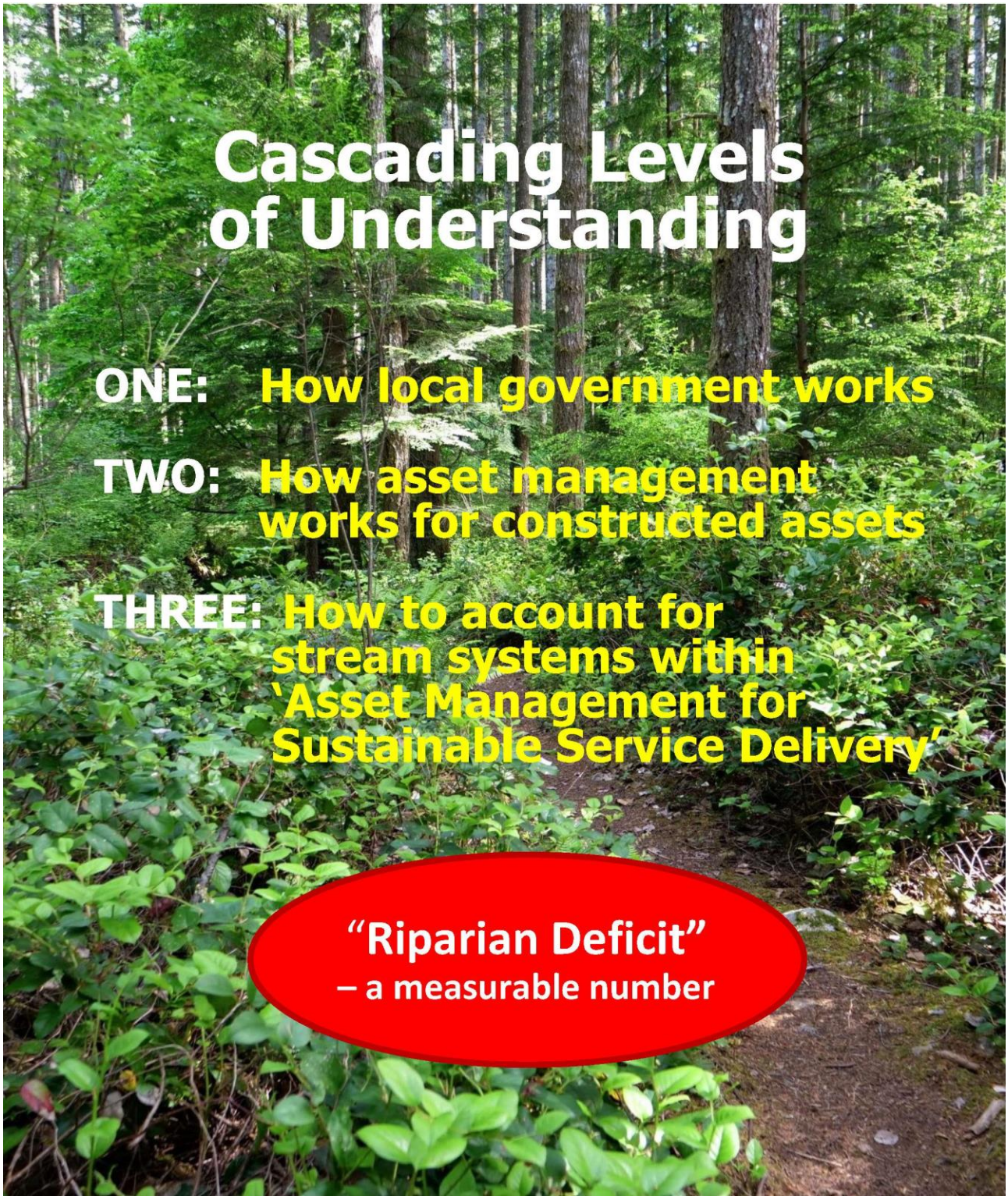
PART E

A Stream System is a Land Use

To provide the reader with an overview of how the financial value of the stream system is determined and how it can used in sustainable service delivery, this Part E is structured in six sections:

1. ***Story Behind the Story of the Ecological Pillar***
2. ***A Stream System is a Natural Commons***
3. ***Ecological Accounting Pillar Addresses the Riparian Deficit***
4. ***Central Ideas of the EAP Methodology***
5. ***Overview of the Research Framework***
6. ***Financial Case for the Stream: Key Findings***

Figure E1 – Overarching Context for Ecological Accounting Process



1. Story Behind the Story of the Ecological Pillar

Local Government Context for EAP

Part C explained the building blocks process for evolving EAP over a 6-year period. Next, this Part E elaborates on the guiding philosophy, methodology and metrics for financial valuation of the worth of natural systems. Context is everything.

Levels of Understanding

To provide a relevant "asset management solution" for local government, one must understand the local government context. **Figure E1** highlights three levels-of-understanding. These are cascading and provide the frame of reference for EAP analyses.

Level One is understanding how local government works in British Columbia. Drilling down, Level Two is understanding how asset management works in practice. Once the first two are mastered, Level Three is about how to integrate stream corridors and other natural assets into a local government Asset Management Strategy.

This reality-check led to a fundamental re-thinking of what matters for the purposes of an Asset Management Strategy. It required the building blocks process to land on the **Riparian Deficit** as the defining concept for operationalizing EAP within a local government Asset Management Strategy.

Ecological Accounting differs from Ecological Economics

What gets measured gets managed and determines whether a line item is included in an Asset Management Strategy. Competing priorities that local governments must constantly reconcile overshadow how one calculates a number. Yet, at the end of the day, it will be all about the number. The number must look right to be right.

Early in the EAP journey, it became clear that **ecological economics theory** does not make sense when applied to the local government setting and asset management. Ecological economics determines general values for natural systems with emphasis on influencing policy and statistical measures. It does not drill down in a way that is helpful to local governments striving, under scrutiny, to make budget decisions.

Financial valuation of stream systems

*"It is not the technical-financial approach that allows us to quantify the **worth** of a natural (ecological) asset. Rather, it is how the community uses and understands the ecological asset that determines the value. In British Columbia, this is a starting point when we talk about EAP, the Ecological Accounting Process, and valuing the **package of ecological services** made possible by the hydrology of a creekshed."*

Tim Pringle, October 2021

Ecological Accounting: Emphasis on 'civil services' that provide a municipal function

With release of Beyond the Guidebook 2015 in November 2015, the EAP journey commenced. In 2016, EAP Chair Tim Pringle wrote a 2-part series for the Asset Management BC Newsletter which mapped out his early thinking behind the Ecological Accounting Pillar.

In Part One, Tim Pringle discusses the importance of devising EAP and the valuation issues that arise. In Part Two, his focus is on how EAP would enable risk assessment of natural assets owned by and available to local government.

Accounting versus Economics

Tim Pringle coined the phrase ecological accounting to make clear the distinction vis-à-vis ecological economics. "The purpose of EAP is to enable comparison of engineered infrastructure to natural systems by means of common units of measurement and value," wrote Tim Pringle in the first article, published in February 2016[1].

"Ecological accounting differs from ecological economics. The latter approach determines general values. Ecological accounting determines which infrastructure services may be drawn from natural assets and the cost of using those services at specific sites and throughout a watershed."

"The challenge is in HOW to calculate the most effective blend of services from nature and engineered infrastructure. The need for measurement and valuation is paramount. Ecological accounting faces the challenge of monetizing natural assets and services in a way that can be compared to engineered assets and services."

Think Like a Watershed: "Human settlement always depends on natural assets for basic needs. Local government, at least in BC, commands the greatest influence on the use of civil services that may be drawn from natural assets." The two articles explore what this process might look like on the ground in the context of site development and drainage.

"Emphasis is on hydrologic functions, the primary natural form maker in watersheds and a key consideration in the process of land development, also a form maker in watersheds."

About Tim Pringle

"Local governments need real numbers to deliver green infrastructure outcomes. It is that simple. Tim Pringle's unusual blend of education and career experience sets him apart from the usual suspects in the 'ecological services crowd'. He is a sociologist who has a working knowledge of real estate finance. This experience propelled his breakthrough in developing the metrics for EAP."

Kim Stephens, March 2022
Waterbucket eNews

[1] https://waterbucket.ca/wscblog/files/2016/03/AMBC-Newsletter_article-by-Tim-Pringle_Feb2016.pdf

Ecological Accounting would allow asset managers and owners to see a more complete picture of value and future costs

Part Two of the EAP series was published in September 2016[2]. This coincided with the launch of the first two demonstration applications to test the EAP methodology and metrics in the Cowichan and Comox valleys on the east coast of Vancouver Island.

"EAP is an economic tool to make real the notion of **'watersheds as infrastructure assets'**," wrote Tim Pringle. This concept is introduced in Part B of this Synthesis Report. The context for both it and EAP is Asset Management for Sustainable Service Delivery: A BC Framework.

Tim Pringle's Part 2 article in the Asset Management BC Newsletter series was complemented by an article titled ***Partnership for Water Sustainability publishes Primer to support vision for "Sustainable Watershed Systems, through Asset Management".*** *This provided the overarching context for EAP*

Four Analytical Approaches: "EAP would support four related analytical approaches to capital expenditure and life cycle costs represented in drainage infrastructure services drawn from natural assets. These are Substitution, Cost Avoidance, Environmental (watershed health) Benefits, and Attributed Values."

"Practitioners would use EAP to determine whether drawing services from natural assets for drainage infrastructure makes financial sense. It would enable practitioners to price expenditures or avoided expenditures that occur in such contexts."

"It follows that potential capital expenditures for engineered services and those drawn from natural assets could be compared. Practitioners could determine the optimum balance of these options. Such design of infrastructure services offers enhanced protection of watershed hydrology (and ecology) as well as lower life-cycle costs for the assets."

A Look Ahead: "EAP would make sustainable service delivery more robust with the inclusion of the value and costs associated with the use of services from natural assets to supply infrastructure."

"EAP would allow Asset Managers and Owners to see a more complete picture of value and future costs, including the funding required for Operating and Maintenance of the components of the system that adapted Natural Assets for infrastructure to save initial capital construction costs," Tim Pringle concludes in Part Two.

[2] https://waterbucket.ca/gi/wp-content/uploads/sites/4/2022/05/AMBC-Newsletter_Partnership-articles_Sept-2016.pdf

Two Early Conclusions Led to a Fundamental Shift in Approach

"Initially, we saw EAP as a tool – that is, the Ecological Accounting Protocol - that would help practitioners calculate the opportunity cost of balancing ecological services with drainage infrastructure. However, our thinking quickly evolved because of what we learned doing the first two case studies in 2016-2017," recalls Tim Pringle, EAP Chair.

"When we designed EAP, there were no predetermined outcomes, but there were goals. One was to confirm the definable benefits of the ecological services supported by the hydrology. Another was to produce a social and financial account about the worth of these services."

"Testing the EAP approach through the Brooklyn Creek and Busy Place Creek demonstration applications on Vancouver Island resulted in this defining conclusion: **EAP is a process, not a protocol**. Thus, we rebranded EAP as the Ecological Accounting Process."

"This was one of two early conclusions. The second relates to the distinction between **worth** and **value**."

A Process, not a Protocol

"The term 'Process' more accurately describes the challenge of working with multiple stakeholders to assess the hydrology of an entire creekshed, or small watershed, to accurately describe the ecological services made possible by the hydrology. This comprehensive approach rarely takes place, and it makes the Ecological Accounting Process (EAP) unique," explains Tim Pringle.

Worth versus Value: "Stakeholders have, by the nature of their engagement in dealing with hydrological and ecological concerns in a creekshed, confirmed what is or is not worthwhile to them. Looking through the 'worth lens' led us to a fundamental shift in approach."

"The EAP methodology places less emphasis on the monetization of ecological services. Instead, the principal focus is on the investment of resources already made by many stakeholders, as well as their aspirations concerning prevention of degradation plus enhancement of ecological services in the creekshed."

"We find that stakeholders have produced a considerable amount of information about risks, concerns, and opportunities. This informs EAP analyses and helps us achieve the research objectives."

Local government's quest for meaningful numbers

"The starting point for application of EAP is recognition that local governments have existing tools in the form of policies and legislation for 'maintenance and management' (M&M) of ecological assets within riparian corridors."

"Until now, what local governments have lacked are a pragmatic methodology for financial valuation, and meaningful metrics that go to the heart of sustainable service delivery."

Tim Pringle, September 2020

How Much to Invest in Stream Systems?

EAP interweaves financial, social, and ecological perspectives within a single number – the Natural Commons Asset Value – to establish the financial case for a stream corridor system. This foundation has two primary metrics or measures: the NCA financial value is expressed as **$ per km of stream**; the annual M&M budget is **1% of the NCA value** consistent with accepted practice for constructed assets.

The NCA value is a measure of the Riparian Deficit which is a measure of the "loss of riparian integrity" due to land use intrusion into the regulated streamside setback zone.

Riparian Deficit is a Conversation Starter

Expressed as the Riparian Deficit, the NCA Value provides environmental planners with a starting point for a balanced conversation with engineers and accountants about the services that natural and constructed assets both provide. **This alone is a game-changer**.

"The EAP process is collaborative. As such, we modify our theoretical and intellectual approach through conversations with all the players. Our goal is to express EAP in language that works for them. We still have work to do with EAP in terms of getting our ideas into language that is easy for a wide audience to use. But we are getting close," says Tim Pringle.

EAP is an application of the systems approach. EAP and slice-and-dice methodologies are at opposite ends of the financial valuation spectrum. As the late John Henneberry pointed out, the latter fall far short of the whole and do not capture the interconnectedness of nature.

Tim Pringle's tribute to John Henneberry

"The University of Sheffield's John Henneberry (1952-2021) was a source of inspiration for me when we were initially developing the methodology and metrics for EAP, the Ecological Accounting Process. He identified the same methodological problems that we experienced in quantifying the financial value of ecological services. Natural systems do not dissect conveniently in order to be quantified and given financial value."

Tim Pringle, October 2021

John Henneberry was a source of inspiration to Tim Pringle during the early years of the EAP program. John's pioneering work in the United Kingdom validated the whole-system philosophy that guides use of EAP. His interests lay at the interface between planning and property; and focused on the use of economic instruments in planning and reproduction of the urban built environment.

John Henneberry (1952-2021)

Professor of Property Development Studies, University of Sheffield, United Kingdom

1. A Stream System is a Natural Commons

Use and Conservation of Land are Equal Values

Use and conservation of land are equal values – this is the starting point for EAP. Therefore, one should not be subrogated to the other. But that is traditionally what communities have done. Use of land has been the dominant consideration.

The concept of the **Natural Commons** underpins EAP. A stream system is a Natural Commons. Because natural systems and human settlement share the landscape, the values associated with the commons must include social, ecological. and financial considerations.

Figure E2 is a key visual aid because it depicts the three categories of "commons". Communities rely on **natural, constructed,** and **institutional** commons for services that support quality of life and property enjoyment.

Use and conservation of **Natural Commons Assets** implies a social contract; that these natural assets will be maintained and managed to ensure access to ecological services in the future. The community has similar expectations concerning constructed commons such as roads and buried infrastructure; and institutional commons such as schools.

Context for financial valuation of regulated riparian zone

Communities use BC Assessment information for "land value capture" (World Resources Institute, M. Hart, Dec 2020). That is, the credible assessments support decisions for land taxation. Some tax revenues are used by local government to pay for infrastructure (constructed, natural and institutional) which all residents and property owners use and enjoy.

EAP methodology recognizes that various legislation affects parcel values – for example, owners of parcels may apply for farm status. If received, assessments may be discounted.

EAP is a Land Use Perspective

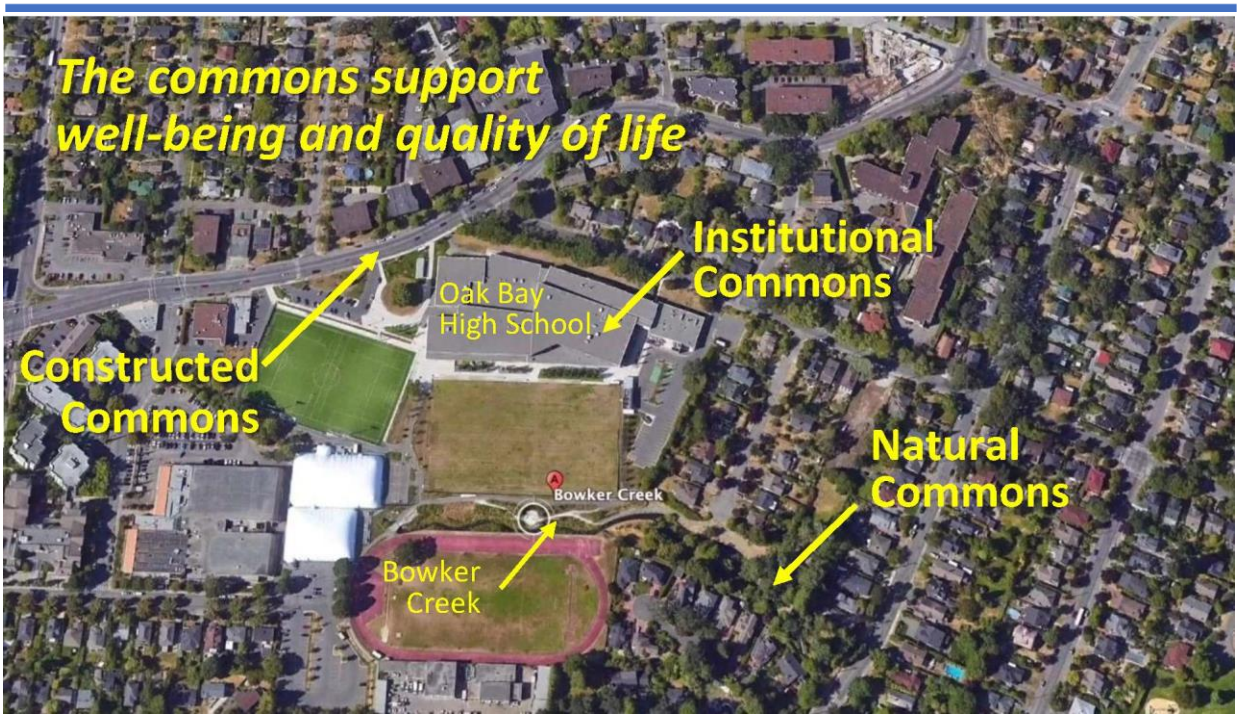
The strength of EAP is in how the methodology looks at and values streams as systems and as a land use. **A stream is a land use because it satisfies two criteria: it is defined in regulations; and it has a financial value.**

EAP uses BC Assessment Authority data to determine the Natural Capital Asset values of streams and water assets. BC Assessment deals with land parcels and improvements. EAP is concerned with the parcels because land parcels are the basis of locating settlement and imposing controls.

BC Assessment data are based on parcels which can be measured, are accurate, and recent (up to date). Also, the data are longitudinal, which means they have been collected for decades.

Figure E2

The concept of the Natural Commons underpins EAP. The image below is a key visual. It depicts three categories of 'commons': natural, constructed and institutional.



This location is in the District of Oak Bay

Foundational concepts that underpin EAP, the Ecological Accounting Process		
Natural Commons	**Constructed Commons**	**Institutional Commons**
As defined by the EAP, a **Natural Commons** is an ecological system that provides ecological services used by nature and the community. A stream is a land use and provides a "package of ecological services". Drainage, recreation, habitat, and enjoyment of property. This is plain language that Councils and Boards understand.	Communities rely on a range of services such as roads, underground utilities, and parks to support lifestyle and property enjoyment. These are **Constructed Commons**. Through taxation, they are maintained and managed to ensure the availability of desired services.	Services such as fire protection and schools are a related kind of constructed commons.

EAP Looks at Individual Parcels

Essentially, EAP analyses describe and quantify the alteration of riparian and nearby upland areas in the creekshed. The key metrics are loss of riparian cover, creation of impervious areas and alteration of water pathways. These concerns apply to all areas of the stream system and imply the following key questions:

Water Pathways – what happens to rainwater after it falls?

Riparian Cover and Conditions – how much is there and how natural are the existing vegetative and soil conditions?

Handling of Drainage – where does rainfall from impervious surfaces and engineered landscapes go to be conveyed away?

The focus is on two zones of interest

EAP is a land use perspective

EAP focuses on historical and current land use practices that changed landscapes, modified hydrology, and led to present-day community perceptions of the worth of a stream and the "package of ecological services" it provides.

EAP uses quantitative and qualitative metrics to evaluate land use realities that alter stream conditions. The Riparian Areas Protection Regulation is the starting point for applying EAP metrics to two "zones of interest":

- **Inner Stream Setback Zone**: This describes the 30m SPEA zone abutting the stream on each side plus the stream width at a nominal 5m, where SPEA is the acronym for the Streamside Protection and Enhancement Area.
- **Outer Land Use Zone:** This describes the 200m upland area adjacent to the setback zone on each side of the stream corridor.

EAP looks at the upland "outer land use zone" in urban areas because infrastructure and buildings may have eliminated riparian and woodland cover, created impervious conditions, and altered how rainwater and runoff reaches streams.

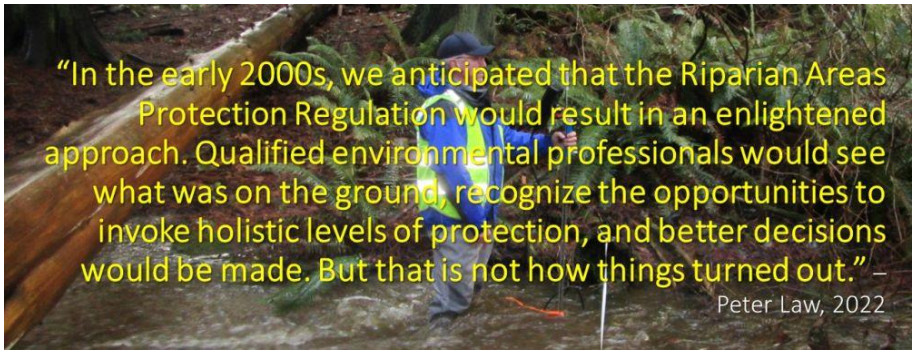
Riparian Areas Protection Regulation: Know your history. Understand the context. If we know how to do a much better job of protecting ecological features and stream systems in our communities and on our landscape, then why aren't communities doing a better job? Why are streams still being degraded? How do we change that?

A short history of the Riparian Areas Protection Regulation is that **riparian ecosystems** have been reduced to **riparian zones**. This is the unintended consequence when there is no effective senior government oversight and there is a failure to look beyond the stream.

It is essential to look beyond the stream

It is in the small tributary streams where the impacts of changes in the seasonal water balance and on riparian integrity are being felt most. According to Peter Law, a former ecosystem biologist in the Ministry of Environment, the intent of the Riparian Protection Areas Regulation was to provide flexibility based on the expected scientific outcomes.

"Instead," he says," we have ended up with simple and minimal-type measures of the level of riparian protection on behalf of fish. Looking beyond the stream to understand the stream as a system is put on the shoulders of others, and those 'others' are not typically brought in. So, what is the consequence? The system context is lost. Small streams are now going dry and have minimal levels of riparian protection."



EAP has 4 measures for a benchmark assessment of riparian cover

Area of the riparian zone (using 30 m setback from the top of stream bank)

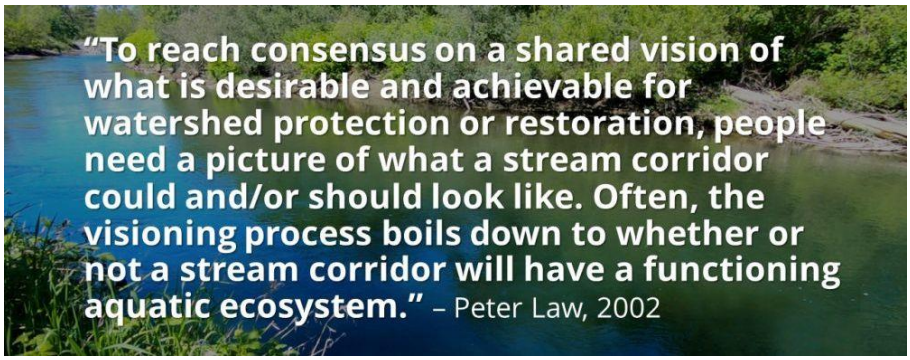
Extent of abutting parcel intrusion into the setback zone

Area of woodland cover as part of the setback zone and adjoining upland area as far as 200m beyond the SPEA setback zone.

Condition of riparian and woodland cover based on type of vegetation and its proximity to the stream.

EAP stays true to the science: EAP understands the stream as a system. EAP builds on the Urban Salmon Habitat Program (USHP) methodology used by fisheries biologists. EAP does a benchmark assessment using four variables to describe and quantify the condition of riparian and woodland assets. The goal is to engender support for systematic M&M investment to offset historical loss of riparian integrity.

Context for a shared vision of the stream: The Stormwater Guidebook discusses the importance of developing a common understanding of what is desirable, practical, and achievable:



3. Ecological Accounting Pillar Addresses the Riparian Deficit

Riparian Deficit Concept is Game-Changing

EAP closes the loop on the 1990s breakthrough in science-based understanding of the correlation between land use changes and impacts on stream integrity, including the riparian ecosystem.

Each EAP case study yielded key lessons and resulted in fresh observations and insights. In Part C, we described these as 'big ideas'. Each case study supported the depth of analysis for subsequent EAP applications. We emphasize that it took a building blocks process to evolve EAP because one “big idea” would lead to the next one.

The case study building blocks process culminated with the biggest idea of all – that the **Riparian Deficit** is the environmental equivalent of the **Infrastructure Funding Gap (Deficit or Liability)**.

Did you know?

The Riparian Deficit quantifies the extent of land use intrusion into the regulated setback zone (riparian area) and the financial implications of the intrusion.

With reference to the Road Map for Protecting Stream System Integrity, EAP shows how to address loss of riparian integrity in a tangible way. This meets a need and fills a gap in master drainage planning and rainwater (water balance) management.

Target-Based Strategy for Riparian Restoration

Now, with EAP as a foundation piece, local governments have a rationale and a metric to do business differently. EAP provides local governments with a measurable metric, the **Riparian Deficit**.

This would allow them to begin the process of engendering community support for a target-based strategy for systematic M&M investment over decades, as opportunities arise, to restore riparian woodlands and native vegetation for the full 30m width of the regulated streamside protection setback zone.

Implementation perspective: Master drainage planning and integrated stormwater planning processes at best pay lip-service to the role of the streamside protection zone within a stream system context, the condition of native vegetation and woodlands cover, and the need for restoration. Now, EAP provides the reason to ask the question, why aren’t these factors considered and given equal weight to engineering considerations?

Land Use Context for Riparian Deficit

The essence of EAP is to discover the Natural Capital Asset (NCA) value of the stream. The concept of the Riparian Deficit interprets what the NCA number means. The interplay of these two concepts involves the following:

> The NCA is the financial value of the stream channel plus the 30m setback on each side.
>
> The Riparian Deficit refers to the extent of land use intrusion into the setback zone. It also indicates what measures the community may have taken to mitigate the impact of parcel development abutting and adjacent to the stream.

Why the term 'Riparian Deficit'?

It is a breakthrough in thinking that directly resulted from the Bings / Menzies EAP Project.

Riparian deficit is an effective way of encapsulating the underlying uniqueness of the EAP theory, methodology and metrics.

It resulted from a shift in understanding that the analytical process for determining "worth" and "value" of a stream system is really about measuring the riparian deficit and expressing it as a social, ecological, and financial value.

Interplay between the NCA and Riparian Deficit concepts is complex

The NCA financial value easily can be quantified. In contrast the Riparian Deficit refers to and qualifies the actions by the community to mitigate the impacts of land use, especially urban development, on the stream setback and nearby upland areas.

For example, land use planning and regulation may have concentrated development in specific zones resulting in costs reflected in the assessed value of parcels. Efforts taken to deal with impervious areas, engineered drainage, landscaped setback areas along the stream, etc. infer the community's sense of social and ecological worth of this Natural Commons.

Application of EAP Metrics: Everyone has expectations, enjoys, and uses streams and other water assets. There is an implied contract to maintain and manage them so that they will be there in the future.

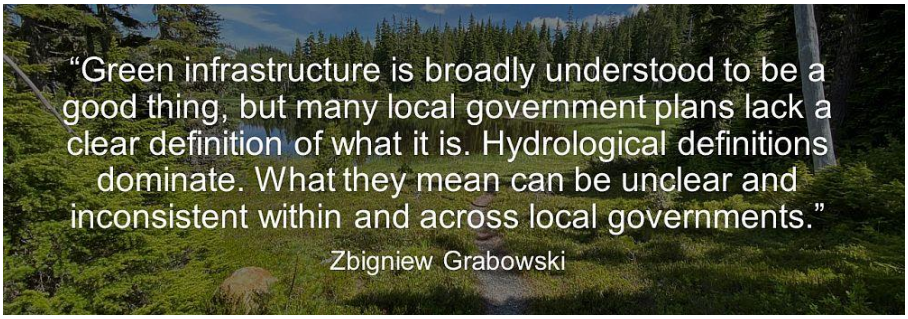
The NCA provides a financial number, an order of magnitude. The Riparian Deficit interprets the social and ecological importance of the NCA result.

This new concept allows environmental planners and engineers to appreciate the implied social contract attending the community's use and expectations of engineered commons and natural commons. The outcome can be a conversation that is grounded and balanced.

EAP and the Green Infrastructure Continuum

In January 2022, the first systematic review of the use and definition of the green infrastructure concept in local government plans in the United States captured attention with this headline: **Cities are murky on how they define 'green infrastructure'**.

Analysis of 122 plans from 20 major cities by Dr. Zbigniew Grabowski of the Cary Institute found that many plans fail to explicitly define green infrastructure. When they do, they tend to focus on stormwater management. A conversation with Dr. Z allowed the Partnership to compare US and BC experience and connect dots.



Design with Nature

The key takeaway from Dr. Z is that the green infrastructure state-of-the-art in the United States is now close to where BC was in 2005 when the Partnership developed a "Design With Nature" framework for a whole-system approach that integrates across infrastructure systems. In the meantime, the Partnership work has continued to progress along the **green infrastructure continuum** as we evolve the systems approach. EAP is the latest evolution and may be the gold standard.

Green Infrastructure Continuum defined

The Partnership for Water Sustainability uses the term 'green infrastructure continuum' to frame how green infrastructure understanding and the state-of-the-art around it are building on experience and evolving over time.

The continuum idea provides context for milestones on the green infrastructure journey in B.C. ***EAP is one point along the continuum****.*

EAP is the latest evolution in a process that began in the 1990s.

More than engineered infrastructure: In 2005, the Partnership framed a "made in BC", *Design With Nature* approach to community development in terms of six objectives (listed in the previous graphic). These embrace yet at the same time transcend engineered infrastructure to provide a comprehensive view. It is a system lens.

Look at Green Infrastructure through a Social Lens

A second takeaway from the research by Dr. Z is the perspective he provides on applying an integrated systems approach to green infrastructure. "There are a lot of 'greening' and sustainability initiatives, but they are not conceptually unified. They are neither thought about in terms of interdependencies nor systemically," he said.

"We had this moment of realization about the diversity of plans when it clicked in our minds about analyzing all the plans in terms of three big buckets: something that is very stormwater-focused, something that is very land-focused, and something that is trying to integrate the two."

Re-imagining green infrastructure as an integrated system: "In the process, we started to uncover **this grain of systems thinking within green infrastructure planning**. It is like a crystal within a larger chaotic mix of planning ideas, an idea allowing us to integrate many different infrastructure systems. Maybe, if we just crystalize that nugget of an idea even more, it will catalyze a more structured way of thinking about these things in US urban planning and beyond," concluded Dr. Z.

His revelation describes the essence of EAP and what the Partnership is striving to accomplish by advancing this foundational concept: **Drainage infrastructure and the stream system together provide the municipal Drainage Service**.

Socio-Ecological Systems Context

"Ecology is not really embedded in any planning practice. Yet we need to understand how infrastructure systems alter the relationship that people have with nature."

"Infrastructure systems are one of the primary stressors on natural systems. This is the context for my research."

"So, what led me to look at green infrastructure through the systems lens? It resulted from thinking about how the social processes shaping landscapes are inseparable from people's relationship with nature, the ecosystem itself, as well as what infrastructure is present on the landscape."

"It is not just about ecological assets. It is also about these hybrid 'built assets' as well as the range of technological innovations."

Dr. Zbigniew Grabowski, February 2022

4. Central Ideas of the EAP Methodology

EAP broadly deals with naturally occurring features in the landscape which produce ecological services intrinsic for nature but also used and enjoyed by residents and property owners. EAP focuses on streams and the riparian system. Four Natural Commons concepts are introduced below. Then, each is described in the order below.

Natural Commons Concepts

Examples of Commons

A stream is an example of a natural commons.

Drainage infrastructure is a type of constructed commons and schools are institutional.

Parks may combine elements of all three commons.

1. **Package of Ecological Services** – *refers to drainage, recreation, habitat, & enjoyment of property.*
2. **Riparian Ecosystems vs Riparian Zones** – *the distinction is important because the two are fundamentally different*.
3. **Worth of the Stream** – *community investment in restoration work is a measure of "willingness to pay"*.
4. **Financial Value of the Natural Commons Asset (NCA)** - *this is the key metric which drives decision-making.*

"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. The package of ecological services provided by the 'natural commons' encompasses drainage, recreation and habitat."

*Marvin Kamenz, Director of Development Services at the Town of Comox, coined the term **'Package of Ecological Services'** in 2018 to describe the many advantages the community expects to receive from a creekshed now and in the future.*

Concept 1 – Package of Ecological Services

A stream that is protected by streamside regulations comprises the stream channel plus the riparian zone. Both support ecological systems. The stream itself is part of a hydrologic system that originates in the landscape draining into the stream.

The surrounding zone and interrelated ecological systems work with the hydrology to provide a range of ecological services and aesthetic uses. These constitute the 'Package of Ecological Services'.

Range of Uses Desired by the Community

Three key words capture the essence of what the phrase 'range of uses' means**:** drainage, recreation, and habitat. A fourth attribute is enjoyment of property. Use of these terms helps readers visualize what the package of ecological services encompasses.

The table below provides supplementary details that further illustrate the 'range of uses' desired by the community.

Hydrology	*Rainwater interception, detention, infiltration, release to interflow and ground water, attenuation of flooding, aquifer recharge, supply to wells and springs*
Aesthetic Uses	*Landmarks, features in parks, natural areas, alignments for trails and greenways, and dedicated conservation areas*
Intrinsic Nature	*Interface with riparian areas – water temperature influence, nutrients for streams, detain infiltration in vegetation and soils* *Habitat for terrestrial and aquatic life, rearing conditions for fish*
Support of Municipal Infrastructure	*Conveyance of stormwater from roads and drainage systems* *Detention of rainwater, attenuation of flooding*

Nature is a system

"With all the talk about integrating natural assets into asset management, the players forget that nature is a system. They focus too much on specific aspects of the system, rather than its interrelated functions."

"Quantifying and valuing nature are complex tasks. Undertaking them alters our conception of nature."

Tim Pringle, October 2021

Illustration of the “Package of Ecological Services” – the range of uses desired by the community, specifically: recreation, habitat and drainage

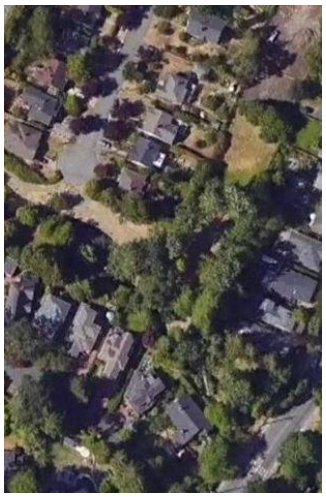
Drainage

Recreation

Habitat

Photo Credits: Jody Watson, Capital Regional District, from a presentation in 2010

Concept 2 – Riparian Ecosystems versus Riparian Zones



Riparian Network

An alternative term, riparian network, could also be used to describe a system composed of a physical stream channel and adjacent riparian (vegetated) corridor. This system provides a critical ecological function in linking terrestrial and aquatic ecosystems in a watershed or creekshed (i.e., 1st order stream)

The EAP analysis makes a distinction between **'riparian ecosystems'** and **'riparian zones**. A stream in a natural condition is supported by a riparian ecosystem, those areas of a watershed that directly influence the functioning condition of the stream. A riparian zone is a fragmented portion of the riparian ecosystem in developed areas where land uses have reduced the vegetated streamside area to the channel width plus a regulated setback each side (typically 15 to 30 meters metres).

Human Alteration of the Landscape

A common history of land use (settlement) on the east coast of Vancouver Island has been the fragmentation of the riparian network in both rural and urbanizing landscapes. However, current official plans contain policies, zoning (bylaws) and development permit area designations that intend to improve the balance between use and conservation of land, especially the valued NCA.

Riparian ecosystems (networks) have become reduced to riparian zones as shown on the maps of today.

Definitions: EAP considers diminution due to fragmentation to be a loss of a riparian network's ecological services that a Natural Commons provides for aquatic and terrestrial life, as well as for property owners, residents, and others in the community. EAP also describes the actions that intervenors undertake to improve streams and riparian areas through ongoing maintenance and management. In a financial valuation context, the following definitions are applied in this document:

Riparian Ecosystem Defined	Riparian Zone Defined
A *riparian ecosystem* in a pristine setting broadly describes a stream and supporting hydrological pathways that sustain flow to the stream as rainwater is infiltrated through surface and sub-soils, gradually moving to groundwater, and then to the stream itself. Within a stream corridor, a riparian ecosystem is the transitional zone between aquatic and terrestrial systems. Typically, it is wetter, cooler and has more diverse habitat then adjacent upland areas. It is also more biologically distinctive.	A *riparian zone* is a fragmented portion of the riparian network in developed areas where land uses have reduced the vegetated streamside area to the channel width plus a regulated setback each side (typically 15 or more metres).

A stream in a natural condition is supported by a riparian ecosystem. A riparian zone is a fragmented portion of the riparian ecosystem in developed areas.

Riparian Ecosystem

Remnant Riparian Area

Photo Credit: Jody Watson, Capital Regional District, from a presentation in 2010

Concept 3 - Worth of the Stream

The concept of worth refers to the ecological uses the community expects and draws from the stream. Community uses refers to the social, ecological and infrastructure expectations of this natural asset.

The scale and magnitude of community investment in M&M is a demonstrable measure, over time, of the **worth to the community** of restoring and/or sustaining a properly functioning stream a stream system so that it provides a "package of ecological services.

This reality includes an implied social contract; that is, the stream will be maintained and managed for future uses and enjoyment. This is an asset management challenge.

Community Investment in the Stream

Historic average annual investment is a proxy measure of community "willingness to pay" and "ability to pay". Social and ecological values are implicit in M&M expenditures. EAP projects examine six categories of investment:

- stream maintenance (by volunteer stream stewards)
- specific projects
- property acquisition
- public processes and planning
- outreach
- research (such as the EAP project)

These categories encompass both cash outlays and the dollar value of the substantial in-kind contribution by the community. The process to quantify "worth" is an attempt to determine a rough measure of the magnitude of M&M investment (community and local government) over a decade or longer. The EAP methodology uses the "worth" number for comparison purposes because the average annual investment in stream systems provides communities with validation and reassurance that they are on the right track.

How much to invest in stream systems?

EAP focuses on "worth to the community" rather than a theoretical value.

EAP emphasizes both social and financial values.

EAP employs one financial valuation process - that is, calculation of the land value of the Natural Commons Asset (NCA).

In the case of a stream, this is the ribbon of land underlying the stream itself and the adjoining setback area required in bylaws and Riparian Areas Regulations.

BC Assessment land values used for this calculation reflect the social commons. Property owners purchase in locations that they think are worth their investment.

Both the calculation of the land value of the NCA and the account of investment in maintenance and management of a stream are reports that can be used for budget strategy and planning as well as for asset management analysis.

Concept 4 - Financial Value of the Natural Commons Asset (NCA)

The EAP methodology considers a stream corridor and its protected setback zone to be a land use. This is the Natural Commons Asset (NCA).

Regulatory Context for NCA Approach

The Riparian Areas Protection Regulation (RAR), implemented as of 2004, defines the "streamside protection and enhancement area" (SPEA) to be a zone extending 30m out from the "top of the bank" of a stream. The EAP methodology analyzes any length of a stream based on a 30m setback zone measured from the centre of the stream.

Local government bylaws concerning watercourses and environmental areas support the SPEA. However, variations to the extent of the setback area occur as permitted under RAR. As well, some land uses (agriculture, aggregate extraction, etc.) are not covered by RAR.

A stream is a land use: This regulatory context intends to protect the stream where land use (subdivision and development) occur. Thus, the stream is defined as a **Land Use**. The implication is that if the stream were not there, the land area it occupies would be committed to the existing nearby land uses.

EAP methodology uses BC Assessment property transaction data to quantify the financial value of the stream and corridor – that is, the Natural Commons Asset. EAP calculates the NCA value based on the assessed values of **abutting** and **adjacent** parcels.

Science behind the NCA Approach

"Instead, we have ended up with simple and minimal-type measures. So, what is the consequence? The system context is lost."

Peter Law, ecosystem biologist, 2022

The detailed science behind the Regulation deems this landscape to be minimum protection for fish habitat. By inference, the SPEA is a defined area that supports the ecological services that can be drawn from the stream. This is the asset to be managed.

However, there is more to it because SPEA: **"means an area adjacent to the stream that links aquatic to terrestrial ecosystems and includes both existing and potential riparian vegetation and existing and potential adjacent upland vegetation that exerts an influence on the stream".**

5. Overview of the Research Framework

What is Measured Gets Managed

Mainstreaming of EAP was built around a program of applied research to test **"usefulness"**, and EAP analyses were guided by a standardized set of research questions and objectives. EAP Projects addressed two reciprocal questions:

> ***What influence does the stream as an ecological system (as a natural commons) have on urban and rural land use near the stream system; and does the stream influence the utility and financial value of parcels?***

Because asset management is the program context, the over-arching intent is that EAP findings would be used to establish line items in local government annual budgets for M&M.

Research Objectives

Although the research framework is common to all, each EAP case study is unique. Each local government is dealing with a distinctive stream system management challenge driven by local circumstances.

1. Establish a measure of "stream worth" to the community based on historic investment in M&M.
2. Quantify the "financial case" for the stream corridor as a Natural Commons Asset (NCA).
3. Suggest a "benchmark guideline" for maintenance and management (M&M) investment in the stream corridor within the context of an Asset Management Plan.
4. Determine whether and how the stream influences the assessed values of parcels that abut or are adjacent to the stream.

A Core Finding: EAP research has proven the validity of using parcel information for quantitative and qualitative analysis of land use impacts on the condition of stream systems.

What is measured gets managed

"Decisions by elected Councils and Boards are made at the parcel scale. Getting it right about the financial valuation of ecological services starts at the parcel scale and recognizing that every parcel is interconnected within a system. EAP is the only ecological methodology that deals with the parcel."

Tim Pringle, March 2022

Community Investment in a Stream System (Research Objective 1)

RESEARCH OBJECTIVE 1:
Establish a measure of "stream worth" to the community based on the historic investment in M&M.

Worth is a quantifiable number. Typically, local governments and stream stewardship groups have a decade or longer record of cash outlays and in-kind effort for stream M&M.

> **The package of ecological services provided by the stream system is the "range of uses" desired by the community, that is – drainage, recreation, habitat, and enjoyment of property.**

How the "Worth" Number is Used

For urban streams, comparison of the "worth" number with the **"1% Criterion"** (i.e., Research Objective #3) serves two purposes: validation that communities are on the right track with M&M investment; and reassurance that the "1% Criterion" makes sense.

Financial Value of a Stream System as a Natural Commons Asset (Research Objective 2)

The Natural Commons Asset (NCA) is the **Inner Stream Setback Zone**, introduced earlier in this Part E. Because it is defined in regulation, the NCA is a **Land Use** in urban and rural areas where there is land development. If the stream did not exist, the land occupied by the stream corridor would be used for residential or other development.

RESEARCH OBJECTIVE 2:
Quantify the "financial case" for the stream corridor as a Natural Commons Asset (NCA)

Steps in the Calculation of NCA Value

A stream is a linear system requiring private parcel owners and the community to be involved in protecting its functioning condition. The NCA calculation is the foundation piece for determining the financial value of the stream for all or any portion of its length.

Figure E3 illustrates the NCA and associated terms and is a useful visual guide.

Figure E3

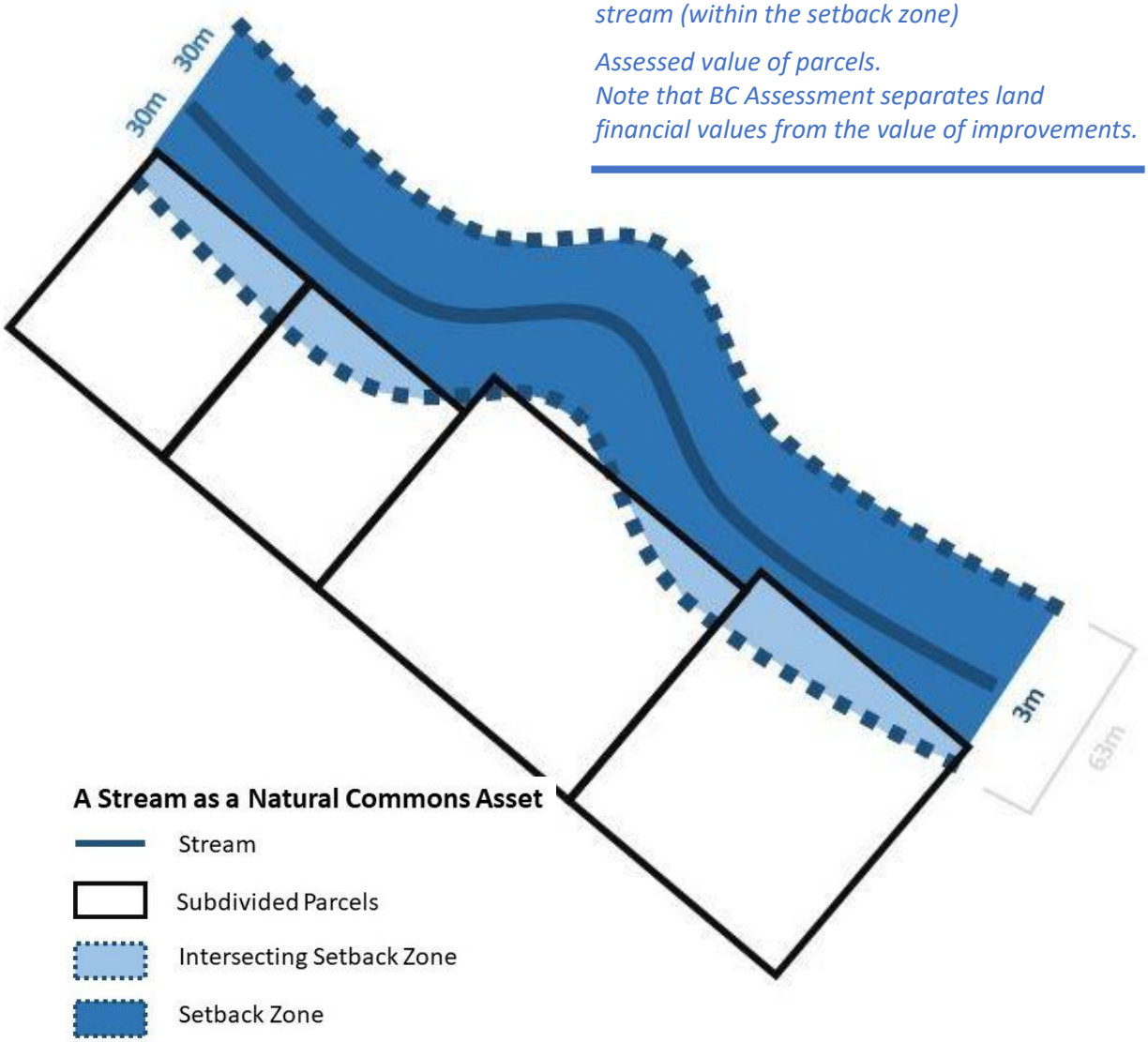
NCA Calculations

EAP metrics take the information listed below about parcels to complete the NCA calculations. The information sources are local government and provincial GIS databases. BC Assessment valuations are used. The metrics are:

Parcel area in m²

Area of abutting parcels within 30 m of the stream (within the setback zone)

Assessed value of parcels.
Note that BC Assessment separates land financial values from the value of improvements.



NCA calculation uses BC Assessment parcel data for the financial analysis: BC Assessment data are accurate, recent, and reflect the motivations of buyers and sellers over time. This means parcel values include social, ecological, and financial trend information. To learn more, refer to the sidebar.

BC Assessment data vs a land appraisal

BC Assessments relate to property prices reflected in market trends for property sales over time.

BC Assessments may differ considerably from present market prices.

Appraisals differ. They are current financial valuations related to market conditions for a specific parcel or property.

The basis of BC Assessment information is data collected over several decades from completed real estate transactions for classes of property. In the case of residential parcels, the current assessment reflects the financial commitments that buyers make to acquire property in a particular location with or without improvements.

Steps in the NCA calculation are listed as follows:

1. Find the Aggregate Area in m² **of the entire setback zone** for the length of the stream under analysis.
2. Find the Aggregate Area **of the portions of parcels that extend into the entire setback zone**. *Where the percentage of parcel area extending into the setback zone is less than 10%, the factor of 10% is used for the aggregate calculation.*

   Express the aggregate portions of parcels in the entire setback zone as a percentage of the aggregate area of the entire setback zone. This can be calculated by sample area and for the entire stream corridor. The expressions are in m².
3. Find the Aggregate Assessed Value of parcels that abut the stream, and which have area in the setback zone.
4. Calculate the aggregate assessed value of parcel area in the setback zone as a percentage of the entire setback zone. This is the Factor.
5. Use the Factor to calculate the aggregate assessed value of the portions of parcels in the setback zone. This is the Product and it will be expressed as **$ per m².**
6. The Product (value of the setback area per m²) can be applied to the setback area of the entire stream length or portion of its length. This is the Natural Commons Asset (NCA) value.

EAP brings clarity by defining the stream setback zone as a land use - because it can be measured and has definition under various pieces of legislation. And to underscore the importance of the NCA value, we reiterate that:

The NCA unit value is a measure of the Riparian Deficit. A comparatively low value is a positive indicator of the effectiveness of streamside setback regulation.

Guideline for an Annual M&M Budget
(Research Objective 3)

RESEARCH OBJECTIVE 3:
Suggest a "benchmark guideline" for M&M investment in the stream corridor within the context of an Asset Management Plan

The context for Research Objective 3 is that the interaction of a constructed drainage infrastructure system with a stream system typically results in an "unfunded infrastructure liability". And this grows over time in the absence of a funding mechanism for M&M of both natural and constructed assets.

Effective M&M of Natural Assets

The EAP program supports local governments adopting an integrated approach to life-cycle M&M of the drainage service. The integrated approach recognizes that constructed infrastructure and stream systems are inter-connected components of the drainage service. Effective M&M of natural assets requires local government commitment backed by line items in an annual report.

Benchmark for Budget Planning: Based on established life-cycle practice for M&M of constructed assets – that is, buildings and buried infrastructure - future annual expenditures for ongoing M&M of a stream corridor could reasonably be set at 1% of the NCA value (Research Objective 2).

The 1% guideline establishes a benchmark for budget planning purposes. Because it uses the BC Assessment database, the NCA value is as real a number as the replacement costs for buildings and buried pipes. It need not be 100% funded by local government. The stewardship sector has access to resources and funding that complement what local governments bring to the table.

More Than Calculations

EAP is the convergence and synthesis of parallel journeys. Valuing use and conservation of land equally is the financial journey. Reconnecting hydrology and stream ecology by design is the applied science journey. The social outcome would be restoration of urban stream integrity.

Influence of the Stream on Urban Parcel Values (Research Objective 4)

RESEARCH OBJECTIVE 4:
Determine whether the stream influences the assessed values of parcels that abut or are adjacent to the stream.

The relevant measure (metric) of stream influence in the urban setting is the **$ per m²** value. This metric reflects two considerations: the developable area qualities of parcels; as well as streamside setback regulations when parcels abut the stream.

EAP typically looks at three case study scenarios to assess stream influence – **whether parcels abut the stream, are adjacent to the stream, or are distant from the stream.** For each scenario, parcel group samples are selected for analysis and comparison.

For the purposes of providing context for Research Objective 4, a succinct summary of what we learned from other EAP case studies is summarized below.

Recognition of a Blended Financial Value

Streamside regulation has been in place in British Columbia for two decades. This restricts potential development of parcels abutting the stream. Parcels are encumbered by the setback zone.

This condition suggests that owners and potential buyers accept the fact that some portion of a parcel is undevelopable. In several EAP case studies, we took a closer look at the numbers to understand the $ value per m² for the abutting parcels without and without the influence of the riparian area.

Based on the analyses, we concluded that parcels abutting a stream exhibit a "blended financial value". We describe this as one value for the developable area of a parcel, and a lesser value for parcel area that cannot be developed due to streamside setback regulations.

What the Numbers Tell Us: If the setback area is removed from the aggregate area of parcels abutting the stream, the $ value per m² exceeds that for the adjacent and distant parcels. This tells us that purchasers of streamside parcels essentially pay a premium for the developable portions of parcels.

6. Financial Case for the Stream: Key Findings

"Integrating natural assets into asset management processes leads to a full understanding of the role of natural assets in sustainable service delivery and how local governments can integrate the protection, maintenance, and enhancement of these assets into strategic and operational decision-making." – Asset Management BC Primer, 2019

Four Generalizations

The EAP methodology focuses on historical and current land use practices that changed landscapes, modified hydrology, and led to present-day community perceptions of the worth of the stream or creekshed and the ecological services it provides.

A whole-system understanding is the starting point for developing meaningful metrics.

The EAP methodology is universal in nature, but each case study situation is unique. Four major observations emerged from the EAP program:

Observation #1 - Some streams may be so altered by changes in the landscape and hydrology that few "normal" ecological functions are observable. In essence, the stream is a discounted natural asset.

Observation #2 - In urban areas, the value of the Natural Commons Asset can be calculated, with confidence, using BC Assessment data. This is yet another game-changing consideration.

Observation #3 - The degree of influence that a stream may have on the financial value of abutting (streamside) and adjacent (bordering the abutting) parcels depends on the variables in play. Size of parcels, date of subdivision, proximity to the stream, neighbourhood and other variables sometimes result in very broad generalizations.

Observation #4 - Rural residential subdivision and agricultural land uses impair the riparian ecosystems that sustain streams. The riparian zone required under regulations is, at best, a partial measure for management.

Did you know?

Riparian area regulations may be superseded by other regulations, including these: Right to Farm Act, Forest Act, Forest Range Practices Act.

Conditions Influencing Financial Values

EAP uses BC Assessment data to find the Natural Capital Asset values of streams and water assets. Financial values, as measured by BC Assessment, are influenced by five conditions:

- The extent to which land use intrudes into streamside protection setback zones (typically 30m on each side of the stream)
- The condition of streamside protection setback zones based on applying these criteria:
    - less than 25% vegetation
    - more than 25% but less than 50% vegetation
    - more than 50% but less than 75%
    - greater than 75% vegetation
- The condition of upland woodland and extended riparian areas beyond (up to 200m) the streamside protection setback zones.
- The types of abutting and adjacent land use and the extent of impervious surfaces.
- The rainwater pathways and what happens to rainwater that falls on developed parcels; based on local government drainage plans.

BC Assessment data are longitudinal and reflect the social (size, location), financial (price, condition) and ecological preferences (price differentials for proximity to a stream and the stream's functioning condition) of purchasers and sellers.

Establishing An Annual Budget for Stream Corridor M&M

After taking all the conditions into account, EAP determines the total financial value of the NCA (streamside protection setback zone) and then suggests how much a local government should include in an Asset Management Plan to address the Riparian Deficit.

In summary, the key takeaway from this Part E boils down to the finding that future expenditures for ongoing M&M of stream corridors could reasonably be set at 1% of the NCA value.

The 1% Guideline is also important from the perspective of providing the basis for comparison with the historic average annual investment in stream M&M. This provides validation and reassurance. For the five Stage 3 case studies, the comparisons showed that the 1% Guideline is the right order-of-magnitude and aligns with "willingness to pay".

A Closing Perspective on Riparian Area Condition Realities

Where stream systems have reduced riparian setbacks, the costs of maintenance and management are expected to be higher than for stream areas that have adequate riparian area. Riparian deficits may also contribute to flooding, erosion, and other problems. The EAP program confirms these realities:

A stream can provide a "package of ecological services" that support natural and human communities.

Where riparian areas are intact and, possibly, include riparian ecosystems, the ecological services will be greater.

Where there is no riparian zone, the stream will provide only conveyance and few, if any, ecological services.

Many communities recognize the importance of ecological values that streams provide and which support quality of life and property enjoyment.

Many communities invest in maintenance (prevent degradation) and management (enhancement) of streams. Investment may include adding to riparian area through property acquisition or legal tools, community amenities (parks, natural areas) derived at time of development of parcels, collaboration of stewardship organizations with local government and businesses, restoration projects, long term plans shared by operating departments, etc.

Key Messages and Cascading Concepts

*We close by repeating the 10 key messages summarized in **Table E1** and the 5 cascading concepts shown in **Figure E4.** This combination captures the essence of what matters about EAP, the Ecological Accounting Process. And once more for emphasis, the over-arching takeaway from this Part E is that:*

The NCA unit value is a measure of the Riparian Deficit. A comparatively low value is a positive indicator of the effectiveness of streamside setback regulation.

How well are we doing?

"One should view EAP as representing one point along a 'green infrastructure continuum'. It is the latest evolution in an ongoing process in British Columbia that had its genesis in the 1990s," stated Tim Pringle in July 2019.

"EAP uses the word 'accounting' in the sense of taking stock and understanding the worth of ecological services as the community uses them. Holding up this mirror reflects opportunities taken or missed and risks avoided or incurred. It asks the question; how well are we doing?"

Table E1 - 10 Key Messages to Remember about EAP

1. Every settled creekshed (watershed) comprises a **Constructed Commons** (roads, utilities, etc.) and a **Natural Commons** (streams, riparian corridors, etc.). Each "commons" is a system.
2. **Hydrology is the engine that powers** ecological services derived from the stream system which is the natural asset or Natural Commons.
3. **Impaired hydrological function** results in diminished ecological services caused by land use activities. The **Riparian Deficit** interprets the extent of this alteration.
4. The **worth of a creekshed is a package of ecological services** made possible by the hydrology. EAP focuses on wetlands, ponds, streams, and riparian areas because these natural features provide services desired by communities.
5. **EAP deals with real numbers** which practitioners in local government need to deliver outcomes.
6. **EAP uses the BC Assessment database** regarding land value to calculate the financial value of the Natural Commons Asset (NCA) – that is, the land underlying the stream itself plus the adjacent regulated setback area.
7. View choices through the **Worth Lens** if the goal is to motivate communities to implement strategies that restore stream function.
8. Both the record of expenditures for maintenance and management (**calculation of worth**) and the financial value of the **NCA calculation** provides information about ecological (natural) assets that can be included in local government financial planning and **Asset Management Strategies and Budgets**.
9. The likelihood of a community taking action depends on **what a community thinks** the stream is worth.
10. Distinguish between maintenance and management – because maintenance is about **preventing or avoiding** degradation, whereas management is about **improving** the condition of the ecological asset.

Figure E4 – Cascading Concepts

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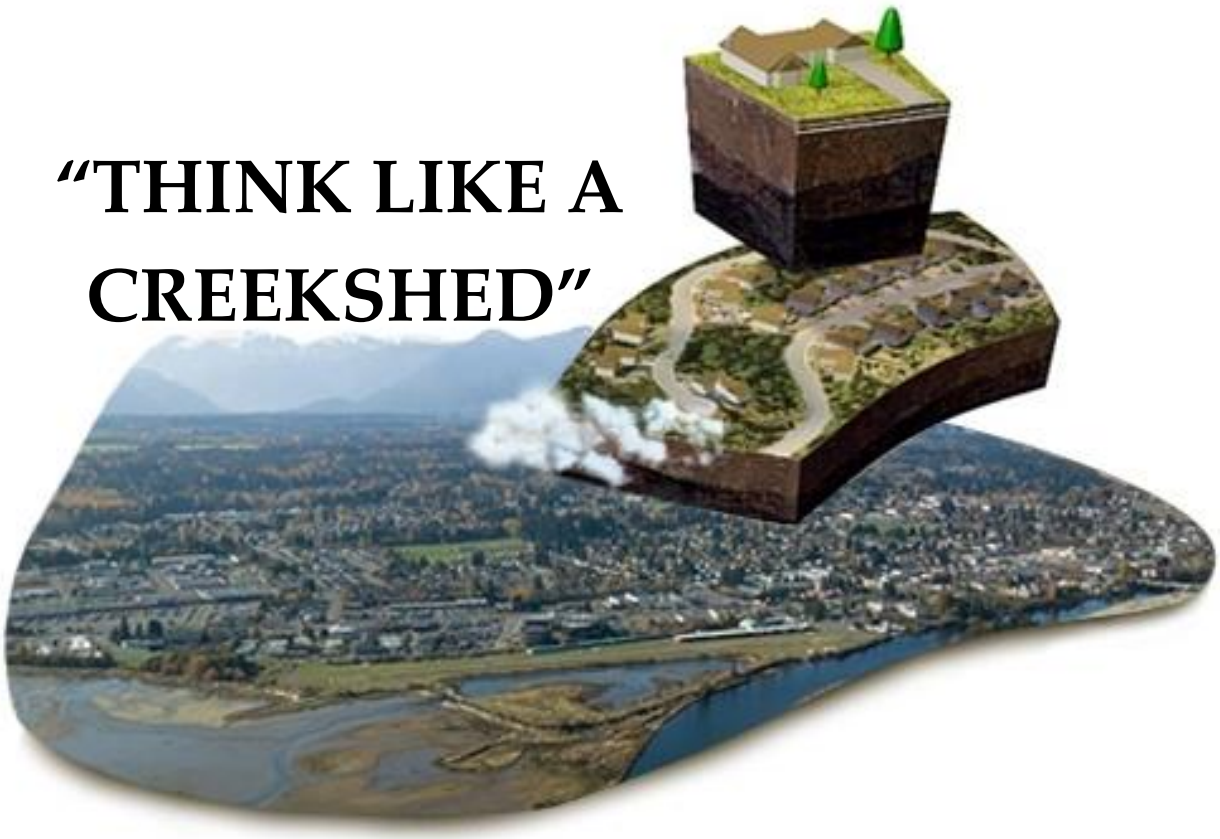
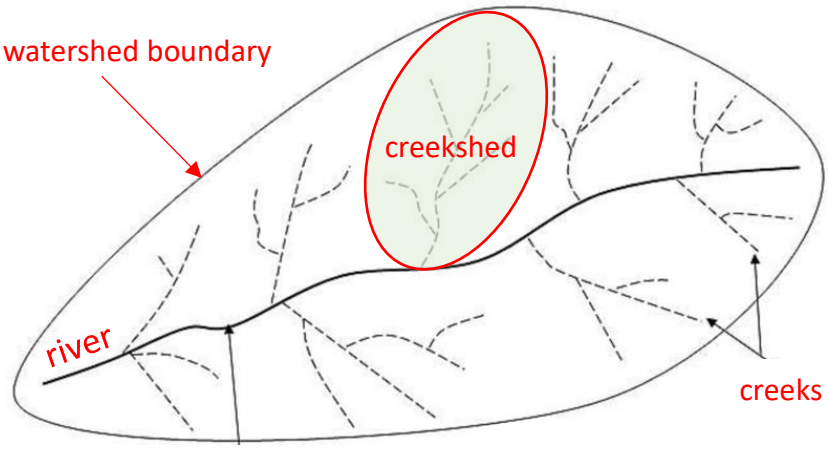
"THINK LIKE A CREEKSHED"



A creekshed is an integrated system:

The need to protect headwater streams and groundwater resources in BC requires that communities expand their view - from one that looks at a site in isolation - to one that considers HOW all sites, the creekshed landscape, streams and foreshores, groundwater aquifers…and PEOPLE….function as a **whole system**.



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