6. Mimic the Water Balance

The first five sections of this Primer have established the context for a science-based, integrated and holistic approach to rainwater and groundwater management. This context allows local governments to establish expectations:

> *This is what we want to collectively and incrementally achieve over time, and this is how we will work together to get there*.

To close the loop, this section provides guidance so that champions in the local government setting will be informed and can then lead the move from awareness to action.

Doing Business Differently in BC

Creating desirable communities and protecting stream health are mutually reinforcing outcomes:

- Living Water Smart is the provincial **VISION** for sustainable land and water stewardship;
- **TOP-DOWN & BOTTOM-UP** collaboration between local governments and the stewardship sector is a critical success factor for "getting the local watershed vision right";
- an over-arching **WATERSHED GOAL** is to manage the natural environment and built environment as integrated components of a healthy watershed;
- the watershed goal can be achieved by making 'green choices' and **DESIGNING WITH NATURE** to protect the water balance;
- inter-regional **KNOWLEDGE-SHARING**, collaboration, alignment and consistency will allow everyone to go farther, more efficiently and effectively, with implementation; and
- achieving the desired outcome is contingent on regulators, planners, developers, designers and others embracing **SHARED RESPONSIBILITY** and aligning their efforts.

If local governments and others are to be effective over time in creating liveable and desirable communities that also protect stream health, it follows that land development practices must strive to mimic the Water Balance.

Local Government Responsibility

The image below is included one more time to remind the reader of key elements of the Water Balance. The Water Balance Methodology links rainfall to stream health protection. Land use activities short-circuit the movement of water, thereby altering the natural water balance. This has stream erosion consequences. Thus, the purpose of 'water-centric' regulation of land development practices is to prevent or mitigate flow short-circuiting.

Think Like a Watershed: Figure 26 provides a high-level overview of local government responsibility to protect the water balance. The *Community Charter* empowers municipalities with extensive and very specific tools to achieve watershed goals and objectives. The *Local Government Act* provides regional districts with similar enabling powers.

"We need to understand the sub-systems that are in play between the time that rainfall is received at the top of the tree canopy and the time that it actually gets to the stream. That's the key to the whole systems approach," states Will Marsh, author of ***Landscape Planning: Environmental Applications,*** a classic textbook.

He retired to BC from the University of Michigan-Flint where he was Chairman of the Department of Earth and Resource Sciences and a Director of the Laboratory for Land and Water Management.

"We too often jump too quickly to the engineering computations about this method or that method....when what we really need is a basic understanding of the land and its functions. In other words, think like a watershed," Will Marsh emphasizes.

Local Government Responsibility to Manage Drainage & Protect Stream Health

The term 'urban watershed' is a metaphor for those watersheds, or parts of watersheds, over which local governments exert control through regulation of land use. The distinction is important because:

- In Metro Vancouver and in the Capital Regional District, for example, the majority of municipalities completely encompass their watershed areas (or else share them with adjoining municipalities).
- Outside the major metropolitan regions, on the other hand, municipalities tend to be located at the bottom end of wilderness watersheds that are subject to provincial regulation.

In British Columbia, the term 'local government' encompasses municipalities and regional districts. The distinction is noteworthy because municipalities and regional districts are governed by the *Community Charter* and *Local Government Act*, respectively.

The *Community Charter* empowers municipalities with extensive and very specific tools to proactively manage the complete spectrum of rainfall events. These tools enable them to achieve watershed goals and objectives. Although the *Local Government Act* provides regional districts with similar enabling powers to establish a drainage function within a service area boundary, regional districts that do not have such a service do not have the same regulatory powers as municipalities. The Ministry of Transportation and Infrastructure has historically regulated drainage in electoral areas.

British Columbia case law makes clear the responsibility of municipalities to manage runoff volume to prevent downstream impacts. An increasingly important corollary to that responsibility is the need to work from the regional down to the site scale, to maintain and advance watershed health to ensure that both water quantity and quality will be sustained to meet both ecosystem and human health needs.

While a municipality has control over HOW rainwater runoff is generated and managed within its residential, commercial and industrial land uses, it does not have the same ability to regulate watershed activities that are taking place outside its municipal boundaries.

In summary, in this Primer **'urban watershed'** refers to drainage tributary areas within which zoning and land use are under the jurisdiction of municipalities or areas for which a regional district has established a drainage service.

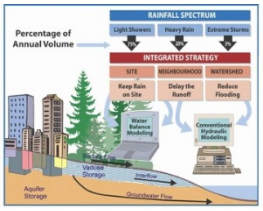
Source: *Beyond the Guidebook 2010: Implementing a New Culture for Urban Watershed Protection and Restoration in British Columbia*, 2010

Figure 26

How to Think Like a Watershed

Introduced in Section 3, the Water Balance Model (WBM) helps water resource practitioners 'think like a watershed'. It also promotes an understanding of how to re-establish the connection to the stream after land is developed.

Storage and Interflow: The reader will recall that Figure 6 shows the generalized flow patterns of natural and post developed conditions. Urban development reduces the 'vadose storage' and 'interflow'. Hence, the purpose of green infrastructure solutions is to capture rain where it falls, and to restore vadose storage and interflow.



The WBM was originally developed to quantify and assess the *hydrologic effectiveness* of green infrastructure to meet performance targets for rainfall capture and runoff control. The systems that are simulated in the WBM strive to mimic the interflow system by providing storage, and by providing the baseflow discharges.

WBM is Unique: The WBM is a scenario comparison tool that bridges planning and engineering; links development sites to the stream and watershed; and enables science-based performance targets to be established. Powered by the QUALHYMO calculation engine, the WBM differs from other drainage modelling tools in three fundamental ways:

- it is web-based;
- development is driven by the community of users; and
- it can help create a vision of the future watershed.

"All three are powerful in their own rights. There is no other comparable web-based tool," states Dr. Charles Rowney, WBM Scientific Authority. In the 1980s, he developed the QUALHYMO calculation engine for the Ontario Ministry of Environment.

WBM Outreach and Training: Launched by an inter-governmental partnership in 2003, the WBM has been rebuilt on a new platform. It is quicker and easier to use; and it now has launch buttons at three scales of investigation: SITE, NEIGHBOURHOOD and WATERSHED. In conjunction with the rebuild, the WBM Partnership is implementing an outreach, and training program to advance Sustainable Rainwater Management. In March 2012, the Okanagan Basin Water Board hosted the first training workshop in the 2012-2013 Series.

"I can see how the graphical results would allow me to communicate relevant information to my public and private-sector clients about the effectiveness of rainwater capture and runoff control options – not with complicated tables and calculations, but with relevant, easy-to-understand visual comparisons of the incremental benefits and costs. What a great tool," reports workshop participant Michelle Sorensen, a professional engineer with a consulting firm based in Kelowna, BC.

Uncertainty Cascade: Figure 27 is a synthesis that comprises eleven steps that cascade down from a theory to interpretation of results. Developed by Dr. Rowney, he has coined this mthe *Uncertainty Cascade.*

"There is a preoccupation with theory, but the heavy lifting takes place in the last four steps. We need to keep our focus on SOLUTIONS on the ground," emphasizes Dr. Rowney. "As we have been working on the WBM, we have been orienting it to THE SOLUTION. We are keeping it as simple as possible, but no simpler. The tool has to be consistent, inexpensive, and workable with limited data. It has to fit the local context, and it has to evolve as we learn."

"We have ample horsepower to pick just about any theory we want and put it inside the WBM. But what we really need to focus on is: *what are the solutions that are really necessary*. An outcome that we are pushing for is the ability to interpret results, and the ability to represent the cases that we are actually trying to solve."

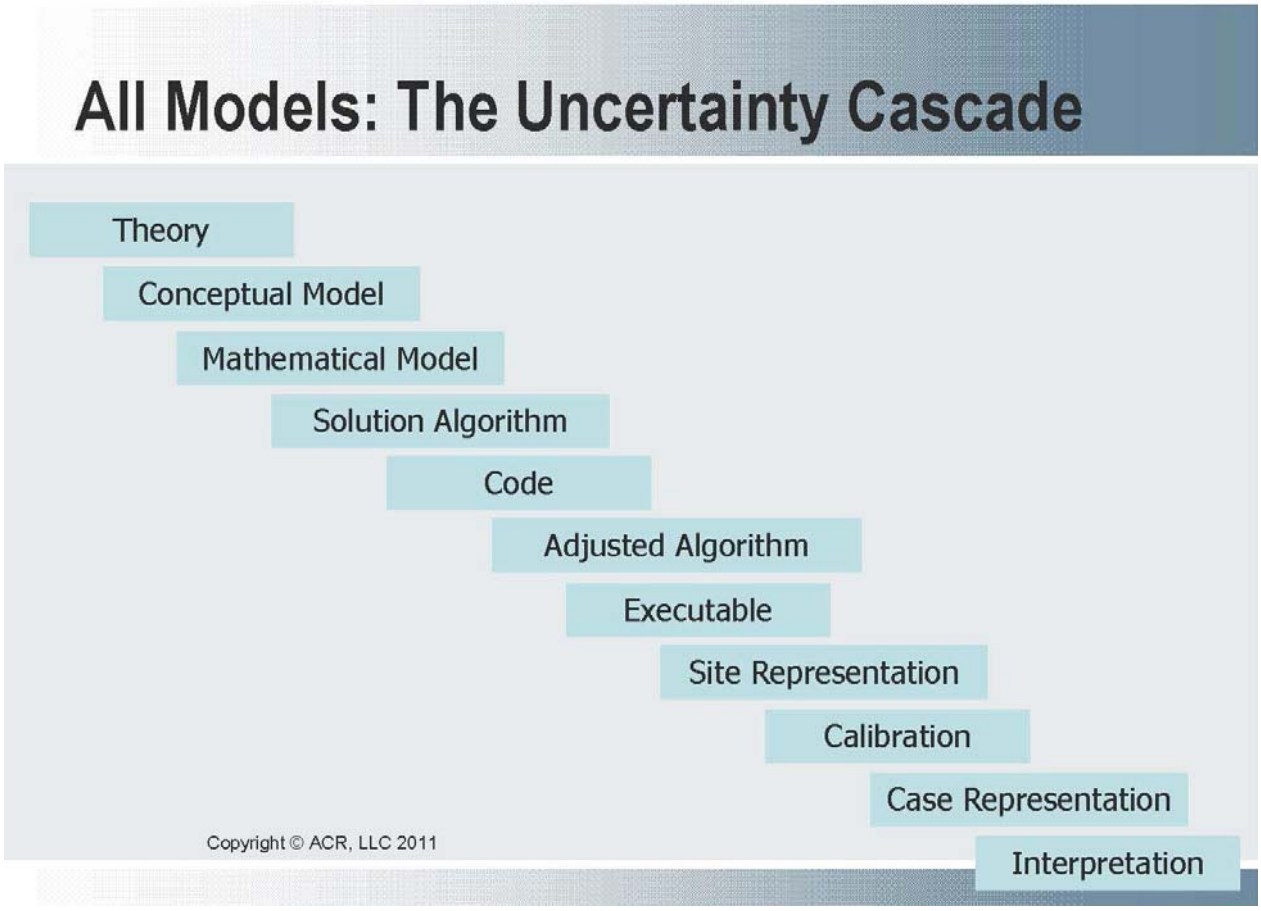


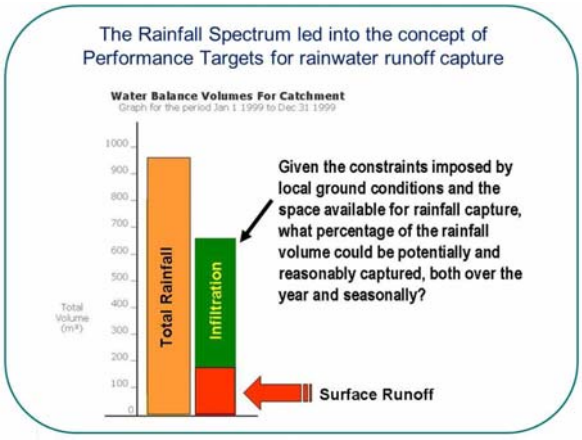
Figure 27

Drainage Modelling: From Theory to Interpretation

Establish Watershed-Specific Performance Targets

In 2002, the Guidebook demonstrated how to bridge the gap between policy and site design, with emphasis on volume control at the site scale. By advancing a performance target approach, the Guidebook initiated a drainage paradigm-shift. In 2007, Beyond the Guidebook addressed the relationship between volume control and resulting flow rates in streams. This connected the dots to stream health.

Developed as an extension of the Guidebook, the Water Balance Model enables the user to evaluate and establish performance targets for rainfall capture and runoff control at the site, neighbourhood and watershed scales.



Translate Water Balance Targets into Design Criteria: Establishing performance targets provides a quantifiable way of measuring success in protecting or restoring a watershed, and for identifying what needs to be done to achieve a certain level of protection for a given watershed.

The Guidebook articulated a guiding principle that "performance targets at the watershed scale provide a starting point to guide the actions of local government in the right direction". A decade ago, this set the stage for translating targets into appropriate site design criteria that would then provide local government staff and developers with practical guidance for achieving the goal of stream health protection.

A Framework for Moving from Planning to Action: Table 2 from *Beyond the Guidebook 2010* identifies what local governments will need to do to protect or restore stream health. Originally released in 2008, it presents a conceptual framework for setting watershed-specific performance targets and then implementing them at the development scale. There must be clear linkages between the targets and development approval processes.

The framework presented in Table 2 envisions a level-of-service approach to setting watershed-specific runoff targets. It identifies questions that need to be asked when evaluating the acceptability of targets. Level-of-service is the integrator for everything that local governments do. Everyone will have to make level-of-service choices. Everyone needs to be thinking in terms of life-cycle costs, especially the future recapitalization of an infrastructure investment.

"The process of establishing an acceptable ***'Level-of-Service***' will require local governments to review, examine, and justify the existing standards and how to transition into the future where costs must be balanced against public needs and expectations," states Jim Dumont, WBM Engineering Applications Authority.

Transition into the Future: Table 2 may also be viewed as a road map to a destination. In one page, it summarizes what needs to be done. Some local governments are progressing along the road map, yet work remains to be done to bring Table 2 to life for all local governments:

- On the one hand, methodologies and tools to establish appropriate watershed-specific targets exist.
- On the other hand, case study examples to demonstrate what integration looks like at multiple scales are still works-in-progress.

"Performance targets should be customized for individual watersheds and catchments, based on what is effective and affordable in the context of watershed-specific conditions," emphasizes the Guidebook. "Continuous Water Balance modeling can be applied to determine what is effective and affordable."

Table 2 (*brought forward from Chapter 7 in 'Beyond the Guidebook 2010'*)

Developing Outcome-Oriented Watershed Plans: Framework for Moving from Planning to Action

Action	Level of Commitment
Complete and implement integrated rainwater/stormwater management plans that are **affordable and effective i**n protecting or restoring Watershed Health	▪ Local governments, in collaboration with senior governments, develop Integrated Plans that enable implementation of integrated strategies for greening the built environment; and include establishing watershed-specific runoff targets (for managing the complete rainfall spectrum) that make sense, meet multiple objectives, are affordable, and result in net environmental benefits at a watershed scale. (*Note: To date, "integrated drainage plans" have typically been called "ISMPs" pursuant to the nomenclature established in Chapter 9 of the 2002 Guidebook. The time has come to describe truly integrated plans as "Watershed Blueprints" to capture the paradigm-shift from pipe-and-convey 'stormwater management' to landscape-based 'rainwater management' that restores watershed function over time)*
	▪ Local governments, in collaboration with senior governments, establish watershed targets that are characteristic of actual conditions in watersheds, recognizing that there will be different strategies for already developed versus partially developed watersheds.
	▪ Local governments, in collaboration with senior governments, evaluate the acceptability of watershed-specific runoff targets on the basis of an evaluation framed by these three questions: 1. What target will achieve the watershed health objective? 2. What needs to be done to make the target achievable? 3. Do the solutions meet the test of affordability and multiple objectives?
	▪ Local governments, in collaboration with senior governments, implement green infrastructure solutions that result in effective rainfall management at the site, catchment and watershed scales.
Embed landscape-based strategies in neighbourhood concept plans	▪ Local governments develop rainwater/stormwater and land use plans through an inter-departmental process that is collaborative and integrated. ▪ Local governments provide guidance as to how watershed-specific targets can be met at the development scale.

Source: **Commentary on Effective Municipal Rainwater/Stormwater Management and Green Infrastructure to Achieve Watershed Health**, April 2008

Released jointly by the Green Infrastructure Partnership and the Inter-Governmental Water Partnership in conjunction with the consultation process for Metro Vancouver's *Integrated Liquid Waste & Resource Management Plan*

The Commentary is accompanied by a paper titled *Beyond the Guidebook: Establish Watershed-Specific Runoff Capture Performance Targets*, released at the 2008 Water Balance Model Partners Forum.

View the Watershed through an Asset Management Lens

The linkages between the natural Water Balance, watershed and stream health, and infrastructure liability have emerged as important pieces in ensuring 'sustainable drainage infrastructure', both fiscally and ecologically.

An Incentive to Do Business Differently: Local governments in British Columbia are faced with this financial challenge: the initial capital cost of infrastructure is about 20% of the life-cycle cost; the other 80% largely represents a future unfunded liability. Each year, the funding shortfall grows. As infrastructure ages and fails, local governments cannot keep up with renewal and/or replacement. This fiscal reality creates the incentive to prevent additional financial impacts.

While developers and new home purchasers pay the initial capital cost of municipal infrastructure, it is local government that assumes responsibility for the long-term cost associated with operation, maintenance and replacement of infrastructure assets. Often this is not adequately funded through property taxation and utility charges, as various political priorities compete for limited tax dollars. In addition, local governments bear the entire financial burden to stabilize and restore watercourses impacted by increased rainwater runoff volume AFTER land is developed.

Sustainable Service Delivery: Tackling the unfunded infrastructure liability has led to a life-cycle way of thinking about infrastructure needs, in particular how to pay for those needs over time. The Province's branding for this holistic approach is *Sustainable Service Delivery.* Refer to Figure 28 for a definition.

Asset management usually commences after something is built. The challenge is to think about what asset management entails BEFORE the asset is built. This paradigm-shift starts with land use and watershed-based planning, to determine what services can be provided sustainably. Viewing the watershed through an asset management lens highlights why 'cost-avoidance' is a driver for local governments to require that development practices mimic the Water Balance.

Design with Nature and Protect the Water Balance: The costs and environmental impacts associated with 'pipe-and-convey' infrastructure contrast with the benefits of 'green' infrastructure at a watershed scale: *natural landscape-based assets reduce runoff volumes, have lower life-cycle costs, decrease stresses applied to creeks, and enhance urban liveability*.

The Brooklyn Creek Case Study (Figure 28) in the Comox Valley illustrates the financial impact when the Water Balance is short-circuited.

"Our Brooklyn Creek experience provides a graphic illustration of an infrastructure liability that is the consequence of NOT designing with nature," reports Glenn Westendorp, Public Works Superintendent with the Town of Comox. "The unforeseen $1.8 million price tag to stabilize and restore the creek became the driver for doing business differently in Comox. This was the cost to the Town of not protecting the Water Balance."

"The Brooklyn Creek experience epitomizes how stripping away the water storage capacity of the watershed landscape impacts on stream health in two ways: loss of baseflow...that is, too little water in dry weather; and channel instability and erosion...that is, too much water for too long during wet weather," observes Jack Minard, Executive Director of the Comox Valley Land Trust.

"A drainage system is more than just storm sewer pipes in roadways and culvert pipes at creek crossings. It also includes the ditches, volume control systems, and the receiving streams all the way to something that will not be affected by the discharge," continues Jim Dumont. "As a profession, we engineers have been very good at generating plans to install pipes and build ponds. But we have overlooked the stream. As the Brooklyn Creek experience shows, this is the unforeseen cost that shows up years later. It is the unfunded infrastructure liability."

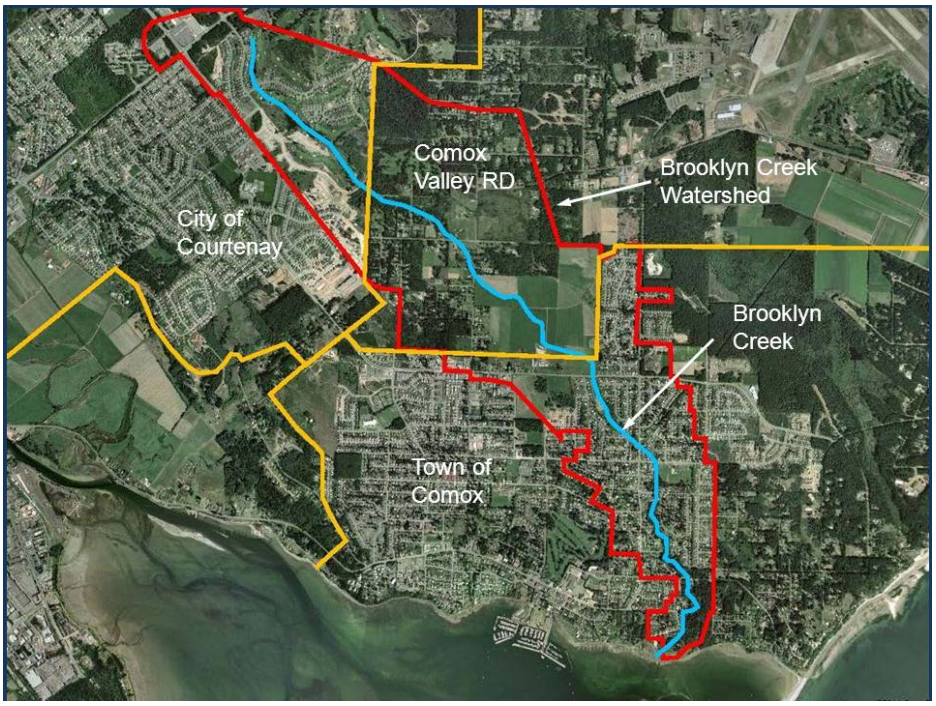


Figure 28

View the Watershed through an Asset Management Lens

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