

Integrating the Site with the Watershed and the Stream

Primer for Integrated Rainwater and Groundwater Management

3. Look at Rainfall Differently

A decade ago, looking at rainfall differently led the Province of BC to develop the *Water Balance Methodology*, and initiate a paradigm-shift in the way rainwater is managed. The Province:

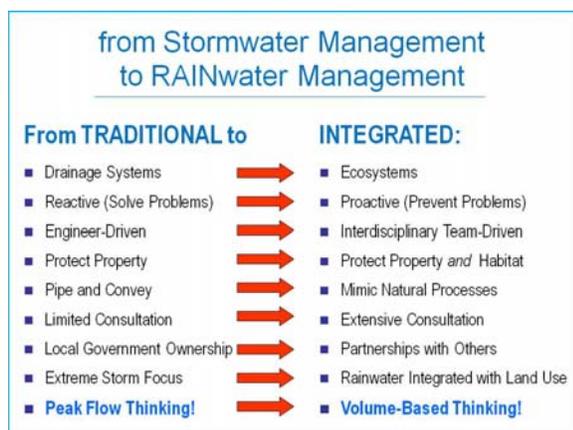
- Formalized the performance target methodology in *Stormwater Planning: A Guidebook for British Columbia*, a provincial guidance document released in 2002.
- Translated science-based understanding so that local governments could establish achievable and affordable performance targets for rainfall capture and runoff control.

BC was the first provincial or state government in North America to implement the Water Balance Methodology.

From Stormwater to Rainwater

The Guidebook was the catalyst for moving from the extreme storm view embodied in conventional 'Stormwater Management' to the integrated, holistic and landscape-based perspective that is embodied in 'Rainwater Management'. In 2002, the Guidebook also set the stage for defining *water sustainability* as an outcome of *green infrastructure* policies and practices. This followed four years later in 2006.

The comparison below captures the evolution of drainage planning in BC between 1970 and 2002. The move to volume-based practice was made possible by the Water Balance Methodology.



The Integrated Strategy: The Water Balance Methodology is founded on the concept known as the *Rainfall Spectrum*: the methodology accounts for all the rainfall-days in a year; and links rain that falls on a site...to the runoff leaving the site...to the flow in a stream.

Reproduced from the Guidebook, Figure 8 illustrates the elements comprising the *Integrated Strategy for Managing the Rainfall Spectrum*. Water gets to a stream in one of three ways: surface runoff, shallow groundwater (interflow), and deep groundwater. Figure 8 shows that each way has a materially different time horizon.

The Rainfall Spectrum is a universal relationship. In other words, the number of rainfall-days and the total rainfall volume per year may vary by region, but the distribution of that volume has a consistent pattern.

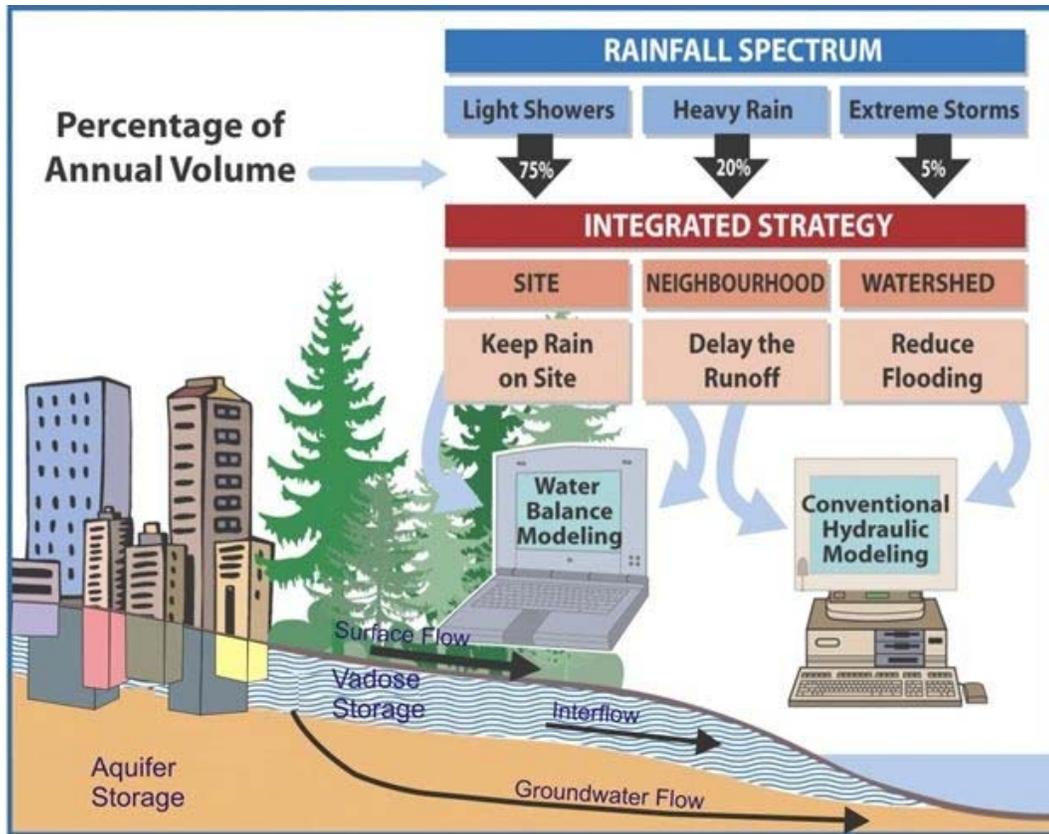
Evolution of the Methodology: The Water Balance Methodology is dynamic; and it is being enhanced over time to incorporate fresh insights resulting from science-based understanding. A key goal is to improve the technical basis for local government decisions. Three milestones in the evolutionary process are introduced below:

- First, in 2002, the Guidebook integrated hydrology and aquatic ecology. This built on Washington State research findings about the four factors limiting stream health. These are introduced in Section 4.
- Then, in 2007, the 'Beyond the Guidebook' initiative added geomorphology to the mix. This addressed the relationship between volume control and resulting flow rates in streams; and correlated stream health with stream erosion.
- Now, in 2012, the understanding yielded by the Englishman River research has added a groundwater dimension to stream health.

The Water Balance Methodology is a foundation block for those tasked with developing a Master Drainage Plan, an Integrated Stormwater Management Plan (ISMP), the Rainwater Management Component of a Liquid Waste Management Plan, or a Watershed Blueprint.

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

Figure 8

Integrated Strategy for Managing the Rainfall Spectrum

Explanatory Notes – Key Messages:

Urban development reduces the 'vadose storage' and interflow. Therefore, restore these capabilities by means of green infrastructure solutions.

Basements and underground structures will lower groundwater levels to the footing level. The ground above this then becomes part of the vadose zone and can be used for vadose storage. When designed properly, this zone can form part of the green infrastructure solution.

Definitions: 'Aquifer Storage' refers to the saturated zone where all void spaces are filled with (ground)water. 'Vadose Storage' refers to the unsaturated zone where void spaces are filled with air AND water.

How Does Water Get to a Stream?

Surface Runoff

- minutes to hours

Shallow Groundwater

- days to seasons

Deep Groundwater

- years to centuries

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Water Balance Methodology

At the turn of the century, the *UniverCity Sustainability Community* atop Burnaby Mountain in Metro Vancouver was the genesis and first case study demonstration for the Water Balance Methodology. By 2002, the Province's decision to embed the Water Balance Methodology in the Stormwater Guidebook defined a turning point in the regulatory vision for drainage planning, from reactive to proactive.

Historical Context: In the mid to late 1990s, widespread changes in thinking about rainwater and stormwater impacts reflected new insights. Historical context is provided as follows:

- **In 1973:** A glimmer of understanding when Thomas Hammer publishes his research findings on the relationship between land use changes and stream erosion.
- **By 1996:** A year of breakthroughs by a number of pioneers results in a 'roadmap' for integrated rainwater management.
- **By 2000:** A mandate to re-invent urban hydrology in order to protect tributary stream health in the Brunette River urban watershed in Metro Vancouver leads to development of the Water Balance Methodology.
- **In 2002:** Province releases the Guidebook.
- **By 2007:** Beyond the Guidebook brings together all the pieces to link the site to the watershed to the stream.

The Water Balance Model, a web-based scenario comparison tool, was developed as an extension of the Guidebook. It enables assessment of how to meet performance targets for rainfall capture.



Launched in 2003, the web-based Water Balance Model was the outcome of a 'building block process' during the 2000 - 2002 period:

- Stormwater Planning: A Guidebook for British Columbia
- Metro Vancouver Report on Stormwater Source Control Evaluation
- Chilliwack Policy & Design Manual for Surface Water Management
- UniverCity:* The Sustainable Community at the top of Burnaby Mountain



Rainfall Distribution: Figure 9 shows that 'light showers' account for most of the annual rainfall volume. When the Guidebook was rolled out in 2002, the images shown as Figure 9 proved to be a powerful education tool because they:

- helped to change the way drainage practitioners and others view rainfall;
- focussed attention on the distinction between *rainfall capture* and *runoff control*; and
- promoted understanding of why infiltration is achievable for much of the year.

Circa 2000, there was fear and doubt that anything could be done to prevent rainwater runoff. The images presented as Figure 8 were among the keys to changing the core beliefs of drainage practitioners.

Hydrologic Changes: Figure 10 illustrates how the proportions of the water balance change as the percentage of hard surface increases: runoff goes up; infiltration and surface evaporation both go down. It too is an important educational tool

"Evaporation is critical and typically gets overlooked in conventional drainage modelling. The role of the tree canopy, for example, in intercepting rainfall has not been fully understood or appreciated," states Jim Dumont, Engineering Applications Authority for the Water Balance Model Partnership. "To maintain the mass balance would require more and more infiltration as development intensifies, but is that a good or bad thing. Too much infiltration can cause significant problems."

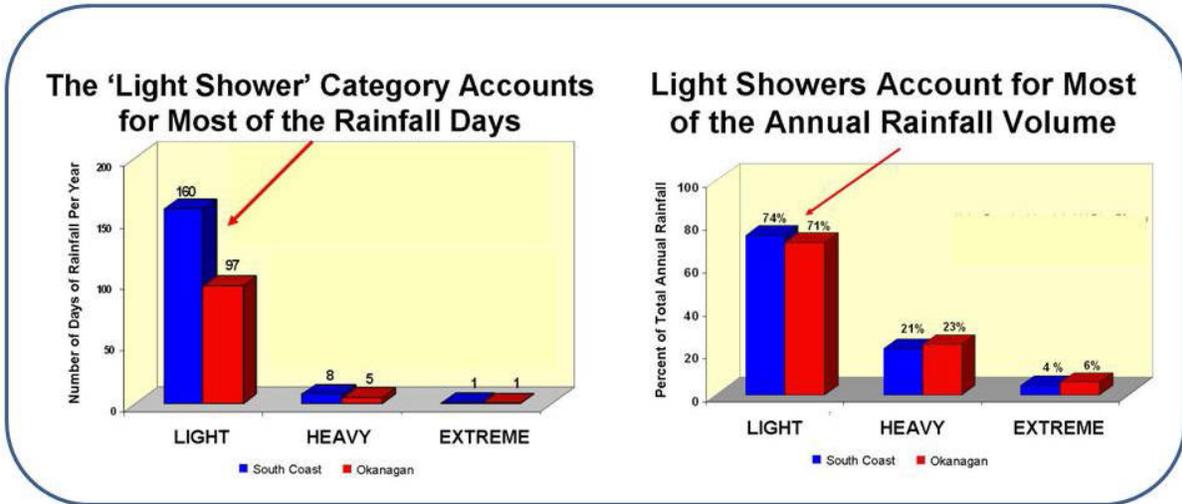


Figure 10 is a foundation piece for managing the *Rainfall Spectrum* (Figure 8). It helps provide an understanding of the pragmatic considerations driving the paradigm-shift from past **peak flow** practice to today's **volume-based** practice.

"What most people overlook is that evaporation is almost equal to infiltration. This means there is increasingly more volume to manage as the landscape is built over. This also means we need to implement landscape-type solutions that mimic the water balance," concludes Jim Dumont.

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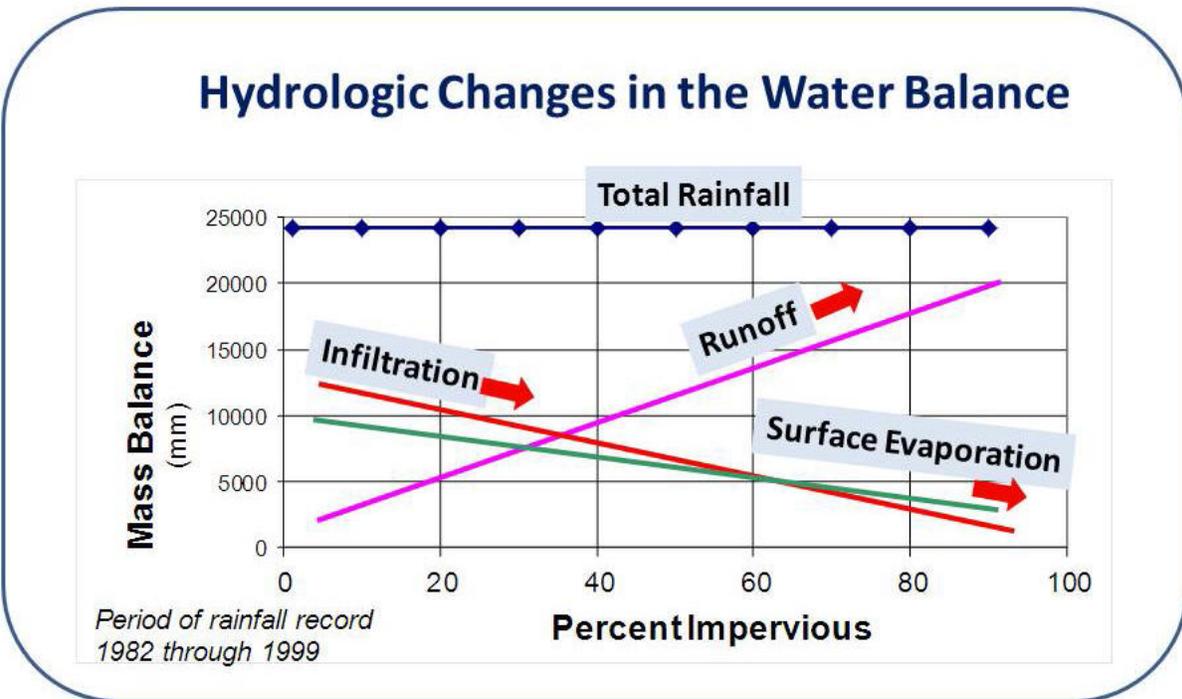
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Source: Chapter 6, *Stormwater Planning: A Guidebook for British Columbia*, 2002

Rainfall Distribution

Figure 9



Source: *Water Balance Model Partnership*

Figure 10