



Transboundary Watershed Alliance (TWA)

Shared Waters Roundtable

February 8, 2006

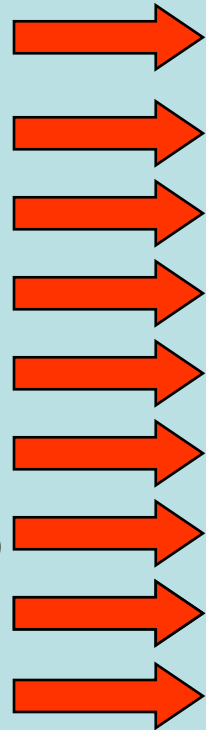
Green Infrastructure & the Water Balance Model: A Tool for Designing with Nature

Rémi Dubé, P.Eng, City of Surrey
Inter-Governmental Partnership

from Stormwater Management to Rainwater Management

From TRADITIONAL to

- Drainage Systems
- Reactive (Solve Problems)
- Engineer-Driven
- Protect Property
- Pipe and Convey
- Limited Consultation
- Local Government Ownership
- Extreme Storm Focus
- Peak Flow Thinking!




INTEGRATED:

- Ecosystems
- Proactive (Prevent Problems)
- Interdisciplinary Team-Driven
- Protect Property *and* Habitat
- Mimic Natural Processes
- Extensive Consultation
- Partnerships with Others
- Rainwater Integrated with Land Use
- Volume-Based Thinking!



Mind Map

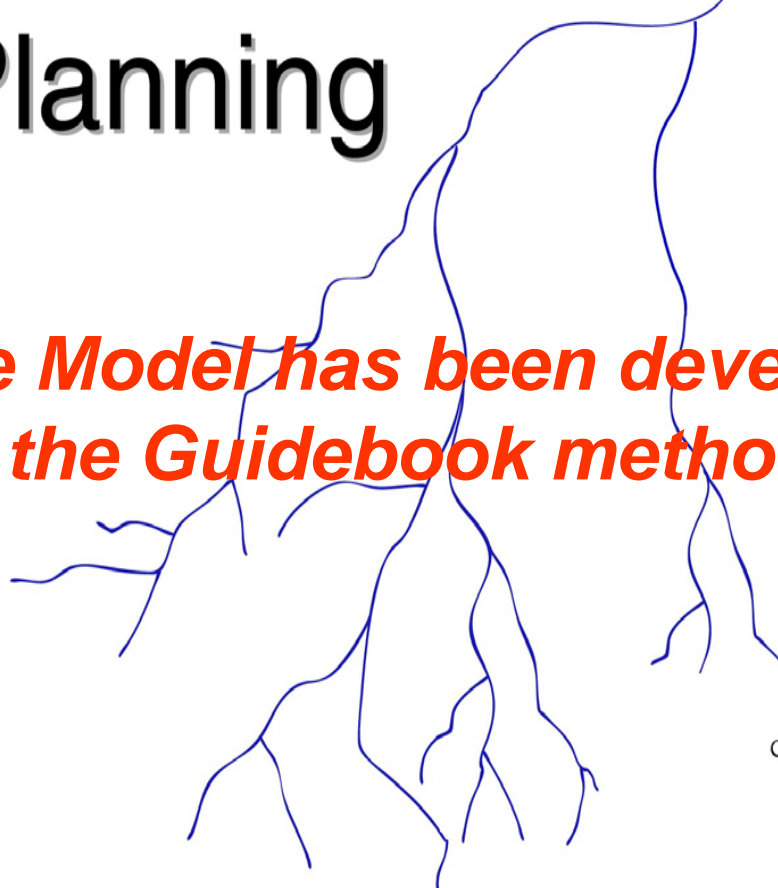
- Guidebook/ISMPs**
 - Changing Paradigms**
 - The Science**
 - Model Evolution**
 - Designing With Nature**
- 



A GUIDEBOOK FOR BRITISH COLUMBIA

Stormwater Planning

The Water Balance Model has been developed as an extension of the Guidebook methodology



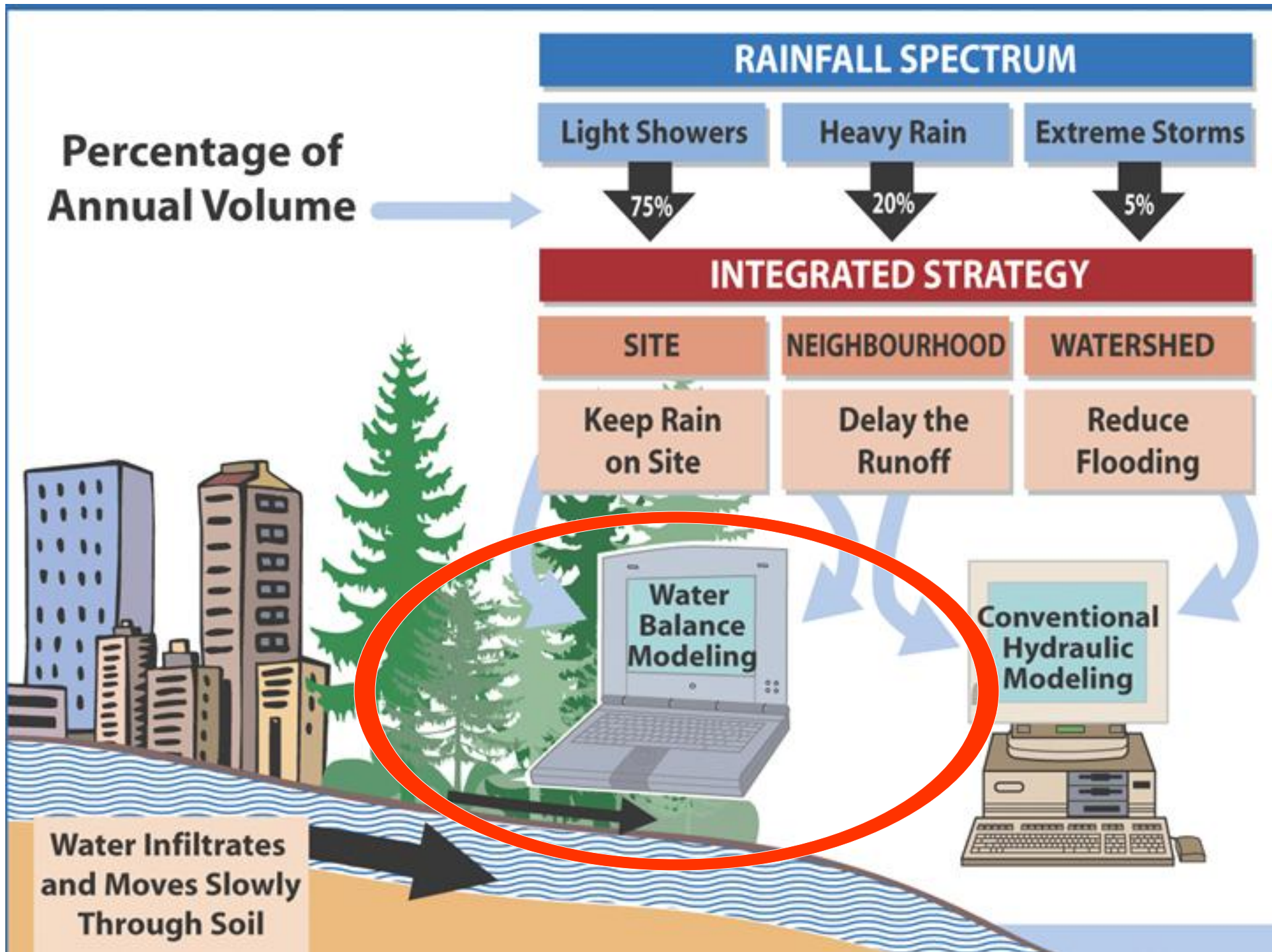
An aerial photograph of a residential development nestled within a dense forest. The houses are scattered across the landscape, with winding roads connecting them. The surrounding area is heavily wooded with green trees.

Guidebook Premise: Land Development and Watershed Protection can be Compatible

Policy Level Development Objectives

Science-Based Understanding
of Development Impacts

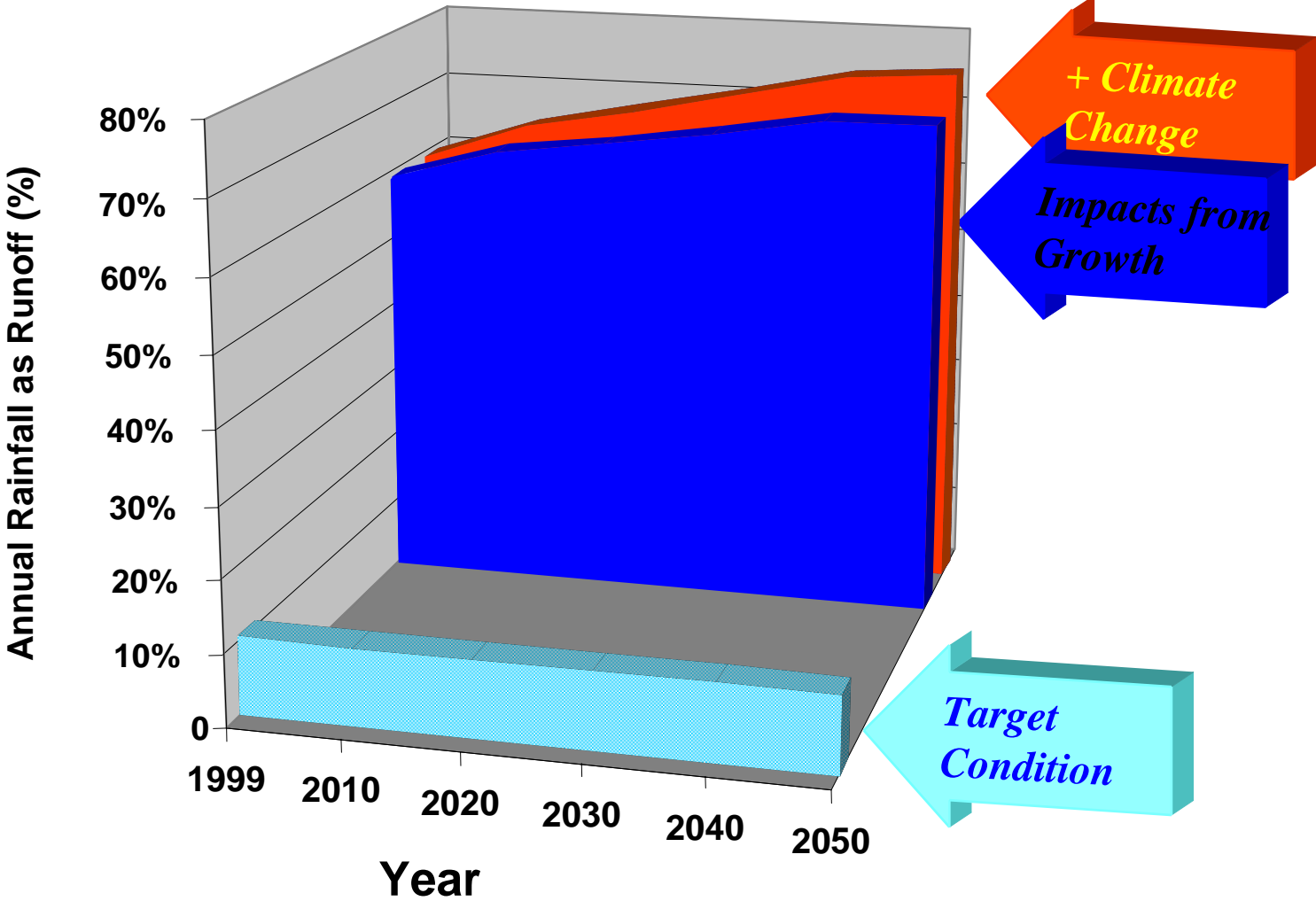
Site Design Practices that achieve Objectives






WATER Balance MODEL FOR BRITISH COLUMBIA

The Watershed Picture: Without Rainfall Capture





Mind Map

- Guidebook/ISMPs**
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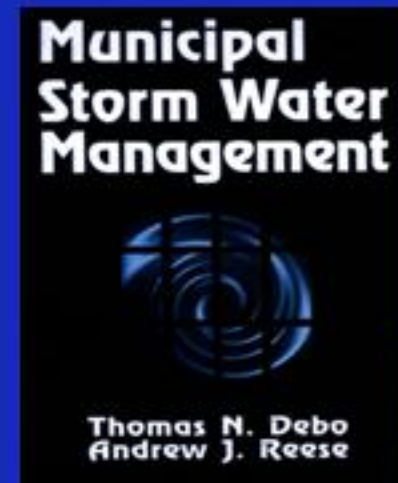


Andy Reese

“Do you know where you really are in the shifting paradigms of stormwater management?”

1. Run it in Ditches
2. Run it in Pipes
3. Run it in Stormwater Pipes
4. Keep it from Stormwater Pipes
5. Well, Just Don't Cause Flooding
6. Oh, and Don't Pollute Either
7. It's the Ecology, Stupid
8. Water is Water is Watershed
9. Green and Bear It

10. Build the Vision, Create the Legacy



Building a Vision & Creating a Legacy

- **Issue:** How We Manage Population Growth
- **Impact:** Growth Resulting in Urban Densification
(Land Constraints; Smaller Lots)
- **Sustainability:** *Means Design with Nature*
- **Built Environment:** We Can Improve It
- **Natural Environment:** We Can Protect It
- **Cumulative Benefits:** Accrue Over Time
- **Outcome:** Sustain Community Livability




Drainage Planning in BC Has Been Evolving Over the Decades

- 1960s: Pipe and Remove
- 1970s: Detain Peak Flows
- 1980s: Reactive Mitigation
- 1990s: Stream Stewardship
(Proactive Management)
- 2000s: Rainwater Management
(Sharing a Vision)



Mind Map

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Why Manage Volume



Erosion



Sedimentation

The Mean Annual Flood (MAF) is the 'channel-forming event'

When the MAF increases, the channel erodes to convey the additional volume

A consequence of channel instability is habitat degradation

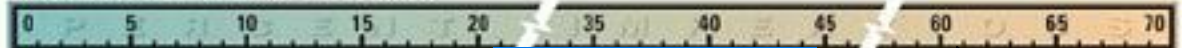
IMPACT OF CHANGES IN HYDROLOGY ON WATERCOURSE EROSION AND BASE FLOW RELATIONSHIPS

(WITHOUT BEST MANAGEMENT PRACTICES)

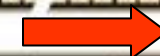
INCREASING URBANIZATION (NO BEST MANAGEMENT PRACTICES)



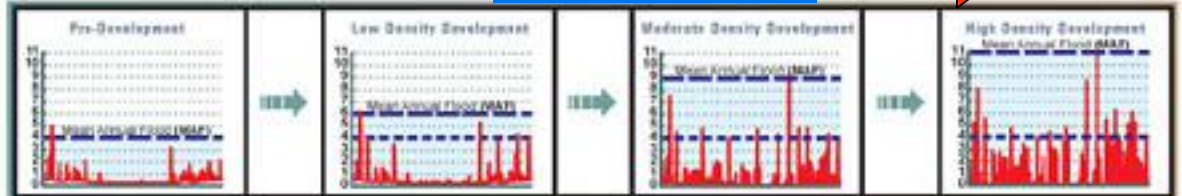
PROPORTION OF IMPERVIOUS LAND AREA (%)



Volume Increasing



EFFECT ON TYPICAL YEAR HYDROGRAPH



EFFECT ON WATERCOURSE EROSION



NUMBER OF STORM EVENTS AT OR ABOVE PREDEVELOPMENT MEAN ANNUAL FLOOD

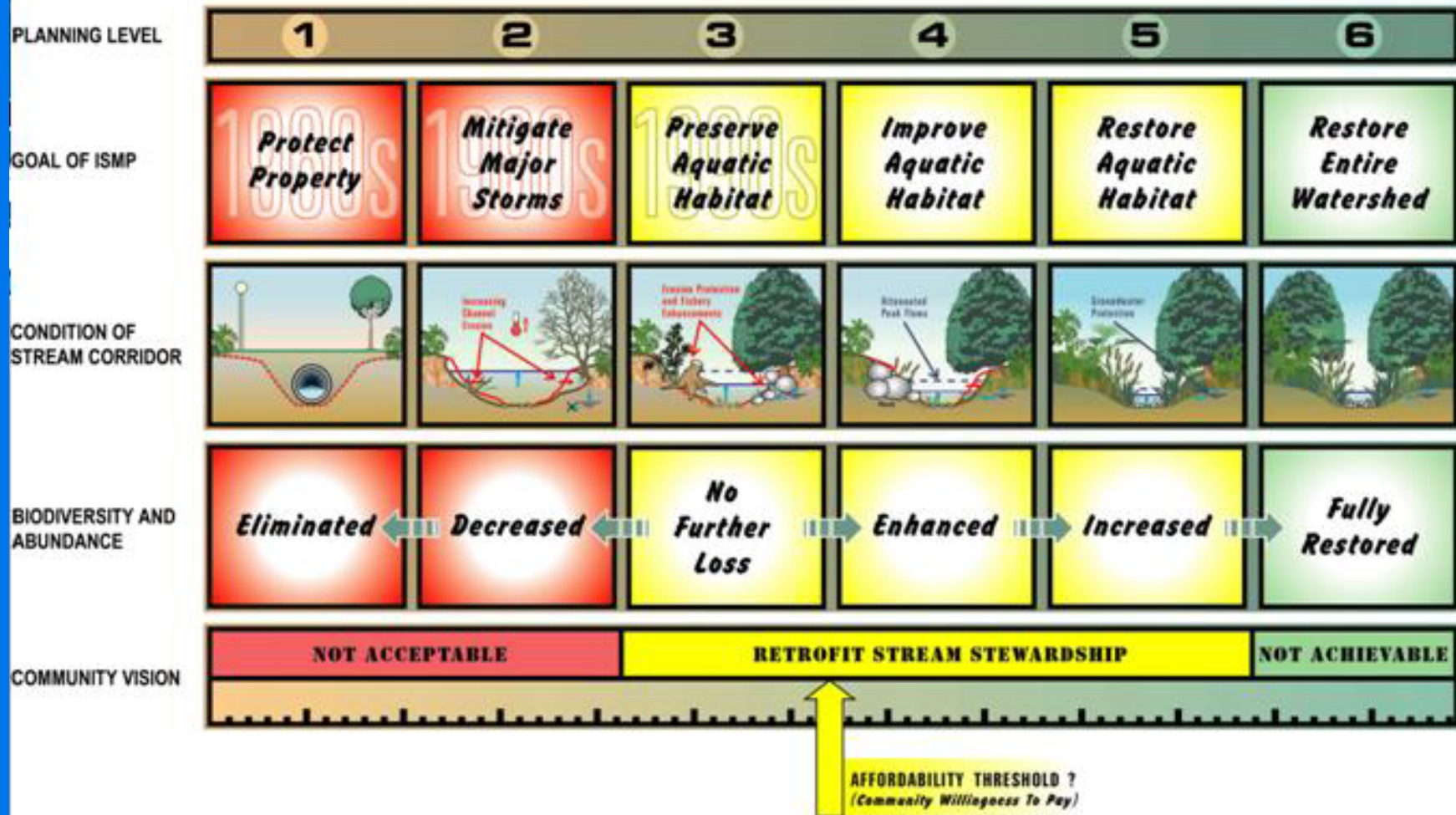


RATIO OF MEAN ANNUAL FLOOD TO WINTER BASE FLOW




ALTERNATIVE VISIONS FOR THE LONG-TERM ENVIRONMENTAL HEALTH OF STREAM CORRIDORS

Conceptual Framework for Selection of ISMP Level





Mind Map

- Guidebook/ISMPs**
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- 

An aerial photograph of a suburban residential neighborhood. The houses are densely packed, with a mix of two-story and three-story homes. The roofs are mostly brown and grey. In the background, there is a large, forested hill with a dense canopy of green trees. The sky is clear and blue. The text "The Water Balance Model is..." is overlaid in yellow on the hillside.

The Water Balance Model is...

A tool that quantifies the benefits –
in terms of reducing **rainwater runoff volume**
- of installing source controls under different
land use, soil and climate conditions



WATER
Balance
MODEL
FOR BRITISH COLUMBIA

The Water Balance Model is the result of a Building Block Process:

GVRD Report on Stormwater Source Control Evaluation

Chilliwack Policy & Design Manual for Surface Water Management

Stormwater Planning:
A Guidebook for British Columbia

UniverCity:

The Sustainable Community at the Top of Burnaby Mountain



Partners



City of Chilliwack

Visit

City of Chilliwack



1. Enter the area of your site, add existing soil conditions, and land use information.
2. Create a graph of rainwater volume summaries and see how well your site performs.
3. Add a Green Roof or a Rain Garden or similar rainwater source control and compare before and after results.

Environmental Best Management Practices for

Key Message:
Anybody with a computer and internet connection can access the model

primary purpose is to provide province-wide guidelines for the maintenance of environmental valuesMore

www.waterbalance.ca

Organizations

Recent Additions...

[British Columbia Ground Water Association](#)

[Canadian Water Resources Association](#)

The Canadian Water Resources Association is a national organization of individuals and organizations interested in the management of Canada's water resources. The membership of the Association is composed of private and public sector water resource professionals including managers, administrators, scientists, academics, students and users. It has branch organizations in eight provinces and members throughout Canada and beyond.

[Watershed Report Card](#)

Events

Jun 2005

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Add an event

Poll

A poll is not available

Adapting the Australian Experience



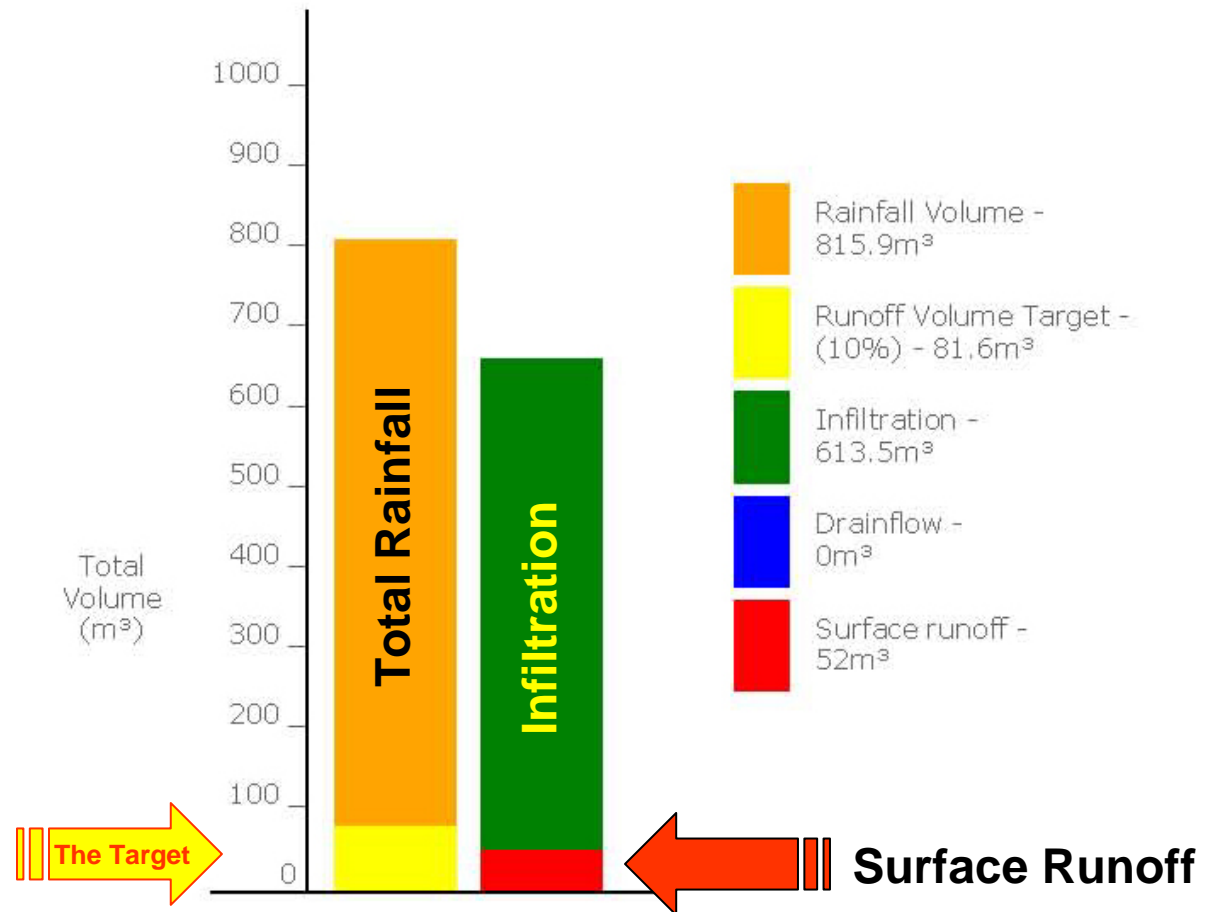


WATER Balance MODEL FOR BRITISH COLUMBIA

It enables users to test the achievability of Performance Targets

Water Balance Volumes For Catchment

Graph for the period Jan 1 1999 to Dec 31 1999





WATER
Balance
MODEL
FOR BRITISH COLUMBIA

Inter-Governmental Partnership: Vision

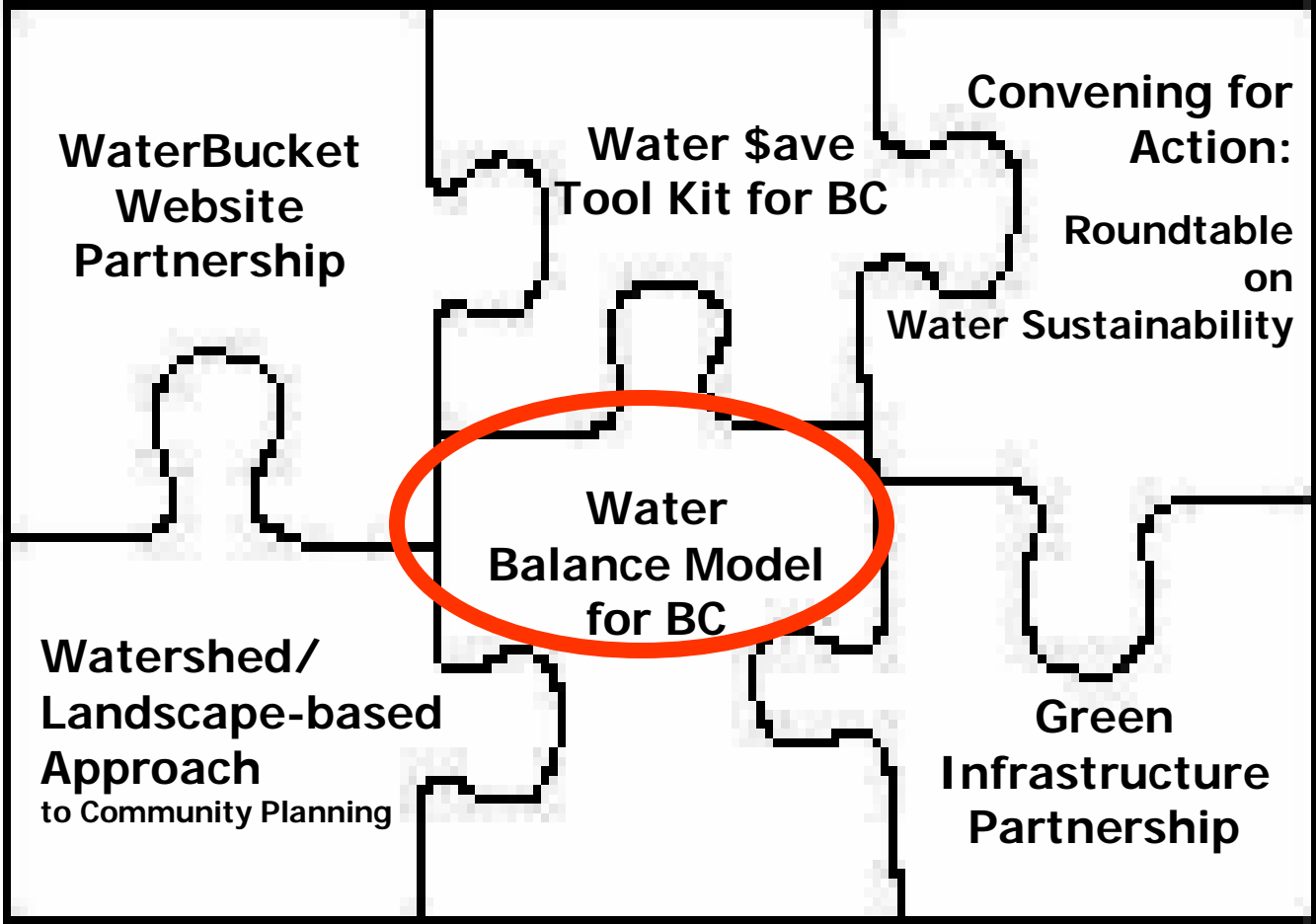
To promote changes in land development practices so that:

- The built environment will preserve and/or restore the natural water balance over time
- Performance targets will be achieved for rainwater runoff volume and flow rate reduction at the source, *where rain falls*




WATER
Balance
MODEL
FOR BRITISH COLUMBIA

...and is also the centrepiece of the **Water Sustainability Action Plan for British Columbia:**





Mind Map

- ☑ **Guidebook/ISMPs**
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- 



How Water Moves Through Soil

Water Balance Model promotes Integration of Perspectives

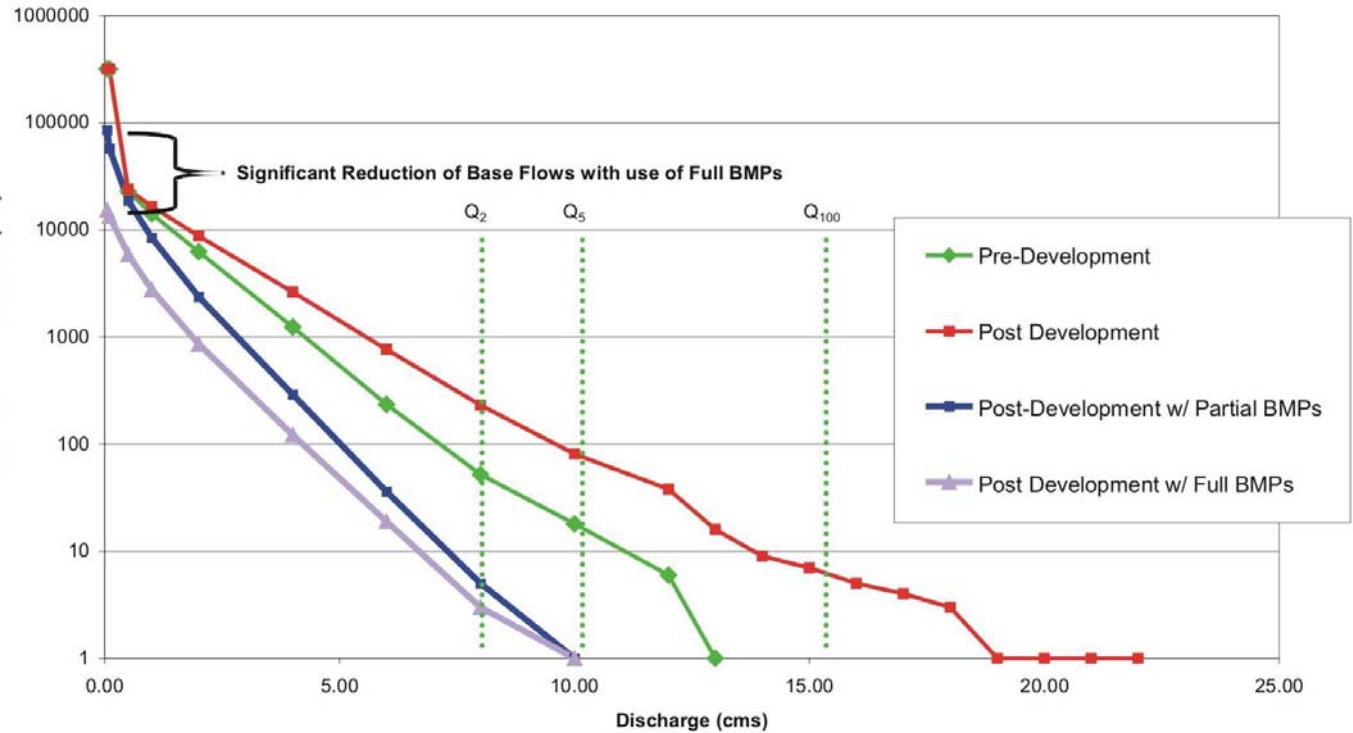
- **Planners:** Tool for Better Use of Space
- **Engineers:** Tool for Pre-Design
- **Landscape Architects:** Tool for Green Solutions
- **Ecologists:** Tool for Watershed Function
- **Educators:** Tool for Social Marketing



WATER Balance MODEL FOR BRITISH COLUMBIA

Compare Discharges

Excedence vs Discharge
Reach 4

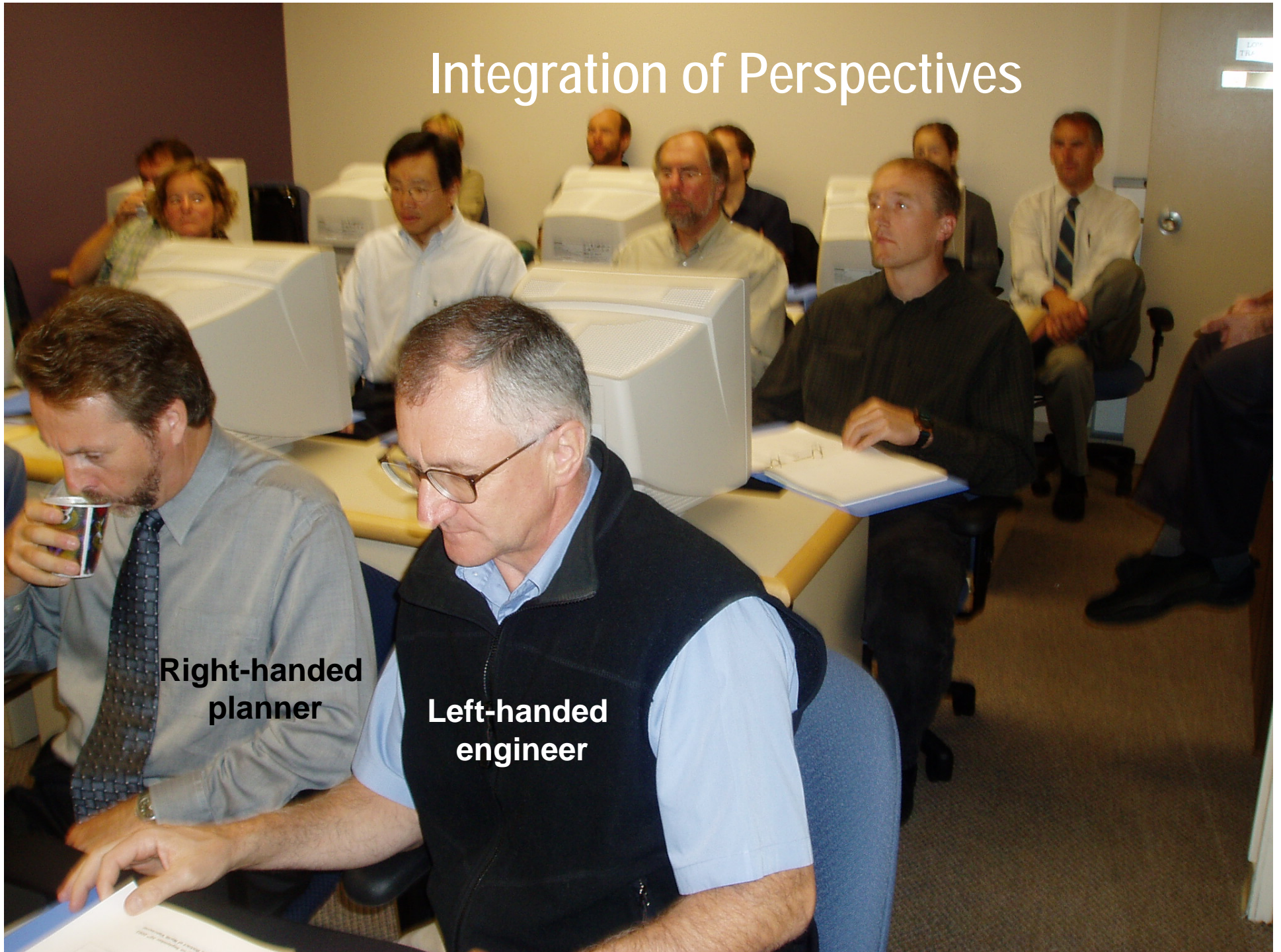


increased frequency



Total Hours of Excedence (hrs)

Integration of Perspectives



**Right-handed
planner**

**Left-handed
engineer**



WATER
Balance
MODEL
FOR BRITISH COLUMBIA

From Rain to Groundwater

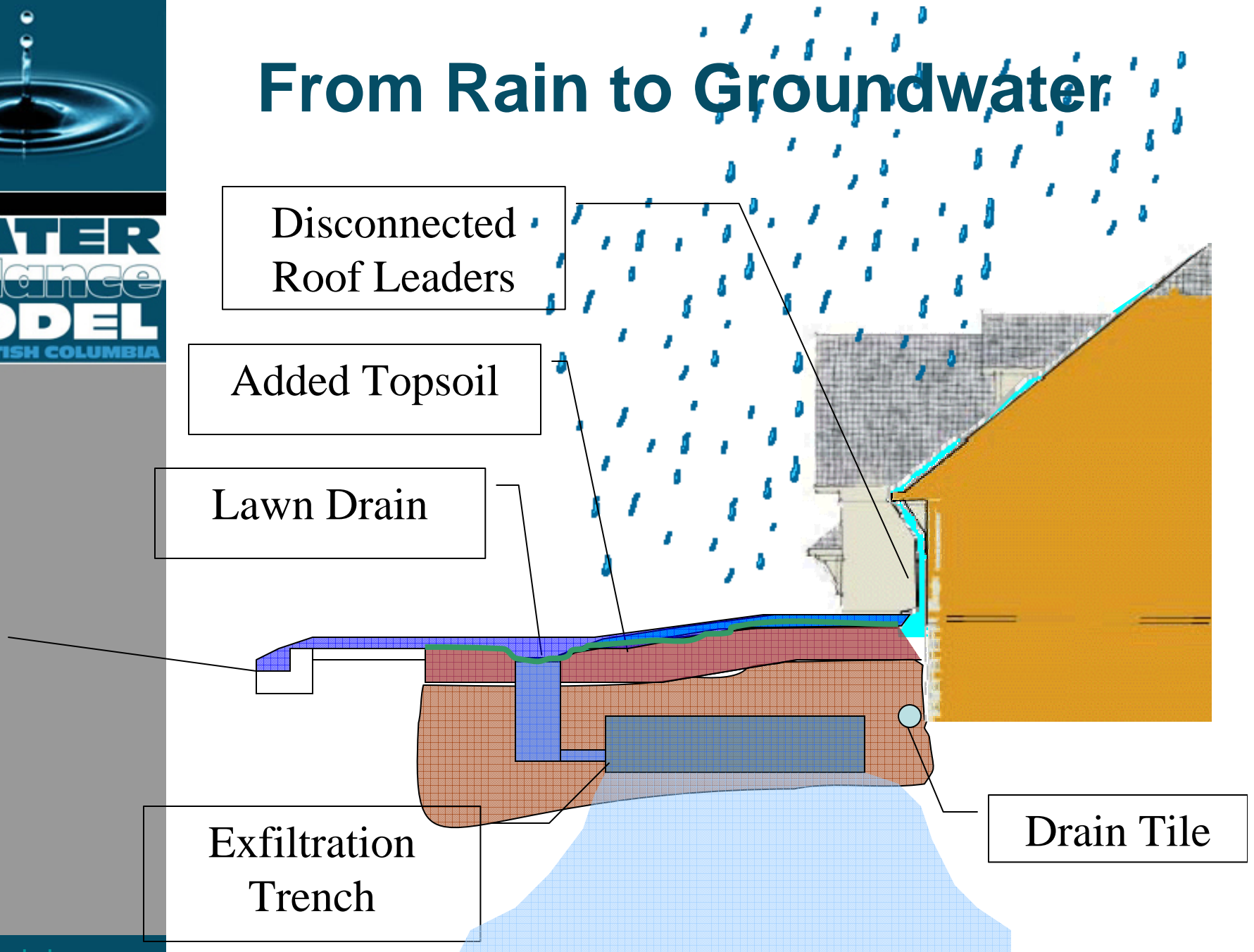
Disconnected
Roof Leaders

Added Topsoil

Lawn Drain

Exfiltration
Trench

Drain Tile





WATER
Balance
MODEL
FOR BRITISH COLUMBIA

Simplifying the Technical Language!

Basic Source Control Types:

- Absorbent Landscape
- Rain Gardens
- Infiltration Swales
- Pervious Paving
- Green Roof

How the Water Balance Model can be used to make better decisions:

- **Local Governments** -
when communicating with the public
- **Planners and Engineers** –
when setting performance targets
- **Developers and their Consultants** -
when testing scenarios
- **Environmental Agencies** -
when monitoring watershed health

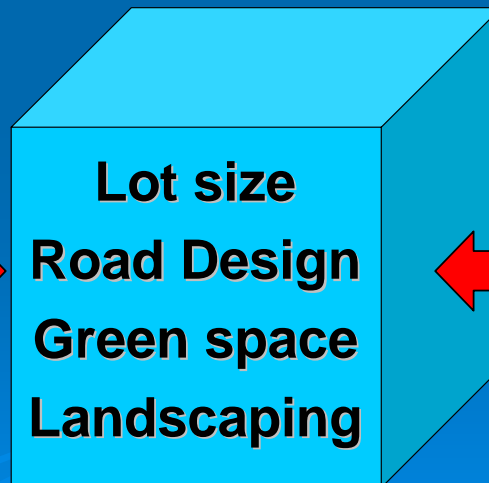
Key Message:

Integrate Actions at Three Scales: Improve Site Practices to Enhance Community Livability

Site



Neighbourhood:



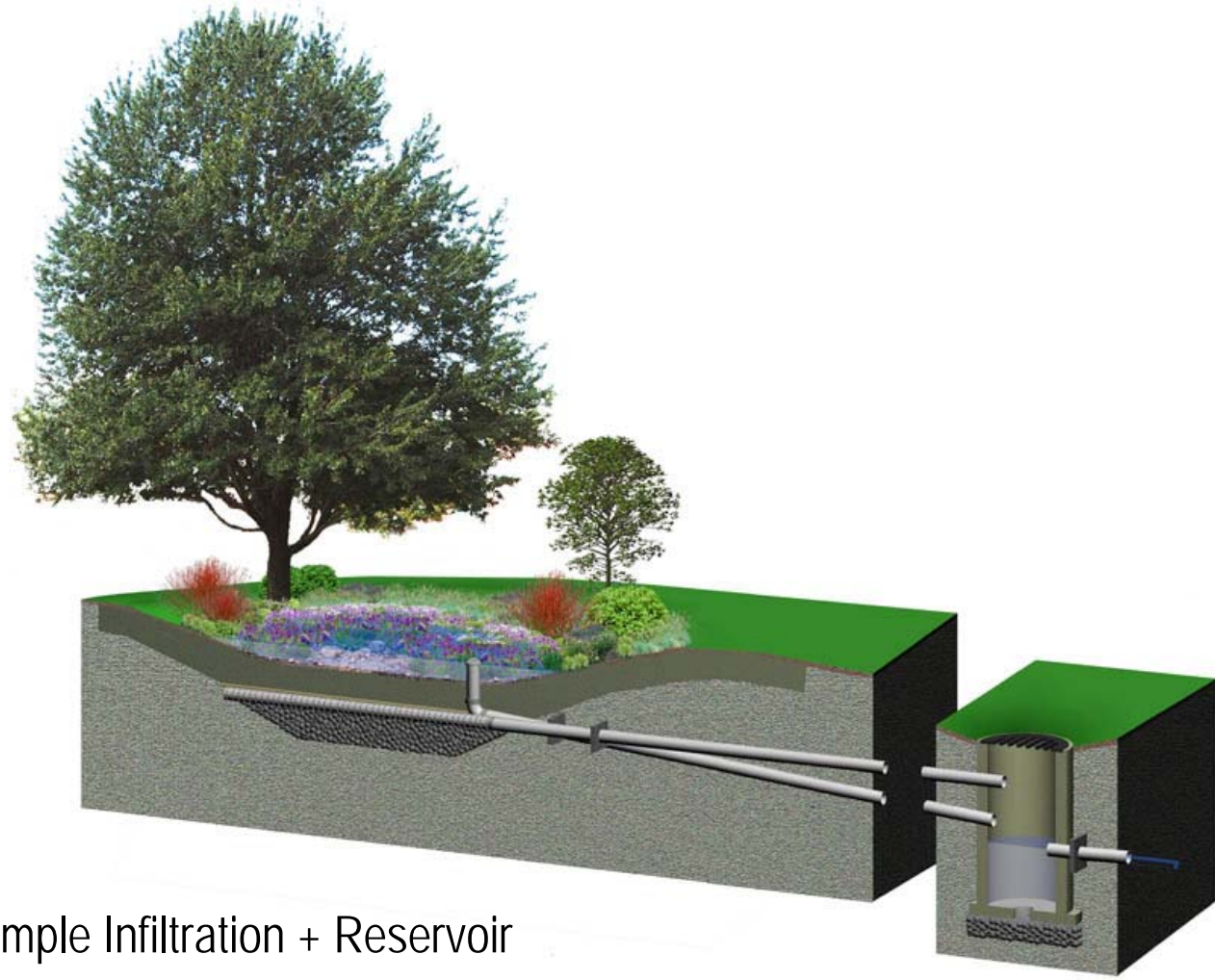
Watershed:





WATER
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‘Break the Connection’ with a Rain Garden

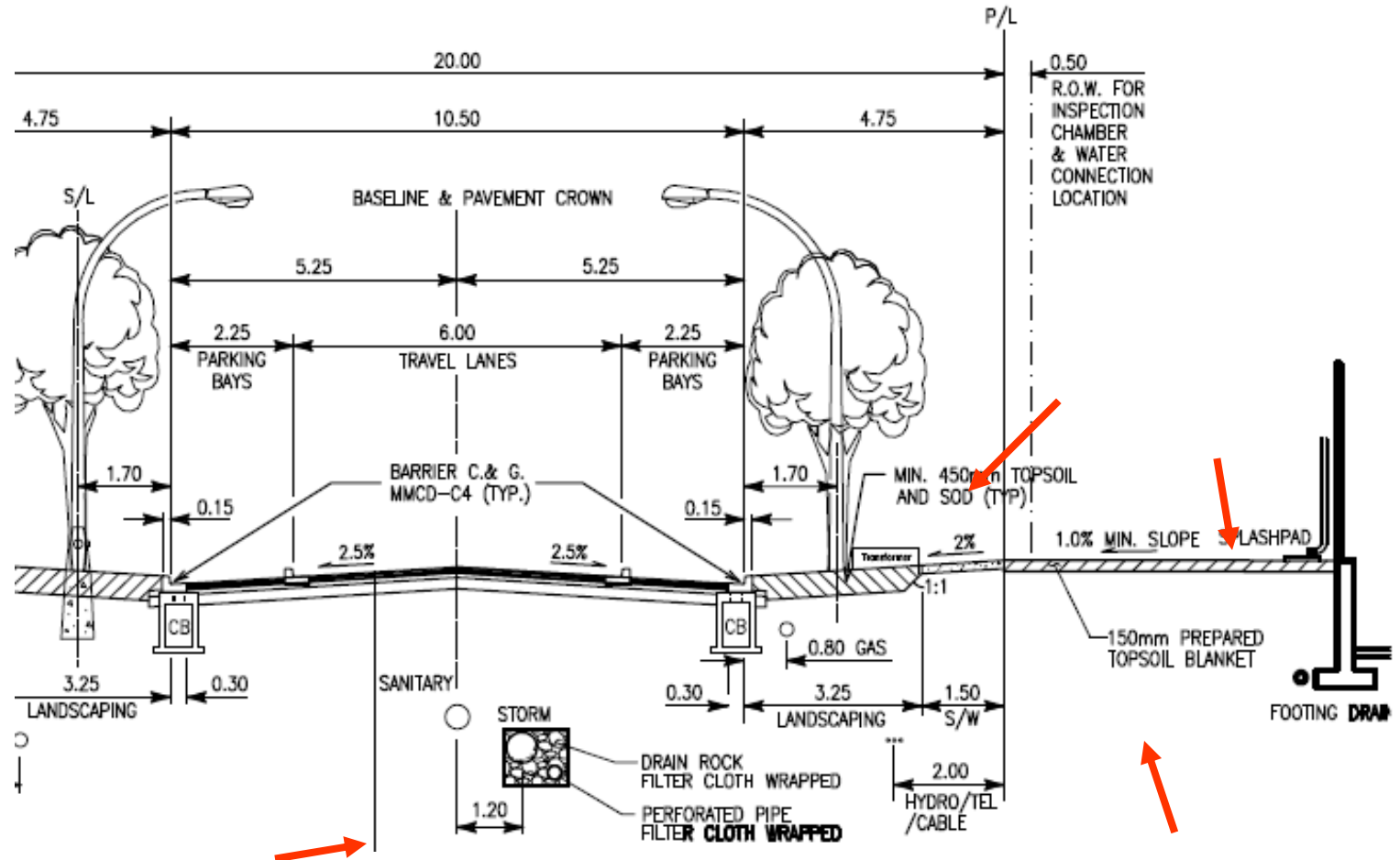


Simple Infiltration + Reservoir
+ Overflow



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Balance
MODEL
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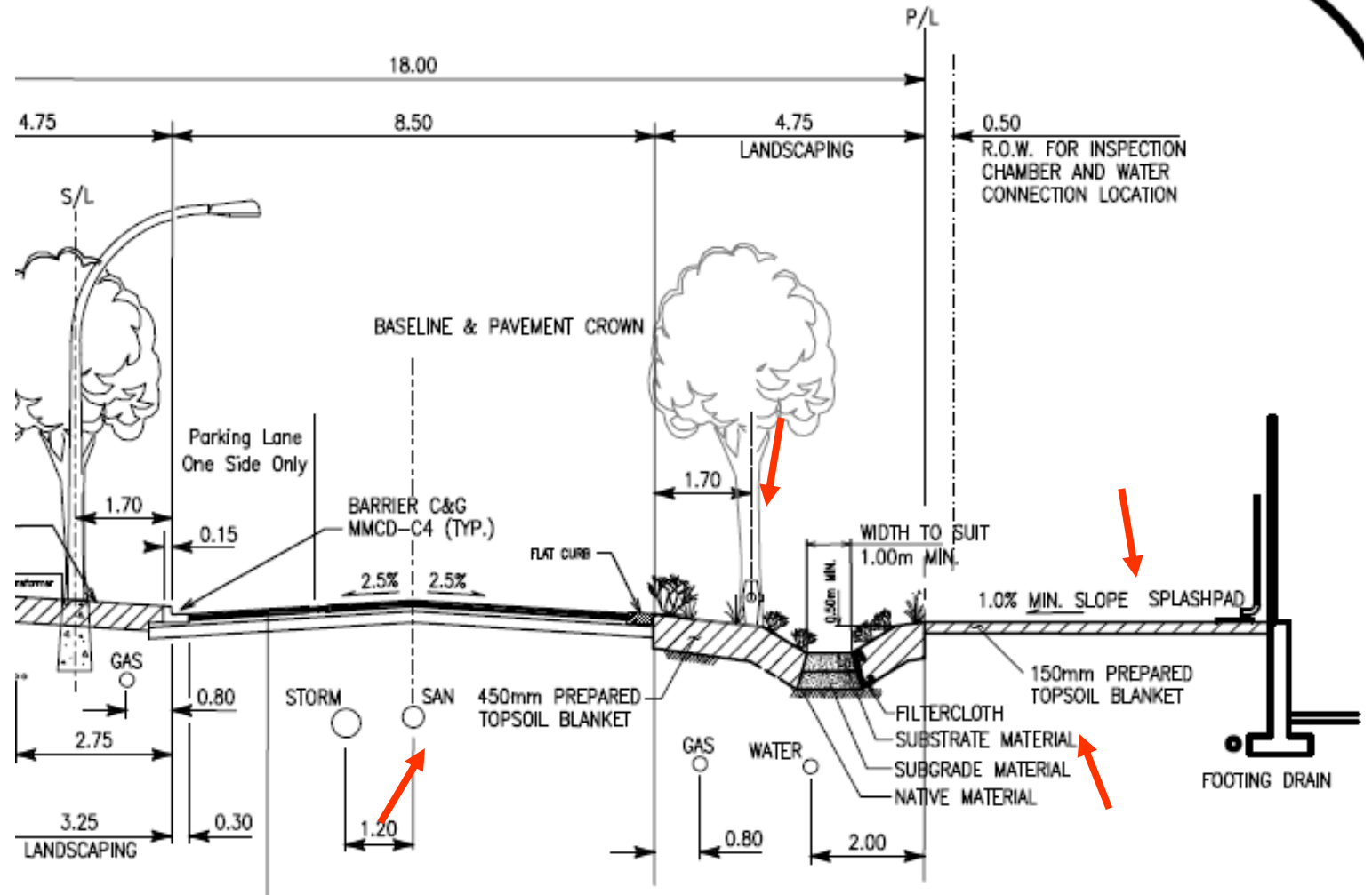
Street BMP Cross-Section



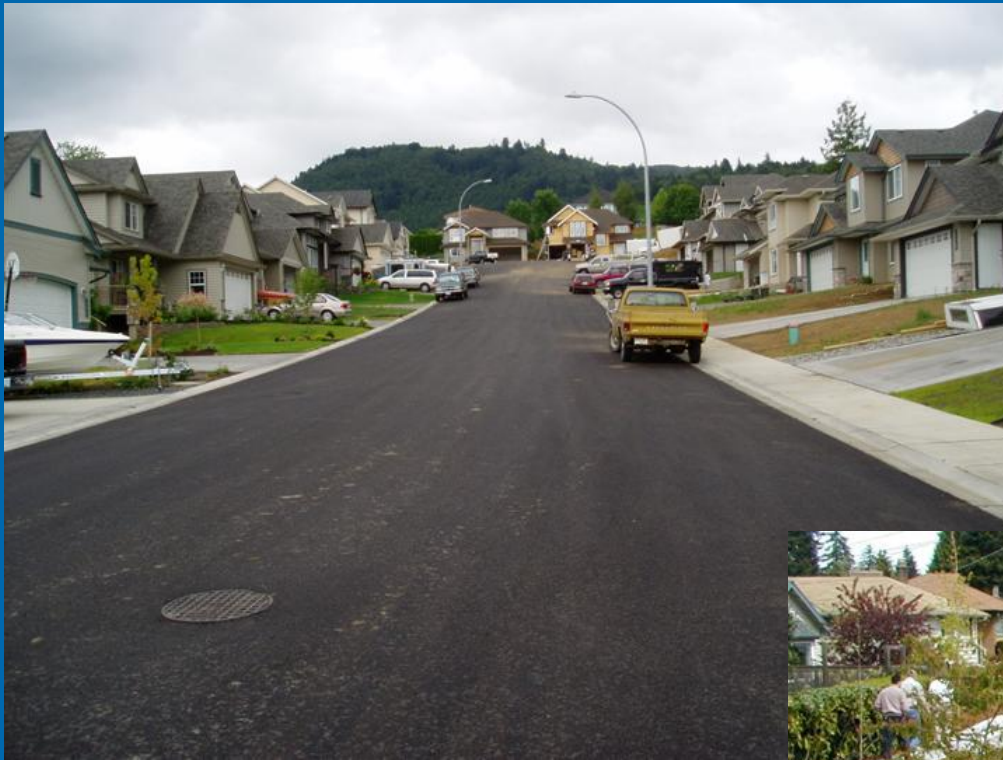


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Balance
MODEL
FOR BRITISH COLUMBIA

Green Street Cross-Section



Livability and Streetscape Design: We Have Choices: An Example



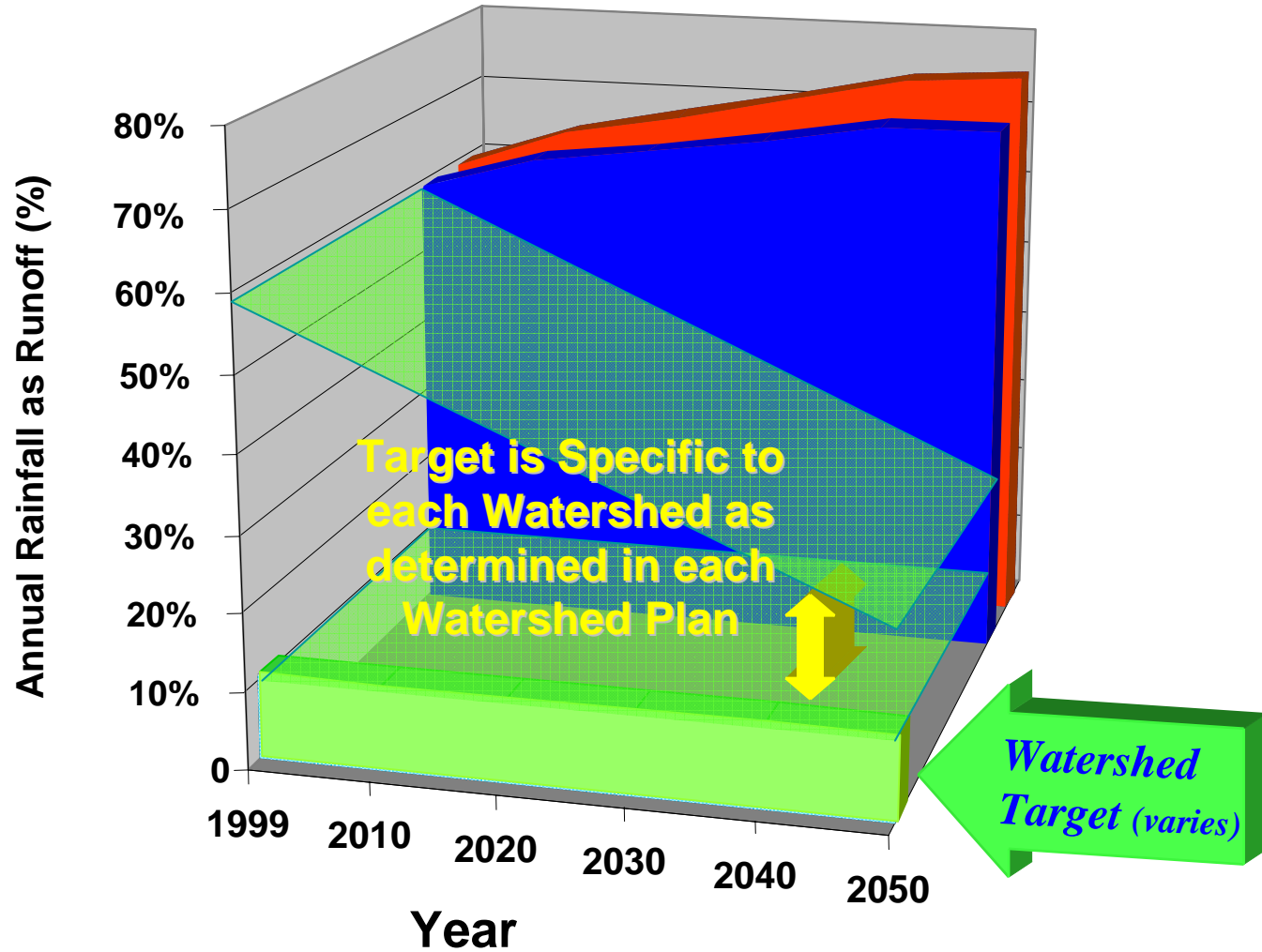
**City of Seattle
Street Edge Alternatives Program**

**Will Streets Be
Sterile and Uninviting,
Or Green and Inviting?**



WATER Balance MODEL FOR BRITISH COLUMBIA

The Watershed Picture: With Rainfall Capture





WATER
Balance
MODEL
FOR BRITISH COLUMBIA

ON-GOING IMPROVEMENTS

Hydrologic Engine Conversion: from soil moisture accounting to QUALHYMO

Broader acceptance

One Stop Shopping

Hydraulic Modelling capabilities

Numerous Routines built in

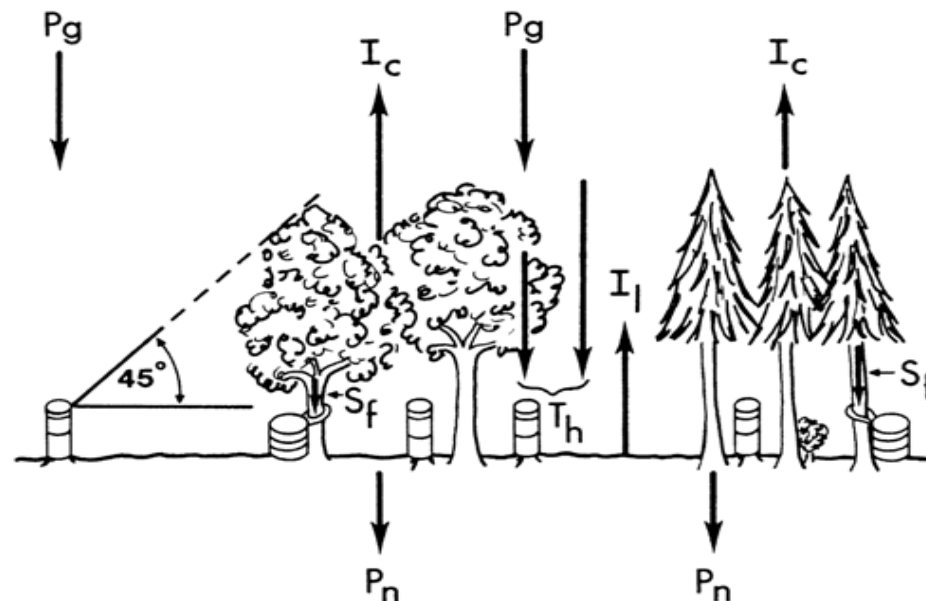
Snowmelt

Multiple year simulations



WATER
Balance
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A **Tree Canopy Module** is currently being developed through a 3-way partnership with the **University of British Columbia** and the **Urban Forest Research Center** at the University of California (Davis)



$$\text{Interception total } I = I_c + I_l$$

$$\text{The amount reaching the forest floor} = T_h + S_f$$

$$\text{Interception by canopy (overstory + understory) } I_c = P_g - T_h - S_f$$

$$\text{Net precipitation } P_n = T_h + S_f - I_l$$



WATER
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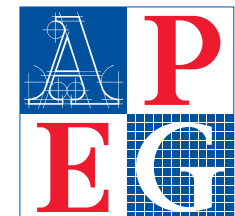
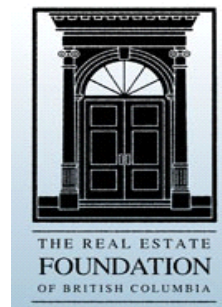
Inter-Governmental Partnership: Key Partnerships

Real Estate Foundation of BC

Urban Development Institute

BC Water and Waste Association

APEGBC



Professional Engineers
and Geoscientists of BC
www.apegbc.ca

An aerial photograph showing a rural landscape. The land is divided into a grid of rectangular parcels, likely agricultural fields. A winding river or stream flows through the center of the image. A road or highway runs diagonally across the lower right portion. The terrain appears to be a mix of green fields and brownish areas, possibly indicating different types of vegetation or soil. The overall scene is a typical rural landscape.

Actions on the Ground...

...Can Result in Cumulative Benefits Over Time!