An aerial photograph showing a large, cleared area for a subdivision under construction. The site is surrounded by dense green forest. In the background, there are rolling hills and mountains under a clear sky. The construction site features several winding roads and cleared plots of land. The text is overlaid in yellow on the image.

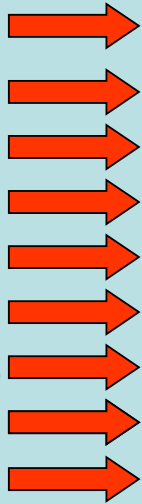
# **Rainfall Capture and “Green” Subdivision Design: Applying the Water Balance Model**

**Kim Stephens, MEng, PEng, Project Coordinator  
Inter-Governmental Partnership**

# from Stormwater Management to Rainwater Management

## From TRADITIONAL to

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



## INTEGRATED:

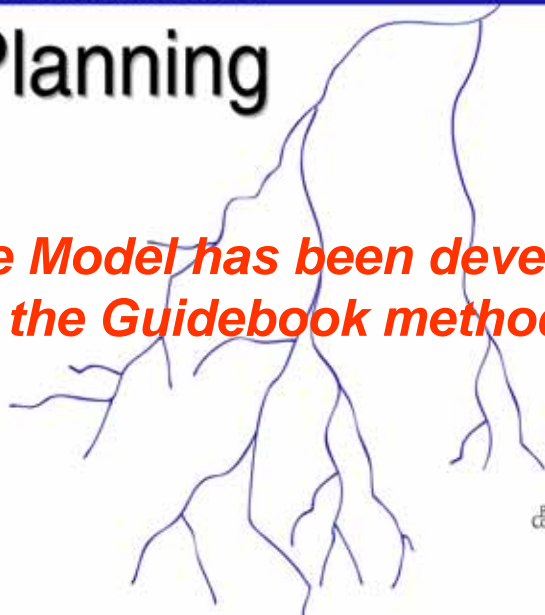
- Ecosystems
- Proactive (Prevent Problems)
- Interdisciplinary Team-Driven
- Protect Property *and* Habitat
- Mimic Natural Processes
- Consensus-Based Decisions
- Partnerships with Others
- Rainwater Integrated with Land Use
- Volume-Based Thinking!



A GUIDEBOOK FOR BRITISH COLUMBIA

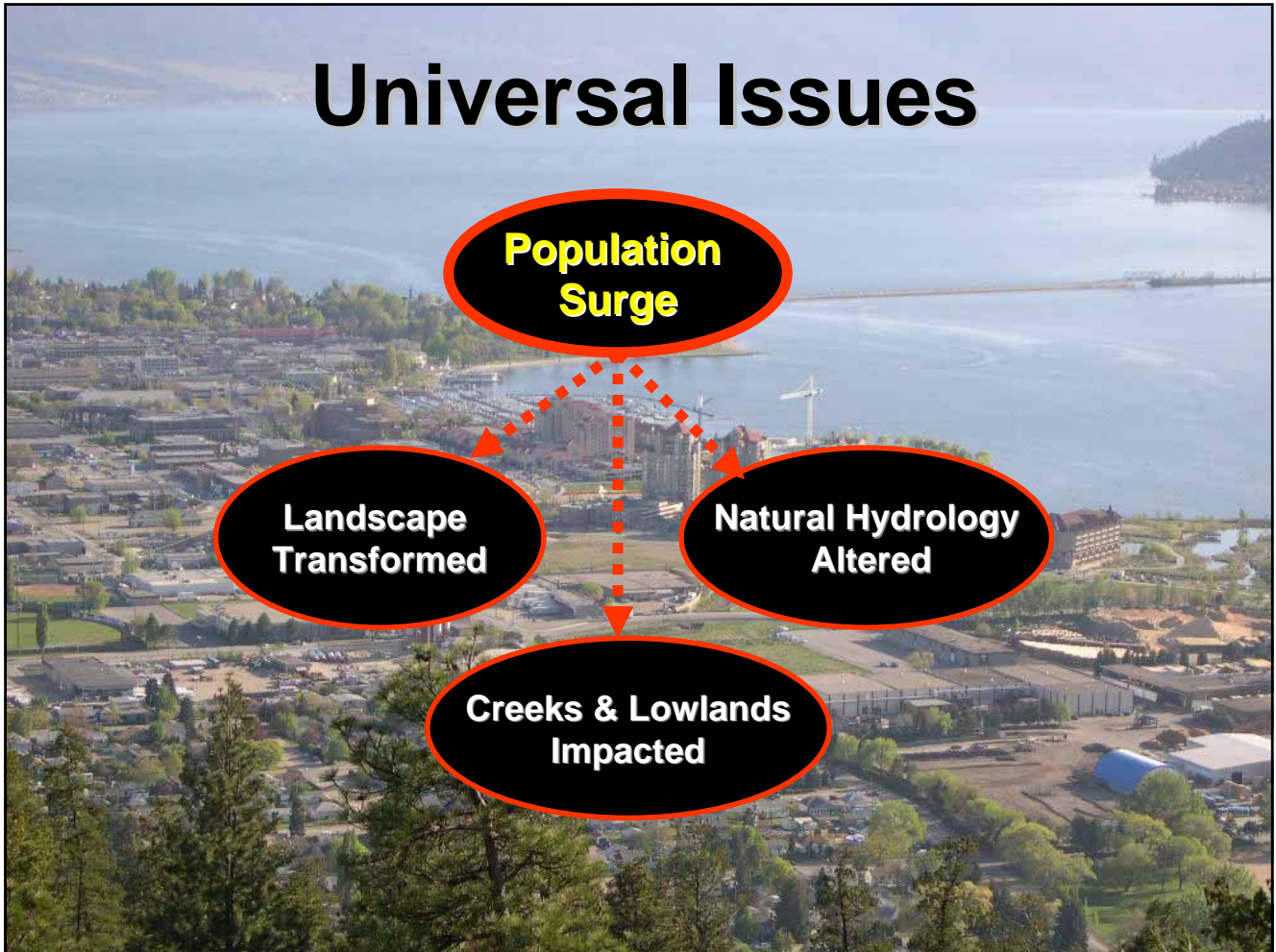
# Stormwater Planning

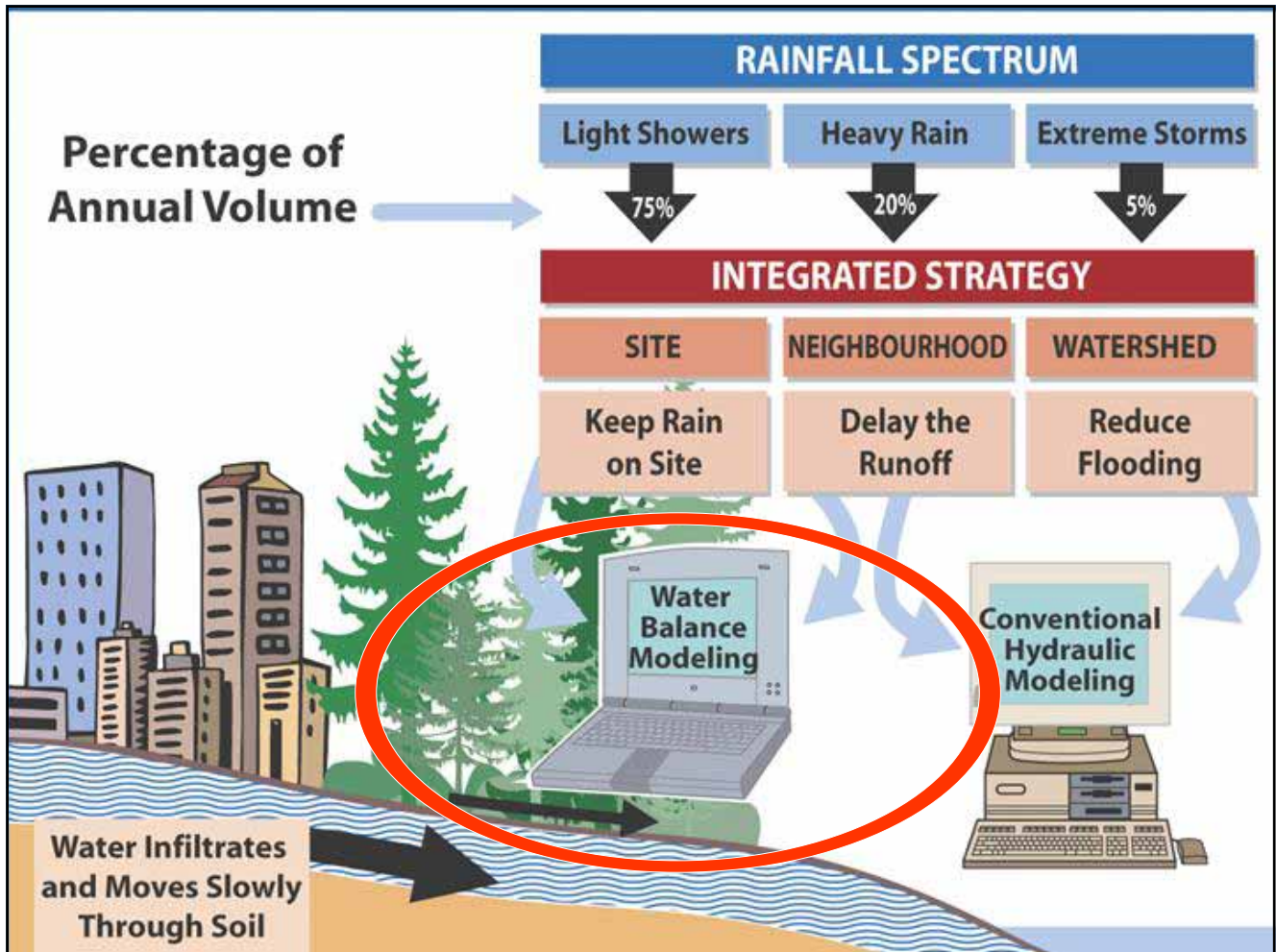
*The Water Balance Model has been developed as an extension of the Guidebook methodology*



 BRITISH COLUMBIA  
Ministry of Water, Land and Air Protection

# Universal Issues



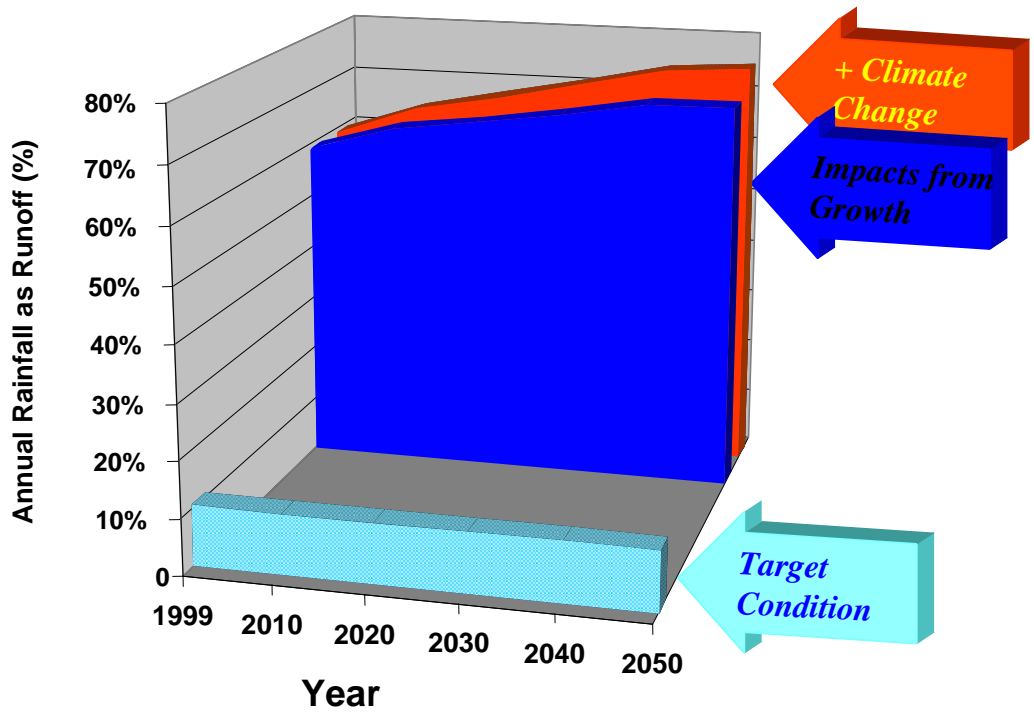




**WATER**  
Balance  
**MODEL**  
FOR BRITISH COLUMBIA

[www.waterbalance.ca](http://www.waterbalance.ca)

## The Watershed Picture: Without Rainfall Capture





# Mind Map



- Paradigms**
- WBM Context**
- The Science**
- Application**

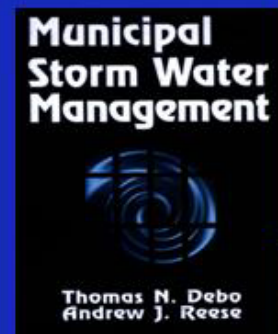


Andy Reese

## “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



- Paradigms**
- WBM Context**
- The Science**
- Application**

																																																	
<a href="#">BRITISH COLUMBIA</a>		<a href="#">WATER BALANCE MODEL</a>		<a href="#">RESOURCES</a>		<a href="#">NETWORKING</a>																																											
<b>Partners</b>  <i>City of Chilliwack</i> Visit City of Chilliwack		 <b>TRY THE MODEL</b> <ol style="list-style-type: none"> <li>1. Enter the area of your site, add existing soil conditions, and land use information.</li> <li>2. Create a graph of rainwater volume summaries and see how well your site performs.</li> <li>3. Add a Green Roof or a Rain Garden or similar rainwater source control and compare before and after results.</li> </ol>		<b>Organizations</b> Recent Additions... <a href="#">British Columbia Ground Water Association</a>  <a href="#">Canadian Water Resources Association</a> 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. <a href="#">Watershed Report Card</a>																																													
<b>Events</b> Jun 2005 <table border="1"> <thead> <tr> <th>Su</th> <th>Mo</th> <th>Tu</th> <th>We</th> <th>Th</th> <th>Fr</th> <th>Sa</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> <tr> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> <td>11</td> </tr> <tr> <td>12</td> <td>13</td> <td>14</td> <td>15</td> <td>16</td> <td>17</td> <td>18</td> </tr> <tr> <td>19</td> <td>20</td> <td>21</td> <td>22</td> <td>23</td> <td>24</td> <td>25</td> </tr> <tr> <td>26</td> <td>27</td> <td>28</td> <td>29</td> <td>30</td> <td></td> <td></td> </tr> </tbody> </table> Add an event		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			<p style="text-align: center;"><b>Key Message:</b>  <b>Anybody with a computer and internet connection can access the model</b></p> <p>primary purpose is to provide province-wide guidelines for the maintenance of environmental values .....More</p> <p style="text-align: center;"><a href="http://www.waterbalance.ca">www.waterbalance.ca</a></p> <p>Adapting the Australian Experience</p>  BASIC PROCEDURES FOR 'SOURCE CONTROL' OF STORMWATER					
Su	Mo	Tu	We	Th	Fr	Sa																																											
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<b>Poll</b> A poll is not available																																																	





**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**



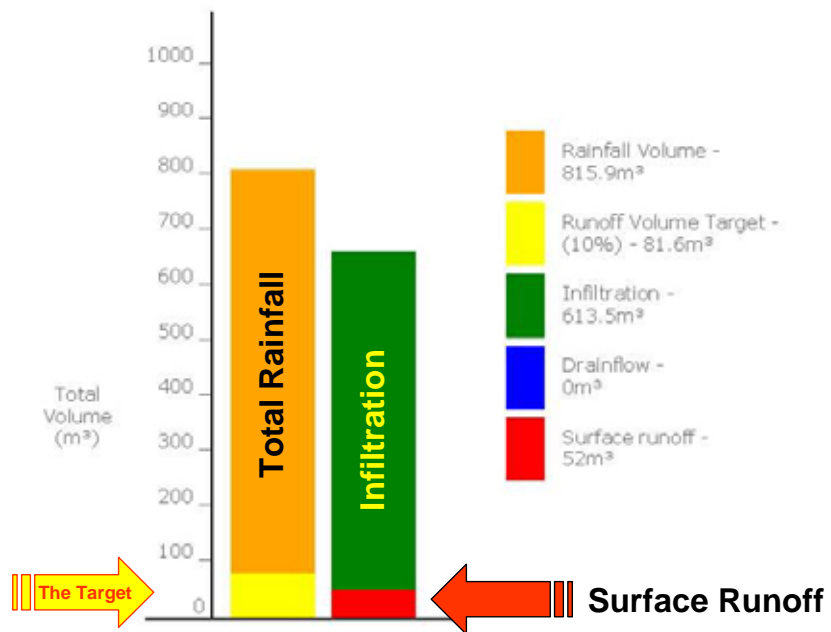
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**Balance**  
**MODEL**  
FOR BRITISH COLUMBIA

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## 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







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Balance  
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## 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*

[www.waterbalance.ca](http://www.waterbalance.ca)



**WATER**  
Balance  
**MODEL**  
FOR BRITISH COLUMBIA

# 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.apeg.bc.ca](http://www.apeg.bc.ca)

[www.waterbalance.ca](http://www.waterbalance.ca)



**WATER**  
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## 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

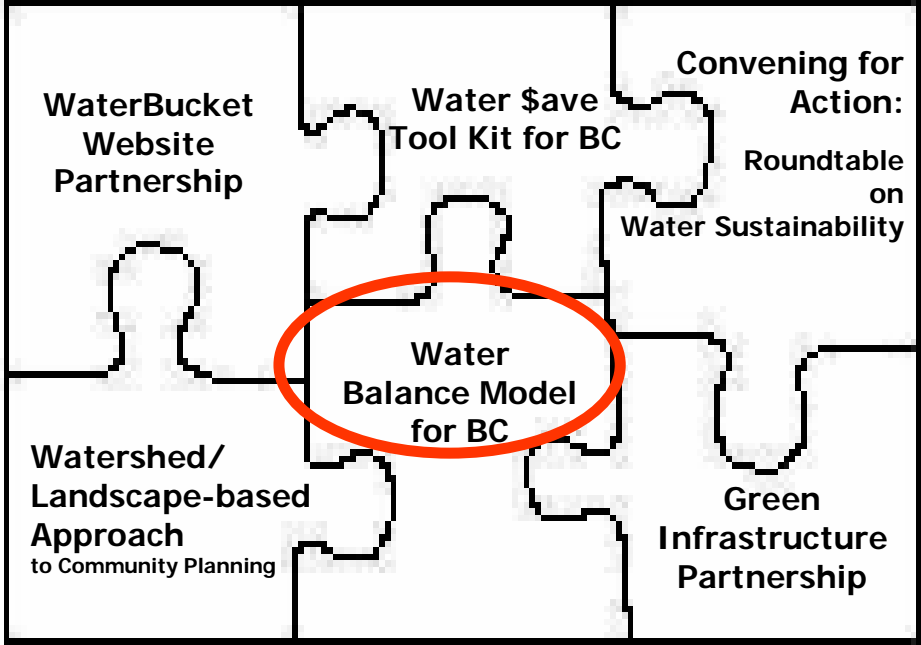


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**...and is also the centrepiece of the  
Water Sustainability Action Plan for  
British Columbia:**



[www.waterbalance.ca](http://www.waterbalance.ca)

# waterbucket

## Our Vision

The vision of WaterBucket.ca is to provide a resource-rich, highly interactive "destination location" website for information and communication related to water sustainability in the Province of B.C.

Visit these Communities of Interest

- ▶ Water Use & Conservation
- ▶ Rainwater Management
- ▶ Green Infrastructure
- ▶ Watershed - Based Planning

We Take Our Water for Granted  
Because we undervalue our precious water...  
(...excerpt from Water Use and Conservation)

Abbotsford Speaks Out on Meters  
The 2004 Water Conservation Survey conducted...  
(...excerpt from Rainwater Management)

sustainable approaches to water resources

*waterbucket.ca* is the communication vehicle for the Action Plan

# Mind Map





# 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)

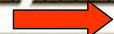
INCREASING URBANIZATION (NO BEST MANAGEMENT PRACTICES)



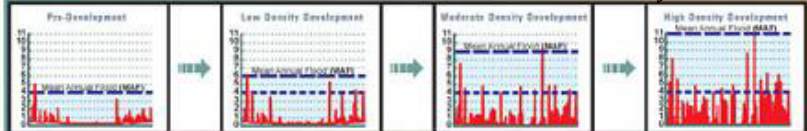
PROPORTION OF IMPERVIOUS LAND AREA (%)



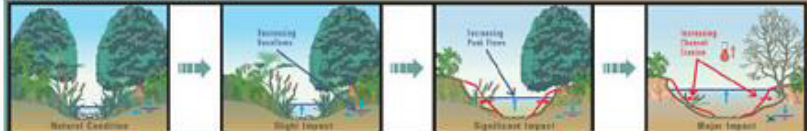
Volume Increasing



EFFECT ON TYPICAL YEAR HYDROGRAPH



EFFECT ON WATERCOURSE EROSION



NUMBER OF STORM EVENTS AT OR ABOVE PREDEVELOPMENT MEAN ANNUAL FLOOD

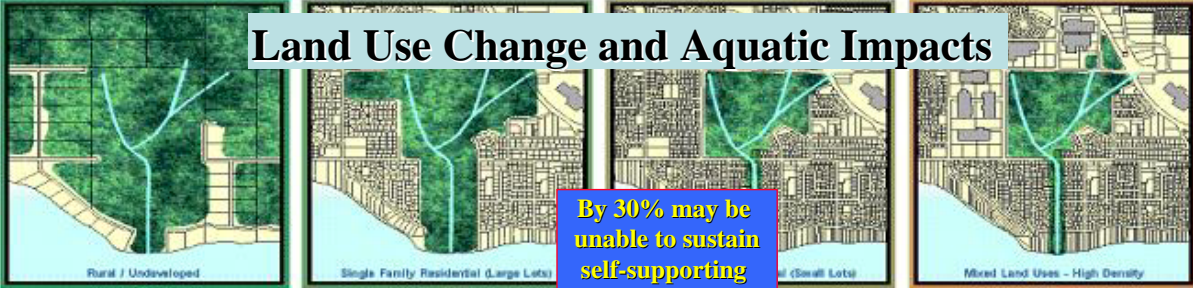


RATIO OF MEAN ANNUAL FLOOD TO WINTER BASE FLOW



# Land Use Change and Aquatic Impacts

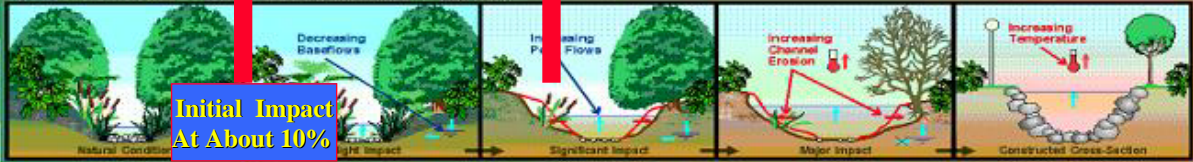
INCREASING URBANIZATION (NO BEST MANAGEMENT PRACTICES)



By 30% may be unable to sustain self-supporting cold-water fish



EFFECT ON WATER QUALITY AND AQUATIC HABITAT

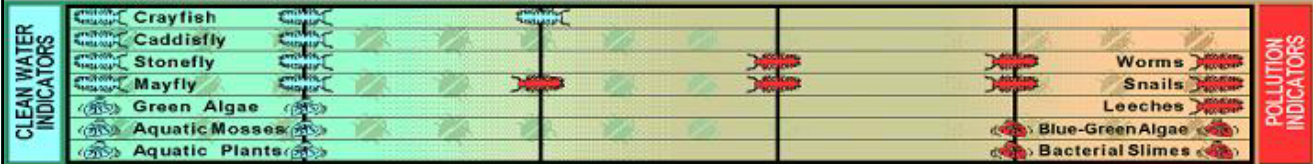


Initial Impact At About 10%

EFFECT ON DIVERSITY AND ABUNDANCE OF THE FISHERIES RESOURCE

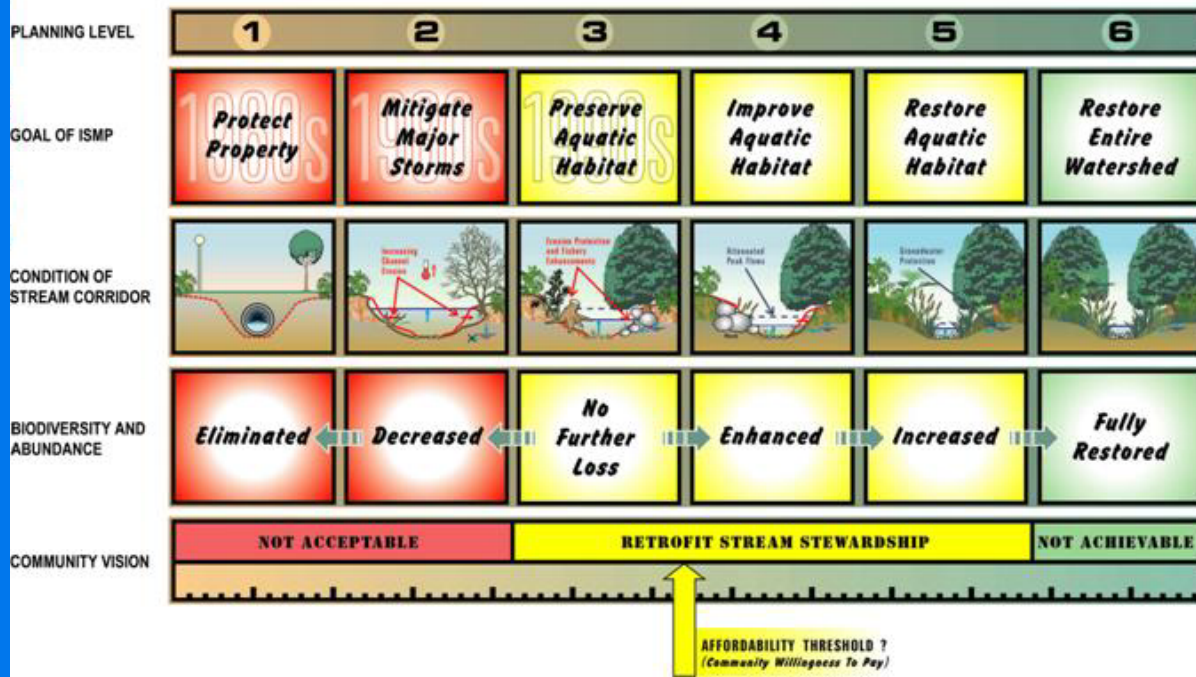


EFFECT ON BIOTIC INDICATORS FOR BENTHIC ORGANISMS



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

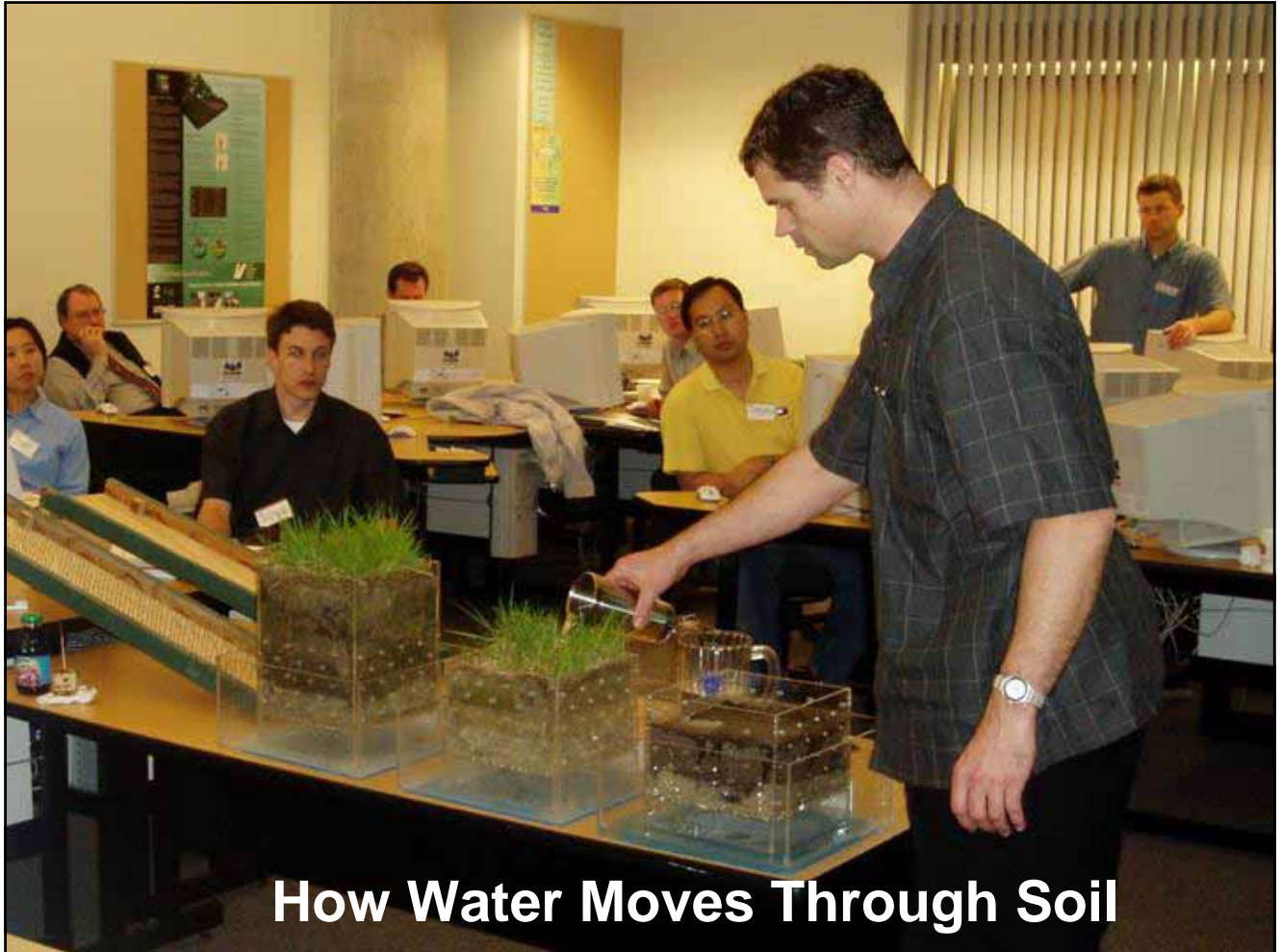
### Conceptual Framework for Selection of ISMP Level





# Mind Map

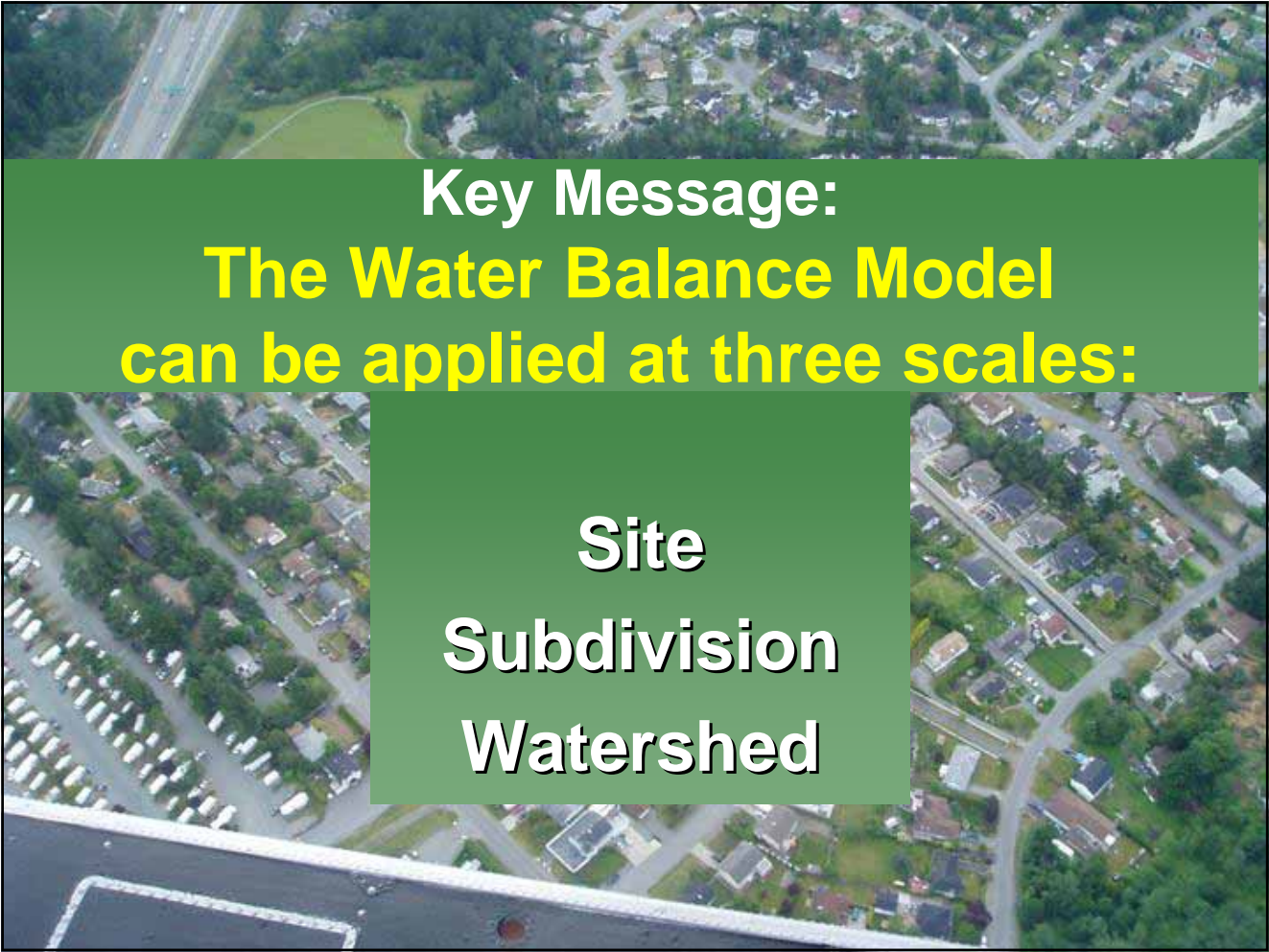




**How Water Moves Through Soil**

An aerial photograph of a residential neighborhood with houses, streets, and a parking lot. A green rectangular overlay is positioned in the upper middle section of the image, containing text. The text is in white and yellow colors.

**Key Message:**  
**The Water Balance Model**  
**can be applied at three scales:**

An aerial photograph of a residential neighborhood with houses, streets, and a parking lot. A green rectangular overlay is positioned in the lower middle section of the image, containing text. The text is in white color.

**Site**  
**Subdivision**  
**Watershed**

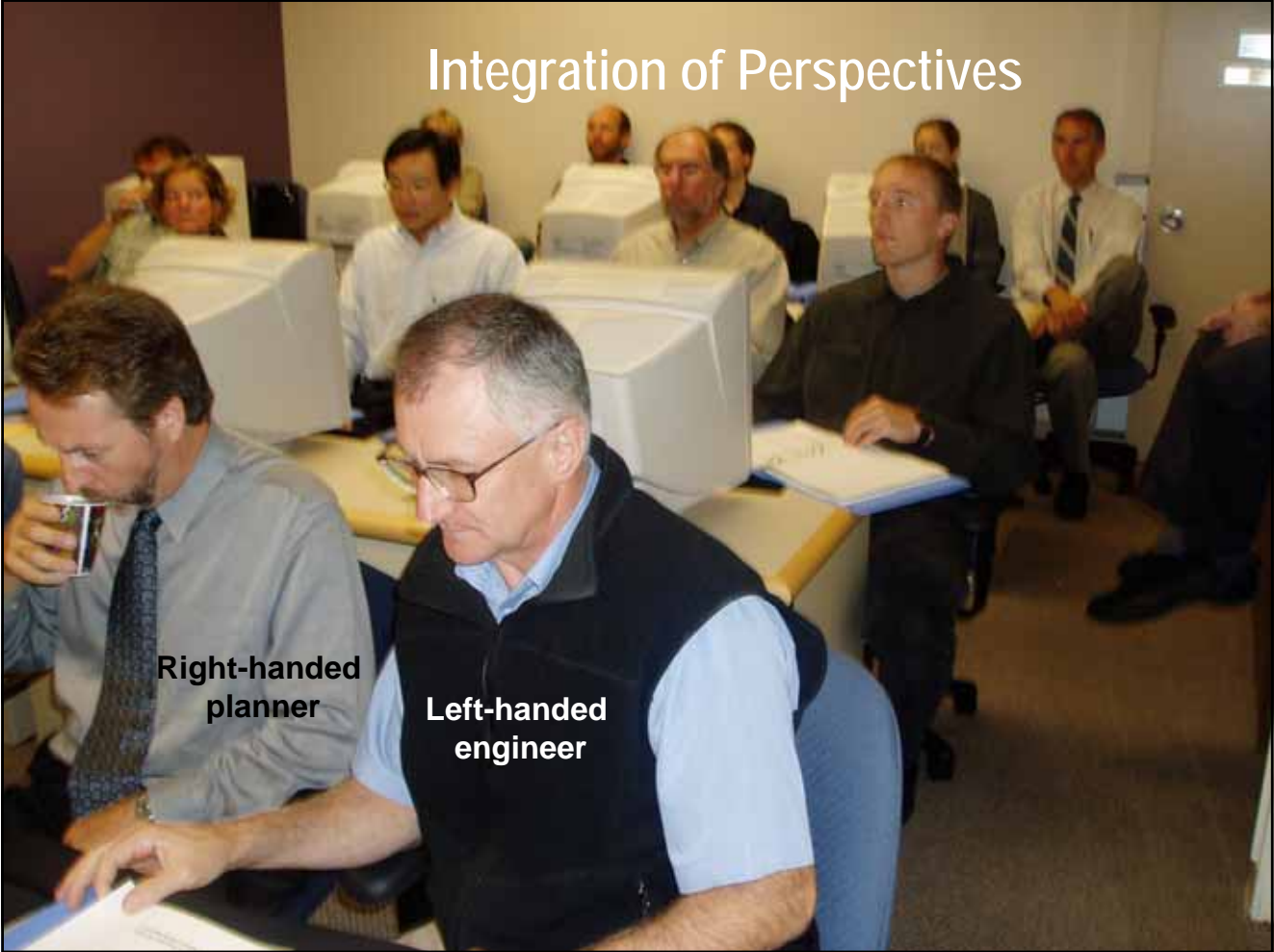




## Water Balance Model promotes Integration of Perspectives

- **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

# Integration of Perspectives



**Right-handed  
planner**

**Left-handed  
engineer**



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## Simplifying the Technical Language!

### Basic Source Control Types:

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

# The Greater Vancouver Regional District has developed Design Guidelines to complement Water Balance Model

## Stormwater Source Control Design Guidelines 2005



Lanarc Consultants Ltd.  
Kerr Wood Leidal Associates Ltd.  
Goya Ngan

FINAL REPORT

April 2005

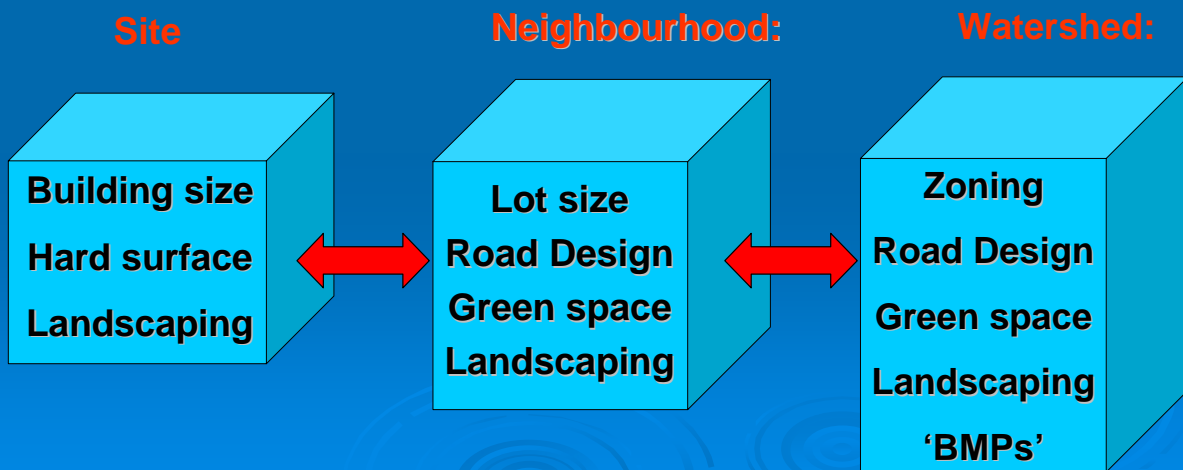


## How the Water Balance Model is being used to make better decisions:

- **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**







**Practical Site Level Solutions  
are Typically Landscape-based**



# Key Messages

- 'Break the connection'
- Encourage 'rain gardens'



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## 'Break the Connection' with a Rain Garden



Simple Infiltration + Reservoir  
+ Overflow

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## **Livability and Streetscape Design: We Have Choices: An Example**



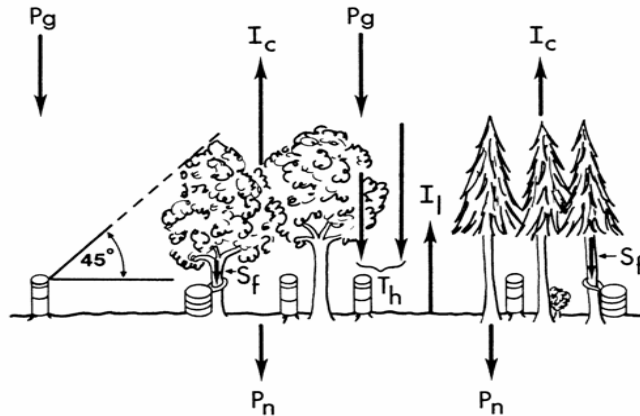
**Will Streets Be  
Sterile and Uninviting,  
Or Green and Inviting?**





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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)



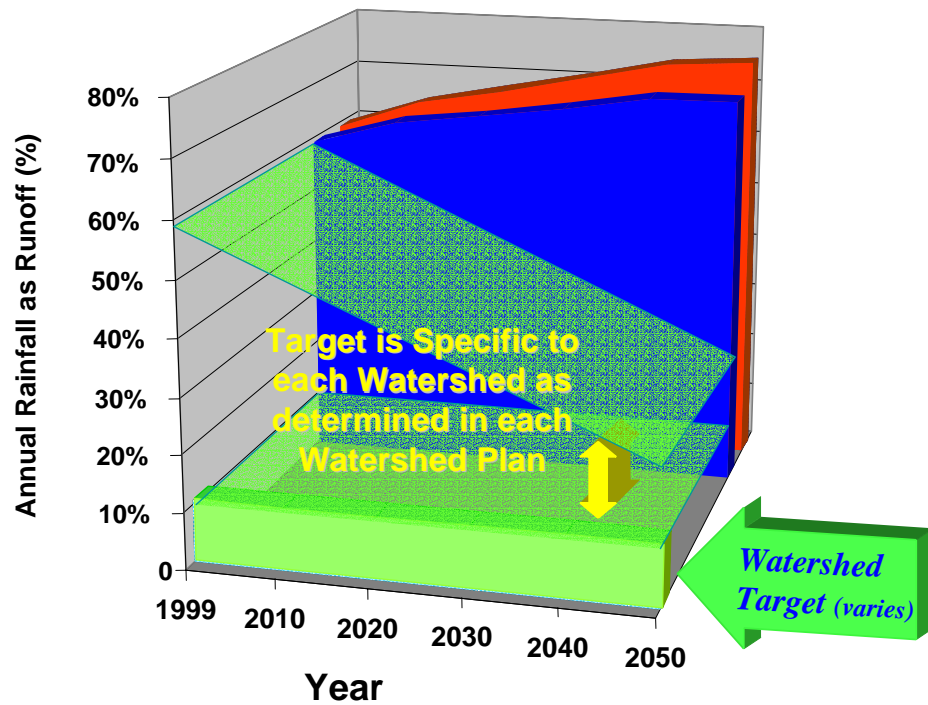
Interception total  $I = I_c + I_l$   
The amount reaching the forest floor  $= T_h + S_f$   
Interception by canopy (overstory + understory)  $I_c = P_g - T_h - S_f$   
Net precipitation  $P_n = T_h + S_f - I_l$

[www.waterbalance.ca](http://www.waterbalance.ca)



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## The Watershed Picture: With Rainfall Capture



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**Integration with QUALHYMO**  
will provide engineers with “one-stop shopping” for:

- **Rainwater Storage Routing**
- **Water Quality**
- **Stream Erosion**
- **Drainage Area Flow Routing**
- **Snowmelt Runoff**

[www.waterbalance.ca](http://www.waterbalance.ca)

An aerial photograph showing a landscape with a river, fields, and a road. The river flows from the top left towards the bottom right. The land is divided into various plots, some of which are green, suggesting agricultural or natural areas. A road or highway runs diagonally across the lower right portion of the image. The overall scene depicts a rural or semi-rural environment with significant land use patterns.

**Actions on the Ground...**

**...Can Result in Cumulative Benefits Over Time!**

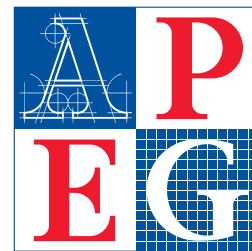


**WATER**  
*Balance*  
**MODEL**  
FOR BRITISH COLUMBIA

## Upcoming WBM Events

co-sponsored by the City of Kelowna and APEGBC

■ **November 30** –  
Continuing Education  
Seminar– *will be half-  
day and will be built  
around an online  
demonstration*



Professional Engineers  
and Geoscientists of BC  
[www.apeg.bc.ca](http://www.apeg.bc.ca)

■ **Early 2006** –  
Training Workshop–  
*will be a full day in a  
computer lab*

