



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

# Water Balance Model to Stormwater Source Controls

Putting Theory into Practice

Ted van der Gulik, BCMAFF  
David Reid, Lanarc Consultants

*BCWWA Water Sustainability  
Committee*



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# Integrated Stormwater Management Planning



Facilitate this



Preserve this



Avoid this

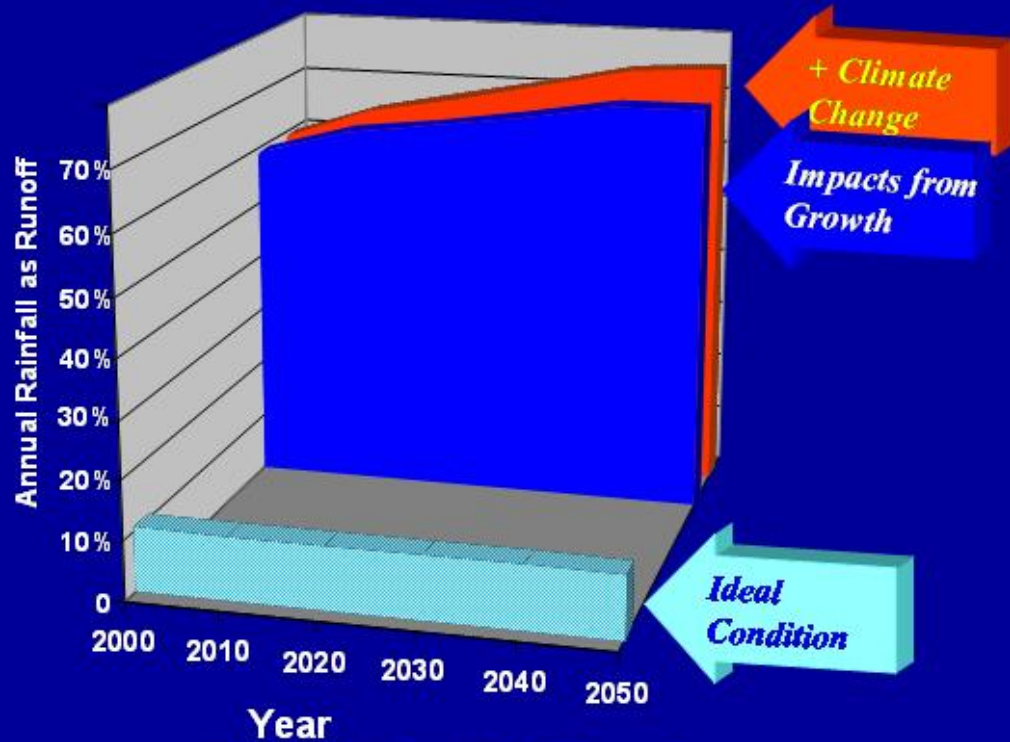
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# WATER Balance MODEL FOR BRITISH COLUMBIA



## Current Watershed Trends



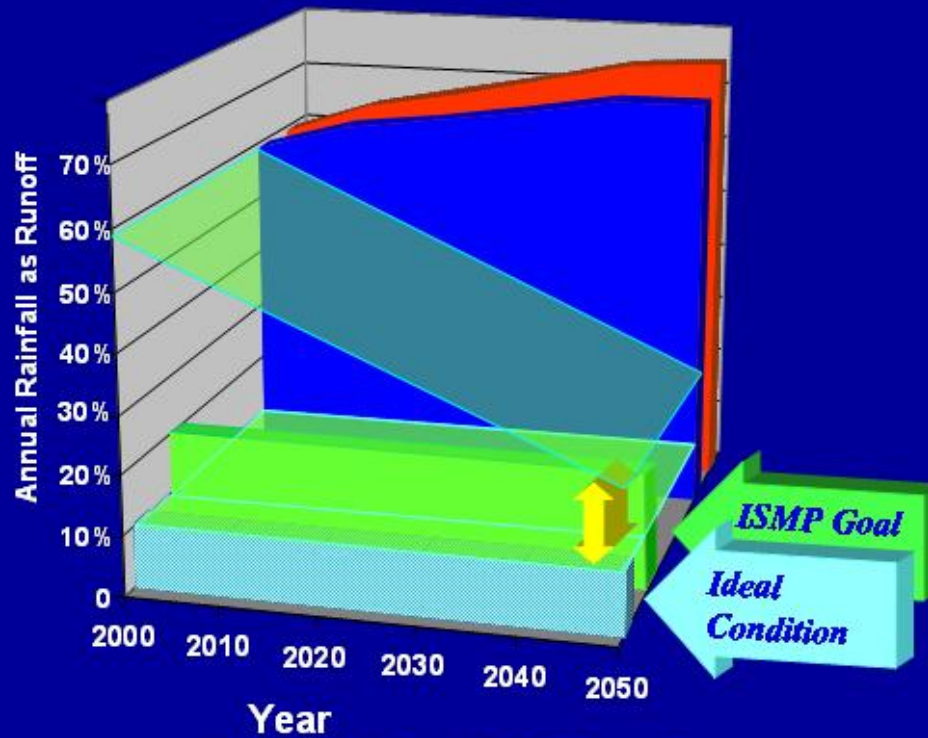
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# WATER Balance MODEL FOR BRITISH COLUMBIA



## ISMP Watershed Goal



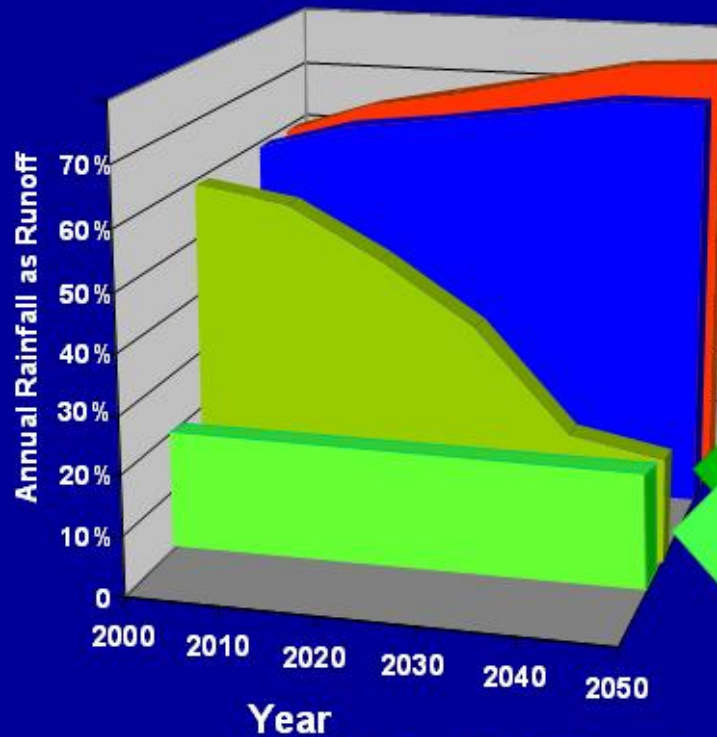
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# WATER Balance MODEL FOR BRITISH COLUMBIA



## Improve Watershed Trend



Successful only if Stormwater Source Controls required for all new construction and redevelopment cycle

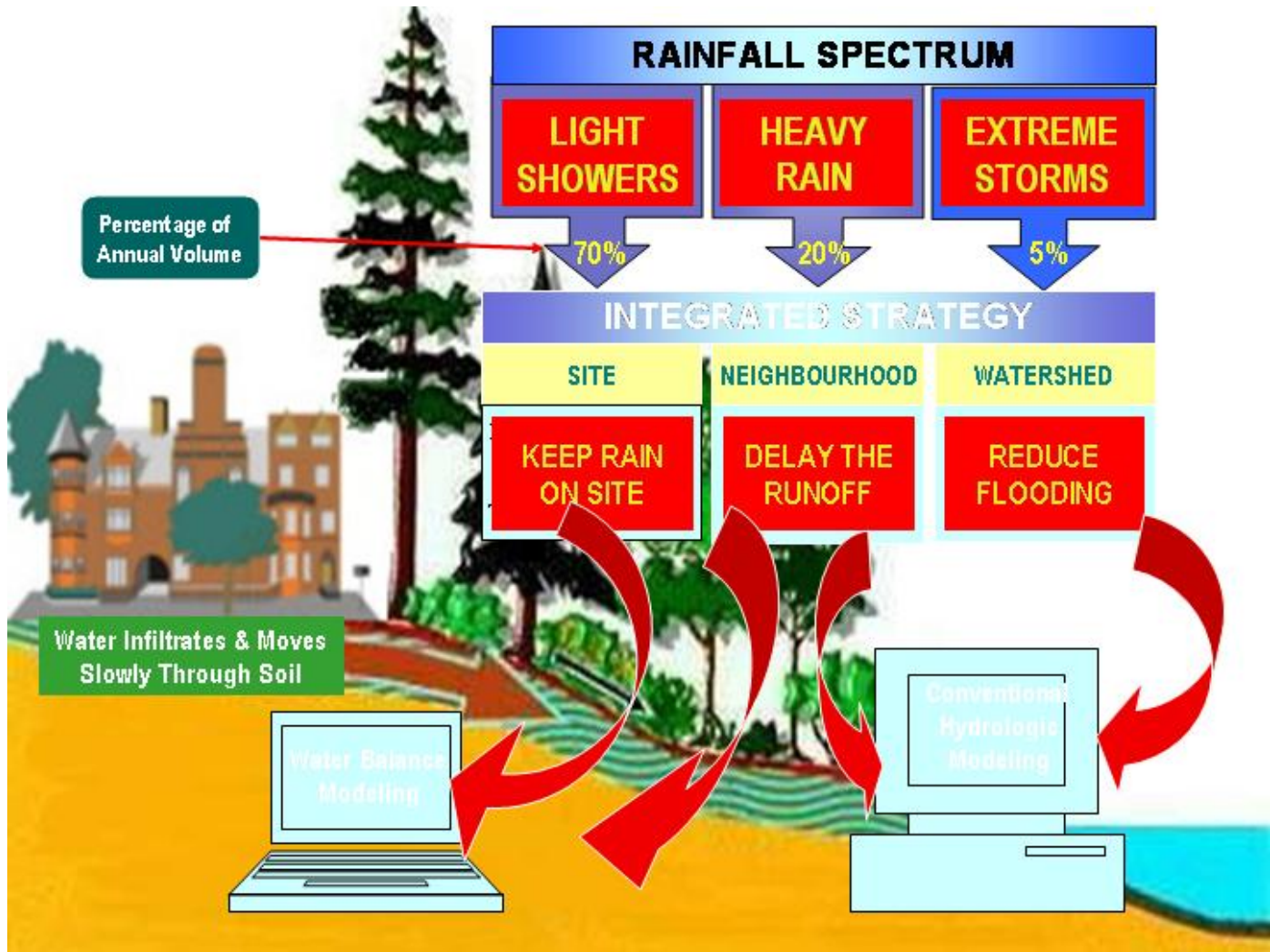
Source Control complexity varies to meet ISMP goals

**Source**  
**ISMP Goal**  
*(varies)*

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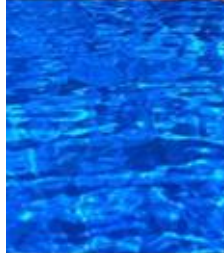


# WATER Balance MODEL FOR BRITISH COLUMBIA





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## Capture the 'Light Showers' because...

- They account for most of the total rain volume that falls each year (i.e. 75%).
  - Small events are manageable
- Capturing the small events reduces 'wear and tear' in watercourses that degrades or eliminates fish habitat
  - Landscaping solutions lend themselves to managing small events.

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## Inter-Governmental Partnership: Steering Committee and Development Team

### Co-Chairs

BC Ministry of Agriculture, Food & Fisheries  
Environment Canada

### • Focus Group

- City of Chilliwack
- City of Surrey
- District of North Vancouver
- Greater Vancouver Regional District

### • Project Team

- KSA Consultants Ltd
- CH2M HILL Canada Ltd
- Lanarc Consultants Ltd

*BCWWA Water Sustainability Committee*





# WATER Balance MODEL FOR BRITISH COLUMBIA



# Water Balance Model Partnership



**DISTRICT OF HIGHLANDS**

**SURREY CITY OF TASKS**

*City of Chilliwack*

**the city of NORTH VANCOUVER**

*CITY OF VANCOUVER*

*City of Kelowna*

**CITY OF Abbotsford**

**Environment Canada** / **Environnement Canada**

**westvancouver** THE NATURAL COMMUNITY

**CITY OF COQUITLAM**

**WORKING TOGETHER FOR THE GEORGIA BASIN**  
**AU TRAVAIL POUR LE BASSIN DE GEORGIA**

**Greater Vancouver Regional District**

**MAPLE RIDGE**  
Incorporated 12 September, 1974

**THE REAL ESTATE FOUNDATION OF BRITISH COLUMBIA**

**BRITISH COLUMBIA**

BCWWA Water Sustainability Committee



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



## Inter-Governmental Partnership: History

- Formed in 2002 as a result of a GVRD- sponsored project on the effectiveness of stormwater source control
- Desire was to develop an internet-based, public-domain scenario modeling tool for stormwater management

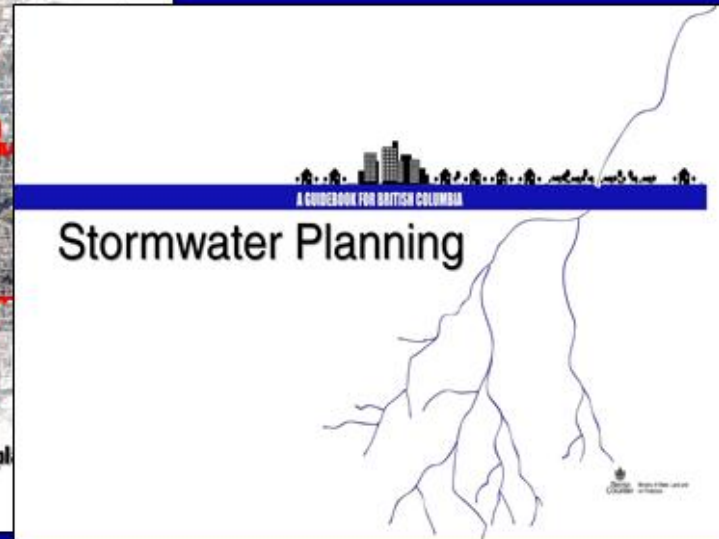
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# WATER Balance MODEL FOR BRITISH COLUMBIA



## Source Control Drivers



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## Inter-Governmental Partnership: Vision

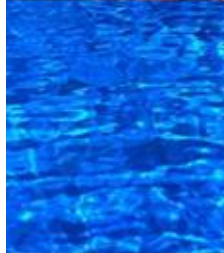
**To promote changes in land  
development practices so that:**

- sites and subdivisions will be designed to function to mimic the natural hydrologic condition to the extent possible
- performance targets will be achieved for runoff volume and flow rate reduction

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# Inter-Governmental Partnership: Key Partnerships

BC Water and Waste Association

Real Estate Foundation of BC

Urban Development Institute



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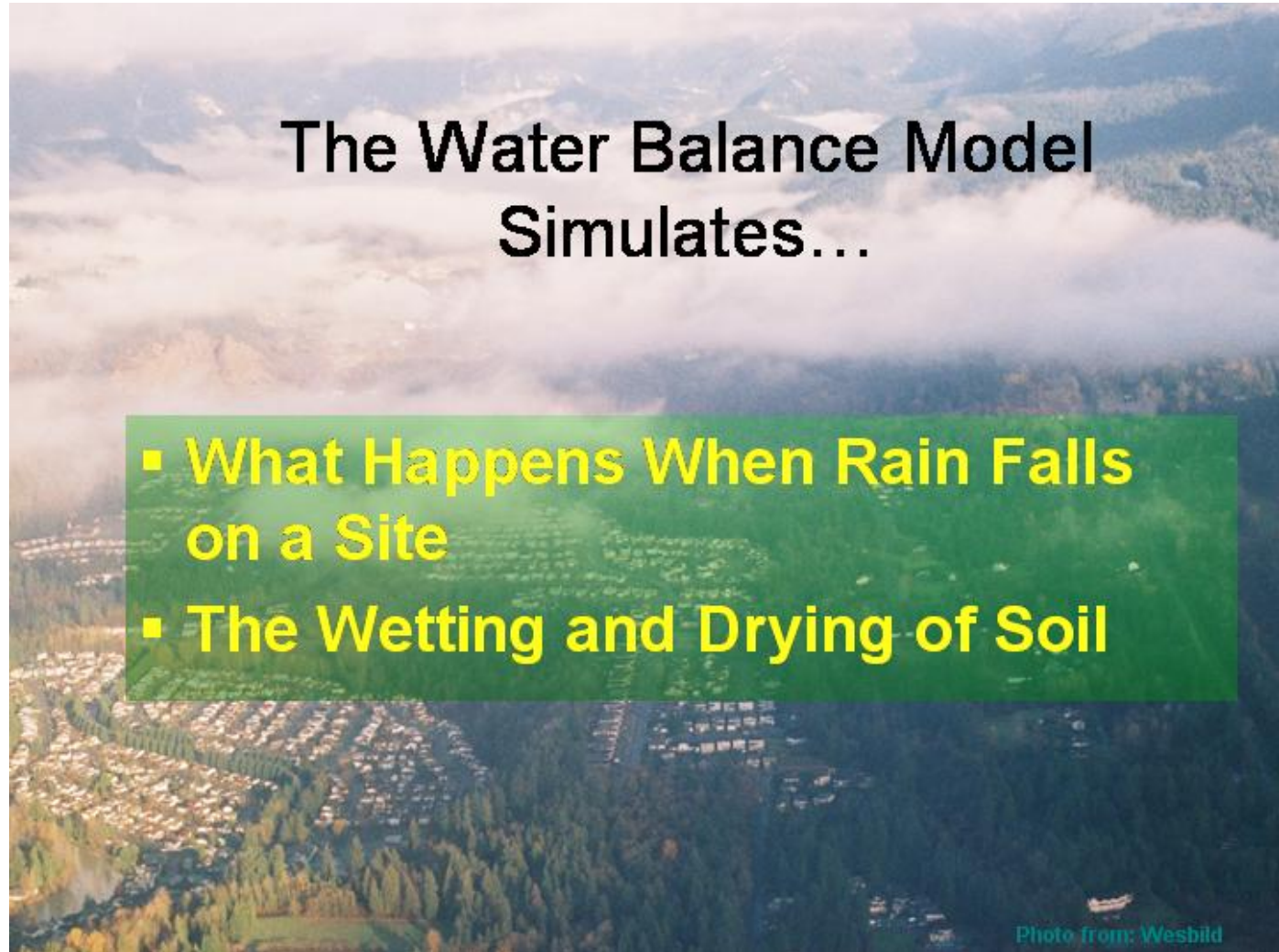
## The Water Balance Model is...

- Free!
- A Decision Support Tool
- Internet-accessible  
[www.waterbalance.ca](http://www.waterbalance.ca)
- Interactive

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## The Water Balance Model Simulates...

- What Happens When Rain Falls on a Site
- The Wetting and Drying of Soil

Photo from: Wesbild



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## Continuing Education Program Comprises Six Modules

- Elected Officials
- Local Government Staff
- Land Development Community
- Municipal Advisory Committees
- Community Stewardship Groups
- Professional Journals

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

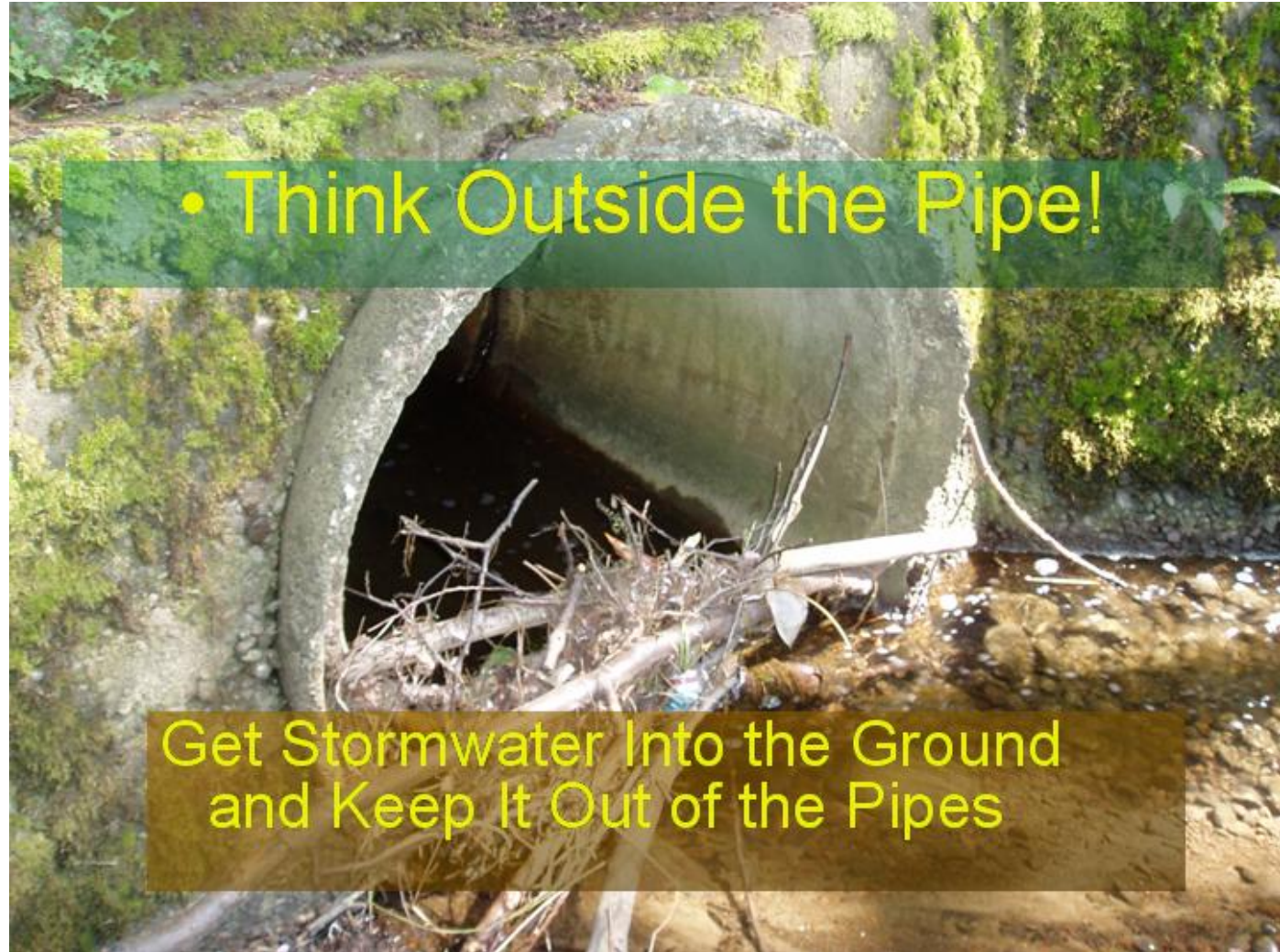
## Tiered Access Protocol

- Project Partner
- Paying Subscriber
- General User

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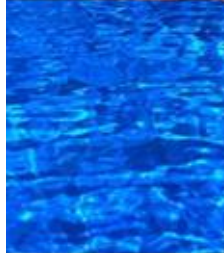


• Think Outside the Pipe!

Get Stormwater Into the Ground  
and Keep It Out of the Pipes



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# Stormwater Source Controls: Preliminary Design Guidelines

## Client

Greater Vancouver Sewerage and Drainage District

## • Focus Group

- SILG and members

## • Project Team

- Lanarc Consultants Ltd.
- Kerr Wood Leidal Associates
- Goya Ngan, Landscape Architect (Europe)

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## Stormwater Source Controls



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## GVRD Source Control Posters

- Basic Source Control Types
  - Absorbent Landscape
  - Infiltration Swales
  - Rain Gardens
  - Pervious Paving
  - Green Roof

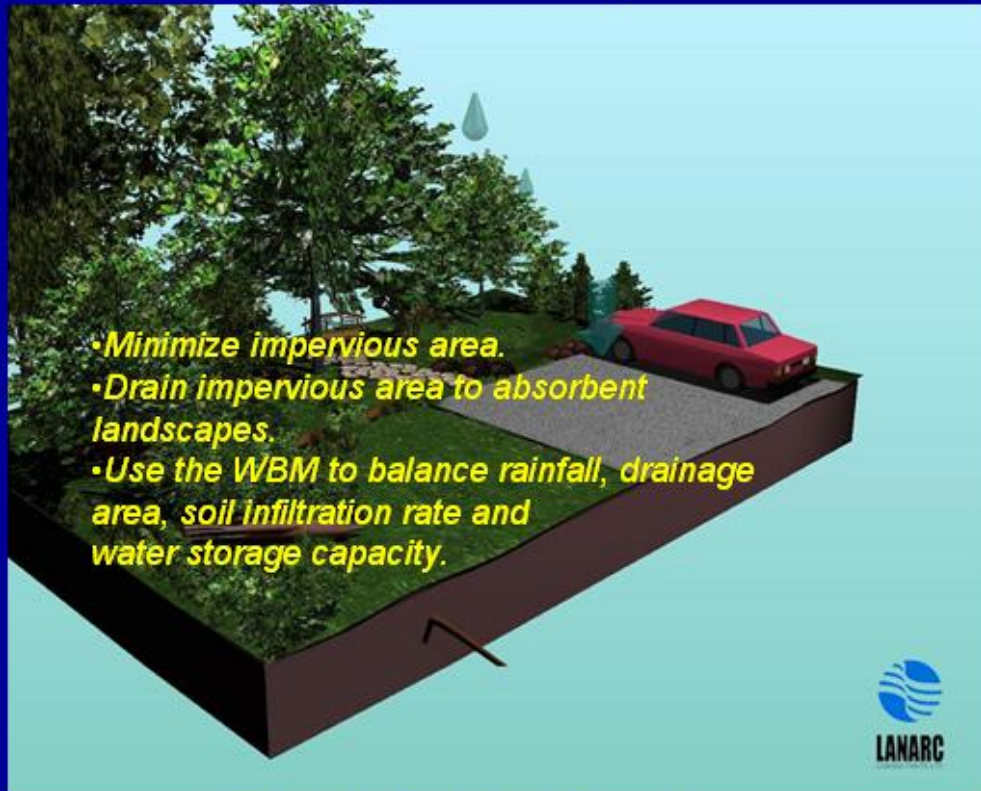
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# WATER Balance MODEL FOR BRITISH COLUMBIA



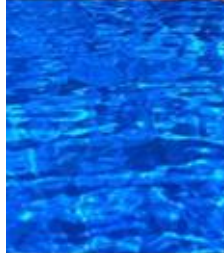
## Absorbent Landscapes



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# WATER Balance MODEL FOR BRITISH COLUMBIA



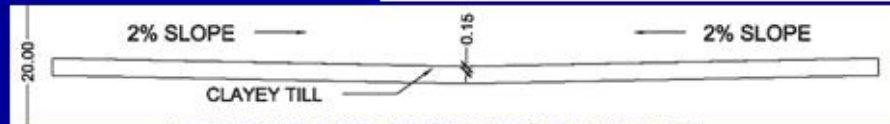
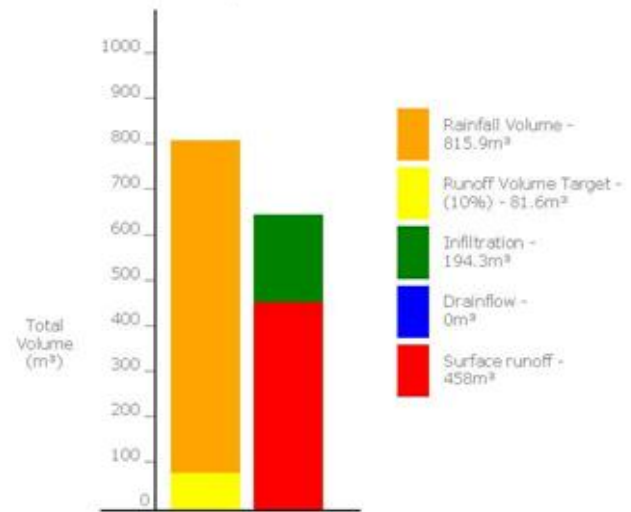
## Absorbent Landscapes

*WBM results for  
Till surface*

GVRD Source Control Research - L - Exposed Till

### Water Balance Volumes For Catchment

Graph for the period Jan 1 1999 to Dec 31 1999





# WATER Balance MODEL FOR BRITISH COLUMBIA



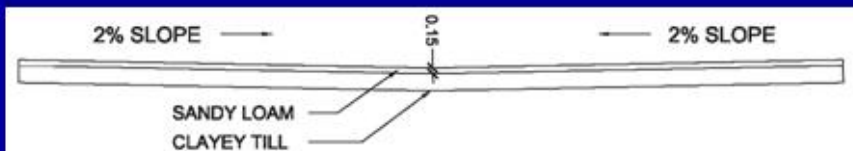
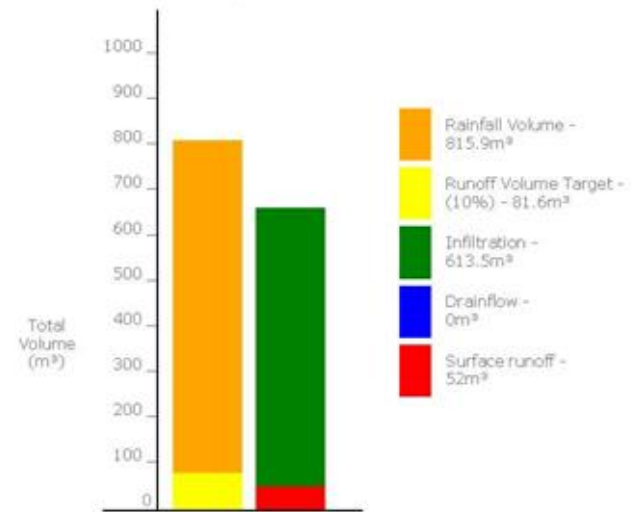
## Absorbent Landscapes

*WBM results for  
Till surface under  
150mm sandy  
loam and grass*

GVRD Source Control Research - 150mm Grass over Till

### Water Balance Volumes For Catchment

Graph for the period Jan 1 1999 to Dec 31 1999







# WATER Balance MODEL FOR BRITISH COLUMBIA



## Absorbent Landscapes

- Urban trees, vegetation and soil play a major role in stormwater detention



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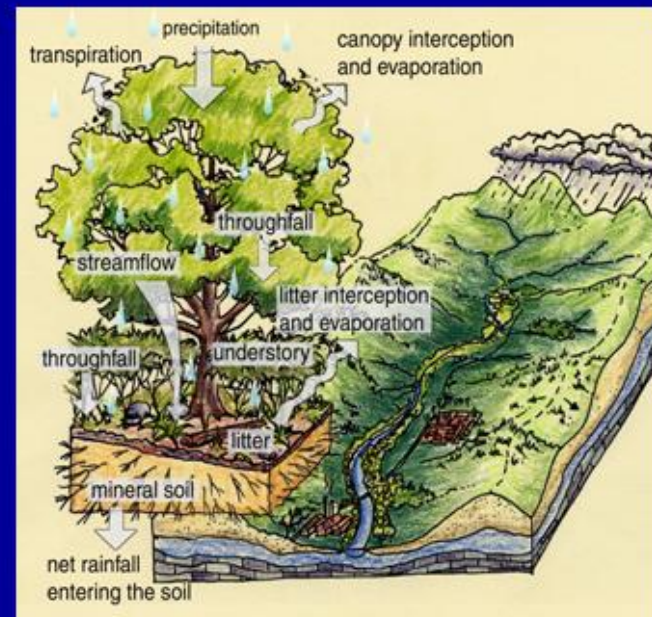


# WATER Balance MODEL FOR BRITISH COLUMBIA



## Soils capture rainfall:

- *7% by volume for sands*
- *18% by volume for loams*
- *Vegetation keeps soil surfaces permeable.*



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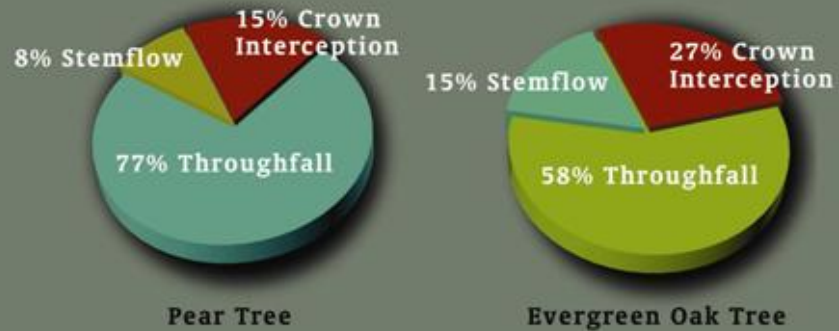


# WATER Balance MODEL FOR BRITISH COLUMBIA



## Trees Capture Rainfall:

Data from "Winter Rainfall Interception of Mature Trees in Davis, California", Xiao et al, 2000.



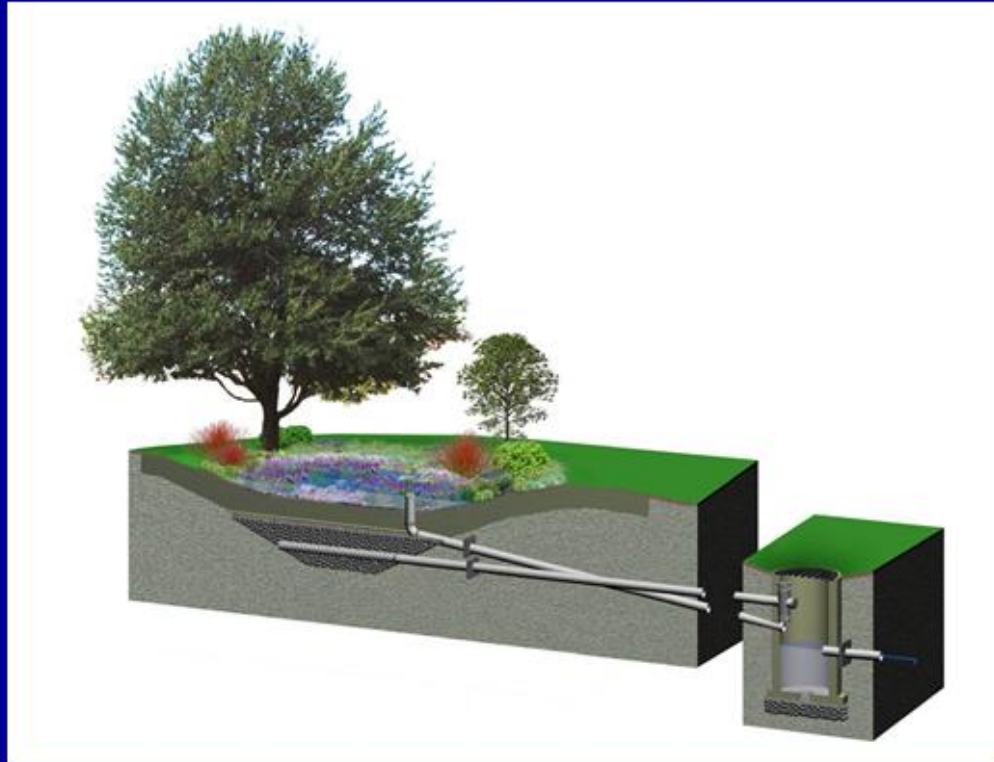
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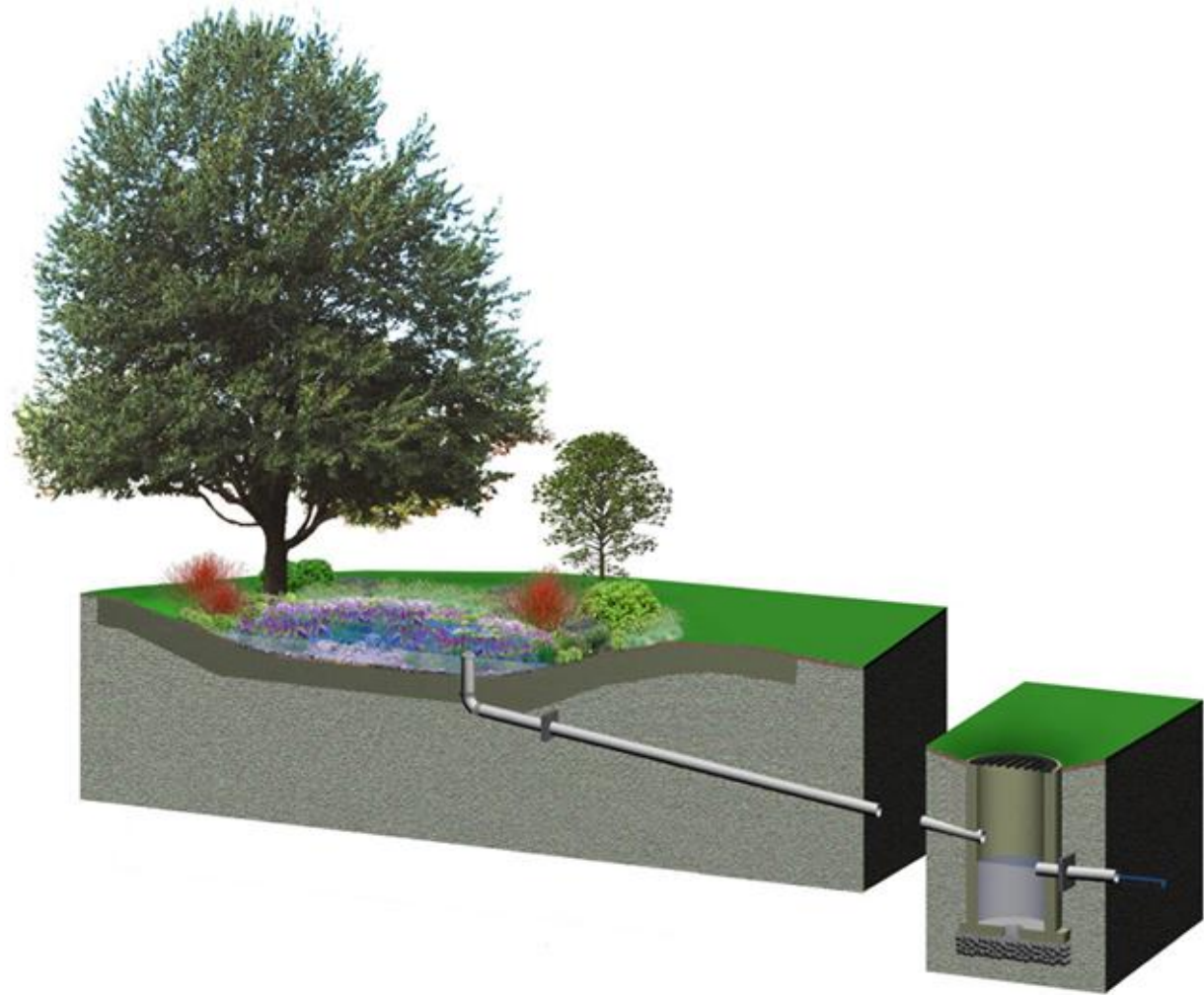
## Rain Gardens (Biofiltration)



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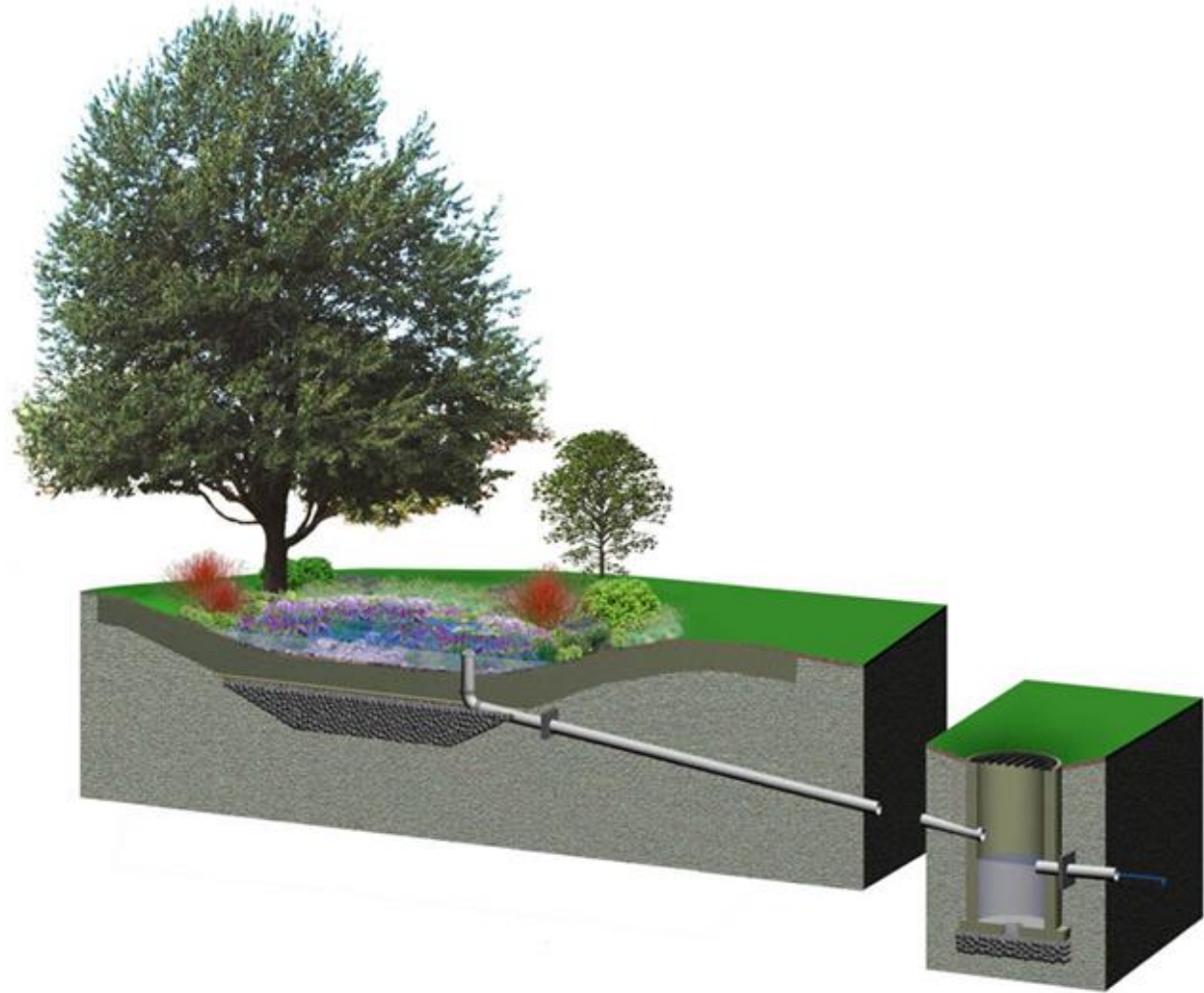


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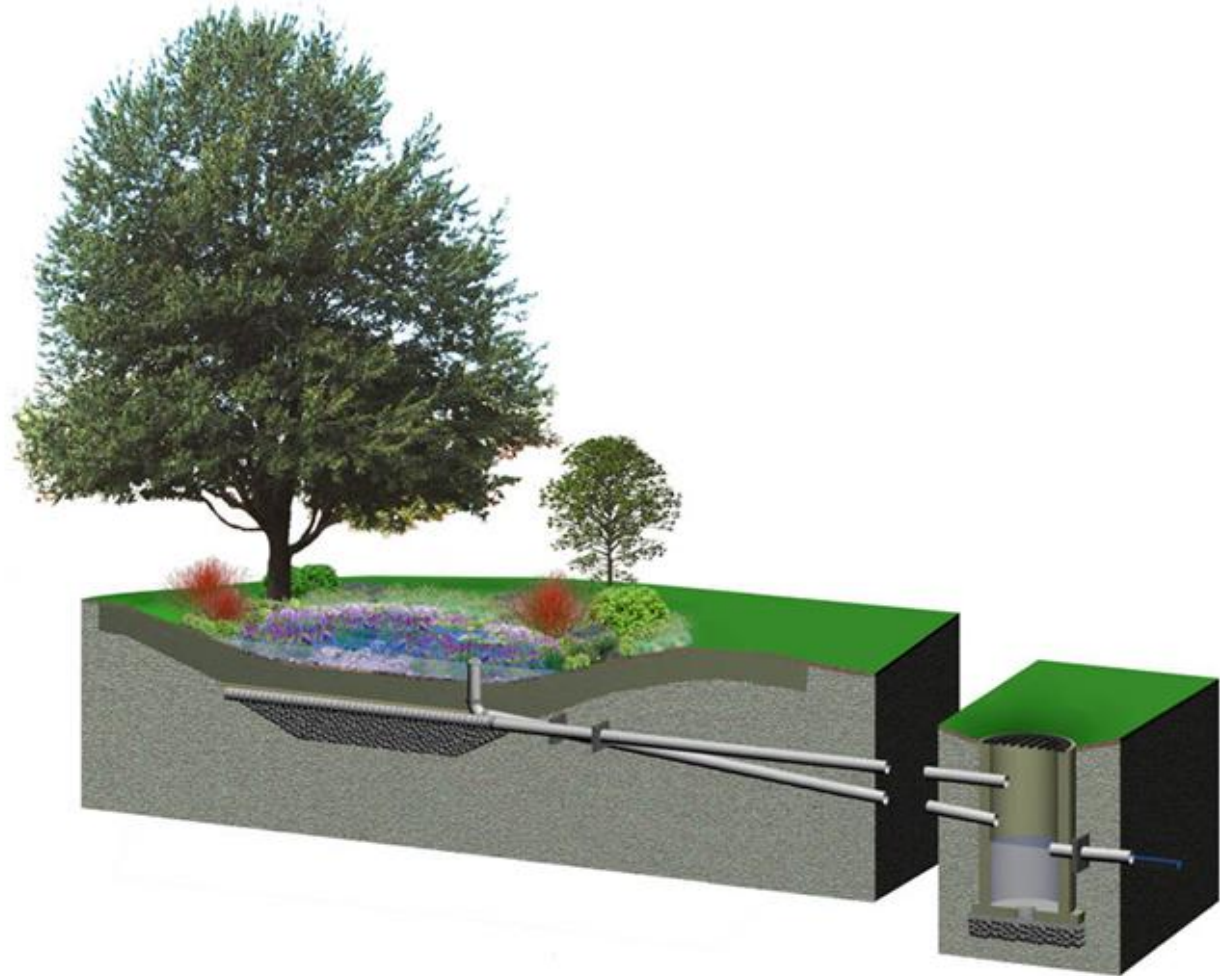


**WATER**  
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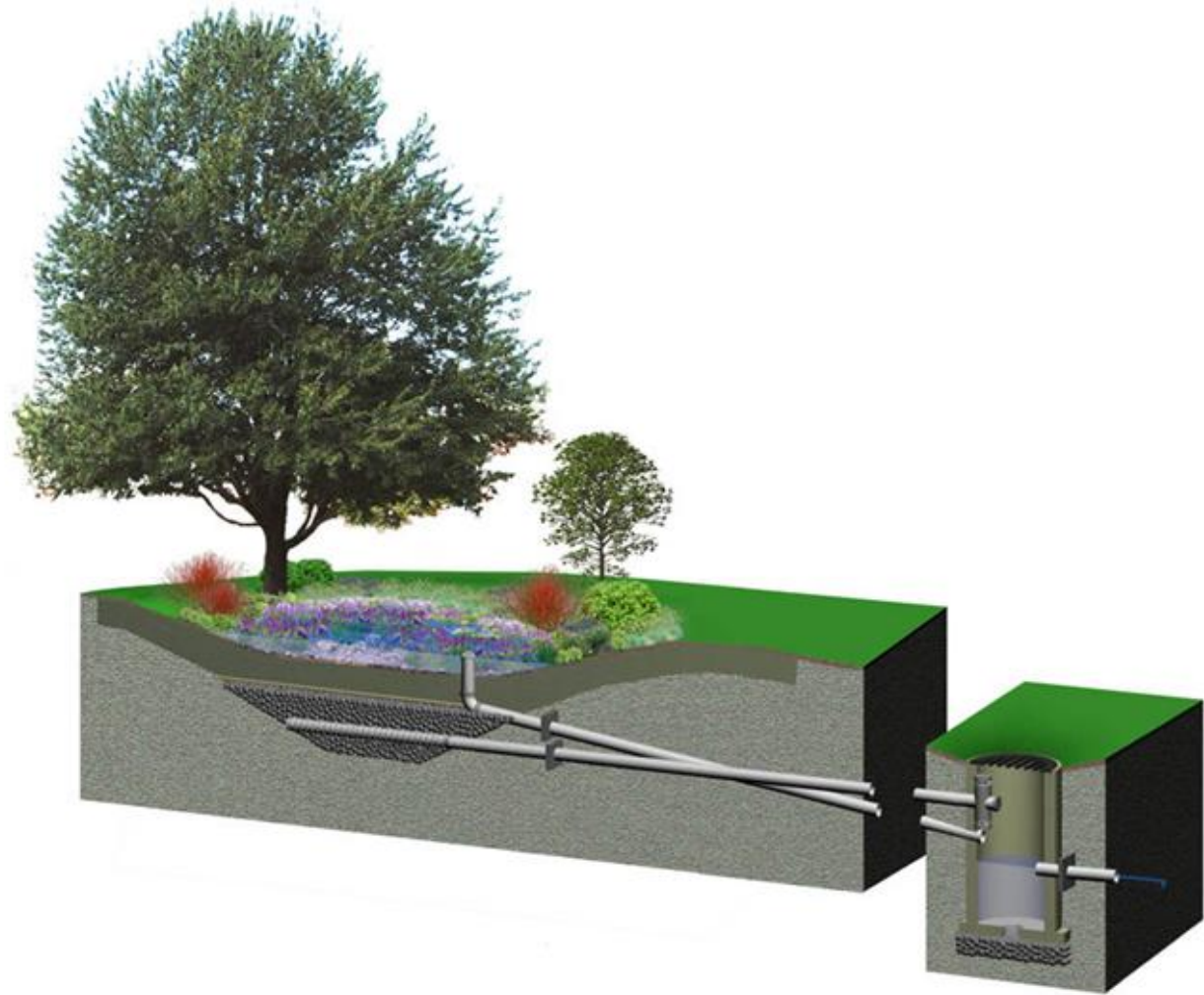


**WATER**  
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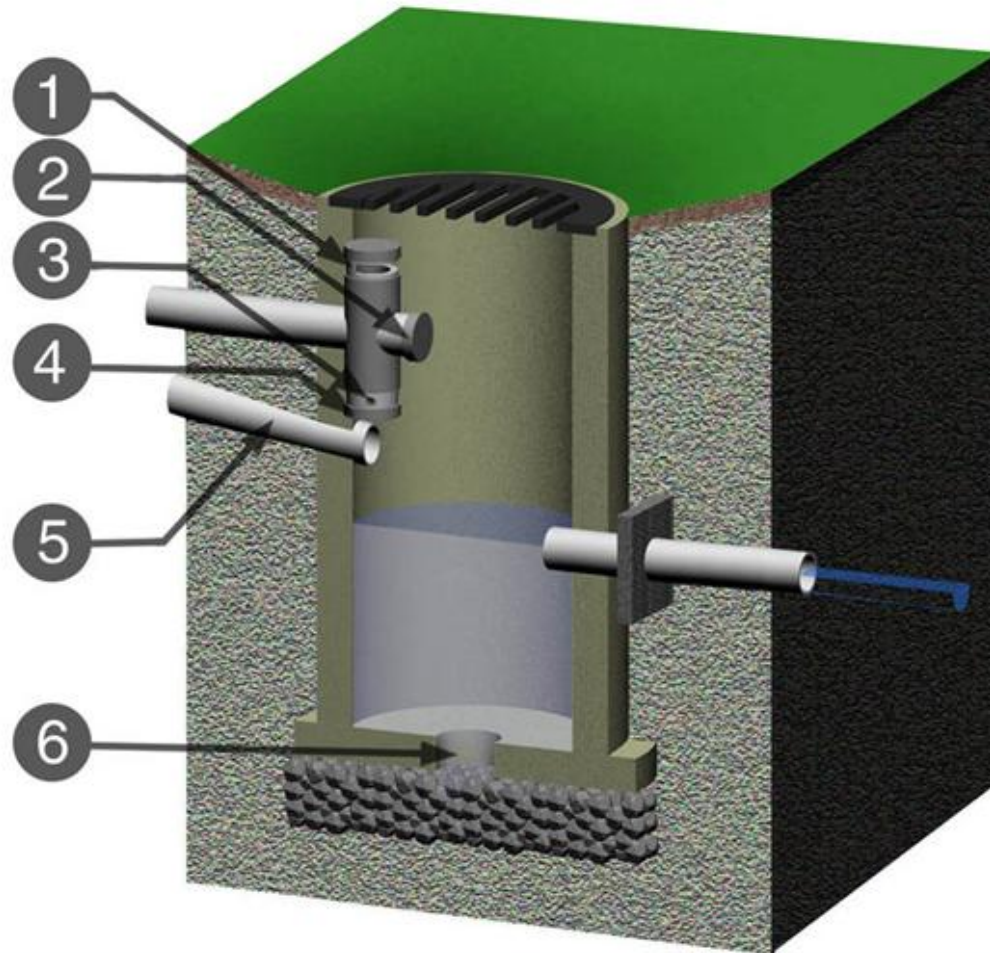
**WATER**  
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# WATER Balance MODEL FOR BRITISH COLUMBIA





**WATER**  
**Balance**  
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# Rain Gardens

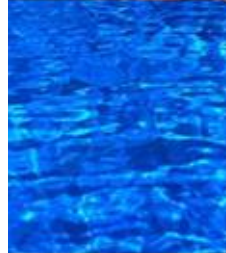
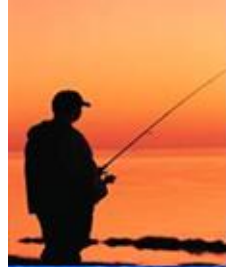


*Buckman Heights, Portland*

*BCWWA Water Sustainability Committee*



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# Rain Gardens



*Buckman Heights, Portland*

*BCWWA Water Sustainability Committee*



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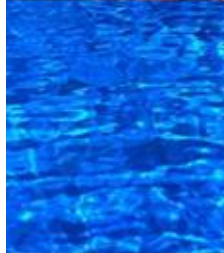
## Rain Gardens



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## Rain Gardens



*No irrigation in Rain Garden / Sand Filter –  
Cascade Station, Portland*

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## Rain Gardens



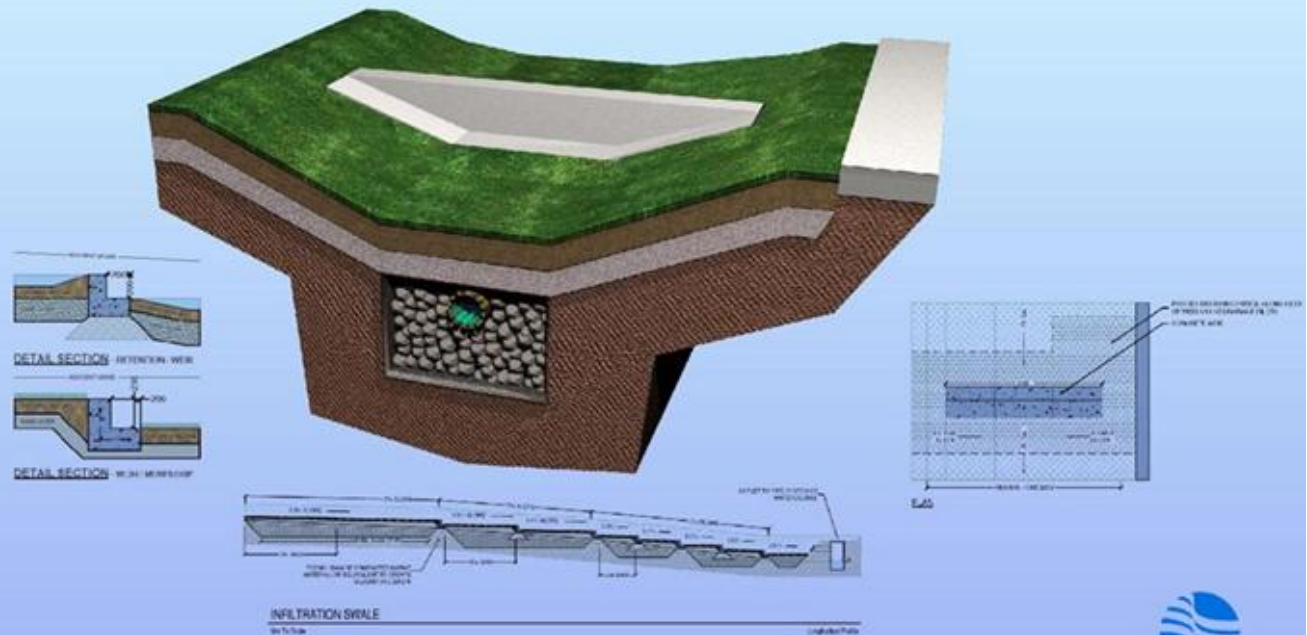
*Informal Shape –  
Water Pollution Control Lab, Portland*

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# WATER Balance MODEL FOR BRITISH COLUMBIA

## Infiltration Swale (Bioswale)





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



## Infiltration Swales



*Infiltration Swale on a Hill –  
Horseshoe Bay Ferry Terminal, West Vancouver*



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



## Infiltration Swale



Stormwater collected in underground cisterns and infiltrated through planted swale & evapotranspiration

*CK Choi Building - UBC*



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# WATER Balance MODEL FOR BRITISH COLUMBIA



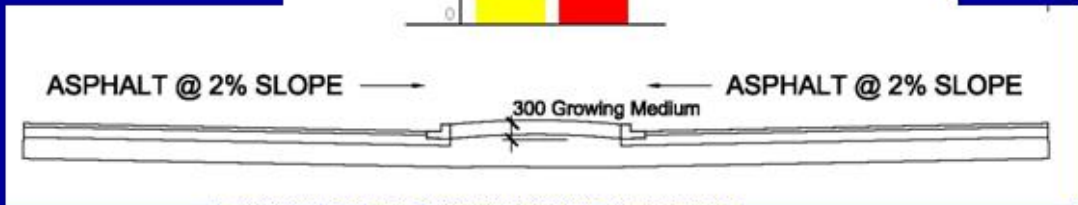
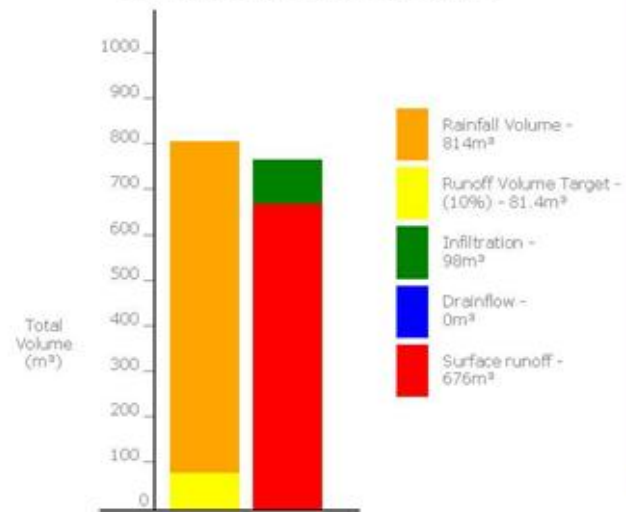
## Infiltration Swale

*WBM results for parking area with raised landscape island*

GVRD Source Control Research - A - Area with Raised Island

### Water Balance Volumes For Catchment

Graph for the period Jan 1 1999 to Dec 31 1999





# WATER Balance MODEL FOR BRITISH COLUMBIA



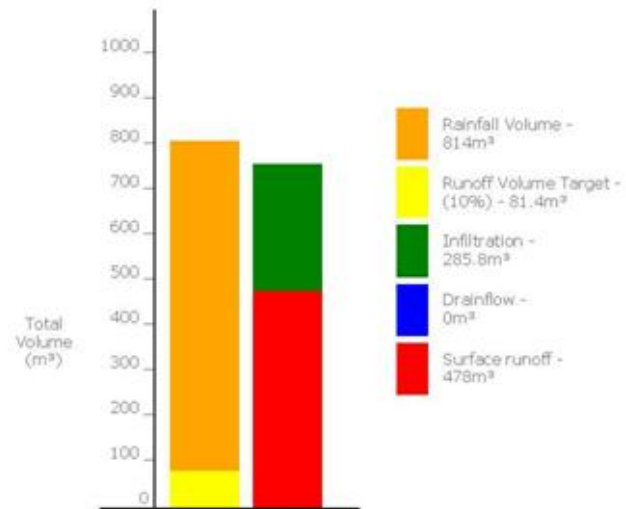
## Infiltration Swale

*WBM results for parking area with infiltration swale*

GVRD Source Control Research - B - Area with Infiltration Swale

### Water Balance Volumes For Catchment

Graph for the period Jan 1 1999 to Dec 31 1999



ASPHALT @ 2% SLOPE



ASPHALT @ 2% SLOPE



# WATER Balance MODEL FOR BRITISH COLUMBIA



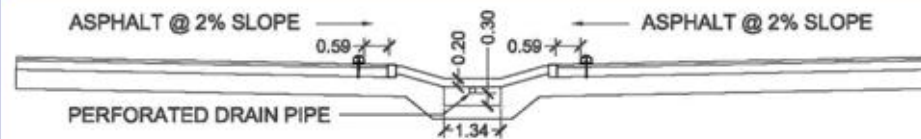
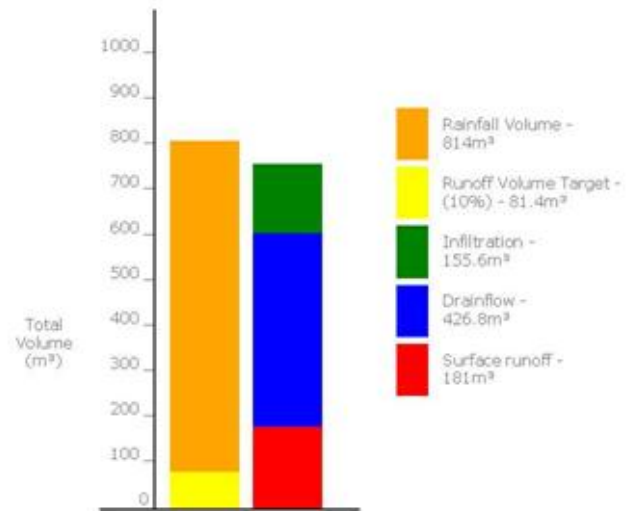
## Infiltration Swale

*WBM results for parking area with infiltration swale + reservoir + perforated drainpipe.*

GVRD Source Control Research - BB - Bioretention with Underdrain

### Water Balance Volumes For Catchment

Graph for the period Jan 1 1999 to Dec 31 1999



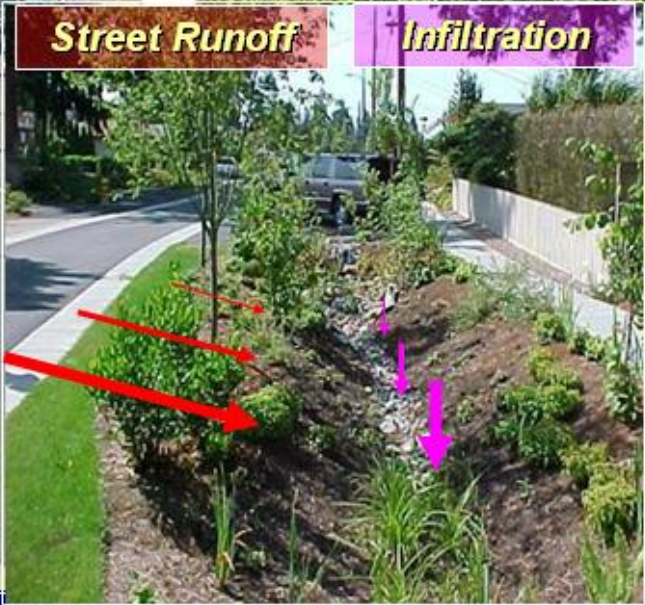


# **WATER** **Balance** **MODEL** FOR BRITISH COLUMBIA



## Infiltration Swale

- One block constructed, 4 more underway
- Flush curb, narrow pavement drains to infiltration swales, roof leaders connected to swales



**Street Runoff**

**Infiltration**



Street Edge Alternative (SEA) – Seattle, WA

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## Infiltration Swale

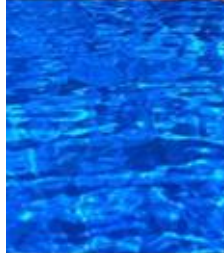


*Swales piped under driveways/parking areas –  
Street Edge Alternative, Seattle*

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## Infiltration Swale



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## Infiltration Swale

*Small parking area ... small swale ... small plants –  
Buckman Heights, Portland*



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## Infiltration Swale



*Manicured grass finish with shrubs –  
Shopping Centre – Issaquah, WA*

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## Infiltration Swale

*Rough grass, shrubs, trees, retaining wall –  
Shopping Centre – Issaquah, WA*



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## Infiltration Swale

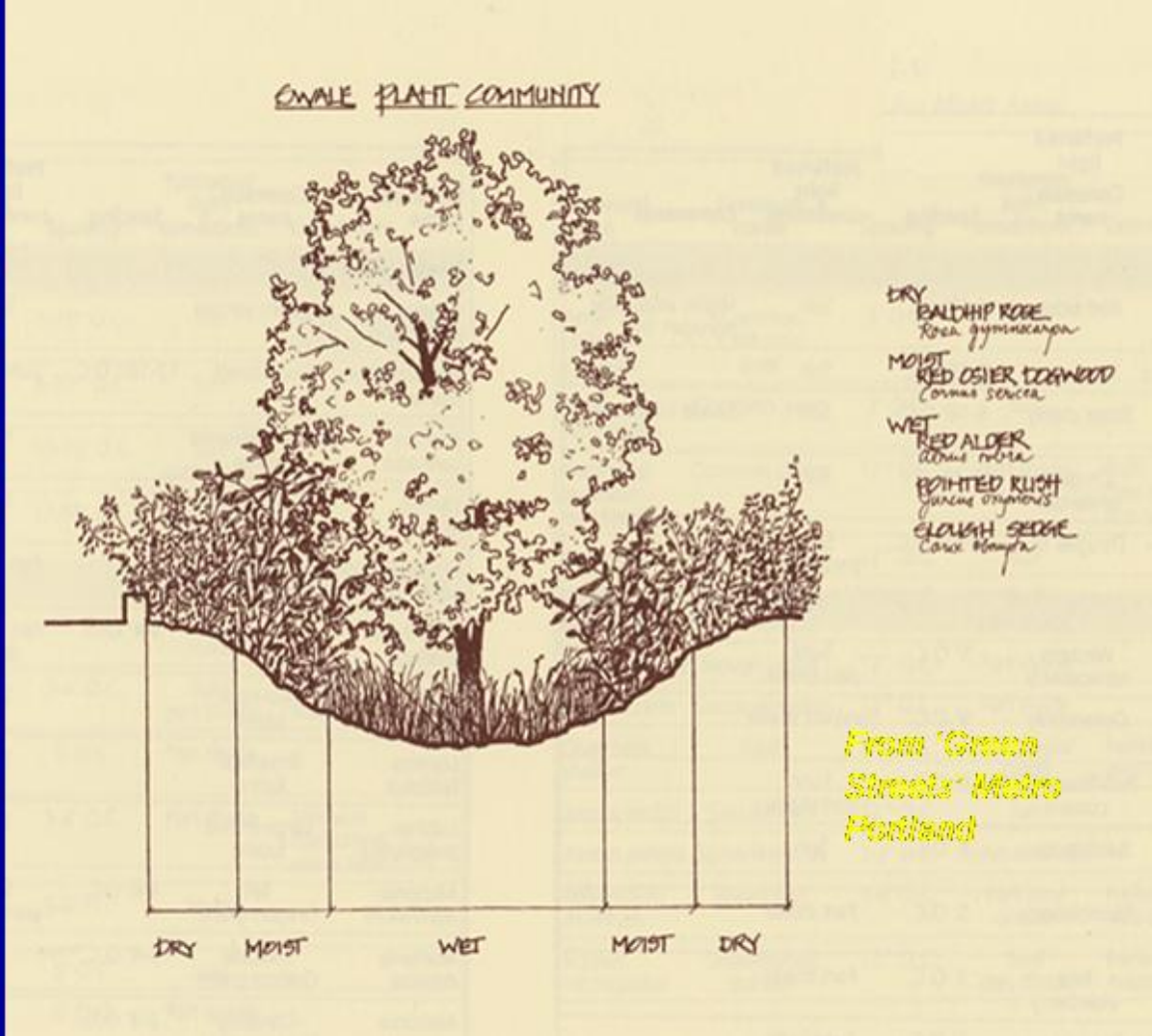


*Manicured shrubs, alder and wetland plants –  
Oregon Museum of Science & Industry, Portland*

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# WATER Balance MODEL FOR BRITISH COLUMBIA

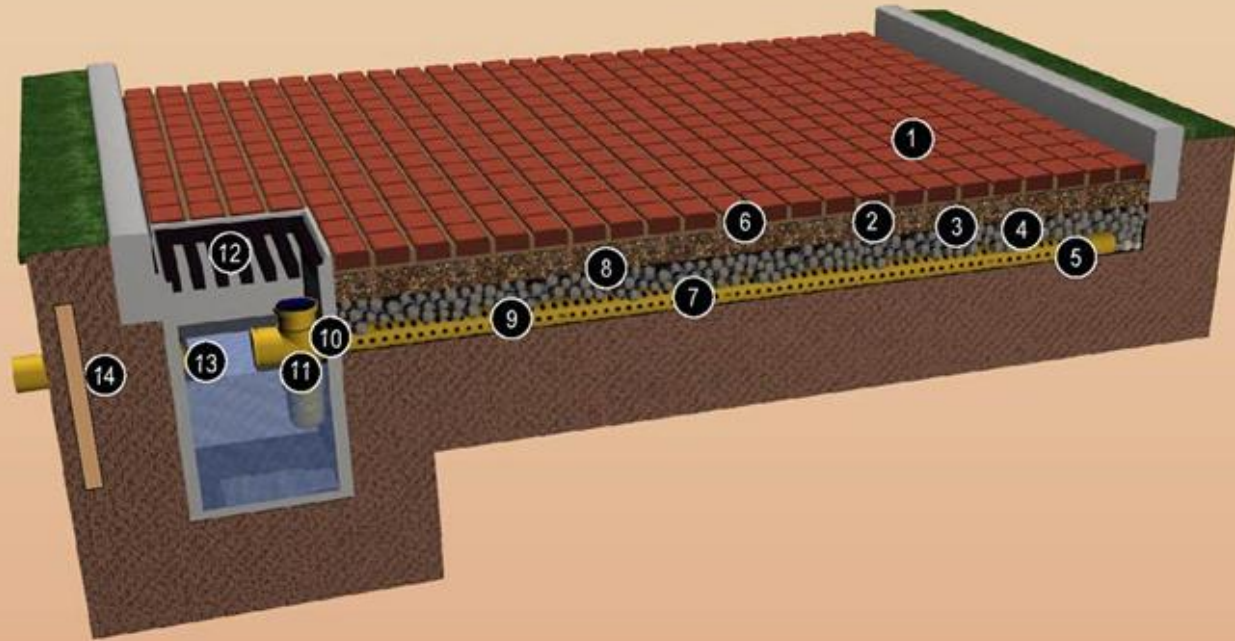


From 'Green  
Streets' Metro  
Portland



# WATER Balance MODEL FOR BRITISH COLUMBIA

## Pervious Paving





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## Pervious Paving

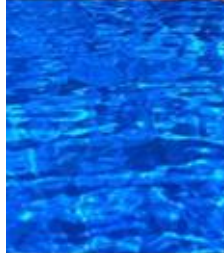


*Pervious Interlocking Concrete Pavers –  
Buckman Terrace, Portland*

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# Pervious Paving



*Aggregate Bedding (not sand)*

*Reservoir Base Course*

*Utrecht, Netherlands*

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# Pervious Paving in the UK



Figure 2.6 Small elemental surfacing blocks

CIRIA C582

*BCWWA Water Sustainability Committee*

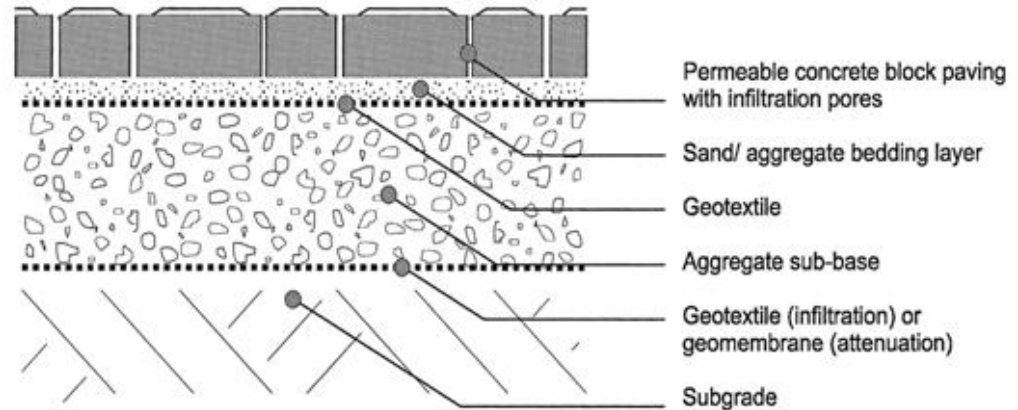




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## Pervious Paving in the UK



CIRIA C582

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## Pervious Paving Surfaces



*Pervious Concrete, Seattle*

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# Pervious Paving Surfaces



*Pervious Cobble, Netherlands*

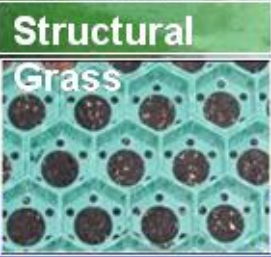
*BCWWA Water Sustainability Committee*



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## Pervious Paving Surfaces

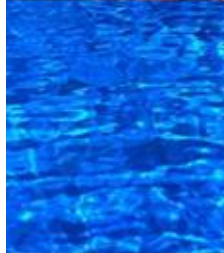


*Country Lanes Project,  
Vancouver*

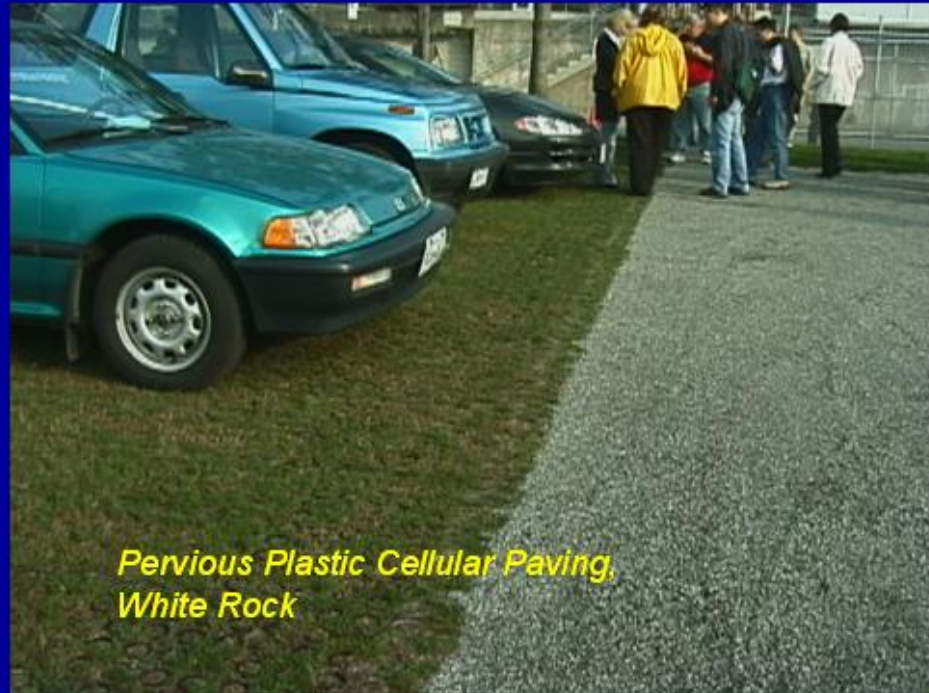
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## Pervious Paving Surfaces



*Pervious Plastic Cellular Paving,  
White Rock*

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# Green Roof

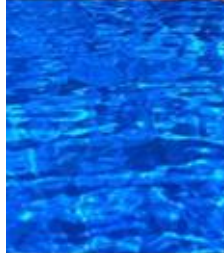


*Installed in about 1 in 7  
new flat roofs in  
Germany*

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## Green Roof



*In 2001, 13,500,000 sq.m. in  
Germany*

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# Over 600 Greenroofs in GVRD



*Vancouver Public Library*

*BCWWA Water Sustainability Committee*





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FOR BRITISH COLUMBIA



## Greenroofs: Integrate Stormwater with Site Design



*Mixed Use Developments, 4200 Block Kingsway, Burnaby*

*BCWWA Water Sustainability Committee*



**WATER**  
**Balance**  
**MODEL**  
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# Rainwater Management

Around the World

'Wadi'  
in the  
Netherlands



Source: Adviesbureau Cuijpers

*BCWWA Water Sustainability Committee*



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## Swale Trench System



*Swale / Trench  
System under  
construction –  
Germany*

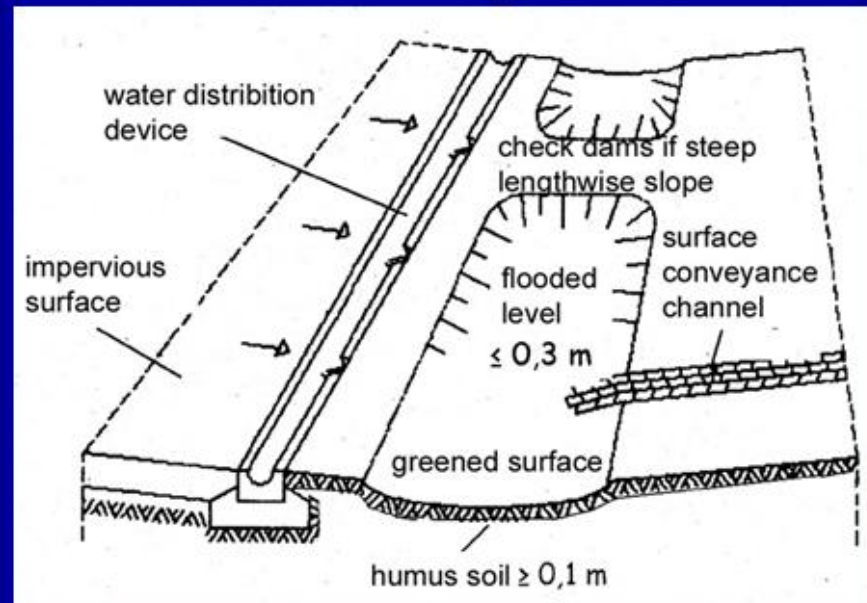
*BCWWA Water Sustainability Committee*



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## Swale Trench System

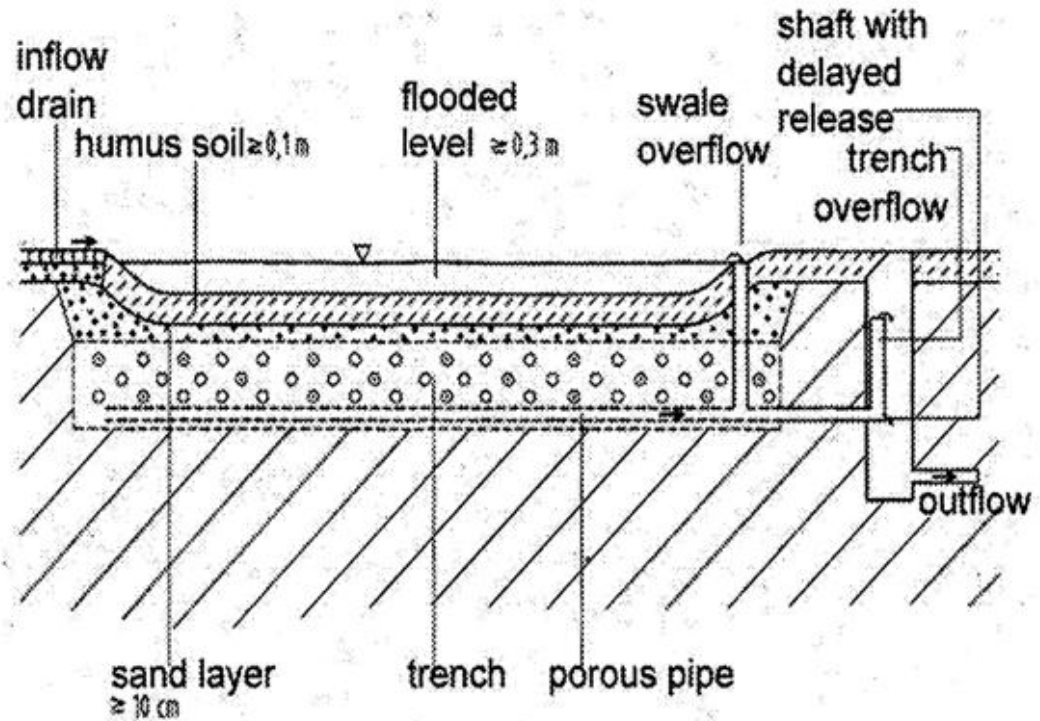


*From German guidelines for  
Natural Rainwater Management (ATV 2002)*

*BCWWA Water Sustainability Committee*

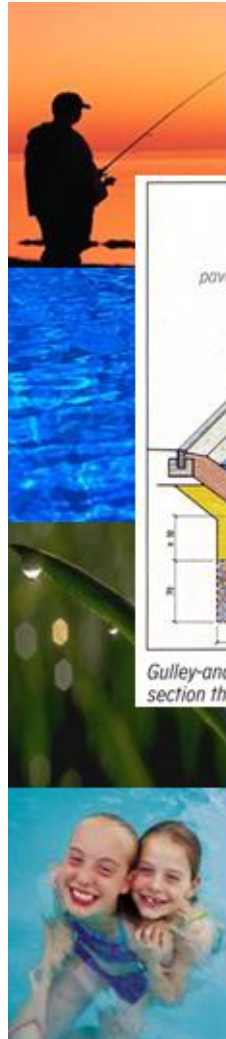


Dia. 10: Element of a Swale-Trench System

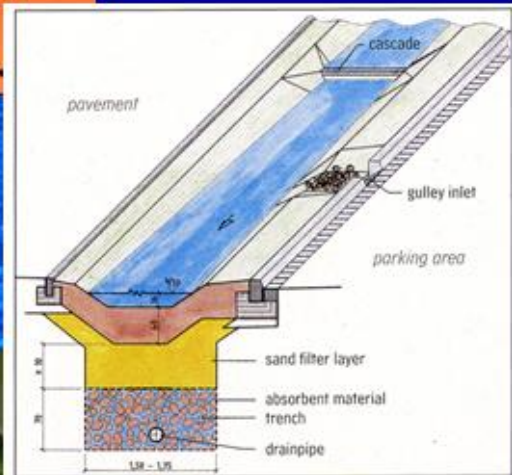




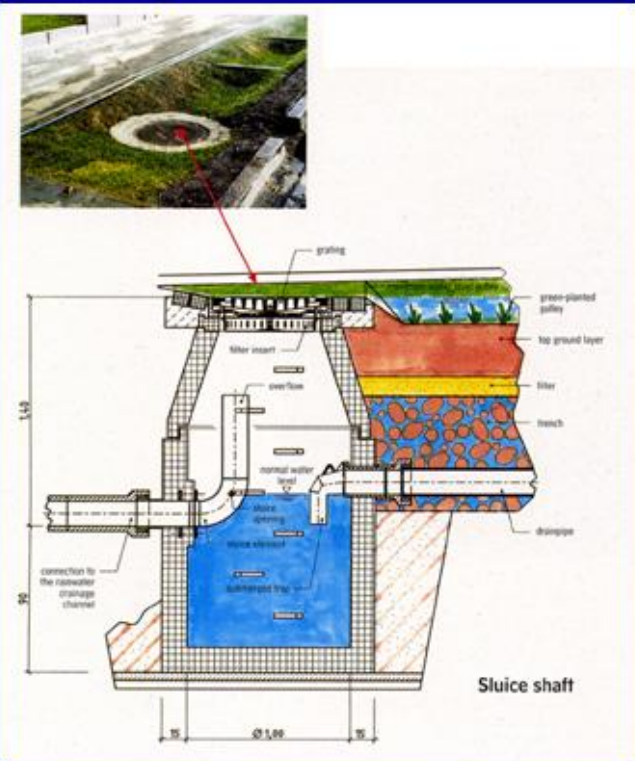
# WATER Balance MODEL FOR BRITISH COLUMBIA



## Swale Trench System



Gully-and-trench system – section through drain-gully

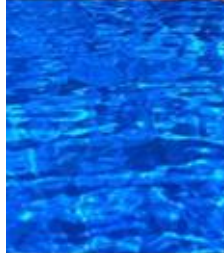


*From German references (Kronsberg)*

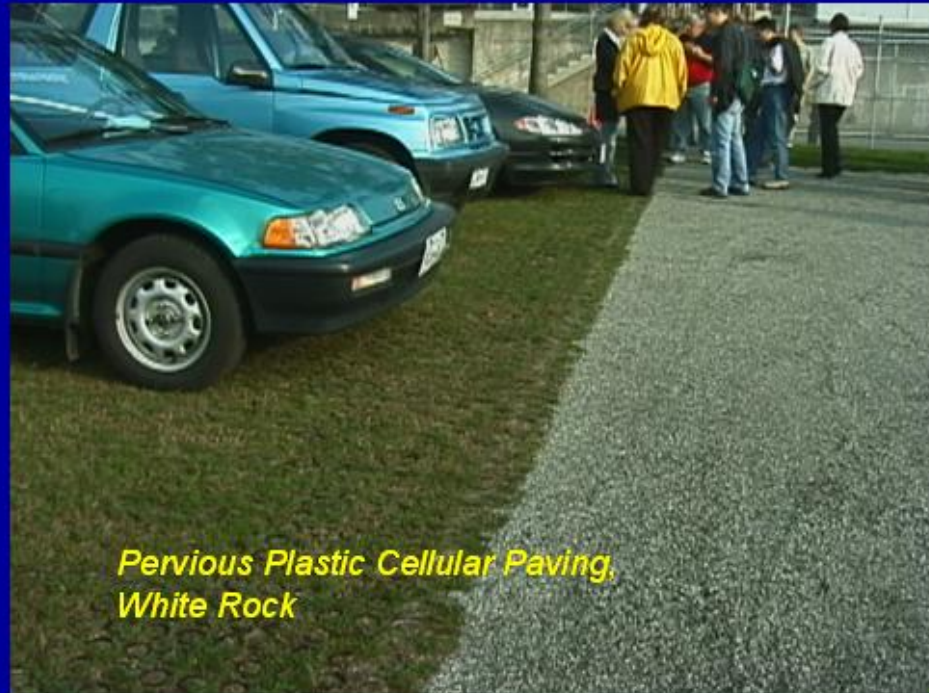
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## Pervious Paving Surfaces



*Pervious Plastic Cellular Paving,  
White Rock*

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## Natural Rainwater Management:

*Integrates* stream corridor values with upland uses

*Integrates* watershed plans with OCPs and neighbourhood plans

*Integrates* designers and builders at site level solutions – key is the development industry

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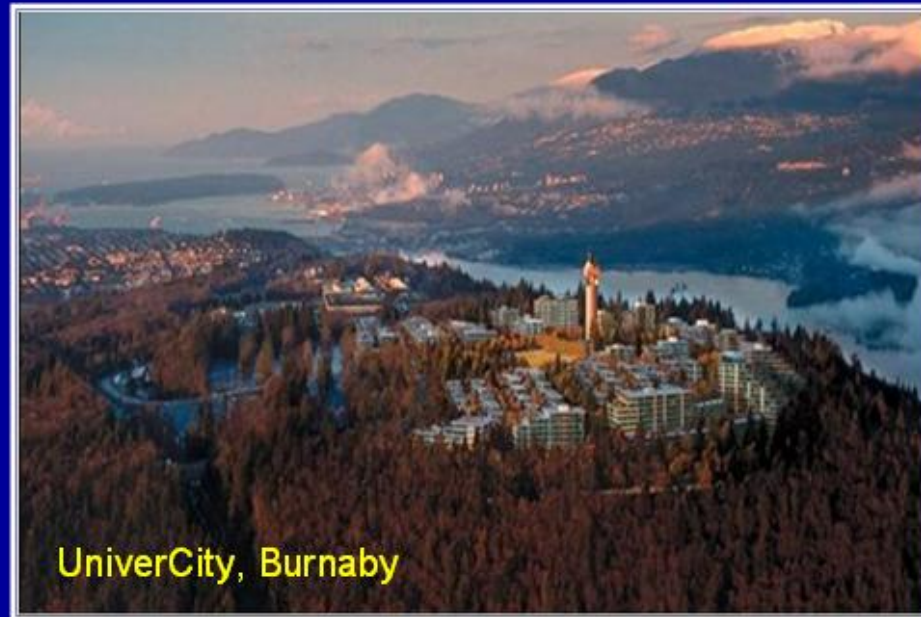




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## Integrate with the Neighbourhood



UniverCity, Burnaby

*BCWWA Water Sustainability Committee*



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



## Integrate with the Neighbourhood

- Greenroofs over parking
- Narrow pavements
- Pervious paving
- Infiltration swales
- Topsoil re-use and compost demonstration
- Watercourse daylighting



UniverCity Highlands Neighbourhood, Burnaby

*BCWWA Water Sustainability Committee*



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



## Integrate with the Neighbourhood

- **Roof leaders disconnected**
- **Infiltration of stormwater**
- **Less Impervious area**
- **Reduced street widths (impervious area)**



Clayton Village, Surrey

*BCWWA Water Sustainability Committee*



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# Natural Rainwater Management

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

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

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Committee*

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