the partnership
for water sustainability in bc

Partnership Releases Rollout Plan for Re-Built Water Balance Model

Drainage Modelling in the 21st Century

Published on the Water Bucket Website – June 2011

Preface

The Water Balance Model is a tool in the toolbox for the Province's Living Water Smart and Green Communities initiatives. It is a scenario modelling and decision support tool. It is accessible to multiple levels of users who have a wide range of technical backgrounds, from hydrology experts to stewardship groups.

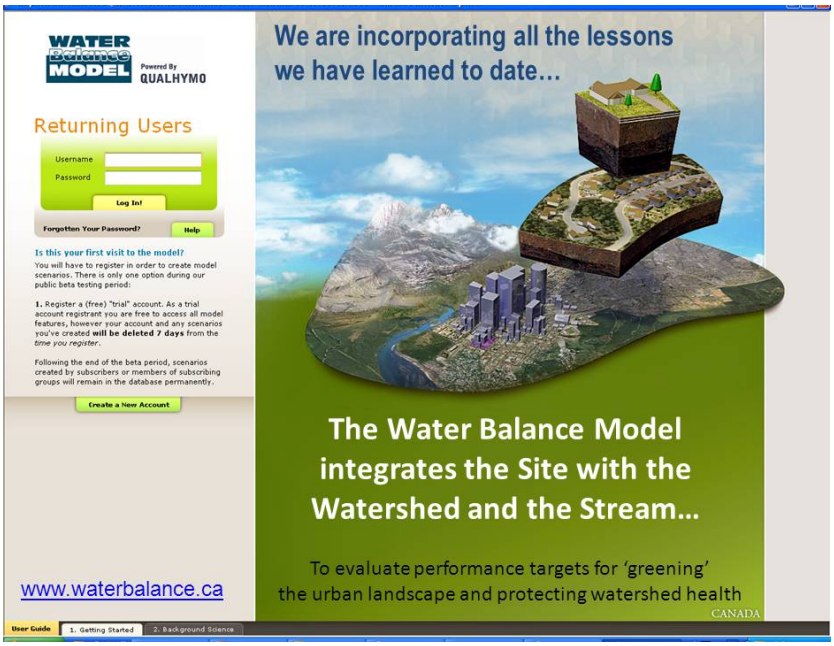
The Partnership for Water Sustainability in British Columbia is helping the Province implement these two initiatives. In April 2011, the Partnership announced that the Water Balance Model is being re-built in two stages:

- ***"Version 2.0":*** *By June 2011, convert the operating platform to one that has a PHP-AJAX-HTML basis; and launch the Stream Erosion and Water Re-Use Modules*
- ***"Version 2.1":*** *By Fall 2011, replace the website front-end with one that has three points of entry to the operating platform; and launch the Climate Change and Tree Canopy Modules.*

The re-built Water Balance Model will allow users to select an environment that fits their knowledge and needs; and having three launch points will facilitate establishing and integrating performance targets at three scales, namely: watershed, neighbourhood and site.

The following article elaborates on Version 2.0; foreshadows Version 2.1; and summarizes the implications of computing technology decisions.

Kim Stephens, Executive DIrector
Partnership for Water Sustainability in British Columbia
June 2011



Partnership Releases Rollout Plan for Re-Built Water Balance Model

Rollout of 'Version 2.0' in June

"We are on schedule. Version 2.0 is completed, and we are currently in beta-testing mode," reports Ted van der Gulik, Chair of the Water Balance Model Partnership. "Before the end of June we will go LIVE, and work on Version 2.1 will follow immediately.

"During the transition period leading up to the 'Go Live' change-over, Partners and Paying Subscribers will have the opportunity to run both the old and new versions and compare the results."

"Those who are experienced and already comfortable using the Water Balance Model will be able to transition smoothly into Version 2.0. While the look-and-feel is essentially unchanged, Version 2.0 is streamlined and cleaner. A big difference is performance: Version 2.0 is so much quicker! Also, the user is no longer required to have the Flash player installed in order run the model."

A Look Ahead to 'Version 2.1' in the Fall

"As the Water Balance Model community has grown and user preferences have evolved, we have reached a point where one WBM interface no longer works for everyone. When we launch Version 2.1 this Fall, we will be providing an environment that supports communities that range from highly experienced experts to enthusiastic newcomers," reports Dr. Charles Rowney, the Partnership's Scientific Authority.

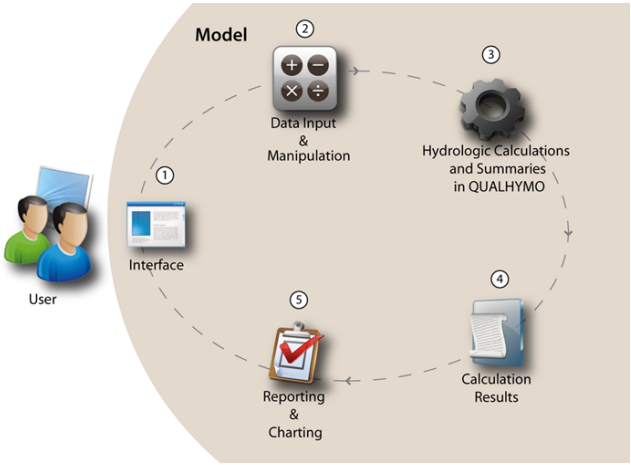
"We are re-building the WBM website front end with three points of entry; these three options will allow people to select an environment that fits their knowledge and needs. What is important in the way we're making this shift is that it facilitates communication without sacrificing rigor or consistency, because in all cases the answers will be founded on the same calculation engine."

Stream Erosion and Water Re-Use Modules

Funding from the Canada Mortgage & Housing Corporation, Environment Canada, CIty of Calgary and the federal government's Regional Adaptation Collaboration (RAC) program has enabled development of four modules, two of which are being unveiled in Version 2.0, namely: Stream Erosion Module; and Water Re-Use Module.

The Stream Erosion Module extends the QUALHYMO engine and WBM interface in order to enable assessment of natural stream sections and development of an erosion index for watershed scenario comparison and development of mitigation methodologies.

The Water Re-Use Module enables assessment of domestic non-potable reuse of rainwater as an alternative to discharge as waste.



Three Scales of Integration

According to Dr. Rowney, three launch points correspond to three common investigation scenarios:

- **WBM for the Watershed** – "This is the scale where the big environmental questions are answered; it is about what happens to the creek as a result of the way the whole system is managed. It is where the environmental science makes itself felt and where features like the Erosion Module provide answers that make stream health real to planners and engineers, or where the long term impact of build-out can be explored."

- **WBM for the Neighbourhood** – "This is the scale of interest to the developer who, consistent with the plan for the watershed and with best practices in local development, wants to lay out a development that includes integrated local solutions. This is where things like regional or multi-dwelling detention facilities can be evaluated, or where Green Infrastructure plans can be looked at in detail."

- **WBM Express for Homeowners** – "This is the lot or site scale, and is especially relevant to redevelopment scenarios where infilling is of interest, or to homeowners interested in exploring the kinds of conservation and environmentally appropriate solutions they can apply on their own lot. Included in this are things like re-use options or cisterns that conserve water for gardening or other uses at home, or where porous paving or other green infrastructure drainage techniques are brought to bear."

"The Water Balance Model allows comparison of multiple scenarios of watershed condition using historical climate data. This supports the design of communities that have no net impact on stream environments," adds Jim Dumont, the Partnership's Engineering Application Authority.

How to Set Performance Targets

The Water Balance Model enables the user to establish performance targets for rainfall capture and runoff control at the site, neighbourhood and watershed scales

Refer to the handout that follows. This presents the methodology for establishing science-based performance targets.

Drainage Modelling in the 21st Century

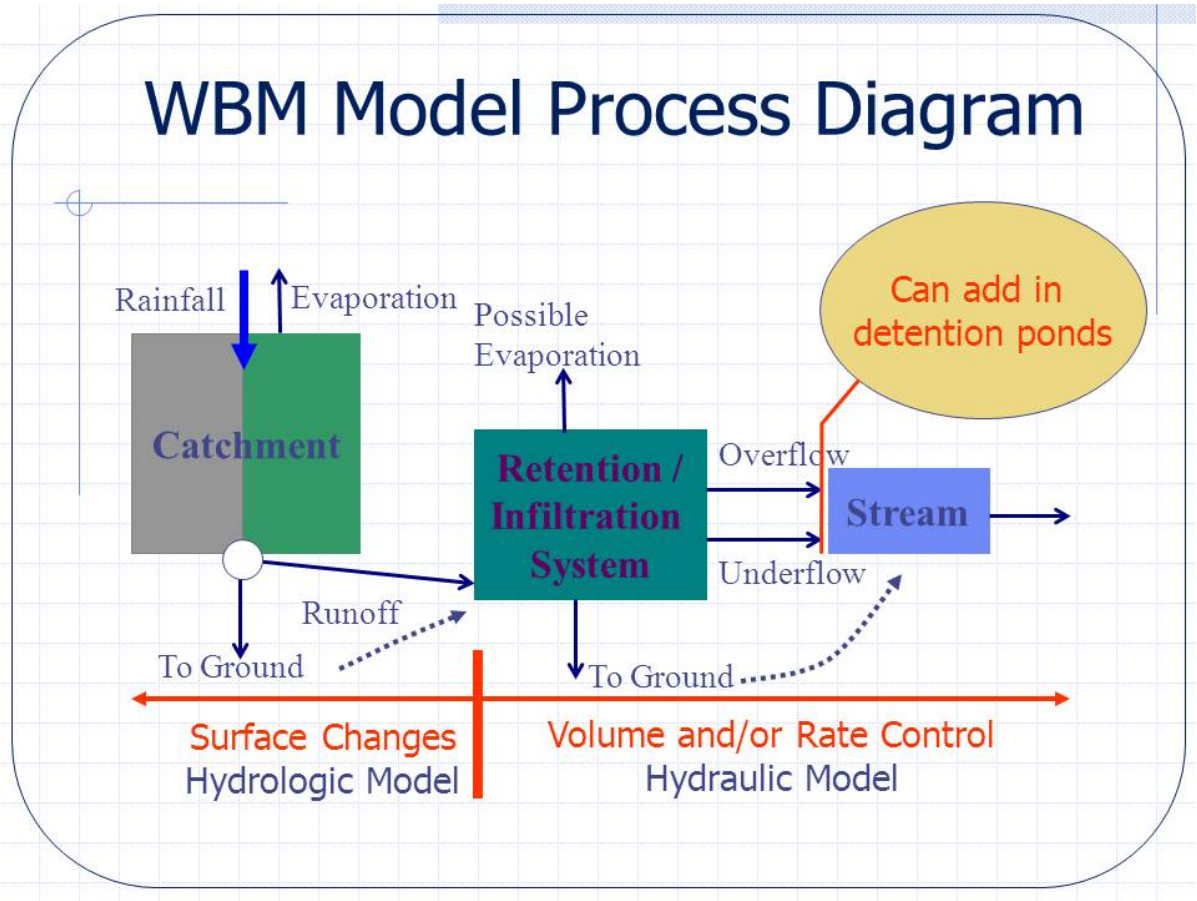
At the Water Balance Model Partners Forum hosted by Metro Vancouver in April 2011, Dr. Charles Rowney reported out on the implications of computing technology decisions. He is a recognized international authority, and is the creator of the QUALHYMO calculation engine.

The Voice of Experience

In providing context for the strategy behind development of the Water Balance Model, Dr. Rowney's theme was: *"The Voice of Experience - What we now know about what drives a successful model"*.

"What we doing with the Water Balance Model is exciting. It is a direct attack on what it takes to get the answers. We are evolving the state of practice. (British Columbia) is the only place I know of where there is a link between the applied practice and climate change, and what are we going to do to make this a routine part of our analysis," stated Dr. Rowney.

"We have learned is that we really need to look at things from the point of view of the solution. As we have been working on the Water Balance Model, 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 be able to evolve as we learn."


WBM Model Process Diagram
Rainfall
Evaporation
Possible Evaporation
Can add in detention ponds
Catchment
Retention / Infiltration System
Overflow
Stream
Underflow
Runoff
To Ground
To Ground
Surface Changes
Hydrologic Model
Volume and/or Rate Control
Hydraulic Model

Partnership for Water Sustainability in British Columbia

Beyond the Guidebook:

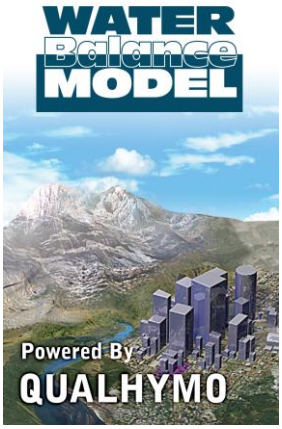
Water Balance Model powered by QUALHYMO

One of the tools developed under the umbrella of the Water Sustainability Action Plan is the **Water Balance Model for British Columbia**.

Developed by an Inter-Governmental Partnership (IGP) as an extension of **Stormwater Planning: A Guidebook for British Columbia**, the Water Balance Model enables users to visualize how to implement green infrastructure solutions that achieve rainwater runoff source control at the site scale.

The Guidebook's premise that **land development and watershed protection can be compatible** represented a radical shift in thinking in 2002. The Guidebook recognized that water volume is something over which local government has control through its infrastructure policies, practices and standards.

Beyond the Guidebook is an initiative that builds on this foundation by advancing a runoff-based approach and tool – the **'Water Balance Model powered by QUALHYMO'** – to help local governments achieve desired urban stream health and environmental protection outcomes at a watershed scale.



May 15, 2011

Hydrologic Impact Assessment

1. Use continuous simulation to assess the mass balance of rainfall, runoff, infiltration and evaporation.

2. Graphically represent the mass balance analysis.

3. Use the continuous simulation to estimate discharge exceedances. These would be the values of runoff plus groundwater return to the system.

4. Present results of flow exceedance analysis results in tabular or graphical format.

5. Use BMP's to achieve the desired objectives.

Establish Targets

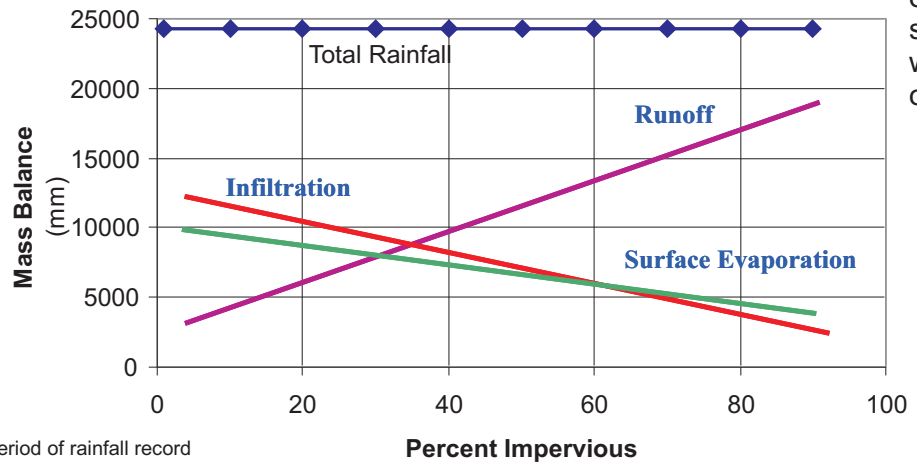
Two methods can be used to establish targets used for design of runoff volume reduction systems and facilities.

1. Use the volume of runoff from redevelopment or existing watershed conditions, or

2. Use the stream flow duration and exceedance analysis combined with the stream erosion potential to establish discharge rate and volume targets.

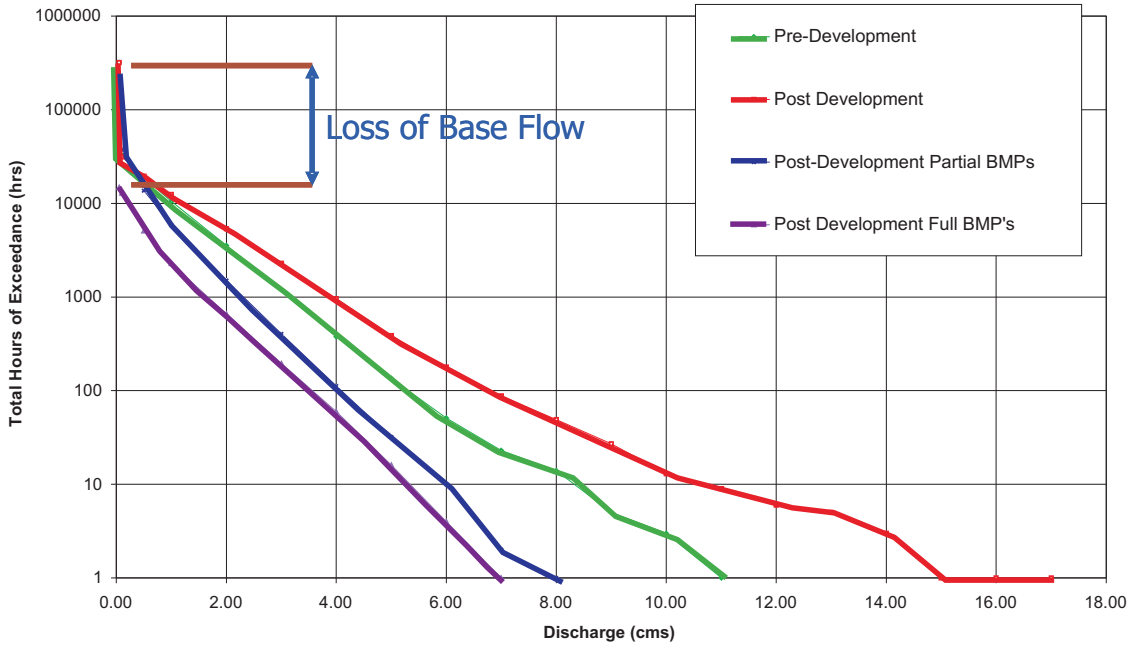
Test and optimize the size and the operation of the runoff volume reduction systems and facilities in the watershed to achieve the desired objectives and targets.

Mass Balance Analysis

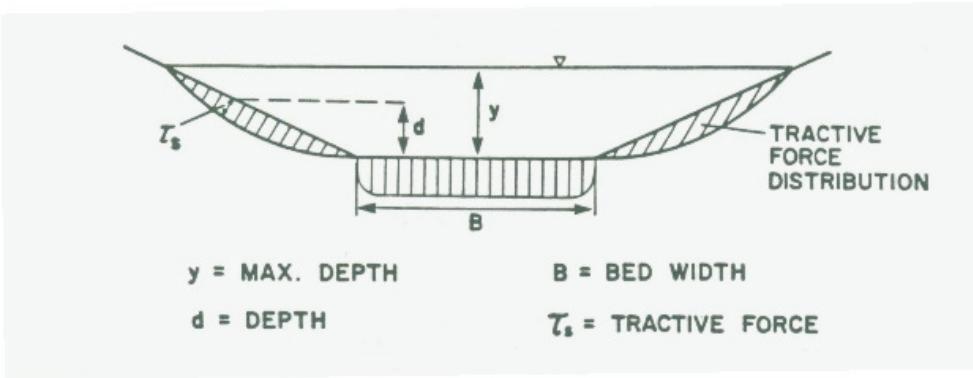


Period of rainfall record
1982 through 1999

Flow Exceedance Analysis



Hydrologic Change Assessment



Steps in the stream assessment

1. Estimate the Tractive Force applied to the stream bed and banks for a range of discharge values.

2. Estimate the critical tractive force below which erosion will not occur. Use only the tractive forces in excess of the critical in the next steps.

3. Use the continuous simulation to estimate the duration of discharge for a range of occurring stream flows.

4. Estimate the Impulse by applying the discharge and estimating the tractive force applied at the section over the duration of the simulation. The impulse is the sum of the tractive force over time

5. Present results for different watershed conditions or runoff volume reduction system alternatives in tabular or graphical format.

Tractive Force

$\tau = \sigma R s$, where

σ = unit weight of water

R = hydraulic radius of flow, and

s = slope of channel

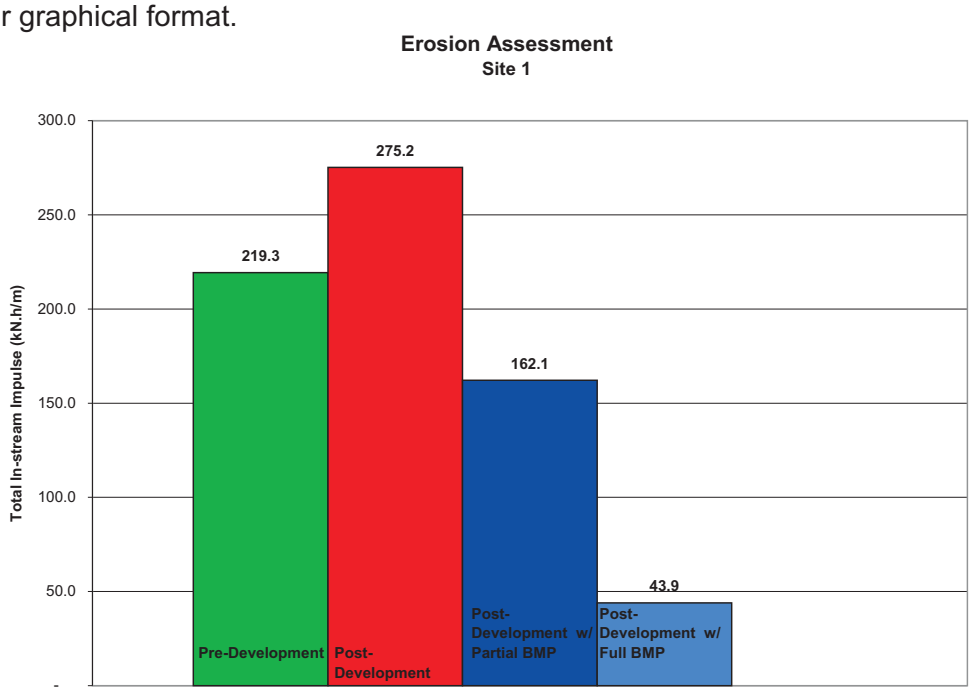
Impulse

$I = \sum(\tau P T)$, where

τ = Tractive Force

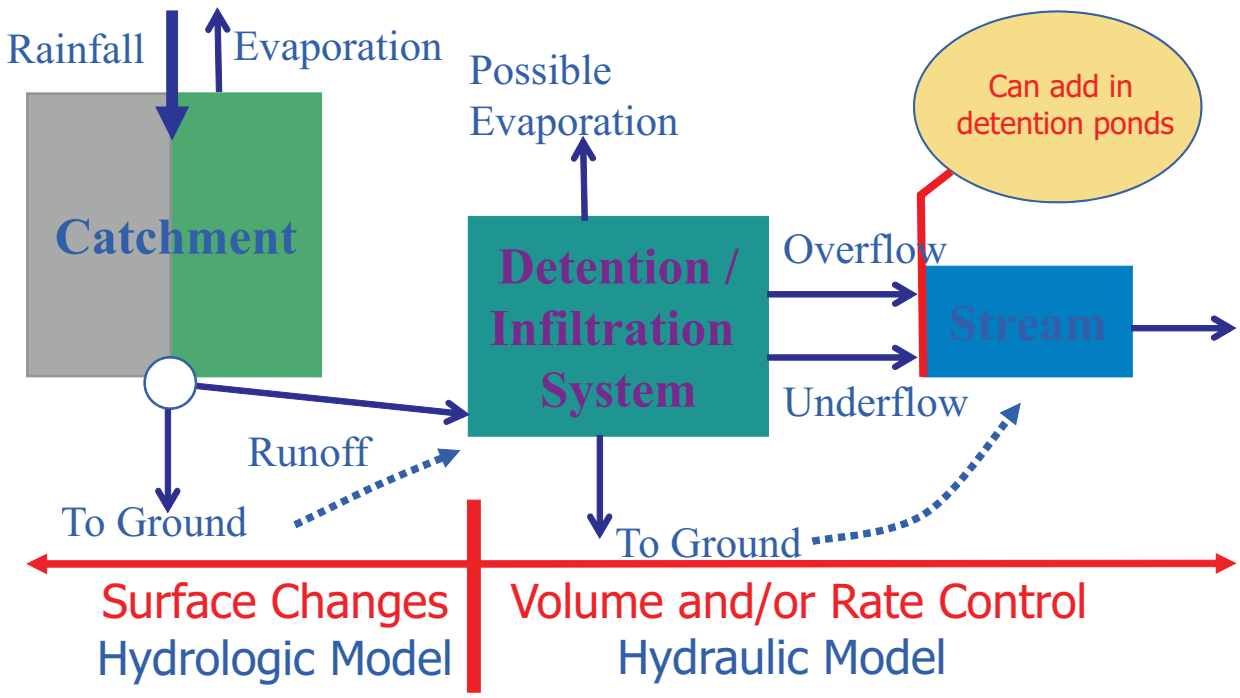
P = wetted perimeter

T = time



Stream Impact Assessment

WBM Model Process Diagram



Modelling Surface Changes - Hydrologic Model

Mitigation with Absorbent Landscapes

- Tree cover density
- Increased top soil depth
- Porous pavement
- Green Roof – Typical
- Some infiltration swales – without storage

Modelling Runoff Reduction - Hydraulic Model

Capture surface runoff and STORE it for infiltration to reduce discharge volume

- Rain gardens with storage
- Infiltration swales with storage
- Surface or subsurface storage
- Infiltration ponds
- Underground galleries