Blending Policy, Science and Site Design in British Columbia

Building a Sustainable Community on Burnaby Mountain

Presentation to APWA Stormwater Managers Committee by

Kim A Stephens, CHM2 HILL Canada

November 2001

The Guiding Principles of Integrated Stormwater Management

- Agree that Stormwater is a Resource
- Design for the Complete Spectrum of Rainfall Events
- Act on a Priority Basis in At-risk Drainage Catchments
- Plan at Three Scales – Watershed, Neighbourhood and Site
- Test Solutions and Reduce Costs through Adaptive Management

A-D-A-P-T

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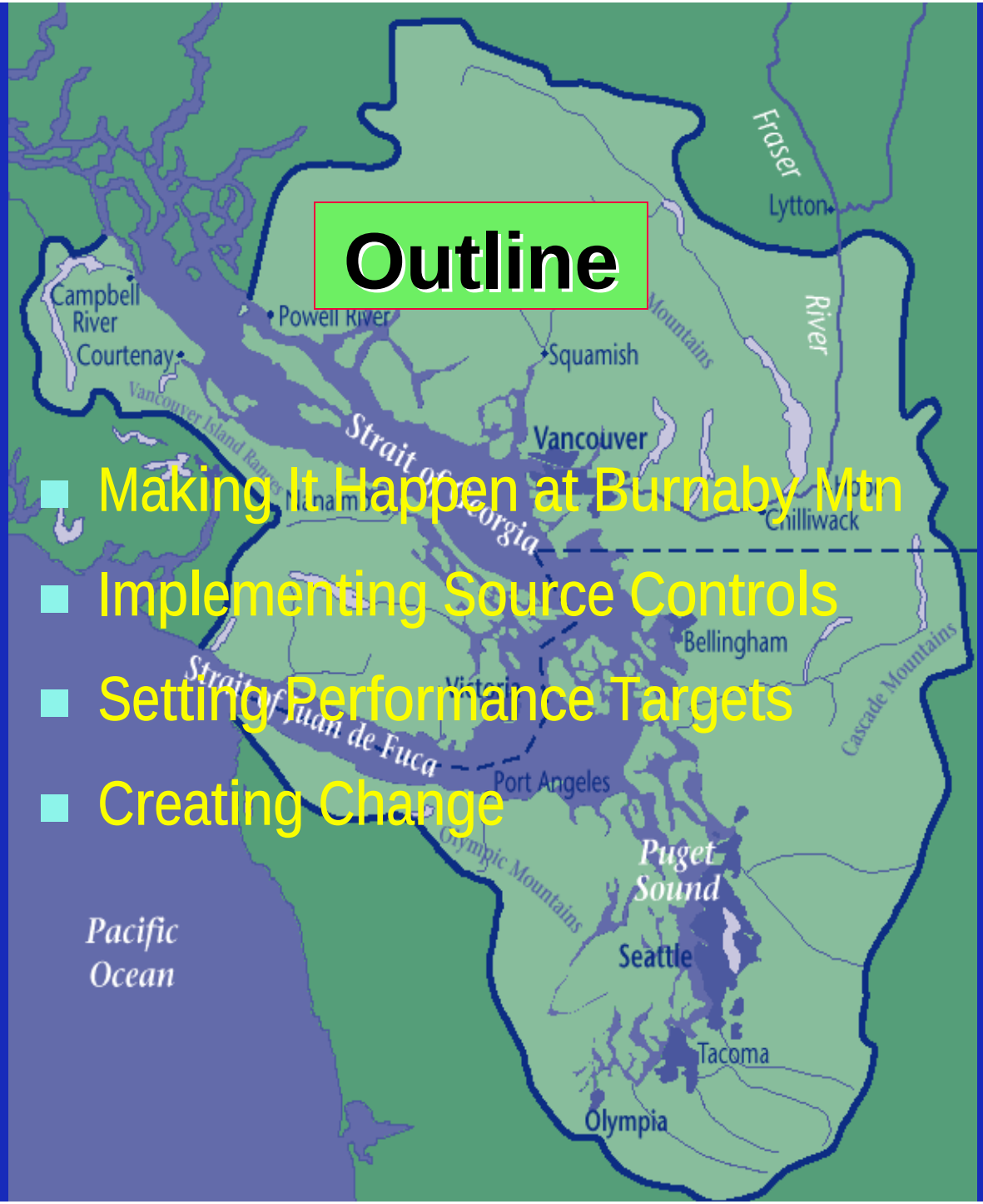
Outline



- Making It Happen at Burnaby Mtn
- Implementing Source Controls
- Setting Performance Targets
- Creating Change


North Shore Mountains
Stanley Park
Brunette Basin
Greater Vancouver Region
Blaine
United States

Guiding Principle #4 - Plan at Three Scales - Watershed, Neighbourhood and Site

Over-arching ***Brunette Basin Plan***

At the watershed level - establish a shared vision, stormwater objectives and priorities

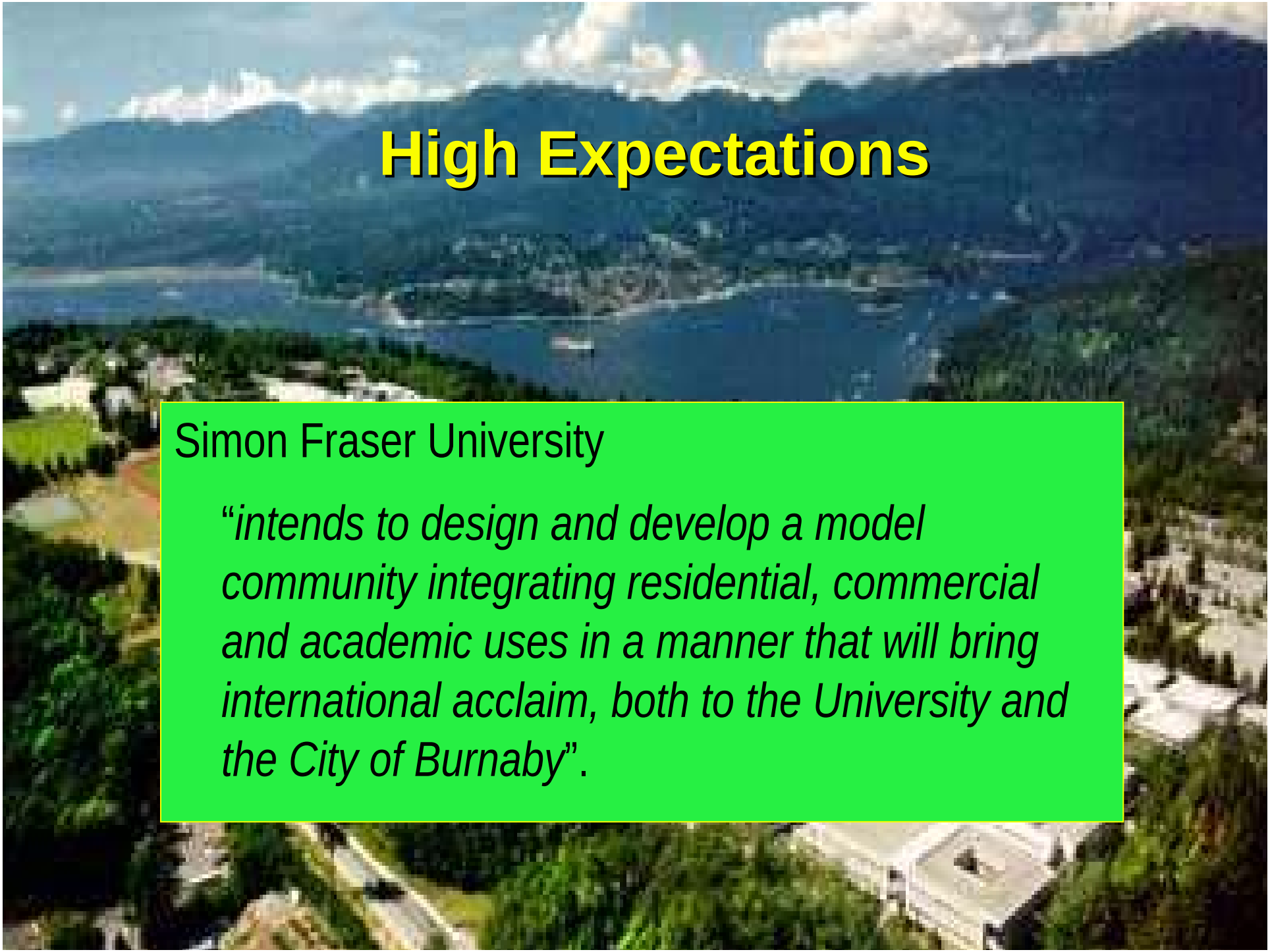
At the neighbourhood level - integrate objectives into community and neighbourhood planning

At the site level - apply site design practices that reduce the volume and rate of runoff, and improve water quality.

simon fraser university

Context for Burnaby Mountain Watercourse & Stormwater Management

Figure 1-2



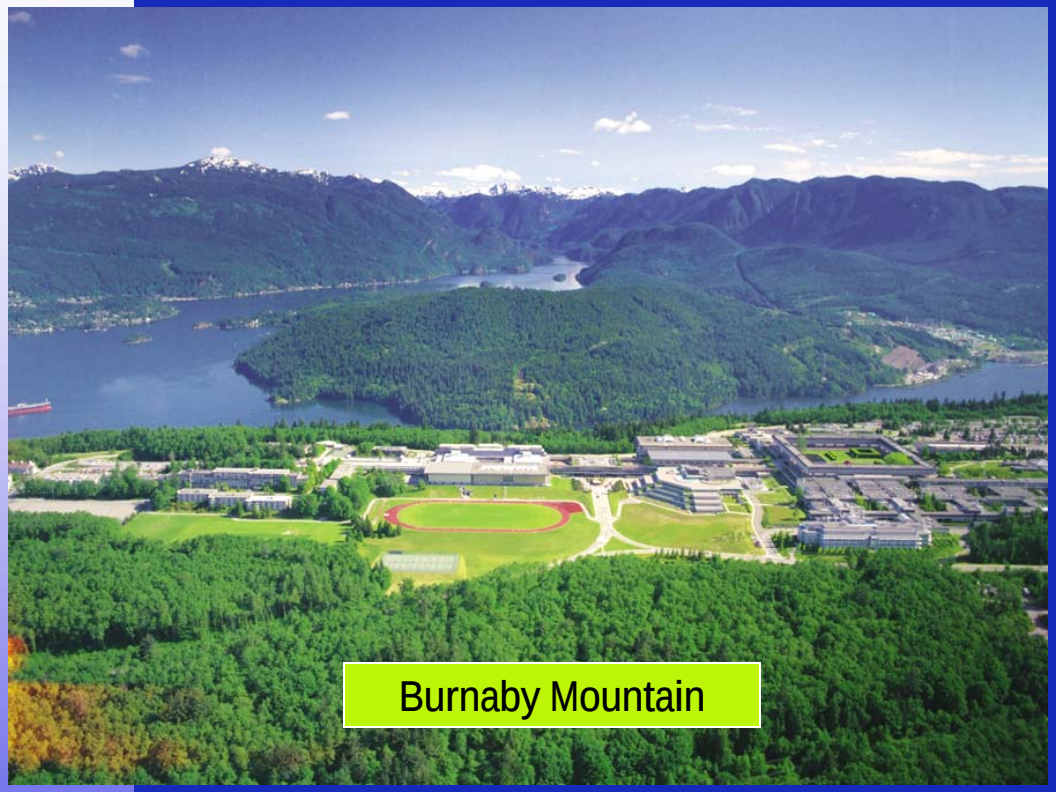
High Expectations

Simon Fraser University

"*intends to design and develop a model community integrating residential, commercial and academic uses in a manner that will bring international acclaim, both to the University and the City of Burnaby*".

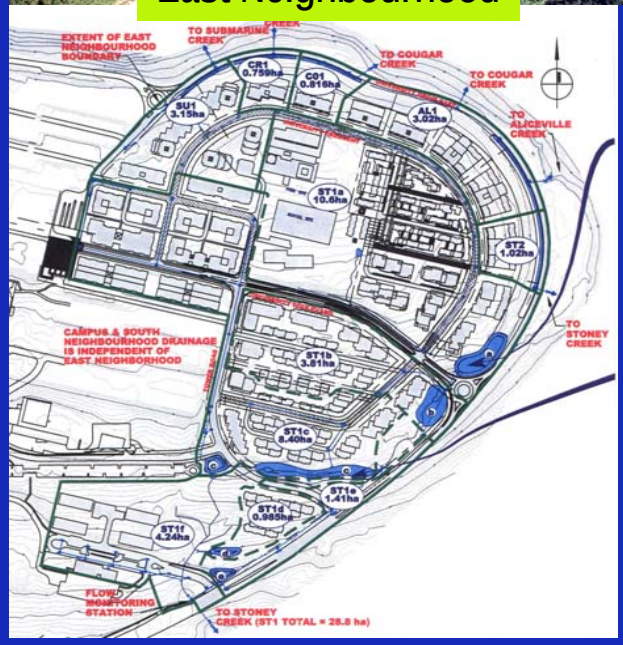
Competing Expectations

- 10,000 people concentrated on 20% of the original land area.
- densities of 40-80 units/acre, FSR 1.7
- a sustainable, compact and complete community.
- no increase in stormwater runoff.
- no decrease in fish habitat.



Burnaby Mountain

East Neighbourhood



The First Project

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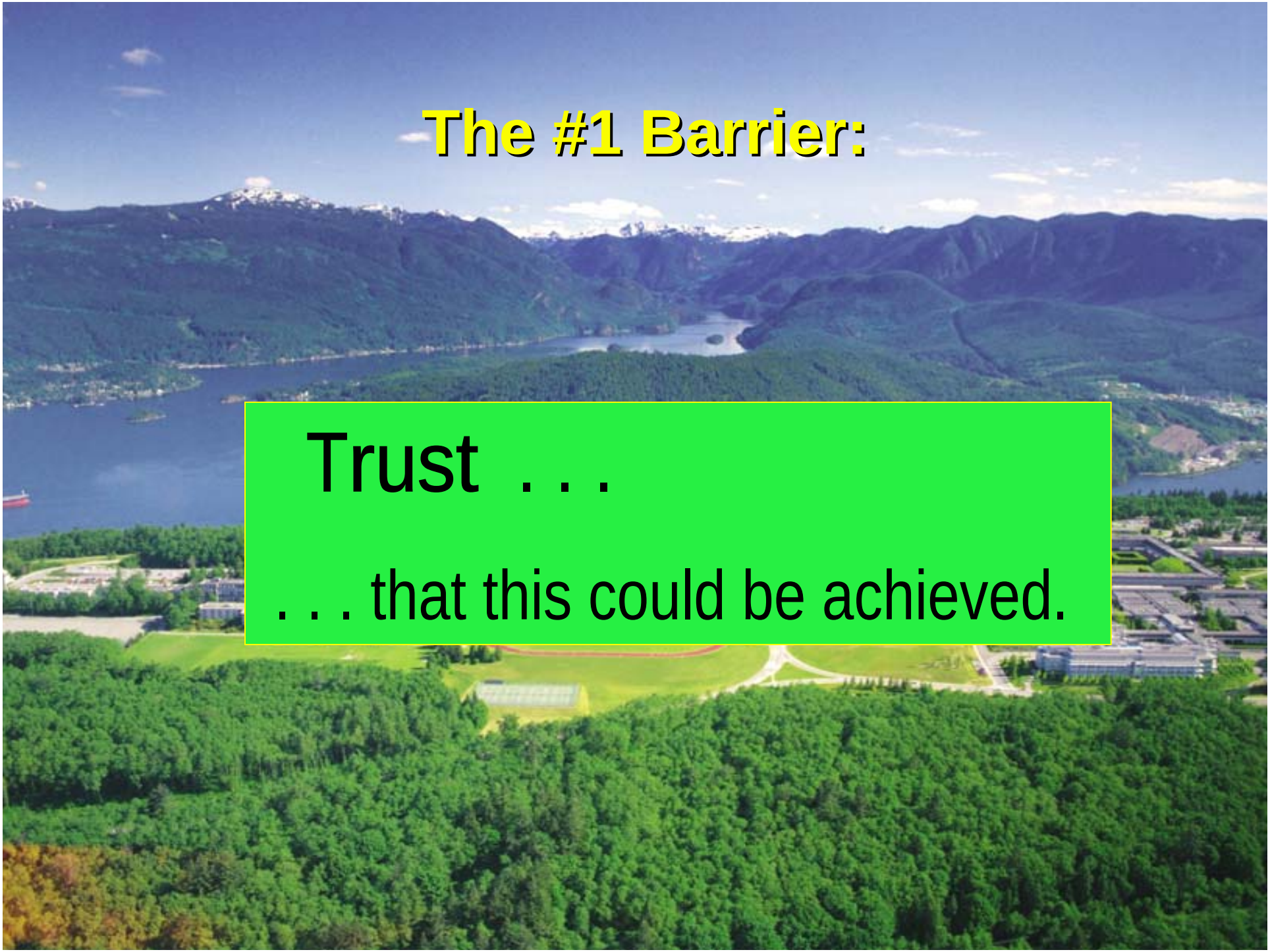
The #1 Barrier:
Trust . . .
. . . that this could be achieved.

The #1 Solution

Earning trust through a process . . .

1. True interdisciplinary teamwork
2. Introductory forum
3. Stakeholder round tables
4. Technical sessions
5. Assured delivery

figure:3

ENVIRONMENTAL SYNTHESIS

new community@simon fraser university

July 18, 2001

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Element # 1 - Forest Drive

- Utilize existing road ditch and drainage outlets to provide *Tier C Off-Parcel Storage* for north slopes perimeter development along Forest Drive.
- Incorporate a swale or pond along the top edge of the forested buffer strip to disperse drainage originating from impervious areas.
- Convey over flow (>5yr. event) to Stoney Creek

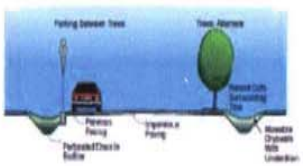
COMBINED DETENTION / INFILTRATION POND

CISTERN DISCHARGING TO PERCOLATION FIELD

CISTERN DISCHARGING TO INFILTRATION POND

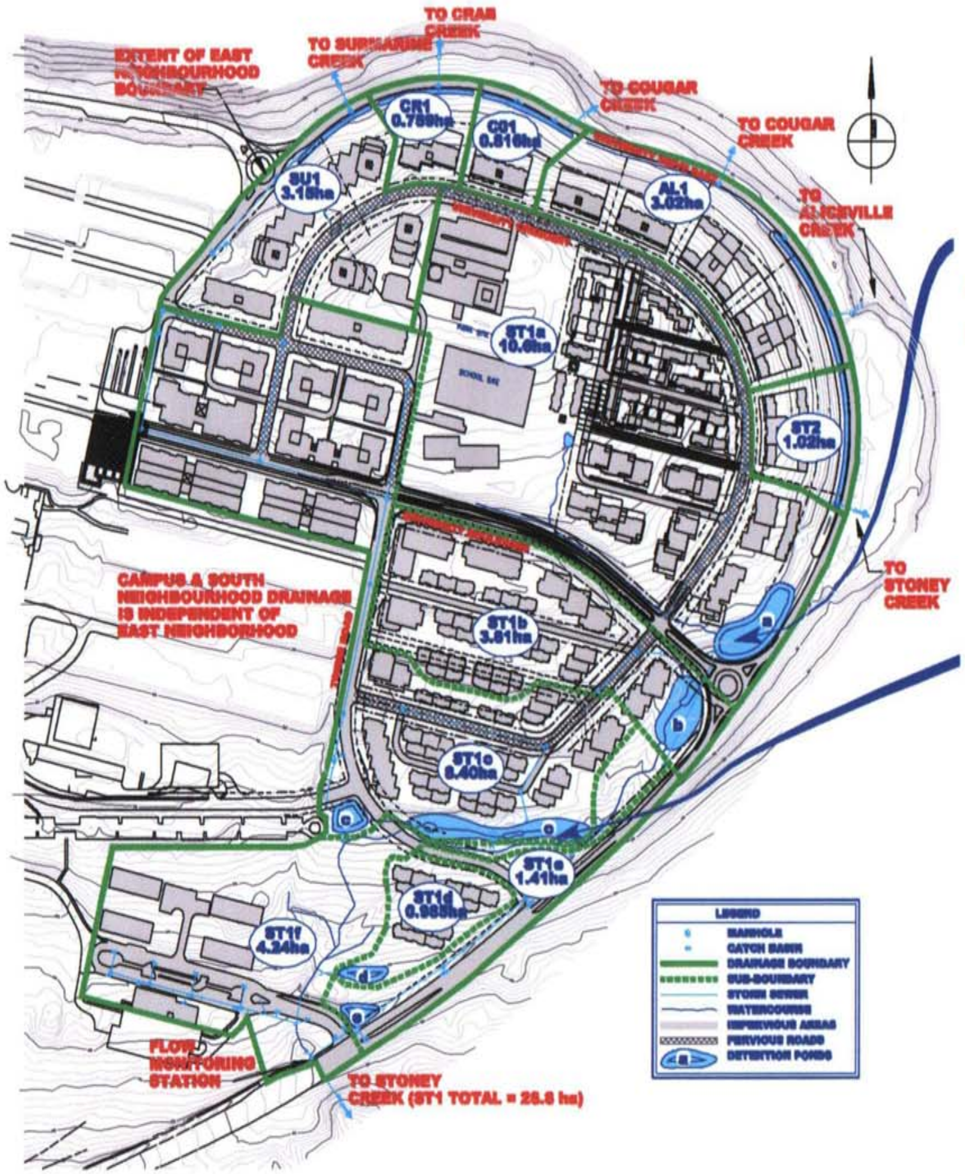
Element # 2 - On-Parcel Detention Storage

- Capture first 35mm of rainfall and return to interflow zone via ground infiltration / percolation.
- Select from a range of options to achieve design objective for rainfall capture.



Element # 3 - Detention Storage Along "Green Road"

- Shed pavement runoff to shallow-graded biofiltration swales, disperse and infiltrate.
- Provide trench infiltration storage volume for the 100mm Tier C rainfall event. (Note: require 1m³ per lineal metre of roadway)
- Install perforated underdrain for redundancy and to provide an escape route.



Element # 4 - Entrance Wetlands (Ponds)

- Construct ponds each side of relocated entrance to provide *Tier C Off-Parcel Storage* for Areas ST1a and ST1b.
- Retrofit upper parking lots in Area ST1b with "hydraulic disconnects" and provide interim Tier A On-Parcel Storage to mitigate the impervious paved area.

Element # 5 - Contour Wetlands (Ponds)

- Construct a Riparian Channel parallel to Forest Drive buffer to replace the existing piped section through the lower parking lots.
- Construct linear contour ponds off-line to provide *Tier C Off-Parcel Storage* for Areas ST1c, d & e.

Criteria for Detention Storage Sizing

[Net Storage Volumes (V_S) per impervious hectare] = [650m³ for the 100mm Tier C rainfall event - 15mm released] + [20% redundancy to allow for a 30mm Tier A rainfall event occuring beforehand] => [Release rate ($0.2Q_2$) = 2 litres per second per hectare (15mm / day)]

[Storage required for a typical 2 hectare parcel with 50% (1ha) impervious cover] = [350m³ On-Parcel (1/3)] + [650m³ Off-Parcel (2/3)]

Watercourse & Stormwater Management Plan for East Neighbourhood

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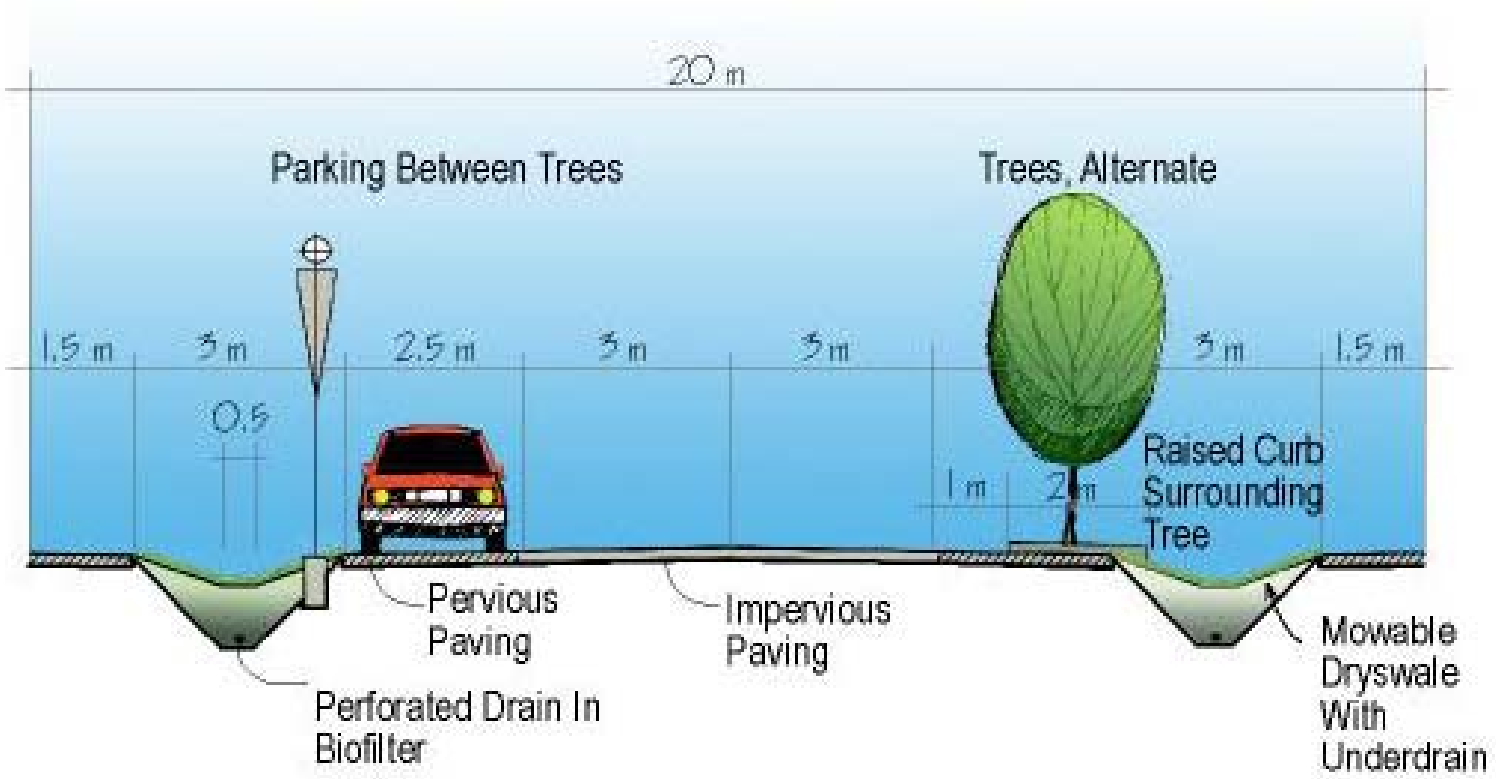
Figure 2

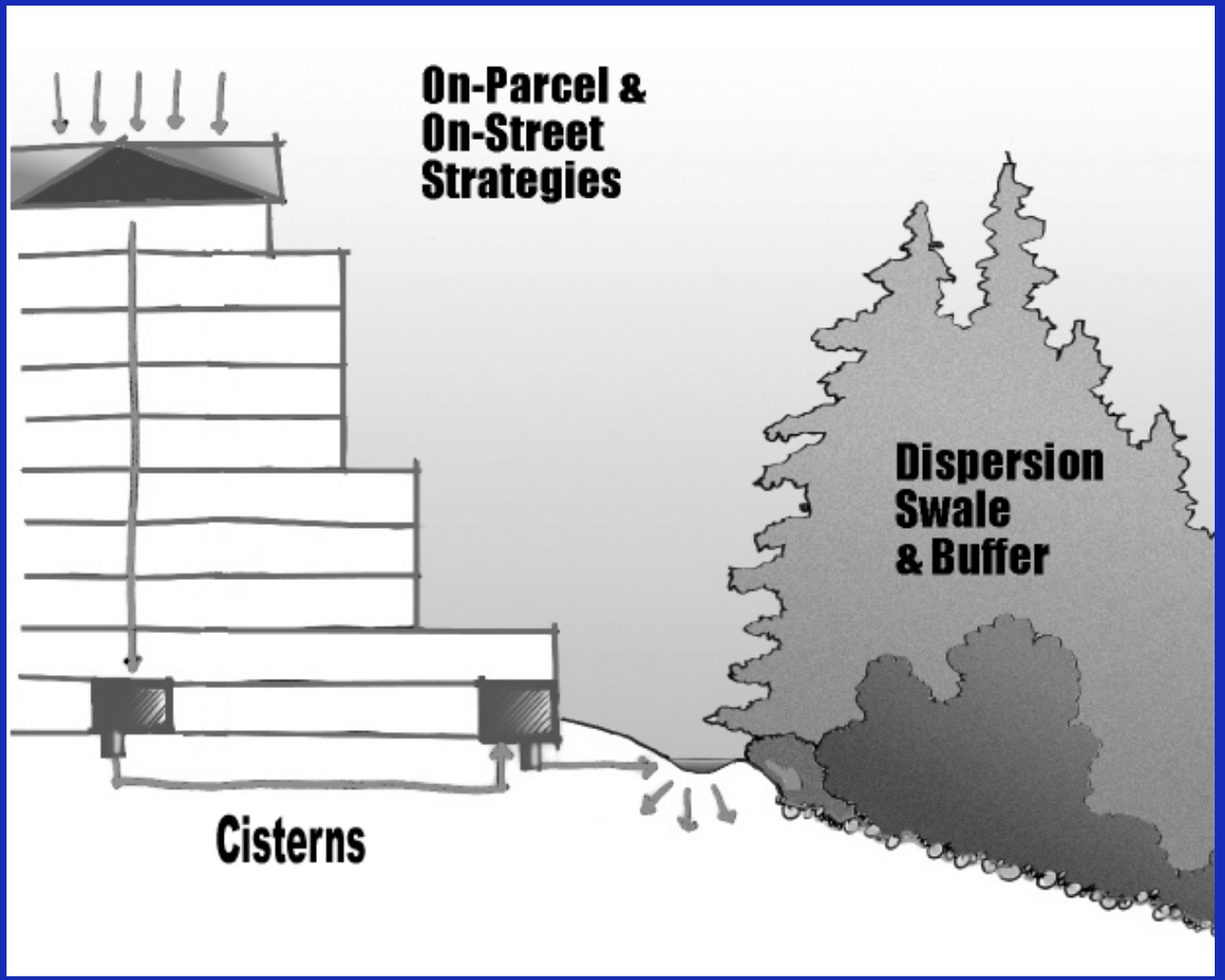


Street Section at Tree with Dryswale/ Underdrain

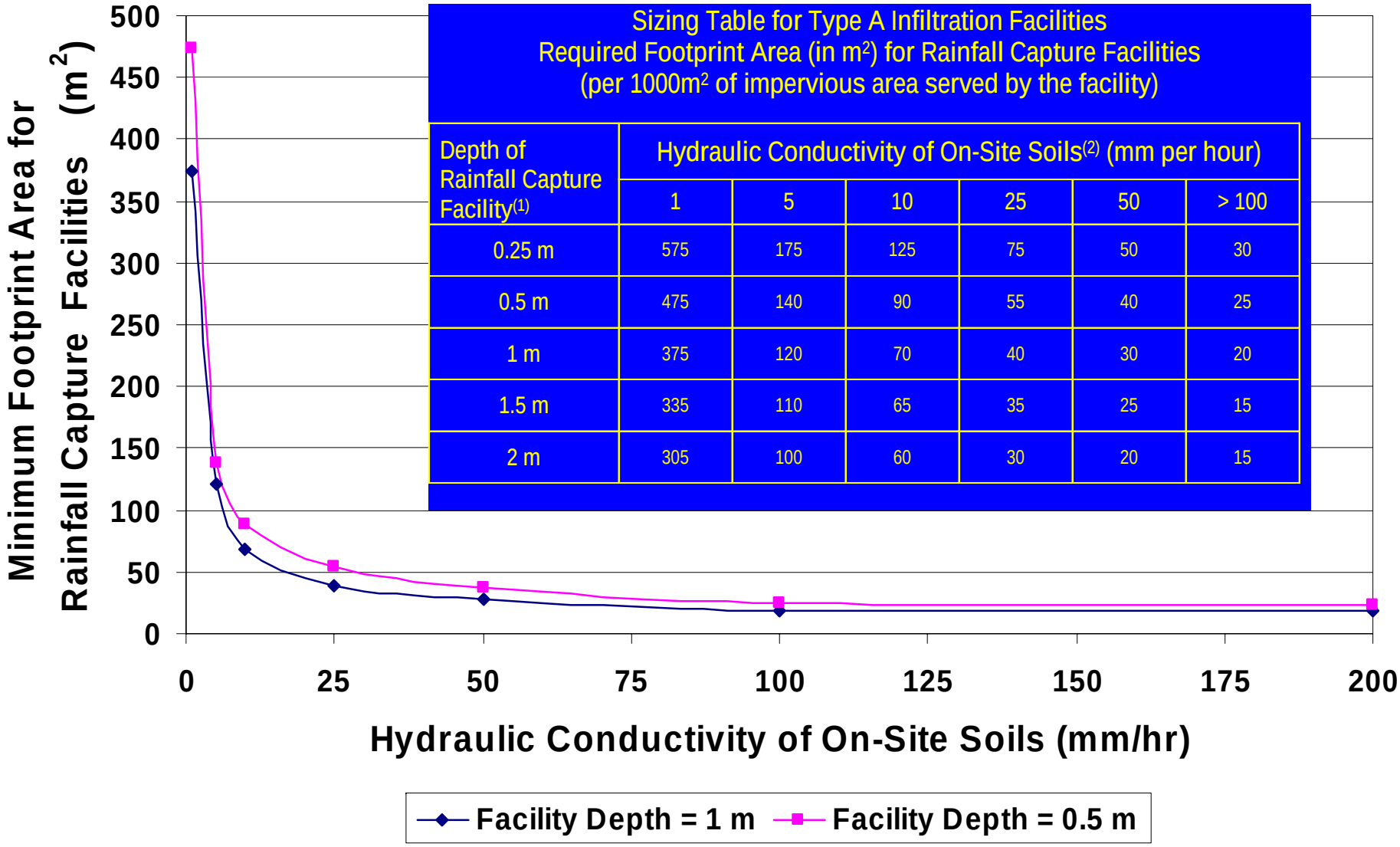
Burnaby Mountain

Multistorey buildings & landscape over underground parking

Cistern Installation in Parking Garages and Landscape Areas



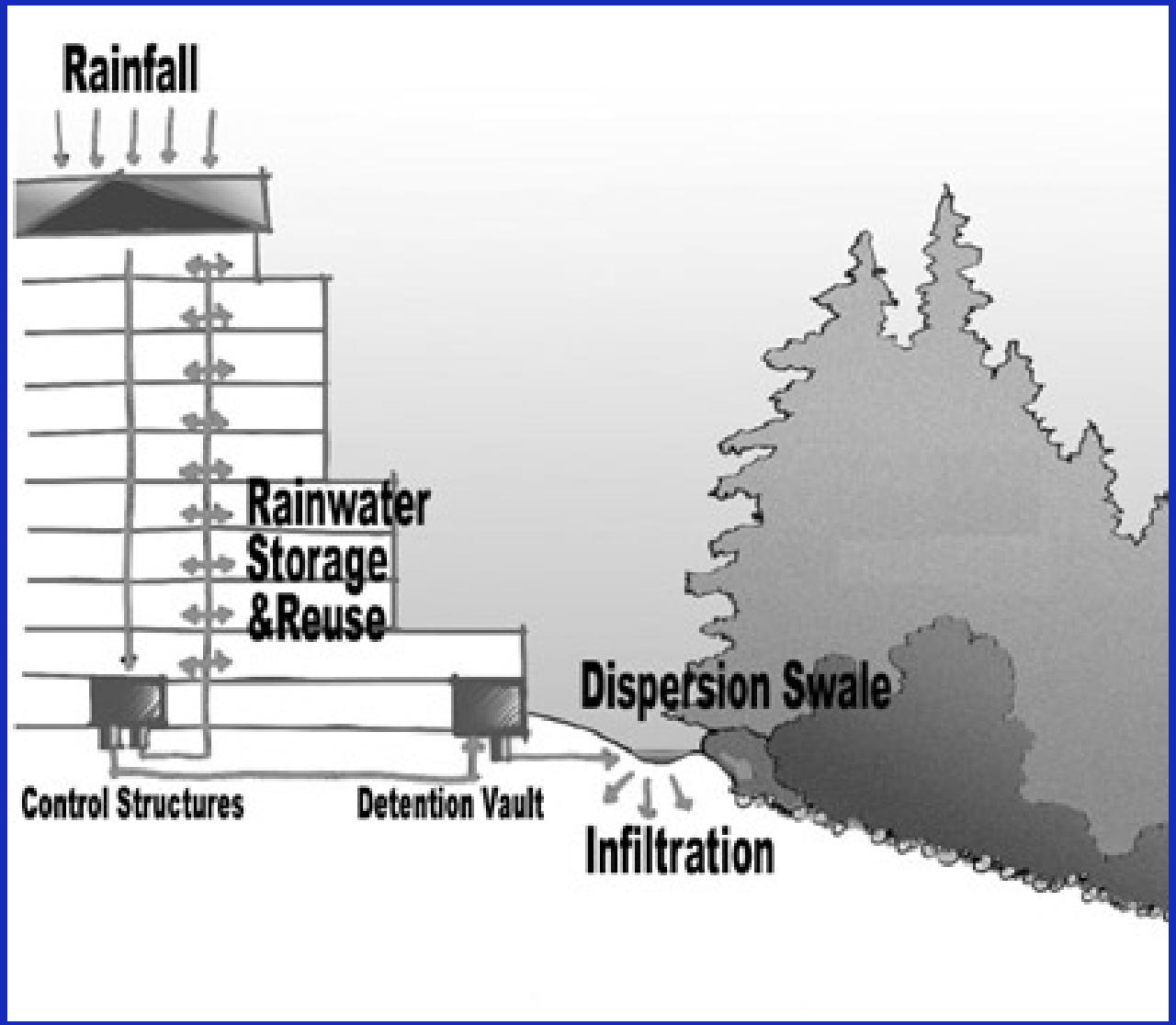
Sizing Rainfall Capture Facilities Based on Hydraulic Conductivity

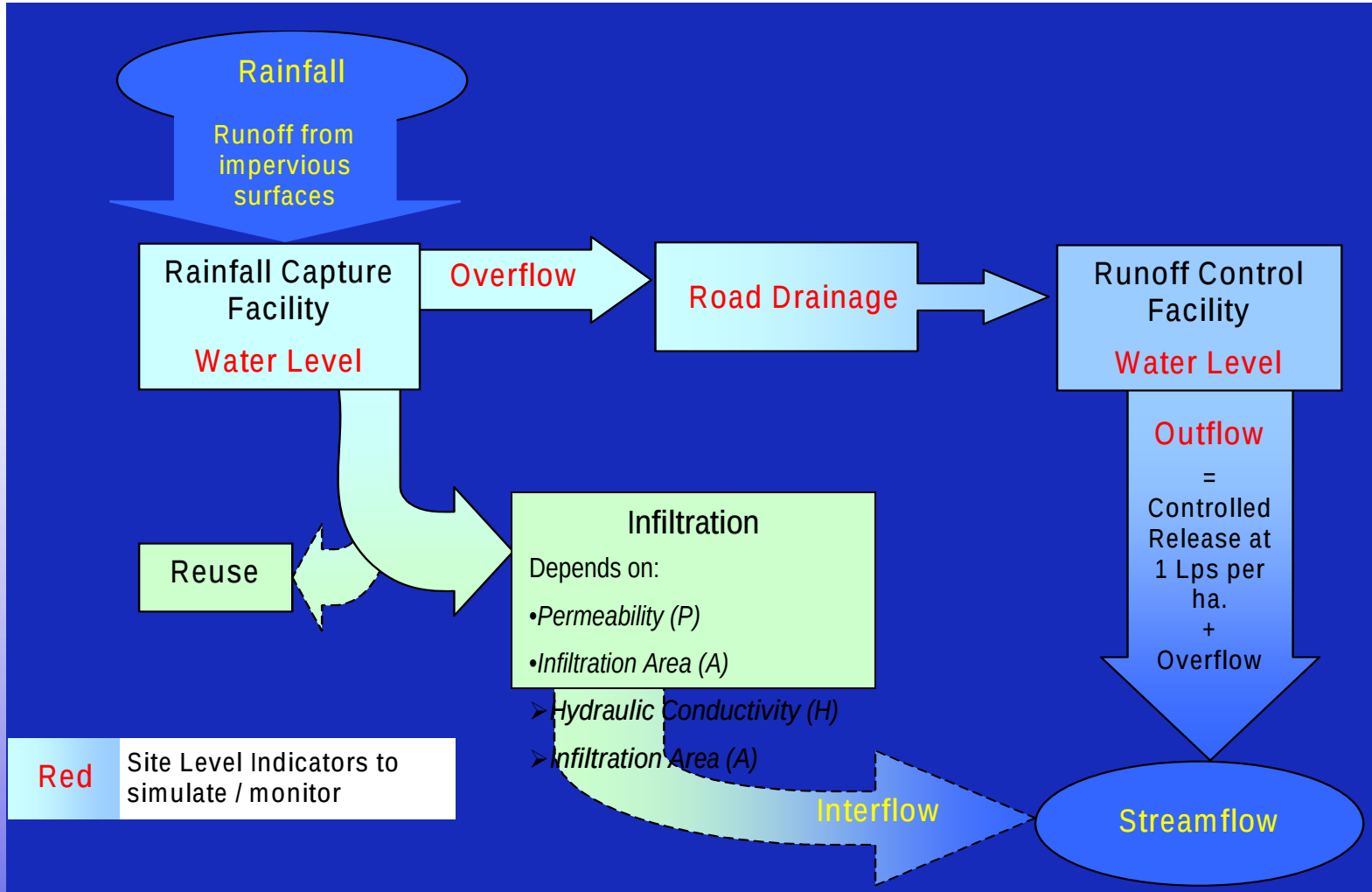


Sizing Table for Type A Infiltration Facilities
Required Footprint Area (in m²) for Rainfall Capture Facilities
(per 1000m² of impervious area served by the facility)

Depth of Rainfall Capture Facility[1]	Hydraulic Conductivity of On-Site Soils[2] (mm per hour)					
	1	5	10	25	50	> 100
0.25 m	575	175	125	75	50	30
0.5 m	475	140	90	55	40	25
1 m	375	120	70	40	30	20
1.5 m	335	110	65	35	25	15
2 m	305	100	60	30	20	15

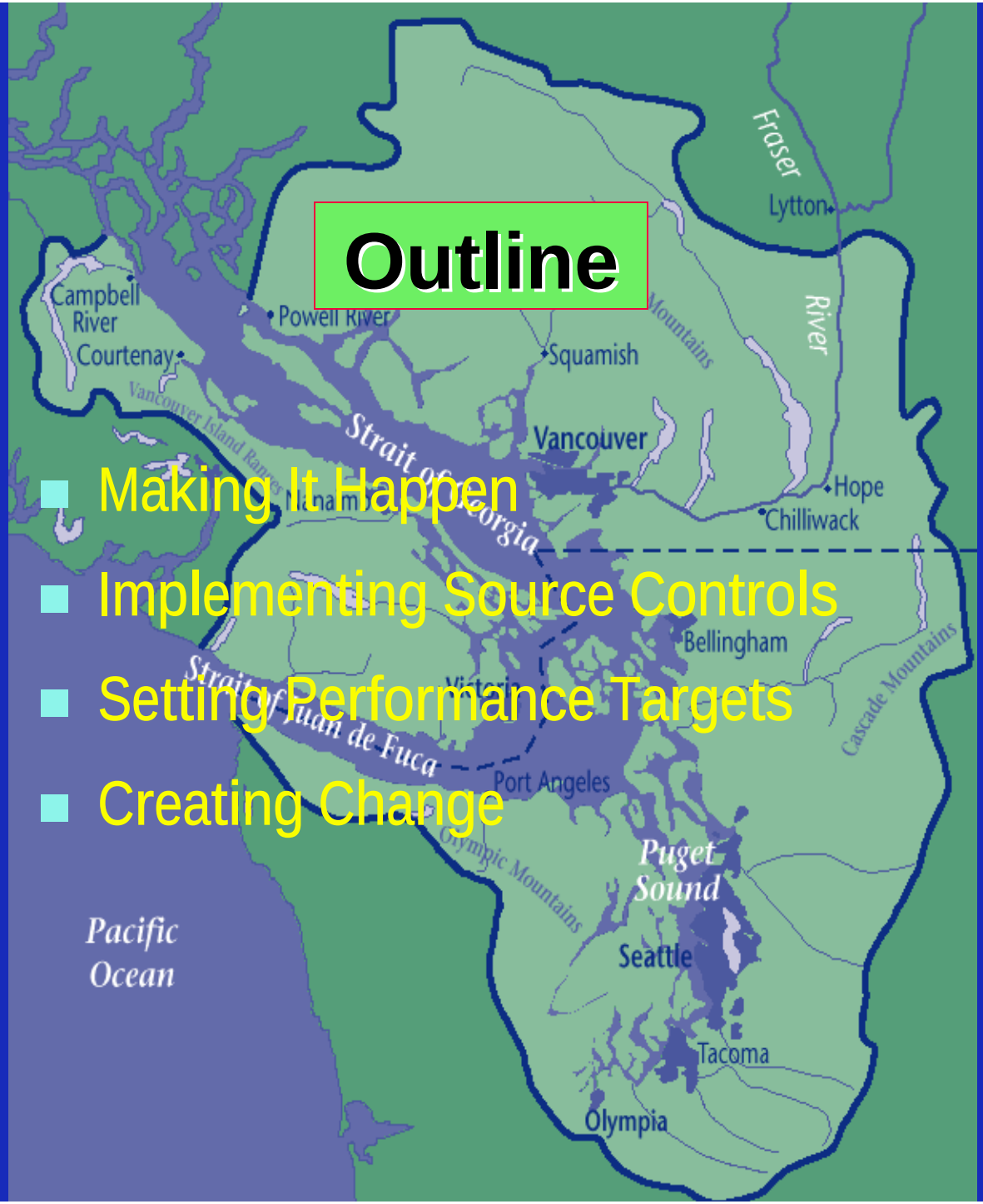
Rainwater Reuse





Indicator	Rainfall Capture Overflow	Runoff Control Overflow	Streamflow
Performance Targets	➢ Total overflow volume should be about 10% of total runoff volume. ➢ The frequency of overflows should be about 6 to 8 times per year, on average.	➢ Total overflow volume should be about 3% of the total runoff volume. ➢ The frequency of overflows should be about once per year, on average.	pre-development hydrograph should be maintained as closely as possible.

Outline



- Making It Happen
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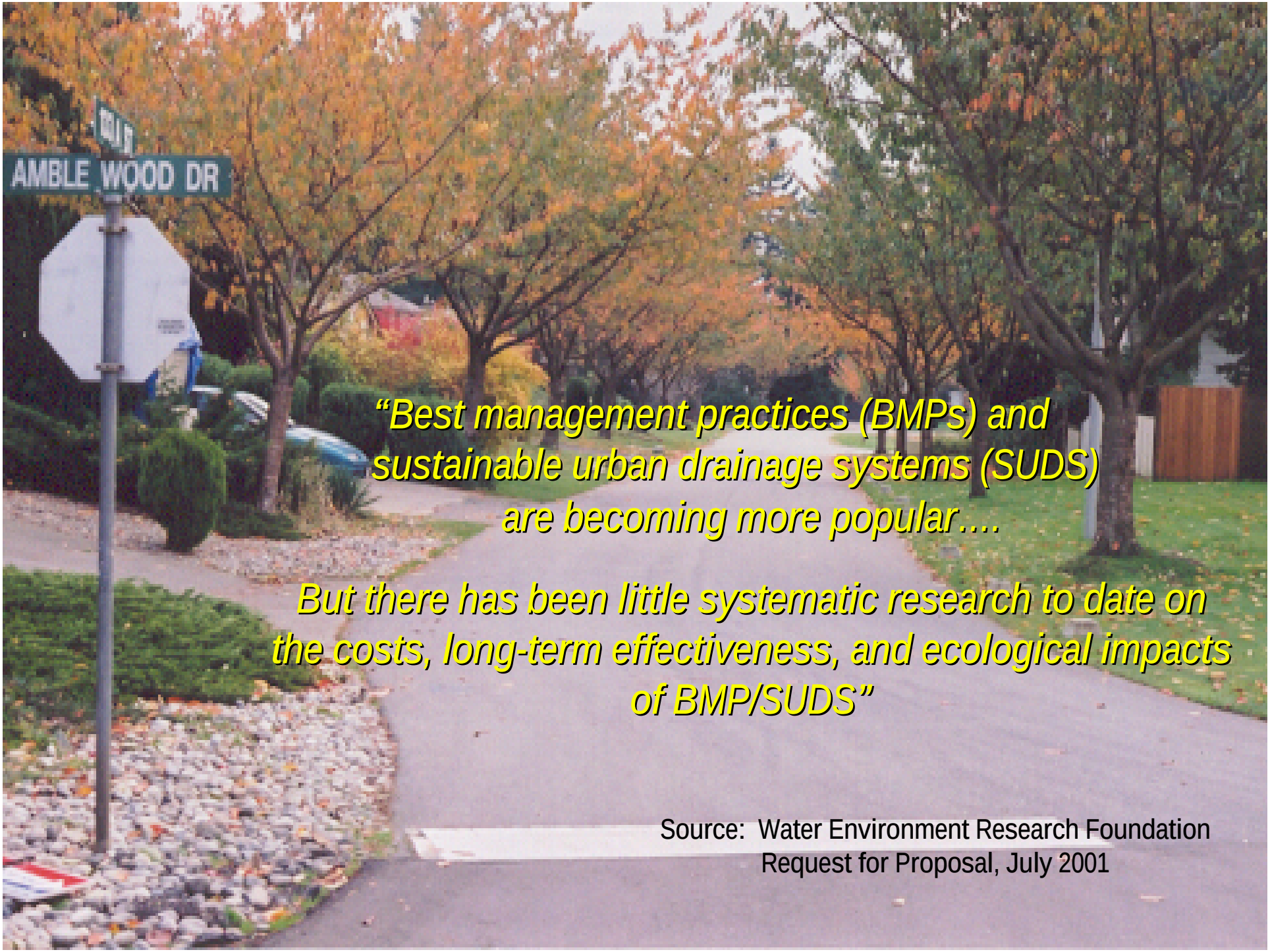
The Core Issue is Changing 'Standard Practice'

Nature's stormwater management system is the soil and vegetation.

Development prevents this function. So,the purpose of Source Controls is to:

- Minimize the impact of development
- Mitigate the impacts that do occur

Land Development and Watershed Protection can be Compatible



"Best management practices (BMPs) and sustainable urban drainage systems (SUDS) are becoming more popular….

But there has been little systematic research to date on the costs, long-term effectiveness, and ecological impacts of BMP/SUDS"

Source: Water Environment Research Foundation Request for Proposal, July 2001

Our *Expert Panel* comprises individuals who are pioneering source-control applications and/or research

- John Argue
- Peter Coombes
- Dan Medina
- Charlie Miller
- Patrick Condon
- Bill Derry
- David Reid

- Infiltration Technology
- Stormwater Re-Use
- Low Impact Development
- Green Roof Technology
- Urban Site Design
- Best Management Practices
- Landscape Architecture

Replica Miner's Cottage
in Retirement Village

Rainwater Tank

Sampling the Rainwater

"Source control technologies are relatively mature. What is lacking is knowledge on how to implement source control technologies to the best advantage of the community"

Peter Coombes
University of Newcastle, Australia

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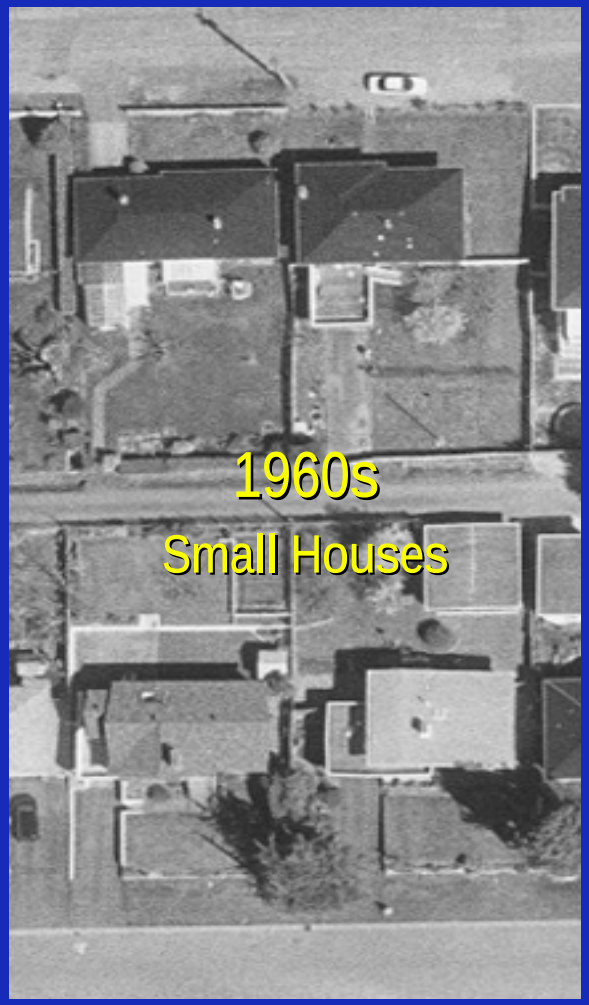
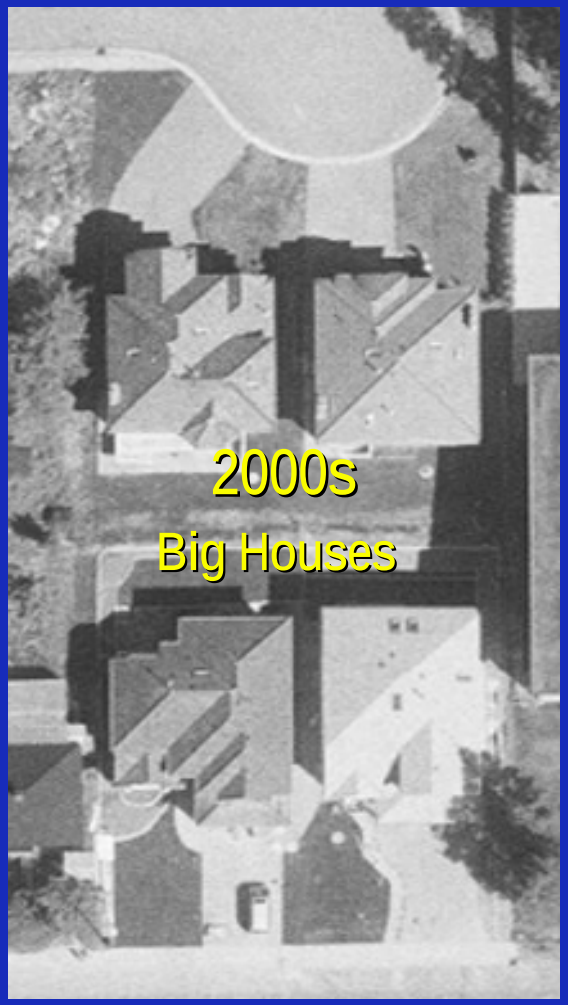
Theme #1

Stormwater Source Control:
How much space is needed?





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Theme #2

The Street System and the Stream System are One System!

Local streets are the branch tips in the tree of the watershed.

Treat them as one!

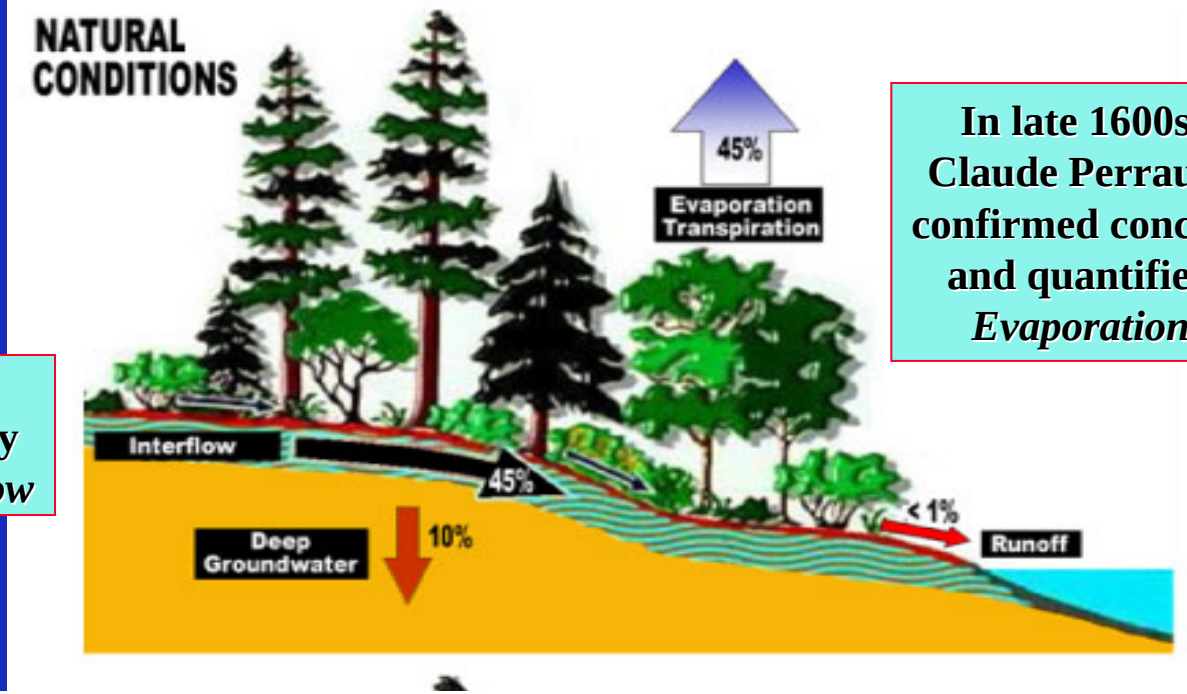
Credit: Patrick Condon

Theme #3

The Common Sense Solution is 'Water Balance Management'

Reduce Risk. Minimize Piped Systems.

Example Annual Water Balance



In late 1600s Claude Perrault confirmed concept and quantified *Evaporation*

In 1580 Bernard Palissy defined *Interflow*

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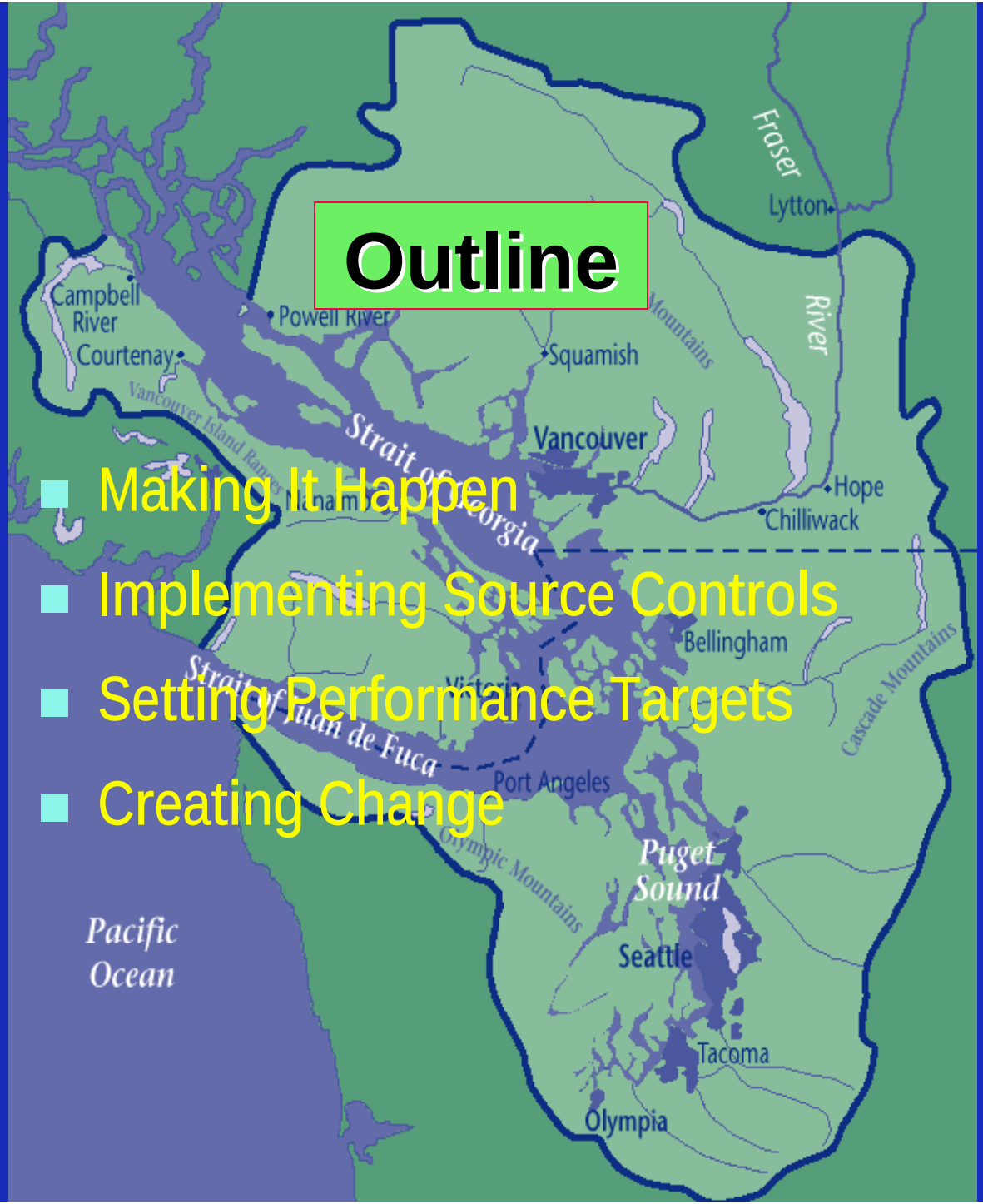
Outline



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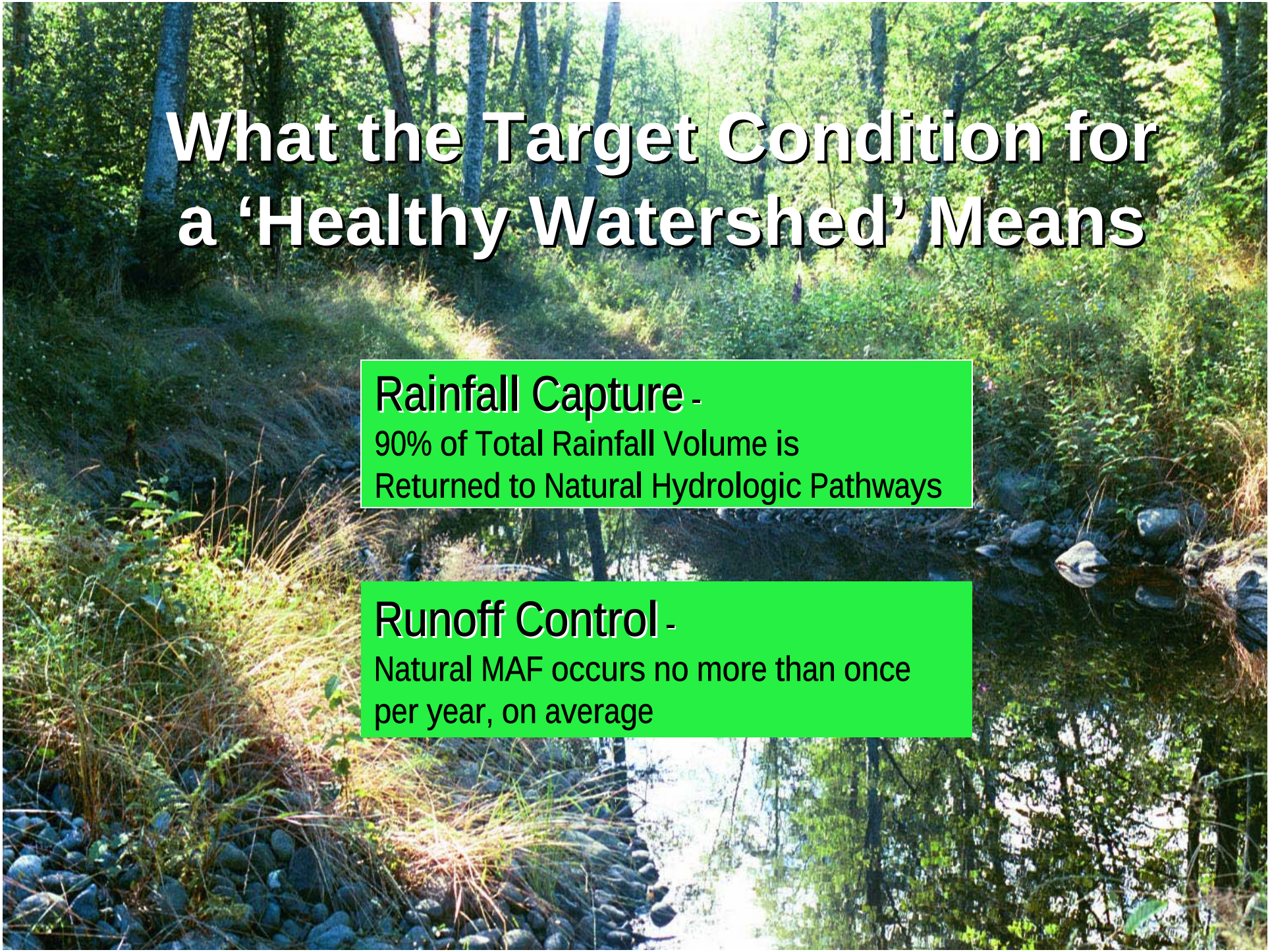
‘Performance Target’

is an environmental management concept for measuring progress in reaching a quantifiable goal

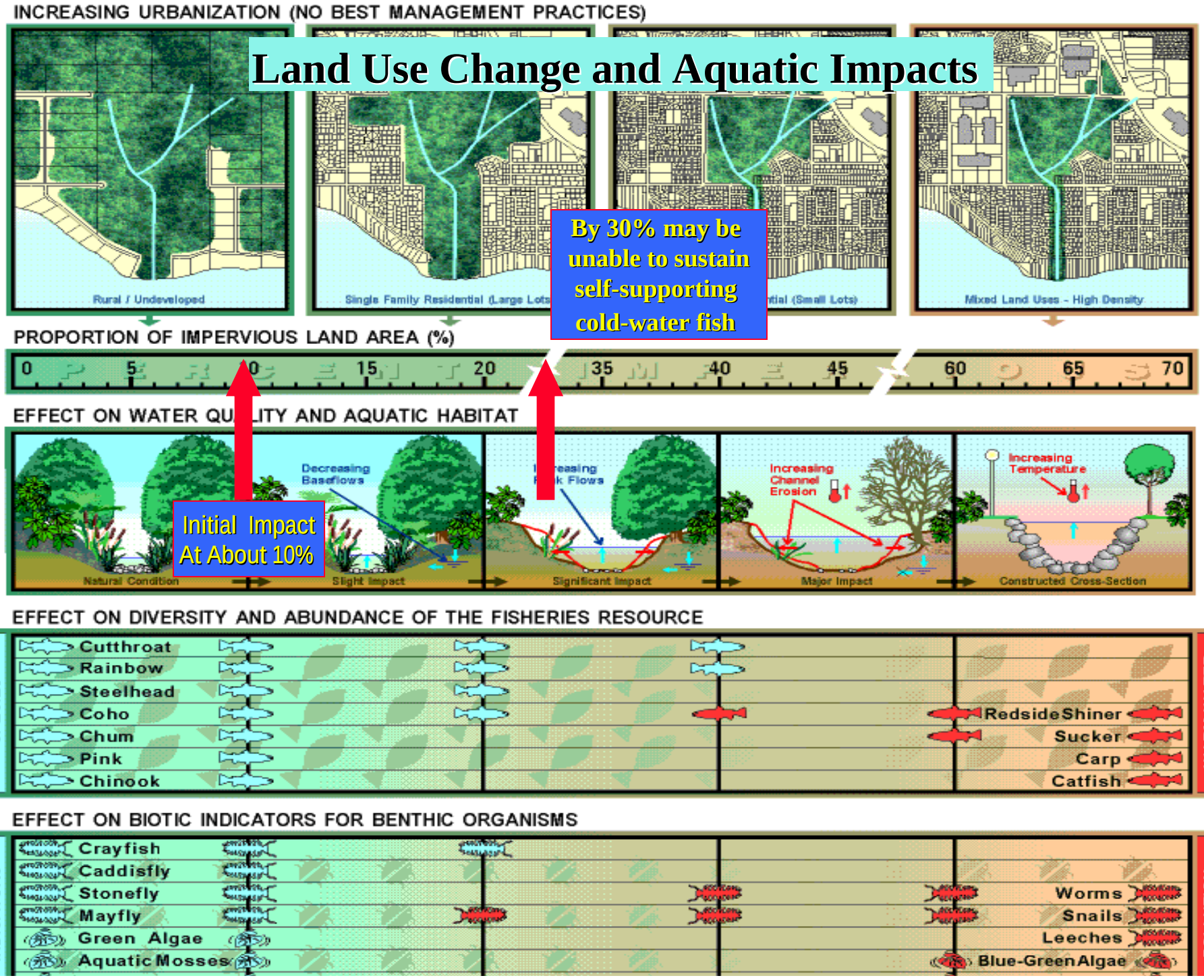


What the Target Condition for a 'Healthy Watershed' Means

Rainfall Capture -
90% of Total Rainfall Volume is Returned to Natural Hydrologic Pathways

Runoff Control -
Natural MAF occurs no more than once per year, on average

Land Use Change and Aquatic Impacts



The Mean Annual Flood (MAF) is the 'channel-forming event' and has a 2-year return period

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

A consequence of channel instability is habitat degradation

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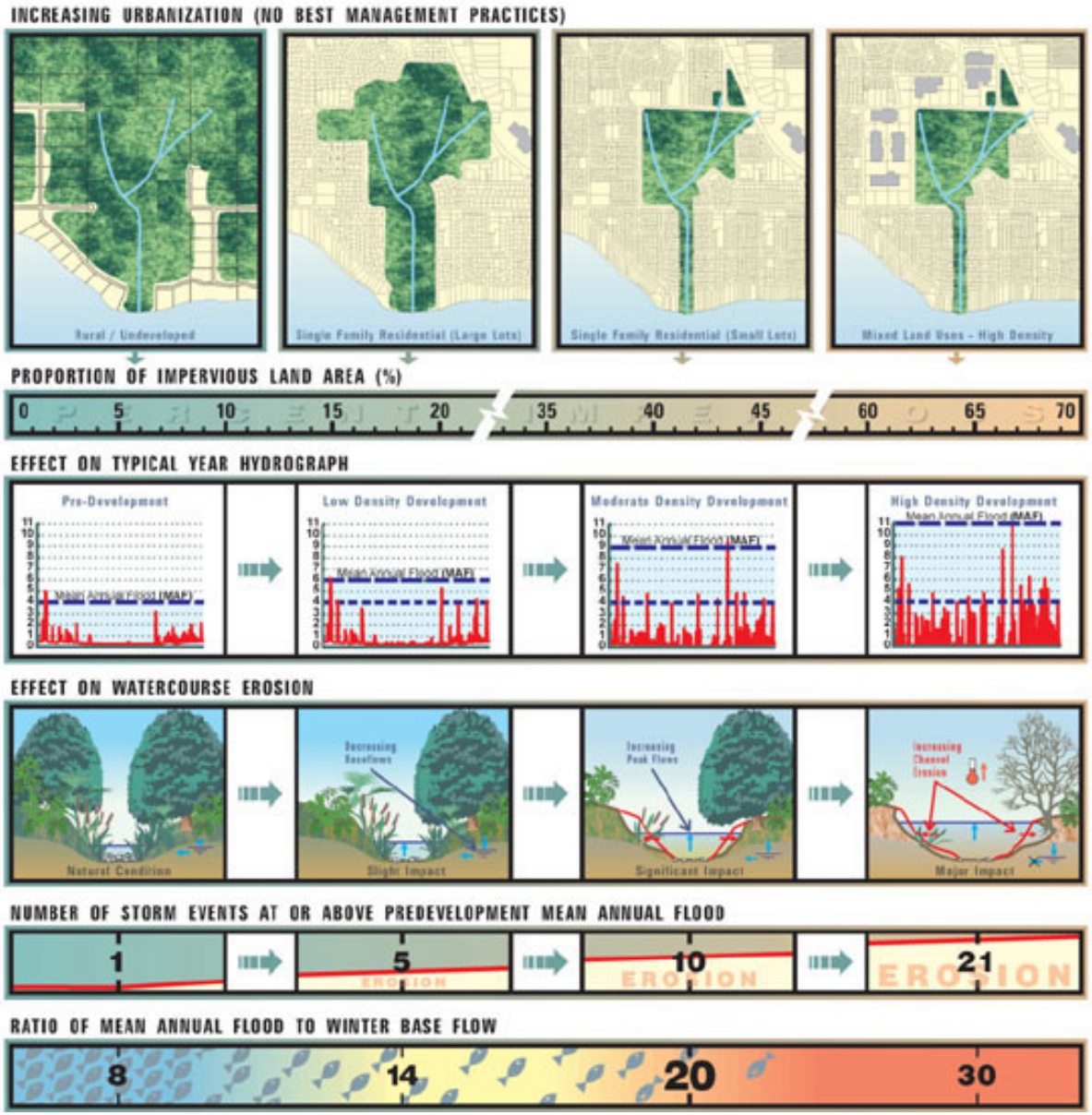
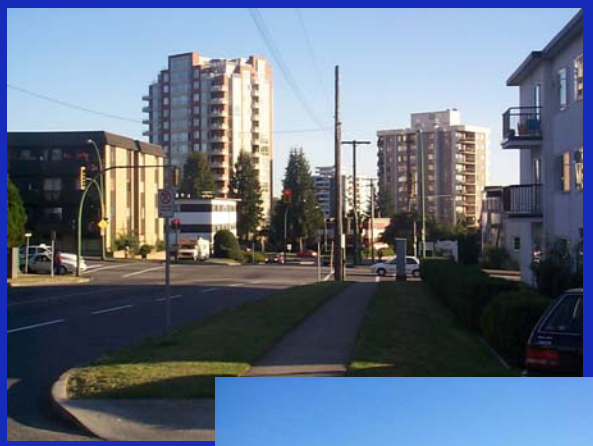
IMPACT OF CHANGES IN HYDROLOGY ON WATERCOURSE EROSION AND BASE FLOW RELATIONSHIPS

(WITHOUT BEST MANAGEMENT PRACTICES)



The *Performance Target* is the same for all watersheds,

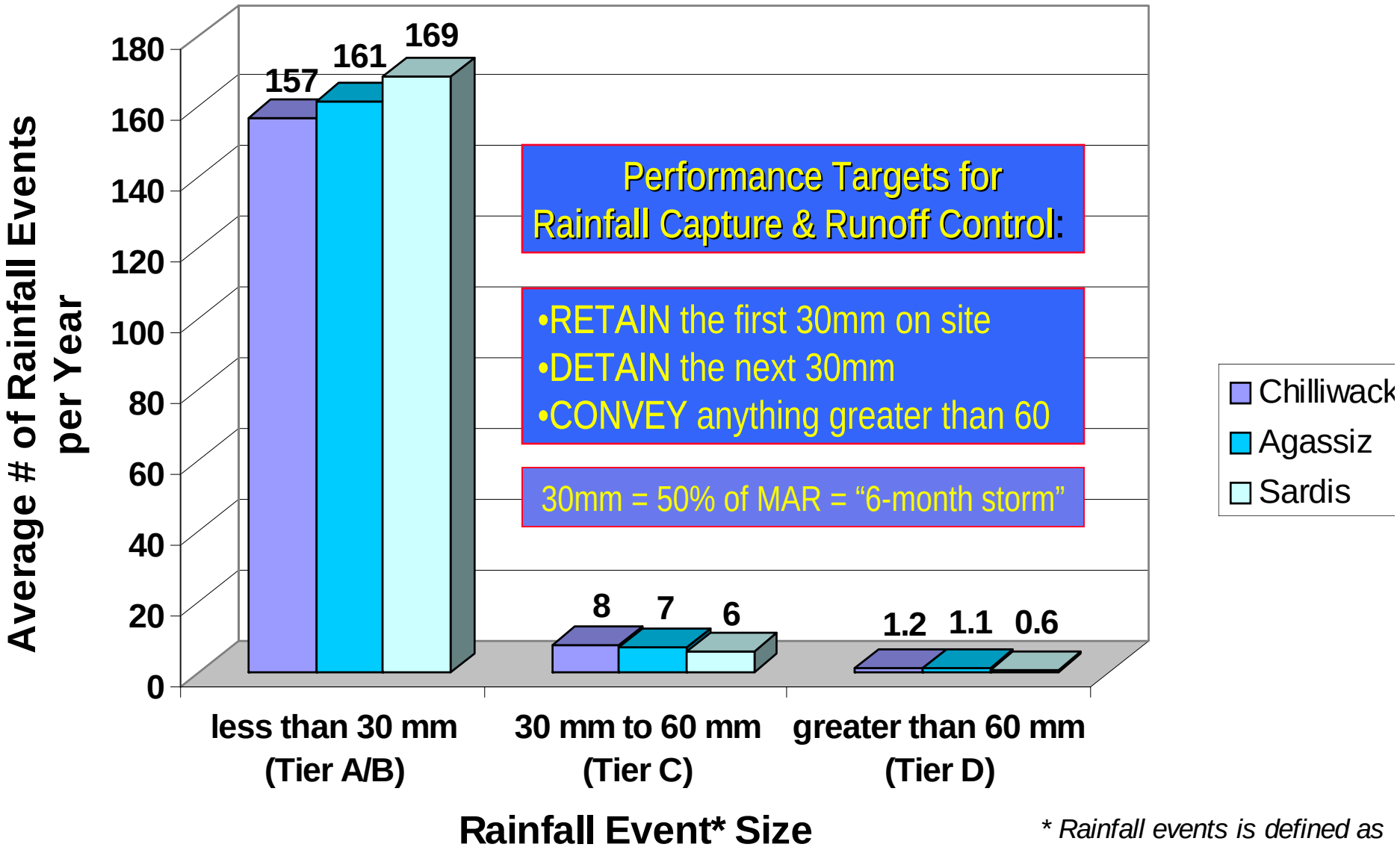
but getting there requires commitment and political will



The distinction between watersheds is the starting condition for protection or restoration, with the critical variable being the time-line for housing and building replacement

Distribution of Number of Annual Rainfall Events

Chilliwack Region



** Rainfall events is defined as total daily rainfall depth (24 hrs*

The *Rainfall Capture Criterion* in the Georgia Basin ranges from...

the first 20mm
on the East Coast of Vancouver Island...

to the first 30mm
at Chilliwack in the Eastern Fraser Valley...

to the first 35mm
at the top of Burnaby Mountain

This represents >90% of the total annual rainfall volume

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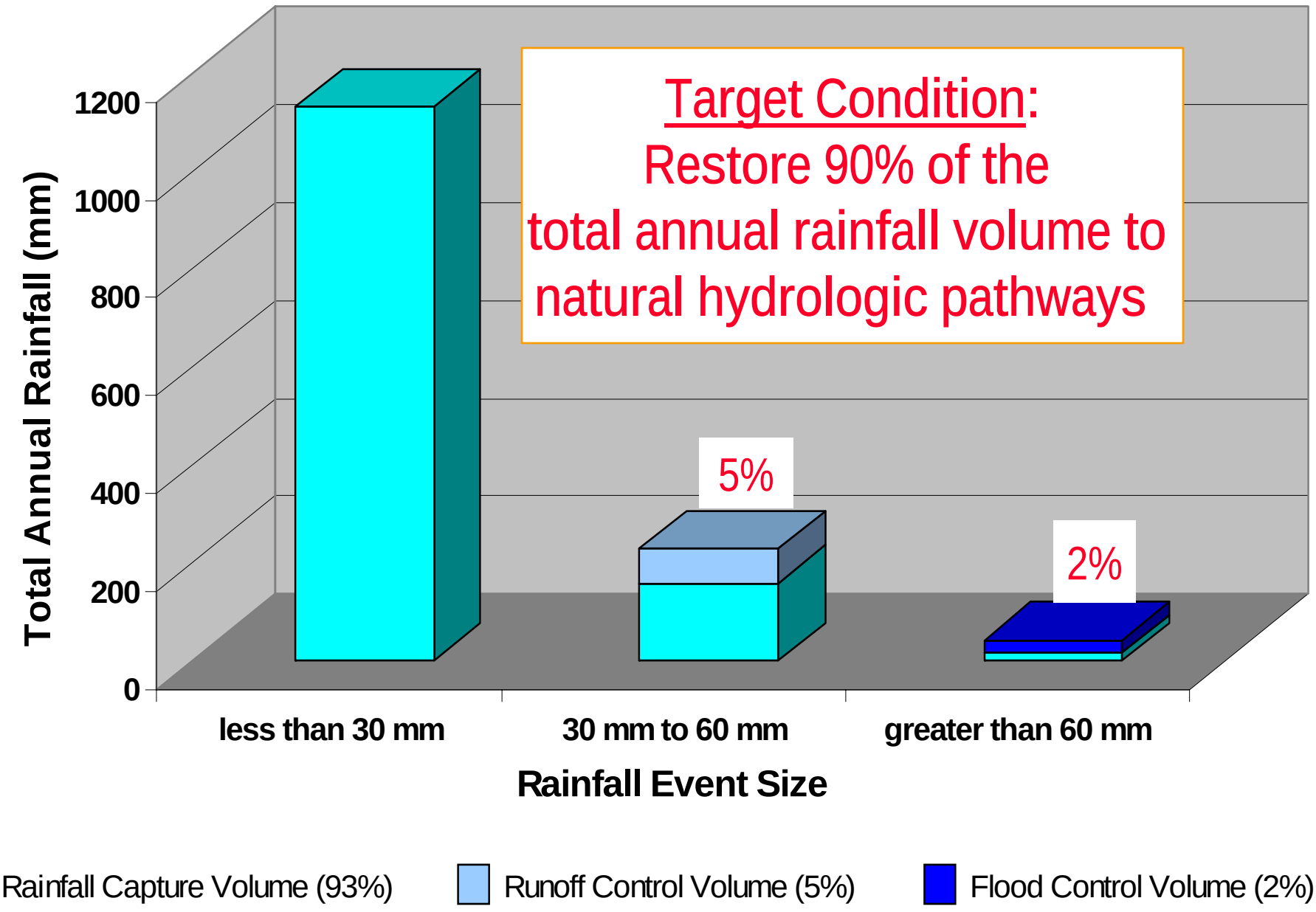
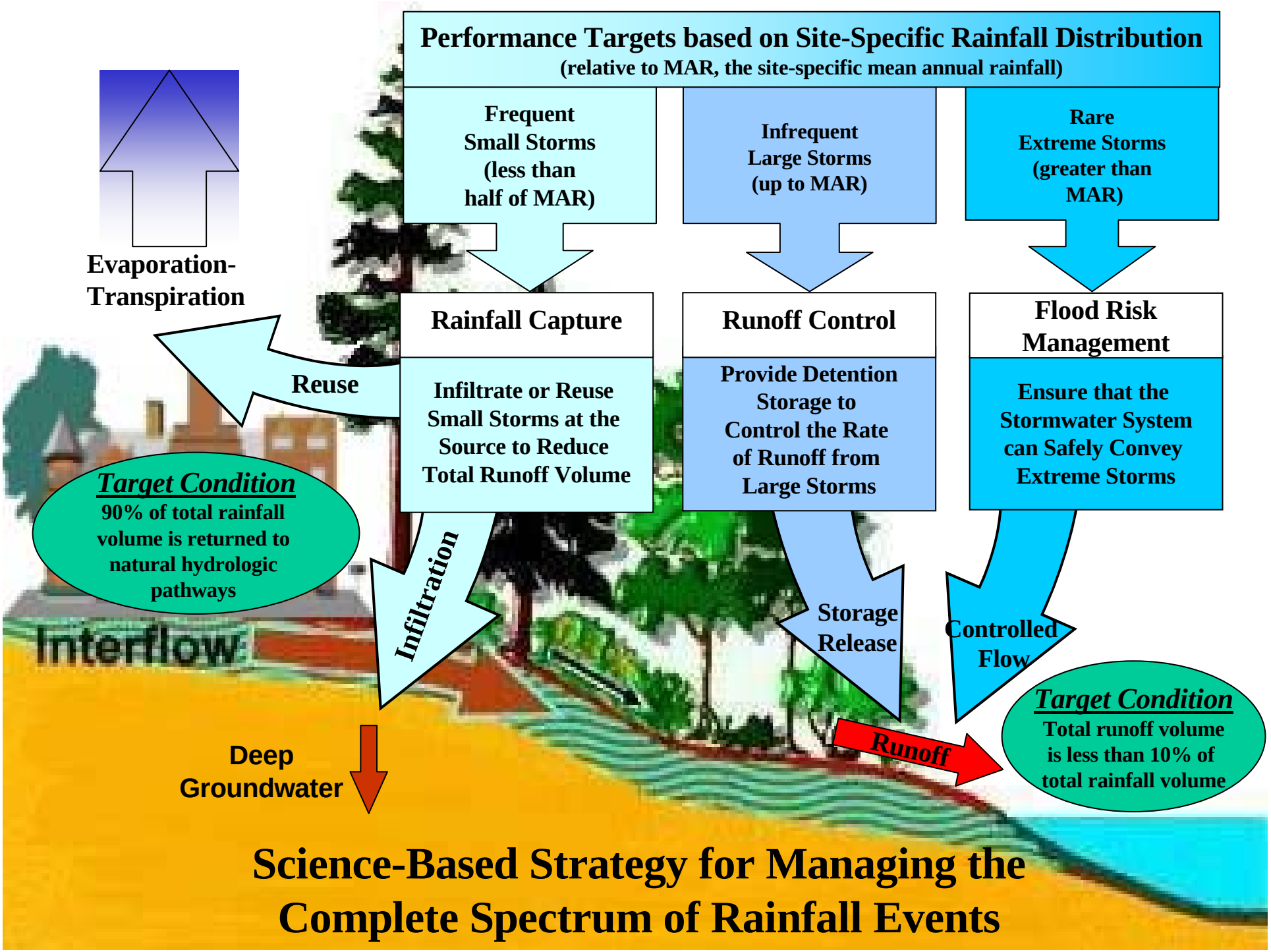
Distribution of Annual Rainfall Volume (Sardis)



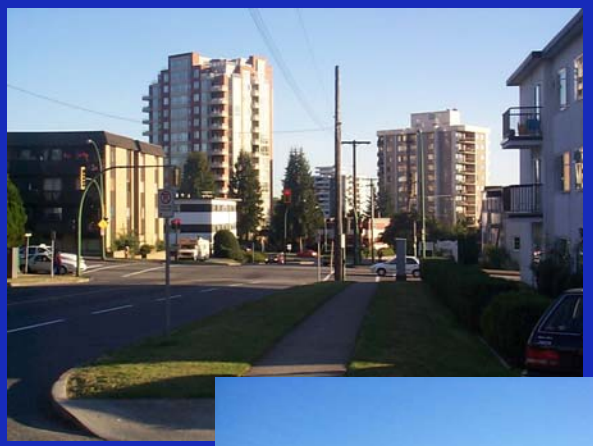

Performance Targets based on Site-Specific Rainfall Distribution
(relative to MAR, the site-specific mean annual rainfall)
Frequent Small Storms (less than half of MAR)
Infrequent Large Storms (up to MAR)
Rare Extreme Storms (greater than MAR)
Evaporation-Transpiration
Rainfall Capture
Runoff Control
Flood Risk Management
Reuse
Infiltrate or Reuse Small Storms at the Source to Reduce Total Runoff Volume
Provide Detention Storage to Control the Rate of Runoff from Large Storms
Ensure that the Stormwater System can Safely Convey Extreme Storms
Target Condition
90% of total rainfall volume is returned to natural hydrologic pathways
Infiltration
Storage Release
Controlled Flow
Interflow
Deep Groundwater
Runoff
Target Condition
Total runoff volume is less than 10% of total rainfall volume
Science-Based Strategy for Managing the Complete Spectrum of Rainfall Events

The breakthrough in thinking has resulted from recognition that...

….*volume* (rather than *flow rate*) is the governing performance measure for the stormwater component of sustainable urban design, and hence holds the key to protection of stream health.

…managing volume will also minimize peak rates for *short duration*, high intensity rainfall events

The *Performance Target* is the same for all watersheds



The distinction between watersheds is the starting condition for restoration, with the critical variable being the time-line for housing and building replacement

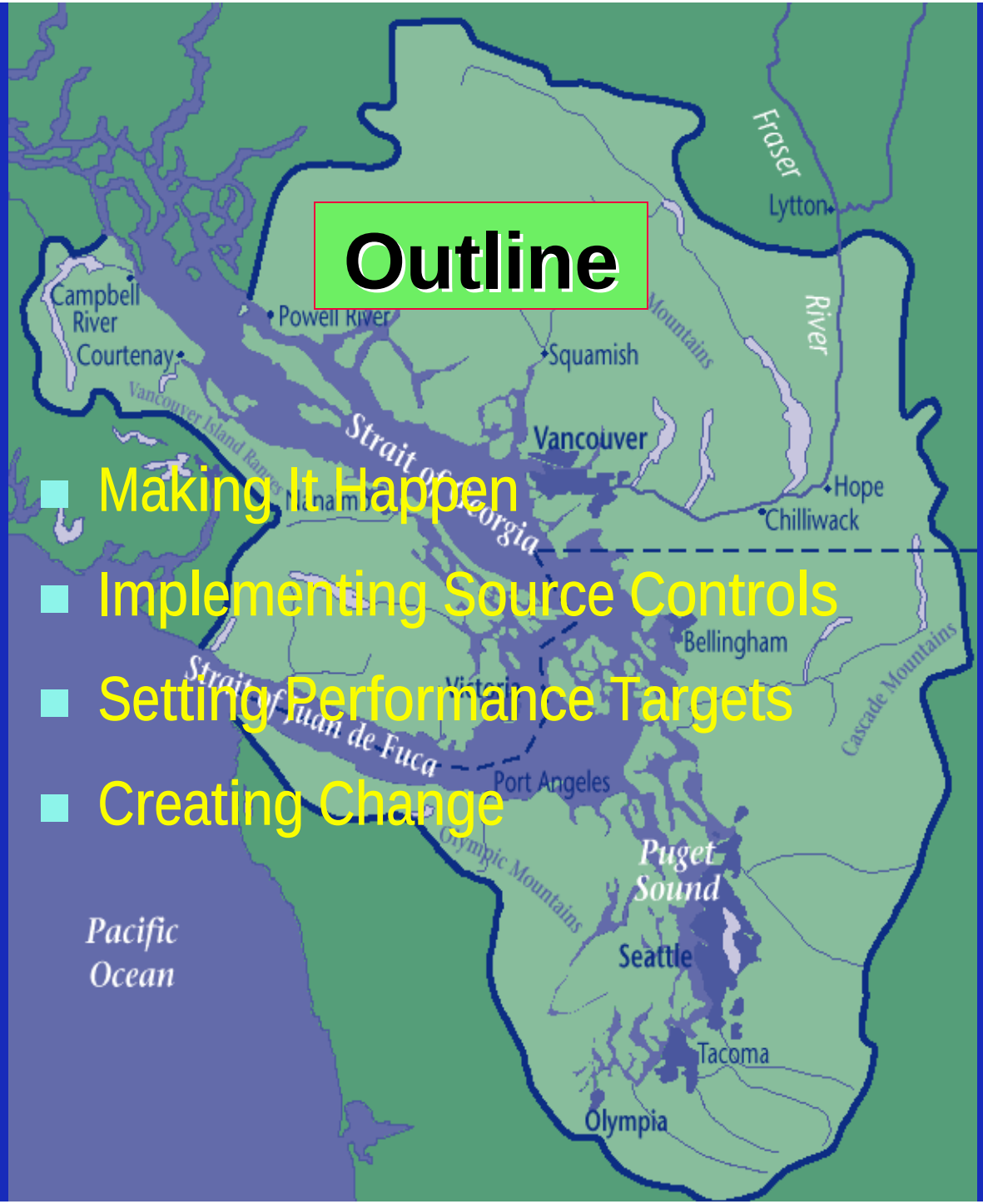
The Water Balance Methodology has built-in flexibility to mitigate 'Climate Change'

Traditional 'IDF-based thinking' no longer makes sense

The *Rainfall Capture Volume* is sized for 24-hour duration and 2-year return period

This capacity far exceeds the volumes resulting from high intensity, short duration 'cloudbursts'

Outline



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Creating Change through Public Communication

A Master Plan may identify needed changes to land use regulations in order to implement a BMP strategy.

But public support and the political system will determine the timing and phasing of those changes.

Public attitudes and the ability of the development community to adapt will set the pace of change.

Creating Change through Public Communication

- **Communicating the Need to Change:** *Fundamental change in development standards, construction and operations will only happen if there is a broad understanding as to why changes are needed, what they are, and how they can be practically accomplished*

- **Ingredients to Build Consensus:**

Public awareness will not be changed in a single

The audience for the new understanding is very broad...

Politicians who must approve new approaches,

Professionals who must change their designs and standards,

Developers who must accept the validity and marketability of the changes

Builders who must construct differently

Maintenance and operations personnel who must manage new and unfamiliar infrastructure

Three Critical Success Factors must be in alignment to Move from Planning to Action

- #1 - Political agreement on the need for action
- #2 - A champion within local government to provide energy and organizational drive to stimulate 'willingness to change'
- #3 - Trust between individuals, and between levels of government

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Guiding Principle #4 - **P**lan at Three Scales - Watershed, Neighbourhood and Site

Over-arching *Brunette Basin Plan*

- **At the watershed level** - establish a shared vision, stormwater objectives and priorities
- **At the neighbourhood level** - integrate objectives into community and neighbourhood planning
- **At the site level** - apply site design practices that reduce the volume and rate of runoff, and improve water quality.