

Lower Hunter Valley & Central Coast Environmental Management Strategy

Water Sensitive Urban Development On Single Lots

Applying the “Soft Options” for Ecosystem-Based Stormwater Management: *Canadian Case Studies*



North Shore Mountains

Stanley Park

Brunette Watershed

City of Surrey

United States

Lower Mainland region
of British Columbia

Relevant Information for Burnaby Mountain & East Clayton

- **Start of Construction:** June 2001?
- **Time-frame to Complete:** >25 years
- **Design Populations:**
 - 10,000 for Burnaby Mountain (multi-family residential)
 - 13,000 for East Clayton (single family residential)
- **Planning Framework:**
 - Burnaby Mountain: *Sustainable Urban Mgmt System (SUMS)*
 - East Clayton: *Condon's Seven Principles for Sustainability*
- **Dominant Issues:** Stormwater (#1) & Transportation (#2)

Responsible jurisdictions accept the need for a change in approach:

- from one that only *Deals with the Consequences*
(This is the traditional end-of-pipe engineering approach that is reactive in solving problems)
- to one that also *Eliminate the Causes* -
(This involves an integrated approach to source-control that prevents problems from occurring)

How does the “integrated approach” compare with a traditional approach?

TRADITIONAL:

- Drainage Systems
- Engineer-driven
- Bureaucratic
- City Ownership
- Narrow



INTEGRATED:

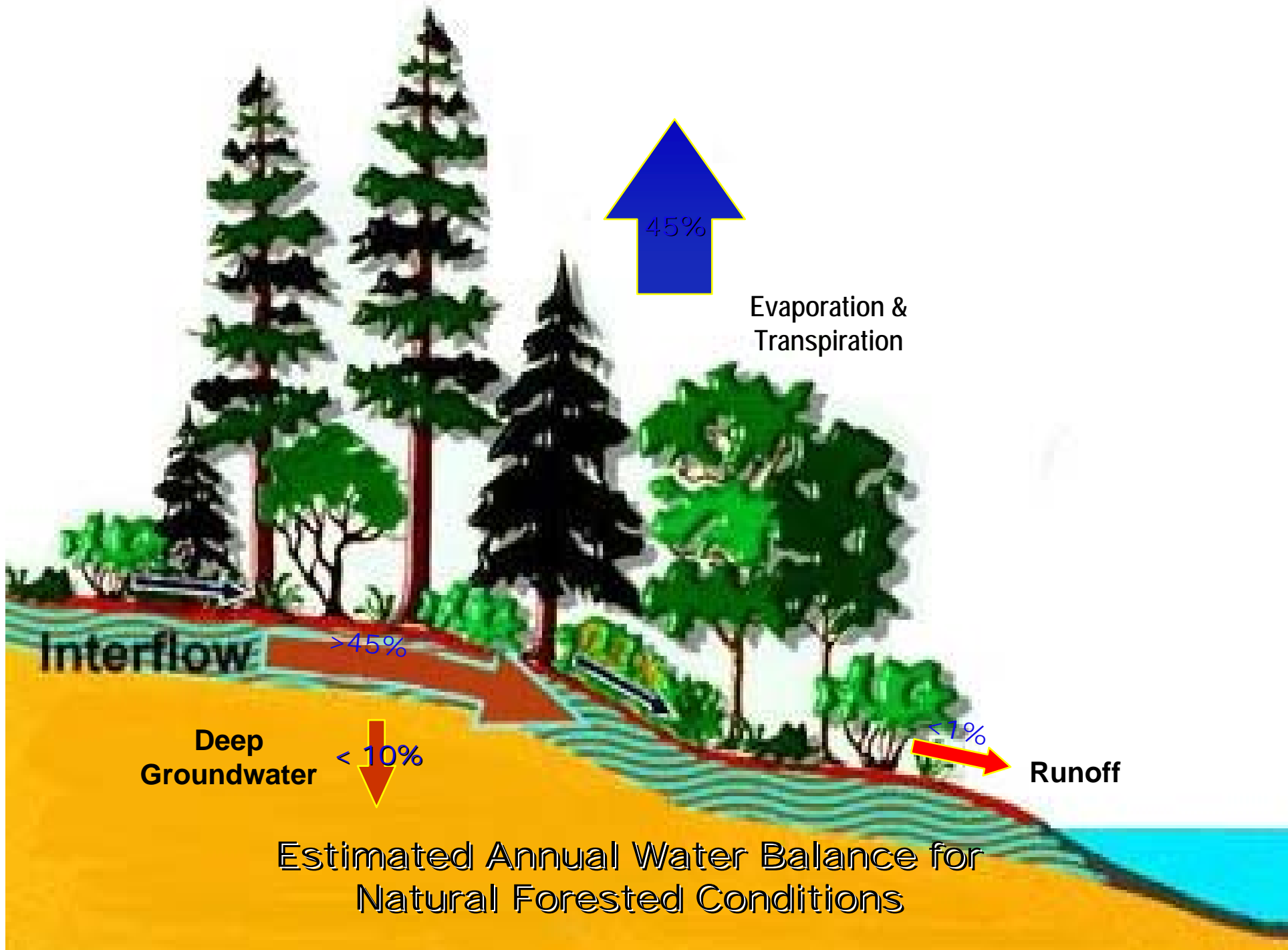
- Ecosystems
- Multi-disciplinary
- Consensus-based
- Partnerships
- Holistic

To solve a problem, we first need to understand the root cause

Development Alters the Natural Water Balance

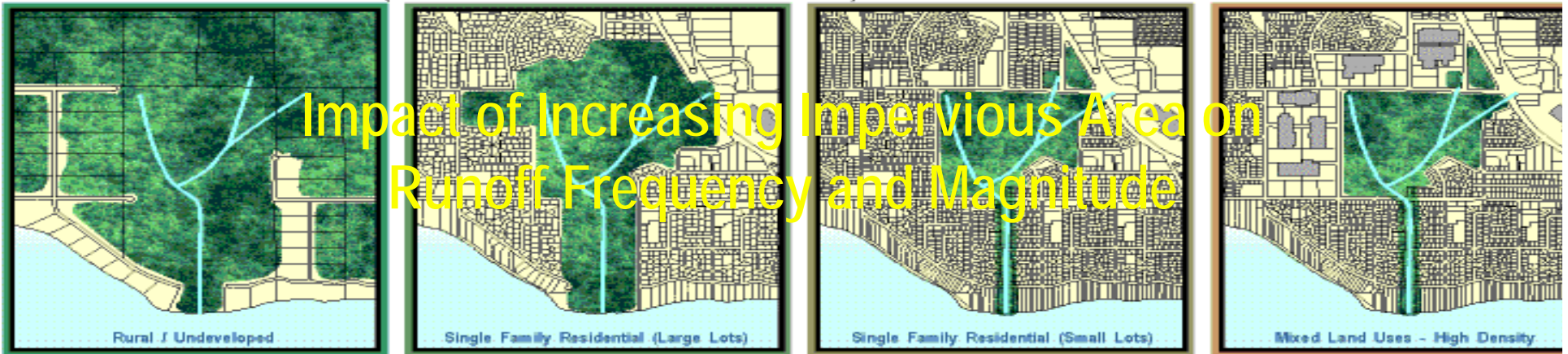
When forest cover is replaced by roads and buildings, less rainfall infiltrates into the ground, less gets taken up by vegetation, and more becomes surface runoff.

The result of water balance change is erosion and flooding



Estimated Annual Water Balance for Natural Forested Conditions

INCREASING URBANIZATION (NO BEST MANAGEMENT PRACTICES)

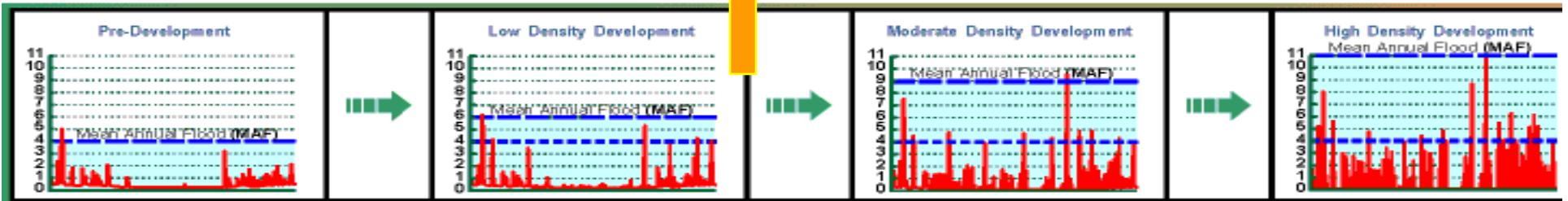


Impact of Increasing Impervious Area on Runoff Frequency and Magnitude

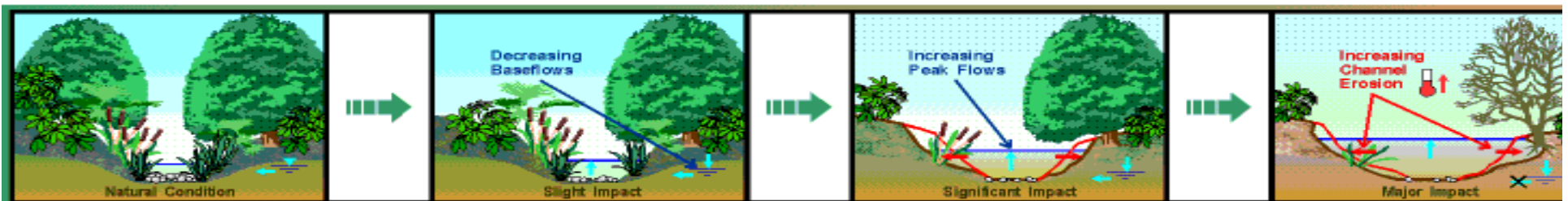
PROPORTION OF IMPERVIOUS LAND AREA (%)



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



What does this mean for an Urban Watershed?

More surface runoff



increase in total runoff *volume*



increase in peak runoff *rates*

- More and Faster from the Uplands
- Flow Concentration in the Lowlands
- Water Trapped by Highways that Act as Barriers

3 18 '97



The result is annual flooding...

3 19 '97

...and ravine erosion



Tree undercut



Culvert vulnerable to blockage

Science-Based Understanding has Changed the Way We Think in British Columbia

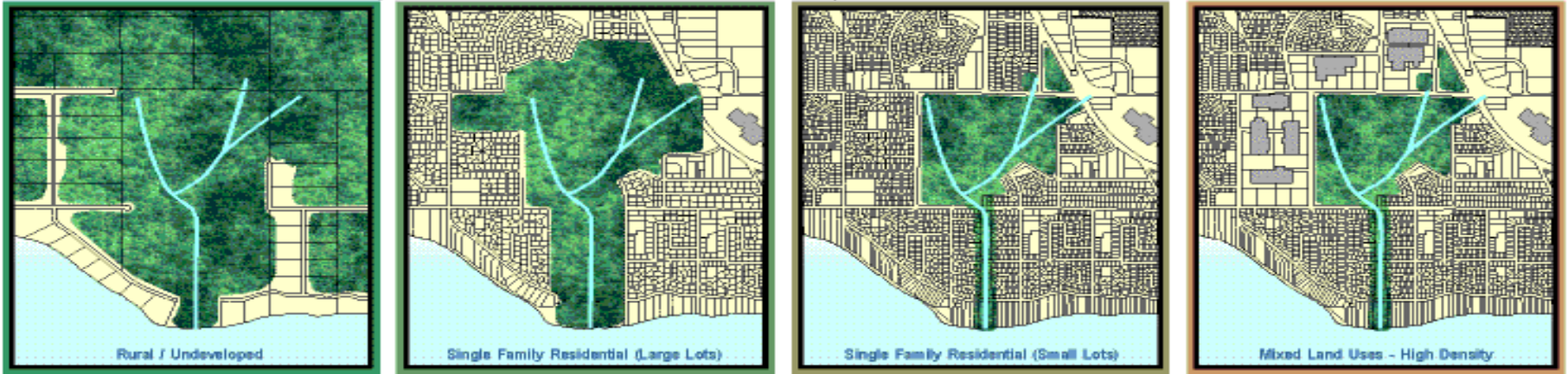
- Washington State research findings released in 1996 (Richard Horner & Chris May)
- Correlated stream health with impervious area and riparian corridor

We now know that the Environmental Health of Streams in the Suburban Environment depends on these Limiting Factors:

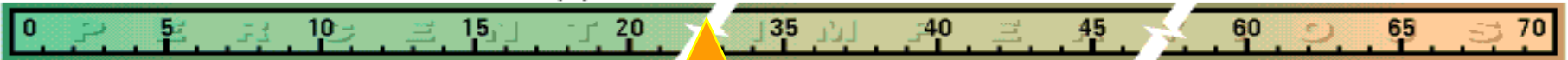
(listed in order-of-priority)

- **Changes in hydrology**
- **Disturbance to riparian corridor**
- **Degradation of aquatic habitat**
- **Deterioration of water quality**

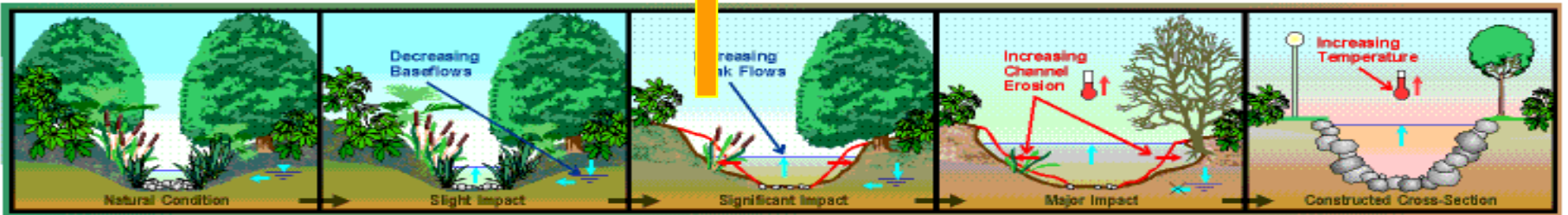
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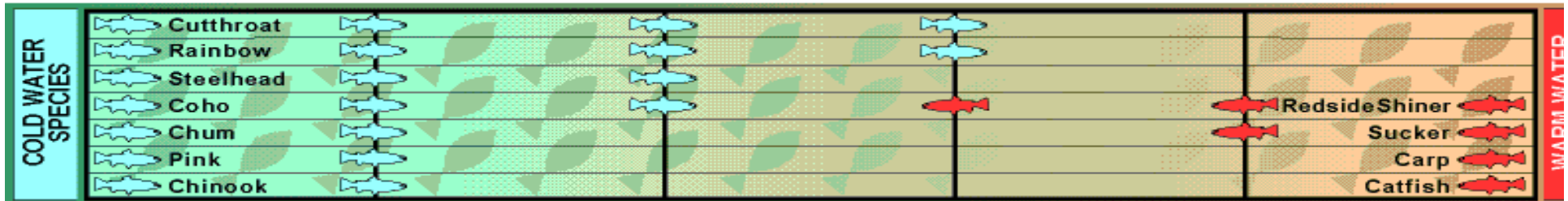
PROPORTION OF IMPERVIOUS LAND AREA (%)



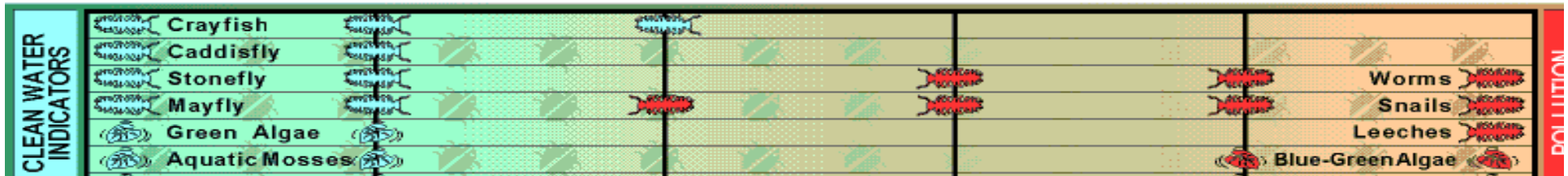
EFFECT ON WATER QUALITY AND AQUATIC HABITAT



EFFECT ON DIVERSITY AND ABUNDANCE OF THE FISHERIES RESOURCE



EFFECT ON BIOTIC INDICATORS FOR BENTHIC ORGANISMS

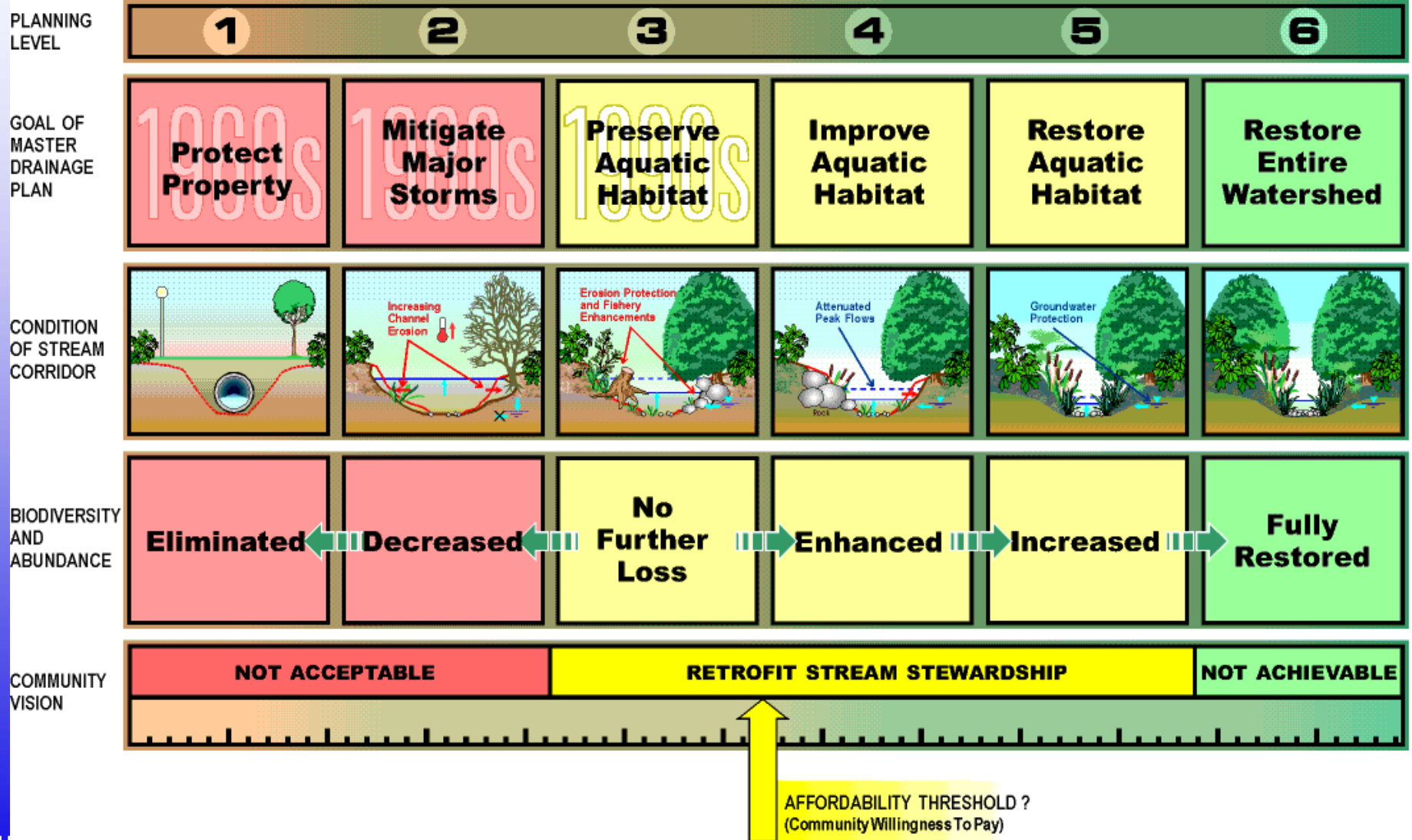


Master Planning Levels: A Framework for Decision-Making

- Translate scientific findings into a graphic decision-making tool for selection of a guiding philosophy
- Reference to impervious area thresholds
- Define strategic objectives and identify management practices to achieve those objectives through an integrated plan

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

Conceptual Framework for Selection of a Planning Level



Creating Stormwater Plans that are Really Community Plans

**Lets talk about sustainable communities and why
we don't have any:**

The Real Dirt!

by

Kim A Stephens

**in collaboration with Patrick Condon,
University of British Columbia**

What is an urban watershed Really?

A big soil
sponge leaking
clean water
into streams.
Urbanization
stops water
from getting to
the sponge.



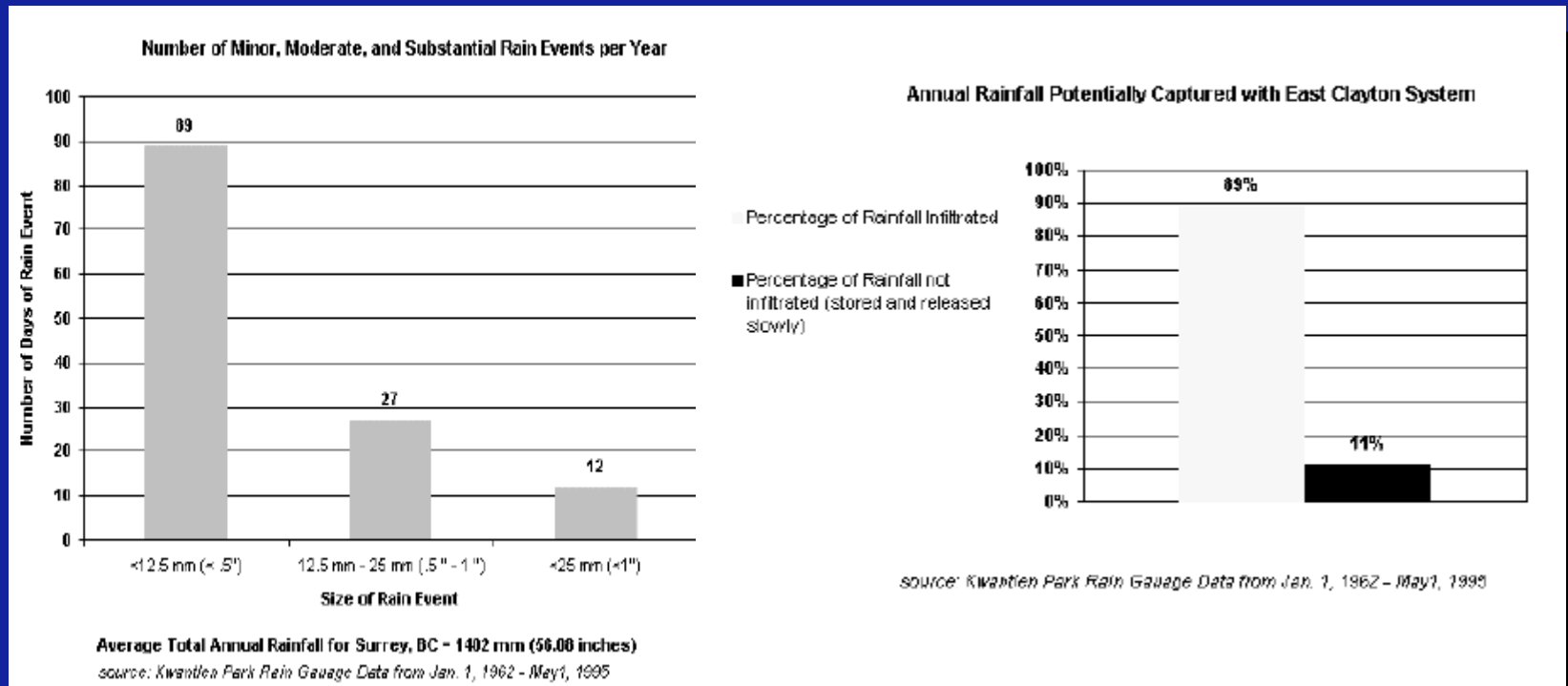
Solution?

Infiltrate, infiltrate, infiltrate

Most storms are small storms.

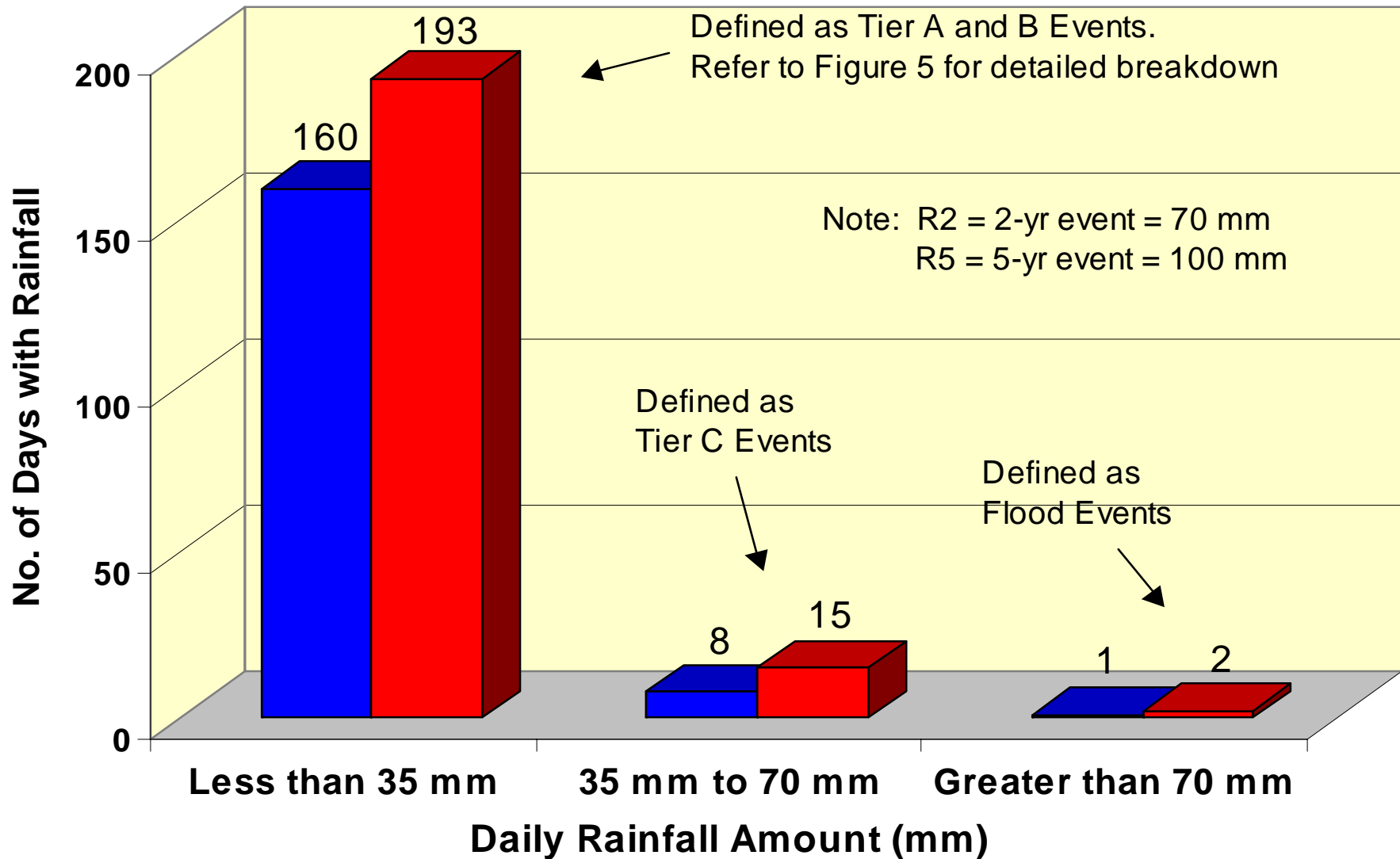
Small storms account for most of the rain.

Capture the first inch of all storms and you capture about 90% of all rain.



Burnaby Mountain Rainfall Analysis

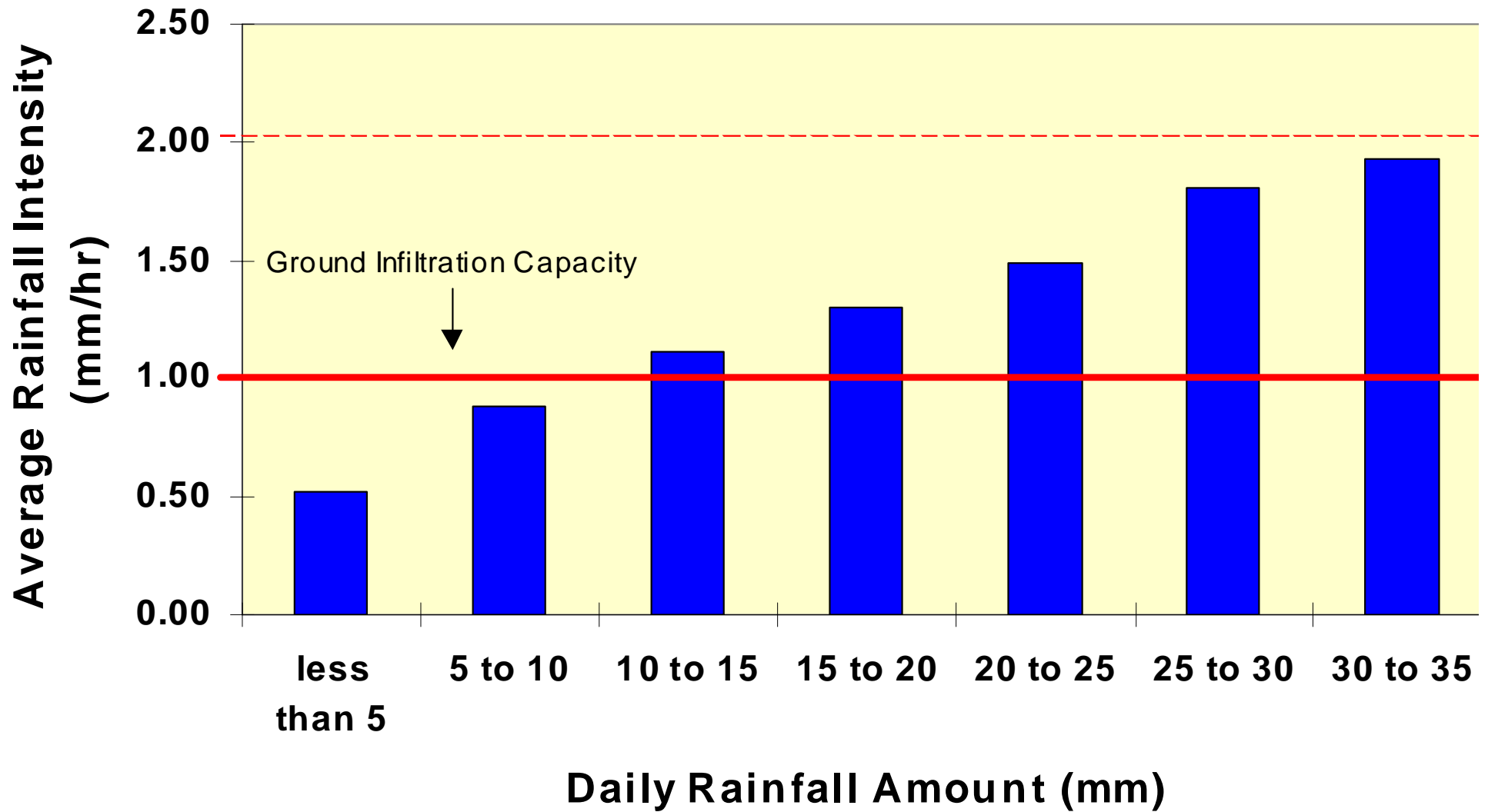
Typical Frequency Distribution for Annual Rainfall



■ Average Year ■ Wettest Year (1999)

Burnaby Mountain Rainfall Analysis

Average Intensity of Small Events



Streets and Streams. The two linked elements of the watershed system.

Local street right of ways constitute over 25 percent of the typical urban watershed!

Class A, B, and C streams with buffers would constitute about 7 percent of this sample watershed.

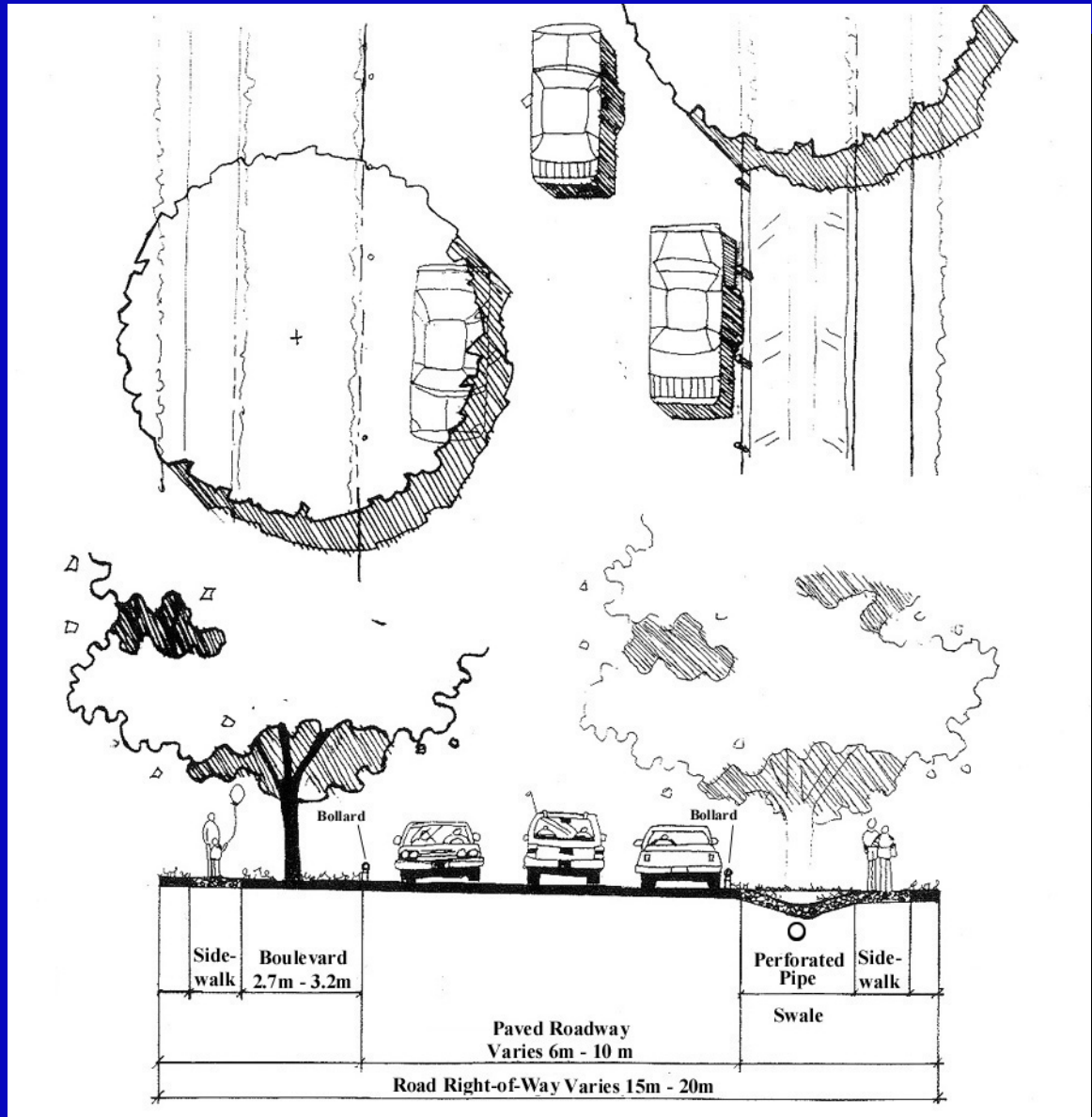


Rule #1:
The Street System and the
Stream System are One
System!

Local
streets are
the branch
tips in the
tree of the
watershed.
Treat them
as one!



Rule #2:
Design streets that infiltrate every drop naturally!



Develop “Green Road” Standards (based on maximum 50% impervious r/w)



Roadway width can vary
from 6m (for 2 travelling lanes only)
to 11m (including 2 parking lanes)

3m wide biofiltration swale
(each side or one side only)
c/w infiltration trench and pipe

Curb-less or
Curbs c/w openings

1960s Mountainside Subdivision



Swale &
Lawn Basin

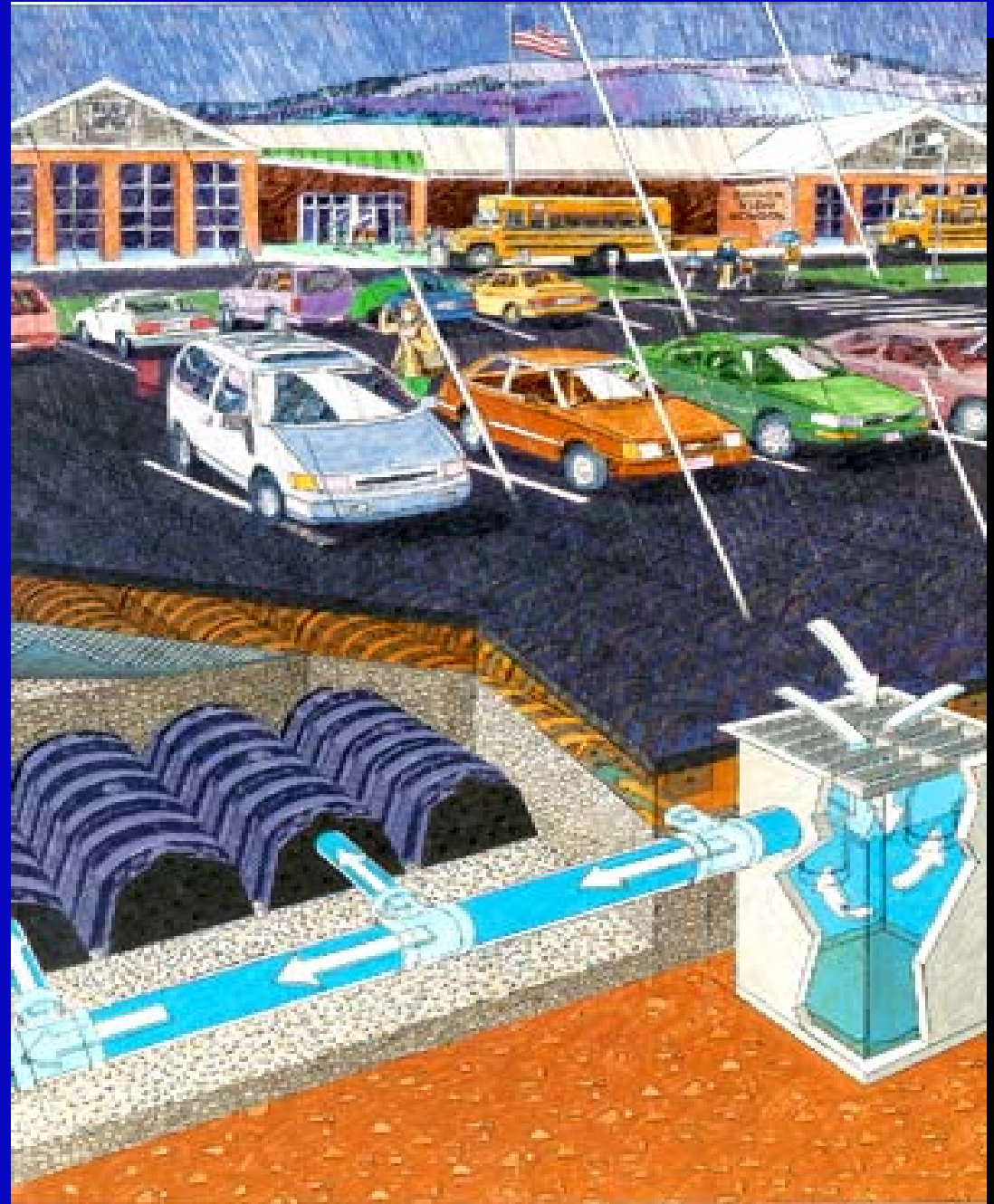
Narrow
No Curb



Tree Canopy

Rule #3:

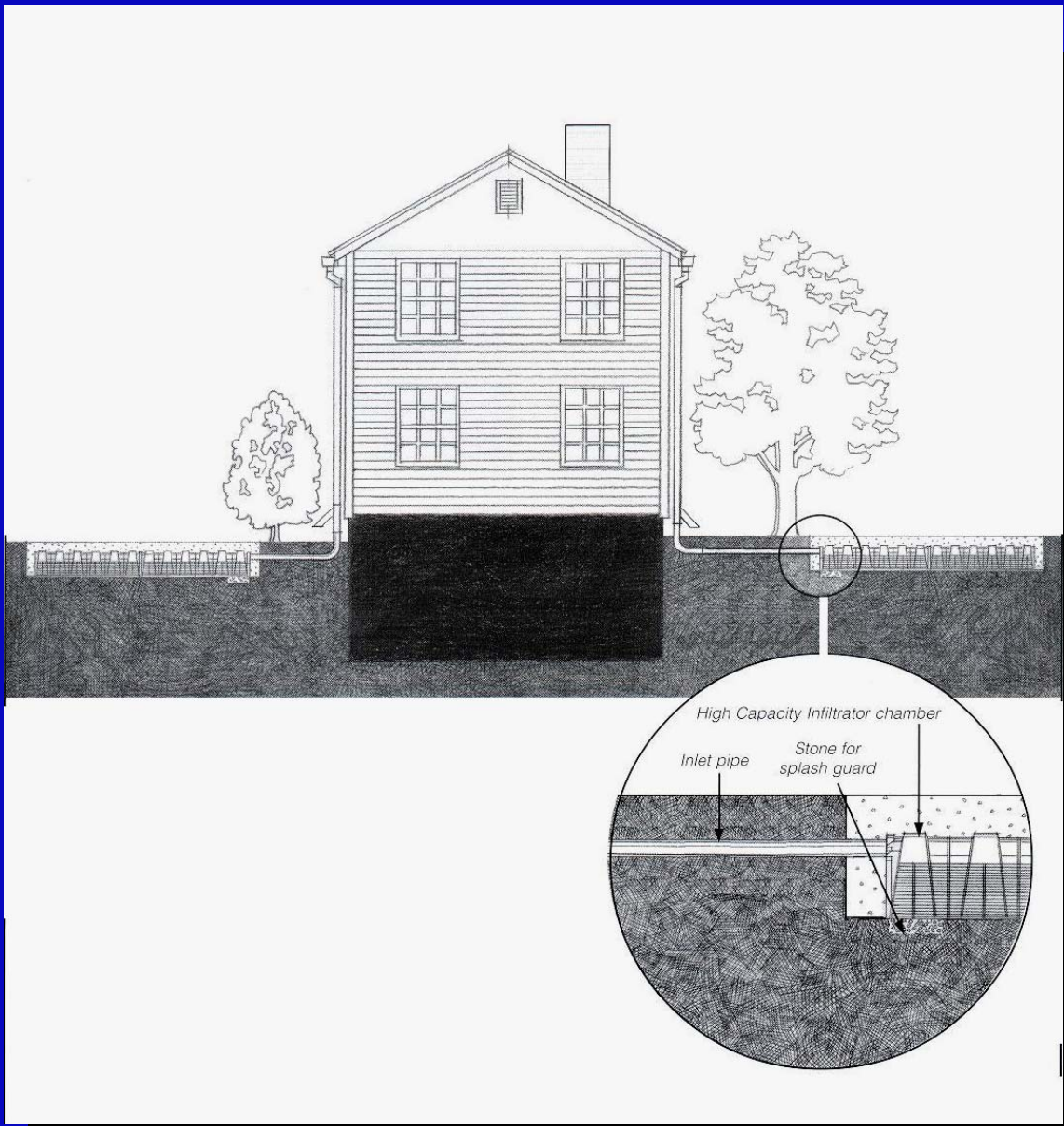
Make
parking
lots that
store and
release
water . . .
Slowly!



Rule #4:

Design
yards that
infiltrate
water

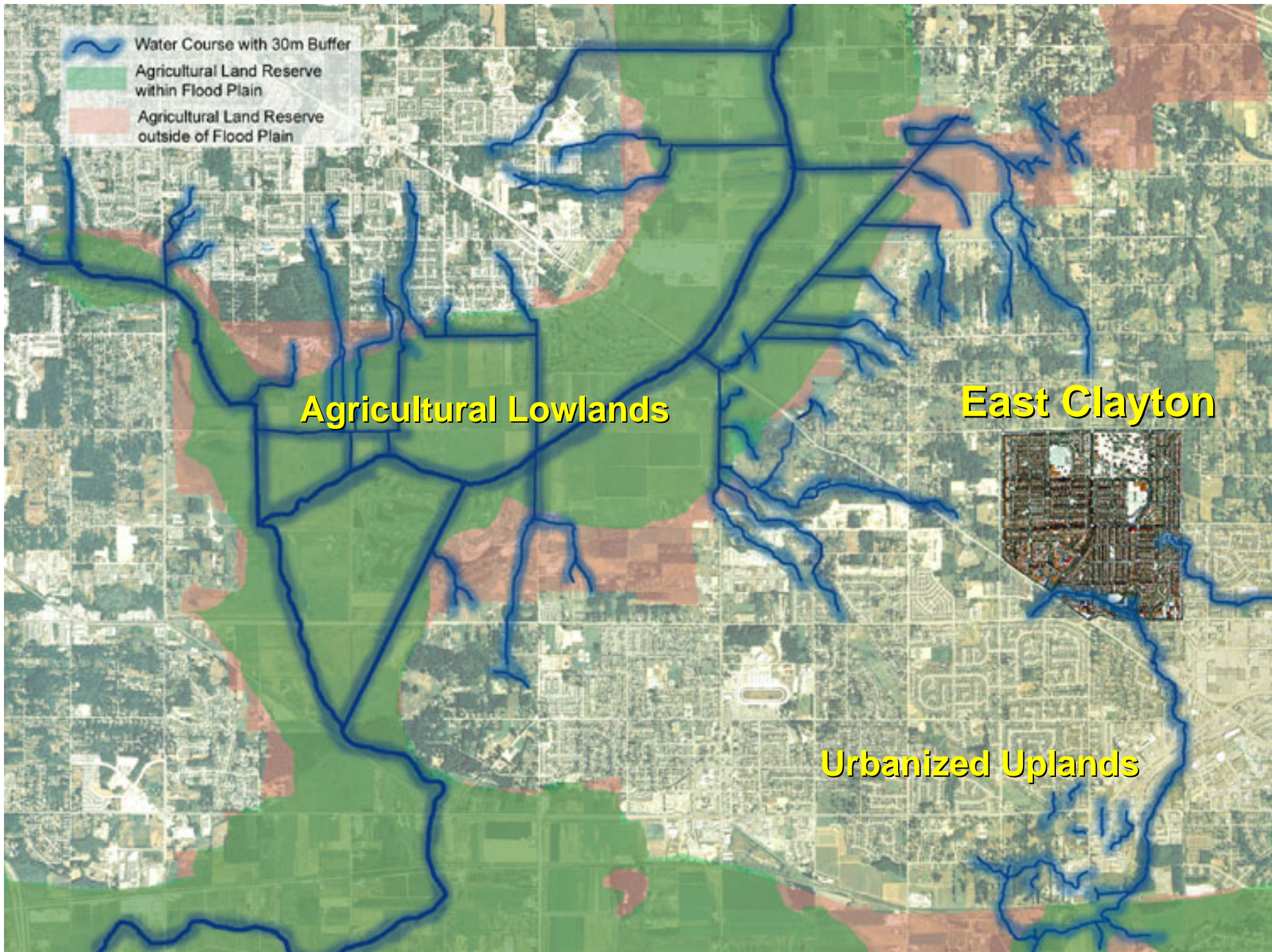
Internally!





Integrate an Urban Forestry Strategy

- 40% Tree Canopy over Residential Lots
- 60% Tree Canopy over Road Rights-of-Way



East Clayton

13,000
Residents

550 Acres

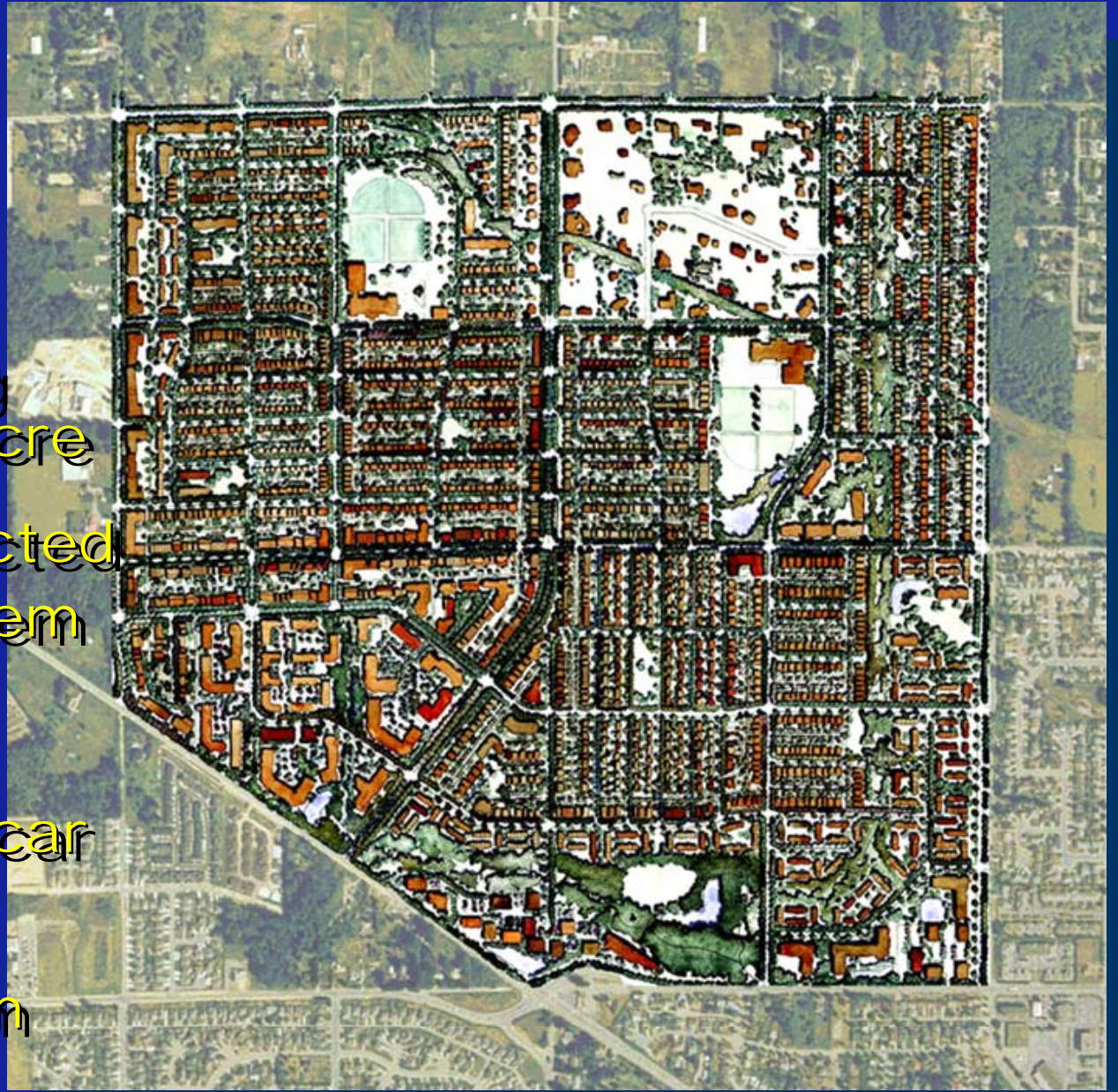
10 Dwelling
Units per Acre

Interconnected
Street System

Pedestrian
Streets

40% fewer car
trips

90% less
downstream
impact



An aerial architectural rendering of a campus. The scene shows a central area with several large, light-colored buildings, possibly academic or administrative buildings, surrounded by green spaces and trees. A river or stream flows through the campus, with a bridge crossing it. The background shows a residential area with smaller houses and more trees. The overall style is a detailed, colorful illustration.

**How did we get there?
Implementation
Charrettes!**

**Goal: People working
together to overcome
institutional impediments to
change.**

What still stands in the way?
Need for backup in first systems



What? You want me to install an infiltration system *AND* a regular system? At *MY* cost?

Uncertain Support from Elected Officials



Look Mr. Mayor, When we go back into chambers you better have a something to say to Mrs. Bradley about her puddle problem - or you can *forget* re-election next term

Lack of authority for City staff



PLEASE Mr. Campbell! I'm only the city planner!

I simply don't *have* the authority to lower DCC (Development Cost Charge) rates, no matter *HOW* laudable your goals.

Lack of Provincial and Federal Support for Early Adopters



Ordinarily we wouldn't be asking for support from your Ministry madam.

But we find ourselves in an, err, somewhat *embarrassing* position!

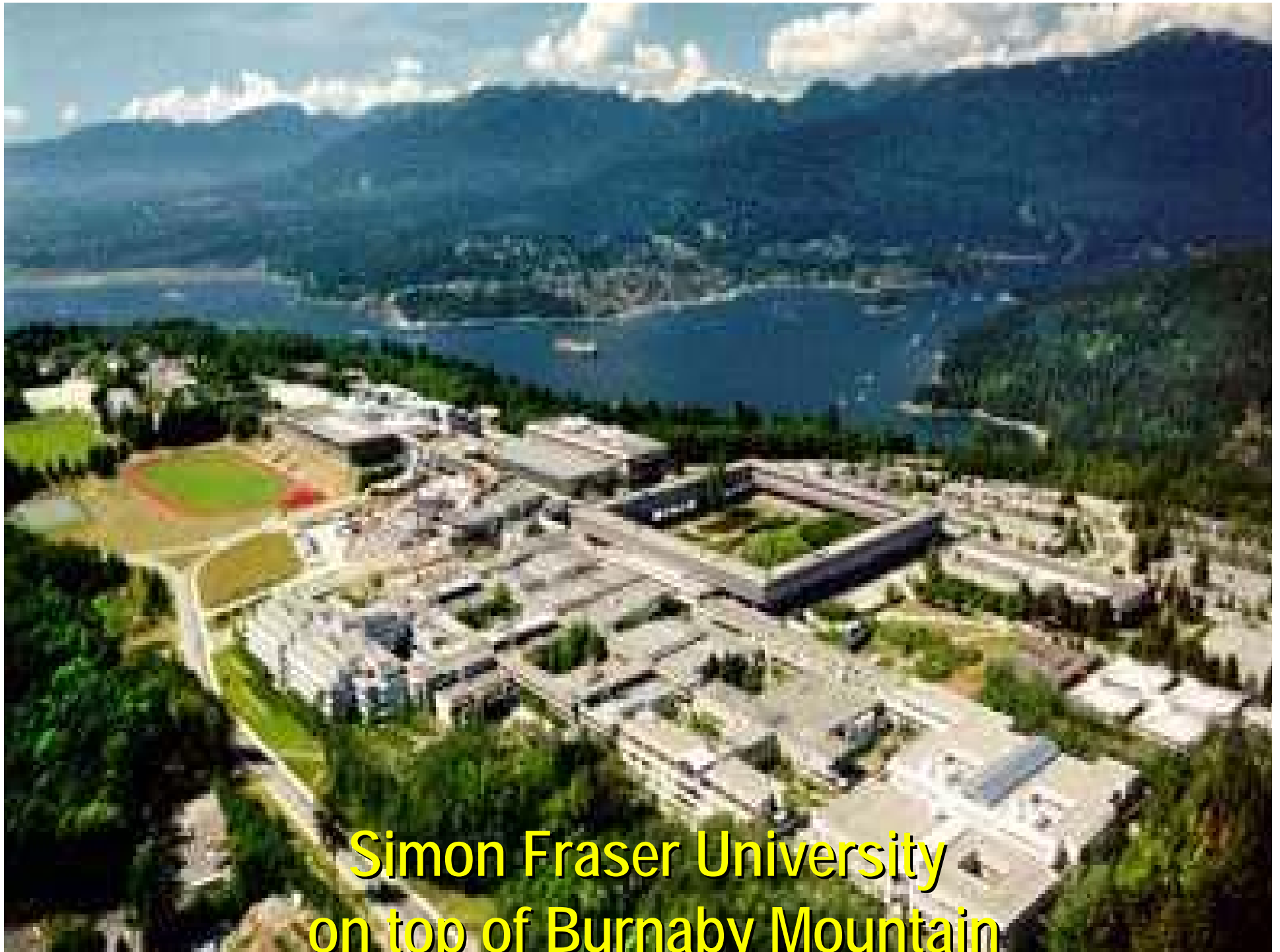
Applying New Approaches to Land Development Case Study on Model Sustainable Communities

**Burnaby Mountain Urban Community
at Simon Fraser University**

Resolving Stakeholder Fear and Doubt, and Managing Stormwater at the Source

by

Kim Stephens in collaboration with David Reid



**Simon Fraser University
on top of Burnaby Mountain**

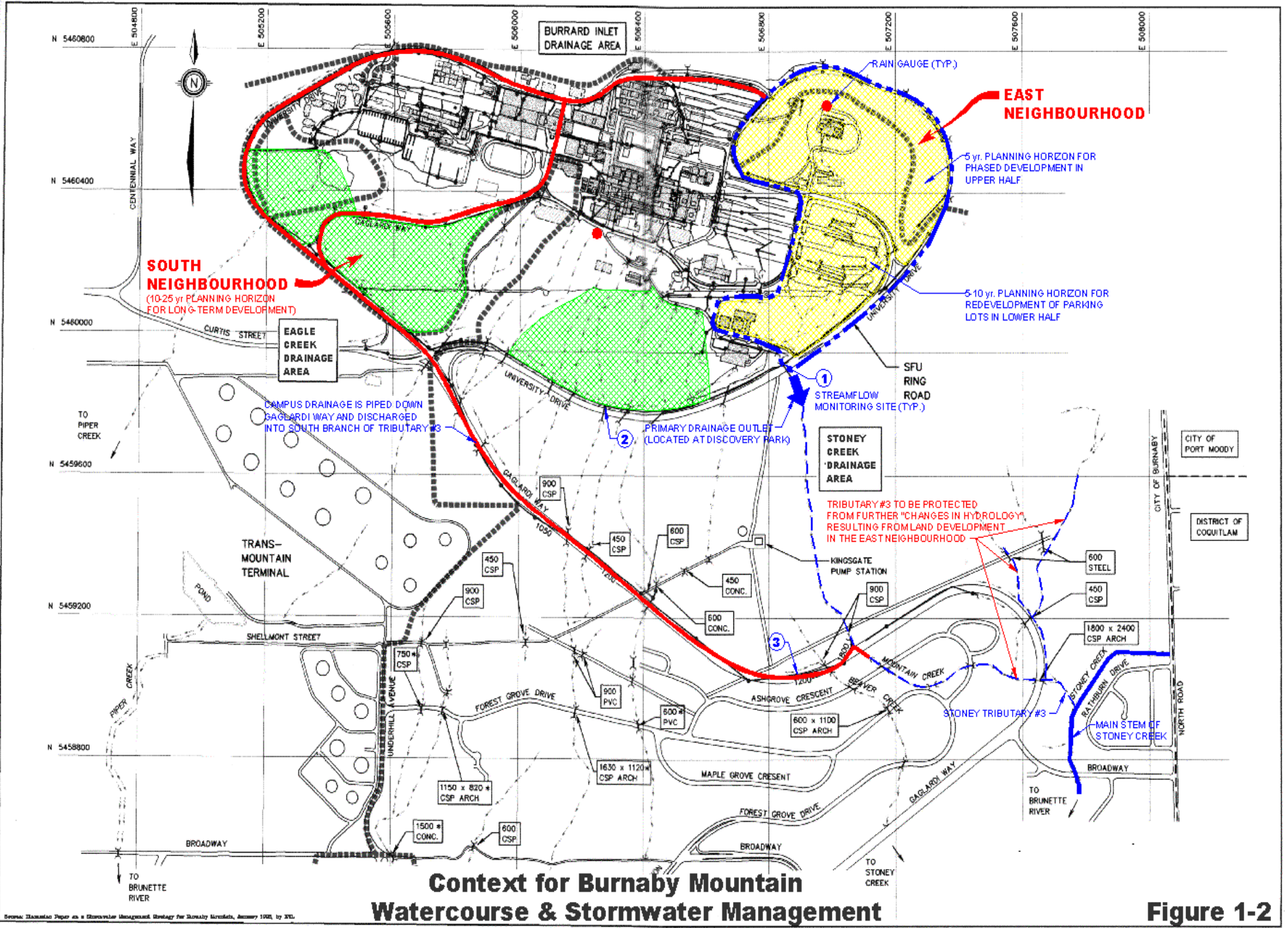
High Expectations

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.



Context for Burnaby Mountain Watercourse & Stormwater Management

Figure 1-2

Source: Technical Paper on a Stormwater Management Strategy for Burnaby Mountain, January 1998, by 201.

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



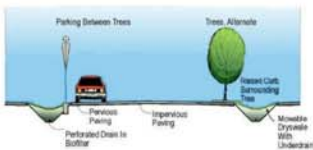
Element # 1 - Forest Drive

- Utilize existing road ditch and drainage outlets to provide Tier C Off-Parcel Storage for Area 1 perimeter development along Forest Drive.
- Incorporate a swale along the top edge of the forested buffer strip to disperse drainage originating from impervious areas.

- COMBINED DETENTION / INFILTRATION POND
- CISTERN DISCHARGING TO PERCOLATION FIELD
- CISTERN DISCHARGING TO INFILTRATION POND

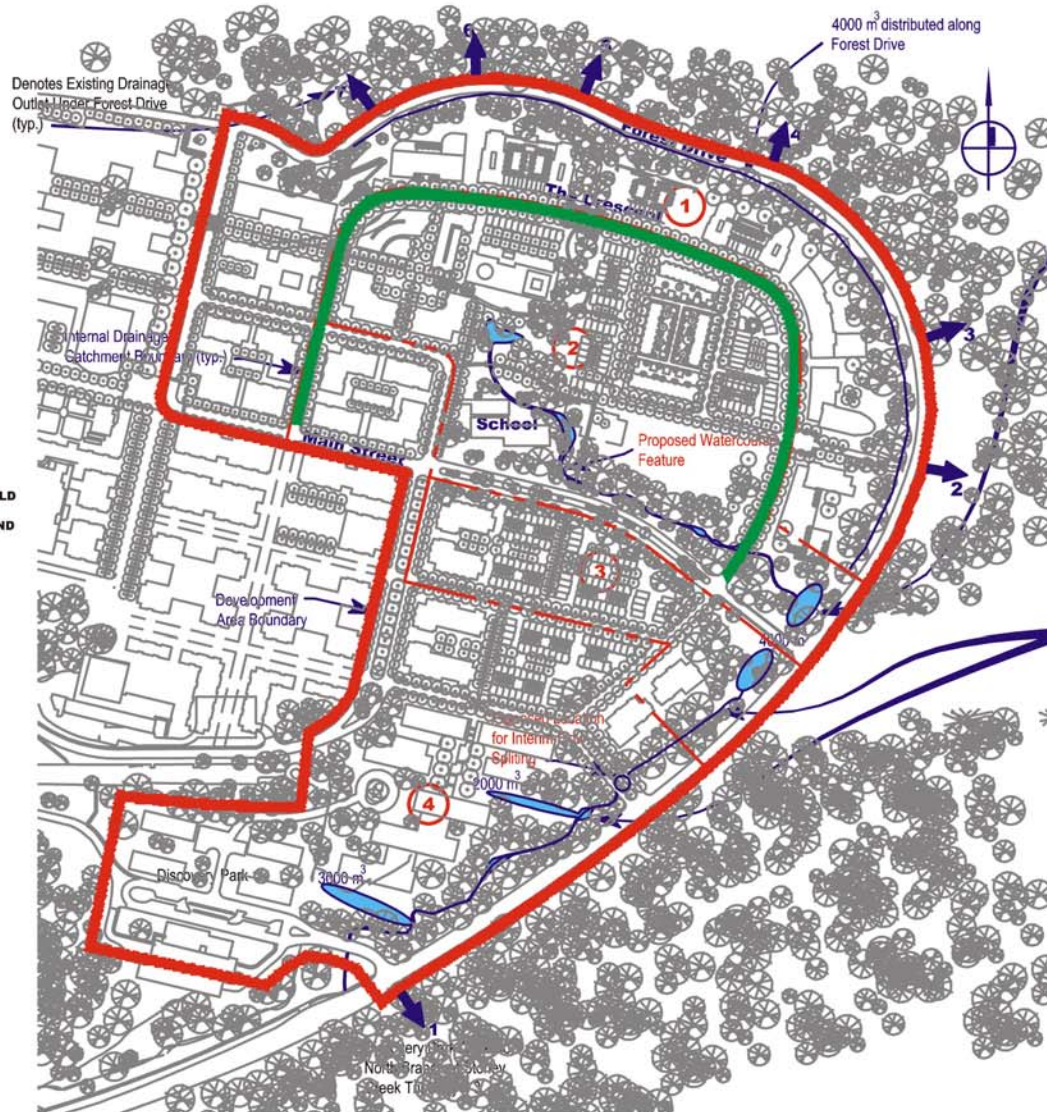
Element # 2 - On-Parcel Detention Storage

- Capture first 35mm / day 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 / day 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 2 and 3.
- Retrofit upper parking lots in Area 3 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.
- Provide interim connection to existing open channel below the parking lots, and maintain flow while "growing a creek" on a new alignment.
- Construct linear contour ponds off-line to provide Tier C Off-Parcel Storage for Area 4.

Criteria for Detention Storage Sizing

Net Storage Volumes (V _s) per 100% impervious hectare	=	850m ³ for the 100mm Tier C rainfall event	+	20% redundancy to allow for a 35mm Tier A rainfall event occurring beforehand	⇒	Release rate (0.5Q ₂) = 2 litres per second per impervious hectare
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Storage required for a typical 1 hectare parcel with 57% impervious cover	=	200m ³ On-Parcel (1/3)	+	400m ³ Off-Parcel (2/3)
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Watercourse & Stormwater Management Plan for East Neighbourhood

Figure 1-3

What is the appropriate balance for stormwater management?

Among:

- On-Parcel Strategies
- On-Street Strategies
- Stormwater Detention Strategies

How much of the problem is addressed at the source (the impervious surface), and how much is passed downstream (to detention ponds)?

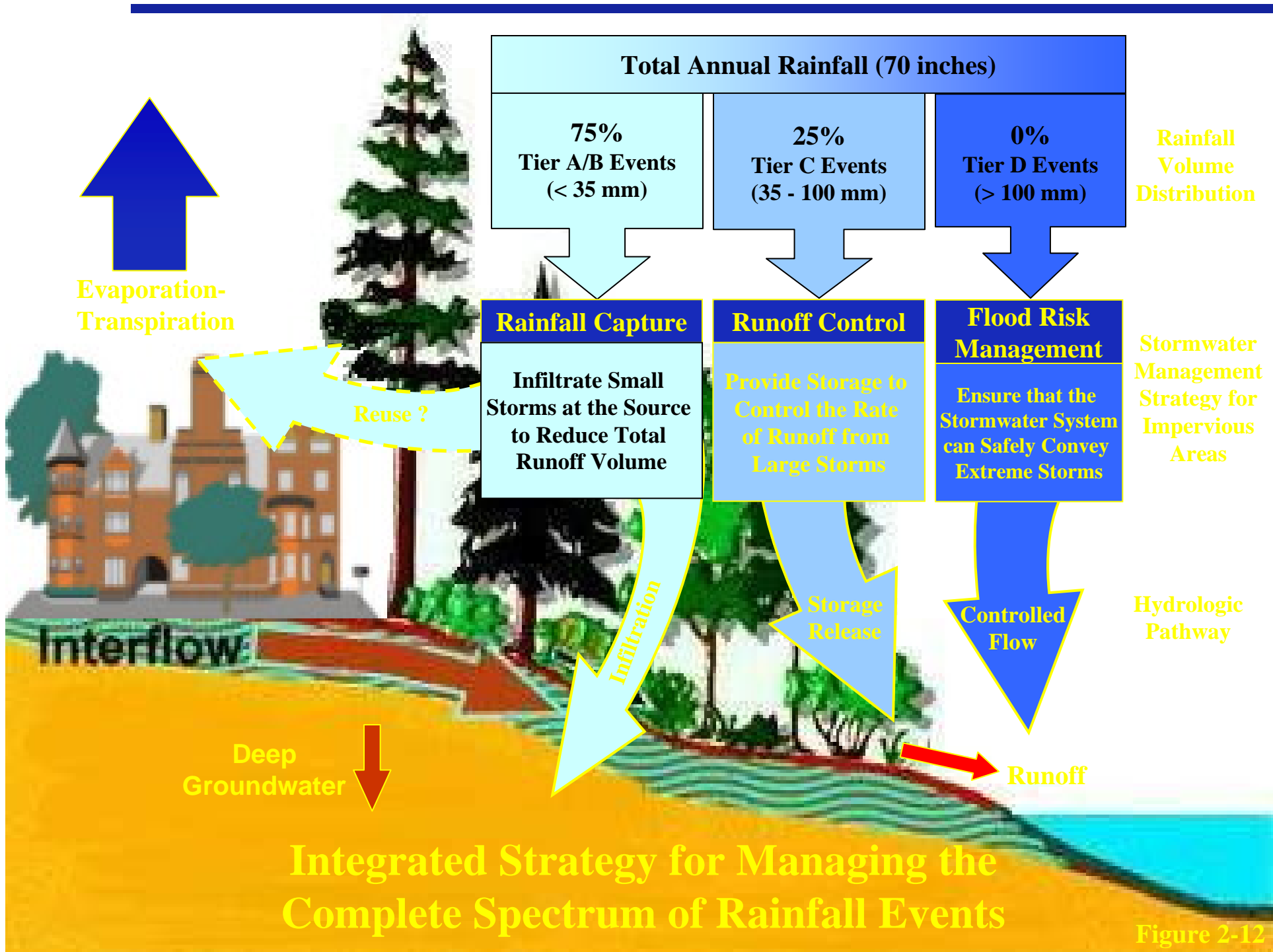


Figure 2-12

In Conclusion, the Benefits in Implementing the 50-Year Vision for Watershed Protection

If we can approximate the natural runoff pattern through *source-control*, then:

- runoff frequency and magnitude reduced
- risk of flood overflow reduced
- erosion and sedimentation minimized

And the aquatic habitat would also benefit