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SUSTAINABLE COMMUNITIES CONFERENCE
OTTAWA 2018

Stormwater Management and Financing in Action

INTEGRATING GREY AND GREEN INFRASTRUCTURE

Gilles Rivard, P. eng. M. Sc.

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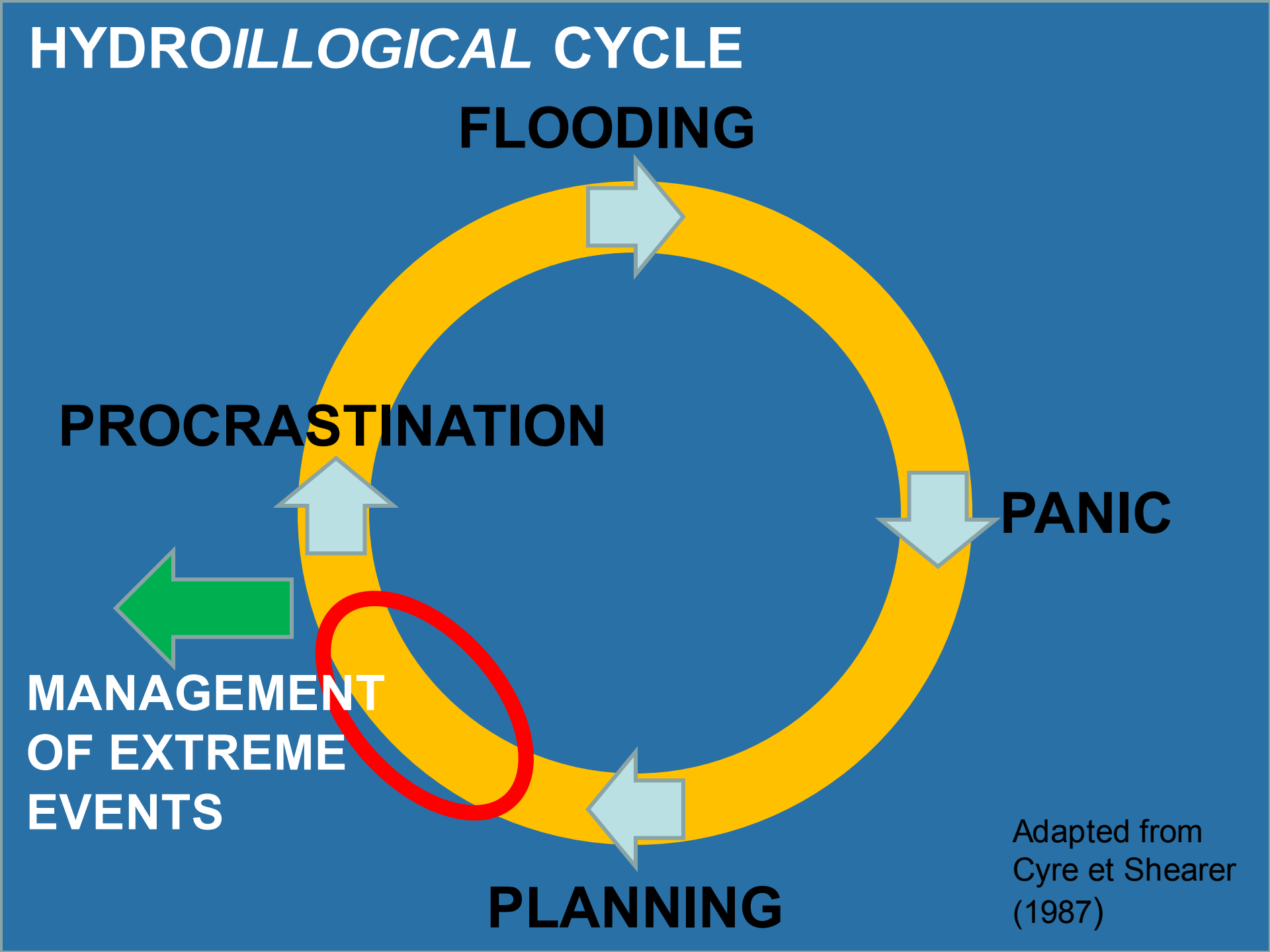
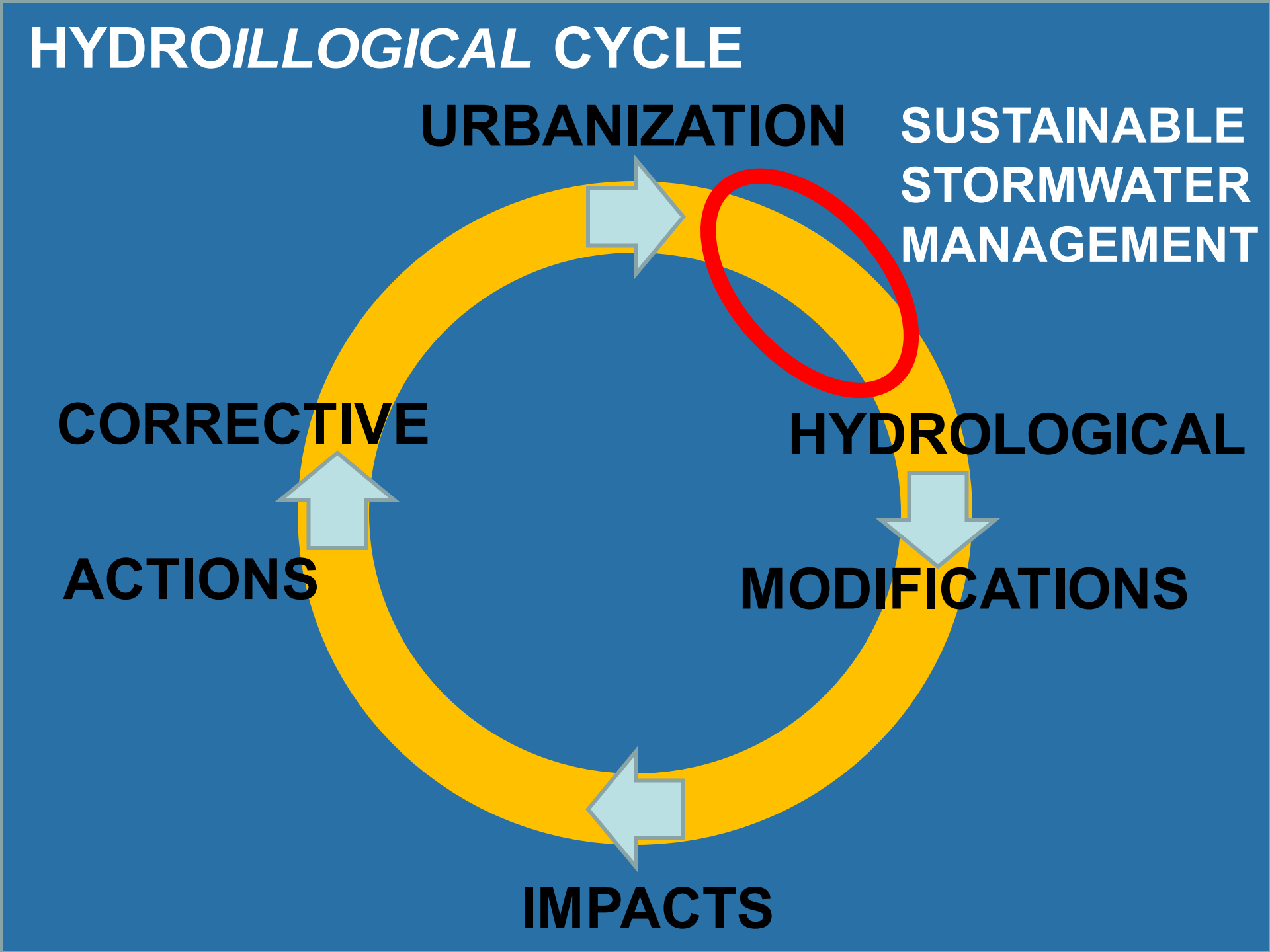
STORMWATER
MANAGEMENT
«GREEN» THINKING
AS A MINDSET

HYDRO*ILLOGICAL* CYCLE



Adapted from Cyre et Shearer (1987)

HYDRO*ILLOGICAL* CYCLE



SCHOPENHAUER

All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident.

The world is my idea

(The World as Will and Idea -1819)

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OUTLINE

- OVERVIEW OF URBAN DRAINAGE EVOLUTION
- BARRIERS
- BENEFITS - OPPORTUNITIES
- NEEDS AND CHALLENGES: THE WAY FORWARD

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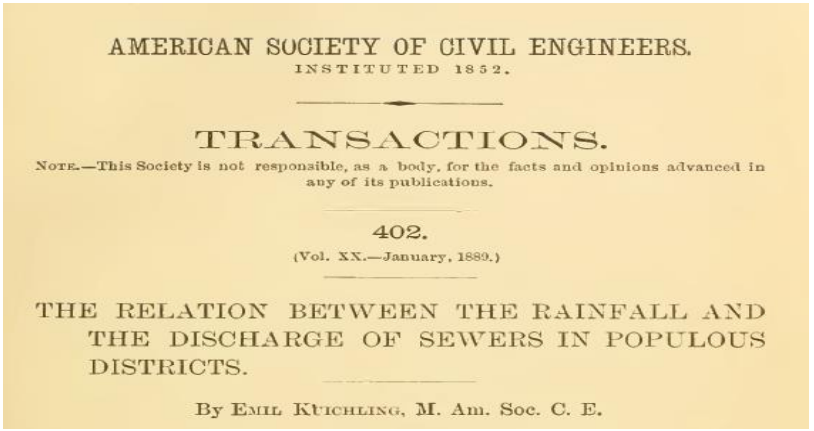
URBAN DRAINAGE

A (VERY) BRIEF HISTORY

- From the mid-1800s and for the next 100 years: very few changes in the design approach
- Main objective:

Rapid and efficient drainage

1899 !!



AMERICAN SOCIETY OF CIVIL ENGINEERS.
INSTITUTED 1852.

TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

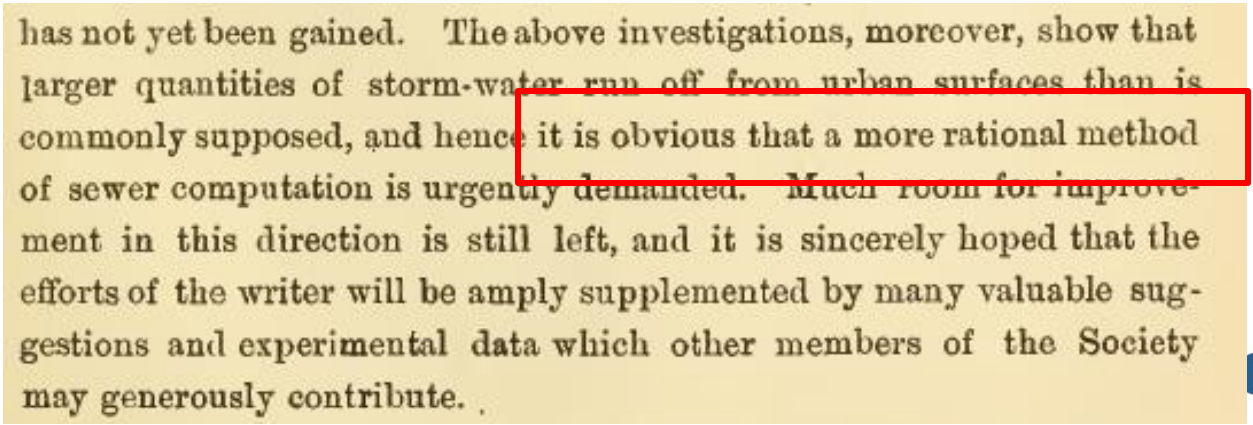
402.

(Vol. XX.—January, 1889.)

THE RELATION BETWEEN THE RAINFALL AND THE DISCHARGE OF SEWERS IN POPULOUS DISTRICTS.

By EMIL KUICHLING, M. Am. Soc. C. E.

Rational Method (1851-Mulvaney and1889-Kuichling)



has not yet been gained. The above investigations, moreover, show that larger quantities of storm-water run off from urban surfaces than is commonly supposed, and hence it is obvious that a more rational method of sewer computation is urgently demanded. Much room for improvement in this direction is still left, and it is sincerely hoped that the efforts of the writer will be amply supplemented by many valuable suggestions and experimental data which other members of the Society may generously contribute.

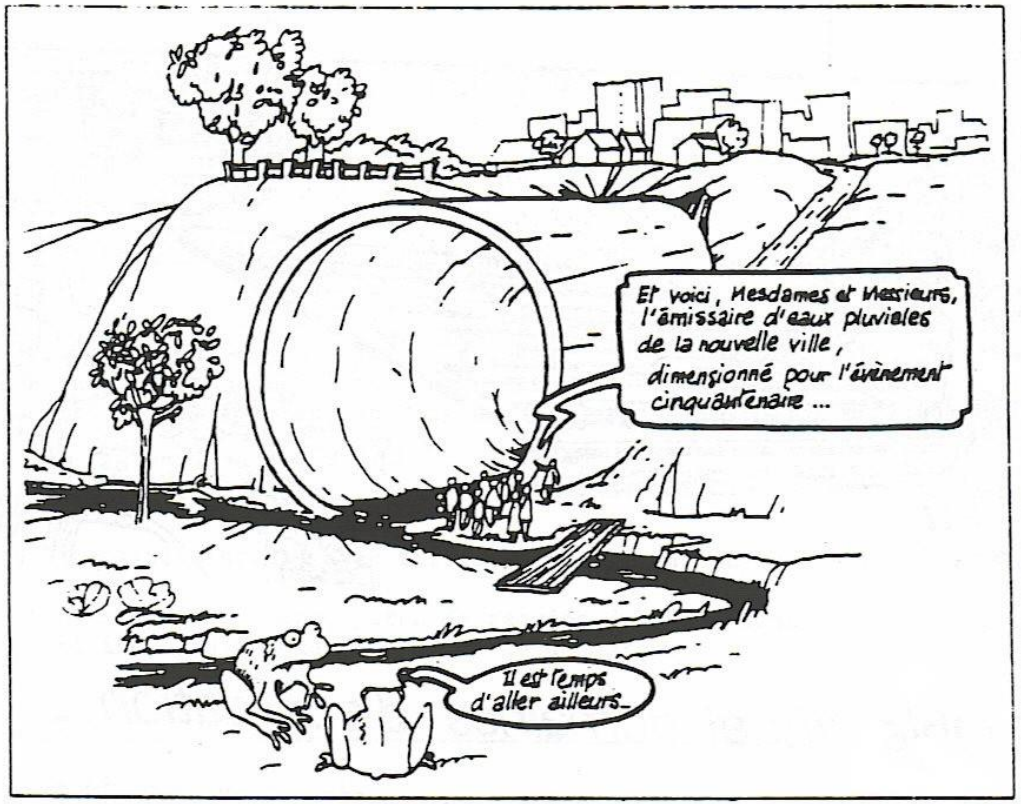
URBAN DRAINAGE

A (VERY) BRIEF HISTORY

- Until the 1960s

Rational Method almost exclusively

RESULT: DOWNSTREAM FLOODING AND WATERCOURSE DEGRADATION



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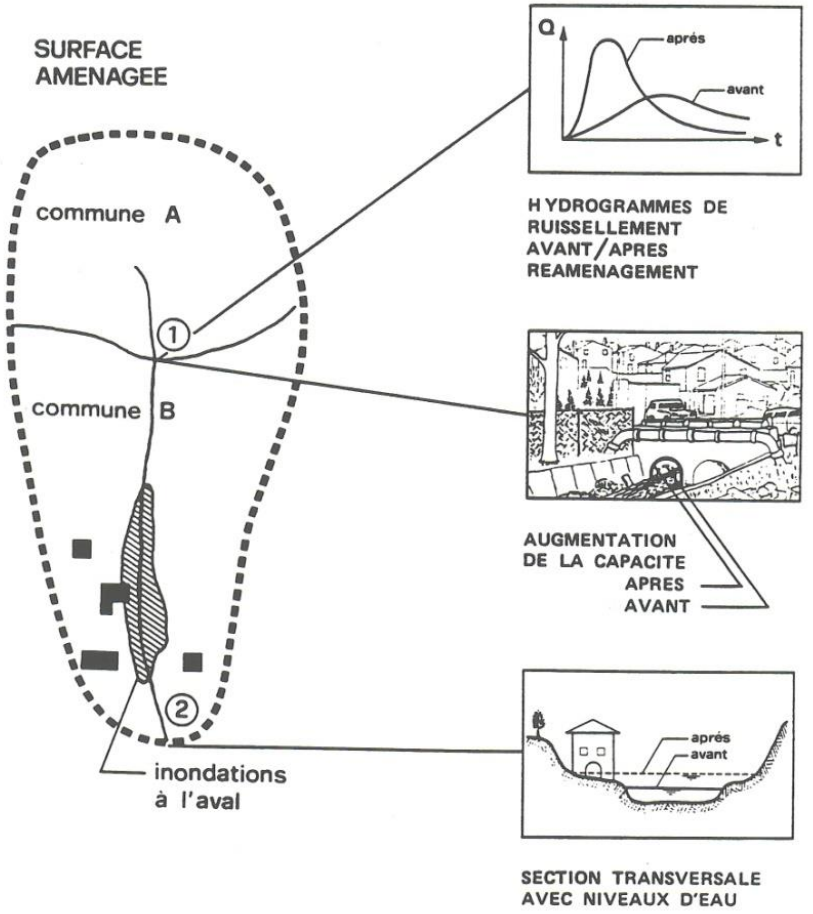
URBAN DRAINAGE

A (VERY) BRIEF HISTORY

- 1970s : **Quantity**
  Controls with **ponds**



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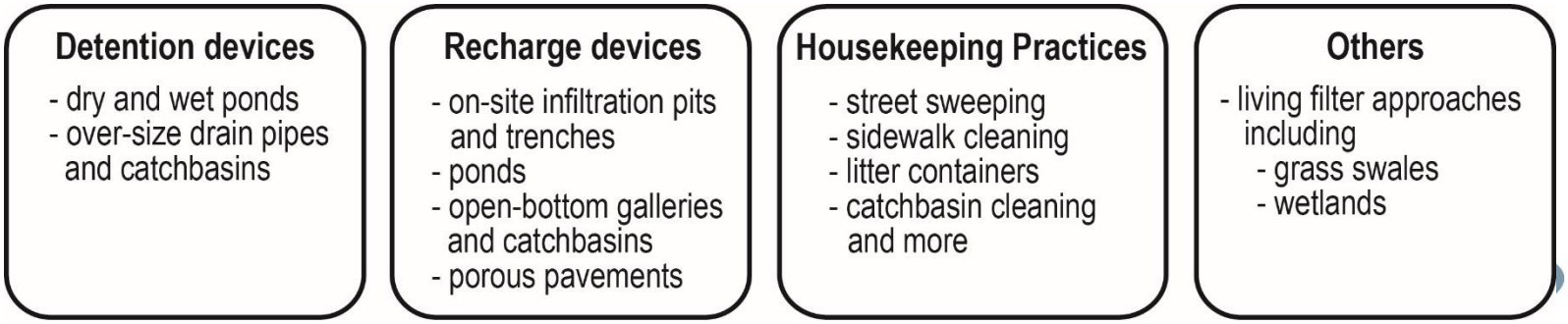
URBAN DRAINAGE

A (VERY) BRIEF HISTORY

- 1980s – National Urban Runoff Program (NURP) (USA) : **Stormwater is polluted !!**
  - Measures for quality control
  - Best Management Practices (BMPs) are «invented»



URBAN DRAINAGE

A (VERY) BRIEF HISTORY

- **2000 – New Mindset**
  - Sustainability
  - Management taking into account ecological systems - Low Impact Development (1999)
  - Better understanding of stormwater impacts and more comprehensive criteria
  - Approaches to integrate stormwater in the urban landscape
  - Watershed Management

URBAN DRAINAGE

A (VERY) BRIEF HISTORY

New fundamental paradigm

Reproduce and maintain natural hydrology and minimize the impacts of urban development

- Decentralized controls - Treatment train
- Complete rainfall spectrum
- Runoff Volume Control

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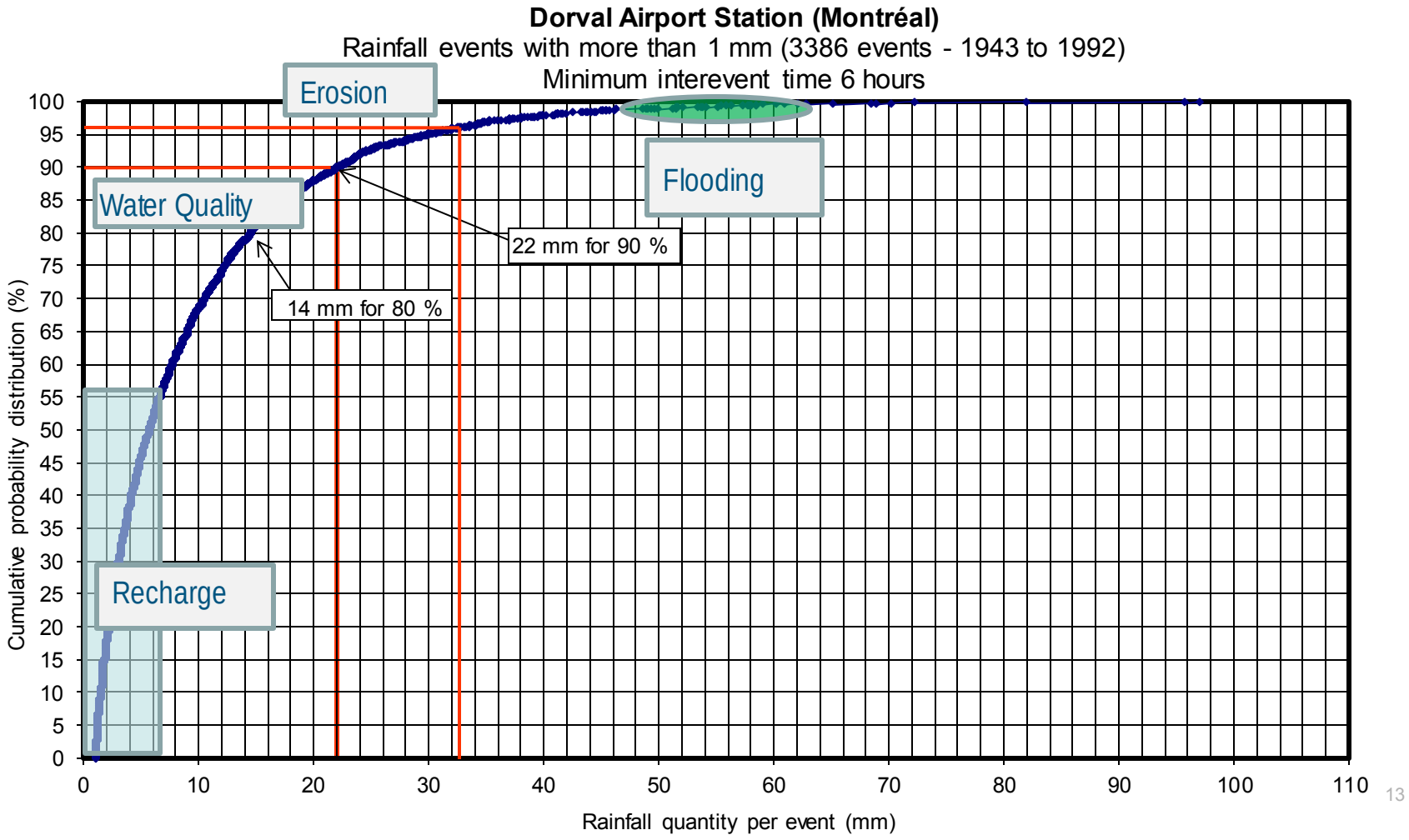
URBAN DRAINAGE NOW



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URBAN DRAINAGE NOW

Quality

Maintenance

Erosion

Flooding

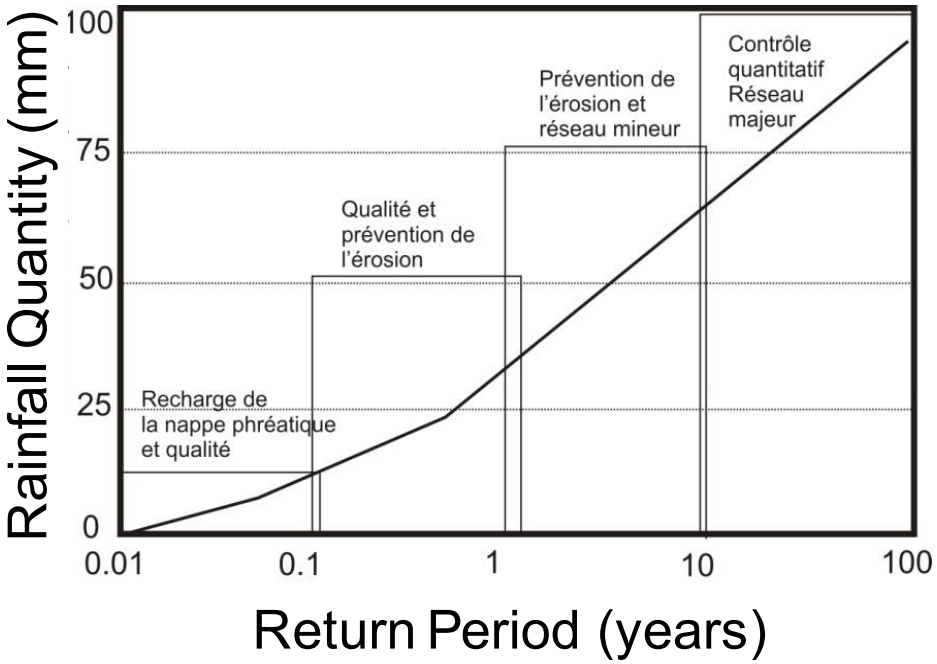
Climate Change

Sewer Overflows

New parameters for design criteria

- Volume Control

- Complete rainfall spectrum



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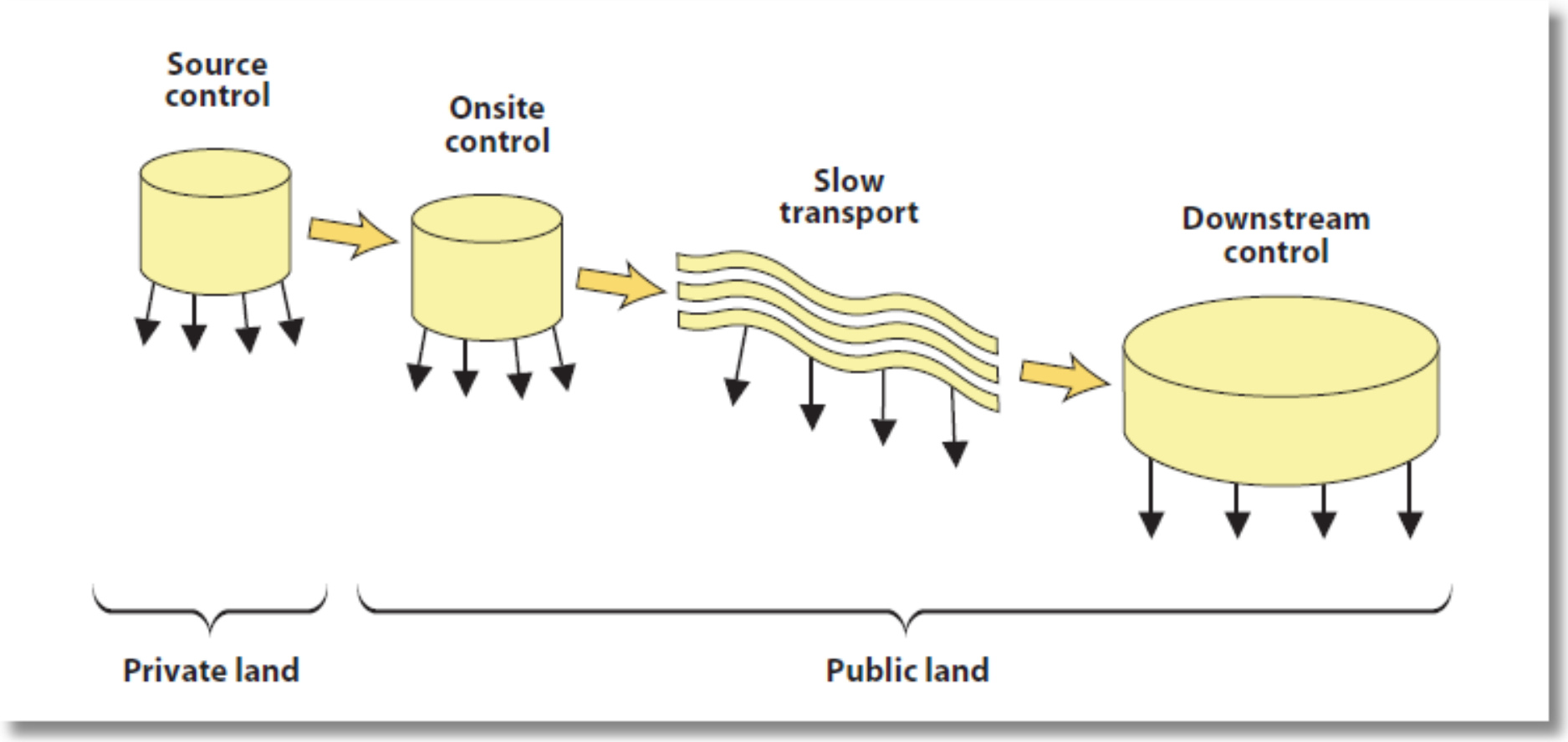
URBAN DRAINAGE NOW

TREATMENT TRAIN



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TERMINOLOGY

BMPs

WSUD

Water Sensitive Cities

Better Site Design

Source Controls

Design with Nature

SUDS

Conservation Design

Stormwater Control Measures(SCMs)

Smart Growth

Integrated Urban Stormwater Management

LIUDD

Green Infrastructures

Decentralized Stormwater Management

Alternative techniques

Sustainable Rainwater Management

Compensatory techniques

TERMINOLOGY

PAPER SPECIFIC FOR OVERVIEW AND DESCRIPTION OF DIFFERENT TERMS

Urban Water Journal

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/nurw20

SUDS, LID, BMPs, WSUD and more - The evolution and application of terminology surrounding urban drainage

Tim D. Fletcher[a], William Shuster[b], William F. Hunt[c], Richard Ashley[d], David Butler[e], Scott Arthur[f], Sam Trowsdale[g], Sylvie Barraud[h], Annette Semadeni-Davies[i], Jean-Luc Bertrand-Krajewski[h], Peter Steen Mikkelsen[j], Gilles Rivard[k], Mathias Uhl[l], Danielle Dagenais[m] & Maria Viklander[n]

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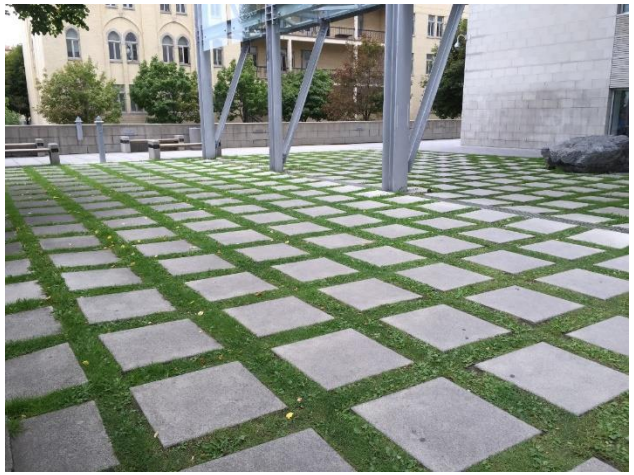
BARRIERS

Reluctance to support new approaches and modify practices

Many of the barriers may be difficult to overcome – systemic and embedded within organisational cultures, practices and processes
(Brown and Farrelly, 2007)

CATEGORIES

1. Technical and physical constraints
2. Legal and regulatory
3. Financial
4. Cultural (social and institutional aspects)



Real vs Perveived Barriers

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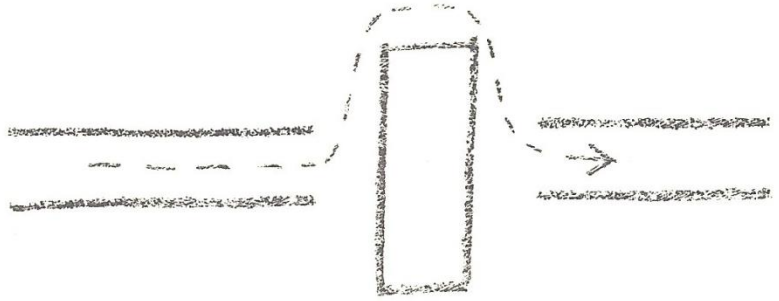
BARRIERS

- REGULATORY FRAMEWORK
- DESIGN GUIDELINES AND FEEDBACK
- MAINTENANCE FOR COLD CLIMATE
- LEVEL OF SERVICE
- CONFLICTING LID GUIDANCE
- PLANNING PROCESS
- EDUCATION – TRAINING
- REVIEW PROCESS
- TERMINOLOGY
- SAFETY CONSIDERATIONS
- FINANCIAL



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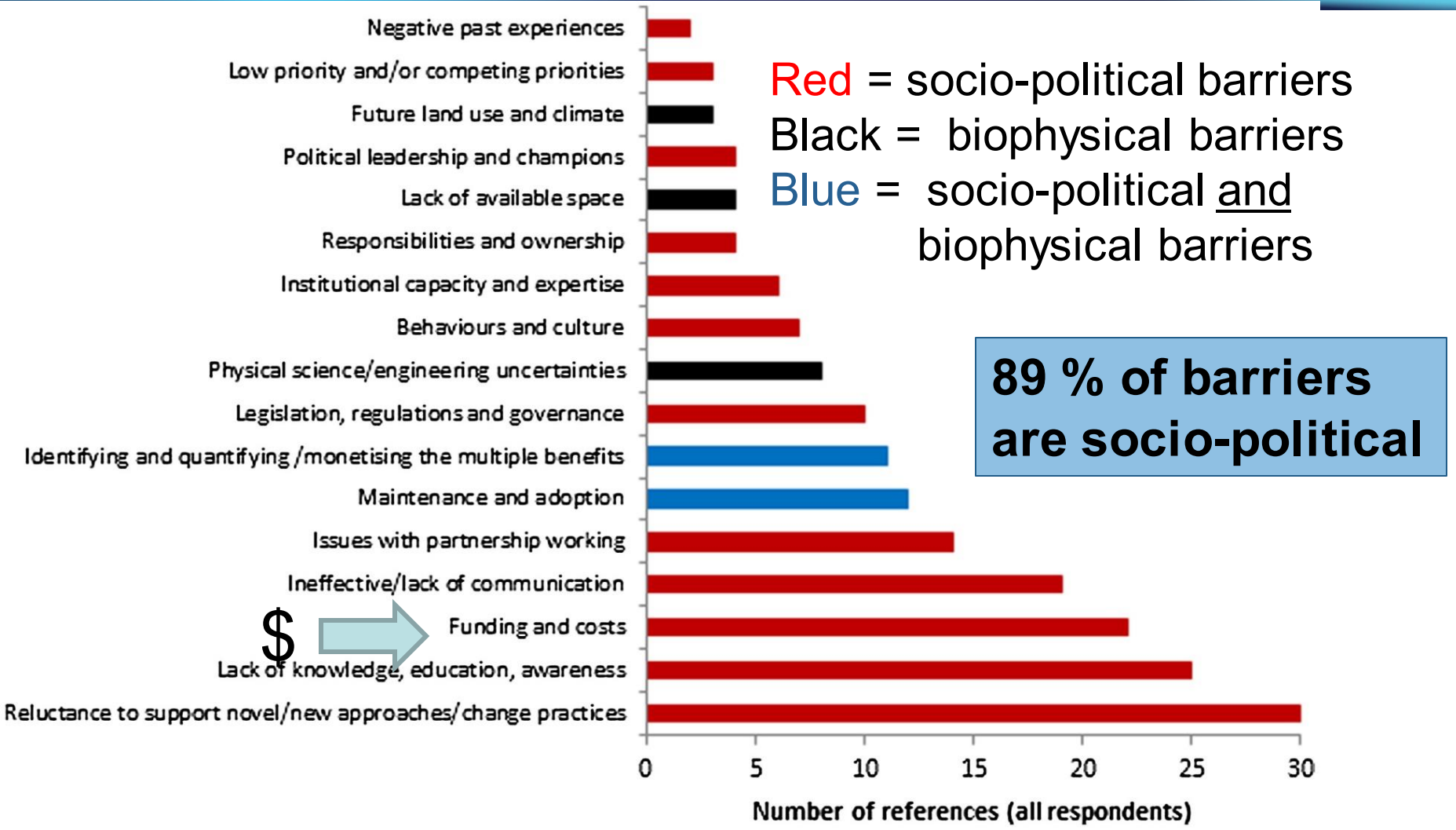
BARRIERS



Red = socio-political barriers
Black = biophysical barriers
Blue = socio-political and biophysical barriers

89 % of barriers are socio-political

Recognising barriers to implementation of Blue-Green Infrastructure: a Newcastle case study, (O'Donnell et al., 2016)

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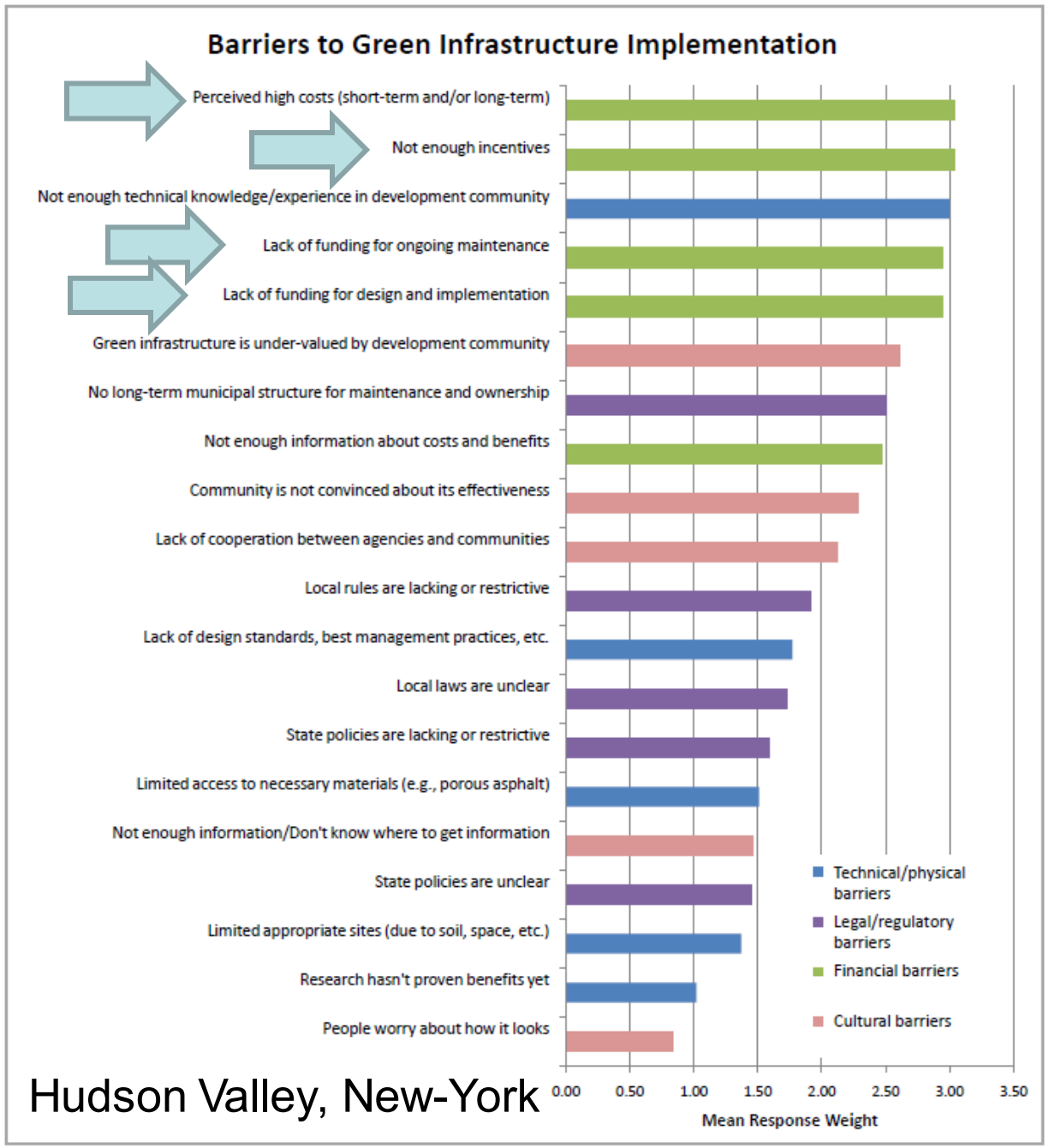
BARRIERS

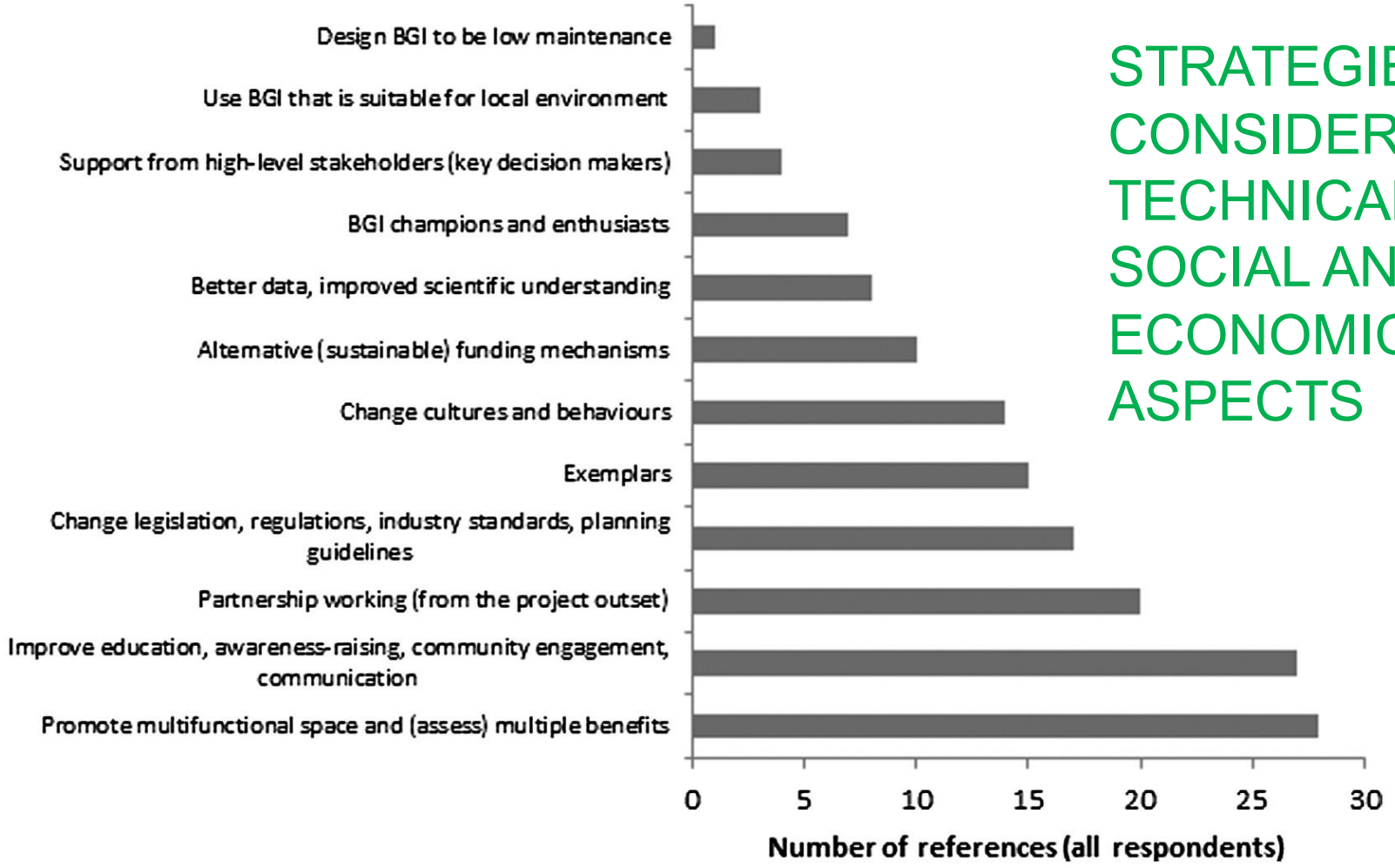
4 of the most significant barriers are financial

- **Technical/Physical**
- **Legal/Regulatory**
- **Financial**
- **Cultural**



Category	Question	# of Responses	Response Weight
Technical and physical barriers	Not enough technical knowledge and experience in development community	113	**3.00**
	Lack of design standards, best management practices, etc.	104	1.77
	Limited access to necessary materials (e.g., porous asphalt)	100	1.51
	Limited appropriate sites (due to soil, space, etc.)	102	1.37
	Research hasn't proven benefits yet	109	1.02
Legal and regulatory barriers	No long-term municipal structure for maintenance and ownership	96	2.50
	Local rules are lacking or restrictive	104	1.91
	Local laws are unclear	101	1.73
	State policies are lacking or restrictive	96	1.59
	State policies are unclear	94	1.45
Financial barriers	Not enough incentives	108	**3.04**
	Perceived high costs (short-term and/or long-term)	110	**3.04**
	Lack of funding for design and implementation	108	**2.95**
	Lack of funding for ongoing maintenance	104	**2.95**
	Not enough information about costs and benefits	110	2.47
Cultural barriers	Green infrastructure is undervalued by development community	112	2.61
	Community is not convinced about its effectiveness	111	2.29
	Lack of cooperation between agencies and communities	105	2.12
	Not enough information/Don't know where to get information	114	1.46
	People worry about how it looks	102	0.84

OVERCOMING BARRIERS



STRATEGIES CONSIDERING TECHNICAL, SOCIAL AND ECONOMIC ASPECTS

Recognising barriers to implementation of Blue-Green Infrastructure: a Newcastle case study, (O'Donnell et al., 2016)

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OVERCOMING BARRIERS

Delivering sustainable urban water management: a review of the hurdles we face

R. R. Brown and M. A. Farrelly

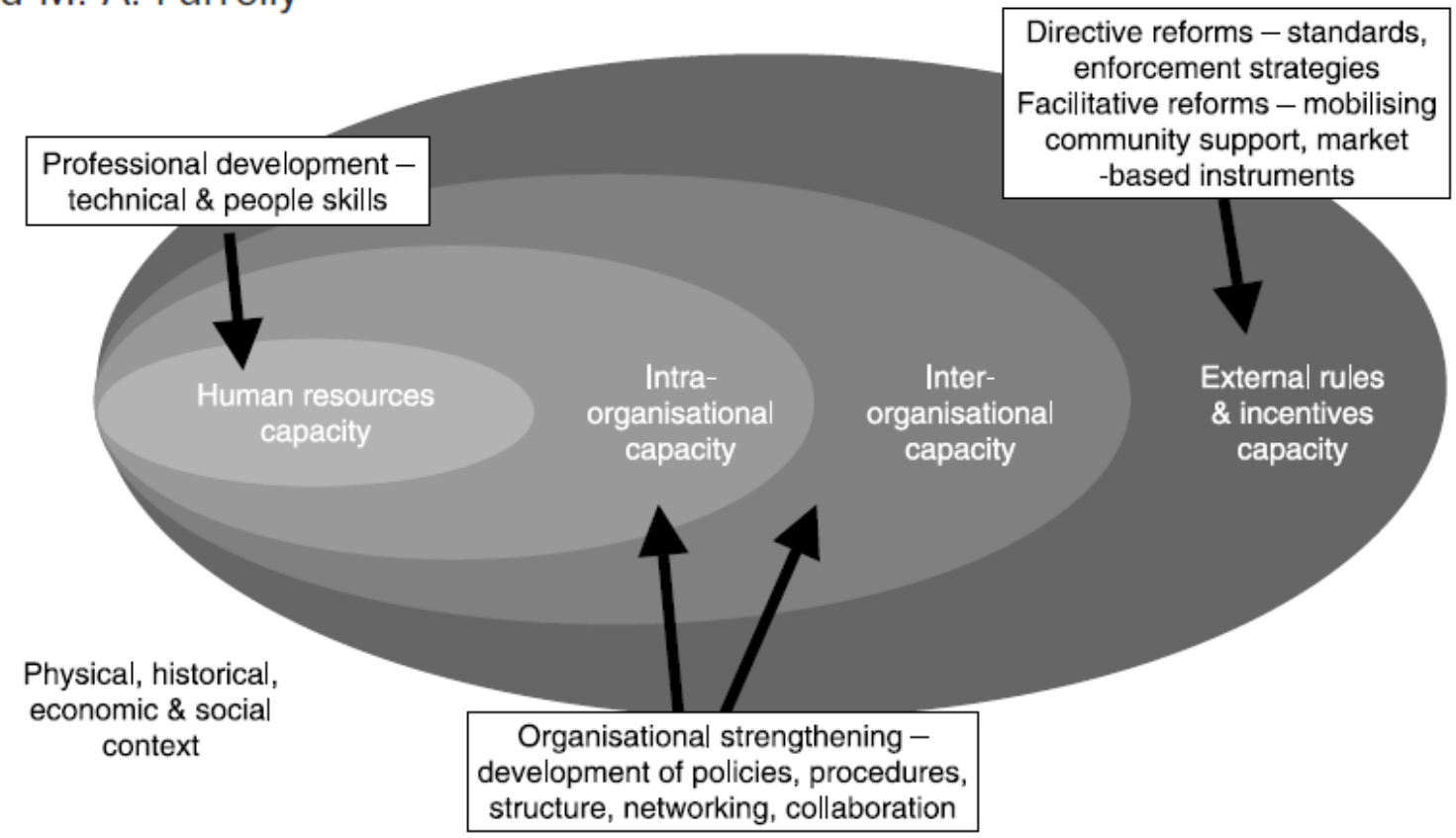


Figure 1 | Institutional Capacity Assessment Framework Source (Brown *et al.* 2006*b*).

BENEFITS OF GREEN INFRASTRUCTURE

Complementing the drainage fonction

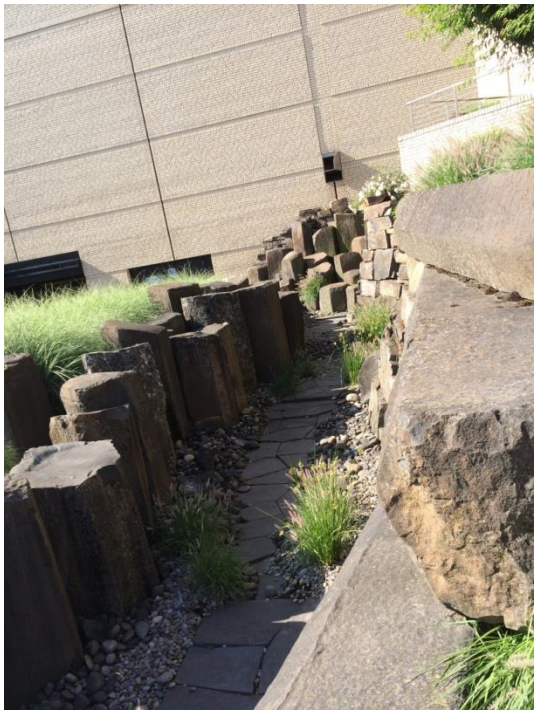
1. **Heat Island Effect**
2. **Water Quality**
3. **Climate Change**
4. **Combined Sewer Overflows**

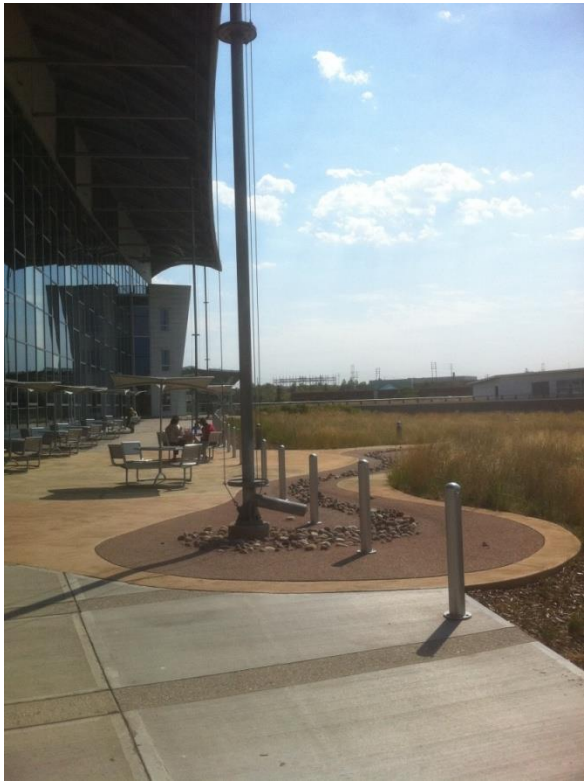
OPPORTUNITIES

NEW AND EXISTING AREAS

WAY FORWARD

WATER IS VISIBLE AND INTEGRATED





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WAY FORWARD

SEEING OPPORTUNITIES

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WAY FORWARD

ROBUST AND FUNCTIONAL DESIGN

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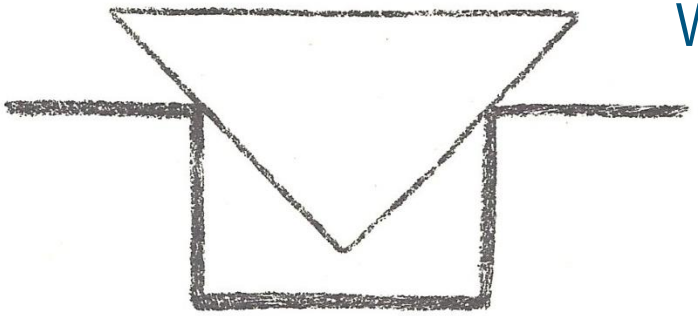
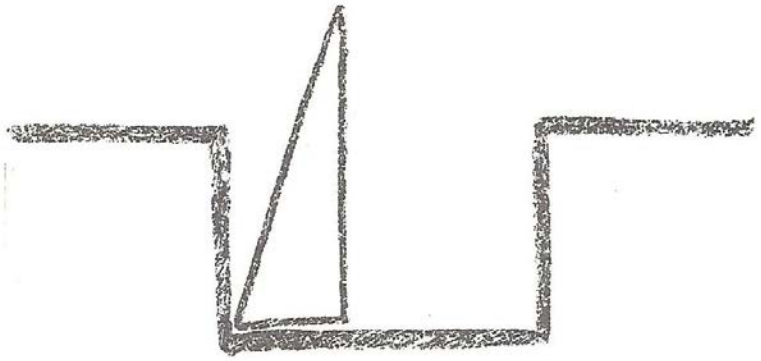
WAY FORWARD

SOLUTIONS

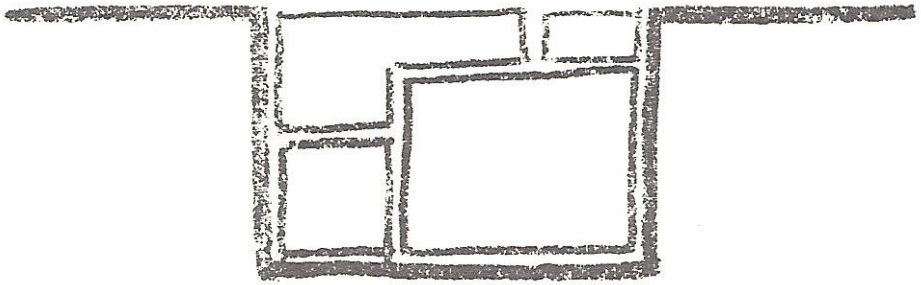
WRONG FIT



INADEQUATE FIT



COMPLICATED



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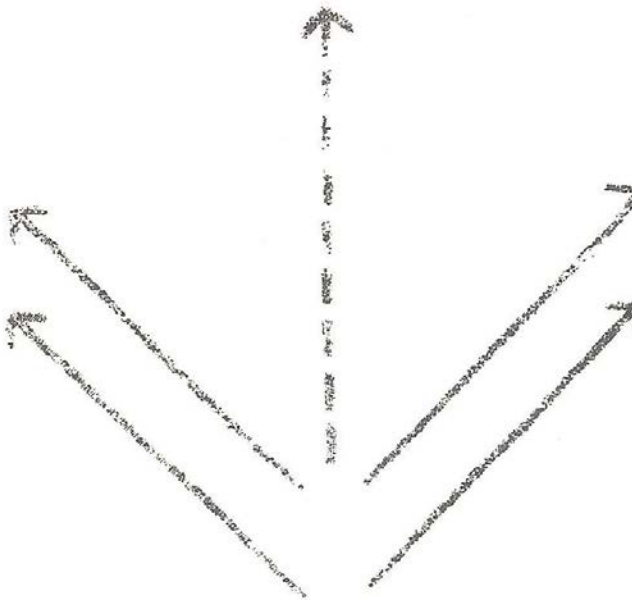
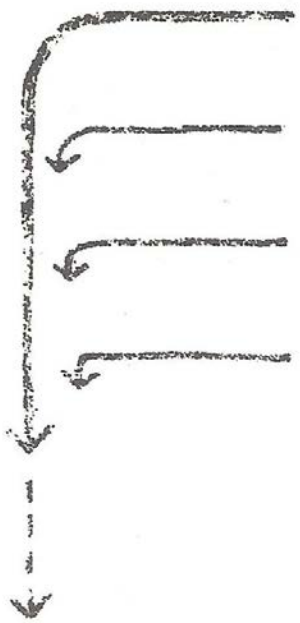
WAY FORWARD

DECISIONS

COMPROMISE



WHO WILL LEAD ?



Urban Planner ?

Landscape Arch. ?

Environment ?

Civil Engineer

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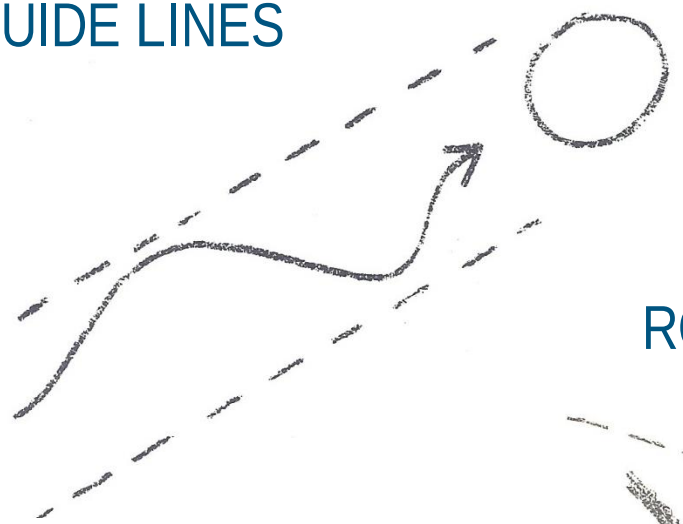
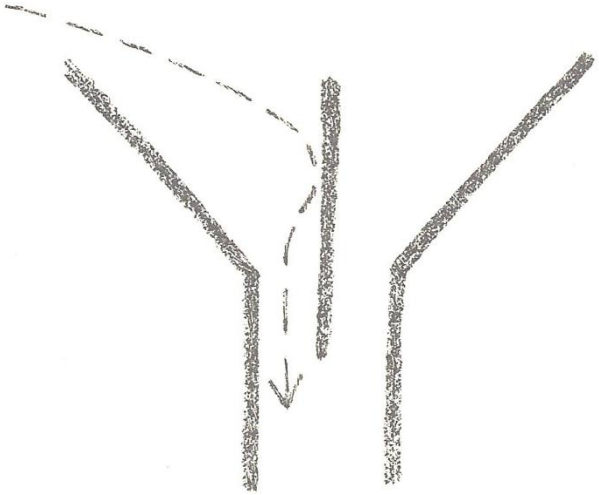
WAY FORWARD

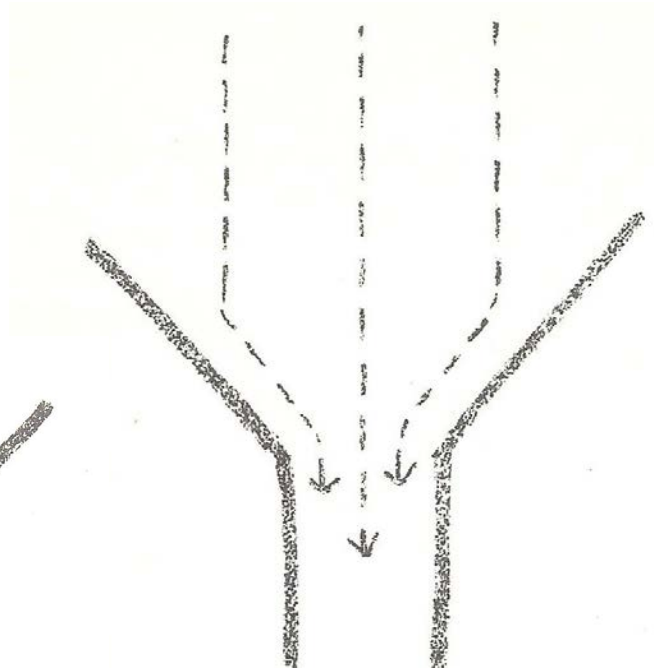
GUIDE LINES



ROBUST DESIGN



EFFECTIVENESS



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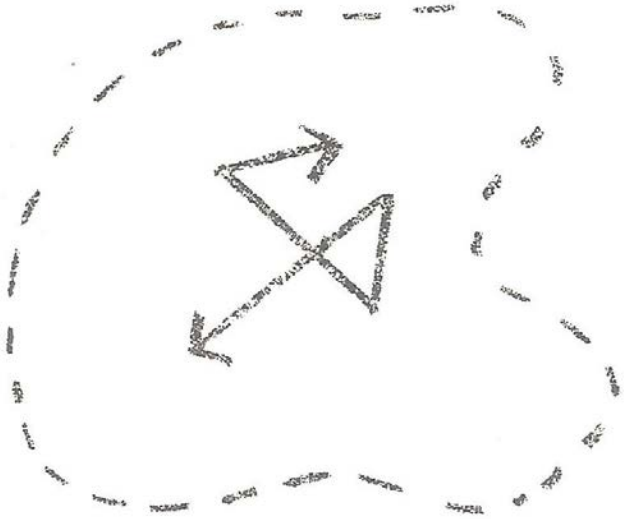
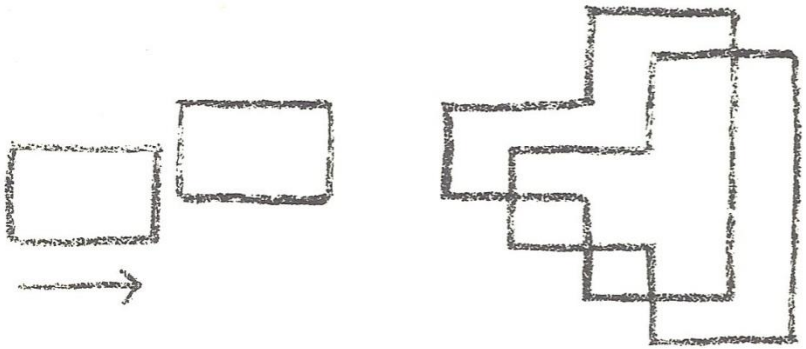
WAY FORWARD

INFORMATION

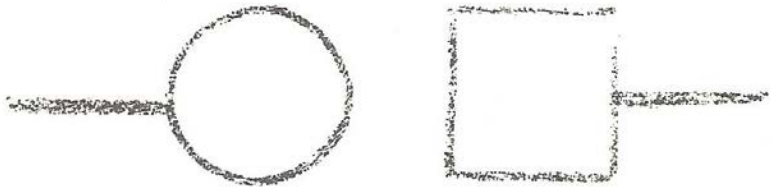


CONFUSION

DIFFERENT PERCEPTIONS



COMMUNICATION



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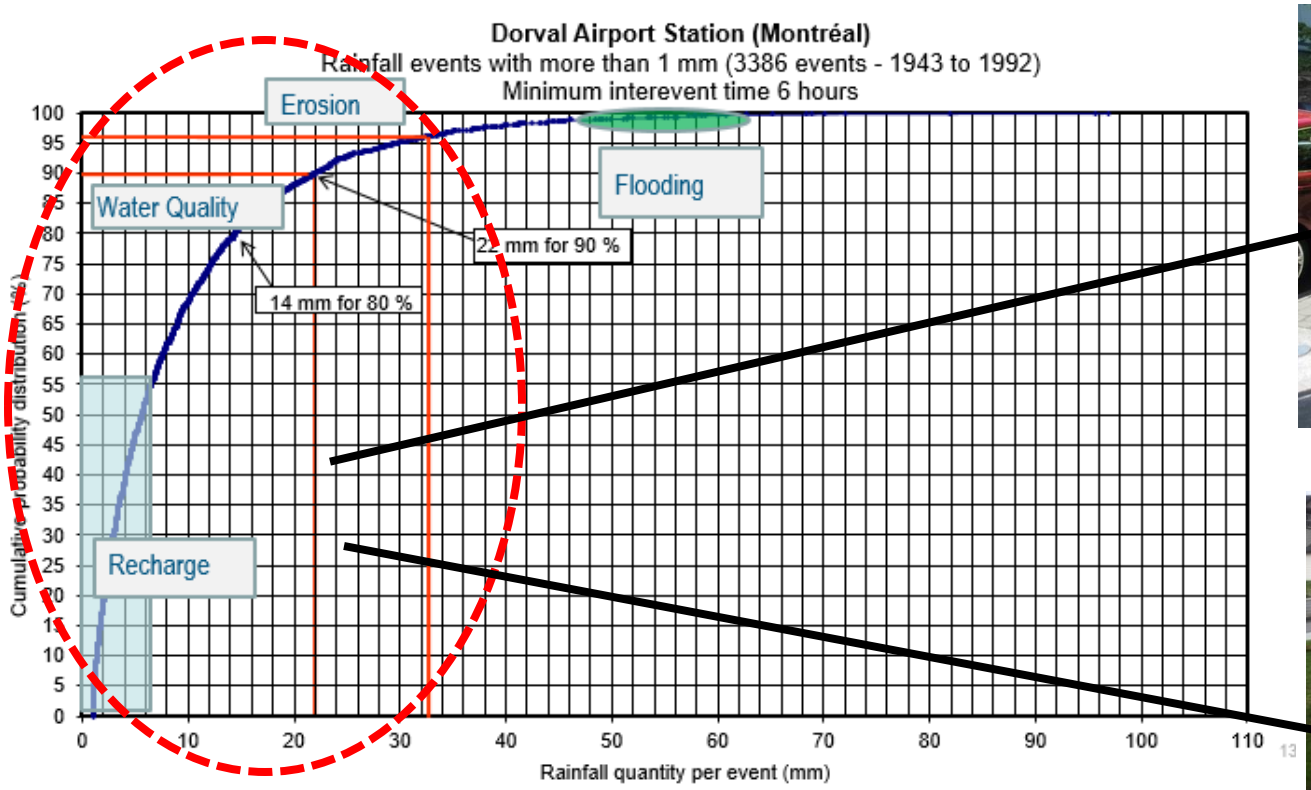
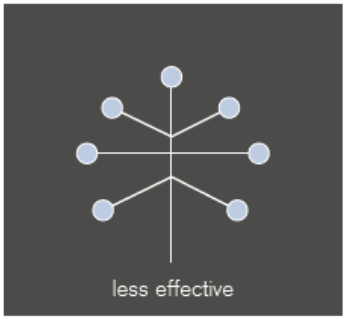
INTEGRATED APPROCHES

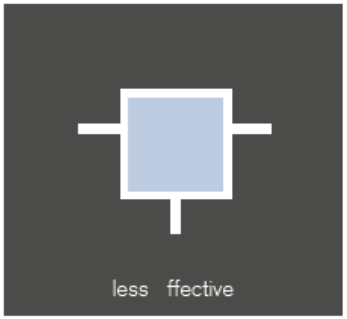
GREEN INFRASTRUCTURES

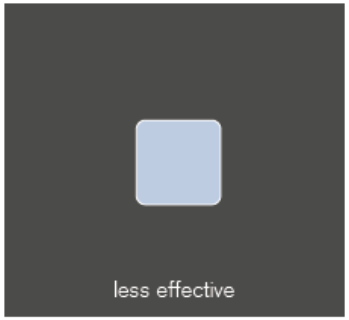


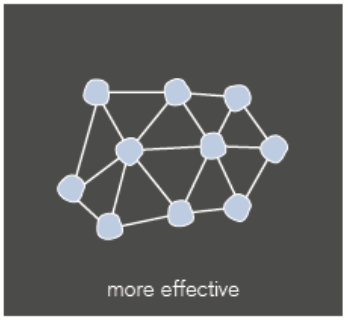
INTEGRATED APPROCHES

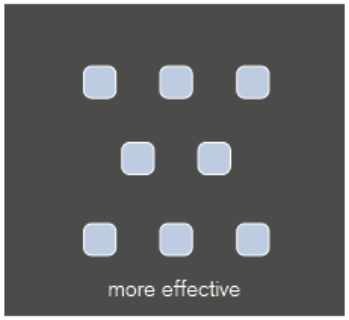
STORMWATER MANAGEMENT



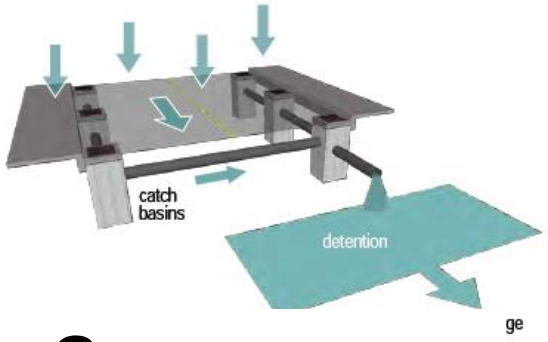








REDUNDANCY **RESILIENCE** **DISTRIBUTION**



«Grey» Infrastructures

«Green» Infrastructures

Adapted from Eastern Washington Manual, 2013

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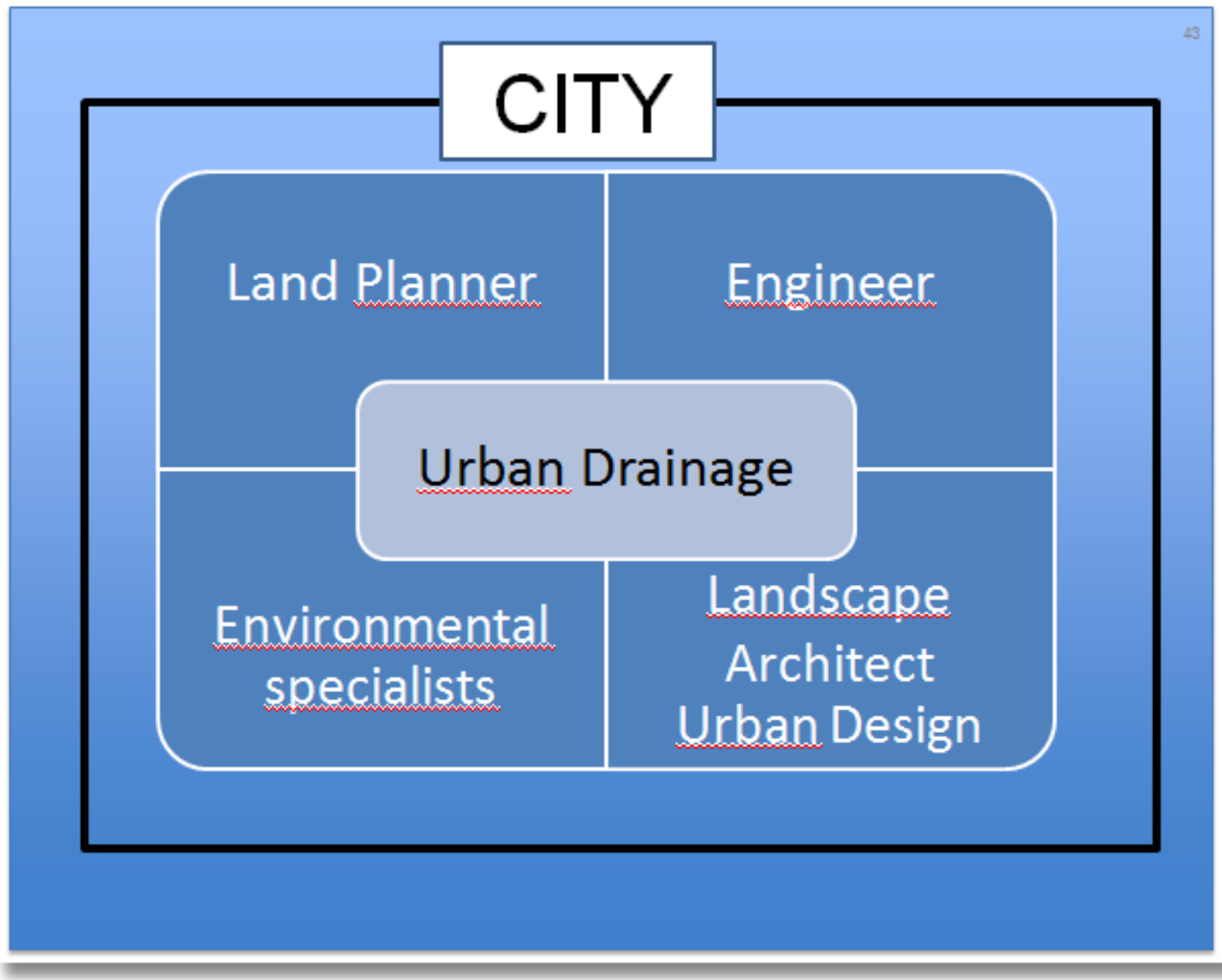
MULTI DISCIPLINES



TO CONCLUDE…

- **GREEN INFRASTRUCTURE IS A NECESSARY ELEMENT FOR SUSTAINABLE DRAINAGE SYSTEMS**

- **MANAGEMENT OF ENTIRE RAINFALL SPECTRUM AND RUNOFF VOLUMES (NOT ONLY DISCHARGES)**

- **SOME OF MAIN BARRIERS ARE FINANCIAL**
- **TO OVERCOME CULTURAL AND INSTITUTIONAL BARRIERS – DEVELOP COMMON REFERENCE SYSTEMS**

TO REALLY CONCLUDE…

- **OPERATION AND MAINTENANCE: GREEN INFRASTRUCTURES IMPLY NEW ORGANIZATIONAL CHALLENGES**
- **REDUCE UNCERTAINTIES THROUGH EDUCATION, TRAINING AND STANDARDIZATION**
- **COLLABORATION AND DESIGN IN A MULTI-DISCIPLINES CONTEXT**

- **BARRIERS TO IMPLEMENT ARE OFTEN INTERDEPENDENT: STRATEGIES SHOULD BE WELL INTEGRATED**

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