Sustainable Surface Water Management in Cities

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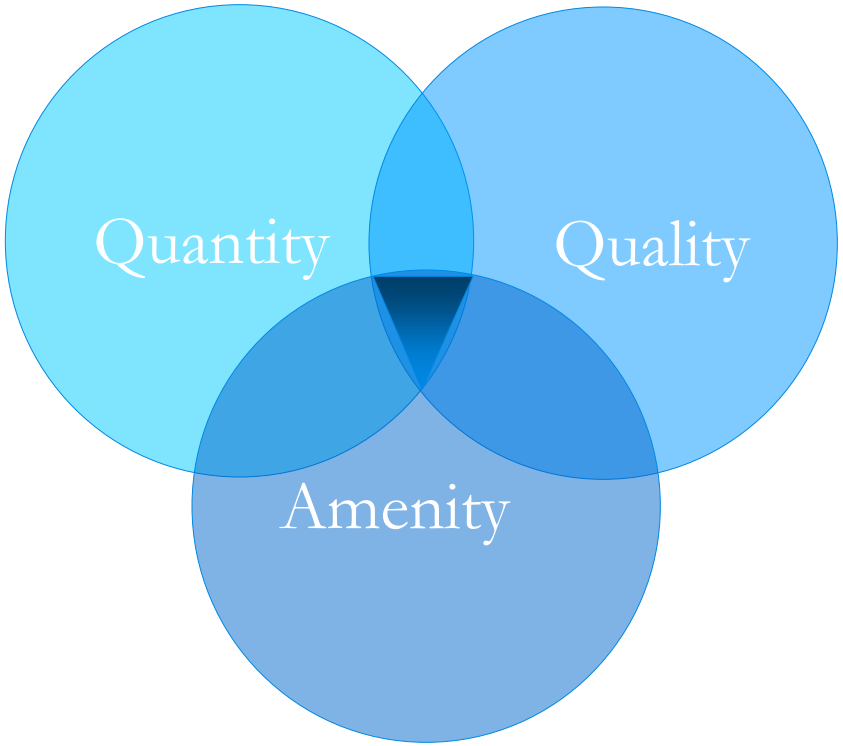
Introduction

This is also the law – just do it!

But some things are just not appropriate

SUDS are the law in Scotland. SUDS are required for ALL new developments. It's the law – just do it!

The SUDS triangle



The SUDS triangle

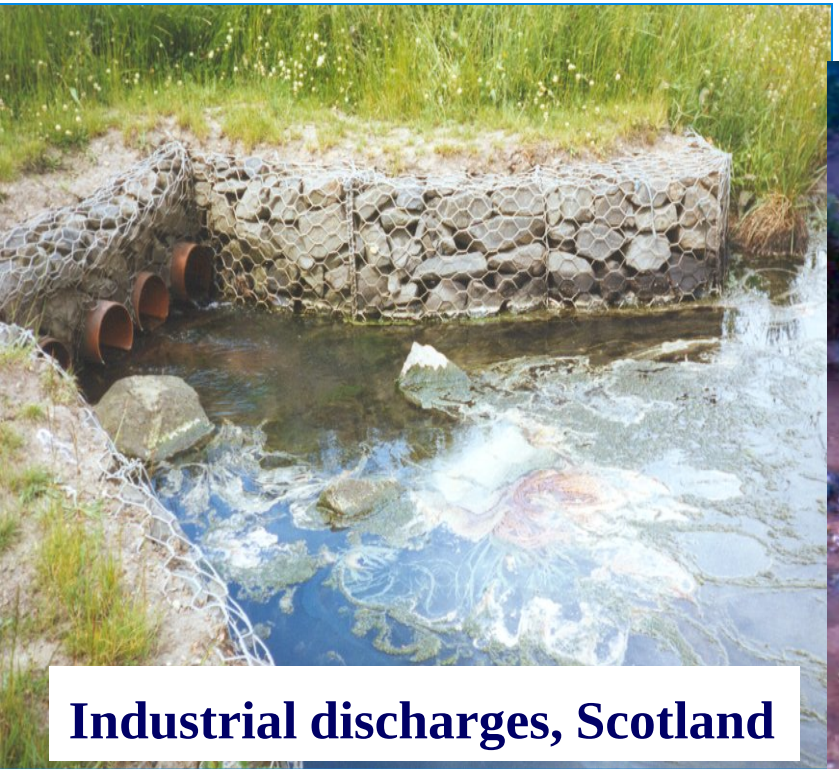
Illustrates the three drivers for drainage systems which are also;

- Technical
- Social
- Environmental

‘Sustainable’ has many different meanings

Water quality problems caused by excess surface water

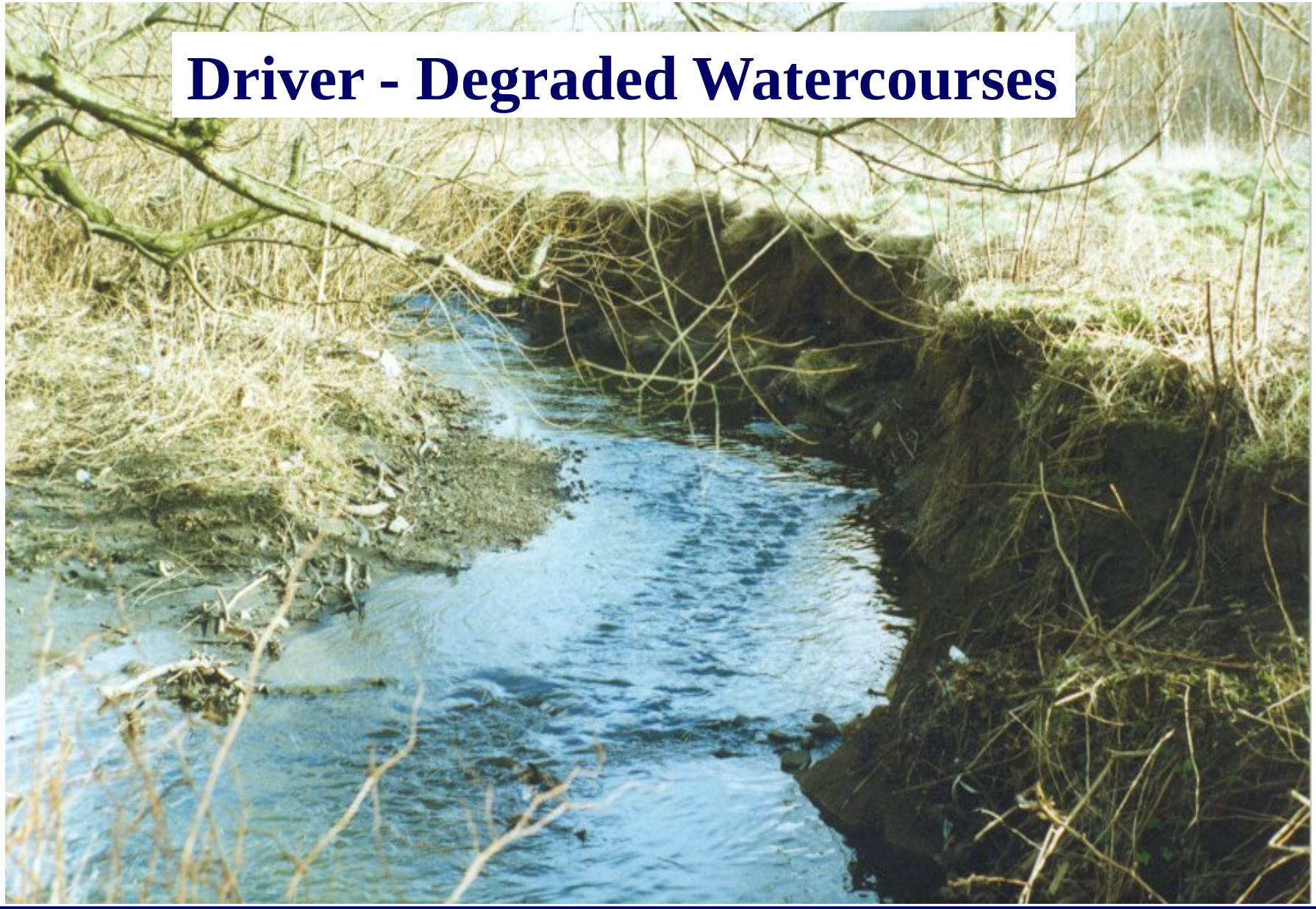
1. Diffuse pollution; industrial, residential, commercial
2. Point source discharges
3. Excessive flow in combined sewers



Industrial discharges, Scotland

Extreme pollution, India

Driver - Degraded Watercourses



Driver – Control of flooding

Driver - Diffuse Pollution

Driver - combined sewer overflow spills

Solutions to water quality problems

1. Traditional solutions of increasing capacities of pipes, pumps, storage.
2. Disconnection of surface water from existing systems (retrofit).
3. Source control solutions in new areas.
4. Site and regional control in new areas.

Good Housekeeping

Source controls are most important element of treatment train

Source Control

Site control

Regional Control - polishing

River

Pollutant Concentration

Distance From Source

Example from Berlin

Berlin – street

Example from Belo Horizonte, Brazil

Belo Horizonte - Flood attenuation pond in park

Drenurbs in Belo Horizonte, Brazil

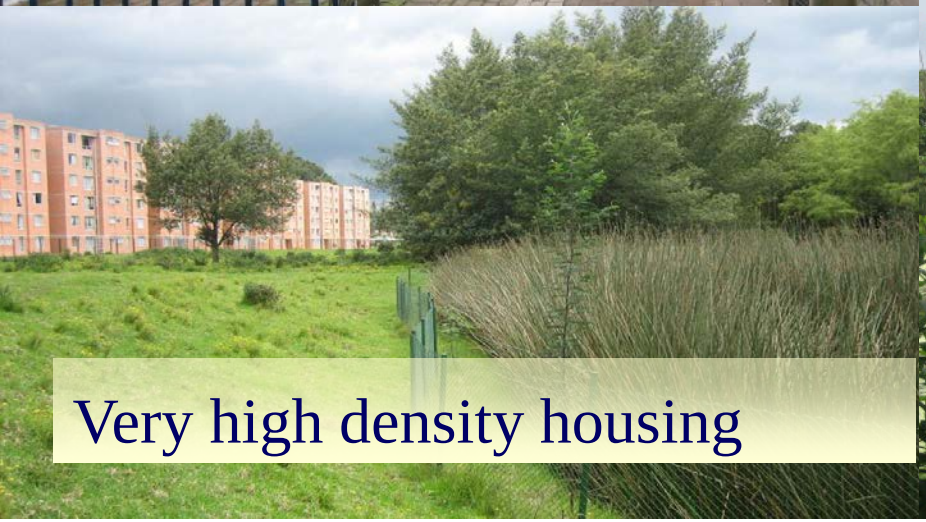
Community at risk of flooding

Flood control pond

Important social area

House values rising fast

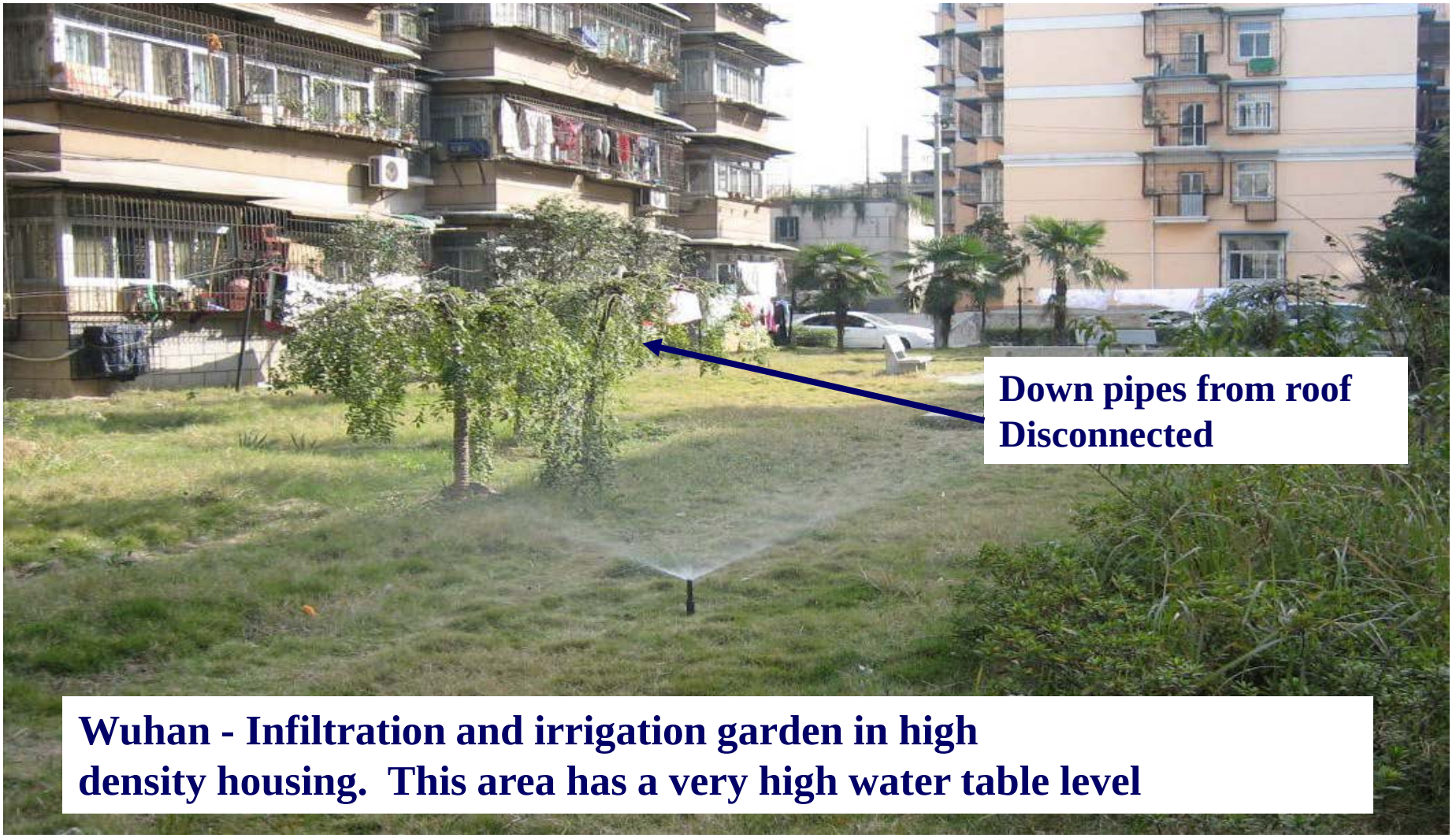
Example from Bogota, Colombia



Very high density housing

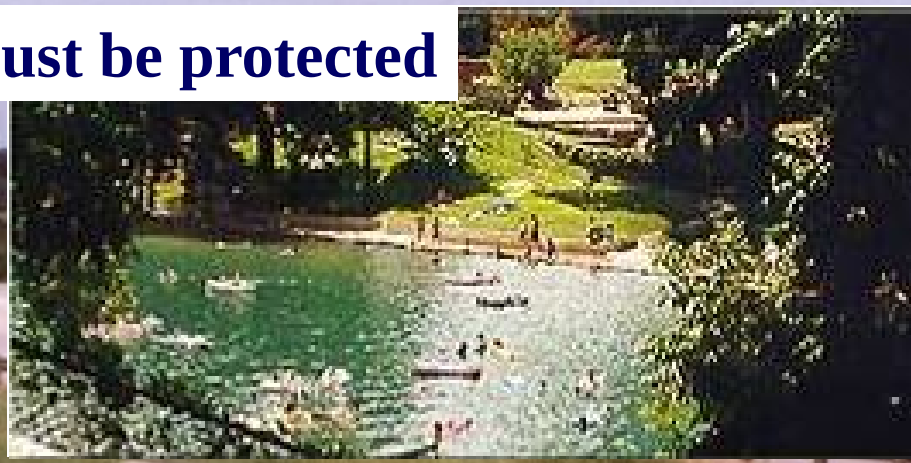
Unique wetlands due to altitude

Example from Wuhan, Central China



Wuhan - Infiltration and irrigation garden in high density housing. This area has a very high water table level

Barton springs – highly valued – must be protected



Austin filters – very expensive protection of groundwater

Example from Vaasa, Finland

Driver – water quality in Gulf of Bothnia

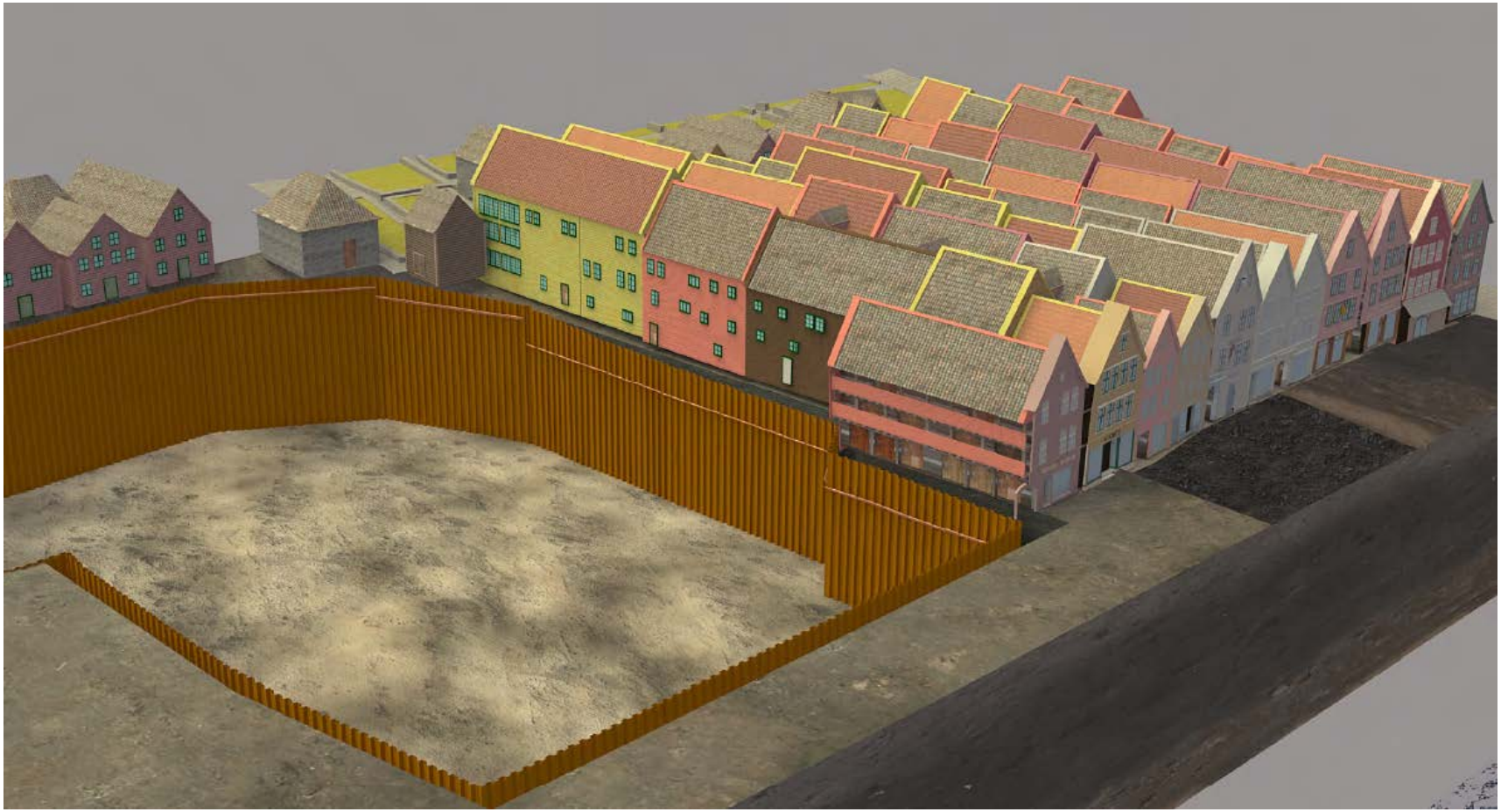
Basin

Disconnected roof water

Example from Bryggen, Bergen

Driver – damage to foundations of ancient buildings

Solution is to use SUDS to re-introduce surface water into ground

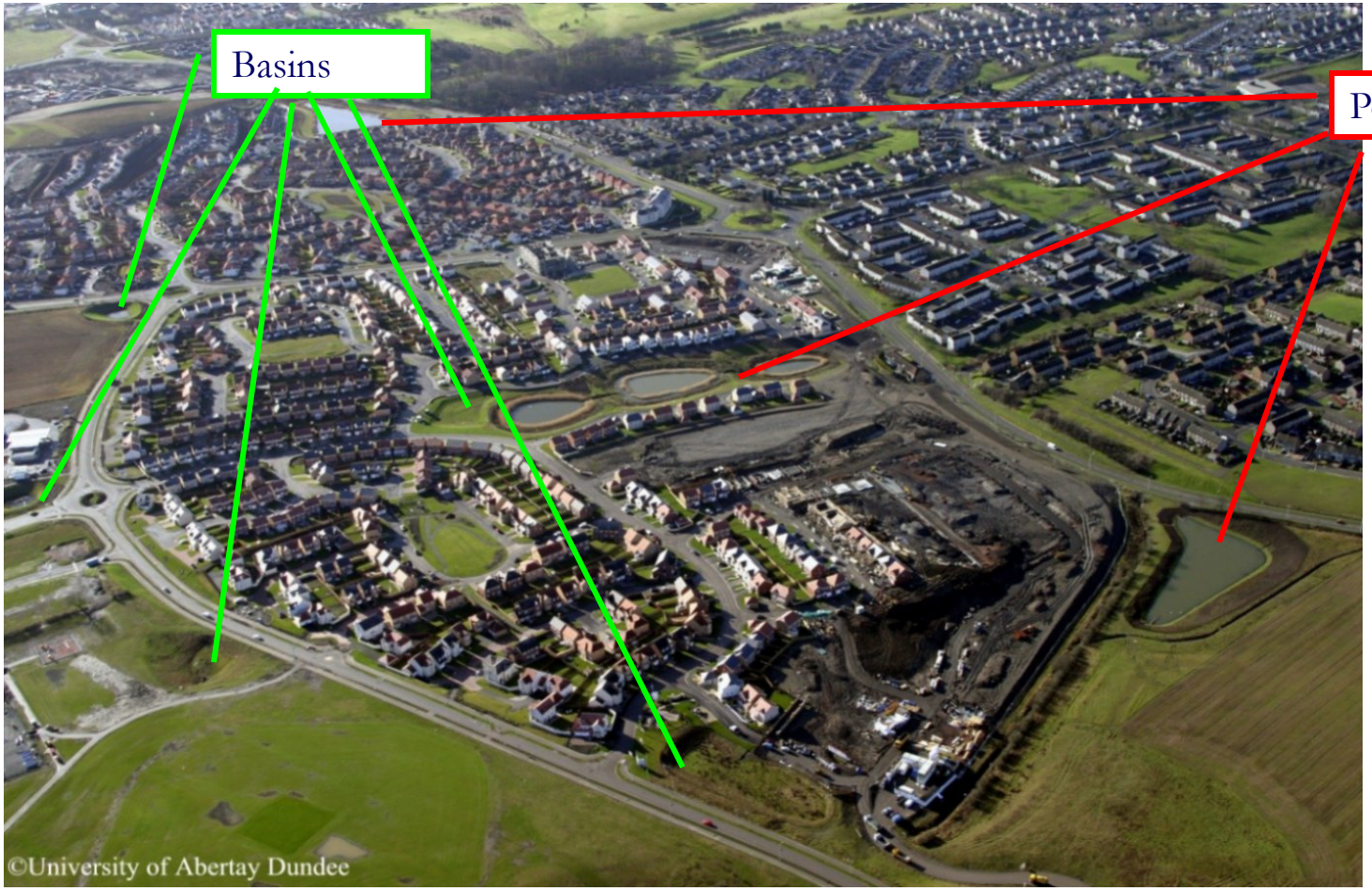


Key Issues in Scotland

1. Levels of treatment related to risk of contamination and damage to receiving water body.
2. Volume and continuation flow to ensure no worse flow conditions downstream.
3. Ownership and maintenance of SUDS
4. Using excellent examples as demonstrations

Examples from Scotland

Major 350 Ha development. Drainage a key driver



Examples from Scotland

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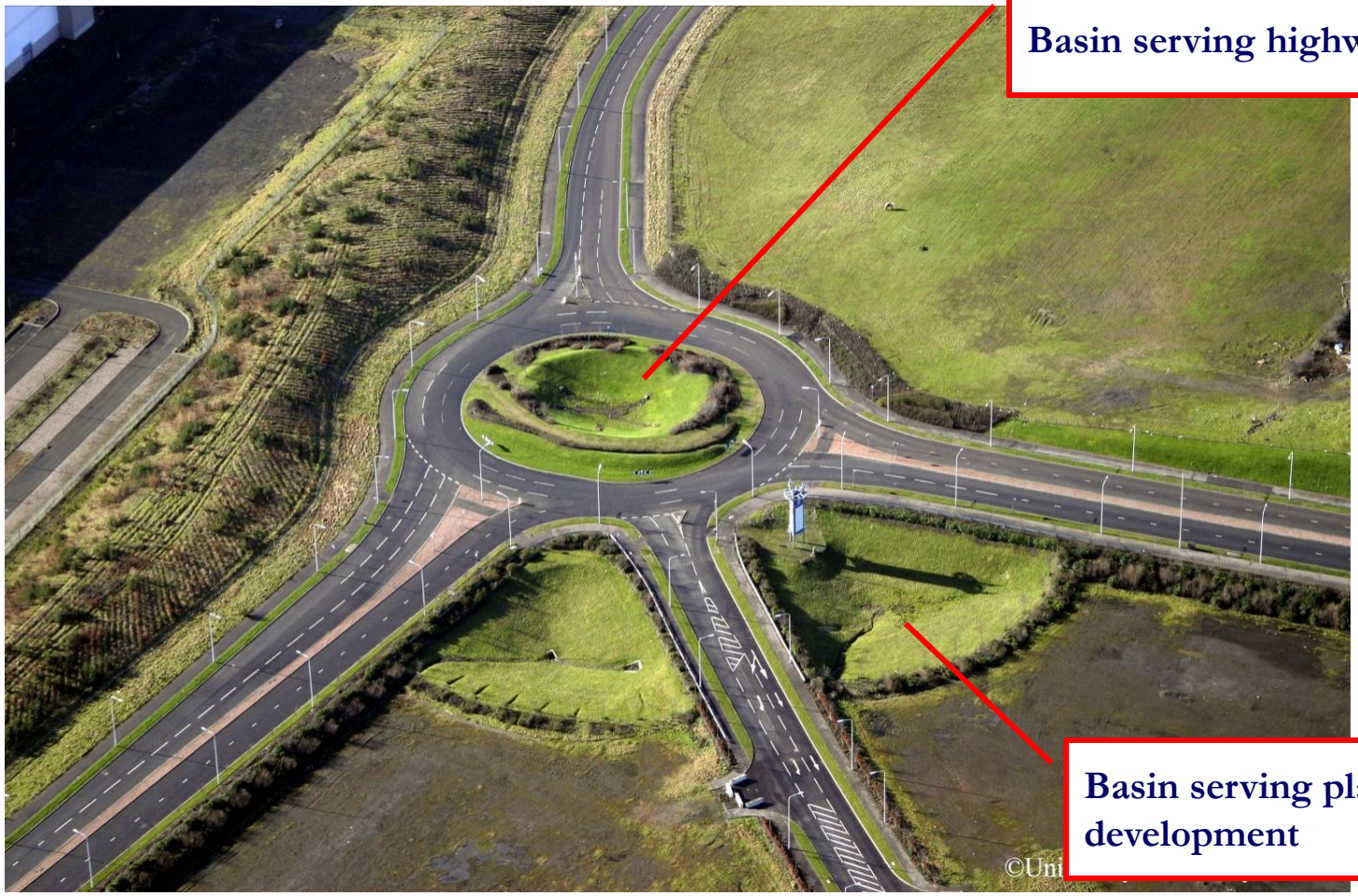


Laying blocks in street renewal in Holland

Retrofit to meet flow and quality requirements

Blocks as part of a Homezone at a school in Scotland

Social agenda.

Attention to detail

Source control in Essen, Germany

Retrofit in rehabilitated housing

Reduction of drainage charge to residents

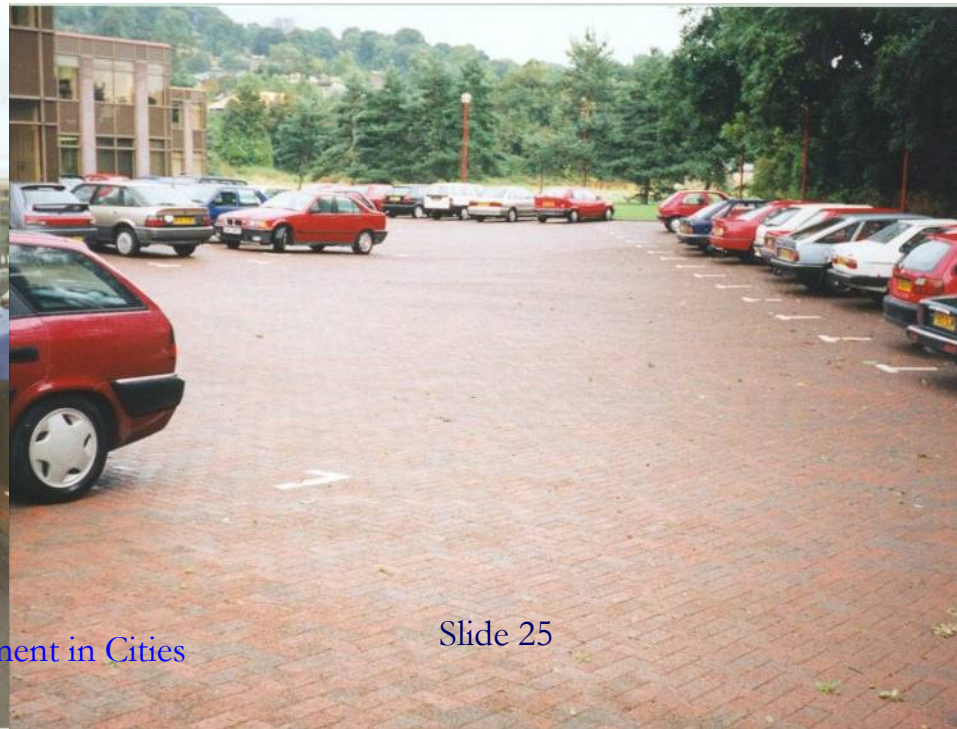
Examples from Scotland

All new developments require SUDS

Source control is preferred by Scottish Environment Protection Agency

Two levels of treatment are normally required

Permeable paving is widely used as source control



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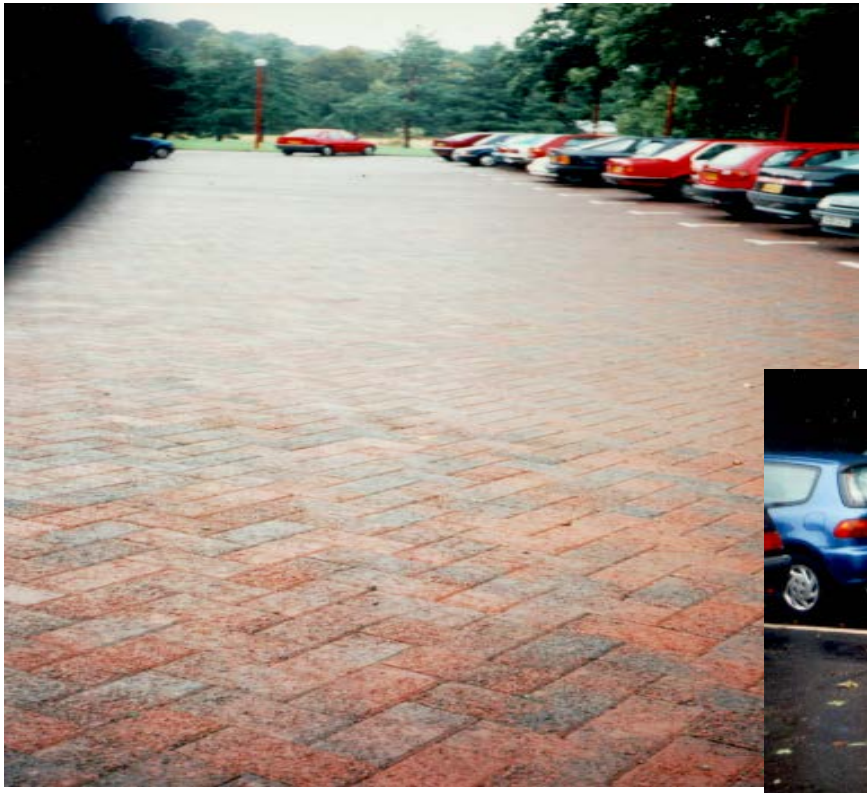


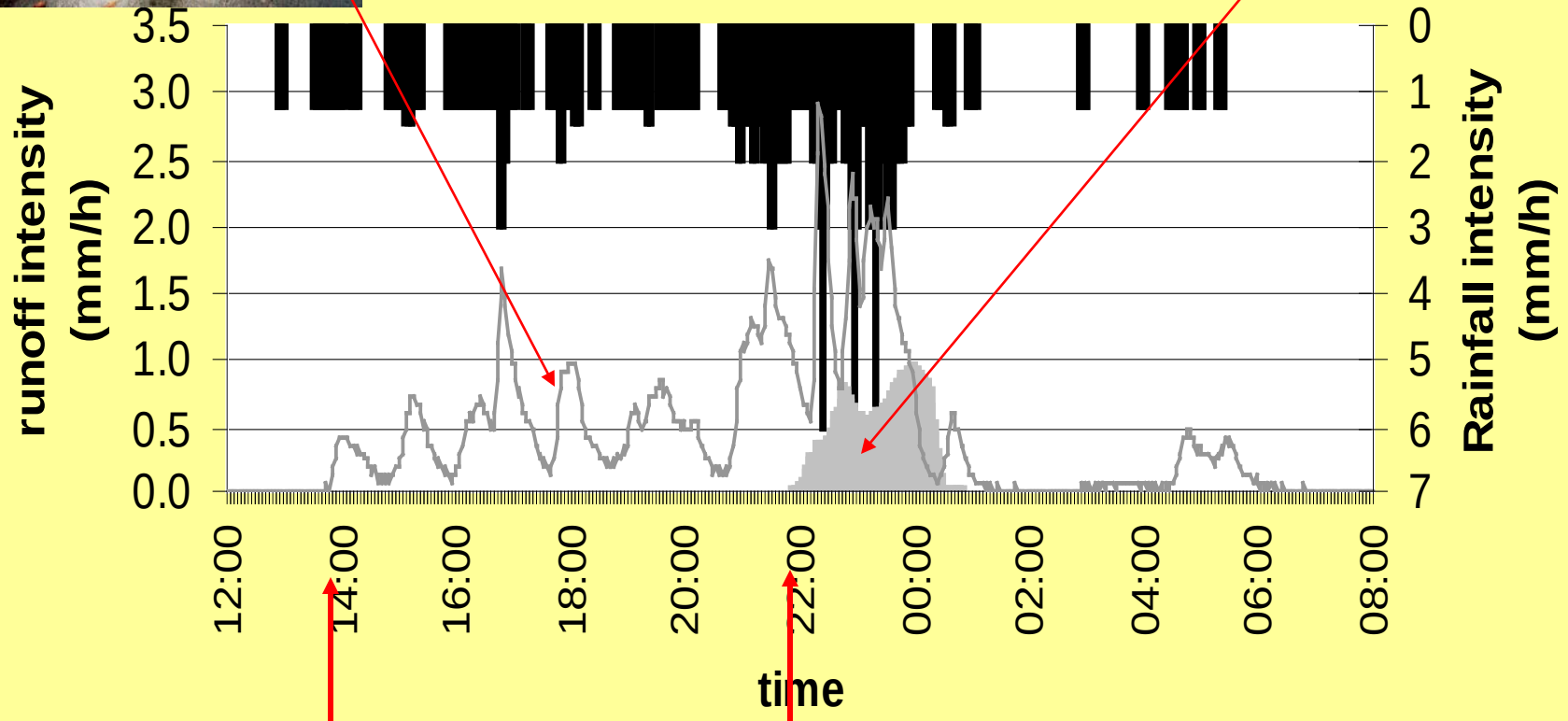
Two car parks – one office

New permeable car park

Earlier car park - asphalt with ponding

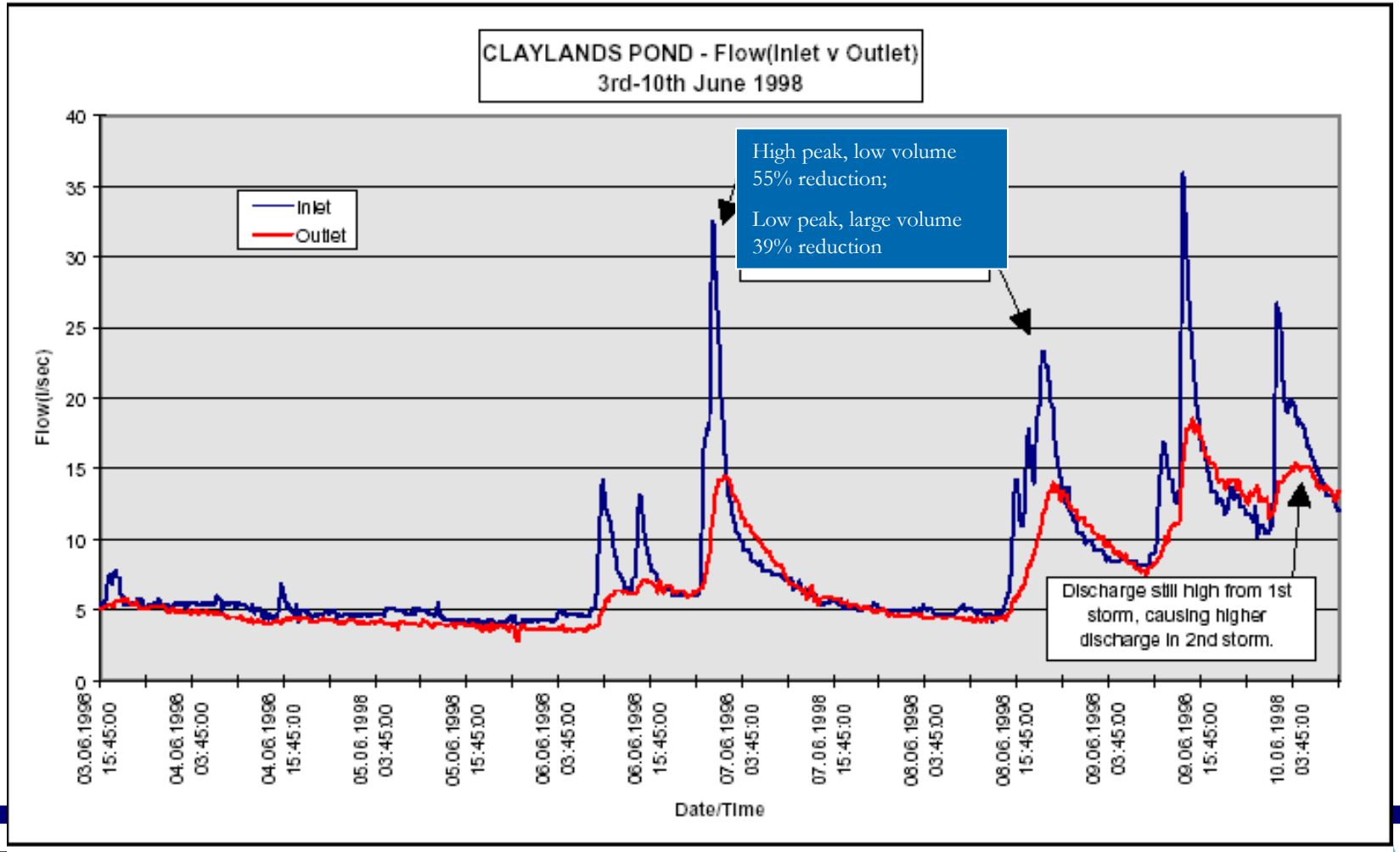
rom Scotland

aving gives good source control



8 hour time delay of runoff

Hydrological Behaviour - Typical Hydrograph of pond



Examples from Scotland

All new developments require SUDS

Source control is preferred by Scottish Environment Protection Agency

Two levels of treatment are normally required

Developers frequently select basins

Examples from Scotland

All new developments require SUDS

Source control is preferred by Scottish Environment Protection Agency

Two levels of treatment are normally required

Ponds give extra treatment and high amenity

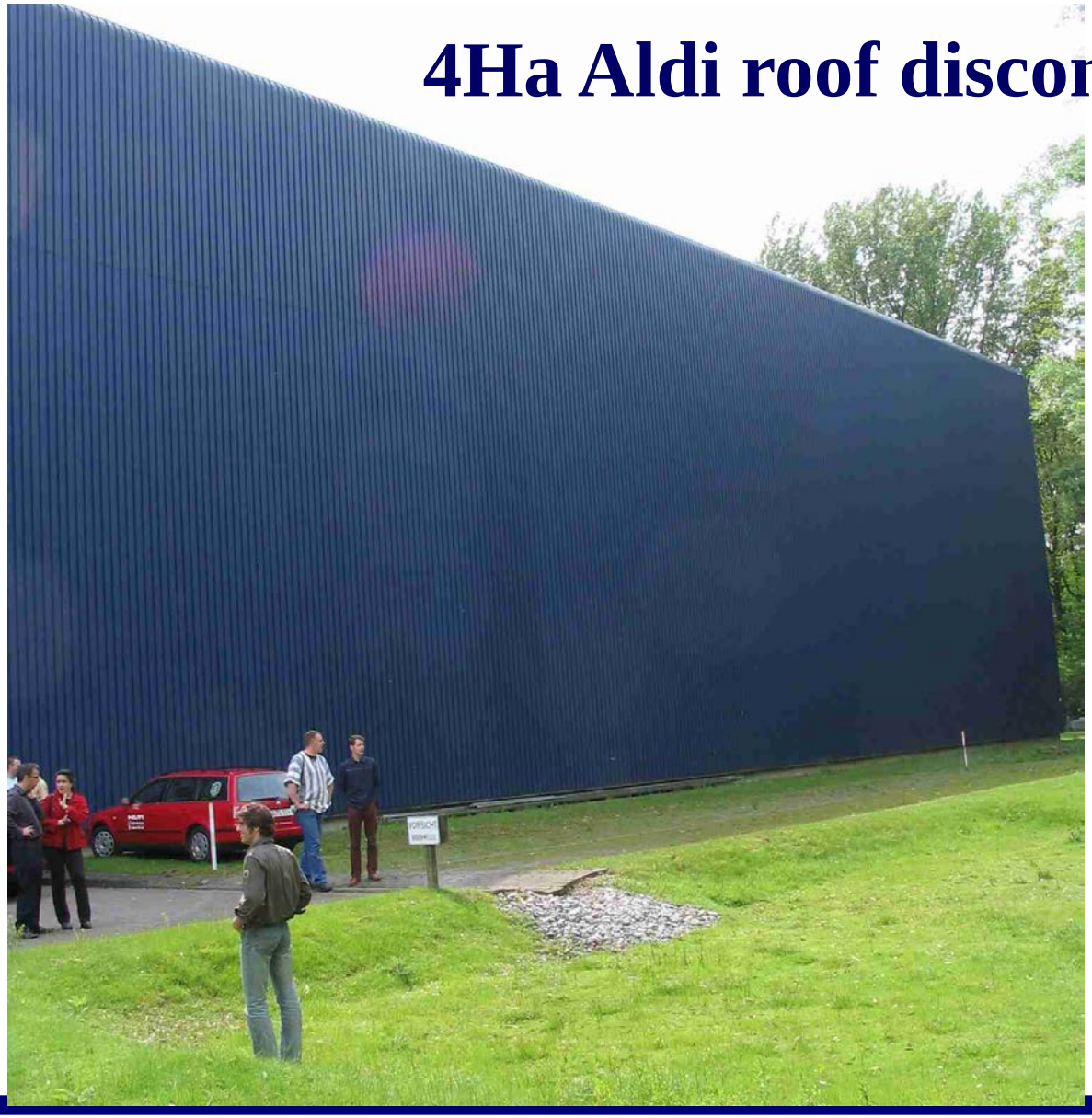
First and second level SUDS

Table 3.3 *Number of treatment train components (assuming effective pre-treatment is in place)*

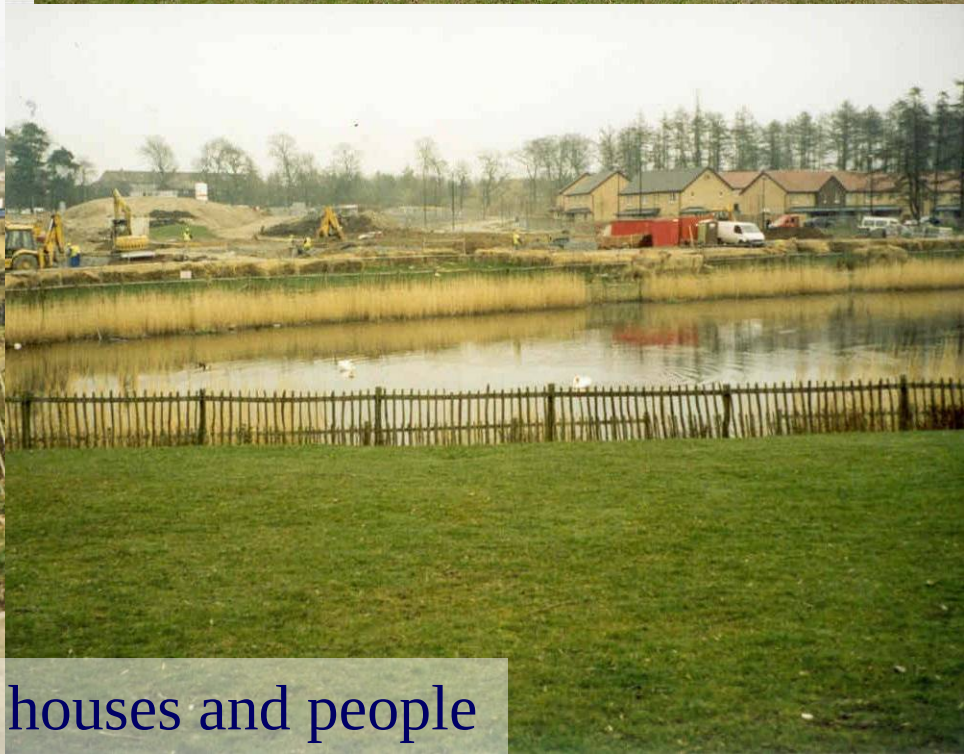
Receiving water sensitivity → / Runoff catchment characteristic ↓	Low	Medium	High
Roofs only	1	1	1
Residential roads, parking areas, commercial zones	2	2	2
Refuse collection/ industrial areas/ loading bays/lorry parks/highways	3	3	3

Permeable Asphalt

4Ha Aldi roof disconnection




Swales
Inadequate culvert
© 2009 Infoterra Ltd & Bluesky
© 2008 Tele Atlas
56°29'17.47" N 3°00'27.76" W
Apr 4, 2007
Eye alt 200 m



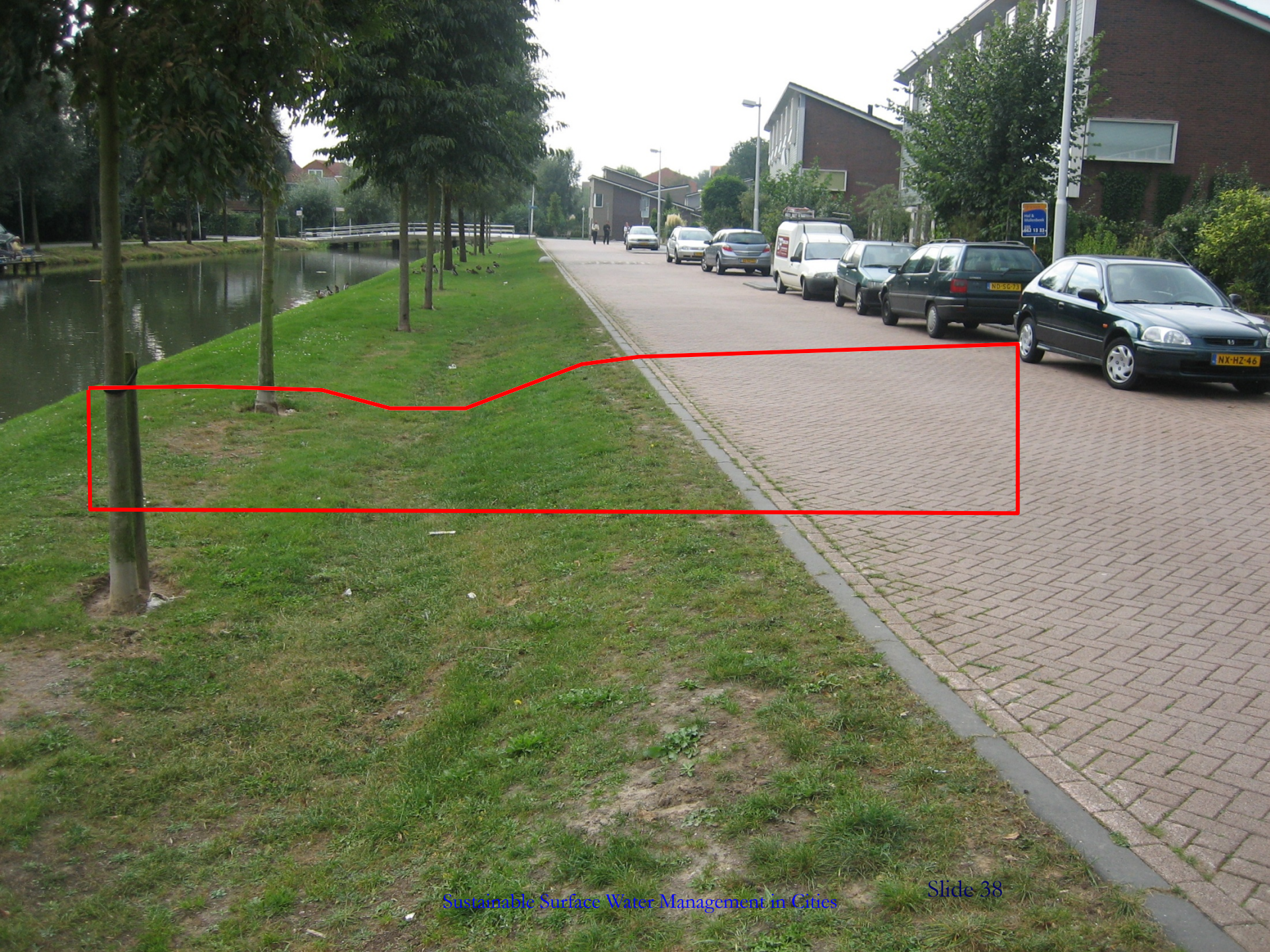
Construction in and around houses and people

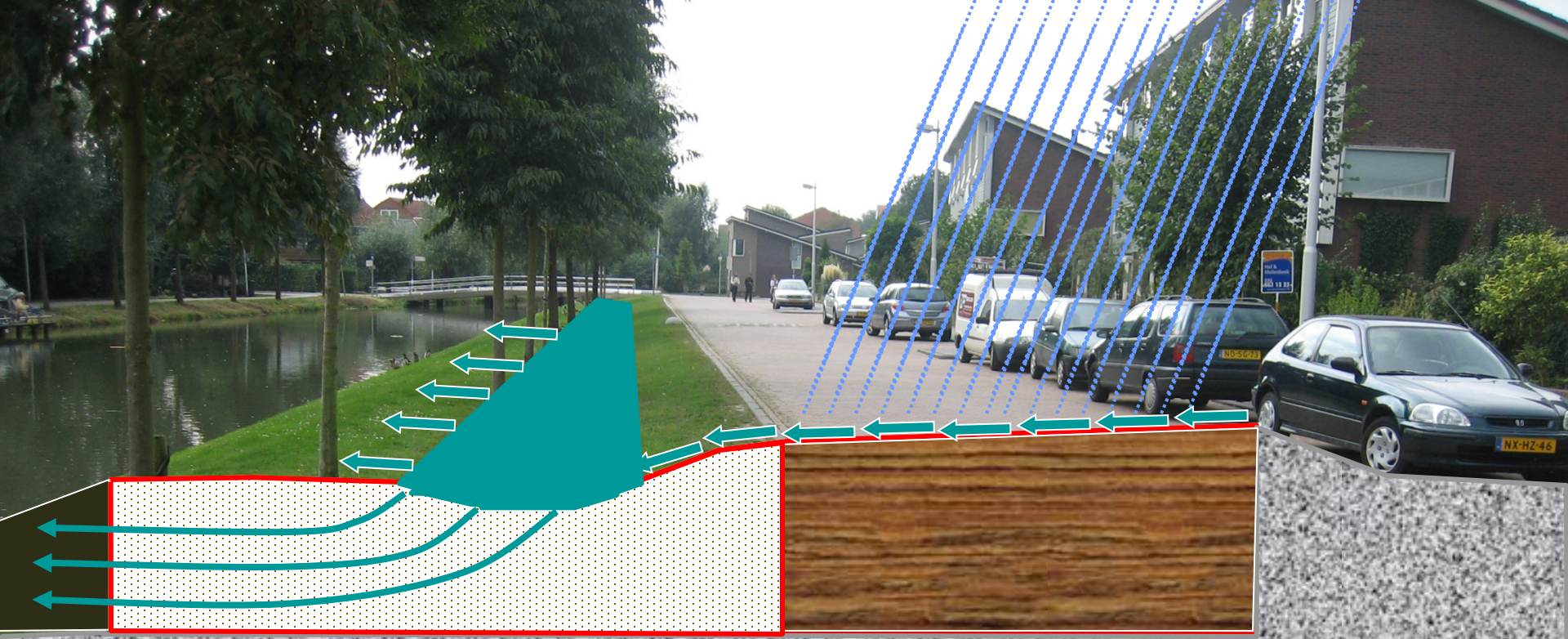
Google arial view of Ardler west pond

Conveyance swale

Examples from Holland

- **SUDS Beside a canal in Holland**.
- Development is high density – this is the only area of green space.
- Control of water takes place both in the road and in the adjacent green space





How many levels of treatment can you see?

Flood problems cause by surface water.

1. Limited channel capacity
2. Insufficient elevation.
3. Construction of new developments.
4. Increasingly paved contributing area.

River Kifisos, Athens

Where did the river go?

Solutions to flooding problems

1. Storage to reduce flows.
2. Bank raising.
3. Moving local people.
4. Diversion channels.
5. Located in SUDS

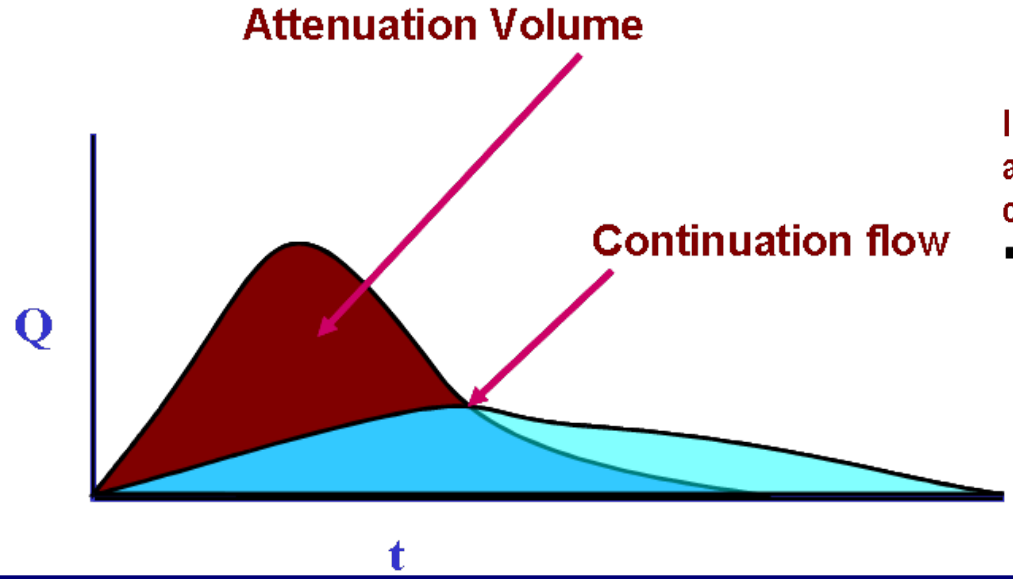
Storage Pond in Colorado, USA

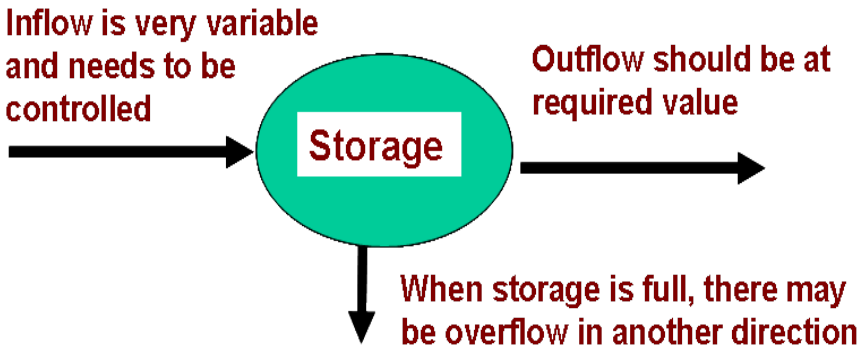
SUDS - hydraulic design points

1. Flow control must be located for hydraulic and maintenance purposes
2. Methods of flow control; pipes, weirs, vortex controls
3. Required storage must be created
4. Design of inlets – access, maintenance, erosion issues

Functions – Volume for Flow Control

- A volume of storage is required to attenuate flows.
- Location of this volume is relatively unimportant – although local control is desirable.
- Configuration of this volume is relatively unimportant.
- External requirements will justify the continuation flow specified.
- A flow control device or pipe is essential to achieve the control required.

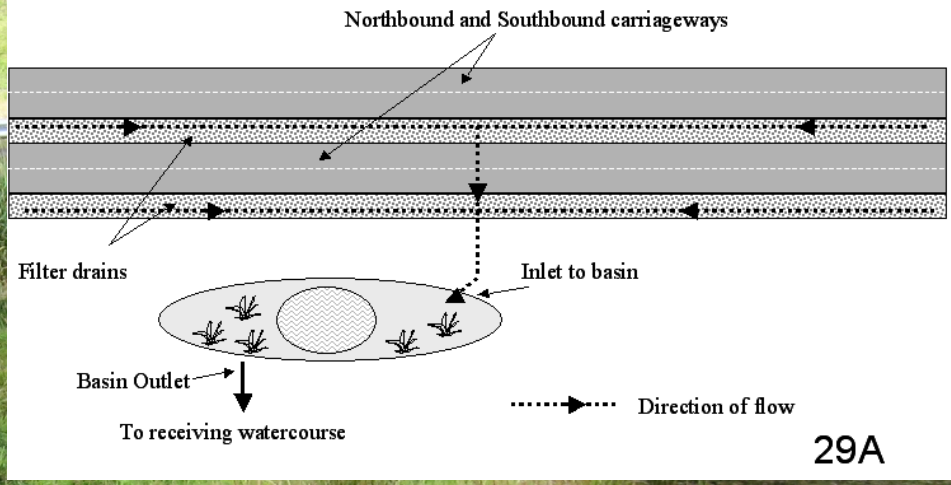




Maintenance is very important - sediment removal

Infiltration study on major highway

Basin 29A



Sample location

Flow Paths

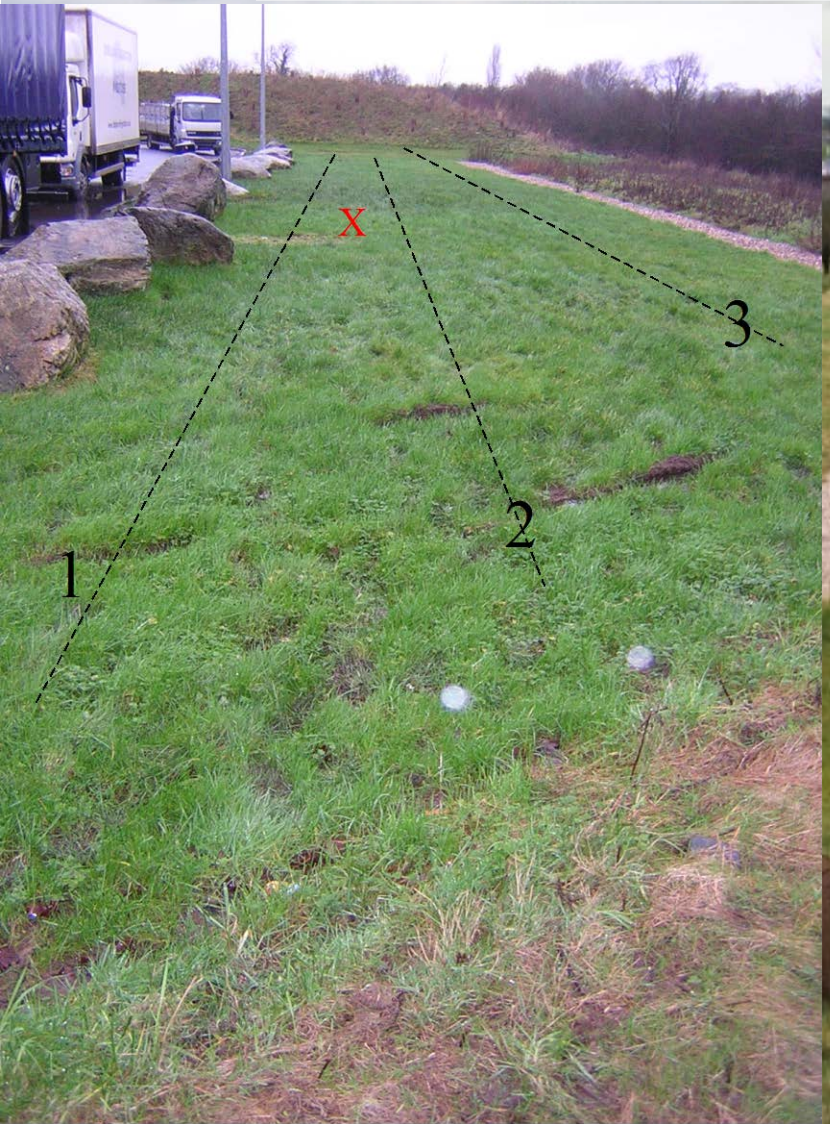
Horizontal and vertical sampling

Inlet

Filter Strip

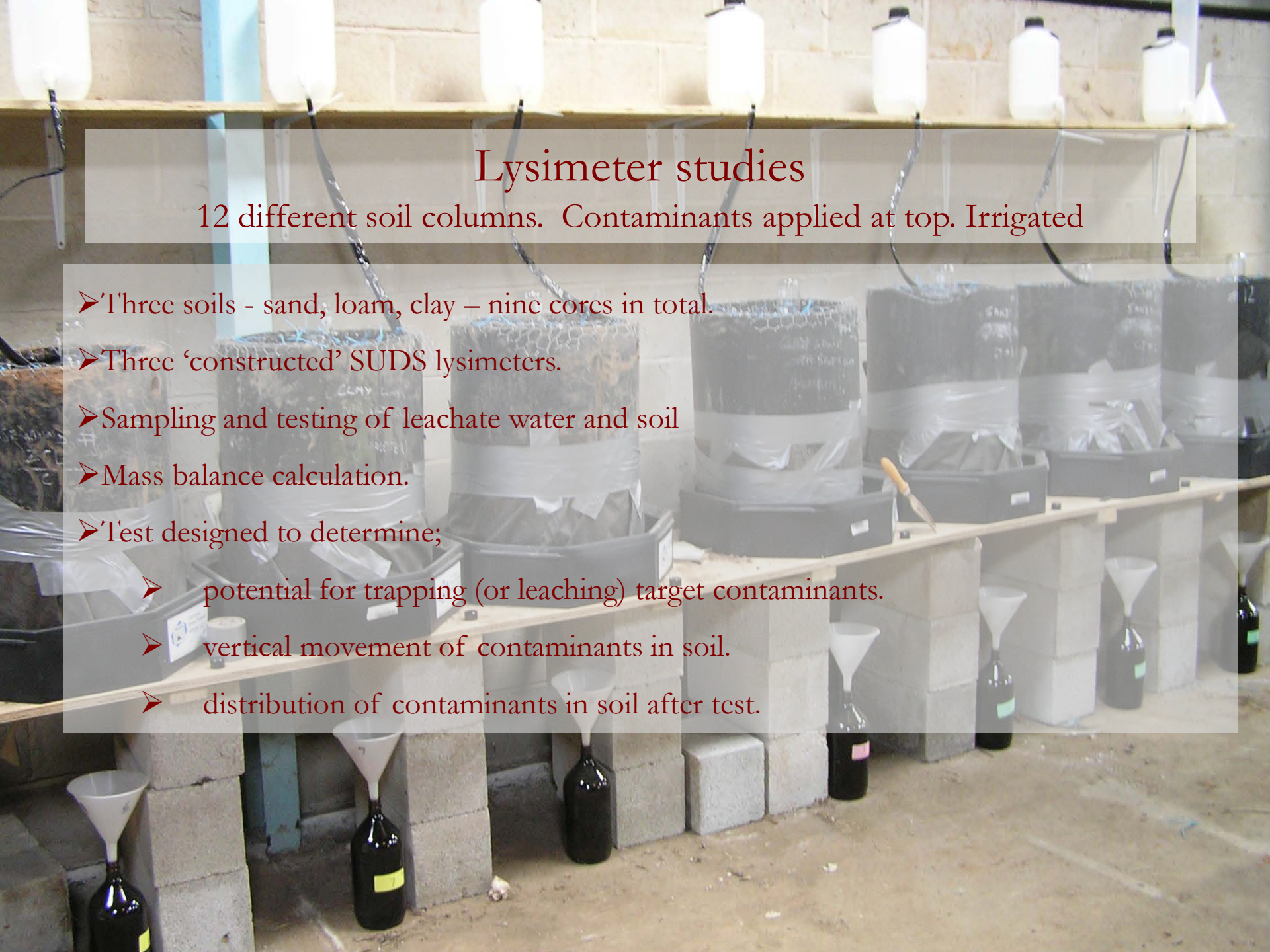
At a motorway service area

Vertical and horizontal difference measured



Degradation Study

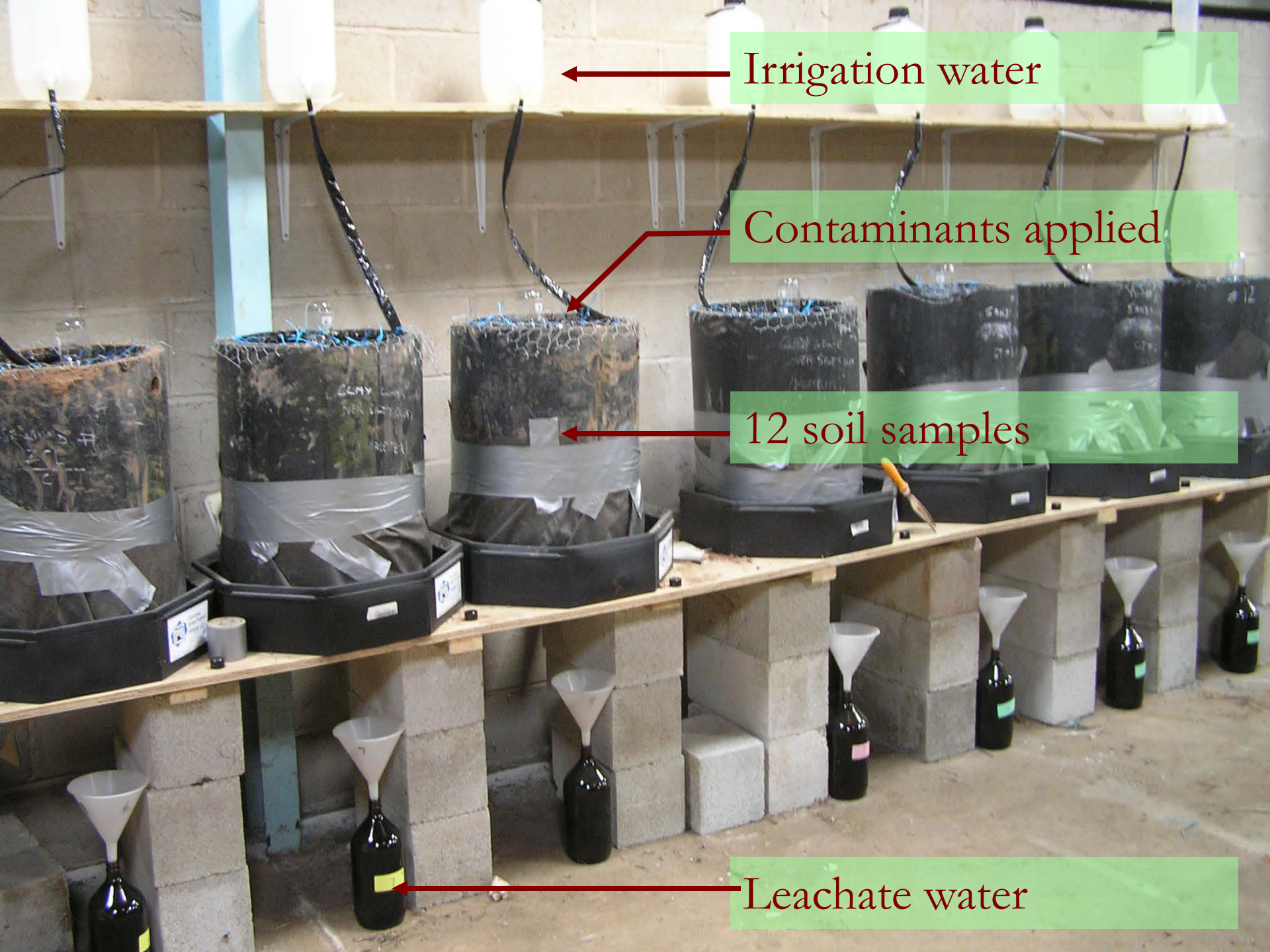
- Lab based study on one of the soils (loam)
- Investigating breakdown of PAH, Hydrocarbons.
- Range of conditions;
  - Two temperatures
  - Two moisture contents
  - 8 timesteps up to 3 months



Lysimeter studies

12 different soil columns. Contaminants applied at top. Irrigated

- Three soils - sand, loam, clay – nine cores in total.
- Three 'constructed' SUDS lysimeters.
- Sampling and testing of leachate water and soil
- Mass balance calculation.
- Test designed to determine;
  - potential for trapping (or leaching) target contaminants.
  - vertical movement of contaminants in soil.
  - distribution of contaminants in soil after test.


Irrigation water
Contaminants applied
12 soil samples
Leachate water

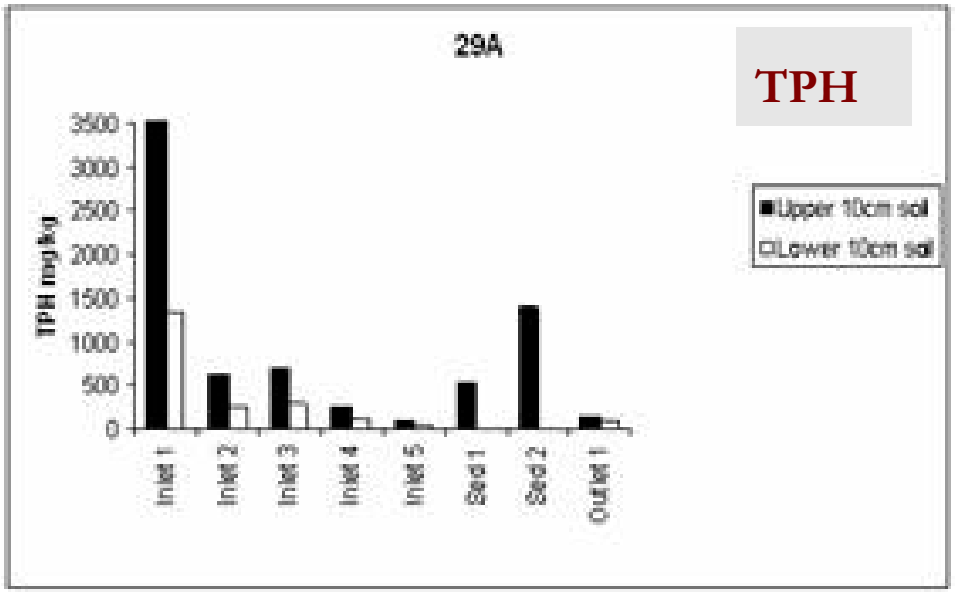
Initial results –Lysimeter percentage removal by soil type

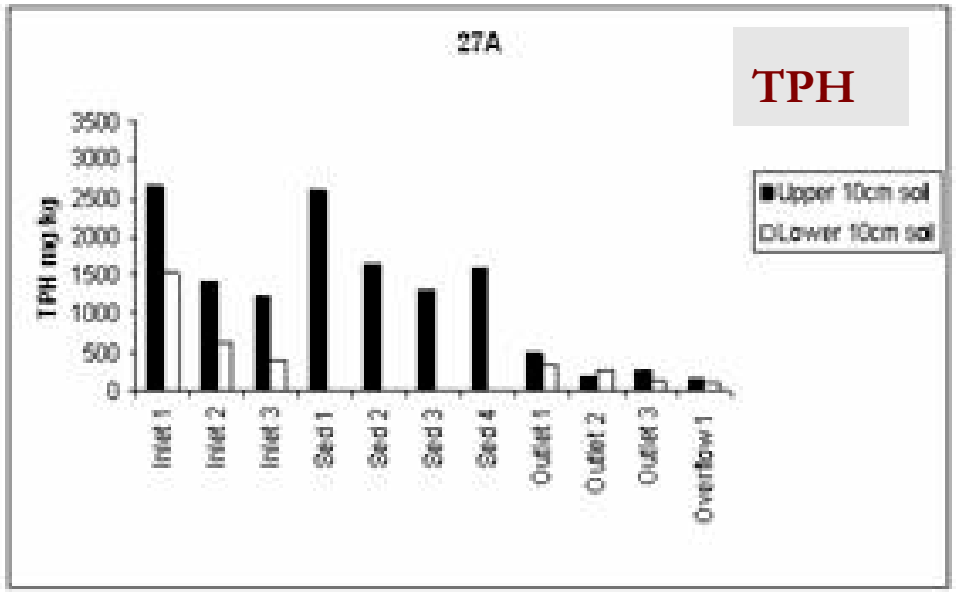
Lysimeter	Cadmium	Copper	Zinc	TPH	Total PAH
SUD	0.039	0.111	0.021	0.003	0.002
Silt	0.146	0.079	0.032	0.010	0.004
Clay	0.192	0.257	0.276	0.053	0.054
Sand	0.233	0.088	0.019	0.010	0.002

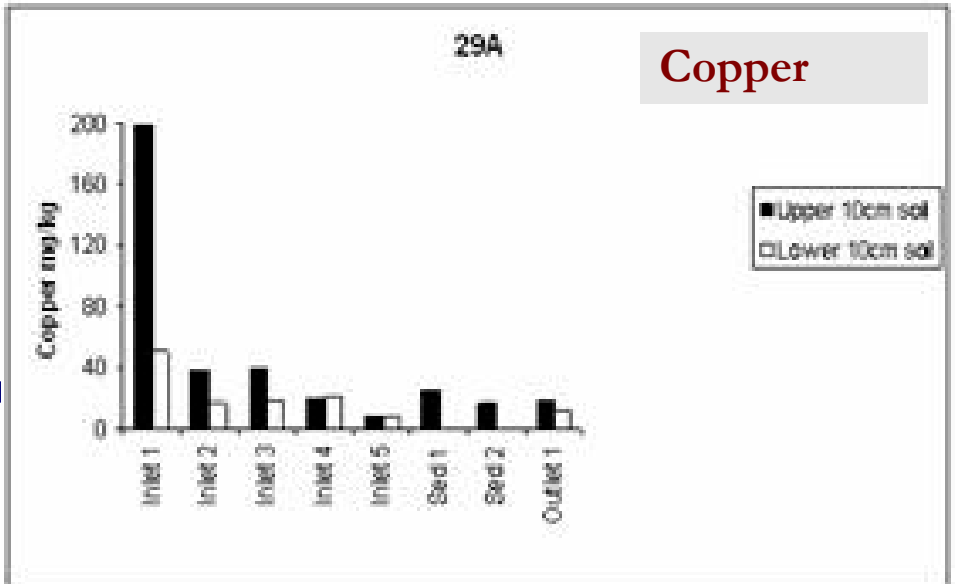
Table 3 *Percentages* of pollutant mass recovered in leachate from soil lysimeters 93 days after pollutant loading applied (total test about 130 days)

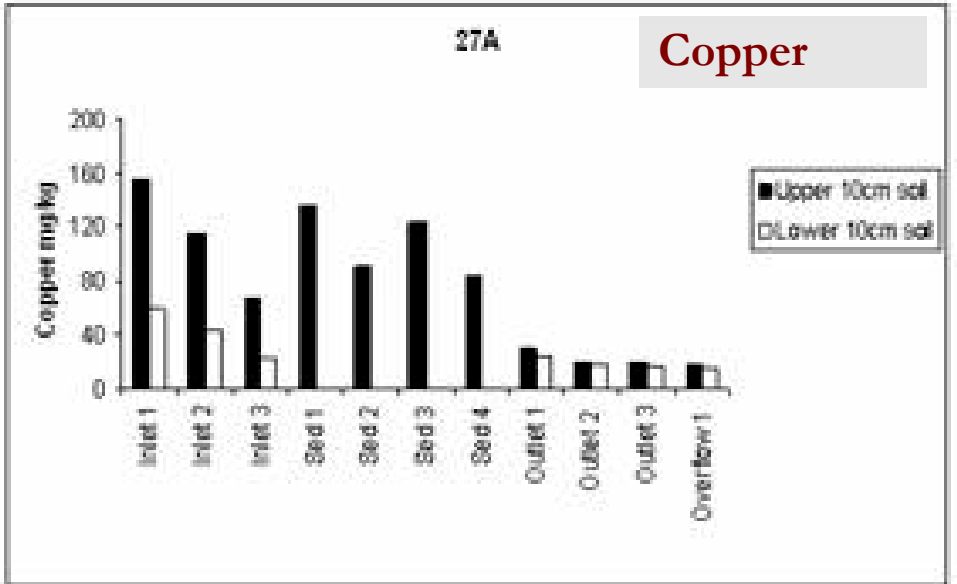
Initial results – field studies

Contaminant concentration in two soil layers









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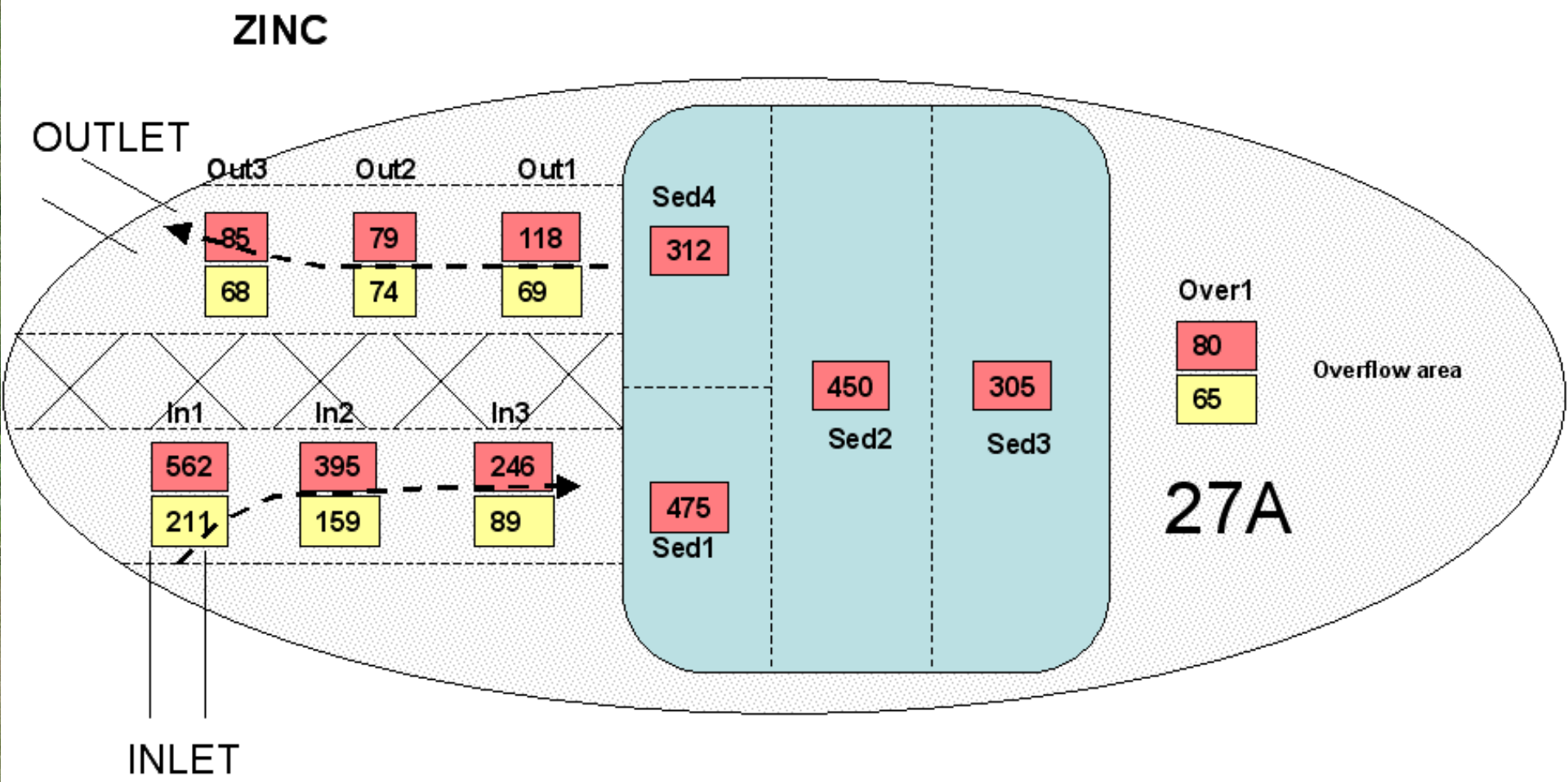

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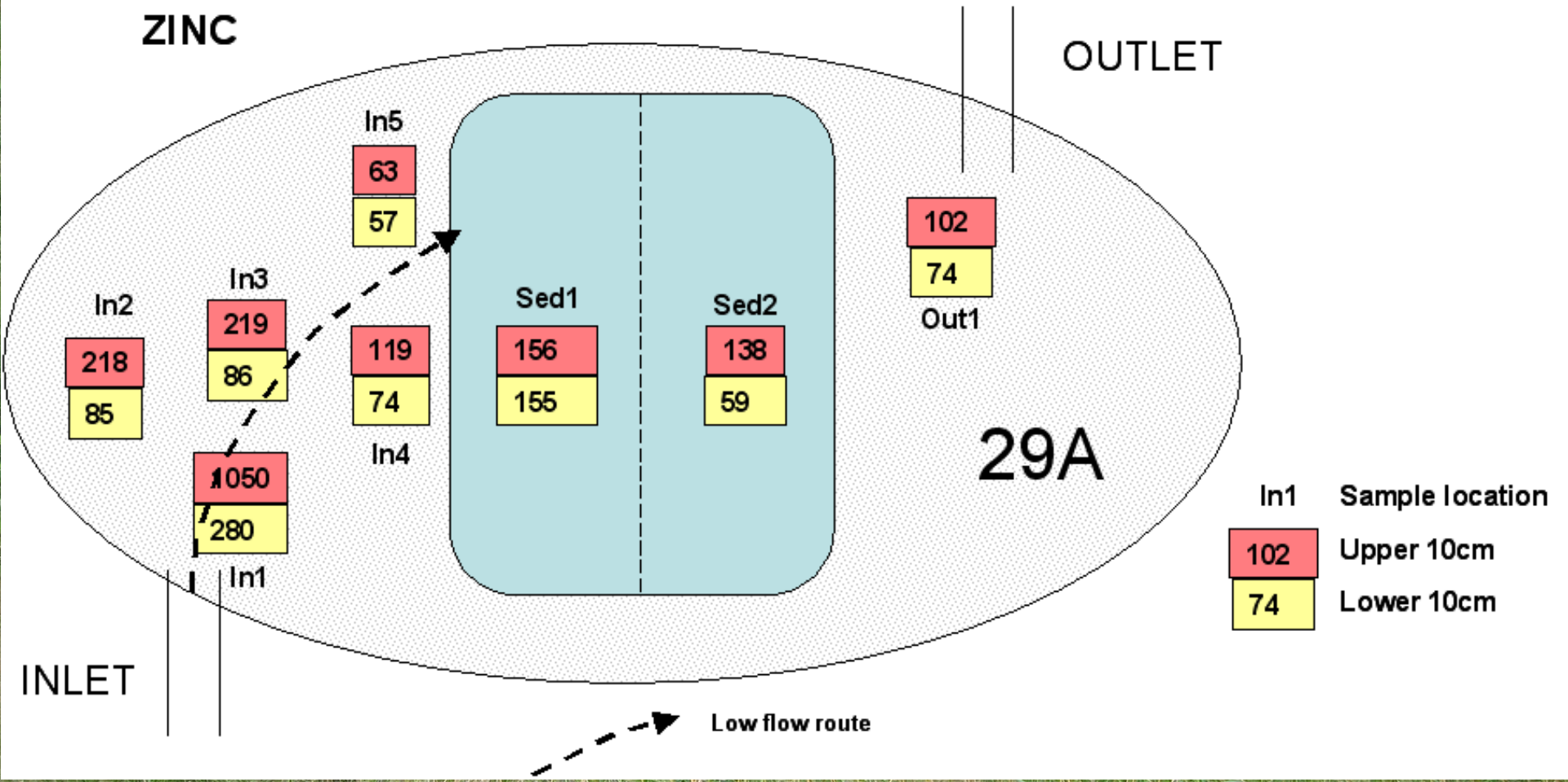

Conclusion

SUDS can be seen to operate in many countries worldwide

Storage and flow control is relatively easy (if space available)

The treatment train concept is used widely.

There are issues of ownership, operation and maintenance

Thank you