

Water Sensitive Cities

Lecture 2: Sustainable Drainage Systems

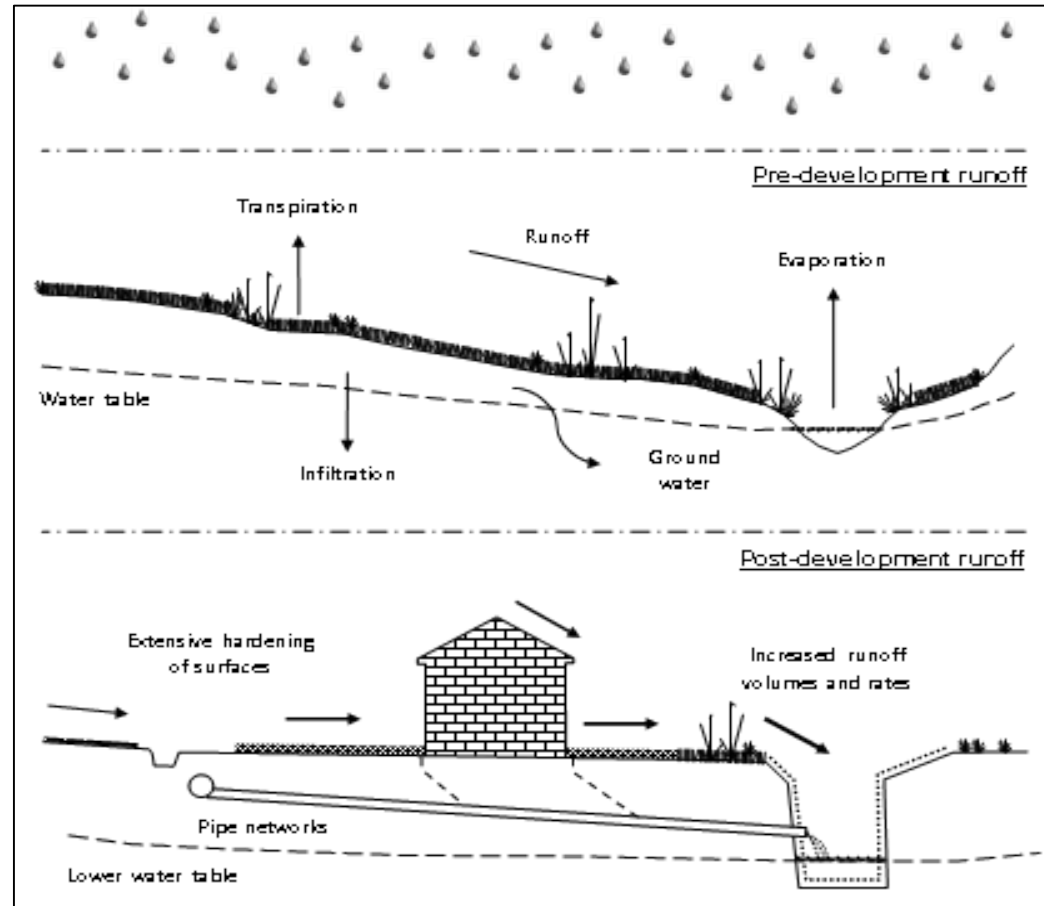
Summer School, UCT, 16 Jan 2018

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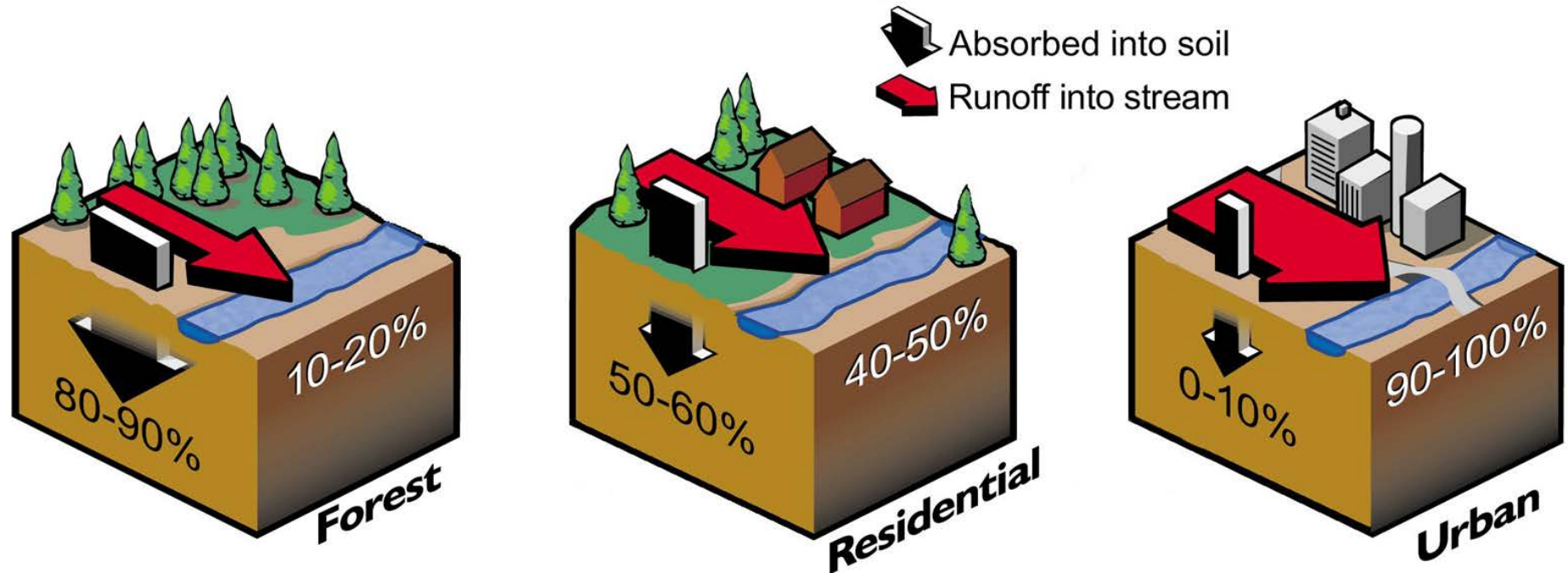


Conventional drainage systems

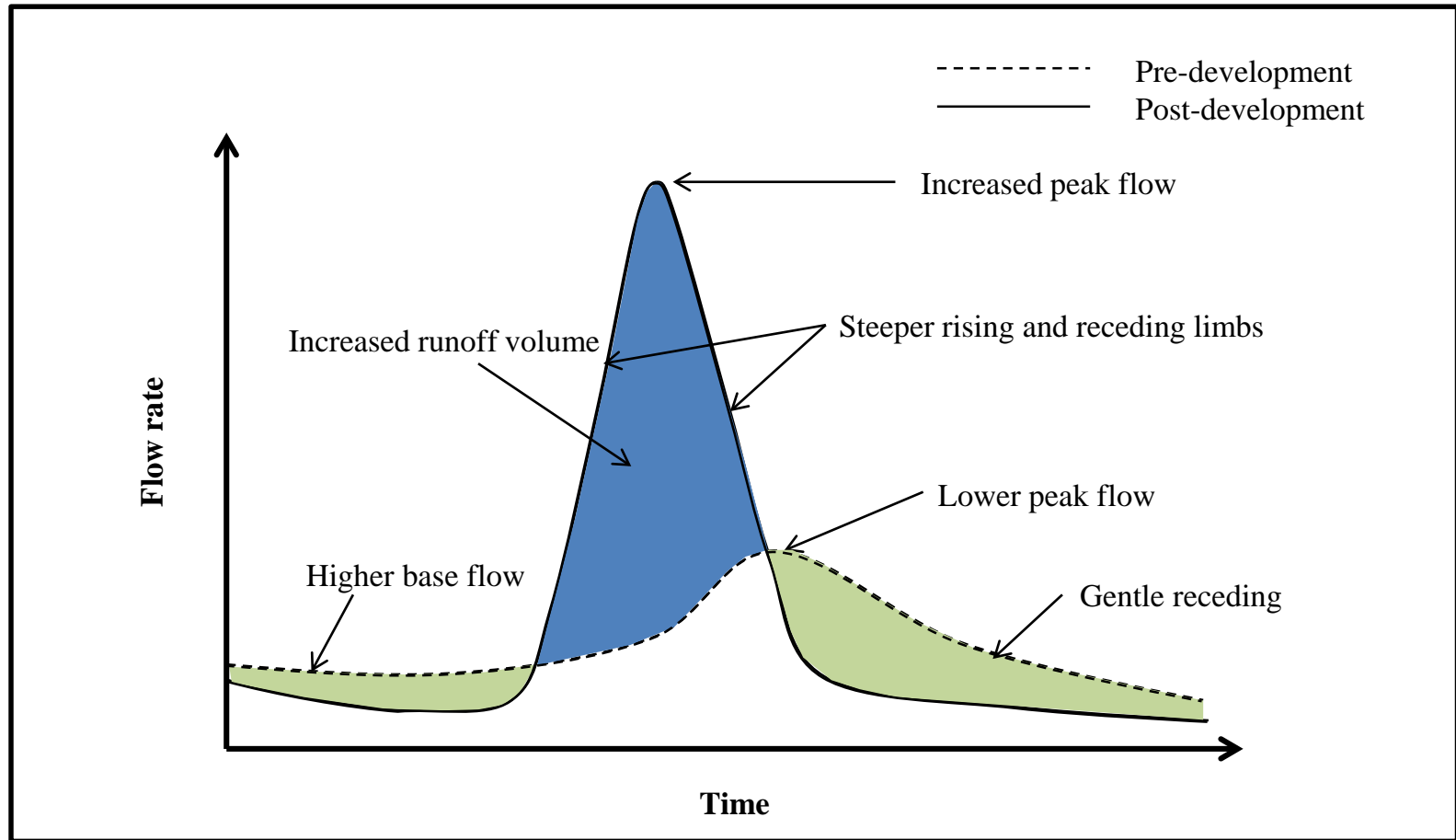
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Historically, drainage systems were designed solely to **minimise inconvenience** and **reduce flood risk** by removing rainwater to the nearest receiving water as rapidly and efficiently as possible



Source: Marsh (1983) as cited in the Georgia Stormwater Management Manual, 2016 edition



Polluted drain (India)

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Sustainable Drainage Systems (SuDS) attempt to mimic the pre-development situation both with regard to runoff quality, runoff quantity, amenity (good for humans) and biodiversity (good for plants and animals) by, *inter alia*,

- treating the stormwater as close to its source as possible, and
- using a “treatment train” to successively treat potential increased post-development pollution and flow rates.

“Soft” engineering – minimize concrete conduits, maximize vegetation

Conventional vs SuDS

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Impervious surfaces



Impervious 'hard' surfaces (roofs, roads, large areas of pavement, and asphalt parking lots) increase the volume and speed of stormwater runoff. This swift surge of water erodes streambeds, reduces groundwater infiltration, and delivers many pollutants and sediment to downstream waters.

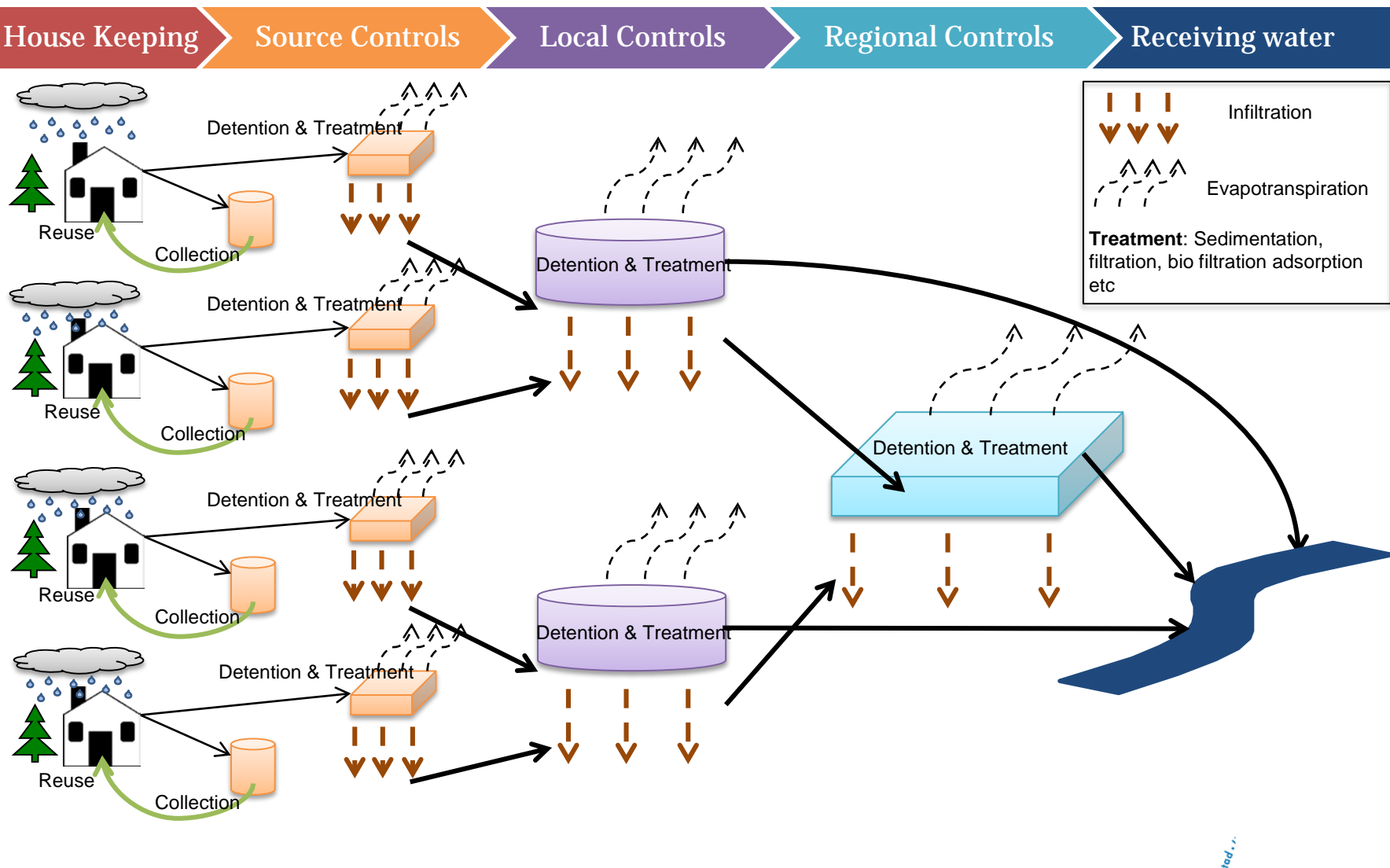
Pervious surfaces



Pervious 'soft' surfaces (green roofs, rain gardens, grass paver parking lots, and infiltration trenches) decrease volume and speed of stormwater runoff. The slowed water seeps into the ground, recharges the water table, and filters out many pollutants and sediment before they arrive in downstream waters.

SuDS Treatment Train

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Good House Keeping Source Controls Local Controls Regional Controls Receiving water

Green roofs (NL)

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Rainwater harvesting (RSA)

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‘Soft’ areas around buildings (NL) 10





Avoid planting anything that requires watering (other than, perhaps, to get established). In particular...

Avoid lawn

Promoting infiltration in the CBD (USA) 12

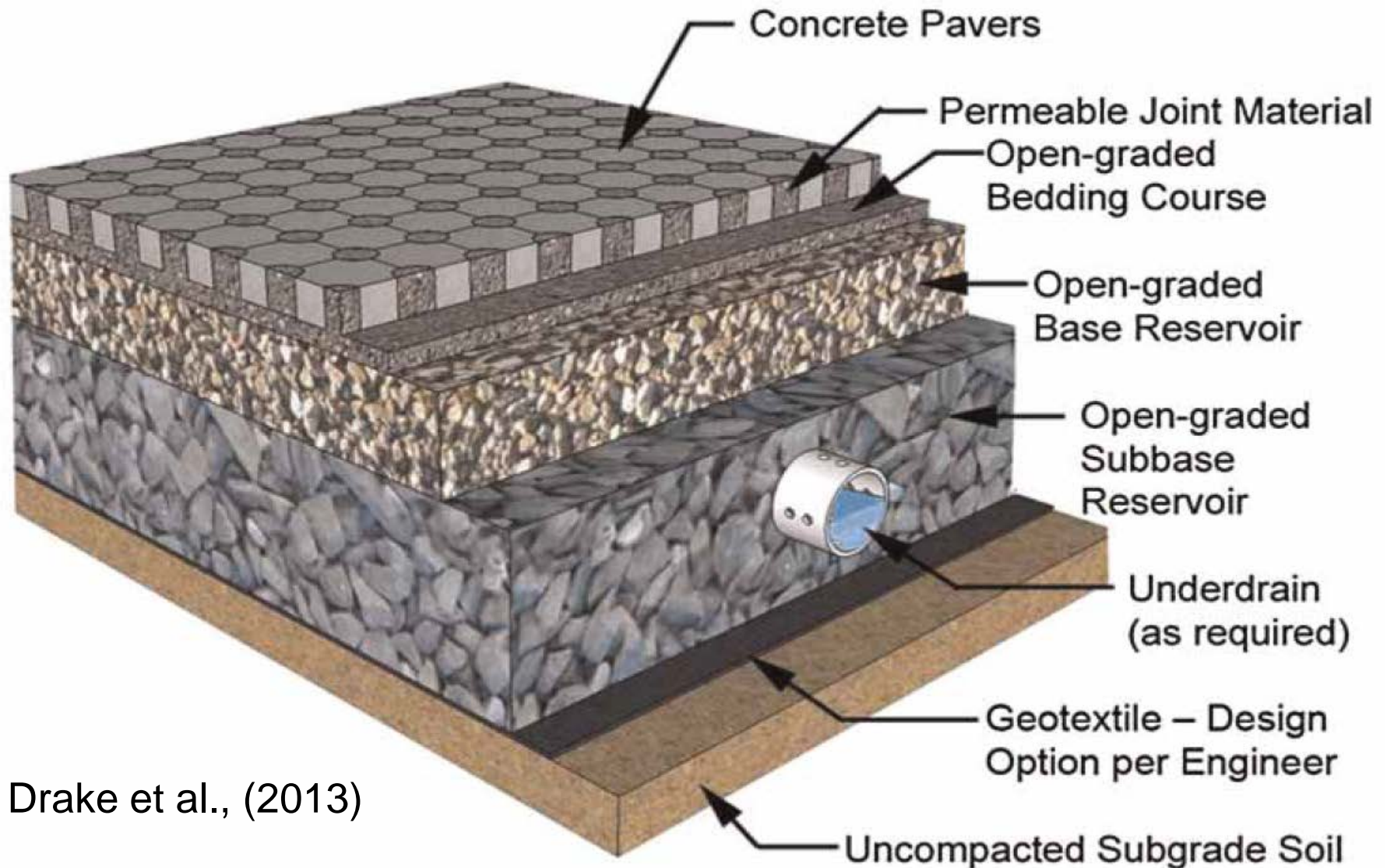


Permeable pavement (RSA) 13



Typical PPS cross-section

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Drake et al., (2013)

Sand Filter (USA)

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Filter strips (USA)

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Swales (SG, RSA)

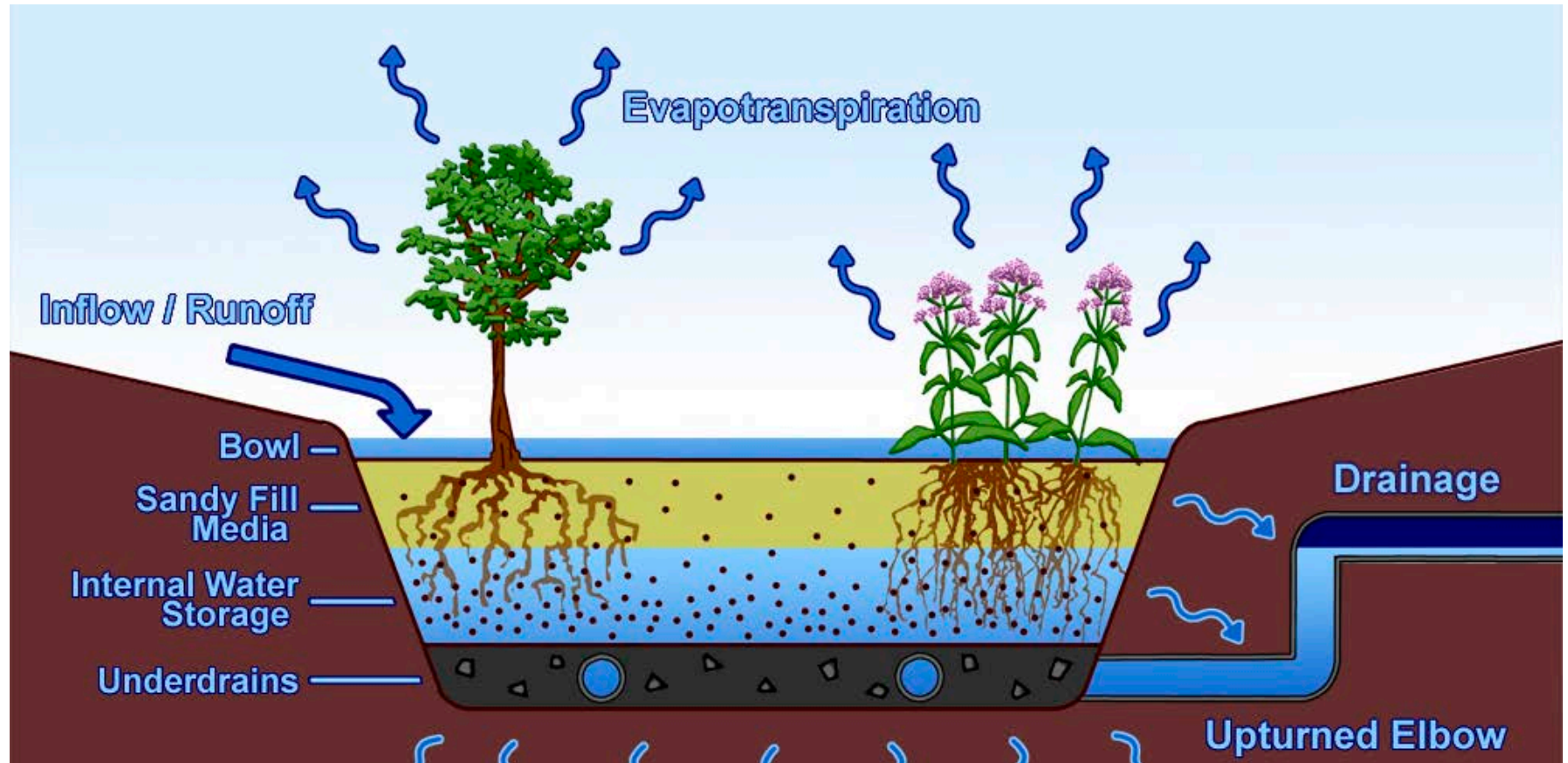
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Bioretention cells (USA)

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Detention ponds (USA, BRA)

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Retention ponds (AUS)

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Wetlands in the City (AUS)

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Alternative Technology for Stormwater Management

The South African Guidelines for Sustainable Drainage Systems

Neil Armitage,
Michael Vice,
Lloyd Fisher-Jeffes,
Kevin Winter,
Andrew Spiegel &
Jessica Dunstan



Appendix G: Sustainable Drainage System (SuDS) Conceptual Design

Why SuDS?

Development normally reduces the natural permeability characteristics of land by replacing the existing surface with impermeable surfaces, typically drained by pipes and/or canals. This also results in the general loss of vegetation, biodiversity and amenity. Conventional drainage systems are generally focused on eliminating flood risk and ignore the water quality, amenity and biodiversity. SuDS aims to mimic the natural hydrological cycle thereby improving water quality, preserving biodiversity and enhancing amenity. The result is a more sustainable and livable city.

Stormwater design hierarchy

The key objectives of the SuDS approach are the effective management of stormwater runoff quantity, quality and the associated amenity and biodiversity as described by the hierarchy below where each level contributes to an improved, more sustainable drainage system.

SuDS Treatment Train

Treatment trains are critical in designing an effective SuDS scheme. The SuDS Treatment Train starts with good housekeeping before moving on to source controls, local controls and regional controls. SuDS controls should be used sequentially in order to optimally treat stormwater runoff.

SuDS Conceptual Design Matrix

Quantity	Quality	Amenity	Biodiversity	Costing
Retention pond	High	High	High	High
Bio-retention area	High	High	High	High
Green roof	High	High	High	High
Detention pond	High	High	High	High
Filter strip	High	High	High	High
Wetland	High	High	High	High

Safety, Health & Environment

There are circumstances where SuDS may be suitable, for example where there is a serious risk of drowning or contamination resulting from point or non-point sources. These risks should be taken into consideration in the design and precautions taken. The 'Note' on the right highlights potential risks that may be found in stormwater. The potential risks of each pollutant on a site needs to be assessed. This is especially important in the case of pathogens where stormwater facilities are open to the general public.

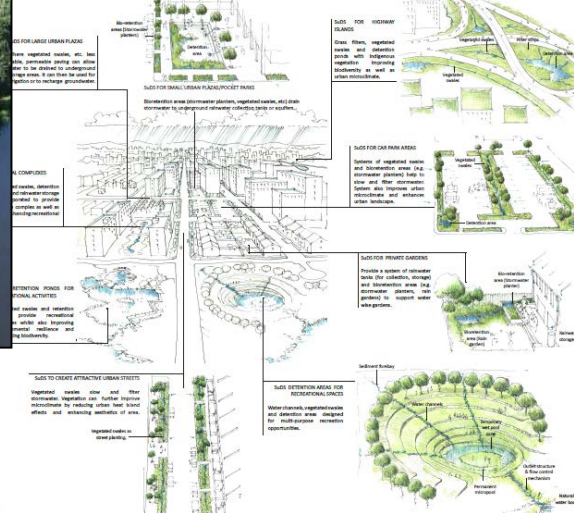
KS/1826: Alternative technology for stormwater management
www.wsud.co.za

Water Sensitive Urban Design (WSUD) for South Africa: FRAMEWORK AND GUIDELINES

Neil Armitage, Lloyd Fisher-Jeffes,
Kirsty Carden, Kevin Winter,
Vinothan Naidoo, Andrew Spiegel,
Ben Mauck & Daniel Coulson



Integrating SuDS into the City (Appendix H)



Three main 'agencies':

1. Rainwater Tanks
2. Open stormwater storage
3. Aquifer (i.e. groundwater) storage and recovery (Managed or unmanaged)

1. **Storage** - it seldom rains when you want the water!

Possible Solutions: Real-time control (RTC) of stormwater ponds; Managed Aquifer Recharge (MAR); Use the water immediately (let the large conventional reservoirs recover)

2. **Water Quality** - SW can be highly contaminated (trash, hydrocarbons, pathogens, nutrients, heavy metals, sediment etc.)

Possible Solutions: 'Fitness-for-purpose' use; Treatment – to potable standard if necessary; use SuDS to reduce contamination

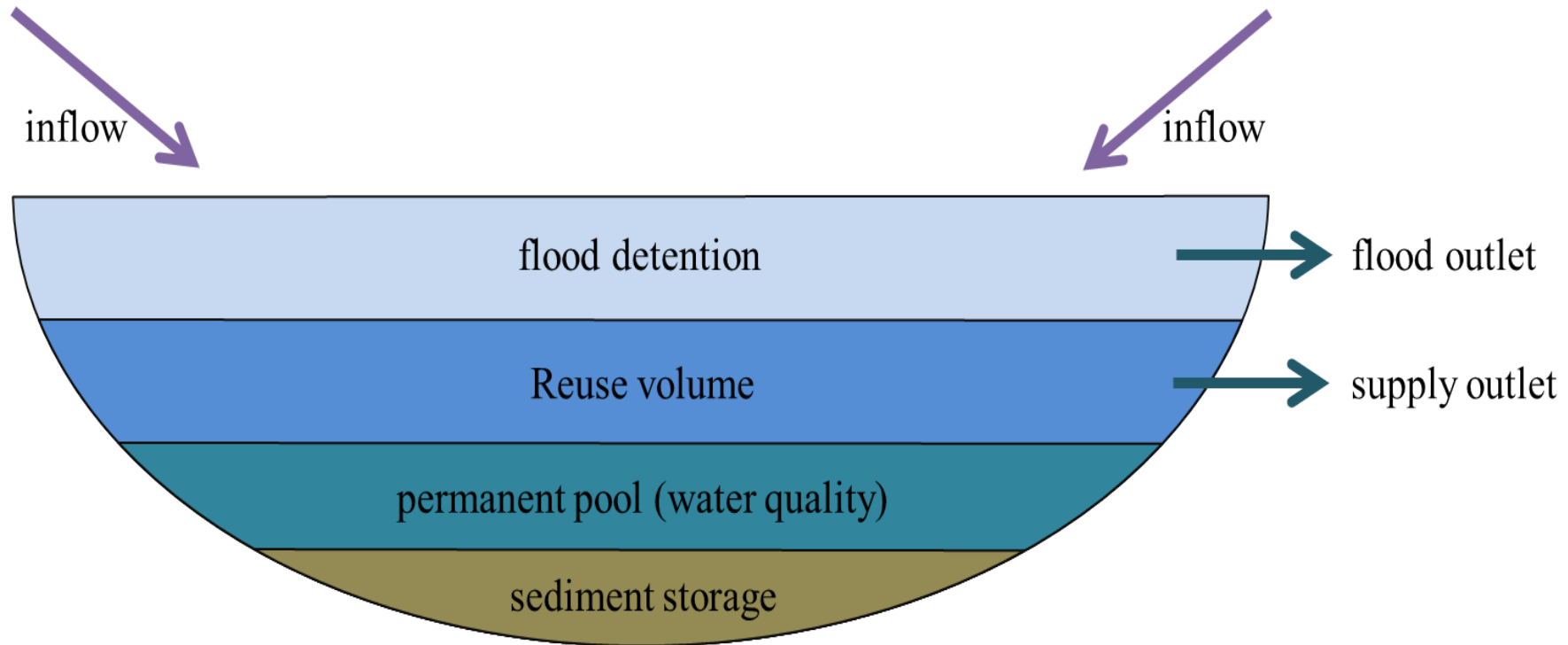
Rainwater Harvesting

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Open storage (retention pond)

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Difficult to find suitable space in the city...

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Stormwater Harvesting in Singapore

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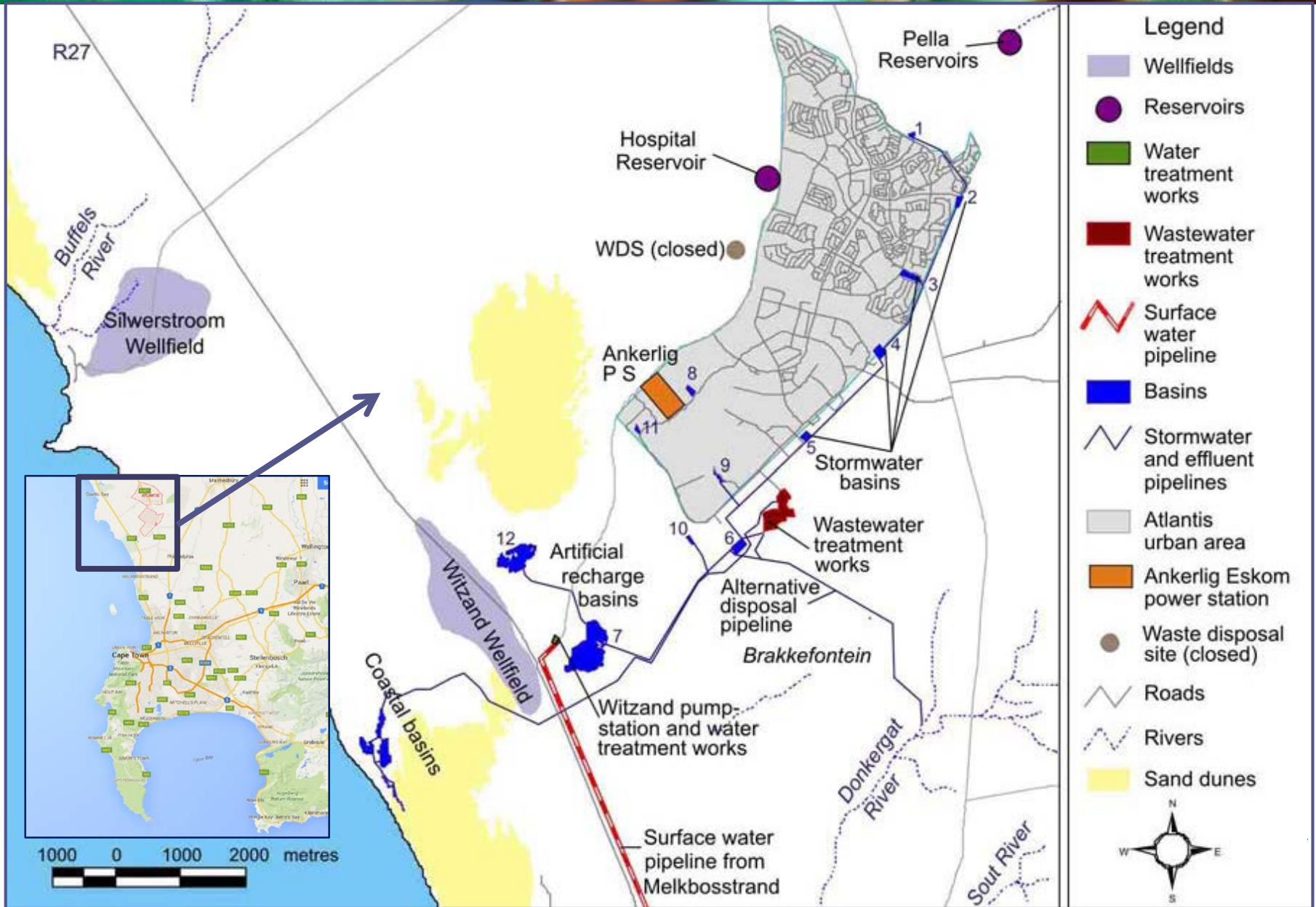






Stormwater Harvesting in Atlantis

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Questions?

<http://www.futurewater.uct.ac.za/>

‘Planting the rain’ – TEXx talk by Brad Lancaster

<https://www.youtube.com/watch?v=I2xDZIpInik>