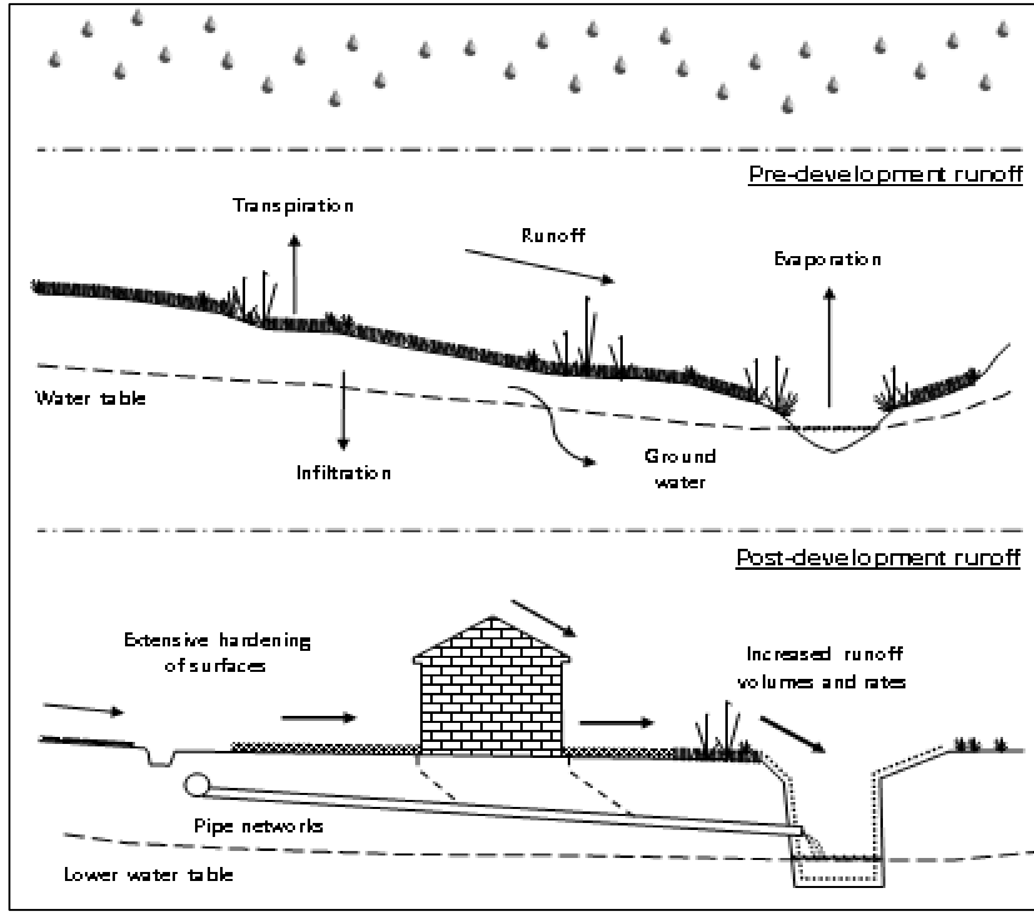
Water Sensitive Cities

Lecture 2: Sustainable Drainage Systems

Summer School, UCT, 16 Jan 2018

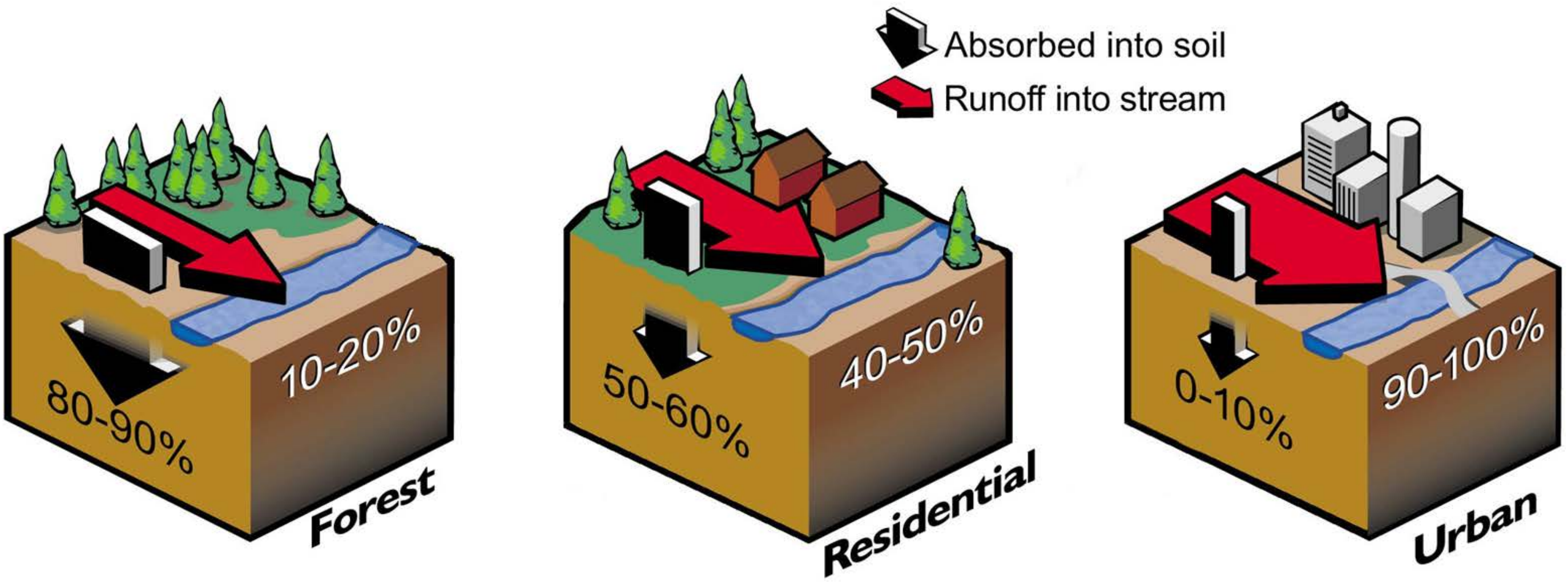
Prof Neil Armitage, PrEng, PhD
Department of Civil Engineering
University of Cape Town
7700 Rondebosch
SOUTH AFRICA

Conventional drainage systems



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

Development vs. hydrology

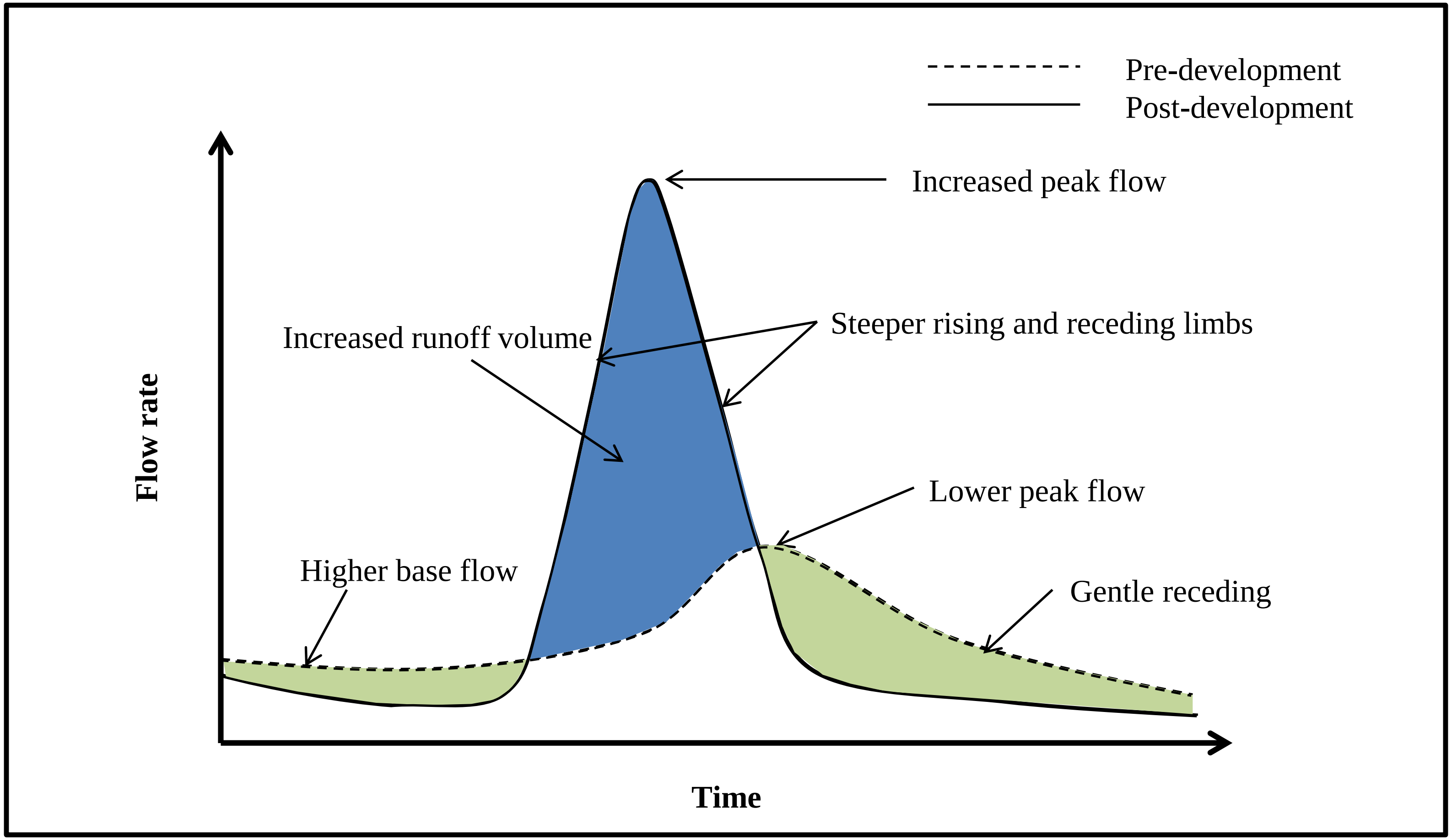


Source: Marsh (1983) as cited in the Georgia Stormwater Management Manual, 2016 edition

FUTURE WATER

University of Cape Town · iYunivesithi yaseKapa · Universiteit van Kaapstad

Impact of conventional drainage



Polluted drain (India)

Sustainable Drainage Systems (SuDS)

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

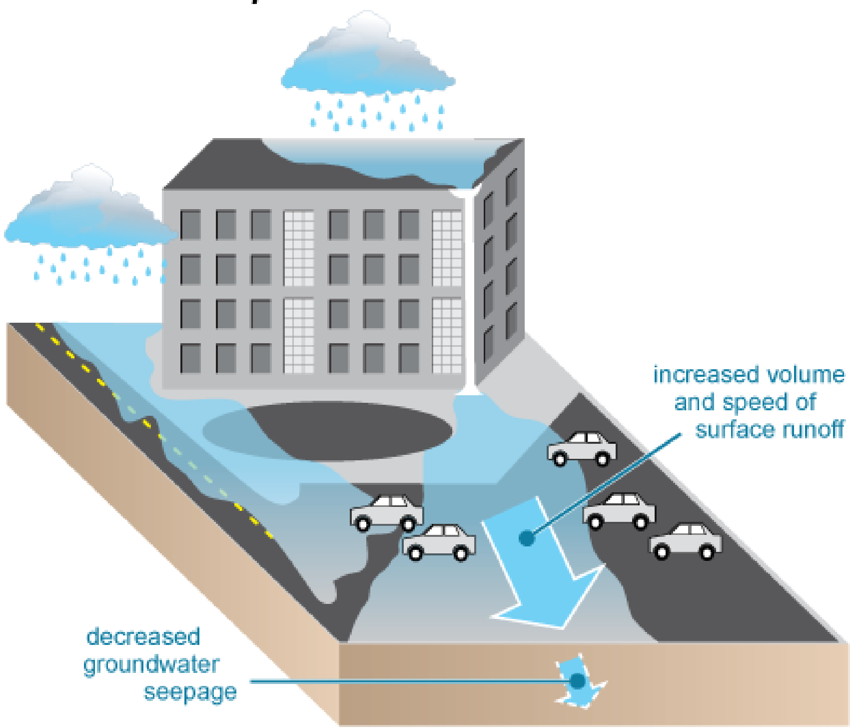
FUTURE WATER

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad

SPES BONA

Conventional vs SuDS

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

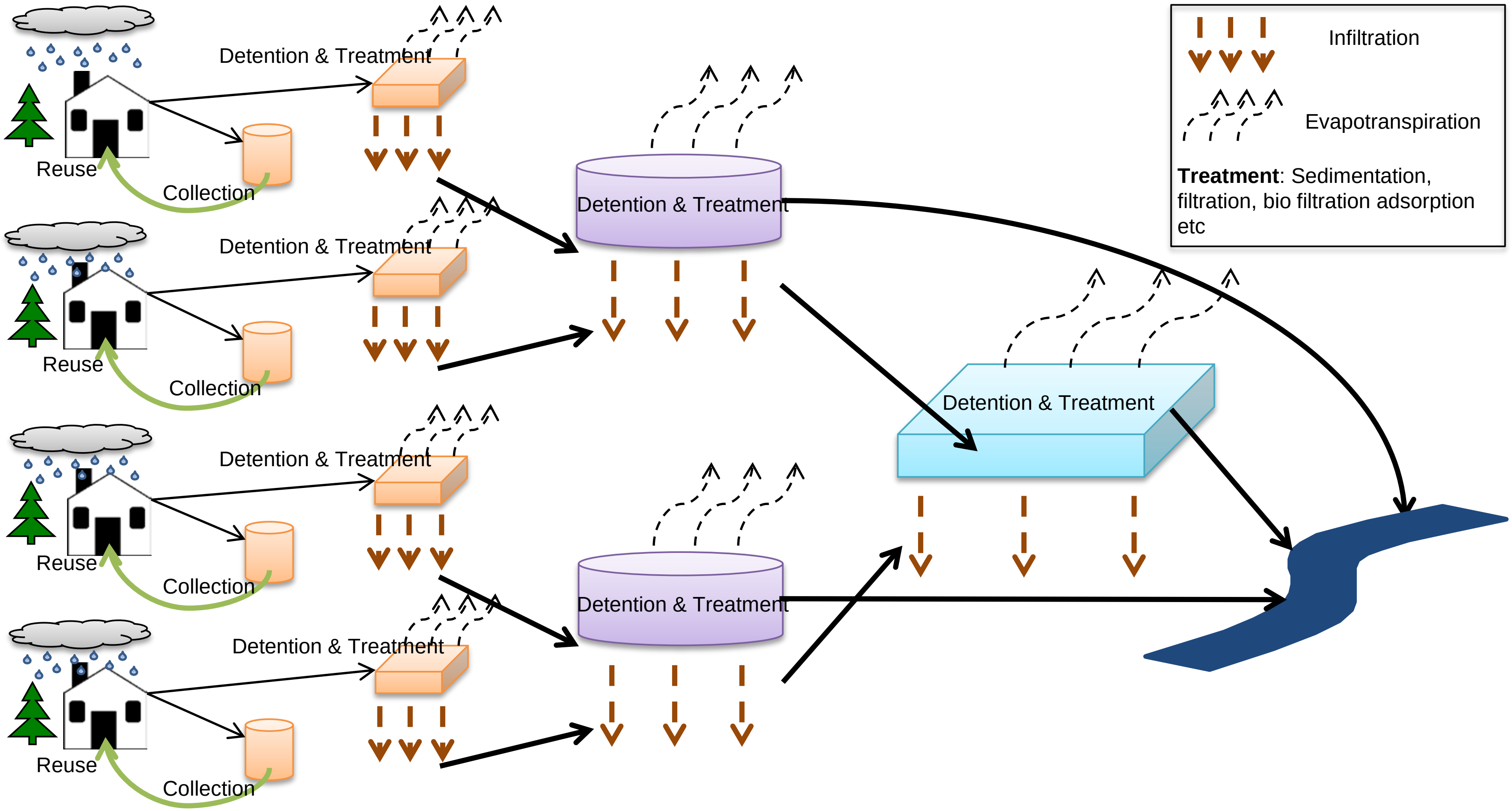
Pervious 'soft' surfaces (green roofs, rain gardens, grass paver parking lots, and infiltration trenches) decrease volume and speed of stormwater runoff. The slowed water seeps into the ground, recharges the water table, and filters out many pollutants and sediment before they arrive in downstream waters.

Conceptual diagram illustrating impervious and pervious surfaces. Impervious surfaces are hard and increase stormwater runoff, causing pollutant and sediment delivery in downstream waters. Pervious surfaces are soft and decrease stromwater runoff, which filters out pollutants and sediments before they arrive in downstream waters.

Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Chesapeake and Atlantic Coastal Bays Trust Fund, 2013. Stormwater Management: Reducing Water Quantity and Improving Water Quality. IAN press, newsletter publication.

SuDS Treatment Train

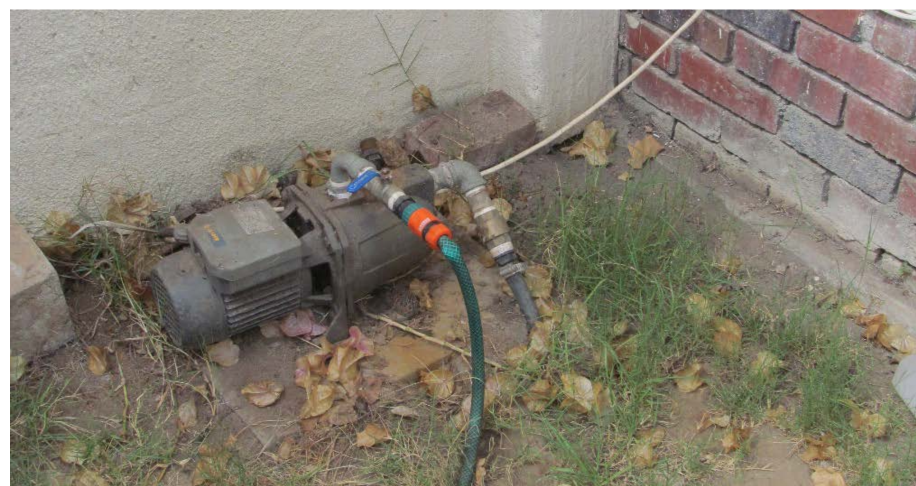
Good House Keeping | Source Controls | Local Controls | Regional Controls | Receiving water



Good House Keeping | Source Controls | Local Controls | Regional Controls | Receiving water

Green roofs (NL)

Rainwater harvesting (RSA)



‘Soft’ areas around buildings (NL)

FUTURE WATER

Water-wise gardening (RSA)

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

Avoid lawn

FUTURE WATER

UCT Urban Water Management

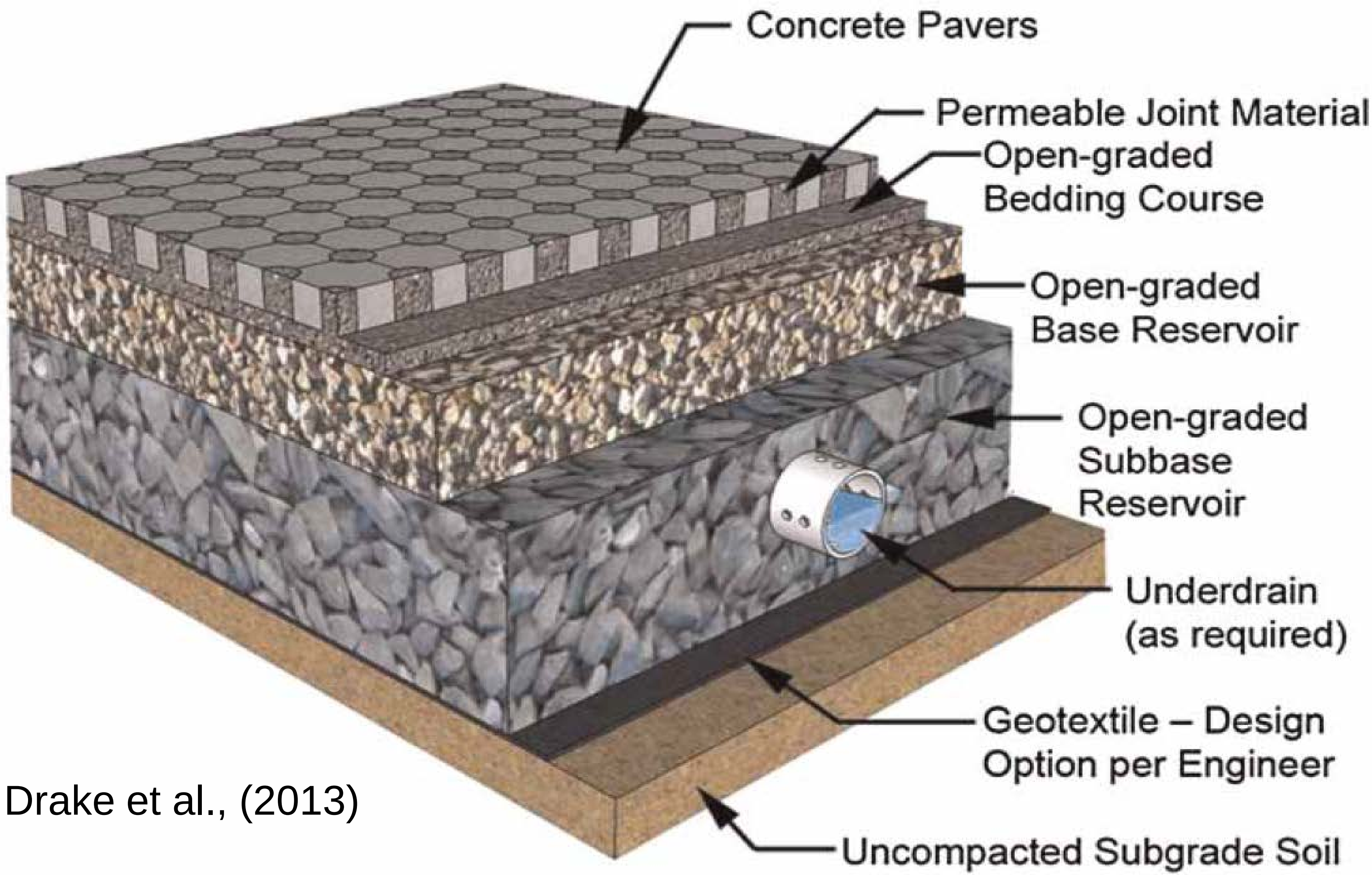
Water Sensitive Design

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad

Promoting infiltration in the CBD (USA)

Permeable pavement (RSA)

Typical PPS cross-section



Drake et al., (2013)

Sand Filter (USA)

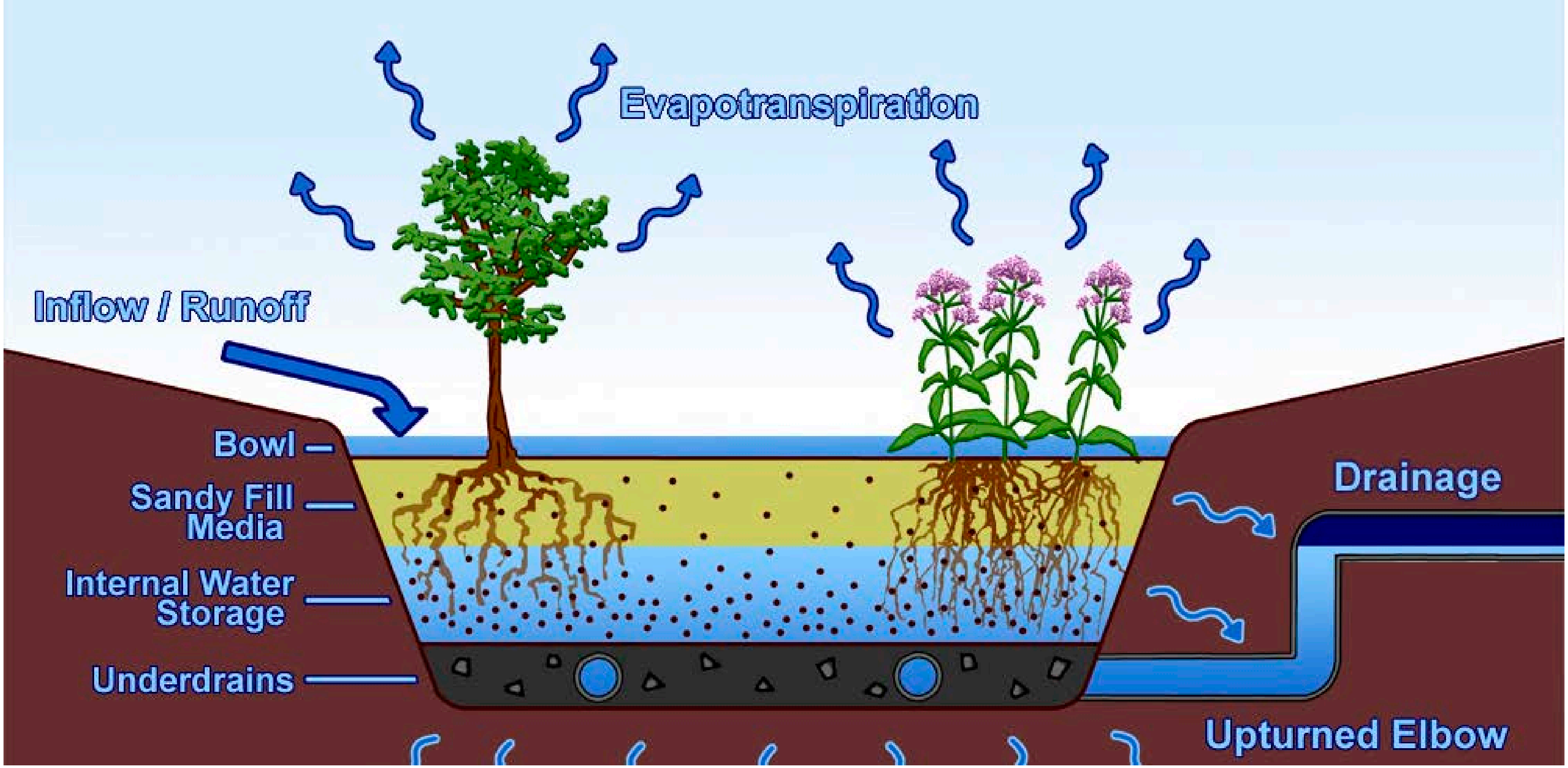
Filter strips (USA)

Swales (SG, RSA)

FUTURE WATER

Bioretention cells (USA)

Bioretention (Rain Gardens)



Source: NCSU

Detention ponds (USA, BRA)

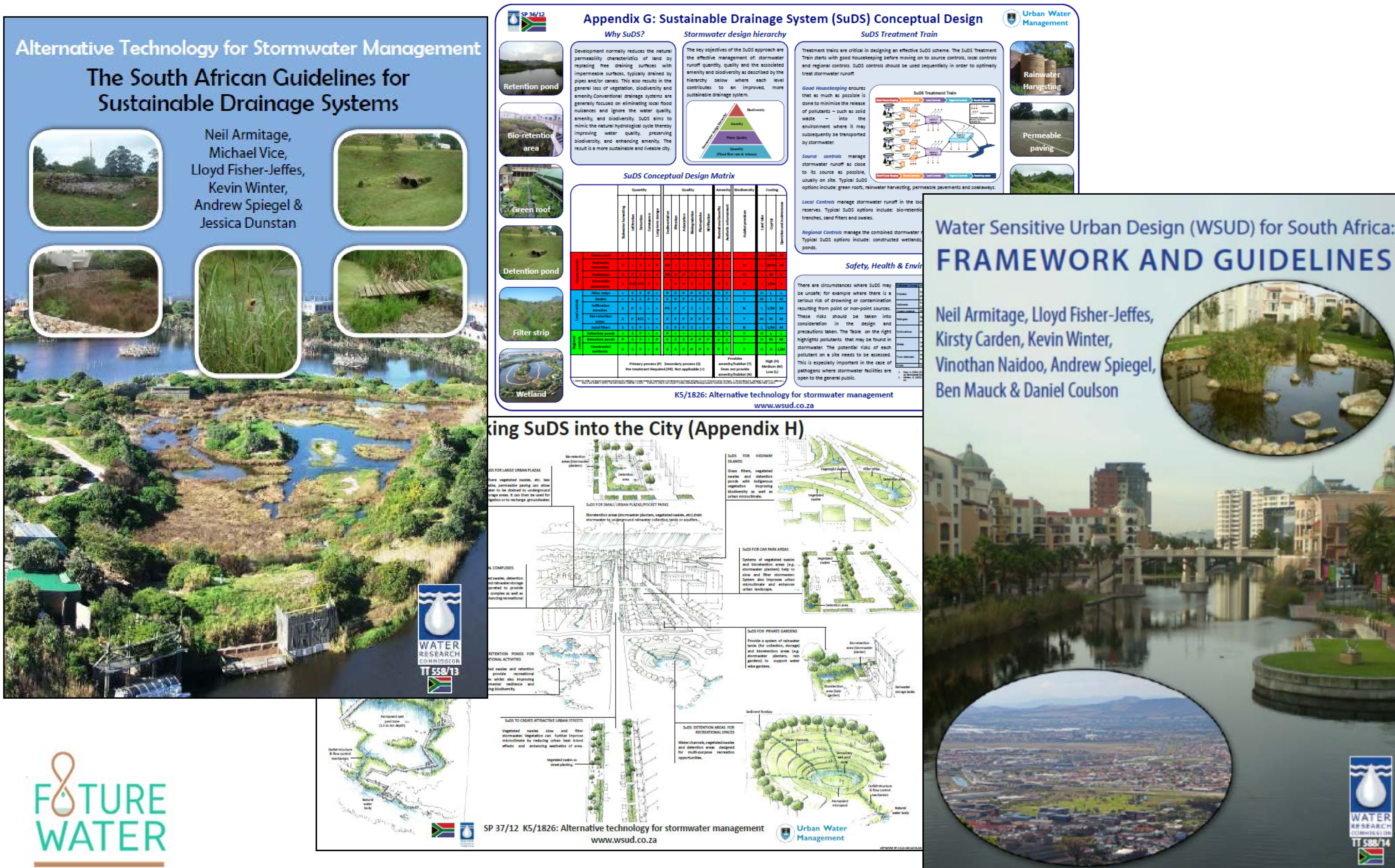
FUTURE WATER

Retention ponds (AUS)

Wetlands (USA)

Wetlands in the City (AUS)

South African guidelines



FUTURE WATER

Rain/Stormwater Harvesting?

Three main 'agencies':

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

The two big challenges

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

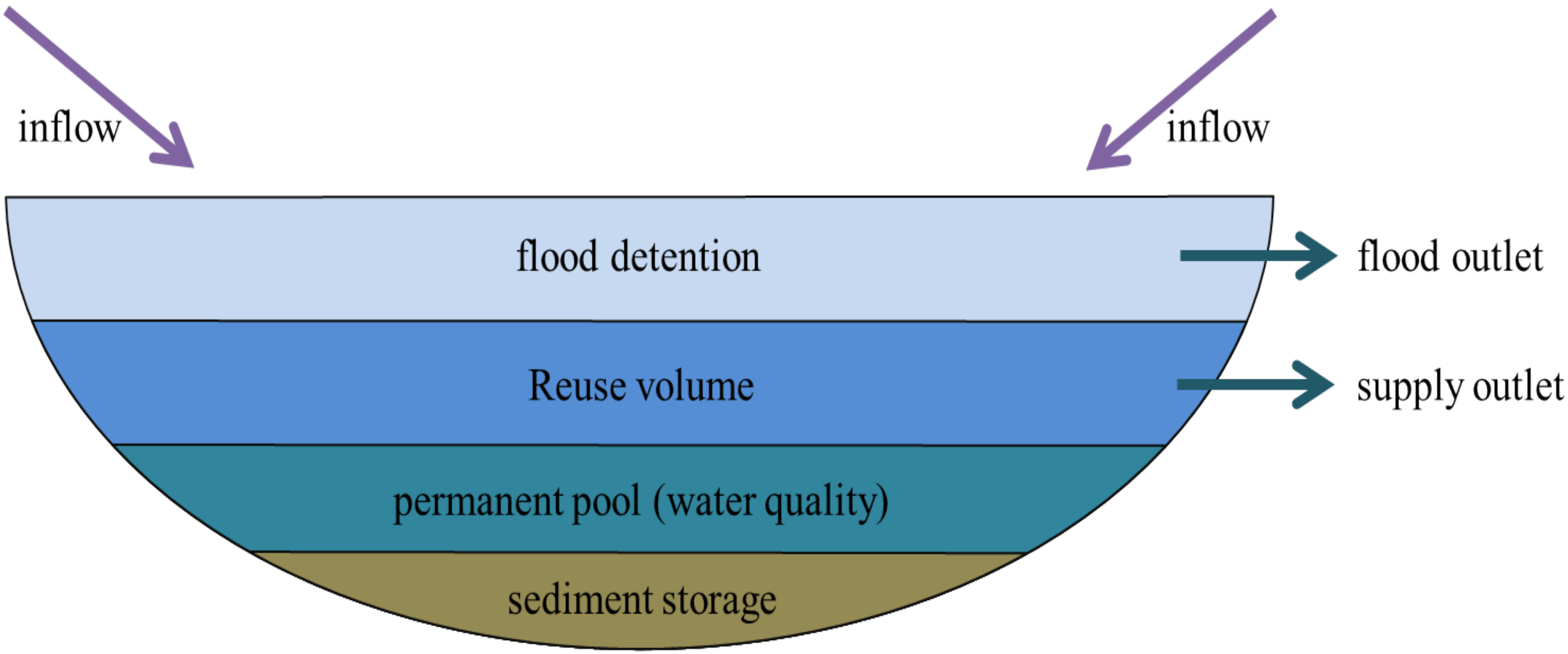
   Possible Solutions: Real-time control (RTC) of stormwater ponds; Managed Aquifer Recharge (MAR); Use the water immediately (let the large conventional reservoirs recover)

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

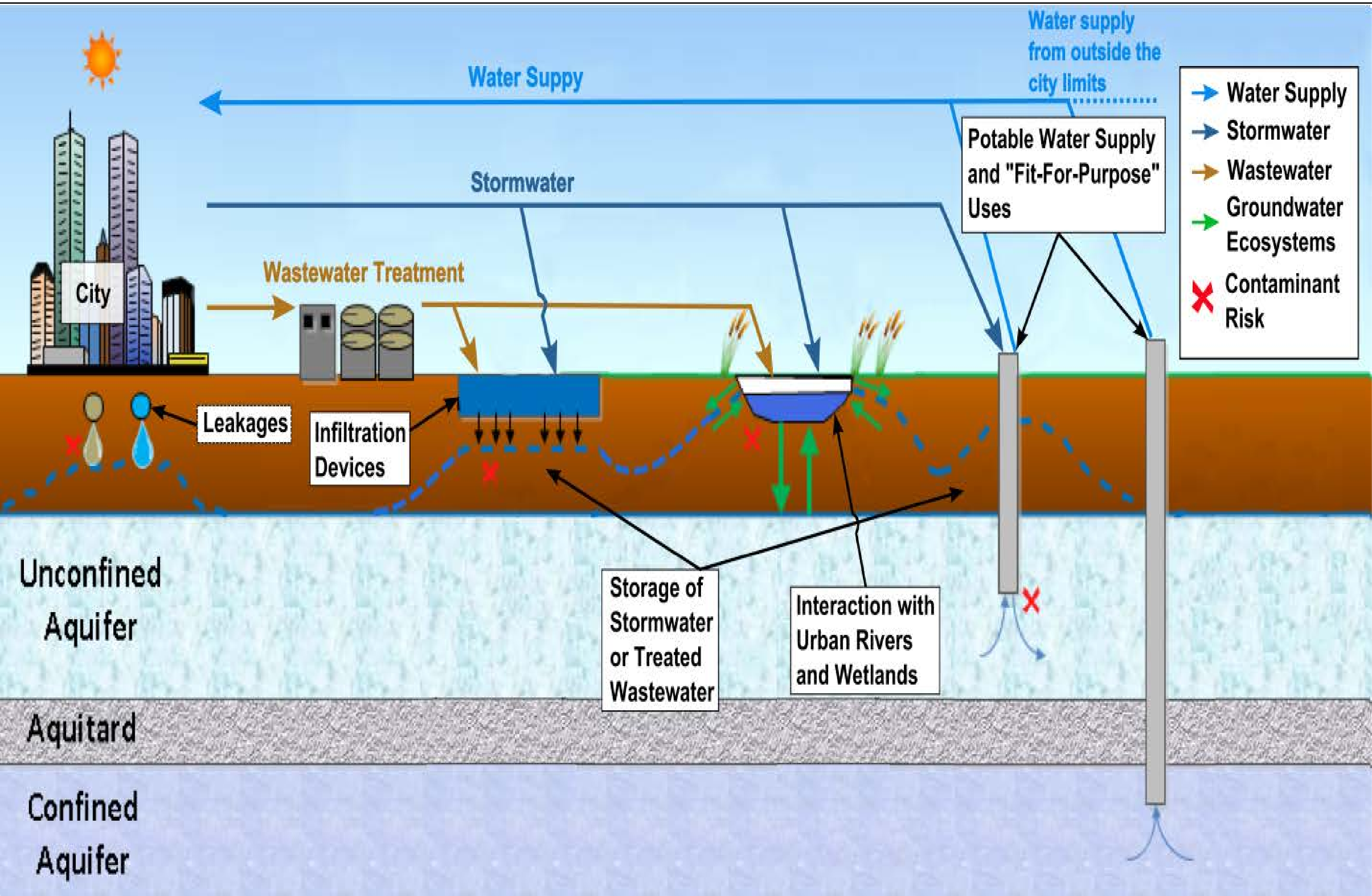
Rainwater Harvesting

Open storage (retention pond)



Difficult to find suitable space in the city…

Groundwater; the hidden resource

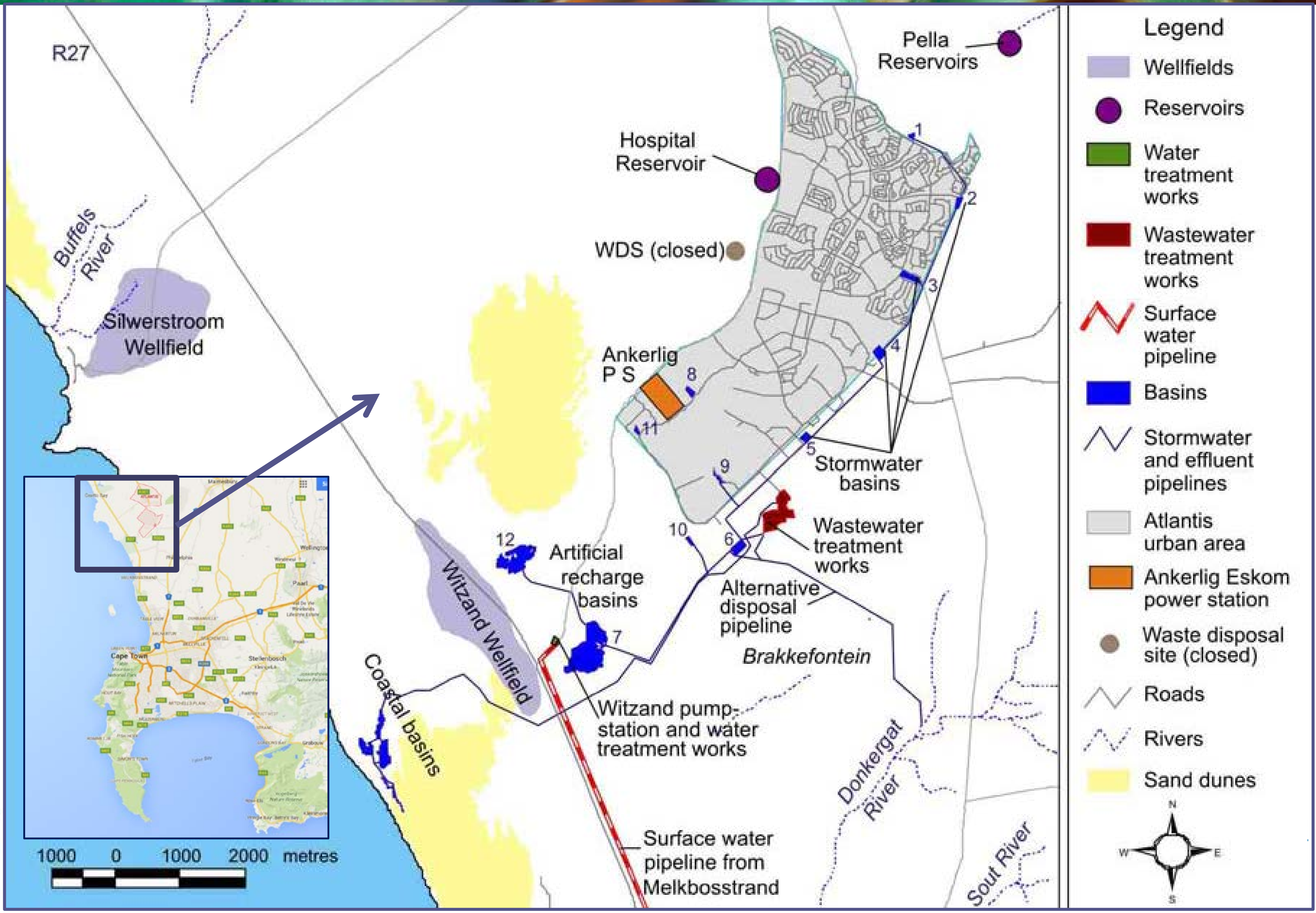


Stormwater Harvesting in Singapore


McDonald's


HSBC

Stormwater Harvesting in Atlantis



Questions?

Questions?

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

‘Planting the rain’ – TEXx talk by Brad Lancaster
https://www.youtube.com/watch?v=I2xDZlpInik