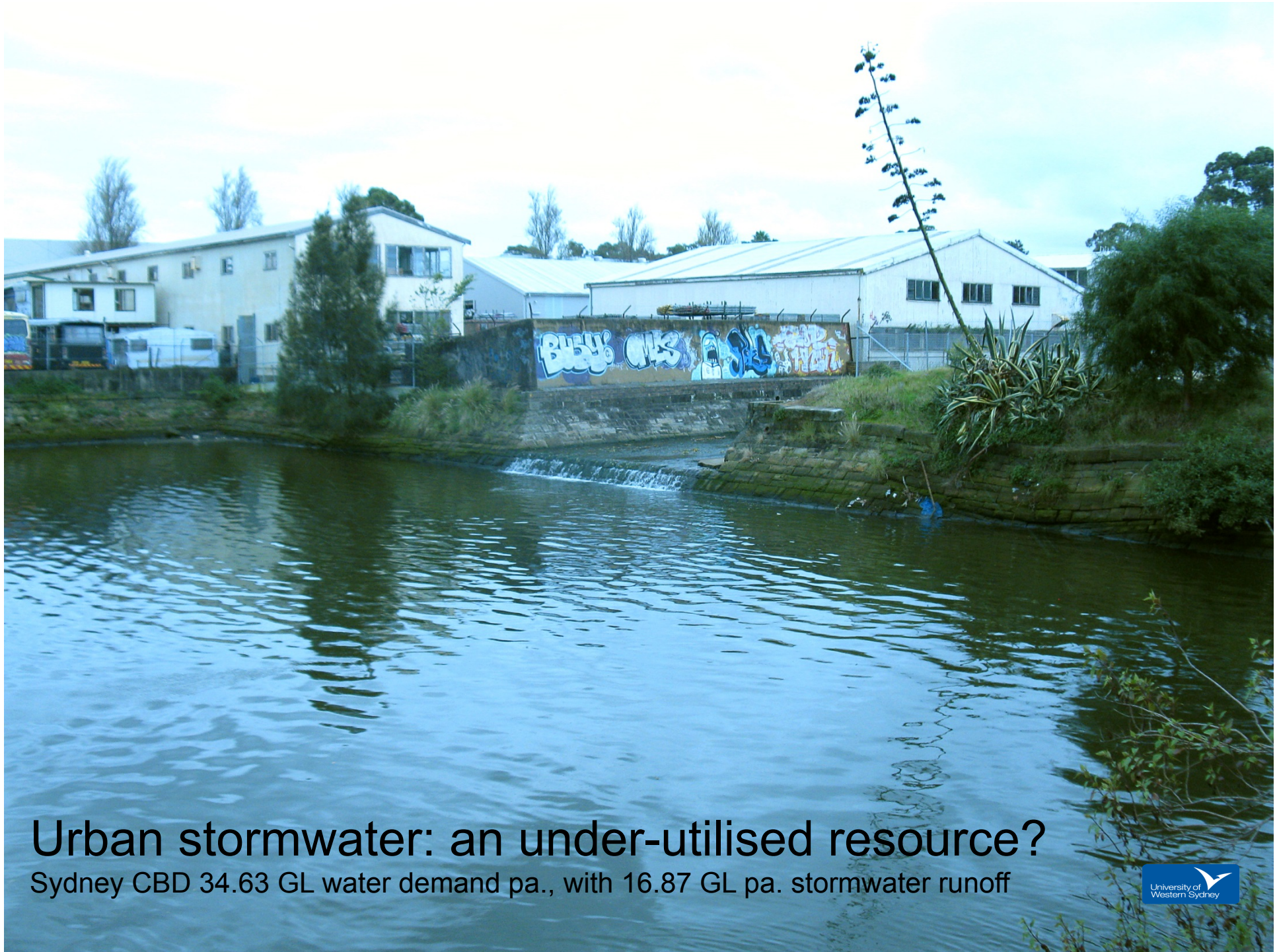


Monitoring stormwater bioretention unit performance for WSUD

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Urban stormwater: an under-utilised resource?

Sydney CBD 34.63 GL water demand pa., with 16.87 GL pa. stormwater runoff

Alexandra Canal, Sydney: 4 km (1887)



Grand Canal, Venice: 4 km



Need for a performance-monitoring framework identified

Raingardens City Road

Saving water and keeping
Sydney Harbour clean

CITY OF SYDNEY

city of villages

This raingarden may look like a regular garden bed, but it's also an underground stormwater treatment system.



A Total Water Cycle Management Initiative.

Urban stormwater traditionally flows to a stormwater drain and enters Sydney Harbour without treatment.

Here on Hardy Street, City of Sydney is installing a new filtration system where stormwater will be directed to raingardens for treatment. Stormwater will also be used to water the gardens, saving precious drinking water.

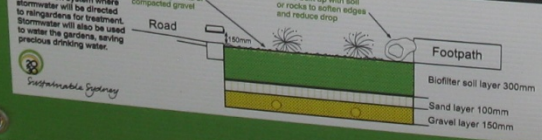
The plants used are native to Sydney and have deep root systems that easily absorb rainwater and pollutants. The soil mixture is also designed to retain and hold rainwater, slowing down the flow.

Because fast-flowing stormwater collects more pollutants, this raingarden will help reduce the amount of polluted run-off entering Sydney Harbour.

Inset sections have interlocking rocks or compacted gravel.

Sidewalk built up with soil or rocks to soften edges and reduce drop.

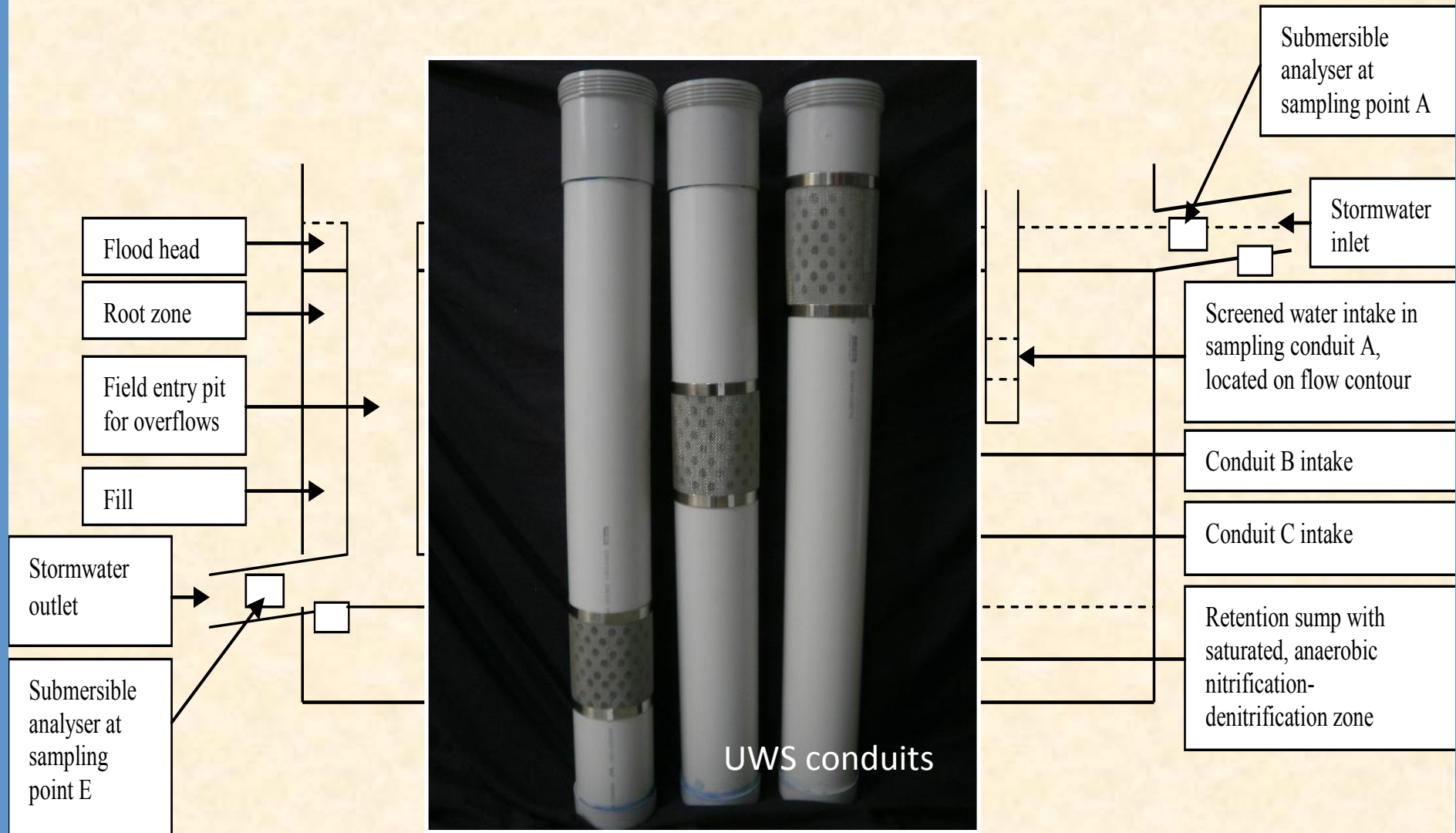
For more information on the City's Total Water Cycle Management Initiative, visit cityofsydney.nsw.gov.au/totalwatercycle



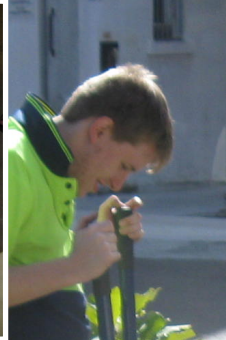
Raingarden
City Road
Saving water and keeping
Sydney Harbour clean

What lies below?

Bioretention unit with sampling conduits on flow contour



Development of conduit system

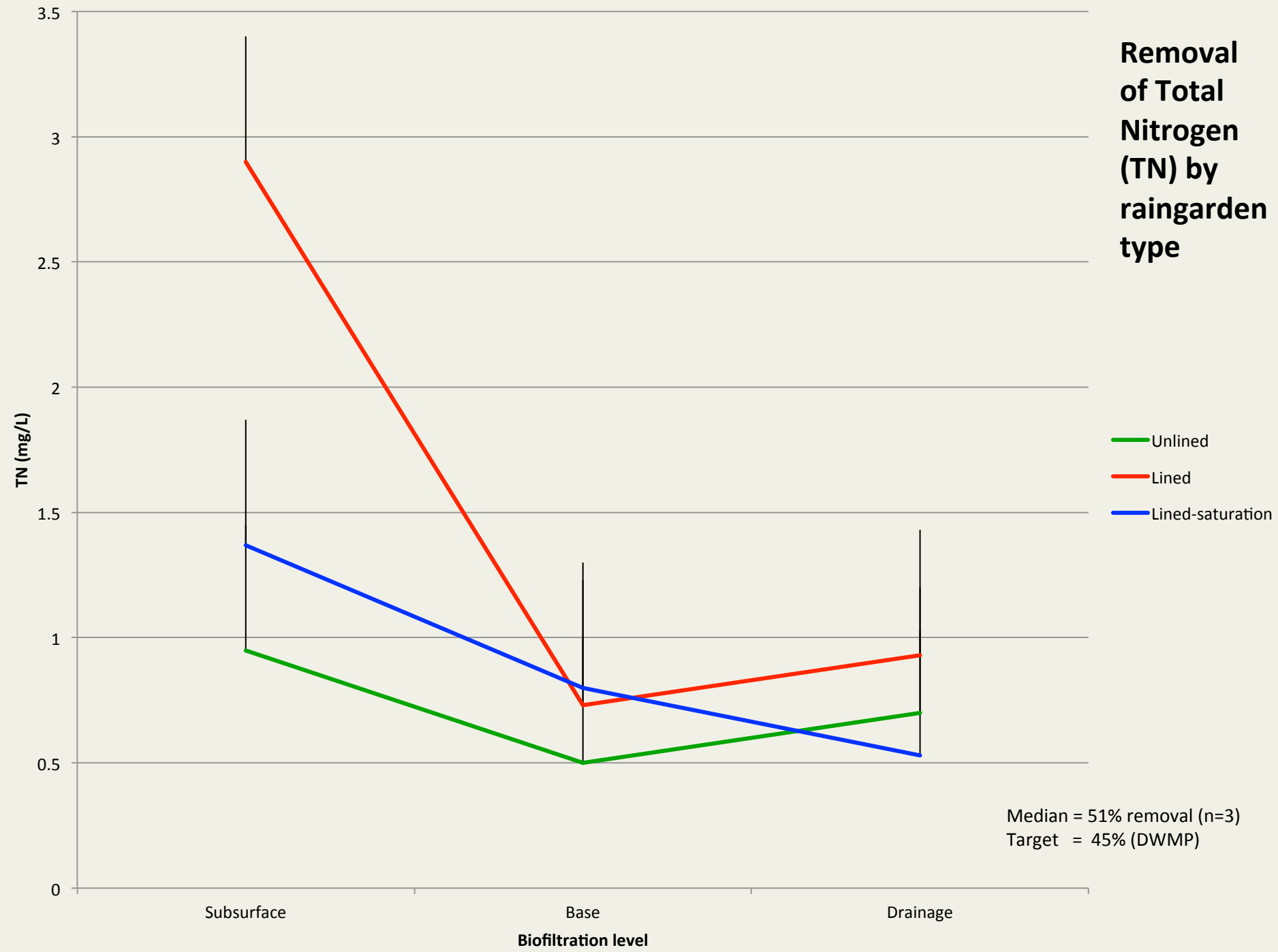


The starting point: catchments and indicators

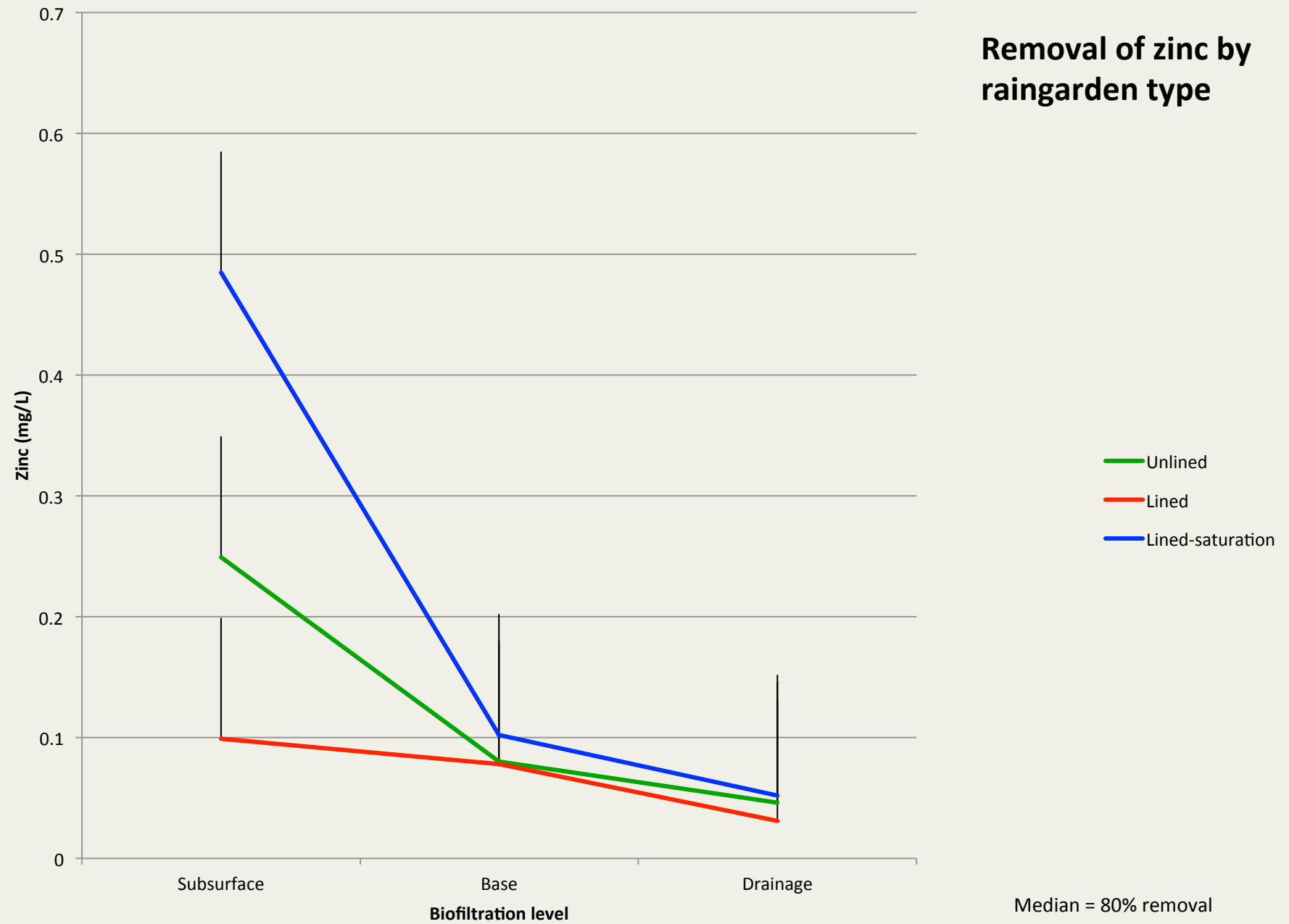
Road runoff of particular importance

- Total Suspended solids (TSS)
- Conductivity
- Nitrogen (ammonia nitrogen and NO_x)
- Total Phosphorous (TP)
- Dissolved organic carbon or UV₂₅₄
- Total Petroleum Hydrocarbons (TPH) (C₆ – C₃₆)
- Benzene, Toluene, Ethylbenzene, Xylene (BTEX)
- Heavy Metals (As, Cd, Cr, Ni, Cu, Pb, Hg, Zn)
- Health indicators total coliforms (TC), Escherichia coli (EC) and Enterococci (Ent)
- MUSIC uses fewer parameters, but is a stochastic planning program, not a performance monitoring program

Removal of Total Nitrogen (TN) by raingarden type



Removal of zinc by raingarden type

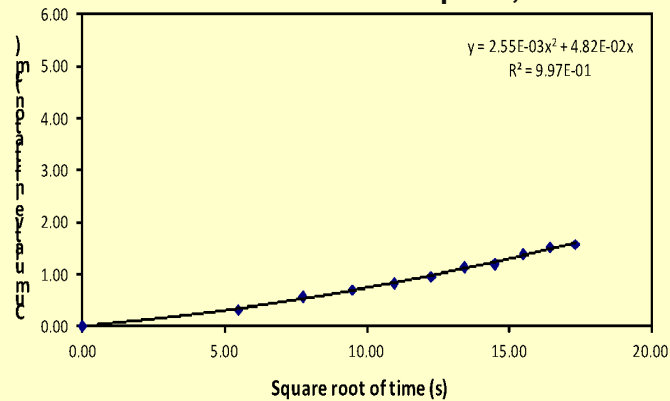


Removal of *E. coli* (EC) by raingarden type

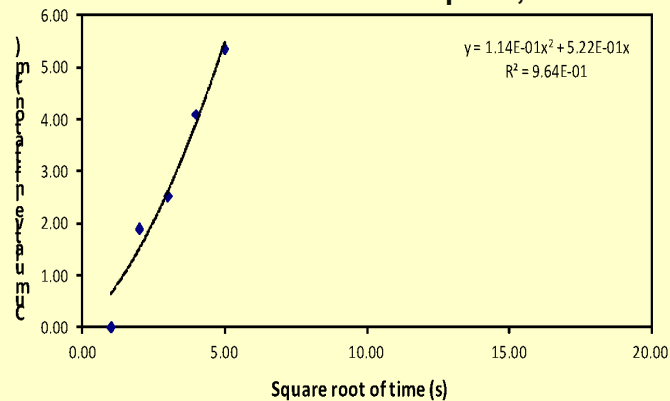


Environmental performance: Micro-infiltrrometry

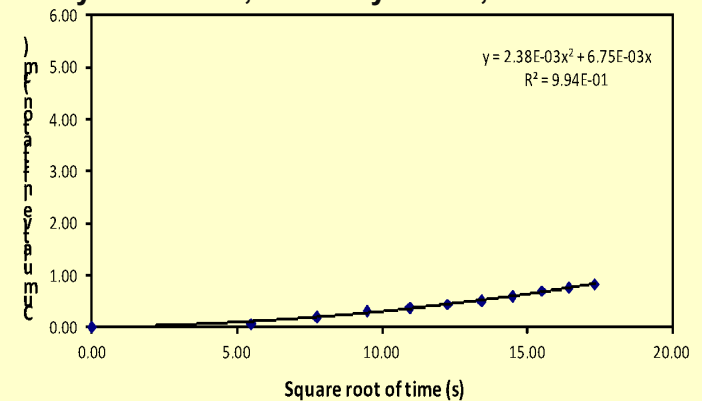
North Cope St, Redfern



South Cope St, Redfern



12-year control, Wolseley Grove, Victoria Park



A case of retarded plant development

| Quadrat number | Southern sector | Central sector | Northern sector | Potential disturbance factors |
|----------------|-----------------|----------------|-----------------|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | Location of raingarden eucalypt trees |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | Location of raingarden eucalypt trees |
| 10 | | | | Excessive leaf litter |
| 11 | | | | Dark areas indicate good coverage, healthy growth |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | Location of raingarden eucaly |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | Location of raingarden eucalypt trees |
| 19 | | | | |
| 20 | | | | Location of foot bridge |
| 21 | | | | |
| 22 | | | | Location of raingarden eucalypt trees |
| 23 | | | | |
| 24 | | | | |
| 25 | | | | Location of raingarden eucalypt trees |
| 26 | | | | |

Surface transect. [eg: Baseline area, Wolseley Grove, Victoria Park]

| | | | | |
|----|---|---|---|---|
| 27 | | | | |
| 28 | | | | Location of irrigator controls. |
| 29 | | | | Location of irrigator controls |
| 30 | | | | |
| 31 | | | | |
| 32 | | | | Location of raingarden eucalypt trees. |
| 33 | | | | |
| 34 | | | | |
| 35 | | | | Location of raingarden eucalypt trees. |
| 36 | | | | |
| 37 | | | | |
| 38 | | | | Location of raingarden eucalypt trees. |
| 39 | | | | Location of footbridge. |
| 40 | | | | |
| 41 | | | | |
| 42 | | | | |
| 43 | | | | |
| 44 | x | x | x | Light areas indicate low coverage. Crosses indicate dieback. Possible causes? |
| 45 | x | x | x | |
| 46 | x | x | x | |
| 47 | x | x | x | |
| 48 | x | x | x | |
| 49 | x | x | x | |
| 50 | x | x | x | |
| 51 | x | x | x | |
| 52 | x | x | x | |

The two areas were compared for building operations, shade, infiltrometry, soil chemistry, etc.

Mainly *Lomandra longifolia*, healthy, strong coverage



Juncus predominates, unhealthy, leaf die-off for all species

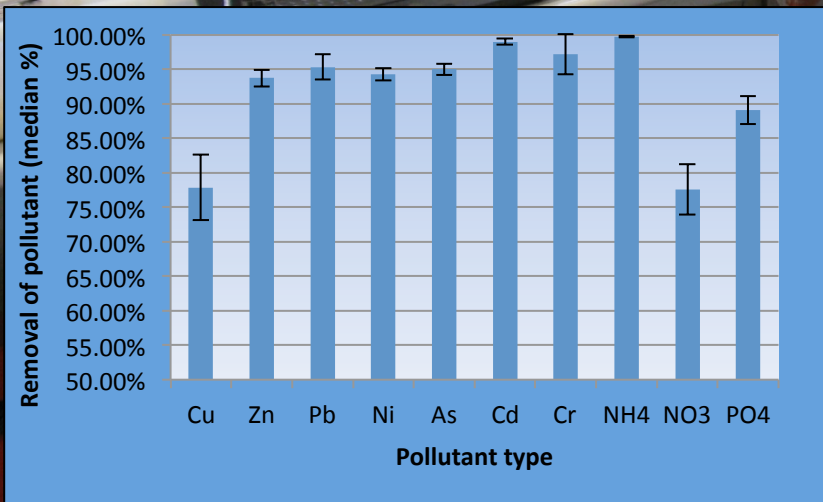


| Metal | Wolseley Grove control (healthy growth) | Wolseley Grove impacted area 1 | Levels in a typical, non-urban, local sandy loam [#] | Potentially toxic range in soil for plants | Australian health investigation threshold for parks | pH dependency for mobility |
|-----------|---|--------------------------------|---|--|---|----------------------------|
| Arsenic | <5 | <5 | <5 | N/A | 200 | Low |
| Cadmium | <1 | <1 | <1 | 3-8 | 40 | Medium |
| Chromium | 3 | 6 | 6 | 75-100 | 200 | Low |
| Iron | 48 | 60 | 50 | 300-500 | - | High |
| Manganese | 0.72 | 0.60 | 0.6 | 1500-3000 | - | High |
| Nickel | 2 | 5 | 6 | 100 | 600 | Medium |
| Copper | 8 | 20 | 7 | 60-125 | 2000 | Medium |
| Lead | 26 | 58 | 12 | 100-400 | 600 | Low |
| Zinc | 44 | 88 | 34 | 70-400 | 14000 | High |

-Verification tests.

-Extended performance experiments using zeolite, blast furnace slag, bio-char and concrete waste

-Technology transfer



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