BLETCHLEY PARK

Southern River

Amended Soils Trial (IMG)

Overview

- Bletchley Park overview & philosophy
- The challenge – legacy nutrients & high ground water
- The options – cost benefit analysis of our options
- The solution – collaboration & amended soils
- Acknowledgements
- The details – Brad Degens, Dept. of Water

Bletchley Park Overview

- Flagship Urban Quarter project
- 150 ha private landholding in Southern River
- 1,600 lots, 2 x CCW and 1 x Bushforever
- Primary Schools, Childcare & 4,000m2 future Local center

Bletchley Park Philosophy

- Progressive project team with a focus on Social, Environmental & Economic priorities
- Opportunity to be industry leading
- Future applications

Cossill & Webley CONSULTING ENGINEERS

essential environmental

EPCAD

URBAN QUARTER

GHD

The Challenge

- High ground water levels
- Legacy nutrients & receiving water bodies (outlet to Balannup Drain which flows to Southern River)
- Subsoils required to control GWL; nutrients mobilized
- Urban water management
  - Pre-post development impact
  - At source treatment
  - Maintenance costs
  - Open space usability

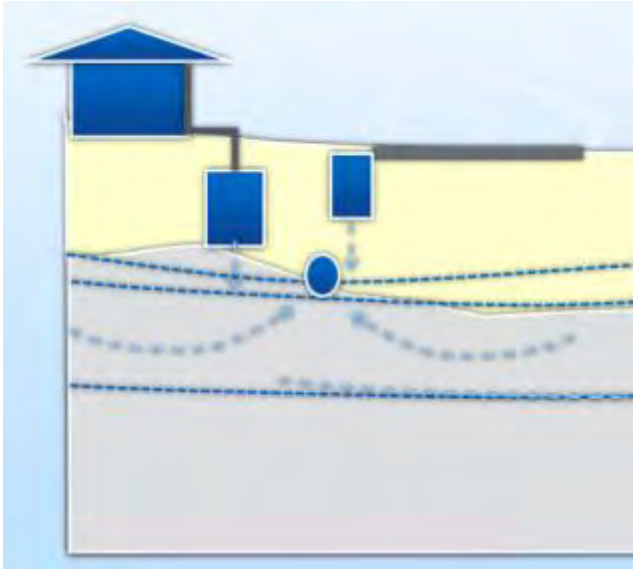
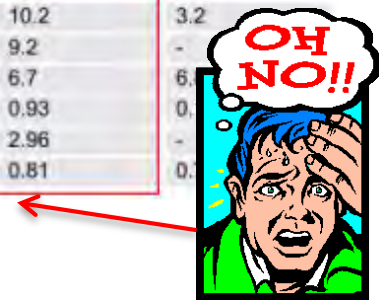


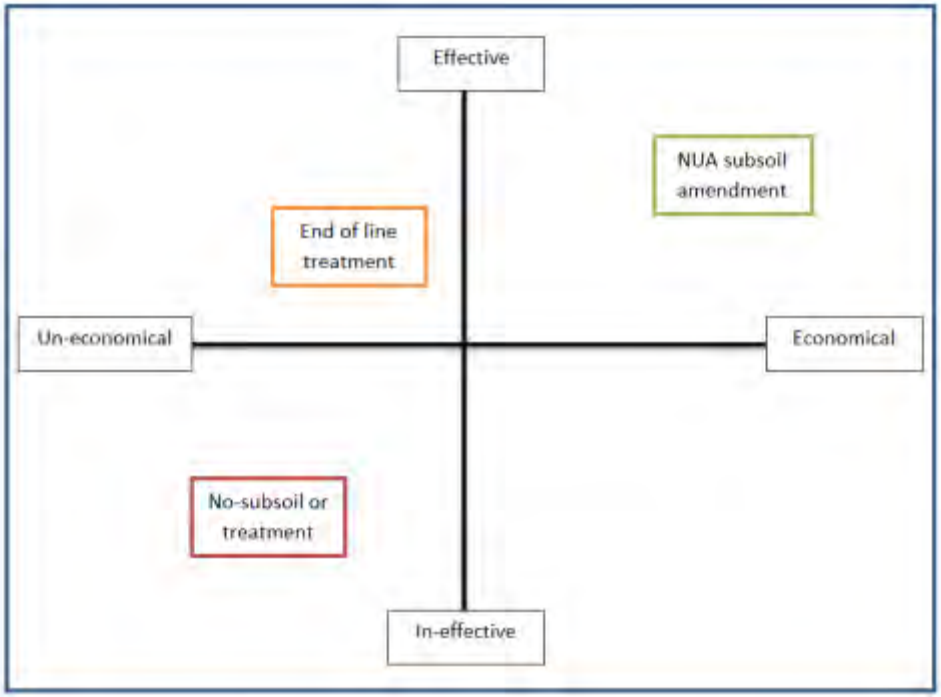
Table 6 Groundwater Physiochemical and Nutrient Data (GHD, 2012)

Parameter	Guideline value	Site	Sept 2011	Jan 2012	2005/06 Monitoring Average
pH	6.5 – 8.0	MW1	5.13	5.01	6.3
		MW2	5.5	5.62	-
		B2	4.12	4.28	4.3
EC	120-300 uS/cm	MW1	397	532	210
		MW2	262	213	-
		B2	257	280	300
Total N	1.2 mg/L	MW1	12.2	10.2	3.2
		MW2	13	9.2	-
		B2	12.1	6.7	6.
Total P	0.065 mg/L	MW1	1.08	0.93	0.
		MW2	3.58	2.96	-
		B2	1.04	0.81	0.



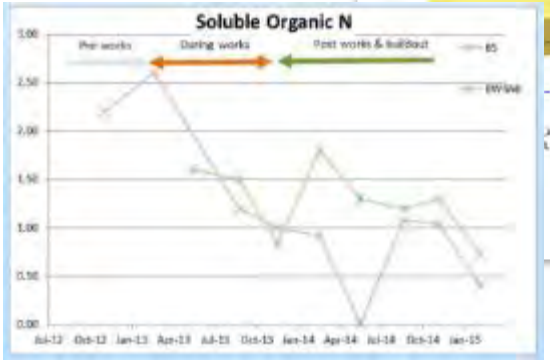
The Options

- 1. No subsoil
- 2. End of line treatment
- 3. NUA Soil amendment



The Solution

- City of Gosnells provided opportunity to participate in a soil amendment trial with DoW, SRT & DoH, incl. NRM funding
- Subsoil surrounds treated with mix of Iron Man Gypsum (IMG, NUA), a by-product of mineral sand mining
- Considerable collaboration to develop design, methodology, testing, & funding of trial
- Now in 3rd year of monitoring with some very promising results
  - 70% reduction in organic nitrogen
  - 95% reduction in soluble phosphorous
  - Freshening of groundwater post development



Acknowledgements

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Jennifer Stritzke (Swan River Trust)
John Savell (Dept. Housing)
Ray Todd & Theo Tham (Cossill and Webley)
Helen Brooks & Shelley Shepherd (Essential Environmental)
Myles Busbridge (GHD)
Snow Smolenski (Tasman Civil)

THANK YOU!

The Details

Mr. Brad Degens
Senior Soil and Water Scientist, Department of Water

THANK YOU!

Government of Western Australia
Department of Water

Iron Man Gypsum Amendment of Subsoil Drains:

Abingdon Trial, Bletchley Park, Southern River

Brad Degens

Water Science, Science and Planning Division

Acknowledgements:

Theo Tham & Ray Todd , Cossill & Webley

Stuart Reside, Urban Quarter Ltd.

Iluka Resources Ltd.

Monitoring co-funded – DoW, SRT & Department of Housing

Outline

- Why subsoil drains – legacy nutrients and urban development in areas with high water-tables
- Trial design
- Monitoring
- Results – first 2 years
- Progressive conclusions and recommendations

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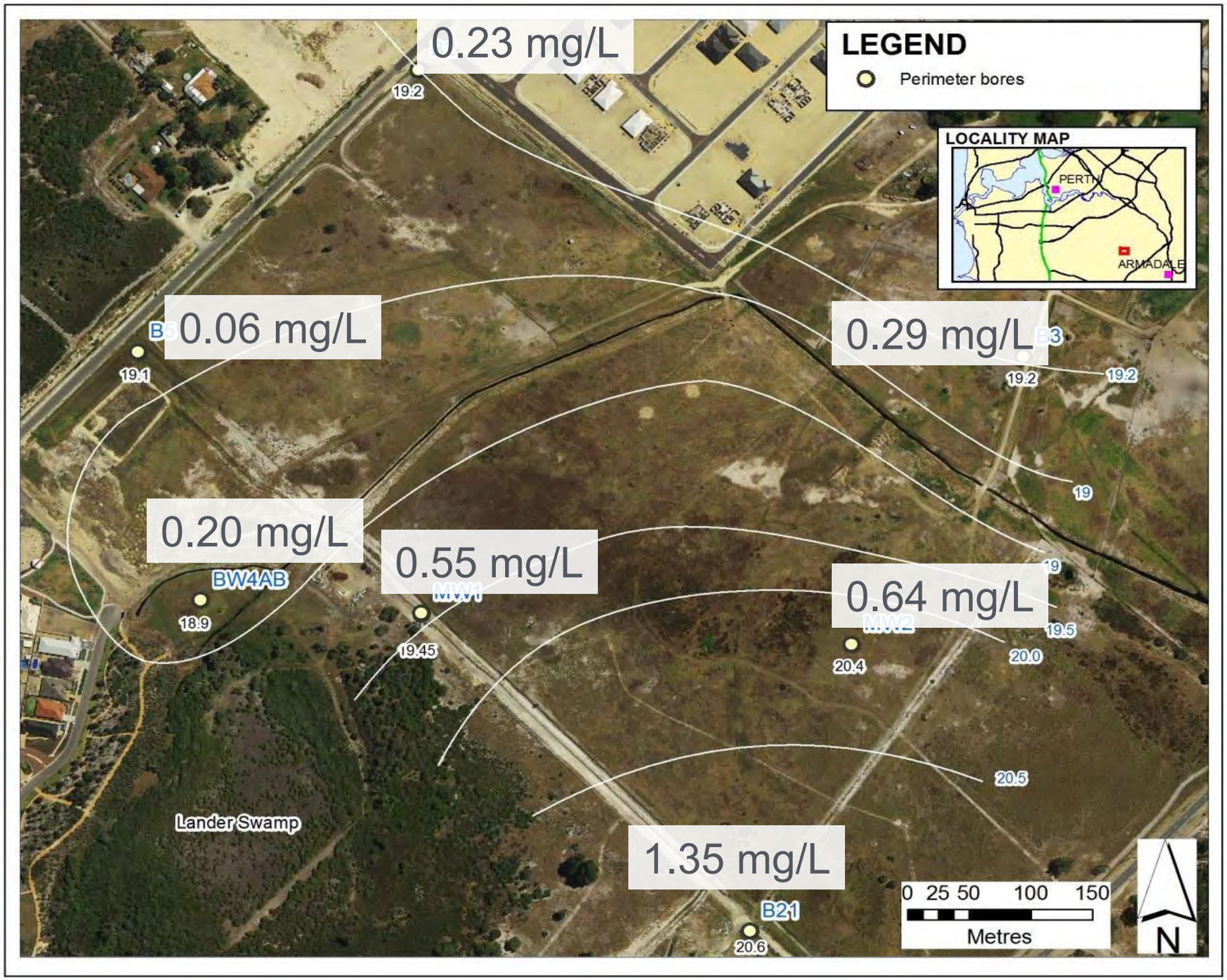
Legacy nutrients in groundwater (soluble P)



Avg. values

(2 year period 2013-2014)

~ 25 to 50 % previous results

Shallow GW (1 - 4m)

Deep GW (prod bore) lower soluble P (0.08 mg/L)

Regional GW flow to NE

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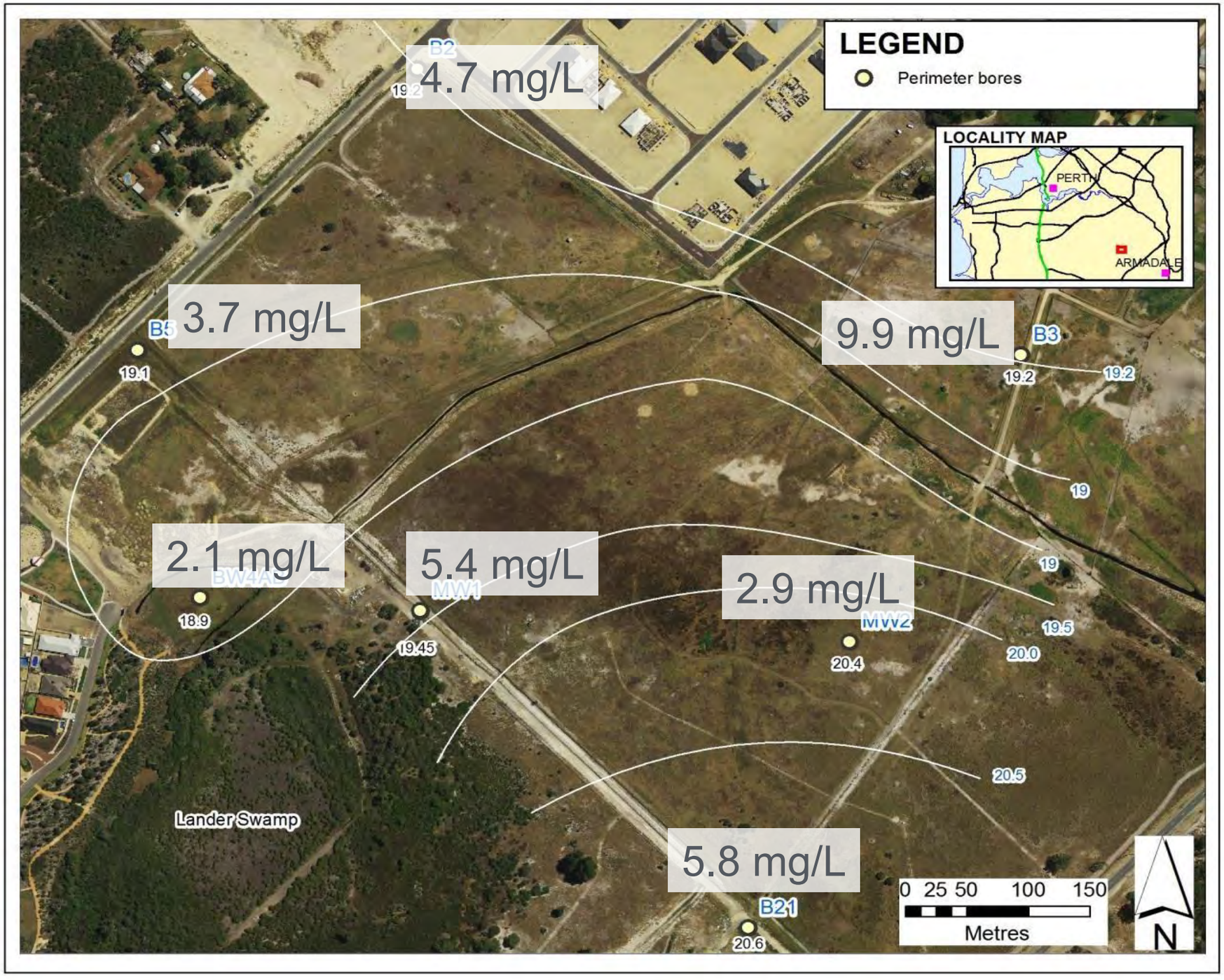
Legacy nutrients in groundwater (Total N)



Avg. values

(2 year period 2013-2014)

Typically >60% DON with balance NH_4

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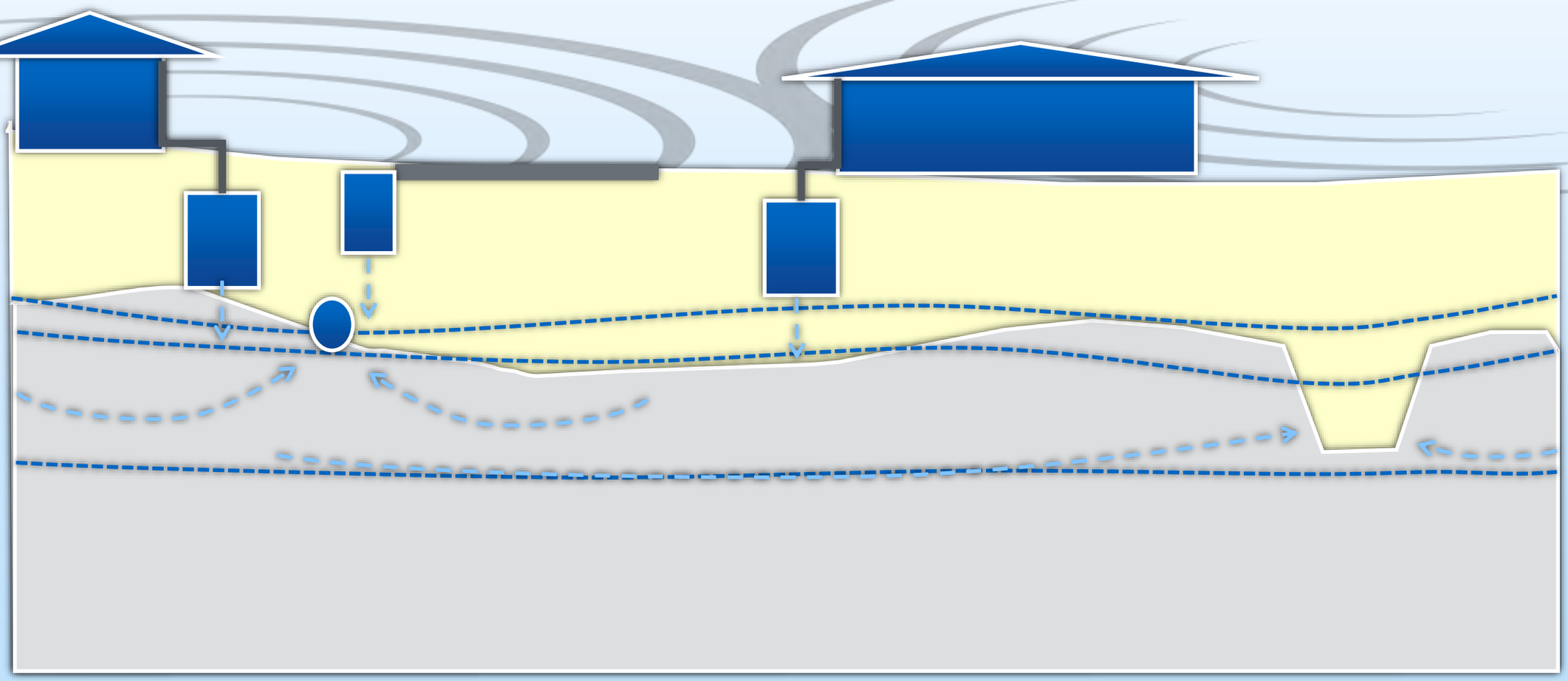
Urbanisation accelerates nutrient movement via GW



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Drain amendment material IMG – Iron Man Gypsum

- Brown, loam like soil material
- By-product of Iluka's mineral sands processing
- 75-85% gypsum, 15-20% fine iron oxides (trace manganese oxide)
- Structureless, slumps when wet, dusty if handled dry
- High P ads capacity (potentially up to 20kg/tonne, CSIRO)

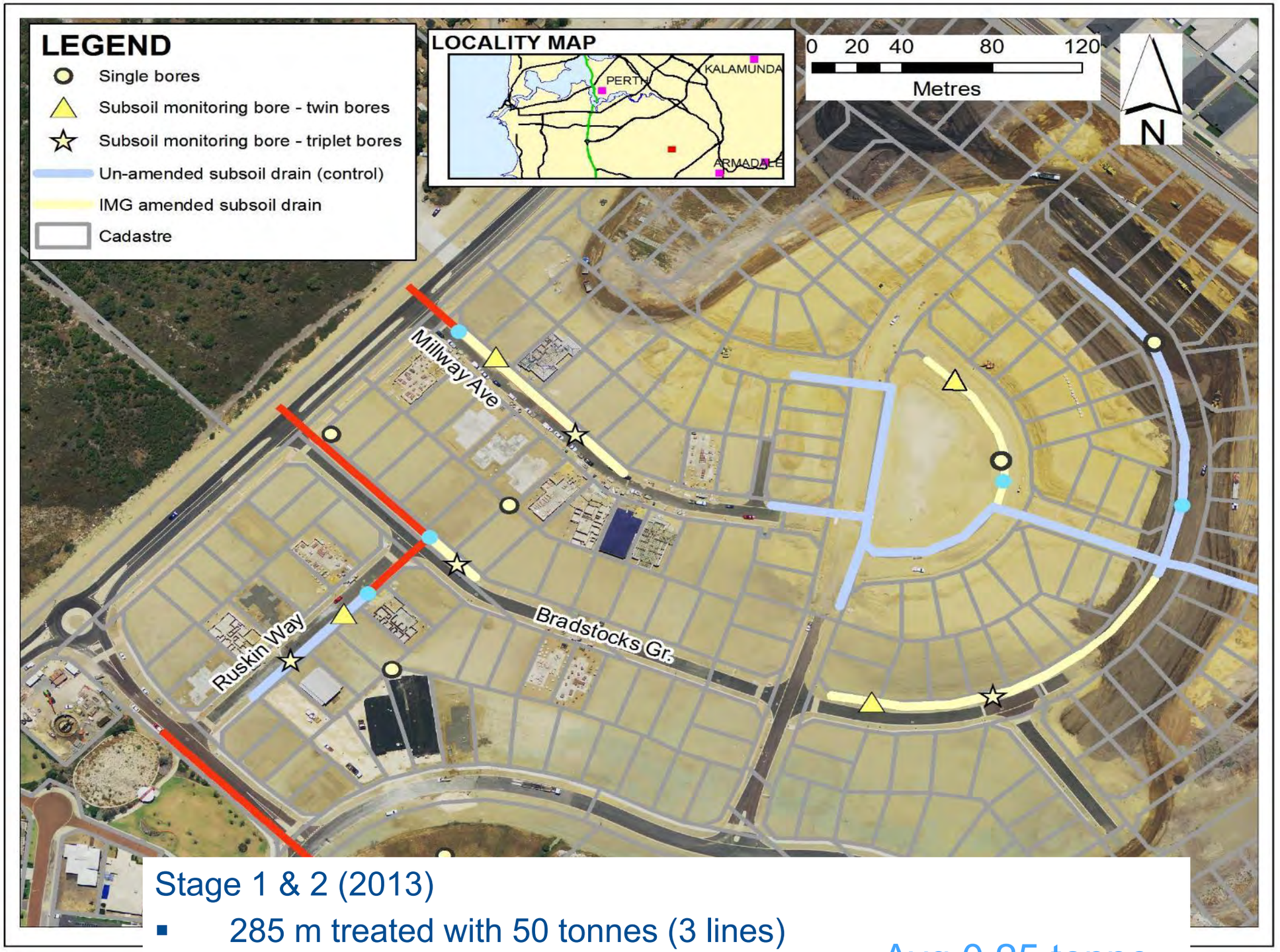
Drain amendment material IMG – Iron Man Gypsum

- Blended with sand fill (@10% v/v) to achieve a permeable reactive medium
- Geotechnically similar to Class 1 sand fill

	IMG amended sand fill		Non-amended sand fill	
	Average	Range	Average	Range
Fines (% by wgt <75 µm)	7	6 – 8	3	2 – 3
Maximum dry density (t/m^3)	1.77	1.74 – 1.80	1.75	1.73 – 1.77
CBR (%)	25	20 – 30	22	11 – 30
Permeability (m/day)	3.4	1.8 – 4.6	3.4	2.6 – 3.8

Abingdon – Bletchley Park Trial

's water future



Stage 1 & 2 (2013)

- 285 m treated with 50 tonnes (3 lines)
- 96 m untreated (1 line)

Later stages (2014-15)

- 338 m using 30 tonnes (2 lines)

Avg 0.25 tonne IMG/m SSD

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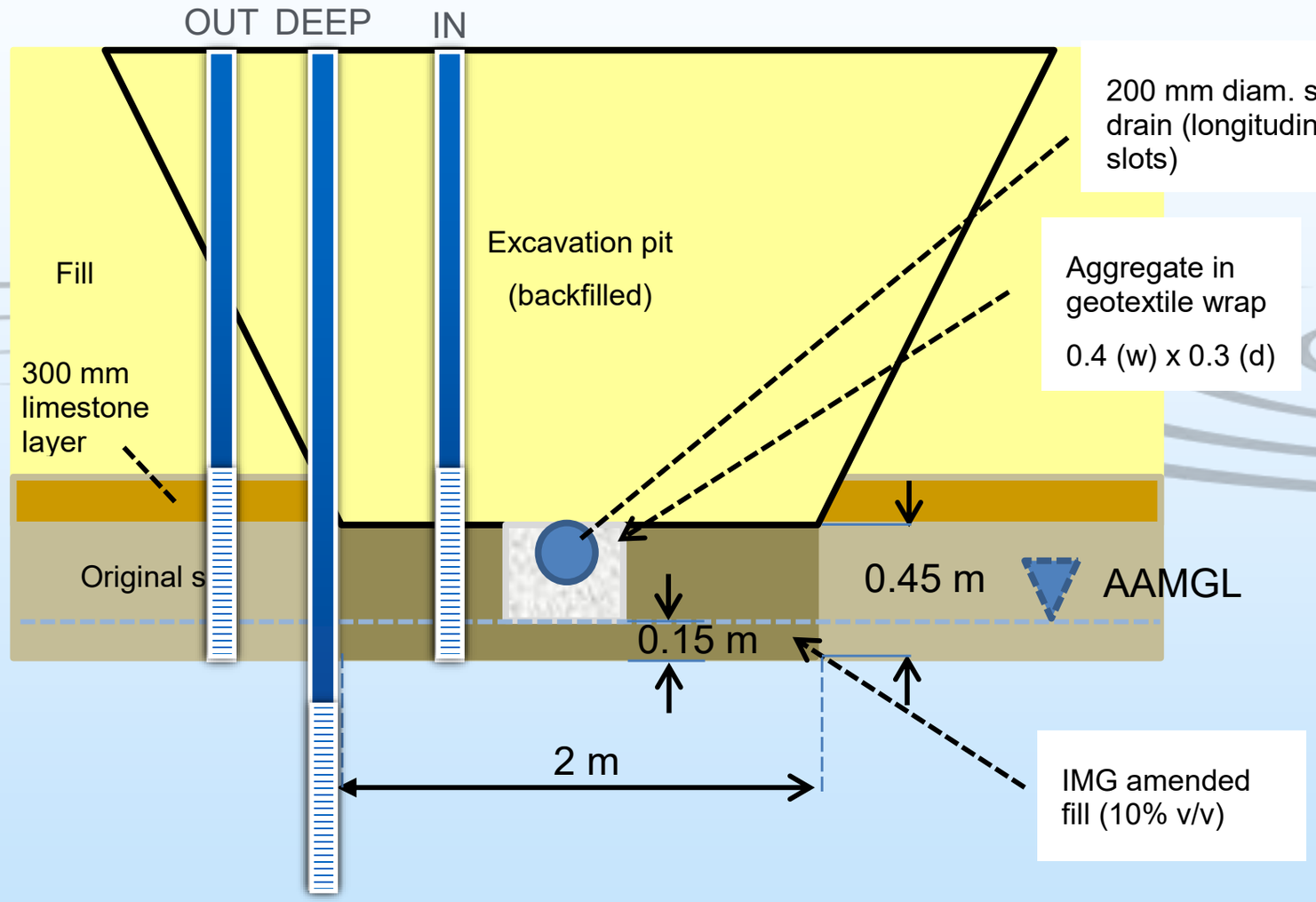
Treatment design + monitoring



- 31 monitoring bores + 8 pits
- 7 pre-development (2-4 m)
- 22 installed adjacent drains + 2 between drains

Overview of monitoring layout

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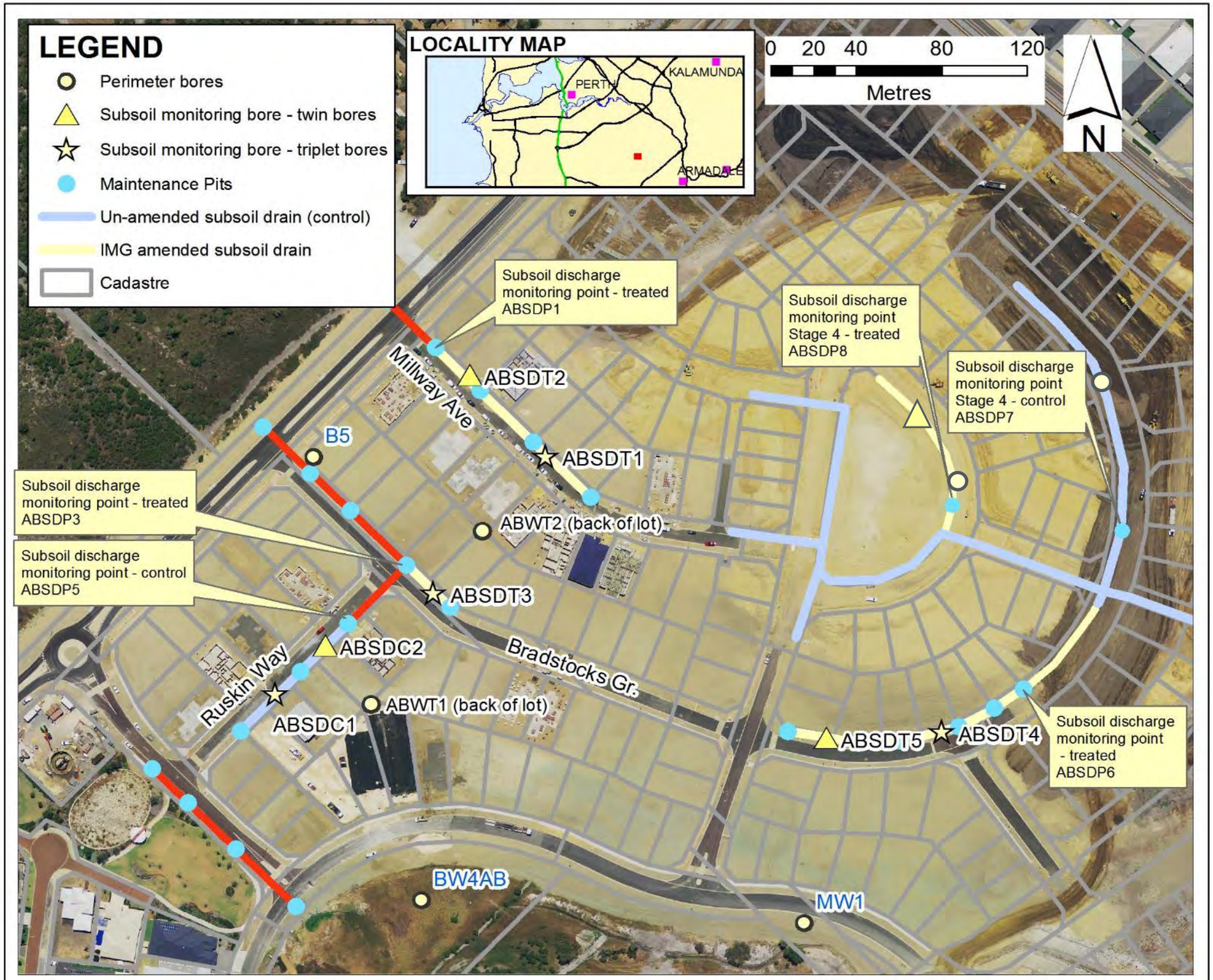

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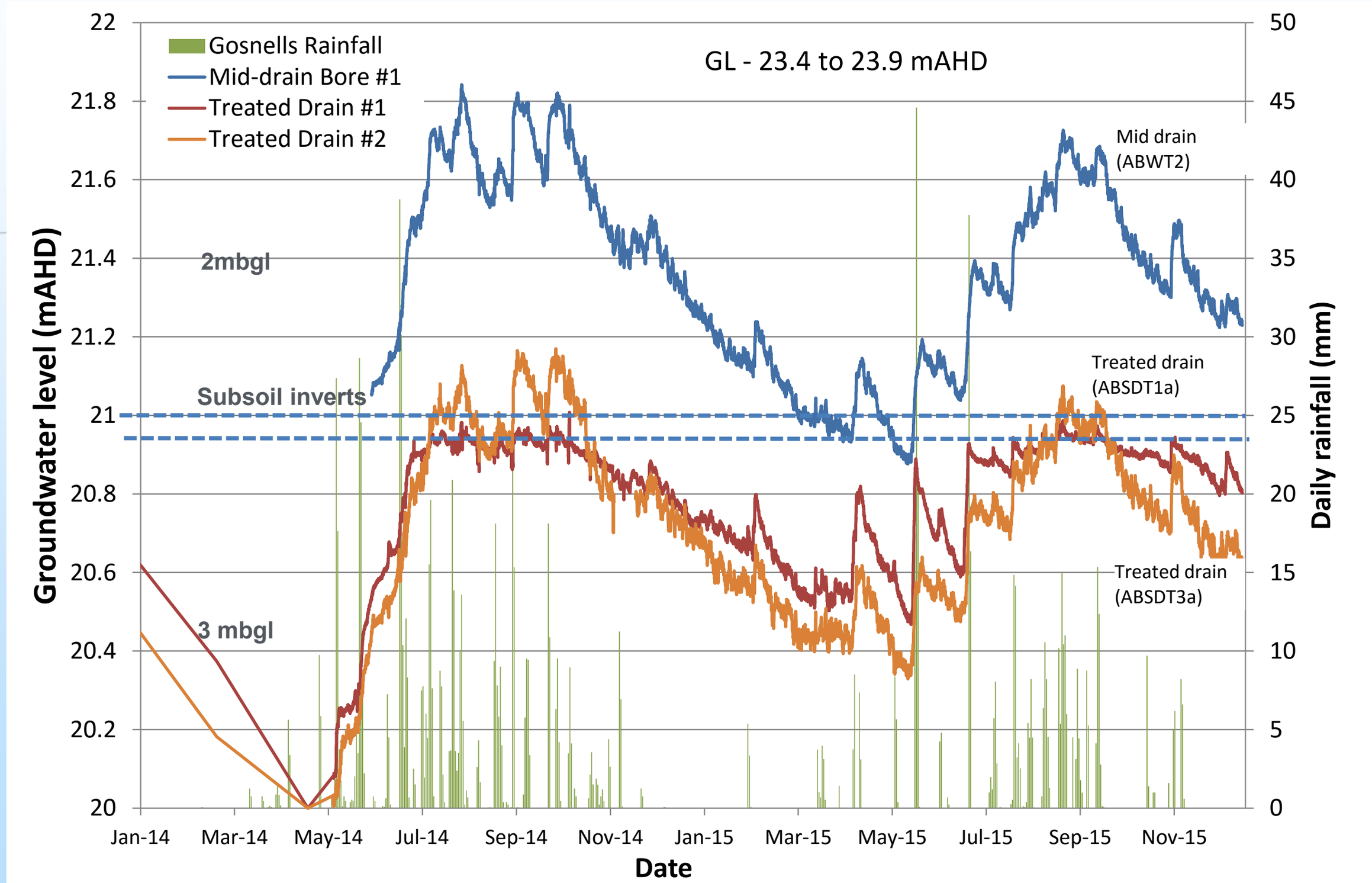
Rapid wetting up – intermittent flow



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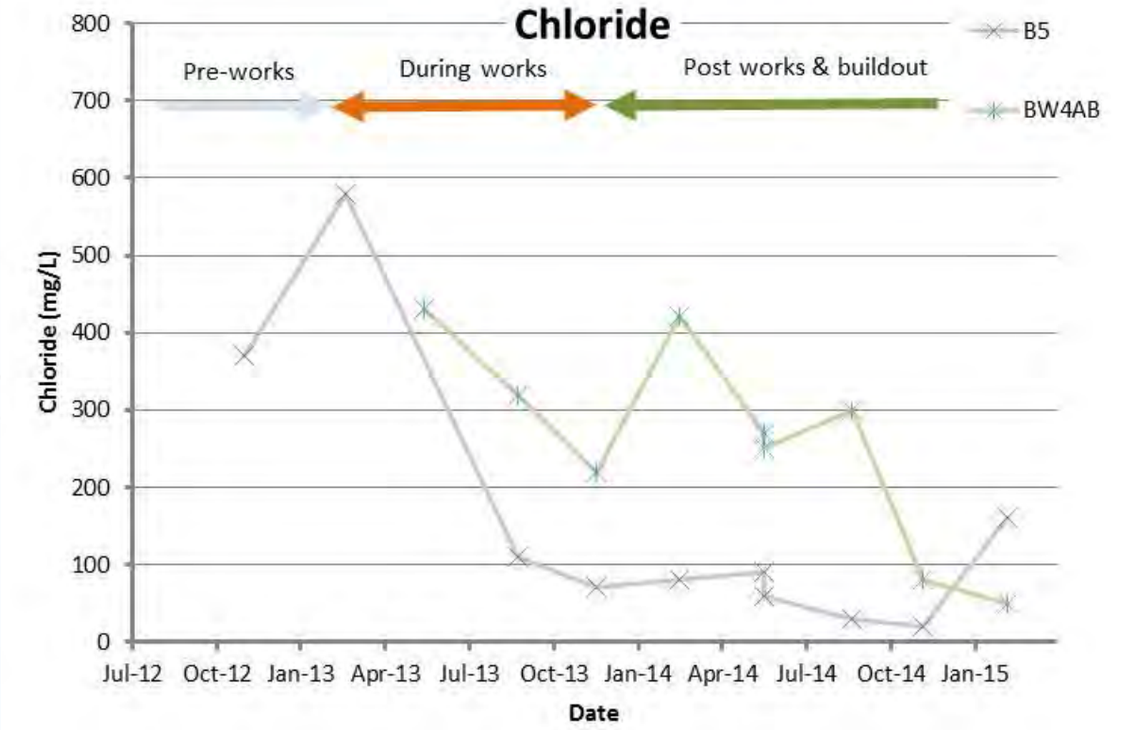
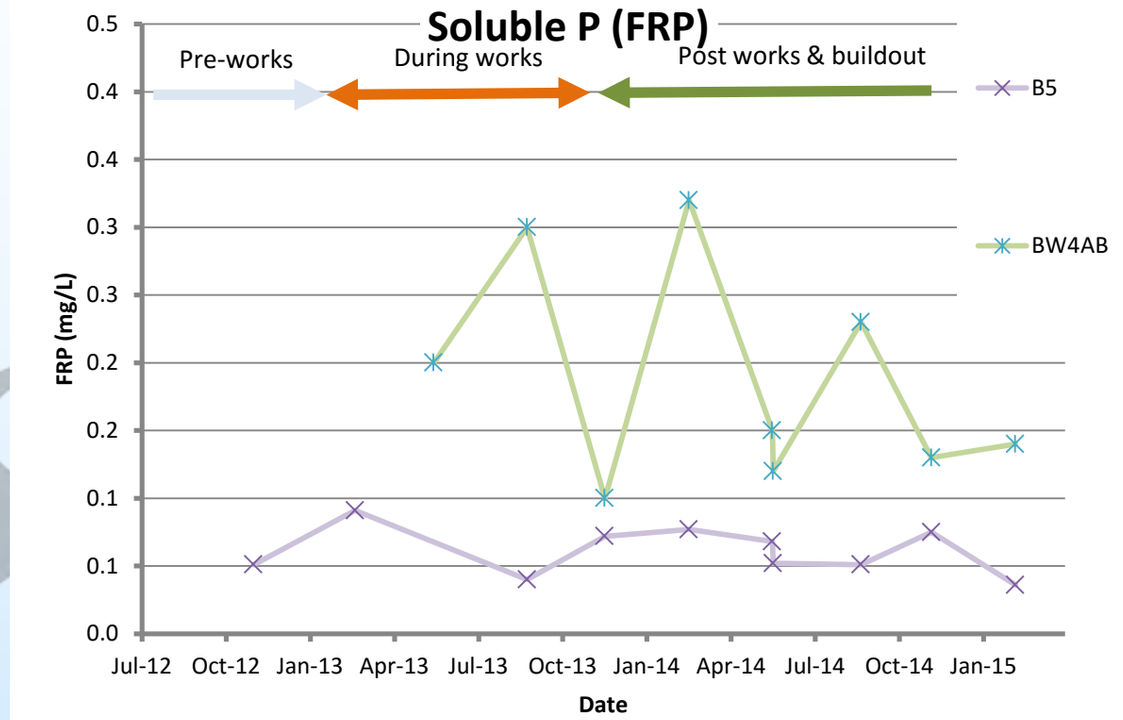
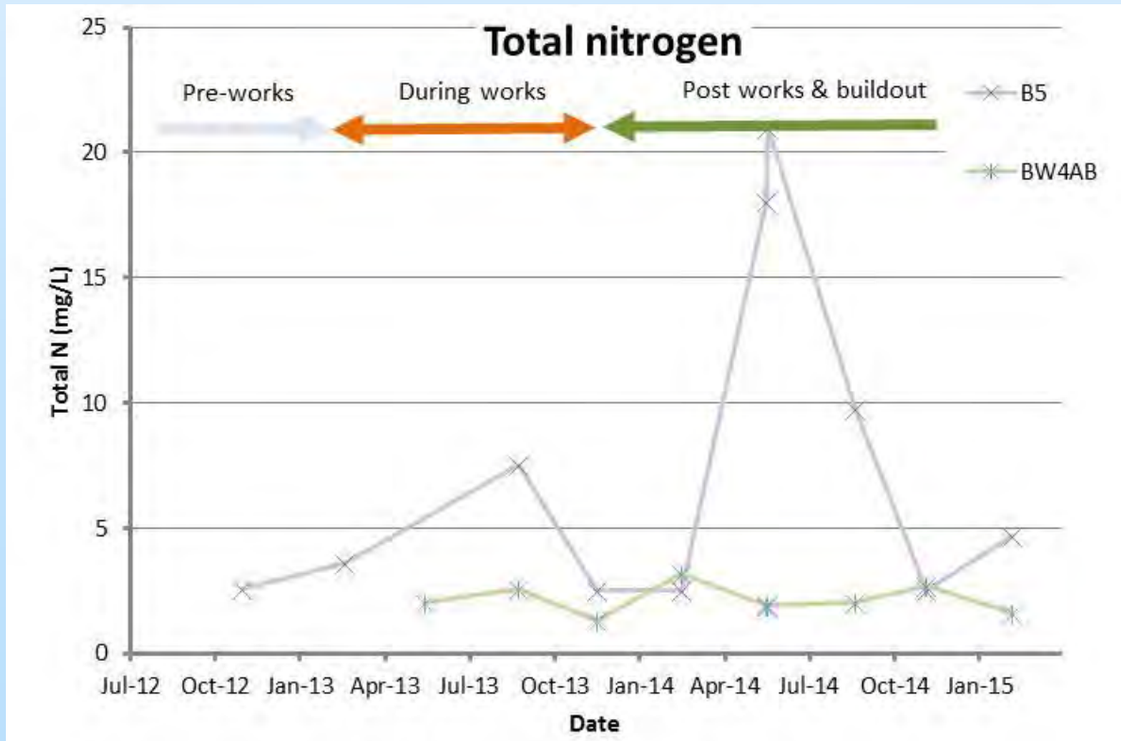
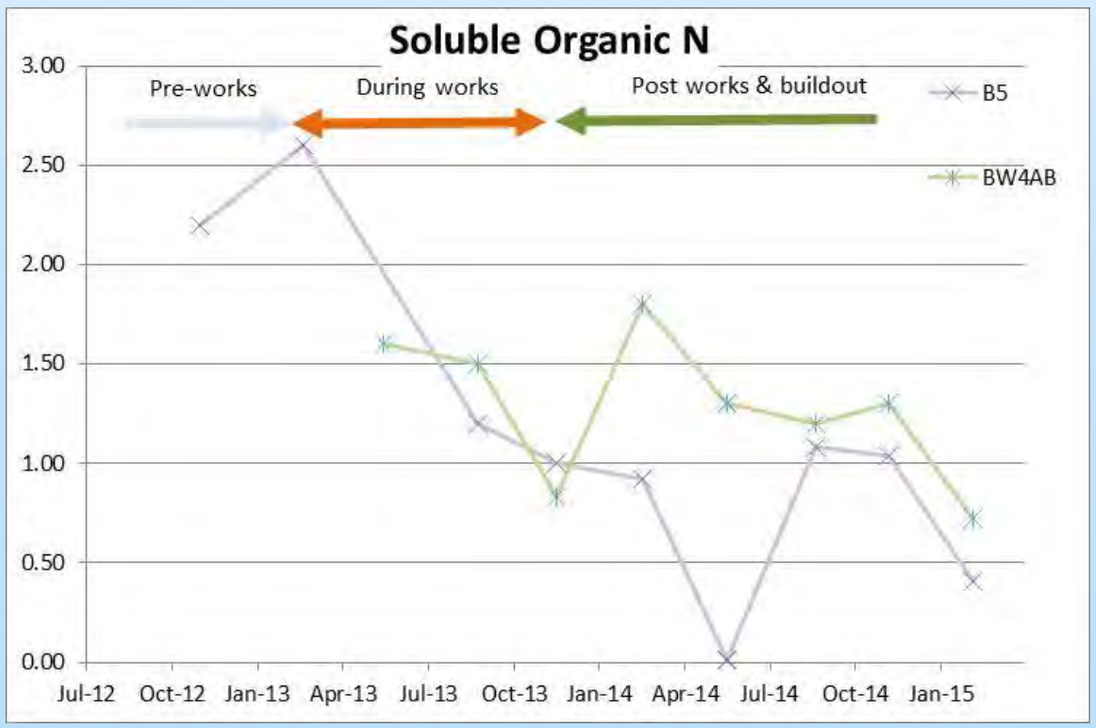
Water quality changes with development









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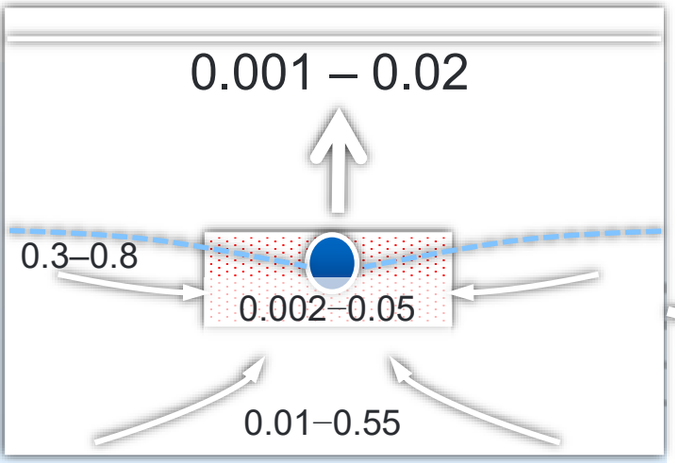
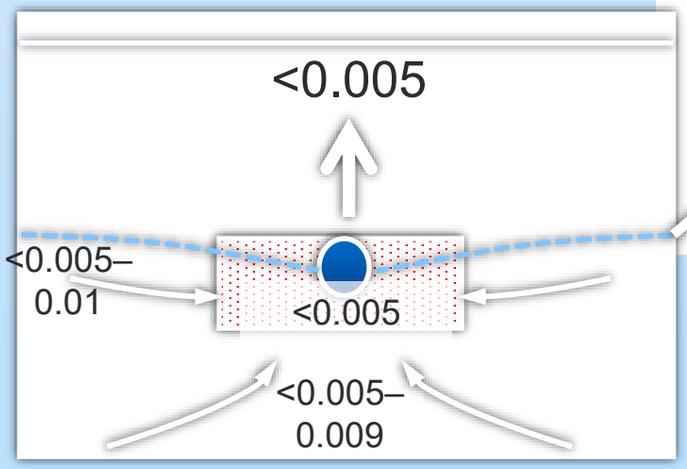
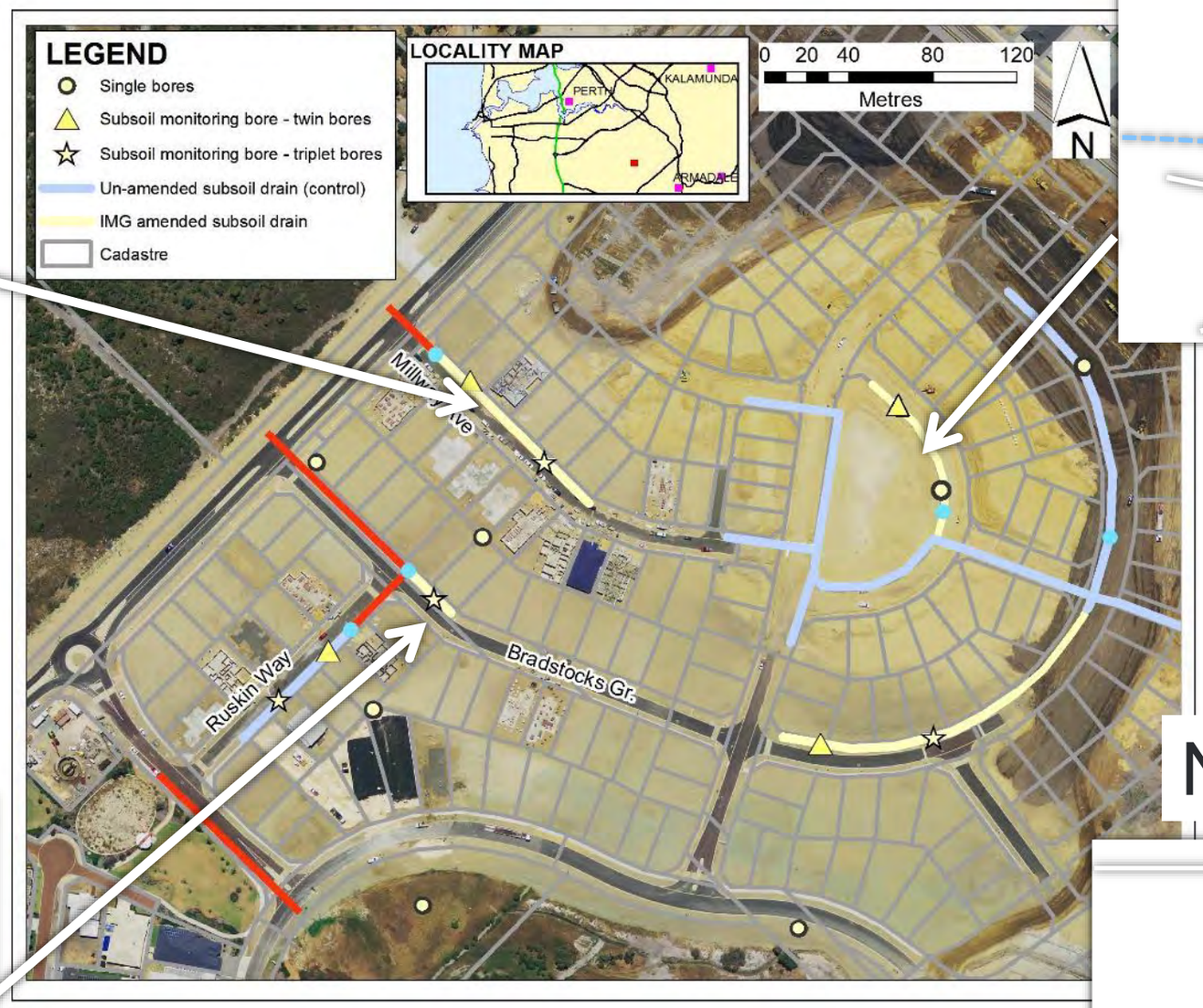
Soluble P removal

IMG-amended
(Stage 1 – 2 yrs year operation)

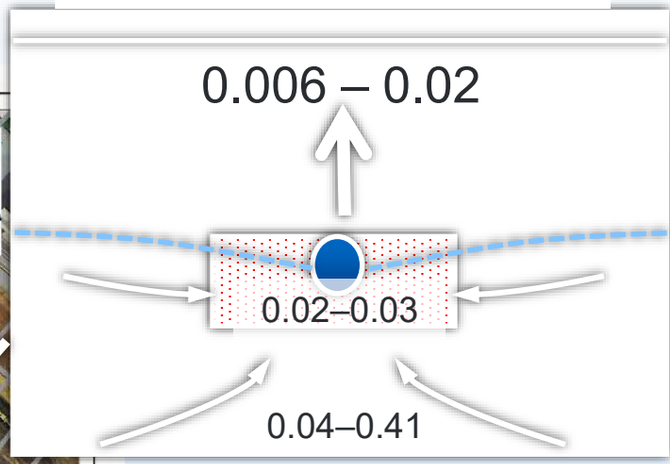


IMG-amended
(Stage 1 – 2 yrs year operation)

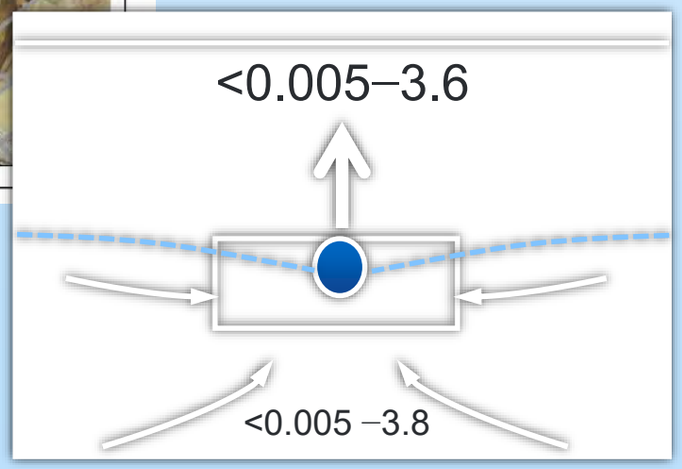




IMG-amended
(Stage 4 – 1st year operation)



Non-amended



Other patterns

- Dissolved organic N reduced by to 70% but on average 50%
- Groundwater also becomes:
  - Fresher – chloride decreases by 50% over the year (shallow>deep)
  - More oxygenated – dissolved O_2 greater in shallow vs deep bore
  - Enriched in Ca, SO_4 – limestone from base + oxidised acid sulfate soils → could assist IMG action

Metals in groundwater

- None above background or controls – most not detectable
  - Silver, cadmium, mercury, lead & selenium below lab reporting limits of 0.001 mg/L
  - Arsenic, chromium, cobalt, molybdenum, nickel & zinc <0.001 to 0.037 mg/L
  - Higher concentrations generally associated with the non-amended sites compared with where IMG was in contact with groundwater – probably due to inversion of soil profiles.
  - Manganese – higher in development than background. No difference with IMG

Geotechnical risks

- Lab testing of extended leaching of several IMG sand blends (mixed on site) to remove most gypsum – equiv. several years of flow
- Corresponding continuous permeability & settlement testing during leaching
- Increase in permeability, no difference in settlement between IMG mix & control
- Analysis after leaching

Main findings

- Large spatial variation nutrient concentrations in shallow groundwater – modified during development
- Proof of concept - 10% IMG blend reduced soluble P concentrations (in GW and drains) to near 0.02 mg/L – now into 3rd year operation.
- Lesser reduction in soluble organic N (~ 50%)
- Shallow groundwater is fresher and more oxidised following development – reduced dissolved iron, preserves reactive iron oxides in IMG that adsorb P
- IMG blend is geotechnically similar to sand fills – no difference from standard sand with extreme leaching

Recommendations

- Tailor blend and design to specific legacy problems on site – reduces soluble P and some soluble organic N (not NH_4/NO_3)
- Use for post-development nutrient flux – capacity may be limited but could be >5 years.
- Ensure IMG is well mixed with fill before installation – treat groundwater prior to seepage to subsoil pipes + pits
- 10% IMG amended sand fill is geotechincally suitable for use as a broader scale amendment for sand fill or as base fill amendment

Thankyou

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- Theo Tham & Ray Todd , Cossill & Webley
- Stuart Reside, Urban Quarter Ltd.
- Iluka Resources Ltd.

Monitoring co-funded by DoW, SRT & Department of Housing