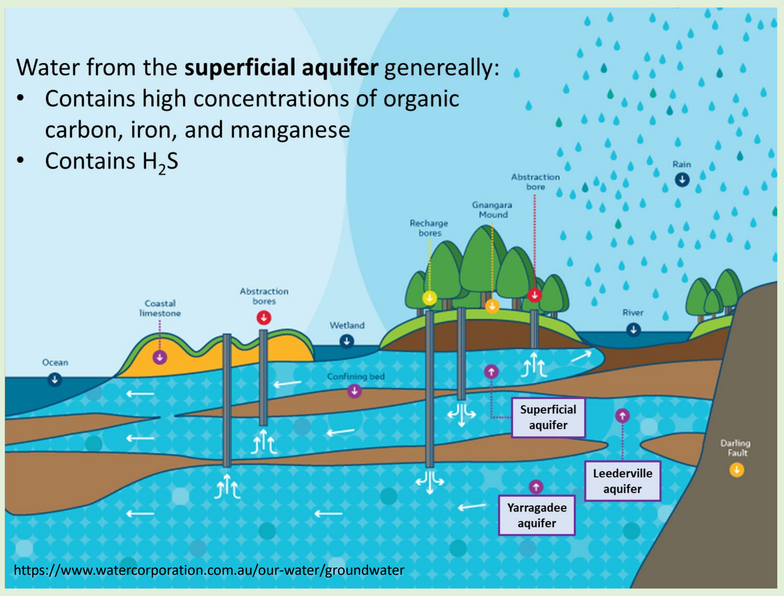
Adapting to Changes to Gnangara Groundwater Allocation: Optimisation of Source Waters and Treatment Processes in Two Groundwater Treatment Plants in Perth, Western Australia

Ina Kristiana[a], Luke Zappia[b], Troy Jansen[b], and Cynthia Joll[a]

[a]Curtin Water Quality Research Group; [b]Water Corporation of Western Australia

Water from the **superficial aquifer** genereally:
- Contains high concentrations of organic carbon, iron, and manganese
- Contains H_2S



https://www.watercorporation.com.au/our-water/groundwater

Context and Scope of Study

40% of the Integrated Water Supply Scheme (Perth) is derived from groundwater

Changes to Gnangara groundwater allocation → Changes to source water supplying GWTPs in Perth: Higher proportions of water from **superficial** bores will be utilised → ! Treatment challenges; ! Aesthetic water quality concerns

Study needed to:
- Understand the treatability of changing source water supplying Groundwater Treatment Plants (GWTPs)
- Optimise treatment processes to maintain quality of treated drinking water

Study Design

Groundwater sample
(single bore or bore blend)

Characterisation of water samples
Analysis of selected water quality parameters: organic and inorganic characteristics informing/predicting treatability

Treatability evaluation & treatment process optimisation
- Plant-scale treatment performance evaluation
- Laboratory-scale treatment experiments (jar tests to simulate plant conditions)
- Analysis of selected water quality parameters (before and after treatment)

Water Quality Parameters
- Dissolved organic carbon (DOC) concentration
- UV absorbance
- Conductivity
- Anions: bromide, chloride, sulfate, nitrate
- Total iron (Fe)
- Total manganese (Mn)

Wanneroo GWTP

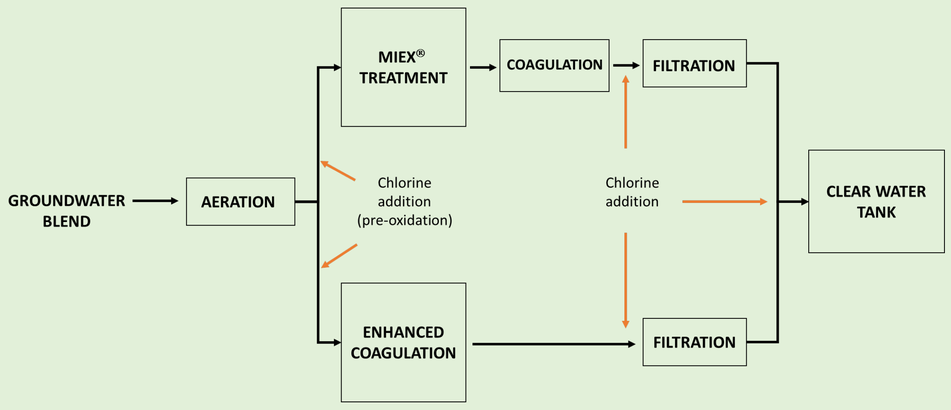


Table 1: Range of water quality parameters corresponding to each type of groundwater

Groundwater Aquifer	DOC (mg/L)	UV_{254}	Conductivity (µS/cm)	Bromide (µg/L)	Total Fe (mg/L)	Total Mn (mg/L)
Superficial	1.2 – 59	0.04 – 3.01	285 – 665	165 – 560	<0.03 – 1.2	<0.01 – 0.13
Leederville	0.34 – 4.5	0.03 – 0.39	310 – 1240	145 – 985	0.7 – 11	0.02 – 0.19
Yarragadee	1.0 – 1.8	0.04 – 0.07	205 – 2560	10 – 150	<0.03 – 0.47	0.01 – 0.05

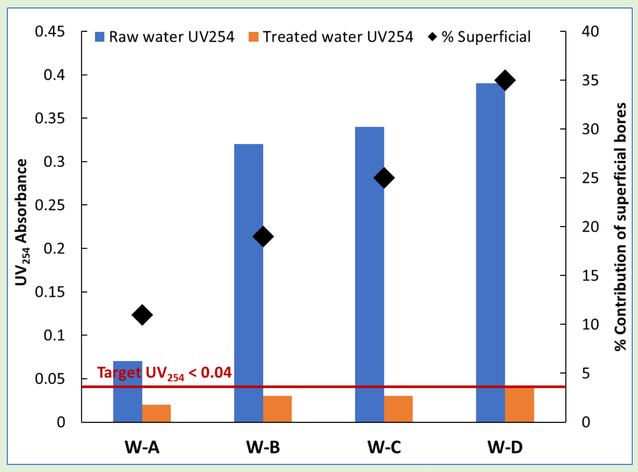


Figure 1: Removal of organic matter at Wanneroo GWTP with increased contribution of superficial bores in the raw water blends W-A, W-B, W-C, and W-D (alum dose in MIEX® treatment stream 25 – 40 mg/L; alum dose in enhanced coagulation stream 60 mg/L)

- ✓ MIEX® resin dose rate and regeneration protocol optimised
- ✓ Lime addition facility commissioned since pH adjustment is needed to process higher proportions of low pH superficial groundwater
- ✓ Target product water quality at the plant (UV_{254} < 0.04) was consistently met despite changes in source water quality (limitations: DOC of raw water blend should be < 5 mg/L)

Mirrabooka GWTP

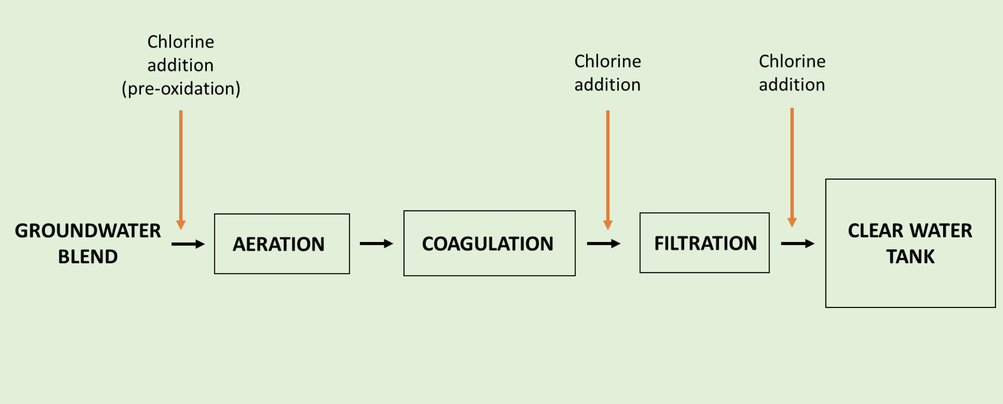


Table 2: Range of water quality parameters corresponding to each type of groundwater

Groundwater Aquifer	DOC (mg/L)	UV_{254}	Conductivity (µS/cm)	Bromide (µg/L)	Total Fe (mg/L)	Total Mn (mg/L)
Superficial	1.1 – 19	0.03 – 0.76	24 – 80	100 – 900	0.12 – 13	0.005 – 0.03
Leederville	0.4 – 1.6	0.005 – 0.03	79 – 144	420 – 900	8.6 – 17	0.10 – 0.26

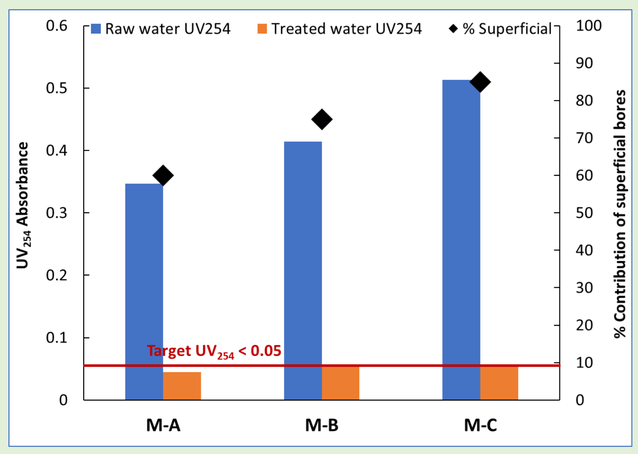


Figure 2: Removal of organic matter in laboratory-scale treatment experiments using Mirrabooka groundwater blends with increasing contribution from superficial bores (alum dose for M-A: 90 mg/L; M-B: 120 mg/L; M-C: 150 mg/L)

- ✓ Alum dose rate optimised for varying contributions of superficial bores
- ✓ Considering target product water quality at the plant (UV_{254} < 0.05) and ADWG aesthetic guideline for Al (0.2 mg/L), DOC of raw water blend should be < 6 mg/L

Conclusions

- ✓ Practical insights to manage unprecedented source water variability to GWTPs
- ✓ Treatment process optimisation to adapt to changes, along with cost-saving measures
- ✓ Demonstration of resilience in maintaining quality and quantity of treated drinking water produced by GWTPs
- ☛ Long-term evaluation of any impact in the treatment performance at the GWTPs and distribution systems is underway
- ☛ Development of model for bore selection for optimal treatability, operations, and maintenance

Presenting author contact details **E: I.Kristiana@curtin.edu.au** **P: 08 9266 9389**