Australia's National Science Agency

Estimating the costs of MAR under uncertainty

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International Association of Hydrogeologists
the World-wide Groundwater Organisation
IAH Commission on Managing Aquifer Recharge

Australian National University

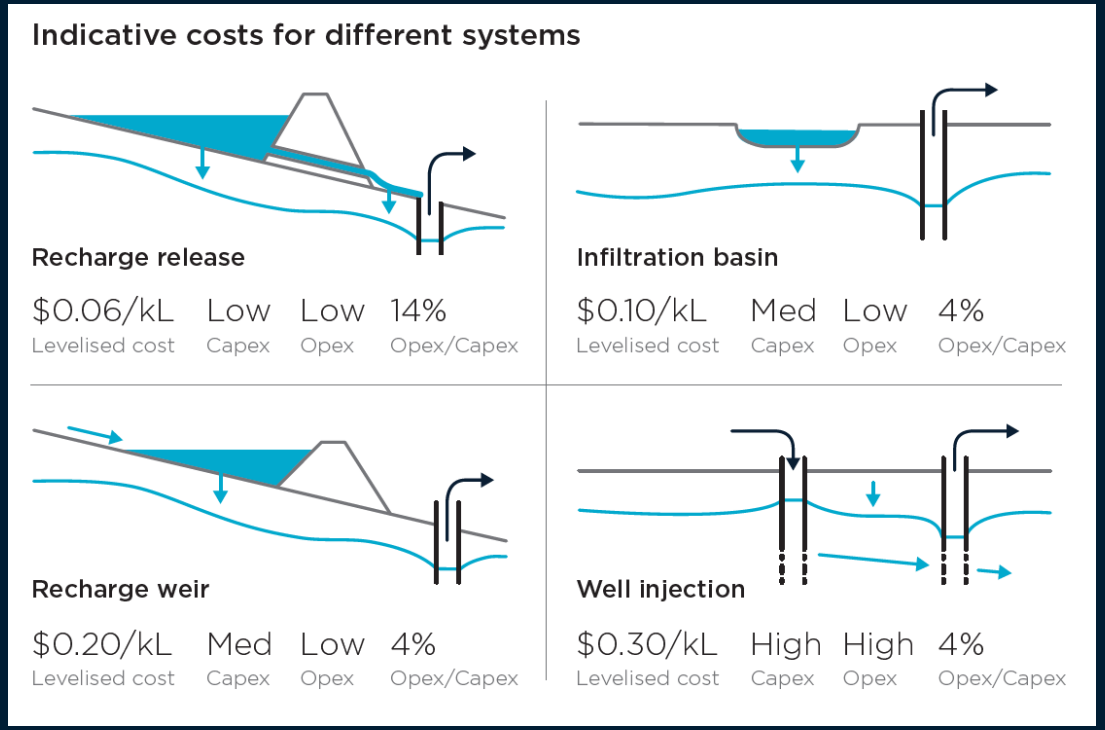
Limitations of previous work

Location specific case studies

Uniform operation, defined scales & conditions

Ranges, uncertainties & sensitivities unaccounted

Indicative costs of conceptual schemes



https://research.csiro.au/mar/what-is-water-banking-how-much-does-it-cost/

A new approach to answering the question

Sustainable Water Resources Management (2024) 10:119
https://doi.org/10.1007/s40899-024-01095-2

ORIGINAL ARTICLE

Estimating the costs of managed aquifer recharge under uncertainty with examples for town water supply in regional Australia

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- Stochastic inputs
- Time varying operation
- Cost curves: scheme types, scales, conditions
- Disaggregated costs, global sensitivity analysis
- Case studies oriented in results envelope

Gonzalez, D., J. Guillaume, L. Peeters, P. Wyrwoll, J. Vanderzalm and D. Page (2024). "Estimating the costs of managed aquifer recharge under uncertainty with examples for town water supply in regional Australia." Sustainable Water Resources Management **10**(3).

Model structure

Static inputs

- River discharge
- Scheme capacity

Stochastic capital costs

- Infrastructure
- Feasibility studies

Stochastic time/volume dependent functions

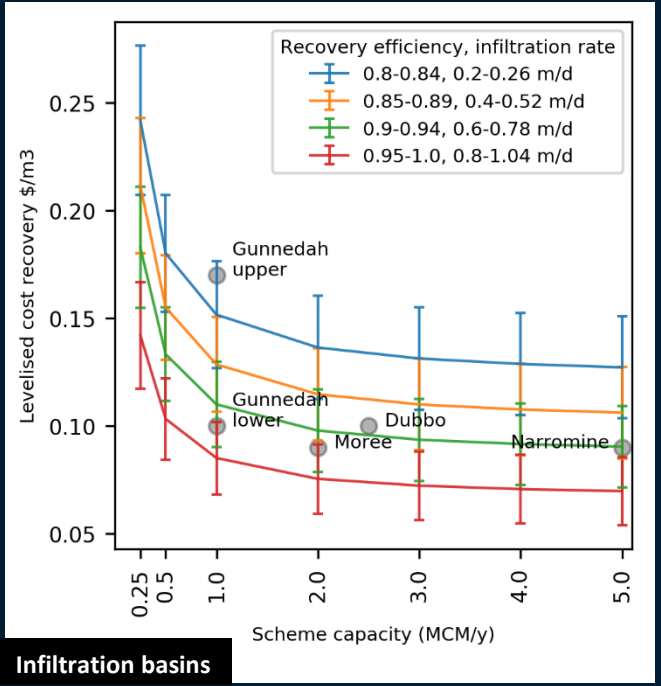
- Recharge/recovery trigger
- Storage efficiency
- Recharged/recovered volumes
- Monitoring costs
- Treatment costs
- Pumping

Discount rate

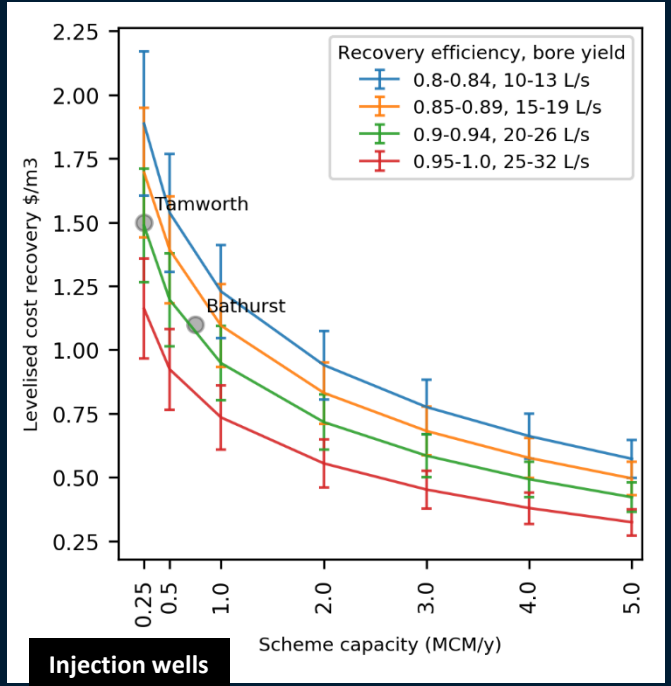
Outputs

- Operating costs
- Capital costs
- Levelised costs
- Sensitivity analysis

Costs curves according to scheme scales & conditions



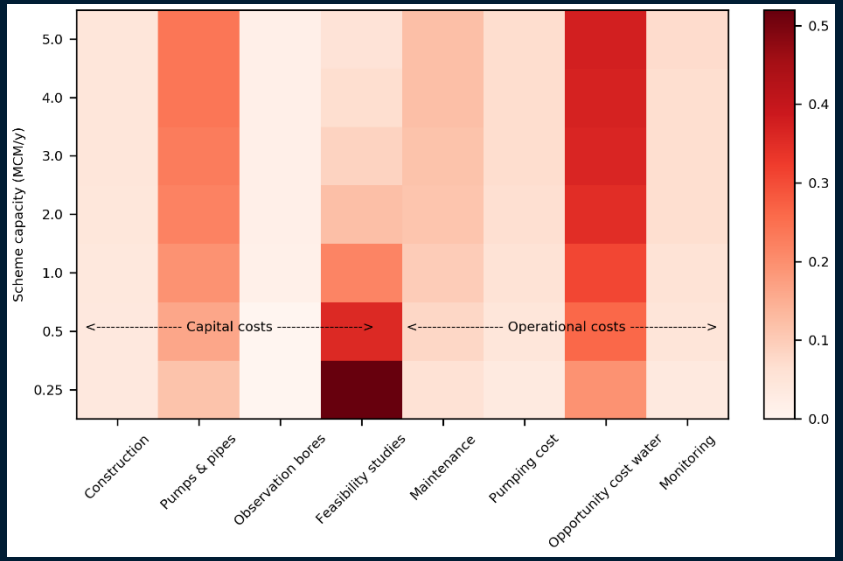
Infiltration basins



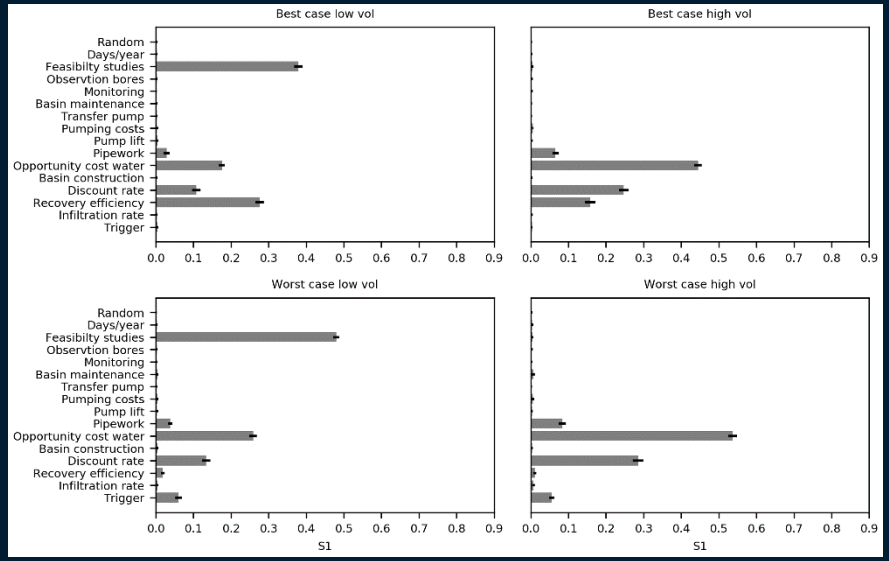
Injection wells

Gonzalez et al. 2024 https://doi.org/10.1007/s40899-024-01095-2

Disaggregated costs & sensitivities



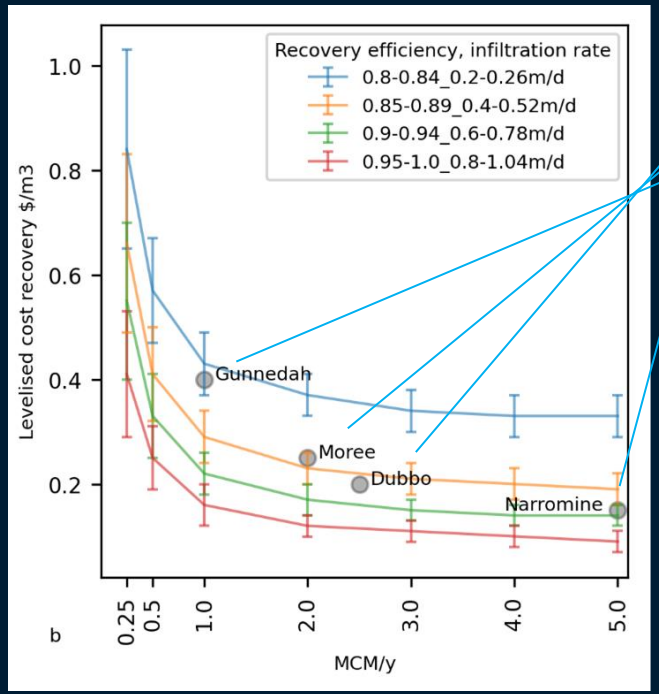
Influential factors vary according to infiltration basin scheme capacity

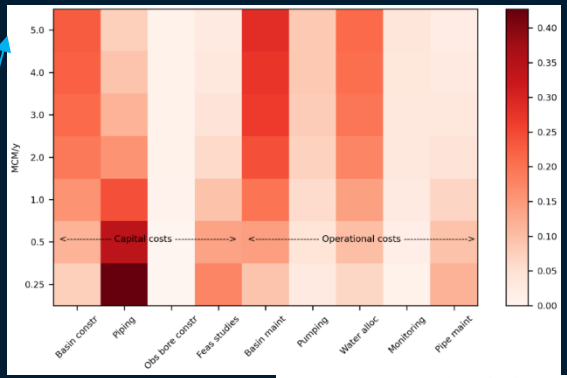


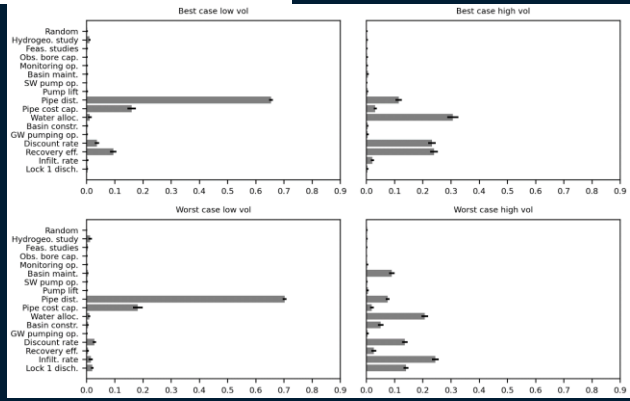
Sensitivities vary with basin scheme scales and operating conditions

Gonzalez et al. 2024 https://doi.org/10.1007/s40899-024-01095-2

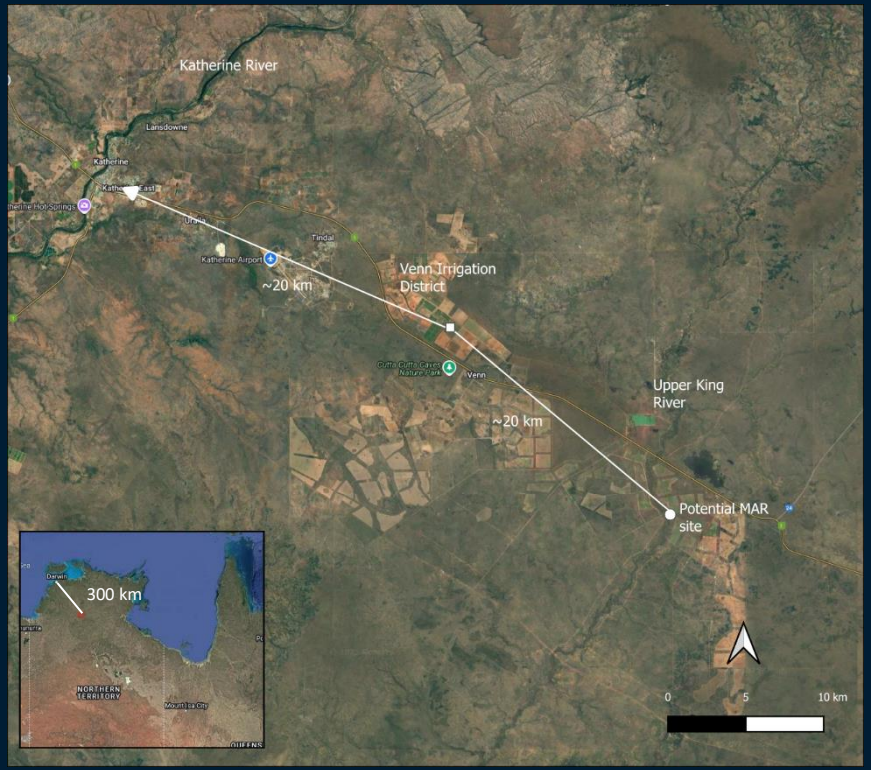
Orienting cases within results envelope







Case study: Upper King River, NT



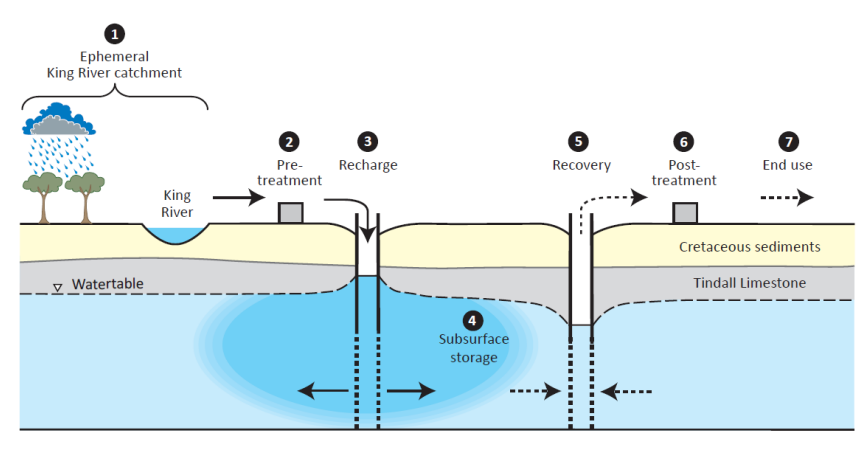
Upper King River MAR investigation site in the Northern Territory, Australia

- Objective: Irrigated agriculture (Venn Irrigation District)
- Source water: Upper King River
- Target aquifer: Tindall Limestone (semi-confined to confined)
- Region features:
- High-value horticulture, abundance of arable land but not water
- Irrigation heavily dependent on groundwater, ‘fully allocated’
- Good groundwater quality
- Variable aquifer properties
- Variable river flow, limits on diversion, turbidity

Priestley S., Page D., Vanderzalm J., Kim, S., Deslandes, A., Barry K., Currie S., Thomas H., Jaeger S., Gonzalez D., Groves, H., and Cobban, D. (2025) Upper King River Stage 2 Pre-commissioning - Managed Aquifer Recharge (MAR) risk assessment. CSIRO, Australia.

Upper King River - dry vs wet

Upper King River aquifer storage transfer and recovery (ASTR) system

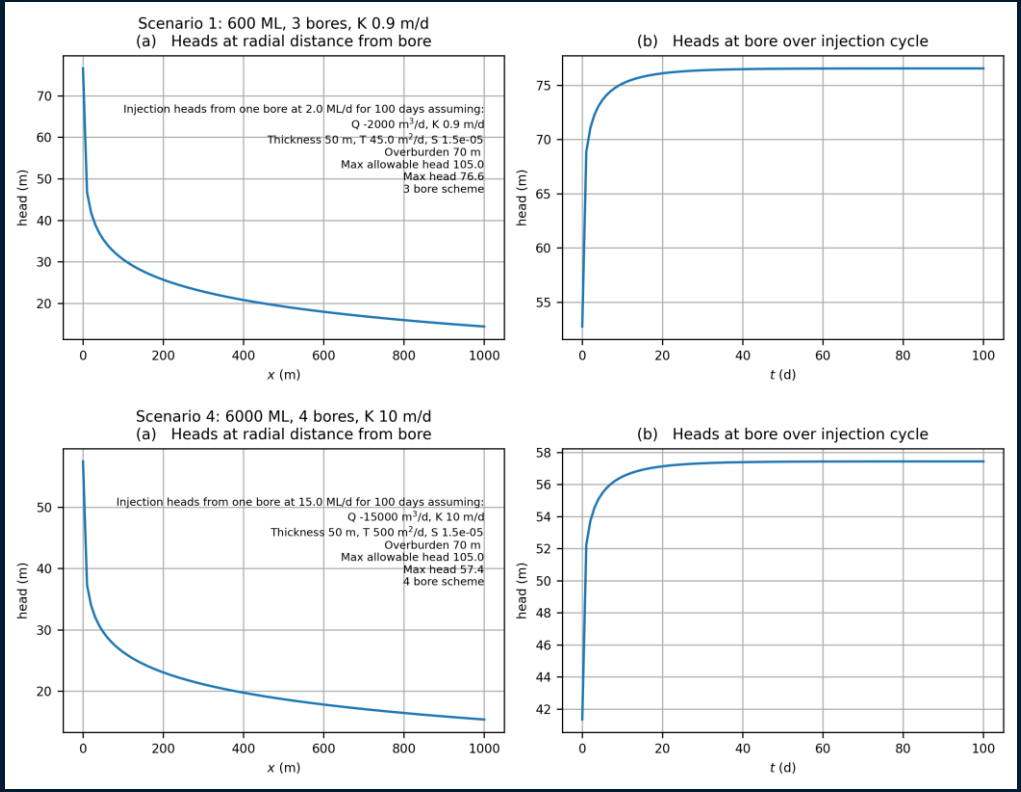


Priestly et al. (2025) Upper King River Stage 2 Pre-commissioning - Managed Aquifer Recharge (MAR) risk assessment. CSIRO, Australia.

Four scenarios

1. **Pilot scale 600 ML/y, K 0.9 m/d (3 wells at 2 ML/d), 3 step treatment**
2. Pilot scale 600 ML/y, K 10 m/d (1 well at 6ML/d), 2 step treatment
3. Full scale 6000 ML/y, K 0.9 m/d (30 wells at 2 ML/d), 3 step treatment
4. **Full scale 6000 ML/y, K 10 m/d (4 wells at 15 ML/d), 2 step treatment**

Analytical modelling of scenarios



Injection pressures below overburden limit

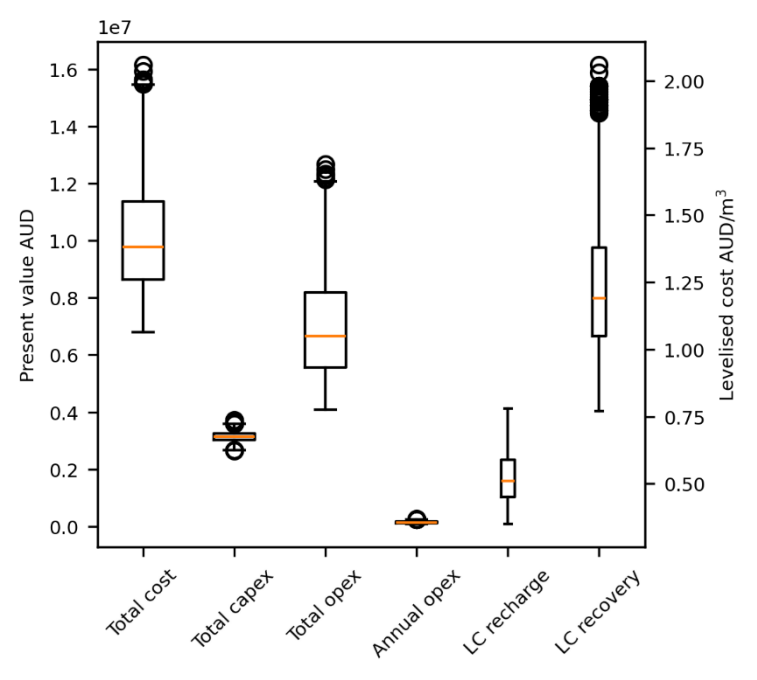
- Maximum allowable head increase of 105 m.

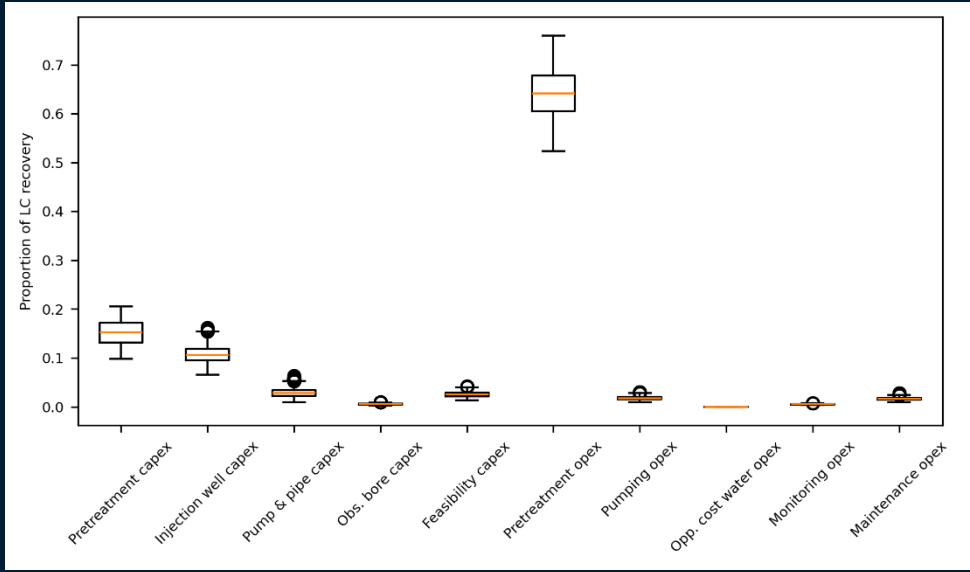
Borehole spacing:

- Multiple bores should be spaced at least 100 m for Scenario 1 (2 ML/d/bore)
- 1000 m for Scenario 3 (15 ML/d/bore).

Hantush and Jacob solution for semi-confined aquifers

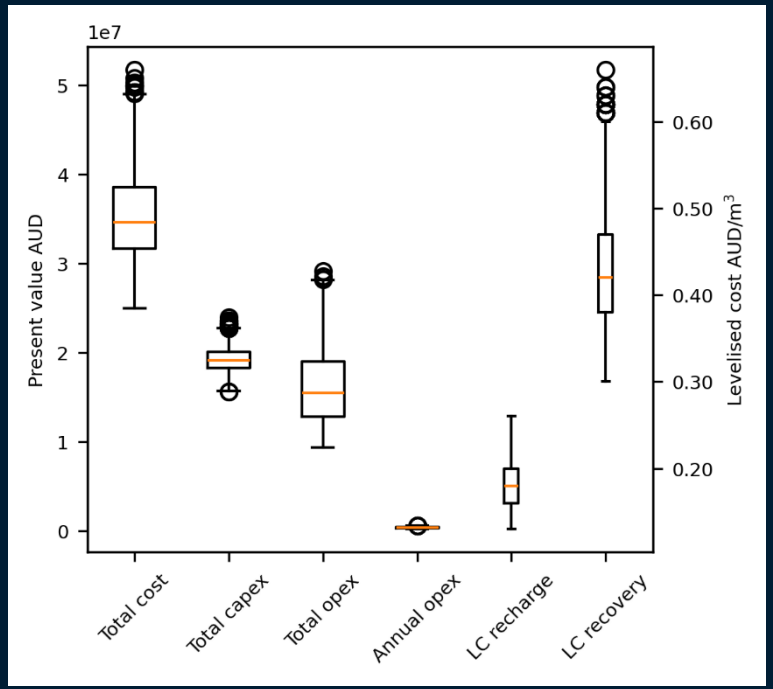
Pilot scale 600 ML/y cost distributions

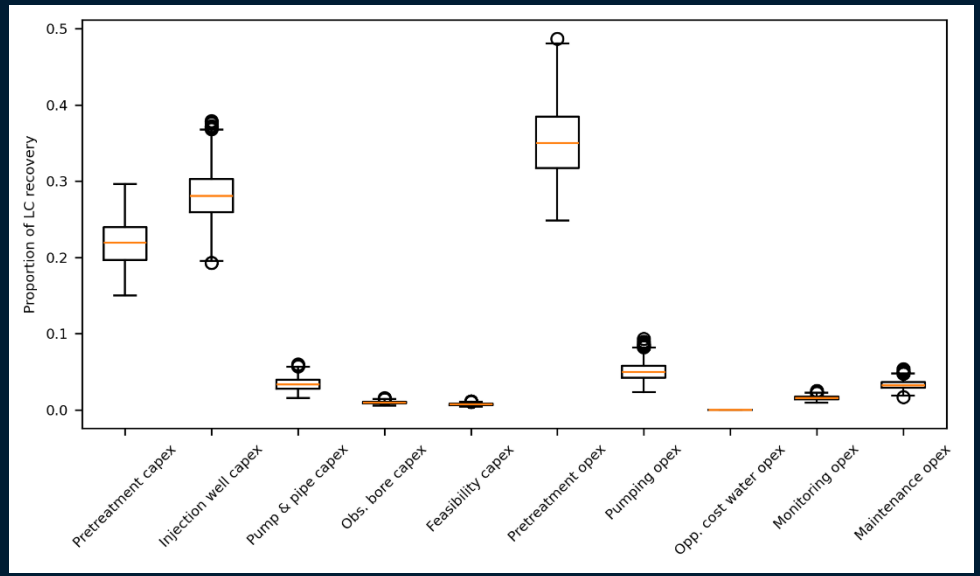




LC recovered water $0.75-2.00/m3

Full scale 6000 ML/y cost distributions





LC recovered water $0.30-0.70/m3

Results over 50-year project horizon

	600 ML/y	6000 ML/y
Total recharge ML	18,594	185,994
Annual storage efficiency	0.93	0.92
Total recovered ML	8,340	83,467
Overall recovery efficiency %	45	45
LC recharge $/m3	0.51	0.18
LC recovery $/m3	1.19	0.42
Total project cost $M	9.8	34.6

Median values

MAR appears viable for horticulture in the Upper King River, NT

Image source: Vecteezy

Image source: ABC News

Mangoes net benefit $2,000/ML

Melons net benefit $10,000/ML

Evans et al. (2017) https://doi.org/10.21139/wej.2017.029

Thank you

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International Association of Hydrogeologists
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IAH Commission on
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