


Field testing of the **Limax sinusoidal slug test system** in the Willunga Embayment, South Australia

Todd C. Rasmussen[1], Chris Turnadge[2], Eddie W. Banks[3], Margaret Shanafield[3], Ron Kreymborg[4], Kieran Harford[4]

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1 University of Georgia, USA
2 CSIRO, Australia
3 Flinders University, Australia
4 Kremford Pty Ltd, Australia

KREMFORD

UNIVERSITY OF GEORGIA

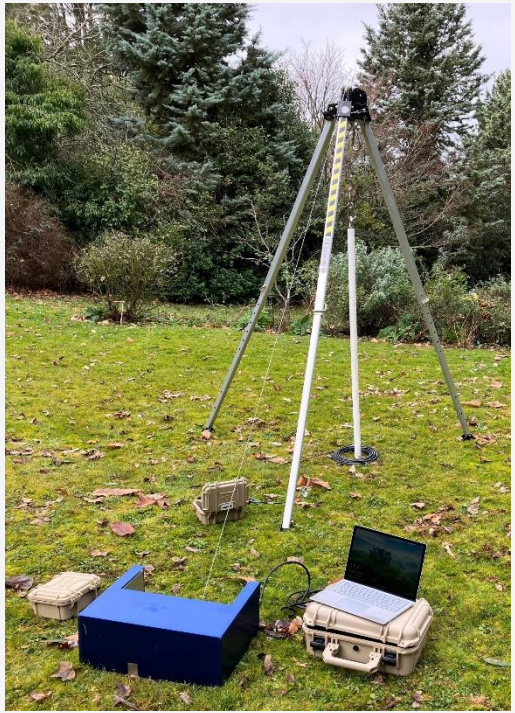
Flinders University

CSIRO

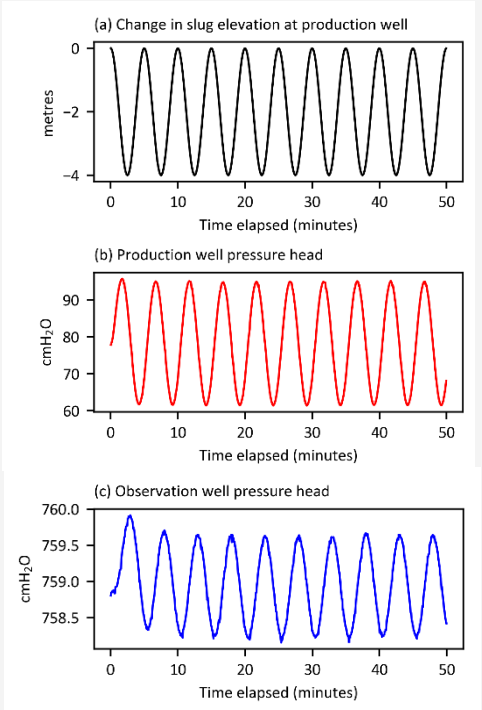
Australia's National Science Agency

Starting at the end

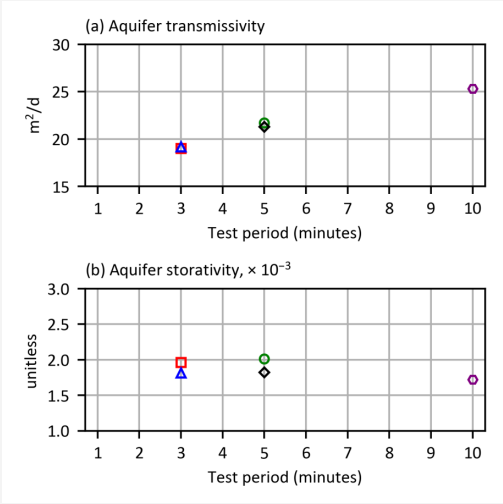
1. **Limax** sinusoidal slug test system



2. Measured **disturbances** and responses



3. Estimates of **hydraulic properties**



Research motivations

1. Two-well pumping tests

- High reliability of characterisation

but

- High associated costs

(Tickell and Nguyen, 2014)

2. Single-well slug tests

- Simple, inexpensive

but

- Can't measure responses at a 2nd well
- Can be affected by skin and BHS effects
- Can't estimate storage reliably

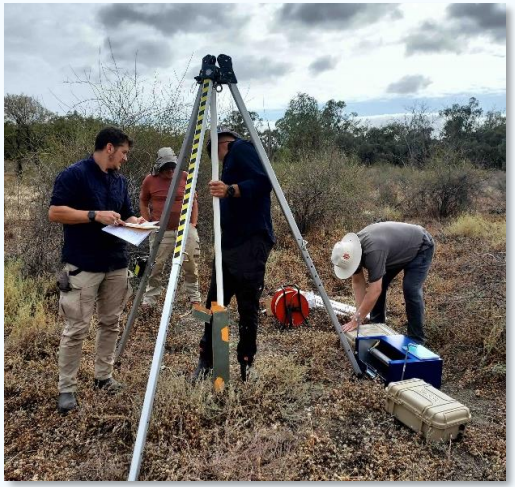
Not best practice for inserting a 6 m slug!

3. Sinusoidal hydraulic tests

- Theory established > 40 years ago
- Typically designed as a two-well test

but

- No accessible field methods available



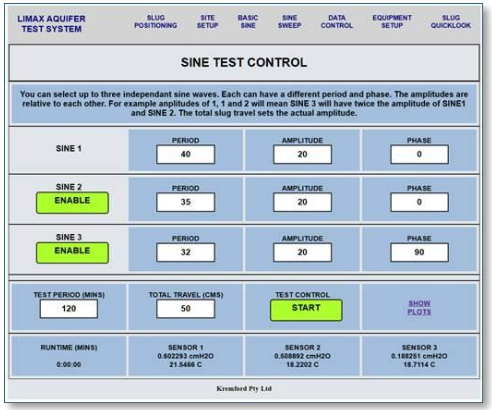
Katarapko Creek field testing, Loxton, SA, 2024

Methods – **Limax** sinusoidal slug test system

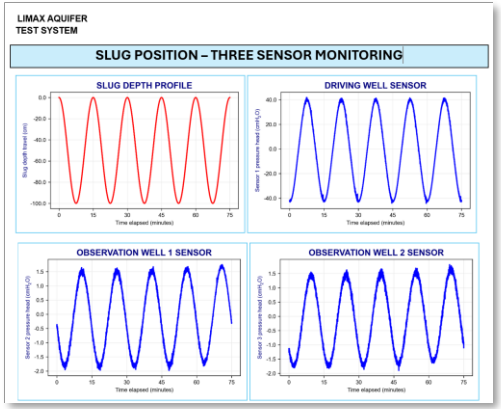
Limax sinusoidal testing system

1. Customised electronically-controlled winch

2. Wireless observation well monitoring



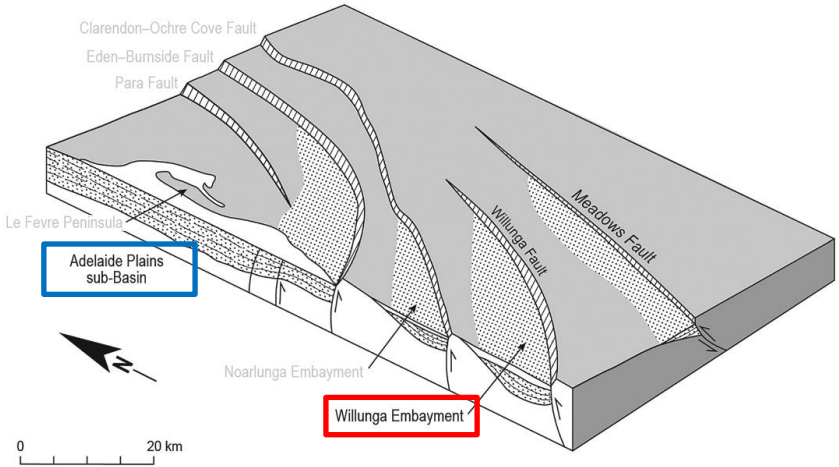
3. Smart device-based control



4. Real-time visualisation

Field site – **Willunga Embayment**, South Australia

Structural geology



Bourman et al. (2022). *Noarlunga and Willunga embayments*, MESA Journal 96: 27–36, after Talbot and Nesbit (1968).

Solid geology

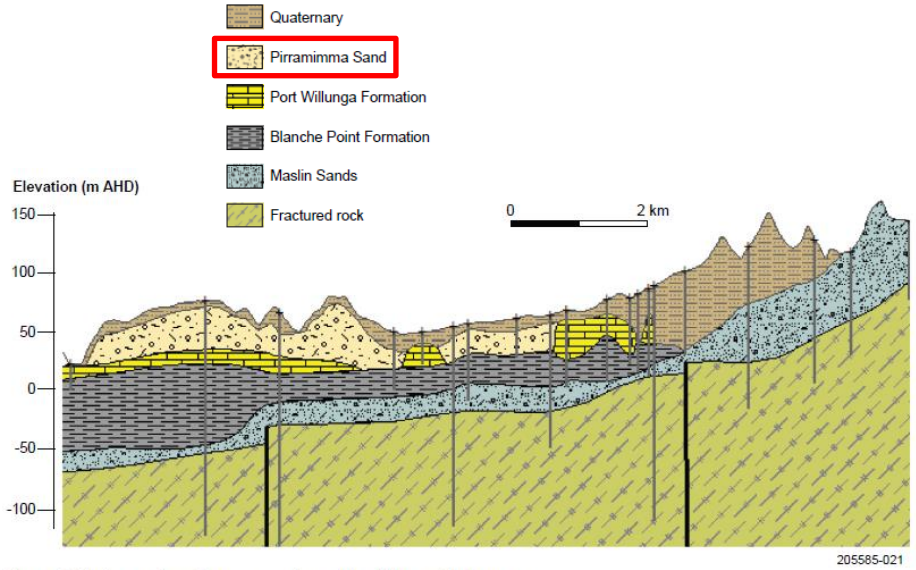


Figure 4 *Hydrostratigraphic cross-sections of the Willunga Embayment.*

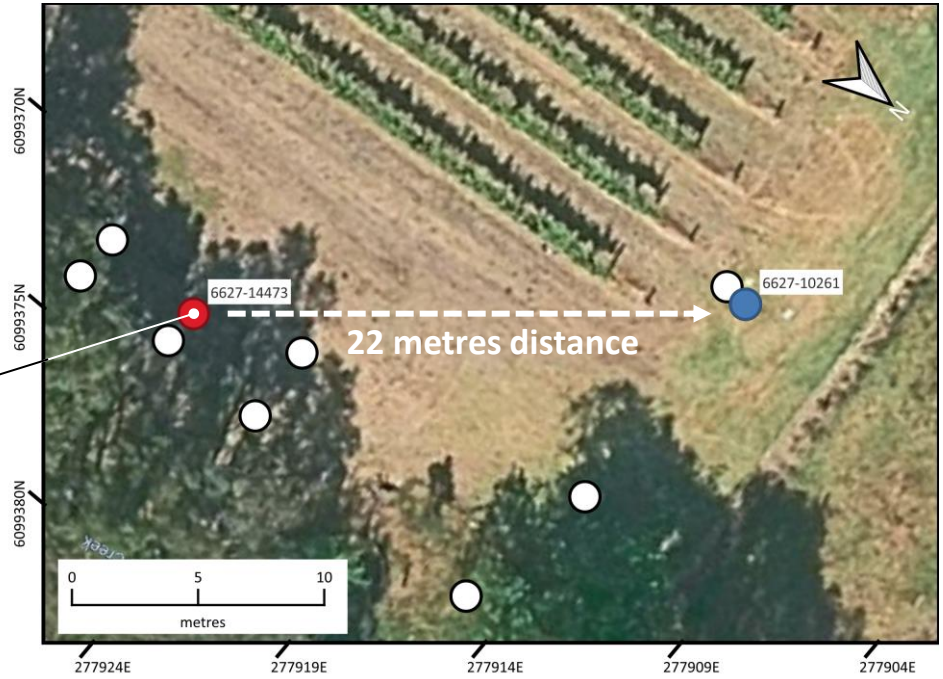
Barnett, S and Bourman, R (2022). *New insights into the Willunga Embayment*, MESA Journal 96: 22–26.

Field testing – **Leconfield site**, June 2025

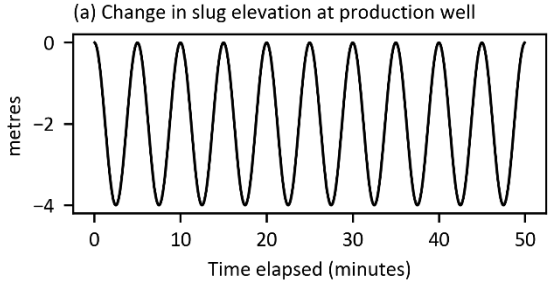
- Densely instrumented site: 19 screens distributed across 10 holes, including 3 x 4-piezometer nests
- DTW ≈ 10 mBGL, screen elevations ≈ 30 mBGL, aquifer thickness ≈ upper 3 m of Pirramimma Sand

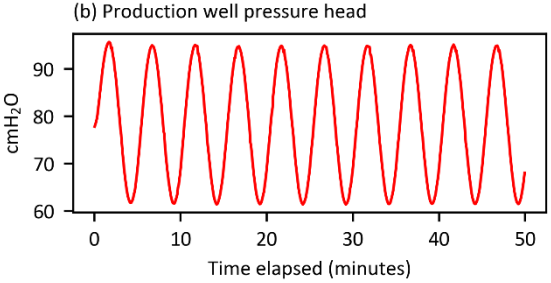
Leconfield site, looking north

Production well U/N 6627-14473



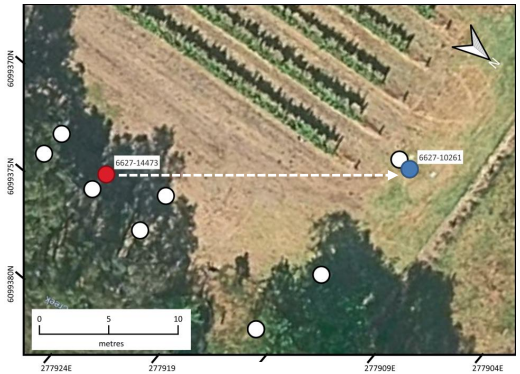
Results – Measured **disturbances** and **responses**

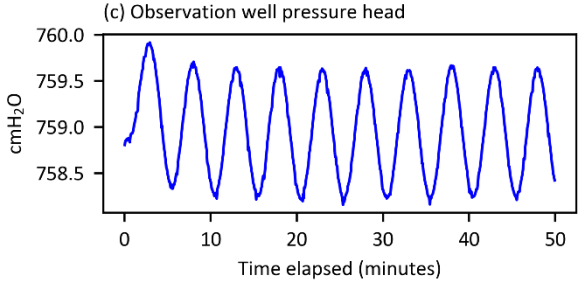




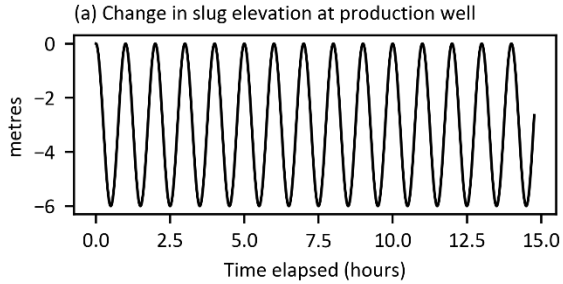
- 3, 5, and 10-minute test periods
- 10 repeated cycles
  - ➢ Test durations of 30-100 minutes

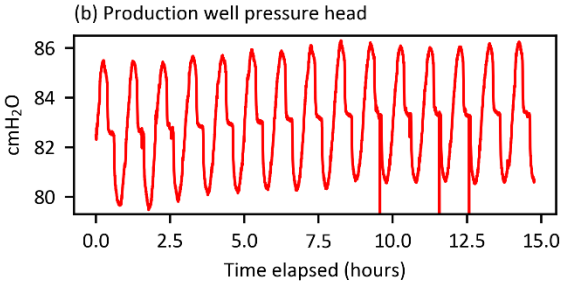
22 metres distance





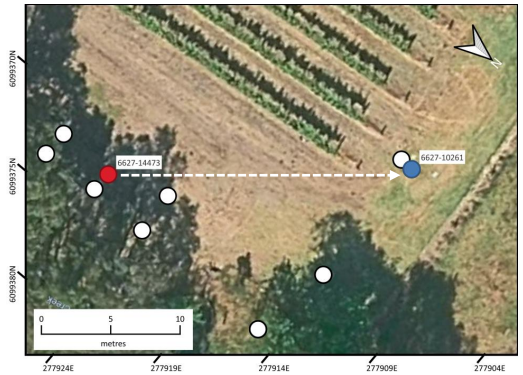
Long period testing – Unattended **overnight** test

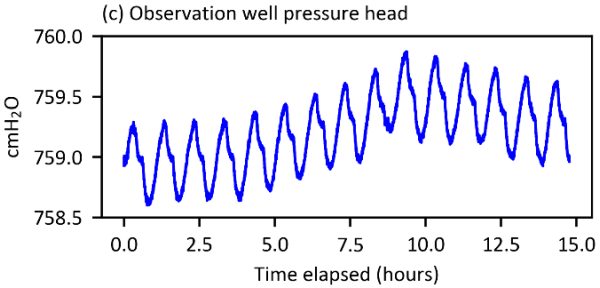




- 15-hour test duration
- 60-minute period
  - ➢ **Longest** active sinusoidal hydraulic test recorded to date!

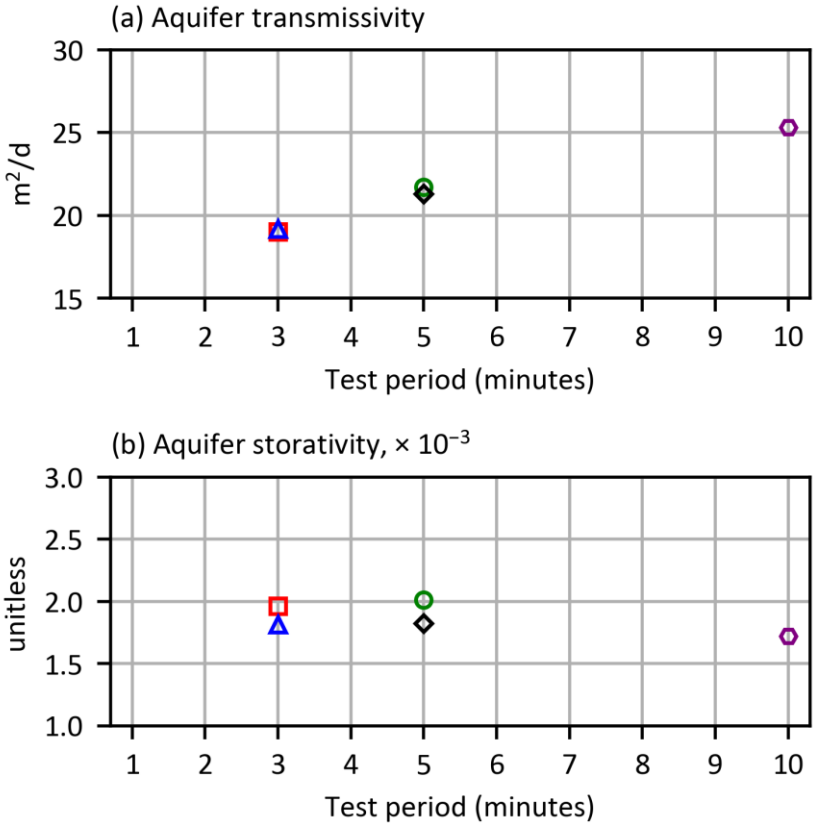
22 metres distance





Results – Interpreted **hydraulic properties**

- **Forward modelling:** Used Black and Kipp (1981) analytical solution for confined aquifer flow
- **Inverse modelling:** Used least squares-based method of Rasmussen et al. (2003) to fit forward model to measured data
- **Consistency:** Both estimated properties generally independent of test period chosen
- **Transmissivity estimates:** lower than might be expected for PWF or PS due to relatively thin aquifer thickness present and tested (3 m)
- **Storativity estimates:** Higher than might be expected, suggesting considerable aquitard leakage at this site



Ending at the end, this time

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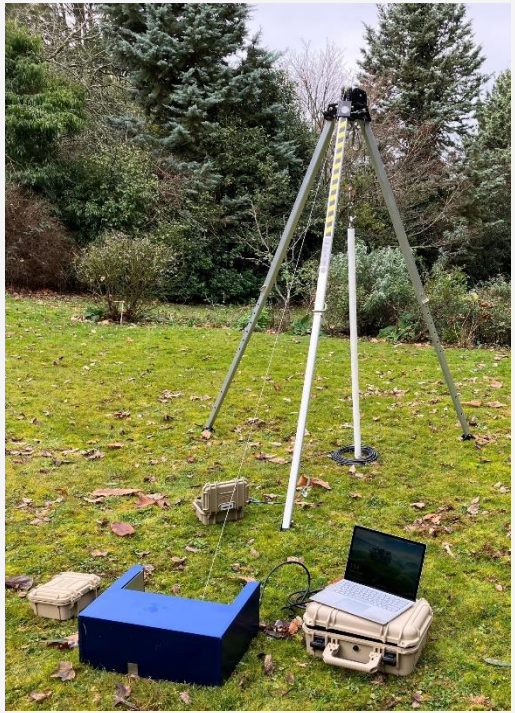

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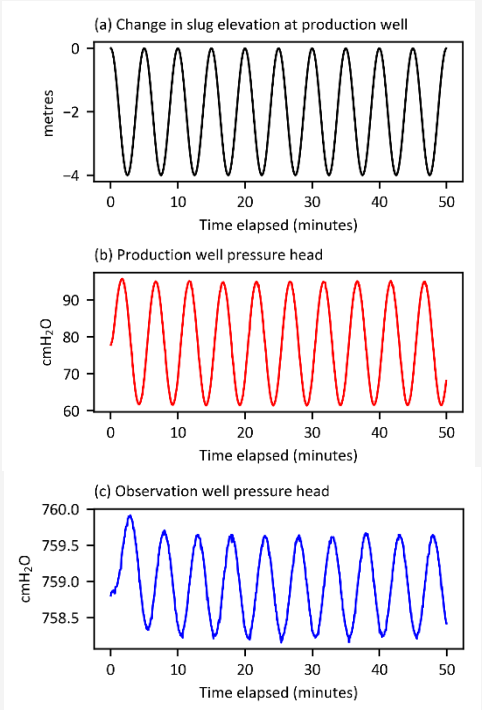

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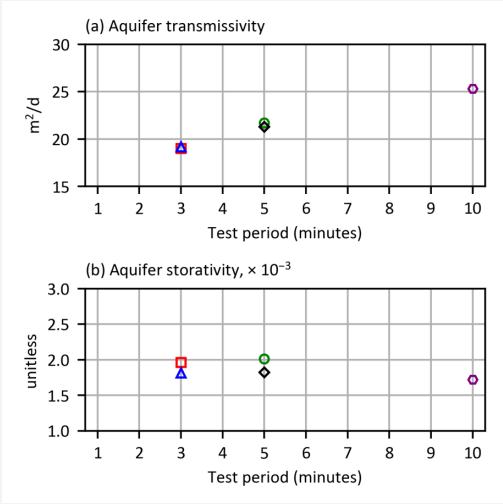

Take-home messages

- Sinusoidal slug tests typically only require **~1-hour duration**
- **No removal** of potentially contaminated water required
- Ideal for characterising **confined** and **leaky** aquifers
- High precision measurement of **mm-scale** responses in **real-time**
- Provide reliable estimates of both **transmissivity** and **storativity**

➢ Come and see the **Limax** system at the **NCGRT booth**!

Limax sinusoidal slug test system

KREMFORD UNIVERSITY OF GEORGIA Flinders University CSIRO

NCGRT Field Methods School, Adelaide, SA, 2023

Katarapko Creek field testing, Loxton, SA, 2024

AGC conference workshop, Perth, WA, 2022

Thank you

Chris Turnadge
Hydrogeologist
CSIRO

chris.turnadge@csiro.au