Advances in LNAPL assessment for cost effective and successful remediation

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Light Non-Aqueous Phase Liquid (LNAPL)

A *functional* description of lighter-than-water hydrocarbons that form a separate liquid phase to water which pose risks from movement, dissolution and vapour release

Can be:

But more often:

This presentation address ***LNAPL movement***: the other risks are important but require separate tools

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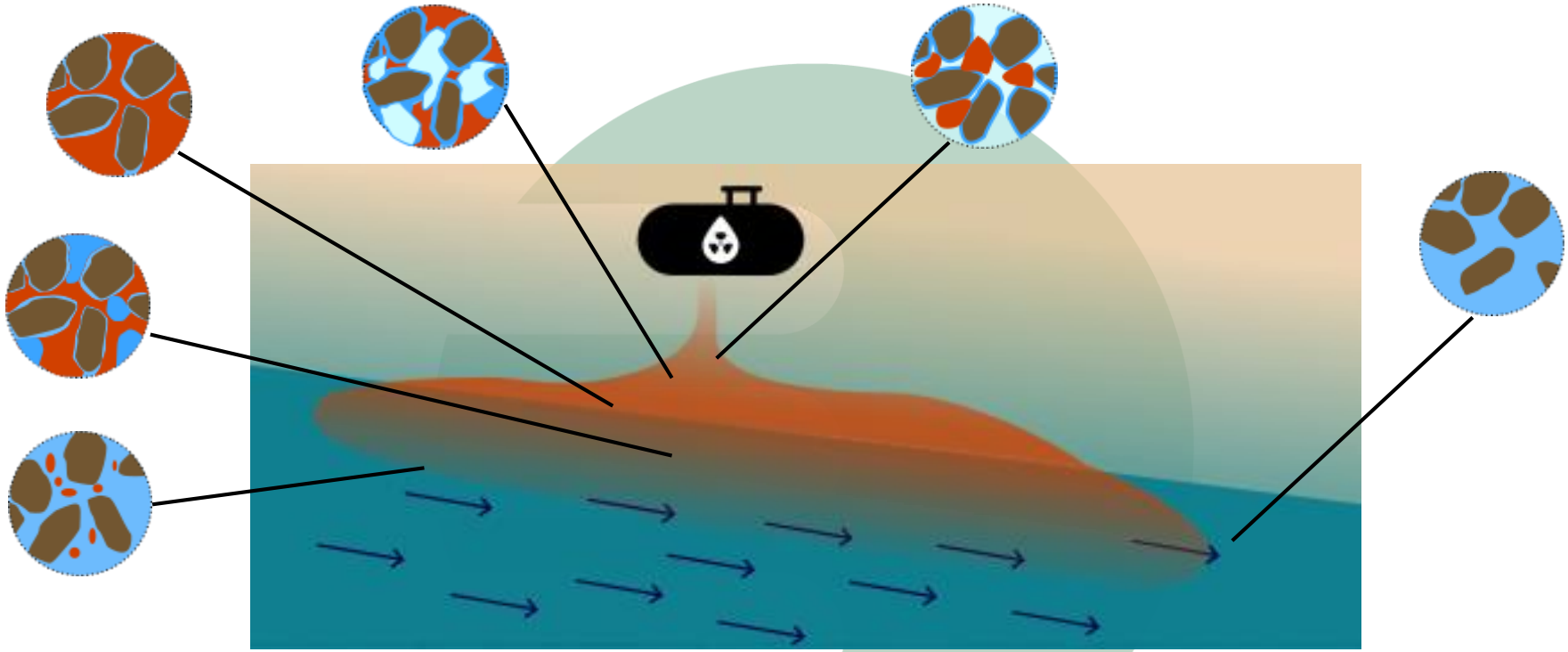
LNAPL in soil: range of saturations



Higher saturations = greater mobility = better recoverability (for a given soil)

Calculate saturations, total mass, risks ← **Understand the mobility** → Informed remediation options and design

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LNAPL in soil: distribution of saturations

Soil is not simple…

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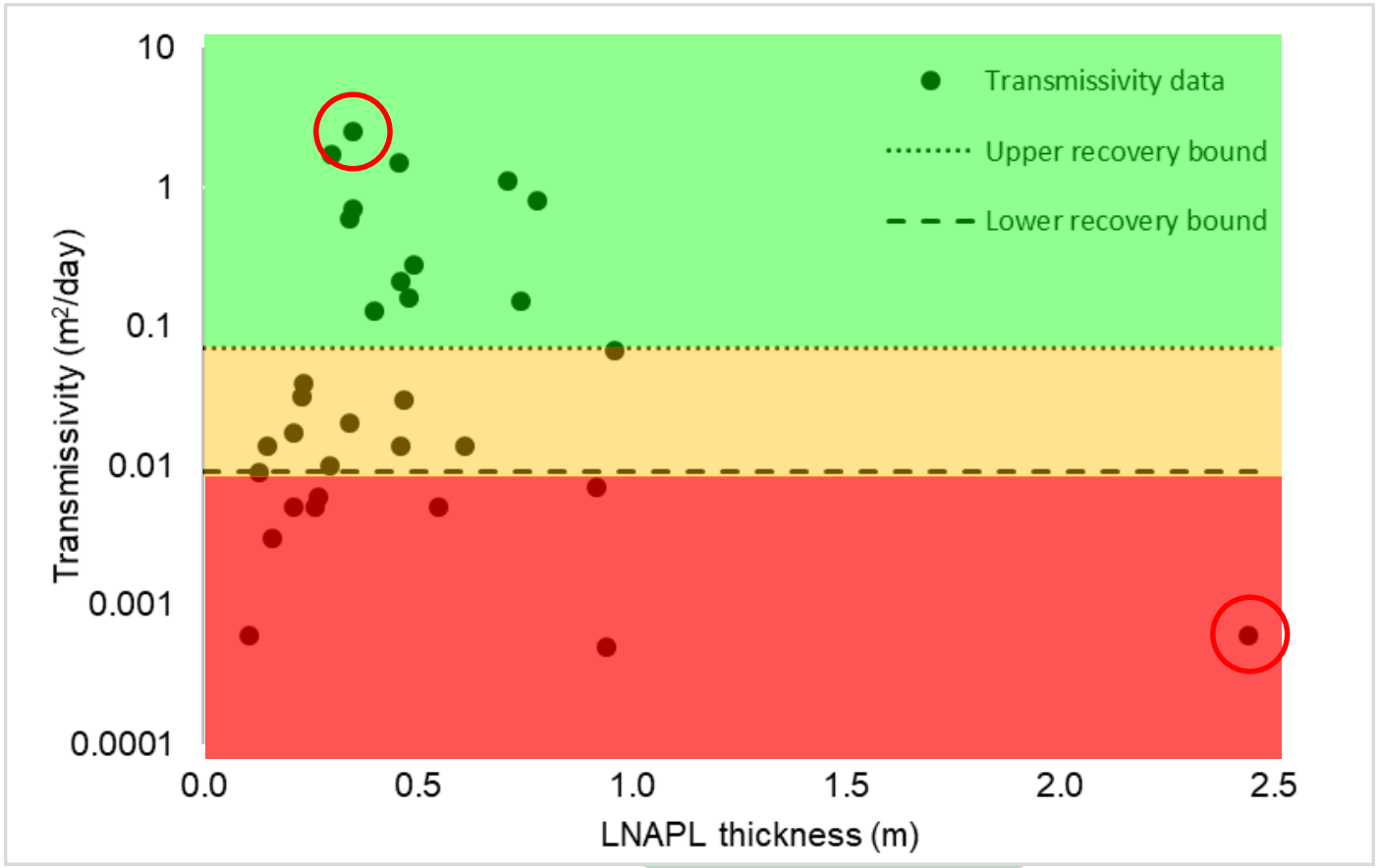
LNAPL in soil: LNAPL thickness in wells



Mobility relates to recoverability, LNAPL thickness does not

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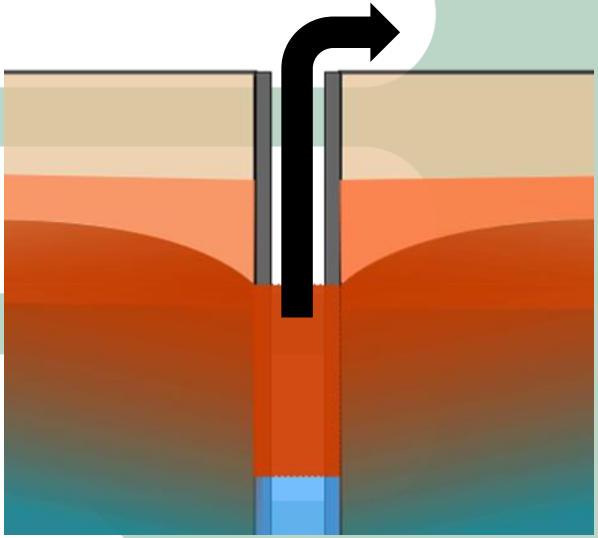
Baildown and skimming tests

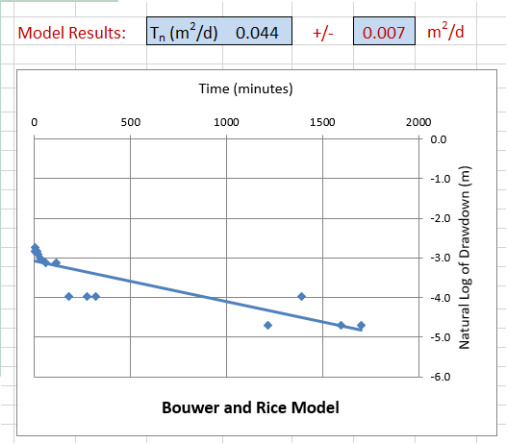
Baildown tests: instantaneous removal of LNAPL
Skimming tests: measurement of LNAPL recovery rate at a measured drawdown

Active tests: stress (drawdown): response (discharge)

Pump out the LNAPL



Provides a transmissivity value which can be used in Conceptual Site Model or as a remedial metric



Drawdown: the difference between the top of the LNAPL at *t0,* and at any point during the test

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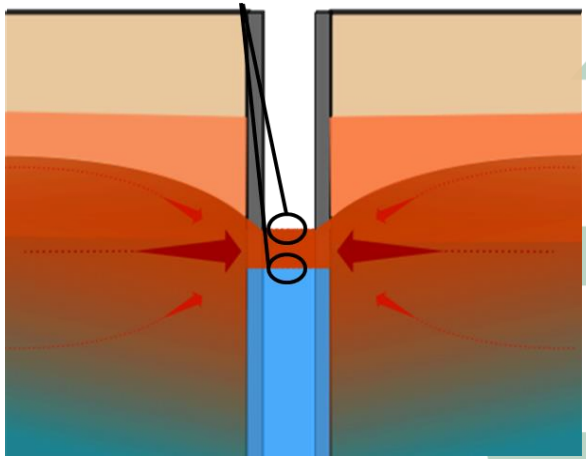
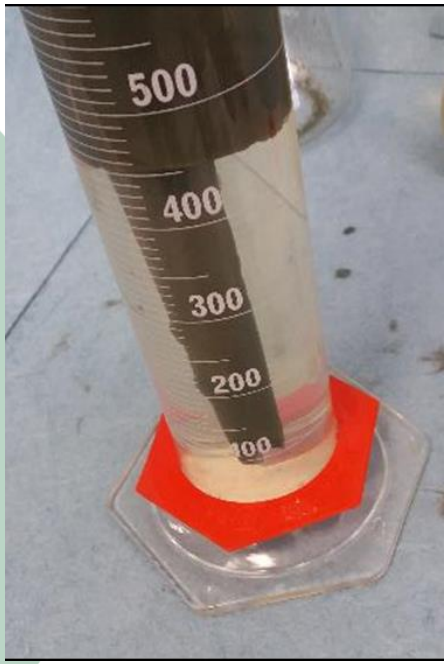
LNAPL issues

Measuring these moving liquid levels:



With this:

Problematic…



- Potential for human error: sites are often uncomfortable and unpleasant
- Active sites especially pose health and safety risks
- Limited measurement range, typically 10% of LNAPL thickness - commonly <50 cm.
- LNAPL recharge may take some time, and people like to go home.
- Expensive, but easy to get wrong

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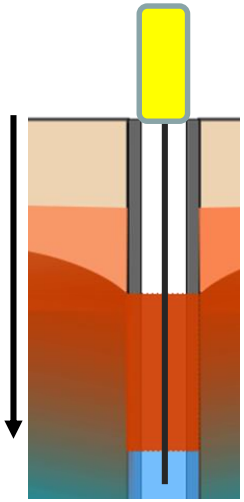
Automatous LNAPL Sensor

Guided wire radar sensor with ‘site’ modifications

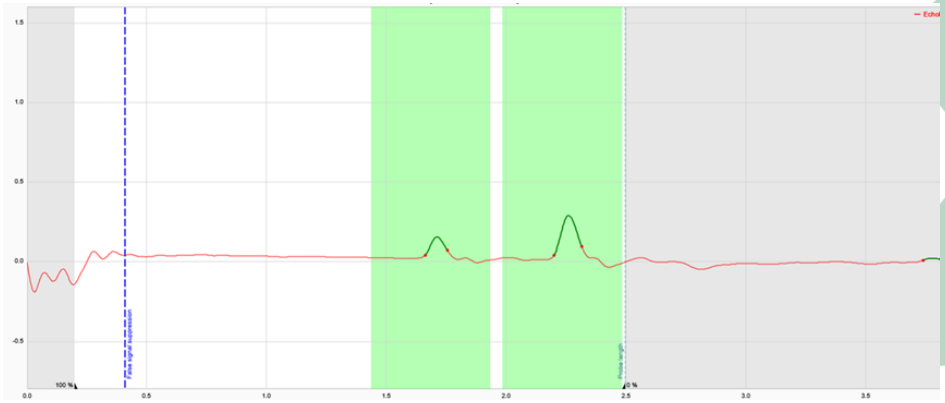
A signal is sent down the guide-wire



Partial reflection from LNAPL

Total reflection from water

Difference between the two signal reflections is proportional to the thickness of the interface (<10 mm* to 70 m)



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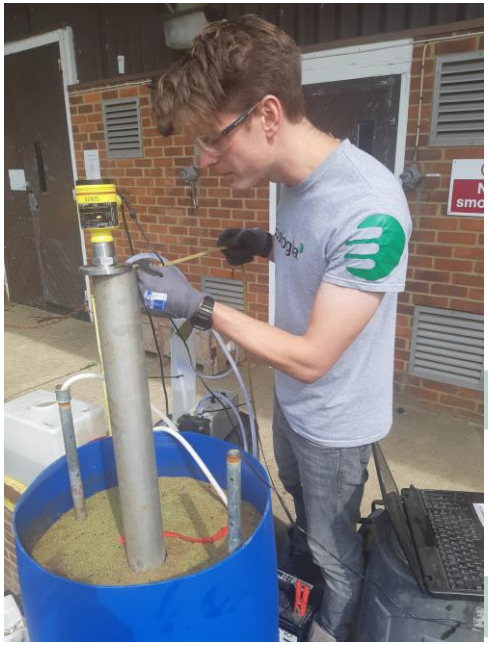
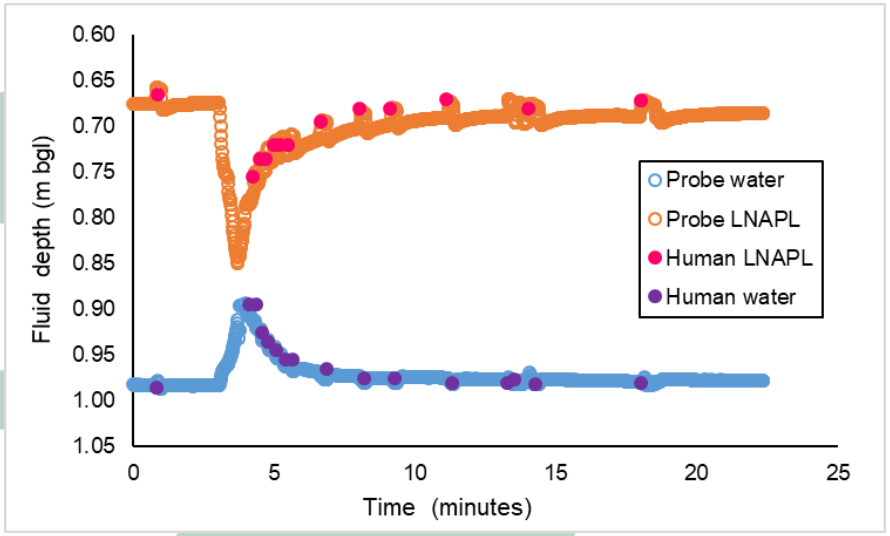
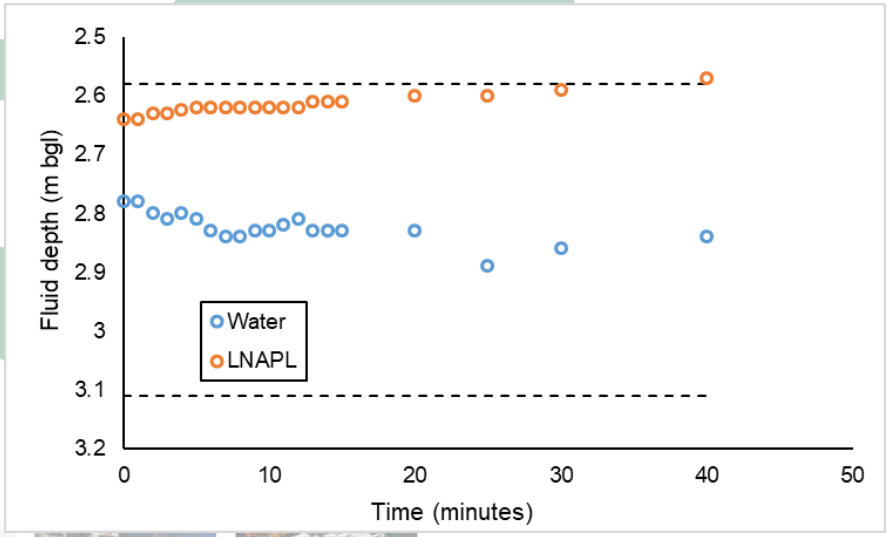
How does it compare?







But in the weather and from less ergonomic wells more usually…

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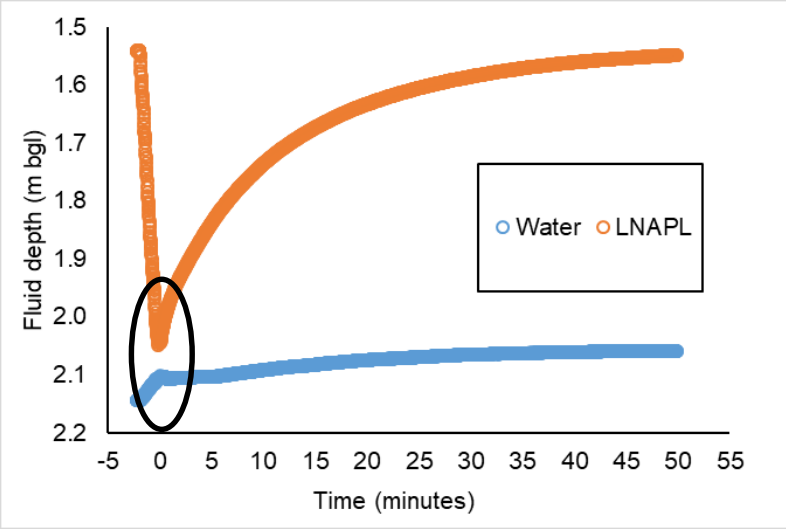
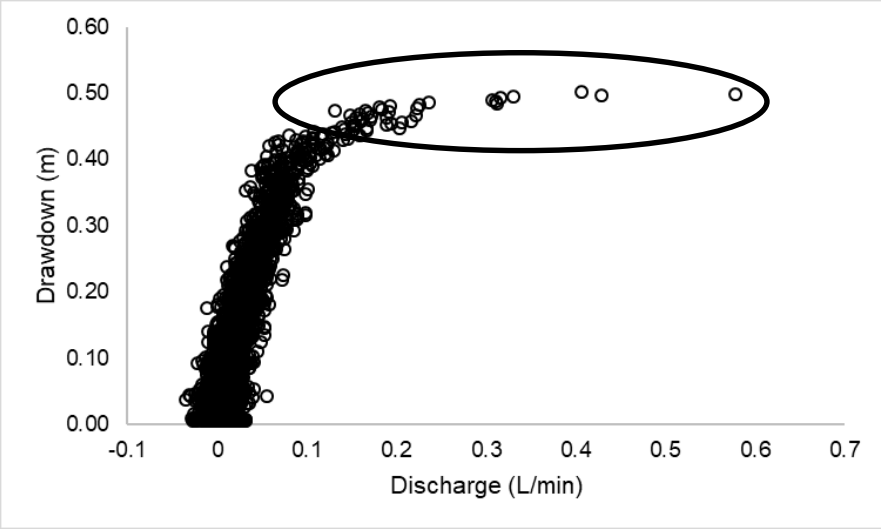
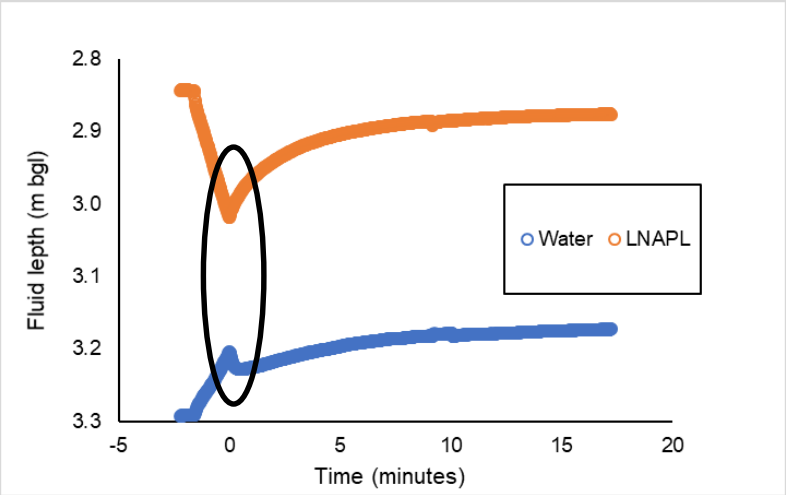
Baildown tests







- High resolution, high frequency data affords improved understanding of recharge regimes
- Data may even not need re-arranging to understand filter-pack recharge

Clear data allows rapid interrogation

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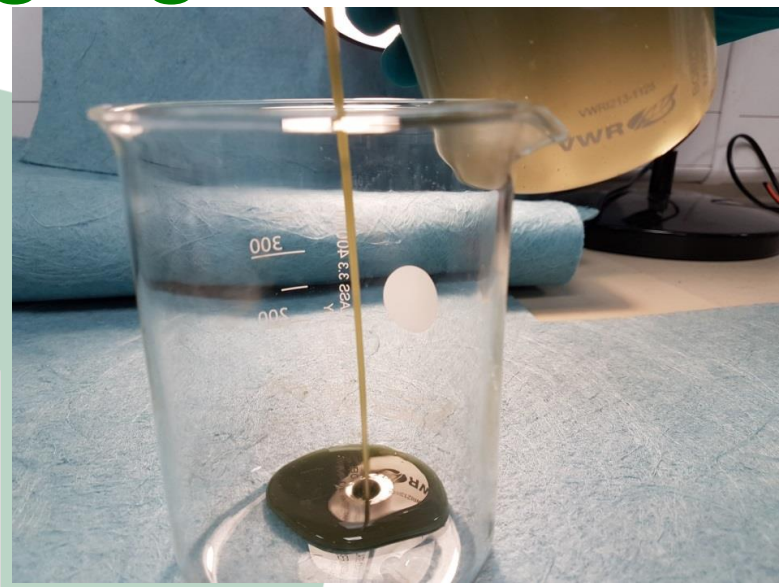
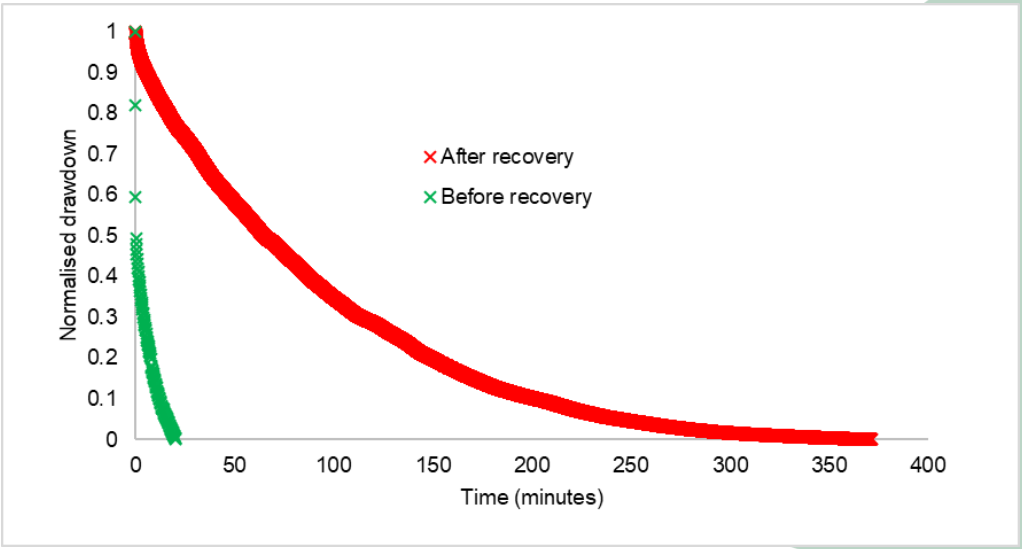
A more challenging LNAPL

- Hydraulic oil (380 cSt – similar to melted chocolate)
- Small thickness initially, so limited drawdown
- In made ground (ballast)
- In an active factory





- Near-continuous data for previously unmeasurable LNAPL
- Results were used in site conceptualisation with a computer model and remediation system design (which predicted the recovery curve)

Any type of LNAPL can now be accurately measured

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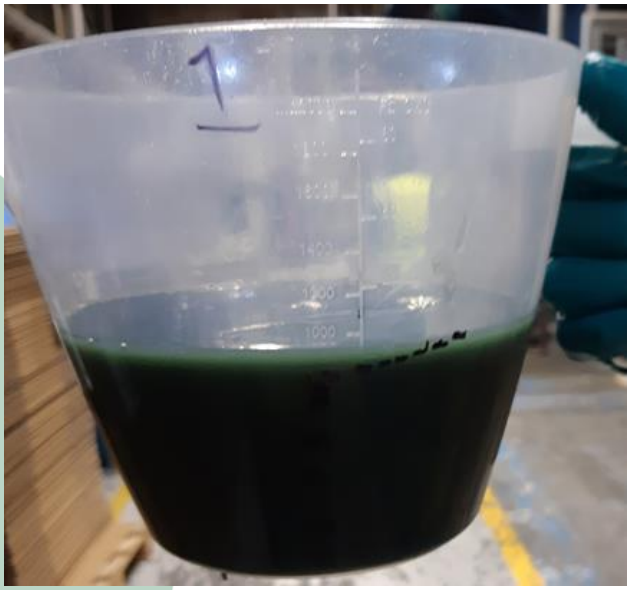
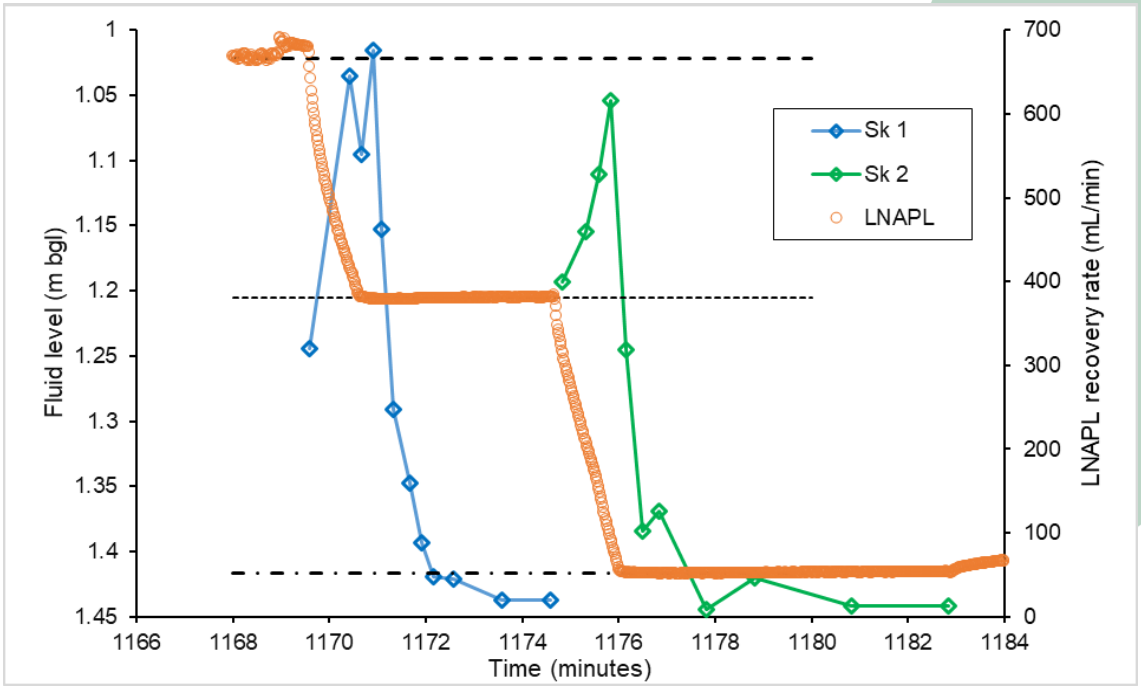
Skimming test

- Recovery of LNAPL at a given drawdown
- Record flow rate
- Stabilised data can be used to calculate a transmissivity.
- Levels can be read in real-time on laptop





- Results were consistent with baildown test (0.04 m^2/day)
- Around ten minutes of data

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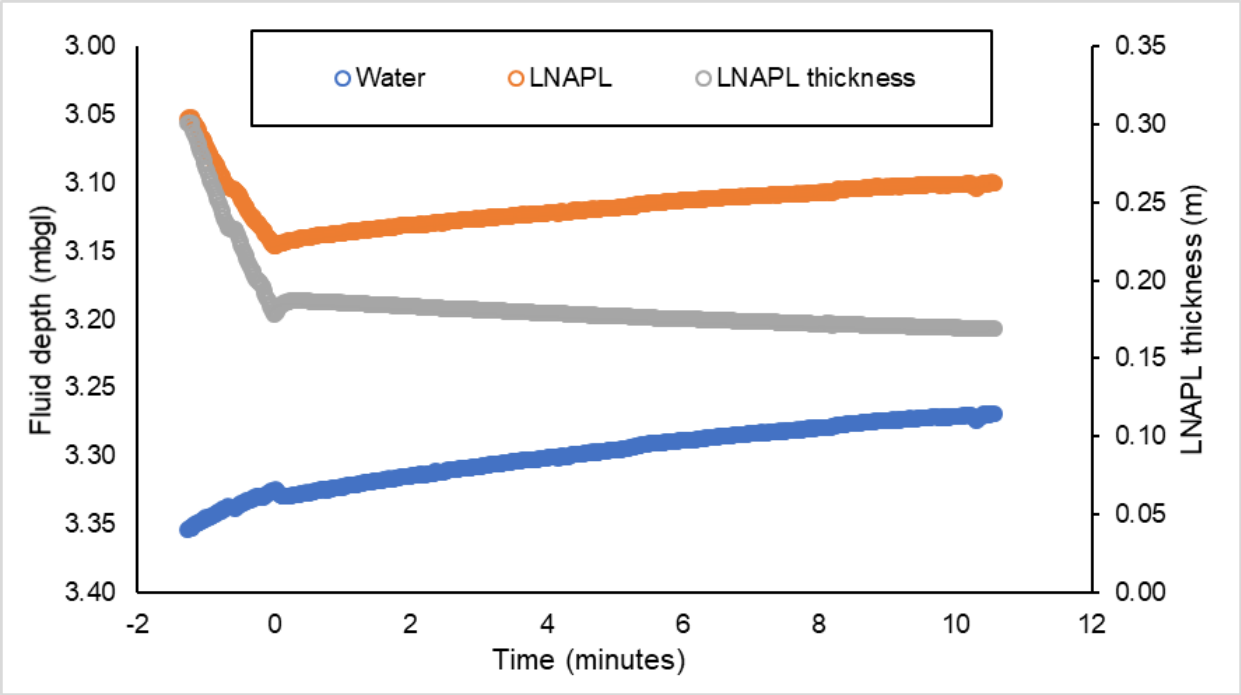
A negative discharge



- River terrace gravels
- LNAPL levels rises post-test
- Water level rises post-test
- But water level rises faster
- LNAPL discharge appears negative

We need to think about how we interpret the data: current tools may not always be applicable

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Conclusions

- LNAPL can be a challenging substance to measure, so CSM may be data poor
- The automatous LNAPL probe provides high quality, meaningful data about the in-situ behaviour of LNAPL
- Better and previously unobtainable data, lower costs, fewer risks
- Can be ATEX-rated, solar or battery powered and remotely accessed.
- We can make informed remedial decisions, provides improved site understanding and modelling, and is already being used in regulatory closure discussions
- A number of projects upcoming, so keep an eye on our Website and LinkedIn.

Any questions?

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