THE UNIVERSITY OF QUEENSLAND
AUSTRALIA
CREATE CHANGE

Geotechnical Engineering Centre

Rock Laboratory Testing and Field Monitoring

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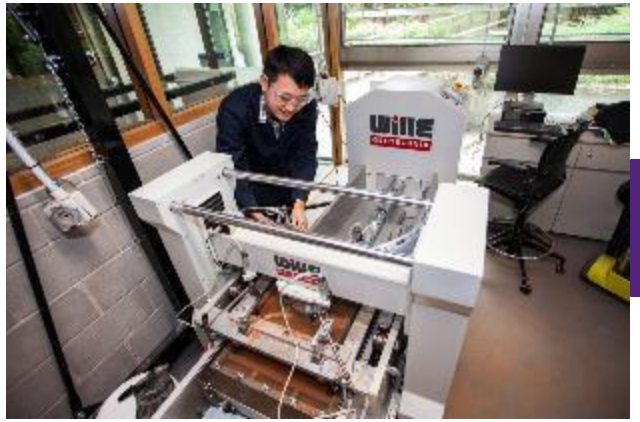
Geotechnical Engineering Centre
School of Civil Engineering
The University of Queensland, Brisbane, Australia
http://geotechnical.civil.uq.edu.au

UQ Geotechnical Engineering Centre Testing Capabilities



Large direct shear and pull-out

High-stress consolidometer

Instrumented soil columns

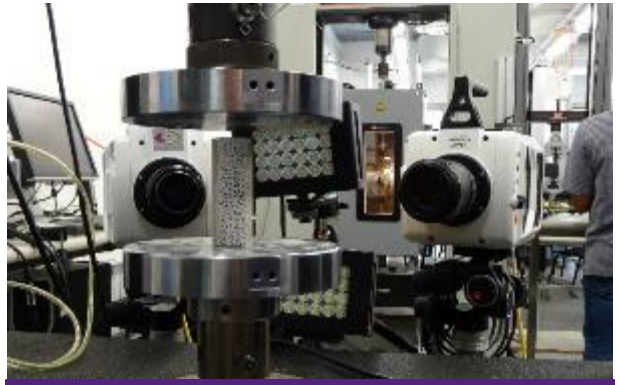
Instrumented field columns

Slurry consolidometer

UQ Geotechnical Engineering Centre Testing Capabilities

Large-scale triaxial

SWCC



Ultra-high speed cameras

True triaxial

Biaxial

Rock preparation

Rock Coring

- Blocks max of 400mmx400mm by 400mm
- Varying core sizes from 20mm to 110mm

Rock preparation

Rock Grinding

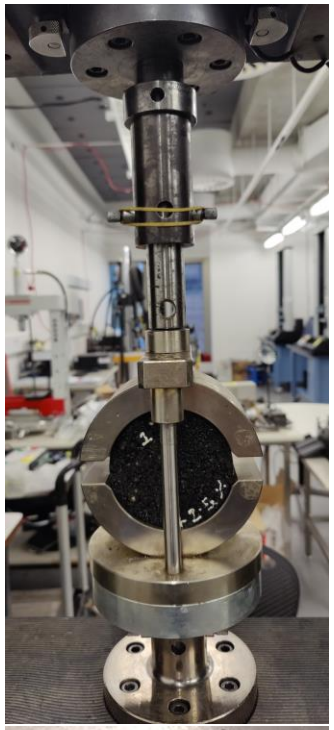
- Any shape
- Grinding on both sides

Rock preparation

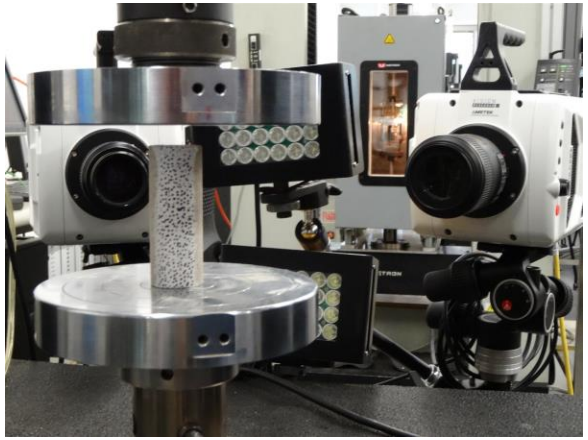
Rock Cutting

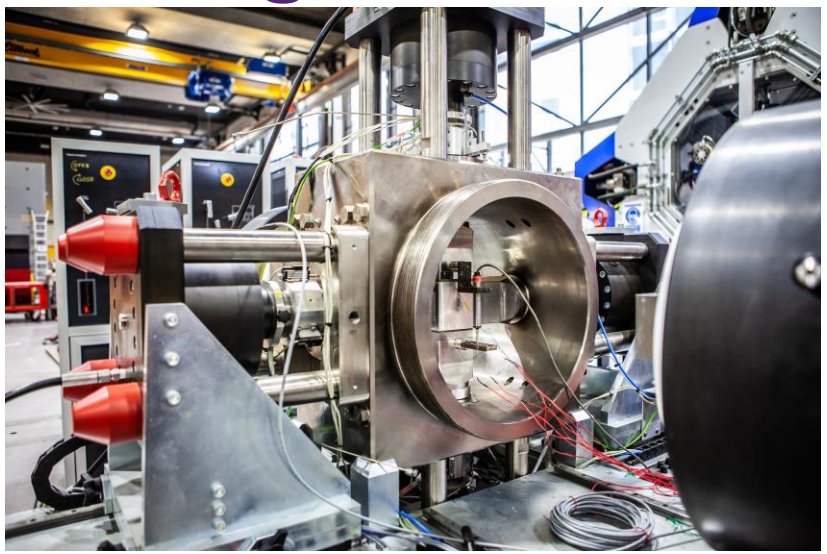
- Multiple sizes
- Any type of rock

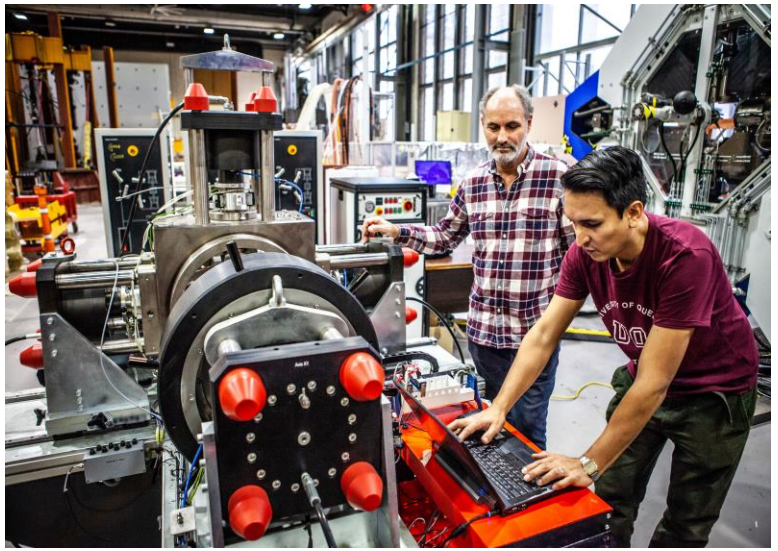
Rocks and asphalt testing



Marshal test







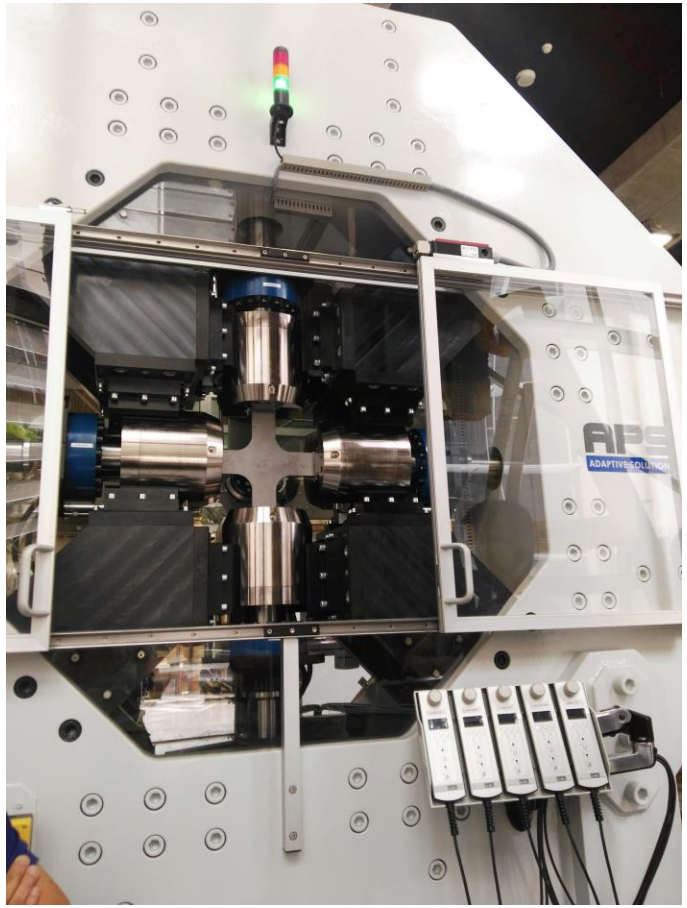
UCS and BTS on rocks

True triaxial test on cubic rock/concrete samples

This unique machine in the world does true triaxial on independent axes, permeability on rock and fracking while changing the chamber temperature

Rocks and asphalt testing

Dynamic biaxial tests on sheets of many types of material



This custom made machine has 4 dynamic actuators that do tension and compression on any number of cycles on any type of material. Applications range from aeronautics, spaceships, cars, asphalt, concrete rock, fibre glass…Any material that can be held as a sheet

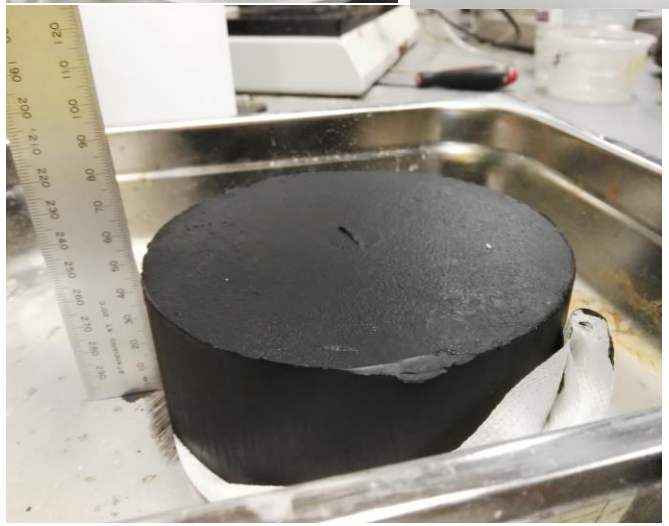
Consolidation tests on rock, soil and tailings

Very thorough test!!

Outcomes like consolidation constants, void ratio, dry density and porosity changes and hydraulic conductivity

Conventional oedometer.
-70/75mm I.D
-20mm height
-Generally up to 1MPa

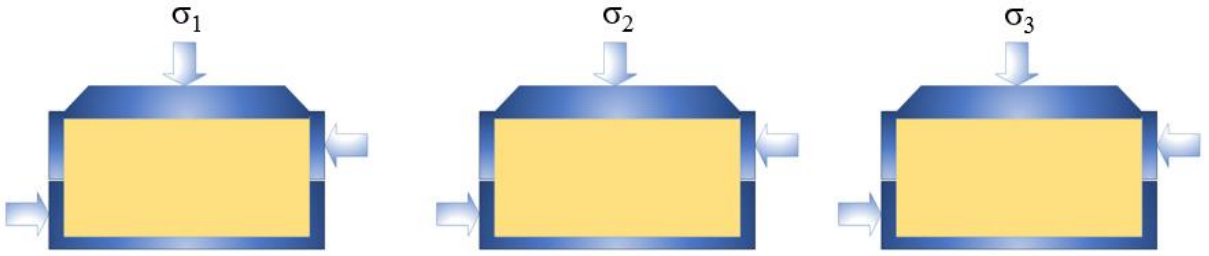
High stress oedometer.
-150mm I.D
-150mm height (1:1)
-Up to 10MPa



Slurry consolidometer.
-150mm I.D
-Can hold slurry
-Can do very low loads (from 5kPa)

Shear tests on rock, soil and tailings

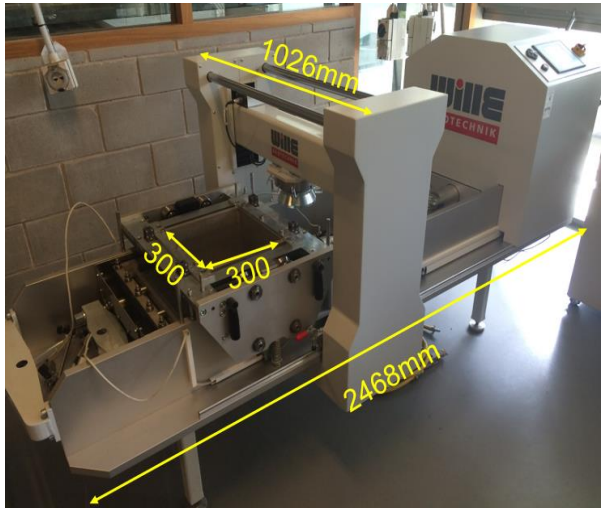
Direct shear test



Typical sketch of a single stage direct shear test:

- What material particle size is appropriate?

Large direct shear at UQ lab.
-150mmx150mm
-300mmx300mm
-Max height of 195mm (up to 19.5mm max. particle size)
-Pull out or shear tests with geogrids



Other useful tests on soil and tailings at the labs

HOEK CELL

ROCK PERMEABILITY

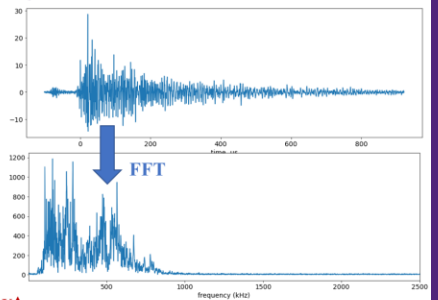
ELECTRIC PROPERTIES

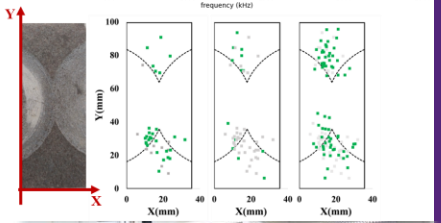
ACCELERATED WEATHERING

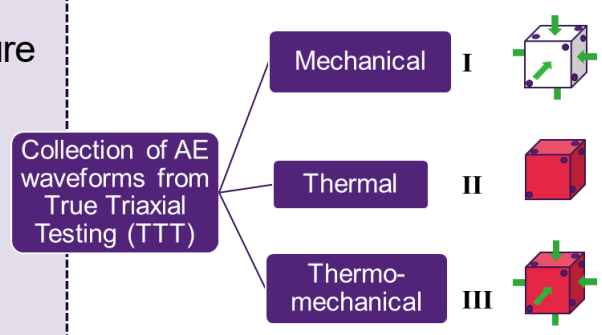
Acoustic Emission Characteristics of Thermomechanical Brittle Rock Fracture

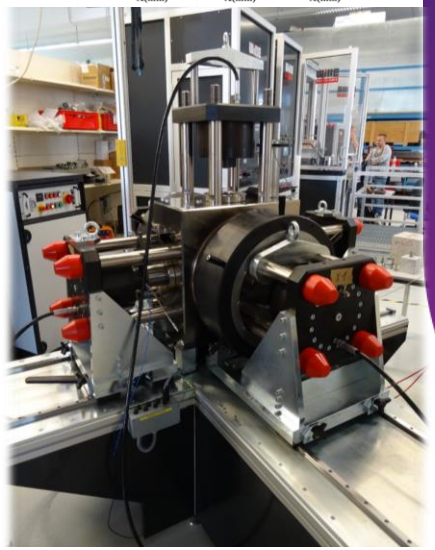
Summary:

Acoustic Emission (AE) sensors can be used to capture transient elastic waves produced by solid materials when stress states are changed. This technique has been used in rock mechanics studies to understand fracture mechanisms. However, the coupled effect of temperature and stress on waveform characteristics has been understudied. This study aims to establish a new method to evaluate the thermomechanical effect of rock fracture using AE waveform characters and to predict catastrophic failures. The proposed method could be used to improve the understanding of deep underground mines and tunnels which are subjected to high stress and temperatures.









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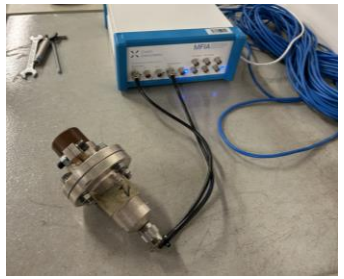
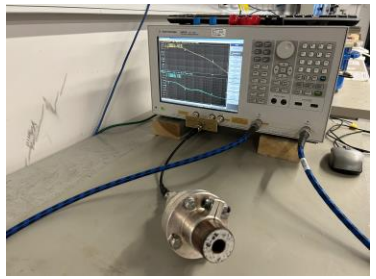
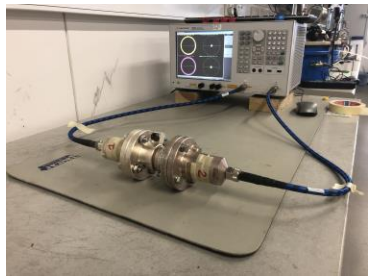
School of Civil Engineering

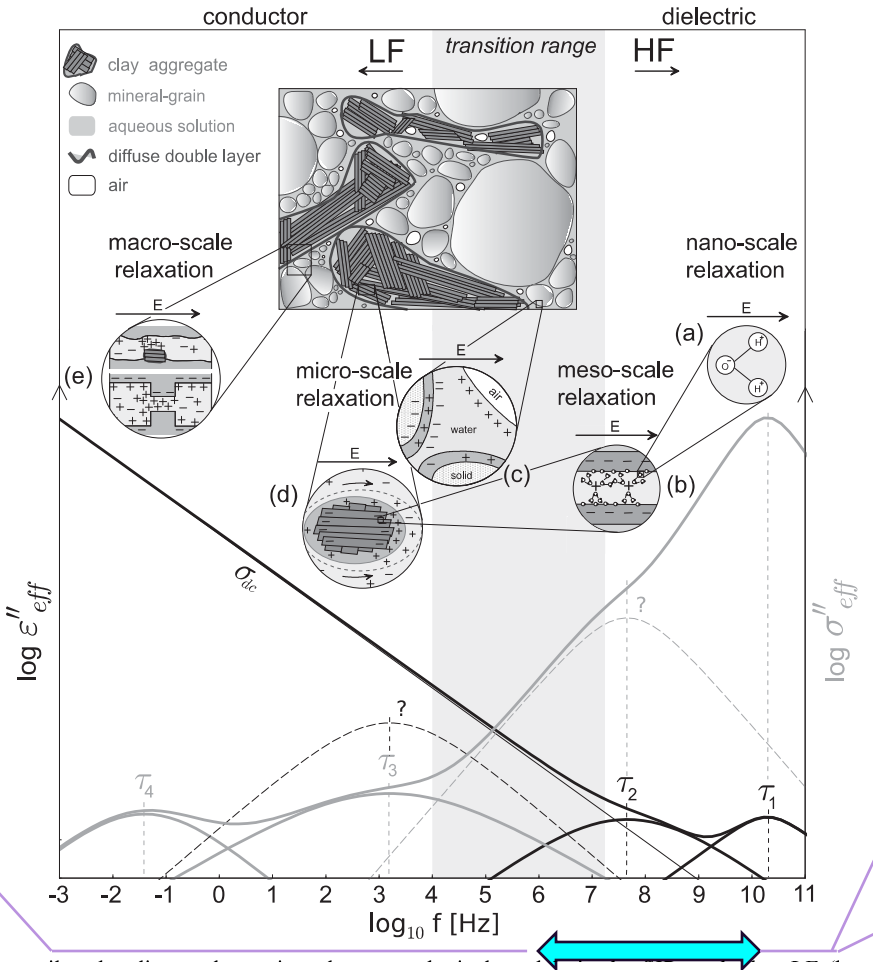
Electrical properties
Overview

coaxial sample





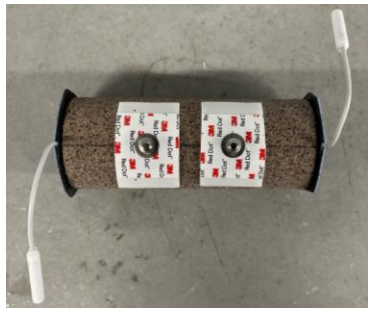


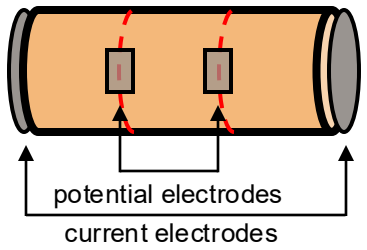


Keysight P9372A

Keysight E5061b-3L5

(cylindrical sample)





VNA

2-point Impedance, GP

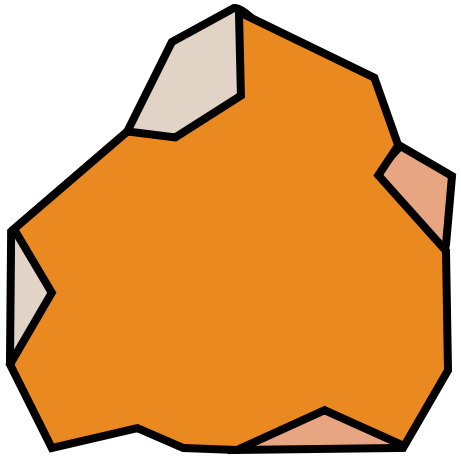
(2-point Impedance, MFIA)

(4-point Impedance)

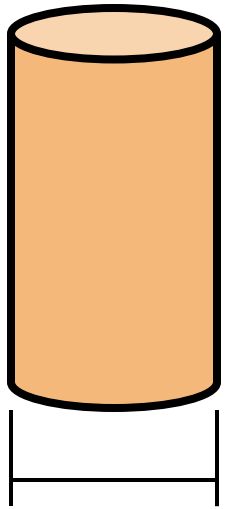
MFIA

Sample Preparation
Process overview

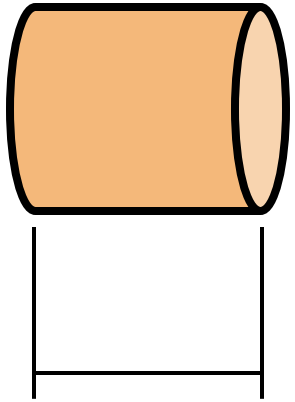
Coring → Cutting → Drilling → Polishing



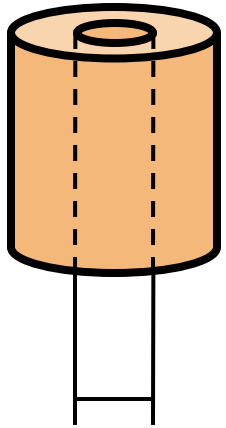
Rock Block



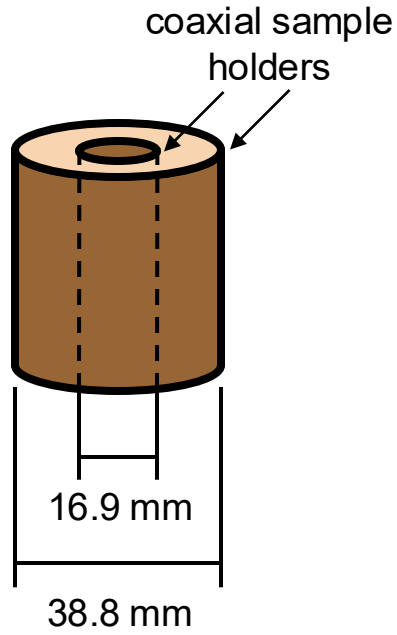
≈ 39.3 mm
(> 38.8 mm)



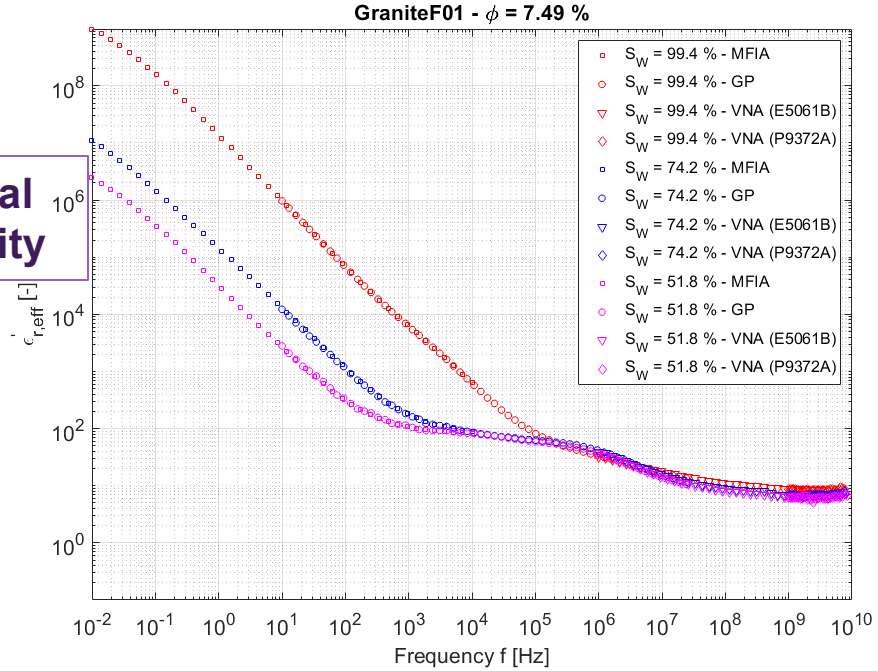
50.0 mm

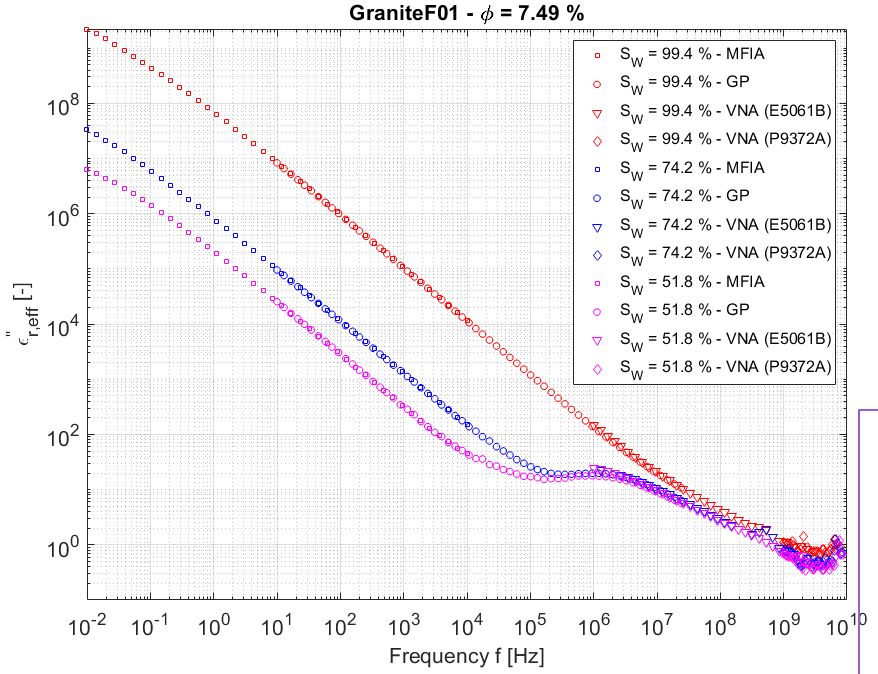


≈ 16.6 mm
(< 16.9 mm)

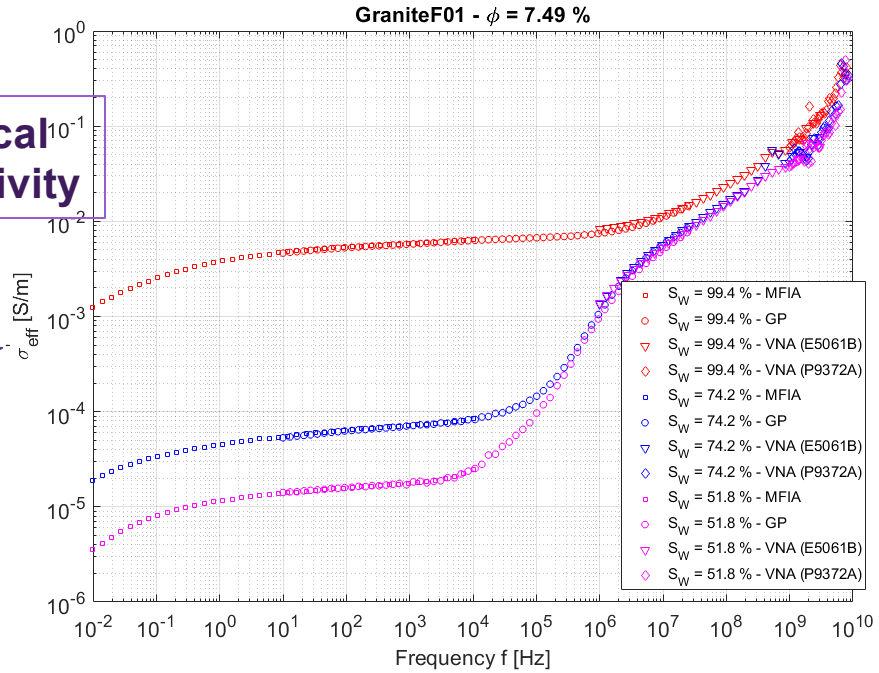


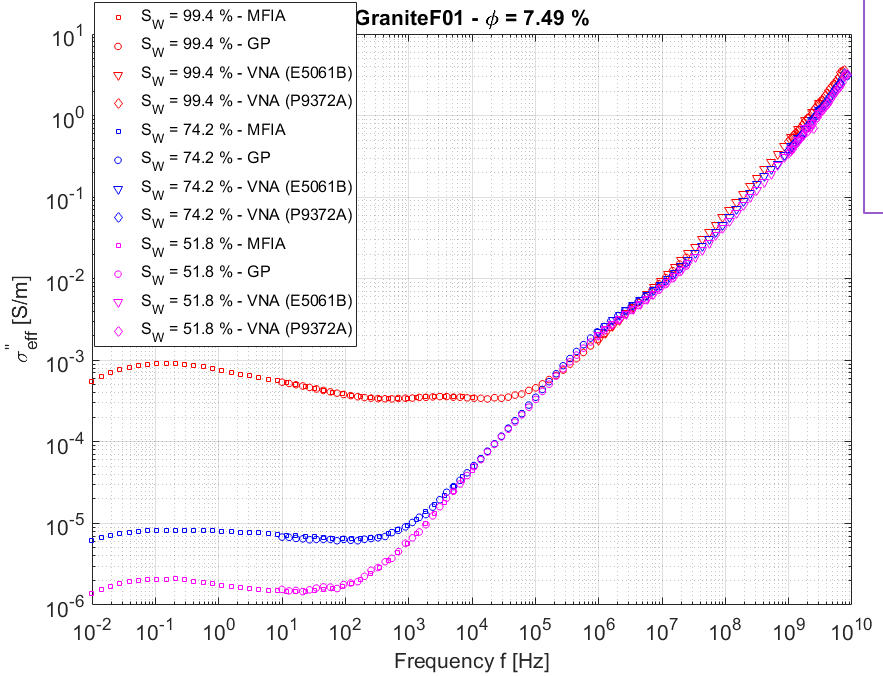
Electrical permitivity





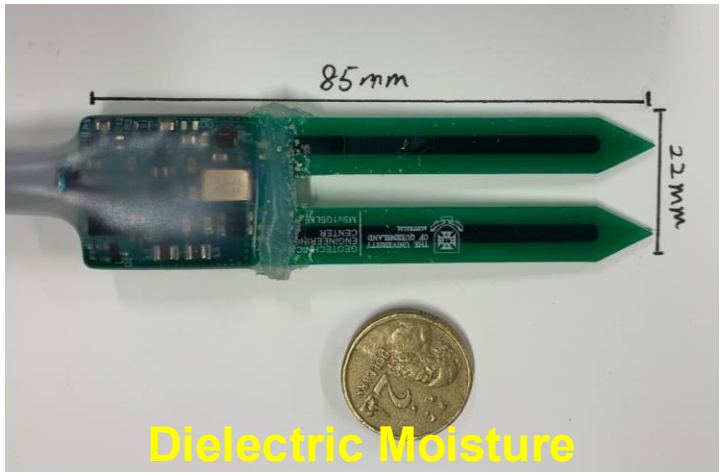
Electrical conductivity





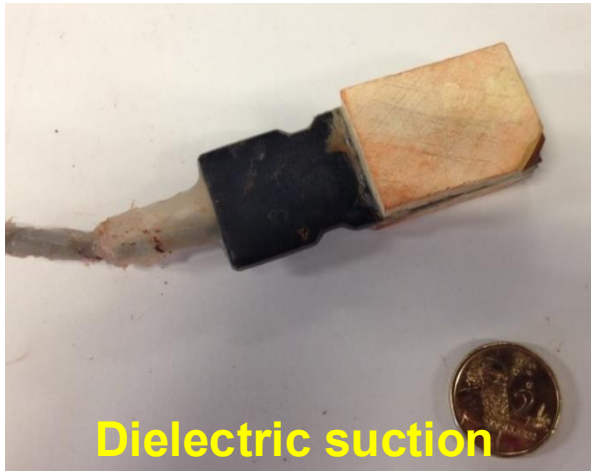
- **Rock properties this helps calculate**
  - **Permeability**
  - **Porosity**
  - **Mineralogy**
  - **Focus on specific frequencies for geophysical outcomes**

GEC Sensors, Loggers and Telemetry



Dielectric Moisture


Piezometer


Dielectric suction


Data Logger

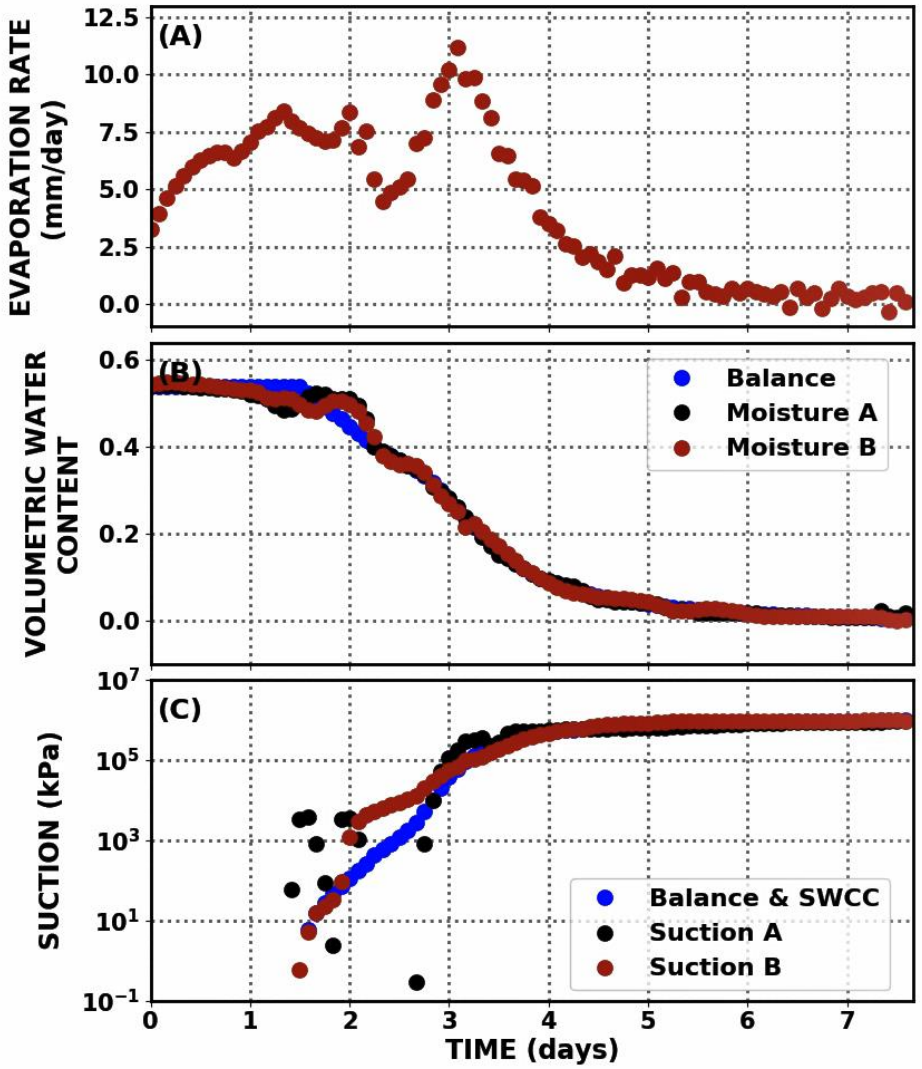
Thermal Suction & temperature

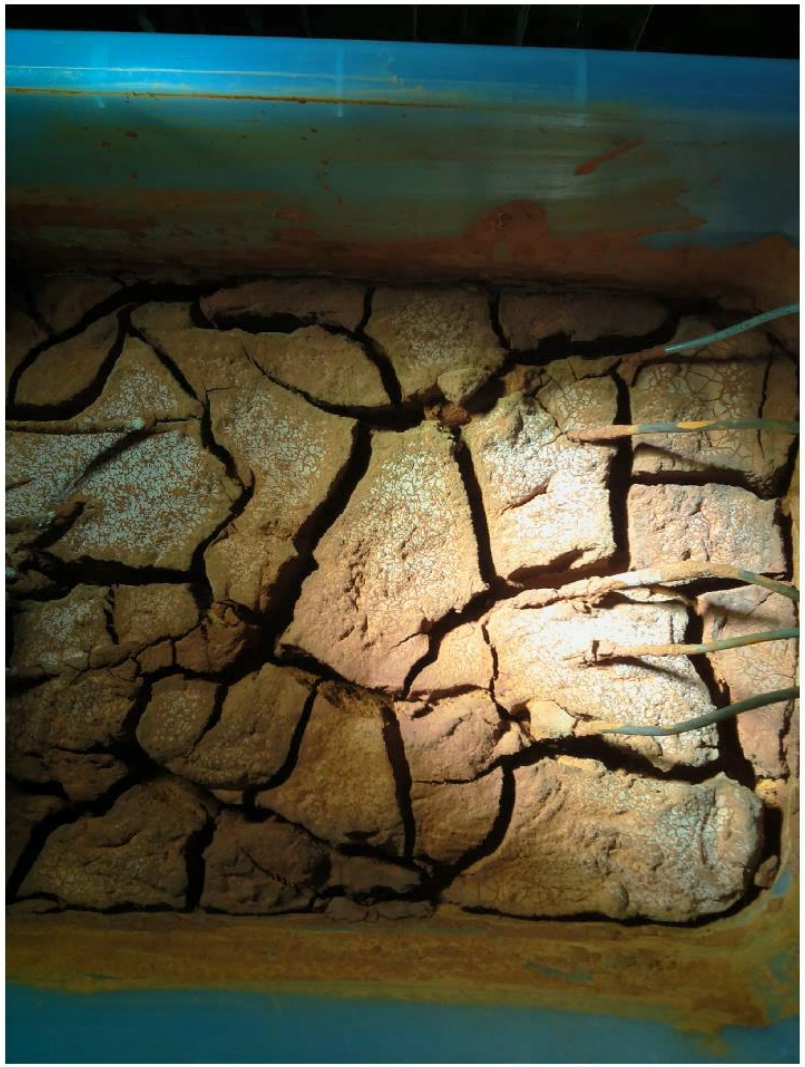

Oxygen concentration


Salinity (humidity)

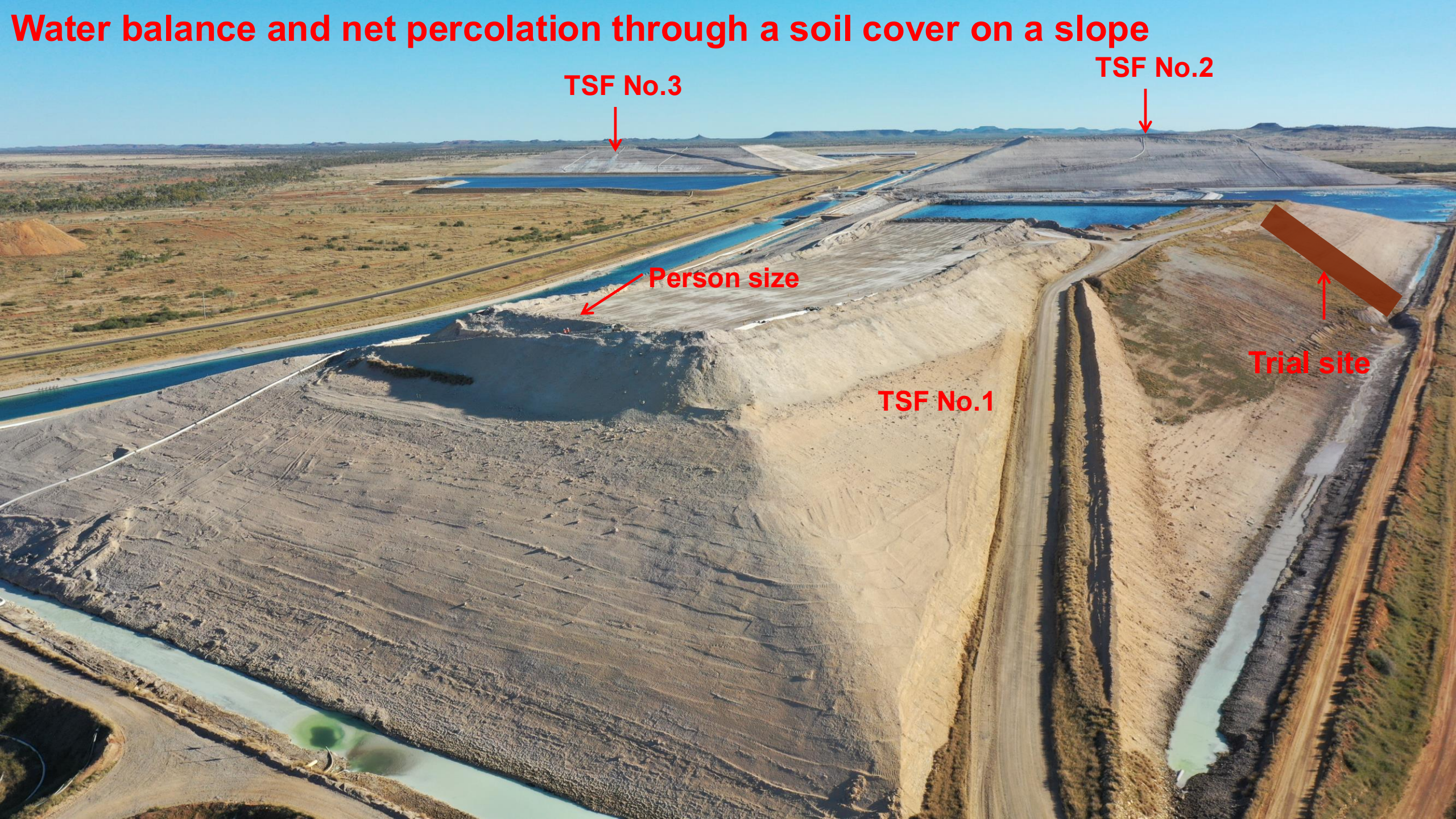

Inclinometer

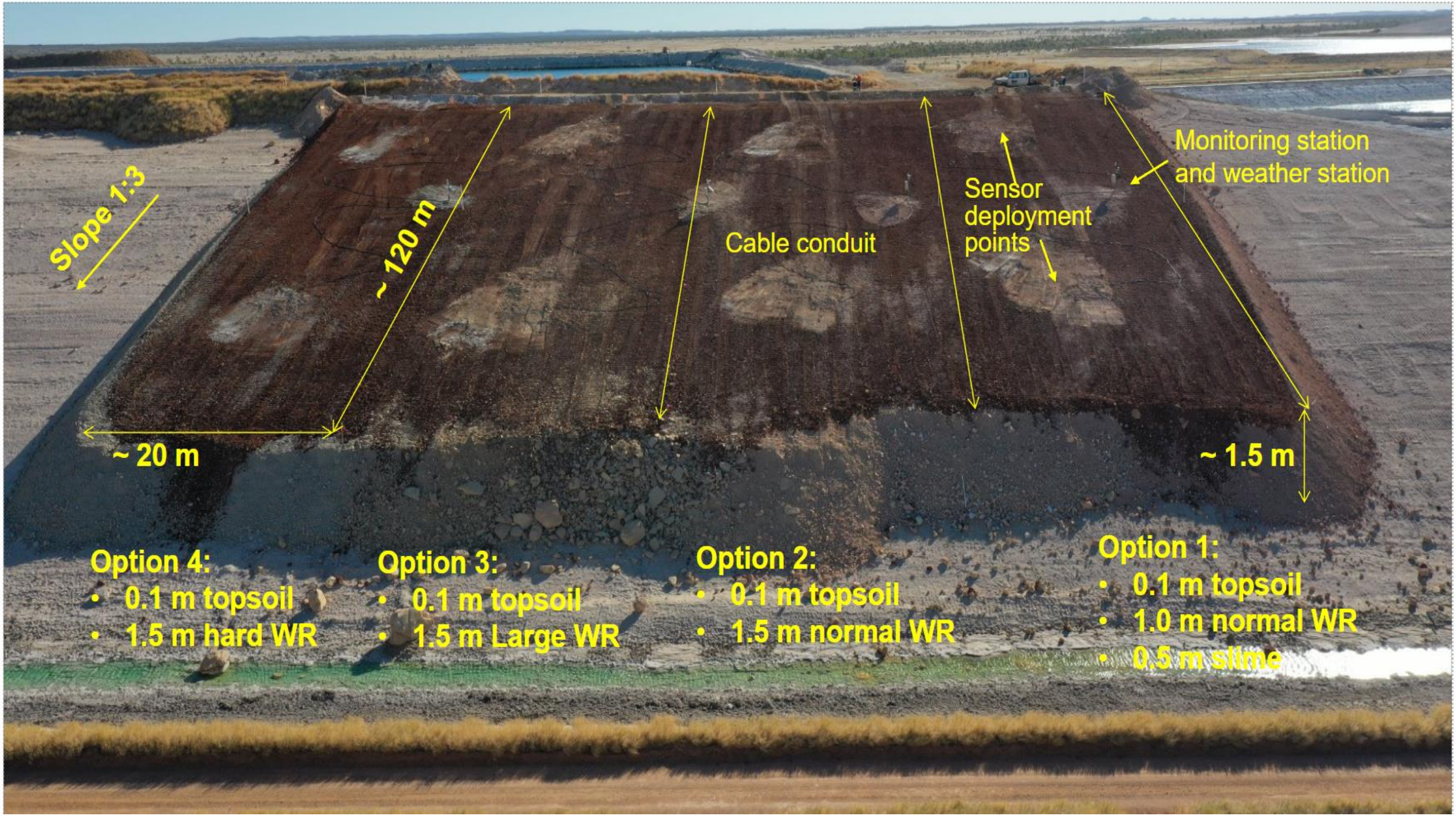
Calibration of Sensors during Desiccation of Red Mud



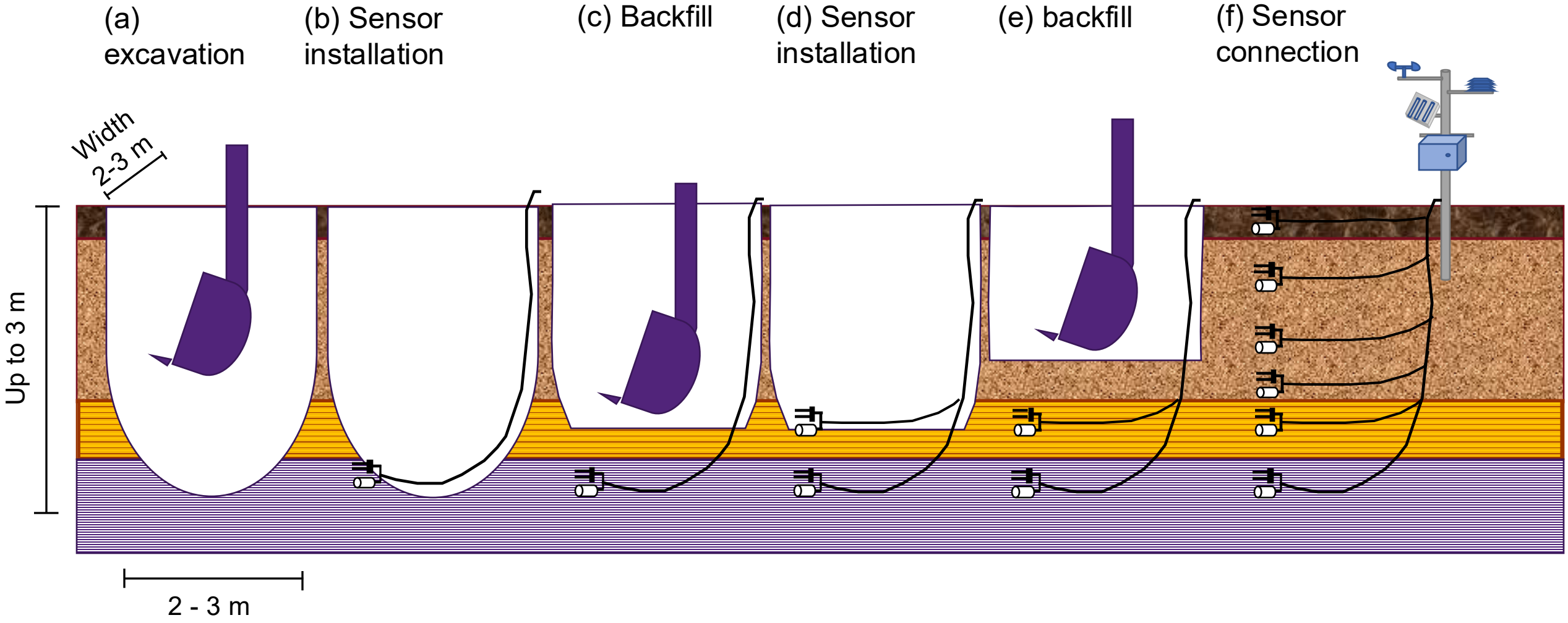


Water balance and net percolation through a soil cover on a slope

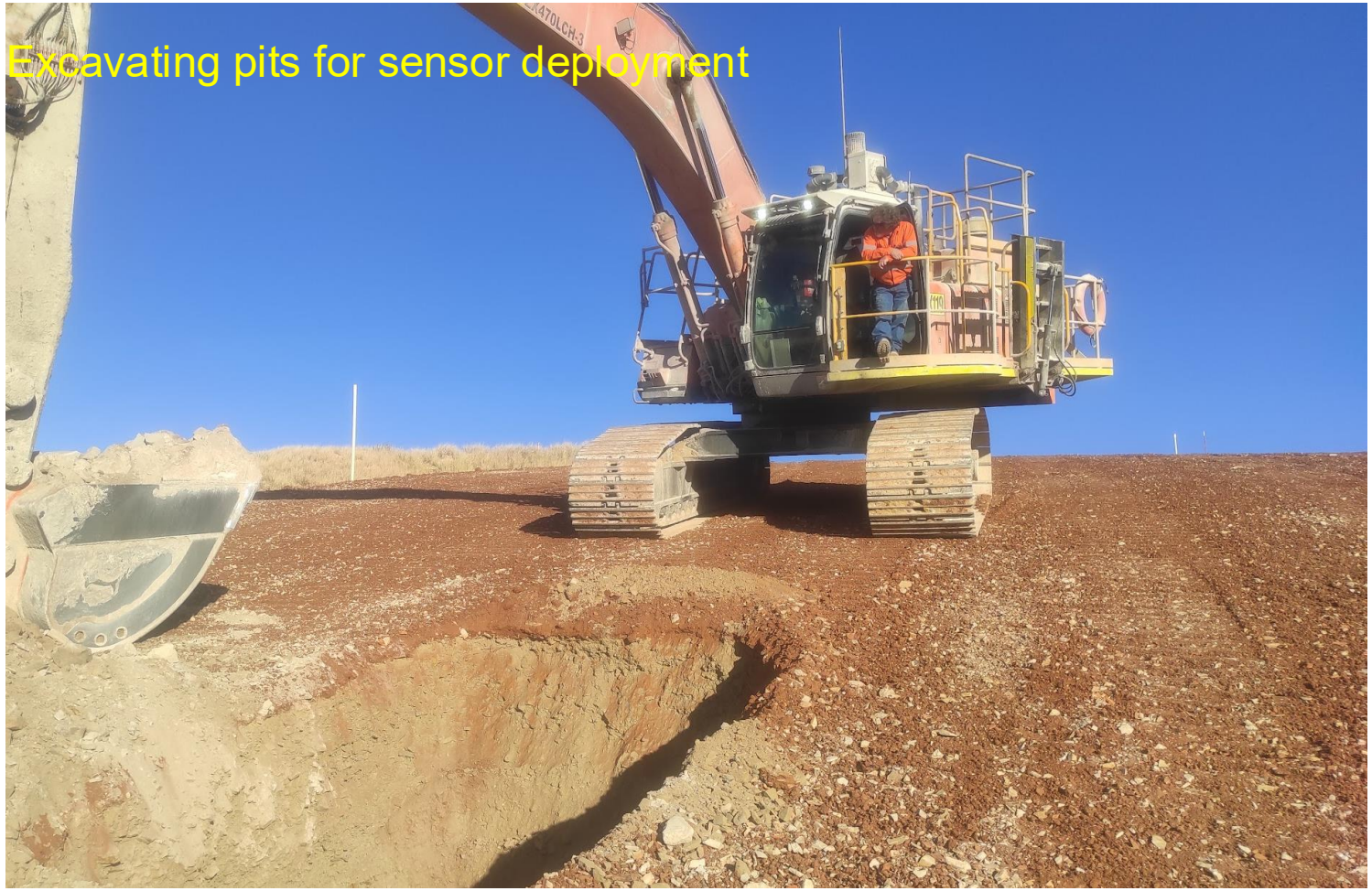


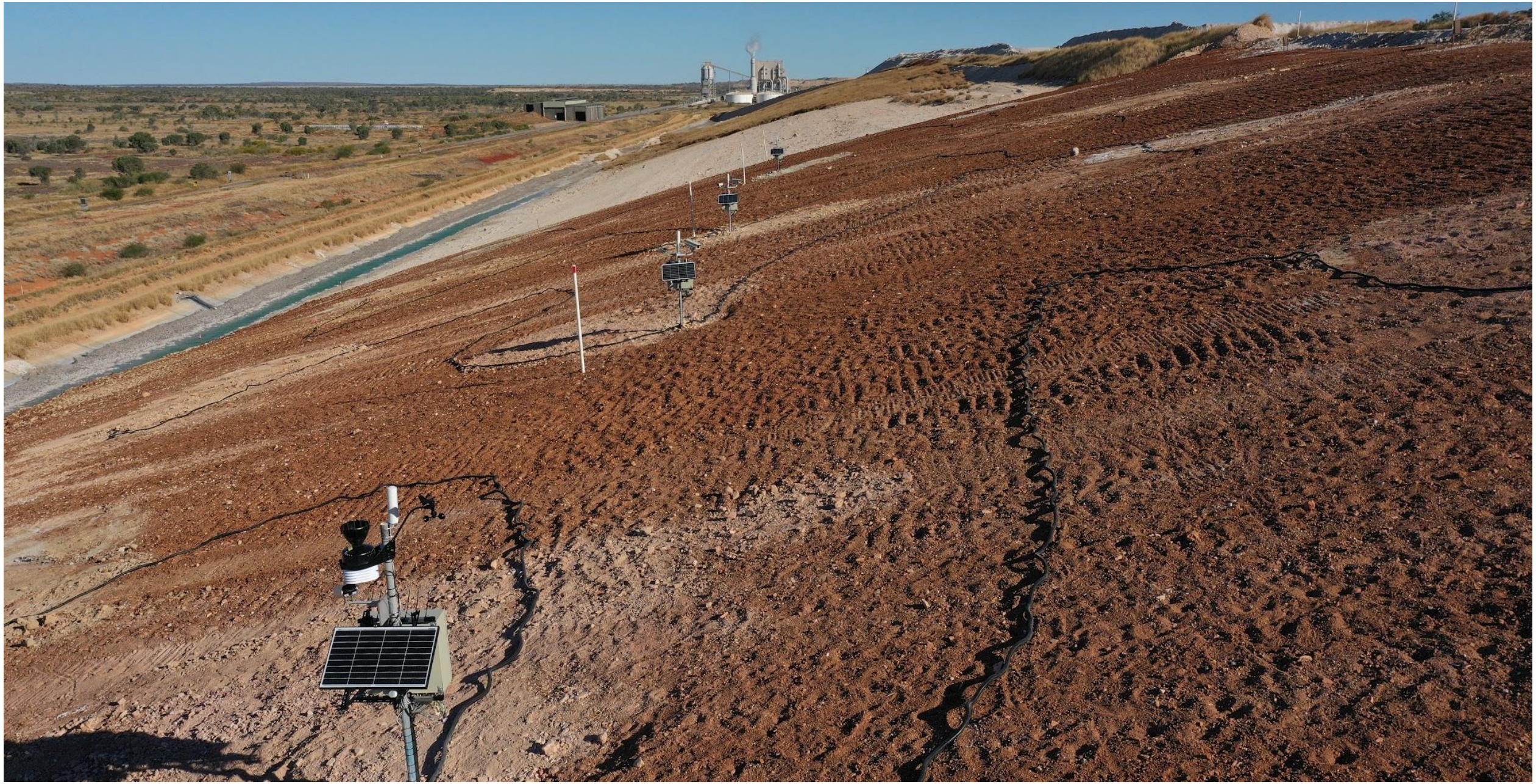

Slope 1:3
~ 120 m
~ 20 m
Cable conduit
Sensor deployment points
Monitoring station and weather station
~ 1.5 m
Option 4:
• 0.1 m topsoil
• 1.5 m hard WR
Option 3:
• 0.1 m topsoil
• 1.5 m Large WR
Option 2:
• 0.1 m topsoil
• 1.5 m normal WR
Option 1:
• 0.1 m topsoil
• 1.0 m normal WR
• 0.5 m slime

Sensor installation procedures

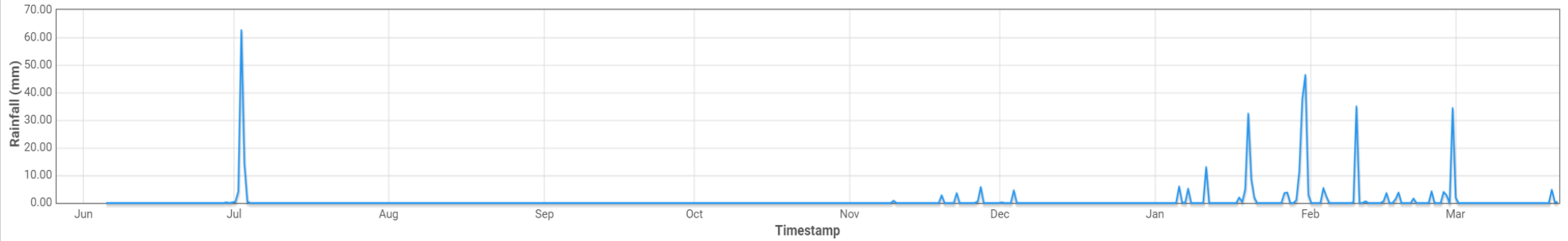


System Deployment

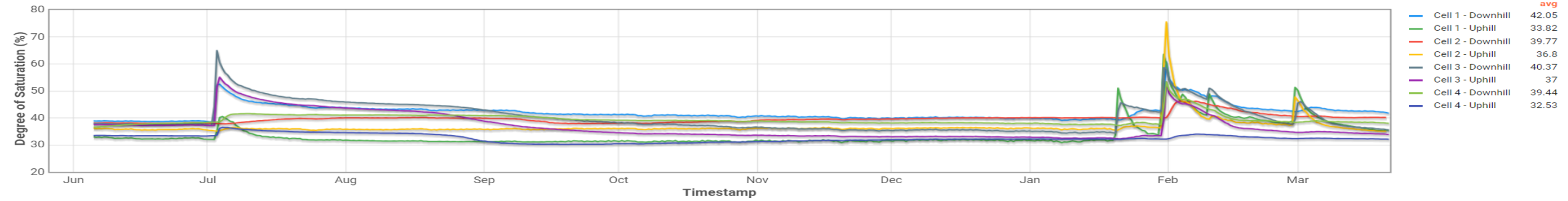




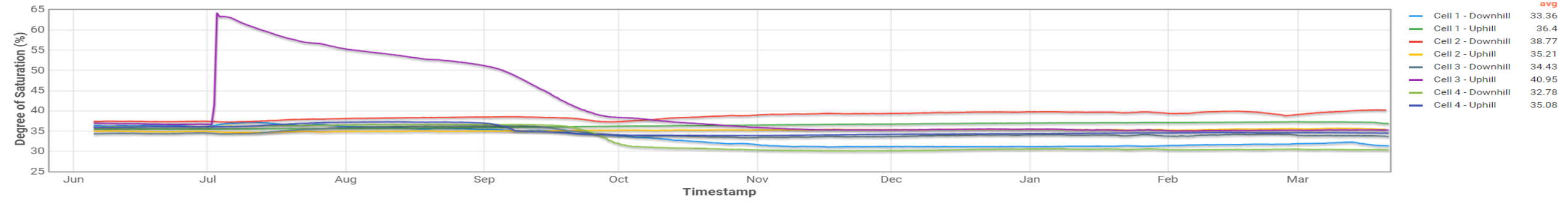
Rainfall



Moisture - Top Soil



Moisture - 0.6 m below ground level





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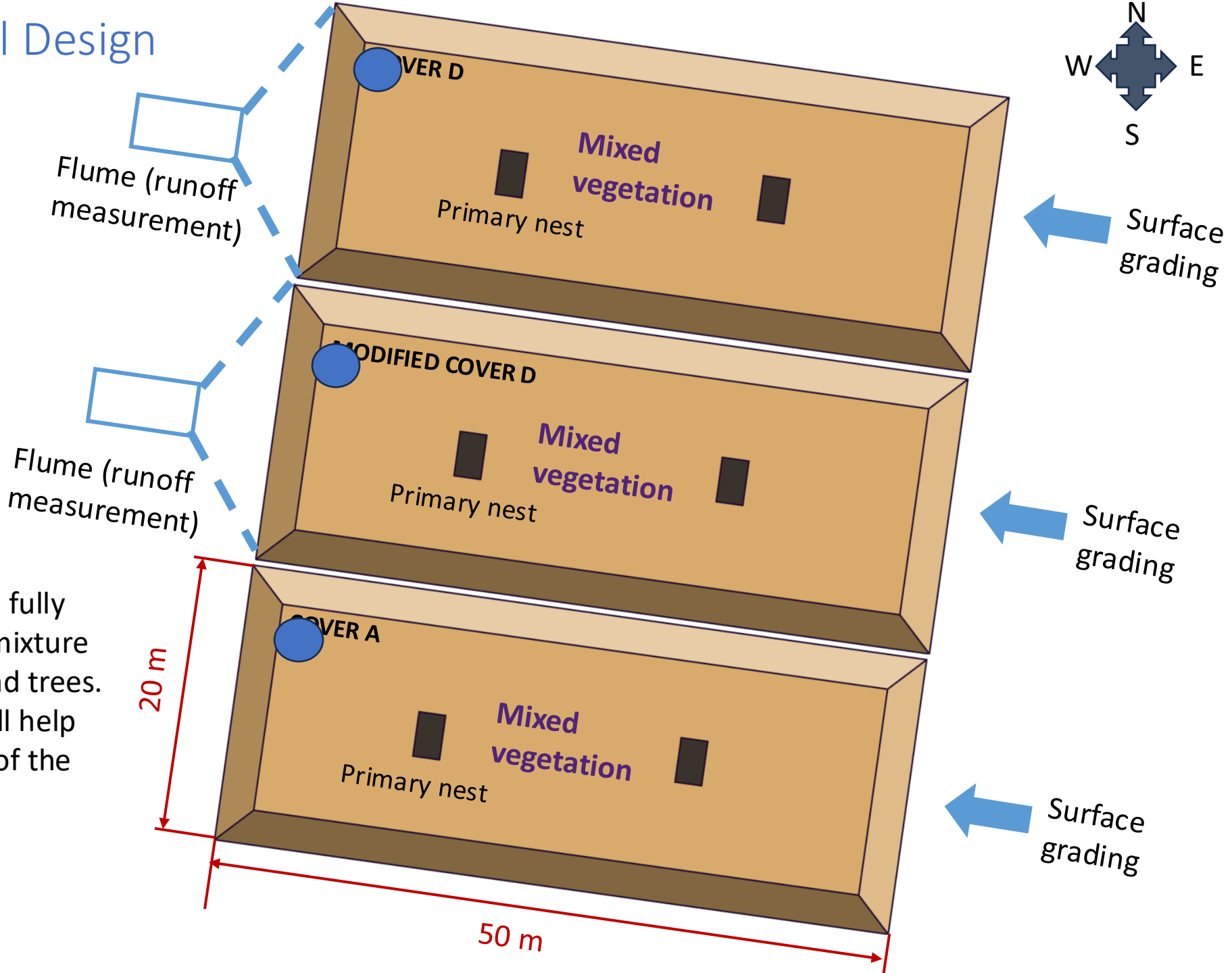
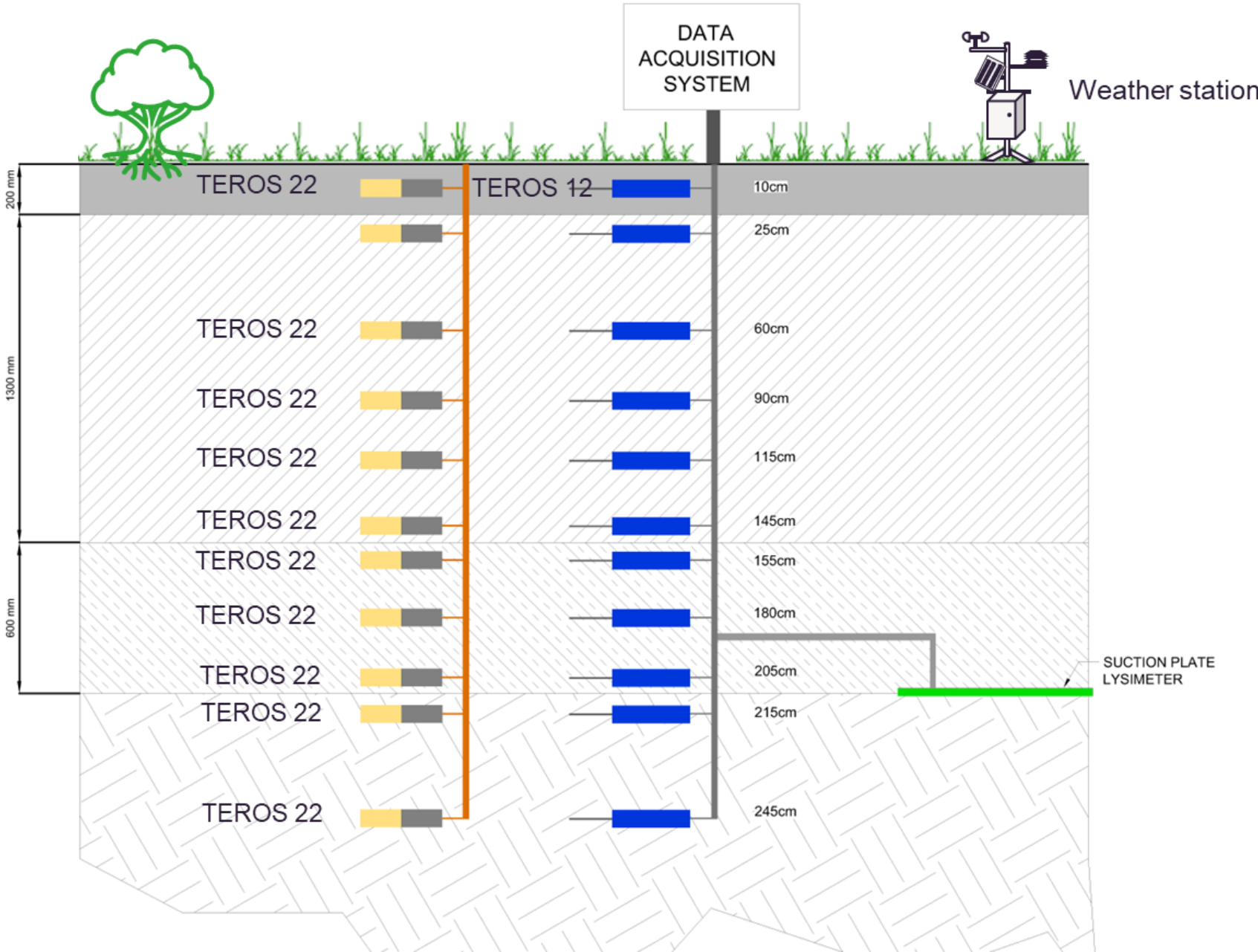
Cover Trial Design



- Three plots will be fully vegetated with a mixture of grass, shrubs and trees.
- Lysimeter trials will help with the decision of the mix

Soil cover design




Deploying suction plates and back fill reduced permeability layer

Marking the sensor deployment locations


Back fill infiltration storage layers

Thank you and questions please

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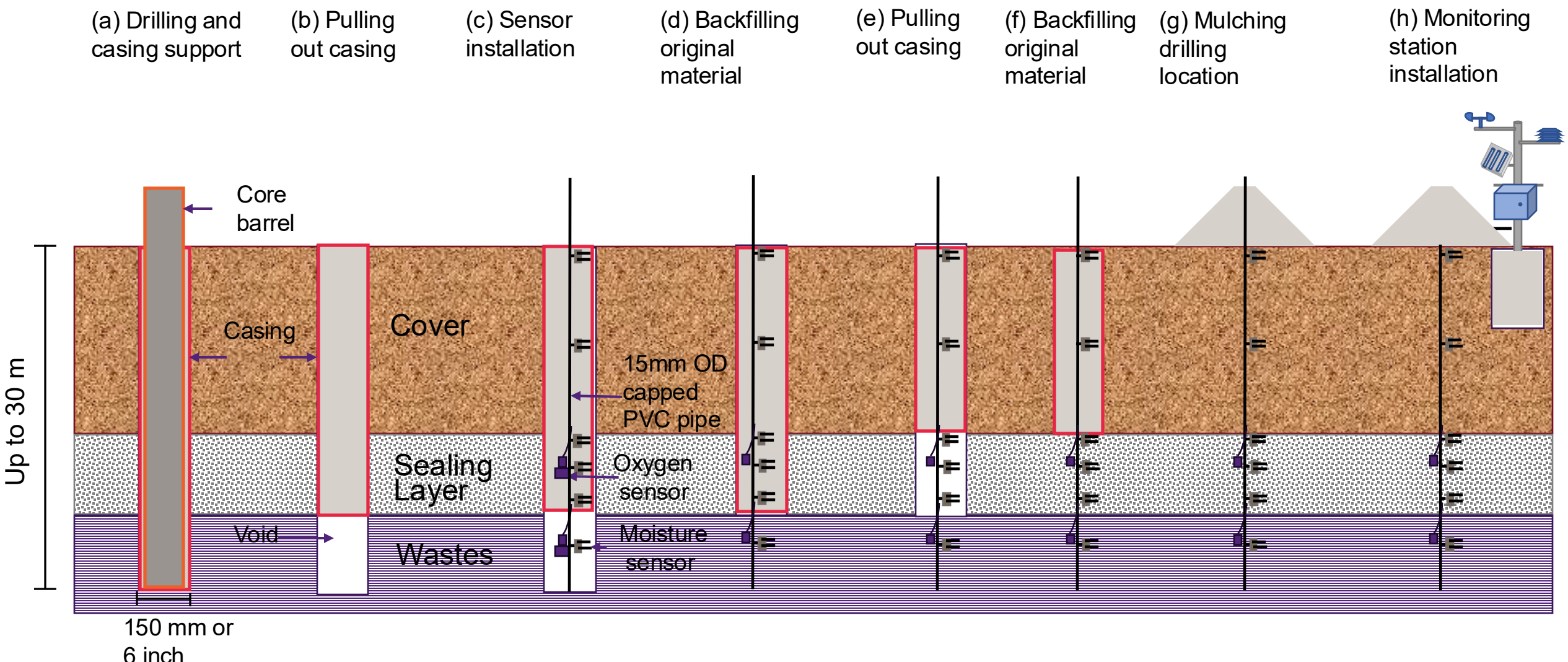
Bury sensor cables

- Avoid UV damage
- Prevent animal bite

Net percolation Through Waste Rock Dumps

Sensor installation by drilling and backfilling



Drilling to the depth up to 30 m below ground level

Lay out sensors on PVC conduit lines

Inserting sensors tied on a PVC into cased borehole

Back filling spoil to the cased borehole

Feeding new section of PVC pipe with sensors

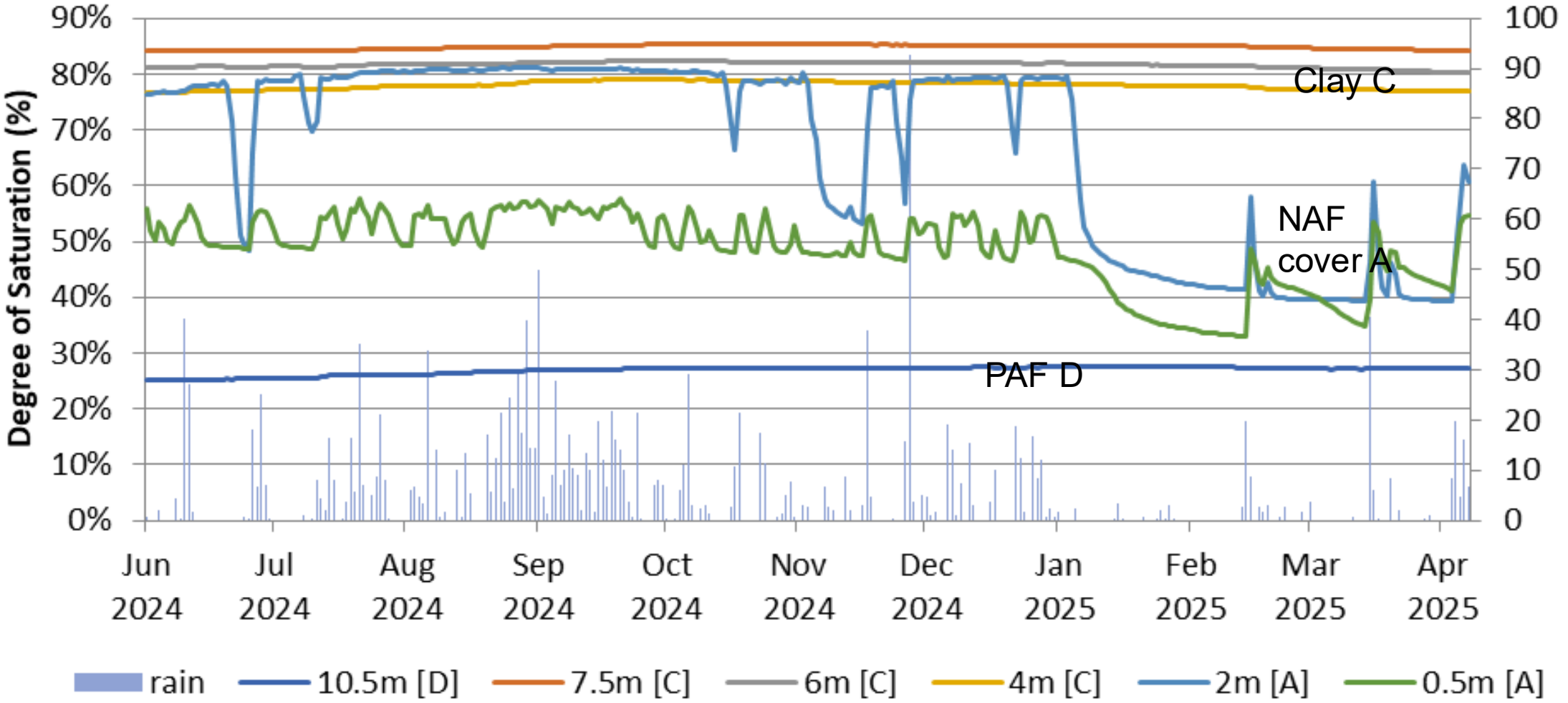
Insert a new 3m section of PVC into the cased borehole

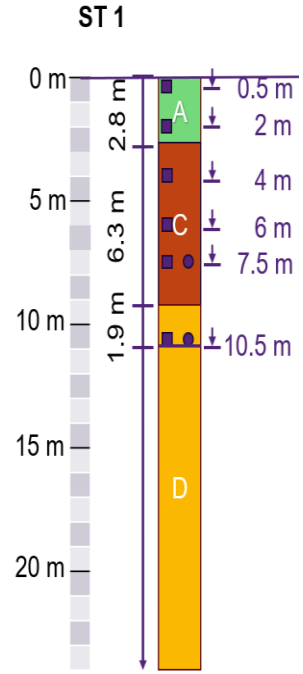
Winding cables above ground as a “sausage”

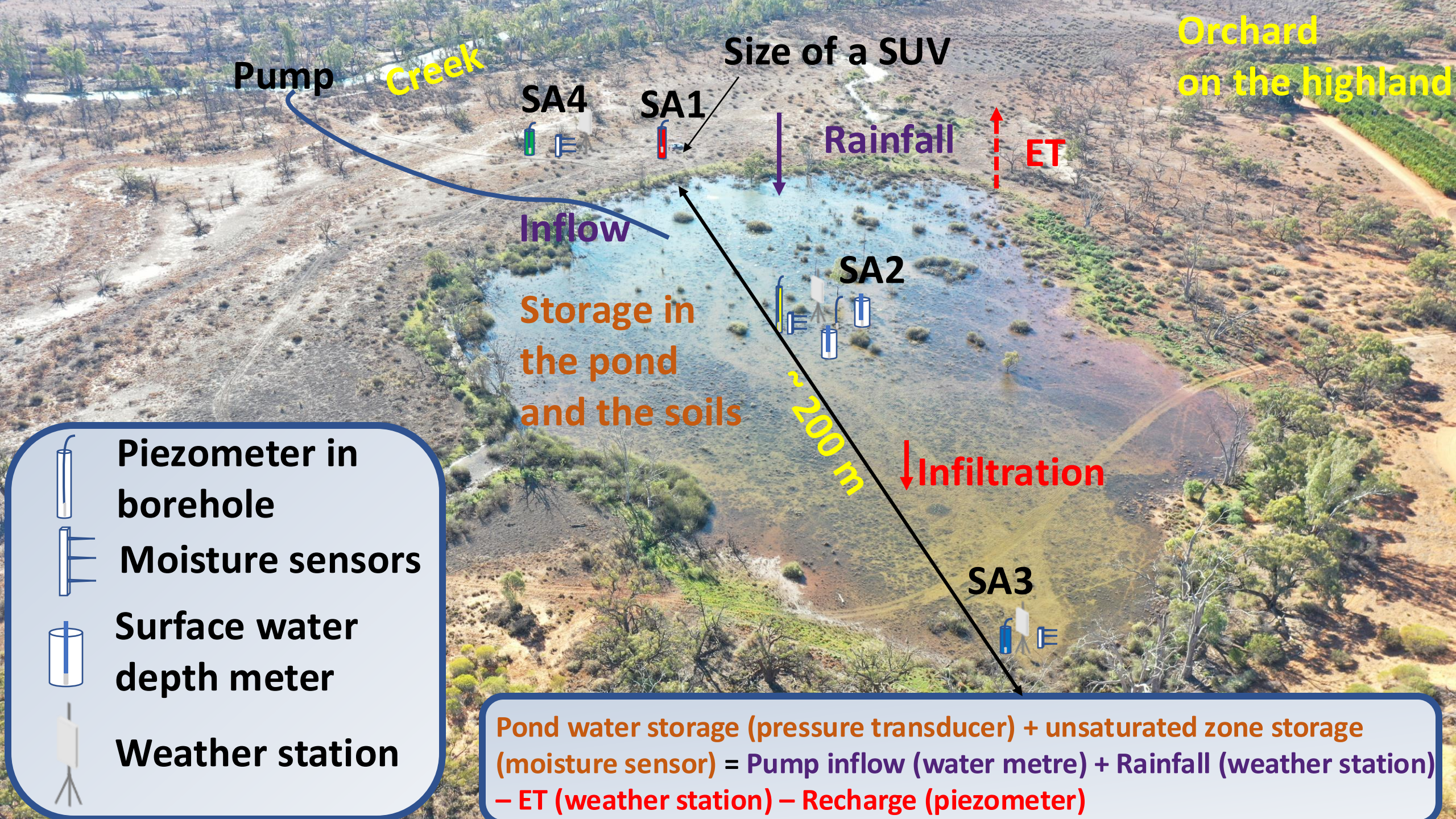
Completion of sensor installation

Completion of Instrumentation

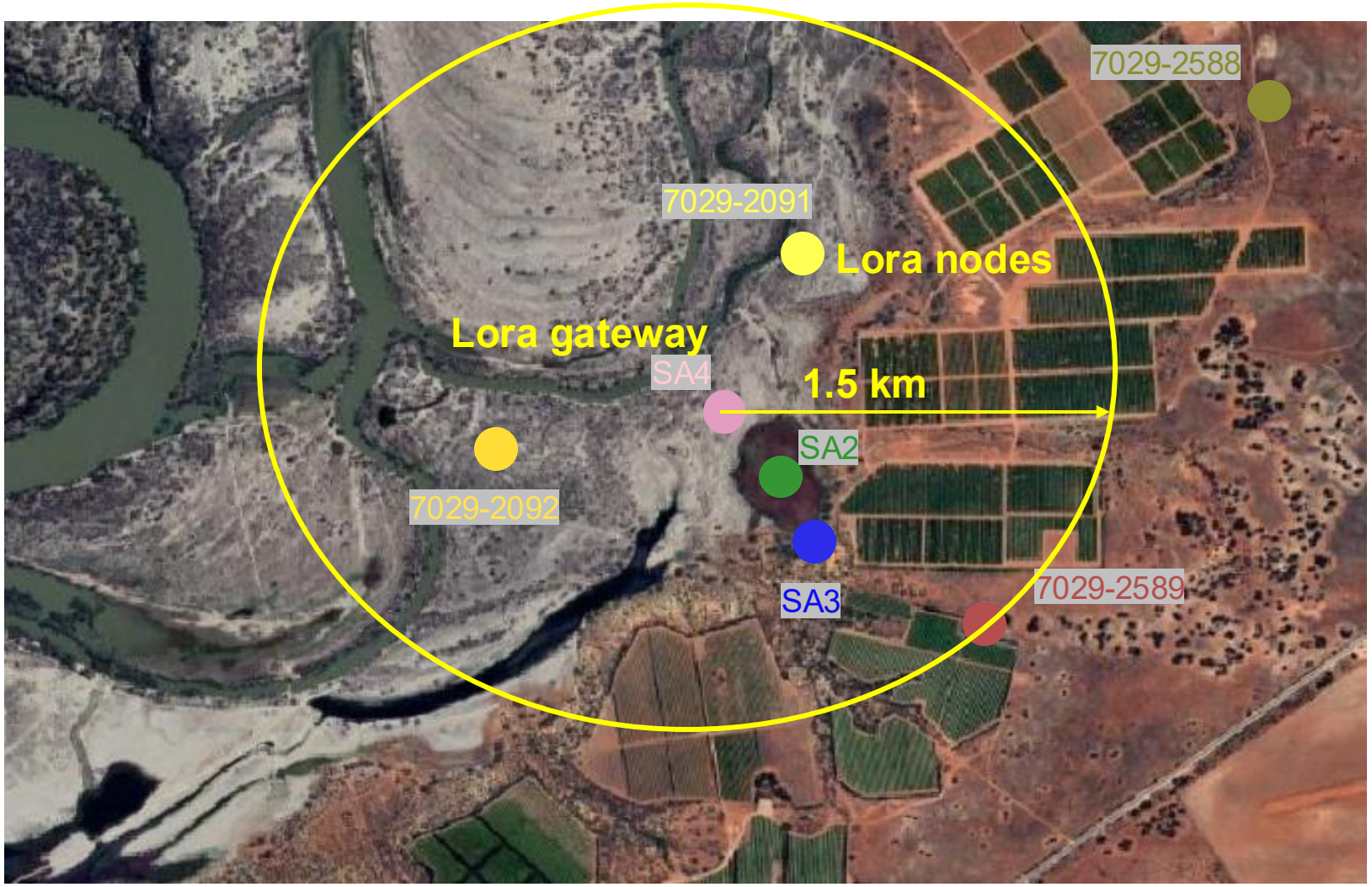
Moisture content over time at a transect with 6.3 m of clay






Pump
Creek
Size of a SUV
Orchard
on the highland
SA4
SA1
Rainfall
ET
Inflow
SA2
Storage in
the pond
and the soils
~ 200 m
Infiltration
SA3
Piezometer in borehole
Moisture sensors
Surface water depth meter
Weather station
Pond water storage (pressure transducer) + unsaturated zone storage (moisture sensor) = Pump inflow (water metre) + Rainfall (weather station) – ET (weather station) – Recharge (piezometer)

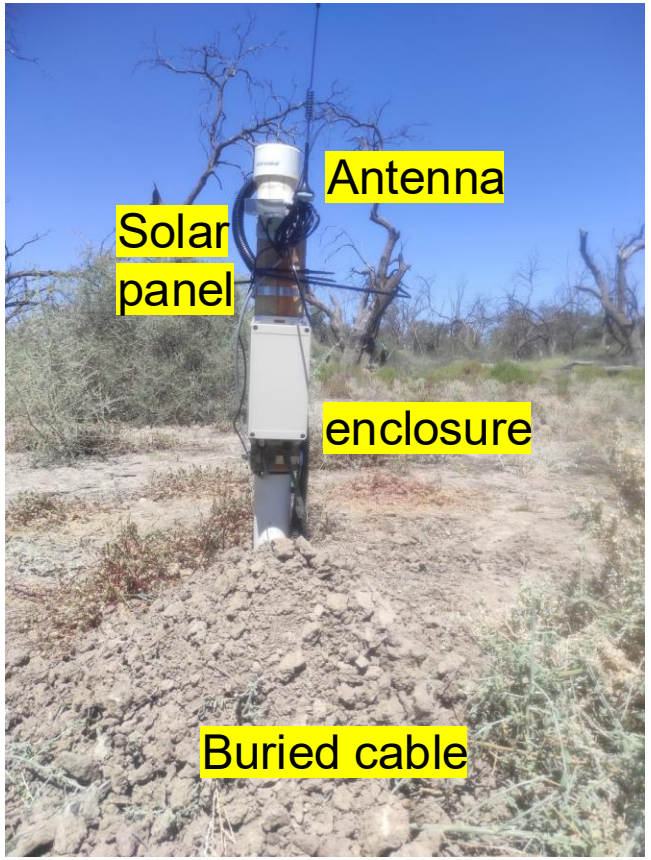
Instrument deployment during flooding



- Gateway is deployed at the SA4
- The gateway can receive data from nodes deployed within ~1.5km range
- Each node has a pressure transducer deployed in a borehole

Lora Gateway

Deploying LoRa node on monitoring boreholes



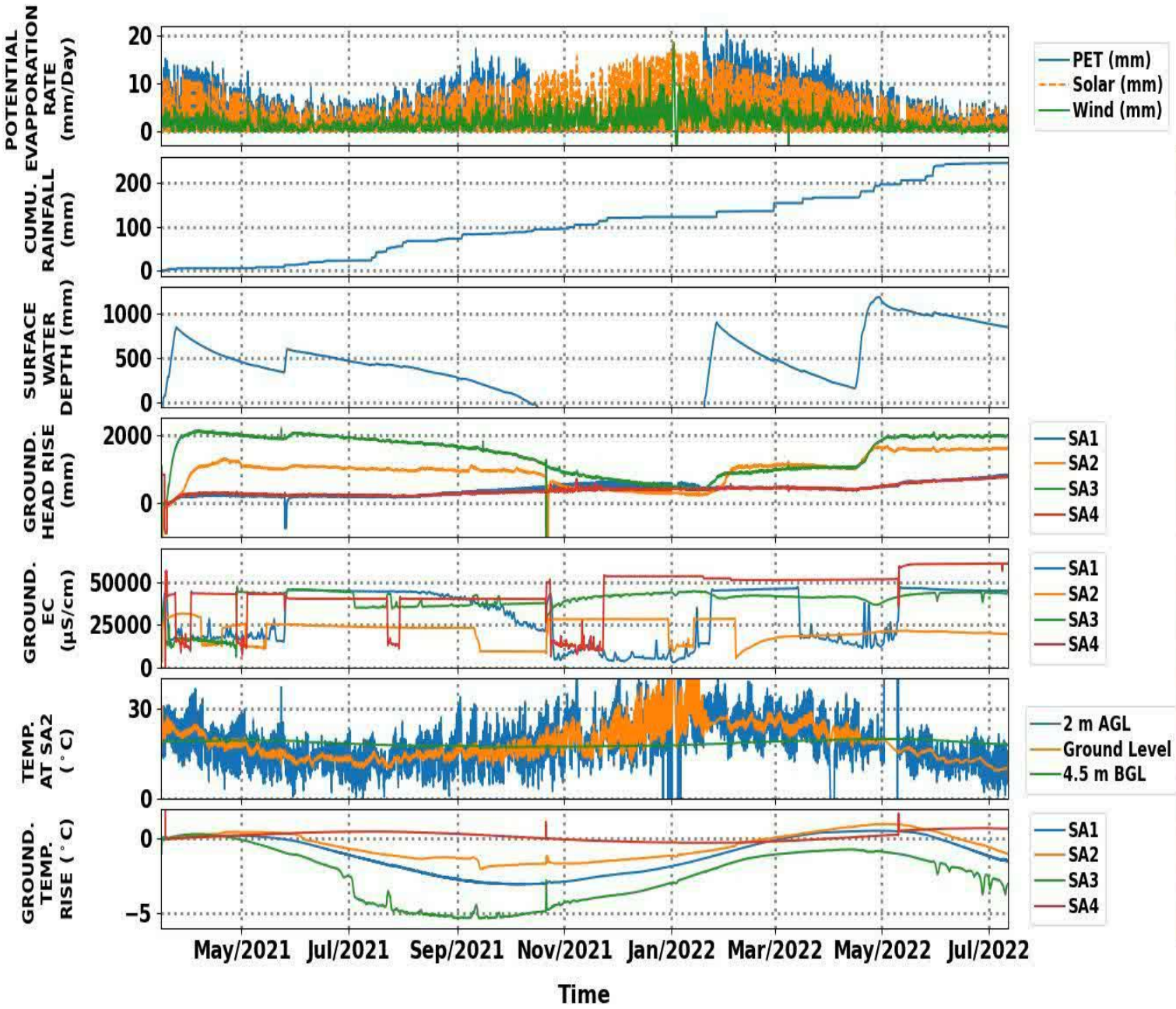
Functions:

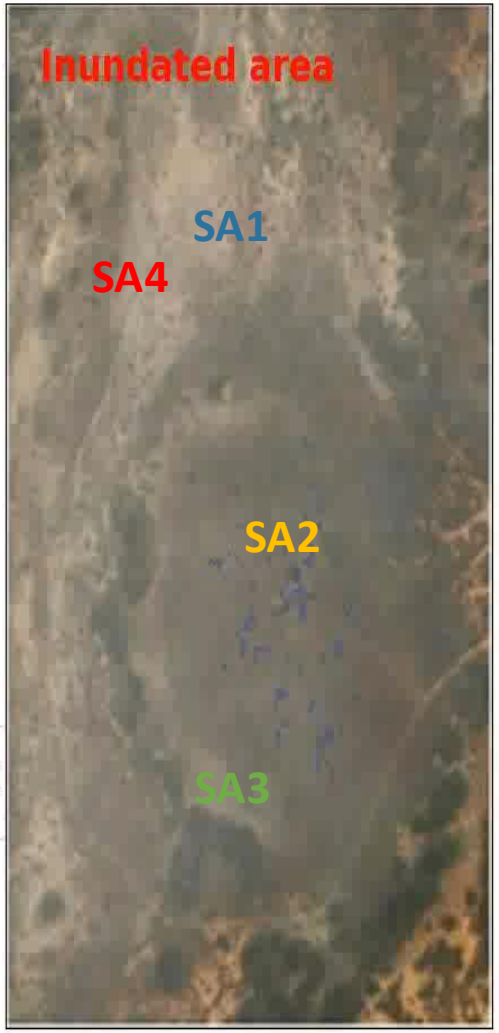
- Solar powered
- Measuring groundwater potentiometric head, EC and temperature
- Transmitting data to gateway

First e-watering

Dry pond

Second e-watering





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- The Jellybean Basin was completely flooded, and the 2-m height instrument tripods were not visible.


TRACO POWER
Drypower
12V 38Ah
DEEP CYCLE POWER
CAUTION


marlin
PEAK
FLATLOCK 1.5


marlin

Monitoring of the Moisture and Resulting Subsidence of Reactive Soils around a Railway Transect

Installation of monitoring station next to a railway

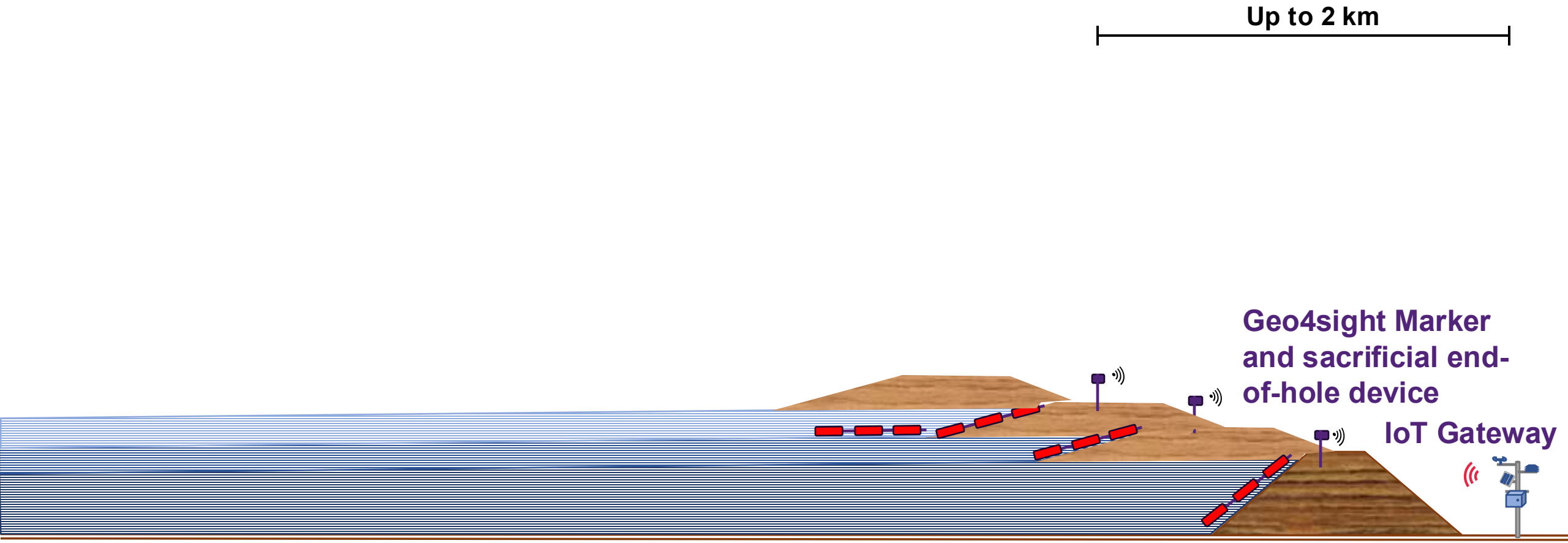
Guelph Infiltrometer to map spatial infiltration and hydraulic conductivities


Cables left at the surface

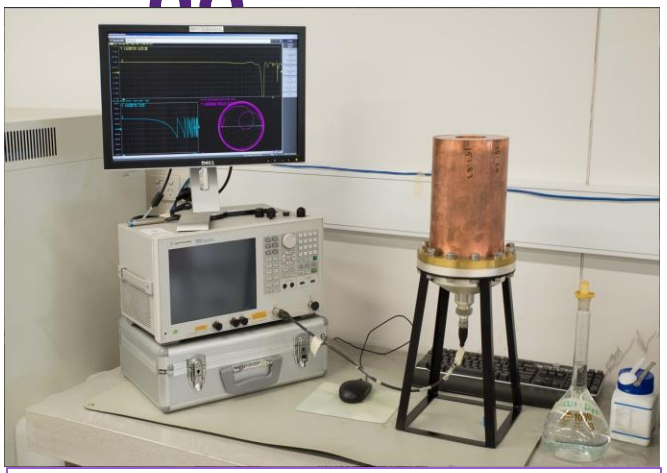
Wireless sensor development

- Sensors are **self-powered**, with a **battery lifespan of 5–10 years**, depending on measurement frequency.
- Sensors are **deployed in arrays**, with spacing of up to **5 m between neighbouring sensors**, and to depths of up to **1.2 km below ground level (BGL)**.
- Each sensor measures **moisture, suction, electrical conductivity (EC), temperature,** and **inclination**.
- Sensors not only **measure** these parameters but also **relay data wirelessly** for real-time monitoring.
- The system layout is **ideal for continuous monitoring** in challenging environments such as:
  - **Block caving operations**, where **surface subsidence** may restrict access.
  - **Tailings storage facilities (TSFs)**, where **raising tailings** can require **cable extension or datalogger relocation**.

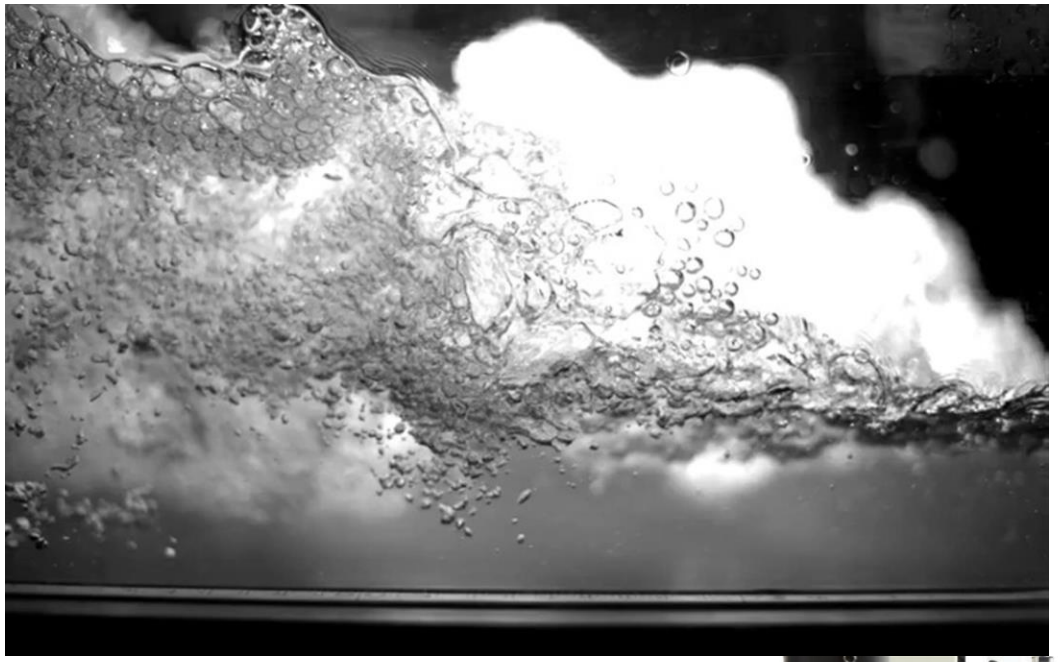
Sensor Deployment method



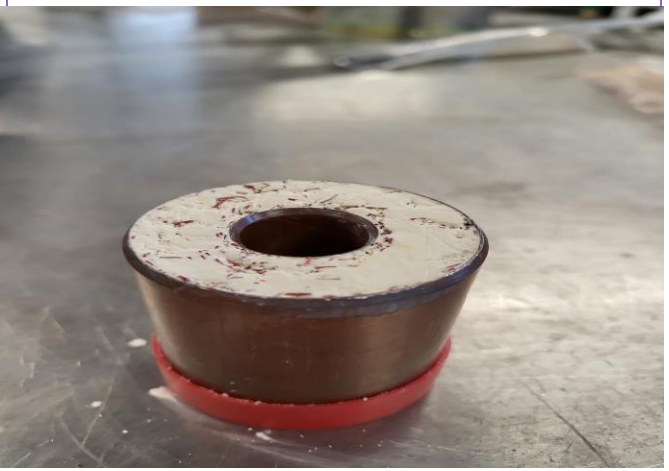
This is just a small amount of what the UQ Geo labs can do

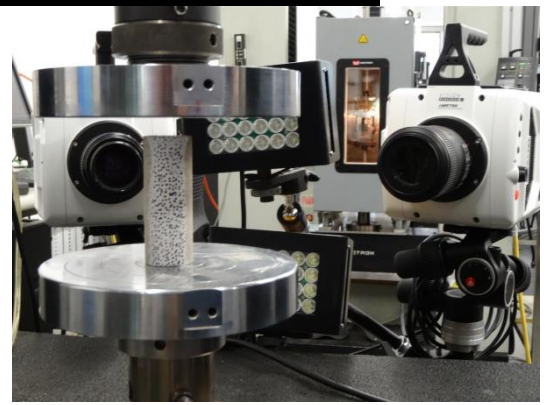


Electrical properties of soil, tailings and rock. Coaxial, TDR, ERT and more



Ultra high speed photography (up to 1000 frames per second)

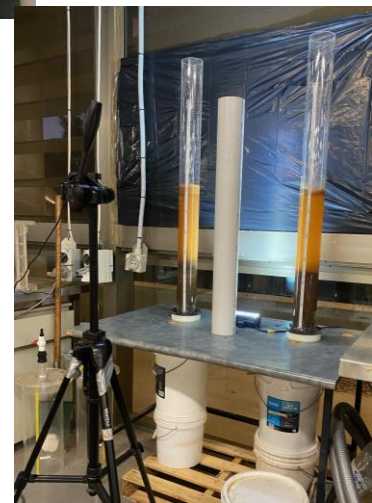




This is just a small amount of what the UQ Geo labs can do

Our focus is to meet the needs of industry partners and clients, students and our own research

We custom made any setup related to monitoring and find solutions to geotechnical questions



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