Underground Pumped Hydro Energy Storage Project (UPHES SRG)
Stakeholder Reference Group

MINUTES: Meeting 2

Date	28/10/2021	
Time	4.00pm – 4.54pm	
Venue	Online due to COVID-19 precautions	
Independent Chair	Abigail Goldberg	Chair and Director, GoldbergBlaise
Invitees	Ms Robyn Charlton Mr Ray Robinson Mr Trevor James	Newstan-Awaba CCC & Lake Macquarie Sustainable Neighbourhoods Alliance Myuna CCC Mandalong CCC & Mandalong MCA
Observers	Mr James McDonough Mr Tim Couchman Mr Anthony Margetts	DPIE - Energy, Resources and Industry ARENA DPIE - Mine Safety
In attendance	Mr Matthew Fellowes Mr James Marshall	Banpu Energy Australia Banpu Energy Australia
Apologies	Mr Peter Leven Mr Glenn Bunny Mr Ryan Skinner	Awabakal & GuriNgai Pty. Ltd Lake Macquarie City Council NSW Emerging Energy Program (observer)

Agenda item		**Action**
1.0	**Welcome and introductions** The Chair welcomed participants, advised apologies and facilitated introduction of new member, Mr James McDonough (DPIE).	
	Declaration of pecuniary interests No new interests were advised.	Participants to update the Chair either inter-session or at meetings should any issues of conflict of interest, perceived or actual, arise.

2.0	**Overview of project progress**
	An update of project progress was provided by Matt Fellowes, who observed that as the project is a world-first, significant new research is required. Matt addressed:
	• A technical explanation of mine subsidence, fracture mechanics and rock loading profiles
	• Activities to date undertaken by the University of Newcastle research program, including in relation to:
	  ○ Goaf consolidation, permeability and porosity, noting that new research was being undertaken that considers the implications of water saturated rocks on goaf rock behaviour. Additionally, a purpose designed large - scale permeameter has been constructed to simulate goaf permeabilities.
	  ○ Water chemistry analysis
	  ○ Reservoir modelling.
	• Regulatory and planning assessments, noting that these investigations are preliminary but early indications are that the process would follow either a State Significant Development (SSD) or Critical State Significant Infrastructure (CSSI) pathway. Both of these pathways require substantial environmental impact inputs.
	
	Participants raised questions in relation to:
	• The potential to use saltwater as well as freshwater. It was noted that this is possible, although saltwater has increased capital cost and different environmental and maintenance implications.
	• Space required for turbines. It was noted that options are being considered at this stage, ranging from small, modular turbines to larger more traditional facilities.
	• Whether the project is specific to Newstan, and whether bord and pillar mines were being considered as well as longwall mines. It was noted that the study is agnostic to any particular mine at this stage.
	• Potential for spontaneous combustion. The potential to draw oxygen into the goaf after pumping the water out has been identified and will be quantified during the numerical modelling.
	The PPt presentation is attached to the Minutes and will be posted online with the Minutes once these are available.	

3.0	**Other business** Participants sought details regarding the website where material is posted. Noted that the website link is: **https://www.banpuenergy.com.au/energy-storage**	
4.0	**Roadmap for meetings going forward** The roadmap for meetings going forward is currently: **Meeting 3** (January 2022): summary of conclusion of Stage 1 Research Program – technical viability.	

	Meeting 4 (April 2022): update on pilot trial progress and appraisal of opportunities for Centennial Lake Macquarie assets. Noted that some delays to the project have arisen due to Covid protocols, however the project remains on track at this stage.	
5.0	**Next meeting** It was agreed that the next meeting would be **4 – 5pm** on **Thursday, 27 January 2022.** This meeting will be **online**. It is hoped that the April meeting will be face-to-face. The Chair closed the meeting with thanks to participants for their interest and involvement. The meeting closed at 4:54pm.	An Agenda and link for the January meeting will be provided ahead of time.

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Underground Pumped Hydro Energy Storage (UPHES) Stakeholder Reference Group Meeting 2 – 28 October 2021

Project Proudly Funded by:

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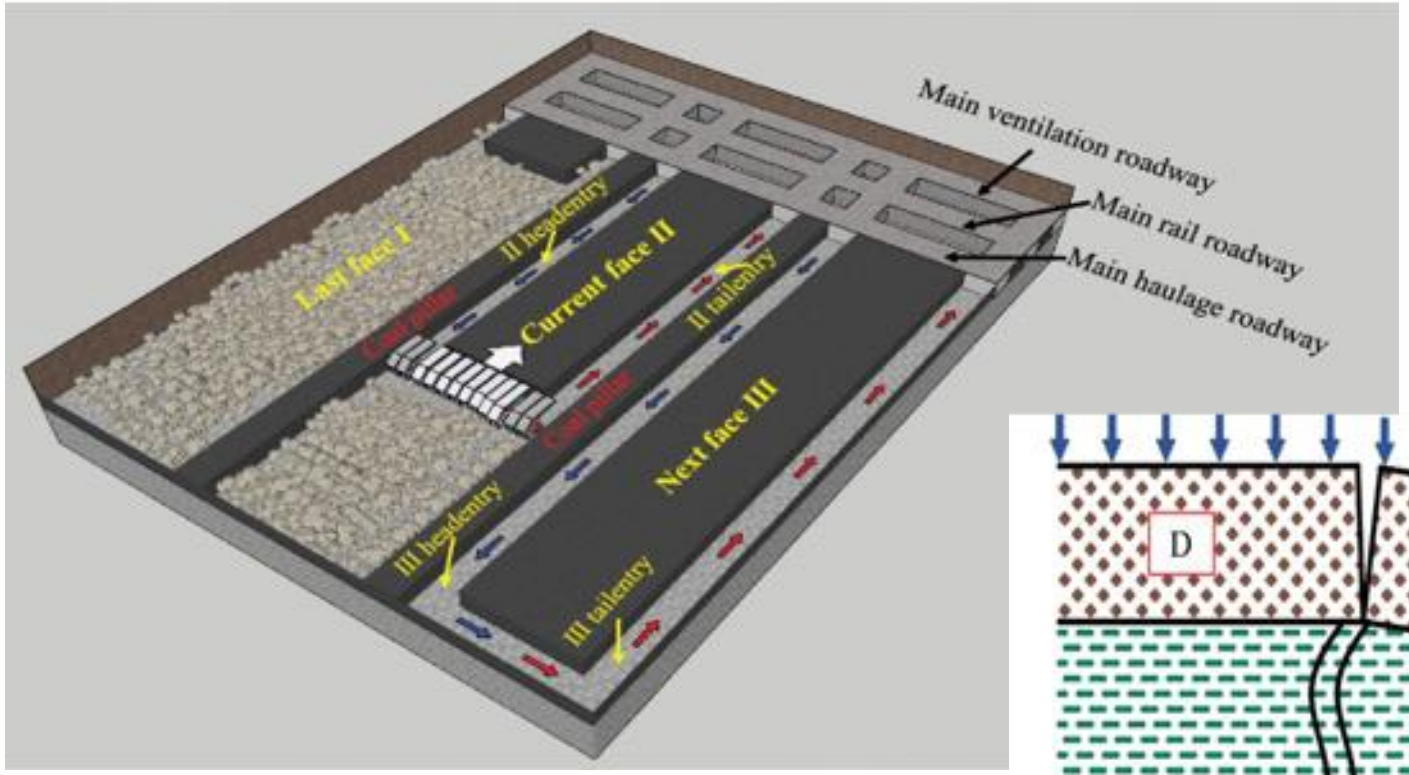
Presentation content

Overview of project progress

- Mine subsidence, fracture mechanics and rock loading profiles
- University of Newcastle research program:
  - Goaf consolidation, permeability and porosity
  - Water chemistry analysis
  - Reservoir modelling
- Planning and Regulatory assessments

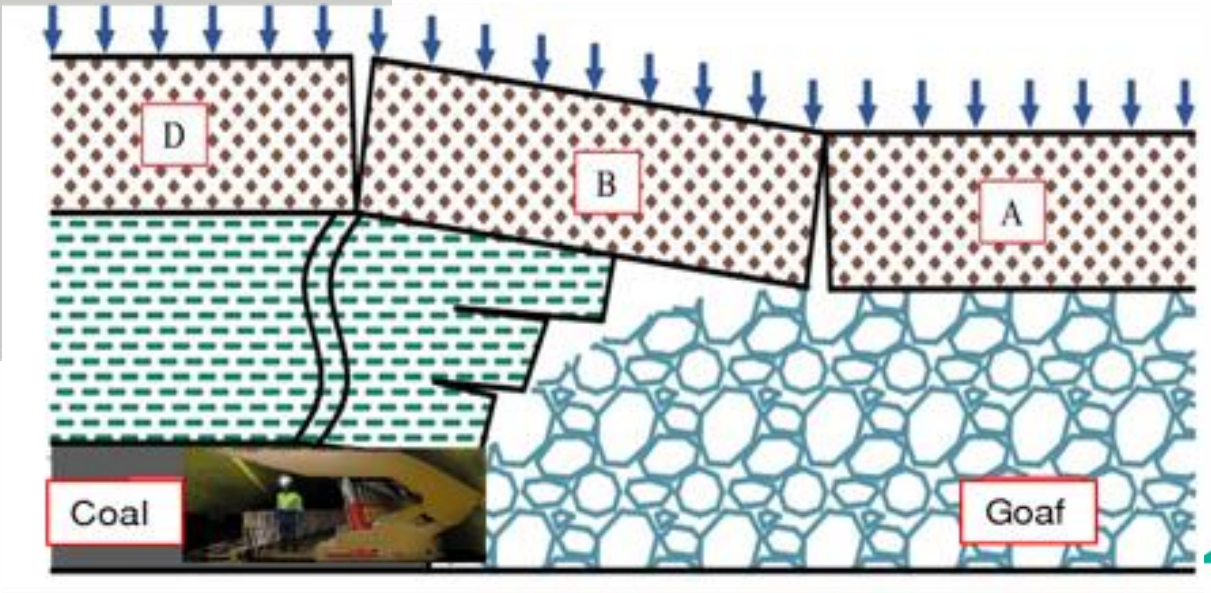
Mine subsidence, fracture mechanics and rock loading profiles

Mine Subsidence

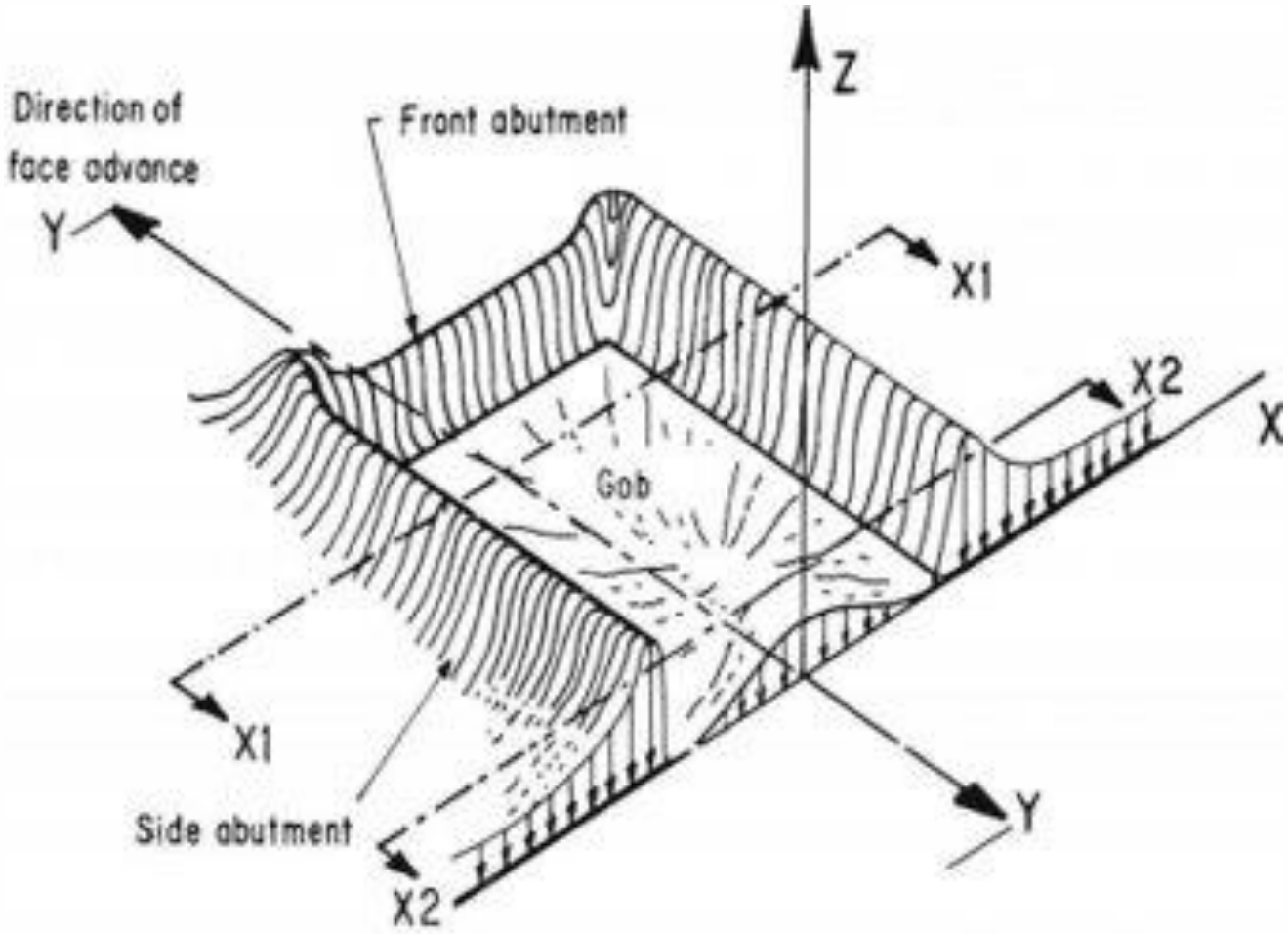


Key design features

- Panel width and depth
- Chain pillar width / height
- Extracted thickness
- Sensitive surface features
  - % extraction



Subsidence Load Profiles



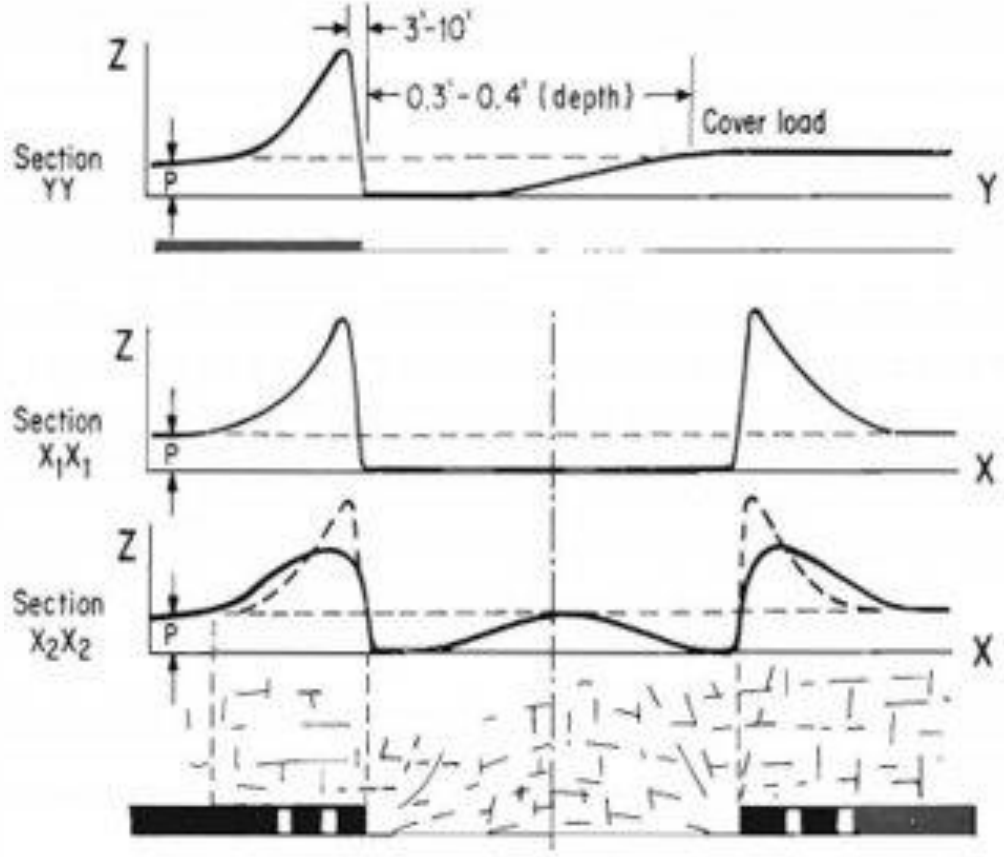
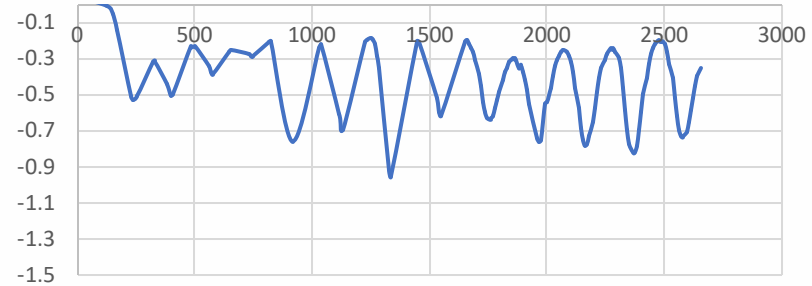


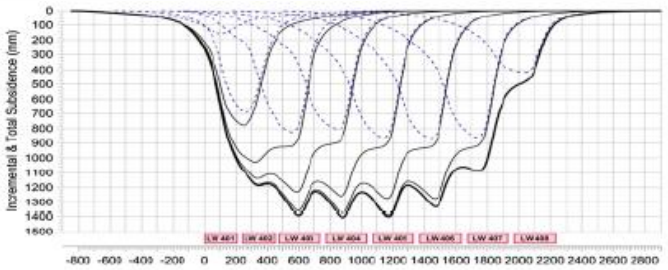
Figure 19.—Distribution of stress around longwall panel. P = cover load. Adapted from Whittaker (47).

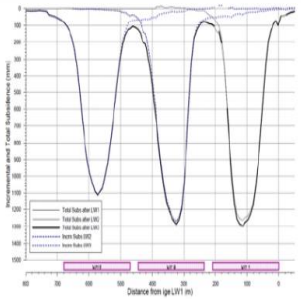
Different Surface Subsidence Patterns

Subsidence patterns have 2 components – sag over the extracted area + compression of coal pillars and strata

Available UPHES volume = extracted coal volume – subsided volume ("area" above these curves)



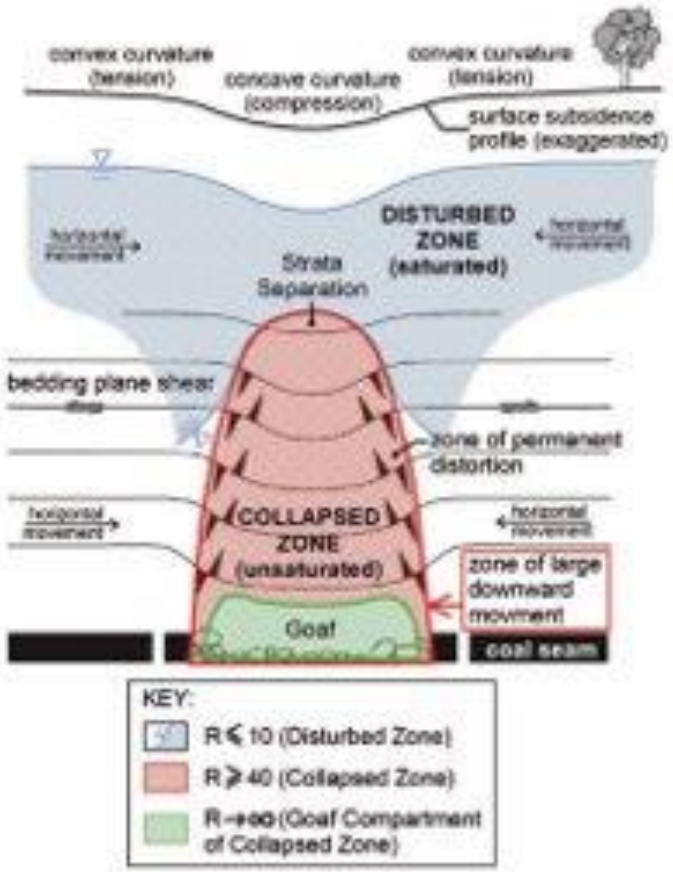




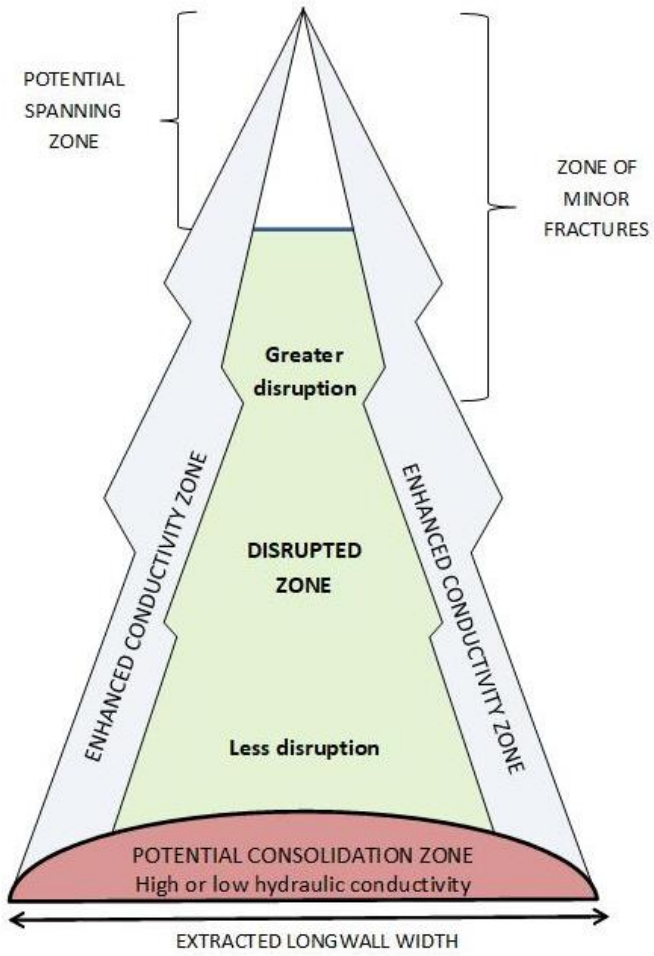
Narrow panels, large pillars	Small sag, small pillar compression **<u>light goaf loading</u>**
Narrow panels, small pillars	Small sag, pillars yield, high goaf loading
Wide panels, wide pillars	Large sag, small pillar compression, high goaf loading

Each mine requires an assessment of the load profile on the goaf

Models for overburden collapse and fracture networks



Conceptual model of longwall caving effects on the groundwater system – after Tammetta 2012



Seedsman fracture zone model

Base Reservoir Model

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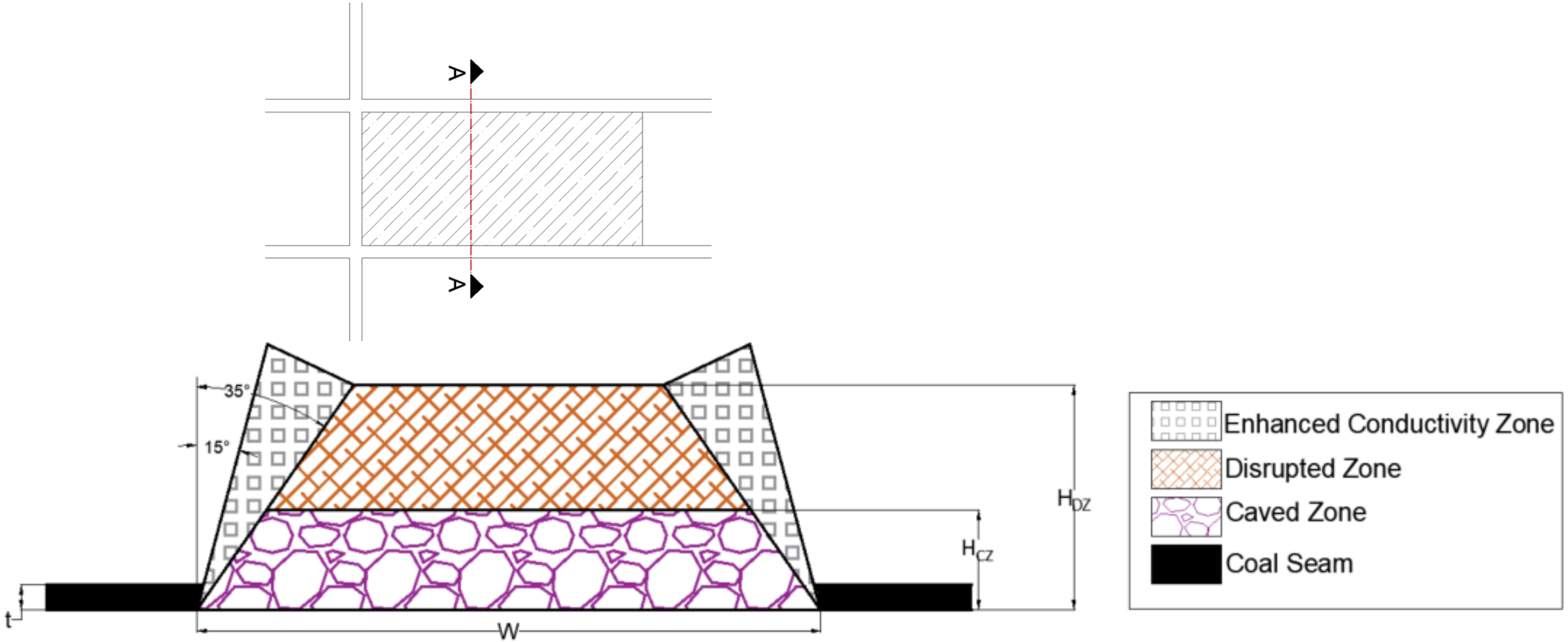
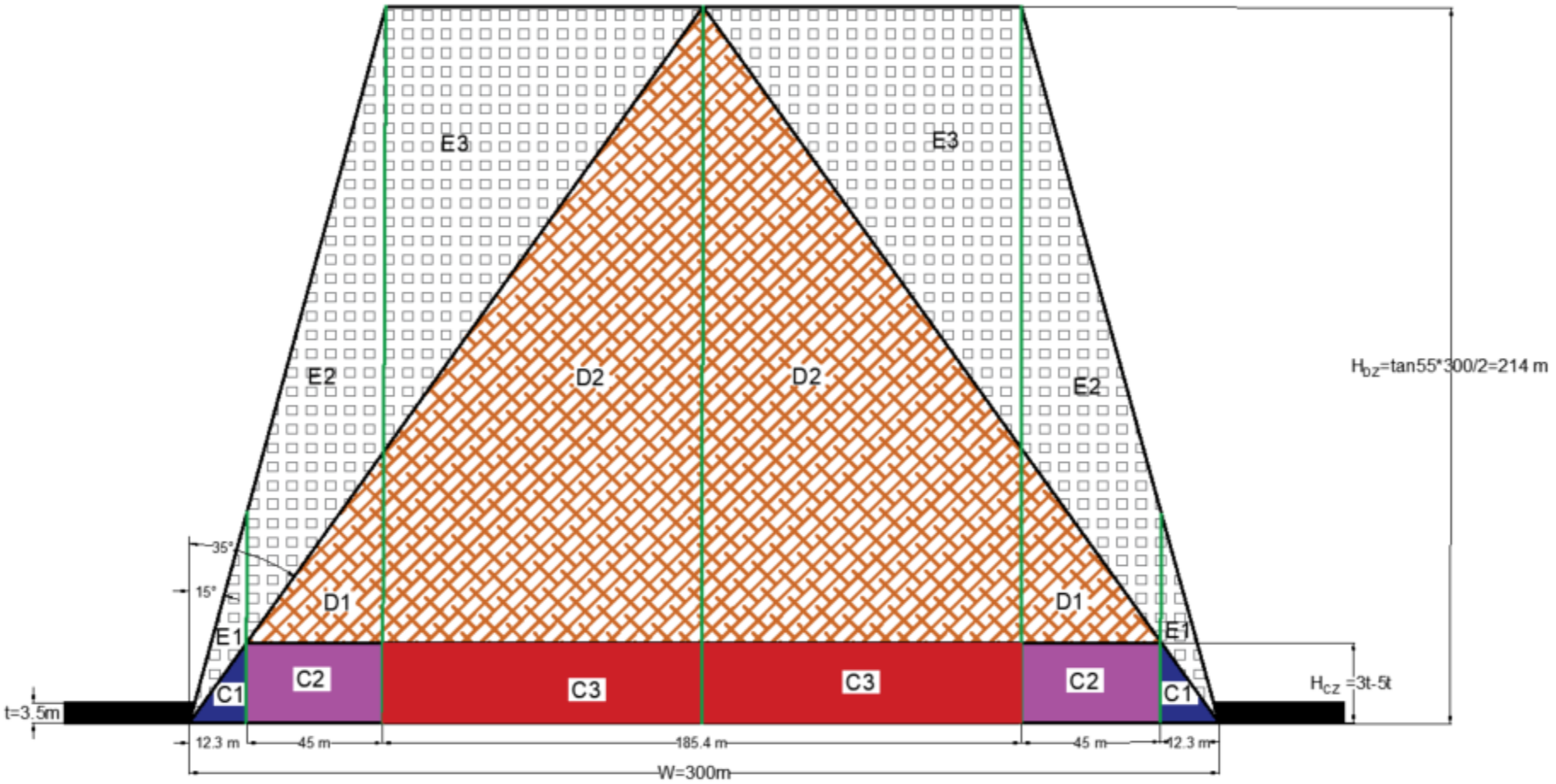
Cross section of the geometry from section line AA



H_{CZ} and H_{DZ} in the cross section is Height of Caved and Disrupted zones, respectively.

Porosity and permeability distribution



Porosity and permeability can be changed in each zone.

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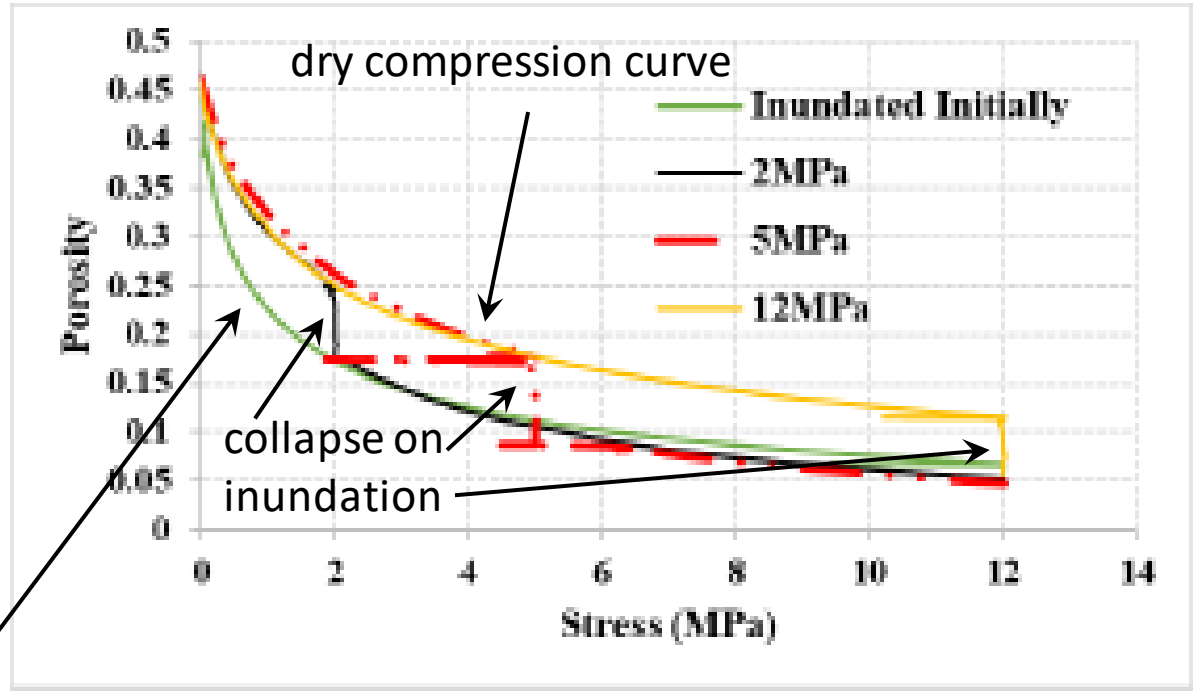
University of Newcastle research program:

- Goaf consolidation, permeability and porosity
- Water chemistry analysis
- Reservoir modelling

Goaf Consolidation

- 300 mm diameter x 250mm high specimens; 4 rock types, 4 stresses.
- Confirmation of expected role of water in decreasing porosity
  - compare yellow (dry) and green (inundated) compression lines

Figure 6 Typical index test specimen: (a) before the test, (b) after the test (wet and consolidated).



Permeability testing – lab and scale up

Collapse on saturation tests

- 550 mm diameter tests
- Stresses of 0.25, 1, 2, 3.5 and 5 MPa
- Porosity and permeability vs stress data
- Indicative hydraulic conductivity values from falling head test on collapsed samples

From L-R Saturated induced collapse test before, during and after (using goaf material)

Large scale permeameter

- 2.4m diameter x 2.4m high
- COVID related delays at test site
- First test scheduled early November

Large scale permeameter test rig under construction

Water chemistry

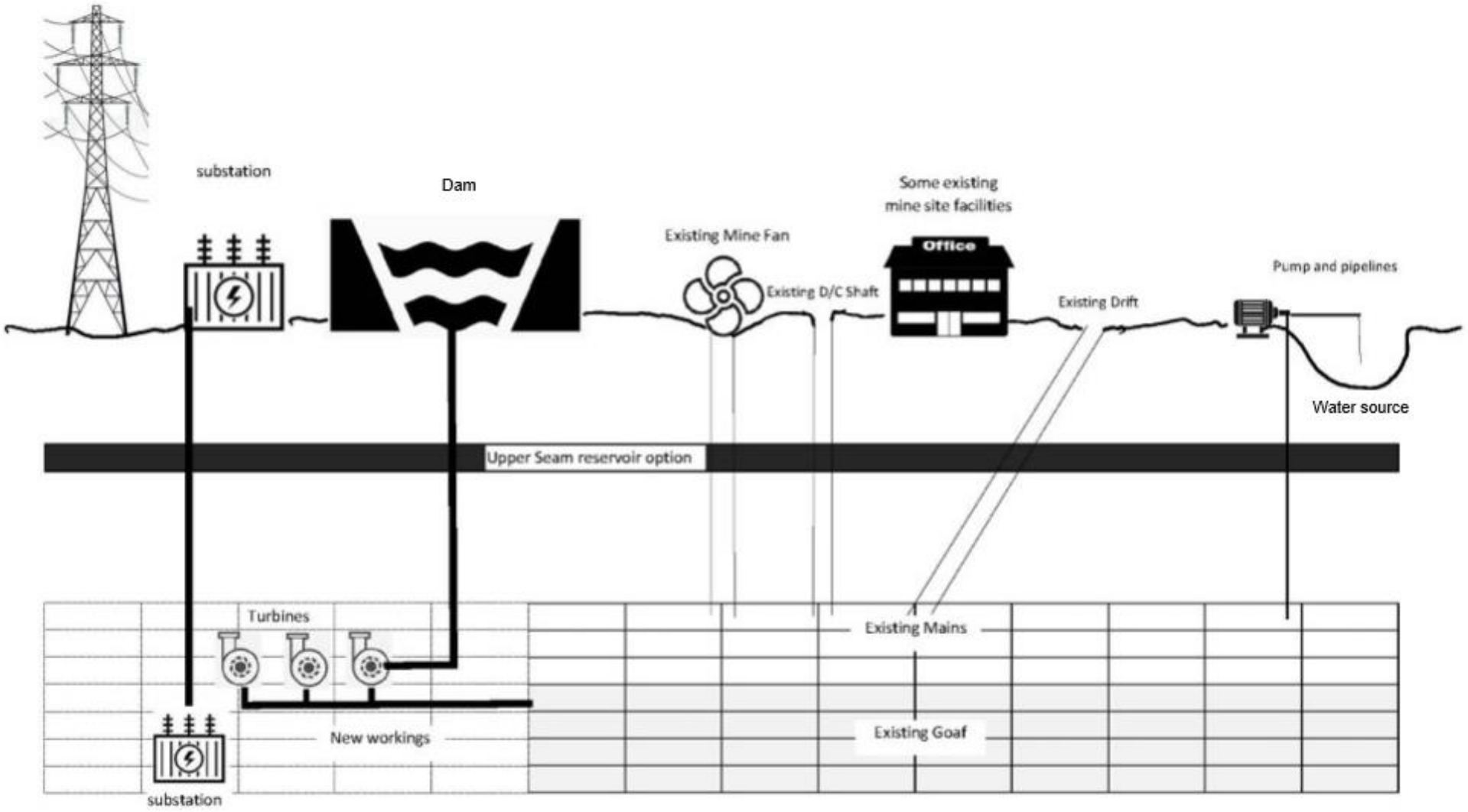
- 2 long term leaching cycle tests now running for > 60 days
- Sample comprises caved zone goaf material
- Daily soaking for ~8-10 hours
- Regular samples taken; analysis via chromatograph as a batch at end of November (100 cycles)

Reservoir modelling

- Water model developed to allow zonal porosity and permeability variation
- Compatible gas reservoir model also developed
- Now awaiting test results before modelling the 2 phase outcomes

Planning and Regulatory Assessment

UPHES Component Schematic



Planning Assessment

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Consideration	Preliminary Comment
NSW Planning Approval	Pathway either State Significant Development (SSD) or Critical State Significant Infrastructure (CSSI)
Connection to the NEM	Subject to AEMO requirements –connection agreement complying with technical and generator performance standards
Land Ownership and Tenure	Project specific determination
Water Licencing	Special Purpose Access Licence under Water Management Act 2000 – initial fill and top up The Planning Application would be assessed in accordance with acquifer interference guidelines which includes minimal harm criteria
Interaction with the Mining Act 1992	Existing Mining approvals will require modification and the co-existing approvals will need to 'talk' to each other - eg the UPHES approval will need to consider the mine leases and associated approvals
Commonwealth EPBC Approval	Project specific determination – the Project may also require approval by the Commonwealth Minister
Native Title	Project specific determination - comply with the Native Title Act 1993
Key Commercial Agreements	Mine operator Connection agreements Tenure agreements

WHSE Regulatory Assessment - NSW

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WHS Act 2011 and WHS Regulation 2017 is the overarching legislation

WHS (Mines & Petroleum Sites) Act 2013 and WHS (Mines & Petroleum Sites) Regulation 2014 provide additional unique provisions related specifically to mining that support the overarching legislation

The mining regulation is enabling legislation with guiding principles but they are still quite prescriptive

The guiding principle components include

- Mining Design Guidelines
- Australian and International Standards
- Codes of Practise

As with the Planning Legislation, the main components (turbines, generators and valves) common to PHES have not been considered in the context of operating in an underground coal mine.

A specific and bespoke engineering design Safety Case will need to be undertaken with safety systems equal to or better than existing equivalent design requirements

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Future Meetings Roadmap

Meeting No.	Content
Meeting 3 January 2022 (exact date TBC)	Summary of conclusion of Stage 1 Research Program – Technical Viability
Meeting 4 April 2022 (exact date TBC)	Update on Pilot Trial Progress – potential underground visit at Newstan Colliery Update on appraisal of opportunities for Centennial Lake Macquarie assets