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Our Ref: 0001P.P5.L1
14 July 2022

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CONFIDENTIAL AND PRIVILEGED

EXPERT OPINION – MT PLEASANT OPTIMISATION PROJECT (SSD-10418)

This letter has been prepared in response to a brief from Environmental Defenders Office (EDO) dated 5 June 2022 (the Brief). The Brief requests review of various documents in relation to the Mt Pleasant Optimisation Project (The Project) and to provide a report which addresses the following issues in regard to any groundwater and/or surface water impacts arising as a result of the Project:

a. summarise any key impacts predicted to arise as a consequence of the Project.
b. In my opinion, was the assessment of environmental impacts, as far as it relates to my areas of expertise, appropriate and sufficient?
c. In my opinion, has the assessment adequately considered any cumulative impacts arising from the Project?
d. What, if any, concerns do I have about the environmental impacts of Project, bearing in mind the mitigation measures proposed?
e. Provide any further observations or opinions which I consider to be relevant.

I confirm that I am qualified to provide expert opinion on these matters of mining effects on groundwater and surface water and that the following letter contains opinions held by myself based upon review of the below-cited reports and data. A copy of my CV is attached to this letter. I also attach a copy of the Brief.

I have read and agree to be bound by Division 2 of Part 31 of the *Uniform Civil Procedure Rules 2005* (UCPR), and the Expert Witness Code of Conduct (Code of Conduct) contained in Schedule 7 of the UCPR.

My opinions addressing items a. to e. above are stated below in the section "Findings". The scientific basis for each these opinions is supported by reference to sections of my "Report" below.

Yours sincerely,

STEVEN PELLS

BE(Civil) MEngSc PhD

FINDINGS

Issue	Statement	Basis
a. summarise any key impacts predicted to arise as a consequence of the Project	The Project will remove both groundwater and its source aquifer in the regions of open-pit mining. Ongoing seepage into the mining pit will cause depressurization of adjacent groundwater resources including loss of baseflow from regional streams.	Section 2.1 and 2.2
	Mine waste is to be stored in a tailings storage facility of appreciable size, which in my view is associated with a high risk of failure, which is a risk to human safety and the environment.	Section 1 and Section 3
	The mine closure plan proposes leaving the mine void open, which over time will create a 'pit lake' from filling with groundwater and surface water inflows until a balance with evaporation is reached. As evaporation is the only 'outflow' the pit lake will become more and more concentrated into the future with salts and other chemical constituents. Hence the closure design is to create a pit lake that becomes an increasingly toxic water body over time without limit or remediation plan, and which is a perennial drain on baseflow in regional rivers.	Section 3
b. was the assessment of environmental impacts, as far as it relates to my areas of expertise, appropriate and sufficient?	The EIS numerical groundwater model potentially underestimates impacts to "highly productive groundwater" resources associated with the alluvium. This underestimation arises due to the manner in which the numerical groundwater model layering is conceptualised, and the adoption of very low values for hydraulic conductivity in the model. Such values are not supported by reasoning or test. There is also appears to be systematic error in the interpretation of field testing (packer testing) that is relied upon in the EIS, and which results in values of hydraulic conductivity that I consider unreasonable.	Section 2.3
	The assessment of the water quality in the pit lake only considers salinity. Concentration of other constituents should also be considered along with the risks such concentrations provide to local flora and fauna.	Section 3
	It is questioned whether creating a pit lake that becomes increasingly toxic *ad infinitum* is an acceptable legacy to pass on to future generations. The EIS mentions possible 'options' for future usage and / or management of the water. A tenable plan for the future should incorporate a proper feasibility study of such	Section 3

	'options', including impacts, costing and sustainability. There is very little information given about the design, specification and management of the tailings storage facility. The facility proposed in the EIS is large and, based on the details in the EIS, can be characterized as having a high risk of failure.	Section 4
c. has the assessment adequately considered any cumulative impacts arising from the Project	Assessment of cumulative impacts dismisses two nearby mining operations on the basis of tenuous assumptions about groundwater movement. Impacts to water resources are considered relative to existing approved mines rather than baseline conditions. This logic offers no environmental protections.	Section 2.4
d. What, if any, concerns do I have about the environmental impacts of Project, bearing in mind the mitigation measures proposed?	I am concerned that the assessment of environmental impacts has not appropriately quantified effects to the alluvial groundwater resources, which are deemed to be "highly productive groundwater" resources. I am concerned that the tailings storage facility design creates an unacceptable risk of failure. I am concerned about the future legacy of a pit lake, in which salts and other constituents will concentrate *ad infinitum* and for which there is no coherent, planned mitigation or management scheme set out in the EIS.	Section 2.3 Section 4 Section 3
e. Provide any further observations or opinions which I consider to be relevant.	I recommend that the original packer testing data are presented for review.	

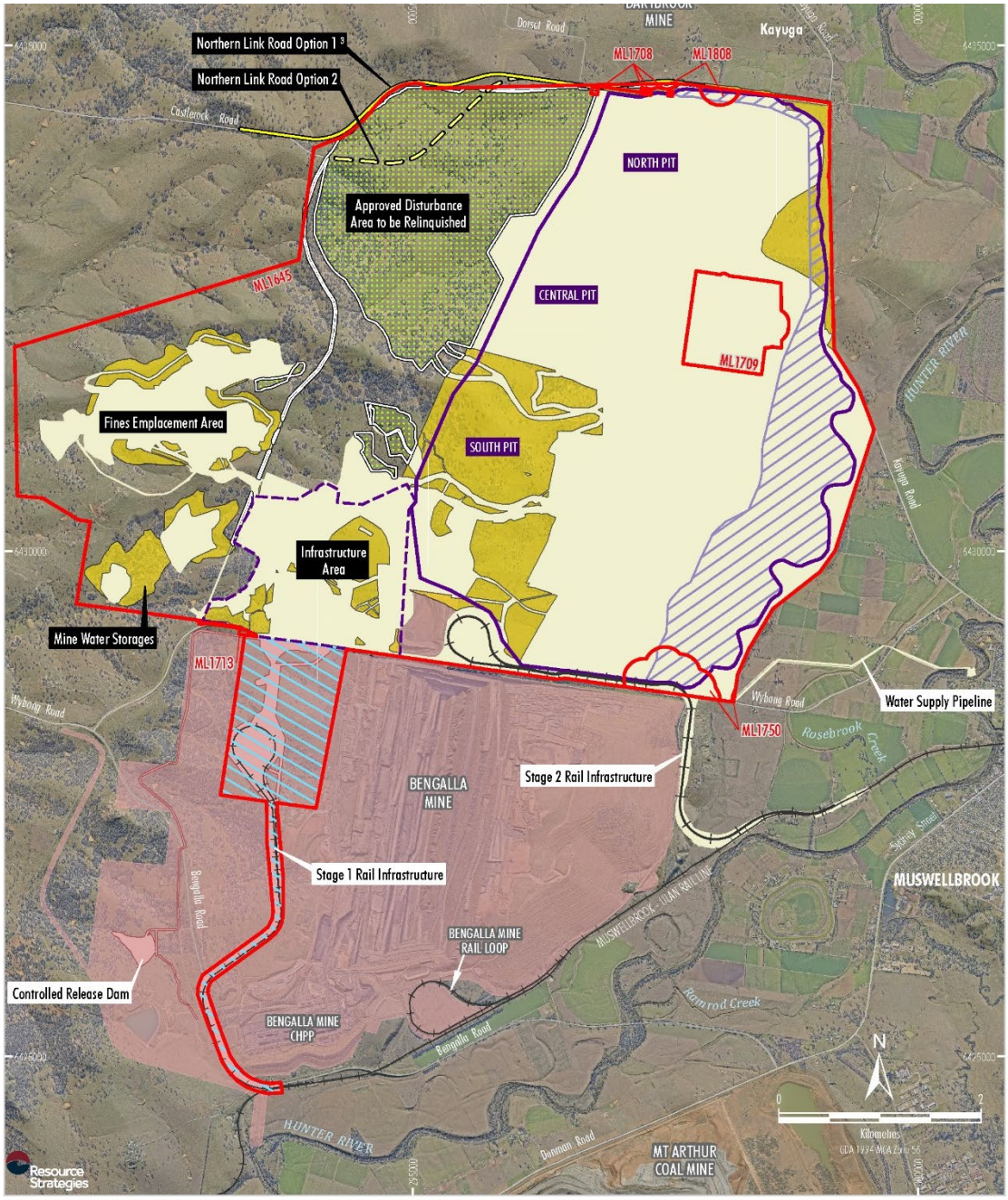
REPORT

1. OVERVIEW OF MT PLEASANT OPTIMISATION PROJECT

The Project comprises an application to extract additional coal within the existing Mt Pleasant Operations Mining Lease (Figure 1) by deepening the pit floor and increasing the rate and duration of mining. The Project proposes to advance the pit excavation from east to west, and leave a new landform (comprising disturbed earth and waste) behind the excavation as it advances (Figure 2). At the end of mining, it is proposed to leave a large excavated void in place, which will fill over time with groundwater seepage and rainfall runoff to form a pit lake (Figure 3). Waste from the mining process (eg the tailings) will be stored in a large tailings dam ("Fines emplacement area" as shown on Figure 1) which is shown in the EIS to comprise 7 stages of advancement in height, up to over 60m height (Figure 4).

The Project is located amidst various other existing mine workings. These mines are targeting the regional coal seams at various depths and with various mining methodologies.

Groundwater resources within coal formations, and adjacent formations, are often of poor quality and not greatly valued as a groundwater resource, at least for human utilisation. However, alluvial deposits adjacent to the tributaries hold groundwater which has been identified in statutory mapping as being a "highly productive groundwater" resource (Figure 6). The classification of "highly productive" attracts more careful protection measures from the Aquifer Interference Policy (AIP).



LEGEND

Existing Mine Elements

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97) [1]
- Infrastructure to be removed under the Terms of Condition 37, Schedule 3 (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]

Additional/Revised Project Elements

- Approved Disturbance Area to be Relinquished [2]
- Approximate Additional Disturbance of Project Extensions [1]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline
- Approximate Extent of Project Open Cut and Waste Rock Emplacement Landforms
- Approximate Extent of Project Out-of-Pit Waste Emplacement
- Revised Infrastructure Area Envelope

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

General Arrangement of the Project

Figure 3-1

Figure 1 – Overview of the existing and proposed mine extents

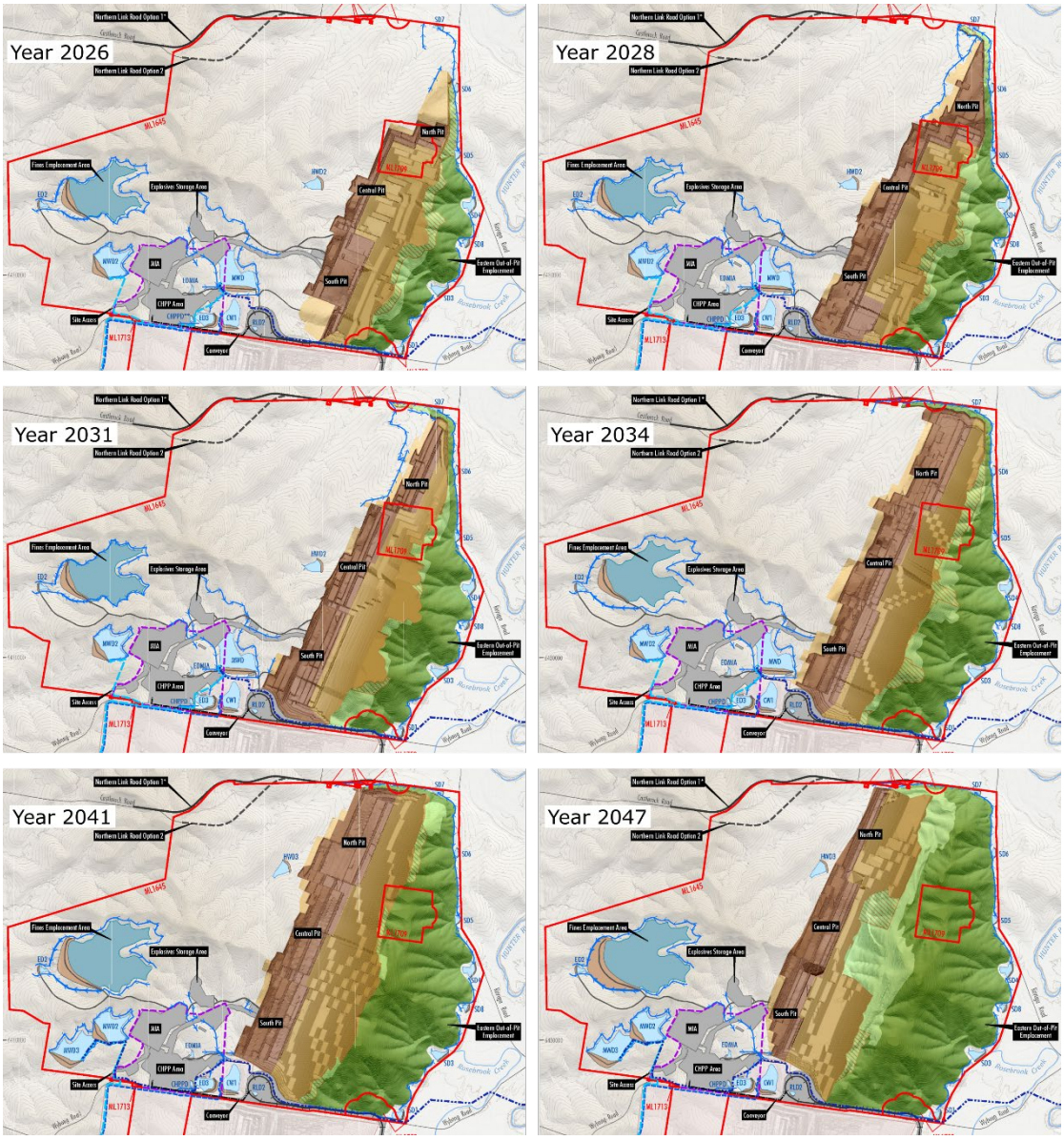


Figure 2 – Planned excavation and landform development

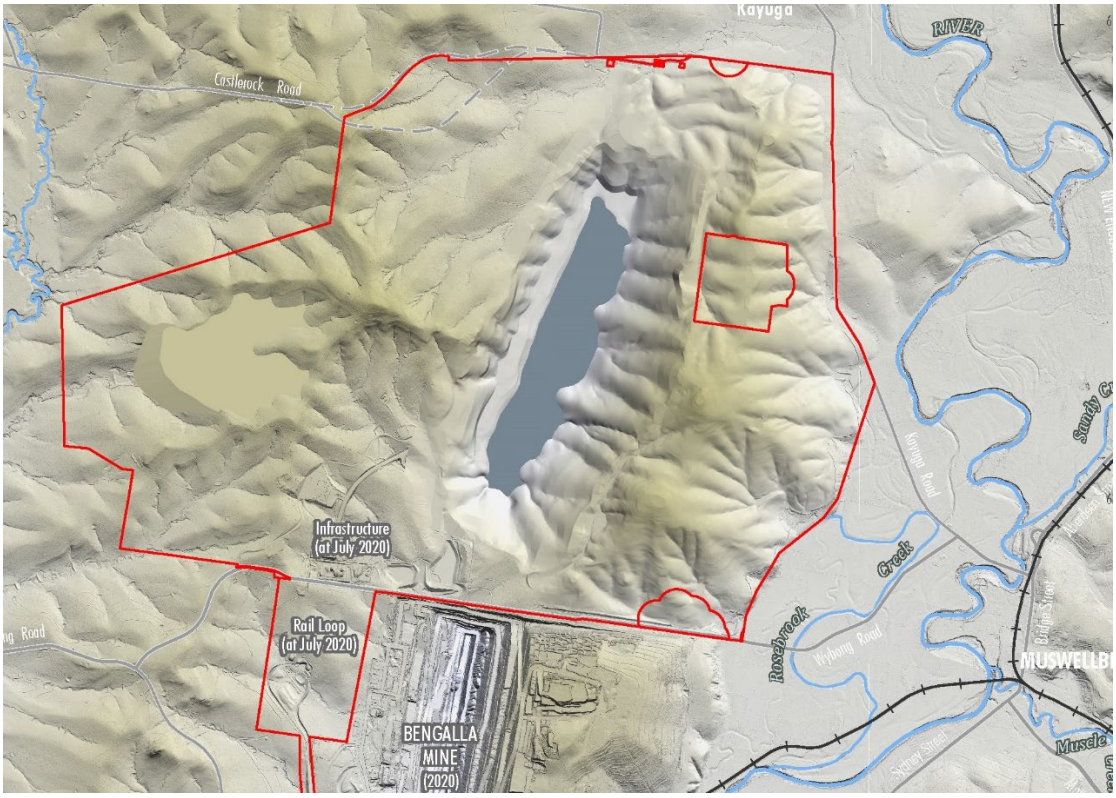


Figure 3 – Proposed closure pit lake

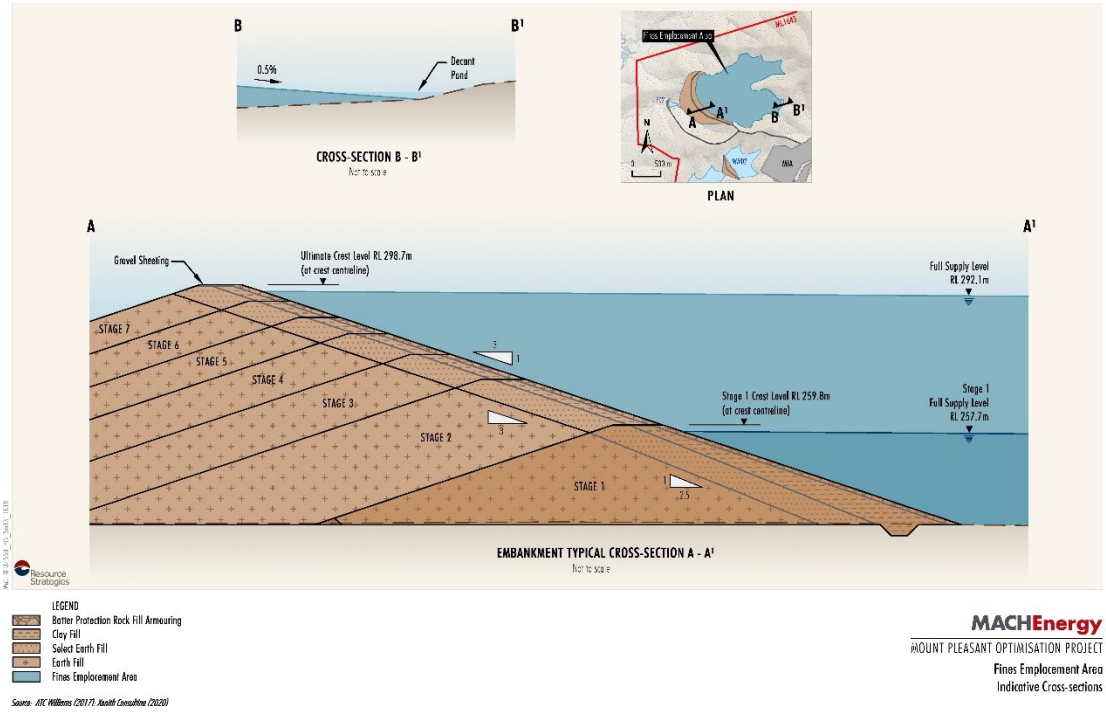


Figure 4 – Proposed tailings storage facility

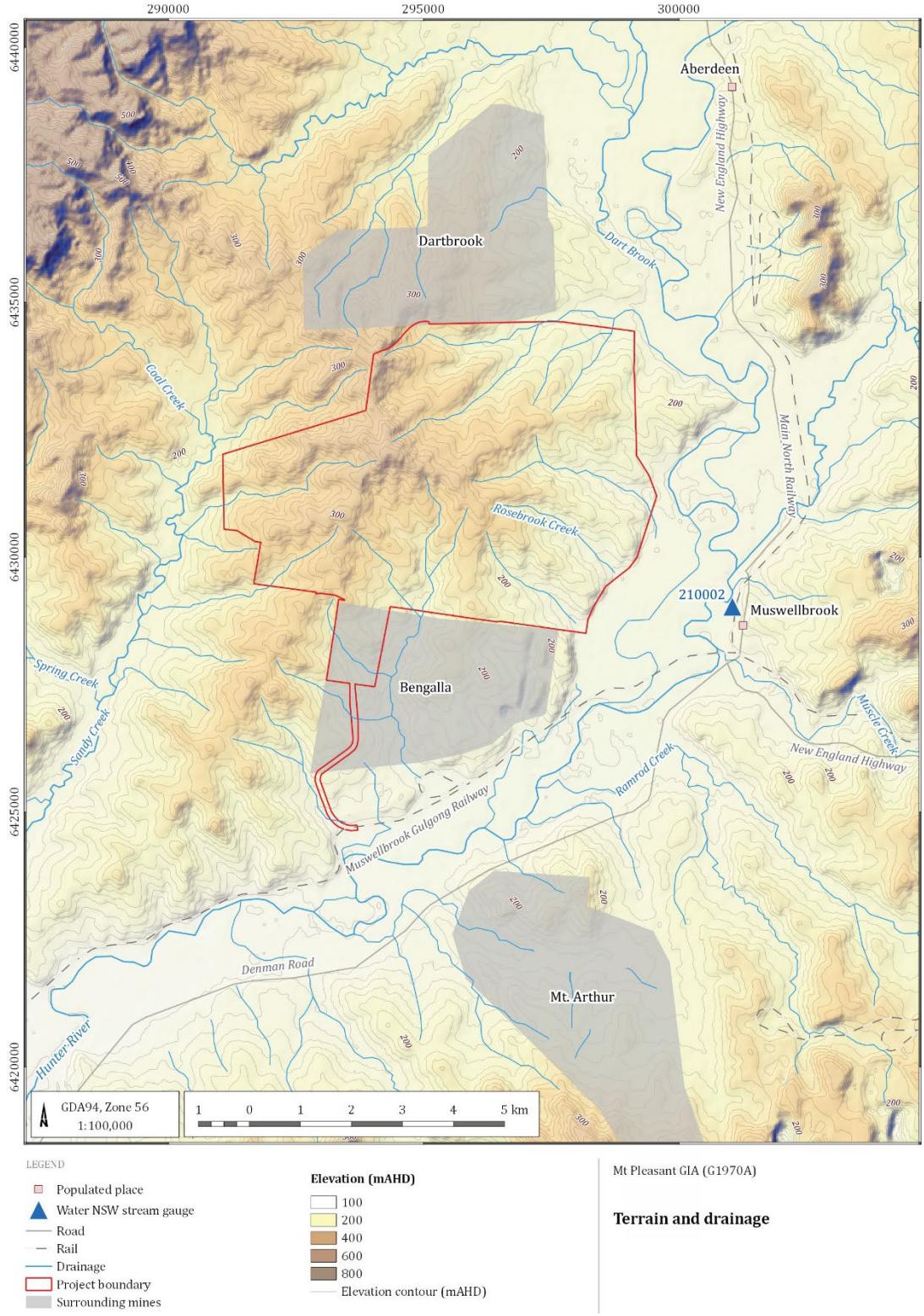


Figure 5 – Overview of the regional terrain and streams

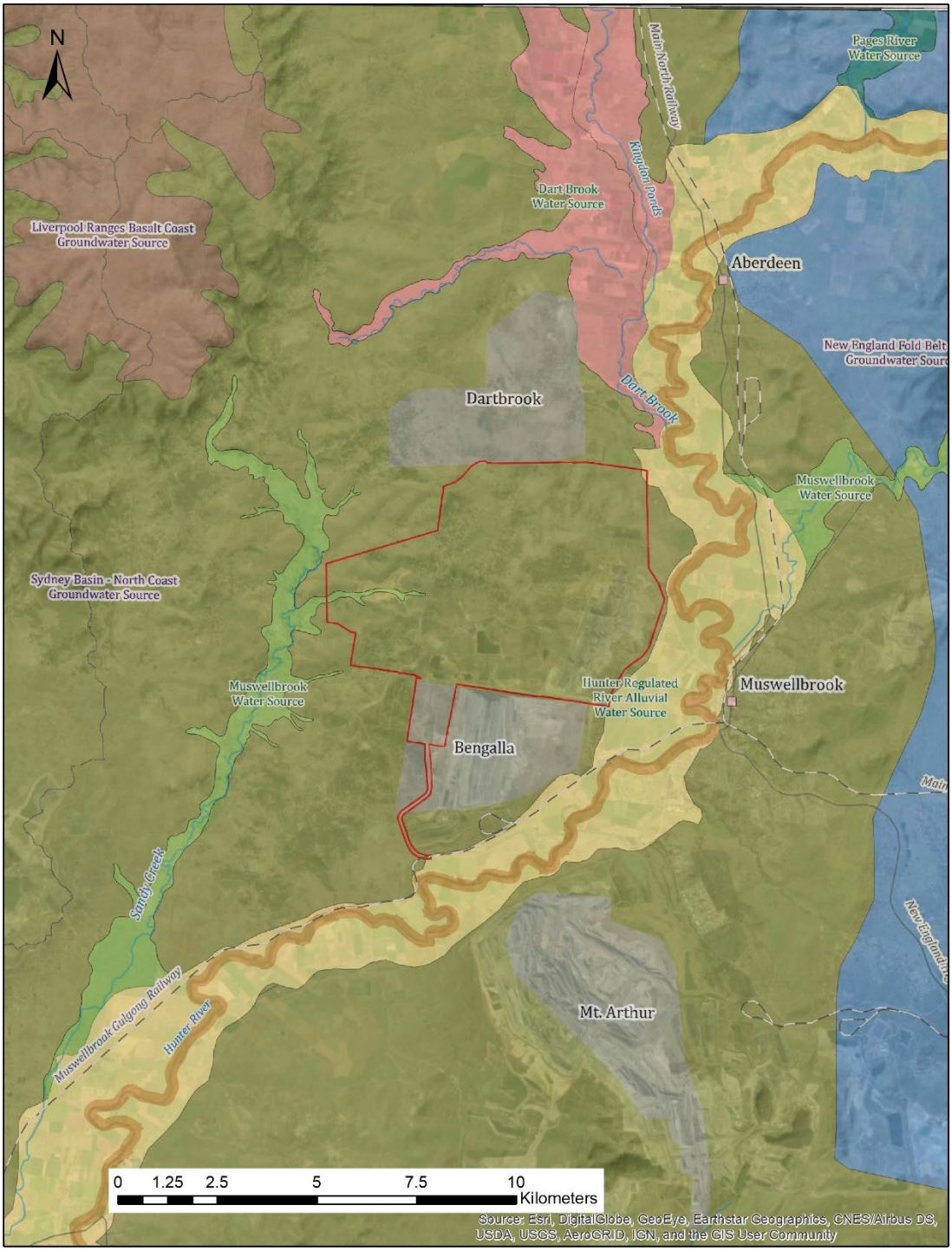


Figure 6 – Overview of the alluvial deposits deemed "highly productive groundwater" (see the "Hunter Regulated River Alluvial Water Source" shaded in yellow)

2. EFFECTS OF THE PROJECT UPON SURFACE AND GROUNDWATER RESOURCES

2.1 Expected effects

Open-cut mining involves accessing the desired underground resource through excavation from the surface. Clearly then, a primary effect of the Proposal is removal of existing resources within the open-cut footprint, including existing creeks and aquifers.

The open-cut mine pit will intersect groundwater from within coal seams and adjacent geological formations. This groundwater will be removed where they are within the pit, but also longer term removal of groundwater resources occurs as seepage flows to the pit are removed through pumping and / or evaporation. The loss of groundwater could be described as a 'drawdown', which I define in this context as a reduction in water quantity within the geology, and this drawdown will propagate further out from the pit over time. It is expected that this drawdown will pass under regions of the alluvial aquifers, and potentially induce downward seepage flow from these alluvial aquifers, causing pressure to drop in the alluvial aquifers and inducing a loss of water from the aquifers and adjacent streams.

2.2 Effects predicted in the EIS

The EIS utilises a 3D numerical groundwater flow model to examine the extent of propagation of effects to groundwater resources. The numerical model is based on the conceptual model presented in Figure 7. The extents of this model is reproduced in Figure 8.

Maps showing predicted drawdown in the EIS are reproduced in Figure 9. In Figure 10 I present these drawdown maps superimposed upon the map showing the alluvial aquifers. It can be seen that drawdown from the Project is predicted to extent far to the west, but not far to the east, and as such is shown to not impact greatly upon the "highly productive" alluvial aquifers. Cumulative drawdown including selected adjacent mining works is shown to impact somewhat upon alluvial aquifers.

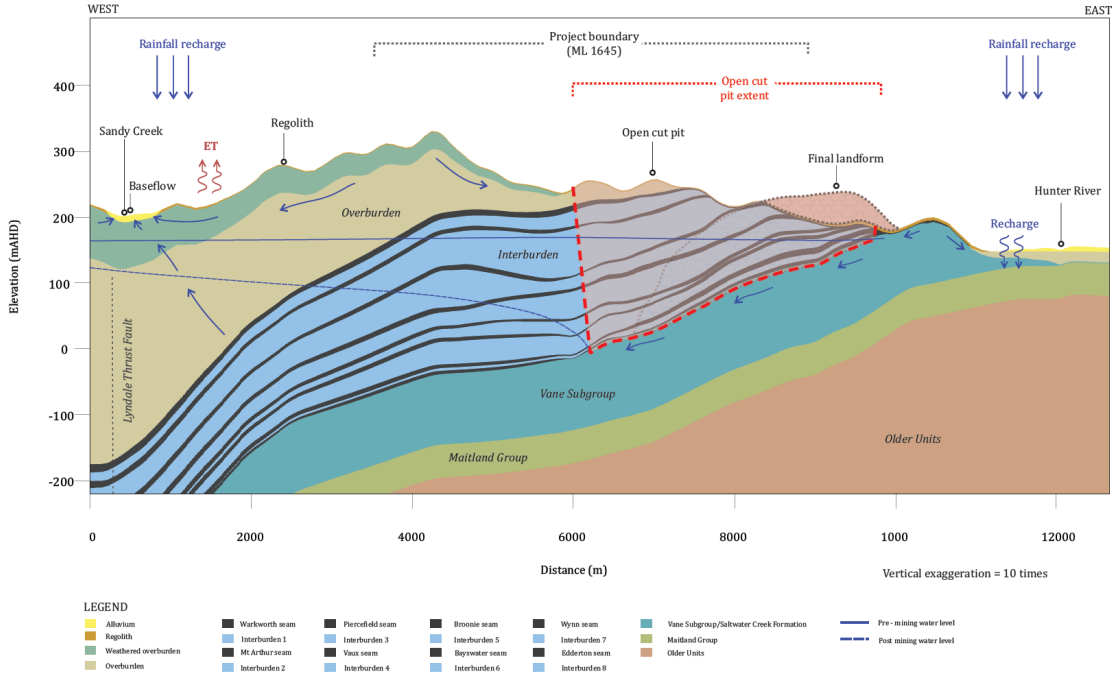


Figure 7 – Conceptual model in the EIS upon which the numerical groundwater model is based

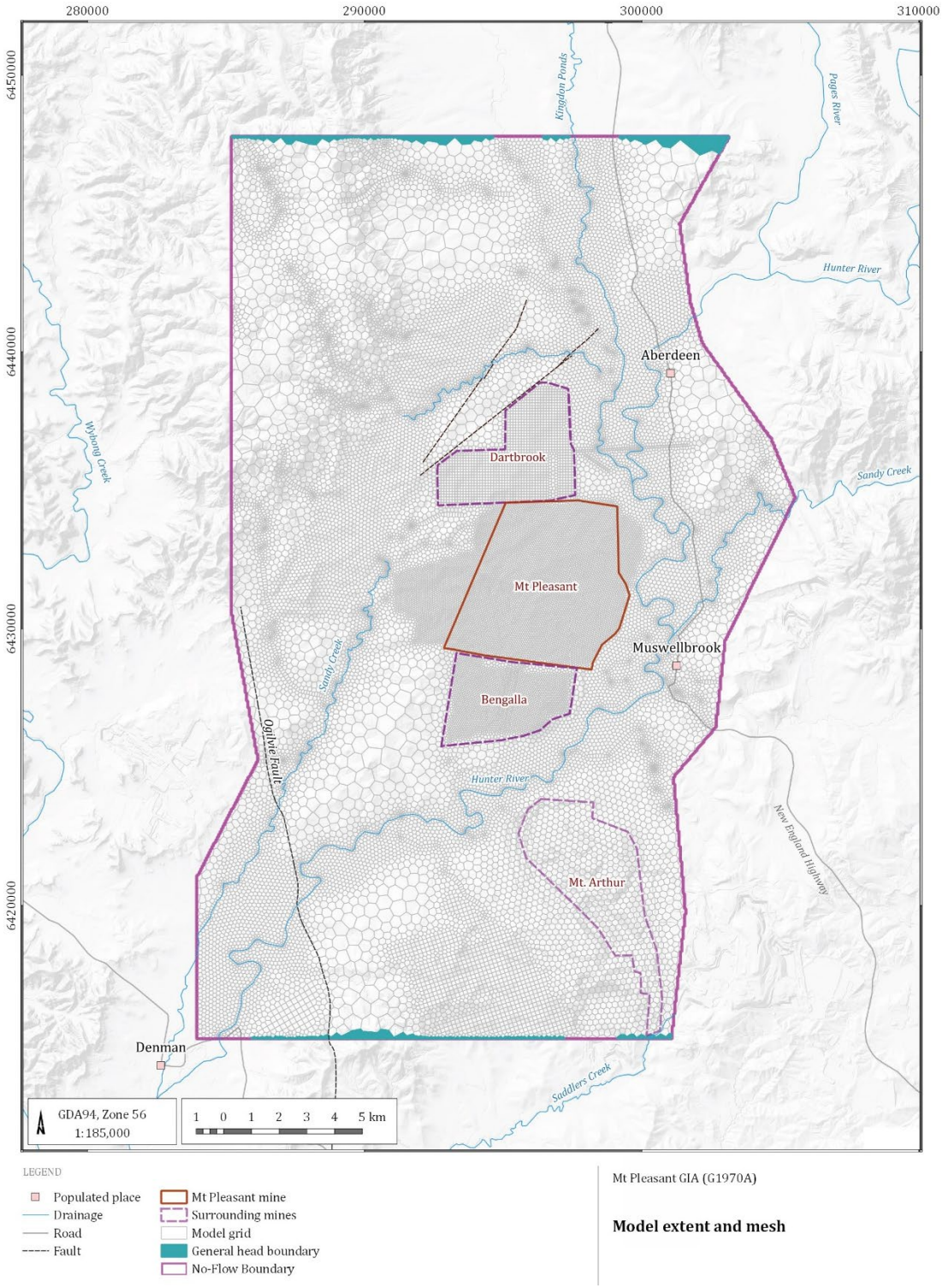


Figure 8 – Extents of numerical groundwater flow model

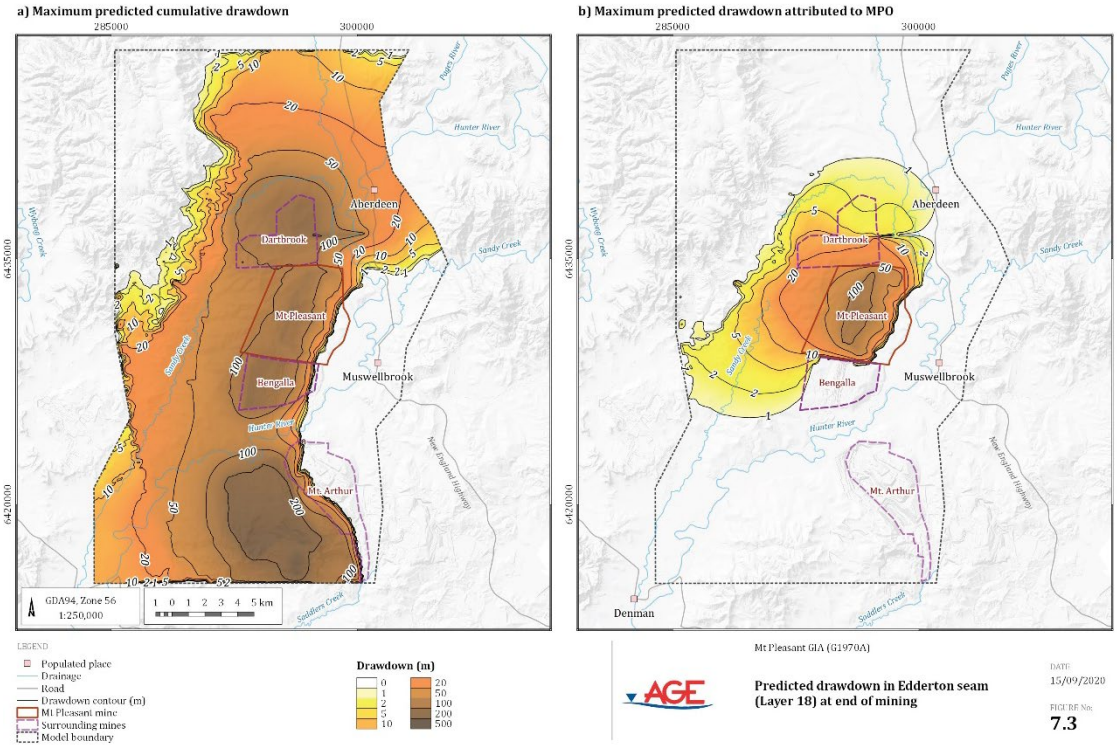


Figure 9 – Predicted drawdown as presented in the EIS

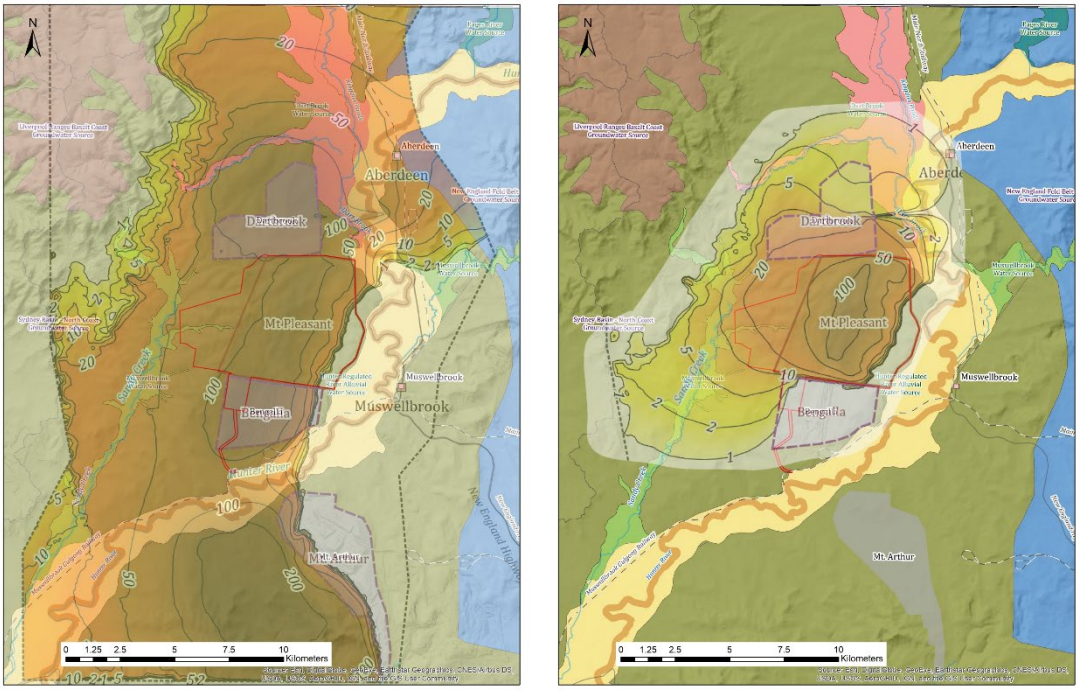


Figure 10 – Predicted drawdown as presented in the EIS superimposed upon alluvium aquifers

2.3 Comments on the suitability of methodology used in the EIS

I am of the view that the values of hydraulic conductivity used in the numerical groundwater model for the coal formations and formations underlying the coal are unrealistically low. It can be seen in Figure 7 that the formations underlying the pit are considered to dip to the east, and hence are positioned in between the alluvial aquifers and the pit. Hence, selection of low values of hydraulic conductivity in these formations effectively shields the alluvium from the effects of the mine. This would have the effect of significantly under predicting impacts on the alluvial aquifers adjacent to the Hunter River. The reason I state that the values of conductivity are too low is:

- The values chosen for horizontal hydraulic conductivity in the coal measures reference results from packer testing that appear to be erroneous, and providing unrealistically low values (explained below); and
- The hydraulic conductivity in the vertical direction is taken to be 1000th of the horizontal conductivity. This is an extremely low ratio, and there is no basis given to adopt such values. Such a heuristic artificially forces water to move parallel to the interpreted stratigraphic seams.

The end result is horizontal hydraulic conductivity values lower that 1 x 10^{-9} m/s and vertical hydraulic conductivity values lower than 1 x 10^{-12} m/s. It is self evident that such low values, if they were real, would prevent mining effects being propagated to the east and toward the alluvium. My assertion is that they are not realistic values. Moreover, to my understanding there are no aquifer tests in any of the formations below the coal measures to validate the choices in the EIS.

Values for packer testing presented in the EIS are reproduced in Figure 11 (I have added an axis showing units of m/s on the right hand side). I note that all tests are in the coal measures (or its interburden), or above (i.e., no testing of the units below the pit extents). This figure shows results from packer testing with values below 1 x 10^{-8} m/s and down to 1 x 10^{-10} m/s. It is a simple matter of physics that packer tests cannot record such low values, as explained below.

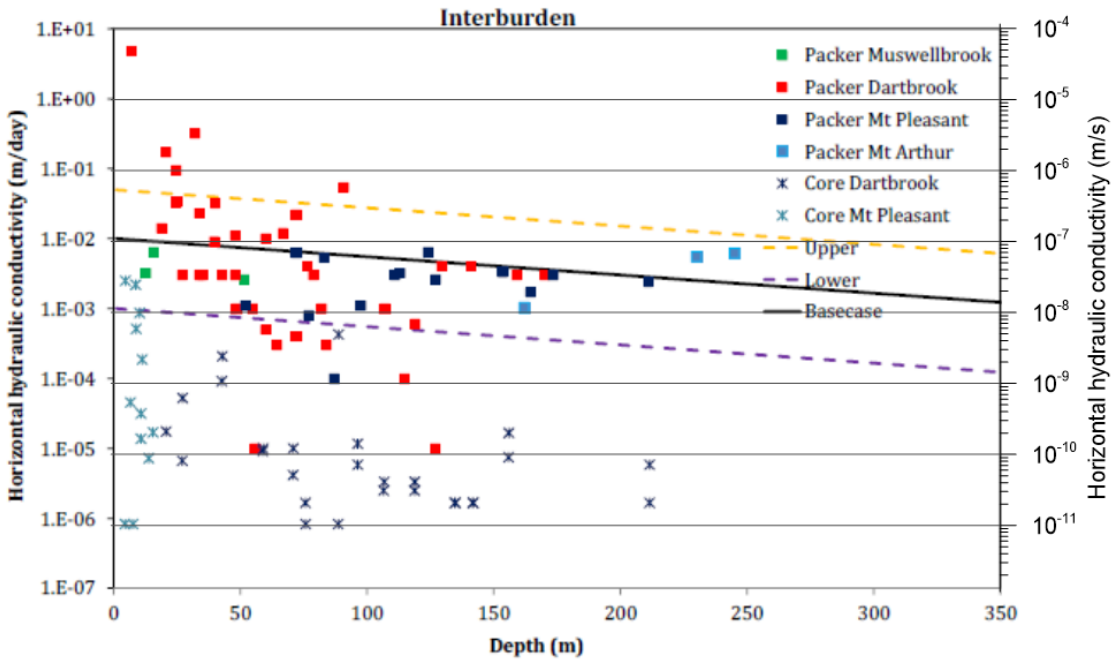


Figure 11 – Predicted drawdown as presented in the EIS superimposed upon alluvium aquifers

A schematic showing a packer test arrangement is shown in Figure 12. The test involves pumping water into the geology in a section of open borehole between two seals (or 'packers') – usually 6 metres apart, but longer and shorter intervals can be used. The rate of water flow into the ground is related the amount of water pressure applied, and it is measurement of this relationship between flow and pressure in a packer test that is analysed to estimate hydraulic conductivity of the ground. Water flow into the ground in a packer test can be quite accurately assessed with Equation (1)[1]:

$$Q = HKF \qquad (1)$$

Where Q is the discharge (ie in m^3/s)

H is the applied pressure (in metres head)
(ie the 'excess head' in Figure 12)

K is the hydraulic conductivity of the geology (m/s)

F is a shape factor

$$= \frac{2\pi L}{\ln\left(\frac{L}{D}+\sqrt{1+\left(\frac{L}{D}\right)^2}\right)}$$

L is the packer open interval (Figure 12)

D is the diameter of the bore
(usually NMLC core ~ 78mm)

When the hydraulic conductivity is very low, only a small quantity of water can be forced into the geology – too small to be measured, unless a great deal of pressure is applied. However, there are physical and practical limits to the amount of pressure that can be applied. Firstly, the testing equipment often can neither deliver nor handle such high pressures. Secondly, if pressures are too high (a head exceeding approximately 1.4 times the depth to the first packer), it would cause hydraulic fracturing (ie similar to 'fracking') of the ground, invalidating the test.

From Figure 11, a result of 1 $x10^{-10}$ m/s is reported for a packer test at 50m below ground. Under these conditions, a maximum 'excess head' of around 100m could be applied, which would result in a flow of 0.0015 Litres per minute (i.e. about 1 drip of water every two seconds). It is simply not possible to measure such small flow rates in the field with packer testing equipment. Hence the result of 1 $x10^{-10}$ m/s reported in the EIS should be reasonably questioned.

In Figure 12 I have plotted the packer test discharge versus excess head for various 'excess heads' and packer test intervals based on Equation (1). I have marked on this plot the possible range of test results based on physical constraints of the test. It can be seen that even for deeper packer tests (some results in Figure 11 indicated tests at 150 and 250m below ground) it is not physically possible to record values of hydraulic conductivity much lower than 1 x 10^{-8} using a packer test. Therefore the packer test data relied upon in the EIS must be erroneous. In my view the original packer testing data used in the EIS should be presented for review.

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[1] Hvorslev, M. (1951) Time Lag and Soil Permeability in Ground-Water Observations, Waterways Experimental Station. Corps of Engineers, U.S. Army, Vicksburg. http://www.csus.edu/indiv/h/hornert/geol_210_summer_2012/week%203%20readings/hvorslev%201951.pdf

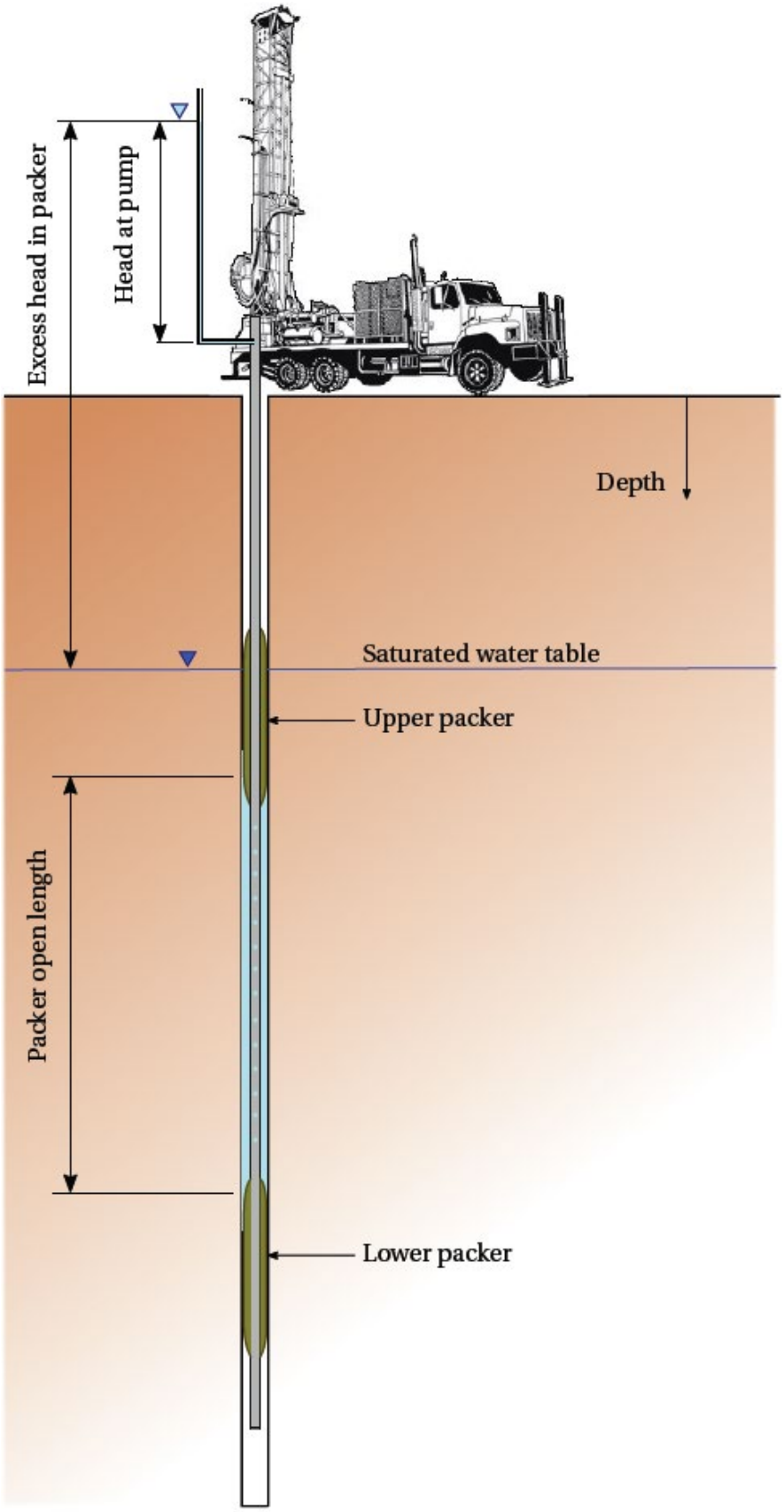

Figure 12 – Schematic of a packer test

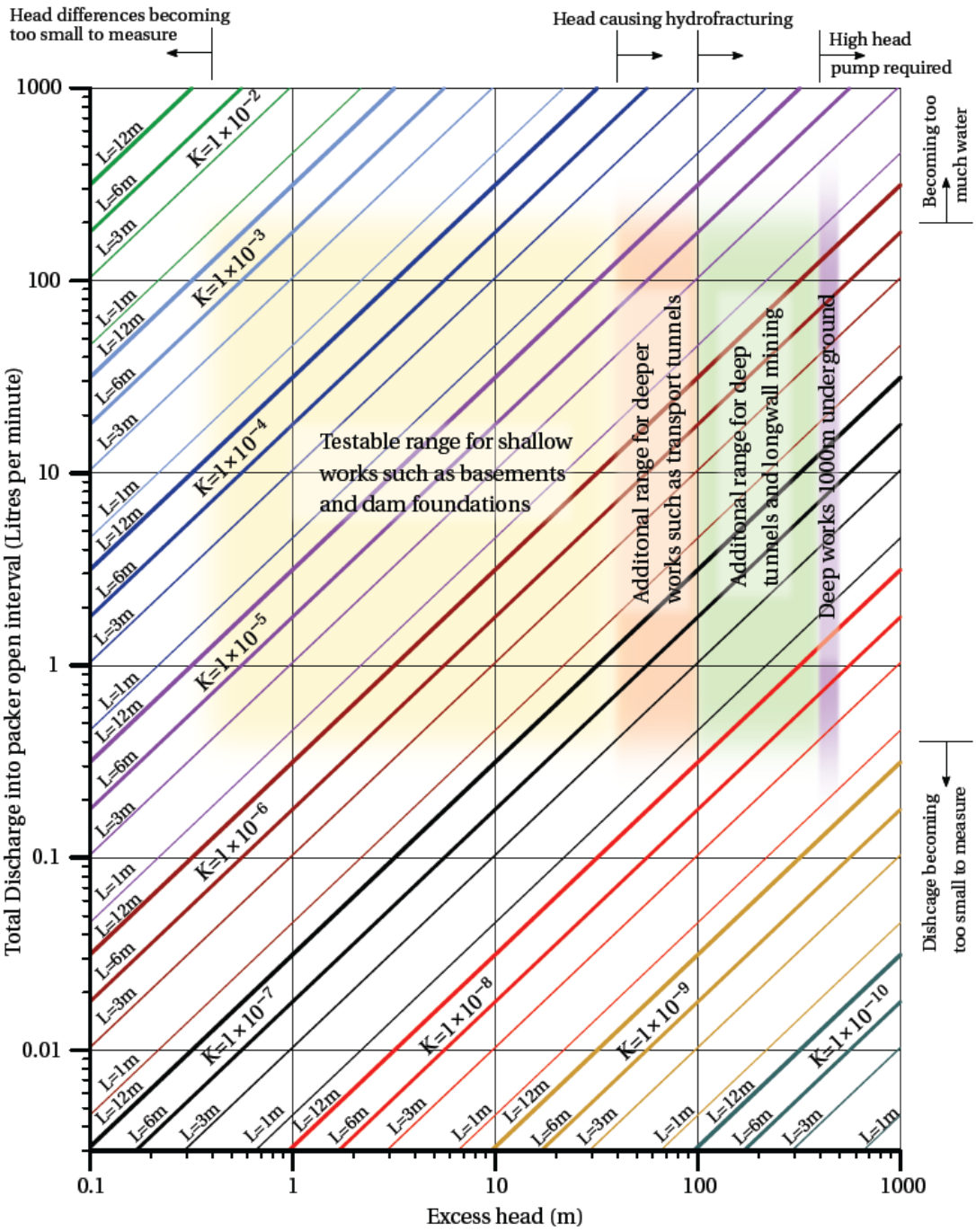

Figure 13 – Practical limits of packer tests

2.4 Discussion of cumulative impacts on surface and groundwater resources

As discussed above, there is extensive mining in the vicinity of the Project, making assessment of cumulative impacts an important matter.

The EIS dismisses possible cumulative impacts with the nearby Mangoola and Muswellbrook Coal mines on the basis that they target different stratigraphy. This dismissal is based on an assumption that groundwater is constrained to move only laterally through seams (a common erroneous heuristic in hydrogeology, and is evidenced in the choice of very low vertical hydraulic conductivity values in modelling).

Like many other EIS documents in this region, this present EIS argues that predicted impacts can be considered negligible based on comparison to the net effects of all operations in the region (eg Section 7.7.3 of the EIS). In my view, this is a problematic argument, as it offers no protection of environmental values once the first project is approved. In my view, cumulative impacts should consider the net impact on the region, as compared to pre-mining ('baseline') conditions, rather that referencing existing mining activities.

3. COMMENTS ON THE FORMATION OF A PIT LAKE

The EIS proposes to leave the excavated pit open after mine closure which will lead to formation of a water body commonly referred to in literature as a 'pit lake'. The pit lake proposed in the EIS has no surface water through-flow to allow flushing of the water in the lake. Rather, the lake will be fed in perpetuity from groundwater inflow and local surface water runoff. The only outflow from the lake, according to the design, is evaporation. The EIS identifies that this will cause the pit lake to accumulate concentrations of salt over time, as the inflowing groundwater has salt content, but evaporation does not remove any salt. The predicted increase in salinity of the lake is modelled in the lake, as per Figure 14, and shows salinity increasing in perpetuity. I have added annotation to show 'beneficial usages' (ie such as for irrigation and stock watering) of saline water, according to the ANZECC guidelines[2] as well as comparison to salt concentrations of seawater.

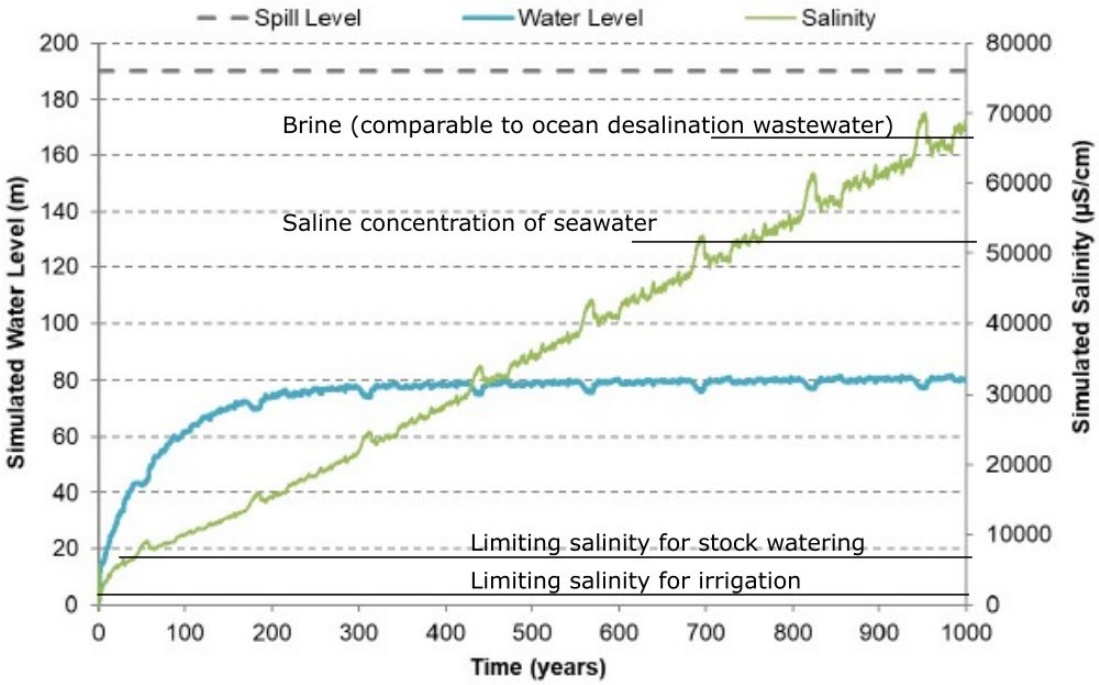

Figure 14 – Predicted pit lake levels and salinity as presented in the EIS

[2] Environment, D. of the, 2012. Australian and New Zealand guidelines for fresh and marine water quality: Volume 1 - The guidelines [WWW Document]. URL http://www.environment.gov.au/water/quality/publications/australian-and-new-zealand-guidelines-fresh-marine-water-quality-volume-1

It can be seen in Figure 14 that the predicted lake salinity precludes any beneficial usages a decade or so after mine closure, and ongoing increases in salinity will ultimately create a briny water body that is foreign to the local habitat. Whilst EIS presents calculations to show that the water will be hydraulically contained, it is difficult to sustain this prediction indefinitely into the future.

The same process that causes increase in concentration of salts may cause similar increases in concentrations of other pollutants or harmful elements, noting that seepage to the pit lake will be via placed coal and fines rejects from the mining process. This means that pit lake may, over time, form water characteristics that need to be closed off to public access in perpetuity, which is impractical and risky. It is also impractical to shield a toxic open water body from local flora and fauna. The EIS does not include any discussion or modelling of these pollutants in the pit lake.

When shown in cross section (Figure 15), it is clear that if the pit lake is maintained at the predicted level, it will remove baseflow from the Hunter River and alluvial aquifers in perpetuity.

The EIS contains some suggestions of possible measures to utilise or manage the pit lake, although there is no well scoped, costed and appraised solution presented. Rather, the pit lake design is simply presented as an uncertain legacy for future generations.

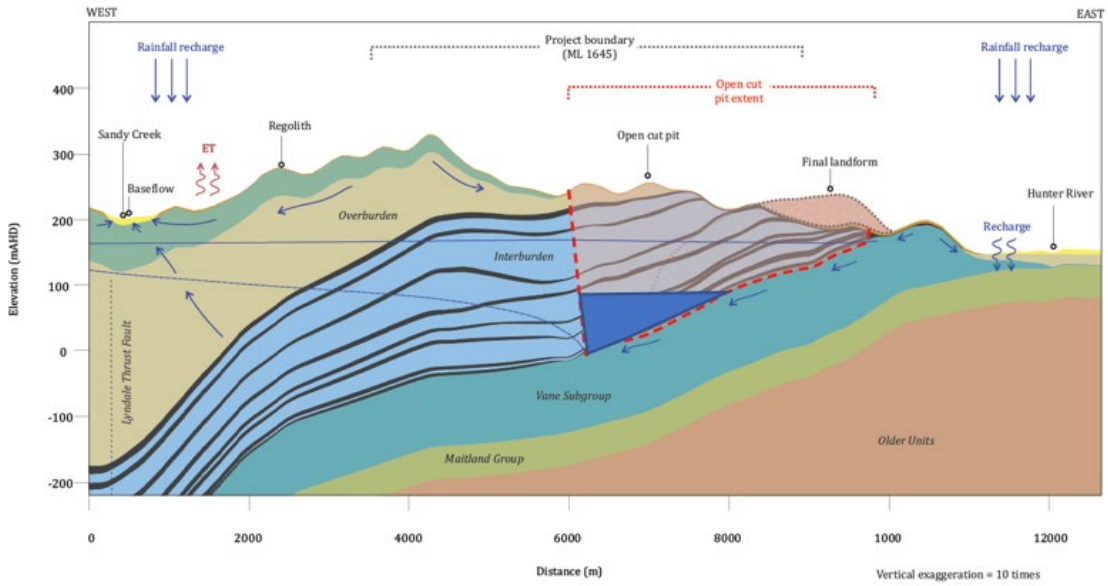

Figure 15 – Pit lake shown upon the EIS conceptual groundwater model

4. COMMENTS ON THE DESIGN AND OPERATION OF THE TAILINGS STORAGE FACILITY

In my review I could find little information in the EIS about the tailings storage facility (aka the Fines Emplacement Area). The cross section reproduced as Figure 4 above shows the planned facility to be large (over 60m height). Figure 4 shows that the embankment features a thin lens of clay fill near the upper surface, and then in turn earthfill. This is not a standard or robust embankment design and in my view would be very vulnerable to piping failure, and appears to be designed on the assumption that it will not be subject to saturation. A more robust design would feature a standard

internal clay core. It is argued that such a significant structure should be accompanied by more robust environmental assessments, considering the risks to the environment from uncontrolled breach, as a has been observed at other similar sites (eg Cadia, NSW). In my view, the EIS should present further design details for the embankment placement and specification and measures that will be put in place to ensure against appropriate capture and/or management of flood inflows.

Pells Consulting

DR STEVEN PELLS

Educational Qualifications:

Bachelor of Engineering (Civil) (Hons), UNSW 2000
Master of Engineering Science, UNSW, 2001
Doctor of Philosophy, UNSW, 2016

Professional Associations:

Member, IAH - International Association of Hydrogeologists
Member, ANCOLD - Australian National Committee on Large Dams
Member, ASCE – American Society of Civil Engineers

FIELDS OF SPECIALISATION:

- Assessment and design of hydraulic structures
- Hydraulics of open channels, spillways and river systems
- Scour / erosion in chutes and spillways
- Hydrology and water resources
- Hydraulic scale physical models
- Groundwater modelling and groundwater investigations
- Impacts to water resources relating to mining and mine effects

Steve took over as director of Pells Consulting ` over 20 years' experience in civil hydraulics, hydrology and groundwater studies. Steven's formative years were spent crafting hydraulic scale models and various roles in consulting developed his particular specialisation in applying water engineering principles to geotechnical and civil engineering problems. In 2016, Steven completed PhD studies at the University of New South Wales, examining erosion and scour within chutes and channels, with particular focus on dam spillways. Steven has authored/co-authored over 30 papers in various fields of civil engineering, including hydraulics, hydrology, groundwater and rock mechanics. He undertakes adjunct lecturing on open channel flows and river systems at Sydney University. Steven remains engaged with research in hydraulic design and scour / erosion within the dams engineering community and in groundwater studies.

EMPLOYMENT:

2021 -	Director, Pells Consulting
2017 – 2021:	Principal, PSM
2016 – 2017:	Principal, Pells Consulting / Adjunct Lecturing, University of Sydney
2011 – 2016:	Associate, Pells Consulting; PhD Candidate, UNSW Australia
2009 – 2011:	Senior Project Engineer - WRL, UNSW Australia
2008 – 2009:	Senior Water Engineer - Cardno Willing
2006 – 2008:	Senior Water Engineer - Ove Arup Partners
2001 – 2006:	Project/Senior Project Engineer - WRL, UNSW Australia
1997 – 2001:	Graduate Geotechnical Engineer - Pells Sullivan & Meynink; Soils Technician (P/T) - Coffey Partners
1994 – 1997:	Carpenter/Joiner - LW Hough P/L

PROJECTS RELATED TO DAMS, HYDRAULICS AND HYDRAULIC STRUCTURES

Member, Dam Expert Review Panel	Government Funded Dams projects	Expert review for 3 major dams projects for WaterNSW
Technical review panel	Awoonga Dam, Gladstone	Technical review for spillway upgrade design, Awoonga Dam for Gladstone Area Water Board
Technical review panel	Big Rocks Weir, Queensland	Technical review for design of proposed weir for Charters Towers Regional Council
Technical review panel	Somerset Dam, Queensland	Technical review of energy dissipation designs, hydraulics and scour issues for planned upgrades to Somerset Dam for SEQWater
Hydrologic analysis and dambreak studies	TSF, Batu, Sumbawa	Analysis for design flows and dam break assessments for concept design of a large TSF in Indonesia
Technical review panel	Multiple Dam CRAs, Queensland	Technical review of over 20 Comprehensive Risk Assessments (CRA's) in Queensland for Sunwater
Third party technical review	TSF, Runruno, Philippines	Technical review of spillway designs for closure and operation
Hydro-geotechnical scour risk assessment	Copeton Dam, NSW	Leading of a comprehensive prediction for scour vulnerability at Copeton Dam. Key task is development of a coupled multi-physics rock mass model and CFD hydraulic model to predict future scour for various design events.
Preliminary hydro-geotechnical Scour Risk Assessment	Blowering Dam, NSW	Review of historical scour at Blowering Dam and advice on ongoing scour risk, based on initial site inspections and application of comparative scour assessment techniques.
Specialist stability assessments	Murchison Dam, Tasmania	Specialist analysis of rockfill stability using a bespoke analysis through coupling of CFD simulations with a dynamic rock mechanics model, along with 3D seepage analysis through rockfill
Member of Technical Review Panel	Rookwood Weir, Queensland	Ongoing review of design and construction
Specialist guidance on CFD and Physical model studies, Rookwood Weir, QLD	Rookwood Weir, Queensland	Provision of specialist advice to regulators on the sufficiency of relying on CFD modelling alone for design purposes, and the possible need for additional physical hydraulic model studies

PROJECTS RELATED TO DAMS, HYDRAULICS AND HYDRAULIC STRUCTURES

Technical Review Panel member	Mole Creek Dam, NSW	Technical review of designs for proposed dam
Preliminary hydro-geotechnical Scour Risk Assessment, Araing Dam, France	French Pyrenees	Review of scour risk at Araing Dam based on review of available geological information and CFD modelling.
Member of Technical Review Panel	Paradise Dam Improvement project	Ongoing review of analysis, design and construction
Guidance on scour assessments,	Teemburra Dam, QLD	Independent review of CFD studies and scour assessments at Teemburra dam
Guidance on scour assessments,	Fred Haigh Dam, QLD	Independent review of CFD studies and scour assessments at Teemburra dam
Petit-Saut Dam,	French Guiana	Assessment and prediction of current and future risks from scour at the main dam outlet. Tasks included development of a geotechnical model, hydrodynamic modelling (1D, 2D and 3D CFD models) and scour risk assessments.
Review of scour potential and remediation options, Burdekin Falls Dam	Burdekin, Queensland	Member of technical review panel for assessing scour risk at Burdekin Falls Dam. Recommendations were provided on required stabilisation works based on UAV surveys, hydraulic studies, geotechnical assessments and scour assessments.
Review of erosion risk, and stability, Somerset dam	Brisbane, Queensland	Technical review and assessment of hydraulics regarding overtopping of abutments at Somerset Dam. Assessment of dam stability in sliding and overturning under extreme flood events.

PROJECTS RELATED TO DAMS, HYDRAULICS AND HYDRAULIC STRUCTURES

Erosion of unlined spillways	PhD studies	An industry linkage grant was awarded to develop improved design methods for assessment of scour on unlined spillways. Investigations have been based on laboratory testing and field studies. Laboratory testing comprised detailed studies on pressure transients in open channel flows under various conditions, and relating the observed measurement to hydraulic indices such as tractive force and stream power dissipation. The measurements are used to develop kinematic models of stability of unlined rock chutes. Field studies included review of erosion at over 30 dam spillways in Australia, South Africa and the USA. Investigations include geological review and mapping, rock mechanics assessments and detailed hydraulic assessments, typically using HEC-RAS. New methods of assessment of erosion were developed based on these investigations
Expert review of embankment failure	Newnes, New South Wales	Expert (legal) review of overtopping / piping failure of a tailing facility. Tasks included forensic site inspection, supported by detailed hydraulic, seepage and stability analyses.
Review and redesign of a 7.5 GL mine-water dam	Goonyella, Queensland	Expert (legal) review of embankment construction in expert witness context. Tasks essentially required complete re-design of the embankment, including material selection and placement, zoning, 3D visualisation and volume calculations, detailed seepage analysis, detailed stability analysis and various supporting hydraulic and geomechanics assessments.
Review of embankment seepage / stability	Wilton NSW	Review of potential piping failure, and detailing of solutions for a private embankment dam.
Hydraulic analysis of the Balikera tunnel	Hunter region, NSW	Hydraulic analysis of discharge through a stream-diversion tunnel, including assessment of the impacts on hydraulics from rock-falls / tunnel collapse.
Dam safety assessment	Narara, NSW	Undertaking of a dam safety assessment, and preparation of dam safety management plan for the Narara Horticultural Dam, New South Wales.

PROJECTS RELATED TO DAMS, HYDRAULICS AND HYDRAULIC STRUCTURES

Dam safety assessment	Hazelwood, VIC	Undertaking of a dam safety assessment of the Hazelwood Cooling Pond, Victoria, in accordance with the Australian National Committee on Large Dams (ANCOLD) guidelines.
Expert Review of Embankment Dam	Dorrigo, NSW	Expert (legal) review of the embankment and hydrology of a 15 m earth embankment dam to advise legal proceedings; witness in court.
Physical Model of Outlet Works, Adelaide Desalination Plant	Adelaide, SA	Design, construction and testing of a physical model of the outlet works (drop structure) from a desalination plant. The model was primarily of clear acrylic piping and, at the scale of 1:6, was over 4 storeys in height.
Lined Storages - Caustic Soda	Gladstone, QLD	Hydraulic modelling and specialist advice on scale modelling of caustic soda storage and distribution networks.
Remediation of Tidal Weir Structures	East Trinity, Qld	Assessment of existing tidal control structures and design of new structures to support tidal flushing of acid sulphate remediation activities.
Testing of Tidal Energy Turbine	Australia	Laboratory testing of power output and efficiency from turbine designs.
Assessment of Hydraulic Forces on Causeway Structures	Queensland	Hydraulic assessments were used as a basis for preparation of guidelines.
Physical testing of large diameter valves	Australia	Physical testing to determine headloss characteristics of large diameter flow valves.
Physical testing of large diameter pipe plug	Australia	Physical testing of the effectiveness of purpose built apparatus to plug and decommission an operating underground pipeline
Physical modelling of a detention basin / weir	Kellyville, NSW	Management, supervision, design and construction of a physical model of instream flood control basin.
Assessment of dam intake structures for Jindabyne Dam	Jindabyne, NSW	Management, design, construction and testing of a physical model to assess the performance of a proposed dam intake structure.
Design of scour protection for rock chutes	Australia	Large scale physical modelling and analysis to develop specifications for rock scour protection for weir structures.

PROJECTS RELATED TO WATER RESOURCES (HYDROLOGY AND HYDROGEOLOGY)

Prediction of tunnel inflows and groundwater pressures for tunnel design,	Various	Site investigations, interpretation, and various analytical and numerical (2D and 3D) modelling to predict inflows and design pressures to support design of various major tunnel works including Cross River Rail (Brisbane); Snowy 2.0 (NSW); Sydney Metro (Sydney); Westconnex (Sydney) and Northconnex (Sydney).
Lead hydrogeologist, design phase	Rozelle Interchange Project, Sydney	Lead hydrogeologist for design services of Rozelle Interchange Project. The role was to coordinate and provide design advice on tunnel inflows, drawdowns and design pressures for a network of 19km of road tunnels in the Sydney CBD based on supervision, undertaking and interpretation of site investigations and aquifer tests and 2D and 3D hydrogeological modelling.
Specialist hydrology and hydrogeology guidance,	Ok Tedi Mine, PNG	Provision of specialist guidance and training for ongoing hydrology and hydro-geological analyses at Ok Tedi Mine, Papua New Guinea.
Groundwater numerical modelling	Sutton Forest	3D numerical groundwater modelling for assessment of impacts to water resources from proposed underground mining operations
Review of groundwater impacts	Various	Review of predicted impacts to water resources from proposed mining operations, including presentation of findings at Planning Assessment Commissions – various locations.
River management, engineering and geomorphology	Lecturing	Adjunct lecturing on river management, Sydney University.
Prediction of mine inflows	Broadmeadow, Queensland	Review and prediction of groundwater inflows and risks for longwall mining operations
Mining impacts on water resources	Newnes, New South Wales	Detailed review of potential impacts on groundwater and surface water resources (ie endangered swamps) due to of dewatering, subsidence and cracking from longwall mining.
Mining impacts on water resources	Bylong, New South Wales	Review of predicted impacts on groundwater and surface water resources from proposed longwall mining.
Mining impacts on water resources	Williamtown, New South Wales	Review of predicted impacts on groundwater and resources from proposed sand mining.

PROJECTS RELATED TO WATER RESOURCES (HYDROLOGY AND HYDROGEOLOGY)

Mining impacts on water resources	Capertee, New South Wales	Review of predicted impacts on groundwater and resources from proposed longwall mining.
Flood studies	Various	Design flood levels and flood risk, various residential properties in Sydney
Expert review of coastal / seasonal groundwater	Ichthys project, NT	Expert (legal) review of groundwater dynamics and impacts to earthworks planning and progress.
Mine water balance assessments	Gregory / Crinum, QLD	Development of regional surface water models and preliminary groundwater models to examine site-wide water balances to guide a mine closure plan.
Groundwater impacts, Longwall mining	Moss Vale, NSW	Development of regional hydrogeological model and undertaking of 3D transient numerical groundwater modelling (MODFLOW) to assess impacts to groundwater from a proposed longwall mine.
Impacts to groundwater from coal seam gas extraction	Various	Independent review of predicted effects on groundwater from proposed coal seam gas (CSG) projects. Reviews typically supported by 2D and 3D numerical groundwater modelling.
Assessment of basement seepage issues	Maroubra, NSW	Appraisal of major seepage issues for a major development in the Botany Sands. Design of dewatering using 3D numerical groundwater model (MODFLOW). Representation of client at legal mediation.
Groundwater impact assessments	Various	Various minor projects to report on groundwater conditions and risks from proposed developments, including roads and pipelines to assist with EIS document preparation.
Review of surface and groundwater effects from longwall mining	Springvale Colliery, NSW	Field reconnaissance, data review and surface water modelling tools were used to provide advice on potential impacts to surface water systems from longwall mining effects.
Expert review of groundwater impacts from longwall mining	NRE Gujarat, NSW	Independent review of environmental assessments of impacts of mining subsidence on groundwater and surface water resources.
Review of hydrology of Thirlmere Lakes	Southern Coalfields, NSW	Undertaking of an independent review of the hydrology of Thirlmere Lakes, and on the evidence for impacts from longwall mining

PROJECTS RELATED TO WATER RESOURCES (HYDROLOGY AND HYDROGEOLOGY)

Ranger Uranium Mine – Flow Modelling of Post-Closure Conditions	Ranger, NT	Construction and calibration of a hydrologic and 1D hydraulic flow model of catchments adjacent to the Ranger Uranium Mine.
Groundwater Characterisation and Numerical Modelling for Rainbow Beach Estate	Rainbow Beach, NSW	Specification of a groundwater investigation and monitoring scheme for characterisation of a coastal aquifer near Port Macquarie. A 3D numerical groundwater model was assembled to simulate the aquifer and to assess impacts from a proposed development.
Design of flood detention ponds	Cecil Hills, NSW	Hydrologic analyses for design of flood detention ponds to support large residential subdivisions.
Urban flood hydrology	Stanmore, NSW	Development of 1D stormwater network models to assess flood risk and design flood mitigation options for an urban catchments in Sydney.
Flood modelling and design	Porters Creek, NSW	Supervision of hydrologic and 2D flood models for flood studies of the Porters Creek catchment.
Review of Catchment Processes	Flemington, ACT	Installation and operation of field equipment and development of water balance models for the catchment.
Review of seawater intrusion of coastal aquifers	Christchurch, New Zealand	Literature review on the processes, international experience and management of seawater intrusion of coastal aquifers to guide policy development in the Christchurch region, New Zealand.
Managed aquifer recharge investigations	Borambil Creek, NSW	Scoping studies to evaluate and advise on aquifer management, enhanced recharge and stream restoration, Borambil Creek in the Upper Namoi catchment, New South Wales.
Aquifer Storage and Recovery Feasibility Assessment	Ipswich, Qld	Desktop studies to assess the feasibility and potential yield of a proposed Aquifer and Storage Recovery Scheme near Ipswich, Brisbane.
Perth Airport Drainage Strategy, Review of Groundwater	Perth, WA	Review of surface water-groundwater in the superficial aquifers in the Swan Coastal Plain to assist with flood modelling of the Perth Airport site.
Review of Geothermal Heat Pump Applications, Energy Australia Building	Sydney, NSW	The design of a large ground-source heat pump system was reviewed based on site characterization and the derivation and application of analytical techniques to simulate heat transport.

PROJECTS RELATED TO WATER RESOURCES (HYDROLOGY AND HYDROGEOLOGY)

Design of Stormwater Capture and Treatment Ponds	Eraring, NSW	Desktop analysis of catchment hydraulics to prepare preliminary design of stormwater capture and treatment infrastructure.
Physical Modelling of flooding and evacuation, Penrith Lakes	Penrith, NSW	Management, supervision, design and re-construction of a physical model to examine flood characteristics, floodplain risk planning and evacuation timing for large lakes development scheme in Western Sydney.
Feasibility of flood harvesting	Broken Hill, NSW	Desktop studies and field investigations to assess feasibility of flood capture infrastructure.
Water Resource Assessments, Far North Queensland	Cairns, Qld	Preparation of a water supply strategy for the Far North Queensland region to meet regional forecast demands over 50 years. Technical sub-studies to assess the yield / reliability of supply options, ranging from large dams to residential rainwater tanks and stormwater harvesting.
Assessment of surface – ground water connectivity	Centennial Park, NSW	Field investigations, monitoring and analysis to provide recommendations to irrigators regarding the impacts to groundwater from the abstraction of water from a public lake systems.
Feasibility of Saline Intake Bores for Seawater Desalination	Central Coast, NSW	Detailed field investigations and interpretation to assess feasibility of large intake bores for a planned seawater desalination scheme. Tasks included undertaking resistivity surveys, drilling supervision, supervision and interpretation of aquifer pumping tests, slug tests and groundwater level and quality monitoring.
Assessment of Groundwater Pollution Sources	Confidential	Presentation and interpretation of resistivity survey data to assess location and extent of groundwater pollution from industrial sources. Advice was used to support litigation.
Groundwater System Characterisation	Blue Mountains, NSW	Supervision of field investigations to characterise groundwater hydraulics and quality in sandstone aquifers in the Blue Mountains, NSW for a proposed quarry. Tasks included supervision of drilling, bore logging, groundwater sampling, and undertaking packer and slug tests and associated analysis to estimate hydraulic properties.

PROJECTS RELATED TO WATER RESOURCES (HYDROLOGY AND HYDROGEOLOGY)

Impacts of Effluent Disposal on Groundwater in Coastal Aquifers	Various	Detailed field investigations into groundwater hydraulics and quality in coastal aquifers to support effluent disposal schemes at various sites in New South Wales, including Hat Head, South West Rocks, Iluka, Hastings Point and Sussex Inlet.
Assessment of Groundwater Seepage for Tunnel Design	Sydney, NSW	Undertaking of permeability testing of sandstone bores in the CBD of Sydney. Results were interpreted to provide parameters to support design of tunnelling works.
Design of a Groundwater Effluent Disposal Scheme	Iluka, NSW	Detailed field investigations and associated interpretation to assess feasibility and support design of an effluent disposal scheme. Tasks included supervision and interpretation of aquifer pumping tests, and assessment of planned infrastructure development locations with respect to coastal processes.

PROJECTS RELATED TO COASTAL ENGINEERING

Geotechnical design of a coastal island	Taren Point, NSW	Site inspections, geotechnical analysis and construction specifications for a manufactured island for fauna habitat.
Seawall design and coastal stability assessments	Various	Site inspection, site characterisation and stability analysis supporting design of seawalls, public access and coastal revetments.
Review of dredging and excavability	Darwin, NT	Expert (legal) analysis of field data to support legal proceedings related to dredging.
Design of geobag seawalls	Byron Bay, NSW	Numerical finite-element and kinematic stability assessment of geo-bag seawall designs
Risk assessment of seawalls	Manly, NSW	Review and risk assessment of geotechnical stability of 18 seawalls in accordance with statutory procedures.
Physical Modelling of Desalination Brine Outlet	Perth, WA	Design, construction and application of a physical model to examine diffusion processes of brine discharge from a large scale desalination plant.
Foreshore Embankment Stabilisation	Penrith, NSW	Provision of specialist advice on options for stabilisation of foreshore regions against erosion around a series of inland lakes.
Appraisal and Design of Coastal Protection Structures	Green Island, Qld	Project manager for the review of the function and condition of a sediment control groyne on Green Island (Great Barrier Reef).
Assessment of Greenwater Overtopping of Offshore Structures	Browse, WA	Technical studies to investigate the extent and impacts of green water overtopping of a number of large scale offshore structures.
Burwood Beach Ocean Outfall Modelling	Newcastle, NSW	Detailed analyses of meteorological conditions were undertaken to predict the statistical frequency of pollution events at beaches adjacent to an ocean outfall.
Review of Sub-Aerial Landslide Tsunami Generation and Propagation, Lihir Gold Mine	Papua New Guinea	A tsunami event, caused by a sub-aerial landslide, was recorded at a local tidal monitoring station. Analyses of the characteristics of the tsunami event were undertaken and used to postulate on the extent, velocity and timing of the landslide.
Breakwater / Revetment Design, Sydney Airport	Sydney, NSW	Undertaking physical model studies for optimisation of toe scour protection requirements for a breakwater / revetment structure at Sydney Airport.
Estuarine Numerical Modelling	Auckland, New Zealand	Set up and calibration of 2D numerical hydrodynamic model for examination of tidal currents and estuarine processes in a region of Auckland Harbour to allow examination of impacts of proposed developments.

PROJECTS RELATED TO COASTAL ENGINEERING

Numerical and Physical Modelling of Mooring Structure	Darwin, NT	Numerical and physical modelling studies to assess amplification or modification of currents adjacent to a large wharf structure during the mooring of large sea vessels.
Ocean Outfall Assessment	Wollongong, NSW	Undertaking physical modelling of a section of proposed outfall design for examination of saline intrusion.
Wind-Wave Growth and Dissipation Studies and Research	Australia	Physical testing and research to investigate the physics of wind – wave interactions and the processes of wave growth and dissipation. Studies resulted in the publication of new research into the growth and dissipation of wind waves.
Seawall Assessment and Design	Manly, NSW	Detailed assessment of the stability and long term performance of a public seawall in Manly, Sydney.
Coastal Erosion Assessment	Glenelg, SA	Numerical assessment of coastal longshore sediment transport to support expert advice for litigation following coastal erosion issues at Glenelg, Adelaide.
Design of Wave Paddle System	Australia	Design, construction and calibration of a wave generation system for undertaking wave basin modelling studies.
Assessment of Sediment Response to Offshore Reef Structures	Australia	Research into the shoreline response to offshore reef structures. Tasks included design, supervision and testing of a movable bed physical model.

PROJECTS RELATED TO CIVIL AND GEOTECHNICAL DESIGN

Flood studies, and flood evacuation advice	Shoalhaven, NSW	Flood studies and flood evacuation plans to support proposed developments
Drainage design for mine closure	Various	Design of drainage for stable landforms of mine emplacements (dumps) for various projects such as Ok Tedi (PNG), PanAust (Laos) and various mines in the Pilbarra region of Australia. Projects included design for estimation of sediment loads and design for control of sediment in very challenging steep landforms
Design of rip-rap lined chutes	Various	Hydrologic and hydraulic analyses for sizing of chutes and designing appropriate lining for resistance to erosion at various mining sites.
Long-term hydrodynamic analysis of scour	Various	Analysis of headcut development and long-term channel scour to support various mine closure studies.
Residential subdivision civil works designs	Narara, New South Wales	Various tasks including site investigations, retaining wall design, foundation design, design of underground tanks systems, to support a residential subdivision
Testing of rock anchors	New South Wales	Design and implementation of specialist rig for testing of stress-strain failure characteristics of specialist rock anchors
Forensic investigation of tunnel failure	South Australia	Forensic review of failure of cut and cover railway tunnel, including specialist seepage and stability analysis and physical modelling.
Review of longwall mining design	Mandalong	Assistance with expert review of legal claim pertaining to planning and design of longwall mining excavations.
Review of tunnel design	Wynyard Walk	Assistance with expert review of design of pedestrian tunnel.
Jet grouting / excavation	Cowper Wharf, NSW	Expert (legal) review of claim regarding jet-grouting and excavatability and disposal of material.
Tunnel construction supervision	Point Piper, NSW	Routine inspection of construction of private pedestrian tunnel
Forensic investigation of piping failure	Yalourn, VIC	Support for expert review of piping-failure of embankment at Yallourn. Tasks included: compilation and management of detailed GIS database of all data relevant to the claim; development of 3D conceptual models; finite element stability assessments, and; numerical seepage modelling.

PROJECTS RELATED TO CIVIL AND GEOTECHNICAL DESIGN

Review of site development options	Hornsby, NSW	3D GIS mapping of geology and earthworks and detailed analysis to assess excavation design and quantities for a legal claim at Hornsby Quarry.
Mine effect monitoring	Wollongong, NSW	Member of technical committee panel for monitoring and protection of public infrastructure (roads) for impacts from longwall mining.
Review of major pit failure	Mulia, Indonesia	3D GIS mapping of geology and earthworks and undertaking finite element analysis to examine options for responding to major earth slip at a mine site
Review of excavation designs	Sydney Opera House, NSW	3D GIS mapping of geology and earthworks and detailed analysis to assess excavation design and quantities for a legal claim at the Opera House carpark.
Review of basement design	Dee Why, NSW	Review of basement piling and waterproofing to support legal claim.
Excavation stability appraisal	Sydney CBD	Review of potential settlement from planned deep excavation in Sydney CBD.
Tunnel lining investigations	M2 tunnel, NSW	Forensic investigations of existing tunnel lining through undertaking of specialist coring and fourier analysis of drummyness testing.
Pond design	Kenny, ACT	Design of pond lining options for proposed in-stream basin.
Residential access tunnel	Point Piper, NSW	Routine monitoring of a residential tunneling project
Yamba Hill Groundwater and Slope Stability Monitoring	Yamba, NSW	Supervision of drilling and installation of groundwater monitoring bores and inclinometers to assess slope stability at Yamba.
Tunnel excavation monitoring	NSW	Routing review of tunnelling monitoring apparatus during construction of the Eastern Distributor Tunnel, Sydney.

PUBLICATIONS

JOURNAL PAPERS / RESEARCH REPORTS

1. **DOUGLAS, K, PELLS, S.E., FELL, R. and PEIRSON, W.L. (2018).** The influence of geological conditions on erosion of unlined spillways in rock. Quarterly Journal of Engineering Geology and Hydrogeology, vol. 51, pp. 219 - 228, http://dx.doi.org/10.1144/qjegh2017-087
2. **PELLS, S.E and DOUGLAS, K. (in publication)** Hydro-geotechnical assessment of scour of rock Book chapter from an international workshop on behalf of the European Group of ICOLD and the French Committee on Dams and Reservoirs, Aussois, France, 11th to 14th December 2017
3. **PELLS, P.J.N., BIENIAWSKI, Z.T., HENCHER, S., PELLS, S.E. (2017).** RQD - Time to rest in peace. Canadian Canadian Geotechnical Journal, 2017, 54(6): 825-834, https://doi.org/10.1139/cgj-2016-0012
4. **PELLS, S., DOUGLAS, K., PELLS, P.J.N., FELL, R., PEIRSON, W.L. (2016)** Rock mass erodibility. J.Hyd.Eng. ASCE. HYENG-9857
5. **PELLS, S.E., 2016**. Erosion of Rock in Spillways (Doctoral Thesis). UNSW Australia, Kensington, N.S.W. http://handle.unsw.edu.au/1959.4/56008
6. **PELLS, S.E. and PELLS, P.J.N, 2015** Application of Dupuit's Equation in SWMM to simulate baseflow. Technical note, ASCE Journal of Hydrologic Engineering,
7. **PELLS, S.E. and PEIRSON, W.L. 2014** DISCUSSION**:** "Evaluation of Overtopping Riprap Design Relationships" by Steven R. Abt, Christopher I. Thornton, Bryan A. Scholl, and Theodore R. Bender *Journal of the American Water Resources Association* (JAWRA) 11 Nov 2014.
8. **PELLS, S.E. and PELLS, P.J.N, 2012**- Impacts of longwall mining and coal seam gas extraction on groundwater regimes in the Sydney basin Part 1 – Theory. Australian Geomechanics Journal Volume 47, No. 3, p.35, September 2012
9. **PELLS, S.E. and PELLS, P.J.N, 2012**- Impacts of longwall mining and coal seam gas extraction on groundwater regimes in the Sydney basin. Part 2 – Practical applications. Australian Geomechanics Journal Volume 47, No. 3, p.51, September 2012
10. **PEIRSON, W L, FIGLUS, J, PELLS, S E and COX, R J 2008** - Placed Rock as Protection against Erosion by Flow down Steep Slopes Journal of Hydraulic Engineering. Volume 134, Issue 9, pp. 1370-1375, 2008.
11. **PEIRSON, W L and PELLS, S E 2004** - A Laboratory Study Of Wave Growth And Air Flow Behaviour Over Waves Strongly Forced By Wind. WRL Research Report 219 on behalf of the United States Army, European Research Office Funding under contract number N62558-04-M-0002, 2004.
12. **PEIRSON, W L, GARCIA, A W and PELLS, S E 2003** - Water Wave Attenuation Due to Opposing Wind Journal of Fluid Mechanics 2003 Vol 487, pp 345 -365, 2003.
13. **PELLS, S E & FELL, R, 2003** - Damage and Cracking of Embankment Dams by Earthquake and the Implications for Internal Erosion and Piping 21st ICOLD Congress 2003 Montreal Q83 83/R18 18.
14. **PELLS, S.E & FELL, R, 2002** - Damage and Cracking of Embankment Dams by Earthquake and the Implications for Internal Erosion and Piping. UNICIV Report Vol 408, 220 pages. UNSW 2002.

PUBLICATIONS

SELECTED CONFERENCE PAPERS

1. **PELLS, S.E; PEIRSON, W.L. & AL_QASSAB, F (2021)** Guidance on the calculation of stream power dissipation for rock scour assessments. Proceedings of the 10th International Conference on Scour and Erosion (ICSE-10) pp 285-292
2. **PELLS, S.E and DOUGLAS, K. (2019).** Guidelines for assessment of scour in unlined spillways. Africa 2019, conference for the International journal on hydropower and dams, 2-4 April 2019, Windhoek, Namibia
3. **PELLS, S.E. 2016** - Assessment and surveillance of erosion risk in unlined spillways. Proceedings, 84th ICOLD Annual Meeting, International Committee on Large Dams 15 - 20 May 2016, Johannesburg, South Africa
4. **PELLS, P.J.N., PELLS, S.E. and VAN SCHALKWYK, M. 2016** A tale of two spillways. Proceedings, 84th ICOLD Annual Meeting, International Committee on Large Dams 15 - 20 May 2016, Johannesburg, South Africa
5. **PELLS, S., FELL, R., DOUGLAS, K., PEIRSON, W. 2016** Erosion Of Unlined Spillways In Rock. Proc. 20th Cong. Asia Pac. Div. Int. Assoc. Hydro Env. Eng. & Res. IAHR APD 2016, August – 28 to 31 2016. Colombo, Sri Lanka\
6. **PELLS, PJN and PELLS, S.E. 2016** The water levels of the Thirlmere Lakes. Proc. 20th Cong. Asia Pac. Div. Int. Assoc. Hydro Env. Eng. & Res. IAHR APD 2016, August – 28 to 31 2016. Colombo, Sri Lanka
7. **PELLS, S.E, PELLS, P.J.N., PEIRSON, W.L., DOUGLAS, K. and FELL, R. 2015** Erosion of unlined spillways in rock – does a 'scour threshold' exist? Proceedings, ANCOLD annual conference, Brisbane, 5-6 November 2015
8. **PELLS, P.J.N and PELLS, S.E. 2015** Hydrogeologists and Geotechnical engineers – lost without translation AGS / IAH Symposium, Sydney 13 November 2015
9. **CARLEY, J. T., MARIANI, A., COX, R., SHAND, T., & PELLS, S. 2013.** History and Future of Seawalls in the Manly Local Government Area. In I. L. Turner (Ed.), Coasts and Ports 2013: 21st Australasian Coastal and Ocean Engineering Conference and the 14th Australasian Port and Harbour Conference. Manly NSW Australia.
10. **PELLS, S.E 2010**- Potential impact of sea-level rise on coastal aquifers. Groundwater 2010 Conference, 31 Oct – 4 Nov 2010, Canberra.
11. **PEIRSON, W L; FIGLUS, J; PELLS, S E and COX, R J. 2008** - Large Rock Protection against Erosion by Flow Down Steep Slopes. In: 9th National Conference on Hydraulics in Water Engineering: Hydraulics 2008. Barton, A.C.T.: Engineers Australia, 2008: [142]-[148].
12. **PELLS, S.E 2008** - Desktop Estimation of Yield For Aquifer Storage Recovery Schemes. In: Lambert, Martin (Editor); Daniell, TM (Editor); Leonard, Michael (Editor). Proceedings of Water Down Under 2008. Modbury, SA: Engineers Australia ; Causal Productions, 2008: 1037-1048.
13. **TIMMS, W., GLAMORE, W & PELLS, S.E. 2005** - Groundwater Quality Impacts Of On-Site Effluent Disposal On-Site '05 Conference Proceedings 2005.
14. **PELLS, S.E., TIMMS, W and TURNER, I.L. 2004** - Managing Groundwater in Coastal Sand Aquifers NSW Coastal Conference Proceedings, 2004.

NUMERICAL MODELLING EXPERIENCE / CAPABILITY

Steven has kept record over the years of specialist software he has utilised in engineering. Some software is now redundant but remains indicative of his skillset.

Hydrogeology	3D Flow	GMS
		FEFLOW
		Groundwater VISTAS
		Visual MODFLOW
		MODFLOW-SURFACT
		SEEP3D
	2D Flow	SEEP/W
		Groundwater in Slide and Phases
	Field Test Analysis	WTAQ
		Aqtesolve
		AquiferTest
Hydrology	WSUD	AQUALM
		MUSIC
	Flood hydrology	XP-RAFTS
		WBNM
		RORB
	Characterisation	Basejumper, HAART
	Continuous	RRL (Simhyd, AWBM)
Hydraulics	1D Hydraulics	XP-SWMM
		Mike 11
		EPA-SWMM
		HEC-RAS
		DRAINS
	2D Hydraulics	XP-SWMM2D
		TUFLOW
		SOBEK
		RMA2
		HEC-RAS 5.0 and later
	3D Hydraulics (CFD)	Flow3D
Pipelines	Network Analysis	EPANET
		WaterGEMS
Geomechanics	Slope stability	Roscience SLIDE
		SLOPE/W
	Deformation	Phase2
		SIGMA/W
Spatial Analysis and Presentation	GIS	MapINFO
		ArcGIS
		QGIS
		Global Mapper

NUMERICAL MODELLING EXPERIENCE / CAPABILITY

	Photogrammetry	Pix4D
	Drafting	Rhinoceros
		AutoCAD
		Sketchup
		Grapher
		Surfer
General Analysis		Excel
		Matlab