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6 December 2024

Mr Stephen O'Donoghue
Department of Planning, Housing & Infrastructure (DPHI)
By Email and NSW Planning Portal

Attention: Jack Turner (DPHI)

Dear Stephen,

Subject: Independent Expert Advisory Panel for Mining MOD6 Recommendations

I refer to the request for information (RFI-77450713) from the Department of Planning, Housing and Infrastructure (DPHI) requesting that Ulan Coal Mines Pty Limited (UCMPL) review and respond to the recommendations provided in the Independent Expert Advisory Panel for Mining (IEAPM) report for MOD6 received 31 October 2024.

UCMPL has reviewed the report and the recommendations provided in the IEAPM MOD6 report. UCMPL outlines the following commitments in relation to the IEAPM's recommendations if DHPI determines to approve MOD6.

Subsidence Prediction and Monitoring

1. UCMPL will review subsidence predictions and monitoring results, annually and as part of development of Extraction Plans. The outcomes of the reviews completed will be reported in Annual Reviews, submitted to DPHI annually. Subsidence predictions will be recalibrated where required, based on the Annual Reviews completed.
2. UCMPL will extend current subsidence monitoring, beyond the predicted angle of draw to capture potential effects and impacts out to at least a 45° angle of draw, subject to the agreement of private property owners for access and where no vegetation clearing is required for areas that extend beyond the approved Project Approval boundary. Where the agreement of a private property owner cannot be obtained, monitoring will extent to the closest available location on land where access is available.
3. UCMPL will update the existing subsidence monitoring program to incorporate special attention to the Mona Creek rock shelters during mining of panels LWW9 and LWW10 at Ulan Underground. The monitoring program will be reviewed and amended as required and as mining progresses, depending on monitoring outcomes, access to private property and vegetation clearing as set out in item 2 above.

Groundwater Monitoring and Modelling

4. UCMPL will install deeper, nested piezometers next to MCMB04 and new nested piezometers or a VWP monitoring bore, close to the confluence of Mona Creek and the Talbragar River. The proposed bores will be located on UCMPL owned land, within the approximate location shown on Figure 1, in Attachment 1.

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Manager of the Ulan Joint Venture

5. UCMPL will update the Ulan Water Management Plan (WMP), which includes the Surface Water and Groundwater Monitoring Program within 6 months of the determination granting approval of MOD6 to:
   - address any inconsistencies between the latest modelling predictions and monitoring commitments. This includes any updates required from routine review and calibration of the groundwater model;
   - reflect the current and expanded groundwater monitoring network;
   - increase the frequency of monitoring water levels in private water bores to minimum 6-monthly, subject to agreement with relevant landholders;
   - align the triggers and TARPs with the latest modelling drawdown predictions in private water bores;
   - increase the number of groundwater level trigger sites to include more existing alluvial, Triassic Wollar Sandstone and Jurassic Pilliga Sandstone monitoring sites north of the amended project area subject to the collection of sufficient baseline data in newly installed bores; and
   - revise or develop appropriate response actions with appropriate timeframes.
6. The updated WMP will continue to be the primary groundwater management plan, as approved by DHPI.
7. The MOD6 groundwater model and Groundwater Impact Assessment was peer reviewed by Dr Doug Weatherill (EMM). The MOD6 peer review report is attached for reference (Attachment 2). No peer review was undertaken as part of the Amendment Report as there were no material changes in the model used. However, the Ulan Coal Complex groundwater model is currently undergoing a formal recalibration process, as required by Project Approval (PA) 08_0184. As part of the recalibration process, a formal groundwater model peer review is being undertaken. The groundwater model incorporates MOD6 changes. This peer review will provide an assessment of the updated groundwater model against the available guidelines. The peer review report prepared in relation to the recalibrated groundwater model will be provided to DCCEEW-Water and DPHI along with the updated groundwater model and the results presented in the updated WMP.
8. UCMPL will continue to undertake detailed reviews every two years of the adequacy of the groundwater conceptual model as new monitoring data is collected as per the existing commitment 6.4.6, contained in Project Approval 08_0184. Where material deviations from expected behaviour for the Jurassic Pilliga Sandstone, the Triassic Wollar Sandstone and the Talbragar/Mona Creek alluvium and stream channel are observed, appropriate updates to the conceptual and numerical model will be undertaken to assist the interpretation of the new information.

Please contact Brad Tanswell on 0429 598 542 or Bradley.Tanswell@glencore.com.au if you would like any additional information or have any questions.

Yours sincerely,

Lucy Stuart
Environment and Community Manager
Ulan Coal Mines Pty Limited

Attachment 1 – Proposed Bore Locations

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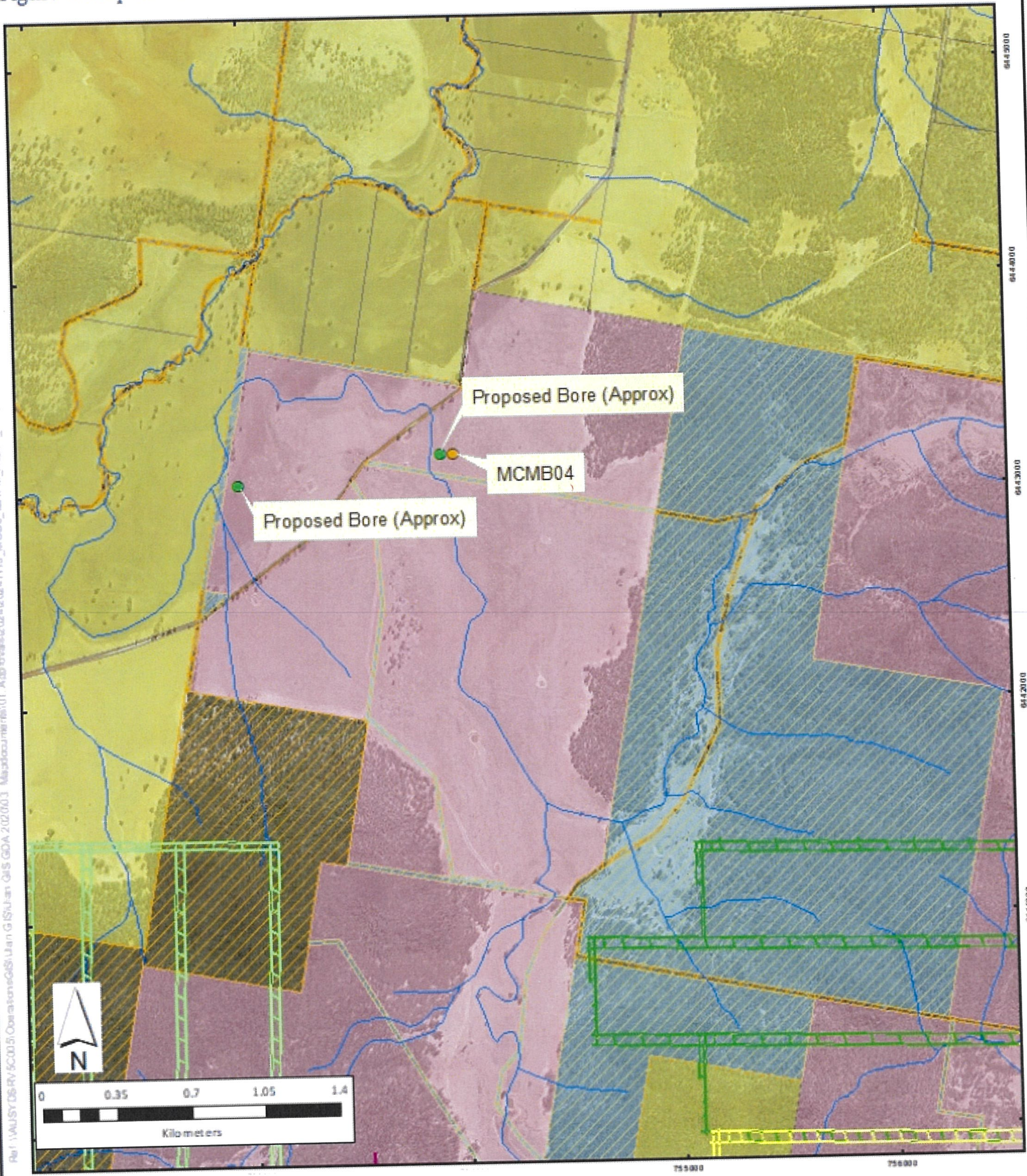
Figure 1: Proposed Bore Location



Legend

- Approximate Proposed Bore Location
- Existing Monitoring Bore
- Ulan West Mine Plan
- Ulan Underground Mine Plan
- UUG MOD 6
- MOD 6 UWO
- Creeks/Rivers
- UCMPL Freehold Land
- UCMPL Mining Leasehold from Crown
- Crown Land
- Private Landholders

GDA2020

Date Created: 6/12/2024
Map Size: A4 Portrait
Scale: 1:25,000
Map Created By: [illegible]
Coordinate System:
GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

Attachment 2 - MOD6 peer review report

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10 February 2022

Kirsty Davies
Principal Environmental Consultant
Umwelt (Australia) Pty Limited
75 York Street
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Re: Ulan Coal Mine Complex MOD6 groundwater modelling and assessment independent review

1 Summary

This letter presents the findings of a peer review of numerical groundwater flow modelling and assessment of the Ulan Coal Mine Complex modification (MOD6).

This review focusses on the numerical groundwater flow modelling and groundwater impact assessment carried out by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). It does not focus on the field testing, data collection and analysis used in support of the groundwater model, nor any of the associated assessments that may provide input to, or rely on outcomes of, the groundwater assessment.

The review was carried out by Dr Doug Weatherill of EMM Consulting Pty Ltd in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). Support was provided by Kate Holder, also of EMM Consulting Pty Ltd, regarding impact assessment and regulatory requirements.

Online meetings, in which aspects of the conceptualisation, model construction and calibration were presented, were held between AGE and the peer reviewer at key stages throughout the modelling.

Draft documentation was provided by AGE for review as follows:

- 5 August 2021: draft Ulan Project (MOD6) – Groundwater Impact Assessment (G1985G.UlanMOD6GIA_Draft v01.01.docx); and
- 5 August 2021: Ulan MOD6 Groundwater Model (G1985G_model_appendix_v01.02.docx).

Despite the delivery date for peer review, both of the above documents indicated a reporting date of 24 June 2021.

Feedback was provided to AGE on the draft documentation in the form of tracked changes on the two documents. This initial review found critical shortcomings in the modelling scenarios and documentation of the modelling. The modelled scenarios did not extend beyond the end of mining and, hence, did not capture, or demonstrate otherwise, delayed responses to mining. Therefore, the predicted impacts did not adequately support the assessment as they were only partial, and not maximum, impacts. Some aspects of the reporting (eg history-matching hydrographs) were missing. In addition to the critical shortcomings, the report required corrections, clarifications and more thorough documentation.

Following revision in response to the above-mentioned peer review, along with comments from Umwelt and Ulan Coal Mines Pty Ltd, final documentation was provided by AGE for review as follows:

- 2 February 2022: Ulan Coal Mines Modification 6 (MOD6) – Groundwater Impact Assessment (UCM1985G.UlanMOD6GIA Report_Draft v02.01a.docx); and
- 2 February 2022: Ulan MOD6 Groundwater Model (UCM1985G_model_appendix_v02.01a.docx).

The date on both documents listed above is 28 January 2022. The final impact assessment, and associated modelling, form the basis for this peer review.

It is the reviewers' view that the final groundwater impact assessment and supporting numerical groundwater flow modelling are broadly fit for purpose and meet the requirements of the NSW and Commonwealth Governments. However, it is recommended it be updated with re-calculated predictions of take from the Talbragar River and Talbragar Alluvial Groundwater Source. The take needs to be reported for each water source, as per the requirements of the AIP. In addition, it is recommended the GIA (or EIS) includes information regarding the intended pathway to secure the additional water entitlement to account for the predicted additional take.

2 Groundwater modelling

The Australian Groundwater Modelling Guidelines (Barnett et al. 2012) suggests a compliance checklist to summarise key review findings. This is presented in Table 2.1.

Table 2.1 Groundwater Model Compliance Checklist: 10-point essential summary

Question	Y/N	Comments re Ulan groundwater model
1. Are the model objectives and model confidence level classification clearly stated?	Yes	The groundwater modelling appendix lists the modelling objectives as: 1) predict groundwater inflow into the underground mine based on the approved mine plan; 2) simulate and predict the extent and area of influence of mining on the water table and deeper groundwater pressures; and 3) predict the loss and/or water take from the water bearing units on site for licensing estimates, including losses to baseflow. The modelling appendix indicates the model is best described by a Class 2 confidence level for the following reasons: • *"rainfall and evaporation data are available for the site (Level 3);* • *groundwater head observations and bore logs are available and with a good coverage around UCC and relevant nearby mines, but without spatial coverage throughout the model domain (Level 2);* • *streamflow data and baseflow estimates available at a few points (Level 2);* • *seasonal fluctuations reasonably replicated in many parts of the model domain (Level 2);* • *scaled RMS error and other calibration statistics, e.g. mean residual, are acceptable (Level 3); and* • *suggested use is for prediction of impacts of proposed developments in aquifers with a medium to high value (Level 2)."* The peer reviewer's own assessment is provided in Table 2.2, which suggests the model aligns best with a Class 2 confidence classification.
2. Are the objectives satisfied?	Yes	Scenarios were developed for a) no mining; b) only Moolarben mining; c) approved Ulan mining (including Moolarben); and d) MOD6 mining (including approved Ulan mining and Moolarben). Subtraction of results of one scenario from another allows calculation of cumulative and incremental impacts in terms of mine inflows, drawdown and water take as required to meet the objectives.
3. Is the conceptual model consistent with objectives and confidence level?	Yes	Conceptual model is sound, based on data and local mining experience, modelling objectives and for impact assessment and licensing purposes.

Table 2.1 Groundwater Model Compliance Checklist: 10-point essential summary

Question	Y/N	Comments re Ulan groundwater model
4. Is the conceptual model based on all available data, presented clearly and reviewed by an appropriate reviewer?	Yes	The conceptual model refers to groundwater investigations from previous mining and modelling in the area and is supported by substantial datasets including: • a detailed geological model; • a 5 m digital elevation model (improving on the 30 m one used for the previous version of the model); • a recent study, including analysis of drilling and geophysics, of the shallow sediments along Mona Creek, previously assumed to be alluvial in nature but now confirmed to be colluvium; • monitoring of groundwater potentiometric levels providing coverage both laterally and with depth through the geological strata. The monitoring provides measured groundwater responses to underground mining undertaken to date, similar to the activities and stresses proposed by MOD6, and therefore provides valuable data to indicate likely properties and future behaviour of the groundwater system; and • limited measurements of mine inflows and stream flows are available.
5. Does the model design conform to best practice?	Yes	Industry-leading software (MODFLOW-USG in combination with a flexible Voronoi polygon mesh) is applied, which constitutes an update from previous models which used the MODFLOW-SURFACT code. The model domain was expanded substantially relative to the previous model and is sufficiently large to encompass the majority of predicted project impacts but does display some predicted drawdown at boundaries. Layers, mesh and boundary conditions are generally consistent with best practice. The analytical Ditton-Merrick approach is adopted to represent the height of fracturing above mined voids. Temporally, quarterly stress periods are employed to represent the progressive development of mining.
6. Is the model calibration satisfactory?	Yes	Calibration was carried out in transient mode over the period spanning 1984 to 2019. Measured hydraulic head data from 151 monitoring locations were used as targets for automated calibration whilst plausible baseflows were maintained and comparison to measured mine inflows is presented. The model slightly underpredicts mine inflows compared to the four measured values of around 15 ML/d. Performance against hydraulic head data, that cover the approved and proposed mining areas, produces a Scaled Root Mean Squared (SRMS) error of 3.95% which is considered acceptable. This value is somewhat biased by four measured values approximately 100 m higher than the remainder of the dataset, meaning that the normalisation conducted in calculating the SRMS value produces a more favourable value than would be the case were these four values not included (the reviewer estimates the value would increase to around 6%, which is still a typically acceptable value). The model generally produces a good match to temporal responses, with modelled and measured hydrographs presented. The model simulates large seasonal responses at some locations where measured data do not indicate such dynamics. This may be caused by the very low specific yield (0.8%) assigned to colluvium.

Table 2.1 Groundwater Model Compliance Checklist: 10-point essential summary

Question	Y/N	Comments re Ulan groundwater model
7. Are the calibrated parameter values and estimated fluxes plausible?	Yes	Calibrated parameter values are generally plausible and comparison is made to values measured by core and packer tests and to previous modelling. Hydraulic conductivity values, interpolated using pilot points, are presented as min, mean and max in an appendix with just one figure documenting a distribution across a model layer. Specific storage and specific yield values are generally plausible. However, it is noted that the specific yield value of 0.8% assigned to colluvium seems very low. Specific storage values conform to the physically possible range outlined by Rau et al. (2018). Recharge rates were calibrated based on the surface geology, and appear to be plausible, but the report does not indicate how these relate to rainfall (eg as a percentage of rainfall) nor how they vary temporally during history-matching, during which a Figure A 5.8 of the transient water balance illustrates they are dynamic. Constant values are adopted for the predictive period. Reference is not made to previous studies or modelling of recharge. Pre-mining, all recharge is modelled as discharging as baseflow to surface water features. No comparison is made to any gauge data or estimates of baseflow. Evapotranspiration is not modelled explicitly and no inflow from or outflow to the surrounding groundwater system is enabled, as no flow boundaries are imposed at model edges. The modelled water balance over the transient history-matching period achieves a good numerical balance and demonstrates a progressive increase in mine inflows. Modelled historical mine inflows are compared to four measurements of around 15 ML/d and demonstrate a generally good match. Modelled inflow is below measured at all four times, ranging from around 1 ML/d to 4 ML/d (or around 7% to 27%) below the measurements. Modelled discharge at The Drip (0.021 L/s) is deemed to be plausible, based on observations (not measurements) by the modelling team.
8. Do the model predictions conform to best practice?	Yes	Scenarios were developed for a) no mining; b) only Moolarben mining; c) approved Ulan mining (including Moolarben); and d) MOD6 mining (including approved Ulan mining and Moolarben). Subtraction of results of one scenario from another allows calculation of cumulative and incremental impacts in terms of mine inflows, drawdown and water take as required to meet the objectives. Mining is simulated with appropriate boundary conditions to represent mining such that predictions of mine inflows, drawdown and water take can be made. A 2,000 year post mining period is simulated to capture potential delayed impacts.
9. Is the uncertainty associated with the simulations/predictions reported?	Yes	The modelling appendix describes an approach to predictive uncertainty analysis which aligns with a type 3 uncertainty analysis “stochastic modelling with Bayesian probability quantification” as outlined in the IESC explanatory note on uncertainty analysis (Middlemis & Peeters 2018). A total of 200 alternative realisations of the model were parameterised by sampling from the pre-calibration parameter ranges defined for the automated calibration process. Of these 200 runs, any that did not converge or meet a satisfactory calibration performance criterion of 10% SRMS error were rejected, leaving 94 accepted alternative realisations. Results of this suite of predictions were used to produce probabilistic outcomes of inflows and drawdown, thereby quantifying the uncertainty in predictions (at least in terms of the parameter values assigned to the model).
10. Is the model fit for purpose?	Yes	It is my opinion that the overall model architecture, calibration and scenario definitions are fit for the purpose of predicting drawdown impacts and mine inflows for licensing purposes.

2.1 Model confidence level classification

The Australian Groundwater Modelling Guidelines (Barnett et al. 2012) provides a classification system that takes into account data used to inform the model conceptualisation, model design, calibration and predictive scenarios. Most models will have attributes that align with more than one class and, generally, the overall confidence level class is determined by the clustering of attributes.

The peer reviewer's assessment of the model using a modified version of the classification table is presented in Table 2.2. This assessment indicates that the model best aligns with a Class 2 description, with some attributes of a Class 3 model. This classification indicates that the modelling conducted for Ulan Coal Mine Complex MOD6 is suitable for impact assessment scenario modelling.

Table 2.2 Model Confidence Class characteristics

Class	Data	Calibration	Prediction	Quantitative Indicators
1	Not much / Sparse coverage	Not possible	Timeframe >> Calibration	Predictive Timeframe >10x Calib'n
	No metered usage	Large error statistic	Large stresses/periods	Predictive Stresses >5x Calib'n
	Low resolution topo DEM	Inadequate data spread	Poor/no verification	Mass balance > 1% (or one-off <5%)
	Poor aquifer geometry	Targets incompatible with model purpose	Transient prediction but steady-state calibration	Properties <> field values
	Basic/Initial conceptualisation			Poor performance stats / no review
2	Some data / OK coverage	Weak seasonal match	Predictive Timeframe > Calib'n	Predictive Timeframe = 3-10x Calib'n
	Some usage data	Some long-term trends wrong	Different stresses &/or periods	Predictive Stresses = 2-5x Calib'n
	Some baseflow estimates and some K & S measurements	Partial performance (eg some stats / part record / model-measure offsets)	No verification but key simulations constrained by data	Mass balance < 1% (all periods)
	Some high res. topo DEM and adequate aquifer geometry	Head & Flux targets constrain calibration	Calib. & prediction consistent (transient or steady-state)	Some properties maybe <> field values.
	Sound conceptualisation, reviewed & stress-tested	Non-uniqueness, sensitivity and qualitative uncertainty addressed	Magnitude & type of stresses outside range of calib'n stresses	Some poor performance or coarse discretisation in key areas/times
3	Plenty data, good coverage	Good performance statistics	Timeframe ~ Calibration	Predictive Timeframe <3x Calib'n
	Good metered volumes (all users)	Most long-term trends matched	Similar stresses &/or periods	Predictive Stresses <2x Calib'n
	Local climate data & baseflows	Most seasonal matches OK	Good verification or all simulations constrained by data	Mass balance < 0.5% (all periods)
	Kh, Kv & Sy measurements from range of tests	Calibration to present day head and flux targets	Steady state prediction only when calibration in steady state	Properties ~ field measurements
	High res. topo DEM all areas & good aquifer geometry	Non-uniqueness minimised &/or parameter identifiability &/or	Suitable computational methods applied & parameters are consistent with conceptualisation	No poor performance or coarse discretisation in key areas (grid/time)
		minimum variance or RCS assessed		
	Mature conceptualisation	Sensitivity &/or Qualitative Uncertainty	Quantitative uncertainty analysis	Review by experienced Hydro/Modeller

(after Table 2-1 of Australian Groundwater Modelling guidelines (Barnett et al. 2012)

Legend

Criterion met at higher Class	Criterion partially met at the relevant Class	Criterion met at the relevant Class	Criterion not met

2.2 Discussion

The modelling appendix, combined with aspects documented directly in the main body of the groundwater impact assessment, cover the broad aspects expected in a modelling report, including project background and modelling objectives, conceptualisation, model design, history matching/calibration, predictive modelling and uncertainty analysis.

Conceptualisation of the groundwater system covers the geological setting, hydraulic properties of the hydrostratigraphic units, climate, surface water, historical mining activities, measured groundwater responses and aspects of water quality. The modelling then focusses on hydraulics only.

The model is built using the MODFLOW-USG numerical groundwater modelling code in combination with a flexible Voronoi polygon mesh. The option to pinch out/deactivate model cells where units are absent is employed for more numerically efficient solution than older MODFLOW codes, whilst enabling greater spatial resolution in areas of interest. The model is discretised vertically into 19 model layers that enable representation of the variability in hydraulic properties, hydraulic head and groundwater flow in the different units. The report does not present the data sources used to define the geometry of the layers but indicates the site geological model was used.

Boundary conditions around the model edge are all assigned as no flow boundaries, which can be considered conservative in terms of drawdown prediction, but may act to reduce modelled mine inflows, given drawdown greater than 2 m does extend to the boundaries. Surface water features are represented with the River (RIV) package with the features allowed only to receive baseflow, but not to lose water to the groundwater system, in line with them being conceptualised as gaining features. Conductance is calculated in a meaningful way, using properties of the individual features represented. Recharge from rainfall and evapotranspiration are combined as net recharge represented using the Recharge (RCH) package and the values adopted are reasonable. Inflow to mine voids is simulated with the Drain (DRN) package which is assigned a high conductance to ensure the mine voids are effectively dewatered. Hydraulic properties are changed over time to represent fracturing above mining using the Time-Variant Materials (TVM) package.

Transient hydraulic head monitoring data from 151 monitoring locations were used to compile a calibration target dataset. The monitoring locations provide good coverage over the approved and proposed mining areas and extend more broadly across the surrounding groundwater system. Appendix A2, which lists the monitoring locations from which data were used to calibrate the model, does not indicate which hydrostratigraphic units are monitored for each site. It would be helpful is this was added and if hydrographs included this information.

The model was calibrated to transient hydraulic head data using an automated approach. The model generally produces good matches to measured responses to mining, but overpredicts seasonal variations at several monitoring locations where no significant seasonality is measured. The reviewer does not consider this to be a major defect in the model when considering the modelling objectives and conceptualisation. Comparison is made against measured mine inflows at four times, with favourable results, reducing non-uniqueness that is introduced when calibrating only to hydraulic head data.

Predictive scenarios were developed for a null case (no mining); only Moolarben mining; approved Ulan mining (including Moolarben); and MOD6 mining (including approved Ulan mining and Moolarben). Subtraction of results of one scenario from another allows calculation of cumulative and incremental impacts in terms of mine inflows, drawdown and water take as required to meet the modelling objectives. This is consistent with best practice and reduces uncertainty in the results.

Uncertainty analysis is conducted in a type 3 manner, as outlined in the IESC explanatory note on uncertainty analysis (Middlemis & Peeters 2018). A total of 200 alternative realisations of the model were parameterised by sampling from the pre-calibration parameter ranges defined for the automated calibration process. Of these 200 runs, any that did not converge or meet a satisfactory calibration performance criterion of 10%

SRMS error were rejected, leaving 94 accepted alternative realisations. Results of this suite of predictions were used to produce probabilistic outcomes of inflows and drawdown, thereby quantifying the uncertainty in predictions.

3 Impact assessment

3.1 Introduction

The Groundwater Impact Assessment report (hereafter referred to as 'the GIA') was reviewed with consideration of the NSW Aquifer Interference Policy (AIP; NOW 2012), the relevant water sharing plans (WSPs) and the *Information guidelines for proponents preparing coal seam gas and large coal mine development proposals* (Commonwealth of Australia 2018).

In NSW, aquifer interference activities, which are those that take water incidentally to the primary purpose of the activity, are assessed against the requirements of the AIP. The AIP clarifies the requirements for obtaining water licences for aquifer interference activities and defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset. The Aquifer Interference Assessment Framework is a step-by-step guide that the water group of the NSW Department of Planning, Industry and Environment (DPIE Water) uses to assess project proposals and modifications against the AIP. The framework is available for proponents to use as a tool to aid the development of an impact assessment.

Appendix B of the GIA provides a comparison of the GIA to "government policy", specifically the AIP (Tables B 0.1 to B 0.4, also referred to as Section 12 in the GIA); Commonwealth assessment requirements regarding impacts to the water quality of water resources (Table B 2.1, or Section 13.1 in the GIA); and the IESC information guidelines (Table B 2.2 to B 2.16, or Section 13.2 in the GIA).

As part of the peer review, a comparison of the above checklists in Section 3.3 and 3.4 below, using the information provided in the GIA, has been conducted.

3.2 Discussion

3.2.1 Impacts

The GIA clearly presents the incremental drawdown and inflows as a result of the proposed modification, with a comparison to predictions for the approved mine plan, and predicted cumulative drawdown. Predicted drawdown at 2035 and drawdown representative of long-term steady state post-closure conditions is presented. This suggests the maximum drawdown is predicted to occur at the end of mining; however, this is not explicitly stated.

High priority GDEs are not identified in the area of predicted incremental drawdown (due to the proposed modification); however, it might be beneficial to provide further supporting information regarding areas where the depth to the watertable is small (ie shallow).

Third-party landholder bores are identified, and drawdown impacts assessed in Section 8.2. The model results indicate some bores may experience drawdown >2 m, triggering make good requirements (compensatory water supply). However, the majority of the identified bores are predicted to be impacted (>2 m drawdown) by the approved mine plan. Section 8.2 does identify additional bores that are predicted to experience drawdown >2 m post-mining (as a result of the modification); however, the impact is predicted to occur a long time after closure.

Although the GIA does not include a conclusion or summary section, the predicted drawdown information presented indicates the proposed modification will have a minor impact on groundwater resources and associated receptors.

The GIA discusses the potential for fracturing (due to mining) to create enhanced vertical connection between the Mona Creek sediments and the underground mine. The GIA states:

> The predicted drawdown is considered conservative because the level of predicted fracturing is not expected to extend to the base of the colluvium and, even if it did, this level of interconnection will not be maintained in reality due to self-sealing nature of the unconsolidated clays disturbed by the initial fracturing.

This statement (regarding "self-sealing") may attract interest from the NSW Government and Commonwealth Government. This review recommends additional supporting information be included in the GIA or EIS, such as subsidence modelling which may have been completed for the proposed modification, but which has not been a subject of this peer review. Based on NSW Government comments provided on the Tahmoor Coal project[1], the NSW Government may not accept "self-sealing" as a control to limit vertical connection between the colluvium and the underground mine.

Although groundwater associated with the Mona Creek colluvial sediments is considered ephemeral and is a less productive groundwater source (and does not have known high priority GDEs associated with it), fracturing that reaches the base of the colluvium is likely to result in surface water losses during times of flow.

3.2.2 Licensing

The GIA presents the predicted indirect take from the Talbragar Alluvial Groundwater Source and the Upper Talbragar River Water Source as one combined take. However, the WSP for the Macquarie Bogan Unregulated Rivers Water Sources 2012 was updated in 2020 by removing the alluvial groundwater sources and a new WSP was created to manage alluvial groundwater (WSP for Macquarie - Castlereagh Groundwater Sources Order 2020) and came into force on 1 July 2020. The WSP rules do not allow trade into or out of the water sources.

It is recommended AGE re-calculates the take and separates it between surface water (from the Upper Talbragar unregulated river) and groundwater (from the Talbragar Alluvial Groundwater Source).

The GIA identifies a shortfall (of 1,389 ML) in water entitlement held by UCMPL in the Sydney Basin MDB Groundwater Source (Sydney Basin MDB (Other) and Macquarie Oxley Management Zone) managed under the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 WSP.

It is unclear, at this stage, if additional entitlement is required for the indirect take from the Upper Talbragar River water source (unregulated river) or the Talbragar Alluvial Groundwater Source.

Section 2.1.2 of the GIA presents the entitlements held by UCMPL. This section of the GIA notes there was a clerical error at the time of issuing water access licence (WAL) 41492. The GIA indicates the WAL was incorrectly assigned to the Oxley Basin Coast Groundwater Source instead of the Sydney Basin-North Coast Groundwater Source (managed under the North Coast Fractured and Porous Rock Groundwater Sources 2016 WSP).

The GIA states UCMPL will acquire additional entitlement (pathway not described) or through internal Glencore transfer arrangements (ie trade).

The reviewers' understanding is that the potential licensing pathways are either one of or a combination of the below:

1 Refer to Section 5.8.2 of https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-897%2120200221T070006.197%20GMT

- trade (permanent or temporary) with other licence holders, including other Glencore owned assets; or
- controlled allocation orders (CAO), noting however that in the 2021 CAO, water was not released in the Oxley Basin Coast Groundwater Source and only 390 unit shares (at $650 per unit share) were released in the Sydney Basin MDB Groundwater Source (management zone not specified).

To meet the requirements of the AIP and the expectations of the NSW Government, it is recommended the GIA (or EIS) include further discussion on the intended licensing pathway.

3.3 Aquifer interference assessment framework

Note that the table numbers presented below are consistent with the table numbers provided in the AIP assessment framework.

Table 3.1 Has the proponent:

	AIP requirement	AGE response	Reviewer comment
1	Described the water source(s)the activity will take water from?	Section 2.1 describes the water sharing plans that the UCMPL will take water from, namely (for approved and the proposed modification): Incidental water take from water sources associated with the Permian sediments: • North Coast Fractured and Porous Rock Groundwater Sources 2016 - Sydney Basin - North Coast Groundwater Source; and • NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 - Sydney Basin MDB (Other) Management Zone. Indirect water take through: • North Coast Fractured and Porous Rock Groundwater Sources 2016 - Oxley Basin Coast Groundwater Source; • Hunter Unregulated and Alluvial Water Sources 2009 - Upper Goulburn River Water Source; • NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020 - Sydney Basin MDB (Macquarie Oxley) Management Zone; • Macquarie Bogan Unregulated Rivers Water Sources 2012 - Upper Talbragar River Water Source; and • Macquarie - Castlereagh Groundwater Sources Order 2020 - Talbragar Alluvial Groundwater Source.	It is noted that the NSW Government has drafted a replacement of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009,* which is on public exhibition. The revised WSP is expected to be in force in July 2022.
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Section 7.1 and Section 8.1 summarise the peak take of groundwater and surface water from each water source due to the approved mining and the additional incremental effect of the proposed modification.	Section 7.1 presents the predicted mine inflows. Section 8.1 presents the calculated peak take from each water source (the annual predicted take is not presented).

Table 3.1 Has the proponent:

	AIP requirement	AGE response	Reviewer comment
			The GIA presents the predicted indirect take from the Talbragar Alluvial Groundwater Source and the Upper Talbragar River Water Source as one take. The WSP for the Macquarie Bogan Unregulated Rivers Water Sources 2012 was updated in 2020 by removing the alluvial groundwater sources and a new WSP was created to manage alluvial groundwater (WSP for Macquarie - Castlereagh Groundwater Sources Order 2020) and came into force on 1 July 2020. The WSP rules do not allow trade into or out of the water sources. It is recommend AGE re-calculates the take and separates it between surface water (from the Upper Talbragar unregulated river) and groundwater (from the Talbragar Alluvial Groundwater Source). The GIA identifies a shortfall (of 1,389 ML) in licences held by UCMPL in the Sydney Basin MDB Groundwater Source (Sydney Basin MDB (Other) Management Zone) managed under the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 WSP. It is unclear, at this stage, if additional entitlement is required for the indirect take from the Upper Talbragar River water source (unregulated river) or the Talbragar Alluvial Groundwater Source.
3	Predicted the total amount ofwater that will be taken from each connected groundwateror surface water source afterthe closure of the activity?	Section 7.3.1 describes post mining impacts	Estimates of take post-mining are presented in Section 8.1. Post-mining take is not provided for the Permian groundwater sources, presumably because there is no active dewatering being simulated. As per the above, the GIA presents the predicted indirect take from the Talbragar Alluvial Groundwater Source and the Upper Talbragar River Water Source as one combined take (managed under separate WSPs as at 1 July 2020). It is recommended AGE re-calculates the take and separates it between surface water (from the Upper Talbragar unregulated river) and groundwater (from the Talbragar Alluvial Groundwater Source.
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (refer to Table 3, below)	Based on 3D numerical modelling	Yes. See Table 3 below
5	Described how and in what proportions this take will beassigned to the affected aquifers and connected surface water sources?	Section 8.1 summarises the peak take of surface water and groundwater from each water source due to mining at UCMPL (incorporating the proposed modification).	Section 8.1 presents the predicted take. As per the above, the GIA presents the predicted indirect take from the Talbragar Alluvial Groundwater Source and the Upper Talbragar River Water Source as one combined take (managed under separate WSPs as at 1 July 2020).

Table 3.1 Has the proponent:

	AIP requirement	AGE response	Reviewer comment
			It is recommended AGE re-calculates the take and separates it between surface water (from the Upper Talbragar unregulated river) and groundwater (from the Talbragar Alluvial Groundwater Source.
6	Described how any licence exemptions might apply?	Refer to Section 8.1	Licensing exemptions do not apply.
7	Described the characteristicsof the water requirements?	Refer to Section 8.1	Section 5 describes the hydrogeology; Section 7.1 presents the predicted mine inflows; and Section 8.1 presents the predicted take.
8	Determined if there are sufficient water entitlements and water allocations that areable to be obtained for the activity?	Section 2.1.1 describes the entitlements held by the proponent and where any additional water allocations may be required. The proponent will ensure all necessary water licences are obtained for UCMPL	Section 2.1.2 presents the entitlements held by UCMPL. This section of the GIA notes there was a clerical error at the time of issuing water access licence (WAL) 41492. It was incorrectly assigned to the Oxley Basin Coast Groundwater Source instead of the Sydney Basin-North Coast Groundwater Source (managed under the North Coast Fractured and Porous Rock Groundwater Sources 2016 WSP). Section 8.1 indicates additional entitlement is required for take from the: • Sydney Basin MDB Groundwater Source (Sydney Basin MDB (Other) Management Zone and the Macquarie Oxley Management Zone) managed under the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 WSP; and • Oxley Basin Coast Groundwater Source managed under the North Coast Fractured and Porous Rock Groundwater Sources 2016 WSP, once the WAL error is corrected. It is unclear, at this stage, if additional entitlement is required for the indirect take from the Upper Talbragar River water source (unregulated river) or the Talbragar Alluvial Groundwater Source. It is recommended AGE re-calculates the take and separates it between surface water (from the Upper Talbragar unregulated river) and groundwater (from the Talbragar Alluvial Groundwater Source).
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Refer to Section 8.1	This is not explicitly discussed in the GIA. Section 8.1 of the GIA presents the predicted indirect take from the Talbragar Alluvial Groundwater Source and the Upper Talbragar River Water Source as one combined take. As outlined above, these water sources are managed under separate WSPs as at 1 July 2020. The WSP rules do not allow trade into or out of the water sources. It is recommended AGE re-calculates the take and separates it between surface water

Table 3.1 Has the proponent:

	AIP requirement	AGE response	Reviewer comment
			(from the Upper Talbragar unregulated river) and groundwater (from the Talbragar Alluvial Groundwater Source).
10	Determined how it will obtainthe required water?	Via direct and indirect take (refer to Section 8.1). Refer to Section 8.1 for discussion regarding available water access licences.	The GIA states UCMPL will acquire additional entitlement (pathway not described) or through internal Glencore transfer arrangements (ie trade). It is the reviewers' understanding that the potential licensing pathways are either one of or a combination of the below: • trade (permanent or temporary) with other licence holders, including other Glencore owned assets; or • controlled allocation orders (CAO), noting however that in the 2021 CAO, water was not released in the Oxley Basin Coast Groundwater Source and only 390 unit shares (at $650 per unit share) were released in the Sydney Basin MDB Groundwater Source (management zone not specified). To meet the requirements of the AIP and the expectations of the NSW Government, it is recommended the GIA (or EIS) includes further discussion on the intended licensing pathway.
11	Considered the effect thatactivation of existing entitlement may have on future available water determinations?	Not applicable	This question relates to where entitlements in a water source are at (or greater than) the long-term average annual extraction limit (LTAAEL), and if all users were to take their full entitlement in a year, it might result available water determinations (AWDs) reducing unit share components below 1 ML to ensure take does not exceed the LTAAEL. Based on the above, it is not likely to be an issue for the Sydney Basin-North Coast Groundwater Source or Sydney Basin MDB Groundwater Source.
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	Refer to the Surface Water Assessment	Surface Water Assessment not viewed by EMM
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Refer to Section 8.1	Predicted post-mining take is reported in Section 8.1 of the GIA. Additional entitlement will be needed in some water sources. See comments above regarding a strategy to secure entitlement(s).
	Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised waterusers? If YES, items 14-16 must be addressed.		
14	Considered any potential forcausing or enhancing hydraulic connections, and quantified the risk?	Observations (refer to Section 5.8 and Appendix A) have guided the application of the empirical formulas to determine the height of continuous fracturing. Available information shows that the zone of continuous / connected	The GIA (and associated Appendix A) discusses the calculated height of fracturing and simulation of it in the groundwater model.

Table 3.1 Has the proponent:

	AIP requirement	AGE response	Reviewer comment
		fracturing has / will come to the surface in the southern extents of the approved mine plan. The only area in the proposed modification mine plan where the fracture zone is expected at the surface in the southern portion of UWLW12, where the modification involves a widening of an already approved panel. The impact assessment is covered in Section 8 and groundwater modelling has included hydraulic property changes due to fracturing, the impacts of which are encapsulated in the predictions.	Section 7.2 states: *the model represents the Mona Creek sediments being vertically connected to the mining area through fracturing (noting the estimated fracture height is close to the base of the colluvium in this area). The predicted drawdown is considered conservative because the level of predicted fracturing is not expected to extend to the base of the colluvium and, even if it did, this level of interconnection will not be maintained in reality due to self-sealing nature of the unconsolidated clays disturbed by the initial fracturing.* It is recommended to reference subsidence modelling work completed for the modification (if available) and the surface water assessment, both of which have not been part of this peer review. It is recommended additional information be provided regarding the potential for the colluvial sediments to "self-seal". Based on NSW Government comments provided on the Tahmoor Coal project, the NSW Government may not accept "self-sealing" as a control to limit vertical connection between the colluvium and the underground mine. Although groundwater associated with the Mona Creek colluvial sediments is considered ephemeral and is a less productive groundwater source (and does not have known high priority GDEs associated with it), fracturing that reaches the base of the colluvium is likely to result in surface water losses during times of flow.
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	Refer to Section 9.	Section 9 of the GIA discusses the results of the predictive uncertainty analysis (which involved varying calibration parameters), with results presented for mine inflows and the extent of the 1 m drawdown contour for various hydrogeological units. Changes to baseflow are not discussed. To address this comment, it is recommended the GIA be updated to include predicted changes in baseflow (as part of the uncertainty analysis).
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Refer to Sections 8.1 and 10	Section 10 discusses the UCC Groundwater Management Plan, which documents strategies for monitoring actual take and comparing to predicted take. The NSW Government is rolling out requirements for "non-urban metering" across the State. It is assumed the UCC Groundwater Management Plan will be updated to reflect the policy requirements or UCMPL will seek exemption from the policy for take that cannot be measured (eg indirect take).

Table 3.1 Has the proponent:

AIP requirement	AGE response	Reviewer comment
		Refer above regarding accounting for take.

Table 3.2 Determining water predictions in accordance with Section 3.2.3 (complete one row only – consider both during and following completion of activity)

	AIP requirement	AGE response	Reviewer comment
1	For the Gateway process, is the estimate based on a simple modelling platform, using suitable baseline data, that is, fit-for-purpose?		Not applicable
2	For State Significant Development or mining or coal seam gas production, is the estimate based on a complex modelling platform that is: • Calibrated against suitable baseline data, and in the case of a reliable water source, over at least two years?	No response provided	Yes, see Section 2 above.
	• Consistent with the Australian Modelling Guidelines?		Yes, see Section 2 above.
	• Independently reviewed, robust and reliable, and deemed fit-for-purpose?		Yes, as part of this peer review (refer to Section 2 above).
3	In all other processes, estimate based on a desk-top analysis that is: • developed using the available baseline data that has been collected at an appropriate frequency and scale; and • fit-for-purpose?		Not applicable

Table 3.3 Has the proponent provided details on:

	AIP requirement	AGE response	Reviewer comment
1	Establishment of baseline groundwater conditions?	Refer to Section 5. The monitoring bore network at the UCC has been installed over a number of different campaigns since 1997. The monitoring network has	The GIA reports on baseline groundwater conditions for the Jurassic sediments, Triassic sediments and Permian units. Monitoring bores have been installed in the Mona Creek sediments, although the date of

Table 3.3 Has the proponent provided details on:

	AIP requirement	AGE response	Reviewer comment
		been adapted over time to ensure that good spatial coverage is maintained.	installation and time series monitoring data are not reported. However, field studies have been conducted to map and characterise the creek sediments and the findings indicate that groundwater associated with the sediments is ephemeral and perched in nature. Given that, it is assumed there are limited data available.
2	A strategy for complying with any water access rules?	Refer to Section 8.1	Predicted take is presented in Section 8.1. It is recommended the GIA (or EIS) includes further discussion on the intended licensing pathway.
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Refer to Section 8.2	Section 8.2 of the GIA presents predicted drawdown at existing third-party landholder bores.
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Refer to Sections 8.1.3, 8.1.4, and 8.2.	Section 8.2 of the GIA presents predicted drawdown at existing third-party landholder bores – it does not explicitly discuss if those bores are licensed or basic landholder rights. Surface water users are not discussed in the GIA. This may be discussed in the Surface Water Assessment, which did not form part of this peer review.
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	There are no high priority GDEs, as defined within WSPs, within the predicted area of drawdown related to the proposed modification (refer to Section 8.3).	The GIA does not identify high priority GDEs in the mining area or Mona Creek area. Section 5.6.1 of GIA notes the BoM GDE Atlas has mapped low potential terrestrial GDEs in the UCC area. AGE reports the depth to the watertable ranges from 0.5 to 80 metres below ground level (mbgl), averaging 15 mbgl. This may be addressed in an ecological report prepared for the modification, however this has not formed part of the peer review. To support the comments made in the GIA (no GDEs), it is recommended consideration of including a figure showing areas (or bores) where the depth to water table is less than 5-10 mbgl, depending on the ecological specialist's understanding of root depths.
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	Refer to Section 8.4	Discussed in Section 8.4, with a focus on Mona Creek, given the modification area.
7	Potential to cause or enhance hydraulic connection between aquifers?	Connections have already been made between the major aquifers due to fracturing that has already occurred. The footprint of these connections will be increased, but there will be no new connections between aquifers	Based on the GIA (Section 7.2) there is the potential for connection between the Mona Creek sediments (ephemeral, perched watertable) and the underground. This has the potential to result in surface water losses during periods of flow (during and following rainfall events)

Table 3.3 Has the proponent provided details on:

	AIP requirement	AGE response	Reviewer comment
8	Potential for river bank instability,or high wall instability or failure to occur?	Refer to surface water report.	The Surface Water Assessment report for the modification has not formed part of this peer review.
9	Details of the method for disposing of extracted activities (for coal seam gas activities)?	Not applicable	Not applicable

Table 3.4 Minimal impact considerations

Aquifer	**Porous Rock – except Great Artesian Basin**
Category	**Highly Productive**
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variation in the watertable, allowing for typical climatic post-water sharing plan variations, 40 metre from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	Watertable drawdown is not explicitly provided, however predicted drawdown in the alluvium / colluvium and Triassic sediments is presented. High priority GDEs or high priority culturally significant sites have not been identified in the area of the predicted incremental drawdown. Appears to be Level 1 impacts.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work	LEVEL 2 – Make good provisions apply The numerical model predicts drawdown >2 m at third-party landholder bores (water supply works) during mining. These bores have been identified for the approved mine plan and proposed modification. The development consent includes conditions regarding compensatory water supply. Post-mining modelling predicts additional bores with >2 m drawdown, however the time period that the impact is predicted varies and is generally in the very long-term.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	LEVEL 1 impacts Section 8.4 of the GIA reports no change to the beneficial use of groundwater sources due to the activity (modification 6).

Table 3.5 Minimal impact considerations

Aquifer	Alluvial
Category	Less productive
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work unless make good provisions apply	LEVEL 1 IMPACT High priority GDEs or high priority culturally significant sites have not been identified in the area of the predicted incremental drawdown.
Water pressure A cumulative pressure head decline of not morethan 40% of the 'post-water sharing plan' pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work.	NOT APPLICABLE
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a 'reliable water supply'.	LEVEL 1 IMPACT Groundwater does not discharge to Mona Creek and the modification is not predicted to change this process.

Table 3.6 Minimal impact considerations

Aquifer	Porous rock or fractured rock
Category	Less productive
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variationin the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependentecosystem or • high priority culturally significant site listed in the schedule of the relevant watersharing plan. **OR** A maximum of a 2 metre water table declinecumulatively at any water supply work.	Watertable drawdown is not explicitly provided, however predicted drawdown in the alluvium / colluvium and Triassic sediments is presented. High priority GDEs or high priority culturally significant sites have not been identified in the area of the predicted incremental drawdown. Appears to be Level 1 impacts.

Table 3.6 Minimal impact considerations

Aquifer	Porous rock or fractured rock
Category	Less productive
Level 1 Minimal Impact Consideration	**Assessment**
Water pressure A cumulative pressure head decline of not morethan a 2 metre decline, at any water supply work.	LEVEL 2 – Make good provisions apply The numerical model predicts drawdown >2 m at third-party landholder bores (water supply works) during mining. These bores have been identified for the approved mine plan and proposed modification. The development consent includes conditions regarding compensatory water supply. Post-mining modelling predicts additional bores with >2 m drawdown, however the time period that the impact is predicted varies and is generally in the very long-term.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	LEVEL 1 impacts Section 8.4 of the GIA reports no change to the beneficial use of groundwater sources due to the activity (modification 6)

Table 3.7 Has the proponent:

AIP requirement		Proponent / AGE response	Reviewer comment
1	Considered types, scale, and likelihood of unforeseen impacts *during operation*?	No response provided	Assessed potential impacts during mining under calibrated "base case" conditions and predictive uncertainty. It is recommended to reference subsidence modelling work completed for the modification (if available) and the surface water assessment, both of which have not formed part of this peer review. Although the Mona Creek colluvial sediments are considered ephemeral and is a less productive groundwater source (and does not have known high priority GDEs associated with it), fracturing that reaches the base of the colluvium is likely to result in surface losses during times of flow (potential surface water impact).
2	Considered types, scale, and likelihood of unforeseen impacts *post closure*?	No response provided	Assessed potential impacts post-mining under calibrated "base case" conditions. Uncertainty analysis was not applied to the post-closure period of groundwater modelling.
3	Proposed mitigation, prevention or avoidance strategies for each of these potential impacts?	No response provided	Impacts are limited to third-party bores and potential for enhanced connection between the Mona Creek sediments (ephemeral and perched watertable). Management and monitoring measures are discussed in Section 10 of the GIA and the UCMPL Groundwater Management Plan, which includes a trigger action response plan. Make good provisions will apply to bores impacted by >2 m drawdown. This is discussed in the UCMPL Groundwater Management Plan. The Groundwater Management Plan will be updated to include the new Mona Creek

Table 3.7 Has the proponent:

AIP requirement		Proponent / AGE response	Reviewer comment
			monitoring bores. It is recommended the Surface Water and Groundwater Response Plan be reviewed to ensure the trigger action response plan is still appropriate with the addition of these bores (ie might need a different trigger, action, response).
4	Proposed remedial actions should the risk minimization strategies fail?	No response provided	Addressed through the Groundwater Management Plan, which will be updated to reflect the modification, if approved. Observations from existing and historical mining have been used to inform the management and response plans.
5	Considered what further mitigation, prevention, avoidance or remedial actions might be required?	No response provided	Section 5.8 of the GIA reports that a "specific monitoring and remediation strategy" will be developed as part of the Extraction Plan in UWLW12 area where fracturing will reach surface (under the existing approved mine plan).
6	Considered what conditions might be appropriate?	No response provided	Not discussed.

Table 3.8 Has the proponent:

AIP requirement		AGE/Proponent response	Reviewer comment
1	Addressed how it will measure and monitor volumetric take? (page 4 of the AIP)	No response provided	Section 10 discusses groundwater monitoring, however the specifics on measuring take are not provided in the GIA. This may be provided in the UCMPL Groundwater Management Plan.
2	Outlined a reporting framework for volumetric take? (page 4 of the AIP)	No response provided	Section 10.3.1 briefly discusses data management and reporting, and notes the Water Management Plan outlines the data management and reporting requirements. The Water Management Plan has not formed part of this peer review.

3.4 Commonwealth assessment requirements

Table 3.9 Summary of impacts to the water quality of the water resource compared to the Department of the Environment and Energy guidelines

Is there a substantial change in water quality of the water resource?	AGE comment	Reviewer comment
Create risks to human or animal health or the condition of the natural environment?	No	No
Substantially reduce the amount of water available for human consumptive uses or for other uses dependent on water quality?	No	No

Table 3.9 **Summary of impacts to the water quality of the water resource compared to the Department of the Environment and Energy guidelines**

Is there a substantial change in water quality of the water resource?	AGE comment	Reviewer comment
Cause persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment?	Refer to Section 8.5. As there are no open cut voids associated with MOD6 there will be no evaporative concentration of salts in groundwaters and therefore there is no mechanism for significant changes to groundwater salinity due to mining.	Section 8.4 of the GIA states: *The proposed modification relates to an underground mine with no significant excavation and therefore no exposure of acid generating materials and no mechanism for the release of heavy metals. Organic chemicals are used in the underground mine and will be used in the proposed modification, but these are common fuels, oils and greases which are typically biodegradable and not persistent.* Based on the above and absence of an open void due to the modification, it appears the modification will not cause an accumulation of such substances in the environment. Note: a geochemical assessment completed for the modification has not formed part of this peer review.
Results in worsening of local water quality where local water quality is superior to local or regional water quality objectives (ie ANZECC guidelines for Fresh and Marine Water Quality)?	No	Not expected.
Salt concentration/generation?	As there are no open cut voids associated with MOD6 there will be no evaporative concentration of salts in groundwaters and therefore there is no mechanism for significant changes to groundwater salinity due to mining.	Not expected as a result of the modification.
Cumulative impact?	Cumulative impacts have been predicted using a numerical model. The cumulative impacts are not predicted to result in a substantial changed in water quality.	The modification is not expected to contribute to cumulative water quality impacts.
If significant impact on hydrology or water quality above, the likelihood of significant impacts to function and ecosystem integrity are to be assessed. The ecosystem function and integrity of a water resource includes the ecosystem components, processes and benefits/services that characterise the water resource.	No	Potential for changes to the integrity of the Mona Creek colluvium, however this water source appears to ephemeral and perched. The GIA reports there are no water dependent assets associated with Mona Creek, however the scope of this peer review did not include an ecological assessment for the proposed modification.

3.4.1 IESC information guideline

The IESC information guideline (Commonwealth of Australia 2018) includes a checklist of specific information needs, which the IESC uses when assessing project information.

In addition to the specific checklist (presented in the GIA and a comparison provided below), the IESC also notes that where assumptions have been made where data and/or analysis are not available, explanation of underlying assumptions should be provided, along with a proposed plan to improve understanding of the system over time, including details of when and how data to support assumptions will be gathered (Commonwealth of Australia 2018).

Table 3.10 Description of the proposal (the proposed modification (MOD6))

Project Information	Addressed in section (AGE comment)	Reviewer comment
Provide a regional overview of the proposed project area including a description of the geological basin; coal resource; surface water catchments; groundwater systems; water-dependent assets; and past, present and reasonably foreseeable coal mining and CSG developments.	Sections 1, 3, 4 and 5	Addressed in the GIA, however further discussion on surface water catchments is presumably provided in the Surface Water Assessment, which has not been viewed.
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations.	Section 2	Addressed in the GIA.
Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Section 1.1	Addressed in the GIA.
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 2	Addressed in the GIA.

Table 3.11 Risk assessment

Project Information	Addressed in section (AGE comment)	Reviewer comment
Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Sections 7, 8 & Appendix A	No specific risk assessment provided; however, assessment of potential impacts due to mining, vertical fracturing and associated dewatering is provided in Section 7 and 8, with uncertainty analysis provided in Section 9.
Assess risks following the implementation of any proposed mitigation and management options to determine if these will reduce risks to an acceptable level based on the identified environmental objectives.	Section 8 and 10	Not specifically addressed; however, potential impacts are considered minor.
Incorporate causal mechanisms and pathways identified in the risk assessment in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	Section 6 & Appendix A	Not specifically addressed (no risk assessment provided in the GIA); however causal pathways are discussed in Section 5, and are simulated in the groundwater model (as described in Section 6 and 7).
The risk assessment should include an assessment of: • all potential cumulative impacts which could affect water resources and water-related assets; and,	Sections 7 & 8	Risk assessment not included in the GIA; however cumulative drawdown is presented in Section 8.6.

Table 3.11 Risk assessment

Project Information	Addressed in section (AGE comment)	Reviewer comment
Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Sections 7, 8 & Appendix A	No specific risk assessment provided; however, assessment of potential impacts due to mining, vertical fracturing and associated dewatering is provided in Section 7 and 8, with uncertainty analysis provided in Section 9.
• mitigation and management options which the proponent could implement to reduce these impacts.		Discussion of management options is provided in Section 10 with reference to the Groundwater Management Plan.

Table 3.12 Groundwater – Context and conceptualisation

Project Information	Addressed in section (AGE comment)	Reviewer comment
Describe and map geology at an appropriate level of horizontal and vertical resolution including: • definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data. • geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	Section 4	Provided in Section 4 and presented on conceptual cross section in Section 5.
Define and describe or characterise significant geological structures (eg faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. Site-specific studies (eg geophysical, coring / wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays). Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.	Sections 4 & 5 (5.8)	Spring Gully Fault is discussed in Section 4.6, including site observations. Faults are not modelled as discrete features. Faults and joints within the Triassic Sandstone underlying Mona Creek have been mapped using geophysical surveys; however, the potential influence of these and the implication of enhanced vertical fracturing due to underground mining has not been discussed in the GIA.
Provide site-specific values for hydraulic parameters (eg vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Section 5.2 and Appendix A	Presented in Section 5.2, noting however that there are limitations on data availability for some parameters and for some units. AGE has presented potential ranges where data are not available.
Provide time series level and water quality data representative of seasonal and climatic cycles.	Section 5.4, 5.5 & 5.8	Select hydrographs presented in Section 5. It would be beneficial to include PZ10A and R894_119 on hydrographs, to support discussions in Section 5.4. Salinity (as electrical conductivity) time-series data are provided in Section 5.5.

Table 3.12 Groundwater – Context and conceptualisation

Project Information	Addressed in section (AGE comment)	Reviewer comment
Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Section 5.1, 5.4 and 5.8	Contour plans of each model layer elevation are provided in Appendix A4. Potentiometric heads (as contours) are presented on Figure 5.6 to 5.8 for the Jurassic, Triassic and Permian formations. There appear to be some bores missing from the maps (eg R894_119 on Figure 5.6 and PZ10A on Figure 5.7). Data recorded at vibrating wire piezometer PZ29 is presented and discussed in Section 5, however Appendix A2 includes a note saying that the monitoring point at PZ29 is "not monitored or erroneous (ie dry or faulty VWP sensor)". It is recommended this be checked, clarified or corrected.
Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations.	Section 5	Groundwater quality is discussed in Section 5.5; however environmental tracer information is not provided. Given the long mining history at this site and that this is a modification to an existing approved mine plan, this information may not be needed (due to low incremental risk).
Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Section 5	Discussed in Section 5.7 and 5.8.
Assess the frequency (and time lags if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Section 5	Discussed in Section 5: • Groundwater associated with Mona Creek sediments is ephemeral and perched, it does not receive groundwater discharge • Groundwater associated with the Jurassic sediments is largely perched, and some areas (including over the UCC area) it is unsaturated • Groundwater associated with the Triassic sediments is in hydraulic connection with the underlying Permian in areas affected by enhanced fracturing, however observations (monitoring data) indicate this effect is localised to the fracturing areas.

Table 3.13 Groundwater – Impacts on water resources and water dependent assets

Project Information	Addressed in section (AGE response)	Reviewer comment
Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: • any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water. • the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance. • the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units. • the possible fracturing of and other damage to confining layers. • for each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	Section 8	Discussed in Section 8. The GIA (and associated Appendix A) discusses the calculated height of fracturing and simulation of it in the groundwater model. Section 7.2 states: *the model represents the Mona Creek sediments being vertically connected to the mining area through fracturing (noting the estimated fracture height is close to the base of the colluvium in this area). The predicted drawdown is considered conservative because the level of predicted fracturing is not expected to extend to the base of the colluvium and, even if it did, this level of interconnection will not be maintained in reality due to self-sealing nature of the unconsolidated clays disturbed by the initial fracturing.* It is recommended to reference subsidence modelling work completed for the modification (if available) and the surface water assessment, both of which have not formed part of this peer review. It is also recommended additional information be provided regarding the potential for the colluvial sediments to "self-seal". Although groundwater associated with the Mona Creek colluvial sediments is considered ephemeral and is not a productive groundwater source (and does not have known high priority GDEs associated with it), fracturing that reaches the base of the colluvium is likely to result in surface water losses during times of flow.
Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Sections 5 and 8**Error! Reference source not found.**	Discussed in Section 5 and 8.
For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Section 8	Discussed in Section 8.
Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Section 2	Section 2 of the GIA refers to the 2000 ANZECC guidelines. Note: these have been updated with the 2018 Australia and New Zealand Water Quality Guidelines; however, many of the guideline values still refer to the

Table 3.13 Groundwater – Impacts on water resources and water dependent assets

Project Information	Addressed in section (AGE response)	Reviewer comment
		values provided in the 2000 guidelines. Environmental flow objectives are not reported in the GIA; these may be reported in the Surface Water Assessment which has not formed part of this peer review.
Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 7.3 and Section 8	Considered as part of the numerical modelling and reported in Section 8.6.
Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	Section 10	Significant impacts, as a result of the modification, are not predicted. Predicted impacts on bores are discussed in Section 8 and management measures are discussed in Section 10 (referring to the Groundwater Management Plan).
Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 10	Managed under the UCMPL Water Management Plan referenced in Section 10.

Table 3.14 Groundwater – Data and monitoring

Project Information	Addressed in section (AGE response)	Reviewer comment
Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Section 5	Data presented in Section 5, however due to the history of mining at the site, there are limited data available regarding pre-development conditions.
Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	Section 5 and 10	Discussed in Section 5 and 10.
Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	Section 5	Section 5 discusses a study (including field program) to improve the conceptual understanding of the Mona Creek sediments and associated groundwater.
Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Section 5 and 10	Discussed in Section 5 and 10.
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (eg QLD Government 2013).	Section 10	Not explicitly discussed, however the groundwater monitoring program is discussed, with reference to the UCMPL

Table 3.14 Groundwater – Data and monitoring

Project Information	Addressed in section (AGE response)	Reviewer comment
		Groundwater Management Plan, in Section 10

Table 3.15 Water dependent assets – Context and conceptualisation

Project Information	Addressed in section (AGE response)	Reviewer comment
Identify water-dependent assets, including: • water-dependent fauna and flora and provide surveys of habitat, flora and fauna (including stygofauna) (see Doody et al. [in press]). • public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.	Section 5.6	Potential GDEs, including "The Drip", are discussed in Section 5.6. Beneficial use is discussed in Section 5.5.
Identify GDEs in accordance with the method outlined by Eamus *et al*. (2006). Information from the GDE Toolbox (Richardson *et al*. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody *et al*. [in press]).	Section 5.6	Specific reference to these methods is not provided in the GIA. This may be addressed in an ecological assessment report completed for the modification (not part of this peer review).
Describe the conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	Section 5.8, 5.9 Ecology Report (XXX)	Discussed in Section 5.6 and 5.9. Tolerance and resilience may be provided in an ecological assessment report completed for the modification (not part of this peer review).
Estimate the ecological water requirements of identified GDEs and other water-dependent assets (see Doody *et al*. [in press]).	Section 5 Ecology Report (XXX)	Not addressed in the GIA. This may be addressed in an ecological assessment report completed for the modification (not part of this peer review).
Identify the hydrogeological units on which any identified GDEs are dependent (see Doody *et al*. [in press]).	Section 5.6	Discussed in Section 5.6.
Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Section 5.6, Appendix A, Ecology Report (XXX)	Discussed in Section 5.6. Not specifically addressed in Appendix A (regarding modelling approach). Ecological report did not form part of this peer review.
Describe the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur) triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	Section 10	Not explicitly discussed in the GIA, however Section 10 refers to the UCMPL Groundwater Management Plan, which includes trigger levels and response plans.

Table 3.16 Water dependent assets – Impacts, risk assessment and management of risks

Project Information	Addressed in section (AGE response)	Reviewer comment
Provide an assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs (see Doody *et al.* [in press]).	Section 8.3 and 8.4	Discussed in Section 8. This may also be addressed in an ecological assessment report completed for the modification (not part of this peer review)
Describe the potential range of drawdown at each affected bore, and clearly articulate of the scale of impacts to other water users.	Section 8.2	Presented in Section 8.2
Indicate the vulnerability to contamination (e.g. from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	Section 8.5	Not specifically addressed in the GIA. Ecological report not reviewed
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	Refer to ecology report (XXXXX)	Ecological report not reviewed. Surface Water Assessment report not reviewed.
Provide estimates of the volume, beneficial uses and impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	Refer to surface water assessment (XXXXX) and ecology report (XXXXX)	Ecological report not reviewed. Surface Water Assessment report not reviewed.
Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Refer to ecology report (XXXXX)	Ecological report not reviewed.
Identify the proposed acceptable level of impact for each water-dependent asset based on leading-practice science and site-specific data, and ideally developed in conjunction with stakeholders.	Refer to ecology report (XXXXX)	Ecological report not reviewed.
Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	Refer to ecology report (XXXXX)	Ecological report not reviewed.

Table 3.17 Water dependent assets – Data and monitoring

Project Information	Addressed in section (AGE response)	Reviewer comment
Identify an appropriate sampling frequency and spatial coverage of monitoring sites to establish pre-development (baseline) conditions, and test potential responses to impacts of the proposal (see Doody *et al.* [in press]).	Refer to ecology report (XXXXX)	Section 5 and 10 discuss the groundwater monitoring program for the site, including proposed additions. Ecological report not viewed by EMM.
Consider concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design, see Doody *et al.* [in press]).	Refer to ecology report (XXXXX)	Ecological report not reviewed.
Develop and describe a monitoring program that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in ecological responses and detects whether ecological responses are within identified thresholds of acceptable change (see Doody *et al.* [in press]).	Refer to ecology report (XXXXX)	Ecological report not reviewed. Section 10 discusses the Groundwater Management Plan, which includes trigger action response plans. This Plan has not been reviewed.

Table 3.17 Water dependent assets – Data and monitoring

Project Information	Addressed in section (AGE response)	Reviewer comment
Describe the proposed process for regular reporting, review and revisions to the monitoring program.	Section 10 Refer to ecology report (XXXXX)	Section 10 introduces monitoring and reporting, including referencing to the Groundwater Management Plan, which has not been reviewed. Ecological report not reviewed.
Ensure ecological monitoring complies with relevant state or national monitoring guidelines (eg the DSITI guideline for sampling stygofauna [QLD Government 2015]).	Refer to ecology report (XXXXX)	Ecological report not reviewed.

Table 3.18 Water and salt balance and water management strategy

Project Information	Addressed in section (AGE response)	Reviewer comment
Provide a quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (eg dust suppression, coal washing etc.), including all sources and uses.	Refer to surface water assessment (XXXXX)	Surface Water Assessment report not reviewed.
Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Refer to surface water assessment (XXXXX)	Surface Water Assessment report not reviewed.
Provide estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	Refer to surface water assessment (XXXXX)	Surface Water Assessment report not reviewed.
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	Refer to surface water assessment (XXXXX)	Surface Water Assessment report not reviewed.

Table 3.19 Cumulative impacts – Context and conceptualisation

Project Information	Addressed in section (AGE response)	Reviewer comment
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 7.3 and Section 8.6	Discussed in Section 7.3 and 8.6.
Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 8	Discussed in Section 8.6.

Table 3.20 Cumulative impacts - Impacts

Project Information	Addressed in section (AGE response)	Reviewer Comment
Provide an assessment of the condition of affected water resources which includes: • identification of all water resources likely to be cumulatively impacted by the proposed development; • a description of the current condition and quality of water resources and information on condition trends; • identification of ecological characteristics, processes, conditions, trends and values of water resources; • adequate water and salt balances; and, • identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	Section 7 and 8 Refer to ecology report (XXXXX)	Section 5 discusses the existing hydrogeological conditions. Section 8 discusses potential impacts. An ecological assessment and surface water assessment may address the other items, however these have not formed part of this peer review.
Assess the cumulative impacts to water resources considering: • the full extent of potential impacts from the proposed project, (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally; • all stages of the development, including exploration, operations and post closure / decommissioning; • appropriately robust, repeatable and transparent methods; • the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts; and, • opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.	Section 7 and 8	Cumulative impacts discussed in Section 8.6.

Table 3.21 Cumulative impacts – Mitigation, monitoring and management

Project Information	Addressed in section (AGE response)	Reviewer comment
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (eg case studies) should be provided.	Refer to SEE Main Text	Not discussed in the GIA. This may be addressed in the EIS, which has not been reviewed.
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Section 10 Refer to SEE Main Text	Monitoring is discussed in Section 10, including reference to the Groundwater Management Plan. Post closure monitoring is not explicitly discussed in the GIA, but may be discussed in the Groundwater Management Plan
Identify cumulative impact environmental objectives.	Section 8.6? Refer to SEE Main Text	Not specifically discussed in the GIA. This may be addressed in the EIS, which has not been reviewed.
Describe appropriate reporting mechanisms.	Refer to SEE Main Text	Reporting is discussed in Section 10, referencing the Groundwater Management Plan

Table 3.21 Cumulative impacts – Mitigation, monitoring and management

Project Information	Addressed in section (AGE response)	Reviewer comment
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (eg case studies) should be provided.	Refer to SEE Main Text	Not discussed in the GIA. This may be addressed in the EIS, which has not been reviewed.
Propose adaptive management measures and management responses.	Section 10 Refer to SEE Main Text	Discussed in Section 10, including referencing the Groundwater Management Plan, which includes trigger action response plans (not reviewed)

Table 3.22 Final landform and voids – Coal mines

Project Information	Addressed in section (AGE response)	Reviewer comment
Identify and consider landscape modifications (eg voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	Preliminary Rehabilitation and Mine Closure Strategy	Report referenced by AGE not reviewed.
Assess the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	Preliminary Rehabilitation and Mine Closure Strategy	Report referenced by AGE not reviewed.
Provide an evaluation of stability of void slopes where failure during extreme events or over the long term (for example due to aquifer recovery causing geological heave and landform failure) may have implications for water quality.	Preliminary Rehabilitation and Mine Closure Strategy	Report referenced by AGE not reviewed
Evaluate mitigating inflows of saline groundwater by planning for partial backfilling of final voids.	Preliminary Rehabilitation and Mine Closure Strategy	Report referenced by AGE not reviewed
Provide an assessment of the long-term impacts to water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should consider: • groundwater behaviour – sink or lateral flow from void. • water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation). • seepage – geochemistry and potential impacts. • long-term water quality, including salinity, pH, metals and toxicity. • measures to prevent migration of void water off-site. For other final landform options considered sufficient detail of potential impacts should be provided to clearly justify the proposed option.	Preliminary Rehabilitation and Mine Closure Strategy	Report referenced by AGE not reviewed. Post-mining recovery is discussed in Section 7.4 (presenting steady state model results).
Assess the probability of overtopping of final voids with variable climate extremes, and management mitigations.	Surface Water Assessment (XXXXX)	Report referenced by AGE not reviewed.

Table 3.23 Acid-forming materials and other contaminants of concern

Project Information	Addressed in section (AGE response)	Reviewer Comment
Identify the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	Geochemistry Assessment	Report referenced by AGE not reviewed.
Identify the presence and volume of potentially acid-forming waste rock, fine-grained amorphous sulphide minerals and coal reject/tailings material and exposure pathways.	Geochemistry Assessment	Report referenced by AGE not reviewed
Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	Geochemistry Assessment	Report referenced by AGE not reviewed.
Describe handling and storage plans for acid-forming material (co-disposal, tailings dam, and encapsulation).	Geochemistry Assessment	Report referenced by AGE not reviewed.
Assess the potential impact to water-dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	Geochemistry Assessment	Report referenced by AGE not reviewed.
Describe proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	Geochemistry Assessment	Report referenced by AGE not reviewed.

4 Conclusion

It is the professional opinion of the undersigned that the groundwater impact assessment and supporting numerical groundwater flow modelling are broadly fit for purpose and meet the requirements of the NSW and Commonwealth Governments. However, it is recommended it be updated with re-calculated predictions of take from the Talbragar River and Talbragar Alluvial Groundwater Source. The take needs to be reported for each water source, as per the requirements of the AIP. In addition, it is recommended the GIA (or EIS) include information regarding the intended pathway to secure the additional water entitlement to account for the predicted additional take.

Yours sincerely

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5 References

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