21 July 2021

Department of Planning, Industry and Environment
Locked Bag 5022
PARRAMATTA NSW 2150
Via Email: Stephen.ODonoghue@planning.nsw.gov.au

Dear Steve,

RE: NARRABRI UNDERGROUND MINE STAGE 3 EXTENSION PROJECT – IESC AND DPIE–WATER RESPONSES AND GROUNDWATER MONITORING CLARIFICATIONS

As you are aware, the New South Wales (NSW) Department of Planning, Industry and Environment (DPIE) placed the Narrabri Underground Mine Stage 3 Extension Project (the Stage 3 Project) Environmental Impact Statement on public exhibition in late 2020.

In response to submissions received during the exhibition period, Narrabri Coal Operations Pty Ltd (NCOPL) lodged its Submission Report on 31 May 2021.

Following this, DPIE has requested the provision of an item by item response to the DPIE-Water and the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) submissions on the Stage 3 Project to allow these agencies to more easily reconcile the detail in the Submissions Report against their submissions (Attachments 1 to 3 of this letter).

In addition, an updated overview of the proposed groundwater monitoring program has also been provided to further clarify monitoring proposed for the Project (Attachment 4 of this letter).

Please do not hesitate to contact the undersigned on 6794 4184, 0448 045 814 or DEllwood@whitehavencoal.com.au should you have any queries.

Yours sincerely,

David Ellwood
Project Director

List of Attachments

Attachment 1	Response to IESC Submission
Attachment 2	Response to DPIE–Water February Submission
Attachment 3	Response to DPIE–Water April Submission
Attachment 4	Updated Groundwater Monitoring Regime

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

ATTACHMENT 1

RESPONSE TO IESC SUBMISSION

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

IESC

Comment 1

IESC states:

> *Overall, the IESC considers that there is still a material risk of impacts on water resources given the current intensive use of groundwater in the region, the predicted extent of subsidence and groundwater drawdown by the project, and the proposed development's proximity to significant water resources such as the Namoi River and its alluvium, springs, other GDEs and the state-listed Lowland Darling River Aquatic Ecological Community (NSW DPI, 2007). Many of these potential impacts were discussed in the IESC's previous advice (IESC, 2019) and are still not adequately addressed.*

Response

Responses to matters raised are provided below. Overall, Narrabri Coal Operations Pty Ltd (NCOPL) has a high degree of confidence in the assessment of water resources and associated ecosystems for the Narrabri Underground Mine Stage 3 Extension Project (the Stage 3 Project) given the assessment undertaken by specialists, which are cognisant of over 10 years of empirical data collected at the Narrabri Mine since operations began, and peer reviews conducted by Mr Brian Barnett, Professor Thomas McMahon and Dr Peter Hancock.

Comment 2

IESC states:

> *A predicted maximum drawdown of the watertable > 10 m is indicated over a large area to the east and northeast of the proposed longwall panels. A steep gradient in the watertable predicted near the Namoi River is apparently related to lithological changes; however, no basis for the ground- truthing of the mapped extent and heterogeneity of these units has been provided. The extent and parameterisation of the hydrogeological units between the proposed longwall panels and the river is uncertain and also contributes to the uncertainty in the predicted net reduction in groundwater discharge to the Namoi River. The predicted reduction in groundwater discharge due to the project is 140 ML/year to the Namoi River by 2192 (AGE 2020, p. 113). The potential for long-term drawdown of the watertable in this water-stressed Groundwater Management Area is of concern and warrants further investigation, modelling and monitoring (Paragraph 22).*

Response (prepared with assistance from AGE)

Predictive uncertainty has been quantified using a stochastic Null Space Monte Carlo based methodology in a manner which is consistent with the current IESC guidance on uncertainty analyses of this type (Middlemis and Peeters, 2018). The sensitivity of model predictions to the parameterisation of all hydrogeological units present between the proposed longwall panels and the Namoi River has therefore been assessed using the most rigorous of the three types of methods identified by Middlemis and Peeters (2018) as being appropriate.

Predictive uncertainty can also arise from a number of other sources including conceptual uncertainties such as the extent of key strata. In keeping with most, if not all, studies of this type, the contribution of other types of uncertainty has been assessed qualitatively, rather than quantitively. Conceptual uncertainty is discussed in Section D 2.4.3 of Appendix D of the Groundwater Assessment (Australasian Groundwater and Environmental Consultants Pty Ltd [AGE, 2020]). As discussed in this section, key controls on the development of impacts between the Narrabri Mine and the Namoi River include the extent of the Hoskissons Coal Seam and the Namoi Alluvium to the east of the Stage 3 Project. The extent of both of these units is considered to be known with a high degree of accuracy. In addition to geological mapping of the area, produced by the Geological Survey of NSW, which typically involves ground truthing using shallow augur holes, further ground truthing of the extent of these strata is provided via 1,600 mine exploration bores and over 1,000 licensed water supply bores in the model domain. Accordingly, no further ground truthing of the extent of these strata was, or is considered, necessary. However, monitoring of groundwater levels and groundwater quality in these and other areas around the Narrabri Mine would continue, in accordance with the Water Management Plan, to confirm impact predictions and to update the Stage 3 Project groundwater model and predictions, where necessary.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Comment 3a

IESC states:

> *In particular, the IESC notes a number of issues with the proponent's assessment of groundwater impacts.*
>
> *a. The groundwater model presented in the Gateway application has been revised, with the proponent undertaking additional work to address many of the issues raised in previous IESC advice. The groundwater modelling provided by the proponent presents extensive steady-state and transient 3D numerical groundwater models accompanied by a stochastic uncertainty quantification of simulated model outputs (AGE 2020, App D, p.12), which have undergone independent peer-review. However, the IESC does not consider that all relevant parameters (e.g. hydraulic conductivity and storativity) and boundary combinations have been considered in the proponent's assessment of potential impacts, which may result in an underestimate of potential impacts. Evidence of this potential underestimate is seen in the reported model-to-measurement misfits, where the calculated range of uncertainty of the modelled groundwater levels does not encompass the actual measured values (AGE 2020, App D, p. 2).*

Response (prepared with assistance from AGE)

As discussed in the Response to Comment 2, the sensitivity of model predictions to all relevant parameters including hydraulic conductivity, storage, boundary condition conductance and other parameters has been assessed and reported in Appendix D of the Groundwater Assessment (AGE, 2020). It is therefore not clear which 'relevant parameters' the IESC comment is referring to.

The final sentence of the IESC Comment 3a which relates to model to measurement misfits does not recognise that any numerical model of this type represents a simplification of a substantially more complex reality or that the purpose of the numerical model is to predict the impacts of the proposed development. Modelled to measurement misfits are inevitable in a model of this type.

Therefore, predicted water levels at monitoring points should be assessed on the ability of the model to predict observed trends and impacts, rather than on whether or not the calculated ranges of uncertainty encompass all of the actual measured values.

Consistent with its stated aim, the model does not seek to exactly match system stresses and other hydrogeological features which affect groundwater levels but which have little or no bearing on the ability of the model to predict impacts. For instance, groundwater level data are available for over 100 monitoring bores completed into the Namoi Alluvium and have been used for calibration of the numerical model. As shown in Figure A1-1, the overall statistical fit to these data is very good, as evidenced by the scaled root mean square (SRMS) error of 3.3 percent (%), which suggests that the overall model parameterisation of the Namoi Alluvium is appropriate.

Nevertheless, as shown in Figure A1-2 the model cannot accurately replicate observed groundwater levels at all locations in the alluvium. In this case, the model is able to accurately replicate the longer term observed seasonal fluctuations and minor observed drawdown (i.e. the observed impact) over the monitored period. On the other hand, modelled groundwater levels are systematically higher than observed and short term fluctuations, which are likely to be related to nearby pumping from the Namoi Alluvium, are also not replicated in the model. In this case, the modelled fit to the observed data would most likely be improved by adding resolution and/or adjusting the elevation of surficial boundary conditions and collecting more detailed pumping records for nearby bores (i.e. to simulate the influence of pumping from these bores). However, such changes would have little or no benefit in terms of the model's ability to predict the indirect impact of the Narrabri Mine on the Namoi Alluvium. In fact, by adding unnecessary complexity into the model, these changes would affect the degree to which predictive uncertainty can be assessed, as required in the IESC guidance note (Middlemis and Peeters, 2018).

A further example which relates to a nested monitoring facility in the Napperby Formation close to the existing mine workings is provided in Figure A1-3. In this example, the model is able to very closely match the water level trends and observed impact at this point, suggesting that the model is a close to perfect predictor of drawdown impact in this case. Given that the purpose of the model is to predict impact this is a more important characteristic of the hydrograph than the fact that absolute modelled levels are around 10 metres (m) lower than predicted.

As mentioned above, all numerical models of this type represent a simplification of a substantially more complex reality. In particular all groundwater models of this type by necessity incorporate a relatively high degree of 'upscaling' whereby relatively thick model layers are used to represent highly heterogenous sedimentary strata. Several hundred layers would likely be required to more fully represent the complexity of the strata potentially affected by the Stage 3 Project. Due to size limitations, a model with this level of detail in the vertical direction would likely not be capable of accurately predicting long term regional drawdown patterns (i.e. drawdown in the horizontal direction). Accordingly, even where alternative parameterisation realisations are developed as part of an uncertainty analysis, it is not possible to replicate observed drawdown and/or absolute levels at all locations. Modelled to measurement misfit (or error) is inevitable and most calibration schemes rely on minimisation of this error such that observed groundwater levels and impacts tend to be under and over-estimated at an approximately even number of locations. A model that systematically over or under estimates absolute groundwater levels and/or impacts would generally not be considered well calibrated.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

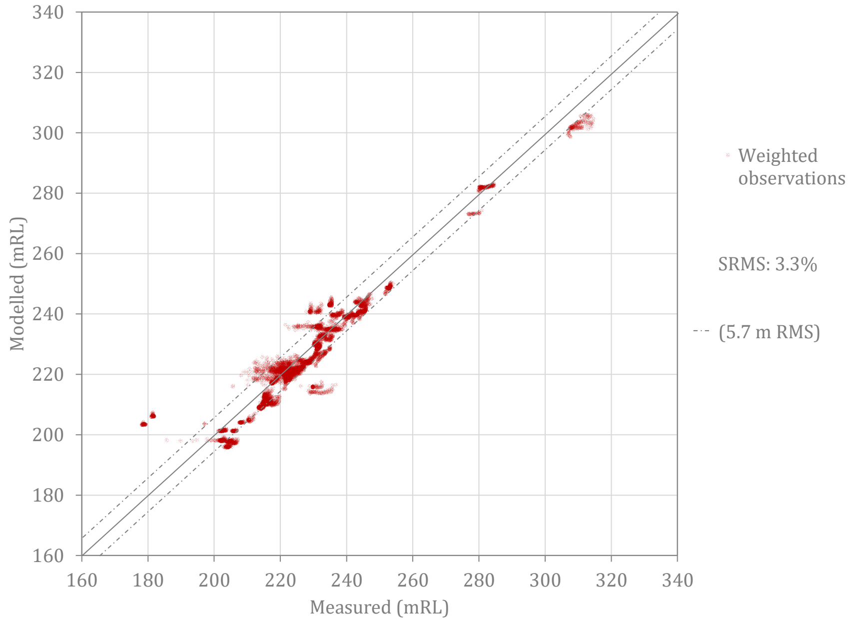


Figure A1-1
Transient Calibration – Modelled vs Observed Groundwater Levels, Namoi Alluvium (Source: AGE [2021])

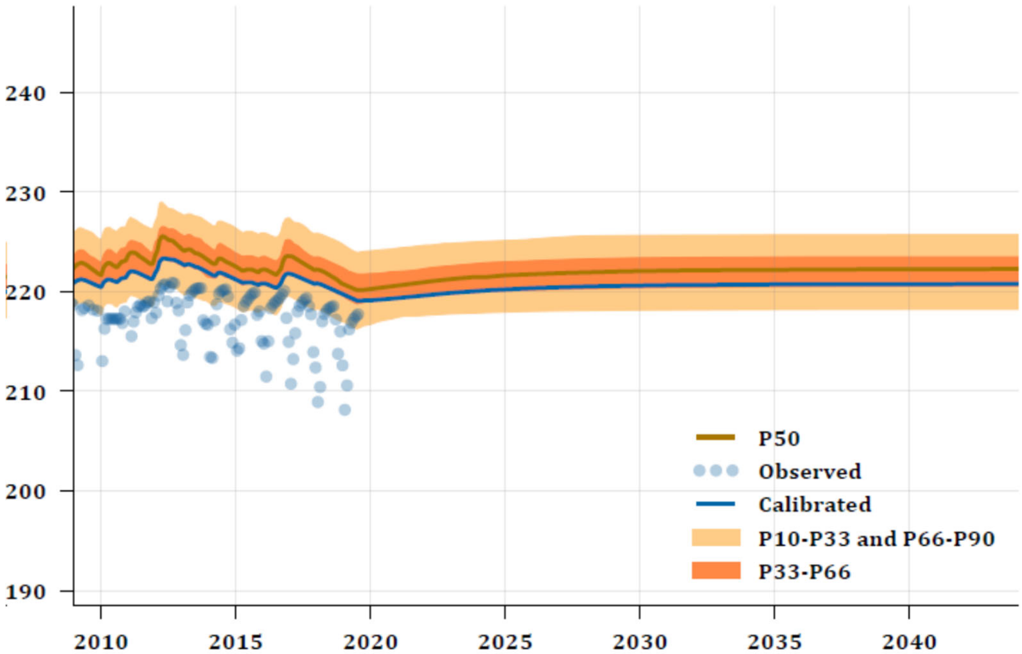


Figure A1-2
Modelled Versus Observed Groundwater Levels, Namoi Alluvium, Monitoring bore 030233.1.3 (Source: AGE [2021])

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

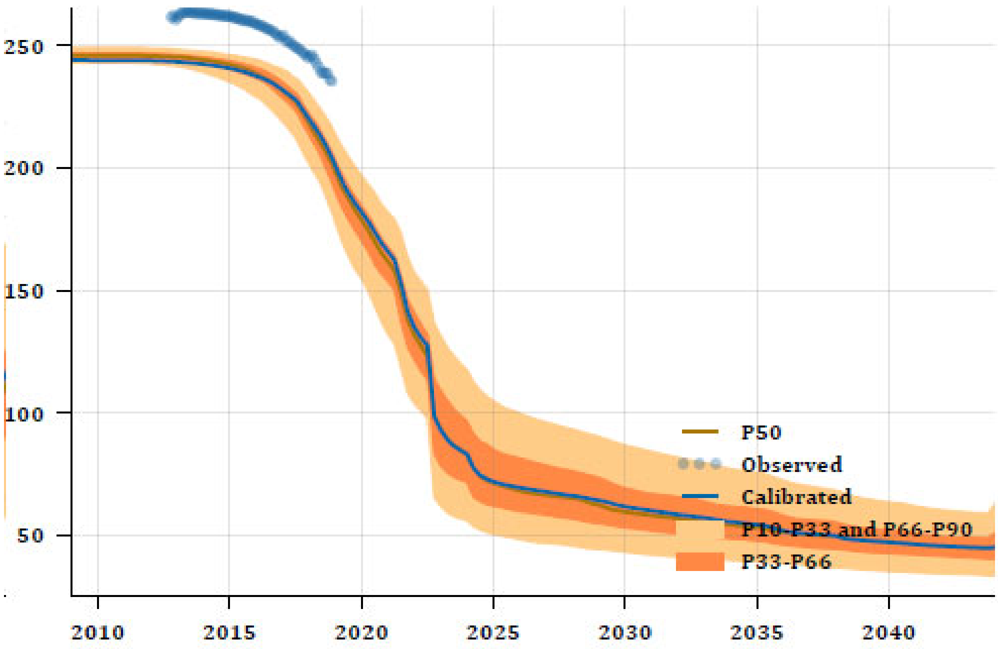


Figure A1-3
Modelled Versus Observed Groundwater Levels, Napperby Formation, Monitoring bore P40_307 (Source: AGE [2021])

A comparison of modelled versus observed groundwater levels in NCOPL monitoring bores located close to the current Narrabri Mine, as reported in Appendix D of the Groundwater Assessment (AGE, 2020) is provided in Figure A1-4. As shown, the data plots either side of the 1:1 line which denotes a perfect match with the observed data suggesting that the calibrated model does not systematically over or under-estimate absolute groundwater levels.

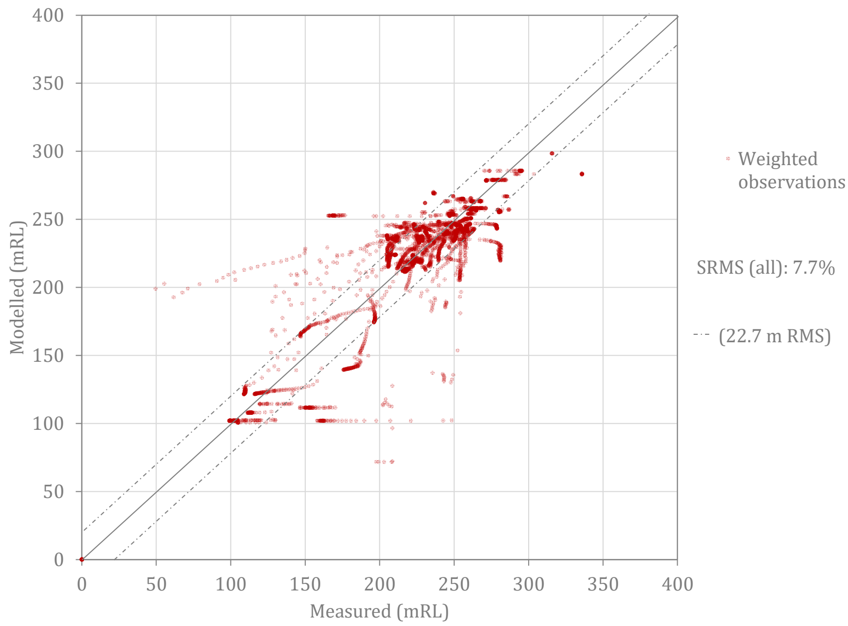


Figure A1-4
Transient Calibration – Modelled vs Observed Groundwater Levels, NCOPL Monitoring Bores (Source: AGE [2021])

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

Table A1-1 presents the results of a similar comparison but this time focussing on modelled versus observed total drawdown rather than absolute groundwater levels. It should be stressed that the values shown in Table A1-1 represent total observed and modelled drawdown relative to the first recorded value and may therefore include drawdown related to pumping for irrigation purposes, climate and other influences, as well as drawdown related to operation of the mine. As shown in Table A1-1, observed drawdown impacts at 43 out of 69 monitoring locations are over-predicted by the model and hence the model appears to be slightly biased towards over-prediction of impacts at most locations, rather than tending to under-estimate impacts as asserted by the IESC. This makes it a conservative tool suitable for impact assessment and decision making.

Table A1-1
Comparison of Observed and Predicted Maximum Drawdowns by Hydrostratigraphic Unit

Formation Monitored	Monitoring Point Count[1]	Observed Maximum Drawdown Range (m)	Predicted Maximum Drawdown Range (m)	No. of Bores Where Predicted Maximum Drawdown Exceeds Observed
Pilliga Sandstone	7	0.01-2.27	0 – 0.72	4 (57%)
Purlawaugh Formation	6	0 – 7.84	0.01 – 0.4	1 (17%)
Garrawilla Volcanics	9	0.06 – 26.88	0.01 – 21.1	5 (56%)
Napperby Formation	15	0 – 35.58	0.08 – 74.68	14 (93%)
Digby Formation	7	0 – 63.91	0.08 – 108.95	4 (57%)
Hoskissons Coal Seam	15	3.05 – 196.33	0.06 – 168.86	11 (73%)
Arkarula Formation	5	0 – 193.27	0.06 – 94.62	2 (40%)
Pamboola Formation	5	0 – 19.44	0.3 – 48.34	4 (80%)
Total	69	0 – 196.33	0 – 168.86	43 (62%)

Source: AGE (2021)

1 NCOPL monitoring points with more than one year of data (i.e. sufficient observed groundwater level data to establish longer term trends).

Brian Barnett relevantly concluded in his peer review:

> *I have concluded that the calibration approach and outcomes meet all reasonable expectations (including guiding principles outlined in Australian Groundwater Modelling Guidelines) and in most regards exceed current industry standards.*

Comment 3b

IESC states:

> *b. The proponent has provided maximum predicted groundwater drawdown maps for each formation. However, these maps only provide drawdown to a 2 m contour. Noting the proponent has not adequately sampled GDEs in the area (Paragraphs 5, 7, 14, 15, 16, 17, 30, 31), a greater resolution in the presented drawdown predictions is required to better assess the potential impacts of the project. For example, drawdown of 0.5 m may substantially alter spring discharge rates and adversely affect aquatic and semi-aquatic communities in the seepage zone. In alluvial sediments shallower than 2 m, a drawdown < 2 m may alter groundwater flux and reduce stygofaunal habitat.*

Response (prepared with assistance from AGE)

Regional drawdown maps for aquifers intended for use in assessing impacts at water supply bores (e.g. Figures 7.3 to 7.8 of the Groundwater Assessment [AGE, 2020]) show 2 m, 5 m, 10 m, 20 m, 50 m, 100 m and 200 m drawdown contours. However, all maps which present water table drawdown at potential Groundwater Dependent Ecosystem (GDE) sites (e.g. Figures 7.25 and 7.26 in the Groundwater Assessment) also show predicted 0.2 m, 0.5 m and 1 m drawdown contours. Furthermore, recognising that some GDEs can be significantly affected by relatively small drawdowns (Section 7.6.2 of the Groundwater Assessment) are provided to the nearest centimetre.

Maximum predicted drawdowns in each aquifer are provided in Attachment 2 of the Submissions Report.

Comment 3c

IESC states:

c. *The IESC notes the approximate heights (4.3 m) and widths (300-400 m) of the longwalls combined with the relatively shallow cover depths of 165-346 m will result in extensive subsidence and surface-to-seam cracking across the site. This in turn will result in increased hydraulic connectivity and drainage of impacted aquifers, resulting in permanent drawdown impacts. Currently, there is an inconsistency between the predictions of the Subsidence Assessment (DGS, 2020) and the conservative assumptions regarding the increases in hydraulic connectivity parameters resulting from this subsidence. Site-specific data should be used to justify the parameter functions applied in the model for hydraulic conductivity and specific storage, particularly around longwall panels.*

Response (prepared with assistance from AGE)

Information on the predicted height of the A-Zone above longwall panels used in the groundwater model are summarised in Table D 2.6 in Appendix D of the Groundwater Assessment (AGE, 2020). Comparison of this table with the equivalent tables (Table 9A and Table 10A of the Subsidence Assessment [Ditton Geotechnical Services, 2020]) confirms that the A-Zone height values adopted in the groundwater study are consistent with those reported in the Subsidence Assessment (Ditton Geotechnical Services, 2020). However, as discussed in Section D 2.5.6.3 in Appendix D of the Groundwater Assessment (AGE, 2020) in relation to the depth of the surface cracking zone beneath the ground surface (the D-Zone) the groundwater assessment adopts a more conservative D-Zone calculation of ten times the panel height, based on previous work by Guo et al (2007). Accordingly, the Groundwater Assessment effectively assumes potential seam-to-surface cracking over larger parts of the mining area than reported in the Subsidence Assessment.

As discussed at in Sections 5.2.11 and D 2.5.6.1 (in Appendix D) of the Groundwater Assessment (AGE, 2020) site specific data, in the form of groundwater data for nested monitoring facility (P57) installed above longwall panel Longwall 108A, has already been used to estimate potential heights of fracturing and calibrate the groundwater model. Modelled hydraulic parameters in the A- and D-Zones are therefore already constrained by site specific data. Furthermore, as summarised in Section D5 of Appendix D of the Groundwater Assessment a range of possible alternative parameters for functions affecting both hydraulic conductivity and storage above longwall panels have been assessed as part of the predictive uncertainty analysis. Further data collection above future longwall panels is also proposed (Attachment 4 of this letter). Additional data from these additional sites will likely act to further refine the range of impacts currently predicted.

Comment 3d

IESC states:

d. *Noting some of the rapid depressurisation of groundwater resources predicted in the EIS groundwater assessment, the groundwater model should be bi-annually updated as works progress at the site. More extensive regional monitoring of the Purlawaugh, Napperby and Digby Formations along with the Garrawilla Volcanics would provide a better indication of hydrostratigraphic unit interaction, and provide the evidence required to explain why the proponent has observed depressurisation in many of these groundwater sources. Updating of the model based on further monitoring of groundwater levels in the area above the longwalls would refine the assessment of the impact on regional groundwater fluxes caused by the increasing vertical hydraulic conductivity in that area (Paragraphs 12, 22).*

Response (prepared with assistance from AGE)

It is assumed that 'bi-annually' in this case means every two years (biennial) rather than every six months. Six-monthly updates would require a near-continuous rolling program of data collection, processing, model re-calibration and predictions. Consistent with Project Approval 08_0144, the current site Water Management Plan for the Narrabri Mine (NCOPL, 2017) includes a commitment to re-calibrate the Stage 3 Project groundwater model two years after commencement of longwall extraction and every five years thereafter. A similar commitment in the revised Water Management Plan for the Stage 3 Project is proposed, whereby the groundwater model would be updated two years after approval of the Stage 3 Project and every five years thereafter. This commitment is consistent with other contemporary projects in NSW. The revised Water Management Plan for the Stage 3 Project would also identify a number of other circumstances, which may trigger further development and/or re-calibration of the model as follows:

- a significant change to the mine plan;
- acquisition of new hydrogeological information, such as groundwater levels and aquifer properties (i.e. hydraulic conductivity), which are different to calibrated values used in the model; and
- groundwater drawdown and inflows which significantly exceed model predictions for that stage of mining.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Additional monitoring recommendations are provided in Section 8.2 of the Groundwater Assessment (AGE, 2020) and include the installation of additional groundwater level and quality monitoring facilities at six locations upstream and downstream of the site on Kurrajong, Pine and Tulla Mullen Creeks (Figure A1-5). In addition to installing standpipe piezometers in the Quaternary alluvium and immediately underlying bedrock strata (as recommended by AGE [2020]), NCOPL proposes to install a further six vibrating wire piezometer (VWP) monitoring nests at each of these locations. Each VWP nest would include monitoring in each stratigraphic present above the Hoskissons Coal Seam.

A subsidence calibration borehole would also be established within the Stage 3 Project mining areas (nominally within Longwalls 203 or 204). In addition, as shown in Figure A1-5 since a number of the existing sites are above proposed longwall panels (and proposed sites in near proximity to the longwall panels) this will also provide additional data on mining impacts. This data would then be used to re-calibrate the model and hence also ultimately address IESC Submission 6 which calls for the use or more site-specific data above longwall panels. More detail is provided in Attachment 4 of this letter.

<u>Comment 3e</u>

IESC states:

> *e. The Groundwater Assessment (AGE, 2020) in the EIS acknowledges the information gaps regarding surface water and groundwater interactions at creeks and springs present at the project site. AGE (2020, p. 146) recommends expansion of the monitoring network to include monitoring bores at these sites. The IESC agrees that the proponent should install these suggested monitoring bores and incorporate their data into the model and update predictions before this project (Stage 3) progresses (see Paragraphs 15, 22).*

Response (prepared with assistance from AGE)

As discussed in the Response to Comment 3d above, additional groundwater monitoring is proposed at six locations shown in Figure A1-5. Each site would comprise standpipe monitoring bores installed into the Quaternary alluvium and immediately underlying bedrock and VWP nests monitoring groundwater levels in underlying units. These additional facilities would be installed as soon as possible after approval is received such that they could provide significant additional groundwater level data into a refinement of the groundwater model to be completed within two years of approval.

<u>Comment 4</u>

IESC states:

> *4. Although the documentation states that there is a current groundwater quality monitoring program, (which includes monthly monitoring of pH and EC, and annual monitoring of major ions, alkalinity, total P and some metals), no data (apart from salinity) are included in the EIS. Additional information on the aquifers monitored and the frequency of monitoring is required, as well as actual data for a wider range of parameters, including the soluble metals identified in the geochemical assessment (antimony, arsenic, cobalt, molybdenum, selenium).*

Response (prepared with assistance from AGE)

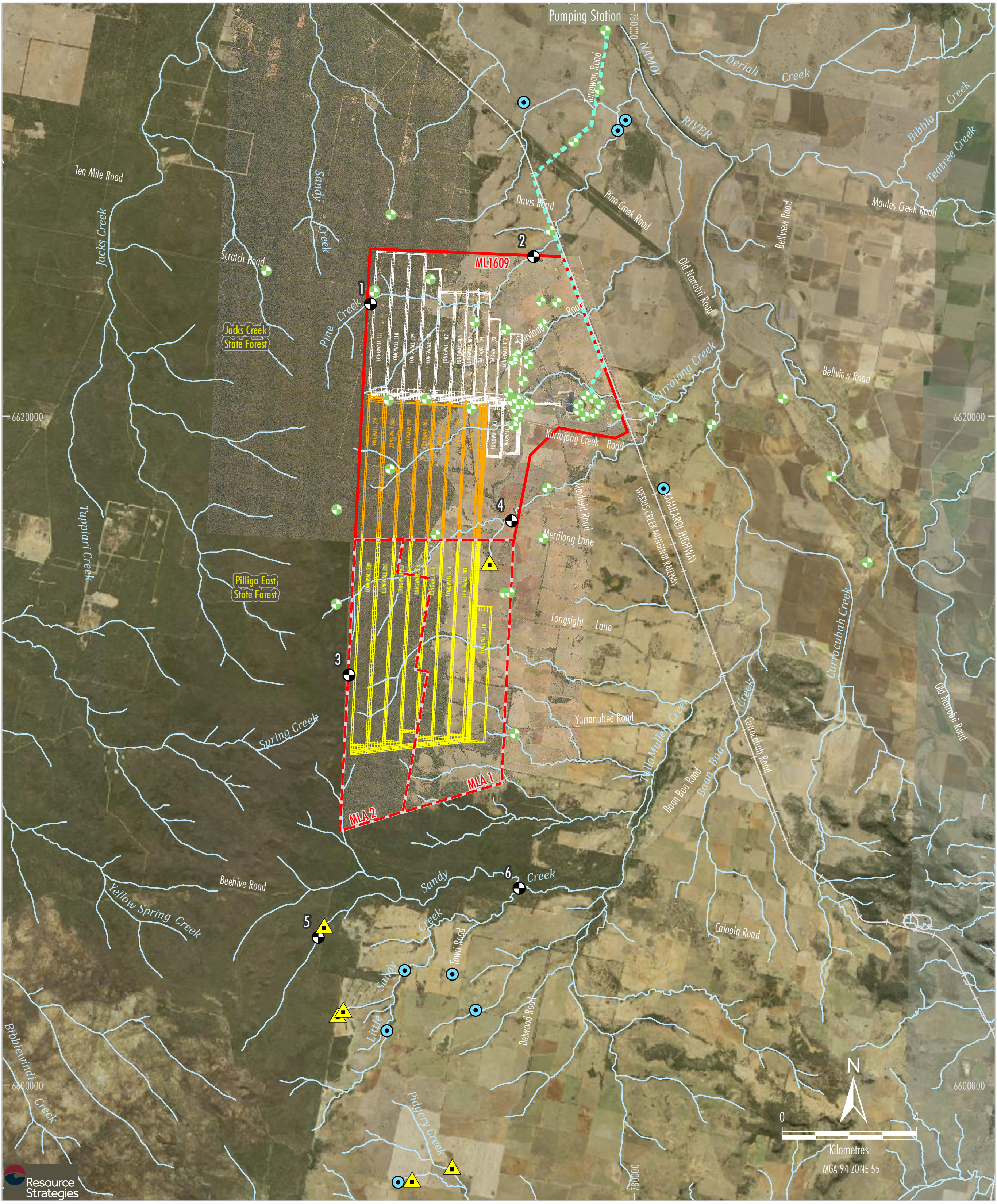
Further details of the Narrabri Mine groundwater quality monitoring program are presented in the currently approved site Water Management Plan (NCOPL, 2017). Groundwater level and quality data collected from the network of monitoring bores is summarised in a series of annual environmental audit reports which are available on the Whitehaven website. These reports also provide a summary of environmental performance over the preceding year in relation to groundwater inflows, groundwater levels and groundwater quality. A revised version of the current Water Management Plan to address regulator comments is currently being assessed by the NSW Department of Planning, Industry and Environment – Water (DPIE-Water). This document would be further revised following approval of the Stage 3 Project.

As documented in Appendix E of the 2019 environmental audit report (Environmental Resources Management Australia Pty Ltd, 2020), groundwater samples taken from the site are regularly tested to confirm arsenic and cobalt concentrations and are typically at or close to detection limits. Testing for antimony, molybdenum and selenium has not routinely been undertaken historically but will be added to the revised Water Management Plan for the Stage 3 Project.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU



LEGEND
- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Existing Namoi River Pipeline (Buried)
- Approved Underground Mining Layout
- Indicative Underground Mining Layout to be Extended for Project
- Indicative Underground Project Mining Layout
- Existing Groundwater Monitoring Site
- Proposed Groundwater Monitoring Site
- Proposed Groundwater Monitoring at Affected Bores
- Proposed Potential Groundwater Feature Monitoring Site

Source: NCOPL (2019); NSW Spatial Services (2019); AGE (2021)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Current and Proposed Groundwater Monitoring Locations

Figure A1-5

Comment 5

IESC states:

5. *The IESC is not confident that the proponent has adequately assessed potential impacts on GDEs, especially springs (Paragraph 8, 14) and stygofauna (Paragraph 16). For groundwater-dependent vegetation, these impacts may include a combination of groundwater drawdown and disruptions to the root systems (e.g. shearing) caused by subsidence (see Paragraphs 30, 31). Distressed or dead trees have been recorded in areas of subsidence over completed mining longwalls (Resource Strategies 2020, p. 100). Despite this information, the proponent states that there will be minimal impacts to the vegetation as changes will happen gradually. Subsidence of up to 3 m and the formation of cracks larger than 0.5 m are highly likely to significantly disrupt root systems of overlying vegetation. Although risks to GDEs have been assessed, the risk matrix contains conflicting information and should be reviewed. For example, the proponent claims that the risk to springs and GDEs due to groundwater drawdown is 'low' whilst according to the matrix values of likelihood (rated 'unlikely') and consequence (rated 'catastrophic'), the risk should be classified as 'high' (Operational Risk Mentoring 2020, p. 15).*

Response

Stygofauna

Dr Peter Hancock assessed the information presented in the Environmental Impact Statement (EIS) relating to potential impacts to stygofauna. The assessment concluded that (Attachment 4 of the Submissions Report):

- the predicted drawdown at Tulla Mullen Creek and Namoi alluvium would have a negligible effect on stygofauna communities; and
- it is very unlikely that the re-injected brine salutation would impact on stygofauna communities.

Root Shearing

As described in the Biodiversity Development Assessment Report (BDAR) (Resource Strategies Pty Ltd [Resource Strategies], 2020), a number of trees were observed to be dead or highly stressed following the completion of mining of Longwalls 101 and 102. The impacts were studied by Eco Logical Australia (2014). The study included:

- tree health assessment and associated data analysis;
- soil landscape character assessment;
- soil moisture assessment;
- groundwater assessment;
- subsidence sheer stress assessment;
- analysis of rainfall preceding subsidence; and
- tree regeneration assessment.

Eco Logical Australia (2014) attributed the observed impacts to factors such as dry conditions, low depth of cover and heavy soil texture. The area with a depth of cover of 180 m and below were found to approximately correlate to the area of potential cracking impacts noted by Eco Logical Australia (2014), however the majority of impacts occurred at a depth of cover of 170 m and below. Figure 31 of the BDAR (Resource Strategies, 2020) shows the areas of 180 m depth of cover for the Stage 3 Project and for the existing Narrabri Mine. For the existing Narrabri Mine, not all trees in this area were observed to be stressed, however, the BDAR assumes all trees within the noted 180 m depth of cover would be impacted. As the Narrabri Mine has moved west, to areas of greater depth of cover, vegetation impacts have not been observed. Furthermore, the assessment by Ditton Geotechnical Services (2020) (Peer Reviewed by Professor Bruce Hebblewhite) indicates that the risk of potential impacts on vegetation due to this mechanism is limited to clayey soils above Longwall 210, particularly if dry conditions prevail at the time of mining.

It is, therefore, considered that the methodology used to assess this potential impact in the BDAR is conservative.

Surface Cracking

As described in the BDAR, land subsidence (which is predicted to occur across the predicted subsidence area) is unlikely to materially impact vegetation or habitat, as dieback or more than occasional tree fall is unlikely. Surface cracking is more likely in the eastern portion of the Stage 3 Project (outside of the majority of woodland areas) because the depth of cover trends from lower to higher, east to west. As noted in the BDAR, it is conceivable that ground animals could fall into subsidence cracks and would likely climb out (i.e. this would not necessarily result in fauna death). Cracks would naturally fill over time or would be remediated.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Risk Rankings of GDEs in the EIS

The consequence level was incorrectly assigned and should have been reported as a 2 (i.e. minor), resulting in a Low risk level. A Low risk level is consistent with the outcomes of the Groundwater Assessment (AGE, 2020) and BDAR (Resource Strategies, 2020).

Comment 6

IESC states:

> *6. The effects of drawdown on vegetation are dismissed as 'minor impacts' (Resource Strategies 2020, p. 103), despite drawdown in many areas being predicted to be 10-20 m. Even in areas where the water is only 2 m below ground level before drawdown, this amount of drawdown is likely to severely impact groundwater-dependent vegetation. Such impacts potentially disrupt vegetated corridors and impair or remove vital habitat for native fauna and flora. The claim that mining-induced changes in groundwater level will be gradual and lie within predicted ranges does not preclude the likelihood that the rates of drawdown will be greater than the ability of the root systems to maintain contact with the water table. Further, when drawdown peaks (estimated as some 150 years post- mining), groundwater levels below many of these terrestrial GDEs may be too low to ameliorate the effects of other stressors such as prolonged drought and dieback.*

Response (prepared with assistance from AGE)

Terrestrial flora in the areas where predicted drawdown is in the order of 10 to 20 m are facultative[1], rather than obligate[2]. Given this, and the fact that the predicted drawdown is expected to occur gradually, the drawdown could potentially result in additional stress to large trees, however, is unlikely to result in widespread loss. Assessment of groundwater drawdown impacts on terrestrial ecosystems is provided in Section 6.19.3 of the EIS:

> *As described in Section 6.4.3, the Project would result in groundwater table drawdown, predominantly due to groundwater inflows to the underground mining area during operations. Groundwater drawdown is expected to occur gradually during operations, with maximum drawdown predicted to occur post mining, and recovery taking many decades (Appendix B).*
>
> *The magnitude of predicted water table drawdown at 'high priority' groundwater dependent vegetation (Figure 6 29b) would be significantly less than the estimated seasonal water table variation (Appendix B), and the drawdown would occur at a very slow rate.*
>
> *Minor changes to the groundwater regime may not have any adverse impacts on facultative groundwater dependent vegetation that uses groundwater as required (opportunistically), but these ecosystems can dieback if reduced access to groundwater is prolonged or if the change is too rapid that the trees are not able to adapt (Appendix D).*
>
> *At some groundwater dependent vegetation, predicted drawdown exceeds 10 m which is expected to result in larger trees potentially not being able to access groundwater in drought conditions (Appendix D).*
>
> *The drawdown could result in additional stress to larger trees associated with the facultative GDEs during prolonged drought conditions, but is not likely to result in the widespread loss of the larger trees, or prevent the long-term viability of the dependent ecosystem, due to (Appendix D):*
>
> - *the GDEs being facultative (not obligate);*
> - *the presence of same ecosystems in areas where groundwater is too deep for trees to access;*
> - *the localised areas of material (i.e. greater than 1 m) predicted drawdown;*
> - *the availability of other water sources during non-drought conditions; and*
> - *the rate of drawdown would occur at a very slow rate.*
>
> *There is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.*
>
> *As discussed in Section 6.4.3, no groundwater quality impacts are anticipated due to the Project during operations or post-mining (Appendix B).*

---

1 Refers to GDEs that use groundwater optionally or opportunistically.

2 Refers to GDEs that are extremely dependant on groundwater.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Maximum drawdowns of less than 5 centimetres (cm) are predicted at three potential spring sites (AGE, 2020). It is therefore considered unlikely that discharge from these springs would be significantly affected. On the other hand, drawdown in excess of the relevant NSW *Aquifer Interference Policy* (AIP) (Department of Primary Industries [DPI] – Office of Water, 2012) threshold is predicted at a number of potential GDE areas. These areas are predominantly located within the Gunnedah Oxley Basin Murray Darling Basin (MDB) Groundwater Source and include areas which are mapped as being dominated by Red Gum, River Red Gum, shallow freshwater wetland sedgeland with smaller areas of Ironbark and Box grassy woodland. The majority of these mapped GDEs are located close to Tulla Mullen Creek to the south east of the Narrabri Mine and in areas close to the Namoi River to the north-east. Predictions suggest that up to 157.9 hectares (ha) of areas mapped as high priority GDEs could experience drawdowns greater than the estimated AIP threshold due to the Stage 3 Project only and 160.9 ha if the Narrabri Gas Project was to be developed concurrently. However, as discussed above, whilst the drawdown could result in additional stress to larger trees associated with the facultative GDEs during prolonged drought conditions, it is not likely to result in the widespread loss of the larger trees, or prevent the long-term viability of the dependent ecosystem. Further assessment of potential impacts on GDEs is provided in Section 6.19 of the EIS.

Current and proposed monitoring locations are shown in Figure A1-5 and include two new monitoring locations to the south of the Stage 3 Project, close to mapped GDE areas.

Comment 7

IESC states:

> 7. *Confidence concerning the impacts to terrestrial GDEs needs to be increased by obtaining field measurements of groundwater use by vegetation (Doody et al. 2019), especially for species overlying the longwalls and in areas where the predicted drawdown is > 5-10 m. Facultative GDEs may largely rely on groundwater during periods of prolonged drought when they are under severe stress. Loss of or decline in the condition of this vegetation is likely to impact on arboreal species such as Squirrel Gliders (Petaurus norfolcensis) and Koalas (Phascolarctos cinereus) that inhabit these trees and are listed as Vulnerable under the Biodiversity Conservation Act 2016 (BC) and/or the EPBC Act.*

Response (prepared with assistance from AGE)

Figure A1-6 shows the location of high priority GDE areas in relation to the approved and Stage 3 Project longwall panels. GDEs where predicted maximum drawdowns exceed 5 m are shown shaded based on the GDE type, other GDEs where maximum impacts of less than 5 m are predicted are shown shaded grey. As shown in this map no GDEs are mapped in areas overlying longwall panels. Maximum impacts of more than 5 m are predicted at a small number of GDE polygons to the east and south-east of the Stage 3 Project area. Further assessment of the potential ecological impacts of these predicted drawdowns on GDEs is provided in Section 6.19 of the EIS. Potential impacts on fauna are discussed in Response to Comment 14.

Comment 8

IESC states:

> 8. *Three springs (Mayfield, Hardys and Eather) are identified as GDEs within and near the project area. Few details are provided about them apart from claims that they are all highly modified and that anecdotal evidence indicates spring flows have declined in the last ten years. However, these still qualify as GDEs and are crucial sources of water in a semi-arid environment. Detailed information on the ecohydrology of all three springs is required, including discharge and recharge rates, water quality and assessments of the diversity and condition of aquatic and semi-aquatic species present (Doody et al. 2019). This information will enable more accurate assessment of likely impacts of drawdown on these GDEs and their biodiversity.*

Response (prepared with assistance from AGE)

Maximum drawdowns of less than 5 cm are predicted at each of the three potential spring sites (Mayfield, Hardys and Eather). Nevertheless further monitoring at each site is outlined in Section 8.2 of the Groundwater Assessment (AGE, 2020), the purpose of which is to observe any changes to flow rates and surface conditions and to confirm whether these features are groundwater dependent. Depending on the results of this monitoring, the revised Water Management Plan for the Stage 3 Project would be updated to include ecological monitoring and further ongoing groundwater and surface water monitoring, similar to the shallow monitoring proposed at the creek sites. Site-specific monitoring details (including monitoring frequency and duration) would then be developed as part of the revised Water Management Plan for the Stage 3 Project.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

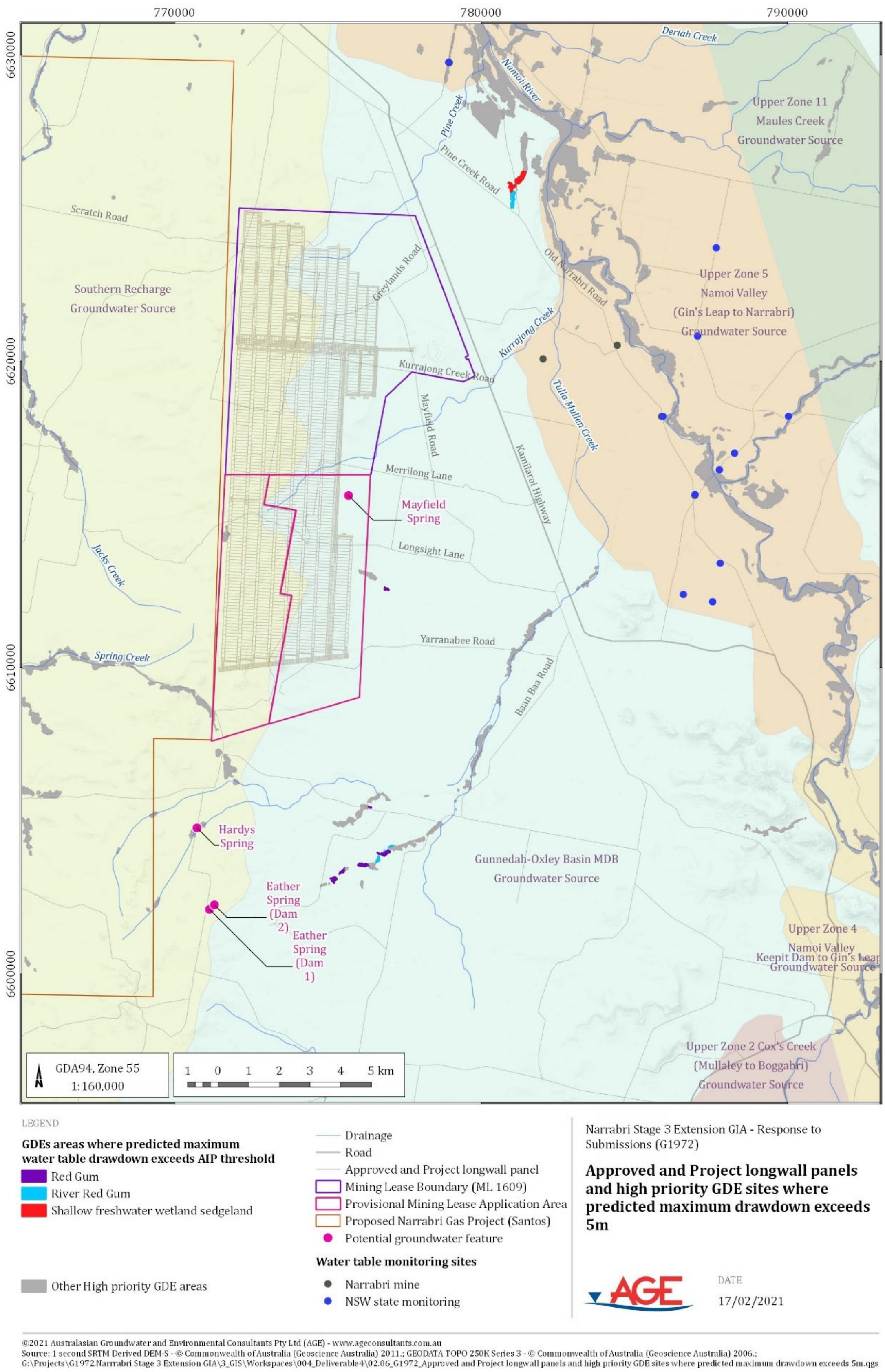


Figure A1-6
Approved and Project Longwall Panels and High Priority GDE Sites where Predicted Maximum Drawdown Exceeds 5 m

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Comment 9

IESC stated:

> 9. *The IESC notes that the proponent has incorporated impacts associated with the Narrabri Gas Project, using Santos' 'base case' scenario, into the cumulative impact predictions of the groundwater modelling. The IESC considers that this is an acceptable approach to assessing potential cumulative groundwater impacts at the site, noting the comments in Paragraph 3b.*

Response

Comment noted.

Comment 10

IESC stated:

> 10. *Considering the significant distances (ca. 30-50 km) to the nearest open cut coal mines in the area, and the justification provided for selecting groundwater model boundaries, it is reasonable for the proponent to exclude the potential cumulative impacts of mines located to the south-west of the project area. Additionally, the geological characteristics of the Boggabri Ridge separating the Mulley sub-basin from the Maules Creek sub-basin justify not including these other open cut mines in the cumulative impact assessment.*

Response

Comment noted.

Comment 11

IESC stated:

> 11. *The proponent has not commented on the likely composition of brine and its potential impacts on groundwater quality when re-injected. No information on the current groundwater quality in the various aquifers, apart from salinity, has been provided by the proponent preventing the IESC from assessing the likely future impacts of brine reinjection on groundwater quality. Assumptions and assessment of brine re-injection on long-term groundwater quality require further justification.*

Response (prepared with assistance from AGE)

In accordance with the AIP, which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focusses on impacts on groundwater salinity or total dissolved solids (TDS).

Potential impacts of the re-injection of brine into the mine goaf at completion of mining are identified in Section 7.8.2 of the Groundwater Assessment (AGE, 2020). The majority of the TDS load in the brine came from underground in the first place (i.e. was pumped to the surface from the coal seam as part of mine dewatering) and the practice of brine re-injection is approved for the existing Narrabri Mine. Given this, the long-term water quality impacts of re-injecting the brine into the Hoskissons Coal Seam was assessed as being negligible for the Project. Nevertheless, as summarised in Section 7.8.2 of the Groundwater Assessment, further calculations were undertaken to quantify the impact of brine re-injection in terms of total salinity. The results, which were based on predicted TDS loads in excess of the 99th percentile presented in the Surface Water Assessment (WRM Water & Environment Pty Ltd [WRM], 2020), suggest a possible slight increase in TDS concentrations in the Hoskissons coal seam in the long term from around 8,700 to 10,100 milligrams per litre (mg/L). Post-mining re-injection is considered unlikely to affect potential groundwater usage in the Hoskissons Coal Seam since few, if any, water supply bores in the area target this unit on account of its high background TDS. Furthermore, no impact on groundwater quality in adjacent aquifers is expected. Numerical modelling results suggest that the goaf areas will not become fully saturated until after 2261 (i.e. around 218 years after closure of the mine). Thereafter, groundwater model predictions also suggest downward head gradients within the mining area long term (i.e. from the Hoskissons Coal Seam to the underlying Arkakula Formation). As summarised in Table 7.8 in the Groundwater Assessment, existing monitoring data indicates an average TDS in the Arkarula Formation of 12,884 mg/L (i.e. more than the predicted long term TDS in the goaf) and hence groundwater quality in this unit might be expected to improve due to leakage from the overlying unit.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Comment 12

IESC stated:

> 12. *Long-term impacts of brine re-injection require further justification which consider the recovery of groundwater levels and change in groundwater flux. The extensive fracturing caused by subsidence provides conduits for brine to migrate widely, including lateral extension contamination, potentially impacting local and adjacent GDEs, water bore resources and local aquifers. Despite hydraulic gradients increasing towards the goafs (i.e. the groundwater flow gradients will act like a sink towards the mine), the increase in hydraulic connectivity above the goafs coupled with the already saline groundwater present in the lower hydrostratigraphic units may have impacts on the groundwater quality long-term. These impacts will see an increase in the EC of water above the goafs. Preferential flow pathways may cause the more saline groundwater to be transported to the Pilliga Sandstone and Namoi River Alluvium present within or near the project area. The proponent should monitor hydraulic interactions above the current goafs present at the mine and trial the injection of harmless tracer-fluids into these goafs to model the flow pathways in the system above the goafs.*

Response (prepared with assistance from AGE)

As discussed in Section 7.8.2 of the Groundwater Assessment (AGE, 2020) and in the Response to Comment 11, numerical model based predictions suggest:

- That the hydraulic conductivity of the goaf area is likely to be sufficiently high to allow re-injection of the brine at the rates required with only minimal head increases (less than 6 m at the point of injection).
- The total volume of brine to be injected represents less than 2% of the pore space in the goaf, which is estimated to be 137,617 megalitres (ML) at the completion of mining.
- That the available pore space would not be filled until around 200 years after mining ceases.

During the estimated 218 year recovery period hydraulic gradients would remain towards the mine leading to the gradual dilution of the brine *in situ* as generally lower TDS groundwater is drawn in from surrounding groundwater units. Longer term predictions, which include simulation of fracturing of the overlying strata, also suggest downward fluxes within the mining area. Hence, whilst this fracturing may lead to the development of preferential pathways in the overlying strata, it is not clear by what mechanism the IESC believes that brine could migrate vertically upwards through these fractures against the prevailing hydraulic gradients, which are towards the mine during the recovery period and downward in the long term. Vertical movement upwards will also tend to be reduced by density differences between the brine and fresher groundwater in the overlying units.

As discussed above (Response to Comment 3d), hydraulic interactions above the goaf areas will be monitored via an expanded network of monitoring facilities which includes a further six VWP nests. However, it is not clear how the IESCs suggestion that harmless tracer fluids be injected into partially saturated goaf areas to model flow pathways in the system above the goaf areas would work. Most tracer fluids injected into these areas would report to the mine drainage system, rather than the overlying strata.

Comment 13

IESC stated:

> 13. *The proponent has not assessed the likely impacts of brine re-injection on GDEs, especially in combination with the effects of drawdown and altered groundwater flux. Given the need to more fully assess GDEs and, in some cases, their level of groundwater dependence (Paragraphs 15), the potential impacts of altered groundwater quality as a result of brine injection are needed.*

Response (prepared with assistance from AGE)

As discussed previously (Response to Comment 11 and 12) and presented in Section 7.8.2 of the Groundwater Assessment (AGE, 2020) the post closure re-injection of relatively small amounts of brine into goaf areas is not expected to impact water quality in adjacent units or at GDEs which are located at surface between 165 m and 400 m above the coal seams. Numerical modelling results which include simulation of the mine and the proposed re-injection indicate that hydraulic gradients will remain towards the goaf areas for around 200 years post-closure and then revert to generally downward gradients once full recovery has been achieved.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Comment 14

IESC stated:

> 14. *The terrestrial vegetation and fauna of the project site have been thoroughly surveyed by the proponent over multiple years. Desktop and survey data indicate the presence of biodiverse communities that include several species listed by the BC and/or EPBC Acts as Vulnerable (e.g. Large-eared Pied Bat (Chalinolobus dwyeri), Koala, Squirrel Glider, Pilliga Mouse (Pseudomys pilligaensis), Corben's Long-eared Bat (Nyctophilus corbeni)). Many of the faunal species are likely to rely on surface water when it is available as well as using riparian and other vegetation for habitat and food. The proponent does not provide detailed assessments of how potential habitat alterations by the project might directly or indirectly affect each of these species during and after mining. Some of the vegetation is likely to be groundwater-dependent and may be adversely affected by drawdown (and possibly brine injection, see Paragraph 11,13) although the extent of the vegetation's dependence on groundwater in the project area is unknown (Paragraph 7, 15). Although springs within and near the project area have been altered, they still have local and regional aquatic values that have not been adequately described and assessed by the proponent (Paragraph 8). Similarly, stygofauna (an obligate GDE) in the zone of predicted drawdown have not been surveyed and are assumed to be unlikely to occur despite other literature describing stygofauna collected along the Namoi River and its tributaries (see Paragraph 16). Watercourses draining the project area are ephemeral and their flow regimes, to which local fauna and vegetation are adapted, are likely to be altered by subsidence that changes patterns of runoff and causes ponding. However, the potential effects of these changes in stream flow regimes on aquatic biota and riparian zone vegetation have not been adequately described and assessed (see Paragraph 17).*

Response

The Stage 3 Project is located within the tributary catchments of Kurrajong Creek, Pine Creek and Tulla Mullen Creek. These creeks are ephemeral, with flow typically occurring only during heavy rainfall events.

Potential impacts on the watercourses were assessed as part of the Surface Water Assessment (WRM, 2020). As described in Section 6.5 of the EIS, the Stage 3 Project would not have a significant impact on the hydrological characteristics of the waterways. The ephemeral nature of the waterways and the broad distribution of waterways and depression zones suggest that there would not be an impact on the number of no-or low-flow days (WRM, 2020). The incremental change in catchment area due to the Stage 3 Project would be minor and would not have a measurable impact on catchment flows (WRM, 2020).

As described in the EIS, the potential subsidence impacts on unnamed ephemeral and intermittent watercourses would be monitored and managed through a process of adaptive management. Under this process:

(i) regular monitoring would detect if and where the impact occurs;

(ii) an assessment would be made to determine the potential consequences of the observed impact; and then

(iii) appropriate control works would be put in place.

Given the above predicted potential impacts on watercourses, there is unlikely to be an adverse impact on the availability of surface water for fauna, including the Large-eared Pied Bat, Koala, Squirrel Glider, Pilliga Mouse, or Corben's Long-eared Bat.

Section 6.19 of the EIS provides an assessment of GDEs drawing on information and assessments within the Groundwater Assessment (AGE, 2020) and the BDAR (Resource Strategies, 2020). The drawdown could result in additional stress to larger trees associated with the facultative GDEs during prolonged drought conditions but is not likely to result in the widespread loss of the larger trees, or prevent the long-term viability of the dependent ecosystem. There is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.

Given the above predicted potential impacts on GDEs, there is unlikely to be a material adverse impact on the fauna habitat, including habitat for the Large-eared Pied Bat, Koala, Squirrel Glider, Pilliga Mouse, or Corben's Long-eared Bat.

As discussed in Response to Comment 6, drawdown could potentially result in additional stress to larger trees associated with facultative GDEs during prolonged drought however is not expected to result in the widespread loss of the larger trees or prevent the long-term viability of the ecosystem.

Dr Peter Hancock assessed the information presented in the EIS relating to potential impacts to stygofauna. The assessment concluded that (Attachment 4 of the Submissions Report):

- the predicted drawdown at Tulla Mullen Creek and Namoi alluvium would have a negligible effect on stygofauna communities;
- it is very unlikely that the re-injected brine salutation would impact on stygofauna communities; and
- it is not considered necessary that additional stygofauna samples be collected from Tulla Mullen Creek, nor from bores near Hardy, Eather and Mayfield Springs.

Comment 15

IESC stated:

15. *Although the proponent has done an extensive desktop survey of potential GDEs, few of these have been verified by ground-truthing (AGE 2020, App. B, p. 142). 'High priority' terrestrial GDEs in, and near, the project area have also been identified based on satellite image analysis with limited ground-truthing (AGE 2020, App. B, p. 122). Some of these potential GDEs occur in areas where drawdown is predicted but these assessments are severely hampered by the paucity of data on groundwater dynamics near these GDEs and uncertainty about the degree of groundwater- dependence of the vegetation. It is recommended that monitoring bores be installed near patches of 'high priority' GDEs in areas where drawdown is predicted so that changes in groundwater levels can be monitored before, during and after mining. Further, the proponent should assess the level of groundwater-dependence (Doody et al. 2019) to confirm that these are indeed GDEs and, if so, the proponent should explain the likely effects of drawdown (and possibly brine injection, see Paragraph 13) on their condition, recruitment and persistence. This is especially relevant for those GDEs where drawdown is predicted to exceed thresholds defined by the Aquifer Interference Policy (AGE 2020, App. B, Table 7.6, p. 124-125). However, potential impacts of drawdown on all GDEs (not just 'high priority' ones) should be assessed by the proponent because they are all defined as Matters of National Environmental Significance (MNES) under the 'water trigger' and have ecological values in this semi-arid landscape, especially where they provide habitat, food or both for EPBC Act-listed species. These GDEs include those along watercourses and on alluvial flats where drawdown is predicted.*

Response

Proposed additional groundwater level and water quality monitoring was discussed previously in the response to Submission 7 (Response to Comment 3d). Current and proposed monitoring locations are shown in Figure A1-5 and include two new monitoring locations to the south of the Stage 3 Project, close to mapped GDE areas.

A field inspection of the relevant high potential GDE vegetation communities was conducted in July 2020 in order to verify the ecological condition and possible groundwater dependency of each community. The dominant flora species along with the geographic location and soil observations were recorded at 49 locations across the mapped terrestrial GDE areas potentially affected by the Stage 3 Project. Depth to water table and soil water holding capacity data for the Stage 3 Project was also used in assessing groundwater dependency of the target vegetation.

The mapped GDE vegetation communities were found to be located across a range of low sand dunes, cleared grazing land with paddock trees, roadside strips on cracking clay, ephemeral creeklines and patches of sedge habitat along an area of intermittent ponding.

The field verification concluded that most of the mapped GDE areas are likely to be facultative GDEs (or have a low potential to access groundwater), however minor changes to the groundwater regime as a result of the Stage 3 Project may not have any adverse impacts on these GDEs and there is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.

Comment 16

IESC stated:

16. *The proponent asserts that stygofauna are unlikely to occur along Kurrajong Creek or other watercourses within the project area because there is no mapped alluvium along these creeks which are also highly ephemeral and either entirely or usually disconnected from the Namoi Alluvium (AGE 2020, App. B, p. 77). However, it is acknowledged that stygofauna might occur in the alluvium of Tulla Mullen Creek and the adjacent Namoi River. Furthermore, stygofauna have been collected from the alluvium of the Namoi River (Korbel et al. 2017) and several sites along nearby Maules Creek (Andersen et al. 2016). The IESC recommends that the proponent test their assumptions about the occurrence of stygofauna by sampling bores along creeks traversing the project area, in the vicinity of the springs that occur in the headwaters of Kurrajong (Mayfield) and Tulla Mullen (Hardys and Eather) creeks, and in the alluvium of the lower Tulla Mullen Creek where drawdown is predicted (AGE 2020, App. B, Fig. 7.24, p. 128). If stygofauna are found, the proponent should assess the likely impacts of the predicted drawdown, especially where groundwater habitats may be isolated from the Namoi Alluvium and other potential sources of colonists. Potential impacts of brine injection on stygofauna (Paragraph 13) should also be assessed.*

Response

Dr Peter Hancock assessed the information presented in the EIS relating to potential impacts to stygofauna (Attachment 4 of the Submissions Report).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Drawdown of the lower Tulla Mullen Creek alluvial aquifer is predicted to be less than one metre for most of the area affected (Figure 6-29a of the EIS). In the area modelled for drawdown, the aquifer of Tulla Mullen Creek is between approximately 20 and 60 m deep, with less extensive alluvium up to 10 m thick extending west along Sandy Creek (Figure 4.3 of the Groundwater Assessment). Stygofauna are most likely to occur in the thicker sections of aquifer because this is where the water level is most stable, and the connection to the Namoi Alluvium likely to be strongest. The modelled drawdown of less than 1 m is within the historical range of drawdown in the Namoi Alluvium (AGE, 2020), and within tolerance range for stygofauna. Further, a drawdown of less than 1 m would not isolate the Tulla Mullen Creek alluvium from the Namoi Alluvium, so there is no risk of stranding or isolating upstream communities.

Dr Peter Hancock concluded that the predicted drawdown at Tulla Mullen Creek and Namoi alluvium would have a negligible effect on stygofauna communities (Attachment 4 of the Submissions Report).

Potential impacts of the re-injection of brine into the mine goaf at completion of mining are identified in Section 7.8.2 of the Groundwater Assessment (AGE, 2020). Since the majority of the TDS load in the brine came from underground in the first place and the practice of brine re-injection is approved for the existing Narrabri Mine, then the long-term water quality impacts of re-injecting these solids in a more concentrated form into the Hoskissons Coal Seam was assessed as being negligible. Nevertheless, as summarised in Section 7.8.2 of the Groundwater Assessment, further calculations were undertaken to quantify the impact of brine re-injection in terms of total salinity. The results, which were based on predicted TDS loads in excess of the 99th percentile presented in the Surface Water Assessment (WRM, 2020), suggest a possible slight increase in TDS concentrations in the Hoskissons coal seam in the long term from around 8,700 to 10,100 mg/L. Post-mining re-injection is, therefore, considered unlikely to affect potential groundwater usage in the Hoskissons Coal Seam since few, if any, water supply bores in the area target this unit on account of its high background TDS.

Furthermore, no impact on groundwater quality in adjacent aquifers is expected. Numerical modelling results suggest that the goaf areas would not become fully saturated until after 2261 (i.e. around 218 years after closure of the mine). Thereafter, groundwater model predictions also suggest downward head gradients within the mining area in the long-term (i.e. from the Hoskissons Coal Seam to the underlying Arkakula Formation). As summarised in Table 7.8 in the Groundwater Assessment (AGE, 2020), existing monitoring data indicates an average TDS in the Arkarula Formation of 12,884 mg/L (i.e. more than the predicted long-term TDS in the goaf), and hence groundwater quality in this unit might be expected to improve due to leakage from the overlying unit.

Dr Peter Hancock concluded that it is very unlikely that the re-injected brine salutation would impact on stygofauna communities (Attachment 4 of the Submissions Report).

Comment 17

IESC stated:

> 17. *Although the creeks draining the project area are ephemeral, they still have significant ecological values (Datry et al. 2017), are MNES under the 'water trigger', and comprise part of The Lowland Darling River aquatic ecological community which is listed as an endangered ecological community (NSW DPI, 2007). Their flow regimes, including ecologically important flow components (such as low-flow spells and number of zero-flow days), are likely to be substantially altered by subsidence-induced changes to catchment topography and runoff, the instream profile (including areas of ponding) and areas where streambed cracking may occur. The proponent does not provide adequate detail of the likely impacts of these changes in flow regimes and their components upon aquatic or semi-aquatic biota and riparian zone vegetation of the undermined creeks. The listing of The Lowland Darling River aquatic ecological community has given all native fish and other aquatic animal life within its boundaries the status of endangered species (NSW DPI 2007, p. 2) and therefore this aspect deserves detailed attention. There should also be an assessment of the collective downstream effects on the flow regime caused by the altered stream flows of Kurrajong Creek and the tributaries of Tulla Mullen Creek that will be undermined.*

Response (prepared with assistance from WRM)

Given WRM's assessment that the Stage 3 Project is unlikely to impact the flow regime of local creeks, it follows that impacts on the Lower Darling River aquatic ecological community would not be material. Impacts on the Lower Darling River aquatic ecological community are addressed in Section 6.4 of the BDAR (Resource Strategies, 2020):

> *The Lowland Darling River aquatic endangered ecological community listed under the FM Act includes the Namoi River (Figure 1) and associated tributaries, such as Kurrajong Creek and Pine Creek. Kurrajong Creek and Pine Creek do not provide any sufficient permanent habitat for aquatic biota as flow likely only occurs during heavy rainfall events. The potential for aquatic GDEs to occur was considered by AGE (2020), who concluded that Kurrajong Creek and Pine Creek are not aquatic GDEs.*
>
> *Kurrajong Creek would be traversed by multiple access tracks and the services corridor associated with the Project within the Development Footprint. There would also be subsidence impacts on watercourses as described in Section 6.2.1. Erosion and sedimentation are discussed in Section 6.2.2.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

The following measures would be implemented to mitigate and manage the adverse impacts on the Lowland Darling River aquatic endangered ecological community (Section 7):

- *vegetation clearance protocol, including delineating areas to be cleared and/or retained (Biodiversity Measure 1);*
- *progressive revegetation of disturbed areas (mine rehabilitation) with species characteristic of the surrounding vegetation (Biodiversity Measure 2);*
- *management of the potential for localised Project-related channel erosion on Kurrajong Creek and other ephemeral creek lines using appropriate sediment and erosion controls (Biodiversity Measure 6);*
- *monitoring programme for creek lines (including Kurrajong Creek) (Biodiversity Measure 7); and*
- *construction of drainage line crossings would be undertaken in accordance with the policy and guideline document of DPI-Fisheries NSW Why do fish need to cross the road? (Fairfull and Witheridge, 2003) (Biodiversity Measure 8).*

Also, as part of the Project, NCOPL would decommission two existing farm dams on Kurrajong Creek prior to longwall mining occurring in those areas. Decommissioning activities would occur generally in accordance with Landcom (2004).

Based on the above, the Project would not adversely impact any threatened species or communities listed under the FM Act. The MOP and Extraction Plan (incorporating the BMP and RMP) would facilitate the implementation of the management measures.

Further it is noted that DPI Fisheries, in its submission, stated:

DPI Fisheries note that subsidence impacts on waterways will be minor.

Comment 18a

IESC stated:

18. There is a low level of confidence in predictions of potential impacts to surface water resources, especially undermined tributaries of Tulla Mullen and Kurrajong creeks, as no explicit account has been given to subsidence and mining-induced fracturing.

a. The proposed operations at the site will likely result in substantial cracking and subsidence above all goafs including to the surface (Paragraph 3c). As far as the IESC can discern, the likely impacts of subsidence and cracking have not been adequately outlined in the surface water assessment of the site. The proponent should demonstrate consideration of the impacts of substantial fracturing on rates of recharge and reliability of baseflow of the ephemeral tributaries, and on the potential for increased losses from the 40 farm dams that are potentially impacted by subsidence. Furthermore, modelling of erosion to tributaries along fractures between LW101 and LW111 will assist in determining potential impacts to other tributaries in the area.

Response (prepared with assistance from WRM)

Section 4.3 of the Surface Water Assessment (WRM, 2020) provides a description of the watercourses that cross the Stage 3 Project area. The explicit assessment of potential impacts of subsidence and mining induced fracturing of these waterways is given in Section 8 of the Surface Water Assessment. The level of assessment was commensurate with the likely risks to environmental harm, given the hydrology of the watercourses and the rehabilitation strategies implemented at the existing Narrabri Mine operations. Further justification for the level of assessment is given in the following responses.

Section 8.1 of the Surface Water Assessment (WRM, 2020) considers and describes the likely impacts of subsidence and cracking on the surface water resources. The assessment concludes that the Stage 3 Project is not expected to impact on the low and medium flows or flow regime of the watercourses. With respect to baseflows, the assessment states that the watercourses are “all ephemeral with minimal to no baseflow” under existing conditions and therefore there would be no baseflow to lose. The downstream vegetation would be adapted to the existing intermittent and infrequent flow conditions already and any change would be significantly less than the natural variation in flow.

Although there is no recorded flow data on site, the statement on the lack of baseflow is based on the 15 years that the NCOPL has been observing the waterways through the planning and operational phases of the mine. It is also based on observations from WRM staff who have inspected the waterways almost every year since 2007.

Further evidence of the lack of baseflow is shown in Figure A1-7, which is a ranked plot of the recorded daily flows at the WaterNSW stream gauge on Bohena Creek at the Newell Highway (GS410905). Although the Bohena Creek catchment is much larger, its flow characteristics are expected to be similar to the site catchments because it drains the Pilliga State Forest and has similar soil and vegetation characteristics as the upper headwaters of the site catchments. Figure A1-7 shows that Bohena Creek flowed on about 15% of days and there is little to no baseflows, which for Bohena Creek could be considered the flows less than 100 megalitres per day (1.1 cubic metres per second). This is also supported by the environmental assessment undertaken for the Narrabri Gas Project (Santos Ltd, 2015), which determined that Bohena Creek is a ‘losing’ stream that loses water to the perched alluvial aquifer.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

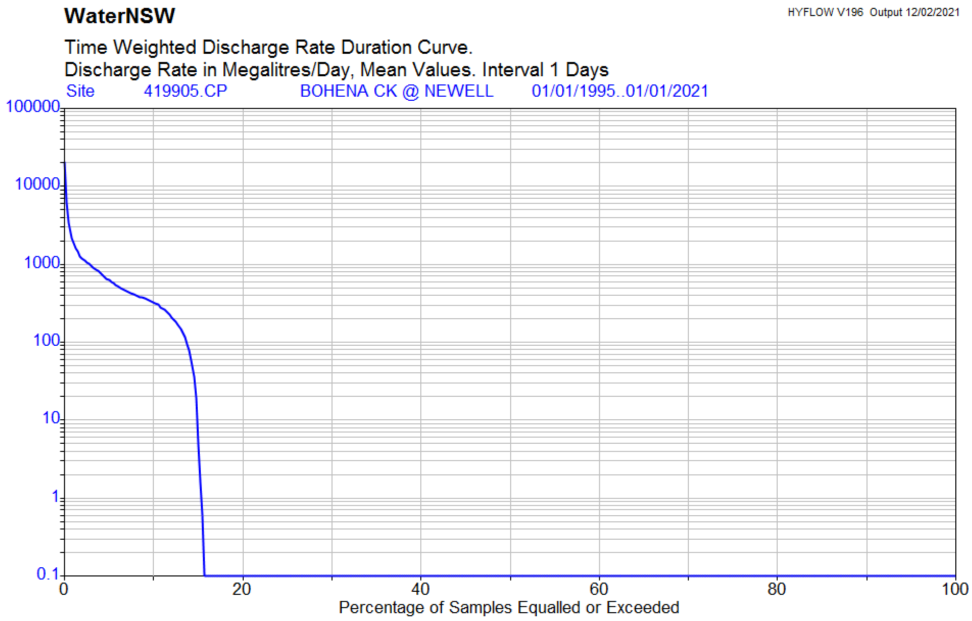


Figure A1-7
Daily flow duration curve, Bohena Creek at the Newell Highway (GS419905)

On the basis that there are no baseflows along the waterways under existing conditions, any impact on stream flows due to subsidence would be to surface runoff and not baseflows. Therefore, the potential loss of baseflows has been adequately considered in the EIS.

NCOPL has not "modelled the erosion to tributaries along fractures between LW101 and LW111". However, the Extraction Plan Water Management Plan (Whitehaven, 2016) commits NCOPL to monitor the area affected by surface cracking on a monthly basis and/or following significant rainfall and remediate the cracks if needed. Pictures of a subsidence induced surface crack and the remediated crack above the existing mine are shown in Figure A1-8. This type of remediation would occur to any of the farm dams if a significant water level draw down was observed. Note that additional leakage from the dams above the existing subsidence area has not occurred to date.

<u>Comment 18b</u>

IESC stated:

> b. *The proponent states that additional surface depressions (ponding) are not expected to impact on the low and medium flows or flow regime of the watercourses as the watercourses are highly ephemeral with no baseflow observed under existing conditions. Although the waterways within the project area are ephemeral, surface water modelling informed by baseline stream gauging is still required to assess water loss from surface waters due to groundwater drawdown and from cracking and ponding, and potential changes in runoff generation processes due to increased surface depressions, under a range of climatic scenarios.*

Response (prepared with assistance from WRM)

NCOPL acknowledges the IESC's recommendation to demonstrate the impacts from surface cracking or subsidence due to the Stage 3 Project on local catchment stream flows. However, establishing a stream gauge that is capable of demonstrating the impacts has always been deemed impractical. First, all assessments undertaken to date have predicted negligible to no loss of stream flows due to the existing and proposed project for the following reasons:

- The predicted surface ponding volumes are small in comparison to the existing ponding volumes and overall stream volumes.
- The loss of surface flow due to surface cracking is deemed unlikely and cracks, when they occur, are remediated (Figure A1-8).
- The Groundwater Assessment (AGE, 2020) predicted existing water table levels some 5 m to 20 m below the bed level of the waterways, suggesting changes to groundwater will not impact on baseflows (as there are minimal to no baseflows).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

Figure A1-8
Photographs of Before and After Crack Remediation at the Narrabri Mine

These predictions have generally been consistent with the observations encountered for the waterways across the existing longwall mining areas.

Given the predicted losses are negligible, a very accurate and reliable stream gauge would be required to predict a change, which is not practical for the local waterways for the following reasons:

- The establishment of a reliable stage discharge relationship (rating curve) for the site would require frequent stream gauging. It is not practical or possible to engage a skilled hydrographer that is local and can attend site and measure the flows given the short duration and infrequent nature of the flow events.
- The monitoring of stream water levels from a waterway with a mobile sandy bed is generally unreliable, as small shifts in sand can change the flow depths. This means that regular stream gauging would be required to ensure the low flow rating curve is up to date and reliable.
- The broad, ill-defined flows mean that a very small increase in water level of 0.1 m to 0.2 m will lead to a significant increase in flow rate, which means that a significant number of gaugings across all flow rates would be required to make the rating reliable. There are an insufficient number of flow events in any year for this to physically occur.
- To overcome these reliability issues, a low flow control weir would be required to both provide reliable water level and stream flow estimates. It is not practical to establish a weir given the volume of sediment and the broad and erosive nature of the existing channels. Further, a Water Supply Works approval under the *Water Management Act 2000* would be required for the weir, which would be hard to demonstrate that it would satisfy the management goal NSW Weir Policy, which states "*The construction of new weirs, or enlargement of existing weirs, shall be discouraged".*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Further to this, even if reliable flow measurements could be obtained, the use of surface water modelling to demonstrate the minor surface flow impacts is impractical, if not impossible. Surface water modelling requires an extensive period of baseline flow data and reliable catchment rainfall data to calibrate the soil moisture loss parameters to derive a pre-disturbance flow sequence. Several years of data would be required for a site such as this given the infrequent nature of the flows. Even if reliable parameters could be adequately calibrated to determine a pre-disturbance flow sequence, the natural variability in surface runoff would far exceed the differences expected by the Stage 3 Project.

Given the above, baseline stream gauging or automatic water level monitoring has not been undertaken to date, nor is it considered appropriate for the waterways crossing the Stage 3 Project.

The annual volume of surface water take due to subsidence-related surface fracturing is not expected to be quantifiable or measurable as it is expected to be near zero. Notwithstanding, NCOPL has committed to continue monitoring the underground dewatered volumes. A sudden increase in the monitored flow following surface runoff would suggest that surface water may have reached the underground workings. Should a sudden increase occur following surface runoff, it would be quantified, reported and have remedial measures implemented to prevent it from occurring again.

Note that no measurable changes in underground dewatered volumes following surface runoff events have been encountered to date at the existing mine.

Section 8.2 of the Surface Water Assessment (WRM, 2020) describes and quantifies the potential impacts of subsidence on the local waterways of the Stage 3 Project. The expected change to proportion of rainfall that would appear as surface runoff is expected to be negligible. Any change would require a change to the pervious/impervious nature of the surface. The only change in impervious surface is an increase in the potential for ponded areas, which only occurs when the ponded areas are full of water. The increased impervious area was calculated to be between 5 ha and 8 ha, or less than 0.1% of the local watercourse catchments. Such a change would not be measurable.

A risk-based approach has also been adopted when considering the potential changes in no- and low-flow days:

- First, the Subsidence Assessment (Ditton Geotechnical Services, 2020) determined that a direct hydraulic connection to the surface due to mine subsidence is unlikely to possible.
- Second, there is generally only surface flow, and not baseflow from the local catchments. The assessment concluded that the Stage 3 Project would not have a measurable impact on surface flows. Notwithstanding, NCOPL has committed to repairing any surface cracks, if required, to minimise the changes in surface flow.
- Last, the local ecology along these waterways is already adapted to these flow conditions and, therefore, there is a low chance of environmental harm. The waterways also only flow for short distances before they drain into greater Tulla Mullen Creek and the Namoi River channels. Given the low to no risk, a more detailed impact assessment on the flow regime (including modelling and collection of detailed monitoring and hydrographic data) is not warranted.

Section 8.6 of the Surface Water Assessment (WRM, 2020) outlines the water licensing considerations for the Stage 3 Project. The additional water captured in the in-stream surface depressions is not expected to be a take of water, as the ponded water remains in-stream. It is also likely to be temporary as any depression would fill with sediment. There is not expected to be any loss of flow from surface cracking.

Notwithstanding the above, NCOPL may rely on its harvestable right entitlement for the Stage 3 Project water storages (subject to incorporation in the Water Management Plan). Additional water entitlement from the *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* is not expected to be required.

In summary, the existing monitoring data from the Narrabri Mine suggests that the water quality risks to the local surface waters potentially impacted by the Stage 3 Project is low. This is a reflection on the adequacy of the existing Surface Water Management strategy, detailed in Sections 5 and 6 of the Surface Water Assessment (WRM, 2020), which outlines a risk-based approach to water management based on water quality.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Comment 19

IESC stated:

19. *The assessment of potential impacts on surface water flows was undertaken assuming that the future climate will be the same as current, an approach which was justified on the basis that climate change impacts are projected to be minimal over the project's life (i.e. to 2044). However, climate change impacts beyond the life of the project were not considered as the available climate projections were deemed inconsistent (WRM 2020, p. 89). While the assumptions made are largely appropriate to the assessment of the water management system over the duration of the Project, they do not provide an adequate understanding of the possible range of hydroclimatic conditions in the longer term. Current science (Grose et al. 2020) indicates likely reductions of 10% to 20% in the austral winter and spring by 2090, and it is reasonable to expect that the low flow regime in the Namoi River will be materially different in the year 2240, which is when the peak baseflow reductions in the Namoi River are expected to occur. Such assessments should consider a range of projected changes based on the distribution of climate model results as their impacts on streamflow regime are highly non-linear.*

Response (prepared with assistance from WRM)

The Namoi River is a regulated system with low flows controlled by releases from Keepit Dam. They are not strictly baseflows. These releases are made to meet the downstream demands for irrigation, stock and domestic and town water supplies (amongst other demands). It is unlikely that the stock and domestic and town water supply demand will change by 2240 without significant population changes further downstream. As such, the Namoi River releases to meet these demands are not expected to be significantly different in 2240 irrespective of climate change.

Comment 20

IESC stated:

20. *It is unclear how the mine-affected water will be treated (filtered?) prior to release. While there have been no controlled releases of mine-affected water into the Namoi River during operations to date, a number of water quality values, including EC, for "filtered" water exceeded the trigger values outlined in Table 4.5 of WRM 2020 (p. 43). Only physico-chemical parameters have been measured and reported in various on-site water storages, so additional monitoring data on other parameters (e.g. soluble metals identified in the geochemical assessment (antimony, arsenic, cobalt, molybdenum, selenium)) should be obtained, especially as there may be uncontrolled releases from sediment dams into Kurrajong Creek.*

Response

The Narrabri Mine has the potential to receive groundwater and surface water inflows in excess of its consumption requirements. The existing water treatment facilities treat groundwater inflows and disturbed area runoff to produce filtered water and a brine waste product. The filtered water (also known as raffinate) is used in underground mining operations, or may be transferred to the Namoi River for controlled release (as per the approved Narrabri Mine). NCOPL may also investigate options for the beneficial re-use of excess water such as internal use (e.g. irrigation) or provision of water to other water users in the region.

Brine (generated from the water treatment facilities) and groundwater inflows are used for dust suppression. Brine is approved to be stored in Brine Storage Ponds at the Pit Top Area.

The existing Project Approval 08_0144 (i.e. the existing consent for the Narrabri Mine) outlines the conditions by which any discharge must occur (Schedule 4, Condition 11):

11. *Any raffinate from the water conditioning plant discharged to the Namoi River must be discharged in accordance with the conditions of an EPL and meet the following criteria:*
    - *(a) 50 percentile of all samples (volume based) are below 250 mg/l of Total Dissolved Solids;*
    - *(b) 100 percentile of all samples (volume based) are below 350 mg/l of Total Dissolved Solids; and*
    - *(c) pH values of all sampled water to be between 6.5 and 8.5.*

Further, Project Approval 08_0144, Schedule 4, Condition 17 requires the development of a Raffinate Discharge and Transfer Control and Monitoring Plan, which must include:

- *(a) be approved by the Secretary prior to any raffinate discharge to the Namoi River;*
- *(b) include measures for the continuous monitoring and recording of volumes of water discharged to the Namoi River;*
- *(c) contain an ambient water quality monitoring program upstream and downstream of the discharge point; and*
- *(d) contain a water quality monitoring program for discharged waters.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

Prior to discharge to the Namoi River, the water quality parameters described in the current or future Project Approval/Development Consent would need to be met, as well as any other requirements of an Environment Protection Licence (EPL), and described in an approved Raffinate Discharge and Transfer Control and Monitoring Plan. In addition, NCOPL would expect similar condition be imposed for the Stage 3 Project. As part of this, NCOPL would consider additional water quality monitoring, including soluble metals.

Comment 21

IESC stated:

> 21. *No data are presented in the EIS for other water quality parameters in the receiving waters e.g. metals, except for mention of one sampling event in January 2020, in which dissolved metals concentrations exceeded the Namoi River Water Quality Objectives for iron, chromium, copper and zinc at more than half the monitoring sites. Additional surface water quality monitoring is needed, including a wider suite of parameters to develop more robust site-specific water quality guidelines (Huynh and Hobbs, 2019).*

Response (prepared with assistance from WRM)

All available surface water quality monitoring data was assessed as part of the EIS. The extreme drought conditions that occurred during the preparation of the EIS meant that limited surface runoff occurred to enable surface water samples to be collected. Surface water sampling is also inherently difficult to obtain in the Narrabri Mine and the Stage 3 Project area due to the small catchments and ephemeral nature of the waterways (i.e. typically limited duration/opportunity for sampling). Access to the more remote locations is also difficult during occasional periods of wet weather.

Section 9.3 of the Surface Water Assessment (WRM, 2020) states that NCOPL has committed to extending the suite of water quality parameters to include those that would be expected from the Stage 3 Project waste materials.

Comment 22a

IESC stated:

> 22. *Although the proponent describes some aspects of monitoring (AGE 2020, p. 145-146), mitigation measures are not presented in detail. Additional suggestions to improve the monitoring follow.*
>
> a. *Ground-truthing of regional-scale geological mapping and hydraulic parameterisation near the Namoi River could provide more confidence in the lithological boundary between alluvium and porous rock aquifers that result in a steep gradient in modelled watertable drawdown. To support this mapping and parametrisation, geophysical surveys and monitoring bores for in-situ testing of hydraulic parameters will provide greater confidence in the extent and magnitude of predicted watertable drawdown within alluvium near the Namoi River.*

Response (prepared with assistance from AGE)

As discussed previously (Response to Comment 2), the position of the lithological boundary between alluvium and porous rock is known with a high degree of accuracy and further ground truthing is not considered as necessary to provide a model that can be used for decision making purposes. The position of the modelled boundary is supported by geological mapping of the area, produced by the Geological Survey of NSW, which is likely to have ground truthed to some extent. Further ground truthing of the extent of these strata is provided via 1,600 mine exploration bores and over 1,000 licensed water supply bores in the model domain.

Comment 22b

IESC stated:

> b. *Ditton details a number of monitoring and mitigation recommendations which are supported by the IESC (DGS 2020, p. E7, 27, 34, 59, 78, 82, 96-97, 102) and the IESC considers that all of these recommendations must be implemented. The current monitoring program should be updated to reflect these recommendations. Further, the spatial coverage of the groundwater monitoring network should be expanded to where there are currently no monitoring bores to the west and south of the proposed project, as discussed in the previous advice (IESC 2019-102, Paragraphs 3-5).*

Response

Proposed additional groundwater level and water quality monitoring was discussed previously in the Response to Comment 3d. Current and proposed monitoring locations are shown in Figure A1-5 and comprise six new locations with monitoring at multiple levels to the west, south and east of the Stage 3 Project.

An additional subsidence crossline above Longwalls 203 to 209 would be installed above the start and finishing ends of the panels to monitor subsidence impacts (Ditton Geotechnical Services, 2020).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Additional subsidence survey monitoring lines would be installed above Longwalls 206 to 209 to monitor subsidence impacts in the Pilliga East State Forest (Ditton Geotechnical Services, 2020).

Visual inspections and mapping of surface impacts (such as cracking) would be undertaken before and after each panel is extracted. Non-conventional monitoring techniques such as cliff line reflectometry and/or drone surveys of minor cliff faces and crack location detection above the woodland areas are also proposed.

In addition, the additional subsidence monitoring of Longwalls 203 to 205 would be implemented to confirm that the setback from Bulga Hill is acceptable.

In addition, consistent with the recommendations of Ditton Geotechnical Services (Ditton Geotechnical Services, 2020), an additional subsurface impact calibration borehole comprising a borehole extensometer and VWPs would be installed to monitor subsidence effects. Mine ventilation flows would also be monitored for possible short-circuiting detection through surface cracks.

Aerial techniques and remote sensing (e.g. LiDAR) would be adopted *in lieu* of traditional ground-based surveys (Ditton Geotechnical Services, 2020), where relevant.

Subsidence monitoring measures would be incorporated into the relevant Extraction Plans for the Stage 3 Project. Attachment 4 of this letter describes the subsurface impact calibration borehole to be installed for the Stage 3 Project, consistent with the recommendations of Ditton Geotechnical Services (2020).

Subsidence management measures proposed for the Stage 3 Project include are described below.

Surface Cracking

The following surface cracking mitigation measures would be adopted:

- regularly inspect the surface during subsidence development above a given panel and map crack locations and their geometry (widths, lengths, depth, shape);
- repair large surface cracks (i.e. greater than approximately 50 mm wide) after subsidence development for a given longwall; and
- should monitoring and inspections indicate the need, implement adaptive management in subsequent mining areas such as leaving a barrier pillar, increasing setback distances from a sensitive area or limit mining to first workings.

Surface crack repair works such as ripping or tyning followed by re-seeding or filling cracks with free-draining, durable gravel into large, deep cracks would be undertaken, as required.

Non-conventional monitoring techniques such as drone surveys for large crack location detection above the woodland areas is also proposed (Ditton Geotechnical Services, 2020).

Sub-surface Cracking

Direct hydraulic connection from the underground workings to the surface is considered ‘unlikely’ to ‘possible’. The following sub-surface cracking monitoring and mitigation measures would be undertaken for the Stage 3 Project (Ditton Geotechnical Services, 2020):

- monitoring of rainfall deficit and underground water takes, and changes to ventilation (i.e. to assist to detect connective cracking);
- repair of surface cracks after active subsidence; and
- installation of further borehole extensometers and piezometers to confirm and monitor height of fracturing.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Steep Slopes

To minimise hazards associated with potential rock falls from steep slopes, the following mitigation measures are proposed (Ditton Geotechnical Services, 2020):

- surface slope and cliff face displacement monitoring (in addition to general subsidence monitoring);
- infilling of surface cracking to prevent excessive ingress of run-off into the slopes;
- areas that may be significantly impacted by erosion after mining are repaired and protected with mitigation works (e.g. regrading, installation of new contour banks and revegetation of exposed areas); and
- ongoing review of any significant changes to surface slopes after each longwall is extracted.

Adaptive Management

Adaptive management strategies for the Stage 3 Project would include (Ditton Geotechnical Services, 2020):

- Ongoing review of predicted subsidence impacts against observed impacts.
- Early warning monitoring campaigns to confirm appropriate setback distances from defined subsidence control zones (i.e. Bulga Hill).
- Evaluation of monitoring results against performance measures with adjustment of the management and control measures, if necessary.
- Crack mapping to improve predictions for cracking areas above future longwalls.

Where relevant, performance measures, monitoring locations/methods, TARPs and contingency plans would be developed in consultation with relevant government agencies.

Comment 22c

IESC stated:

> *c. Additional monitoring with multi-level VWPs above the centreline of the first new longwall panels (similar to the VWPs in borehole 57 above LW108) is required. IESC agrees with the recommendation of the peer reviewer (Jacobs, 2020) that this additional monitoring is essential to improve the local database of subsidence effects and impacts. Site-specific data should be used to justify the parameter functions applied in the groundwater model for hydraulic conductivity and specific storage, particularly above and near longwall panels.*

Response (prepared with assistance from AGE)

As discussed in the Response to Comment 3d, the installation of an additional calibration borehole similar to P57 are proposed.

Comment 23

IESC stated:

> *23. While the groundwater quality monitoring plan indicates that pH and EC are monitored monthly, and additional parameters are monitored annually (including major ions, alkalinity, total phosphorus and some metals), none of these data (except salinity) is presented in the EIS. The limited data provided are compared to NEPM guideline values for stock watering, as well as site-specific trigger values. However, these site-specific trigger values are not shown, making it difficult for the IESC to determine if the monitoring or guidelines are appropriate to protect groundwater systems. No monitoring of shallow groundwater (Quaternary Alluvium) is undertaken currently.*

Response (prepared with assistance from AGE)

As indicated in the Response to Comment 4, further details of the Narrabri Mine groundwater quality monitoring program are presented in the current site Water Management Plan (NCOPL, 2017). Groundwater level and quality data collected from the network of monitoring bores is summarised in a series of annual environmental review reports available on the Whitehaven website. These reports also provide a summary of environmental performance over the preceding year in relation to groundwater inflows, groundwater levels and groundwater quality. An updated version of the current Water Management Plan to address regulator comments is currently being assessed by DPIE-Water. This document, which identifies a range of site-specific triggers and related management actions, will be further revised following approval of the Stage 3 Project.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Proposed additional groundwater level and water quality monitoring was discussed previously in the Response to Comment 3d. Current and proposed monitoring locations are shown in Figure A1-5 and include shallow groundwater monitoring of groundwater levels in the Quaternary Alluvium, consistent with Appendix D of the EIS.

Comment 24

IESC stated:

> 24. *The proponent still does not appear to have sufficient licences for predicted take from the NSW Gunnedah Oxley Basin water source. Notably, the peak volumes requiring licencing exceed current licensing by 1,089 ML/ year. Prudent management of this water resource would dictate licenses should be obtained before operations commence.*

Response

NCOPL currently holds sufficient licences to cover the predicted maximum licensing requirements for the Stage 3 Project with the exception of the following water sources:

- Gunnedah Oxley Basin MDB Groundwater Source regulated by the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*; and
- Lower Namoi Groundwater Source regulated by the Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020.

To address the identified shortfall in Gunnedah-Oxley Basin MDB groundwater source, given that over 3,000 ML of excess water in this source was held by Whitehaven in 2019, allocation would be transferred from other Whitehaven operations to meet the Stage 3 Project requirements. The current excess entitlements which are available from other Whitehaven operations are shown in Table A1-2.

For the predicted licensing requirements in the Lower Namoi Groundwater Source, NCOPL would seek and obtain the appropriate entitlements on the open market in accordance with the appropriate trading rules of the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020*. Based on recent water trading statistics, there is sufficient market depth in the Lower Namoi Groundwater Source to accommodate the very small allocation required for the Stage 3 Project (i.e. up to 1 megalitre per year).

Table A1-2
Whitehaven's Gunnedah-Oxley Basin MDB Groundwater Source Water Access Licences

Site	Water Access Licence	Allocation (ML)	Whitehavens' 2019 Take (ML)
Narrabri Mine	29549	818	380
	43017	403	0
Werris Creek Mine	32224	211	53
	29506	50	0
Sunnyside Mine	29537	120	26.76
Canyon Mine	29548	50	0
Maules Creek Mine	29467	306*	333
	36641	800	50
Rocglen Mine	29461	120	0
	36758	700	30
Tarrawonga Mine	31084	250	58
Vickery Mine	36576	600	0
Whitehaven (total)	-	4,428	904

* Additional 76.5 ML carryover from 2017/18 Water Year.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Comment 25a

IESC stated:

25. *There is little to no confidence in the predictions of the lack of baseflow in the ephemeral tributaries as no modelling or monitoring has been completed or planned to be completed.*

    a. *Clarification is required to determine if streams are predominately gaining or losing to determine their groundwater dependence (OWS 2020, p. 6-7).*

Response (prepared with assistance from WRM)

As discussed in Section 3.3.1 and 5.8.2 of the Groundwater Assessment (AGE, 2020) all of the creeks draining the immediate Project area (i.e. Pine Creek, Kurrajong Creek [Plate A1-1], Jacks Creek and Tulla Mullen Creek [Plate A1-2]) are highly ephemeral. Flow is only observed in these creeks immediately after significant rainfall events. Accordingly, they are considered to be predominantly losing systems which would provide an additional source of periodic recharge to underlying groundwater systems during heavy rainfall periods.

Comment 25b

IESC stated:

b. *The proponent does not consider potential impacts of subsidence on the local waterways of the proposed project, where it might be expected that changes in surface depressions (and ponding) will change the proportion of rainfall that appears as surface runoff. Installing stream gauges was a recommendation from the last IESC Advice (IESC 2019, p. 2), and installing gauges (for example, along the mid-reaches of Kurrajong Creek, a location on Tulla Mullen Creek downstream of the project area, or at a point below their confluence above the Namoi River) could be used in combination with existing gauges to assess impacts over time.*

Response (prepared with assistance from WRM)

Section 8.2 of the Surface Water Assessment (WRM, 2020) describes and quantifies the potential impacts of subsidence on the local waterways of the Stage 3 Project. The expected change to proportion of rainfall that would appear as surface runoff is expected to be negligible. Any change would require a change to the pervious/impervious nature of the surface. The only change in impervious surface is an increase in the potential for ponded areas, which only occurs when the ponded areas are full of water. The increased ponding area was calculated to be between 5 ha and 8 ha, or less than 0.1% of the local watercourse catchments. Such a change would not be measurable given the infrequent flow regime. The installation of a stream gauge for the local waterways is discussed in the Response to Comment 18b.

Comment 26

IESC stated:

26. *The proponent's mitigation strategy to manage the cracks due to subsidence is for them to fill naturally or for the larger cracks to manually fill them in with machinery. Due to the possible magnitude of these cracks, this is an unreasonable and impractical strategy as well as potentially unsafe. The cracks have been previously mentioned in the advice (IESC 2019-102, Paragraph 10b) and much of this does not appear to have been addressed.*

Response (prepared with assistance from WRM)

NCOPL acknowledges the IESC's recommendation to demonstrate the impacts from surface cracking or subsidence due to the Stage 3 Project on local catchment stream flows. However, establishing a stream gauge that is capable of demonstrating the impacts has always been deemed impractical (i.e. in WRM's aforementioned on-site experience). First, all assessments undertaken to date have predicted negligible to no loss of stream flows due to the existing Narrabri Mine and Project for the following reasons:

- The predicted surface ponding volumes are small in comparison to the existing ponding volumes and overall stream volumes.
- The loss of surface flow due to surface cracking is deemed unlikely and cracks, when they do occur, are remediated (Figure A1-8).
- The Groundwater Assessment (AGE, 2020) predicted existing water table levels some 5 m to 20 m below the bed level of the waterways, suggesting changes to groundwater would not impact on baseflows (as there are no baseflows).

These predictions have generally been consistent with the observations encountered for the waterways across the existing longwall mining areas.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

WHC-17-54_NSP_Stg3_EIS SR_DPIE_001A

Resource Strategies

Source: WRM (2020)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Photographs of Kurrajong Creek

Plate A1-1

WHC-17-54_NSP_Stg3_EIS SR_DPIE_002A

Resource Strategies

Source: WRM (2020)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Photographs of Tulla Mullen Creek Tributary 1

Plate A1-2

In addition, the Subsidence Assessment (Ditton Geotechnical Services, 2020) concludes that there is potential, albeit highly unlikely, that creek flows could be temporarily re-routed into open cracks to below-surface pathways and re-surface downstream of the mining extraction limits in the mining area. The resurfacing of the flows would not be a loss of flow to the system. Further to this, remedial measures (such as shown in Figure A1-8) would be implemented to ensure it would not be repeated, if it did occur.

Given the predicted surface water losses are negligible, a very accurate and reliable stream gauge would be required to predict a change, which is not practical for the local waterways for the following reasons:

- The establishment of a reliable stage discharge relationship (rating curve) for the site would require frequent stream gauging. It is not practical or possible to engage a skilled hydrographer that is local and can attend site and measure the flows given the short duration and infrequent nature of the flow events.
- The monitoring of stream water levels from a waterway with a mobile sandy bed is generally unreliable, as small shifts in sand can change the flow depths. This means that regular stream gauging would be required to ensure the low flow rating curve is up to date and reliable.
- The broad, ill-defined flows mean that a very small increase in water level of 0.1 m to 0.2 m would lead to a significant increase in flow rate, which means that a significant number of gaugings across all flow rates would be required to make the rating reliable. There are an insufficient number of flow events in any year for this to physically occur.
- To overcome these reliability issues, a low flow control weir would be required to provide both reliable water level and stream flow estimates. It is not practical to establish a weir given the volume of sediment and the broad and erosive nature of the existing channels. Further, a Water Supply Works approval under the *Water Management Act 2000* would be required for the weir, which would be hard to demonstrate that it would satisfy the management goal NSW Weirs Policy, which states *The construction of new weirs, or enlargement of existing weirs, shall be discouraged*.

Further to this, if reliable flow measurements could be obtained, the use of surface water modelling to demonstrate the minor surface flow impacts is impractical and not meaningful. Surface water modelling requires an extensive period of baseline flow data and reliable catchment rainfall data to calibrate the soil moisture loss parameters to derive a pre-disturbance flow sequence. Several years of data would be required for a site such as this, given the infrequent nature of the flows, to derive a reliable soil moisture accounting model to simulate stream flows. Even if reliable parameters could be adequately calibrated to determine a pre-disturbance flow sequence, the natural variability in surface runoff would far exceed the differences expected by the Stage 3 Project (which are negligible).

Given the above, baseline stream gauging or automatic water level monitoring has not been undertaken to date, nor is it considered appropriate for the waterways traversing the Stage 3 Project.

The annual volume of surface water take due to subsidence-related surface fracturing is not expected to be quantifiable or measurable as it is expected to be near zero. Notwithstanding, NCOPL has committed to continue monitoring the underground dewatered volumes. A sudden increase in the monitored flow following surface runoff would suggest that surface water may have reached the underground workings. Should a sudden increase occur following surface runoff, it would be quantified, reported and have remedial measures implemented to prevent it from occurring again.

Note that no measurable changes in underground dewatered volumes following surface runoff events have been encountered to date at the existing mine.

Section 8.2 of the Surface Water Assessment (WRM, 2020) describes and quantifies the potential impacts of subsidence on the local waterways of the Stage 3 Project. The expected change to proportion of rainfall that would appear as surface runoff is expected to be negligible. Any change would require a change to the pervious/impervious nature of the surface. The only change in impervious surface is an increase in the potential for ponded areas, which only occurs when the ponded areas are full of water. The increased impervious area was calculated to be between 5 ha and 8 ha, or less than 0.1% of the local watercourse catchments. Such a change would not be measurable.

A risk-based approach has also been adopted when considering the potential changes in no- and low-flow days:

- First, the Subsidence Assessment (Ditton Geotechnical Services, 2020) determined that a direct hydraulic connection to the surface due to mine subsidence is unlikely to possible.
- Second, there is generally only surface flow, and not baseflow from the local catchments. The assessment concluded that the Stage 3 Project would not have a measurable impact on surface flows. Notwithstanding, NCOPL has committed to repairing any surface cracks, if required, to minimise the changes in surface flow.
- Last, the local ecology along these waterways is already adapted to these flow conditions and, therefore, there is a low chance of environmental harm. The waterways also only flow for short distances before they drain into greater Tulla Mullen Creek and the Namoi River channels. Given the low to no risk, a more detailed impact assessment on the flow regime (including modelling and collection of detailed monitoring and hydrographic data) is not warranted.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Section 8.6 of the Surface Water Assessment (WRM, 2020) outlines the water licensing considerations for the Stage 3 Project. The additional water captured in the in-stream surface depressions is not expected to be a take of water, as the ponded water remains in-stream. It is also likely to be temporary as any depression would fill with sediment. There is not expected to be any loss of flow from surface cracking.

Notwithstanding the above, NCOPL may rely on its harvestable right entitlement for the Stage 3 Project water storages (subject to incorporation in the Water Management Plan). Additional water entitlement from the *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* is not expected to be required.

In summary, the existing monitoring data from the Narrabri Mine suggests that the water quality risks to the local surface waters potentially impacted by the Stage 3 Project is low. This is a reflection on the adequacy of the existing Surface Water Management strategy, detailed in Sections 5 and 6 of the Surface Water Assessment (WRM, 2020), which outlines a risk-based approach to water management based on water quality.

Comment 27

IESC stated:

> *27. Background physico-chemical and chemical parameters for the Namoi River (particularly EC values) which may receive controlled releases, as well as Kurrajong Creek which may receive overflows from sediment dams, are required.*

Response

Section 4.5 of the Surface Water Assessment (WRM, 2020) describes the background surface water monitoring program for Kurrajong Creek and the Namoi River. NCOPL has committed to continuing the monitoring program over both the existing and the Stage 3 Project area and include other parameters of relevance to the Stage 3 Project.

Comment 28

IESC stated:

> *28. No Trigger Action Response Plan (TARP) for the existing mine was provided. Clarification is required as to whether baseline values for water quality (physico-chemical parameters and contaminants) have been established for the existing mine which gained approval in 2011.*

Response

A Trigger Action Response Plan (TARP) for the existing mine is included in the Water Management Plan. It includes triggers and responses for water quality measured in the receiving waters and water quality (and volumes) measured in the water storage dams. For the receiving waters, the current TARP references water quality triggers referenced in EPL 12789 for oils and grease, pH and total suspended solids.

Section 4.5 and Table 4.4 of the Surface Water Assessment (WRM 2020) presents the background water quality data collected at the site since 2007. The sites denoted as KCUS, KCDS, KC1US, KC2US collect runoff from catchments that have not been disturbed by mining activities and would be suitable to derive baseline water quality.

The Water Management Plan and the associated TARPs will be updated to incorporate the Stage 3 Project and will include the water quality parameters with sufficient baseline data, namely electrical conductivity and total organic carbon with the 90th percentile background level selected for the baseline trigger.

Note that baseline total suspended solid concentrations for median and 80th percentile values at the background stations significantly exceed the 100th percentile concentration limits in the EPL. NCOPL will liaise with the Environment Protection Authority to determine the most appropriate limits in consideration of the baseline data.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Comment 29b

IESC stated:

> 29. *As the IESC specified in the previous advice (IESC 2019-102, Paragraph 17), a surface water assessment is needed which:*
>
> b. *uses appropriate surface water quality data consistent with the ANZG (2018) guidelines for aquatic ecosystem protection to inform impacts and risks;*

Response

Section 4.5 of the Surface Water Assessment (WRM, 2020) describes the background water quality data that has been collected at the existing mine and the regional environment since 2007. The data is compared with the *Namoi River Water Quality and River Flow Objectives* 'Ecosystem' trigger values in the Surface Water Assessment. These objectives have been developed by the NSW Government that are specific to the Namoi River and are therefore the most appropriate. Some of the Namoi objectives are based on the ANZECC and ARMCANZ default trigger values where insufficient local data is available. Note that the *Australian New Zealand Water Quality Guidelines* (Australian and New Zealand Guidelines, 2018) recommends to use local data when it is available and references the NSW Objectives as the most appropriate.

Comment 29c

IESC stated:

> c. *includes baseline and event-based monitoring of water quality parameters over a sufficient time period to enable the derivation of appropriate site-specific water quality guideline values (Huynh and Hobbs, 2019). The parameters monitored, frequency of monitoring and actual monitoring data should be included;*

Response (prepared with assistance from WRM)

Given the ephemeral infrequent nature of the stream flows, all baseline monitoring is 'event based'. However, the flow rate associated with the monitoring samples was not collected due to the difficulty in defining stream flows for these catchments. Sufficient data is available to derive appropriate site-specific water quality guideline values and these are presented in Table 4.4 of the Surface Water Assessment (WRM, 2020).

Comment 29d

IESC stated:

> d. *uses a risk-based approach to identify key surface waters that might be impacted (e.g. through direct and indirect discharges, subsidence fracturing, ponding or erosion), and considers how the proposal may alter the number of low- and zero-flow days and potentially impact on instream biota. The proposed development area is drained by ephemeral streams whose flow regime is likely to be altered by subsidence and, potentially, groundwater drawdown. Altered flow regimes will affect the capacity of these ephemeral streams to provide habitat for aquatic species (WRM 2020, p. 9) or support the important ecosystem services provided by these types of surface waters (WRM 2020, p. 9);*

Response (prepared with assistance from WRM)

Section 4.5 of the Surface Water Assessment (WRM, 2020) compares the background (upstream) and downstream water quality data collected at the existing mine to date. This includes runoff from the existing subsided areas. The comparison found that "*the differences in water quality between undisturbed monitoring locations (KCUS, KC1US and KC2US) and those located downstream of the Narrabri Mine (KCDS, KC1DS, KC2DS, PC and PC1) is small. Further, there has not been an increasing (or decreasing) trend in recorded water quality over the life of the Narrabri Mine.*"

The existing monitoring data suggests that the water quality risks to the local surface waters potentially impacted by the Stage 3 Project is low. This is a reflection on the adequacy of the existing Surface Water Management strategy, detailed in Section 5 and Section 6 of the Surface Water Assessment (WRM, 2020), which outlines a risk-based approach to water management based on water quality.

A risk-based approach has also been adopted when considering the potential changes in no and low flow days.

- First, the Subsidence Assessment (Ditton Geotechnical Services, 2020) determined that a direct hydraulic connection to the surface due to mine subsidence is unlikely to possible.
- Second, the response to question 18 above has demonstrated that there is generally only surface flow, and not baseflow from the local catchments. The assessment concluded that the Stage 3 Project would not have a measurable impact on surface flows. Notwithstanding this, NCOPL has committed to repairing any surface cracks, if required, to minimise the changes in surface flow.

- Last, the local ecology along these waterways is already adapted to these flow conditions and therefore there is a low chance of environmental harm. The waterways also only flow for short distances before they drain into greater Tulla Mullen Creek and the Namoi River channels. Given the low to no risk, a more detailed impact assessment on the flow regime (including modelling and collection of detailed monitoring and hydrographic data) is not warranted.

Comment 29e

IESC stated:

> e. *identifies the existing (baseline) hydrological regimes of all watercourses, including into the Namoi within the potential zone of hydrological impacts based on selected site-specific monitoring, and how these translate into the flow regime of the creek entering the Namoi River; and*

Response

Section 4.3 of the Surface Water Assessment (WRM, 2020) describes the hydrological regimes of the local watercourses based on local observations taken since the planning stages of the existing mine.

Comment 29f

IESC stated:

> f. *informs appropriate mitigation strategies (e.g. timing and methods for re-establishing drainage lines to minimise erosion, and actions to be taken when there is a suspected exceedance of a guideline value).*

Response

The above risk assessment was considered when developing the TARP in the existing Water Management Plan for changes in watercourse morphology and ground disturbances above the longwall panels.

Comment 30

IESC stated:

> 30. *The proponent is commended for efforts to redesign the mine's layout to avoid or minimise subsidence-related impacts on, for example, Bulga Hill which is habitat for the EPBC Act-listed Large-eared Pied Bat although it is noted that other rocky outcrops, also used as habitat, will be undermined. However, avoiding or mitigating drawdown and subsidence-related impacts on watercourses, riparian zone vegetation and GDEs is much more challenging. It is unlikely that any mitigation of subsidence-related effects on streamflow regimes (Paragraph 17, 29d) is possible. The proponent should monitor aquatic values (e.g. aquatic macroinvertebrates, amphibians) of the undermined watercourses before, during and after mining so that predictions about the potential impacts of subsidence can be tested as well as the effectiveness of filling and repairing cracks in the streambed. Similarly, ponding and root shearing may adversely affect some riparian zone vegetation along the undermined watercourses. Monitoring of riparian zone vegetation condition and cover should be done sufficiently often to detect any changes associated with mining and to trigger rehabilitation actions such as replanting.*

Response (prepared with assistance from AGE)

Terrestrial Ecosystems

Terrestrial flora in the areas where predicted drawdown is in the order of 10 to 20 m are facultative[3], rather than obligate[4]. Given this, and the fact that the predicted drawdown is expected to occur gradually, the drawdown could potentially result in additional stress to large trees, however, is unlikely to result in widespread loss. Assessment of groundwater drawdown impacts on terrestrial ecosystems is provided in Section 6.19.3 of the EIS:

> *As described in Section 6.4.3, the Project would result in groundwater table drawdown, predominantly due to groundwater inflows to the underground mining area during operations. Groundwater drawdown is expected to occur gradually during operations, with maximum drawdown predicted to occur post mining, and recovery taking many decades (Appendix B).*
>
> *The magnitude of predicted water table drawdown at 'high priority' groundwater dependent vegetation (Figure 6 29b) would be significantly less than the estimated seasonal water table variation (Appendix B), and the drawdown would occur at a very slow rate.*
>
> *Minor changes to the groundwater regime may not have any adverse impacts on facultative groundwater dependent vegetation that uses groundwater as required (opportunistically), but these ecosystems can dieback if reduced access to groundwater is prolonged or if the change is too rapid that the trees are not able to adapt (Appendix D).*

---

3 Refers to GDEs that use groundwater optionally or opportunistically.

4 Refers to GDEs that are extremely dependant on groundwater.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

At some groundwater dependent vegetation, predicted drawdown exceeds 10 m which is expected to result in larger trees potentially not being able to access groundwater in drought conditions (Appendix D).

The drawdown could result in additional stress to larger trees associated with the facultative GDEs during prolonged drought conditions, but is not likely to result in the widespread loss of the larger trees, or prevent the long-term viability of the dependent ecosystem, due to (Appendix D):

- *the GDEs being facultative (not obligate);*
- *the presence of same ecosystems in areas where groundwater is too deep for trees to access;*
- *the localised areas of material (i.e. greater than 1 m) predicted drawdown;*
- *the availability of other water sources during non-drought conditions; and*
- *the rate of drawdown would occur at a very slow rate.*

There is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.

As discussed in Section 6.4.3, no groundwater quality impacts are anticipated due to the Project during operations or post-mining (Appendix B).

Maximum drawdowns of less than 5 cm are predicted at three potential spring sites (AGE, 2020). It is therefore considered unlikely that discharge from these springs would be significantly affected. On the other hand, drawdown in excess of the relevant AIP threshold is predicted at a number of potential GDE areas. These areas are predominantly located within the Gunnedah Oxley Basin MDB Groundwater Source and include areas which are mapped as being dominated by Red Gum, River Red Gum, shallow freshwater wetland sedgeland with smaller areas of Ironbark and Box grassy woodland. The majority of these mapped GDEs are located close to Tulla Mullen Creek to the south east of the Narrabri Mine and in areas close to the Namoi River to the north-east. Predictions suggest that up to 157.9 ha of areas mapped as high priority GDEs could experience drawdowns greater than the estimated AIP threshold due to the Stage 3 Project only and 160.9 ha if the Narrabri Gas Project was to be developed concurrently. Further assessment of potential impacts on GDEs is provided in Section 6.19 of the EIS.

Current and proposed monitoring locations are shown in Figure A1-5 and include two new monitoring locations to the south of the Stage 3 Project close to mapped GDE areas.

Figure A1-6 shows the location of high-priority GDE areas in relation to the approved and Stage 3 Project longwall panels. GDEs where predicted maximum drawdowns exceed 5 m (a threshold mentioned by the IESC as being of interest) are shown shaded based on the GDE type, other GDEs where maximum impacts of less than 5 m are predicted are shown shaded grey. As shown in this map no GDEs are mapped in areas overlying longwall panels. Maximum impacts of more than 5 m are predicted at a small number of GDE polygons to the east and south-east of the Stage 3 Project area. Further assessment of the potential ecological impacts of these predicted drawdowns on GDEs is provided in Section 6.19 of the EIS.

Maximum drawdowns of less than 5 cm are predicted at three potential spring sites. Further monitoring at the Mayfield, Hardys and Eather spring sites is outlined in Section 8.2 of the Groundwater Assessment (AGE, 2020). The purpose is to observe any changes to flow rates and surface conditions and to confirm whether these features are groundwater-dependent. Depending on the results of these visits, further ongoing groundwater and surface water monitoring at these sites, similar to the shallow monitoring proposed at the creek sites would be implemented in addition to ecological monitoring. Site-specific monitoring details (including monitoring frequency and duration) would then be developed as part of the revised Water Management Plan.

Given the abovementioned impacts, no monitoring of aquatic biota is proposed or considered necessary.

Riparian Vegetation Monitoring

As described in the BDAR, a Creek Line Monitoring Programme is comprised of annual geomorphic survey of creek stability and condition for up to two years after longwall mining in the vicinity of the creek is complete.

The stated key performance criteria is noted as a ‘change to overall drainage pattern is not more than predicted detected alteration in channel dimensions or processes within normal range compared to baseline data’.

Remediation of ponding areas would include:

- Ponding areas located in areas with no significant vegetation and where the water quality of the ponded water is non-saline are to be allowed to self-correct.
- Ponding areas located in areas with significant vegetation to be assessed and remedial measures (e.g. drainage) developed and implemented in consultation with the landholder and a suitably qualified specialist (e.g. hydrogeologist, geomorphologist).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Comment 31

IESC stated:

31. *When the proponent has established the degree of groundwater-dependence of terrestrial GDEs, including those not rated as 'high priority' (Paragraph 15), monitoring will be required to detect whether drawdown (potentially combined with subsidence) is having an impact. There are few if any feasible mitigation measures to rectify the impacts of groundwater drawdown on GDEs. In some instances, drawdown may coincide with subsidence-related impacts such as root shearing that may impact groundwater-dependent vegetation. Although there is no evidence that vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown-related impacts (Resource Strategies 2020, p. 118), the extent of this drawdown may not yet have peaked. To get a clearer perspective on how drawdown and subsidence may affect undermined groundwater-dependent vegetation, the proponent could monitor groundwater use by vegetation overlying proposed longwalls (especially in areas where the watertable is < 10 m) during and after mining, matching this with measures of vegetation condition and recruitment. The effectiveness of any mitigation strategies could then be assessed.*

Response

Refer to the Response to Comment 30 above.

Comment 32

IESC stated:

32. *The proponent also needs to ascertain whether stygofauna occur in the area of predicted drawdown (Paragraph 16) and, if so, whether there is a risk that assemblages may be lost or isolated from sources of potential colonists. Although predicted drawdown is < 2 m in much of the alluvium where stygofauna are likely to be found, this limited drawdown in areas where alluvial sediments are only shallow may be enough to isolate stygofaunal assemblages. There may also be impacts on ecosystem services provided by groundwater microbes that are stranded or killed by drawdown in shallow alluvial sediments. Again, mitigation measures to prevent or ameliorate this drawdown are unlikely to be feasible.*

Response

Dr Peter Hancock assessed the information presented in the EIS relating to potential impacts to stygofauna (Attachment 4 to the Submissions Report).

Drawdown of the lower Tulla Mullen Creek alluvial aquifer is predicted to be less than one metre for most of the area affected (Figure 6-29a of the EIS). In the area modelled for drawdown, the aquifer of Tulla Mullen Creek is between approximately 20 and 60 m deep, with less extensive alluvium up to 10 m thick extending west along Sandy Creek (Figure 4.3 of the Groundwater Assessment). Stygofauna are most likely to occur in the thicker sections of aquifer because this is where the water level is most stable, and the connection to the Namoi Alluvium likely to be strongest. The modelled drawdown of less than 1 m is within the historical range of drawdown in the Namoi Alluvium (AGE, 2020), and within tolerance range for stygofauna. Further, a drawdown of less than 1 m would not isolate the Tulla Mullen Creek alluvium from the Namoi Alluvium, so there is no risk of stranding or isolating upstream communities.

Dr Peter Hancock concluded that the predicted drawdown at Tulla Mullen Creek and Namoi alluvium would have a negligible effect on stygofauna communities.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

References

Australasian Groundwater and Environment Consultants Pty Ltd (2020) *Groundwater Assessment – Narrabri Underground Mine Stage 3 Extension Project*. Prepared for Narrabri Coal Operations Pty Ltd.

Australian and New Zealand Guidelines (2018) *Australian New Zealand Water Quality Guidelines*.

Department of Primary Industries – Office of Water (2012) *Aquifer Interference Policy*.

Ditton Geotechnical Services Pty Ltd (2020) *Mine Subsidence Assessment - Narrabri Underground Mine Stage 3 Extension Project*. Prepared for Narrabri Coal Operations Pty Ltd.

Eco Logical Australia (2014) *Narrabri Mine Tree Health Assessment (LW101-103)*. Prepared for Narrabri Coal Operations Pty Ltd.

Environmental Resources Management Australia Pty Ltd (2020) *Independent Environmental Audit 2019*.

Guo, H., Adhikary, D., and Gaveva, D. (2007) *Hydrogeological response to longwall mining, ACARP Report C14033*. CSIRO Exploration and Mining: Australian Coal Industry's Research Program (ACARP).

Heritage, Y., and Gale, W., (2009) *Using Helium as a Tracer Gas to Measure Vertical Overburden Conductivity Above Extraction Panels*.

Middlemis and Peeters (2018) *Uncertainty Analysis – Guidance for groundwater modelling within a risk management framework*.

Narrabri Coal Operations Pty Ltd (2017) *Narrabri Mine Extraction Plan Water Management Plan LW107 to LW110*.

Resource Strategies Pty Ltd (2020) *Biodiversity Development Assessment Report*. Prepared for Narrabri Coal Operations Pty Ltd.

Santos Ltd (2015) *Narrabri Gas Project Environmental Impact Statement*.

Whitehaven Coal Limited (2016) *Narrabri Mine Extraction Plan Water Management Plan LW101 to LW106*.

WRM Water & Environment Pty Ltd (2020) *Narrabri Underground Mine Stage 3 Extension Project Surface Water Assessment*. Prepared for Narrabri Coal Operations Pty Ltd.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

ATTACHMENT 2

RESPONSE TO DPIE–WATER FEBRUARY SUBMISSION

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

DPIE-Water (February Submission)

<u>Submission 1</u>

DPIE-Water stated:

- *Existing water entitlements held by the proponent are adequate to account for the proposed peak water take in all water sources except the Gunnedah Oxley Basin MDB groundwater source and the Lower Namoi Groundwater Source. An additional 1089 units of entitlement will be required in the Gunnedah Oxley Basin groundwater source. 1 unit of entitlement is required in the Lower Namoi Groundwater Source with sufficient market depth available.*

Response

Refer to the Response to Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) Comment 24 (Attachment 1 of this letter).

<u>Submission 1</u>

DPIE-Water stated:

- *The feasibility, in terms of availability and timing, of transferring the Gunnedah-Oxley Basin MDB water requirement from other Whitehaven operations has not been demonstrated. The proponent should provide a detailed breakdown of Water Access Licences (WAL) held and the projects they are applicable, and a detailed plan of how WALs are to be transferred to meet all requirements across multiple projects.*

Response (prepared with assistance from AGE)

As required under the NSW *Aquifer Interference Policy* (AIP) (Department of Primary Industries [DPI] – Office of Water, 2012), additional take from groundwater sources which feature in Water Sharing Plans have been assessed and are presented in Section 7.7 of the Groundwater Assessment (Australasian Groundwater and Environmental Consultants Pty [AGE], 2020). The assessment concludes that Narrabri Coal Operations Pty Ltd (NCOPL) already holds sufficient licences to account for the predicted groundwater take from the Upper and Lower Namoi Regulated River Water Sources, the Upper Namoi Zone 5 and the Great Artesian Basin (GAB) Southern Recharge Zone. As explained in Section 7.10.1 of the Groundwater Assessment this reflects the fact that the predicted impacts of the Narrabri Underground Mine Stage 3 Extension Project (Stage 3 Project) on the Namoi River, Quaternary Alluvium and GAB Southern Recharge Zones are less than previously predicted and approved. Furthermore, since the predicted total take from the Namoi Alluvium (up to 65 megalitres per year [ML/year]) is substantially less than previously predicted (260 ML/year), the Stage 3 Project is also considered to align with the Namoi Catchment Action Plan 2010-2020 threshold for alluvial aquifers (i.e. to never exceed historical maximum drawdown levels [Namoi Catchment Management Authority, 2011]).

The Groundwater Assessment (AGE, 2020) also notes that the majority of the licensed take would be required under the Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources (i.e. for the Gunnedah-Oxley Basin Murray Darling Basin (MDB) Groundwater Source). This groundwater source is significantly under-allocated and has had several controlled allocation periods of interest between 2017 and 2020. Most recently, the Controlled Allocation Order (Various Groundwater Sources) 2020 is offering 4,043 shares of the Gunnedah-Oxley Basin MDB Groundwater Source. Whitehaven Coal Limited has excess entitlements in this groundwater source across its operations which would be used for the Stage 3 Project (refer to the Response to IESC Comment 24 in Attachment 1 of this letter including Table A1-2).

For the predicted licensing requirements in the Lower Namoi Groundwater Source (i.e. up to approximately 1 ML/year), NCOPL would seek and obtain the appropriate entitlements on the open market in accordance with the appropriate trading rules of the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020*. Based on recent water trading statistics, there is sufficient market depth in the Lower Namoi Groundwater Source to accommodate the very small allocation required for the Stage 3 Project (i.e. up to 1 ML/year).

<u>Submission 1</u>

DPIE-Water stated:

- *Insufficient assessment has been provided to quantify the water take due to subsidence related surface cracking for both the existing and proposed project. The EIS has indicated that where the cover is less than 300m above the 360m wide longwall panels or the cover is less than 390m above the wider panels it is likely that creek flows would be temporarily rerouted into the open cracks. There is also the potential for water losses from farm dams due to the subsidence impacts. In accordance with the NSW Aquifer Interference Policy this surface water take needs to be quantified and accounted for.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Response

Section 8.2 of the Surface Water Assessment (WRM, 2020) describes the expected changes in surface flow due to the Stage 3 Project, which is expected to be negligible. The Subsidence Assessment (Ditton Geotechnical Services Pty Ltd [Ditton Geotechnical Services], 2020) determined that there is unlikely to be any direct hydraulic connection between the surface flows and underground workings and therefore the loss of surface water flow due to surface cracking is not expected.

The Subsidence Assessment (Ditton Geotechnical Services, 2020) notes that there is potential, albeit highly unlikely, that creek flows could be temporarily re-routed into open cracks to below-surface pathways and re-surface downstream of the mining extraction limits in the mining area. The resurfacing of the flows would not be a loss of low to the system. Further to this, remedial measures would be implemented to ensure it would not be repeated, if it did occur.

Further detail on the quantification of the potential water take due to subsidence related surface cracking is provided in the Response to IESC Comment 18b (Attachment 1 of this letter).

<u>Submission 1 (Pre-approval recommendation)</u>

DPIE-Water stated:

- *Quantify the annual volume of surface water take due to subsidence related surface fracturing for both the existing and proposed project for a range of climatic scenarios (wet, average and dry)*

Response (prepared with assistance from WRM)

The annual volume of surface water take due to subsidence related surface fracturing is not expected to be quantifiable or measurable as it is expected to be near zero. Notwithstanding, NCOPL has committed to continue the monitoring of the underground dewatered volumes. A sudden increase in the monitored flow following surface runoff would suggest that surface water may have reached the underground workings. Should a sudden increase occur following surface runoff, it will be quantified, reported and remedial measures implemented to prevent it from occurring.

Note that no measurable changes in underground dewatered volumes following surface runoff events has been encountered to date at the existing mine, despite areas with a relatively low depth of cover (less than 170 metres [m]) having been mined to date.

<u>Submission 1 (Pre-approval recommendation)</u>

DPIE-Water stated:

- *demonstrate sufficient entitlement can be acquired in the relevant water source to account for the maximum surface water take which includes take resulting from subsidence related to surface cracking*

Response (prepared with assistance from WRM)

Section 8.6 of the Surface Water Assessment (WRM Water & Environment Pty Ltd [WRM], 2020) outlines the water licensing considerations for the Stage 3 Project. The additional water captured in the in-stream surface depressions is not expected to be a take of water, as the ponded water remains in stream. It is also likely to be temporary as any depression will fill with sediment. There is not expected to be any measurable or quantifiable loss of flow from surface cracking.

<u>Submission 1 (Pre-approval recommendation)</u>

DPIE-Water stated:

- *demonstrate that the required groundwater entitlements can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan. The proponent should also provide a detailed breakdown of all WALs held and the projects they are applicable, with a detailed plan of how WALs are to be transferred to meet all requirements across multiple projects.*

Response

Refer to the Response to Submission 1 above related to licensing requirements and the Response to IESC Comment 24 in Attachment 1 of this letter.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 1 (Post-approval recommendation)

DPIE-Water stated:

- *The proponent must ensure sufficient water entitlement is held in a water access licence/s to account for the maximum predicted take for each water source prior to take occurring*

Response (prepared with assistance from WRM)

NCOPL may rely on its harvestable right entitlement for the Stage 3 Project water storages (subject to incorporation in the revised Water Management Plan). Additional water entitlement from the Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012 is not expected to be required.

Responses regarding availability of groundwater Water Access Licences (WALs) are provided above and in the Response to IESC Comment 24 in Attachment 1 of this letter.

NCOPL would ensure that relevant nomination of work dealing applications for WALs proposed to account for water take by the Stage 3 Project have been completed prior to the water take occurring.

Submission 2

DPIE-Water stated:

- *The underground mine extracts coal at various depths below ground level. This results in subsidence troughs oriented north-south, crossing local watercourses at near perpendicular angles.*

Response

Noted.

Submission 2

DPIE-Water stated:

- *The subsidence impacts are predicted to increase erosion of watercourses due to increased channel slope on the downstream side of each chain pillar and where the flow in minor channels is diverted to join larger creeks at different locations.*
- *These watercourses cross multiple subsidence block alignments and are expected to have significant channel gradient change as subsidence occurs and stream flow velocities increase from upstream chain pillars towards the centre of the individual longwall subsidence trough. All the affected watercourses are sand bedded systems, with moderate to very high sensitivity to altered channel bed gradients. Alteration of surface gradient may exceed bedform competence thresholds by up to an order of magnitude.*
- *The affected watercourses are generally low order (1-2 Strahler) and are within 'hardened' banks, limiting lateral migration with the exception of Kurrajong Creek and Tulla Mullen Creek Tributary 1. With reference to the NSW River Styles database, DPIE Water considers that the two watercourses that may be impacted and trigger bed incision and flushing release of sand slugs are Kurrajong Ck and Tulla Mullen Creek Tributary No. 1. The loose sand beds of these watercourses are vulnerable to bed incision and channel degradation. Increased bed gradients along sand bed river channels lacking exposed bedrock controls or large woody debris are likely to incise and lead to extensive channel degradation. There is evidence of this as Kurrajong Creek has incised and degraded for several hundred metres immediately downstream of the easternmost longwall panel alignment.*

Response (prepared with assistance from WRM)

Section 8.1 of the Surface Water Assessment (WRM, 2020) describes the potential impacts on Kurrajong Creek and Tulla Mullen Creek Tributary No. 1. The assessment draws upon surface water impacts in Pine Creek Tributary1 and Pine Creek associated with existing subsidence (e.g. ponding) above Longwalls 101 to 109 are generally consistent with the predicted impacts (WRM, 2015), with maximum ground subsidence depths up to approximately 2.75 m. Impacts include ponding, which may or may not be confined to the creek channel (in-stream or over bank ponding), flow direction changes against contour banks, increased or accelerated in-stream erosion and sedimentation generated by the altered channel gradients, increased water salinity as a result of increased storage time over saline soils and degradation of riparian vegetation as a consequence of inundation (NCOPL, 2017). The evidence of the existing headward erosion on Kurrajong Creek (which is historical and not mine-related) is described in Section 4.3 of the Surface Water Assessment (WRM, 2020).

As described in the assessment, some bed incision is expected on the downstream side of each chain pillar due to the increased channel slope. The loose sand bed material eroded from these reaches are expected to accumulate in the subsidence trough immediately upstream of the next chain pillar, which has a significantly reduced channel slope.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

This process is expected to occur across each chain pillar as mining progresses upstream. As the bed across the chain pillars erode and the subsidence depressions accumulate the sediment, the only significant long term bed form change will be at the upstream end of the most western longwall panel, which will remain with an increased slope, and at the eastern side of the most downstream panel, which will have a reduced bed slope. The streams are all first and second order watercourses with very little catchment at the upstream end of the most western longwall panel, significantly reducing the potential long-term impacts.

As a result, although changes to the channel morphology are expected, they are not expected to lead to significant geomorphic changes, such as an avulsion, or create a downstream sand slug (as the sand would be captured in the depressions).

NCOPL has committed to continue monitoring the channel changes across the existing mine and the waterways impacted by the Stage 3 Project and implement mitigation measures if required. These commitments are given in the currently approved Water Management Plan (NCOPL, 2017).

Submission 2

DPIE-Water stated:

- *Surface subsidence is predicted to range between 2.35-2.8 metres. Maximum surface deformation is concentrated within the half longwall block alignment closest to the outer limit for each longwall block. Where subsidence troughs intersect watercourses, localised tension fractures create drainage conduits from surface into the deformed rock mass overlying the extracted panel, termed the goaf.*

Response

Noted.

Submission 2

DPIE-Water stated:

- *The Environmental Impact Statement refers to a Subsidence Management Plan Trigger Action Response Plan (TARP) requirement for the existing mining operation in relation to stream channel impacts. No details are provided on trigger values or any response measures for potential or actual subsidence impacts or bed incision risk to these watercourses.*

Response

A Trigger Action Response Plan (TARP) for the Narrabri Mine is included in the *Narrabri Mine Extraction Plan Water Management Plan LW 107 to LW 110* (NCOPL, 2017). It includes triggers and responses for water quality measured in the receiving waters and water quality (and volumes) measured in the water storage dams. For the receiving waters, the current TARP references water quality triggers referenced in Environment Protection Licence (EPL) 12789 for oils and grease, pH and total suspended solids.

The TARP contains two levels of triggers that would result in remedial actions being invoked in relation to the following aspects:

- water quality;
- ponding;
- changes in water course morphology;
- erosion above longwall panels;
- groundwater levels and quality;
- hydraulic connectivity; and
- mine inflows quantity and quality.

Section 4.5 and Table 4.4 of the Surface Water Assessment (WRM, 2020) presents the background water quality data collected at the site since 2007. The sites denoted as KCUS, KCDS, KC1US, KC2US collect runoff from catchments that have not been disturbed by mining activities and would be suitable to derive baseline water quality.

The Water Management Plan and the associated TARPs would be updated to incorporate the Stage 3 Project and would include the water quality parameters with sufficient baseline data, namely electrical conductivity (EC) and total organic carbon (TOC) with the 90th percentile background level selected for the baseline trigger.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Note that baseline total suspended solid concentrations for median and 80th percentile values at the background stations significantly exceed the 100th percentile concentration limits in the EPL. NCOPL would liaise with the Environment Protection Authority (EPA) during development of the Water Management Plan for the Stage 3 Project to determine the most appropriate limits in consideration of the baseline data.

NCOPL supports the expansion of the surface water and groundwater monitoring program, including development of TARPs. The TARPs would be developed in consultation with DPIE–Water. A draft groundwater monitoring program is presented in Attachment 4 of this letter. It is envisaged that this program would be refined in consultation with DPIE-Water during preparation of the Water Management Plan for the Stage 3 Project.

Submission 2

DPIE-Water stated:

- *This is not adequate for risk assessment or conditions for the extension. A description of channel form and any channel incision or bed and bank scour in watercourses overlying previous and existing mining operations should be provided to allow an assessment of channel alteration risk and documentation of channel alteration or remediation.*

Response

Refer to Response to Submission 2 above related to the existing evidence of erosion.

Submission 2

DPIE-Water stated:

- *Monitoring and remediation of such impacts to ensure stability will need to be implemented.*

Response

NCOPL currently undertakes monitoring and management of surface cracking in accordance with its:

- *Procedure for Subsidence Monitoring and Management of LW107 - LW110* (NCOPL, 2020a); and
- *Procedure for Subsidence Crack Repair (in limited access areas)* (NCOPL, 2020b).

The *Procedure for Subsidence Monitoring and Management of LW107 - LW110* (NCOPL, 2020a) includes a TARP which outlines triggers for surface cracking, creek stability and ponding impacts. In relation to impacts on watercourses, triggers have been developed including:

- surface cracking;
- creek stability and condition;
- creek bed and bank stability;
- observed subsidence ponding; and
- surface water quality.

Subsidence monitoring of the Narrabri Mine has identified subsidence-related cracking within the modelled estimations described in the Subsidence Assessment (Ditton Geotechnical Services, 2020). These cracks have been successfully managed to date by filling in naturally (for small cracks) or by use of machinery for larger cracks (Figure A1-8).

NCOPL proposes to continue monitoring, management and reporting of subsidence-related surface cracking in accordance with the current procedures. The procedures would be evaluated from time to time to assess their suitability.

Project remediation works would be undertaken in consideration of the *Guidelines for Controlled Activities on Waterfront Land* (Natural Resources Access Regulator [NRAR], 2018).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 2 (Post-approval Recommendation)

DPIE-Water stated:

- *Triggers for investigation and remedial action of subsidence impacts to watercourses should be specified in the TARP and provided to DPIE Water for review. Where existing channel deterioration is detected, the application should nominate options for response and remediation of subsidence channel gradient alteration as well as bed and bank cracking.*

Response

As described in the Response to Submission 2 above, various existing TARPs have been developed for the Narrabri Mine. In addition, NCOPL supports the expansion of the surface water and groundwater monitoring program, including development of TARPs. The TARPs would be developed in consultation with DPIE–Water. A draft groundwater monitoring program is presented in Attachment 4 of this letter. It is envisaged that this program would be refined in consultation with DPIE-Water during preparation of the Water Management Plan for the Stage 3 Project.

Submission 2 (Post-approval Recommendation)

DPIE-Water stated:

- *Performance reporting on channel form and any remedial actions undertaken should be provided to the Department for assessment and review of River Style condition and future geomorphic recovery.*

Response

Reporting of watercourse remediation would continue to be conducted via the Annual Review.

Submission 2 (Post-approval Recommendation)

DPIE-Water stated:

- *Subsidence impacts to watercourses need to be remediated to ensure stability and natural ecological functioning. Works are to be in accordance with the Guidelines for Controlled Activities on Waterfront Land (NRAR 2018).*

Response

Refer to the Response to Submission 2 above related to remediation of subsidence impacts and relevant TARPs.

Submission 3

DPIE-Water stated:

- *Drawdowns are predicted to exceed minimal impact considerations at eight third-party bores and several potential groundwater dependent ecosystem areas. The proponent has committed to make-good provisions for affected groundwater users.*

Response

Noted. An additional bore census round was undertaken, subsequent to the Environmental Impact Statement (EIS) lodgement, which resulted in new bores being identified. Ultimately, a total of nine privately-owned bores are predicted to exceed the AIP minimal impact threshold. Of these, six bores may experience drawdown which results in some impairment of water production from the bore. NCOPL has committed to these bore owners to:

- conduct a groundwater yield test (where allowed by the installed bore head works);
- monitor any drawdown as it develops; and
- implement ‘make good’ measures (such as installation of a new bore) during the operational phase of the Stage 3 Project.

Consultation with these landholders is continuing.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 3

DPIE-Water stated:

- *The project's dewatering requirement results in a maximum drawdown which closely matches the Aquifer Interference Policy (AIP) minimal impact consideration threshold of 2 metres at the boundary of the Namoi Alluvium. (Refer to Figure 1 in Appendix B). Therefore, predicted drawdowns at all bores accessing "highly productive" water sources are within the AIP minimal impact criteria.*

Response

Noted.

Submission 3

DPIE-Water stated:

- *The tight-scale map insets provided by the proponent show 2 metre drawdown contours coinciding very closely to the mapped alluvial groundwater source edge. Given this closeness, and the sensitivity of the Upper Namoi Zone 4 and 5 water sources, further detail should be provided testing the sensitivity of, and providing confidence in the accuracy of, the modelled predictions.*

Response (prepared with assistance from AGE)

As described in Appendix D (Section D 5) of the Groundwater Assessment (AGE, 2020) the sensitivity of model predictions to parameter uncertainty has already been assessed via completion of a predictive uncertainty analysis. Hence in addition to the 'best estimate' predictions of drawdown in Quaternary Alluvium/regolith drawdowns shown in Figure 7.8 of the Groundwater Assessment and predictions for a further 100 realisations can be analysed statistically to assess the likelihood of the 2 m drawdown contour extending further onto the Namoi Alluvium. The results of this statistical analysis are presented in Figure A2-1. A very similar plot was presented in the Appendix D of the Groundwater Assessment but has been revised for clarity to show drawdown in model layer 1 (i.e. the Quaternary Alluvium/regolith) rather than at the water table. As shown in Figure A2-1, uncertainty analysis results suggest that impacts of more than 2 m are very unlikely to occur within the Namoi Alluvium at any point in the future. This is because the indirect loss of groundwater from the base of the alluvium to the depressurised underlying Permian strata is less than the recharge rate to the alluvial groundwater system for all of the model realisations. The unconsolidated nature of the Namoi Alluvium means that it is characterised by substantially higher recharge, hydraulic conductivity and storage properties than the underlying consolidated Permian strata such that the relatively minor drawdowns predicted towards the limit of the Permian strata reduce rapidly at the boundary of the alluvium.

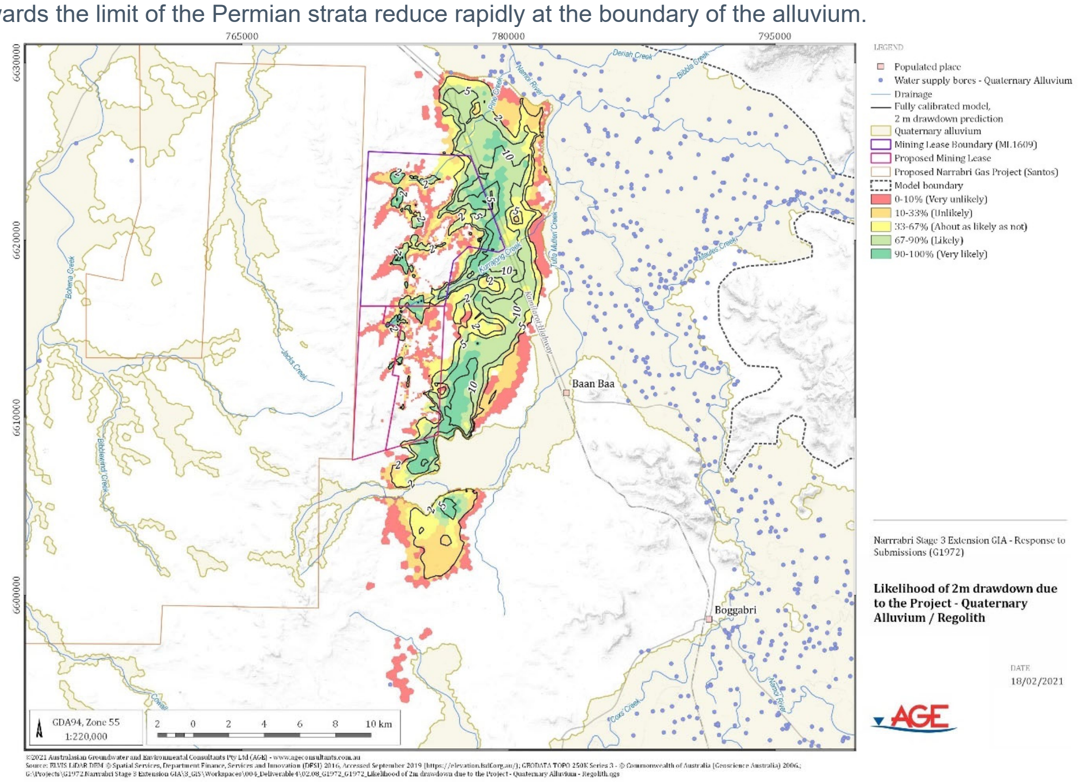


Figure A2-1
Likelihood of 2 m drawdown due to the Stage 3 Project – Quaternary Alluvium/Regolith

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 3

DPIE-Water stated:

- *The timing of the maximum predicted extent of drawdown has not been specified on the drawdown-contour maps or in the immediately related passages of text.*

Response (prepared with assistance from AGE)

Additional maps showing the year in which predicted maximum drawdown occurs in each aquifer are provided in Attachment 2 of the Submissions Report. Note that only those areas where predicted maximum drawdown exceed 0.2 m are shown.

Submission 3

DPIE-Water stated:

- *The potential for drawdown within model layer 11 (Pamboola and older Formations) to impact on the directly overlying alluvium to the east of the project has not been adequately discussed. Six third-party bores within the extent of the model domain are sourcing groundwater from that aquifer, with a combined total licensed volume of 17,250 ML/year. This indicates that aquifer is significant, with potential for connectivity with adjacent aquifers.*

Response (prepared with assistance from AGE)

Predicted maximum drawdown in model layer 11 (Pamboola and older formations) and the location of the six third party bores (GW060176, GW059104, GW901840, GW967175, GW901242, GW001907) which have been attributed to this layer based on bore depths is shown in Figure A2-2. As shown in Figure A2-2, all six of these bores are situated well outside of the predicted 2 m drawdown contour for this unit. It should also be noted that:

- as shown in Figure A2-2, all six of the bores are located within areas where Quaternary Alluvium is present at outcrop;
- the depth of each bore, which vary from 61 to 132 m, only marginally exceeds the estimated depth of the Quaternary Alluvium;
- the licensed volumes for five of the six bores are in the range 2,546 to 5,504 ML/year are considered to be unusually high for bores in consolidated Permian age units; and
- NSW Water Register entries for all six of the properties containing these bores identify the Namoi Alluvium as the water source.

It is therefore considered most likely that these bores draw most, if not all, of their supply from the Namoi Alluvium aquifer and that the attribution of these bores to the Pamboola Formation over-estimates the significance of this unit as a water supply. In either case, as discussed previously, drawdown impacts of more than 2 m are not expected in any part of the Namoi Alluvium aquifer or in the underlying Permian age units at any of these six locations.

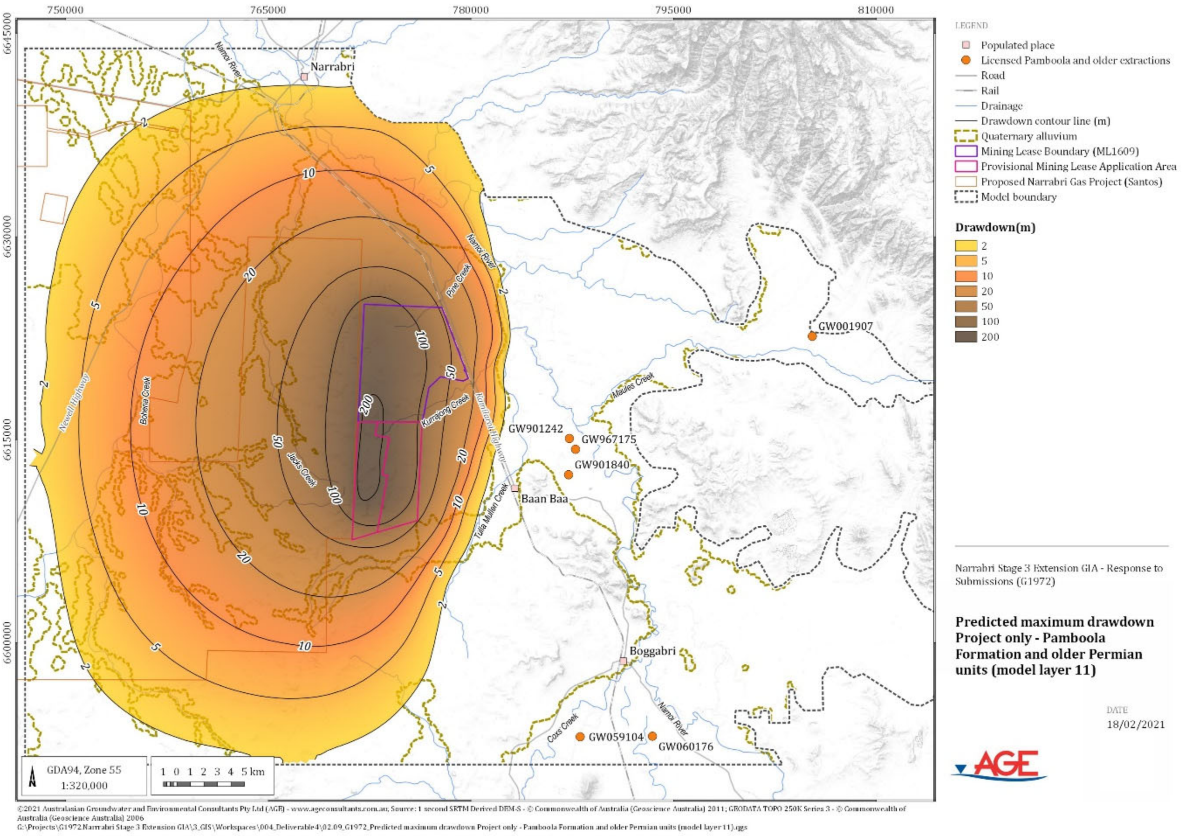


Figure A2-2
Predicted Maximum Drawdown Project Only – Pamboola Formation and Older Permian Units (model layer 11)

Submission 3

DPIE-Water stated:

- *Based on water salinity, the project meets the water-quality minimal impact consideration. The consideration of other indices (apart from total salinity) of water quality in relation to the beneficial use category, or vulnerability of potential receptors or users, has not been presented.*

Response (prepared with assistance from AGE)

In accordance with the AIP, which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focusses on impacts on groundwater salinity or total dissolved solids (TDS).

Monitoring of inflows to the current mine workings and water held within the current storage facilities is limited to pH, EC, TDS, grease, and TOC. Accordingly, no information is available on likely concentrations of metals or other indices. However, impacts on beneficial use or other receptors or users are also likely to be negligible for all constituents since:

- the load of metals and other constituents in the water to be re-injected originated in the Hoskissons Coal Seam in the first place;
- numerical model predictions indicate flow towards the goaf areas for around 200 years after mining ceases; and
- longer term once groundwater levels fully recover then numerical model predictions indicate downward flow within the mining area from the Hoskissons Coal Seam to the underlying Arkarula Formation which is already saline (12,884 milligrams per litre [mg/L] TDS on average).

Accordingly, there are no known mechanisms by which brine re-injected to the goaf could migrate to potential receptors which include existing water supply bores and surficial Groundwater Dependent Ecosystems (GDEs).

Submission 3

DPIE-Water stated:

- *The project exceeds the level 1 minimal impact consideration for water table drawdown at two potential Groundwater Dependent Ecosystem (GDE) areas of approximately 7.4 ha in the Namoi Alluvial Groundwater Source, and approximately 153.5 ha in the Gunnedah-Oxley Basin MDB Groundwater Source.*

Response

Noted.

Submission 3

DPIE-Water stated:

- *The proponent has committed to make-good provisions, however areas mapped remotely as having a high potential for GDE have not been field verified (other than spring sites) or had their ecological condition and related risk assessed. Seasonal baseline groundwater levels in areas of potential GDEs have not been confirmed through direct measurement.*

Response (prepared with assistance from AGE)

As discussed in Section 8.2 of the Groundwater Assessment (AGE, 2020) further monitoring of the Mayfield, Hardys and Eather Springs and at two locations close to Tulla Mullen Creek tributary is also proposed if the Stage 3 Project is approved. Proposed locations for the Tulla Mullen Creek tributary sites are shown in Figure A1-5 and have been selected based in part on proximity to the potential GDE areas shown.

A field inspection of the relevant high potential GDE vegetation communities was conducted in July 2020 in order to verify the ecological condition and possible groundwater dependency of each community. The dominant flora species along with the geographic location and soil observations were recorded at 49 locations across the mapped terrestrial GDE areas potentially affected by the Stage 3 Project. Depth to water table and soil water holding capacity data for the Stage 3 Project was also used in assessing groundwater dependency of the target vegetation.

The mapped GDE vegetation communities were found to be located across a range of low sand dunes, cleared grazing land with paddock trees, roadside strips on cracking clay, ephemeral creeklines and patches of sedge habitat along an area of intermittent ponding.

The field verification concluded that most of the mapped GDE areas are likely to be facultative GDEs (or have a low potential to access groundwater), however minor changes to the groundwater regime as a result of the Stage 3 Project may not have any adverse impacts on these GDEs and there is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.

Further consideration of the likelihood of impact on GDEs is provided in the Response to IESC Comment 5 (Attachment 1 of this letter).

Submission 3

DPIE-Water stated:

- *Groundwater collected by the mine water management systems underground is pumped to the surface where it is treated by a reverse osmosis plant. During mining, the brine stream is directed to a series of lined brine water storage ponds. At the completion of mining, any remaining brine would be re-injected into the mine goaf. The brine injection volumes and total dissolved-solids concentrations given in the groundwater assessment (Appendix B) and the surface water assessment (Appendix C) are inconsistent and the source of some data cannot be traced. The maximum estimated brine injection volume specified in Appendix B is based on the median predicted value given in Appendix C. A risk thus exists for the true volume, and the associated quantity of total dissolved solids, to be significantly larger than estimated.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Response (prepared with assistance from AGE)

As summarised in Table 7.8 of the Groundwater Assessment (AGE, 2020) brine re-injection impacts have been assessed assuming an inflow volume of 2,830 megalitres (ML) and TDS concentration of 76,554 mg/L. Final site water balance results presented in the Stage 3 Project Surface Water Assessment (WRM, 2020) present a range of predictions. Critically, however, as shown in Table A2-1 the predicted average long-term concentration in the goaf depends on the total load of dissolved solids (i.e. the product of the volume and the concentration). Hence, adoption of any of the final values summarised in the Stage 3 Project Surface Water Assessment would result in lower predicted concentrations since the load in each of the four scenarios is lower than that used in the Groundwater Assessment. Accordingly, the predictions in the Groundwater Assessment are considered to be conservative. Loads and hence impacts under the 99th percentile scenario presented in the Surface Water Assessment would be lower than modelled in the Groundwater Assessment.

Table A2-1
Predicted Long Term Average Brine Concentrations in the Goaf for Different TDS Re-injection Load Scenarios

Scenario source	Volume (ML)	TDS (mg/L)	Load (tonnes)	Predicted Average Goaf Concentration (mg/L)
Groundwater assessment	2,830	76,554	216,648	10,157
Surface water assessment - 20th percentile	2,657	67,770	180,065	9,894
Surface water assessment - 50th percentile	2,832	64,110	181,560	9,904
Surface water assessment - 80th percentile	3,098	57,767	178,962	9,882
Surface water assessment - 99th percentile	3,895	46,004	179,186	9,888

Submission 3 (Pre-approval Recommendation)

DPIE-Water stated:

- *The proponent provides clarification on the forecast maximum drawdown in relation to:*
  - *The accuracy and reliability of the maximum drawdown that equates specifically to the minimal impact consideration (Aquifer Interference Policy 2012) of 2 metres at the boundary of the Namoi Alluvium.*

Response

Refer to the Response to Submission 3 above regarding the sensitivity of model predictions adopted for the Groundwater Assessment (AGE, 2020).

Submission 3 (Pre-approval Recommendation)

DPIE-Water stated:

  - *The potential for drawdown within model layer 11 (Pamboola and older Formations) to impact on the directly overlying alluvium to the east of the project.*

Response

Refer to the Response to Submission 3 above regarding model layer 11.

Submission 3 (Pre-approval Recommendation)

DPIE-Water stated:

- *The proponent clarifies the estimated volumes and salinity of remaining brine to be re-injected into the mine goaf at the completion of mining.*

Response

Refer to the Response to Submission 3 above regarding potential brine re-injection impacts.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 3 (Pre-approval Recommendation)

DPIE-Water stated:

- *The proponent field-verifies the existence, ecological condition and ecosystem value of the mapped terrestrial groundwater dependent ecosystem areas potentially affected by the project and advises on the make good provisions as required.*

Response

A field inspection of the relevant high potential GDE vegetation communities was conducted in July 2020 in order to verify the ecological condition and possible groundwater dependency of each community. The dominant flora species along with the geographic location and soil observations were recorded at 49 locations across the mapped terrestrial GDE areas potentially affected by the Stage 3 Project. Depth to water table and soil water holding capacity data for the Stage 3 Project was also used in assessing groundwater dependency of the target vegetation.

The mapped GDE vegetation communities were found to be located across a range of low sand dunes, cleared grazing land with paddock trees, roadside strips on cracking clay, ephemeral creeklines and patches of sedge habitat along an area of intermittent ponding.

The field verification concluded that most of the mapped GDE areas are likely to be facultative GDEs (or have a low potential to access groundwater), however minor changes to the groundwater regime as a result of the Stage 3 Project may not have any adverse impacts on these GDEs and there is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.

The Narrabri Mine operates an extensive existing groundwater monitoring network to monitor the response to mining operations in nearby aquifers. Ongoing monitoring of groundwater levels and quality would be used to assess the extent and rate of groundwater impacts (including groundwater table drawdown), and to distinguish natural groundwater level fluctuations (e.g. response to rainfall) from groundwater level impacts due to mining. AGE (2020) has also recommended additional monitoring sites be included in the monitoring network as part of the Stage 3 Project.

The results of the groundwater monitoring programme would be used to progressively refine the numerical model developed for the Groundwater Assessment (AGE, 2020) over the life of the Stage 3 Project. The numerical model would be used as a management tool for the periodic review and validation of predicted groundwater impacts, including groundwater table drawdown.

Submission 4

DPIE-Water stated:

- *DPIE Water is currently reviewing the groundwater model as part of a 5 yearly review as required by Condition 9 of Schedule 4 of Project Approval PA08_0144 and plan to provide this advice including recommendations by early February 2020 so that the proponent is able to review and respond in their Response to Submissions.*

Response

Refer to Attachment 3 of this letter.

Submission 5

DPIE-Water stated:

The current groundwater monitoring network has a number of deficiencies that we recommend are addressed. These are as follows:

- *No monitoring sites exist to the south of the proposal, and only one site (Vibrating Wire Piezometer) exists to the immediate east. Additional monitoring should be designed for these areas for early detection of impacts on third party bores.*

Response

Additional monitoring recommendations are provided in Section 8.2 of the Groundwater Assessment (AGE, 2020) and in Response to the IESC Comment 3d (Attachment 1 of this letter).

New monitoring points are proposed at four locations to the east and south of the Stage 3 Project area.

Additional monitoring of water quality reporting to the underground mine workings and of groundwater levels and groundwater quality at three potential spring sites is also proposed in the Groundwater Assessment (AGE, 2020).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Existing and proposed shallow groundwater monitoring facilities in and around surface infrastructure will be identified in the revised Water Management Plan.

Submission 5

DPIE-Water stated:

- *There is inadequate monitoring in some areas that potentially host groundwater dependent ecosystems. No monitoring sites exist in the alluvium and Tulla Mullen Creek and its tributaries to the immediate east, southeast and south of the proposal, or in the vicinity of Spring Creek to the immediate west.*

Response (prepared with assistance from AGE)

Additional monitoring recommendations are provided in Section 8.2 of the Groundwater Assessment (AGE, 2020) and in the response above. Groundwater monitoring at the six additional sites shown in Figure A1-5. Each site would comprise:

- two shallow standpipe monitoring bores monitoring groundwater levels and water quality in the Quaternary Alluvium and the immediately underlying bedrock; and
- a nested vibrating wire piezometer (VWP) facility including monitoring of all groundwater levels in consolidated units from the Hoskissons Coal Seam to the ground surface.

Proposed locations for the Tulla Mullen Creek tributary sites are shown in Figure A1-5 and have been selected based in part on proximity to the potential GDE areas shown.

Additional monitoring of water quality reporting to the underground mine workings and of groundwater levels and groundwater quality at three potential spring sites is also proposed in the Groundwater Assessment (AGE, 2020). Monitoring includes sites in the vicinity of Tulla Mullen Creek to the south of the Stage 3 Project. However, additional sites are not proposed to the east or south-east of the Stage 3 Project (because of the limited potential for significant impacts in these areas; or in Spring Creek as this creek is located outside of the Stage 3 Project underground mine footprint).

Attachment 4 of this letter provides a draft groundwater monitoring program overview for the Stage 3 Project.

Submission 5

DPIE-Water stated:

- *Additional monitoring sites will be needed for the proposed additional water management infrastructure (e.g. mine-water storage), up and down gradient of the facility.*

Response

The current monitoring network includes a network of shallow monitoring bores around existing water storage facilities. The Southern Mine Water Storage would be developed at the southern ventilation complex for the Stage 3 Project. Shallow groundwater monitoring up and down gradient would be undertaken at this storage consistent with the existing storages. Attachment 4 of this letter provides further details.

Submission 5

DPIE-Water stated:

- *The EIS Appendix A Section 12 recommends additional borehole extensometers and variable bore rams installations for subsidence-impact monitoring. This should occur.*

Response

As recommended by Ditton Geotechnical Services and described in Section 4.2.1 of the Stage 3 Project Submissions Report, on-going review of the height of continuous fracturing above selected panels (Longwalls 110 to 111 and some of Longwalls 201 to 210) would provide additional prediction points to allow for:

(i) wider longwalls;

(ii) multiple panel effects; and

(iii) geological interaction and allow groundwater models to be re-calibrated if necessary.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

The new calibration borehole would comprise nests of deep borehole piezometers (greater than 30 m depth) and shallow standpipe piezometers (less than 30 m depth) and deep wireline extensometers to aid with interpretation of nearby piezometer data should be installed above selected longwall centrelines at distances greater than 300 m (0.7 x cover depth or panel width) from the panel ends. It is proposed to install the new calibration borehole in Longwall 203 or Longwall 204, however the precise location would be dependent on the timing of the Stage 3 Project approval and the progression of existing and proposed mining.

Submission 5

DPIE-Water stated:

- *There are geological units in which baseline water quality has not been adequately defined. Water quality is inadequately represented by a single sampling site for each of the Hoskissons Coal Seam and Arkarula Formation, and water from the Digby Formation has not been sampled. The broad spread in electrical conductivity (Appendix B Fig. 5.8) from four bores in the Purlawaugh Formation and three in the Pamboola Formation indicates that these formations are inadequately represented for water quality.*

Response (prepared with assistance from AGE)

Additional monitoring of water quality at a number of gathering points in the underground mine workings (i.e. in the mine water collection system) which will provide additional information on water quality in the Hoskissons Coal Seam (and potentially overlaying aquifers) is proposed in Section 8.2 the Groundwater Assessment (AGE, 2020). Furthermore, additional monitoring in 12 additional shallow bores at the six monitoring sites shown in Figure A1-5 is also now proposed to complement an existing site groundwater quality database comprising data for over 1,300 samples collected from 40 monitoring points.

A number of units in the area appear to be characterised by highly variable water chemistry. This is considered to be consistent with the heterogeneity of these strata. It is not clear how many monitoring points would be required for DPIE-Water to assess the water quality of each unit as being adequately represented. However, given the nature of the development the existing and proposed level of water quality monitoring is considered commensurate with the relatively low likelihood of any significant impacts. Other than possible minor changes to water quality, due to changing groundwater flow directions, operation of the mine dewatering system is unlikely to result in any significant water quality impacts.

The Digby Formation at the site typically comprises a massive 15 m conglomerate unit and there is no known local extraction from this unit as such the value monitoring of water quality in this aquitard is considered to be limited.

Submission 5

DPIE-Water stated:

- *The methodology applied at groundwater monitoring sites for the early detection of potential subsidence-related impacts has not been clearly and explicitly presented.*

Response (prepared with assistance from AGE)

Early detection of potential subsidence impacts will be provided by monitoring at additional VWP nests installed in close proximity to proposed longwall panels (see Figure A1-5, Sites 1-4).

Submission 5

DPIE-Water stated:

The assessment methodologies for the establishment of baseline water-quality status and the interpretation of change or trends are inadequately defined and are based on total salinity only. Water- quality objectives have not been clearly defined for each relevant water source and have not been reported to display status over time in relation to trigger values.

Inconsistent water quality objectives are presented. The proponent refers to National Environmental Protection Measures guidelines for livestock and to the 97.5th percentile of the available baseline data. Conversely, laboratory results are tabulated against "groundwater assessment criteria", being the national water quality guideline default values for drinking, irrigation and freshwater-species protection (Appendix D of Appendix G of Appendix B).

Response (prepared with assistance from AGE)

NCOPL supports the recommendations for the expanded groundwater monitoring program described in Section 8.2 of the Groundwater Assessment (AGE, 2020) and Attachment 4 of the EIS. A draft groundwater monitoring program overview has been provided as Attachment 4 of this letter. It is envisaged that this program would be refined in consultation with DPIE-Water part of preparation of a revised Water Management Plan for the Stage 3 Project.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Further details of the current Narrabri Mine groundwater quality monitoring program (i.e. in addition to salinity) are presented in the current site Water Management Plan (NCOPL, 2017). Groundwater level and quality data collected from the network of monitoring bores is summarised in a series of annual environmental reports, including in the 2019 Annual Review (NCOPL, 2020c). These reports also provide a summary of environmental performance over the preceding year in relation to groundwater inflows, groundwater levels and groundwater quality and include a comparison of laboratory results with a number of different water quality objectives. The DPIE-Water comment that inconsistent water quality objectives are presented therefore appears to be related to the current site Water Management Plan and Annual Review reports. This, and other similar comments, can only be addressed by revisions to these separate project documents.

A revised version of the current Water Management Plan to address other separately provided regulator comments is currently being assessed by DPIE-Water. This document would be further updated to incorporate the Stage 3 Project and comments received from DPIE-Water on the EIS.

As documented in Appendix E of the 2019 Annual Review (NCOPL, 2020c), groundwater samples taken from the Narrabri Mine are regularly tested to confirm arsenic and cobalt concentrations and are typically at or close to detection limits. Testing for antimony, molybdenum and selenium has not routinely been undertaken historically but would be added to the revised Water Management Plan.

In accordance with the AIP (DPI – Office of Water, 2012), which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focuses on impacts on groundwater salinity or TDS.

Submission 5

DPIE-Water stated:

> *Multiple water-quality populations are clearly distinguishable for most hydrostratigraphic units by their dissolved major-ion ratios but have not been considered in defining baseline. A broad water-quality analytical suite is being monitored at existing operations, including field-based measurements of temperature, electrical conductivity and pH, and a number of laboratory measurements that may be critical condition indices that should be considered.*

Response (prepared with assistance from AGE)

The apparent multiple water quality populations evident in piper and other major ion chemistry plots are considered likely to reflect the highly heterogenous nature of many of the hydrostratigraphic units present at the site. Given the observed variability in water chemistry between bores installed into the same strata, bore specific, rather than strata specific, baselines will be defined in the Stage 3 Project Water Management Plan. Appropriate trigger levels will then also be defined in the Stage 3 Project Water Management Plan to track any changes against these bore specific baselines and determine any actual water quality impacts at individual bores.

Given the nature of the development, the existing and proposed level of water quality monitoring is considered commensurate with the relatively low likelihood of any significant impacts (AGE, 2020). Other than possible minor changes to water quality, due to changing groundwater flow directions, operation of the mine dewatering system is unlikely to result in any significant water quality impacts.

Submission 5

DPIE-Water stated:

> *Time-series charts have not been provided to clearly display reference (baseline) state, variability, and change and trends in relation to trigger values for each water-quality objective since monitoring commenced in 2007. Only summary statistics and charts of electrical conductivity (as box plots and time-series) and dissolved major-ion ratios (Piper diagram) are presented.*
>
> *The conversion between electrical conductivity and total dissolved solids has been performed inconsistently and should consider the major ionic composition of the waters.*

Response (prepared with assistance from AGE)

NCOPL supports the recommendations for the expanded groundwater monitoring program described in Section 8.2 of the Groundwater Assessment (AGE, 2020) and Attachment 4 of the EIS. A draft groundwater monitoring program overview has been provided as Attachment 4 of this letter. It is envisaged that this program would be refined in consultation with DPIE-Water part of preparation of a revised Water Management Plan for the Stage 3 Project. Further details of the Narrabri Mine groundwater quality monitoring program (i.e. in addition to salinity) are presented in the current site Water Management Plan (NCOPL, 2017). Groundwater level and quality data collected from the network of monitoring bores is summarised in a series of annual environmental reports, including in the 2019 Annual Review (NCOPL, 2020c). These reports also provide a summary of environmental performance over the preceding year in relation to groundwater inflows, groundwater levels and groundwater quality (albeit data is tabulated rather than plotted as requested by the DPIE-Water).

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

A revised draft of the Stage 2 Water Management Plan to address regulator comments is currently being assessed by DPIE-Water. This document would be updated to incorporate the Stage 3 Project.

As documented in Appendix E of the 2019 Annual Review (NCOPL, 2020c), groundwater samples taken from the Narrabri Mine are regularly tested to confirm arsenic and cobalt concentrations and are typically at or close to detection limits. Testing for antimony, molybdenum and selenium has not routinely been undertaken historically but would be added to the revised Water Management Plan for the Stage 3 Project.

In accordance with the AIP (DPI – Office of Water, 2012), which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focuses on impacts on groundwater salinity or TDS.

Submission 5

DPIE-Water stated:

> *An existing Groundwater Response Plan for the mine is proposed to be reviewed and updated for the project modification and would describe any additional measures and procedures that would be implemented over the life of the project to respond to any exceedances. These should be developed in consultation with DPIE Water.*

Response

A TARP for the Narrabri Mine is included in the *Narrabri Mine Extraction Plan Water Management Plan LW 107 to LW 110* (NCOPL, 2017). It includes triggers and responses for water quality measured in the receiving waters and water quality (and volumes) measured in the water storage dams. For the receiving waters, the current TARP references water quality triggers referenced in EPL 12789 for oils and grease, pH and total suspended solids.

The TARP contains two levels of triggers that would result in remedial actions being invoked in relation to the following aspects:

- water quality;
- ponding;
- changes in water course morphology;
- erosion above longwall panels;
- groundwater levels and quality;
- hydraulic connectivity; and
- mine inflows quantity and quality.

Section 4.5 and Table 4.4 of the Surface Water Assessment (WRM, 2020) presents the background water quality data collected at the site since 2007. The sites denoted as KCUS, KCDS, KC1US, KC2US collect runoff from catchments that have not been disturbed by mining activities and would be suitable to derive baseline water quality.

The Water Management Plan and the associated TARPs would be updated to incorporate the Stage 3 Project and would include the water quality parameters with sufficient baseline data, namely EC and TOC with the 90th percentile background level selected for the baseline trigger.

Note that baseline total suspended solid concentrations for median and 80th percentile values at the background stations significantly exceed the 100th percentile concentration limits in the EPL. NCOPL would liaise with the EPA to determine the most appropriate limits in consideration of the baseline data.

NCOPL supports the expansion of the surface water and groundwater monitoring program, including development of TARPs. The TARPs would be developed in consultation with DPIE-Water. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan for the Stage 3 Project.

Submission 5

DPIE-Water stated:

> *A data-quality assurance plan, detailing appropriate quality assurance procedures for all types of measurements including historic data, has not been referred to in the EIS or included as part of the currently active water management plan or extraction plan. Accordingly, data reliability has not been assessed and quality control measures have not been integrated to provide confidence in data interpretation.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

> *Sample collection procedures are not given in the EIS and, for current operations, are inadequately described in the water management plan to enable independent repeatability and a data-quality assessment. Bore purging records were not provided. The use of an in-line flow-through cell for EC, pH and temperature measurements, and equipment decontamination method, have not been specified. Measurements from bailed groundwater samples, with undisclosed purge volumes, have been accepted as being fully representative and usable. Quality control data for field-based measurements have not been provided; field-based measurements of temperature, EC and pH have not been verified against laboratory measurements or the reasons for any difference identified. The earliest electrical conductivity measurements from many sites are an order of magnitude lower than subsequent measurements. Measurements from the Hoskissons Coal Seam are highly variable over time (site P18). These measurements require verification.*

Response

All groundwater level data used for conceptualisation and groundwater modelling purposes in the Groundwater Assessment (AGE, 2020) was subject to review comprising:

- graphical review of a groundwater level hydrograph for each monitoring point, to identify any isolated erroneous readings; and
- review of groundwater level contours for each hydrostratigraphic unit based on average groundwater levels at each observation point, to identify any anomalously high or low average groundwater level readings.

In accordance with the AIP (DPI – Office of Water, 2012), which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focuses on impacts on groundwater salinity or total dissolved solids (TDS). Salinity data were similarly graphically reviewed by AGE.

The Water Management Plan would be updated to incorporate the Stage 3 Project. The revised Water Management Plan would include a data quality assurance plan and control protocols and would consider comments provided by DPIE-Water.

Submission 5

DPIE-Water stated:

> *Vibrating wire piezometer data were assumed, without providing evidence, to be sufficiently accurate according to their given description: "appears to be of good quality and not prone to the long equilibration periods…".*

Response (prepared with assistance from AGE)

Potential measurement error in VWP derived data is discussed in Section D 3.2.1 in Appendix D of the Groundwater Assessment (AGE, 2020). As discussed, whilst data obtained via VWP installations is likely to be subject to larger errors than other monitoring point types, it is considered useful data for model calibration and other purposes. In particular VWP data essentially provides point information on *in situ* pressures which cannot be obtained in other ways, especially in areas above longwall panels.

All groundwater level data used for conceptualisation and groundwater modelling purposes in the Groundwater Assessment (AGE, 2020) was subject to review comprising:

- graphical review of a groundwater level hydrograph for each monitoring point, to identify any isolated erroneous readings; and
- review of groundwater level contours for each hydrostratigraphic unit based on average groundwater levels at each observation point, to identify any anomalously high or low average groundwater level readings.

Data for VWPs were therefore effectively verified against manual dips from other nearby standpipe piezometers in the same unit. Any erroneous data identified during this review were flagged and excluded from use for conceptualisation and model calibration purposes. In total, some 1,437 daily groundwater level records, representing around 1 percent (%) of the total Narrabri mine data set, were flagged as being potentially erroneous. As expected, the vast majority of the data flagged were related to VWP installations rather than manual dips from standpipe monitoring piezometers.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 5 (Post-approval Recommendation)

DPIE-Water stated:

- *The Water Management Plan (WMP) be updated to reflect additional monitoring, metering and management measures to report on groundwater inflows and potential impacts to water sources due to the underground development. Where existing monitoring bores are to be impacted, suitable alternatives need to be installed with baseline data collection commenced prior to mining activities. The WMP update should include:*

  a. an appropriate data-quality assurance plan based on relevant standards or guidelines:

    i. for water levels – see WMSTC (2019).

    ii. for water quality – see US EPA (2006) and Mueller (2015).

    iii. for other measurements – apply the most applicable industry standard or guideline available.

  The plan must include a rigorous approach for testing the accuracy and drift of vibrating wire piezometers.

  b. clear procedures for the establishment and updating of site-specific baseline status, and the early detection of state trends and change for sensitive receptors (aquifer integrity, groundwater dependent ecosystems, third-party bores, subsidence-related impacts):

    i. as per ANZG (2018) for water quality.

    ii. with uncertainty, estimated from quality-control data and integrated with reported results and interpretations.

    iii. including control charts, or other appropriate time-series statistical method, in annual reports.

Response

NCOPL supports the recommended update to the Water Management Plan to reflect additional monitoring, metering and management measures to report on groundwater inflows and potential impacts to water sources.

The revised Water Management Plan for the Stage 3 Project would include an appropriate data-quality assurance plan, which would be developed in consultation with DPIE-Water. The revised Water Management Plan would also include procedures for the establishment and updating of site-specific baseline status, and the early detection of state trends and change for sensitive receptors, which would be developed in consultation with DPIE-Water.

Submission 5 (Post-approval Recommendation)

DPIE-Water stated:

  c. additional groundwater monitoring sites as follows:

    i. West, south and east of the project where there are either no monitoring bores at all, or none along nearby water courses and related alluvium, for the early detection of impacts on any field-verified groundwater dependent ecosystems and third-party bores.

    ii. In the Namoi Valley alluvium where any field-verified groundwater dependent ecosystem is >1 km from existing monitoring bores.

    iii. In the Hoskissons Coal Seam, Arkarula Formation, Digby Formation, Purlawaugh Formation, and the Pamboola Formation and older Permian units directly beneath the alluvium, to provide a more representative set of water-quality data.

    iv. In any other geological units for which multiple distinct water-quality populations are clearly recognised from major-ion ratios.

    v. Up- and down-flow from the proposed new mine-water storage to monitor potential leakage.

    vi. At sites suitable for monitoring subsidence-related impacts via borehole extensometers and vibrating wire piezometers installations as recommended in EIS Appendix A Section 12.

    vii. At sites suitable for verifying the principal groundwater recharge areas.

    viii. In areas suitable for verifying the hydrological significance of geological faults.

    ix. Any sites necessary to address spatial uncertainty in model predictions.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Response

Additional monitoring recommendations are provided in Section 8.2 of the Groundwater Assessment (AGE, 2020) and have been developed further in response to IESC and DPIE-Water submissions. Additional groundwater monitoring is proposed at the six additional sites shown in Figure A1-5. Each site will comprise:

- two shallow standpipe monitoring bores monitoring groundwater levels and water quality in the Quaternary Alluvium and the immediately underlying bedrock; and
- a nested VWP facility including monitoring of all groundwater levels in consolidated units from the Hoskissons Coal Seam to the ground surface.

Additional monitoring of water quality entering the underground mine workings and of groundwater levels and groundwater quality at three potential spring sites is also proposed in the Groundwater Assessment (AGE, 2020).

Once installed, these additional monitoring points will be incorporated into the existing monitoring network and the revised Water Management Plan for the Stage 3 Project. The additional points include up to six shallow alluvium monitoring points (depending on the extent of the alluvium encountered) and a further six monitoring points in the consolidated strata immediately underlying the alluvium. VWP nests at each location will provide groundwater level monitoring in all strata present between the ground surface and the Hoskissons Coal Seam. A table summarising the key aspects of the proposed additional monitoring and a comparison of these aspects against the DPIE-Water comments is provided in Table A3-1 below.

Table A3-1
Summary Comparison of Monitoring Program with DPIE-Water Comments Received

	Comment	Aspect of Monitoring Program
i.	*West, south and east of the project where there are either no monitoring bores at all, or none along nearby water courses and related alluvium, for the early detection of impacts on any field-verified groundwater dependent ecosystems and third-party bores.*	As shown in Figure A1-5, additional monitoring is proposed at two locations on the western margin of the mining areas (Sites 1 and 3), two locations to the north and two locations to the south of the Stage 3 Project (Sites 1 and 2; 5 and 6, respectively). These monitoring locations are located close to watercourses and would include monitoring of any surficial alluvium and each underlying bedrock strata overlying the Hoskissons Coal Seam. Monitoring points 5 and 6 (Figure A1-5) are also located within, or close to, areas which have been identified as potential GDEs. As shown in Figure A1-5, additional monitoring is also proposed at a number of other potential GDEs as well as at existing water supply bores which may be affected at some point in the future.
ii.	*In the Namoi Valley alluvium where any field-verified groundwater dependent ecosystem is >1 km from existing monitoring bores.*	No additional monitoring in the Namoi Alluvium is proposed. WaterNSW operates a substantial groundwater level and water quality monitoring network in this aquifer and the NCOPL monitoring network already includes monitoring at nine monitoring bores installed within Quaternary Alluvium (predominantly the Namoi Alluvium). No significant impacts are predicted at any potential GDEs or existing water supply works within the Namoi Alluvium and hence no additional monitoring is recommended by AGE, over and above that already in place.
iii.	*In the Hoskissons Coal Seam, Arkarula Formation, Digby Formation, Purlawaugh Formation, and the Pamboola Formation and older Permian units directly beneath the alluvium, to provide a more representative set of water-quality data.*	Additional monitoring of water quality in bedrock strata directly underlying the alluvium, as well as in any overlying alluvium is proposed at each of the six sites shown in Figure A1-5.
iv.	*In any other geological units for which multiple distinct water-quality populations are clearly recognised from major-ion ratios.*	The additional water quality data described above will complement the existing NCOPL water quality monitoring network which already includes monitoring in each of the hydrostratigraphic units potentially impacted by the Project.
v.	*Up- and down-flow from the proposed new mine-water storage to monitor potential leakage.*	Shallow groundwater monitoring is proposed at the Southern Mine Water Storage (up and down gradient).
vi.	*At sites suitable for monitoring subsidence-related impacts via borehole extensometers and vibrating wire piezometers installations as recommended in EIS Appendix A Section 12.*	Additional nested VWPs and extensometers, similar to those previously installed above Longwall 108A, are proposed potentially above Longwalls 203 or 204. As shown in Figure A1-5, nested VWPs will also be installed at Sites 1 and 3, close to Longwall 111 and 209, respectively, and would therefore provide additional information on groundwater responses above a further two panels.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Table A3-1 (Continued)
Summary Comparison of Monitoring Program with DPIE-Water Comments Received

	Comment	Aspect of Monitoring Program
vii.	*At sites suitable for verifying the principal groundwater recharge areas.*	Given the location of the Stage 3 Project close to a topographic high recharge would occur to any/all hydrostratigraphic units present at outcrop. Groundwater levels and water quality are already monitored at a number of locations within each outcropping unit and additional monitoring is proposed as described above. These data have been, and will continue to be, used for calibration of the Stage 3 Project groundwater model including calibration of recharge rates to each unit present.
viii.	*In areas suitable for verifying the hydrological significance of geological faults.*	A number of mapped minor faults are represented within the Stage 3 Project groundwater model and groundwater level data are available for a number of monitoring bores in close proximity to these features. The fact that the groundwater flow model could be calibrated to data for these bores without requiring any adjustment of modelled fault permeability suggests that these minor faults are hydrogeologically insignificant and no further dedicated monitoring is required, over and above the additional monitoring described above.
ix.	*Any sites necessary to address spatial uncertainty in model predictions.*	Uncertainty analysis results suggest that the uncertainty in model predictions is greatest towards the south and west of the Stage 3 Project. As shown in Figure A1-5 and discussed above, additional monitoring is proposed in all strata present between the Hoskissons Coal Seam and surface at two locations to the south (Sites 5 and 6) of the Stage 3 Project and two locations on the western margin of the mining areas (Sites 1 and 3) which would also assist with reducing predictive uncertainty in these two areas.

Submission 5 (Post-approval Recommendation)

DPIE-Water stated:

- *The ability to accurately meter and monitor water take from surface and groundwater sources will need to be developed with ongoing review of actual versus modelled predictions. This will be a key component to confirm impact predictions, the adequacy of mitigating measures and compliance for water take.*

Response

The approved Water Management Plan and related annual review reports which relate to the existing/approved Narrabri Mine are available via the Narrabri Mine website (https://whitehavencoal.com.au/ourbusiness/documentation/?q=Narrabri+Mine).

The updated draft of the Stage 2 Water Management Plan (i.e. for the approved Narrabri Mine) includes further information on predicted takes from each groundwater source and where possible compares predicted with actual takes. A comparison of predicted takes for each groundwater source against current allocations is also presented in the updated draft of the Stage 2 Water Management Plan.

The updated draft of the Stage 2 Water Management Plan has recently been submitted to DPIE-Water and addresses many of the matters raised in the DPIE-Water April Submission on the Stage 3 Project. It is intended that this draft Water Management Plan would be further reviewed and updated on approval of the Stage 3 Project, incorporating the proposed additional monitoring outlined in the Groundwater Assessment (AGE, 2020) and addressing the DPIE-Water submissions relating to the Water Management Plan.

Submission 5 (Post-approval Recommendation)

DPIE-Water stated:

- *the Groundwater Response Plan (TARP) be updated in consultation with DPIE Water.*

Response

The existing TARPs would be updated for the Stage 3 Project in consultation with DPIE-Water.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Submission 5 (Post-approval Recommendation)

DPIE-Water stated:

- *all data on groundwater levels, quality, and data quality control be provided in a csv format to accompany the release of Annual Reviews.*

Response

NCOPL regularly updates its website to include monitoring data (including groundwater levels and quality). The Narrabri Mine website is available here: https://whitehavencoal.com.au/our-business/our-assets/narrabri-mine/

Data would be provided in CSV format if requested.

Submission 6

DPIE-Water stated:

- *A comprehensive water balance for the underground operations will be required to validate groundwater take predictions and to inform model updates and licence requirements. This will need to include accurate metering of water pumped into and out of the mine combined with modelled inputs and outputs. The groundwater level monitoring program will assist in verifying groundwater level changes associated with inflows to the mine and to identify any changes inconsistent with predictions.*

Response (prepared with assistance from WRM)

Section 7 of the Surface Water Assessment (WRM, 2020) describes the water balance modelling undertaken for the Narrabri Mine. Water balance modelling has been continually refined and updated since mining operations commenced to incorporate changes in procedures and metered water data. The model is deemed to be suitably calibrated and sufficient to be used to define the volume of dewatered groundwater, separate from returned underground mine filtered water. The process used to calculate these volumes is described in Section 5.5 of the Surface Water Assessment.

NCOPL would continue collecting and metering all inflows and outflows and use the water balance model to calculate the groundwater take.

Submission 6

DPIE-Water stated:

- *Based on a review of current approvals held for this project under the Water Management Act 2000 it is evident a number have expired and consideration needs to be given to relevant exclusions due to the State Significant Development status of this project.*

Response

NCOPL would ensure that relevant nomination of work dealing applications for Water Access Licences proposed to account for water take by the Stage 3 Project have been completed prior to the water take occurring and would not rely on expired approvals.

Submission 6 (Post-approval Recommendation)

DPIE-Water stated:

- *The proponent must report on water take at the site each year (direct and indirect) in the Annual Review. This is to include water take where a water licence is required and where an exemption applies. Where a water licence is required the water take needs to be reviewed against existing water licences.*

Response

NCOPL would report on water take at the site each year (direct and indirect) in the Annual Review and review against existing licences.

Submission 6 (Post-approval Recommendation)

DPIE-Water stated:

- *The proponent must ensure that relevant nomination of work dealing applications for Water Access Licences proposed to account for water take by the project have been completed prior to the water take occurring.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Response

NCOPL would ensure that relevant nomination of work dealing applications for WALs proposed to account for water take by the Stage 3 Project have been completed prior to the water take occurring.

Submission 6 (Post-approval Recommendation)

DPIE-Water stated:

- *The proponent must comply with the rules of the relevant water sharing plans.*

Response

NCOPL would comply with the relevant water sharing plans for the Stage 3 Project.

Submission 6 (Post-approval Recommendation)

DPIE-Water stated:

- *The proponent discusses with NRAR the necessary regulatory arrangement for water supply and take infrastructure for the Narrabri Coal Mine in consideration of applicable exclusions under the Environmental Planning and Assessment Act 1979.*

Response

Under section 4.41(1)(g) of the EP&A Act, if the Stage 3 Project is approved as a State Significant Development, water use approvals under section 89, water management works approvals under section 90, and activity approvals (excluding aquifer interference approvals) under section 91 of the *Water Management Act 2000* would not be required for the Stage 3 Project. NCOPL would consult with NRAR in regard to the necessary regulatory arrangement for water supply and take infrastructure for the Narrabri Mine in consideration of applicable exclusions under the *Environmental Planning and Assessment Act 1979*.

References

Australasian Groundwater and Environment Consultants Pty Ltd (2020) *Groundwater Assessment – Narrabri Underground Mine Stage 3 Extension Project*. Prepared for Narrabri Coal Operations Pty Ltd.

Department of Primary Industries – Office of Water (2012) *Aquifer Interference Policy*.

Ditton Geotechnical Services Pty Ltd (2020) *Mine Subsidence Assessment - Narrabri Underground Mine Stage 3 Extension Project*. Prepared for Narrabri Coal Operations Pty Ltd.

Namoi Catchment Management Authority (2011) *Namoi Catchment Action Plan 2010 – 2020*.

Narrabri Coal Operations Pty Ltd (2017) *Narrabri Mine Extraction Plan Water Management Plan LW107 to LW110*.

Narrabri Coal Operations Pty Ltd (2020a) *Procedure for Subsidence Monitoring and Management of LW107 - LW110.*

Narrabri Coal Operations Pty Ltd (2020b) *Procedure for Subsidence Crack Repair (in limited access areas).*

Narrabri Coal Operations Pty Ltd (2020c) *Narrabri Mine 2019 Annual Review*.

Natural Resources Access Regulator (2018) *Guidelines for Controlled Activities on Waterfront Land*.

WRM Water & Environment Pty Ltd (2015) *Modification 5 Surface Water Assessment.*

WRM Water & Environment Pty Ltd (2020) *Narrabri Underground Mine Stage 3 Extension Project Surface Water Assessment*. Prepared for Narrabri Coal Operations Pty Ltd.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

ATTACHMENT 3

RESPONSE TO DPIE–WATER APRIL SUBMISSION

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

DPIE-Water (April Submission)

Recommendation 1

DPIE-Water stated:

1. *The Model Calibration Report should be revised to make it fit for the purpose of meeting Schedule 4, Condition 9 in Stage 2 Modification 5 (MOD5) Mine Approval (PA 08_144). This must be done only after revising the 2020 Model as described in recommendation 2 below.*

Response

Refer to the responses to Recommendation 2a to 2j below.

Recommendation 2a

DPIE-Water stated:

2. *The 2020 Model, the EIS Model Report (October 2020) and the groundwater assessment should be revised to resolve issues identified above and provide confidence in the modelling work and efficiently inform decisions on the proposed extension. These improvements should include, but not be limited to:*

   a. *Provision of data supporting the development of the conceptualisation and model parameters. This should include justification of the very high level of vertical hydraulic anisotropy for some layers and choice of modelling to represent surface water-groundwater interactions. Hydrogeological cross sections showing vertical groundwater head gradients and flow directions are required for conceptualisation.*

Response (prepared with assistance from AGE)

Modelled Anisotropy

Data used to support the vertical hydraulic conductivity and anisotropy values adopted in the modelling work is presented and discussed in Section 5.3.2 of the Groundwater Assessment (Australasian Groundwater and Environment Consultants Pty Ltd [AGE], 2020a). As described in Section D3.3 of Appendix D of the Groundwater Assessment initial anisotropy values and ranges for calibration were then defined for modelling purposes through reference to the thickness, degree of consolidation and average lithological composition of each model layer (Figure A3-1) as well as previous model calibration. Hence, relatively thin and/or homogenous consolidated layers including the Pilliga Sandstone, Garrawilla Volcanics, Napperby Sill, Digby Conglomerate, Hoskissons Coal Seam and Arkarula Formation were assigned initial anisotropy ratios of 100 and a range of 10 to 1,000 used for calibration. The same initial value and range was also adopted for the Quaternary alluvium, colluvium and regolith in model layer 1. Accordingly initial values adopted for these seven layers were therefore the same as the ‘accepted’ value identified in the DPIE-Water advice (i.e. 100).

Higher initial anisotropies of 1,000 were therefore only assigned to layers representing the remaining four consolidated layers (the Purlawaugh, Napperby upper, Napperby lower and Pamboola layers) on the basis that these layers are relatively thick and/or more lithologically heterogenous. As shown in Figure A3-1 the available lithological data, which comprises around 400,000 metres (m) of drilling in 1,900 exploration holes suggests that these strata comprise 30-60 percent (%) fine material (mudstone, claystone and siltstone), substantially more than the other strata present. The relatively high initial anisotropy values adopted for selected layers are therefore considered to be supported by:

- lithological data for some 1,900 exploration holes (Figure A3-1);
- the available hydraulic test data, comparison of median and harmonic means of core test results to arithmetic average of slug test results suggests anisotropies of over 100,000 in some cases (see Section 5.3.2 of the Groundwater Assessment [AGE, 2020a]); and
- previous model calibration results (HydroSimulations, 2019) which returned anisotropy values ranging from 100 to 8,750.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

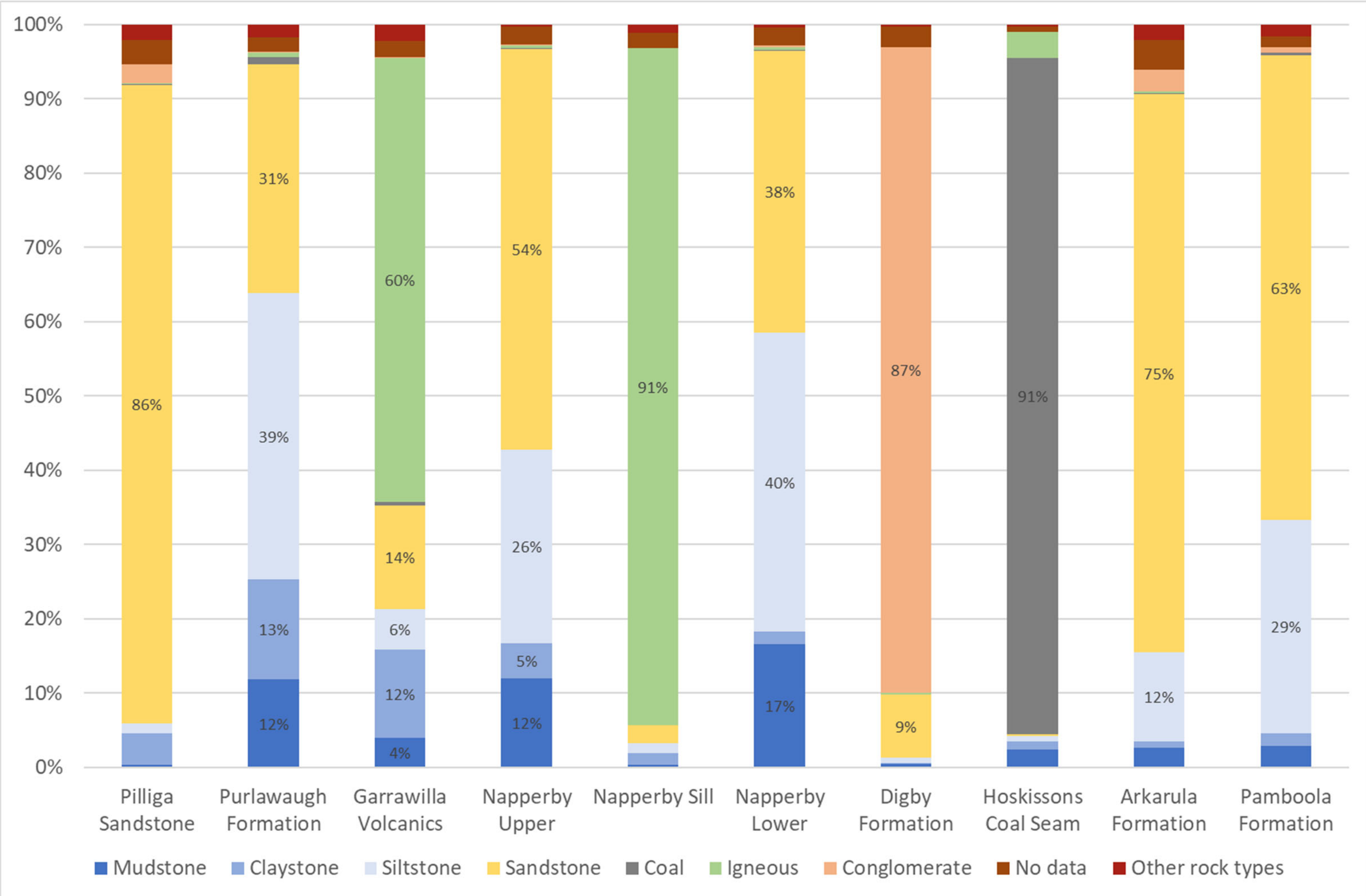


Figure A3-1
Average Lithological Composition of the Main Hydrostratigraphic Units from NCOPL Exploration Drilling Results

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Furthermore, as described in Appendix D of the Groundwater Assessment (AGE, 2020a) a range of anisotropy values were explored during the model calibration and then further explored during the predictive uncertainty analysis. For the four layers discussed above (i.e. the Purlawaugh, Napperby upper, Napperby lower and Pamboola layers) where relatively high initial values were adopted then lower bound anisotropy values of 100 were adopted for the calibration and uncertainty analysis. Hence where necessary to fit the data then modelled anisotropies were adjusted from their initial values during the calibration process. Calibrated anisotropies are summarised in Table D 3.7 of Appendix D of the Groundwater Assessment and confirm that anisotropies only significantly exceed 100 in three of the 11 model layers, the Purlawaugh Formation (Layer 3), the Napperby upper (Layer 5) and the Garrawilla Volcanics (Layer 4). Modelled anisotropies for the Napperby lower (Layer 7) and the Pamboola Formation (Layer 11) were therefore substantially reduced during the calibration. Conversely the anisotropy of the Garrawilla Volcanics was increased to fit the observed data. As shown in Table D 3.7 of Appendix D of the Groundwater Assessment model calibrated anisotropy values range from 10 to 10,421, however it is not clear where the DPIE-Water comment that anisotropies of 100,000 have been assumed in some layers originated.

The sensitivity of model predictions to the same wide range of anisotropies used for calibration were then further assessed through completion of a predictive uncertainty analysis.

Representation of Surface Water – Groundwater Interactions

As described in Section 2.5.2 of Appendix D of the Groundwater Assessment (AGE, 2020a), major water courses in the modelled domain (i.e. the Namoi River, Maules Creek, Cox's Creek and Bohena Creek) have been modelled using the MODFLOW Stream package. Observed flow data, which is available for each of these water courses, suggests flows are relatively persistent which, in turn, suggests that groundwater discharge is occurring for at least part of the time. Conversely, potentially significant leakage may be occurring from these water courses during periods when groundwater levels fall below the river/creek bed. Accordingly, these water courses were simulated using the MODFLOW stream package which simulates surface water flow gains or losses (depending on the relative levels in the water course and underlying aquifer). This package also routes flow along the modelled water courses hence ensuring that total modelled flow losses cannot exceed flow gains in the upstream catchment.

The remaining mapped water courses in the area have been simulated using the MODFLOW river package but parameterised in a way that prevents any loss (i.e. they act like MODFLOW drains). This is achieved by setting the modelled river level to the same value as the bed level (i.e. assigning a water depth of zero). This representation is consistent with the highly ephemeral nature of these minor water courses. Flow is understood to occur in these channels only following heavy rainfall and for a limited time period, suggesting limited interaction between groundwater and surface water in either direction.

Since surface water runoff to watercourses is not simulated in the model, potential additional recharge from this source is not simulated directly. Recharge to shallow alluvium systems may therefore be under-estimated. However, from an impact assessment point of view this is likely to result in a conservative over-estimation of impacts on these shallow systems, since additional recharge of this type would act to buffer drawdown impact caused by development of the mine.

Conceptualisation

A conceptual schematic illustrating the hydrogeological setting of the area and a description of the conceptual model is provided in Section 5.9 of the Groundwater Assessment (AGE, 2020a). Groundwater level flow directions and observed head differences at nested monitoring points are also discussed at length in Section 5.2 of the Groundwater Assessment although are not shown on the schematic itself.

A number of additional cross sections through the numerical groundwater flow model, developed for landholder consultation purposes were also included in Attachment 5 of the Submissions Report. Cross section locations are shown in Figure A1 in Attachment 5 of the Submissions Report.

Recommendation 2b

DPIE-Water stated:

> *b. Confirmation whether or not the mine area includes alluvium and regolith as there are discrepancies between maps in the report. Corrections on impacts may be necessary.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Response (prepared with assistance from AGE)

Mapped surface geology used for model construction purposes is shown in Figure 4.5 of the Groundwater Assessment (AGE, 2020a). As shown, no areas of Quaternary Alluvium are mapped within the current mining lease (ML) or the mining lease application (MLA) areas. However, colluvium valley flank deposits are mapped across part of these areas. Furthermore, based on Commonwealth Scientific and Industrial Research Organisation (CSIRO) Quaternary cover mapping (Wilford et al., 2015) un-mapped weathered regolith or residual soils are also thought likely to be present in areas where consolidated bedrock strata are mapped at outcrop. Accordingly, as shown in Appendix D Figure D3.1 of Appendix D of the Groundwater Assessment model layer 1 which represents the Quaternary Alluvium, colluvium and regolith is present across the entire model domain. Outside of the areas of mapped Quaternary Alluvium the thickness of this surficial layer is based on the CSIRO data set (Wilford et al., 2015).

Recommendation 2c

DPIE-Water stated:

> *c. Confirm the impact and probability of impact on the alluvium aquifer, Great Artesian Basin aquifer and on surface water flows using the extension only scenario and cumulative worst case scenario (Narrabri Gas + existing Narrabri Coal + proposed extension).*

Response (prepared with assistance from AGE)

An additional scenario and associated reporting to assess the Narrabri Underground Mine Stage 3 Extension Project (the Stage 3 Project) on its own is not considered by AGE to be worthwhile in this case. The Stage 3 Project mine plan includes the extension southwards of each of the approved Stage 2 panels, such that the proposed mine plan will deviate from the approved plan once development of the first longwall panel (Longwall 209) extends beyond the boundary of the current lease area. The Stage 3 Project mine plan therefore involves significant year-on-year alterations to the approved Stage 2 plan and is not therefore a simple extension (i.e. the physical extensions into the new MLA area would occur progressively over a long period as each longwall individually progresses). Accordingly, any Stage 3 Project extension scenario, whereby only the southern half of each panel is developed, would be an entirely theoretical construct which would not be possible to implement in practice. It would also not be possible to measure the separate groundwater inflows from Stage 2 against the Stage 3 Project for the same reasons. The Groundwater Assessment (AGE, 2020a) reports on the predicted impacts of:

- the Stage 3 Project mine plan (i.e. the Stage 3 Project only); and
- concurrent development of the Narrabri Gas Project and Stage 3 Project (i.e. cumulative impacts).

A comparison of Project only impacts with Stage 2 impact predictions developed by Hydrosimulations (2015) is then also presented in Section 7.10 of the Groundwater Assessment (AGE, 2020a). With regard to flow impacts on over and underlying units, the predicted impacts of the Stage 3 Project are less than the predicted Stage 2 Modification 5 impacts which have already been approved. Conversely, additional licences for direct extraction from the Gunnedah Oxley Basin Murray Darling Basin water source will be required since inflow to the extended mine workings will be increased.

Recommendation 2d

DPIE-Water stated:

> *d. Reviewing the completeness of the rationale for model layers. With respect to the Namoi Alluvium represented as a single layer, consider whether this may constrain the sensitivity of the model to its vertical hydraulic conductivity. Consider adding information on the choice of the variable layering of the Napperby Formation.*

Response (prepared with assistance from AGE)

The rationale for adopting a single layer for the Namoi Alluvium is presented in Section D 2.4.3 of Appendix D of the Groundwater Assessment (AGE, 2020a). A single layer was adopted for this unit on the basis that:

- the boundary between Narrabri Formation and the underlying Gunnedah Formation is not always obvious;
- previous detailed modelling of the Namoi Alluvium (McNeilage, 2006) suggested very similar properties for both of these formations; and
- reference to a series of east-west lithological sections through the Namoi Alluvium, see Appendix E of the Groundwater Assessment show no clear stratification of the alluvium.

With regard to whether or not the adoption of a single layer constrains the sensitivity of the model to its vertical hydraulic conductivity, parameter identifiability, or the sensitivity of the calibration to each model parameter, is summarised in Appendix D Table D3.10 of the Groundwater Assessment (AGE, 2020a). As shown in this table the calibration is actually more sensitive to the horizontal hydraulic conductivity of the Quaternary Alluvium than most other parameters, including the vertical hydraulic conductivity of this layer. This is related to concentration of observation bores in this unit. As summarised in Table D 3.1 in Appendix D of the Groundwater Assessment, almost half of the 229 observation bores used for model calibration are completed into the Quaternary Alluvium. Furthermore, a relatively good match to this observed data has been achieved which suggests that the single layer conceptualisation is not inconsistent with the available data.

Recommendation 2e

DPIE-Water stated:

> *e. Consideration on consistency between modelling approaches in the area, especially on boundary locations and types.*

Response (prepared with assistance from AGE)

The DPIE-Water letter alludes to some apparent inconsistencies between groundwater models developed to assess the impacts of the Narrabri Coal Mine, the Narrabri Gas Project and Boggabri-Tarrawonga-Maules Creek (BTM) complex, in particular with regard to peripheral (lateral) boundary conditions and types.

BTM Complex Model

With respect to the BTM complex model (AGE, 2020b) there appear to be few, if any, significant inconsistencies with regard to the lateral boundary conditions and types. The BTM complex model simulates the impact of extraction from a number of relatively shallow coal seams targeted by open cut operations at the Boggabri, Tarrawonga and Maules Creek mines to the east of the Namoi River. The targeted seams, which form part of the Maules Creek sub-basin, dip towards the east and do not extend beneath the Namoi Alluvium. Hence, predicted impacts extend largely eastward from the mine and no significant drawdown is predicted in the Namoi Alluvium. As outlined in the Groundwater Assessment (AGE, 2020a) the Narrabri Mine is located to the west of the Namoi River and targets the Hoskissons Coal Seam. On this side of the river the strata dip towards the west and the targeted coal seam, which forms part of the Mullaley Sub-Basin, also does not extend beneath the Namoi Alluvium. Hence predicted impacts to the east of the mine are limited in extent and no significant drawdown is predicted in the Namoi Alluvium. Both the BTM and Narrabri models, however, extend beyond the Namoi River such that each model is able to predict drawdown at the river without the location of the boundary affecting predictions. As expected, given that the BTM and Narrabri mines are located in different sub-basins, there is no overlap of predicted impacts.

With regard to lateral boundaries both the BTM complex and Narrabri models then also employ a mixture of general head or no-flow boundary conditions around the periphery of the model domain. No flow boundary conditions are adopted in areas where no cross boundary flow is anticipated (e.g. across the Mooki Thrust Fault in the BTM complex model). General head boundaries are used in areas where flow into, or out of, the model domain is anticipated (e.g. within the Namoi Alluvium).

Similar internal boundary conditions have also been adopted in the two models. Both models simulate the Namoi River using the MODFLOW Stream package and simulate other minor water courses using the MODFLOW River package, but parameterised in a way that prevents any loss (i.e. they act like MODFLOW drains). However, unlike the BTM complex model the Narrabri Mine model simulates Maules Creek using the MODFLOW Stream package, rather than the MODFLOW River package. Since the Narrabri Mine is not predicted to have any significant impact on groundwater levels in the vicinity of Maules Creek this difference between the two models is considered unlikely to make any material difference to impacts predicted in the Groundwater Assessment (AGE, 2020a).

Furthermore, it is noted in the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) advice that (IESC, 2020):

> *10. Considering the significant distances (ca. 30-50 km) to the nearest open cut coal mines in the area, and the justification provided for selecting groundwater model boundaries, it is reasonable for the proponent to exclude the potential cumulative impacts of mines located to the south-west of the project area. Additionally, the geological characteristics of the Boggabri Ridge separating the Mulley sub-basin from the Maules Creek sub-basin justify not including these other open cut mines in the cumulative impact assessment.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

Narrabri Gas Project

Consistent with the larger footprint and depth of extraction at the Narrabri Gas Project a substantially larger model domain was developed as part of the impact assessment for this project (CDM Smith, 2016). In this case the active model domain extends to the boundaries of the Gunnedah Basin and beyond in some cases. Lateral boundaries comprise no-flow or prescribed head boundary conditions depending on whether or not groundwater flow into or out of the model domain is anticipated. The rationale used to select appropriate lateral boundary conditions is therefore considered to be consistent with that adopted for the BTM and Narrabri models. Nevertheless, some differences may arise in the different models due to the different model domains. For instance, unlike the Narrabri Gas Project model (CDM Smith, 2016) the Narrabri Mine model (AGE, 2020a) does not extend to the limit of the Gunnedah Basin to the west and therefore employs a general head boundary at the western boundary of the model, since groundwater flow is expected across this boundary. No such boundary is employed in the Narrabri Gas Project model since this model extends to the boundary of the Gunnedah Basin and beyond.

Internally, the Narrabri Gas Project model (CDM Smith, 2016) used MODFLOW River cells to simulate groundwater-surface water interaction with the Namoi River and Cox's Creek. Other water courses do not appear to have been simulated in the model. In general, the MODFLOW Stream package used to represent the Namoi River and Cox's Creek in the Narrabri Mine and BTM models (AGE, 2020a; AGE, 2020b) is considered to be a better option than the River package. As discussed in the Response to Comment 2a, use of the Stream package ensures that total modelled flow losses cannot exceed flow gains in the upstream catchment. The apparent absence of other water courses from the Narrabri Gas Project model (CDM Smith, 2016) is also considered to be a deficiency. However, given that predicted impacts on the water table due to the Narrabri Gas Project are negligible (CDM Smith, 2016) it is considered unlikely that the use of the stream package and/or simulation of more water courses would have materially affected the reported impacts.

Given that the Narrabri Gas Project targets the same coal seam as the Narrabri Coal Mine and is located immediately to the west, overlapping impacts are expected and a cumulative impact scenario including the concurrent operation of both projects has been included in the Groundwater Assessment (AGE, 2020a).

Furthermore, it is noted in the IESC advice that (IESC, 2020):

> 9. *The IESC notes that the proponent has incorporated impacts associated with the Narrabri Gas Project, using Santos' 'base case' scenario, into the cumulative impact predictions of the groundwater modelling. The IESC considers that this is an acceptable approach to assessing potential cumulative groundwater impacts at the site, noting the comments in Paragraph 3b.*

Recommendation 2f

DPIE-Water stated:

> f. *DPIE Water notes that the model does not include the brine injection activities. The reason of the omission needs to be transparent.*

Response (prepared with assistance from AGE)

The potential water quality impacts of brine disposal into the mine goaf at completion of mining are described in Section 7.8.2 of the Groundwater Assessment (AGE, 2020a). This assessment makes reference to output from a re-injection scenario undertaken using the numerical model which was undertaken to quantify:

- what level of head increase would occur at the point of injection;
- post closure inflow rates to the goaf; and
- how long groundwater levels would take to recover to fill the void spaces within the goaf.

Thereafter, a series of analytical calculations were undertaken drawing on heads and flows calculated using the numerical model to quantify potential impacts on water quality.

All reported head and flow predictions are based on model runs which include re-injection.

Recommendation 2g

DPIE-Water stated:

> g. *Model calibration requires clarifications. Information need to be more transparent and complete especially with respect to calibration metrics for steady state calibration. The model may require adjustments.*

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Response (prepared with assistance from AGE)

Calibration of the numerical model was undertaken using a single simulation with an initial steady state stress period used to derived initial conditions for subsequent transient stress periods. Accordingly, the calibration scatter plots, shown in Figures D 3.8, D 3.9 and D 3.10 in Appendix D of the Groundwater Assessment (AGE, 2020a), include measurements used for calibration of the steady state and transient stress periods. Consequently, the reported scaled root mean square error statistics (SRMS) represent combined steady state and transient statistics, although will tend to be dominated by the transient results. Scatter plots showing measurements used to calibrate the steady state model stress period only are shown in Figures A3-2, A3-3 and A3-4. As summarised in Table A3-2, SRMS statistics for the initial steady state stress are comparable to, or slightly better, than those reported for the combined steady state and transient data sets reported in the Groundwater Assessment and are also within ranges typically considered acceptable for models of this type.

In addition, the peer reviewer, Mr Brian Barnett concluded:

> *I have concluded that the calibration approach and outcomes meet all reasonable expectations (including guiding principles outlined in the Australian Groundwater Modelling Guidelines) and in most regards exceed current industry standards.*

Table A3-2
SRMS Calibration Statistics

Bore group	Steady State SRMS	Combined Steady State and Transient SRMS
Namoi Alluvium	3.9%	3.3%
NCOPL monitoring bores	8.8%	7.7%
Other monitoring bores	4.8%	9.4%

NCOPL = Narrabri Coal Operations Pty Ltd.

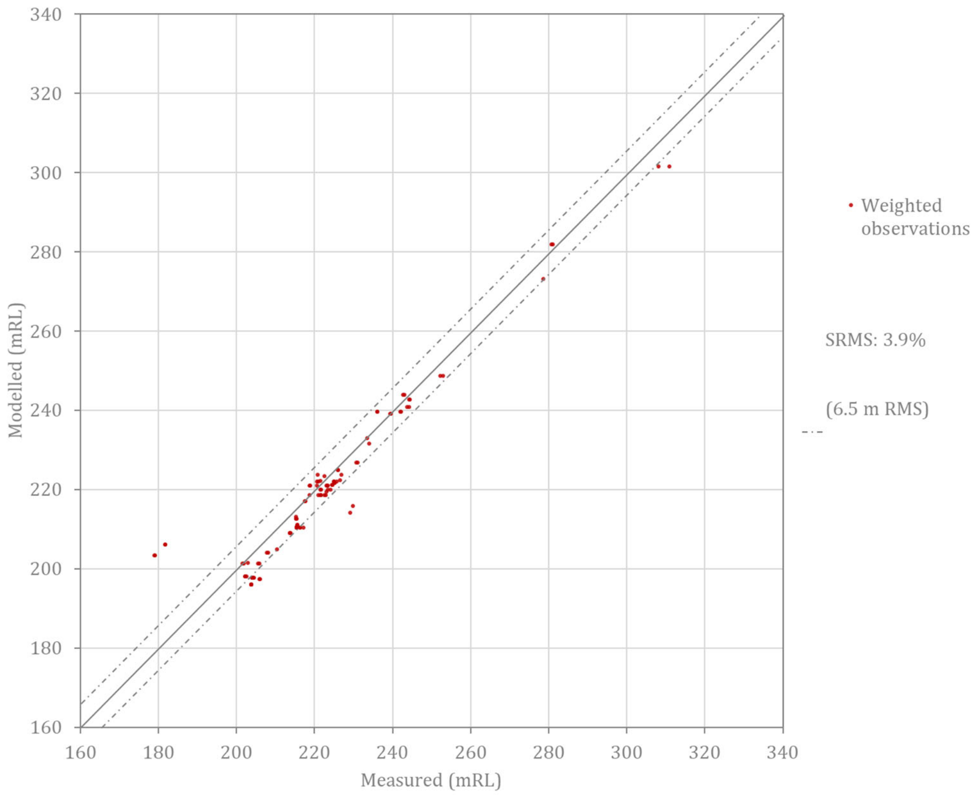


Figure A3-2
Steady State Calibration – Modelled vs Observed Groundwater Levels, Namoi Alluvium

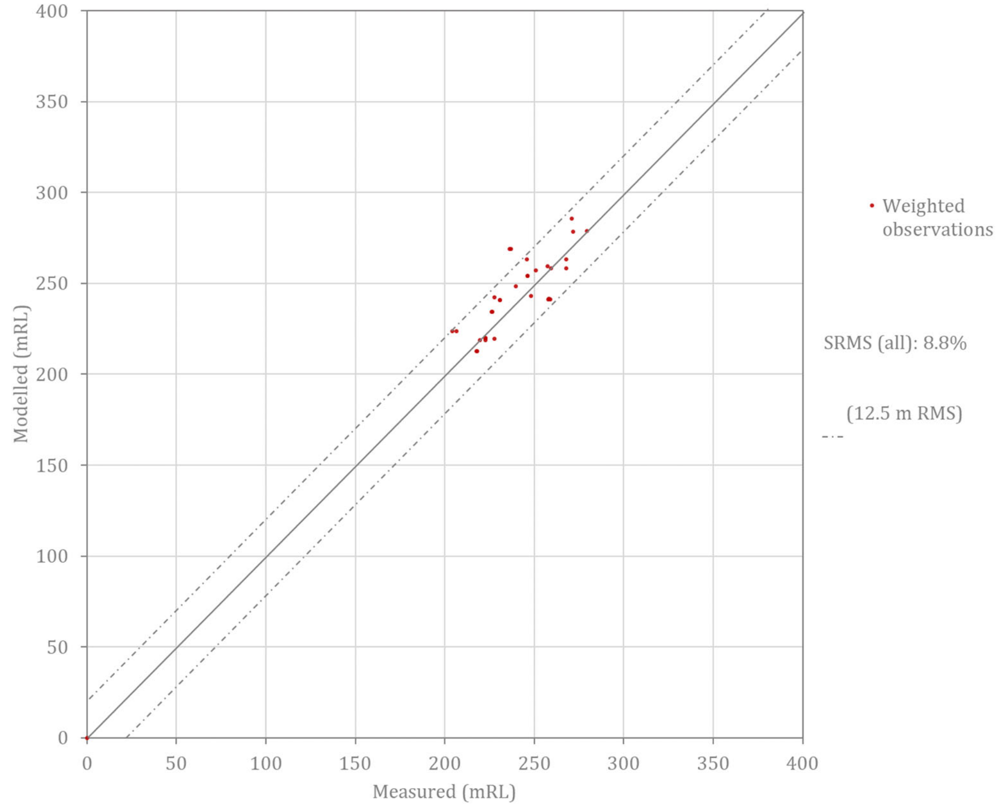


Figure A3-3
Steady State calibration – modelled vs observed groundwater levels, NCOPL monitoring bores

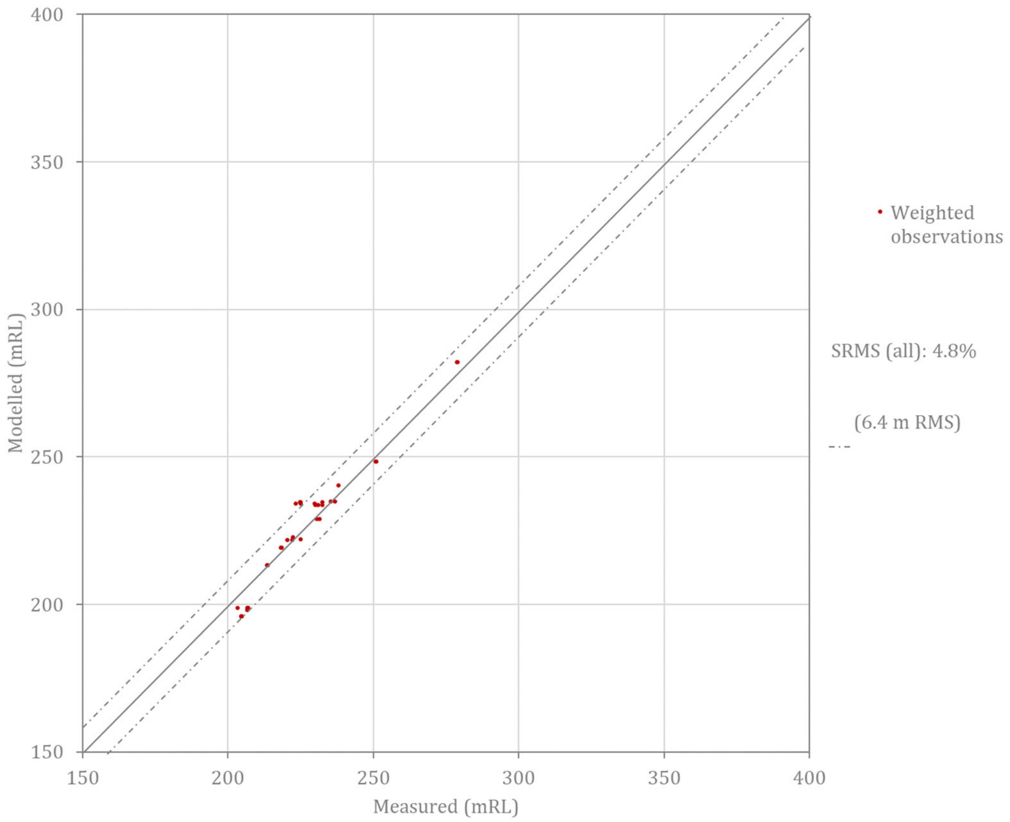


Figure A3-4
Steady State calibration – modelled vs observed groundwater levels, other bores

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

Recommendation 2h

DPIE-Water stated:

> h. *A review of the initial assumption for the transient model is required. The report indicates a positive value for the change in groundwater system's storage (7.9 ML/day, the equivalent to ~2.9 GL/year or a total increase in groundwater storage of 30.3 GL over the transient modelling period 1 January 2009–30 June 2019). This appears inconsistent with the rainfall conditions during that period.*

Response (prepared with assistance from AGE)

Modelled water balance results for the calibration period January 2009 to June 2019 are presented in the Table D 3.11 in Appendix D of the Groundwater Assessment (AGE, 2020a). On average over the calibration period these results suggest storage inflows of 57.8 megalitres per day (ML/day) compared to storage outflows of 49.9 ML/day. Accordingly, on average over the period modelled, 7.9 ML/day is being released from storage into the model leading to generally declining modelled groundwater levels, especially during the recent period. Contrary to the assertion in the DPIE-Water letter, this is considered to be consistent with the relatively dry rainfall conditions which have persisted during the majority of this period (see Figure 3.1 in the Groundwater Assessment).

Recommendation 2i

DPIE-Water stated:

> i. *A review of the assumption resulting in an apparent gain in surface water systems from groundwater. DPIE Water finds the outcome counter-intuitive and suggests field data may indicate the opposite relationship. Evidence needs to be shown to support the current assumptions.*

Response (prepared with assistance from AGE)

This item appears to relate to surface water – groundwater interaction components of the modelled water balance shown in Table D 3.11 in Appendix D of the Groundwater Assessment (AGE, 2020a). As reported in this table, model results suggest net discharges of groundwater to both minor and major water courses. It should be stressed that gaining conditions are not assumed in any way in the model but are a result of the model calibration. In addition to time series data for over 100 observation bores within the Namoi Alluvium, the calibration data set includes observed baseflow gains/losses in the Namoi River between Boggabri and Narrabri. As reported in Table D 3.12 in Appendix D of the Groundwater Assessment, on average over the calibration period, observed baseflow gains were 19.3 ML/day, compared to modelled baseflow gains of 14.3 ML/day. Hence, if anything the model is slightly underestimating actual gains. Furthermore, as shown in Figure D 3.8 of Appendix D of the Groundwater Assessment and in Figure A3-2, the observed groundwater levels in the Namoi Alluvium are generally well matched in the model. In particular there is little to no evidence that the model is systematically over-estimating groundwater levels and hence flow towards the Namoi Alluvium. If anything, as shown in Figure A3-2, modelled groundwater levels tend to be generally slightly lower than observed. Given that observed heads in the vicinity of the Namoi River and observed gains in the river itself are both relatively well matched it is not clear why the Department considers the modelled gain to be counter-intuitive.

Recommendation 2j

DPIE-Water stated:

> j. *Finally, the modelling report would benefit with improved formatting and better presentation. It is a difficult document to navigate. The report should also be stand alone. Inconsistent definition of parameters like hydraulic conductivity vertical anisotropy makes it hard to undertake comparisons. It is defined as 'Kh:Kv' in the model calibration section whereas it is defined as 'Kv:Kx' in the uncertainty analysis section.*

Response (prepared with assistance from AGE)

It is understood that the DPIE-Water comments relating to the document being difficult to navigate relate to Appendix D of the Groundwater Assessment (AGE, 2020a) report, which provides further detail on the numerical modelling work undertaken. Appendix D of the Groundwater Assessment was intended to be read in conjunction with the main report and as such is not stand-alone. To avoid repetition there are numerous cross references to the main body of the report and impact predictions are not presented in Appendix D of the Groundwater Assessment. AGE recognises that this is not a perfect solution but on balance think this represents a better option for all readers (i.e. including members of the public reviewing the report) than adding all the modelling detail into the main body of the report. Nevertheless, DPIE–Water's comments will be taken on board and AGE will seek to address the navigation difficulties, as far as possible, in future reporting.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139
10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390
WHITEHAVENCOAL.COM.AU

Recommendation 3

DPIE-Water stated:

> 3. *The Proponent should simulate and assess appropriate scenarios to inform decisions on the project.*

Response

Refer to the Response to Submission 2c regarding the justification for the selected modelled scenarios.

Recommendation 4

DPIE-Water stated:

> 4. *The Proponent should prepare and implement field investigation program/s to fill the data gaps identified in the EIS Model Report.*

Response (prepared with assistance from AGE)

Additional monitoring of water quality entering the underground mine workings which will provide additional information on water quality in the Hoskissons Coal Seam is proposed in Section 8.2 the Groundwater Assessment (AGE, 2020a). Furthermore, additional monitoring in 12 additional shallow bores at the six monitoring sites shown in Figure A1-5 is also now proposed.

A number of units in the area appear to be characterised by highly variable water chemistry. This is considered to be consistent with the heterogeneity of these strata. It is not clear how many monitoring points would be required for DPIE-Water to assess the water quality of each unit as being adequately represented and hence this requirement is effectively open ended. However, given the nature of the development the existing and proposed level of water quality monitoring is considered commensurate with the relatively low likelihood of any significant impacts. Other than possible minor changes to water quality, due to changing groundwater flow directions, operation of the mine dewatering system is unlikely to result in any significant water quality impacts.

The Digby Formation at the site typically comprises a massive 15 m conglomerate unit and there is no known local extraction from this unit.

Recommendation 5

DPIE-Water stated:

> 5. *DPIE P&A should retain Schedule 4, Condition 9 in the current Stage 2 Modification 5 (MOD5) Mine Approval (PA 08_144) in all future approvals relating to the Mine.*

Response

Noted.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

References

Australasian Groundwater and Environment Consultants Pty Ltd (2020a) *Groundwater Assessment – Narrabri Underground Mine Stage 3 Extension Project*. Prepared for Narrabri Coal Operations Pty Ltd.

Australasian Groundwater and Environment Consultants Pty Ltd (2020b) *Boggabri, Tarrawonga, Maules Creek Complex Groundwater Model Update*.

CDM Smith (2016) *Narrabri Gas Project Groundwater Impact Assessment*.

HydroSimulations (2015) *Narrabri Mine Modification, Groundwater Assessment.*

HydroSimulations (2019) *Narrabri Underground Mine Stage 3 Extension Project: Gateway Application Preliminary Groundwater Assessment*.

Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (2020) *Advice to decision maker on coal mining project – IESC 2020-119: Narrabri Underground Mine Stage 3 Extension Project (Narrabri Mine Extension) (State Ref No 9882) – Expansion*.

McNeilage, C. (2006) *Upper Namoi groundwater flow model*. Published by NSW Department of Natural Resources.

Wilford, J., Searle, R., Thomas, M. and Grundy, M. (2015) *Soil and Landscape Grid National Soil Attribute Maps – Depth of Regolith (3" resolution) – Release 2*. V6.

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

ATTACHMENT 4

UPDATED GROUNDWATER MONITORING REGIME

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

WHITEHAVENCOAL.COM.AU

Table A4-1
Draft Overview of the Stage 3 Project Groundwater Monitoring Program

Monitoring Focus	EIS Section	Submissions Report Section	Current and Proposed Monitoring Sites	Monitoring Parameters	Proposed Frequency	Figure Reference
Groundwater	Section 6.4	▪ N/A	▪ Continued operation of extensive groundwater monitoring network, including the 63 monitoring bores and a number of VWPs operated by NCOPL.	▪ Water level, EC and pH (monthly). ▪ Annual monitoring of: - physical parameters (e.g. alkalinity, ED, TDS, TSS and pH); - cations (e.g. calcium, magnesium, sodium and potassium); - anions (e.g. carbonate, bicarbonate, sulphate and chloride); - dissolved metals (e.g. aluminium, antimony, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, silver, selenium and zinc); and - nutrients (e.g. ammonia, nitrate, phosphorous and reactive phosphorous).	▪ Monitoring bores - monthly. ▪ VWPs - continuous.	▪ Figure A1-5
		▪ Section 4.2.1	▪ Operation of additional monitoring bores standpipes (in the Quaternary Alluvium and the immediately underlying bedrock) and VWPs (monitoring all geological units from the Hoskissons Coal Seam to the surface) at six locations located upstream and downstream of the Stage 3 Project on Pine (Sites 1 and 2), Kurrajong (Sites 3 and 4) and Tulla Mullen/Sandy Creeks (or tributaries) (Sites 5 and 6).	▪ Water level, EC and pH (monthly). ▪ Annual monitoring of: - physical parameters (e.g. ED, TDS, TSS and pH); - cations (e.g. calcium, magnesium, sodium and potassium); - anions (e.g. carbonate, bicarbonate, sulphate and chloride); - dissolved metals (e.g. aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, selenium, zinc); and - nutrients (e.g. ammonia, nitrate, phosphorous, reactive phosphorous).	▪ Monitoring bores - monthly. ▪ VWPs - continuous.	▪ Figure A1-5

Narrabri Coal Operations Pty Ltd ABN 15 129 850 139

10 Kurrajong Road, Baan Baa NSW 2390 | P 02 6794 4755 | F 02 6794 4753
Locked Bag 1002, Narrabri NSW 2390

Table A4-1 (Continued)
Draft Overview of the Stage 3 Project Groundwater Monitoring Program

Monitoring Focus	EIS Section	Submissions Report Section	Current and Proposed Monitoring Sites	Monitoring Parameters	Proposed Frequency	Figure Reference
Groundwater (Continued)	▪ N/A	▪ N/A	▪ Monitoring at affected bores.	▪ Water level.	Undertaken in accordance with the 'make good' agreement (currently being prepared for consultation with landholder).	▪ Figure A1-5
	▪ N/A	▪ N/A	▪ Shallow groundwater monitoring at the Southern Mine Water Storage.	▪ Water level, EC and pH (monthly). ▪ Annual monitoring of: - physical parameters (e.g. alkalinity, ED, TDS, TSS and pH); - cations (e.g. calcium, magnesium, sodium and potassium); - anions (e.g. carbonate, bicarbonate, sulphate and chloride); - dissolved metals (e.g. aluminium, antimony, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, silver, selenium and zinc); and - nutrients (e.g. ammonia, nitrate, phosphorous and reactive phosphorous).	▪ Water level, EC and pH (monthly). ▪ All other parameters – annually.	Not shown (to be located upstream and downstream of the Southern Mine Water Storage)
	▪ Section 8.2 of Appendix B.	▪	▪ Additional monitoring of water quality entering the underground mine workings (i.e. in the mine water collection system).	▪ TDS, pH and temperature.	▪ Continuous.	Not shown
Subsidence (Subsurface Cracking)	Section 6.3	▪ Section 4.2.1	▪ Calibration borehole – deep borehole piezometers, shallow standpipe piezometers and deep wireline extensometers.	▪ Water level, displacement.	▪ One installation during the Stage 3 Project (likely Longwalls 203 or 204).	Not shown
GDEs	Section 8.2 of the Groundwater Assessment	▪ Attachment 7	▪ Site visits to Hardys, Mayfield, Eather and Blairmore Feature 1 and 2s.	▪ Site observations of flow rates and surface conditions.	▪ Annually	▪ Figure A1-5