

## Advice to decision maker on coal mining project

### IESC 2014-046: Boundary Hill South Project (EPBC 2012/6324) – Expansion

<b>Requesting agency</b>	The Australian Government Department of the Environment and the Queensland Department of Environment and Heritage Protection
<b>Date of request</b>	3 April 2014
<b>Date request accepted</b>	4 April 2014
<b>Advice stage</b>	Assessment

#### Advice

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and the Queensland Department of Environment and Heritage Protection to provide advice on the Boundary Hill South Project in Queensland.

This advice draws upon aspects of information in the Draft Environmental Impact Statement, including additional reports provided by the proponent relating to Callide Mine operations and previous groundwater studies by the proponent, together with the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The proposed Boundary Hill South project is an extension to existing operations at the Callide Mine, located in the Callide Basin approximately 20 km north of Biloela and 85 km south-west of Gladstone, Queensland. The existing Callide Mine complex produces over 8 Mtpa of product coal which is used to service the adjacent Callide Power Station. With a production rate of approximately 2.6 million tonnes per annum (Mtpa) of product coal for approximately 20 years, the proposed Boundary Hill South would replace production from the existing Boundary Hill pit as reserves there become depleted. The proposed site is situated immediately south-east of the existing Boundary Hill mine pit, separated by the ephemeral Campbell (Gate) Creek. The proposed project covers 630 ha, of which 485 ha would be subject to direct disturbance by the mining operations and infrastructure.

Campbell (Gate) Creek forms part of the Callide Creek catchment, which discharges into the Dawson River in the Fitzroy Basin. The Callide Valley irrigation area, which lies approximately 10 km west of the proposed project, relies on groundwater from the alluvium associated with Callide Creek. The Callide and Kroombit dams (upstream of the confluence with Campbell (Gate) Creek) release water to downstream weirs on Callide Creek to provide groundwater recharge. Within the region, landholders predominantly rely on the Precipice Sandstone aquifer or shallow groundwater within the floodplain alluvium. Field surveys have confirmed the presence of the squatter pigeon (*Geophaps scripta*

*scripta*), listed as 'Vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the black-chinned honeyeater (*Melithreptus gularis*) and the little pied bat (*Chalinolobus picatus*) both listed as 'Near Threatened' under the *Nature Conservation Act 1992* (Qld). In addition to the species recorded, the northern quoll (*Dasyurus hallucatus*), listed as 'Endangered' under the EPBC Act, is considered likely to occur within the project site based on habitat suitability and nearby occurrences.

The IESC recognises that the proposed expansion project is situated in a region already subject to a series of mines that form the Callide Mine complex, and the scale of the extension is small in comparison with the total production from the Callide Mine complex. However, in the absence of a groundwater conceptualisation that accurately portrays the hydrogeology of the Callide Basin, it is difficult to characterise impacts and comment on appropriate mitigation and management measures. The advice therefore, necessarily identifies significant further information or data that is needed to address the questions asked. The IESC, in line with its Information Guidelines<sup>1</sup>, has considered whether the proposed project assessment has used the following:

#### Relevant data and information: key conclusions

Sufficient data to clearly understand the regional conceptual hydrogeology of the Callide Basin is not provided. Data from a broader scale groundwater monitoring plan would assist with developing an adequate conceptual model so that the risks of the projects to groundwater resources can be assessed. Monitoring of water abstractions from the existing Callide Mine pits would assist in calibration of the groundwater model and would increase confidence in model predictions.

Assessment of the existence of potential groundwater dependent ecosystems (GDEs) is not available to assist in understanding the potential impacts on habitat for threatened and migratory species. Sampling of macroinvertebrates was not undertaken in accordance with Queensland Government protocols for ephemeral streams. Higher resolution mapping of stream power, pre- and post-mining in Campbell (Gate) Creek for a range of higher frequency flow events has not been undertaken.

#### Application of appropriate methodologies: key conclusions

The Callide Basin is modelled as a closed basin without lateral groundwater discharge. On the information available, this is not considered suitable. This also limits the model's suitability to assess the impact of the proposal on the depletion of groundwater in the western Callide Basin which could impact GDE's and groundwater-surface water interactions. A conceptual model representing the linkage between hydrological and ecological processes is lacking. These processes include groundwater-surface water interactions and dependencies, such that the potential impacts from drawdown, reduced stream flow and recharge of the alluvium groundwater system can be assessed. The resolution and scale of the existing floodplain hydraulic model for Campbell (Gate) Creek are not appropriate to adequately assess flood impacts.

#### Reasonable values and parameters in calculation: key conclusions

Anisotropy ratios (between horizontal and vertical hydraulic conductivities) used in the groundwater model are not substantiated and may not be appropriate.

The low ratio in peak flows between the 1 in 2 ARI and the 1 in 100 ARI flood events is not considered plausible, suggesting that the data to represent the 1 in 100 ARI event, and peak flood impacts, may be underestimated.

The IESC's advice, in response to the requesting agency's specific questions is provided below.

*Question 1: Regional groundwater modelling to address the regional water issues relevant to the project has not been submitted by the proponent (to be provided as amendments to the submitted EIS*

*if required). Does the IESC consider the presented groundwater monitoring data from the Callide Mine sufficient to address the regional groundwater impact for this project? If monitoring data are not sufficient, what key areas and issues need to be addressed in the delivery of a regional ground water model specifically for this project?*

#### Response

1. There is insufficient monitoring data available to characterise the groundwater processes (including discharges and groundwater-surface water interactions) and support the development of a robust conceptual model. Any further numerical modelling is unlikely to address the regional water issues relevant to the project if an adequate conceptual model is not developed.

#### Explanation

2. The proponent has assumed no hydraulic connection between the Precipice Sandstone and the alluvium of the Callide Basin, however this is not justified by the information presented. The Precipice Sandstone is predicted to be impacted by drawdown and if hydraulic connectivity exists, drawdown may propagate to the alluvium of the Callide Basin, and impacts to users of the alluvial groundwater may occur.
3. Within the numerical model, the proponent has assumed no groundwater-surface water interactions; however this is not adequately supported by the information provided and at odds with anecdotal evidence from landholders.
4. It is expected that groundwater discharge would support Groundwater Dependent Ecosystems and other water related assets, however without discharge incorporated in the model, it is not possible to predict the full suite of impacts. Discharges may occur via lateral connection with adjacent groundwater systems, via springs, interactions with surface water bodies, or groundwater use by vegetation. None of these are proposed by the proponent in their conceptual model, nor represented in the numerical model.
5. Key elements to improve the understanding of the conceptual hydrology and predictions of the likely impacts of the proposal, include:
  - a. A Callide Basin wide monitoring plan (including a map, with inset maps focussing on intensive monitored areas near the mines) should be provided with monitoring bores in the Precipice Sandstone and the Callide Coal Measures (CCM) (nested sites preferred) clearly marked, and drawdown predictions (contours) in the background. The map should be accompanied by a table that lists the proposed locations, monitoring frequency and triggers;
  - b. Groundwater head maps for the Precipice Sandstone and CCM for the entire Callide Basin, including historical groundwater heads, to verify the conceptual hydrogeological model and identify potential discharge mechanisms. These may include the presence/absence of a shallow water table, upward vertical hydraulic gradients and artesian bores, and GDEs (including springs, discharge to surface water bodies, or groundwater use by vegetation);
  - c. Consideration of potential hydraulic connection between the Precipice Sandstone and alluvium; including hydrogeological cross-sections along NE-SW direction, to assess the potential juxtaposition of key aquifers or possible linking units such as alluvial fan deposits; and
  - d. Monitoring of individual mine pit water abstractions to revise/calibrate the numerical groundwater flow model

*Question 2: Is the existing groundwater model parameterisation and construction adequate to assess the potential impacts on groundwater, interactions with surface water, uses of that groundwater and surface water, and water dependent assets? a) Is the IESC satisfied that the range of uncertainty in predictions are appropriately investigated and quantified? b) What can be done to improve the inadequacies identified, noting that there are proposals for additional model development outlined by the proponent?*

#### Response

6. The existing groundwater model parameterisation and construction are not adequate, due in particular to inadequate or insufficiently justified boundary conditions, recharge estimates, hydraulic conductivity and anisotropy ratios, and lack of a robust conceptual groundwater model, including a lack of information around the extent and hydraulic characteristics of the Callide Creek Alluvium. The range of uncertainty in predictions is also not appropriately quantified, as the stochastic model runs do not address the shortcomings of the conceptual and numerical groundwater flow models. The proponent's proposal to convert the existing numerical flow model to a cumulative and transient model will not address the inadequacies identified, as the shortcomings and uncertainties in the current model would remain.

#### Explanation

7. The numerical groundwater flow model domain is surrounded by no-flow boundaries and assumes that the Callide Basin operates as a closed groundwater system, with no hydrogeological connection with other basins. No evidence of groundwater heads or flow lines is provided by the proponent for the north-western and south-eastern boundaries to support the use of no-flow boundaries for these areas. The separation of the numerical groundwater flow model domain from the Callide Creek Alluvium with the use of a no-flow boundary in the west is also not adequately supported.
8. There is uncertainty in the model calibration as there is insufficient distribution of groundwater level measurements and a broad range of uncertainty in recharge estimates used to calibrate the model. The values used in the model for the anisotropy ratio (horizontal (measured) to vertical (calculated) hydraulic conductivity) do not appear to be supported by available data. Confidence in the calibration is further reduced by the lack of mine pit inflow data.
9. Well abstractions, including the three bores used for mine water supply, have not been incorporated in the model. These may represent significant abstractions, which, if not addressed, could affect the accuracy of drawdown predictions and water budget estimates.
10. The groundwater numerical model does not adequately represent the conceptual model (which itself does not adequately represent the groundwater flow system). The following inconsistencies between the conceptual and numerical model should be addressed:
  - a. The proponent has used drains and seepage faces in the numerical model to simulate groundwater-surface water interactions however this does not represent any discharge process described in the proponent's conceptual hydrogeological model. Surface watercourses in the model should be changed from 'drain' features to 'rivers' to allow for recharge during flow events.
  - b. Drain cells should be set in appropriate layers to simulate inflow to the pits. The model geometry should be revised to more accurately represent the hydraulic conductivity of the basement layer (Muncon Volcanics) in the numerical model.
  - c. Inclusion, in the numerical model, of the Quaternary and Tertiary age alluvial strata as described in the conceptual hydrogeology. Impacts of the proposal on groundwater discharge

and the lateral propagation of drawdown may be underestimated because of the exclusion of these strata from the numerical model; and

- d. The water balance model requires clarification and explanation, as the information provided contains inconsistencies between modelled inflows for the various Callide Mine pits, and the total water balance provided for the groundwater model.
11. Once the numerical model has been revised, modelling of the regional context can be undertaken and appropriate mitigation measures developed.

*Question 3: What does the Committee consider are the likely and potential impacts of the proposed action on surface and groundwater resources, in particular, changes to surface and/or groundwater dynamics and resources, including downstream resources that may support surface habitat for listed threatened species and communities and migratory species? Are there additional measures and commitments required to mitigate and manage impacts to MNES and water dependent assets?*

Response

12. The proposal is predicted to impact on groundwater and surface water resources in the region, however, the full suite of impacts is difficult to characterise given the limitations of the groundwater model, the lack of integration of surface water attributes into that model and a lack of adequate ecological survey information.
13. The possible surface water impacts would include increased sediment transport and associated effects on aquatic ecosystems, possible reduction in stream flow (approximately 50%) affecting watercourses and environmental values (such as threatened species supported by the watercourses) and an alteration of the potential contribution of stream flow to recharge of the Precipice Sandstone.

Explanation

14. Increased sediment transport downstream will impact on water dependent ecosystems. The proponent has outlined a range of mitigation measures to minimise the sedimentation impacts in an existing erosion and sediment control plan, however the document needs updating to address the proposed Boundary Hill South Project. Monitoring regimes for pre-, during and post-operations also need to include trigger values to allow determination of impacts on flora, fauna and the geomorphology of the watercourses.
15. It is difficult to assess the applicability of other proposed mitigation and management as the full suite of ecological impacts has not been described. Information gaps as they relate to ecological impacts are detailed below, and where appropriate, suggested improvements are recommended:
- a. GDEs: Insufficient information has been provided regarding the presence of GDEs in the region. The forecast 50% reduction in flow volume along Campbell (Gate) Creek as a result of diverting flood waters around the mine pit will reduce recharge to the shallow alluvial aquifer systems in this area. It is anticipated that this will have a direct impact on any terrestrial vegetation that rely on water from the shallow water table. There are areas of Brigalow (*Acacia harpophylla* dominant and co-dominant) communities of the Brigalow Belt, which have been mapped to the west (within 3km) and south (within 5km) of the proposed site. The extent to which these communities would rely on overbank flows or be impacted by reduced recharge to the alluvium materials as a result reduced flow in Campbell (Gate) Creek has not been assessed. An adequate assessment of the potential reduction in flow and associated impacts on these terrestrial ecological communities is needed.

- b. Aquatic ecosystems: The aquatic ecosystem assessment and characterisation relies heavily on data collected by the Queensland Government that is greater than 10 years old. This does not conform to the sampling protocol for Queensland rivers and streams requiring a minimum of two sample sets in one year, and therefore further sampling should be undertaken.
- c. Stygofauna: A single survey was undertaken to determine presence/absence of stygofauna in the region across eleven bores. Multiple surveys are needed to determine the species composition of stygofaunal communities at a single bore (Eberhard et al. 2009) as stygofauna communities appear to have a high degree of temporal variability. Repeated sampling should be undertaken.
- d. Threatened and migratory species: The watercourses and drainage lines provide narrow corridors through the centre and west of the proposed site. Risks to threatened (e.g. squatter pigeon, *Geophaps scripta scripta*) and migratory species (e.g. Black-faced monarch *Monarcha melanopsis*) that may utilise these corridors should be assessed, including through an assessment of the impact of reduced flows leading to a lack of recharge to the alluvium.
- e. The proponent has assessed that habitat for twelve migratory species is present or “possible” within the development area; however, potential groundwater drawdown impacts on habitat for these species have not been assessed.
- f. The IESC further suggests that:
  - i. habitat associations for migratory and threatened species known or likely to use habitat within the predicted area of groundwater drawdown be clearly identified;
  - ii. the discrepancy between information contained within different sections of the EIS about the presence and likely impacts on migratory species be resolved;
  - iii. risks to migratory species and their habitat from groundwater drawdown be assessed, particularly in relation to potential impacts to wetland areas and groundwater dependent terrestrial vegetation, and appropriate monitoring and mitigation measures be identified if necessary; and
  - iv. potential cumulative impacts on water-dependent habitat for migratory species and threatened species be assessed.

*Question 4: How likely and severe is the risk of the project inducing interaction between aquifers?*

Response

- 16. It is considered that the project has the potential to affect interactions between the Precipice Sandstone and the CCM compared to the pre-mining state. However, the confidence in this likelihood would be improved by adequate conceptualisation of the hydraulic characteristics of the project area, and the proponent’s existing numerical groundwater flow model would need significant improvements, as discussed in response to Question 2, to provide reliable predictions on the severity of the induced changes.

Explanation

- 17. Changes may include reduced vertical hydraulic gradient from the CCM to the Precipice Sandstone due to a preferential reduction in the groundwater head within the CCM. The reduction in the vertical hydraulic gradient may subsequently result in reduced groundwater head in the Precipice Sandstone and reduced flow (or flow reversal) from the Precipice Sandstone to shallow groundwater resources contained in the alluvium and the Biloela Formation in the western part of the Callide Basin.

*Question 5: Does the EIS, including the water management plan, provide sufficient detail to address the ongoing monitoring and management of surface and groundwater related impacts? a) Are there additional measures and commitments required to mitigate and manage impacts to water related assets? b) Are the provided management options adequate to manage local and regional flooding? What modifications or additions would address any significant shortcomings?*

#### Response

18. The EIS, including the Water Management Plan, does not provide sufficient detail to address ongoing monitoring and management of surface water and groundwater related impacts or the effect of these impacts on dependent ecosystems. Suggested modifications or additional measures to address the shortcomings are provided below.

#### Explanation

19. The Water Management Plan does not provide an adequate groundwater monitoring plan. Improvements for regional groundwater monitoring in the Callide Basin are suggested in the answer to Questions 1 and 2 of this advice. Consideration and incorporation of these matters would improve the ability of the monitoring plan to detect and measure potential impacts on groundwater resources and dependent assets.
20. The Water Management Plan's ability to detect, monitor and manage impacts on surface water resources and aquatic ecology monitoring would be improved by:
- a. Revising the proposed monitoring locations to target the locations and indicators most likely to be impacted by the proposed project;
  - b. Retaining monitoring site RM07 on Campbell (Gate) Creek for use as an impact assessment site and create a new reference site to the east of the proposed site;
  - c. Establishing two additional impact assessment sites; one on Campbell (Gate) Creek between RM07 and the confluence with Callide Creek (IM12); and the other on the Southern Drainage Line tributary (Southern Extension levy) receiving runoff from the southern extent of the Eastern Road Diversion levy;
  - d. Undertaking automated flow-based water quality sampling rather than opportunistic grab sampling; and
  - e. Incorporating macroinvertebrate sampling and analysis using the standardised assessment method for ephemeral streams as described in the Department of Natural Resources and Mines (Qld) (Aug 2001).
21. The IESC recommends that a terrestrial vegetation survey should be undertaken to establish the degree of groundwater dependency, as described in point 15.a. A monitoring plan should be developed to provide early warning of water related impacts on any groundwater dependent ecosystems west of the proposed site. The monitoring program should target terrestrial habitat in the alluvial deposits. Two sites should be established to complement in stream monitoring sites RM07 and one other at a new site to be located between monitoring sites RM07 and IM12.
22. The scope and resolution of the flood study's hydraulic model are insufficient to reliably characterise any impacts on stream morphology or sediment transport. The IESC suggests adoption of the following approaches to more accurately assess impacts:
- a. Increase the grid resolution of the hydraulic model or include Campbell (Gate) Creek as a 1D element in the model. Sections of Campbell (Gate) Creek are of a smaller scale than the

resolution of the Digital Terrain Model, reducing the reliability of model results. This in turn is likely to result in stream velocities, and changes in velocity, being underestimated;

- b. Use model results for the 1 in 2 year average recurrent interval (ARI) flood event to assess changes in stream velocity as well as the results from lower frequency flood events. Model results indicate that flow velocity increases are higher during the 1 in 2 year events (greater than 0.5 m/s), which is likely to create stream stability issues in Campbell (Gate) Creek and the Southern Drainage Line;
- c. Conduct a validation process which involves comparing the flood study results against a regional flood frequency analyses for the area to provide higher levels of confidence that the predicted flood flows are reliable. While the proponent has checked the model results against the Rational Method, this method is not considered to be as reliable as regional data sets;
- d. The hydraulic model should be extended further downstream, beyond the confluence of Campbell (Gate) Creek and the South Western Drainage Line, to enable the full extent of the area of deposition to be estimated and suitable management measures to be identified. This area and the area further downstream of this confluence are likely to be an area of significant sediment deposition based on the change in velocity distribution.
- e. The final landform (including final void) should be designed with consideration of impacts to water resources in perpetuity, and ensure that these impacts are minimised through mitigation, monitoring and management measures. A final void management plan should be developed prior to completion of mining to detail such measures.

<b>Date of advice</b>	14 May 2014
<b>Source documentation available to the Committee in the formulation of this advice</b>	<p>Anglo Coal (Callide Management) Pty Ltd. Callide Mine – Annual Groundwater Monitoring Reports (2013).</p> <p>Anglo Coal (Callide Management) Pty Ltd, 2014. Boundary Hill South Project Environmental Impact Statement.</p> <p>Anglo Coal (Callide Management) Pty Ltd. Callide Mine – Existing Management Plans.</p> <p>Anglo Coal (Callide Management) Pty Ltd. Callide Mine – Preliminary Draft Water Management Plan (WMP) Version 04a. Issued for review on 9 Aug 2013</p> <p>Department of Natural Resources and Mines (Qld), 2001. Australia-Wide Assessment of River Health: Queensland AusRivAS Sampling and Processing Manual. Monitoring river health initiative technical report: report number 12. Freshwater Biological Monitoring.</p> <p>Eberhard, et al 2009. Exploring the relationship between sampling efficiency and short-range endemism for groundwater fauna in the Pilbara region, Western Australia. Freshwater Biology 54: 885-901.</p> <p>GHD 2013a. Callide Mine Callide Basin Groundwater Flow Model: Model Development and Calibration. Prepared for Anglo Coal (Callide Management) Pty Ltd.</p> <p>GHD 2013b. Boundary Hill South Project Groundwater Assessment: Callide Mine Callide Basin Groundwater Flow Model: Boundary Hill South Lease Extension Project Impact Model. Prepared for Anglo Coal (Callide Management) Pty Ltd.</p> <p>Matrix+ Consulting Pty Ltd, 2007. Boundary Hill Mine Extension – Hydrogeological Assessment. September 2007. Prepared for Anglo Coal (Callide Management) Pty Ltd.</p> <p>Parsons Brinckerhoff, 2006. Callide Mine Biodiversity Action Plan. Prepared for Anglo</p>



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Richardson, et al 2011 The Australian Groundwater Dependent Ecosystems Toolbox. National Water Commission, Canberra.

Rob Lait and Associates Pty Ltd, 2013. Boundary Hill South lease extension project Environmental Impact Assessment Groundwater Aspects: Project 210. Prepared for Anglo Coal (Callide Management) Pty Ltd.

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**References  
cited within the  
Committee's  
advice**

<sup>1</sup> Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources available at: <http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf>

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