Further review of United Wambo Open Cut Coal Mine Project – groundwater impacts

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Introduction

This is the third expert report I have prepared regarding the proposed United Wambo Open Cut Coal Mine Project (project), examining the topic of groundwater (and related surface water) impacts of the project. I was asked to prepare this report by EDO NSW on behalf of the Hunter Environment Lobby (HEL), to address the following questions:

a) Have the concerns raised by you (if any) in your previous assessment been adequately addressed?
b) Provide any further observations or opinions that you consider to be relevant, having regard to the circumstances of this matter.

This report is designed to be read in conjunction with the previous two expert reports I prepared on 21st September 2016 and 13th February 2018, following the release of the original EIS and proponent's Response to Submissions (RTS), respectively.

Since that time, additional information has been provided by the proponent as part of the Independent Planning Commission's (IPC's) assessment of the project and the IPC's recommendations, and the 'merit assessment' conducted by the Department of Planning and Environment (DPE).

I have read the Code of Conduct in Schedule 7 of the Uniform Civil Procedure Rules, and agree to be bound by it in preparing this report.

Background and summary of previous concerns raised:

The previous concerns which I raised regarding the adequacy of the groundwater and surface water assessments involved three main topics:

-Groundwater levels, flow patterns and ground-surface water interaction
-Groundwater quality
-Groundwater dependent ecosystems

At the time of writing both of my previous reports, I indicated that there were a number of inadequacies and data gaps in the materials presented by the proponent, which hindered a thorough analysis of the impacts in these topic areas.

In the Independent Planning Commission's report, a series of recommendations related to water resources were made. Those relevant to the topics listed above are as follows:

> ***R40*** *The applicant should confirm why only 27 of 77 bores and 11 of 24 VMPs are currently monitored under the groundwater monitoring program*
>
> ***R41*** *The applicant and the Department should confirm the extent to which privately owned bores and mine owned bores, located within the alluvial aquifers, would be impacted by the project*

(The applicant responded by stating that no privately owned bores are predicted to be impacted in the alluvium).

> ***R42*** *The applicant should provide details of the proposed additional monitoring bores, including periodic sampling of stygofauna, to account for recommendations made in its EIS.*

In response to these recommendations, the project proponent provided additional information and responses which in some cases partially addressed some of the inadequacies I previously identified; however, most of my concerns remain unchanged as there has been little done to address data gaps and other deficiencies pointed out in my previous reports.

A detailed discussion of whether specific inadequacies pointed out in my previous reports have been subsequently addressed in the process of responding to these recommendations is presented below, structured under sub-headings for each of the above topic areas.

Groundwater levels, flow patterns and ground-surface water interaction

Some additional work in the assessment of groundwater impacts from the project has been conducted. This includes the 'Additional Groundwater Assessment' (Appendix 11 of the response to the IPC's recommendations), responses provided to the IPC's recommendations with respect to water resources (R40 to R42) and responses to a request for additional information from the DPE. In most cases these responses have done little to address the specific concerns raised in my previous reports. Below the specific concerns are outlined along with whether and to what degree the additional materials have addressed these issues.

-Lack of hydrographs & linking of these to water level contour maps, use of these combined data to better understand spatial and temporal influences on groundwater flow patterns (including existing mining operations):

This issue remains un-addressed. There are still open questions with respect to the spatial and temporal trends in groundwater levels, and their relationship to factors such as climate, geology/topography and existing mining. Without this information, observed trends in groundwater levels are likely to be open to ambiguous interpretation, and resolution of the cause of changes to groundwater levels (due to mining or other influences) difficult to achieve.

-Questions regarding the adequacy of the spatial coverage of the monitoring bore network (note this applies to groundwater quality also):

The IPC raised a question regarding the adequacy of the groundwater monitoring network, and number of bores included (see recommendation R40). In response, the applicant clarified that 31 existing bores and 20 vibrating wire piezometers are being monitored, with 4 additional bores and 6 additional vibrating wire piezometers to be installed.

Further advice on this issue was sought by DPE. In response, the applicant provided a map of groundwater monitoring bore and vibrating wire piezometer locations (Attachment 3 of letter to DPE dated 11th October 2018).

This map indicates that two additional monitoring bores and two additional vibrating wire piezometers will be installed on top of the existing monitoring network, to the north of the Approved and Proposed Wambo Open Cut. These additional monitoring points are a marginal improvement on the network as assessed in my previous expert report, and partly address the concern that spatial coverage of monitoring bores to the north and west of the project was inadequate. However, there are still relatively few monitoring points to the west of the Wambo

Open Cut, meaning it will be difficult to detect and characterise potential changes in groundwater levels in this area resulting due to expanded mining operations.

The depth(s) and aquifers to be monitored by the new bores and piezometers should also be provided.

-Need for a dedicated study of ground-surface water interaction, including further field data to inform conceptual modelling and alternative modelling approaches (given the general poor suitability of the type of modelling adopted to capture spatial and temporal dynamics of ground-surface water interaction):

No dedicated report discussing the dynamics of groundwater-surface water interaction (beyond what can be estimated on the basis of the large-scale fully saturated groundwater flow model) has been completed. No additional field studies have been conducted to further examine the nature and dynamics of ground-surface water interaction (such as changes in the direction and magnitude of ground-surface or surface-groundwater exchange over time). This is a major potential oversight which was not captured in the IPC's assessment and recommendations. Minor updates to the estimated quantities of baseflow lost from Wollombi Brook and the Hunter River under the proposed mining scenario are presented in the Revised Landform Modelling report (Appendix 11 of the response to IPC recommendations), however there has been no significant change in the methodologies or assumptions used or the results determined using this updated modelling.

It is noted in the IPC's report, that DPE has indicated that there is a 'cumulative predicted drawdown in the Quaternary alluvium adjacent to the Hunter River of up to 10m'. The predicted changes in baseflow volumes (e.g. to Wollombi Brook) and outflow from surface water to groundwater (the Hunter River) are then given in terms of approximate averages over the length of the project. Given the importance of seasonal dynamics to the function of Australia's aquatic ecosystems (Boulton et al., 2014), this potentially means that there is insufficient detail to properly understand ecological impacts of changes to baseflow/stream leakage at different times of the year (e.g. different stages of the project, different climatic periods/seasons where the availability of surface water changes).

It should also be noted that the limitations of the type of modelling conducted to make these estimates mean that there are large uncertainties associated with the drawdown levels, leakage rates and thus water volume changes resulting due to ground-surface water interaction. Without further detailed field data and additional modelling at different scale(s) (as described in my previous report) there is the prospect that substantially different impacts may in fact arise compared to those predicted in the modelling conducted to date.

Some assumptions made in the IPC's assessment report with respect to ground-surface water interaction are also questionable and warrant further interrogation:

- That reduction in discharge of 'saline' water to streams will result in improvement of water quality (p. 54). Note that many riparian and aquatic ecosystems in Australia are adapted to natural salinity which is characteristic of many waterways. It is overly simplistic to say that lower salinity = higher quality water with respect to the function of ecological communities. This requires proper site-specific ecological assessments. No in depth study looking at changes in stream water chemistry over time, the causes of these changes (e.g. existing mining vs. natural influences) or the resulting effects on ecological health of waterways has been conducted.

- Because the Hunter River is a 'losing' stream, that drawdown in the alluvial aquifer below the stream will have minimal impact on flow volumes (p. 54). In fact, the

drawdown may lead to significantly greater loss of water ('capture'), due to the effect on hydraulic gradients in the ground-surface water system (Konikow and Leake, 2014). Again, this is a topic which is poorly characterised or understood to date at the site.

-Lack of field data to inform hydraulic parameters of near-stream geological materials (e.g., streambed hydraulic conductivity, alluvial aquifer hydraulic conductivity and storage coefficients):

As implied above, this issue is also not addressed. Without field-based estimates of the hydraulic parameters of the key units (e.g. Hunter River alluvium) there will be significant uncertainty with respect to possible rates of leakage and loss of baseflow (both volume and timing) in Wollombi Brook and the Hunter River during mining.

Groundwater quality

Some further investigation of water quality effects was included in the Additional Groundwater Assessment (Appendix 11 of the response to the IPC's recommendations). This focusses on the potential salinity impacts after mine-closure, using updated final landform modelling. The work indicates that some additional generation of salinity will occur, impacting Wollombi Brook, following site rehabilitation (the magnitude of change is not considered significant).

The major concerns/oversights raised with respect to groundwater quality in my previous report were:

-Limited baseline groundwater quality data and lack of thorough discussion of patterns & trends in groundwater quality data and their relation to flow patterns, water-rock interaction, mining and other factors:

No additional work has been done to address this issue in the applicant's responses to the IPC. The IPC's report also did not raise baseline groundwater quality data as being an important issue for consideration, and made no recommendations in this regard. As a result, it is likely that any changes to groundwater quality (which may in turn have an impact on surface water) will be difficult to conclusively explain and/or resolve in the event that they are observed during monitoring. This is likely to be exacerbated by inadequacies in the proposed monitoring program (see below), which may not capture changes early enough or in sufficient detail to properly establish cause and mitigate impacts.

-Adequacy of monitoring network (e.g., have additional monitoring points for groundwater quality been installed north of the proposed mine pits)?

As discussed earlier, the addition of 2 new monitoring bores to the north of the Wambo Open Cut marginally increases the spatial coverage of the network for monitoring groundwater. An important point is that the vibrating wire piezometers, which are the predominant type of monitoring point to the north of the proposed pits, can only be used to monitor water level and can't be used to sample groundwater for quality. There is thus still a major gap in the monitoring network's ability to monitor changes in groundwater quality as mining progresses, particularly to the north of the mine pits.

-Problems with the presentation of water quality data which prevent clear visualisation of spatial and temporal trends at various localities:

Specific issues included:

- Groundwater quality data being aggregated in the previous reporting and not able to be linked to locations
- Lack of Piper/Schoeller plots or other common methods to visualise groundwater quality and type more clearly
- Lack of analysis of spatial and temporal trends in groundwater quality data
- Limited analysis and discussion to link trends in groundwater quality to key governing processes (such as water-rock reactions, geochemical conditions, influence of mining operations in the area)
- Key parameters not monitored (e.g. redox)
- Inadequate explanation of previous instances of elevated metals concentrations (e.g. aluminium, manganese, arsenic), and their links to other geochemical parameters such as pH and Eh.
- Problems with the proposed groundwater sampling program (infrequent sampling for metals, no monitoring of redox)

With the exception of some additional details provided about the proposed groundwater monitoring program, these issues have not been addressed. According to the applicant's response to the IPC's report regarding the groundwater monitoring program, field water quality parameters will be monitored bi-monthly, 'comprehensive' monitoring will occur once per year, and metals concentrations will be monitored quarterly. Redox is still not proposed to be monitored. The proposed monitoring frequency is unlikely to be adequate to rapidly detect and mitigate changes in groundwater quality, which in turn may impact surface water quality though ground-surface water interaction.

Groundwater dependent ecosystems
Additional/updated surveying done prior to the RTS addressed some previous concerns with respect to the adequacy of the groundwater dependent ecosystems (GDE) survey. However, outstanding issues included:

-The fact that the updated stygofauna sampling had only sampled at one point in time (e.g., no repeat sampling to look at variability over time)
-Only a small number of sites sampled (5 bores)

In the applicant's response to the IPC's recommendations regarding water resources, it is stated that further stygofauna surveys will be conducted 'periodically', to be outlined in the Groundwater Monitoring Program (not yet available). This issue is thus yet to be resolved conclusively. Details of the locations, frequency and methodology of the stygofauna surveys are not available for public or independent scientific scrutiny. The proposal to monitor 'every three years' after mining commences (see Response to IPC recommendations report) seems inadequate for capturing variability and possible impacts which may arise during the early stages of mining.

The fact that the revised groundwater monitoring program is not available means that there is no way for the public to scrutinise the planned groundwater monitoring program. It is a reasonable expectation that communities with an interest in the environmental values of the region be given information about the specific details of groundwater and surface water monitoring programs, as well as baseline datasets, prior to a determination being made regarding project approval.

Potential impacts of the project and ability of conditions to address these

As noted in my previous two expert reports, there are three major types of impact which may arise from the project:

- Drawdown / loss of groundwater storage in aquifers which may impact private bores and potential GDEs
- Reductions in baseflow to streams, and reduced availability of water in the alluvial aquifer(s)
- Groundwater quality impacts (e.g. heavy metal contamination) – noting that at the time of the previous report, the baseline data and analysis conducted were inadequate to make a proper assessment of the most likely future impacts in this regard (advice which was echoed by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) in September 2016).

    - *There are indications of significant existing water quality impacts (e.g. exceedance of guideline values for metals including aluminium and manganese) which have not been adequately explained. Related impacts to surface water (e.g. through ground-surface water interaction) are also uncertain until such time as the existing groundwater quality impacts and greater detail of the dynamics of ground-surface water interaction are properly characterised.*

The additional work done by the applicant since my previous report has done little to further address these issues beyond what was already presented in the EIS and RTS. The IPC and DPE appear to be satisfied that impacts will be minimal, that these have been assessed satisfactorily and that any residual impact is manageable using conditions.

The DPE also believes that all issues raised by the IESC in its 2016 advice with respect to groundwater and surface water impacts have been addressed. As far as I can gather however, the IESC have not provided further advice as to whether its initial concerns have been addressed. It is hard to see how some of these concerns have been addressed - for example, one of the key conclusions of the IESC advice was:

> *"The water quality data provided in the assessment documentation for both groundwater and surface water was limited in spatial and temporal representation, preventing a clear identification of baseline conditions and potential impacts offsite. This is particularly the case for metals and nutrients."*

Only very limited additional surface water and groundwater quality data were provided in the applicant's RTS – e.g., only one further sample of surface water for metals and nutrients analysis was collected (from Wollombi Brook) during the additional monitoring period (October 2016 to Feb 2017). No additional data were collected for any of the other streams in the region – see table 2.3 of the RTS Part B. While it is clear from the data analysed in the RTS that concentrations of metals (particularly aluminium) exceeded ANZECC guidelines for freshwater ecosystem protection in ground and surface water, no credible mechanism for this has been provided, and there is still no understanding of whether these water quality impacts relate to existing mining on the site and/or whether they might be expected to further increase, if mining expands on the current site as proposed.

For groundwater, the only additional data collected were those regularly collected as part of current annual monitoring program on the existing site (one additional monitoring event). Some additional analysis and discussion of groundwater metals concentrations (particularly trends in aluminium over time) were included in the RTS, but there was not a clear explanation provided for high periodic high concentrations of metals observed in some sites (aside from speculation that this reflects 'natural processes').

In order to resolve whether indeed the previous issues and concerns raised by the IESC have indeed been addressed (independently of my analysis in this report), it would be valuable to seek the IESC's opinion as to whether indeed its initial concerns have been addressed through the RTS. This type of repeat assessment is within the scope of the committee's work[1].

Project conditions
The DPE issued a report discussing the IPC's recommendations, and providing a series of proposed conditions of consent for the project (outlined in Appendix F of the report). The proposed conditions include requirements to develop a water management plan (including groundwater management plan), conduct a groundwater dependent ecosystem study and comply with performance criteria as laid out in Table 4. These conditions may in part guard against the possible groundwater and surface water impacts described above. However, there are some major potential issues/questions:

-Preparation of the Groundwater Management Plan and groundwater dependent ecosystem study are required before commencement of development; however, these are not required prior to an approval decision on the project. Communities may reasonably argue that they should be given an opportunity to review and critique the Groundwater Management Plan, Stygofauna survey, as well as initial baseline data prior to project approval. Following approval there may be limited opportunity for community or independent scientific input into these processes.

-Similarly, the applicant will be required to determine performance criteria and trigger levels for identifying and investigating impacts on stygofauna, regional & local aquifers and site-specific stream water quality objectives, but these are not required before an approval decision is made. Likewise, post-approval, opportunities for community/independent critique of these criteria (and their adequacy) is likely to be limited.

-Remedial actions required, should the performance measures (e.g. in Table 4 of the DPE proposed conditions) not be achieved, are yet to be determined. For example, the Groundwater Management Plan requires:

> *'a plan to respond to any exceedences of the groundwater performance criteria and repair, mitigate and/or offset any adverse groundwater impacts of the development'*

Coupled with the fact that the methodology for ensuring compliance with performance criteria (and many of the criteria themselves) have not yet been developed, this raises concerns over whether it will be possible to independently review and critique important specifics about the methodology for detecting and responding to changes in groundwater or surface water quality or quantity.

-Given the lack of clear explanation of observed historical trends in groundwater levels and groundwater and surface water quality, and their relationship to particular influences (climate, on-site mining and/or adjacent mining operations) the determination of impacts (for example on alluvial aquifer water levels or stream water quality) related to the mining operations, as opposed to other potential influences, is likely to be ambiguous and open to interpretation. This may create problems down the line with the attribution of responsibility for observed changes in water quality and quantity characteristics, and the implementation of timely and effective remedial/mitigating actions.

[1] See for example, the advice provided by the committee on the New Acland Stage 3 expansion in response to a request to re-visit and re-assess issues raised in the committee's earlier advice on this project.

References

Boulton, A., Brock, M., Robson, B., Ryder, D., Chambers, J., Davis, J. 2014. Australian Freshwater Ecology: Processes and Management (2nd Ed). Wiley Blackwell, 386pp.

Konikow, L.F., Leake, S.A. 2014. Depletion and capture: Revisiting "The source of water derived from wells" Groundwater 52, 100-111.

Declaration:

I declare that this report has been prepared in line with the requirements of an expert witness for the Land and Environment Court of NSW and that it contains my impartial expert opinion on matters relevant to my professional expertise.

Signed:

Date: 12th December 2018