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PEER REVIEW STATEMENT - ADDENDUM

ATTENTION:	Mr Paul Freeman, NSW Dept of Planning Infrastructure and Environment	
FROM:	Hugh Middlemis, Principal Groundwater Engineer, Hydrogeologic Pty Ltd	
REFERENCES:	**13 Sept 2019**	DPIE ref: Vickery Extension Project Groundwater Assessment
	HGL job#: 61.073	
SUBJECT:	**Vickery Extension Project groundwater assessment peer review - ADDENDUM**	

This brief statement forms an addendum to the independent peer review (Middlemis, 2018) of the groundwater assessment for the Vickery Extension Project that is currently under review through the Independent Planning Commission (IPC) process.

This addendum outlines mainly 'by exception' responses from this independent groundwater expert on key matters set out in several new documents issued during the IPC process, notably:

- IPC (2019). Vickery Extension Project Issues Final Report. State of New South Wales through the Independent Planning Commission. 30 April 2019.
- Whitehaven Coal Limited (2019a). Vickery Extension Project Submissions Report. Aug. 2019.
- Whitehaven Coal Limited (2019b). Vickery Extension Project Environmental Impact Statement Response to Groundwater Assessment Peer Review Comments August 2019.
- HydroSimulations (2019). Vickery Extension Project Groundwater Sensitivity Analysis. Technical Memo prepared for Whitehaven Coal Limited. 9 August 2019. Ref HS2019/34.

This addendum and the original peer review report should be read together as expert advice to the Department of Planning Infrastructure and Environment (DPIE) on groundwater matters.

1. Summary of Issues

The IPC (2019) issues report outlined some information gaps and issues that would benefit from additional clarification and justification. Many of these issues have been addressed by various reports, notably Whitehaven (2019a, 2019b) and HydroSimulations (2019), although that is my opinion and various agencies and the IPC may deem otherwise. The key residual issue is the need for detailed investigation of post-mining predicted impacts, although adequate time is arguably available during mining operations for further investigations.

Examples of where, in my opinion, adequate information has been provided on key issues include the following (i.e. in response to the IPC Issues Report at paragraphs 86, 93 and 99):

- Groundwater model sensitivity analysis (HydroSimulations 2019), and the application of the results to justify the largely adequate qualitative uncertainty analysis interpretations (see also Whitehaven 2019a, 2019b).
- Additional groundwater model scenario of a backfilled final void; when combined with the residual final void scenario described in the EIS, these two final landform scenarios essentially 'bracket' as 'end members' the range of post-mining groundwater system responses that may be expected; the potential density-driven outflow question raised in the peer review has been adequately addressed in Whitehaven (2019a, 2019b).
- a map of predicted groundwater drawdown in relation to groundwater dependent ecosystems (GDEs), and risk analysis discussion is set out in Whitehaven (2019a).
- With respect, the distinctions between the alluvial and fractured rock aquifers in terms of

their characterisation and connectivity properties derived from field studies, monitoring and modelling were adequately documented in the EIS, in my opinion. This also applies to the predicted water table drawdown impacts, noting that the term 'water table' refers to the upper boundary of an unconfined aquifer at atmospheric pressure. Hence, the plots of water table drawdown presented in the EIS adequately quantify the cumulative impacts across these aquifer systems due to the drawdowns from mine drainage and water supply borefield pumping. Additional explanations on this topic are provided in Whitehaven (2019a).

- With respect, the criticisms of the groundwater model performance outlined in the final bullet on paragraph 99 of the IPC Issues Report are not justified, in my opinion. There appears to be a misinterpretation of Figure 42 in Appendix A of the EIS, suggesting a 'spurious correlation' by inferring transients from a plot that is not a time series. The time series plots presented in the sensitivity analysis report (HydroSimulations 2019) exhibit the generally good groundwater model calibration performance, even under a wide range of parameter values. There is adequate discussion in the reports by HydroSimulations (2018, 2019) and Whitehaven (2019a, 2019b) to explain the few occurrences of divergences of the modelled from the measured (not uncommon with groundwater modelling), and this was also commented on in the peer review report. The model performance is not perfect (none ever is), but it is fit for the purpose of mining project impact assessment.

Examples of where, in my opinion, adequate information has **not** been provided relate mainly to the post-mining impact assessment, including:

- IPC suggestions for further information (summarised in paragraph 101 of IPC Issues Report):
  - the adequacy of the Applicant's justification and costing of a no void option;
  - the Applicant's consideration of long-term groundwater and water quality models for a no void option to assess the potential impacts of groundwater flow through such a rehabilitated Project site.
- IESC requests for the following (i.e. paragraph 86 of IPC Issues Report):
  - detailed geochemical and water chemistry analyses, particularly in relation to the final void and/or landform.

2. Post-Mining Impact Assessment

As discussed in the accompanying peer review report (Middlemis 2018), the post-mining final void water balance assessment is adequate (informed by the groundwater modelling), but the application of the groundwater model to investigate closure options and related uncertainties, and the lack of geochemical analysis of water quality issues, is less than one would expect in terms of best practice.

There are two post-mining scenarios presented:

- a final void lake for the Vickery Extension Project (in addition to the existing Blue Lake) documented in the EIS, and
- a completely backfilled final pit documented in the sensitivity analysis report (HydroSimulations 2019).

2.1 Groundwater Quality Issues for Complete Backfill and Final Void Options

The backfilled final pit scenario applies a recharge rate to the waste rock emplacements of 5%, and a 1% case is also presented. The recharge rates are high and perhaps questionable in relation to the calibrated recharge rate to the alluvium of about 1%. Other options are available for waste emplacement that may limit the recharge rate (e.g. capping with low permeability material), which would reduce the mounding and consequent seepage rates, but this has not been reported.

The effect of the relatively high recharge rate to the waste rock emplacements appears to result in a groundwater mound centred on the backfilled pit. This results in what is described as low quality seepage through the backfilled pits, although geochemical analysis has not been reported.

Regarding final void water quality, Whitehaven (2019a) states at the top of page 33: '... it is considered this scenario (backfilled void) is environmentally inferior, as lower quality groundwater (i.e. infiltration into the backfilled mined void) would flow towards the Namoi River alluvium (rather than to the final void lake for the preferred scenario where it acts as a groundwater sink)'. The second part of that sentence is justified, but the first part of that sentence indicates that the backfilled mined voids generate poor quality water due to infiltration through the waste rock emplacements. There is no geochemical analysis provided to justify the statement, but low quality seepage would not be a surprising occurrence. Logic would then indicate that the backfilling of the other two final voids that were part of the approved Vickery Coal Project would also result in poor quality groundwater flows. Currently, there is no geochemical analysis of the water quality characteristics of any seepage, nor any groundwater modelling of the transport and fate of any seepage flows. Even for the final void lake, there is only an assessment of the salinity and no other geochemical analysis. Therefore, the assessment of final void water quality and potential impacts is inadequate, in my opinion.

Unless and until a geochemical analysis is completed, it cannot be known whether the 'low quality' groundwater seepage from the partially or completely backfilled pits (i.e. the final void or backfilled pit options, respectively) may be problematic in terms of its transport and fate to final discharge to the environment and interaction with any ecological receptors. For the completely backfilled pit, the groundwater flow pattern is radially outwards, towards the Namoi River alluvium, and into the low permeability Maules Creek Formation. It should be remembered that this is a high recharge backfill case, and it is not known what the flow pattern might be with a different (optimal?) final landform (see also next section). For the proposed final void option, it has been clearly shown to act as a long term sink, with seepage inputs to the final void lake from the surrounding partially backfilled mined voids, but with no potential for groundwater outflow. However, there is no geochemical assessment of its water quality, other than salinity, nor assessment of what potential beneficial uses (or otherwise) could be invoked.

2.2 Investigation of Optimal Post-Mining Landform

Put simply, the final landform strategy adopted is to design the final void such that it remains a long term sink and captures any seepage/infiltration through the waste rock emplacements to the mined void areas. The geochemistry of the seepage or the terminal final void lake has not been characterised, other than to estimate the lake salinity.

The two post-mining scenarios effectively bracket the range of outcomes but do not conclusively identify the optimum scenario that achieves a balance between mine operational and economic efficiency issues, water balance and water quality, and environmental impact issues. In my view, it is misleading to suggest that there is an additional cost to 're-design' the waste emplacement strategy (Whitehaven (2019b), s.3, p.A7). This cost will be incurred operationally anyway, as it is common knowledge that mine plans become outdated as soon as they are adopted, and that mining operations are always being refined and optimised throughout the mine life.

Whitehaven have committed to a final landform including one residual void (in addition to the existing Blue Lake). They have also committed to conducting ongoing review of the mine plan during operations such that the size of the final void (depth and area) and catchment area reporting to the final void is minimised as far as is reasonable and feasible. In my view, the groundwater assessment does not yet fully justify the selection of one residual void (additional to Blue Lake) as an optimum post-mining landform. However, it is reasonable to commit to further investigations to identify that optimum. While it appears that there may be time during mining operations to complete those investigations, the investigations should be conducted within the first ten years of mining, so that there is adequate time to efficiently adjust the waste emplacement planning to deliver the optimal outcome.

It is recommended that consideration be given to devising suitable project approval conditions that would require the iterative integration of mine planning with groundwater modelling to investigate final landform scenarios and identify the optimal balanced solution that that minimises operational costs and rehabilitation and post-mining legacy impacts and costs, rather than simply minimising operational costs by minimising waste emplacement costs.

2.3 Monitoring and Evaluation

Whitehaven (2019a) have reiterated the commitment to "Ongoing groundwater monitoring ... with the results to be used to confirm any residual uncertainty in the modelling and inform ongoing licensing requirements. The groundwater monitoring results would be compared to model predictions, with the model revised and recalibrated every 5 years as required." This action was commended in the peer review (Middlemis 2018) and is endorsed.

Yours sincerely,

Hydrogeologic Pty Ltd

Hugh

Hugh Middlemis (Principal Groundwater Engineer)

Declaration: For the record, the reviewer (Hugh Middlemis) is an engineer, hydrogeologist and independent modelling specialist with more than 38 years' experience. Hugh was principal author of the first Australian groundwater modelling guidelines (Middlemis et al, 2001) that formed the basis for the latest guidelines (Barnett et al. 2012) and was awarded a Churchill Fellowship in 2004 to benchmark groundwater modelling best practice. He is principal author on two guidance reports on modelling uncertainty (Middlemis and Peeters 2018; and Middlemis et al. 2019). A detailed statement on potential conflicts of interest was presented in Middlemis (2018) and we again assert no potential conflict of interest.

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