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Planning Assessment Commission
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SYDNEY NSW 2001

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Russell Vale Colliery Underground Expansion Project

Executive Summary

All the available environmental assessment documents with hydrological information for the proposed underground mine expansion have been reviewed. In summary, the environmental assessments are generally of very good quality, however several issues need to be addressed in my opinion before some predictions and potential impacts can be considered to be adequately addressed. Specifically, this refers to:

- The high uncertainty surrounding increased groundwater losses from hydraulically connected streams and potential impacts on the Cataract Dam inflows.
- The lack of testing of the conceptual model through the numerical model. Calibration to short term pressure heads and poor spatial representation means there is a high risk of equifinality in explaining the distribution of pressure, and testing multiple hypotheses within the model is a necessary rectification. This can also be substantially improved through the collection of various geochemical proxies and associated water quality information, since this will immediately constrain or dismiss the flow paths within the existing model.
- The degree of hydraulic connection from the upland swamps, to shallow and deeper groundwater systems cannot be adequately tested based on the current information, and it is strongly recommended more appropriate field data is collected before an informed impact assessment can be made.

Background

Wollongong Coal proposes to extend their long wall operations to both consolidate existing operations and increase the underground extraction to eight longwalls. I have been briefed by EDO NSW on behalf of Illawarra Residents for Responsible Mining to conduct an independent expert review of the relevant sections of the Environmental Impact Statement (**EIS**), Preferred Project Report and Response to Submission (**RTS**), Residual Matters Report, relevant Peer Reviews, DPE Secretary's Preliminary Environmental Assessment Report (**Secretary's Report**) and Recommended Conditions of Consent (**Conditions**), and provide my view of any potential hydrological and hydrogeological impacts from the mining extension based on this material. I acknowledge that I have read the Code of Conduct under the UPCR and I agree to be bound by it.

Existing Peer Reviews

First, I note a number expert reviews corresponding to multiple versions of groundwater and surface water impact assessments of the proposed expansion. Each of these have provided comprehensive technical commentary and criticism of all hydrological components, especially tenuous conceptual interpretation based the available groundwater data and implementation in the numerical model. I note that many of the technical recommendations are yet to be addressed in the groundwater assessment.

Additional and complementary comments on hydrology related issues are provided below.

Dam inflows

The EIS notes that the numerical estimates of streamflow losses from streams should be compared with an analysis of baseflow behaviour based on actual streamflow data. This is also a recommendation I endorse, and note that such an exercise is necessary before potential impacts on inflows to Cataract Dam can be properly evaluated (which are currently stated from the model results alone). As they currently stand, the assessment of potential impacts on Cataract Dam inflows is very poorly constrained and requires additional work to be considered adequate.

Groundwater Model

In the construction of the groundwater model, the integrity and distribution of the low permeability aquitards between the fractured sandstone aquifers is of critical importance, especially in the case of the Bald Hill Claystone as this appears to be the first major vertical flow boundary. Although the Stanwell Park Claystone is also present at greater depth, the proposed mining extensions will apparently breach this, therefore removing its ability to act locally as a confining layer and transport barrier. I am not convinced the existing environmental assessment (EA) has developed an adequate conceptual model for the likely chain of hydrological impacts that would occur as a result of the mining extensions. That being said, the model could be used to test the flow path assumptions that are currently within it. Unfortunately this level of investigation is not reached in the EA, and therefore many assumptions remain highly uncertain. Therefore, my strong recommendation would be to use the current numerical model to interrogate flow path dependence on 1) the timescale for drawdown on the Scarborough sandstone and associated aquifers, since this appears to have greater pressure head, 2) any potential preferential flow paths within the Stanwell Park Claystone which may permit transfer with overlying aquifers, 3) the transition to inflow from the overlying Bulgo sandstone, its degree of confinement below the Bald Hill Claystone, and the timescales for its drawdown, 4) preferential or other flow paths through the Bald Hill Claystone (the EA is restricted to known faults and dykes), and 5) reaction of hydraulically connected surface water features (disconnected features will theoretically not be impacted by drawdown, as stated in the EA).

Although the numerical model has been conducted according to best practice, and I think the consultants have done a good job given the data and time constraints, this does not necessarily render the model useful in capturing the actual flow paths and potential impacts. One important constraint here is the extremely limited (spatially and temporally) regional piezometer dataset used to calibrate the model, no long term trends are able to be determined, and even less likely to be predicted with confidence. None of these measurements are within locations that would permit the potential flow paths connections between the surface water, shallow groundwater systems (such as swamps) and deeper aquifers to be confidently established. It is clear that some thickness of unsaturated zone may exist between shallow and deeper groundwater, however in loosing systems the hydraulic connection can be abrupt and highly confined laterally. Therefore if there is no monitoring data within this very small spatial area, the hydraulic connection will not be captured, and may instead be misinterpreted as disconnected. My recommendation to the PAC is to allow the collection of more appropriate data to explicitly test the hydraulic connections and therefore be in a more reasonable position to exclude these possible misinterpretations.

Upland Swamps

Regarding the potential impact on upland swamps, there also appears to be a lot of qualitative conjecture using groundwater levels. By this I mean the evidence used to determine whether surface swamps are or are not likely to be impacted seems to be whether some qualitative change in the swamp groundwater level can be observed beyond a qualitative comparison of natural variability, despite constant mine water inflows (Groundwater Assessment and Biosis Report). This neglects the timescales involved in depressurisation, and is a highly misleading approach to take. Put simply, just because surface drainage due to drawdown is not immediately observed, or even observed on the medium term (e.g. over 10 years), does not mean this will not eventually occur. Surface pressure waves moving across the ocean take weeks to months to reach a coastline, and they have only water and air to move against. Within porous media, and a mix of low and high permeability, the propagation of drawdown to the surface could easily take longer than 10 years, perhaps longer than 30 or 40 years, and beyond the distances considered in this EA.

Model Testing

A final observation relates to statements above about concerns with the conceptual model. The conceptual groundwater model implemented in the numerical model could actually be correct, but there is no way to evaluate this without constraining the actual flow paths by testing multiple hypotheses. This involves testing hypotheses in the model itself (as previously stated), but also using complementary methods to interrogate expectations of the conceptual model. The most

obvious and practical method in this case would be to use water quality or geochemistry (including major element chemistry, basic redox parameters, isotopes, and possibly groundwater ages), which together offer a simple toolbox of constraints for the poorly understood flowpaths in the current model. This is an absolute necessity in such a variable fracture flow system, and my recommendation is for this to be undertaken before the groundwater assessment can be considered adequate.

Yours Sincerely,

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Employment:

February 2013 – present: Lecturer in hydrology, School of Geography, Planning, and Environmental Management, University of Queensland

October 2010 – January 2013: Research Fellow, School of Civil and Environmental Engineering, University of New South Wales

Visiting student:

May 2010 – November 2010: Christian-Albrechts University Kiel, Germany

April 2010 – November 2010: Danish Technical Univeristy, Denmark

Education:

2011 PhD Hydrology, University of Wollongong

2005 BSc (Hons) Geology, University of Wollongong

Teaching:

ENVM3201 Catchment processes and management (co-ordinator)

GEOS2101 Climatology and hydrology

GEOS2100 Introduction to environmental systems

GEOS3102 Global Change: Problems and Prospects

Research students:

PhD:

Abdollah Jarihani 2013 – present: "Developing Remotely-Sensed Data Approaches to Predicting Land Cover and Condition Impacts on Hydrological Processes in Data-Poor Dryland Landscapes"

Ralph Trancoso de Silva 2013 – present: "Spatial and temporal hydrology and vegetation dynamics throughout Eastern Australia"

Maria Consuelo Santamaria Ferrada 2013 – present "Potential implications of canal estates function for CO2 and nutrient budgets in coastal systems"

Steven Howell 2014 – present:

Honours:

Cameron Woodruff 2013 – 2014: "ground and surface water interaction across freshwater to tidal transitions"

Jeda Palmer 2014 “modelling feedbacks between changing organic content and soil hydrology”

Danielle Uddy 2014 “Improved flood probability assessment through synoptic classification”

Cian Mooney 2014 “streambed biogeochemical consequences of potential sea level rise at freshwater margins”

Lettitia Sabburg 2014 - present

Publications:

Larsen, J, Gibbes, B, Quiggan, J. 2014. Dam hard: Water storage is a historic headache for Australia. Water: Journal of the Australian Water Association. 41(8) 24-26.

C. Woodward, J. Shulmeister, J. Larsen, G. E. Jacobsen, A. Zawadzki. 2014. The hydrological legacy of deforestation on global wetlands. Science, 346(6211) 844-847.

C. Rüdiger, M.Doubková, J.R.Larsen, J.P. Walker, W. Wagner. 2014. Similarities between spaceborne active and airborne passive microwave observations at 1km resolution. IEEE Geoscience and Remote Sensing Letters. 11(12), 2178-2182

A.M. McCallum, M. S. Andersen, J.R. Larsen, G. C. Rau, R.I Acworth. 2014. Controls on river-aquifer interactions in a semi-arid environment established point and reach measurements. Water Resources Research, 50(4), 2815-2829

I. Reinfelds, E. Swanson, T. Cohen, J. Larsen, A. Nolan. 2014. Hydrospatial assessment of streamflow yields and effects of climate change: Snowy Mountains, Australia. Journal of Hydrology, 512, 206-220.

L.A. Gliganic, T.J. Cohen, J.-H. May, J.D. Jansen, G.C. Nanson, A. Dosseto, J.R. Larsen, M. Aubert. 2014. Late Holocene hydrologic and environmental variability along the eastern Flinders Ranges and Lake Frome, Australia. The Holocene, 24, 104-117

Larsen, A., Bork, H.-R., Fuchs, M., Fuelling, A., Larsen, J.R. 2013. The processes and timing of sediment delivery from headwaters to the trunk stream of a central European mountain gully catchment. Geomorphology, 201, 215-226.

Fitzsimmons, K.E., Cohen, T.J., Hesse, P.P., Jansen, J., Nanson, G.C., May, J.-H., Barrows, T.T., Haberlah, D., Hilgers, A., Kelly, T., 2013. Late Quaternary palaeoenvironmental change in the Australian drylands. Quaternary Science Reviews, 74, 78-96.

Jansen, J., Nanson, G., Cohen, T., Fujioka, T., Fabel, D., Larsen, J., Codilean, A., Price, D., Bowman, H., May, J.-H., 2013. Lowland river responses to intraplate tectonism and climate forcing quantified with luminescence and cosmogenic 10Be. Earth and Planetary Science Letters, 366, 49-58.

Cohen, T., Nanson, G., Jansen, J., Gliganic, L., May, J.-H., Larsen, J., Goodwin, I., Browning, S., Price, D., 2012. A pluvial episode identified in arid Australia during the Medieval Climatic Anomaly. Quaternary Science Reviews, 56, 167-171.

Cohen, T., Nanson, G., Jansen, J., Jones, B., Jacobs, Z., Larsen, J., May, J.-H., Treble, P., Price, D., Smith, A., 2012. Late Quaternary mega-lakes fed by the northern and southern river systems of central Australia: Varying moisture sources and increased continental aridity. Palaeogeography, Palaeoclimatology, Palaeoecology, 356-357, 89-108.

Larsen, J.R., 2011. Was Evaporation Lower During the Last Glacial Maximum? Quaternary Australasia 28, 11.

Cendón, D.I., Larsen, J.R., Jones, B.G., Nanson, G.C., Rickleman, D., Hankin, S.I., Pueyo, J.J., Maroulis, J., 2010. Freshwater recharge into a shallow saline groundwater system, Cooper Creek floodplain, Queensland, Australia. Journal of Hydrology 392, 150-163.

Ladd, B., Larsen, J.R., Bonser, S.P., 2010. Effect of two types of tree guards (with and without weed control) on tree seedling establishment. Ecological Management & Restoration 11, 75-76.

Cohen, T.J., Nanson, G.C., Larsen, J.R., Jones, B., Price, D.M., Coleman, M., Pietsch, T., 2010. Late Quaternary aeolian and fluvial interactions on the Cooper Creek Fan and the association between linear and source-bordering dunes, Strzelecki Desert, Australia. Quaternary Science Reviews 29, 455-471.

Ladd, B., Bonser, S.P., Peri, P.L., Larsen, J.R., Laffan, S.W., Pepper, D.A., Cendón, D.I., 2009. Towards a physical description of habitat: quantifying environmental adversity (abiotic stress) in temperate forest and woodland ecosystems. Journal of ecology 97, 964-971.

Nanson, G.C., Price, D.M., Jones, B.G., Maroulis, J.C., Coleman, M., Bowman, H., Cohen, T.J., Pietsch, T.J., Larsen, J.R., 2008. Alluvial evidence for major climate and flow regime changes during the middle and late Quaternary in eastern central Australia. Geomorphology 101, 109-129.

Client Reports and other publications:

Larsen, J**.**, Leon, J., McGrath, C., Trancoso, R. 2013. Review of the catchment processes relevant to the Great Barrier Reef region. Great Barrier Reef Marine Park Authority, Townsville, Qld.

Holmes, G., McGrath, C., Larsen, J., Hockings, M., Moss, P. 2013.Fish habitat connectivity case study: Lower Fitzroy River basin. Great Barrier Reef Marine Park Authority, Townsville, Qld.

Holmes, G., McGrath, C., Larsen, J., Hockings, M., Moss, P. 2013. Development case study: Baffle basin. Great Barrier Reef Marine Park Authority, Townsville, Qld.

Larsen, J.R. 2011. Aspects of the contemporary and Quaternary hydrology of the Lake Eyre Basin, Australia. Unpublished PhD Thesis, University of Wollongong, Australia.

Larsen, J.R, Cendón, D.I., Nanson, G.C., Jones, B.G. (2009) Billabongs (waterholes), unique geomorphology and hydrology in action in arid Australia. Online vignette for the textbook Key Concepts in Geomorphology, Bierman, P and Montgomery, D (eds).

Larsen, J.R, Cohen, T.J., Nanson, G.C., Jones, B.G., Jansen, J., and May, J.-H. (2009) Climate change in the dead heart of Australia. Online vignette for the textbook: Key Concepts in Geomorphology, Bierman, P and Montgomery, D (eds).

Invited talks:

Australian Rivers Institute, Griffith University 16/5/2014 “Incorporating carbon quality and transport into the freshwater carbon cycle”

Qld branch of the International Association of Hydrogeologists 12/2/2014 “Improving our understanding of recharge”

University of Queensland, Centre for Coal Seam Gas 12/11/2013 “Improving our understanding of recharge”

University of Queensland, School of GPEM “Carbon quality and the freshwater carbon cycle”. 18/9/2013.

University of Queensland, School of Civil Engineering. 8/9/2012

NSW branch of the International Association of Hydrogeologists 4/4/2012.

Service:

University:

School of GPEM Research committee.

Reviewer of geography course outlines 2013 - 2014.

Honours, Masters, and PhD review panels.

Discipline:

American Geophysical Union technical committee for the unsaturated zone

INQUA early career researcher committee

Journal reviewer for: Nature Science Reports, Water Resources Research, Journal of Hydrology, Frontiers in Earth Science (Hydrosphere), Hydrology and Earth System Science, Hydrological Research, River Research and Applications, Water.

Grant reviews for Australian Research Council.

Grants (including industry projects):

2015 – 2017. Groundwater recharge in the Surat Basin. Santos, QGC, Arrow Energy, Origin

2015 – 2018. Climate and environmental history of SE Queensland dunefields. Australian Research Council Discovery Projects $364,900

2013 – 2014. Development of new capabilities in Earth System monitoring. University of Queensland Major Equipment & Infrastructure. $139,210

2013. A coupled high temperature elemental analyser - gas chromatograph - mass spectrometer for climate, water and ecological research. Australian Research Council Large Infrastructure Equipment Fund. $150,000

2013 – 2014. Recharge estimation in the Surat Basin. Santos, QGC, Arrow energy. $313,928

2013. Facility for advanced characterisation of dissolved organic carbon. University of Queensland Major Equipment & Infrastructure. $ 105,000

2013. Review of the catchment processes relevant to the Great Barrier Reef region. Great Barrier Reef Marine Park Authority. $ 13,473.44

2013. Review of current & potential future industrial & residential development activities in the Baffle Basin of the Burnett Mary Region. Great Barrier Reef Marine Park Authority. $ 13,470.71

2013. Review of current and potential future grazing and water resource use in Central Queensland and identification of opportunities to improve the maintenance and/or restoration of costal ecosystem function. Great Barrier Reef Marine Park Authority $ 13,473.44