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Expert Review
Narrabri Gas Project Environmental Impact Statement and Response to Submissions

I was briefed by EDO NSW acting on behalf of the North West Alliance to provide expert advice relating to the **Narrabri Gas Project Environmental Impact Statement (EIS) and Response to Submissions**. In completing this review I have specifically addressed the following issues in relation to **Groundwater Dependent Ecosystems (GDEs)**:

a) the adequacy of the information provided in the environmental impact assessment and the Response to Submissions
b) what, if any, additional work would be required to complete an adequate assessment of the impacts of the Project on groundwater dependent ecosystems
c) the likely impacts on groundwater dependent ecosystems arising from the Project if approved.

I have based my opinion my review of the following documents:

Environment Impact Statement
a) Table of contents:
b) Executive summary:
c) Chapter 02 Location and setting:
d) Chapter 06 Project description:
e) Chapter 11 Groundwater and geology (sections 11.4.6, 11.5.1 and 11.7):
f) Chapter 16 Aquatic ecology:
g) Appendix F Groundwater impact assessment
h) Appendix T3 Chemical Risk Assessment:

Response to Submissions
a) Executive Summary
b) Table of Contents
c) Response to IESC
d) Response to NSW DPI
e) Response to Forestry Corporation
f) Groundwater Impacts
g) Aquatic Ecology
h) Baseline Data

i) Stygofauna
j) Appendix L Errata

IESC 2017-086: Narrabri Gas Project (EPBC 2014/7376; SSD 6456)

Prior to the preparation of this report I have read Schedule 7 – Expert Witness Code of Conduct of the *Uniform Civil Procedure Rules*. I have prepared this report in accordance with those Rules and agree to be bound by the Expert Witness Code of Conduct in relation to my evidence.

Scope of comments

It is beyond my expertise to comment on the adequacy of the regional groundwater model and subsequent predictions provided in the EIS. I have assumed that the model is correct and accurate, and can reliably predict changes to groundwater level and pressure. However, I do note the concerns of the IESC in regards to the suitability of this model and its ability to reliably determine the magnitude of local-scale impacts which are of relevance to GDEs. If the model is not able to reliably predict groundwater changes then this represents a very significant limitation of the EIS and would warrant a major review of all predictions on which that model is based.

I have limited my comments to matters relating to GDEs as outlined in the EIS, and in subsequent responses to submissions. I have considered the implications of changes in both water quantity (level and pressure) and quality on these ecosystems.

The EIS outlines three GDE types that were assessed (11.4.6). These types are based on were:

- Type 1 GDEs - aquifers and stygofauna ecosystems referring to ecosystems that reside within the spaces of caves and aquifers.

- Type 2 GDEs - ecosystems dependent on the surface expression of groundwater, referring to ecosystems that are connected to groundwater that comes to the earth's surface, within wetlands, lakes, seeps, springs and river baseflow.

- Type 3 GDEs - ecosystems dependent on the sub surface presence of groundwater, referring to ecosystems associated with terrestrial vegetation utilising the water table below the natural surface.

Comments on EIS and RTS
Identification of GDEs

The EIS (P 11-41) states that potential Type 2 and Type 3 GDEs were found in the assessment area but no Type 1 GDEs were identified. The Proponent's omission of the Namoi Alluvium as a Type 1 GDE is acknowledged in the Response to Submissions.

- *Type 1 GDEs*

The statement that "no Type 1 GDEs were identified from the stygofauna assessment" (section 11.1.6) suggests that the EIS fails to recognise that the presence of stygofauna does not define an aquifer ecosystem. The publication by Eamus et al (2006) in which this classification of GDEs was proposed states clearly that "All subterranean waters constitute GDEs, even if the biotic component of the ecosystem is limited to a microbial flora" (p100). Consequently, the EIS should

consider the potential impacts of the proposed activities on GDEs in all aquifers, irrespective of whether or not they contain stygofauna.

The focus on stygofauna as the defining characteristic of Type 1 GDEs ignores the ecological importance of the microbial communities in aquifers. Microbes (Bacteria, Archaea, Fungi) in aquifers play important geochemical roles, particularly in improving groundwater quality by breaking down contaminants, including nitrates. These services are critical to maintaining groundwater quality as fit for purpose, and changes to microbial communities as a result of the proposed development may compromise the ongoing provision of clean water in the aquifers. The risk assessment for Type 1 aquifers should consider the risks to microbial assemblages in the aquifers and their capacity for water quality maintenance.

I agree with statements in the EIS that stygofauna are unlikely to occur in the deeper aquifers and coal seams, although stygofauna have previously been found in coal seams connected to alluvial aquifers (Hose et al 2015). However, I disagree with the conclusion that there are unlikely to be stygofauna in the shallow aquifer. In my opinion, the sampling undertaken to date is insufficient to justify this conclusion. Further sampling of the shallow aquifers for stygofauna is needed.

Fauna are typically heterogeneously distributed and multiple sampling events (over space and time) are needed to adequately describe the stygofauna in an aquifer (e.g. Eberhard et al 2009; Hose & Lategan 2012). Furthermore, the current limited sampling effort is insufficient to establish with any confidence the baseline conditions against which future monitoring data will be compared.

The Proponent does not address risks to the shallow alluvium ecosystems on the basis that any stygofauna will likely be found outside the project area. There is currently no evidence to support this statement either way. Stygofauna frequently have a high degree of endemism at very small spatial scales (e.g. Harvey et al 2002) and further sampling of stygofauna in the Pilliga sandstone, the Bohena Creek alluvium and widely in the Namoi alluvium is needed before this statement can be reliably made.

The Proponent has not included GDEs in the monitoring plan because ‘there is an insignificant risk of impact due to the large degree of physical separation, both vertically in the sub-surface and horizontally at the surface, and therefore lack of connectivity between the target coal seams and GDEs’. Further, the Proponent states in the EIS that baseline data on GDEs is not needed because they will not be monitored.

The current exclusion of GDEs in the Water Monitoring Plan is unacceptable. Monitoring of GDEs is needed because the proposed development may cause changes to GDEs that may not be detected by changes in water quality and quantity. This is particularly important because the sensitivity of the biota in GDEs to environmental changes is poorly known. A comprehensive monitoring program should regularly observe the potential stressors (here water quality and quantity) AND the response in the target system (e.g. GDE condition). The Response to Submissions repeatedly cites that the monitoring program will be “focussed on early detection of a specific and measurable change… in water quantity or quality within water assets…”. Monitoring should also include monitoring condition of the assets (GDEs) to be protected.

- *Type 2 and 3 GDEs*

The Proponent appears to have undertaken a relatively thorough review of likely Type 2 and 3 GDEs in the project area. However, most were excluded based on a further desktop analysis rather than through field truthing and validation studies. Eamus et al (2006) provide a detailed list of potential methods for determining groundwater dependence that can be applied here, and while these have been applied at some sites, a more detailed field-based assessment of potential GDEs is needed. Assessments of groundwater dependence of GDEs have been based on insufficient data and further assessment of these systems is needed.

It is concerning that 8 of 21 (38%) of sites that passed the initial screening and were identified as being potential GDEs were not visited, so there is no confirmation of their dependence or otherwise. This means that the risk assessment does not adequately address risks to GDEs in the project area. It is important that all GDEs are adequately assessed prior to any activity taking place, and to ensure adequate baseline data as a reference for future changes should the project be approved. The current limited assessment does not provide adequate baseline information.

The Proponent determines low ecological value for many Type 2 and 3 GDEs on the basis that they are already degraded (Appendix F). Unfortunately, riverine ecosystems across western NSW, and particularly in the Namoi Catchment are already degraded by agricultural activities such that there are few if any undisturbed aquatic habitats. Consequently, the value of the GDEs should be considered in a regional context.

Water quantity

There is no knowledge of how depressurisation changes the microbial communities in aquifers. There is evidence from marine ecosystems that microbial communities change with hydrostatic pressure (eg Marietou & Bartlett 2014), which suggests that some change is also likely to changes in pressure in aquifers, but the extent and significance, particularly in terms of microbial communities and ecosystem services, are unknown. This may be particularly significant for local landowners if there are changes to pressure (and hence microbial communities) in water supply bores.

The EIS states that impacts to GDEs will be negligible because the predicted drawdown is less than 0.5 m and within the error of the groundwater model. This is not an ecologically-sound argument for negligible impact. The fact that the predicted drawdown may be zero based on the uncertainty in the predictions of the model, it equally may be 0.5 m (or potentially more). The Proponent needs to provide an ecologically-based argument for these changes not impacting the GDEs, one that considers the groundwater regime required by those ecosystems and biota.

The Response to Submissions regarding stygofauna (6.16.4) reiterates the model outputs as the reason why stygofauna will not be affected, but fails to express these values in terms of the aquifer depths and hence the availability of habitat for stygofauna. Here, an ecologically-based explanation of why stygofauna will not be affected by this drawdown is needed.

Water quality

The discharge of produced water to Bohena Creek is planned to occur under high flow conditions. Given the high hydraulic connectivity between the surface waters and the alluvium, it is likely that mixed river and discharge water will enter the alluvial aquifer. The implications of this water entering the aquifer have been dismissed on the basis of the prior assumption of the lack of stygofauna in the shallow alluvium.

In line with comments above about the need to consider microbial processes and more detailed sampling of stygofauna in the shallow aquifers, a risk assessment of impacts of the produced water on these systems is needed. This assessment should consider using biota that are endemic to these systems. If further sampling provides stronger evidence of the absence of stygofauna in the shallow aquifers, the risk assessment should consider the maintenance of microbial communities and ecosystem functions.

Concentrations of Ammonia predicted to occur following dilution of the permeate released to Bohena Creek (6-10 mg/L) (EIS, Appendix T3, Table 6-6) are in the range likely to be acutely toxic to stygofauna (Boutin et al 1995; Di Lorenzo et al 2014; based on ionized ammonium). Consequently, there is a need for a more detailed assessment of the risks associated with the discharge of produced water in Bohena Creek.

In relation to water quality, the Proponent does not address several key points raised by the IESC. These are points 28-31 in IESC (2017) that relate to the risk assessment of produced water released to Bohena Creek.

Yours sincerely

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References

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