

Advice to decision maker on coal mining project

IESC 2017-090: Ironbark No. 1 Project (EPBC 2007/3643) – New Development

Requesting agency	The Australian Government Department of the Environment and Energy
Date of request	1 November 2017
Date request accepted	1 November 2017
Advice stage	Assessment

Summary

The Ironbark No. 1 Project is a new underground coal mine, located approximately 35 km north-east of Moranbah, Queensland. The proposed project will cover an area of 3400 ha and extract approximately 5 million tonnes per year of run-of-mine coal for approximately 20 years.

The proposed project may impact on riparian vegetation, watercourses, downstream water quality, and farm dams. The IESC has suggested additional mitigation measures that will reduce the likely impacts of the project.

The main impacts of this project on water resources will be through subsidence. This will affect the morphology of watercourses and will likely lower the water table, affecting groundwater-dependent ecosystems (GDEs).

The IESC has identified a number of key improvements required in planning for the proposed project. To implement these, the proponent should provide:

- a comprehensive risk assessment for the project;
- baseline ecological and geomorphological information;
- more detail on how impacts on GDEs (e.g. riparian vegetation) will be mitigated; and
- an updated plan to manage impacts to watercourses and farm dams.

The IESC notes that most of the documentation for the project dates from 2012 or earlier. Since 2012, there have been changes to the mine plan and surface infrastructure that are not reflected in the documentation. This hampers assessment of impacts and risks.

Context

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 Energy to provide advice on the Ironbark No. 1 Project in Queensland. This project was previously known as the Ellensfield Coal Project.

This advice draws upon information in the Environmental Impact Statement (EIS) and Environmental Impact Statement Update Report, together with the expert deliberations of the IESC. The presented documentation includes a number of iterations for the proposed project (for example, two versions of the groundwater model), which, despite a linking document, made it difficult for the IESC to clearly determine the scope of the project and hence the potential impacts. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

Key Potential Impacts

- Impacts to riparian vegetation as a result of subsidence and fracturing, including an area of endangered Brigalow ecological community.
- Impacts to riparian vegetation as a GDE from drawdown of the water table.
- Impacts to surface water quality from increased erosion as a result of subsidence.
- Reduced surface water flows.

Response to questions

The IESC's advice, in response to the requesting agency's specific questions is provided below. The responses to questions 1 and 2 are combined due to their complementary nature.

Question 1: Can the Committee comment on whether the information provided in the EIS documentation, including the modelling undertaken, is adequate to identify and assess the potential impacts of the project on surface and groundwater resources? If the information is not sufficient, what additional material would assist in the identification and assessment of impacts to water resources?

Question 2: Can the Committee discuss whether the proponent's assessment of groundwater and surface water provide reasonable estimations of the potential impacts to water resources, their severity and likelihood of occurrence? Are any other impacts likely?

1. The proponent acknowledges that watercourses and farm dams may be affected by subsidence. The IESC additionally considers that riparian vegetation is likely to be affected by subsidence. The IESC notes that some of this vegetation is the Brigalow ecological community, which is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This community also occurs in non-riparian areas in the project area, where it may also experience adverse effects from subsidence.
2. A comprehensive risk assessment is needed to ensure that all project risks are identified and addressed. This would be particularly valuable in helping to minimise environmental risks when siting infrastructure and in targeting monitoring and adaptive management programs. One such risk assessment framework is the Failure Modes and Effects Analysis (FMEA) method. A

modification of this method has been applied in the Bioregional Assessments program (Australian Government 2017).

3. The information provided in the EIS is generally adequate to identify the types of potential impacts. However, to measure impacts and appropriately target management, mitigation and potential offset measures, additional baseline information is required prior to commencement of mining operations.

Groundwater

4. The main potential impact from this project on groundwater resources is a lowering of the water table in the alluvial aquifer, reducing surface water flows and affecting riparian vegetation. The IESC assumes for impact assessment purposes, unless proven otherwise, that riparian vegetation is dependent on groundwater and that the water table will decline following mining.
5. The proponent characterises the shallow alluvial groundwater system as being disconnected from the underlying regional groundwater system. Although the proponent has installed four shallow monitoring bores, only one of these (EFGW1S) appears to be screened in the alluvium. Monitoring data from one bore is inadequate to justify a conceptualisation of a groundwater system.
6. Additional data on the current depth of groundwater within the alluvium from multiple bores would assist in better understanding the risk the proposed project poses to riparian and other groundwater-dependent vegetation. Additional information, such as hydrochemical data (e.g. environmental tracers) from the alluvium and underlying aquifer, would also assist in characterising the system. Monitoring of the change in groundwater heads after mining commences would then confirm the level of hydrological impact to the alluvium. This would require installation of additional monitoring bores in the alluvium.
7. The model and associated data appears to have been designed for operational requirements, but its use for environmental assessment, requires additional conceptualisation and data, particularly to estimate the impact on riparian vegetation. The existing groundwater model does not include the alluvium as a layer.
8. Data from piezometers screened in each aquifer across the site is required to support the model's development. Additional pump tests are required that are designed appropriately to evaluate connectivity with the alluvium and characterise hydraulic parameters. It was acknowledged in the groundwater reports that the 39 open boreholes used for calibration of modelling were influenced by groundwater levels in multiple aquifers. Additional site-specific information (i.e. recharge, hydraulic conductivity and storativity) needs to be obtained to support development of a fit-for-purpose model.
9. Subsidence-induced surface fracturing is likely to affect water levels in the alluvium. Surface fracturing and, where it occurs, connective fracturing could allow shallow groundwater to travel down into the underlying strata. Fracturing above longwall panels will also alter the hydraulic parameters of the strata, which should be included in the modelling.
 - a. There would be greater confidence in the proponent's predictions if more recent understanding for this part of the Basin was used to verify empirically based predictions. Data from the Carborough Downs mine to the south of this project may assist with this. The assessment of fracturing (EIS Update Report, App. G) makes use of methods outlined in a 2003 paper published by the Australian Coal Industry's Research Program (Ditton and Frith 2003). The fracturing and subsidence predictions date from 2012. Since 2003, some advances have been made in predictive capacity. These provide some guidance to improving predictions and in understanding the limitations of predictions. The proponent's assessment

would be improved by adoption of methods to integrate geomechanical and hydrogeological approaches (e.g. David et al. 2017) and incorporate these in impact predictions. Adhikary, Poulsen and Khanal (2017) report use of the particle-based distinct-element method to better model connective fracturing. Recent work (e.g. Galvin 2017) has highlighted that even in areas where the geology is relatively well characterised, there can be substantial uncertainty in predictions.

- b. Subsidence will also affect groundwater quantity both through surface fracturing and, in areas of shallow cover, potentially through tortuous but potentially connected flow paths to longwall goafs. The effects of this on groundwater have not been modelled.

Surface Water

10. Subsidence will affect watercourses through changes to stream morphology. This will increase the potential for further erosion and turbidity in watercourses where these are already a problem. Surface runoff may be affected by ponding in the catchment above longwall panels, potentially altering stream flows from reduced local runoff.
11. Predictions about subsidence and fracturing are therefore central to understanding the potential magnitude and extent of impacts to surface water. Surface fracturing will allow some water to drain from the watercourses. To the extent that water levels in the alluvium are reduced, surface water will also more readily drain into the groundwater system. This may further reduce the persistence and volume of stream flow. As discussed above, there is uncertainty in the magnitude and effect that subsidence is likely to have on groundwater behaviour in the alluvial system.
12. The flood modelling is suitable for impact assessment, as long as it is acknowledged that there is the potential for impacts to be greater than those predicted.

Water-dependent Ecosystems

13. The proponent does not identify any GDEs, despite identifying substantial areas of riparian vegetation and endangered and 'of concern' vegetation communities (see Additional Information 2017, Figure 7). The proponent also notes that there is 'relatively high floral diversity' on the site (EIS, p. 14-17). The ephemeral nature of watercourses in this area means that it is likely that much of the riparian vegetation has some degree of groundwater dependence.
14. The proponent specifically argues that Brigalow (*Acacia harpophylla*) is not groundwater-dependent, based on the rooting depth of the species and depth to groundwater across the site. The Brigalow ecological community is listed as endangered under the EPBC Act. The very limited groundwater level dataset does indicate groundwater levels within 4 m of the surface near areas where 'of concern' vegetation communities occur. Shallow groundwater levels are therefore likely to occur in other areas across the project site. Where Brigalow occurs in areas with shallow groundwater, it is likely to be a facultative groundwater user. One area mapped as the Brigalow community is close to Spade Creek and another to Alpha Creek. There is another patch of the community mapped as adjoining Alpha Creek (see EIS, Fig 14.1.2, p. 14-10). Consequently, it is possible that shallow groundwater in areas distant from the creek could support groundwater-dependent vegetation. The paucity of groundwater data does not allow this to be tested.
15. There may be effects of ponding induced by subsidence on the Brigalow community and other vegetation.
16. The IESC notes that areas mapped as Brigalow regrowth in the original EIS (Figure 14.1.2, p. 14-10) are not included in the most recent mapping of the ecological community (Additional Information, Figure 7, p. 51). It is unclear whether these areas of regrowth conform to the definition of the ecological community under the EPBC Act.

17. Areas of native vegetation belonging to ecological communities 'of concern' are mapped along Spade Creek and Alpha Creek, including above proposed longwall panels (Additional Information, Figure 7, p. 51). The IESC considers that these may be at risk from subsidence, and adaptive management may be required. Mitigation measures are discussed in response to question 3.
18. Riparian vegetation may be affected by the proposed development both directly and indirectly. The indirect impacts of subsidence on shallow alluvial groundwater levels are potentially the most significant. As discussed above, the extent to which surface fracturing will decrease water levels in the alluvium is difficult to determine, given the available information. Subsidence is also predicted to reduce the stability of sections of the creeks. If not remediated successfully, the resulting bank erosion will remove some riparian vegetation. Subsidence may directly affect vegetation through surface fracturing that shears or exposes roots (EIS Update Report, Subsidence Management Plan, p. 55). These direct impacts would be highly localised and are unlikely to result in extensive vegetation dieback but still constitute an impact on the plant communities. The IESC notes that vegetation that is located away from areas of alluvium will also experience the effects of subsidence. This includes some of the area of EPBC-listed Brigalow ecological community.
19. Given the nature of the hydrogeology, the IESC agrees with the proponent's assessment that groundwater drawdown in regional Permian aquifers (as distinct from impacts on the potentially perched alluvial aquifers) is unlikely to affect groundwater-dependent ecosystems.
20. The proponent assessed stream health by plotting SIGNAL-2 scores (Chessman, 2003) against family richness of the aquatic macroinvertebrates sampled from five sites. This was supplemented with counts of families in the *Plecoptera* (stoneflies), *Ephemeroptera* (mayflies), and *Trichoptera* (caddisflies) because these taxa are particularly sensitive to disturbance. The results indicated 'severely degraded' conditions (EIS, App. L), interpreted as reflecting the high turbidity and potentially high nutrient levels. However, the proponent's consultant admits that these results can occur in non-impacted ephemeral streams in the area where high turbidity and other harsh environmental conditions occur naturally. Chessman et al. (2010) point out that macroinvertebrate-based methods for assessing the condition of Australian dryland rivers are inadequate, and might be improved with (i) reference data that accounts for antecedent hydrological conditions, (ii) consideration of long-term taxonomic richness, (iii) evaluation of invertebrate population sizes, (iv) analysis of assemblage data by trait composition and (v) using genus as the default level of taxonomic resolution. These improvements should be considered in subsequent monitoring of stream health in the project area (see response to question 3).

Question 3: Can the Committee comment on whether the proposed monitoring, mitigation and management measures proposed in the EIS and all subsequent documentation is adequate to identify, avoid or reduce the likelihood and extent of impacts to water resources? If not, what additional measures would be needed to monitor, mitigate and manage impacts to water resources?

Groundwater

21. If a decline in alluvial groundwater levels is to be used as a management trigger, the IESC suggests a trigger-action-response approach. Based on at least two years of baseline data, trigger levels for groundwater decline and impacts to riparian vegetation could be defined. Collection of suitable baseline data would require installation of a series of bores screened in the alluvium, including in close proximity to threatened ecological communities, and at control sites, to collect water level data over a period of two years prior to impacts occurring. The monitoring network would need to be spaced densely enough that it could be used to identify the different responses in the alluvium to subsidence at different depths of overburden cover.

22. The proponent's own assessment suggest that groundwater monitoring should be undertaken in areas where connective fracturing is predicted (EIS, App. H, p. 43). If a perched aquifer is present in this area, it is in this location that the greatest impact to the water table would be expected.

Surface Water

23. A holistic approach should be taken to management of subsidence, erosion and consequent turbidity in streams on site. This should be done under an adaptive management framework, taking account of local conditions. Some sections of creeks are already subject to channel and bank erosion, while other stretches are in good condition. Hard engineering approaches such as armouring should only be considered in creek sections that are in poorest condition. Remediation through natural readjustment, revegetation and soft engineering measures, such as geofabrics, should be prioritised. Bank revegetation in advance of mining would improve the stability of the watercourse and may reduce the need for subsequent engineered structures or earthworks. The IESC recommends that the following measures be undertaken to monitor and manage impacts from subsidence. While the proponent commits (Additional Information, p. 7) to regrading only as a 'last resort', the IESC considers regrading to be an inappropriate and ineffective remediation measure in the sandy streams in this area.
- a. Monitoring should be undertaken to measure the temporal changes in stream geomorphology and hydrology in response to subsidence. If impacts are different to those predicted, mitigation plans should be revised accordingly. Monitoring should also be continued to ensure that the erosion control measures are effective. If not, additional measures should be implemented.
 - b. Monitoring bed profiles (both cross-stream and longitudinal) should be repeated to determine whether, and in what locations, active erosion is occurring, and whether the bed is stabilising over time.
 - c. The subsidence management plan should be updated to clearly set out the monitoring and mitigation measures that will be implemented. This should include monitoring, with triggers for a hierarchy of management responses.
24. The proponent also notes that LW207 will result in the Australian Coal Industry's Research Program guideline limits being exceeded at one location for the 1:50 AEP event. The proponent does not appear to propose any mitigation of this. The IESC suggests strategies to optimise erosion resilience should be considered.
25. The proponent states that farm dams could be remediated following mining by excavating and re-establishing the base of dams. Details of how to determine which dams have been affected by subsidence and require remediation should be included in management plans. These plans should also include the protocol for remediation and verification of successful remediation.

Water-dependent Ecosystems

26. The proponent could consider alternative mining methods below areas of vegetation with high conservation significance, such as the threatened Brigalow community or high-value riparian corridors.
27. One of the potential impacts from subsidence is through bank and channel bed erosion leading to greater channel instability, turbidity and impacts on aquatic ecosystems. This can be mitigated through appropriate restoration of the watercourses (see discussion above). If aquatic macroinvertebrate sampling is to be used to assess the effectiveness of this mitigation on stream health, the recommendations by Chessman et al. (2010) in paragraph 20 should be considered.

28. A decline in vegetation community resilience through stress induced by a lowered water table and potentially (in some locations) by root shear or uplift may require additional management. To mitigate this impact, the IESC suggests that measures to increase ecosystem resilience are considered. These could include, but are not limited to:
- fencing riparian vegetation (if this has not already been undertaken);
 - controlling invasive species; and
 - supplementary planting of local native species that are not dependent on groundwater.

It is recommended that these measures be initiated prior to impacts occurring, so that alluvial, riparian and in-channel ecosystems have greater resilience to the stresses placed on them by subsidence.

29. The mitigation strategy should be informed by further investigation of the composition and distribution of groundwater-dependent vegetation in the project area. Examination of satellite or aerial imagery (e.g. Eamus et al. 2015) may help to identify areas that are at greatest risk from groundwater drawdown.

Question 4: Can the Committee provide discussion on whether the assessment gives adequate consideration of the project's contribution to cumulative impacts associated with other mining activities and coal seam gas production in the area?

30. In conjunction with other mines in the region, this project will contribute to a regional depressurisation of these aquifers, particularly the Permian coal seams. The proponent has not discussed potential cumulative impacts.
31. The large number of mining proposals in this region will result in substantial clearing and other impacts to native groundwater-dependent vegetation. This will include impacts to areas of the EPBC-listed Brigalow threatened ecological community. This project will contribute to impacts on native vegetation, mostly through physical processes and lowering of alluvial groundwater levels. Through cumulative impacts from development in this area may cause remnant ecological communities to become scarcer.
32. The potential impacts on downstream surface water quality from this project will affect, cumulatively with other regional activities, water quality in the Fitzroy catchment. Mitigation measures to reduce turbidity and sedimentation issues are discussed in response to question 3. The Fitzroy River is a significant contributor of suspended sediment to the Great Barrier Reef. Erosion on site should be managed so that downstream sediment loads are not increased as a result of the project.

Date of advice	15 December 2017
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Source documentation available to the IESC in the formulation of this advice	<p>Additional Information 2012 <i>Ironbark No. 1 Coal Project: Additional information for the Department of Environment and Energy</i>, Report prepared by Hansen Bailey on behalf of Fitzroy Australia Resources Pty Ltd, 24 October 2017</p> <p>EIS Update Report: <i>Ellensfield Coal Mine Project EIS Update</i>, Report prepared by URS on behalf of Vale Australia Pty Ltd, 7 September 2012</p> <p>Environmental Impact Statement 2009: <i>Ellensfield Coal Mine Project Environment Impact Statement</i>, Report prepared by URS on behalf of Vale Australia Pty Ltd</p>
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**References
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IESC's advice**

- Adhikary A, Poulsen B and Khanal M 2017. *Assessment of longwall mining induced connective fracturing of overburden strata*, ACARP Report C24020, CSIRO, Australia.
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