

## Advice to decision maker on coal mining project

### IESC 2014-055: South Galilee Coal Project (EPBC 2010-5496, CGMF 188) – New Development

<b>Requesting agency</b>	The Australian Government Department of the Environment The Queensland Office of the Coordinator-General
<b>Date of request</b>	08 July 2014
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<b>Advice stage</b>	Assessment

#### 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 the Queensland Office of the Coordinator-General to provide advice on the Alpha Coal Management (a joint venture of AMCI and Bandanna Energy) South Galilee Coal Project (SGCP) in Queensland.

The Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (IIESC) provided advice on the Environmental Impact Statement (EIS) for the SGCP in 2012. Since then, the proponent has revised the mine plan and produced an Additional Environmental Impact Statement (AEIS). Revision of the mine plan has reduced the likely impacts to surface water resources, as stream diversions are not proposed and defined watercourses will not be undermined. However, the AEIS does not address IIESC advice on the need for: peer review of the groundwater model; assessment of risks to water related assets; and a regional monitoring programme.

This advice draws upon aspects of information in the EIS and AEIS, together with the IIESC advice (IIESC, 2012) and the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The SGCP is located within the Galilee Basin, 12 km south-west of the town of Alpha in the southern Burdekin Valley in central Queensland. An open-cut and underground coal mining operation is proposed, extracting up to 21 million tonnes per annum of run of mine coal from the D1 and D2 coal seams, with an estimated operating life of 33 years. The proposed project area covers approximately 310 km<sup>2</sup> and lies approximately 350 km upstream of the Burdekin Falls Dam and 510 km upstream of the Burdekin River mouth. The SGCP is the smallest and southern-most of a series of planned coal mines in the region, including Waratah's China First (Galilee Coal) Project and GVK Hancock's Alpha Coal and Kevin's Corner projects. Key water related assets within proximity of the SGCP area include: water supply bores for Alpha town; the Clematis Sandstone, a recharge bed of the Great Artesian Basin (GAB); GAB springs to the west of the model domain; and potential groundwater dependent ecosystems (GDEs).

### Key potential impacts

The key potential impacts of the SGCP on surface and groundwater resources are: drawdown and depleted groundwater flow in the Clematis Sandstone, with the potential for impacts on GAB recharge and springs; uncontrolled releases of water from the site into the environment; and increased connectivity between coal seams and overlying hydrostratigraphic units, plus increased sediment transport to Tallarenha Creek, as a result of subsidence.

### Assessment against information guidelines

The IESC, in line with its Information Guidelines (IESC, 2014), has considered whether the project assessment documentation has used the following:

#### *Relevant data and information: key conclusions*

The proponent has revised and recalibrated its numerical groundwater model using recent groundwater level data. However, the AEIS lacks: information on groundwater levels and flows in the Clematis Sandstone; field assessment of the groundwater dependency of terrestrial and aquatic ecosystems; and water quality and flow/level data to characterise the existing condition of surface and groundwater resources.

#### *Application of appropriate methodologies: key conclusions*

The proponent has developed an 8 layer numerical groundwater model which simulates cumulative impacts from nearby mining operations. To better understand potential impacts to the GAB, the proponent's groundwater model should include: further separation of aquifer and aquitard units; multiple estimates of recharge values from a range of techniques; a water balance for layer 2; robust uncertainty and sensitivity analyses; and an independent peer review.

#### *Reasonable values and parameters in calculation: key conclusions*

To improve confidence in groundwater impact predictions, justification is needed for the proponent's adopted hydraulic parameters for layers 1-4, boundary conditions, and simulation of subsidence in the revised groundwater model. Parameters used to estimate flow depletion along Tallarenha Creek should be specified and updated for the revised mine plan to improve confidence in surface water impact predictions. Justification for runoff rates and sensitivity/uncertainty analyses are needed to reduce uncertainty in the site water balance.

### **Advice**

The IESC's advice in response to the requesting agencies specific questions is provided below.

Question 1: Is the groundwater model adequate to assess the potential impacts on groundwater, interactions with surface water, water resources and water dependent assets (including listed threatened species and communities and groundwater dependent ecosystems) and users of that surface water and groundwater, specifically:

a. Does the Committee agree with the proponent's interpretation of the conceptual groundwater model and its appropriateness to the risks of the project? If not, please specify an alternative interpretation of the conceptual groundwater model?

b. Did the EIS and Additional Information (AEIS) satisfactorily identify the key uncertainties and risks around outputs of the groundwater modelling in relation to impacts on water resources? Is the IESC satisfied that the model parameterisation and construction were reliable and that the range of uncertainty in predictions is appropriately quantified and addressed?

## Response

1. The groundwater model allows for the prediction of impacts to groundwater, surface water and water related assets. However more comprehensive sensitivity/uncertainty analyses, including model construction, adopted boundary and discharge conditions, hydraulic parameterisation, and recharge rates, would allow for better quantification of the likely range of outcomes.
  - a. The conceptual groundwater model is appropriate but its translation to a numerical model needs improvement, particularly regarding the separation of aquifers and confining units in layer 2.
  - b. The uncertainties in groundwater modelling, such as the recharge rates and hydraulic parameterisation, are not adequately identified nor addressed in the project assessment documentation.

## Explanation

### *Numerical Groundwater Model Layers*

2. The proponent's conceptual model is appropriate but the numerical groundwater model layers, particularly layer 2, do not adequately represent the hydrogeological units described in the conceptual model.
  - a. In the groundwater model developed for the EIS Triassic to Permian strata were combined into a single model layer, layer 2. This layer included a regional aquifer (Clematis Sandstone), confining beds or aquitards (Moolayember Formation, Rewan Formation and Dunda Beds) and another low-hydraulic conductivity unit (Bandanna Formation).
  - b. In the revised model, this layer has been split, with the Clematis Sandstone and Moolayember Formation now represented by layer 2 and the Rewan-Dunda confining units and Bandanna Formation by layer 3. The 20:80 split between these layers conflicts with the increase in the thickness of Clematis Sandstone compared to the combined thickness of the layers towards the west of the model domain.
3. As the hydraulic conductivity for the Clematis Sandstone is considerably larger than that of the Moolayember Formation, Rewan Formation or Dunda Beds, the revised model construction is likely to underestimate drawdown in the Clematis Sandstone. Further evidence is needed to validate both the 20:80 split between layers 2 and 3 and the maintenance of the Moolayember Formation in the same layer as the Clematis Sandstone; or the geometry of layer 2 should be revised.

### *Boundary Conditions*

4. The values adopted for general head boundary (GHB) conditions used in parts of the model are not specified. Of particular concern is the adoption of GHB conditions that are identical for any depth at a given location. These conditions have the potential to overestimate horizontal groundwater flow and underestimate vertical groundwater flow.
5. The ephemeral Native Companion Creek was adopted as the eastern boundary for the numerical model. The creek is unlikely to act as a barrier to groundwater flow, particularly for deeper layers.
6. To address the uncertainties regarding boundary conditions, justification for current conditions needs to be provided and a sensitivity analysis undertaken. A range of boundary conditions (including no flow, constant head or general head boundaries, and river cells) should be trialled and the resulting model performance (drawdowns and water balances) analysed.

### *Discharge*

7. The numerical model allows for the interaction between groundwater and surface water. However, the proponent's water balance shows no impact to streamflow across the model domain as a result of groundwater drawdown from the SGCP. Further consideration should be given to the finer-scale temporal and spatial variation in surface water-groundwater interaction in the ephemeral streams, particularly along Alpha Creek (see paragraph 48).
8. In the limited areas where the water table is modelled within 10 metres of the ground surface, groundwater is discharged from the model through evapotranspiration. This evapotranspiration is a considerable part of the outflows from the numerical model. No justification for the 10 metre value (known as the extinction depth) was provided. Further justification and sensitivity/uncertainty analysis for the adopted extinction depth is needed.

### *Hydraulic Parameterisation*

9. The adopted hydraulic conductivities for layer 2 are considerably lower than those adopted by URS for the nearby Alpha (2012a) and Kevin's Corner (2012b) projects. Using lower hydraulic conductivities underestimates the rate of groundwater inflow to the pit and underground mine.
10. The specific yields for layers 1 and 2 in the calibrated model are up to an order of magnitude less than specific yields typically used for alluvial or sandstone formations (see Freeze and Cherry, 1979, p.37; Kruseman and DeRiddler, 1994, p.24; Fetter, 1988). This is likely to overestimate the rate, and depth, of drawdown near the mine and underestimate the lateral extent of drawdown away from the mine including in the vicinity of the GAB recharge beds or Alpha town water supply.
11. The adopted anisotropy ratio for the majority of layer 2 is an order of magnitude larger than that adopted by URS (2012b) or that reported in literature (see Freeze and Cherry, 1979, p.32; Todd and Mays, 2005, p.103). The high anisotropy ratio used by the proponent will underestimate the potential for vertical propagation of drawdown.
12. To quantify uncertainty, the groundwater model should use a wide range of plausible values for all hydraulic parameters (see paragraph 17).

### *Recharge*

13. Rainfall recharge was estimated using a chloride mass balance and represented in the model using a spatially-variable effective percentage of recorded annual rainfall. This approach does not reflect the episodic nature of recharge. Further, the recharge values are lower than expected, particularly as shallow rooted vegetation (the SGCP is referred to as predominantly cleared farmland) would increase the potential for recharge (see Petheram *et al.*, 2000).
14. Recharge estimates would be improved by:
  - a. Using several methods to assess a range of recharge values (refer Petheram *et al.*, 2000 and Kellett *et al.*, 2003);
  - b. Quantifying uncertainty in recharge estimates; and
  - c. Extending the sensitivity analysis to allow for the simultaneous analysis of recharge and hydraulic parameters, as described in paragraph 17.

### *Uncertainty/Sensitivity*

15. Stresses during mining differ considerably from those used for calibration, which creates significant uncertainty in the model.

16. The model uses low and fixed values for recharge, as well as low hydraulic conductivity and specific yield. Taken together, these features are likely to underestimate groundwater flow and storage within the model. In particular, the model may underestimate the impact of the SGCP on flow depletion in the Clematis Sandstone and other GAB groundwater resources, including springs.
17. Groundwater model sensitivity analyses should be undertaken by establishing a range of values for each parameter, forming scenarios using combinations of randomly chosen values and comparing model outputs. Monte-Carlo and other probability-based approaches can be applied to identify and quantify predictive uncertainty.

Question 2: Did the EIS and AEIS provided by the proponent satisfactorily identify the key uncertainties and risks around outputs of the subsidence modelling in relation to impacts on water resources? Is the IESC satisfied that the model parameterisation and construction were reliable and that the range of uncertainty in predictions is appropriately quantified and addressed?

- a. The proponent has concluded that there is a low risk of direct hydraulic connectivity between the surface and the coal seam as a result of subsidence. Does the Committee agree with this conclusion?
- b. Does the Committee agree that the revised underground footprint does not impact the flow patterns within Tallarenha Creek from subsidence?

Response

18. Uncertainty exists in relation to outputs from subsidence modelling, which has not been addressed by the proponent when modelling impacts to water resources. The AEIS does not specify the parameters used to simulate subsidence-induced fracturing in the revised groundwater model, nor does it quantify potential reductions in surface water flow as a result of subsidence. As such, there is low confidence in the predicted impacts to water resources as a result of subsidence.
  - a. Given the lack of data provided on the geotechnical properties of overburden, it is difficult to determine the risk of direct hydraulic connectivity between the surface and the coal seam as a result of subsidence. However, the relatively shallow depth of the coal seams suggests that there is the potential for a direct connection. Further monitoring is needed to inform the assessment of this risk.
  - b. No. Under the revised SGCP layout there is the potential for reduction in streamflow to Tallarenha Creek as a result of subsidence impacts to its tributaries.

Explanation

*Uncertainty in subsidence predictions*

19. Subsidence at the surface as a result of longwall mining has been estimated by the proponent at a maximum of 5.04 metres. However, subsidence estimations are uncertain as they are based on a previous mine plan and apply relationships found in the Bowen Basin.

*Simulation of subsidence in the groundwater model*

20. The numerical groundwater model developed for the EIS used increased hydraulic conductivities post-mining to simulate fracture zone effects above the SGCP longwall mining areas. However:
  - a. Inadequate justification was provided for the enhanced hydraulic conductivities used to represent fracturing, caving or backfilling above the goaf.

- b. The subsidence modelling is not described in the AEIS. Due to the changes in model construction (e.g. splitting layers 2 and 3) there is some uncertainty as to the approach taken to represent fracture zone effects in the revised groundwater model.
21. The proponent should clarify and provide further justification for the parameterisation of subsidence-induced fracturing in the revised groundwater model.
  22. Direct measurement of borehole deformation and fracturing, as well as monitoring of changes to aquifer properties and enhanced vertical permeability, would provide data regarding actual flow rates through the sub-surface fracture network. This information would allow for improved assessment and adaptive management of the risk to groundwater resources and changes to surface water-groundwater connectivity as a result of subsidence.

*Subsidence impacts on surface flows*

23. Subsidence is expected to result in a series of long pools on tributaries in the upper Tallarenha Creek catchment. Should the anticipated subsidence occur this would result in: reduced flow to Tallarenha Creek; erosion and increased sediment export to Tallarenha Creek; a reduction in floodplain inundation and connectivity to downstream ecosystems; and the potential for displacement of arid adapted species by generalists/pest species due to the more regular availability of water in the landscape.
24. The proponent should provide a detailed monitoring plan stating the number, depth and location of the proposed monitoring sites in the shallow fractured zones, including some in proximity to surface drainage lines. Management strategies for subsidence are addressed in paragraphs 42 and 43.

Question 3: Is the Committee satisfied that there is sufficient information in the water balance model and that it has been appropriately applied to represent impacts of surface water losses as a result of open cut voids and losses through subsidence?

Response

25. No. The key concerns with the information in and application of the site water balance model are:
  - a. Values used in the site water balance model have the potential to underestimate groundwater inflows and surface runoff. The uncertainty in these values is not addressed by the proponent and sensitivity analyses were limited;
  - b. The design of the water management system is uncertain with very large storages, unspecified water supply for the site, and conflicting or missing information relating to mine water releases; and
  - c. Insufficient information was provided on surface water losses as a result of open cut voids and subsidence under the revised mine layout.

Explanation

*Site water balance*

26. Site water balance calculations may underestimate groundwater inflows due to significant uncertainties in groundwater modelling (see paragraphs 15-17) and could also underestimate surface water runoff (long-term runoff coefficients for the hardstand and open cut areas, in particular, appear to be low). The site water balance sensitivity analysis should be extended to address these issues and the water management strategy revised to include contingency provisions for variations in the actual volumes of water to be managed.

### *Water management system design*

27. The proposed mine water management system relies on the use of very large storages for potentially mine-affected water ('saline water'). The proponent suggests that alternative approaches to water management need to be considered, but has not provided any further information. The viability of, and environmental consequences associated with, these alternatives should be investigated and the final system design confirmed.
28. The site water balance model shows that an external water source will be required from year one, but the source of the raw water supply is not described. Further description of the external water supply source, including its quality, ability to meet demand and storage should be provided.
29. The location of proposed release points, release rules (quality, flow and timing) and the monitoring regime should be revised to reflect the design of the water management system. This should include: releases from both waste rock runoff ('dirty') water dams; spills from the saline water system; and overflows from the dirty water system.
30. In order to assess potential impacts to water resources including water related assets, the Environmental Management Plan (EMP) should provide a description of the range of water discharges expected to occur to each creek system from the SGCP. The proposed releases should be compared to the existing regime, with appropriate thresholds adopted based on discharge volumes, timing and existing water quality.

### *Surface water losses*

31. The predicted reduction in streamflow as a result of the SGCP has not been updated in the AEIS. Whilst the impact on stream yields for Dead Horse Creek and Sapling Creek would be minimal under the revised mine layout, a reduction in yield is still likely for Tallarenha Creek due to subsidence-induced ponding and surface cracking in its contributing catchment. The proponent should provide details of the streamflow assessment methodology and review the potential impacts under the revised mine plan for a range of flow statistics (including median annual flow and any changes in seasonal patterns, or variations in impact in wet or dry years).

Question 4: Are there additional measures and commitments beyond those set out in the EIS and AEIS required to mitigate and manage impacts to water dependent assets including ecological and human users of water?
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### Response

32. The selection of mitigation and management measures for water related assets needs to be informed by further identification of assets, monitoring, and assessment of potential impacts to those assets from the SGCP. Additional measures or commitments are needed to address uncertainties in relation to:
  - a. Groundwater monitoring (see also paragraph 57);
  - b. Revision of the groundwater model;
  - c. Cumulative impacts;
  - d. Subsidence management (see also paragraphs 22 and 24); and
  - e. Water related assets (including GDEs and the Alpha town water supply).

## Explanation

### *Groundwater monitoring*

33. The proponent should provide a comprehensive groundwater monitoring and management plan (GMMP) that is informed by the results of a groundwater model sensitivity analysis (see paragraph 17) and systematic assessment of GDEs (see paragraph 49). The GMMP should include maps for each hydrogeological unit, which identify monitoring sites, highlight nested sites and display predicted cumulative drawdown. The GMMP should specify proposed monitoring site coordinates, proposed depths, monitoring parameters and frequency.
34. Given the uncertainty in groundwater modelling, specific measures to monitor effects on the GAB should be included in the GMMP, including clarification of how many monitoring bores will be established in the Clematis Sandstone, and their location. Consideration should be given to monitoring against an absolute cumulative drawdown limit for the Clematis Sandstone, with appropriate monitoring locations, potential early warning triggers, and subsequent management responses defined.
35. Commitments for groundwater and surface water monitoring should be consistent with the National Water Quality Management Strategy.

### *Revision of the groundwater model*

36. The proponent states that “if monitoring and evaluation shows that the predicted drawdown impacts differ from actual impacts by 20%; this should trigger review and recalibration of the numerical groundwater model to the measured data, and preparation of appropriate reports”. The IESC notes that:
  - a. Recalibrating a model will not protect water related assets from drawdown; and
  - b. An eight layer model with many hydraulic zones can easily be modified locally, but such modification will not reduce the uncertainty associated with subsequent predictions.
37. As a minimum, a more sensitive trigger value for review of the groundwater model should be established. Review of the groundwater model is also recommended on a regular basis (every three years) to incorporate additional monitoring information. Revisions to the groundwater model should be independently peer reviewed and the GMMP updated accordingly, including additional mitigation measures to protect water resources.

### *Cumulative impacts*

38. The proponent has modelled cumulative impacts to groundwater from the SGCP together with the Alpha, Kevin’s Corner and Galilee Coal projects, which shows a much greater magnitude and drawdown extent than for the SGCP project alone, with SGCP impacts relatively minor in comparison to the effect of the other projects.
39. Assessment of cumulative impacts would be strengthened by consideration of impacts to groundwater quality; groundwater-surface water interactions; GDEs; physical disruption to aquifers; surface water; aquatic ecosystems; and access to water resources by other water users.
40. Specific measures to monitor cumulative effects should be included by synchronising the SGCP monitoring programme with that of other mines. Modifications or alternatives to minimise, mitigate or avoid potential cumulative impacts should also be considered, including combining management elements of the SGCP, such as shared water supply or water transfer schemes, with those of nearby mines.



41. The Lake Eyre Basin, which includes the Galilee subregion, has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposed project should be made accessible to this Bioregional Assessment to assist the knowledge base for regional scale assessments.

#### *Subsidence management*

42. The project assessment documentation does not articulate management strategies that would effectively address impacts on surface water resources or ecological assets as a result of subsidence. The proponent has indicated that connectivity with the natural watercourse downstream would be achieved through the excavation of connecting channels along the flow path of Tallarenha Creek tributaries. Further justification is needed to explain how this strategy addresses:
  - a. The progressive nature of subsidence through the life of the mine operation;
  - b. The loss of the natural flow regime and connectivity (important for distribution and processing of organic matter and movement of aquatic biota);
  - c. The potential for upstream migration of an erosion head in response to steepening of the effective stream slope, which would generate additional sediment and extend the zone of impact upstream of the subsidence impact area; and
  - d. The impact that the ponding of water would have on riparian and aquatic flora and fauna.
43. An adaptive management framework should be developed to monitor and address subsidence impacts on downstream environments. Management options should include a sediment trapping system, reducing coal extraction thickness or the use of narrower longwall panels. Triggers for mitigation and management measures need to be provided in order to ensure that risks to surface water resources and aquatic ecosystems are managed.

#### *Water related assets*

44. Some water related assets downstream of the mine site represent refugial habitat, including palustrine habitat which occurs in a lagoon adjacent to Alpha Creek (AC1), and is uncommon habitat within the proposed project area.
45. Water related assets, including water dependent fauna, flora and habitat should be identified. Further information on water related assets needs to be provided in the EMP including: pre-mining condition of water related assets; the water regime required to maintain assets; impacts to the assets from SGCP (changes to flow regimes, water quality, channel morphology, habitat and erosion zones with consideration of seasonal variations and extreme events such as floods); monitoring requirements with measurable thresholds and triggers; and options to minimise, mitigate or avoid impacts.

#### *Alpha town water supply*

46. Further assessment comparing drawdown predictions with bore-specific screen, water level and production details for Alpha town water supply bores is needed to understand the potential for impacts to the Alpha town water supply.

#### *Groundwater dependent ecosystems*

47. No GDEs were identified by the proponent within the SGCP area. However, sampling for stygofauna was limited and field surveys to assess the potential for GDEs have not been conducted, even though there are several vegetation communities present, such as Red Gum (*Eucalyptus camaldulensis*), Coolibah (*Eucalyptus coolabah*), Brigalow (*Acacia harpophylla*) and

Bushhouse Paperbark (*Melaleuca tamariscina*), that have the potential for deep root structures (phreatophytic).

48. The information provided in the project assessment documentation (water table depths, species mapping, references to permanent flows in sections of the creek and the reliance of Alpha town on the alluvium for water supply) suggests the potential for the riparian vegetation along Alpha Creek to be groundwater dependent, at least in part. The assessment of groundwater dependence and any potential impacts as a result of the SGCP should include:
  - a. A detailed riparian survey including the installation of shallow piezometers along Alpha Creek to determine the extent of surface water-groundwater interaction; and
  - b. A finer scale spatial representation of the depth to groundwater and its seasonal variability, along with the location of threatened ecological communities and predicted drawdown contours.
49. A systematic approach to assessment of GDEs is recommended in which:
  - a. The hydrogeological conceptualisation identifies areas of shallow groundwater (less than 20 metres below ground level) and groundwater discharge;
  - b. Vegetation and wetland mapping is overlaid to identify areas of potential GDEs; and
  - c. Techniques from the Australian GDE Toolbox (Richardson *et al.*, 2011) are applied to confirm groundwater use by vegetation and groundwater discharge to surface water bodies.
50. The EMP should incorporate ongoing monitoring and mitigation measures that reflect the water requirements of any identified GDEs, as described for water related assets in paragraph 45.

Question 5: Is the Committee satisfied the project will have a minor impact on the Great Artesian Basin?
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Response

51. No. The proponent has not demonstrated that the SGCP will have a minor impact on the GAB.
  - a. The range of uncertainties associated with the groundwater model predictions are not adequately recognised or addressed by the proponent.
  - b. The groundwater balance demonstrates that the major impacts as a result of SGCP are drawdown and reduced boundary outflow. Whilst reductions in boundary outflow are not specified for individual layers, drawdown impacts are predicted to occur in the Clematis Sandstone, a recharge aquifer for the GAB.
  - c. The assumption that recharge to the GAB will not change as a result of the SGCP needs to be supported by evidence.

Explanation

*Uncertainty*

52. The groundwater model predictions are subject to considerable uncertainty due to: inconsistencies between the conceptual and numerical models (see paragraph 2); lack of justification for adopted boundary conditions (see paragraphs 4-5), discharge conditions (see paragraphs 7-8), hydraulic parameterisation (see paragraphs 9-11) and recharge rates (see paragraph 13); as well as inadequate sensitivity analysis (see paragraph 17). There is particular uncertainty in predicted impacts to the GAB as there are no monitoring bores in the Clematis Sandstone.

### *Drawdown*

53. Predicted cumulative drawdown in layer 2, which includes the Clematis Sandstone, is up to 10 metres, with reducing drawdown stretching to the western model boundary. In the absence of a layer 2-specific water balance, drawdown can be considered as a proxy for flow depletion, so there is the potential for reduced flows to the GAB near the western edge of the model.
54. The predicted drawdown due to the SGCP in layer 2 is up to 3 metres. However, Figure 19 in the AEIS displays drawdown in layer 2 of up to 100 metres, where the formations represented by layer 2 do not exist. One hundred metres exceeds the entire head above, and the thickness of layer 2. This figure is misleading as predicted drawdown contours should only be presented where formations exist.

### *Boundary outflow*

55. The predicted reduction in outflow from the model along its western margin is important as it more than likely represents decreased flow to the GAB. Whilst the proponent states that outflow along the western model boundary is mainly through deeper units that are not connected to the GAB, evidence, such as the groundwater flow from each layer, needs to be provided to support this statement.
56. As no specific water balance is provided for layer 2, no effect can be specified on GAB resources situated outside the model boundaries (including springs). A water balance for layer 2, in particular the Clematis Sandstone, should be provided. An appropriate analysis of the results is needed, including the potential effects on GAB springs to the west of the model domain.

### *Recharge*

57. Spatially distributed recharge to the groundwater model was set up as a set percentage of rainfall (see paragraph 13). The fact that the model results indicate no change in the recharge is the result of carrying through this assumption and should not be used as a conclusion that there will be no impact to recharge to the GAB. The validity of the assumption that GAB recharge is not impacted by the SGCP should be supported by further evidence, including appropriate monitoring of groundwater levels and flows in the Clematis Sandstone.

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<b>Date of advice</b>	14 August 2014
<b>Source documentation available to the IESC in the formulation of this advice</b>	Alpha Coal Management 2012. South Galilee Coal Project Environmental Impact Statement. Available online at <a href="http://www.dsdip.qld.gov.au/assessments-and-approvals/south-galilee-coal-project.html">http://www.dsdip.qld.gov.au/assessments-and-approvals/south-galilee-coal-project.html</a> Alpha Coal Management 2014. South Galilee Coal Project Additional Environmental Impact Statement. Available online at <a href="http://www.dsdip.qld.gov.au/assessments-and-approvals/south-galilee-coal-project.html">http://www.dsdip.qld.gov.au/assessments-and-approvals/south-galilee-coal-project.html</a> IESC 2012. Advice to decision maker on coal mining project, South Galilee Project (EPBC 2010/5496), 29 June 2012.
<b>References cited within the IESC's advice</b>	IESC 2014. Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals. April 2014. Available online at: <a href="http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf">http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf</a> Fetter, C.W. 1988. Applied Hydrogeology. Second Edition, Merrill Publishing Co., Columbus, Ohio, 43216. Freeze, R.A., Cherry, J.A. 1979, Groundwater: Englewood Cliffs, NJ, Prentice-Hall. Kellett J.R., Ransley T.R., Coram J., Jaycock J., Barcaly D.F., McMahon, G.A., Foster

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