Shenhua Watermark Coal Project Advisory Report

10 January 2014

Shenhua Watermark Coal Project Advisory Report© State of New South Wales through the NSW Mining & Petroleum Gateway Panel, 2014.

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Executive Summary

As requested by the Director-General of the Department of Planning & Infrastructure, the Mining & Petroleum Gateway Panel (the Panel) has sought to determine the significance of potential impacts from the Shenhua Watermark Coal Project on Biophysical Strategic Agricultural Land (BSAL) and propose additional mitigation measures where necessary.

The State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007, Section 17, provides the *relevant criteria* for the Panel in assessing a Gateway Application. Whilst this advisory report does not relate to a Gateway Application, the *relevant criteria* provide an appropriate framework for this report. The *relevant criteria* are that the proposed development will not significantly reduce the agricultural productivity of any BSAL, based on a consideration of disturbance, soil physical and chemical characteristics, groundwater, fragmentation of land use and loss of land.

The Panel advises that the groundwater studies for the Project meet industry standards. Accepting the inherent limitations of predictive modelling, the groundwater model presented is an appropriate predictive tool. The Project meets the Level 1 minimal impact considerations, with respect to water levels, in the Aquifer Interference Policy. However, predicted saline water quality in backfilled areas and the final void pit lake is considered by the Panel to be a significant long-term risk to water quality in surrounding creeks and alluvial aquifers. It is reasonably foreseeable that this impact could make these waters unsuitable for agricultural use.

The proponent has applied incorrect methodology and obfuscates the verification of BSAL soils. The Panel notes that early draft versions of the interim protocol for BSAL verification were available for the proponent to use in 2012 but were not used. As a result, significant uncertainty remains as to the extent and location of BSAL soils potentially affected by the Project. This fundamentally hinders the Panel's assessment of the Project's impacts on BSAL.

The Panel concludes that the Project should not proceed until the following has been completed.

1. A 'Project area' for detailed BSAL assessment is defined in accordance with statutory requirements;
2. The interim protocol for BSAL verification by OEH and OASFS (2013), as gazetted on 12 April 2013, is applied across the Project area;
3. Further modelling to justify salinity predictions in the final void pit lake and/or mine plan changes to eliminate the final void;
4. The proponent amends its Project documentation to:
    a. Reflect proper BSAL verification and mapping;
    b. Demonstrate that impacts on BSAL have been avoided or minimised; and,
    c. Clearly show that the Project will not significantly reduce the agricultural productivity of any BSAL, based on a consideration of disturbance, soil physical and chemical characteristics, groundwater, fragmentation of land use and loss of land.
5. The Panel examines the amended Project documentation to determine the significance of the Project's potential impacts on BSAL and provides advice to the Director-General.

The Panel is cognisant that the Project Exploration Licence area adjoins highly productive irrigated cropping land on the Liverpool Plains and requires that any agricultural impact assessment for the Project carefully consider the agricultural resources, systems and enterprises of the surrounding locality.

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1 Contents and Terms of Reference

On 13 November 2013, the Director-General of the Department of Planning & Infrastructure (DP&I) issued a request for advice to the Chairperson of the Mining & Petroleum Gateway Panel (the Panel). This request concerned the potential impacts of the Shenhua Watermark Coal Project on Biophysical Strategic Agricultural Land (BSAL) and the advice sought was specifically as follows.

1. *The significance of the project's potential impacts on BSAL; and,*
2. *Whether any additional reasonable and feasible mitigation measures could be implemented to materially reduce the potential impacts of the project (on) BSAL.*

The Director-General initially requested this advice be provided by 10 December 2013. A subsequent extension of time was granted to 10 January 2014 following a request from the Panel.

1.1 Methods

1.1.1 The Panel

All six members of the Panel considered this request for advice. The members are as follows.

Mr Terry Short, Chairperson
Assoc Prof Brett Whelan
Dr Russell Frith
Dr Ian Lavering
Mr George Gates
Prof Garry Willgoose

1.1.2 Panel Meetings

The Panel has held the following meetings in relation to this request for advice.

- The Panel was briefed by DP&I on 13 November 2013; and,
- The Panel met subsequently on 22 November to discuss the request for advice.

1.1.3 Document review

At the briefing, DP&I provided the Panel with the following documentation (in the order presented).

- iMine, 2013. Shenhua Watermark Coal Project, Preliminary Advice with Regard to Merit Assessment. Advice to NSW Department of Planning & Infrastructure, July 2013.
- Minister for Planning & Infrastructure, 2013. Request to Planning Assessment Commission, Watermark Coal Project, Section 23D of the Environment Planning Assessment Act 1979, Clauses 268R and 268 V of the Environmental Planning and Assessment Regulation 2000, 8 May 2013.
- IESC, 2013. Advice to Decision Maker on Coal Mining Project, Proposed Action: Watermark Coal Project (EPBC 2011/6201) – New Development, Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mine Development to NSW Department of Planning & Infrastructure, 17 April 2013.
- Department of Primary Industries, 2013. Review of the Agricultural Impact Statement prepared by Hansen Bailey for Watermark Coal Project, Comments from Office of

Agricultural Sustainability and Food Security, Comments to NSW Department of Planning & Infrastructure, 21 April 2013.

- Department of Primary Industries, 2013. Watermark Coal Project (SSD 4975) Response to Exhibition of Environmental Impact Statement (EIS), Comments from Fisheries, NSW, NSW Office of Water, Crown Lands, Office of Agricultural Sustainability and Food Security, and Forests Corporation NSW to Department of Planning & Infrastructure, 23 May 2013.
- Cotton Australia, 2013. RE: Watermark Coal Project Environmental Impact Statement. Comments to NSW Department of Planning & Infrastructure, 10 May 2013.
- NSW Farmers Association Gunnedah District Council, 2013. RE: SSD-4975, Watermark Coal Project. Comments to NSW Department of Planning & Infrastructure (26 April 2013) and Submission to NSW Department of Planning & Infrastructure on Watermark Coal Project Environmental Impact Statement Agricultural Impact Statement, May 2013.
- Economists at Large, 2013. Review of Watermark Coal Project Environmental Impact Statement Economic Impact Assessment, a report for the Caroona Coal Action Group, April 2013.
- Hansen Bailey, 2013. Watermark Coal Project, Environmental Impact Statement, Volumes I-II, Appendices A-Z, February 2013.
- Hansen Bailey, 2013. Watermark Coal Project, Response to Submissions, Main Report and Appendices A-E, November 2013.
- Earth Systems, 2013. Independent Review of the Environmental Impact Statement for the Watermark Project prepared for the Caroona Coal Action group by Earth Systems, May 2013.
- Caroona Coal Action Group, 2013. Comments to the NSW Department of Planning & Infrastructure, 10 May 2013.
- Shenhua Watermark Coal Pty Limited, 2013. Watermark Project, Gateway Panel Site Visit – November 2013. Printed material provided 15 November 2013 to illustrate locations seen adjacent to project.

The Panel has, through its own enquiry, also considered the following relevant documentation:

- Zhang, X., Gao, L., Barrett, D. and Chen, Y., 2013. A multi-criteria evaluation of water management for sustainable mining. 20th International Congress on Modelling and Simulation, Adelaide, Australia, 1-6 December 2013, pp. 482-488., www. mssanz.org.au/modsim2013.
- Gao, L., Conner, J.D., Barrett, D., Chen, Y, and Zhang, X., 2013. Strategic water management for reliable mine water supply under dynamical climates. 20th International Congress on Modelling and Simulation, Adelaide, Australia, 1-6 December 2013, pp. 2373-2379., www. mssanz.org.au/modsim2013.

1.1.4 Field inspection

The Panel did not conduct a field inspection specific to this request for advice. Notwithstanding, the Panel did undertake an issue-specific tour of the Liverpool Plains on 15 November 2013. This tour included attending the Project site and speaking with the proponent, and also speaking with stakeholders and local landholders.

2 The Proposed Project

Shenhua Watermark Coal Pty Limited (the proponent) is seeking State Significant Development Consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* for the development and operation of an open cut coal mine. The Project is located approximately 25 kilometres (km) south south-east of the township of Gunnedah and to the immediate west of the village of Breeza within the Gunnedah Local Government Area (LGA) on the Liverpool Plains. It is proposed that the mine will produce about 10 million tonnes per annum (MTPA) of coal for a period of 30 years. The Project area is Exploration Licence (EL) 7223 covering 9,500 hectares (ha).

On 19 April 2012, the Director-General of DP&I issued Environmental Assessment Requirements (the DGRs) for the Project, making particular reference to the then draft *New England North West Strategic Regional Land Use Plan* (SRLUP). Amongst other things, the DGRs required the proponent to prepare an Agricultural Impact Statement (AIS) that *"includes a specific focussed assessment of the impacts of the proposal on strategic agricultural land…"*

While the Project will not be required to prepare a Gateway Application, the DGRs provide an implicit mandate and expectation from the Director-General, for compliance with the SRLUP and evaluation of potential impacts on strategic agricultural land.

Following adequacy assessment in late 2012, the Project submitted an Environmental Impact Statement (EIS), incorporating an Agricultural Impact Statement, to DP&I in February 2013 (Hansen Bailey, 2013a). The EIS was exhibited for two months until 26 April 2013 and some 146 submissions were received, most opposing the development. The Proponent has subsequently reviewed submissions and provided DP&I with a Response to Submissions (RTS) document (Hansen Bailey, 2013b). It is thought that the Planning Assessment Commission (PAC) will undertake a review of the Project with public hearings in early 2014.

In summary, the Project involves:

- The development of an open cut mining operation extracting up to 10 Million tonnes per annum of Run of Mine (ROM) coal from the Hoskissons and Melvilles seams over a period of 30 years;
- Utilising a standard mining equipment fleet of excavators and shovels, supported by haul trucks, dozers, graders, drill rigs and water carts;
- Progressive rehabilitation of all disturbed areas;
- The co-disposal of tailings and coarse reject within the Overburden Emplacement Areas;
- The construction and operation of a Mine Access Road;
- The construction and operation of administration, workshop and related facilities;
- The construction and operation of a Coal Handling and Preparation Plant with a throughput of 10 Million tonnes per annum of Run of Mine coal;
- The construction and operation of a rail spur, rail loop, Kamilaroi Highway rail overpass, associated train load out facility and connection to the Werris Creek to Moree Railway Line;
- Transportation of product coal by rail via the Werris Creek to Moree Railway Line and the Main Northern Railway Line to the Port of Newcastle for export;

- The construction and operation of surface and groundwater management and reticulation infrastructure including pipelines, pumping stations/bore field and associated infrastructure for access to water from the groundwater aquifers in the vicinity of the Project, the Mooki River and private dams to the north-east of the Project Boundary;
- The closure of Court Lane, Rowarth Road, Whitby Road, part of The Dip Road (from the intersection of Clift Road to Nea Siding Road) and other unnamed paper roads within the Project Boundary;
- The installation of communications and electricity infrastructure; and,
- A workforce of approximately 600 full-time equivalent employees during construction and up to approximately 600 full-time equivalent employees and associated contractors during operation of the Project at full production.

The Project general layout is provided (Figure 1) and the mine is proposed to essentially operate within a *disturbance boundary* area. Some of the infrastructure such as water, power and communications infrastructure will be located outside the *disturbance boundary* (and quite possibly the Project Boundary). Minor additional disturbance associated with ancillary works including fencing, firebreaks, water diversion structures, pipelines, a bore field, minor contour banks, access tracks, explosives storage facilities, power lines, sediment and erosion control structures will also be required and are part of the Project for which consent is sought.

Generally, the Panel observes that the detailed agricultural assessment and specifically BSAL verification, has been undertaken for the *disturbance boundary* area only, and not for the entire and larger Project area, i.e. the EL.

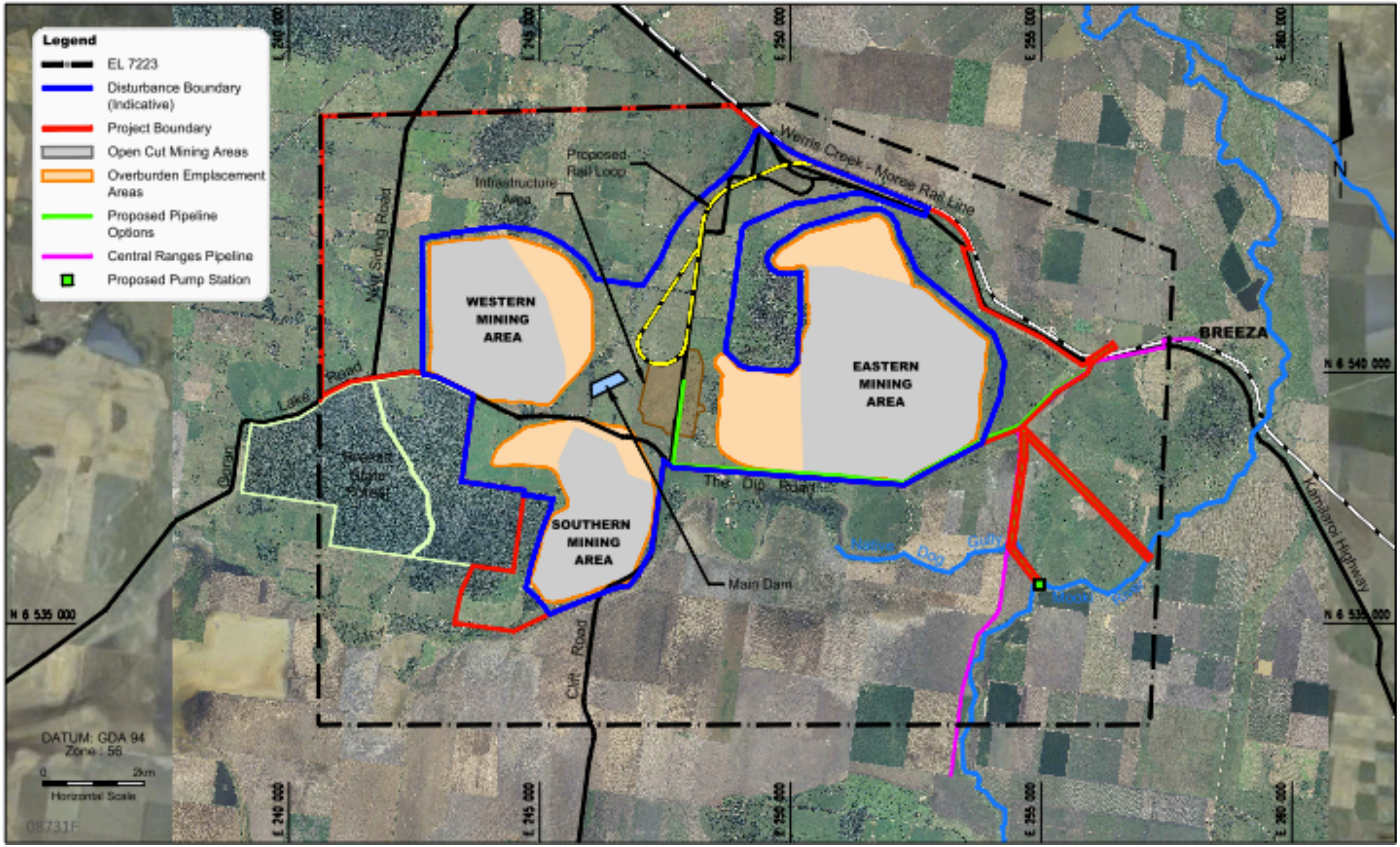

Figure 1 Project layout (after Hansen Bailey 2013b)

3 Biophysical Strategic Agricultural Land (BSAL) Verification

The Panel advises that the Project's verification of BSAL soil is materially deficient because:

1. For the proposed mine site, verification of BSAL soil is confined to the *disturbance area* and was not completed across the larger proposed Project area. In accordance with the agricultural impact statement technical notes (DPI, 2013a), the Project area *"means the development application area including all land directly used for the project as well as surrounding buffer lands and offset zones which may be managed by the project."*
2. The BSAL soil verification process used is noncompliant with statutory requirements, specifically the interim protocol for BSAL verification by OEH & OASFS (2013); and,
3. For the Additional Offsite Biodiversity Offset Area, no proper verification has been done.

3.1 Definition

The NSW Government (OEH and OASFS, 2013) defines BSAL as follows.

> *"Land with a rare combination of natural resources highly suitable for agriculture. These lands intrinsically have the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality. BSAL is able to be used sustainably for intensive purposes such as cultivation. Such land is inherently fertile and generally lacks significant biophysical constraints."*

BSAL has been mapped at the regional scale for the SLURP using a more quantitative approach that encompasses the above description (DPI, 2012). Areas that are included in the regional BSAL map are defined below.

Properties with access to a reliable water supply, defined by:

- Rainfall of 350mm or more per annum (9 out of 10 years), OR
- A regulated river (maps show those within 150m), OR
- A 5th order or higher unregulated river (maps show those within 150m), OR
- An unregulated river which flows at least 95 per cent of the time (maps show those within150m), OR
- Highly productive groundwater sources, as declared by the NSW Office of Water. These are characterised by bores having yield rates greater than 5L/s and total dissolved solids of less than 1,500mg/L and exclude miscellaneous alluvial aquifers, also known as small storage aquifers.

AND

- Land that falls under soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH), where it is also present with land capability classes I, II or III under the Land and Soil Capability Mapping of NSW (OEH).

OR

- Land that falls under soil fertility classes 'moderate' under the Draft Inherent General Fertility of NSW (OEH), where it is also present with land capability classes I or II under the Land and Soil Capability Mapping of NSW (OEH).

This relates to the methodology used to produce mapping to indicate areas of likely BSAL across the State. These criteria do not form any component of BSAL verification.

3.2 Verification of BSAL potentially affected by the Project

It is the Panel's view that the proponent has applied incorrect methodology and obfuscates the verification of BSAL soils. The Panel advises that significant uncertainty remains as to the extent and location of BSAL soils potentially affected by the Project. This fundamentally hinders the Panel's assessment of the Project's impacts on BSAL.

The Panel advises that the Project should not proceed until the following has been completed.

- A 'Project area' for detailed BSAL assessment is defined in accordance with statutory requirements;
- The interim protocol for BSAL verification by OEH and OASFS (2013), as gazetted on 12 April 2013, should be applied across the Project area;
- The proponent amends Project documentation to:
  - Reflect proper BSAL verification and mapping;
  - Demonstrate that impacts on BSAL have been avoided or minimised; and,
  - Clearly show that the Project will not significantly reduce the agricultural productivity of any BSAL, based on a consideration of disturbance, soil physical and chemical characteristics, groundwater, fragmentation of land use and loss of land.
- The Panel examines the amended Project documentation to determine the significance of the Project's potential impacts on BSAL and provides advice to the Director-General.

The Panel is cognisant that the Project EL adjoins highly productive irrigated farming land on the Liverpool Plains and requires that any agricultural impact assessment for the Project considers carefully the agricultural resources, systems and enterprises of the surrounding locality.

Issues relating to methodologies used for verification of BSAL were raised to the proponent at adequacy (e.g. iMine, 2012) and in Government agency submissions on the EIS (e.g. DPI, 2013b). The proponent asserts in its RTS (Hansen Bailey, 2013b) that the interim protocol for BSAL verification by OEH and OASFS (2013) was *"not finalised at the time the impact assessment was undertaken"* and therefore, alternate methods were used to verify BSAL. It is the Panel's view that, while the interim protocol for BSAL verification was not Gazetted until April 2013, earlier versions were available for the proponent's use in 2012 (see: DPI, 2013b) and should have been used.

The Panel notes that the proponent currently obfuscates the identification and verification of BSAL soils. For example, the RTS (page 401) by Hansen Bailey (2013b) states:

> *Site verification of the land within the Project Boundary and biodiversity offsets in accordance with the Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (Interim Protocol) (OEH and DPI, 2013) and the Soil Landscapes of*

the Curlewis 1:100,000 Map Sheet (Banks, 1995) has not resulted in additional BSAL beyond the 96 ha being impacted by the Project.

In the Panel's opinion, this statement is false and misleading. It is false because the interim protocol for BSAL verification has not been applied on the Additional Offsite Biodiversity Offset Area. It is misleading because historic reconnaissance-scale land and soil capability mapping is not a criterion for BSAL verification. Neither is the *cultivation history* of the site nor a *reconnaissance level site inspection*, as stated by Hansen Bailey (2013b): page 403. The statutory process for identification and verification of BSAL soils, including ten on-ground site verification criteria, are detailed in OEH and OASFS (2013).

3.2.1 Verification within the Project area

An appropriate Project area has not been defined and detailed soil and land capability assessment and BSAL verification is restricted to an arbitrary *disturbance boundary*. This is inconsistent with requirements for BSAL verification and guidelines for the preparation of agricultural impact statements, that require a larger Project area to be considered in detail. For example, DPI (2013a) define the required Project area as the Development Application area, including all land directly used for the project as well as surrounding buffer lands and offset zones which may be managed by the Project, plus a 100 m buffer and areas of contiguous BSAL. Within this area, detailed measurements are expected. It is considered likely that, had a compliant Project area been assessed, the total area of BSAL verified would be considerably larger than that currently stated.

The BSAL assessment presented, which is limited to the *disturbance boundary*, incorrectly uses land and soil capability classes as an early criterion for BSAL verification, e.g. dot points on page 402 of Hansen Bailey (2013b). Land and soil capability class mapping is not, in isolation, a surrogate for BSAL verification in accordance with the interim protocol for BSAL verification by OEH and OASFS (2013).

The Panel advises that BSAL has not been correctly verified in the Project area because:

- Assessment is limited to an arbitrary *disturbance boundary* area which is only a portion of the Development Application area; and,
- BSAL soil has not been correctly verified in the *disturbance boundary* area. Land and soil capability classes have potentially been used to assess BSAL soils as non-BSAL, e.g. *Soil type 8 (the Carinya soil landscape) was found to have high fertility characteristics; however the land capability of these soils was class V, which does (not) meet the relevant criteria to be considered as BSAL* (see page 402 of the RTS by Hansen Bailey (2013b)). The Panel notes that Soil type 8, a brown vertosol with moderate to high inherent fertility, is not mentioned in the land and soil capability assessment (see: EIS, Appendix Y) and it could well be BSAL.

3.2.2 Additional Offsite Biodiversity Offset Area

The extent of BSAL on the Additional Offsite Biodiversity Area has not been verified and remains unknown. The assessment presented in Hansen Bailey (2013b) is invalid because it relies on the following.

- Historic, reconnaissance-scale soil and land capability mapping by the Catchment Management Authority to discriminate BSAL; and,
- Some *"reconnaissance level site inspection"* rather than application of the interim protocol for BSAL verification (OEH and OASFS, 2013) including detailed soil assessment on-ground.

4 Panel Assessment of Impacts on BSAL

The State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (the Mining SEPP) s17, provides the *relevant criteria* for the Panel in determining an application. Whilst this advisory report does not relate to an application, the *relevant criteria* provide an appropriate framework for providing advice.

The relevant criteria are that the proposed development will not significantly reduce the agricultural productivity of any BSAL, based on a consideration of disturbance, soil physical and chemical characteristics, groundwater, fragmentation of land use and loss of land. The Panel has assessed the potential impacts on BSAL as follows.

4.1 Significance of the project's potential impacts on BSAL

4.1.1 Any impacts on the land through surface area disturbance and subsidence

The proposed mine is solely an open cut. There are no underground or highwall mining workings within the proposal and therefore there are no mining subsidence issues to consider.

According to Hansen Bailey (2013b), the Project will cause the loss of 96 ha of BSAL within the disturbance area. The Panel predicts that this figure is not accurate, as the proponent has not verified BSAL in accordance with the interim protocol for BSAL verification and associated guidelines available (see Section 3.2.1 of this report).

At its extremities, the proposed *disturbance area* is within a short distance of mapped BSAL on the Liverpool Plains. It is the Panel's view that the proximity of proposed mining to this mapped BSAL, which is known by the Panel to be utilised for precision agricultural production systems, has the potential to adversely impact on the agricultural productivity of that land. These potential indirect impacts are thought to include:

- Some water level and water quality changes in adjacent alluvial aquifers, that are an integral part of BSAL use, in terms of both their productivity and/or water quality both during mining operations and longer-term following the completion of the proposed mining in around 30 years; and,
- Mining produced dust affecting the value of certain crops, particularly cotton, which is understood to be most valuable when it is pure white and not contaminated with dust.

The associated impacts of noise and visual amenity from open cut mining are duly recognised by the Panel. However as the scope of work is limited to assessing the impact on BSAL rather than on local residents or local tourism for example, these specific impacts are given no further consideration herein.

4.1.2 Any impacts on soil fertility, effective rooting depth or soil drainage

The 96 ha of BSAL identified by the proponent in the mine disturbance area is classified as Class III land capability and the majority falls within the eastern mining footprint. It is proposed that this BSAL be lost to the mining operation. The proponent states that 100 ha of BSAL will be restored in the rehabilitation process (Hansen Bailey 2013a). How this will be achieved is not made clear in either Hansen Bailey (2013a) or Hansen Bailey (2013b).

The BSAL soil to be lost to the mining operation is predominantly a medium high to highly fertile Red Ferrosol. The proponent's rehabilitation program states generally that stripped topsoil and subsoil will be stored separately for replacement following completion of mining activities. The rehabilitation for Class III land aims to rebuild a soil profile with a minimum topsoil and subsoil depth of 0.3m and 0.5m respectively.

Unless the topsoil and subsoil of the Red Ferrosol is stored separately and reinstated together as a complete soil profile, the fertility and physical properties of the soil will not be maintained. It can be expected that soil fertility and effective rooting depth may be reduced and infiltration and soil drainage rates increased.

4.1.3 Any increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH

If the BSAL Red Ferrosol is rebuilt then the rehabilitation process should not affect the soil salinity and soil pH. Given the proponent has stated that 100 ha of BSAL will be returned, the surface rockiness, number of rocky outcrops and surface slope can be expected to be within BSAL parameters. The proponent has documented that a post-decommissioning soil survey and land capability assessment regime will be undertaken in accordance with relevant guidelines and Australian Standards to ensure post disturbance land meets the nominated land capability classes. The Panel recommends that this be extended to include BSAL verification and that this verification is performed well prior to mine closure.

4.1.4 Any impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy)

The Shenhua Watermark mining footprint is located next to the highly valued and complex alluvial groundwater system that underlies the Liverpool Plains. Mining will be restricted to the hill country and there will be a buffer of at least 150 m between the mine and the alluvial boundary. The Gateway Panel has undertaken its assessment of groundwater after considering the following:

- The rules and criteria of the Aquifer Interference Policy (NOW 2012);
- The rules in the relevant water sharing plans (NOW 2003, 2011);
- Upper Namoi Valley groundwater status report (NOW, 2011)
- The advice from the Independent Expert Scientific Committee (IESC, 2013);
- Comments from NSW Office of Water (NOW, 2013);
- Data and analyses contained in the EIS and the responses to submissions (RTS);
- Information contained within submissions on the EIS; and
- Independent advice to DP&I from Kalf and Associates (2013).

The Panel considers that the key aspect to this groundwater assessment is the acceptability or otherwise of the 3D groundwater flow model. The supporting hydrogeological information (water chemistry data, water age dating, geophysics, water level monitoring, other groundwater models and previous studies) provides additional lines of evidence for the assessment and is also provided (see Appendix A).

The Panel's key findings with respect to groundwater are as follows.

- The MODFLOW-SURFACT software used for groundwater modelling is considered appropriate.
- The model is a Class 3 model (Barnet et al, 2012) and that the model statistics are adequate for it to be used as a predictive tool.
- At the southern edge of the mine lease the spatial resolution of the model is of the same order as the thickness of the dipping aquifers and aquicludes which may impact on the accuracy of the head drawdown predictions to the immediate south of mine. This is discussed further in the sensitivity analysis (see Appendix A).
- The Project meets the requirements of the Aquifer Interference Policy both in terms of water licensing issues and water asset/environmental impacts.
- The impact of increased seepage of saline water from the Permian rocks to the Gunnedah formation has not been demonstrated with sufficient clarity. Mixing ratios have not been presented to demonstrate that the beneficial use of the deeper parts of this aquifer will not change.
- The predicted water quality in the final void remains unclear. It is recommended that further work be undertaken to justify the salinity predictions in the final void.
- Whilst the model scenarios indicate the final void will not overflow and will be a sink for groundwater flow, this conclusion needs to be substantiated through regular model updates and data collection on spoil recharge rates.
- The boundary between the Permian rocks and the Narrabri formation is considered accurate but the spatial location or the buried Gunnedah formation should be considered an approximation only.
- The cumulative impact work by the proponent is considered to be minimal.

4.1.5 Any fragmentation of agricultural land uses

Hansen Bailey (2013a and 2013b) does not include assessment of fragmentation of agricultural land as a result of the Project.

4.1.6 Any reduction in the area of BSAL

The Panel is unable to decide the potential reduction in the area of BSAL because the BSAL verification provided is non-compliant with the interim protocol for BSAL verification and associated guidelines.

4.2 Whether any additional reasonable and feasible mitigation measures could be implemented to materially reduce the potential impacts of the project on BSAL

It is not possible for the Panel to propose additional mitigation measures because the verification of BSAL is materially flawed.

The Panel advises that:

- The proponent has likely underestimated the extent of BSAL potentially affected by the Project; and,
- Compliant verification of potentially affected BSAL is needed before the appropriateness or otherwise of mitigation measures can be assessed or additional measures proposed.

5 Panel's Advice to the Director-General

The Panel has assessed the Shenhua Watermark Project and provides the Director-General with the following advice with respect to the Terms of Reference.

5.1 Key findings

The Panel's key findings are as follows.

1. The proponent has applied incorrect methodology for BSAL verification and this is non-compliant with statutory requirements;
2. The proponent obfuscates the verification of BSAL and likely underestimates the true extent of potentially affected BSAL;
3. Predicted saline water qualities in backfilled areas and the final void pit lake is a significant long-term risk to water quality in surrounding creeks and the alluvial aquifers;
4. The Project is surrounded by highly productive, irrigated farming systems on the Liverpool Plains, and much of this farming land is likely BSAL; and,
5. Based on the proponent's information, the Panel cannot decide the significance of potential impacts of mining on BSAL.

The Panel advises that the Project should not proceed until the following has been completed.

- A 'Project area' for detailed BSAL assessment is defined in accordance with statutory requirements;
- The interim protocol for BSAL verification by OEH and OASFS (2013), as gazetted on 12 April 2013, should be applied across the Project area;
- Further modelling to justify salinity predictions in the final void pit lake and/or mine plan changes to eliminate the final void;
- The proponent amends Project documentation to:
    - Reflect proper BSAL verification and mapping;
    - Demonstrate that impacts on BSAL have been avoided or minimised; and,

- Clearly show that the Project will not significantly reduce the agricultural productivity of any BSAL, based on a consideration of disturbance, soil physical and chemical characteristics, groundwater, fragmentation of land use and loss of land.

- The Panel examines the amended Project documentation to determine the significance of the Project's potential impacts on BSAL and provides advice to the Director-General.

The Panel is cognisant that the Project EL adjoins highly productive irrigated farming land on the Liverpool Plains and would consider that any agricultural impact assessment for the Project considers carefully the agricultural resources, systems and enterprises of the surrounding locality.

5.2 Significance of impacts

With regard to the significance of potential impacts on BSAL, the Panel finds:

1. The significance of potential impacts on BSAL cannot be decided due to the deficient, non-compliant verification process used by the proponent;

2. There is significant potential BSAL adjacent to the Project on the Liverpool Plains; and,

3. There is up to 600ha of potential BSAL within the Offsite Biodiversity Offset Area and this has not been verified.

5.3 Additional mitigation measures

At this time, the Panel is unable to decide what, if any, additional mitigation measures would be appropriate given the deficiencies discussed herein.

6 References

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DPI (2013b) Letter from DPI to DP&I, reference OUT134864, dated 24 April 2013.

Hansen Bailey (2013a) Watermark Coal Project – Environmental Impact Statement. Hansen Bailey.

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APPENDIX A

Further discussion on the impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy)

A.1 Hydrogeological Background

Groundwater under the Liverpool Plains is one of the most studied and researched alluvial groundwater systems in Australia. Groundwater extraction for irrigation purposes commenced in the 1960s and developed steadily from that time onwards. Because of the importance of the resource the NSW government undertook exploration drilling into the alluvium (from late 1970s to 1990s) and set up an extensive network of monitoring bores. Few bores however were drilled into the underlying Permian bedrock as it was not the groundwater system of interest due to its low yielding capability and brackish water.

The importance of the alluvial groundwater resources to irrigators cannot be overstated. Considerable angst was endured by groundwater licence holders when the NSW government reduced groundwater entitlements (2006) as part of the Water Reform process to make groundwater management sustainable in the Namoi Valley.

Whilst the mining footprint is located on Permian outcrop rocks within the Gunnedah-Oxley (Other) Zone of the Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, the impacts of the proposed mine will inevitably extend beyond its boundaries into three other alluvial water source areas:

- Upper Namoi Groundwater source Zone 3;
- Upper Namoi Groundwater source Zone 7; and,
- Upper Namoi Groundwater source Zone 8.

The Gunnedah-Oxley MDB water source has two management zones one called 'Spring Ridge' and the second called 'Other'. The mining operations will occur in the Gunnedah-Oxley MDB (Other) management zone, which is considered a 'less productive' aquifer. Modelled impacts extend to The Gunnedah-Oxley MDB (Spring Ridge) management zone, which is used for irrigation and can be considered 'highly productive'.

It is important to note that for the alluvial groundwater sources (Zones 3, 7, and 8) the Gunnedah Formation and the overlying Narrabri Formation are not separated out in the WSPs but are treated as one groundwater source. The NSW Aquifer Interference Policy works at a water source level so for the purpose of this assessment the Upper Namoi Groundwater sources (Zones 3, 7 and 8) are all considered 'highly productive".

All NSW groundwater sharing plans permit groundwater trading (both permanent and temporary) as required under the National Water Initiative (NWC, 2004). Groundwater trading can only occur however within the water source and not across water source boundaries. Water cannot trade for example between Zones 7 and 8. Water trading is also not permitted across management zones such as in the Gunnedah-Oxley MDB water source.

A.2 Groundwater Data and Conceptual Model

The geological and hydrogeological information supplied in the EIS and accompanying documents, compliments and adds to the understanding of the groundwater flow system in the vicinity of the proposal. As stated previously, extensive drilling investigations, modelling and research has occurred on the alluvial groundwater resources of the Liverpool Plains. This body of scientific work has been considered by Shenhua Watermark and together with its own studies used in the conceptualisation of groundwater flow.

The very extensive record (31 years) of groundwater level measurements in the alluvium was beneficial to model calibration purposes. The field program undertaken by Shenhua's consultants to fill data gaps, particularly with respect to hydraulic parameters in the Permian sediments, water chemistry, age dating and water level monitoring in gap areas was well designed. This has provided sufficient data to build a groundwater flow model. A total of 94 monitoring bores were drilled for the project, which supplemented the 351 alluvial monitoring bores owned by NOW. In addition, 176 aquifer tests, laboratory tests on 32 cores and 24,000 chemical analyses were carried out.

The Panel recognises this substantial body of information but also notes that there are data uncertainties in some areas such as; the timing of groundwater extraction in the irrigation industry, knowledge about hard rock hydraulic parameters away from the mining site, the lack of recharge measurements and little understanding of groundwater dependent ecosystems off site.

The Panel believes that the conceptualisation of the local and regional hydrogeology is sensible and is presented sufficiently in terms of block diagrams and other graphics to show the recharge/discharge processes. The conceptualisation fits with other research in the area. The NOW states that conceptualisation is adequate. The two groundwater model peer reviewers (Merrick 2013 and Kalf, 2013) also believe it is appropriate and plausible. The IESC has some concerns on conceptualisation and these are addressed in the RTS.

Whilst the IESC would like to see the model extended in a northerly direction to Gins Leap (25 km) the Panel does not consider this necessary. The model as presented is a sub-regional model (75 km x 91 km) and is already very extensive. The model boundaries are at sufficient distance from the mine area so as to not influence the output in any substantive way. The impacts identified by the modelling are restricted close to the mining area (3.2 km for the 1m drawdown contour).

Given the southern extent of drawdowns in the Permian extend significantly outside the mine lease and under BSAL land, and the importance of the overlying aquicludes to protect the alluvial aquifers from this drawdown, the Panel is of the view that the high resolution portion of the computational domain (Figure 8.2, see also the strata representation in the model to the immediate south of the Southern Mining Area in the bottom of Figure 8.3) in the predictive model should extend further south by 3 kms to ensure that discretisation errors in the model representation of the dipping aquifers and aquicludes does not impact on the simulations.

The Panel is aware of the limitations and uncertainties that exist in any modelling study and that true model verification can only be assessed following major stresses to the groundwater system, such as the onset of groundwater dewatering associated with mining activities.

A.3 Groundwater model

Two separate models were developed each with 11 layers. The groundwater model grid covered an area of 6,825 km2 and was approximately 75 km in width (east to west) and 91 km in length (north to south). The first model had cell sizes of 200m to 500m and consisted of 300,000 cells. This was run in steady state mode to estimate pre-development conditions and get a handle on hydraulic parameters. The second model is the prediction transient model. It has finer cell resolution (50 m by

50 m) and contains 1.2 million model cells. Both models were calibrated by automatic techniques (i.e. PEST) which is considered a state-of-the-art calibration procedure. The parameters collected from the field studies were used as a guide to set the outer bounds for calibration purposes.

The MODFLOW-SURFACT software that was used is considered appropriate. The model has been peer reviewed by Merrick (2013) against National Modelling Guidelines (MDBC, 2001 and Barnet, 2012) and he found it to be fit for purpose for addressing potential environmental impacts and for estimating pit inflows. Kalf (2013) has undertaken an independent review of the modelling work for DP&I and found the model to have achieved a sufficient level of accuracy for prediction purposes.

The Panel agrees that the model is a Class 3 model (Barnet et al, 2012) and that the model statistics are adequate for it to be used as a predictive tool. This is the highest class of groundwater model. The modelling is judged to be in line with industry standards and that the uncertainty analysis has been done more extensively than is normal practice in Australia.

The Panel's detailed appraisal of the model has highlighted the following:

- A visual inspection of the predicted water levels against measured data shows a good fit for many areas, however there are some notably poor fits in the Permian outcrop areas. Whilst this is a common outcome when modelling groundwater flow in consolidated rocks it is of concern here because this is the region where the mine will interact with the locally important alluvial groundwater systems to the south, and the Permian formation is potentially a major pathway of possible interconnection between the mine and the alluvial systems.
- Steady state predevelopment conditions are assumed at 1980. This is obviously not the case as irrigation development was well under way by this date.
- Recharge figures vary from other groundwater models in the Namoi and are very high at the break of slope;
- The use of historical monthly rainfall data is preferable, rather than the use of average annual values;
- Flooding was not identified separately in the modelling;
- River stages are held constant whilst minor drainage lines have been set as discharge sites. It would have been preferable to use actual river heights on say a monthly basis;
- Evapotranspiration may have been over estimated (see comments by Merrick 2012);
- Geological faulting is handled as a calibration parameter, which found that faults behave as a resistive structure to flow. This should be substantiated in the field through pumping tests;
- The vertical conductivity being tied to the horizontal conductivity value is a modelling short cut but it is not valid in nature;
- The northern prescribed head boundary should be time variant. It is not clear if this is the case;
- At the southern edge of the mine lease the transition from fine to coarse resolution (from 50m to 250m) in the north-south direction in the predictive model precludes accurate representation of the thickness of the dipping aquifers and aquicludes and may impact on the accuracy of the head drawdown predictions in the alluvials to the immediate south of mine.

Notwithstanding the above, the Panel considers the groundwater model meets industry standards and can be used in management decisions, provided that extensive ongoing monitoring occurs together with two yearly model updates (in the early years of mining relaxed to 5 yearly after say year 10) to confirm or otherwise the size of predicted impacts. This may require recalibration of the model and the comments given above should be addressed at this time.

A.4 Groundwater Sensitivity and Uncertainty Analysis

The sensitivity analysis is on the whole well done and uses state-of-the-art techniques. The comparison with calibration data is well founded so the probability error bands on model drawdowns, etc. are likely to be realistic within the bounds of the parameters for which the sensitivity analysis was performed.

However, while the sensitivity and uncertainty analyses are well done there are a number of areas where it could be improved:

- There is no sensitivity study of the reliability and sensitivity of the effects of faults in the interconnectivity between the coal seams and the Narrabri and Gunnedah formations.
- Given that the Permian conductivity was found to be one of the most sensitive values some indication from the calibration using PEST of the *error of estimation* of the conductivity is warranted to better quantify the risk so that the impact on the model predictions can be quantified.
- The Panel supports the recommendation of the sensitivity analysis being revisited as more data becomes available. This will potentially require recalibration of the model, or at least reassessment of parameter bounds in the uncertainty analysis.
- The analyses did not look at errors in determining strata depths or interconnectivity (e.g. due to faulting) between the Permian formation and the alluvial aquifers. This is also related to the coarse resolution of the model directly to the south of the Southern Mining Area, in the area where the highest offsite impacts in the Permian formations were found. The sensitivity study should include, as a minimum, consideration of the thickness of the aquiclude overlying the Permian, and the positions of the Narrabri-Gunnedah formation interface and alluvial-bedrock interface.

Subject to these caveats the aquifer depressurisation uncertainty estimates in the EIS are likely to be realistic.

A.5 Aquifer Interference Policy (AIP)

The aquifer interference policy (NOW, 2012) has two essential requirements. The first is that all aquifer interference activities such as mining must hold appropriate licences for the water they take as part of their operation. This includes the movement of water from one water source to another. An example is the loss of surface water to underlying alluvium or hard rock aquifers as a consequence of nearby mining activities. A groundwater flow model usually determines the volumes involved, as they cannot be readily measured. A water licence gives the holder a share of the pool of water available for extraction. It also puts shareholders on the same footing and prevents the erosion of the share value through the unauthorised take of water.

The second important requirement is the assessment of impacts to ensure that minimal impacts are not exceeded on nearby water assets. No government in Australia requires development proposals to have nil impacts. In NSW, the AIP establishes and objectively defines minimum impact considerations for groundwater sources, connected water sources, and their dependent ecosystems, culturally significant sites and existing water users. Key criteria are provided in the AIP for both 'highly productive' groundwater sources and 'less highly productive' groundwater sources (NOW, 2012). The Mining and Petroleum SEPP (2007) requires the Panel to consider potential impacts on the 'highly productive' groundwater sources.

If the minimal impact criteria specified in the AIP are not exceeded then, this is called a Level 1 impact and it is an acceptable impact. Where the impacts are greater than Level 1 but by no more than the accuracy of an otherwise robust groundwater model, then the project will be considered as having impacts that are within the range of acceptability but will have additional conditions imposed, should it be approved.

Where the predicted impacts are clearly greater than the Level 1 then the proponent will be required to do additional studies to fully assess the predicted impacts. If this additional assessment shows that the predicted impacts do not prevent the **long-term** viability of the relevant water dependent asset, then the impacts will be considered to be acceptable.

The groundwater model has predicted the take of water both during and after mining for the various water sources that are impacted. The results reported in NOW (2013) are tabulated below.

TABLE 1: Predicted Groundwater Take and Total Share Component

Water source	Predicted peak annual water take during mining (ML)	Total share component required for project (units)	Share component already held by Shenhua (units)	Total share component issued (units)
Namoi Groundwater Zone 3	1.1	1.2	nil	17,101
Namoi Groundwater Zone 7	101.8	112	42	3,697
Namoi Groundwater Zone 8	0.4	0.4	164	16,122
Porous Rock (Gunnedah-Oxley Basin (Other))	756	940	nil	16,784**
Porous Rock (Gunnedah-Oxley Basin (Spring Ridge)	33	42	nil	
Mooki River	47.5	53	nil	30,350
Lake Goran	0	0	1223*	32,171

*Subject to conditions

** Most of this water is held in the Spring Ridge zone. Trade is not permitted between zones.

Shenhua Watermark can obtain water from the trading market or via a controlled allocation for the Porous Rock - Gunnedah-Oxley Basin (Other) water management zone.

A.3 Assessment against AIP

Requirement 1: adequate and secure project water supply

NOW (2013) has stated that "the proponent has not demonstrated that its predicted water take can be secured through water licences". This position is difficult to reconcile given the substantial share component that is available for trade (Groundwater Zones 3, 7, 8 and Mooki River) as compared to the modest volumes required. See Table 1 in Appendix A for volumes. The porous rock water source (Gunnedah-Oxley MDB) is perhaps less likely to have any substantial depth to a water trading market but there is the option of a controlled allocation for new licenses if the Minister for Primary Industries wishes to allow this option. It is understood that the appropriate water licences have to be in place before mining commences and Shenhua have made an undertaking to achieve this outcome.

The Panel believes the water licensing issue can be resolved through water trading and perhaps a controlled allocation order. Further discussions between the proponent and NOW may be required.

Requirement 2: minimal impact considerations

The zone of depressurisation generated by the mine extends to a maximum of 3.2 km in Year 25 of the project. Groundwater modelling for the Project predicted a temporary drawdown of greater than 1 m, but less than 2 m in four bores on private land to the south of the Project. These are bores GW015505, GW029468, GW037713 and GW967790. The predicted drawdown ranged from 1.4 m in GW015505 to 1 m in GW037713. Drawdown in all other bores was less than 1 m. This is less than the 2m impact identified as minimal for highly productive groundwater sources in the AIP.

NOW (2013) has been critical of some parts of the groundwater modelling effort. However in the attachment to their comments, they have judged the proposal to meet the **Level 1** minimal impacts considerations in the NSW Aquifer Interference Policy. The Panel assumes this is for all affected groundwater sources and agrees with this assessment, based on the modelling results provided and the likely errors around the model output (see previous comment on model accuracy). Changing the model parameters would affect the predicted impacts in the surrounding bores so ongoing monitoring of water levels at these bores and surrounding the mine is critical to verify the model results.

It is noted that no high priority groundwater dependent ecosystems or culturally significant sites have been identified in either water sharing plans or in the EIS.

With respect to water quality the Panel finds that it is very unlikely that the increased flux of groundwater from the backfilled mining areas will influence the beneficial use of the Narrabri Formation. This is because the discharging water quality post mining is similar to that found in the Narrabri Formation.

The impact of increased seepage of saline water from the Permian rocks to the Gunnedah Formation has not been demonstrated with sufficient clarity. Mixing ratios have not been presented. The Panel also questions the predicted final water quality in the final void.

The AIP requirement to not increase by more than 1% the long term average salinity in nearby streams, only applies to highly connected surface water sources. Neither the Mooki River nor Quirindi Creek have been identified as highly connected in water sharing plans. The presence of thick layers of clay (aquitards) below these water features prevents them being considered hydraulically 'highly' connected.

A.6 Other relevant comments

Black Soil Plains Buffer Zone

The proponent has gone to considerable lengths to identify the location of the alluvial Narrabri and Gunnedah Formations in proximity to the proposed mine. Whilst the boundary between the Permian rocks and the Narrabri Formation is considered accurate the spatial location of the Gunnedah Formation should be considered an approximation only. This is because it is difficult to distinguish between the two formations using geophysical techniques and water age dating techniques, with any precision, as neither has a unique signal. The formations are known to grade into another and do not have a unique geophysical signal.

For assessment purposes the Gunnedah Formation has been delineated sufficiently well to estimate the potential impacts on groundwater users in this formation.

Final void impacts on groundwater and surface water

The final void water balance modelling using OPSIM is considered appropriate for the task of assessing the long-term water levels in the final void post-rehabilitation. The use of results from MODFLOW for input to OPSIM is appropriate to the task, though it does entail some assumptions about within spoil chemistry and how the final void lake and the groundwater interact. These assumptions are outlined in Appendix A. Accordingly there are a number of uncertainties in the OPSIM modelling that cannot be clarified from the modelling presented in the EIS.

The Panel considers that the predicted salinities for the final void lake are likely too low (EIS predicts 5000 mg/l). If the final void lake is more saline than predicted then the salt load into the surrounding aquifers and surface waters, will be greater than stated.

It is recommended that further work be undertaken to justify the salinity predictions in the final void.

Whilst the model scenarios indicate the final void will not overflow and will be a sink for groundwater flow, this conclusion needs to be substantiated through regular model updates and data collection on spoil recharge rates.

Cumulative impacts

The cumulative impact work by the proponent is considered to be minimal. The Namoi Water Study (SWS 2012) is referenced in the EIS and Shenhua Watermark aim to incorporate a number of recommendations from that study, on both water quality protection and groundwater monitoring, where practicable. The proponent's position is that there is no other coal mine or coal seam gas proposal approved for development in their vicinity so further cumulative impact assessment is not warranted by them as it is not possible to know which proposals may get approved.

Zone 7 in the Upper Namoi alluvium has been identified in the Namoi Water Study as an area of potential cumulative impact if both Shenhua Watermark and the Caroona Coal Project are approved.

Further work will be required on cumulative impacts if these two mines proceed towards approval in a similar time frame.

Great Artesian Basin (GAB)

The IESC has sought clarification on the proponent's impact on the Surat Basin Sediments. Presumably this question relates to the important GAB sandstone aquifers that occur within the Surat Basin. The RTS correctly points out that whilst there are Jurassic rocks (Pilliga Sandstone) of similar age and nature, to the south west of the mine, they are part of the Oxley Basin and are not hydraulically part of the GAB. Surat Basin sediments do not occur in the vicinity of the mine.

Surface Water Impacts

The use of AWBM and OPSIM for the surface water yield analysis for the Mooki River and Lake Goran assessment is supported (EIS Appendix S, Section 6.3). However, from the report it is unclear exactly what data has been used to calibrate the AWBM model. Normally time series of discharge would be used for calibration to capture the full time varying dynamics of the flow but it appears from the report that the flow-duration curves have been used instead (e.g. rates of change in flow, rather than simply the proportion of flows in given ranges). The discussion in the remainder of this paragraph assumes that this latter approach was used. This latter approach will only guarantee that the proportions of high to low flows will be correctly modelled and will not guarantee that the pattern of high and low flows over time is correctly captured. Capturing this time varying pattern of flow may be important for correct simulation of Lake Goran, where lake levels are likely to be a function of the sequence of high and low flows with time. This may also impact the mine water balance simulations (and storage volumes, spills, etc) in Chapter 7. The impact of this on the conclusions cannot be assessed from the information in the report.

The use of the RAFTS and TUFLOW models for design flood assessment is supported. The calibration procedure is supported. The design flood estimation procedures used to predict the flood discharges for the range of flood frequencies and PMF are sound.