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11 June 2013

Mr David Kitto
Director, Mining & Industry Projects
Department of Planning
GPO Box 39
SYDNEY NSW 2001

Attention: Sara Wilson

Dear Sara,

Moolarben Coal Project Stage 2 – Water Licensing – Wollar Creek Water Source

The Department has requested further clarification on Moolarben Coal Mines (MCM) proposed approach to licensing predicted water take from connected alluvial and surface waters of the Wollar Creek Water Source for the Moolarben Stage 2 Project, particularly in relation to:

- The conversion of an aquifer access licence to an unregulated river access licence to account for creek baseflow reductions, including consideration of:
  - The *Access Licence Dealing Principles Order 2004*.
  - The information requirements of section 3.2.3 of the Aquifer Interference Policy.
  - The affect on basic landholder rights users.
- The potential worst case unmitigated take from local alluvial aquifers and the resultant indirect affect on baseflow within the Wollar Creek Water Source.

A response to each of the above issues is set out below and in the accompanying attachments. This response has been prepared with the assistance of Ashurst and Dundon Consulting Pty Limited.

1. Background

The Moolarben Stage 2 Project will be principally developed within the Murragamba and 'Eastern' creek catchments. These catchments drain to Wilpinjong Creek which drains to Wollar Creek (12 km downstream) and then to the Goulburn River. Murragamba, 'Eastern' and Wilpinjong creeks are part of the larger Wollar Creek catchment. The Wollar Creek catchment drains an area of about 53,200 ha. The Murragamba and 'Eastern' creek sub-catchments cover an area of about 3,150 ha or about 6% of the Wollar Creek catchment.

Murragamba and 'Eastern' creeks are low order ephemeral drainage systems that flow only in response to recent rainfall. That is, there is insufficient baseflow (groundwater discharge) to sustain surface flow during low or no rainfall periods and there are no surface discharges from these creeks during these periods into Wilpinjong Creek. Wilpinjong Creek has a similar flow response. The Wilpinjong Coal Mine has been monitoring flow in Wilpinjong Creek since 2006, including at flow monitoring points upstream of the Wilpinjong Coal Mine in the vicinity of the Moolarben Stage 2 Project. This data has been used to understand surface water flows within Wilpinjong Creek which indicates in drier periods creek flow is restricted to a few days following significant rainfall events, while in wetter periods flow may continue for several months at a time.

The surface drainages and connected alluvial aquifers of the Wollar Creek catchment form the Wollar Creek Water Source. The Wollar Creek Water Source is one of a number of distinct water sources that are managed for extraction in accordance with the rules of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (HUAWSP). The Wollar Creek Water Source forms part of the Goulburn Extraction Management Unit, which is one of four extraction management units

defined by the HUAWSP. The availability of water for extraction from the Wollar Creek Water Source (and from eleven other water sources) is based on the long-term annual average extraction from the Goulburn Extraction Management Unit.

Wollar Creek and its connected alluvial aquifer is the major tributary of the Wollar Creek Water Source. It is the only creek line within the Wollar Creek Water Source that is monitored by a permanent NSW Office of Water (NOW) stream flow gauge. There is also a number of NOW groundwater monitoring bores established within the Wollar Creek alluvial aquifer. This is generally indicative of the higher level of reliable available surface and alluvial groundwater associated with Wollar Creek, which supports surface and alluvial water extraction for farming, irrigation and other uses. It is also indicative of the lower level of reliable water available and less productive land areas situated elsewhere in the Wollar creek catchment (such as Murragamba, 'Eastern' and Wilpinjong creeks).

MCM has previously reported the predicted alluvial groundwater take and associated baseflow reductions that will result from the proposed Moolarben Stage 2 Project. For the Wollar Creek Water Source this equates to 236 ML/year, comprising:

- up to 168 ML/year of direct and indirect take of alluvial groundwater – 160ML/year of this volume is attributed to direct loss of groundwater within mined alluvium, a further 1.8ML/year is attributed to loss of recharge to alluvium; and
- up to 68 ML/year of indirect take of baseflow from Murragamba and Wilpinjong creeks (and tributaries where relevant).

A summary of the previously reported predicted quantum and timing of this water take against the Moolarben Stage 2 Project schedule is summarised below:

Mine Year	Alluvial Groundwater Mine Inflows (ML/year)	Connected Surface Water Baseflow Reduction (ML/year)	Total Combined Alluvial* and Connected Surface Water Take (ML/year)
Year 0	0	0	0
Year 2	0.8	3.2	165.8
Year 4	0.0	6.1	167.9
Year 6	0.0	6.7	168.5
Year 8	0.3	6.8	168.6
Year 10	5.6	34.6	202.0
Year 12	6.5	57.6	225.9
Year 14	6.0	64.1	231.9
Year 16	6.1	65.7	233.6
Year 18	5.0	66.7	233.5
Year 20	3.6	67.9	233.3
100 Years Post-Mining	0	9.2	9.2

* Note: The total predicted alluvial water take includes mine inflows plus 160ML/year loss of groundwater from mined alluvium and 1.8ML/year from loss of recharge. These quantities were previously described in the 13 June 2012 RPS Aquaterra report: *Moolarben Stage 2 – Groundwater Accounting and Water Sharing Plan Summary*, which was provided to the NOW and the Department on 18 June 2012 and 17 October 2012, respectively.

According to the HUAWSP there are 78 unit shares of unregulated river access licences and 1,354 unit shares of aquifer access licences available for trade within the Wollar Creek Water Source. There are also 0.04ML/day (14.6ML/year) of domestic and stock rights (combined unregulated river and aquifer basic landholder rights use) and 19ML/year of domestic and stock access licences accounted for in this water source.

This indicates there is limited market availability of unregulated river access licences but adequate market availability of aquifer access licences within the Wollar Creek Water Source. Further, there are limited basic rights users within this water source compared to other water sources within the HUAWSP area. According to the HUAWSP basic rights use in the Wollar Creek Water Source accounts for less than 0.6% of all basic rights use within the Goulburn Extraction Management Unit. It is also noted that since the commencement of the HUAWSP practically all private landholdings within the Wollar Creek catchment have been acquired by mining companies (i.e., Moolarben, Ulan and Wilpinjong coal mines).

Yancoal has discussed the mechanisms available under the *Water Management Act 2000* (WM Act) and HUAWSP to enable MCM to lawfully account for the predicted Stage 2 water take from the Wollar Creek Water Source with NOW legal officers (Tim Holden and Alex O'Mara). Yancoal has also sought separate legal advice on this matter.

MCM has previously advised it has an option agreement to acquire a 218 ML aquifer access licence within the Wollar Creek Water Source. Further, that it proposes to convert 68 ML of this licence to an unregulated river access licence. This will enable MCM to account for the majority of the predicted Wollar Creek Water Source water take associated with the Moolarben Stage 2 Project. The proposed licence conversion will result in a small residual shortfall (18 ML) in alluvial entitlements that will need to be made up through additional aquifer access licence purchases, or through some other appropriate alternative mechanism.

2. Water Licensing Considerations

In our meeting on 2 April 2013, the Department and NOW requested further clarification on MCM's ability to license alluvial and connected surface water impacts on the Wollar Creek Water Source associated with the development of the proposed Moolarben Stage 2 Project.

As previously indicated, MCM proposes using aquifer access licence entitlements to account for the Stage 2 related impacts on both alluvial and connected surface waters within the Wollar Creek Water Source. This will require converting a share of available aquifer access licence entitlements to unregulated river access licence entitlements.

While this conversion is lawful under the rules of HUAWSP the Department and NOW have requested MCM:

- Demonstrate that the proposed conversion is consistent with the relevant principles of the *Access Licence Dealing Principles Order 2004* (ALDP Order).
- Consider the proposed conversion against the information requirements in section 3.2.3 of the NSW Aquifer Interference Policy (AIP).
- Consider whether the proposed access licence conversion will have any subsequent adverse impact on downstream water users, particularly basic landholder rights users.

2.1 Water Sharing Plan Rules

Clause 72(b) of the HUAWSP permits conversion (under Section 71O of the WM Act) of an aquifer access licence to an unregulated river access licence within the Wollar Creek Water Source.

Hence the proposed conversion is lawfully permitted under the rules of the HUAWSP.

2.2 Access Licence Dealing Principles

Applications for access licence dealings (such as the proposed access licence conversion) are required to be considered against the principles of the ALDP Order.

A summary of the potential effect of the proposed access licence conversion against the dealing principles is provided in **Attachment 1**. Only those aspects of the dealing principles relevant to the proposed dealing have been considered. The relevant principles for the purpose of considering the proposed access licence conversion are contained in clauses 7 to 11 of the ALDP Order. (Note dealings principles serve two purposes – to guide development of Water Sharing Plan dealing rules and to regulate or prohibit particular dealings).

In summary, the proposed conversion of an aquifer access licence to an unregulated river access licence (equivalent to 68 units) in the Wollar Creek Water Source:

- Will not result in adverse impacts on environmental water and water dependent ecosystems.
- Will not cause adverse water quality impacts.
- Will not adversely affect any areas of high conservation value, including areas of indigenous, cultural, heritage or spiritual significance.
- Will not increase extraction commitments above sustainable levels.
- Will not result in adverse impacts on basics rights or other access licence users.
- Will enable social and economic benefits associated with the trade of water to be maximized.

Hence the access licence conversion within the Wollar Creek Water Source is consistent with the dealings principles of the ALDP Order.

Consequently there is nothing in the ALDP Order to inhibit or prevent the proposed access licence conversion and the dealing should be allowed to proceed lawfully in accordance with the rules of the HUAWSP.

2.3 Aquifer Interference Policy

The AIP commenced in September 2012 and describes the general assessment requirements for aquifer interference activities. Section 3.2.3 of the policy sets out the information requirements for proponents to enable an assessment of the proposed activity against the minimal impact considerations of the AIP.

NOW has requested MCM consider the proposed access licence conversion against the information requirements of section 3.2.3 of the AIP. A summary of the potential effect of the proposed access licence conversion against these considerations is provided in **Attachment 2**.

The proposed access licence conversion is required to enable MCM to account for the predicted indirect take of unregulated river water from the Wollar Creek Water Source as a consequence of carrying out the proposed development.

In summary:

- There is sufficient, adequate and appropriate baseline monitoring data to support the proposed access licence conversion and the Moolarben Stage 2 Project.
- There are no cease-to-pump or commence-to-pump rules established within the HUAWSP for access licences within the Wollar Creek Water Source. However the water sharing plan allows the Minister to make such rules during the life of the plan. If such rules are made during the life of the plan or in any subsequently revised plan over the life of the Moolarben Stage 2 Project then MCM will implement measures to return water that may be taken by the Moolarben Stage 2 Project during any such period where such a rule may apply.
- There are no private landholdings with river frontage to Wilpinjong Creek or that have access to a connected alluvial aquifer on Wilpinjong Creek. Hence no private basic rights users within the Wollar Creek Water Source will be affected by the proposed conversion or the Moolarben Stage 2 Project.
- The majority of land within the Wollar Creek catchment is mine-owned. Hence no privately owned landholding using an access licence within the Wollar Creek Water Source will be affected by the proposed conversion (or the Moolarben Stage 2 Project). There are no other access licence or works approvals within the Wollar Creek Water Source in the vicinity of the Moolarben Stage 2 Project that would cause the access licence conversion to contravene the distance restrictions that apply to the water source within the HUAWSP.
- There are no high priority groundwater dependent ecosystems (GDEs) identified in the HUAWSP for the Wollar Creek Water Source. There are some local GDEs within the Moolarben Stage 2 Project area but the majority of these are derived from or associated with groundwater discharges from non alluvial aquifers (i.e. Permian coal formation aquifers, which are not part of the Wollar Creek Water Source and are not managed under the rules of the HUAWSP).
- There will be a reduction in saline water from palaeochannel and underlying Permian coal formation aquifers discharging to surface waters and connected alluvial aquifers as a result of the Moolarben Stage 2 Project, which will beneficially improve water quality in Wilpinjong Creek in the long-term.
- The hydraulic connection between non-alluvial aquifers and alluvial aquifers and connected surface waters will be locally altered by the Moolarben Stage 2 Project. The final post-mine groundwater level is predicted to be lower than the pre-mining level which is expected to reduce groundwater discharge and subsequent baseflow contributions to Wilpinjong Creek lower than pre-mining levels. Appropriate licence entitlements will be retired to account for any associated long-term effects.
- There will be no risk to the stability of the banks of Wilpinjong Creek as a result of the Moolarben Stage 2 Project.

The impacts of the Moolarben Stage 2 Project on local water resources have been assessed in detail by technical specialists. The outcomes of these assessments including management and mitigation of impacts is described in detail in the Stage 2 Environmental Assessment Report, Preferred Project Report, Response to Submissions Report and other supporting documents. The information contained within these reports adequately addresses the information requirements of the AIP for consideration of the proposed access licence conversion. (Note the AIP was introduced post preparation of these reports).

3. Alluvial Aquifer Connectivity

In its letter to the Department dated 17 May 2013 NOW has questioned whether the groundwater model has accurately presented the connectivity between the proposed Moolarben Stage 2 Project and alluvial water sources. NOW has indicated that if the level of connectivity is significantly higher than that presented by the model then this could lead to:

- Under predicted alluvial groundwater mine inflows and potentially greater baseflow reductions in Wilpinjong Creek in the short term.
- Potential adverse impacts on alluvial water quality in the long term.

3.1 Re-evaluated "Worst Case" Water Take Impacts

MCM has carried out further modelling to investigate the quantum of water take from the Wollar Creek Water Source assuming a higher level of connectivity between the mine and alluvial aquifers (see **Attachment 3**). This included sensitivity testing of the permeability of local alluvial aquifers. It is noted that local alluvial aquifers or palaeochannel aquifers in the vicinity of the Moolarben Stage 2 Project are not defined on the published geological map for the area, with mapped alluvium identified along Wilpinjong Creek further downstream from the project boundary.

An analysis of the modelling outputs indicates that increasing the permeability of the alluvial aquifers increases connectivity with the mine with resultant increased mine inflows and baseflow reductions. However, the results are inconsistent with infield hydrogeological test results and baseline surface flow and groundwater monitoring data. Hence the derived model outcomes are highly improbable and unrealistic. Notwithstanding, the re-evaluated maximum "worst case" (but highly improbable) water quantity impacts predicted by the model are:

- up to 178 ML/year reduction in Wilpinjong Creek baseflow (or about 0.5 ML/day); and
- up to 256 ML/year of alluvial groundwater inflow to the mine (or about 0.7 ML/day).

A comparison of the re-evaluated highly unlikely (i.e. unrealistic) "worst case" project related water impacts with the more likely (i.e. realistic) water take impacts is presented in the following table:

Model scenario	Estimated maximum alluvial groundwater mine inflows (ML/year)	Estimated maximum reduction in Wilpinjong Creek baseflow (ML/year)
Re-evaluated highly improbable "worst case" impacts, assuming increased alluvium permeability (including the Tertiary palaeochannel) in connection with the mine pit	**256**	**110**
Most probable mine life impacts	**168**	**68**

Note the maximum water take impact occurs at about year 10 of the open cut mine sequence.

The magnitude of these water quantity impacts does not preclude MCM from securing appropriate water licence entitlements to account for the take of water from these water sources.

3.2 Water Quality Impacts

The modelling carried out for the PPR indicated that in the long-term (100 years post-mining) the water table within the backfilled open cut pit would be slightly lower at the northern end of the pit area than the pre-mining water level. This, together with the proposed final void to be retained at the very eastern end of open cut pit, are measures that are expected to keep discharges from the backfilled pit, and baseflow contributions to Wilpinjong Creek, lower than at pre-mining levels. Higher rates of rainfall infiltration to the backfilled pit material are also expected, which will lead to lower salinity groundwater within the backfilled pit compared to pre-mining groundwater quality. Accordingly, the conclusions detailed in previous groundwater impact assessment reports have stated that long-term impacts on water quality in the Wilpinjong Creek system and its associated alluvium will be beneficial not adverse.

4. Contingencies

The modeling indicates that prior to about year 10 of the project the most realistic predicted alluvial groundwater mine inflows and associated base flow reduction is quite modest (i.e. less than 1 ML/year and less than 10 ML/year, respectively). This is primarily due to mining occurring in areas distal to the alluvial aquifers and connected surface water sources. Hence there is adequate time to monitor the effect of the Moolarben Stage 2 Project on these water sources prior to potentially higher impacts being realised.

To assist in this regard MCM will:

- Refine its monitoring program to include additional piezometers within alluvial areas (including palaeochannel areas).
- Undertake periodic model re-calibration, including at two years after commencing coal extraction, then at five yearly intervals for the life of the mine.

In the event this indicates that re-modelled or realised direct and indirect water take from alluvial aquifers and connected surface water sources in the Wollar Creek Water Source is higher than predicted then MCM will either:

- Permanently or temporarily trade additional water entitlements to account for the additional water take. This may require an additional access licence conversion to that proposed above due to the limited depth of unregulated river

access licence entitlements within the Wollar Creek Water Source. (Note MCM has identified access licence holders who are willing to enter into a temporary trade).

- Implement return flows (of a suitable quality) to Wilpinjong Creek to account for the increased water take impacts on the creek. This is consistent with the AIP. (Note returning water back to the creek may also be required where the Minister may in future years implement cease-to-pump provisions for the Wollar Creek Water Source).
- Investigate other reasonable and feasible mitigation measures to reduce the total direct and indirect water take due to the Moolarben Stage 2 Project from alluvial aquifers and connected surface waters.

We trust this information will enable the Department to finalise its assessment of the Moolarben Stage 2 Project application and we look forward to receiving draft conditions in due course.

If you require further clarification or additional information on any aspect of the above, I can be contacted on (02) 6376 1568, 0429 223 688 or via email at lbowden@moolarbencoal.com.au.

Yours faithfully

Luke Bowden
Environment and Community Relations Manager

Attachments:

1. Consideration of the Aquifer Interference Policy information requirements (section 3.2.3) – aquifer access licence conversion to unregulated river access licence within the Wollar Creek Water Source.
2. Consideration of the Access Licence Dealing Principles Order 2004 to the proposed dealing – aquifer access licence conversion to unregulated river access licence within the Wollar Creek Water Source.
3. Dundon Consulting Pty Limited letter report dated 7 June 2013.

ATTACHMENT 1

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Consideration of the *Access Licence Dealing Principles Order 2004* to the proposed dealing – aquifer access licence conversion to unregulated river access licence within the Wollar Creek Water Source

Clause	Access Licence Dealing Principle	Consideration of effect of proposed access licence conversion
7	**Impacts on water sources**	
	(1) Dealings should not adversely affect environmental water and water dependent ecosystems as identified in any relevant management plan.	The rules of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (HUAWSP) provide outcomes that protect, preserve, maintain or enhance important river flow dependent and high priority groundwater dependent ecosystems. This is achieved (inter alia) by preventing extraction above the long-term average annual extraction limit determined for each extraction management unit. The Wollar Creek Water Source is part of the Goulburn Extraction Management Unit. The HUAWSP sets the long-term average annual extraction limit for the Goulburn Extraction Management Unit as the total of all licensed extraction from water sources within this extraction management unit at the commencement of the plan (2009), including basics rights use. The proposed dealing seeks to convert an aquifer access licence to an unregulated river access licence. The proposed dealing will not increase the total extraction from the Wollar Creek Water Source and will therefore not increase extraction above the long-term average annual extraction limit that has been set for the Goulburn Extraction Management Unit. Hence the proposed dealing will not affect the planned environmental water established and protected by the HUAWSP. There are no high priority groundwater dependent ecosystems identified in the HUAWSP for the Wollar Creek Water Source. The report card for the Wollar Creek Water Source indicates: • the water source has a low relative instream value; and • there is a low risk to instream value from extraction impacts.
	(2) Dealings should be consistent with any strategies to maintain or enhance water quality identified in any relevant management plan.	The report card for the Wollar Creek Water Source indicates: • alluvial groundwater is of good quality but is underlain by saline water associated with Permian coal measure formations; and • a loss in alluvial freshwater results in reduced water quality. The proposed dealing will reduce the volume of groundwater extracted under alluvial access licence thereby potentially reducing any adverse affect on water quality resulting from extraction of alluvial freshwater. The report card also indicates: • the relative instream value is low and there is a low risk to instream value from extraction impacts. Overall there will an improvement in water quality due to: • reduced aquifer access licence extraction for irrigation; and • reduced localised saline groundwater baseflows (as a result of the mining activity).
	(3) In unregulated river water sources, dealings should not increase commitments to take water from water sources or parts of water sources identified in any relevant management plan as being of high conservation value.	There are no specifically defined management zones within the Wollar Creek Water Source that apply to either unregulated river or aquifer access licences and there are no areas identified within the water source as having high conservation value. The Wollar Creek Water Source is part of the Goulburn Extraction Management Unit. The HUAWSP sets the long-term average annual extraction limit for the Goulburn Extraction Management Unit as the total of all licensed extraction from water sources within this extraction management unit at the commencement of the plan (2009), including basics rights use. The proposed dealing seeks to convert an aquifer access licence to an unregulated river access licence. The proposed dealing will not increase the total extraction from the Wollar Creek Water Source and will therefore not increase extraction above the long-term average annual extraction limit that has been set for the Goulburn Extraction Management Unit. The report card for the Wollar Creek Water Source indicates: • licensed water use within the water source equates to 2.63% of total water use within the Goulburn Extraction management Unit. Hence the proposed dealing will not increase the total extraction from the Wollar Creek Water Source or the Goulburn Extraction management Unit. The report card also indicates: • the water source has a low relative instream value; and • there is a low risk to instream value from extraction impacts.

Clause	Access Licence Dealing Principle	Consideration of effect of proposed access licence conversion
7	**Impacts on water sources (cont'd)**	
	(4) In unregulated river water sources or groundwater sources, dealings should not increase commitments to take water from water sources or parts of water sources above sustainable levels identified in any relevant management plan.	The Wollar Creek Water Source is part of the Goulburn Extraction Management Unit. The HUAWSP sets the long-term average annual extraction limit for the Goulburn Extraction Management Unit as the total of all licensed extraction from water sources within this extraction management unit at the commencement of the plan (2009), including basics rights use. The HUAWSP provides rules to protect environmental water, basic landholder rights and available water under other access licences for the Goulburn Extraction Management Unit and its component Wollar Creek Water Source. There are no flow classes or cease to pump (or commence to pump) rules established in the HUAWSP for the Wollar Creek Water Source. However, the Minister may set flow classes by year ten of the plan (based on studies to set appropriate trigger levels). There is no total daily extraction limit established (or assigned) in the HUAWSP for the Wollar Creek Water Source, however there is no unassigned total daily extraction limit for the water source. There is no individual daily extraction limit established (or assigned) to access licences in HUAWSP for the Wollar Creek Water Source. There are no separate or specifically defined management zones within the Wollar Creek Water Source that apply to either unregulated river or aquifer access licences. The HUAWSP recognises the connectivity between surface and groundwater. The report card for the Wollar Creek Water Source indicates: • licensed water use within the water source equates to 2.63% of total water use within the Goulburn Extraction management Unit. The proposed dealing will not increase the total extraction from the Wollar Creek Water Source and will therefore not increase extraction above the long-term average annual extraction limit that has been set for the Goulburn Extraction Management Unit. The proposed dealing seeks to convert an aquifer access licence to an unregulated river access licence. The proposed dealing will result in conditions relating to aquifer access licence extraction being transferred to the unregulated river access licence. The report card for the Wollar Creek Water Source indicates there are visible flow triggers on some access licences.
	(5) and (6)	Not relevant to the proposed dealing.
8	**Impacts on indigenous, cultural, heritage or spiritual matters**	
	(1) Dealings should not adversely affect geographical and other features of indigenous significance.	There are no registered geographical landforms or registered features of indigenous significance (i.e. Aboriginal Places) within the Wollar Creek Water Source. The Goulburn River National Park and Munghorn Gap Nature Reserve which form the headwaters to part of the Wollar Creek Water Source are upstream of the proposed mining activity and there will be no impact on these estate areas from the proposed licence dealing.
	(2) Dealings should not adversely affect geographical and other features of major cultural, heritage or spiritual significance.	There are no registered geographical landforms or registered features of indigenous significance (i.e. Aboriginal Places) within the Wollar Creek Water Source. There are no lands of cultural significance to Aboriginal persons listed in Schedule 14 of the National Parks and Wildlife Act 1974 within the Wollar Creek Water Source.
9	**Impacts on water users**	
	(1) Dealings should not adversely affect the ability of a person to exercise their basic landholder rights.	There are no privately-owned properties with river frontage to Wilpinjong Creek[1]. Hence the proposed dealing will not adversely affect unregulated river basic rights use for private landholders on Wilpinjong Creek. Freehold land with river frontage or access to connected alluvial aquifers on Wilpinjong Creek is either owned by MCM, Ulan Coal Mine or Wilpinjong Coal Mine. There are no other basic landholder rights users (including harvestable rights users, unregulated river users or bore users) within the Wollar Creek Water Source that will be adversely affected by the proposed dealing. The commensurate reduction in alluvial access licence entitlements that will result from the proposed conversion may improve the ability of basic rights users to extract bore water from the alluvial aquifer connected to Wollar Creek, however the majority of landholdings within the Wollar Creek catchment are now mine-owned (see footnote 1).

[1] Appendix 7 to Wilpinjong Coal Project Approval 05-0021 (as modified)

Clause	Access Licence Dealing Principle	Consideration of effect of proposed access licence conversion
9	**Impacts on water users (cont'd)**	
	(2) Dealings should have no more than minimal effect on the ability of a person to take water using an existing approved water supply work and any associated access licences. This should be addressed by constraints on dealings established in access licence dealing rules in relevant management plans.	There are no privately-owned properties with river frontage to Wilpinjong Creek and the majority of landholdings within the Wollar Creek catchment are now mine-owned (see footnote 1). The adjacent Wilpinjong Coal Mine has at least four bores developed into the Wilpinjong Creek alluvial aquifer adjacent to that mine. These bores are located at least 4 km from the Moolarben Stage 2 Project and are not predicted to be adversely affected (quality or quantity) by the Moolarben Stage 2 Project. There are no other existing water supply works or associated access licences within the Wollar Creek Water Source within the vicinity of the proposed Moolarben Stage 2 Project that will be adversely affected by the proposed dealing. The proposed conversion will not create a new work that will contravene the distance rules within the HUAWSP.
10	**Maximising social and economic benefits**	
	(1) The objective of access licence dealings is to help to facilitate maximising social and economic benefits to the community of access licences as required under the objects of the Act. Dealings do this by: (a) allowing water to move between alternative uses, and (b) allowing the establishment of water markets that value the access licences, thereby encouraging investment in water efficient infrastructure, and (c) allowing greater flexibility to access licence holders.	The report card for the Wollar Creek Water Source indicates: • 79% of existing unregulated river access licences and 35% of existing aquifer access licences are used for irrigation; • 10% of existing unregulated river access licences and 65% of existing aquifer access licences are used for industrial purposes; and • there is low economic dependence of the local community on water extracted for irrigation. The report card is silent on the economic dependence of the local community on access licences for industrial purposes. The proposed licence conversion will enable the development of the Moolarben Stage 2 Project which will have social and economic benefits[2]; hence the proposed dealing is consistent with the intent of this clause.
	(2) Subject to other principles in this Order, access licence dealing rules should allow maximum flexibility in dealings to promote the objectives set out in subclause (1).	The proposed licence conversion is consistent with the intent of this clause.
11	**Conversion of access licence to new category**	
	(1) This clause applies to access licence dealings under section 71O of the Act.	The proposed licence conversion is consistent with section 71O of the *Water Management Act 2000*.
	(2) Dealings under section 71O are prohibited: (a) if the licence is proposed to be converted to category regulated river (conveyance) or category estuarine or category coastal or category supplementary, or (b) if the licence is suspended, or (c) if the licence is a specific purpose access licence and there is provision in the regulations or the relevant water sharing plan for applications to be made under section 61 of the Act for new licences of that category/ subcategory in relation to the water source to which the licence relates, or (d) if the licence is a specific purpose access licence and that licence nominates a water supply work on land that gives rise to a domestic and stock right under section 52 of the Act.	Not relevant to the proposed dealing: • the proposed licence conversion is lawful under clause 72(b) of the HUAWSP; • the root aquifer access licence has not been suspended or cancelled; and • the root aquifer access licence (or the proposed unregulated river access licence resulting from the conversion) is not a special purpose access licences as defined by clause 5 of the *Water Management (General) Regulation 2011*.

[2] Moolarben Coal Project Stage 2 Environmental Assessment and Preferred Project Report

Clause	Access Licence Dealing Principle	Consideration of effect of proposed access licence conversion
11	**Conversion of access licence to new category (cont'd)**	
	(3) Dealings under section 71O are prohibited unless provisions of the relevant management plan: (a) protect environmental water from being affected by such dealings, and (b) protect basic landholder rights from being affected by such dealings, and (c) protect the available water under other access licences from being affected by such dealings.	The Wollar Creek Water Source is part of the Goulburn Extraction Management Unit. The HUAWSP provides rules to protect environmental water, basic landholder rights and available water under other access licences for the Goulburn Extraction Management Unit and its component Wollar Creek Water Source. The report card for the Wollar Creek Water Source indicates: • the water source comprises 2.63% of total Goulburn Extraction Management Unit entitlements; • the water source has a low relative instream value; and • there is a low risk to instream value from extraction impacts. The proposed licence conversion will not increase the net take of water from the Wollar Creek Water Source. Refer the consideration to clause 9(1) above in relation to basic rights users. The proposed licence conversion is lawful under clause 72(b) of the HUAWSP.
	(4) The share and extraction components of a new licence issued under a dealing under section 71O must comply with any requirements that are specified in the relevant management plan for a licence granted under section 63 of the Act for the new category.	The HUAWSP prescribes the rules pertaining to the proposed licence conversion and the conditions that may apply to the new licence as a result of the conversion. The proposed dealing will result in conditions relating to aquifer access licence extraction being transferred to the unregulated river access licence. The report card for the Wollar Creek Water Source indicates there are visible flow triggers on some access licences. These rules and conditions are consistent with the intent of this clause.
	(5) Except for where it is otherwise specified in access licence dealing rules in the relevant management plan water allocations remaining in the water allocation account of the cancelled licence are to be credited to the new licence provided there is a forfeiture of an amount that is equal to the difference between the share components of the cancelled licence and the new licence where the new share component is lower. Note. The forfeiture of water from the water allocation account of the converted licence is required to minimise potential impacts on the reliability of water allocations to other licence holders in the following water year.	The HUAWSP prescribes the rules pertaining to the proposed licence conversion and the conditions that may apply to the new licence as a result of the conversion. These rules and conditions are consistent with the intent of this clause.
	(6) The share component on a new access licence issued under a dealing under section 71O is to be of a quantity equal to the quantity on the cancelled licence multiplied by a conversion factor determined by the Minister in accordance with any rules set out in the relevant management plan.	The HUAWSP prescribes the rules pertaining to the proposed licence conversion and the conditions that may apply to the new licence as a result of the conversion. These rules and conditions are consistent with the intent of this clause.
	(7) Conversion factor rules in management plans: (a) must be based on protecting environmental water and basic landholder rights as specified in the management plans, and maintaining available water to other access licences, and (b) are not to be set for the purpose of achieving a reduction in overall water extraction from water sources.	The HUAWSP prescribes the rules pertaining to the proposed licence conversion and the conditions that may apply to the new licence as a result of the conversion. These rules and conditions are consistent with the intent of this clause. Refer the consideration to clause 9(1) above in relation to basic rights users.
	(8) Subject to (4), the extraction component and nominated water supply works on the new licence are to be the same as those that were on the cancelled licence.	The HUAWSP prescribes the rules pertaining to the proposed licence conversion and the conditions that may apply to the new licence as a result of the conversion. These rules and conditions are consistent with the intent of this clause.
	(9) Subject to the other parts of this clause, access licence dealing rules may prohibit or regulate these dealings provided this is done consistent with the principles in Part 2 of this Order.	The HUAWSP prescribes the rules pertaining to the proposed licence conversion and the conditions that may apply to the new licence as a result of the conversion. These rules and conditions are consistent with the intent of this clause, and clauses 7 to 10 (i.e. Part 2 of the *Access Licence Dealing Principles Order 2004*).

ATTACHMENT 2

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Consideration of the Aquifer Interference Policy information requirements (section 3.2.3) – aquifer access licence conversion to unregulated river access licence within the Wollar Creek Water Source

Information requirement	Consideration of the proposed project against the AIP information requirement
Establishment of baseline groundwater conditions including groundwater depth, quality and flow based on sampling of all existing bores in the area potentially affected by the activity, any existing monitoring bores and any new monitoring bores that may be required under an authorisation issued under the *Mining Act 1992* or the *Petroleum (Onshore) Act 1991*.	Baseline monitoring of groundwater levels and groundwater quality has been maintained across the area of potential impact of the Moolarben Stage 2 Project since 2005. The monitoring network includes more than 30 bores (mostly standpipe piezometer bores, but with a small number of multi-level vibrating wire piezometer bores) developed into different groundwater bearing strata within the Moolarben Stage 2 Project area and within the Wollar Creek Water Source catchment. Piezometers have been installed to monitor groundwater level and quality within the following aquifer units: • Quaternary Alluvium; • Tertiary paleochannel deposits; • Upper Triassic (and overlying Jurassic where present); • Lower Triassic; • Upper Permian coal measures; • Middle Permian coal measures; • Ulan Seam coal measures; • Shoalhaven Group (Marrangaroo Formation and Nile SubGroup); and • Basement (consisting mostly of granites and metavolcanics). (Note only the Quaternary alluvium and potentially the Tertiary paleochannel deposit aquifers, where connected to surface water sources, are managed under the rules of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (HUAWSP)). The baseline monitoring data has been reported in the groundwater impact assessment reports for the Moolarben Stage 2 Project. A selection (23) of the standpipe bores are monitored monthly for water level, six monthly for pH, TDS and EC, and annually for a comprehensive analysis including major anions, cations and metals. The results of this monitoring is reported annually in the Moolarben Stage 1 Annual Environmental Management Report (AEMR). The groundwater assessment report presented in the Moolarben Stage 2 Preferred Project[1] included hydrographs for all monitoring bores covering the period 2005 to 2011. Hydrographs for the period September 2011 to August 2012 are presented in the Moolarben Stage 1 2011-2102 AEMR[2]. Monitoring and reporting of groundwater levels and quality will continue for the life of the Moolarben Stage 2 Project.
A strategy for complying with any water access rules applying to relevant categories of water access licences, as specified in relevant water sharing plans. For example, returning water of an acceptable quality to the affected water source during periods when flows are at levels below which water users are not permitted to pump.	The majority of the Moolarben Stage 2 Project will be developed within the Murragamba and 'Eastern' creek sub-catchments of the Wollar Creek Water Source. Direct and indirect water take arising from the project will need to be licensed under the rules of the HUAWSP for the Wollar Creek Water Source. The predicted combined alluvial and connected surface water take (resulting from mine inflows and baseflow reductions) from the Wollar Creek Water Source due to the Moolarben Stage 2 Project[3] is 236 ML/year, comprising: • Up to 168 ML/year of direct and indirect take of alluvial groundwater, which will require accounting against an aquifer access licence. (Note 160ML/year of this volume is attributed to direct loss of groundwater within mined alluvium, a further 1.8ML/year is attributed to loss of recharge to alluvium). • Up to 68 ML/year of indirect take of baseflow from Murragamba and Wilpinjong creeks (and tributaries where relevant), which will require accounting against an unregulated river access licence. The HUAWSP prescribes the water access rules applicable to volumetric water licensing within the Wollar Creek Water Source. The Wollar Creek Water Source is part of the Goulburn Extraction Management Unit. The HUAWSP sets the long-term average annual extraction limit for the Goulburn Extraction Management Unit as the total of all licensed extraction from water sources within this extraction management unit at the commencement of the plan (2009), including basics rights use. There are no flow classes or cease to pump (or commence to pump) rules established in the HUAWSP for the Wollar Creek Water Source, however, flow classes may be set by year ten of the plan (based on studies to set appropriate trigger levels). There is no total daily extraction limit established (or assigned) in the HUAWSP for the Wollar

[1] Appendix E of the PPR

[2] Moolarben Coal Annual Environmental Management Report 2011-2012 (available at www.moolarbencoal.com.au)

[3] Moolarben Stage 2 – Groundwater Accounting and Water Sharing Plan Summary, RPS Aquaterra report, June 2012

Information requirement	Consideration of the proposed project against the AIP information requirement
	Creek Water Source, however there is no unassigned total daily extraction limit for the water source. There is no individual daily extraction limit established (or assigned) to access licences in the HUAWSP for the Wollar Creek Water Source. There are no specifically defined management zones within the Wollar Creek Water Source that apply to either unregulated river or aquifer access licences. Notwithstanding the above, where the Minister may vary the specific rules relating to extraction of water under the HUAWSP then Moolarben Coal Mines (MCM) will abide by these rules. This may require either increasing the volume of access licences held by MCM by trading within the water market for the Wollar Creek Water Source or alternatively investigating and implementing measures to reduce the direct and indirect take of water from the water source. This may require: • returning water of a suitable quality to the unregulated river system at times when flows are at levels below which water users are not permitted to pump; • implementing engineering controls to reduce or avoid pit inflows (such as low permeability barriers); or • some other appropriate alternate mechanism.
Details of potential water level, quality or pressure drawdown impacts on nearby water users who are exercising their right to take water under a basic landholder right. Consideration will need to be given to any relevant distance restriction requirements that may be specified in any relevant water sharing plan or any remediation measures to address these impacts.	There are no privately-owned properties with river frontage to Wilpinjong Creek[4]. Hence the proposed Moolarben Stage 2 Project will not adversely affect unregulated river basic rights use for private landholders on Wilpinjong Creek. Freehold land with river frontage or access to connected alluvial aquifers on Wilpinjong Creek is either owned by MCM, Ulan Coal Mine or Wilpinjong Coal Mine. There are no other basic landholder rights users (including harvestable rights users, unregulated river users or bore users) within the Wollar Creek Water Source (or adjacent Upper Goulburn River Water Source) that will be adversely affected by the proposed dealing. The impact of the proposed project on all non-water sharing plan groundwater related users was assessed in the groundwater impact assessment for the project[5].
Details of potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources.	There are no nearby private landholdings with alluvial aquifer access licences or connected unregulated river access licences within the Wollar Creek Water Source (or adjacent Upper Goulburn River Water Source) that will be adversely affected by the Moolarben Stage 2 Project. The adjacent Wilpinjong Coal Mine has at least four bores developed into the Wilpinjong Creek alluvial aquifer adjacent to that mine. These bores are located at least 4 km from the Moolarben Stage 2 Project and are not predicted to be adversely affected (quality or quantity) by the Moolarben Stage 2 Project[6].
Details of potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems.	There are no high priority groundwater dependent ecosystems identified in the HUAWSP for the Wollar Creek Water Source. The report card for the Wollar Creek Water Source indicates: • the water source has a low relative instream value; and • there is a low risk to instream value from extraction impacts. Wilpinjong Creek and its tributaries are intermittent streams with highly variable flow regimes, responding principally to rainfall events – in drier years, flow periods may be restricted to a few days following significant rainfall events while in wetter periods, when the catchment soils and shallow aquifers are fully saturated, flow may continue for several months at a time. Localised water dependent ecosystems have adjusted to this regime[7]. The existence of localised water dependent ecosystems associated with Murragamba Creek, 'Eastern' Creek and Wilpinjong Creek, as well as springs and seepages, has been identified in the ecological studies for the proposed Moolarben Stage 2 Project[8]. Water level and quality impacts on these water dependent ecosystems were assessed in the groundwater impact assessment for the project[9]. This assessment identified that up to 43 localised water dependent ecosystem sites associated with dams, soaks, seeps and waterholes will be mined out by the development of the proposed Moolarben Stage 2 Project open cut pit. The majority of these sites are associated with groundwater discharge from the Permian coal formation including the weathered regolith.
Details of potential for increased saline or contaminated water inflows to aquifers and highly connected river systems.	The report card for the Wollar Creek Water Source indicates: • alluvial groundwater is of good quality but is underlain by saline water associated with

[4] Appendix 7 to Wilpinjong Coal Project Approval 05-0021 (as modified)

[5] Appendix L to Appendix E of the Moolarben Coal Project Stage 2 Preferred Project Report

[6] Appendix E of the Moolarben Coal Project Stage 2 Preferred Project Report

[7] Appendix C to Wilpinjong Coal Mine 2011 Modification Environmental Assessment

[8] Appendix 7 to Moolarben Coal Project Stage 2 Environmental Assessment

[9] Appendix E to Moolarben Coal Project Stage 2 Preferred Project Report

Information requirement	Consideration of the proposed project against the AIP information requirement
	Permian coal measure formations. The proposed Moolarben Stage 2 Project will improve surface water quality downstream of the project due to the temporary reduction in saline groundwater seepages that currently contribute to stream baseflow. During mining, groundwater quality of localised alluvial aquifers is predicted to improve due to a reduction in saline leakage from the underlying Permian coal formation. Further water quality improvements are expected from a higher rate of rainfall infiltration into backfilled pit material compared with pre-mining infiltration rates to the in-situ alluvial aquifer. Post-mining, the groundwater that accumulates within the backfilled pit is expected to be of lower salinity than the pre-mining salinity of the alluvium and other unconsolidated material (colluvium and weathered bedrock) due to both a higher rate of rainfall infiltration and a reduced contribution of saline leakage or seepage from the underlying Permian coal formation. A proposed final void at the eastern end of the Stage 2 open cut pit will ensure that a groundwater sink is always present in that area, ensuring that any saline groundwater that might emerge over the very long term will be contained within the groundwater depression associated with this groundwater sink. No releases of contaminated water are contemplated for the proposed Moolarben Stage 2 Project. However, any unforeseen future need for water discharge from the Moolarben Stage 2 Project would be consistent with the relevant conditions of an appropriate Environmental Protection Licence granted under the *Protection of the Environment Operations Act 1997.*
Details of the potential to cause or enhance hydraulic connection between aquifers.	The proposed Moolarben Stage 2 Project will result in a number of changes to the existing stratigraphy and hydraulic connection between aquifers. Within the proposed open cut pit, mining will remove all strata down to the Ulan Seam. This strata is currently heterogeneous in relation to both lithology and permeability, and comprises an alternating sequence of low permeability sandstones, siltstones, claystones and conglomerates, with moderately permeable coal seams. Thus the strata is alternately poorly permeable and moderately permeable, resulting in a sequence that has a very low overall permeability vertically across the bedding, with moderate overall horizontal permeability parallel with bedding within the occasional coal seams. Following mining, the open cut will be backfilled with excavated overburden and interburden material, which at small scale is highly heterogeneous, but at larger scale is much more homogeneous than the in-situ rock (i.e. the pre-mining situation). The backfilled material will result in an increased degree of hydraulic connection from the surface down to the base of the Ulan Seam, within the former open cut footprint. This is likely to result in more active recharge down to the base of the Permian strata than currently occurs (i.e. the pre-mining situation). Within the proposed underground mining areas, the Ulan Coal Seam will be substantially removed from areas within the longwall panel footprints. Subsidence fracturing will enhance vertical permeability and horizontal permeability within the subsided zones above extracted panels. This will result in a more interconnected aquifer system within the Permian strata, and possibly with the near surface weathered sandstone bedrock layer. However, this will not affect water sources managed under the HUAWSP. This was described in the groundwater impact assessment for the Moolarben Stage 2 Project[10].
Details of the potential for river bank instability, or high wall instability or failure to occur.	The proposed open cut mine will be generally set back from the banks of Wilpinjong Creek by greater than 200m. Hence there will be nil risk of river bank instability in Wilpinjong Creek due to the location of the open cut mine. The proposed design for the re-construction of mined through areas of Murragamba and 'Eastern' creeks incorporates specific measures to establish and maintain stable banks along the reconstructed creeks. A detailed monitoring and management plan will be prepared and implemented prior to re-construction of the creeks. Post construction bank stability will be confirmed by monitoring to ensure stable banks are maintained and water quality protected. The proposed mine design includes a small final void located in the eastern area of the Moolarben Stage 2 open cut pit. This void will be located at least 750m from Wilpinjong Creek or its connected alluvium, with the highwall of the void located at an even greater distance from the creek. The design of the final highwall will ensure there is no potential for instability or failure or subsequent adverse impact on the Wollar Creek Water Source.
Details of the method for disposing of extracted water (in the case of coal seam gas activities).	This proposal is not a coal seam gas activity. Currently there is no proposal for off-site water discharge into the Wollar Creek Water Source. However, any unforeseen future need for water discharge from the Moolarben Stage 2 Project would be consistent with the relevant conditions of an appropriate Environmental Protection Licence granted under the *Protection of the Environment Operations Act 1997.*

[10] Ibid

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ATTACHMENT 3

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7 June 2013

Moolarben Coal Mines Ltd
Locked Bag 2003
MUDGEE, NSW 2850

Attention: Mr Michael Moore

Dear Michael,

Re: Email from NOW to DoPI dated 19 April 2013, with attached internal NOW memo dated 9 April 2013

This letter has been prepared to respond to the matters raised by John Williams (NOW) in his internal email to Michael Williams dated 9 April 2013. This memo was forwarded by email to David Kitto (DoPI) on 19 April 2013 by Mitchell Isaacs (NOW). The Isaacs email and attached Williams memo were forwarded to Yancoal on 22 April 2013 by Sara Wilson (DoPI).

The Isaacs email of 19 April states:

> *"As I understand, it comes down to our technical guys having a different interpretation of the underground scenario, while I understand the data is consistent with both interpretations.*
>
> *My understanding is that our guys' conceptual model has the extent of the paleochannel more closely linked with the surface water system, resulting in a higher level of connectivity than has been modelled. I don't know the significance of this as I don't think it has been modelled.*
>
> *I would expect that a proponent should consider these alternative conceptual models, consistent with the Australian Groundwater Modelling Guidelines, and consider the impacts of both.*
>
> *I understand that Kalf did not examine if the location of the data points was adequate to resolve between these two models.*
>
> *I would hope to see:*
> *- Modelling of a higher level of connectivity so that we can understand the impacts of this through the development of an associated water balance*
> *- Consideration of collection of additional data to provide greater certainty to a particular conceptual model. I'm not sure of the feasibility of this.*
> *- Monitoring plan developed to ensure that we can improve our understanding of the connectivity as any activity progresses, and reassess the impacts on the water resources*
> *- A contingency plan to address what actions will be taken if the conceptual model is not correct, and how impacts will be mitigated.*

The Williams internal NOW memo is attached (Attachment A). The principal conclusions of that memo were:

- NOW considers that the bore network used to characterise the paleochannel and alluvial aquifers had limitations, leading to an inaccurate (in NOW's view) interpretation that there is only limited hydraulic connectivity between the paleochannel and alluvial aquifers and the present Murragamba Creek and Wilpinjong Creek drainage system.
- The level of investigation related to impacts with open cut coal mining on the paleochannel and alluvial aquifers is not commensurate with the risk posed. It is unknown whether the Stage 2 proposal would adhere to the minimal impact considerations of the AI Policy.

The Williams memo recommends *"... in accordance with the NSW Aquifer Interference Policy (page 27) that*

- *A model and associated water balance be prepared with the NOW conceptualisation used*
- *The proponent provides an undertaking to hold all entitlement projected to be required in the appropriate water sources."*

The Aquifer Interference Policy at page 27 states (inter alia) that:

> *"Proponents of any project that may be defined as an aquifer interference activity under the Water Management Act 2000 will also be required to provide estimates of all quantities of water that are likely to be taken from any water source during and following cessation of the activity and all predicted impacts associated with the activity, based on the following minimum requirements:*
>
> - *if a development consent under Part 4, Division 4.1 of the EP&A Act applies or for any mining or CSG production activity not subject to the Gateway, estimated based on complex modelling platform that is:*
>
> - *calibrated and validated (where practical) to the available baseline data that has been collected at an appropriate frequency and scale and over a sufficient period of time to incorporate typical temporal variations. In instances where an activity has a high likelihood of causing more than minimal harm to a "reliable water supply", at least 2 years of baseline data is required; and*
> - *consistent with the Australian Groundwater Modelling Guidelines; and*
> - *independently reviewed and determined to be robust and reliable, and deemed fit-for-purpose to the satisfaction of the Minister; and*
>
> - *if a development consent under Part 4, Division 4.1 or Part 5.1 of the EP&A Act has been granted or for any approved mining or CSG production activity that was not subject to the Gateway, the NSW Office of Water will recommend that a condition of approval require that the maximum of the predicted annual water quantities are to be licensed from the commencement of the activity regardless of when water will actually commence to be taken. This is required to eliminate any risk of there being insufficient market depth from which to obtain the necessary water entitlements at any point in time in the future. The proponent should therefore demonstrate during the planning assessment process that these licences can be acquired if development consent is granted."*

Further to the receipt of the correspondence discussed above, Yancoal sought a meeting with representatives of NOW to discuss the matters raised by NOW and to agree on specific actions to address them. This meeting was held in the NOW offices on Tuesday 7 May 2013.

Following that meeting, Mitchell Isaacs (NOW) forwarded a letter to David Kitto (DoPI) dated 17 May 2013, which summarised the outstanding NOW concerns as follows:

> *"Should the level of connectivity be significantly higher than presented by the proponent, the impacts could include:*
>
> *a. Short term, increased inflows to the mine, and reduced base flows to the Wilpinjong Creek*

b. Longer term, potential for impacts on water quality in the alluvium if there was a reversal in groundwater flow from mine spoil into the alluvium.

In order that the Office of Water can better understand the scale of these risks, I request that the proponent provide an estimation of the impacts that could occur if a significantly higher level of connectivity did in fact occur.

Further, I request that any approval be conditioned to ensure that:

- *Prior to commencement of activities, a monitoring plan be developed to ensure that understanding of the actual connectivity will be improved as the activity progresses, and the impacts on the water resources be reassessed*
- *The proponent develops a mitigation strategy to ensure that both water quantity and water quality risks from a higher than predicted level of connectivity can be effectively addressed*
- *The proponent be required to hold all entitlement projected to be required in the appropriate water sources, as revised from time to time with improved data."*

This response has been prepared in accordance with the specific requirements detailed in the various correspondence discussed above.

Nature of Tertiary Paleochannel Alluvium and Quaternary Alluvium

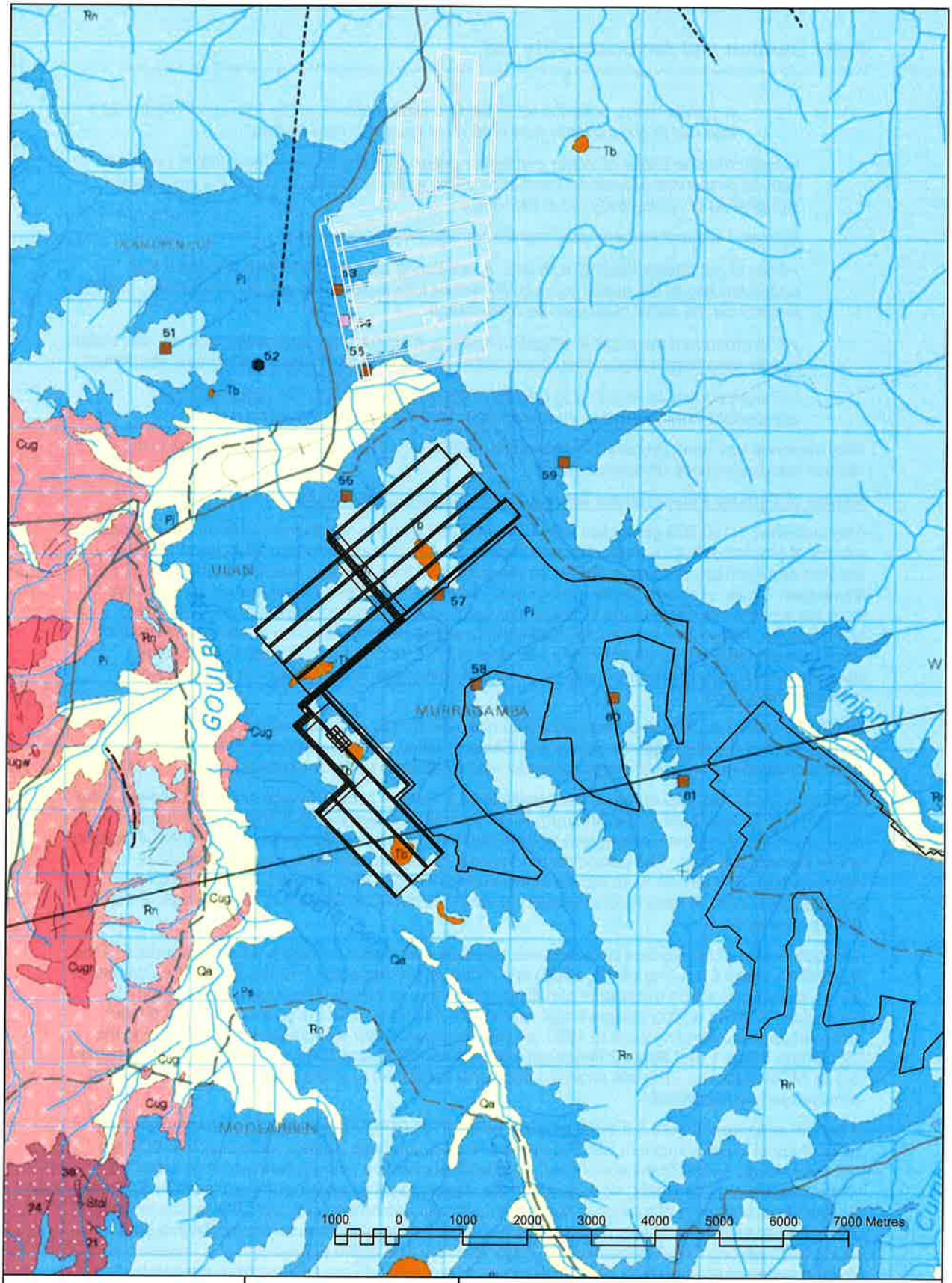
The published 1:100,000 geological map (Gulgong 8823) shows no alluvium at all in the immediate vicinity of Moolarben's OC4 (see attached **Figure 1**). Quaternary alluvium, associated with the present day drainage system, is shown on the published map in areas extending upstream into the Moolarben Creek – Lagoon Creek system, and within the Wilpinjong Creek system downstream from the eastern boundary of the Moolarben project area. But no alluvium is shown within the Murragamba Valley, and even along Wilpinjong Creek there is an absence of alluvium along the section extending from south of UG4 to well east of OC4, close to the Wilpinjong mine. The paleochannel alluvium, which is believed to be of Tertiary age, is only known in the area from drilling intersections.

Drilling by MCM has revealed unconsolidated material (mostly colluvium rather than alluvium) across parts of the Murragamba Valley and Eastern Valley, but generally as a thin veneer of unconsolidated material that merges laterally with weathered bedrock material.

Drilling by MCM has also revealed the presence of a Tertiary paleodrainage which is believed to be the remnant former route of the Goulburn River drainage system before it shifted to its present northerly route along the western side of UG4 and thence through the Permian and Triassic outcrop areas towards the east. The paleochannel deposits have been drilled to maximum depth of approximately 375 mAHD, ie to depths below surface of up to 50m or more, depending on the surface elevations. A base level of erosion around 375 mAHD is consistent with the bulk of the drilling intersections.

The distribution of the Tertiary paleochannel alluvium was shown on Figure 4.3 in Appendix 5 of the Moolarben Stage 2 EA (Aquaterra, 2008) and Figure 3.3 in Appendix E of the PPR (RPS Aquaterra, 2011), based entirely on the results of drilling, as there is no clear surface expression of the paleochannel. The drilling included coal exploration drilling by both the government and private coal companies extending back to 1980, as well as groundwater piezometers installed during the Moolarben Stage 1 and Stage 2 investigations between 2005 and 2008. Further coal drilling carried out by MCM since the PPR has provided additional confirmation of the paleochannel in areas that were not previously drilled.

It can be seen from Figure 3.3 in Appendix E of the PPR (RPS Aquaterra, 2011) that the Tertiary paleochannel is not coincident with the present surface drainage system, indicating that they are not ubiquitously hydraulically connected. Hydraulic connection could potentially exist in places where the two are coincident, such as along the tributary that extends north-east towards Splitters Hollow Dam, and parts of the upper Murragamba Creek catchment, although differences in water levels and groundwater quality suggest that even in those areas hydraulic connectivity is poor. Much of Wilpinjong Creek is located well away from the axis of the paleochannel. Likewise the lower reaches of Murragamba Creek traverse rock outcrop, and are isolated from the paleochannel.



DATE: 5 June 2013	SCALE: 1 : 80 000	**Moolarben Coal Operations Limited**
AUTHOR: MAR CHECKED: PJD	PROJECT NO: 13-0264	**OC4 Boundary on Gulgong 1:100,000 Geological Map**
DRAWING NO: 0264-001	REVISION: 0	
Dundon Consulting Pty Ltd		**Figure 1**

John Williams in his memo indicated that in his opinion, the groundwater bores used to determine the hydraulic properties of the alluvium were not likely to be typical of the most permeable parts of the alluvium. He questioned whether the hydraulic conductivity values adopted for the groundwater model were appropriate, and suggested that the values used could lead to (in the short term) an under-estimate of the amount of baseflow reduction that would be caused by the mining of OC4, and (in the longer term) an under-estimate of the potential for saline discharges from the backfilled mine area to the Wilpinjong Creek system, and thence to the Goulburn River. He also suggested that the connectivity between the alluvium and the present creek system is being under-represented by the groundwater model.

Each of these assertions is addressed in turn.

Hydraulic Conductivity Used for the Alluvium in the Groundwater Modelling

We believe that the adopted hydraulic conductivity values are truly representative of the alluvium, as explained below.

The values used in the model for the Quaternary and Tertiary alluvium were as follows:

Table 1: Hydraulic Conductivity Values Used for Alluvium in Stage 2 and PPR Modelling

Alluvium Zone (refer Figure 2)	Hydraulic Conductivity Values Used in Modelling (m/d)				Comment
	Stage 2 EA		PPR		
	Kh	Kv	Kh	Kv	
Quaternary alluvium	3.0	0.1	3.0	0.1	Limited development – shallow depth localised occurrence. Distribution defined from published geological map.
Tertiary paleochannel alluvium – Moolarben Creek (east of OC3)	0.7	0.07	0.7	0.07	Limited presence. Distribution determined from coal exploration drilling.
Tertiary paleochannel alluvium – region between UG4 and upstream of OC4	1.0	0.005	1.0	0.005	Trunk paleochannel – distribution defined from coal exploration drilling and limited groundwater monitoring bores and test bore.
Tertiary paleochannel alluvium – Murragamba and Eastern Creek valleys, and Wilpinjong Creek valley adjacent to OC4	0.4	0.005	1.5[1]	0.15	Trunk and tributary paleochannels – distribution defined from coal exploration drilling and groundwater monitoring bores.

The distribution of the above alluvium zones in the PPR modelling is shown on the attached **Figure 2**.

[1] Note that the PPR groundwater assessment report RPS Aquaterra (2011) stated that the hydraulic conductivity values used for the fourth zone in **Table 1** above were Kh = 0.4 m/d and Kv = 0.005 m/d. However, in fact the values used in the modelling were not the same as those that had been used in the Stage 2 groundwater assessment (Aquaterra, 2008) but were increased to 1.5 m/d (Kh) and 0.15 m/d (Kv) respectively. The change was made in the model, but was not picked up in the report text or figures.

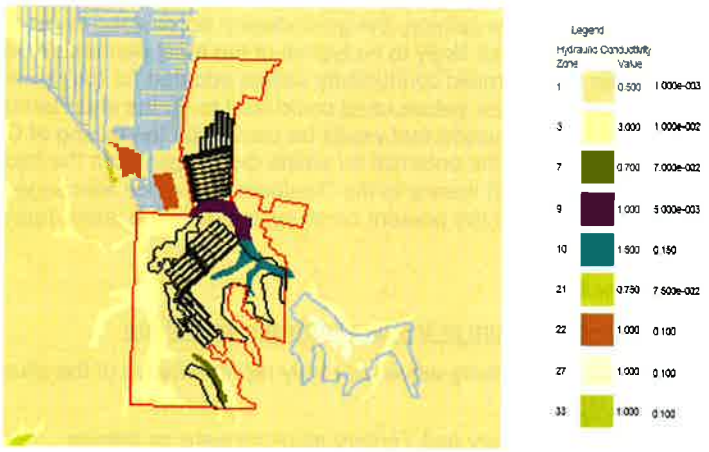


Figure 2 – Hydraulic Conductivity Zones as Modelled in PPR Groundwater Assessment

The hydraulic testing results that were primarily used to derive values of hydraulic conductivity for the groundwater model were as follows:

Table 2: Hydraulic Testing Results Used to Determine Hydraulic Conductivity Values Used for Alluvium in Stage 2 and PPR Modelling

Bore	Type of Test	Date Tested	Discharge Rate (L/s)	Transmissivity (m^2/d)	Average Horizontal Hydraulic Conductivity (m/d)
Quaternary Alluvium:					
PZ50C	Slug	11 Apr 2006	-	-	1.4
PZ55	Slug	1 Apr 2006	-	-	0.9 / 0.3*
PZ58	Slug	7 Nov 2005	-	-	0.21 / 0.05*
PZ72C	CR pumping test	31 Mar 2006	0.2	6.1	2.0
	Recovery			9.2	3.0
Tertiary Paleochannel Alluvium – Moolarben Creek:					
PZ58	Slug	7 Nov 2005	-	-	0.21 / 0.05*
Tertiary Paleochannel Alluvium – Wilpinjong Creek System:					
PZ52	CR pumping test	8 Dec 2005	0.2	1.5	0.05 – 0.125
TB52B	CR pumping test	22 Feb 2006	2.0	6.1	0.2 – 0.8
	Recovery			6.1	0.2 – 0.8
PZ166	CR pumping test	30 Apr 2008	0.2	1.2	0.2
	Slug test	30 Apr 2008	-	-	0.2
PZ181	CR pumping test	28 Jul 2008	0.13	1.1	0.4
PZ183	Slug test	29 Jul 2008	-	-	0.3
Regolith – Murragamba Creek Valley:					
PZ165	Slug test	22 May 2008	-	-	0.01
PZ167	Slug test	5 May 2008	-	-	0.18
PZ173	Slug test	29 Apr 2008	-	-	0.10
PZ177	Slug test	8 May 2008	-	-	0.15

* Early time data/late time data

The above testing results are presented in the Moolarben Stage 2 PPR groundwater assessment report (RPS Aquaterra, 2011).

Based on the above testing results, the choice of horizontal hydraulic conductivity values in the model is considered reasonable. It is our opinion that the results of hydraulic testing should be preferred over assumed values based on textbook permeability ranges for typical types of alluvium.

The most significant test result is that from bore TB52B. This bore was constructed as a test or production bore, with 150mm diameter casing and screens, specifically to test the potential of the paleochannel alluvium as a water supply source. The site for this bore, close to the site of coal bore DMWP03R, was chosen on the basis of the information derived from the available coal exploration bore logs. The log from DMWP03R reported alluvium to 47m depth, which is close to the deepest intersection in the records, and included the thickest intersection of gravels (17m). The alluvium was described as follows in the log:

0-8m	medium and coarse clayey sand
8-25m	pebbly gravel, poorly sorted, becoming granular below 14m
25-47m	medium and coarse clayey sand, subrounded.

The pumping test on TB52B was a 7 hour test conducted at a rate of 2L/s. It revealed a transmissivity of 6.1 m^2/d, which equates to an average hydraulic conductivity of 0.2 to 0.8 m/d. The bore is located close to the confluence of the main trunk paleochannel and a tributary which is interpreted to extend to the north-east sub-parallel to the upper section of Wilpinjong Creek. This site is thus likely to be at the higher end of the range of permeability within the paleochannel system. The relevance of the determined hydraulic conductivity value in relation to the ranges of values suggested in various hydrogeology textbooks is discussed below.

The groundwater modelling carried out for the Stage 2 EA and the PPR assumed full hydraulic connectivity between the alluvium and the stream system. The recent alluvium associated with the present drainage system (Quaternary alluvium) and the paleochannel alluvium (Tertiary) are both included in the same model layer. The layer thickness reflects the true thickness of the paleochannel alluvium where present, based on the depths revealed by drilling. Finally, the stream bed conductance value assumed in the model was uniformly high (1000 m^2/d) which ensures no impedance to flow between the groundwater and the stream in either direction. Hence, where the streams overlie the paleochannel, full interconnection is assumed in the model.

Comparison of Adopted Conductivity Values with Textbook Ranges for Types of Paleochannel Alluvium

To compare the test results and the adopted model values with textbook ranges of hydraulic conductivity, we have undertaken a detailed analysis of the sample descriptions in the bore logs of all bores that drilled into paleochannel alluvium. We have firstly extracted from the logs of all bores that reportedly drilled more than 5m thickness of alluvium[2], including both coal exploration holes and the groundwater monitoring bores and test bores installed by MCM, the descriptions of the alluvium to determine the proportions of different types of alluvium within the total alluvium formation. All bores reporting alluvium to greater than 5m were included.

The descriptions of the alluvium drilled in these bores show that there is a substantial variability in the grain size of the alluvium, ranging from clay to silt to fine sand, medium sand, coarse sand and gravel. The sample descriptions also show that the material is commonly poorly sorted, although there are some sites where relatively clean, well sorted granular material has been described.

[2] The term "alluvium" as used here includes all unconsolidated material other than that which is clearly identifiable as in-situ weathered bedrock. It therefore includes true alluvium, colluvium and some highly weathered and totally decomposed bedrock which has an appearance that is almost indistinguishable from alluvium. This analysis of alluvium distribution is therefore potentially an over-statement of the extent of true alluvium.
In some of the oldest coal exploration bore logs, the material that was drilled by rotary methods before coring commenced is denoted in the logs merely as "open hole". In these cases, it has been assumed that all of this material could be "alluvium" (as described above).

Next, a search of the literature was undertaken to determine typical values for hydraulic conductivity for different types of alluvium. This search revealed the following:

Domenico and Schwartz[3]		
Gravel	hydraulic conductivity range	26 – 2600 m/d
Coarse sand	"	0.08 – 520 m/d
Medium sand	"	0.08 – 40 m/d
Fine sand	"	0.02 – 17 m/d
Bear[4]		
Well sorted gravel	hydraulic conductivity range	900 – 90000 m/d
Well sorted sand or sand and gravel	"	0.9 – 900 m/d
Very fine sand, silt	"	0.00009 – 0.9 m/d
Freeze and Cherry[5]		
Gravel	hydraulic conductivity range	27 – 27000 m/d
Clean sand	"	0.3 – 270 m/d
Silty sand	"	0.03 – 27 m/d
Silt	"	0.00003 – 0.3 m/d
Clay	"	<0.0003 m/d
Fetter[6]		
Well sorted gravel	hydraulic conductivity range	9 – 900 m/d
Well sorted sands	"	0.9 – 90 m/d
Silty sands, fine sands	"	0.009 – 0.9 m/d
Silt, sandy silts, clayey sands	"	0.0009 – 0.09 m/d
Clay	"	0.000001 – 0.001 m/d
Clapp and Hornberger[7] (soil permeability)		
Sand	average hydraulic conductivity	15 m/d
Sandy loam	"	3 m/d
Silty loam	"	0.6 m/d
Sandy clay loam	"	5.5 m/d
Sandy clay	"	0.02 m/d
Silty clay	"	0.009 m/d
Clay	"	0.01 m/d.

The above ranges from the literature reveal two things of note. Firstly, there is considerable difference between the texts, particularly for the coarser materials (gravels and coarse sand). Secondly, the ranges for all types of alluvium are very large, generally covering several orders of magnitude. The hydraulic conductivity of alluvium is highly variable, mainly due to variable degrees of sorting (clean gravels would be much more permeable than sandy or clayey gravels), and also

[3] "Physical and Chemical Hydrogeology", by P Domenico and F Schwartz, 1990 (Wiley)
[4] "Dynamics of Fluids in Porous Media", by J Bear, 1972 (Dover Publications)
[5] "Groundwater", by R A Freeze and J A Cherry, 1979 (Prentice Hall)
[6] "Applied Hydrogeology", by C W Fetter, 2001 (Pearson)
[7] "Empirical equations for some soil hydraulic properties", by R B Clapp and G M Hornberger, 1978 (Water Res Research, 14/4, p 601)

due to variable degrees of compaction (loosely packed gravels would be much more permeable than densely packed gravels). Mixtures of different grain sizes lead to a substantially lower permeability as the smaller sized grains infill the spaces between the larger grains.

Most of the literature sources refer to clean materials. However, Freeze and Cherry suggest a range for silty sand, and quote average soil hydraulic conductivities suggested by Clapp and Hornberger, including silty loam, sandy loam, sandy clay loam, sandy clay and silty clay, which illustrate the effect of poor sorting on hydraulic conductivity. No reference could be found for poorly sorted gravel or clayey gravels, or conglomerate. However, the results of hydraulic testing on bore TB52B as discussed above suggest that poor sorting and/or the presence of clay or silt with the gravel is likely to result in hydraulic conductivity values very much at the lower end of (or even below) the ranges quoted for clean, well-sorted gravels. Conglomerate, being indurated rather than unconsolidated, is likely to have a very much lower hydraulic conductivity than gravel or mixed sand and gravel.

An analysis of the sample descriptions for the 20 bores located within the main trunk paleochannel shows the following distributions of various types of material:

Table 3: Distribution of Different Types of Alluvium Material in Main Trunk Paleochannel (total metres drilled and percent of total)

Description	Below SWL – total metres drilled (20 bores in all)	Percentage of total alluvium below SWL	Representative hydraulic conductivity value (based on textbook ranges – see below) (m/d)	Component of total hydraulic conductivity for paleochannel alluvium as a whole (m/d)
Clean gravel	60.0	14	20	2.8
Mixed gravel and sand	70.5	16	10	1.6
Clean sand fine-coarse	105.3	24	5	1.2
Clayey gravel	9.5	2	0.5	0.01
Clayey sand-gravel	22.8	5	0.1	0.005
Poorly sorted clayey sand	76.1	18	0.05	0.009
Silt	2.0	0.5	0.01	0.00005
Clay / silty clay / clayey silt	55.6	13	0.001	0.00013
Conglomerate	30.0	7	0.0001	0.000007
Total	431.8	100	-	5.6

Appropriate textbook values for hydraulic conductivity have been assigned to the different types of alluvium in **Table 3** above, and then used to compile an equivalent conductivity value for the alluvium, based on the proportions of each type of alluvium derived from the logs of bores located within the interpreted trunk paleochannel. The textbook values selected are towards the lower end of the ranges from the textbooks, but not right at the lower end.

This approach leads to an equivalent hydraulic conductivity value of 5.6 m/d, based on textbook values (**Table 3**). This is higher than, but of the same order as, the values actually adopted in the groundwater modelling. The model adopted values for the paleochannel near OC4 are in fact intermediate between the values determined from testing and the nominal textbook-derived value.

The value of 5.6 m/d derived in Table 3 above is an order of magnitude higher than the value determined from the pumping test on bore TB52B. It is considered that the reason for this is probably that the Tertiary alluvium deeper within the paleochannels is less well sorted and probably more compacted (or indurated) than the typical granular alluvium considered by the textbook

authors when compiling their ranges for unconsolidated alluvial sediments. It should be noted that the values used for the paleochannel alluvium in the groundwater modelling are all within the textbook ranges, albeit at the lower end of the ranges.

In conclusion, we believe it is appropriate to rely on the results of testing rather than textbook values, even though the above analysis suggests that a textbook approach might lead to slightly higher values.

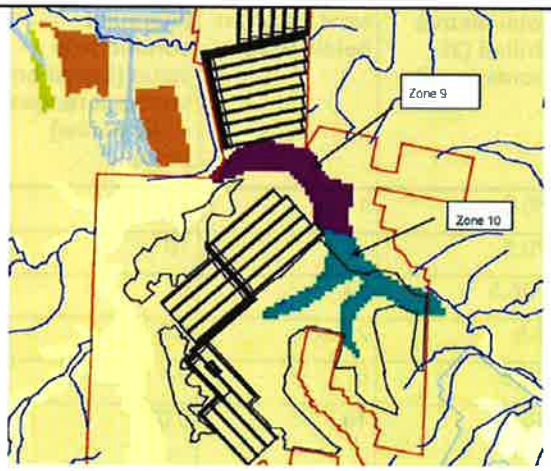
Additional Modelling

However, we have explored with the groundwater model the consequences if a higher value of hydraulic conductivity were to be applied to the paleochannel alluvium. This would assist with the development of contingency actions for the event that hydraulic conductivity values turn out to be higher than the field test results suggest.

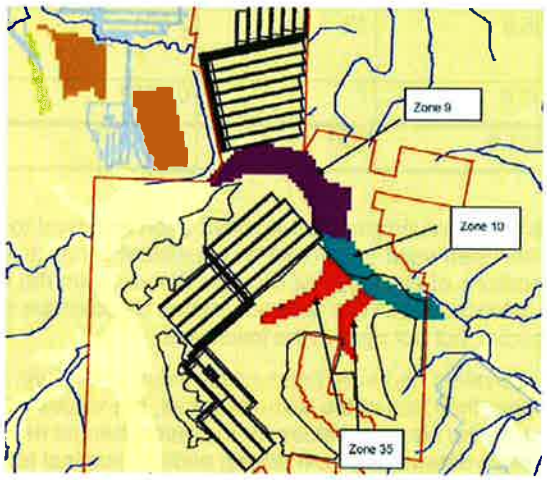
The PPR groundwater model has been re-run for the following two scenarios:

- Scenario 1 – Paleochannel hydraulic conductivity increased to Kh = 10 m/d and Kv = 1 m/d
- Scenario 2 – Trunk paleochannel hydraulic conductivity increased to Kh = 50 m/d and Kv = 5 m/d; tributary paleochannel conductivity increased to Kh = 10 m/d and Kv = 1 m/d.

The distribution of Kh and Kv values for the two scenarios are shown on **Figure 3**.



Scenario 1 **Zone 9: Kh = 10 m/d/Kv = 1 m/d; Zone 10: Kh = 10 m/d/Kv = 1 m/d**



Scenario 2 **Zone 9 and Zone 10: Kh = 50 m/d/Kv = 5 m/d; Zone 35: Kh = 10 m/d/Kv = 1 m/d**

Figure 3 – Hydraulic Conductivity Zones for Paleochannel Hydraulic Conductivity – Scenarios 1 and 2

In both scenarios, the hydraulic conductivity values for the Quaternary alluvium were unchanged from those used in the PPR modelling. All other input parameters were retained with the same values as the modelling completed for the PPR, and all mine progressions were represented with the same drain cell configurations as the PPR modelling.

In both scenarios, no attempt was made to re-calibrate the groundwater model for the higher K values, and starting head conditions assumed for the new scenarios were the same as for the PPR modelling. In other words, the additional scenarios were run using uncalibrated models.

Both scenarios were run twice –

- firstly with all projects (Ulan, Wilpinjong, Moolarben Stage 1 and Stage 2); and
- secondly with all projects except Stage 2 (ie Ulan, Wilpinjong and Moolarben Stage 1).

By subtracting the predicted impacts of the "without Stage 2" model from the "all projects" model, the incremental impacts due to Stage 2 only could be determined.

The results have been determined for pit inflows and baseflow impacts.

In the two additional scenarios modelled, total pit inflows to OC4 are predicted to increase slightly above those predicted in the PPR modelling, as illustrated on **Figure 4**.

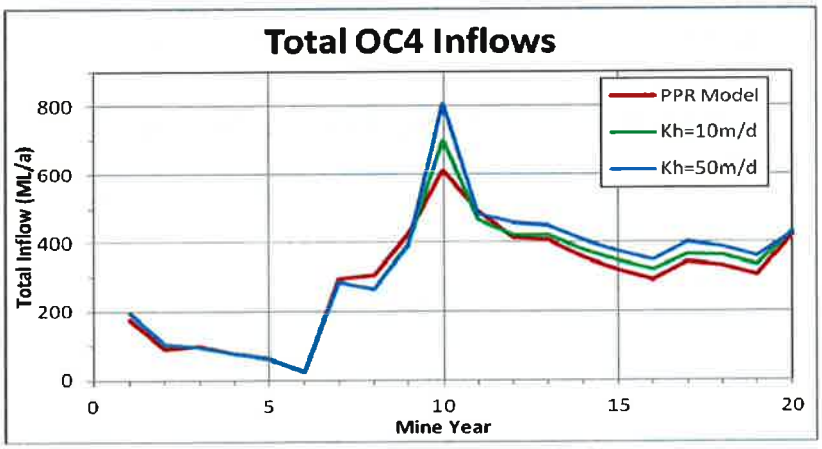


Figure 4 - Predicted Total Groundwater Inflows to OC4 (Alluvium + Permian)

The peak inflow, which occurs in Year 10, is predicted to be up to 14% higher (for Kh = 10 m/d) or 31% higher (for Kh = 50 m/d) than predicted in the modelling for the PPR. The inflows shown on **Figure 5** are total inflows, ie from both alluvium and Permian, however as the only changes from the PPR model are the changed hydraulic conductivity values in the paleochannel alluvium, it is reasonable to assume that the majority of the increase in total inflows will be inflows from the paleochannel alluvium.

Baseflow impacts from Moolarben Stage 2 are also predicted to be higher in the two higher K modelling scenarios. Baseflows include both alluvium and Permian baseflow contributions.

The baseflows have been extracted from the model outputs for three river reaches, R107 (Murragamba Creek system), R108 (Wilpinjong Creek upstream of the Murragamba Creek confluence) and R109A (Wilpinjong Creek between the Murragamba Creek and the boundary of the Wilpinjong project).

The locations of these reaches are shown on **Figure 5**.

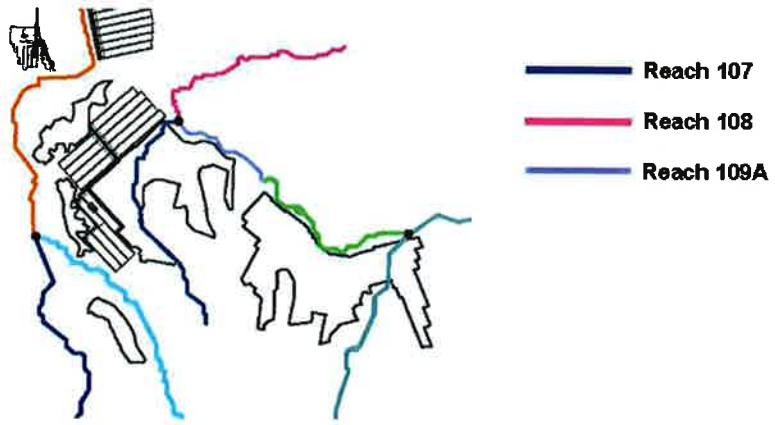


Figure 5 – Locations of Surface Water Reaches 107, 108 and 109A

Figure 6 shows comparative baseflow reductions due to Moolarben Stage 2 in the above three reaches combined. It is seen that maximum baseflow reduction is predicted to be 178 ML/a for the Kh = 10m/d case, compared with maximum baseflow reduction of 67.1 ML/d in the PPR modelling. For a Kh of 50m/d, the maximum baseflow reduction is predicted to be 191.8 ML/a, compared with 67.1 ML/a for the PPR modelling.

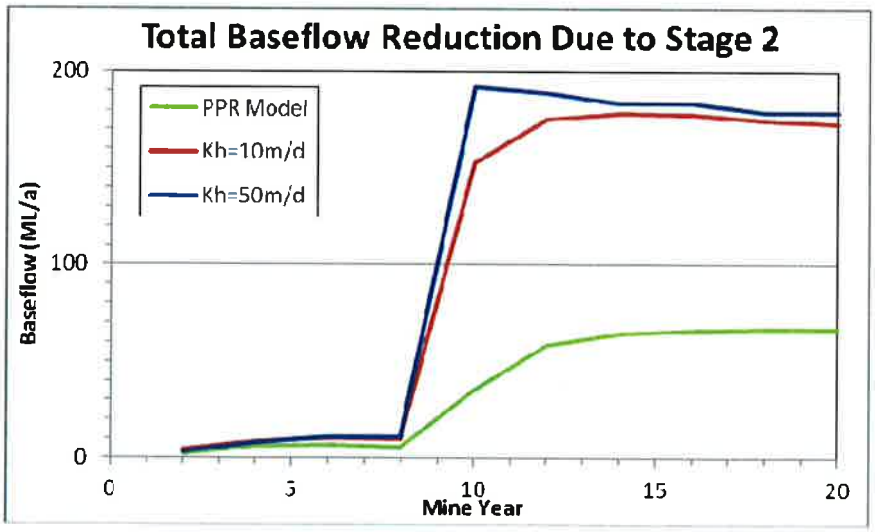


Figure 6 – Predicted Baseflow Reduction Due to Stage 2 - Reaches R107, R108 and R109A

However, the predicted impacts due to Stage 2 (ie the incremental increase in impact between the "all projects" model and the "no Stage 2" model) have been determined with models that are uncalibrated, the implications of which are discussed further below. Hence the impacts predicted must be considered with caution. The unreliability of these predicted impacts is perhaps best illustrated by consideration of the total pre-Stage 2 baseflows predicted by the two high permeability model scenarios, compared with actual observed stream flows.

Total baseflows predicted by the two new scenarios are found to be unrealistically high, as illustrated by **Figure 7**. This graph shows a comparison of the actual streamflows monitored at Wilpinjong Coal Mine's gauging station MOOLC003 on Wilpinjong Creek, just upstream of the Murragamba Creek confluence, during an early part of the streamflow record (October-November 2010), with the pre-mining baseflows predicted for reach R108 in the PPR and the two new modelling scenarios. All are converted into units of ML/d.

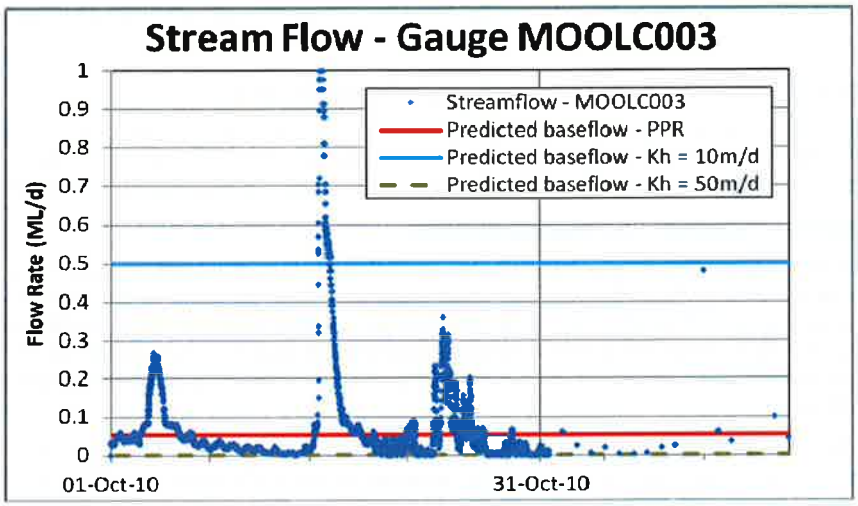


Figure 7 - Monitored Streamflow vs Predicted Baseflows - Gauge MOOLC003 (Wilpinjong Creek)

The PPR model predicted a pre-Stage 2 baseflow of 20.5 ML/a, or 0.056 ML/d, for Reach R108, whereas the Kh = 10m/d scenario model predicted a pre-Stage 2 baseflow of 180 ML/a, or 0.5 ML/d. The Kh = 10m/d baseflow is not consistent with the actual streamflows monitored at the gauge, whereas the PPR model baseflow is.

Note also that the Kh = 50m/d scenario predicts zero baseflow for this reach, as in this model the groundwater heads are predicted to be below the bed level of Wilpinjong Creek. This also is not consistent with the actual streamflows monitored at the gauge, or the observed groundwater levels in that area.

The models with higher K values for the paleochannel alluvium are not calibrated models, as stated earlier. In order to calibrate the two new models with observed heads and baseflows in Wilpinjong Creek, it would be necessary to adjust other parameters in the model, such as recharge rates, or the hydraulic conductivity values of other model layers, and then re-run the full sequence of prediction models. It is expected that if this were done, the predicted impacts due to the Moolarben Stage 2 project would end up similar to those already predicted by the PPR model.

Notwithstanding this limitation, the scenario modelling exercise does give an indication of the potential affect that higher permeability of the paleochannel alluvium would have on predicted impacts, if nothing else were changed, and acknowledging that these predictions are from un-calibrated models. It provides some guidance for a plausible upper bound of impacts, and may assist MCM to developing an appropriate contingency measure.

MCM may for example commit to purchasing additional licence allocations (above the commitments made in the PPR) in the event that permeabilities are ultimately found to be higher. If inflows or baseflow impacts are found to be higher than predicted, this would not occur until Year 9 or Year 10. Thus there is ample time to monitor the impacts from the first few years of mining, and gain more detailed information about the nature of the paleochannel alluvium through installation of additional groundwater monitoring bores and ongoing monitoring of groundwater levels and streamflow in the areas around Wilpinjong Creek.

The additional maximum baseflow reduction due to Stage 2 predicted by the Kh = 10m/d scenario model is approximately 110 ML/a[8]. The additional maximum groundwater inflow to OC4 predicted by the Kh = 10 m/d scenario model is 88 ML/a. These numbers may assist MCM with its contingency planning, although they are considered to have an extremely low probability of occurrence (less than 1 %) due to the inconsistency of these predicted impacts with monitored streamflows at the MOOLC003 gauging station as discussed above. The Kh = 50m/d scenario is

[8] This additional baseflow reduction, and the additional groundwater inflow, would be additional to the predicted baseflow impacts and inflows reported in the PPR and supporting documents.

not considered sufficiently valid to take its predicted impacts into account in any contingency planning.

Consistency with Requirements of the Aquifer Interference Policy

Considering the matters raised in the preceding sections of this letter, we believe that the modelling carried out for the PPR, and the proposed purchase of licences to meet the maximum predicted impacts on both groundwater take and baseflow reductions, meet the requirements of the AI Policy.

Additions to the Groundwater Monitoring Network

It s recommended that additional monitoring bores be installed along the northern boundary and the northern end of the eastern boundary of OC4. The locations would be as close as practicable outside of the pit and would be sited to survive the mining activities and not interfere with mining infrastructure. It is envisaged that monitoring bores would be at intervals not greater than 500m, with additional infill locations where deemed necessary. The purpose of these monitoring bores would be twofold:

- To obtain additional information on the nature and distribution of the paleochannel alluvium in areas where there is only limited information at present. All bores would be subjected to hydraulic testing on completion.
- To allow ongoing monitoring of water levels and water quality, throughout the mine life and beyond. It is recommended that all bores be equipped with automated monitoring equipment for both water level and quality, to be supplemented by periodic manual monitoring and sampling.

These additional monitoring bores could be installed during the first year of mining from OC4, to provide sufficient period of monitoring prior to mining approaching the northern pit boundary in around Year 9 or Year 10.

Periodic Model Re-Calibration

It has been recommended in the PPR that the groundwater model would be reviewed frequently, with a formal post-audit and re-calibration proposed initially 2 years after the commencement of coal production, and thereafter every 5 years through the mine life. As additional information comes available from ongoing coal drilling and groundwater drilling, the representation of the paleochannel alluvium should be updated in the model as part of this re-calibration process.

After model re-calibration, the forward prediction modelling should be re-done to confirm the predictions of impacts as detailed in the PPR. In particular, any change to the predicted impacts on the alluvium and streamflows associated with Wilpinjong Creek and its tributaries should be assessed to confirm that adequate licensed entitlements are held to offset the expected impacts.

Long-Term Salinity Issues

The modelling carried out for the PPR indicated that in the long-term (100 years post-mining) the water table within the backfilled OC4 would be slightly lower at the northern end of the pit shell area than the pre-mining water level. This was illustrated in the PPR groundwater impact assessment (RPS Aquaterra, 2011) on Figures 6.9c and 6.11c. These show an east-west cross-section through the model at northing 6423750, firstly pre-mining (Figure 6.9c) and then after 100 years post-mining recovery (Figure 6.11c). The location of this section was shown on Figure 6.8 in that report.

It can be seen that along most of this section the final recovery water level is lower than the pre-mining level. This, together with the proposed final void to be retained at the very eastern end of OC4, are measures that are expected to keep discharges from the backfilled pit, and baseflow contributions to the Wilpinjong Creek system, lower than at pre-mining levels. Higher rates of rainfall infiltration to the backfill material are expected, leading to an overall lower salinity groundwater within the backfill material compared to pre-mining salinity. Accordingly, the conclusions detailed in previous groundwater impact assessment reports have stated that long-term impacts on water quality in the Wilpinjong Creek system and its associated alluvium will be slightly beneficial not adverse.

The effects of higher paleochannel permeability on the long-term salinity were not assessed with the two high K model scenarios. This was not considered to be appropriate as these models were not calibrated models. It is recommended that future model reviews and re-calibration look at this issue, if (although considered unlikely) it transpires that paleochannel permeabilities are in fact

higher than currently believed. If future modelling suggests that long-term saline discharges from the pit area may arise, then contingency measures should then be implemented, with the most likely solution being the incorporation of an additional pit void along part of the northern pit boundary, the purpose of which would be to create a groundwater sink to contain saline groundwater within pit backfill material.

I trust the above satisfactorily addresses the matters raised by NOW in the recent correspondence. Please contact me if you wish to discuss any aspect of this letter report further.

Yours faithfully,

Peter Dundon, Director

Encl Figures:

Figure 1	OC4 Boundary on Gulgong 1:100,000 Geological Map
Figure 2	Hydraulic Conductivity Zones as Modelled in PPR Groundwater Assessment
Figure 3	Hydraulic Conductivity Zones for Paleochannel Hydraulic Conductivity – Scenarios 1 and 2
Figure 4	Predicted Total Groundwater Inflows to OC4 (Alluvium + Permian)
Figure 5	Locations of Surface Water Reaches 107, 108 and 109A
Figure 6	Predicted Baseflow Reduction Due to Stage 2 - Reaches R107, R108 and R109A
Figure 7	Monitored Streamflow vs Predicted Baseflows - Gauge MOOLC003 (Wilpinjong Creek)

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Please consider the environment before printing this email.

>>> David Kitto 24/04/2013 8:10 AM >>>

>>> Mitchell Isaacs 4/19/2013 6:32 pm >>>
David,

Please find attached our internal technical review of Kalf's advice.

As I understand, it comes down to our techncial guys having a different interpretation of the underground scenario, while I understand the data is consistent with both interpretations.

My understanding is that our guys' conceptual model has the extent of the paleochannel more closely linked with the surface water system, resulting in a higher level of connectivity than has been modelled. I don't know the significance of this as I don't think it has been modelled.

I would expect that a proponent should consider these alternative conceptual models, consistent with the Australian Groundwater Modelling Guidelines, and consider the impacts of both.

I understand that Kalf did not examine if the location of the data points was adequate to resolve between these two models.

I would hope to see:
- Modelling of a higher level of connectivity so that we can understand the impacts of this through the development of an associated water balance
- Consideration of collection of additional data to provide greater certainty to a particular conceptual model. I'm not sure of the feasibility of this.
- Monitoring plan developed to ensure that we can improve our understanding of the connectivity as any activity progresses, and reassess the impacts on the water resources
- A contingency plan to address what actions will be taken if the conceptual model is not correct, and how impacts will be mitigated.

Happy to talk further.

Thanks
Mitchell

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Department of Primary Industries
Office of Water

Internal memo

to Michael Williams
Manager Groundwater

cc. Rob Brownbill, Senior Hydrogeologist

from John Williams
Regional Hydrogeologist
A/Team Leader Groundwater

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e Johnpaul.williams@water.nsw.gov.au

date 9 April 2013

Subject: ER20296 Independent Reviewer's response to NOW submission for the Moolarben Coal Mine Stage 2 EIS.

1. Purpose

To provide comment on Dr Frans Kalf's independent groundwater review (9 October 2012) of NOW's response to the Moolarben Stage 2 Environmental Assessment.

2. Background

Department of Planning and Infrastructure (DoPI) engaged Kalf and Associates (KA) to undertake a review and comment on the adequacy of the documents related to the Moolarben Coal Mines Pty Ltd (MCM) Stage 2 Response to Submissions (RTS) that followed the exhibition of the Preferred Project Report (PPR).

The KA response outlines that NOW's submission consisted of the following points:

- Palaeochannel interaction conceptualisation;
- Water Sharing Plan and Groundwater 'Take' by Open Cut 4 from the alluvium;
- Geomorphic review; and
- Adequacy of cumulative Impacts, final void, mitigation, monitoring and outstanding issues.

The primary issue raised by the NOW's assessment of the PPR related to the adequacy of the proponent's assessment of the Palaeochannel extent and their view of the limited potential hydrogeolgical connection with Wilpinjong Creek and the alluvial aquifer. Open cut mining of the palaeochannel carries a significant risk of altering water quality and flows in Wilpinjong Creek and the connected alluvial aquifers.

2.1 Proposal

MCM is located to the east of the village Ulan within the Hunter Valley NSW. In September 2007 MCM was given approval for Stage 1, consisting of 3 open cut pits and one underground mine. Stage 2 comprises one open cut and two underground coal mines with a total estimated coal resource of 292 Mt. **Figure 1** depicts the proposed extent for the open cut and underground mining activities, distribution of MCM monitoring bores and the extent of Quaternary alluvium and Tertiary palaeochannel deposits.

3. Discussion - Palaeochannel channel interaction conceptualisation

In addressing NOW's concerns regarding the palaeochannel, KA have responded as follows:

for gravels and on par with the range expected for silt and silty sands (ref: pg 29, Freeze and Cherry, 1979). A higher permeability would have had a significant influence on the modelling results on water make from the palaeochannel and stream losses. It would be informative to run a model scenario assigning a higher and more characteristic permeability for the Tertiary gravels and Quaternary alluvium.

4. Conclusions

The KA independent review does not address in any detail the concerns raised by NOW in relation to observed limitations with the bore network used to characterise the palaeochannel and alluvial aquifers. Based on the proponent's investigation of the MCM bore network, KA accepts the conceptual model of the alluvial and palaeochannel aquifers without consideration of the concerns with the design of the bore network as raised by NOW. Consequently, the inadequate bore design results in an alternative characterisation of the alluvial aquifer's hydraulic parameters, such that the model exhibits only limited hydraulic connectivity with the present Murragamba and Wilpinjong creek drainage system.

The level of investigation related to the impacts with open cut mining on the palaeochannel and alluvial aquifers as part of Stage 2 is not commensurate with the risk posed. Given the problems we note in the design of the bore network, the proponents conceptual model may not be supported by the data. Hence it is unknown whether the Stage 2 proposal would adhere with the minimal impact considerations of the AI Policy.

The additional issues raised were not part of the Groundwater Unit's submission and are best addressed by the commenting officer.

5. Recommendation

There appears to be a basic disagreement between NOW and the Proponent on the conceptualisation of the aquifers based on the available information. The impact is on the resultant water balances where the proponent largely intercepts recharge and impacts on the volume of groundwater in storage while the NOW interpretation induces more water from the stream and intercepts more groundwater discharge to the stream.

We RECOMMEND in accordance with the NSW Aquifer Interference Policy (page 27) that

- A model and associated water balance be prepared with the NOW conceptualisation used
- The proponent provides an undertaking to hold all entitlement projected to be required in the appropriate water sources.

Endorsed: Rob Brownbill, Senior Hydrogeologist. 16 April 2013

Approved

16th April 2013

R M Williams, Manager Groundwater WRAM

"This issue has been dealt with satisfactorily in the RTS section 4.9.2 that indicates that the palaeochannel was subject to a drilling program, test pumping and slug tests including water sampling. It concludes, '...The Tertiary palaeochannel deposits have only limited hydraulic connectivity with the present Murragamba and Wilpinjong creek drainage system'. Nevertheless the palaeochannels were included in the model as being part of the more recent alluvium in the top most model layer extending where necessary to the total base level of the palaeochannels. This approach is considered to be suitable and conservative including setting the streambeds with large conductances to allow free interaction of stream flow with the underlying alluvial and palaeochannel sediments."

Further:

"Monitoring of the Moolarben site is very extensive when compared to many other mine sites. There are a large number of observation bores and piezometers that should be sufficient to monitor water and pressure levels over the site."

Additionally KA states:

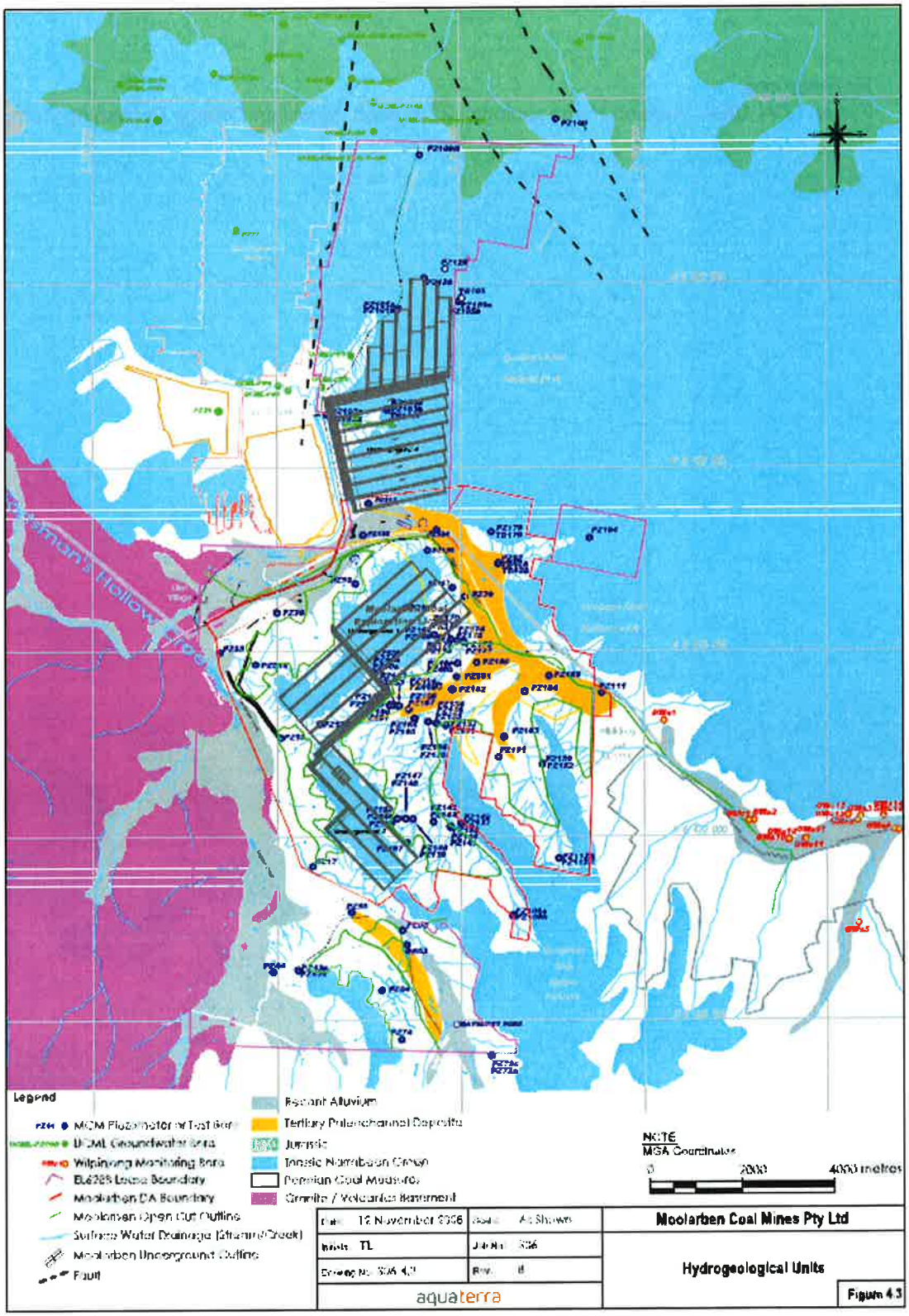
"It should be borne in mind in assessing the importance of the palaeochannels that the groundwater contained in these channels and at shallow depth is brackish to saline and can not be considered to be a potable or an important water source."

It is noted that the KA review does not consider the actual bore construction and location details of the bore network but gives general acceptance on the network adequacy based on the number of bores. The bore network used to characterise the groundwater quality for the different aquifer types is provided in **Figure 1**. The following points were noted as part of the NOW review of the bore network:

- The majority of bores being used to define the alluvial/palaeochannel aquifers are located outside the mapped alluvial/palaeochannel extent (i.e. PZ50C, PZ58, PZ112B PZ72C, PZ177,) and contain elevated salinity concentrations.
- The majority of bores located within the boundary of the alluvial palaeochannel and hard rock areas are only on the smaller tributaries not within the main trunk of the palaeochannel (e.g. PZ112B, PZ166, PZ167, PZ181, PZ183, PZ184) and these contain elevated salinity concentrations.
- The bore logs indicate a discrepancy in placement of the screened interval for bores used to define the alluvium, and in some bores the water intake zone is not set against any alluvial lithology, e.g. PZ181 recorded coal and mudstone at the intake screen depths.
- A 'no result' was reported for water quality PZ180 and PZ182. Both bores were drilled to greater depths than the completed depth. These two bores were located on tributaries of the palaeochannel and bore logs indicate the presence of palaeochannel gravels below the depth of the screened interval. It is unclear why these bores were backfilled and screened at a depth where a sample could not be obtained.
- Three bores are located on the main trunk of the palaeochannel and have reported salinities of less than 500 mg/L.
- Two bores (PZ55, PZ125) that are suitably located on the Moolarben Quaternary alluvium have reported salinities of less than 500 mg/L.

It is expected that at the boundaries of the alluvial aquifer and boundaries of the palaeochannel, the water quality would naturally be more saline and therefore not indicative of the water quality within the broader alluvial / palaeochannel aquifers. As such the bore network used to characterise the palaeochannel / alluvial aquifer system has been designed in a way that does not allow the highest beneficial use of the alluvial groundwater resource to be identified. Similarly this compromises the aquifer permeability determination as the bore design is not sufficiently robust to give adequate representation. The hydraulic conductivity assigned to represent the palaeochannel / alluvial aquifer is 0.4 m/d, which is well below the textbook range

Figure 1 MCM Mine Plan



References

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