ENCLOSURE 2

RESPONSES TO EPA QUERIES

Moolarben Coal Complex – Open Cut Optimisation Modification

Response to NSW Environment Protection Authority Supplementary Submission

OVERVIEW

LIST OF ATTACHEMENTS

1. *Background*

Moolarben Coal Operations Pty Ltd (MCO), a wholly owned subsidiary of Yancoal Australia Limited, is proposing to optimise open cut mining operations at the Moolarben Coal Complex. These optimisations would require MCO to modify Project Approvals for Stage 1 and Stage 2 (herein referred to as the Open Cut Optimisation Modification [the Modification]).

An Environmental Assessment (EA) for the Modification was on public exhibition between 7 November and 7 December 2017, and received submissions from NSW Government Agencies, Non-Government Organisations and members of the public.

MCO considered each submission received for the Modification and submitted a Response to Submissions (RTS) on 24 May 2018.

The NSW Environment Protection Authority (EPA) provided a response to the RTS on 5 July 2018. The comments and requests for information provided by the EPA covered the topics provided in Table 1, below.

Table 1
Reconciliation of EPA Comments / Requests for Additional Information

Topic	Relevant Section
Noise	Section 3
Air quality	Section 4
Proposed salt load to be discharged to the upper Goulburn River	Section 5
Proposed increase in flows in the upper Goulburn River	Section 6
Quality of the proposed discharge waters	Section 7
Cumulative impact of the proposed discharges with those of the Ulan Coal Mine	Section 8
Underground disposal of brine	Section 9

2. Changes to the Modification following Submission of RTS

Controlled Release Limits

Following further consultation with the NSW Department of Planning and Environment (DPE) and the EPA in regard to the Modification, MCO proposes the following changes to controlled release volume and salinity limits:

- **Salinity limit**:
  - Maximum proposed salinity limit of 685 microSiemens per centimetre (µS/cm) (a reduction in comparison to the currently authorised salinity limit of 900 µS/cm in MCO's EPL 12932).
  - This limit is consistent with the 80th percentile upstream salinity level of the Goulburn River (based on combined data collected from monitoring locations UMC SW01 and GS 210046).
- **Volume limits**:
  - Up to 10 ML/day (as currently authorised by EPL 12932) for the remainder of Moolarben Coal Complex mine life, with the exceptions below.
  - Up to 15 ML/day during operations in UG4.
  - As the site water balance for the Modification predicted releases greater than the proposed staged discharge limit (as set out above) would be required during prolonged wet periods, and consistent with discussions with the EPA, the ability to temporarily release greater than the staged discharge limit following prolonged wet periods would be required (to the satisfaction of the EPA and subject to the conditions of EPL 12932 as varied).

The effect of the above is that, when compared to the currently authorised limits of EPL 12932, there would be:

- A reduction in the salinity of controlled releases for the remainder of the mine life.
- A reduction in annual salt loads released to the Goulburn River for the majority of the mine life.
- No increase in the controlled release volume limit for the majority of the mine life.
- The ability for MCO to release water in a controlled manner following periods of prolonged wet weather to minimise the risk of uncontrolled release of mine water.

$PM_{2.5}$ Monitor

To enable the collection of site-specific particulate matter <2.5 micrometres (µm) ($PM_{2.5}$) concentration data, MCO proposes to install a real-time $PM_{2.5}$ monitor.

3. Noise

MCO notes the EPA considers matters relating to noise have now been addressed through the recommended conditions of consent provided in EPA's original response to the exhibited EA.

4. Air Quality

Watering of Roads

In regard to the emission control efficiency of 90% adopted by Todoroski Air Sciences (2017) to model the watering of roads, EPA provided the following recommendation:

> *The EPA recommends a condition of approval requiring the proponent achieve and maintain control efficiency on dust from roads on the premises of 90% or greater at all times.*

MCO does not consider an additional approval condition requiring MCO to achieve and maintain control efficiency on dust from haul roads on-site at 90% or greater at all times to be necessary on the basis that air quality impacts mitigation and performance is already conditioned via the following:

- Condition 20, Schedule 3 of Project Approval (05_0117) and Condition 21, Schedule 3 of Project Approval (08_0135) require MCO to implement best management practice to minimise dust emissions.
- Condition 17, Schedule 3 of Project Approval (05_0117) and Condition 18, Schedule 3 of Project Approval (08_0135) specify air quality criteria for total suspended particles (TSP), particulate matter <10 µm (PM_{10}) and deposited dust.

MCO would continue to implement best management practice at the Moolarben Coal Complex and assess the operations against the air quality criteria provided in Project Approvals (05_0117 and 08_0135) to confirm compliance is being maintained.

Assessment of 24-hour $PM_{2.5}$ concentration

In regard to the assessment of 24-hour $PM_{2.5}$ concentration, EPA provided the following recommendation:

> *The consent authority notes and considers the $PM_{2.5}$ assessment uncertainty and associated assessment results when determining the proposal.*

As noted by the EPA, there is no site-specific $PM_{2.5}$ monitoring data in the vicinity of the Moolarben Coal Complex. In absence of local $PM_{2.5}$ monitoring data, it is not possible to strictly follow guidance in the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* for cumulative assessment of 24-hour average concentrations of $PM_{2.5}$, and this is the reason the EPA refers to uncertainty in the $PM_{2.5}$ assessment.

To enable site-specific $PM_{2.5}$ concentration data to be collected in the future, MCO proposes to install a real-time $PM_{2.5}$ monitor and include this as part of its Air Quality Monitoring Program.

Predictive / Reactive Management Scheme

In regard to predictive and reactive management of air quality, EPA provided the following recommendation:

> *The consent authority note that the RTS does not provide additional and robust analysis demonstrating the current reactive management system effectively prevents all potential additional exceedences of the 24-hr average PM_{10} and $PM_{2.5}$ impact assessment criteria.*

The Moolarben Coal Complex is an operating mine. Therefore, MCO's record of compliance with Project Approval air quality limits is considered to provide robust evidence of the effectiveness of MCO's existing predictive / reactive air quality management system in preventing exceedances of 24-hour average PM_{10} criteria levels.

The predictive / reactive air quality management system would continue for the Modification, and is considered to be directly relevant given the Modification would not result in any material change to the number of fleet items, peak daily intensity of material movement, or the proximity of activities to receivers or exposed areas, which are all key elements that may result in dust emissions.

It should be noted recent monitoring results demonstrate:

- no exceedances of dust deposition criteria over the most recent Annual Review period (2017 calendar year) or Monthly Monitoring Reports for the months January 2018 to June 2018; and
- no exceedances of particulate matter criteria attributable to the Moolarben Coal Complex over the most recent Annual Review Period (2017 calendar year) or Monthly Monitoring Reports for the months January 2018 to June 2018.

As noted above, MCO would further improve its existing Air Quality Monitoring program through the installation of a real-time $PM_{2.5}$ monitor.

MCO considers the evidence of existing performance, in combination with the modelling conducted for the Modification (i.e. which predicts very low risk of exceedances consistent with past performance), provides the robust analysis demonstrating effectiveness of the current reactive air quality management requested by the EPA.

5. Proposed Salt Load to be Discharged to the Upper Goulburn River

The EPA stated the following issue requires further consideration:

> *… the proposed salt load to be discharged to the upper Goulburn River*

The effect of the propose reduction in controlled release salinity limit and no increase in the controlled release volume limit for the majority of the mine life (refer to Section 2) is that there would be a reduction in annual salt loads released to the Goulburn River for the majority of the mine life, when compared to what is currently authorised by the EPA under existing EPLs.

During operations in UG4, there would be a reduction in annual salt loads released to the Goulburn River in comparison to what was assessed in the Modification EA.

6. Proposed Increase in Flows in the Upper Goulburn River

The EPA stated the following issue requires further consideration:

> *… the proposed increase in flows in the upper Goulburn River*

As stated in Section 2, MCO proposes to maintain the currently authorised controlled release volume limit of 10 ML/day (as per EPL 12932) for the majority of the mine life, except during operations in UG4 and following periods of prolonged wet weather.

This reduction in proposed controlled release volume limit will reduce any potential impact to the Goulburn River Diversion and Goulburn River when compared to 20 ML/day proposed in the Modification EA (as was assessed in detail in the Modification EA).

7. Quality of the Proposed Discharge Waters

The EPA stated the following issue requires further consideration:

> *… the quality of proposed discharge water*

As stated in Section 2, MCO proposes to reduce the currently authorised salinity discharge limit from 900 µS/cm to 685 µS/cm.

The value of 685 µS/cm is based on the 80th percentile salinity level from the upstream location identified by the EPA as the suitable reference point (i.e. the location represented by monitoring sites GS 210046 [Ulan] and UMC SW01). Available data from this upstream location has been used to determine the 80th percentile value of 685 µS/cm.

In regard to the metal concentration, the EPA stated:

> *The RTS proposes a selective approach to deriving trigger values whereby the site-specific trigger value is proposed when it is less than the default trigger value and the default trigger value is proposed when it is less than the site-specific trigger value. This approach is inconsistent with the ANZECC methodology (see Figure 3.1.2 in ANZECC 2000).*

The EPA's statement is not correct.

The approach to metal concentration limits in the RTS is consistent with the process described in the Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC Guideline), whereby the "guideline trigger value" is preferentially adopted, as these "*represent the best current estimates of the concentrations of chemicals that should have no significant adverse effects on the aquatic ecosystem"* (as described in the ANZECC Guideline).

Figure 3.1.2 of the ANZECC Guideline is reproduced below, and clearly states the use of local reference data (i.e. derivation of a site-specific trigger value) "*applies only for the case where background data <u>exceed</u> <u>default values</u> from the box immediately below*" (emphasis added).

The *"box immediately below"* refers to Table 3.4.1 of the ANZECC Guideline. All of the proposed concentration limits for metals proposed in RTS (refer to Table 4 of the RTS) are based on the guideline trigger values specified in Table 3.4.1 of the ANZECC Guideline, with the exception of aluminium, where the background data exceeds the default guideline trigger value.

Further support for the approach adopted in the RTS is provided in the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Developments (IESC) draft Explanatory Note '*How to derive Site-specific Guideline Values for Physical and Chemical Parameters: IESC Information Guidelines Explanatory Note*' (the draft Explanatory Note) (IESC, 2018). Figure 4 of the draft Explanatory Note is reproduced below.

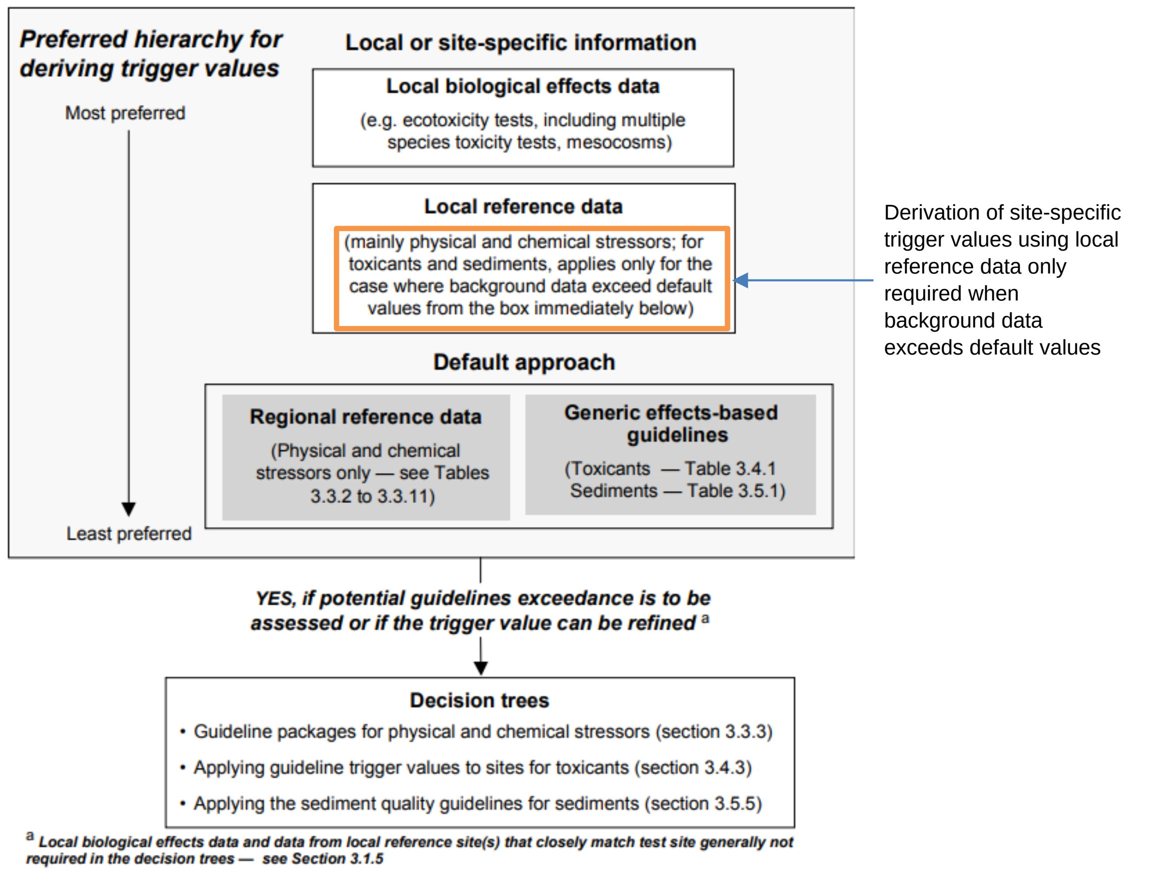

Figure 3.1.2 Procedures for deriving and refining trigger values, and assessing test sites, for physical and chemical stressors and toxicants in water and sediment. Dark grey shading indicates most likely point of entry for users requiring trigger values.

Figure 3.1.2 – Reproduced from the ANZECC Guideline

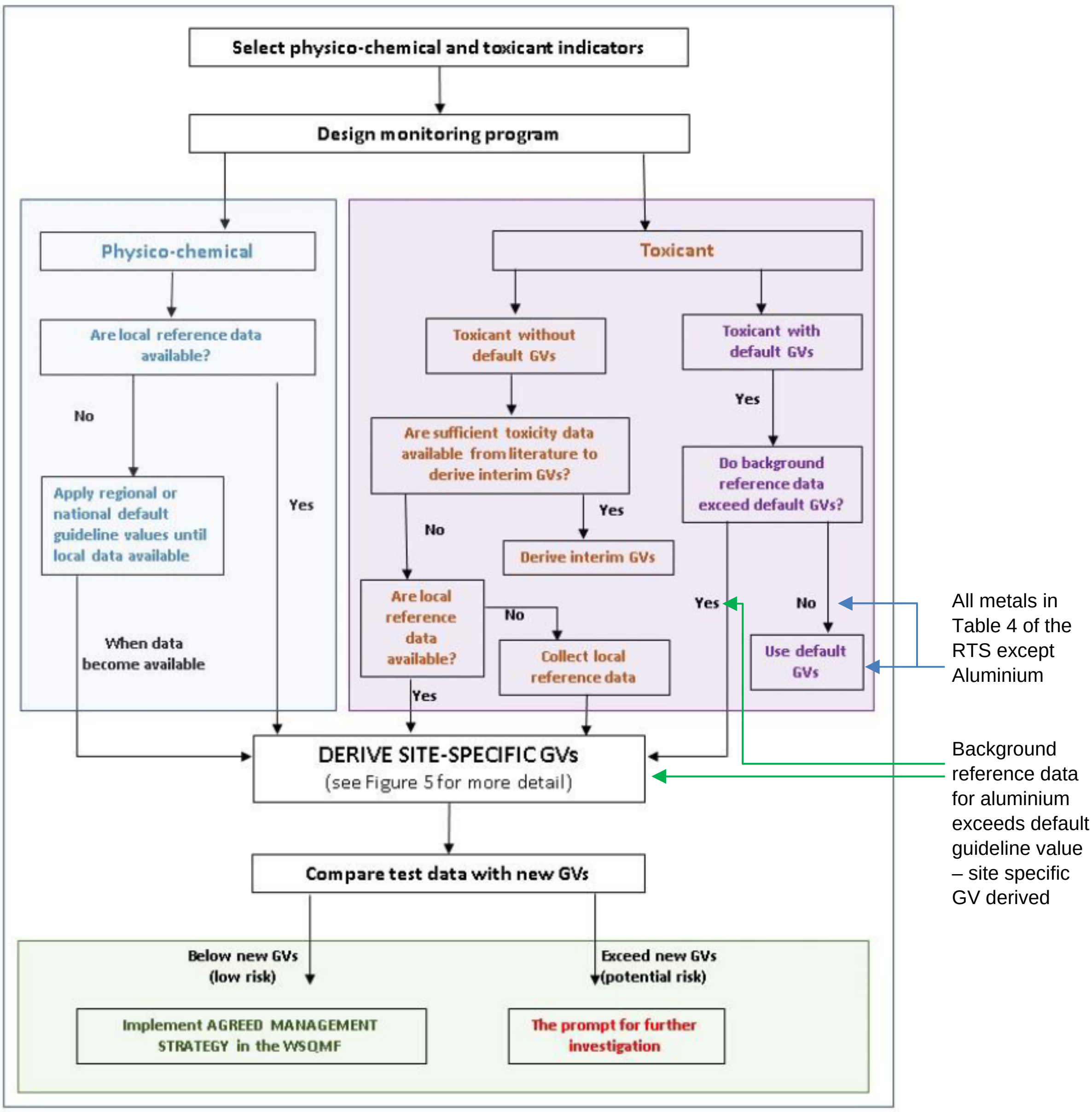

Figure 4: A decision tree of steps to derive site-specific GVs for physico-chemical stressors and toxicants in CSG and LCM industry water and sediment

Figure 4 – Reproduced from the IESC's draft Explanatory Note

8. Cumulative Impact of the Proposed Discharges with those of the Ulan Coal Mine

The EPA stated the following issue requires further consideration:

… the cumulative impact of the proposed discharges with those of the Ulan Coal Mine.

As stated in Section 2, MCO proposes to maintain the currently authorised controlled release volume limit of 10 ML/day (as per EPL 12932) for the majority of the mine life, except during operations in UG4 and following periods of prolonged wet weather.

As such, there would be no change to the cumulative volume limits currently authorised for the majority of the mine life, and a reduction in the cumulative potential impacts to the Goulburn River Diversion and Goulburn River when compared to 20 ML/day proposed in the Modification EA (as was assessed in detail in the Modification EA cumulatively with the currently authorised release limit of 30 ML/day from the Ulan Mine Complex).

9. Underground Disposal of Brine

For the reduced salinity limit of 685 µS/cm, the reduction in proposed controlled release volumes would result in a reduction in brine production.

EPA provided comments on the suitability of the proposed options for the disposal of brine, summarised as follows:

- Consideration of alternatives to underground brine storage.
- Consideration of diffusion as a transport process.
- The compatibility of brine with the surrounding groundwater.
- Solute concentrations at nearby receptors.

It is noted the reduction in proposed controlled release volume limits (as described in Section 2) would also result in reduced brine generation over the life of the mine.

Attachment 1 provides additional analysis by Dr Noel Merrick of HydroSimulations in consideration of the reduced brine to be produced for the reduced controlled release volume limits (in comparison to what was previously assessed in the Modification EA) (Section 2). Dr Merrick concludes the potential impact of brine storage in the UG4 void to the quality of groundwater would be less than what was previously assessed (i.e. as per previous assessment, there is expected to be an insignificant impact to groundwater quality).

Alternatives

Alternative brine storage options are described in the Modification EA and RTS, including application via water truck to catchment areas reporting only to mine water storages and storage in on-site dams.

Permanent storage of brine underground is proposed following the completion of underground mining in UG4.

Compared to long-term storage of brine at the surface, underground storage of brine in the UG4 void is the superior option for operational, economic and environmental reasons (e.g. it avoids the need to build and maintain additional dams and eliminates the risk of uncontrolled spills to surface water following extreme weather events).

Dilution

The EPA considers diffusion has been omitted as a key solute transport process.

The effect of molecular diffusion of salts in the brine (due to concentration differences) would be negligible compared to the macro transport mechanisms that have been considered by Dr Merrick, which include:

- Pressure gradients that determine groundwater flow directions (e.g. depressurisation of the coal seam would create a groundwater 'sink' in the UG4 void preventing outward migration of brine during recovery of groundwater levels, which is expected to take approximately 30-35 years).
- Permeabilities of the surrounding strata (i.e. due to the significantly higher permeability of the coal seam, approximately 80% of any salt mobilised from the brine stored underground would move laterally and remain in the coal seam).
- Gravity (i.e. density of brine would restrict the migration of highly saline groundwater, and as such, most of the brine would not move away from its point of deposition).

Compatibility

The suitability of the UG4 void for brine storage is based on the following:

- There is limited potential for the brine to migrate out of the mined-out void or coal seam.
- There are no known other users of the groundwaters within the Ulan Seam (other than mining companies).
- Any salt that could migrate from the UG4 void following recovery would be at a salinity significantly lower than brine, would be subject to significant dilution from groundwater in the surrounding and overlying strata and, as such, would not significantly change the quality of the surrounding groundwater.

Solute Concentrations

No change to solute concentrations at sensitive receptors (i.e. significant creeks and rivers), dependent ecosystems, significant sites or water supply works due to brine storage in the UG4 void is predicted for more than 200 years (Attachment 1).

10. References

Australian and New Zealand Environment and Conservation Council (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (2018). *How to derive site-specific guideline values for physical and chemical parameters: IESC Information Guidelines Explanatory Note*. Draft.

Todoroski Air Sciences (2017). *Air Quality Assessment, Moolarben Coal Project OC Optimisation Modification*.

ATTACHMENT 1

HYDROSIMULATIONS (2018)
MOOLARBEN OC MODIFICATION – BRINE STORAGE
(LETTER DATED 23 AUGUST 2018)

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DATE: 23 August 2018

TO: Graham Chase
Environmental & Community Manager
Moolarben Coal Operations Pty Ltd

FROM: Dr Noel Merrick and Ms Becky Rollins

RE: Moolarben OC Modification - Brine Storage

OUR REF: HS2018/05d

Introduction

This memo responds to a request from Moolarben Coal Operations (MCO) for advice on a matter raised by the NSW Environment Protection Authority (EPA) in their assessment of the Moolarben Open Cut Optimisation Modification (the Modification).

In their email dated 5 July 2018, the EPA stated that a remaining issue associated with the Modification related to the underground storage of brine from the proposed water treatment facility in the underground UG4 void space (after the completion of mining).

HydroSimulations has previously considered the underground storage of brine in the UG4 void (refer to our letter dated 22 May 2018) for a scenario where it was proposed that up to 20 ML/day of water would be released to the Goulburn River Diversion following treatment at the proposed water treatment facility.

For this scenario it was concluded:

- Prior to the recovery of groundwater levels in the UG4 void, the migration of groundwater (including stored brine) from the UG4 void cannot occur for at least 30-35 years as the void would be a groundwater sink.
- Following recovery, it is expected no significant change to salinity of the surrounding groundwater would occur.

It is understood MCO now proposes a reduced controlled release salinity limit of 685 µS/cm.

In addition, MCO proposes to reduce the volume of water to be released from the 20 ML/day previously assessed to 10 ML/day (except during UG4 [15 ML/day] or following periods of prolonged wet weather).

The proposed reduction in the volume of controlled release water would reduce the quantity of water required to be treated, with an associated reduction in brine production.

As a result, the potential impact of brine storage in the UG4 void would be less than what has previously been assessed (i.e. there is expected to be an insignificant impact to groundwater quality).

The analysis that follows considers the potential impacts of underground storage of brine for the reduced controlled release volume limits proposed by MCO.

Dilution

During the recovery period, the UG4 void would be a groundwater sink for approximately 30-35 years after the completion of mining, preventing the migration of brine from the UG4 void. Should any salt migrate from the UG4 void after this time, it would not migrate at the concentration of brine. This is because the greater density of the brine in the UG4 void compared to the surrounding groundwater would restrict the migration of ions.

Only groundwater at significantly lower salinity than brine could migrate from the UG4 void. Any groundwater migrating from the UG4 void would be significantly diluted with groundwater from the surrounding and overlying strata.

The reduction in brine production proposed by MCO (as a result of the proposed reduction in controlled release water volumes) would increase dilution potential for any groundwater migrating from the UG4 void.

Spatial Analysis

To assist in provision of an informed opinion, we have interrogated the groundwater model to give groundwater head patterns at the water table (**Figure 1**) and the Ulan Seam (Layer 9; **Figure 2**) at 100 years after completion of UG4 mining, and an approximate water table profile across UG4 from the Goulburn River Diversion at the Ulan Mining Complex East Pit to Saddlers Creek (**Figure 3**).

Figure 1 shows that long-term groundwater flow at the level of the water table would follow arcuate paths across the UG4 footprint towards the Goulburn River to the east, near site B. The approximate path lengths from key sites are:

- From site A: 0.7 km
- From site D: 1.1 km
- From site C: 3.3 km.

Shorter westerly paths are evident from the southern half of UG4 to the west, but the transect in **Figure 3** suggests that groundwater would remain beneath the bed of the Goulburn River Diversion.

Groundwater flow paths at the level of the Ulan Seam (**Figure 2**) would pass through the UG4 void in an easterly direction. In the southern third of the UG4 void, groundwater in the Ulan Seam would migrate to the west.

During mining, and for the period immediately following completion of mining to about 2059 (i.e. 30-35 years), the direction of groundwater flow will be into the UG4 void. This means that any brine deposited in the mine void (Layer 9) near the most northerly point, site A, cannot move out of this layer, other than down-dip to a greater depth. After about 2059 the groundwater gradient would change as the mine void fills up, so that the groundwater level would increase and flow direction from the UG4 void could be upwards as well as outwards from that time (i.e. as the regional groundwater level recovers above the mined UG4 void).

To the north-east of the UG4 void, at site B, groundwater heads would remain depressurised for several decades post-mining. The head in the coal seam would exceed the water table elevation at about 2044, approximately 18 years after completion of mining. No upward migration would be possible prior to this time.

The spatial analysis presented above would not change as a result of the reduction in brine production due to MCO's proposed reduction in controlled release water volumes.

The EPA's submission refers to diffusion (in response to concentration gradients) as a mechanism for brine migration that has not been considered. While molecular diffusion may occur at the micro-scale, it is well known that this process is extremely slow and can be significant only over geologic time scales (millennia) (Freeze and Cherry, 1979). In addition, diffusion would have a negligible effect on solute migration when compared to the macro transport processes that have been considered in the groundwater modelling and analysis conducted for this report (i.e. the effects of depressurisation of the groundwater system following dewatering of the Ulan Seam, vertical and horizontal permeabilities, and gravity).

Temporal Analysis

Groundwater movement times are governed by groundwater velocities, which can be estimated from Darcy's Law on the assumption that the fluid is not dense.

In reality, brine stored in the UG4 void would be denser than the surrounding groundwater and movement of the brine calculated from Darcy's Law would be an overestimate and probably a severe overestimate. This is particularly the case for vertical upwards migration from the void due to the increase in fluid salinity in the void resulting in an increase in density.

The conservative lateral groundwater velocity is:

$$V_{LAT} = \frac{Kx}{n}\frac{dh}{dx}$$

where *Kx* is horizontal hydraulic conductivity; *n* is effective porosity; and *dh/dx* is the lateral hydraulic gradient.

The conservative vertical groundwater velocity is:

$$V_{VERT} = \frac{Kz}{n}\frac{dh}{dz}$$

where *Kz* is vertical hydraulic conductivity; *n* is effective porosity; and *dh/dz* is the vertical hydraulic gradient.

The fastest lateral velocities at the northern end of UG4 would occur at the level of the water table in weathered rock, for which relevant parameters (taken from the groundwater model) are: *Kx* ~ 0.02 m/day; *n* ~ 0.01; *dh/dx* ~ 0.016 [i.e. (393-382)m/700m at site A]. The lateral velocity estimate is 0.032 m/day (i.e. about 12 m/year).

Given significantly higher permeability in the coal seam, lateral groundwater flow through coal would occur at a higher velocity estimated at about 4 m/day (1.3 km/year).

The vertical velocity from the level of the coal seam to the level of the water table is controlled by the lowest vertical hydraulic conductivity in the stratigraphic section. For relevant parameters of *Kz* ~ 0.0002 m/day; *n* ~ 0.01; *dh/dx* ~ 0.1, the vertical velocity estimate is 0.002 m/day (i.e. about 70 cm/year).

Vertical travel time is:

$$t_{VERT} = \frac{Z}{V_{VERT}}$$

where *Z* is the distance of the coal seam to the water table at a point in the UG4 footprint.

For a height *Z* ~ 100 m, the vertical travel time would be 50,000 days (about 140 years).

The lateral and vertical mass fluxes can be calculated from the groundwater velocities and from the seam cross-sectional area (for lateral flow) and planar area (for vertical flow). The result is that approximately 80% of the volume of any salt mobilised from the brine stored underground would move laterally. However, it is expected that most of the brine, being dense, would not move away from its point of deposition.

As such, no change to solute concentrations at the water table due to brine storage in the UG4 void is predicted for at least 170 years[1], and for at least 230 years[2] at sensitive receptors associated with the Goulburn River.

Opinion

Based on the foregoing analysis, our findings are:

- As a result of the proposed reduction in brine production, potential impacts of brine storage in the UG4 void to the quality of groundwater would be less than those previously assessed (i.e. there is expected to be an insignificant impact to groundwater quality).
- This conclusion is based on the following:
  - As the Ulan Seam dips to the north-east, brine deposited in the UG4 void would tend to accumulate at

[1] About 30 years as a sink followed by 140 years upwards migration.
[2] About 60 years from site A to the river at 12 m/year.

the northern end of the UG4 void (near site A) and would back up from there towards sites D and C, depending on the volumes to be deposited.

- Due to the depressurisation of the coal seam and overlying formations during mining, the underground mining area would remain a groundwater sink during the recovery period for 30-35 years.
- The migration of groundwater from the UG4 void cannot occur for at least 30-35 years, and then (for vertical flow) at a rate governed by the lowest permeability in the stratigraphic section.
- Following recovery, an insignificant change to the salinity of the surrounding groundwater is expected given:
    - The density of brine would restrict the migration of highly saline groundwater, and as such, most of the brine would not move away from its point of deposition, and any brine that does migrate would have salinity significantly lower than brine.
    - Following recovery of groundwater levels, 80% of any groundwater in the UG4 void that migrates would move laterally and remain within the coal seam aquifer.
    - There would be significant dilution of any groundwater migrating from within the UG4 void by groundwater in the surrounding and overlying (>100m thickness) strata.
- No change to solute concentrations at sensitive receptors, dependent ecosystems, significant sites or water supply works is predicted due to brine storage in the UG4 void for more than 200 years.

Given the above, it is considered the risk of impacts from storing brine underground to surrounding groundwater resources is very low. When compared to alternative storage methods (e.g. storage in dams at the surface), underground storage is the superior and lowest risk option as it eliminates the potential for uncontrolled spills to surface water resources. MCO's recent proposal to reduce controlled release volumes and associated brine production would further reduce potential risks.

Yours sincerely

Dr Noel Merrick

<u>Reference</u>

Freeze, R. A. and Cherry, J. A., 1979, *Groundwater*. Prentice-Hall, Englewood Cliffs, New Jersey, 604p.

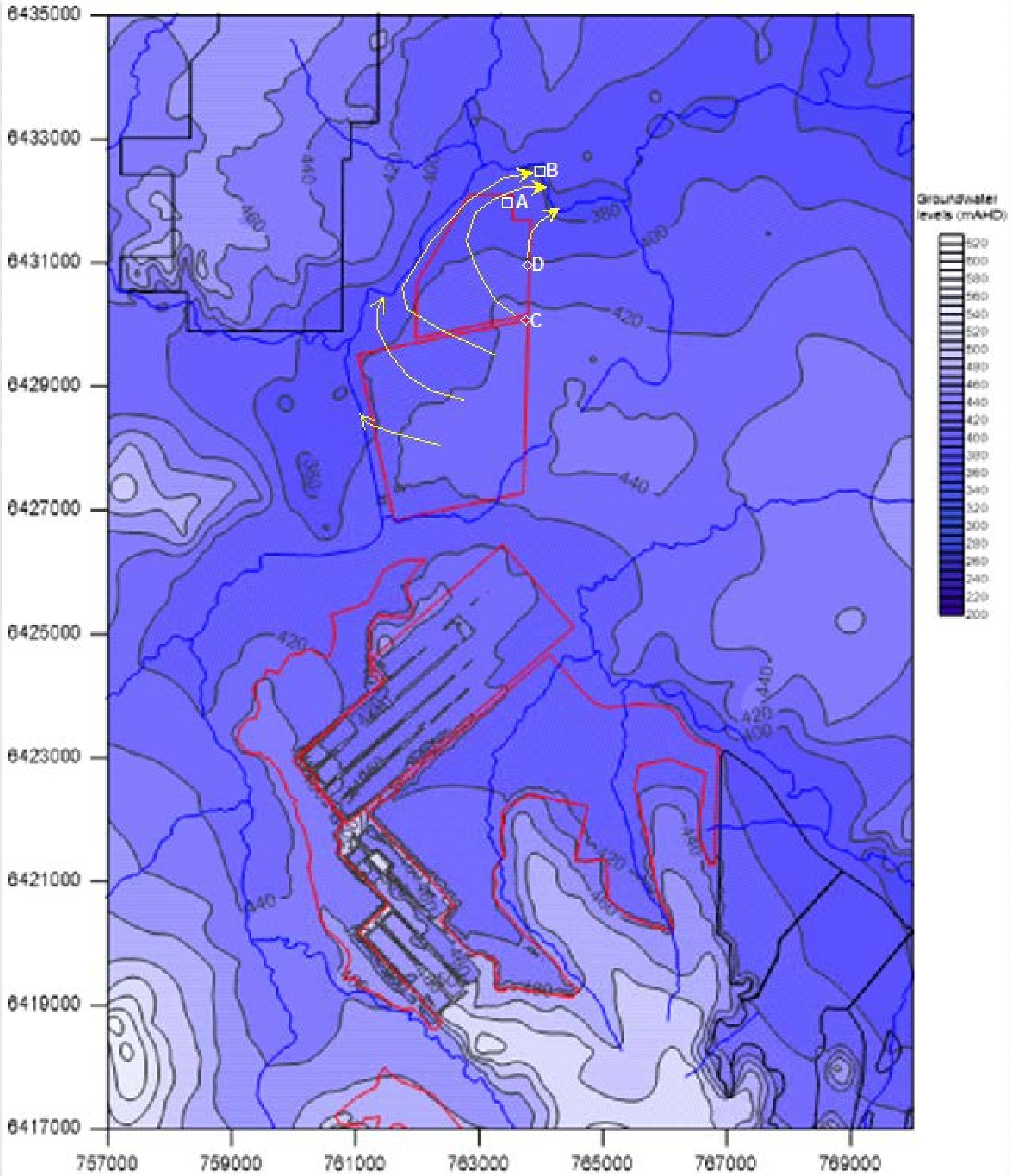

Figure 1. Predicted water table pattern and flow directions 100 years after completion of mining

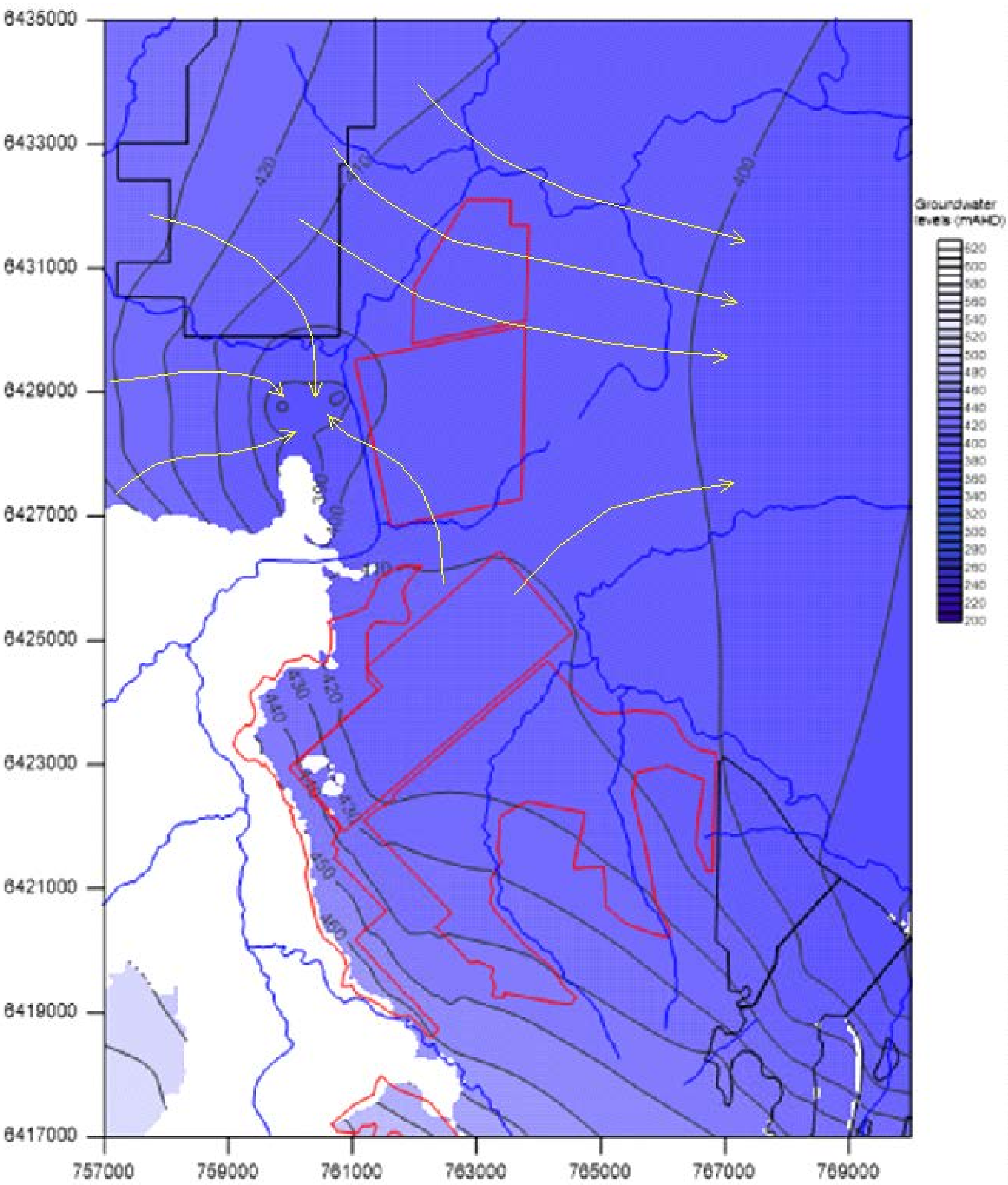

Figure 2. Predicted Ulan Seam groundwater head pattern and flow directions 100 years after completion of mining

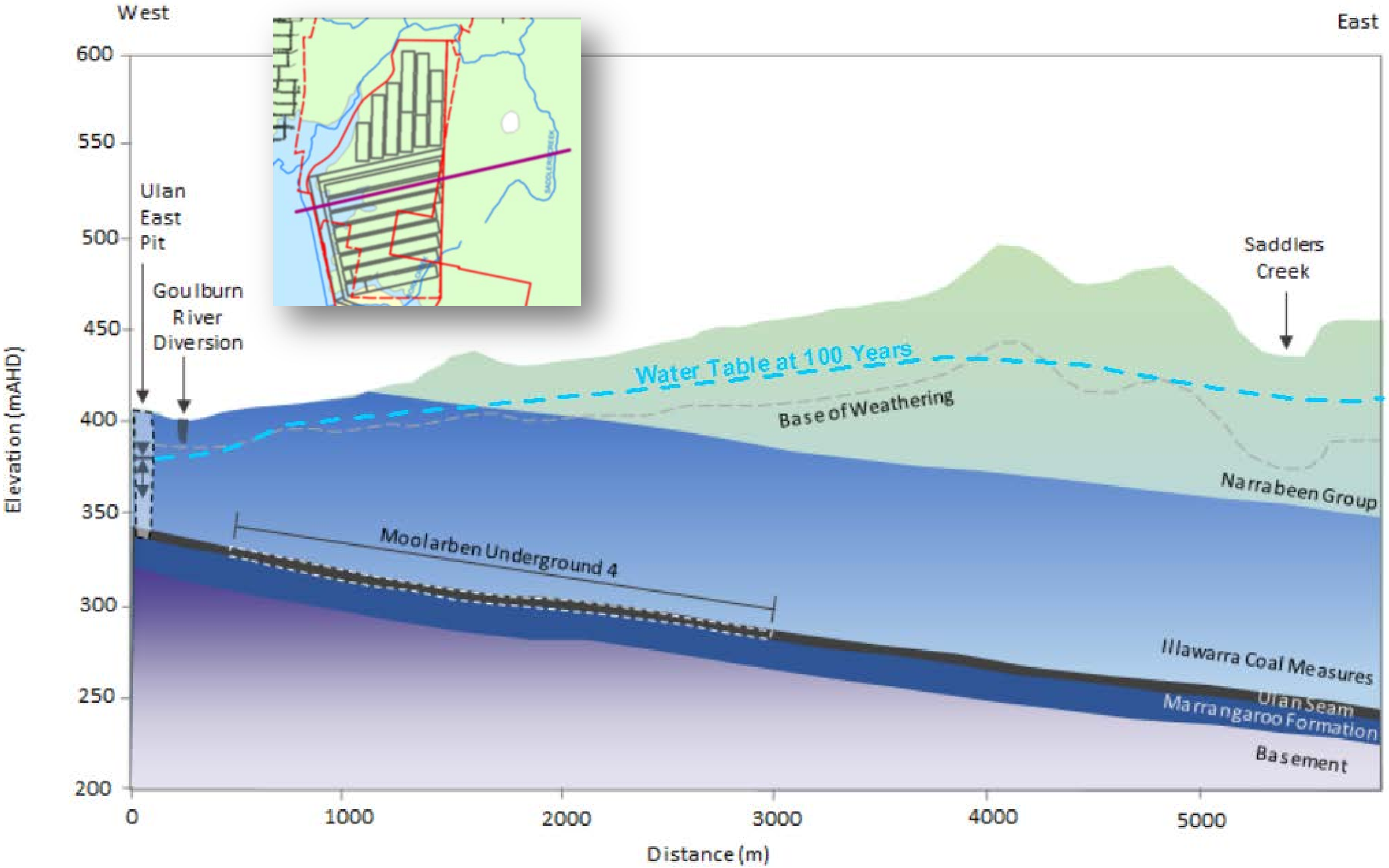

Figure 3. Predicted water table profile 100 years after completion of mining