YANCOAL
兖煤澳大利亚有限公司
MOOLARBEN COAL

GROUNDWATER MANAGEMENT PLAN

Document	Version	Issue	Effective	Review	Author	Approved
MCO_ENV_PLN_0038	4	Oct 20	Oct 20	Nov 21	MCO	SA

Version	Issue Date	Approval Date	Section Modified	Reason for Modification	Review Team
1	Jul 2015	Jul 2015	All	Document developed in accordance with PA 05_0117 and PA 08_0135	MCO, Dundon Consulting Pty Ltd
2	Feb 2018	Mar 2018	All	General Review and Update, including UG1 Extraction Plan Approval	MCO, HydroSimulations
3	Feb 2020	Apr 2020	All	To incorporate approved modifications to Stage 1 (MOD 14) and Stage 2 (MOD 3) of the Project	MCO, HydroSimulations
4	Oct 2020	Oct 2020	All	To incorporate approval of Modification 15 (Stage 1)	MCO

Approved: S.J. Archibald Date: 28 October 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

1.0 INTRODUCTION

The Moolarben Coal Complex is located approximately 40 kilometres (km) north of Mudgee in the Western Coalfields of New South Wales (NSW) (Figure 1).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Yancoal Moolarben Pty Ltd (YM) and a consortium of Korean power companies). MCO, and YM are wholly owned subsidiaries of Yancoal Australia Limited (Yancoal).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and would continue to be carried out in accordance with NSW Project Approval (05_0117) (Moolarben Coal Project Stage 1) as modified and NSW Project Approval (08_0135) (Moolarben Coal Project Stage 2) as modified.

Mining operations at the Moolarben Coal Complex are undertaken in accordance with the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) approvals EPBC 2007/3297, EPBC 2008/4444, EPBC 2013/6926 and EPBC 2017/7974.

The current mining operations at the Moolarben Coal Complex are conducted in accordance with the requirements of the conditions of Mining Lease (ML) 1605, ML 1606, ML 1628, ML 1691 and ML 1715 granted under the *Mining Act 1992*.

The general arrangement of the Moolarben Coal Complex, showing modifications, is provided in Figure 2.

1.1 PURPOSE AND SCOPE

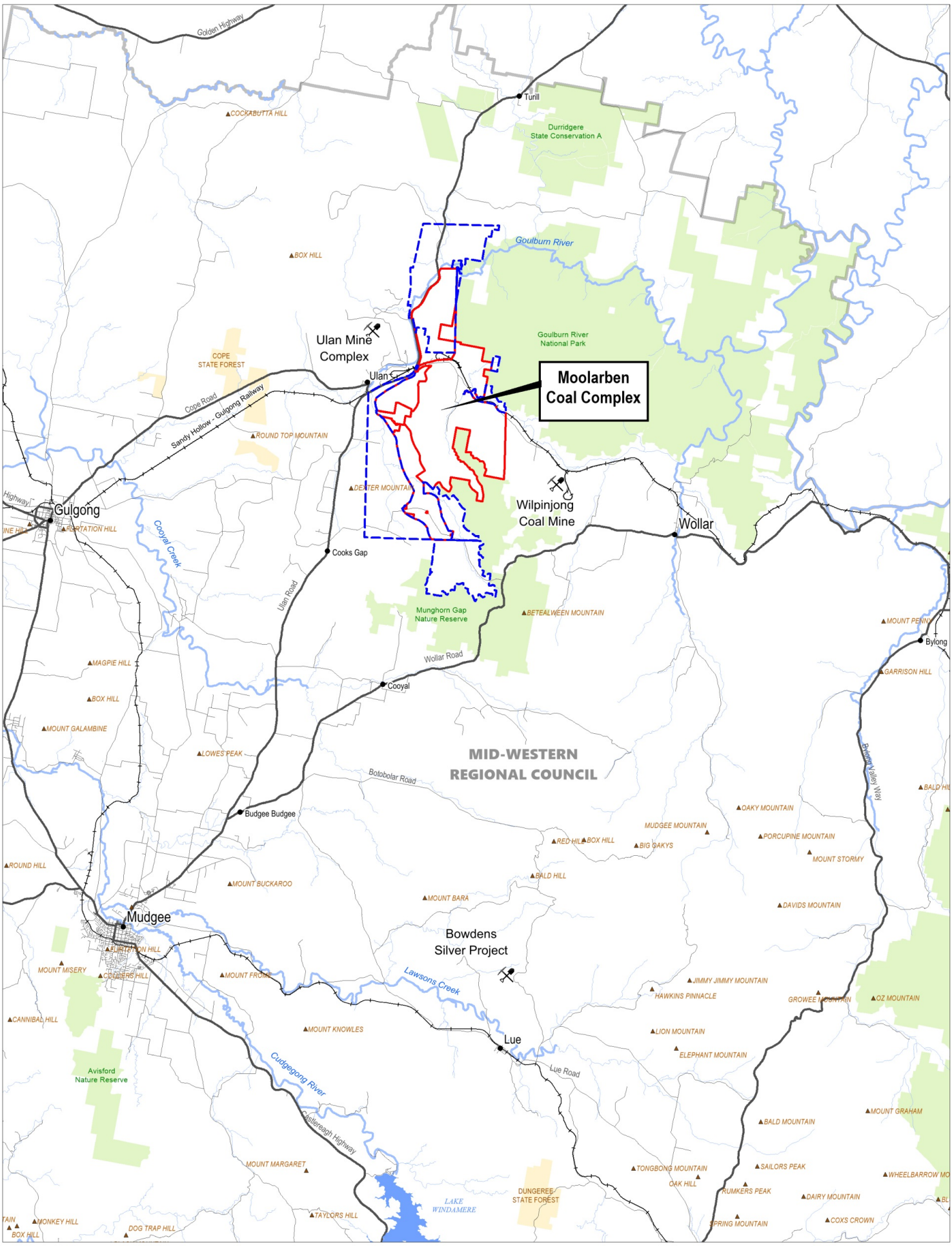
This Groundwater Management Plan (GWMP) has been prepared by MCO to satisfy the requirements of NSW Project Approval (05_0117) (as modified) and the NSW Project Approval (08_0135) (as modified).

This GWMP describes the management of groundwater at the Moolarben Coal Complex in accordance with the above listed Project Approvals.

1.2 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

The Secretary of the NSW Department of Planning and Environment (DP&E) (now the NSW Department of Planning, Industry and Environment (DPIE)) approved Peter Dundon (Dundon Consulting Pty Ltd) and Dr Noel Merrick (HydroSimulations) as suitably qualified and experienced experts for the preparation of the GWMP.

The GWMP was prepared in consultation with Dundon Consulting Pty Ltd and HydroSimulations.



Legend

- Exploration Licence Boundary
- Mining Lease Boundary
- LocalGovernmentArea
- National Park / Nature Reserve
- State Forest

N

YANCOAL 兖煤澳大利亚有限公司 MOOLARBEN COAL

Figure 1
Regional Location

File: G:\1.1 EMS\1.2 Management Plans\Extraction Plan\03. LW104-105\09. Plans\Mapinfo Workspaces\Longwall Layout.wor

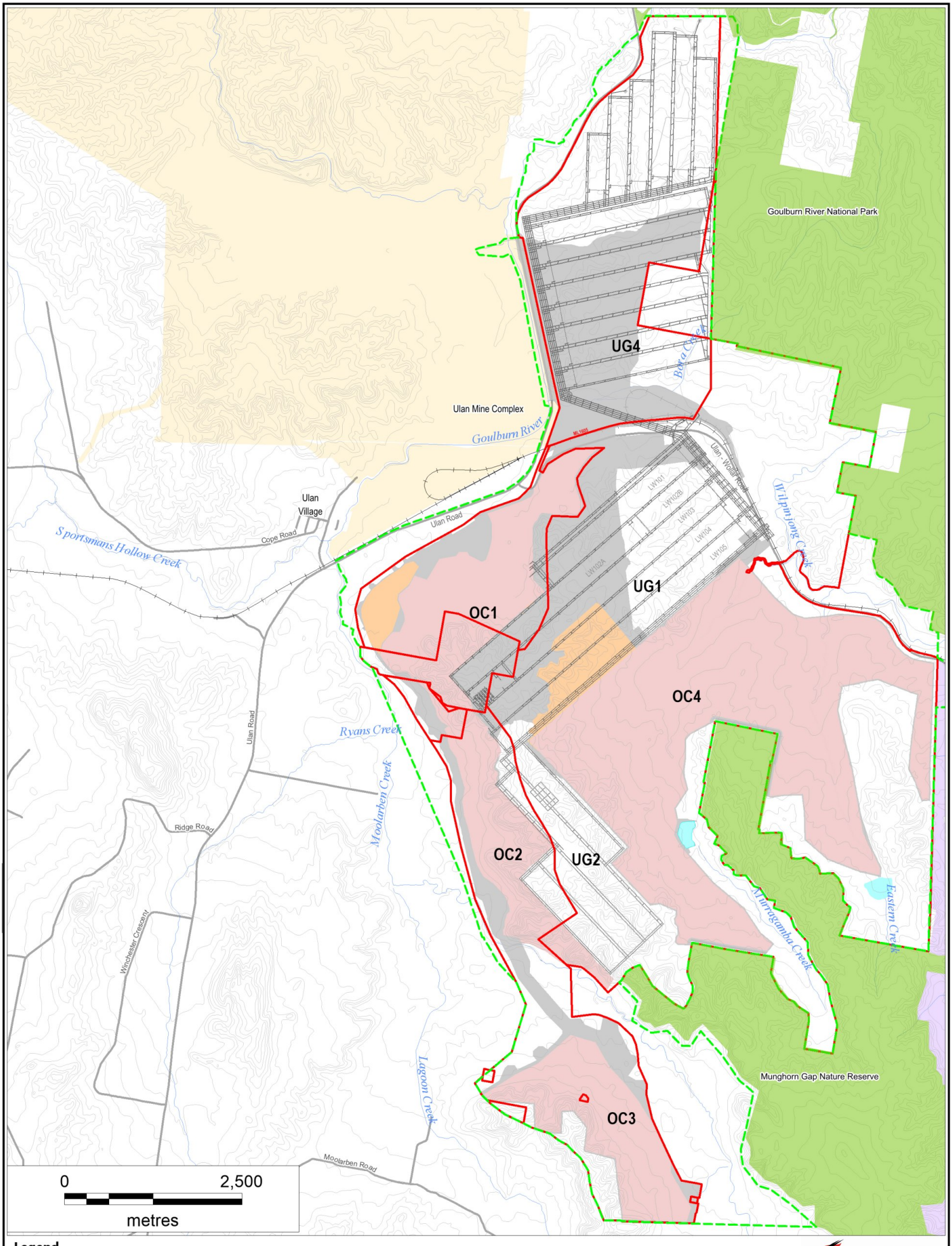


Figure 2
Approved Moolarben Coal Project (Stage 1 and Stage 2)
Indicative General Arrangement

1.3 STRUCTURE OF THE GROUNDWATER MANAGEMENT PLAN

The remainder of the GWMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the GWMP.

Section 3: Outlines the existing groundwater conditions.

Section 4: Provides baseline monitoring data.

Section 5: Describes groundwater model predictions and validation.

Section 6: Outlines the groundwater monitoring program.

Section 7: Describes the protection of The Drip.

Section 8: Describes the trigger levels and management responses (including contingency plans).

Section 9: Provides details for the review and improvement of environmental performance.

Section 10: Describes the management and reporting of incidents, complaints and non-compliances.

Section 11: Provides references cited in the GWMP.

2.0 STATUTORY AND PROJECT APPROVAL REQUIREMENTS

MCO's statutory obligations are contained in:

- the conditions of the NSW Project Approval (05_0117) (as modified) and NSW Project Approval (08_0135) (as modified);
- the conditions of the Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926, EPBC 2008/4444 and EPBC 2017/7974);
- relevant licences and permits, including conditions attached to mining leases and Environment Protection Licence 12932; and
- other relevant legislation.

2.1 EP&A ACT APPROVAL

2.1.1 Groundwater Management Plan Requirements

This GWMP has been prepared in accordance with Condition 33, Schedule 3 and Condition 29, Schedule 3 of the NSW Project Approvals (05_0117 and 08_0135, respectively). Attachment 1 presents these requirements and indicates where they are addressed within this GWMP.

2.1.2 General Management Plan Requirements

Condition 3, Schedule 5 and Condition 3, Schedule 6 of the NSW Project Approvals (05_0117 and 08_0135, respectively) outline general management plan requirements that are applicable to the preparation of the GWMP. Attachment 1 presents these requirements and indicates where they are addressed within this GWMP.

2.1.3 COMMITMENTS

Each of the two Project Approvals includes a Statement of Commitments by the Proponent. The Commitments which relate to groundwater are listed in Attachment 1.

2.2 WATER LICENCES HELD BY MCO

The water licences held by MCO are listed in Table 1

Groundwater use including incidental use or "take" of groundwater will be assessed for each water source affected by the Moolarben Coal Complex, and accounted for by way of the groundwater licences (and associated conditions) held by the Moolarben Coal Complex.

Table 1: Water Licences Held by MCO

Licence Number	Description
WAL36340, WAL37583 and WAL19424	Wollar Creek Water Source – Hunter Unregulated and Alluvial Water Sources
WAL37582 and WAL41888	Upper Goulburn River Water Source – Hunter Unregulated and Alluvial Water Sources
WAL39799	Sydney Basin - North Coast Fractured and Porous Rock Groundwater Source
20BL173935	Monitoring and Test Bores

[1] In accordance with Condition 29, Schedule 3 and Condition 25, Schedule 3 of the NSW Project Approvals (05_0117 and 08_0135, respectively), MCO would obtain additional licences under the *Water Management Act 2000* and *Water Act 1912* as they are required for activities at the Moolarben Coal Complex.

Current and indicative bore hole locations are shown on Figure 3.

2.3 OTHER LEGISLATION

MCO will operate the Moolarben Coal Complex in accordance with the NSW Project Approvals (05_0117 and 08_0135) and Commonwealth Approvals (EPBC 2007/3297, 2013/6936, 2008/4444 and 2017/7974), as well as any other NSW Acts, Regulations and Guidelines that may be applicable to a Part 3A Project.

A summary of the NSW Acts, Regulations and Guidelines that may be relevant to the MCO is provided in Section 2 of the WAMP.

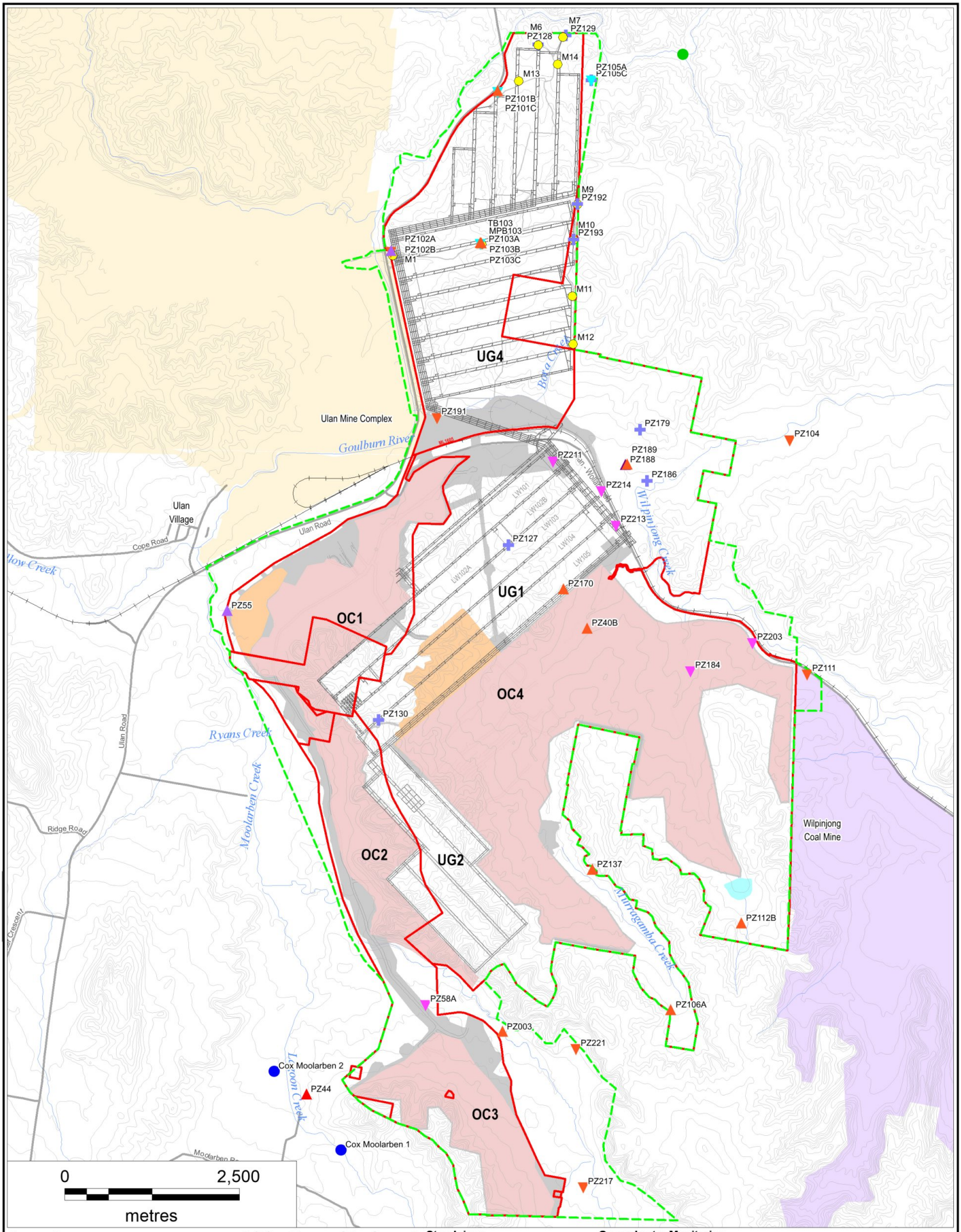


Figure 3
Groundwater Monitoring Network

3.0 EXISTING GROUNDWATER CONDITIONS

Regional groundwater investigations were carried out for the Moolarben Coal Stage 1 and Stage 2 Projects.

A description of the hydrological regime and groundwater quality is provided in:

- *Moolarben Coal Project – Groundwater Assessment* (Peter Dundon and Associates Pty Ltd, 2006);
- *Moolarben Stage 2 Groundwater Assessment* (Aquaterra Consulting Pty Ltd, 2008);
- *Moolarben Complex Stage 2 – Preferred Project Report – Groundwater Impact* Assessment (RPS Aquaterra, 2011);
- *Moolarben Coal Project Stage 1 Optimisation Modification Groundwater Assessment* (Australasian Groundwater & Environmental Consultants Pty Ltd, 2013);
- *Moolarben Coal Complex – UG1 Optimisation Modification – Groundwater Assessment* (Dundon Consulting Pty Ltd, 2015); and
- *Moolarben Coal Open Cut Optimisation Modification Groundwater Assessment* (HydroSimulations, 2017).

The main hydrogeological units within and surrounding the Moolarben Coal Complex include:

- Quaternary alluvium associated with the present day drainage system.
- Tertiary alluvium in palaeochannel that are not related to the present day drainage system, and are believed to be generally poorly connected hydraulically with the surface drainages.
- Triassic sandstones of the Narrabeen Group.
- Permian coal measures, which includes the Ulan Seam near the base of the unit.
- Permian Marrangaroo Conglomerate.
- Basement units that include Carboniferous volcanics and granite.

The main aquifers in the vicinity of the Moolarben Coal Complex are associated with alluvium adjacent to the major drainages and the Ulan Seam[1], although neither have been assessed as or are considered to possess major water supply potential. There is also some aquifer potential in other parts of the Permian coal measures (e.g. sandstones, siltstones, conglomerates and minor coal seams). MCO has approval to develop a dewatering/production borefield within the Ulan Seam and overlying Permian strata. The Triassic sandstones also provide some aquifer potential, which is generally low yielding. The Triassic

[1] The alluvial groundwater sources are regulated under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (alluvial WSP). Non alluvial groundwater sources are regulated under the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources* (non alluvial WSP).

sandstone supports a small number of stock and domestic bores on private properties to the north of the Moolarben Complex. Perched groundwater in the Triassic sandstones supports the water feature on the Goulburn River known as The Drip.

Recharge to the groundwater system occurs by infiltration of rainfall and downward percolation through the near surface weathered rock and alluvium where present. Recharge to deeper relatively more permeable units within the Permian coal measures occurs by downward seepage into the permeable units where they subcrop beneath the alluvium or weathered rock cover, and then flow along the bedding in each stratigraphic unit under the influence of the regional hydraulic gradients.

The Permian and overlying Triassic strata generally dip in a north-easterly direction away from the edge of the Sydney Basin which is located very close to the subcrop line of the Ulan Seam. Recharge to the Ulan Seam occurs primarily along the subcrop line, and groundwater then flows down gradient within the strata to the north-east.

Pre-mining groundwater conditions were significantly altered by the neighbouring Ulan Mine Complex to the west, which began operating well over 40 years before Moolarben Coal Operations. Earlier mining at Ulan Mine Complex resulted in dewatering of the Ulan Seam and overlying hydrogeological units.

Springs and groundwater seeps in nearby creek valleys and localised pools and soaks along the creeks support riparian vegetation; however, none of these constitute high priority Groundwater Dependent Ecosystems (GDEs) listed under the Water Sharing Plans.

3.1 LICENSED BORES IN THE PROJECT VICINITY

Groundwater usage in the area is primarily composed of mine dewatering for the Moolarben Coal Complex and the neighbouring Ulan Mine Complex and Wilpinjong Coal Mine.

There is one private bore in the vicinity of the Moolarben Coal Complex, located to the northeast of UG4. The bore is a relatively shallow bore (24 m) developed in Triassic strata and connected to the river alluvium. The predicted drawdown is less than the 2 m minimal impact considerations as specified under the AIP. The location and baseline condition of this bore is summarised in Table 2. Additional detail is available in Attachment 3.

Table 2: Baseline Condition of Privately Owned Bores

Census Point ID	Easting	Northing	Bore Type	Licence No.	Work ID	Hydrogeological Unit	Water Level (m AHD)	EC (µS/cm)	pH	Yield (L/s)
SP49	765208	6431971	Domestic	80BL236762	GW800279	Triassic Narrabeen Group	371	730	6.00	-

EC = electrical conductivity
µS/cm = microSiemens per centimetre
m AHD = metres Australian Height Datum

4.0 BASELINE DATA

4.1 HYDROGEOLOGICAL DATA

A summary of baseline data which has informed the description of the existing groundwater conditions in Section 3.0 is provided in Attachment 2.

A detailed description of the available baseline data is provided in *Moolarben Coal Project – Groundwater Assessment* (Peter Dundon and Associates Pty Ltd, 2006), *Moolarben Stage 2 Groundwater Assessment* (Aquaterra Consulting Pty Ltd, 2008), *Moolarben Complex Stage 2 – Preferred Project Report – Groundwater Impact* Assessment (RPS Aquaterra, 2011), *Moolarben Coal Project Stage 1 Optimisation Modification Groundwater Assessment* (Australasian Groundwater & Environmental Consultants Pty Ltd, 2013), *Moolarben Coal Complex – UG1 Optimisation Modification – Groundwater Assessment* (Dundon Consulting Pty Ltd, 2015) and *Moolarben Coal Complex Open Cut Optimisation Modification Groundwater Assessment* (HydroSimulations, 2017).

The above reports contain a full account of all available groundwater monitoring data collected prior to the issue of each respective report. This data includes the following:

- Piezometer and test bore water levels/pressures.
- Laboratory analysis results of water samples.
- Permeability data which can be used to approximate the yield of aquifers.
- Baseline data at privately owned bores (e.g. groundwater levels, yield and quality data where available) (refer Section 3.1 and Table 2).

Annual groundwater monitoring data is available in the Annual Reviews which are available on the Moolarben Coal website. Refer to Section 4 of the WAMP for more detail on Annual Review reporting. Given existing depressurisation and dewatering associated with the mining at the Ulan Mine Complex which has created a prominent depression in groundwater levels/pressures within the Ulan Seam, the poorer water quality and limited beneficial use of these aquifers, baseline yield data for the Permian hydrogeological units is limited.

The relationship between groundwater and both natural (i.e. climatic) and mining-related stresses is dynamic, with both long term and short term trends being relevant. Therefore, ongoing monitoring is considered to be actively contributing to the baseline dataset.

4.2 METEOROLOGICAL DATA

A summary of meteorological conditions at the Moolarben Coal Complex is included in Section 3.1 of the Site Water Balance and reported annually in MCO's Annual Review.

5.0 GROUNDWATER MODEL PREDICTIONS AND VALIDATION PROCESS

There has been progressive development of the Moolarben groundwater model since the initial Stage 1 groundwater impact assessment studies. The most recent groundwater model (the Moolarben Coal Complex Model) was developed as part of the *Moolarben Coal Complex Open Cut Optimisation Modification Groundwater Assessment* (HydroSimulations, 2017). The new groundwater model was calibrated against ongoing baseline data collected at the Moolarben Coal Complex (Section 4), as well as data sourced under the data sharing agreements and through Annual Environmental Management Reports for the neighbouring Ulan Mine Complex and Wilpinjong Coal Mine.

The model assumes a mine schedule and sequence. The actual mine sequence and schedule may vary from that in the HydroSimulations model. Further detail regarding the features of the Moolarben Coal Complex Model are provided in the *Moolarben Coal Complex Open Cut Optimisation Modification Groundwater Assessment* (HydroSimulations, 2017).

5.1 Periodic Groundwater Model Validation

In accordance with Commitment 24 of the Stage 2 (08_0135) Project Approval, MCO will complete a groundwater modelling post-audit and re-calibration (where required) 2 years after commencement of Stage 2 coal production, and 5 yearly thereafter. Should any groundwater post-audit indicate a significant variance from the model predictions, MCO will initiate an investigation by a suitably qualified and experienced specialist and where required obtain additional groundwater licence allocations and/or implement remedial actions developed in consultation with DoI Lands and Water and DPIE.

6.0 MONITORING PROGRAM

Groundwater monitoring is undertaken in accordance with NSW Project Approvals (05_0117 and 08_0135) and the commitments outlined in the environmental assessments undertaken for the Moolarben Coal Complex.

Since groundwater investigations commenced in 2005, a broad network of monitoring bores has been installed. NSW Project Approval (05_0117) originally included a requirement to optimise monitoring and water management. Accordingly, MCO commissioned a Regional Water Supply/Monitoring Investigation into the opportunities to optimise water sharing and to rationalise the monitoring and data-sharing between the three mines.

The outcome of this investigation was the *Regional Water Supply and Monitoring Investigation* report (Aquaterra Consulting, 2009). The recommendations from this report and subsequent monitoring have informed the monitoring program described in this GWMP.

The assessment of riparian vegetation undertaken by Ecovision Consulting for the Stage 2 EA did not indicate any specific riparian plant communities that could be considered GDEs and therefore no specific groundwater monitoring for riparian vegetation communities is required (refer to Section 3.0).

6.1 GROUNDWATER MONITORING

Groundwater monitoring piezometers within the Moolarben Coal Complex monitoring network covers all major hydrogeological units and are broadly distributed across the project area (Figure 3). The monitoring network and schedules are listed in Table A5 of Attachment 2.

The monitoring piezometers include both standpipe bores and multi-level VWP bores. The standpipe piezometers can be used for monitoring water level either manually or with an automated datalogger, as well as for collection of water samples for groundwater quality monitoring purposes. The VWPs are grouted and therefore can only be used for monitoring groundwater pressures.

Approximately 11 of the groundwater monitoring bores will be removed due to the progression of mining. The remaining bores will continue to provide sufficient monitoring resolution.

One additional groundwater monitoring bore (VWP) will be installed on the eastern side of Wilpinjong Creek[2] to provide additional monitoring data as mining in OC4 progresses to the north-east (i.e. installed prior to 2023, subject to necessary approvals).

[2] Indicative coordinates of 765,800mE; 6,424,500mN

6.1.1 Groundwater Extraction

Groundwater extraction from all extraction bores is monitored by means of a flow-meter attached to the bore headworks or installed in the discharge pipeline as required under the conditions of the relevant water licences. The Environment and Community Manager (or delegate) will be responsible for monitoring and recording of volumes extracted.

Volumes of water pumped from each open cut location are monitored by means of flow meters fitted to pipelines or recording of pumping times and rates. Water reporting to the open cut and underground pits may include groundwater seepage inflows, supply inflows, recirculation and rainfall runoff. The rainfall component is calculated where appropriate from the current surface water model as part of the Annual Review. Groundwater take is estimated as part of the Annual Review. The estimate incorporates site water balance reconciliations, licensed extractions, recirculation to underground and water take for the period. Indirect or passive take is based on modelling predictions for the relevant period.

Operational water balance reviews will be performed monthly, collating groundwater extractions, in-pit rainfall accumulation and runoff, as well as imported water to inform on-site water management.

6.1.2 Groundwater Levels

The current monitoring program for groundwater levels is detailed in Attachment 2. The piezometers listed in Attachment 2 will be monitored manually on a monthly basis, or continuously by means of automatic dataloggers, as detailed in the tables. Monitoring at piezometer locations within mine disturbance areas will be discontinued as mining progresses in these areas.

Data from the MCO monitoring programme is supplemented with data available from DoI Lands and Water's real-time monitoring bores in the region (Figure 3).

6.1.3 Groundwater Quality

Groundwater quality is monitored in the standpipe bores listed in Attachment 2. Samples are taken six-monthly and sent for laboratory analysis (Table 3). Field measurements of EC and pH are recorded at the time of water quality sampling conducted for relevant bores.

Table 3: Groundwater Quality Monitoring Program

Class	Parameters
Physical parameters	EC, Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and pH
Major cations	calcium, magnesium, sodium, potassium
Major anions	carbonate, bicarbonate, chloride and sulphate
Dissolved metals	aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc
Nutrients	ammonia, nitrate, phosphorus, reactive phosphorus

Class	Parameters
Other	fluoride

6.1.4 Leachate/Seepage Losses from Water and Waste Storages

Mine Water Storages will be visually inspected weekly by the area supervisor, and annually by a delegate of the OC Technical Services Manager to assess structural integrity and detect potential loss of seepage or leachate. Additional measures will be developed on a risk basis or where visual monitoring indicates that seepage losses from water and/or waste storages may be occurring.

Seepage from out-of-pit waste emplacement areas reporting to sediment dams is monitored and reported in accordance with Section 6.5 of the Surface Water Management Plan.

6.2 STREAMFLOW

Streamflow monitoring forms part of the surface water monitoring regime. An integrated monitoring network has been established between MCO, Ulan Coal Mines Limited and Wilpinjong Coal Pty Limited. The streamflow data from this program will inform the monitoring of stream baseflows (i.e. net groundwater discharge to the stream system) through the life of the Moolarben Coal Complex. Streamflow monitoring is discussed further in the Surface Water Management Plan (SWMP).

6.3 CLIMATIC MONITORING

Climate monitoring data is collected from an automatic weather station on site, as detailed in the SWB. The recorded rainfall data is used to differentiate between natural groundwater level variations caused by rainfall induced recharge and discharge and mining (or other abstraction related) induced variations. For shallow unconfined aquifers there is a direct and often immediate relationship between rainfall and groundwater level. For deeper aquifers this relationship still holds but the response time is greater. MCO will engage a suitably qualified expert to differentiate the natural groundwater level variations from mining induced variations.

6.4 ADDITIONAL PIEZOMETERS

6.4.1 OC3 MONITORING PROGRAM

Following the *Moolarben Coal Complex Open Cut Optimisation Modification Groundwater Assessment* (HydroSimulations, 2017), further drilling down gradient from OC3 in the proximity to Moolarben Creek was completed in 2018 and 2019. This drilling program found groundwater to be associated with the Permian coal measures (either within or below the Ulan Coal Seam). The alluvium in the area to be unsaturated. MCO has installed groundwater monitoring bores (PZ217 and PZ221) located between the OC3 boundary, and Moolarben Creek and Munghorn Gap Nature Reserve within the intersected aquifers (both within the Ulan seam).

Groundwater bores (PZ217 and PZ221) are shown in Figure 3 and included in the monitoring program in Section 6. Data from these bores will be recorded in future Annual Reviews and revisions to the GWMP.

6.4.2 OC4 MONITORING PROGRAM

In accordance with Condition 26, Schedule 3 of NSW Project Approval 08-0135 three additional monitoring bores located within the paleochannel between OC4 and the boundary of Wilpinjong Creek were installed in 2015. Monitoring and reporting on these three bores was captured within previous version of the GWMP. As two of the three bores encountered unsaturated paleochannel, they have subsequently been removed from the monitoring program. Monitoring and testing of the remaining bore (PZ203) will continue as part of the monitoring program in Section 6.

6.5 BRINE EMPLACEMENT IN UNDERGROUND WORKINGS

MCO have an approved Brine Management Plan in accordance with Condition 33A, Schedule 3 of Project Approval (05_0117), which includes a program to monitor potential impacts of brine storage, transfer and disposal in underground workings. The Groundwater Management Plan will be updated prior to the disposal of brine underground.

7.0 PROTECTION OF THE DRIP

Condition 32, Schedule 3 of Project Approval (05_0117) and Condition 28, Schedule 3 of Project Approval (08_0135) outline the water management performance measures that are applicable to the Moolarben Coal Complex. Of these, the performance measure related to groundwater is for the Moolarben Coal Complex to result in nil impact on water supply to the Drip.

The Drip is a prominent local dripping sandstone feature located on the northern side of the Goulburn River to the north of UG4 and the Moolarben Coal Complex.

The groundwater discharges are derived from perched groundwater in zones that are exposed in the cliff faces. The perched aquifers are in the Triassic Narrabeen Group sediments, and are formed by accumulations of groundwater above less permeable horizons in the Triassic sequence. The groundwater seepages are only observed on the northern side of the Goulburn River.

Previous groundwater impact assessments have concluded that The Drip will not be affected by the Moolarben Coal Complex.

The groundwater monitoring network for the Moolarben Coal Complex includes multi-level VWP bores and standpipe piezometer bores located south of the Goulburn River, as detailed in Table 4 and shown on Figure 3. The intervals monitored by these piezometers include each of the principal hydrogeological units.

The piezometers listed in Table 4 will be monitored to establish baseline trends in water levels or pressures in advance of mining in UG4.

The groundwater monitoring network for the Drip will be reviewed, and if required, revised, prior to mining in UG4 Longwall Panels 12, 13 and 14.

Table 4: Monitoring Network Near Goulburn River

Piezometer	Type of Bore	Screen Interval / Piezometer Depth	Lithology Monitored	Water Level Monitoring Frequency	Water Quality Monitoring
PZ128	VWP	20	Triassic	Monthly	NA
		36	Permian OB		
		55	Permian OB		
PZ129	VWP	35	Triassic	Monthly	NA
		53	Permian OB		
		74	Permian OB		
PZ101C	SP	24-30	Triassic	Monthly	6-monthly
PZ101B	SP	54-60	Permian OB	Monthly	6-monthly
PZ105C	SP	20-28	Lower Triassic	Monthly	6-monthly
PZ105A	VWP	28	Permian OB	Monthly	NA
	VWP	80	Permian OB	Monthly	NA
	VWP	118	Ulan Seam	Monthly	NA
	VWP	130	Ulan Seam	Monthly	NA
PZ192	VWP	68	Triassic	Monthly	NA
		166	Ulan seam roof		
		178	Ulan seam base		
PZ193	VWP	80	Top Permian	Monthly	NA
		162	Ulan seam roof		
		184	Ulan seam base		
PZ103C	SP	24-30	Triassic	Monthly	6-monthly
PZ103A	SP	118-127	Ulan seam	Monthly	6-monthly
PZ102B	SP	80-86	Ulan seam	Monthly	6-monthly
PZ102A	SP	116-125	Marrangaroo Conglomerate	Monthly	6-monthly

OB – overburden

8.0 INVESTIGATION TRIGGER LEVELS AND MANAGEMENT RESPONSES

Groundwater investigation trigger values for water quality and level have been developed using statistical analysis of baseline groundwater monitoring data and consideration of applicable post baseline data. Trigger action response plans including the trigger investigations, and performance measure exceedance/incident notifications and responses are described in Section 8.2.

The groundwater monitoring program is summarised in Section 6 and Table A5 of Attachment 2.

Periodic review of performance is undertaken by comparison of observed monitoring results against model predictions. The performance is assessed in terms of specific parameters by the application of investigation trigger values which are used to initiate an investigation and necessary response action, as detailed in the following sections.

Trigger values are designed as conservative measurements that identify the potential of a performance exceedance. The trigger level values allow for a timely response to the potential of a performance exceedance before an actual performance exceedance occurs.

8.1 INVESTIGATION TRIGGER LEVELS

MCO has established investigation trigger values to determine the need for investigation and possible response actions for potential impacts to groundwater levels and quality in the Alluvial and Triassic aquifers. The Permian strata extensively affected by past mining (Section 3.0), is predicted to undergo significant further impact from ongoing mining at the Moolarben Coal Complex, the Ulan Mine Complex and the Wilpinjong Coal Mine, and contains groundwater of generally poor quality (see baseline water quality ranges in Attachment 2 (Table A5) and beneficial use category ranges listed in Table 5). Accordingly, trigger levels have not been set for the majority of monitoring piezometers screened in the Permian and Ulan Seams.

Trigger bores are pre-existing bore monitoring locations that will remain over the majority of the mine life and provide full coverage of the MCO area. Existing trigger point locations are currently monitoring water quality and level in accordance with NSW Project Approval (05_117) (as modified) and NSW Project Approval (08_0135) (as modified).

8.1.1 Groundwater Quality Investigation Triggers

The ANZECC guidelines for *Fresh and Marine Water Quality* (2000) apply to the quality of both surface waters and groundwaters since they have been developed to protect environmental values relating to above-ground uses such as irrigation and stock use.

ANZECC (2000) recommends that wherever possible site-specific data be used to define trigger values for physical and chemical factors which can adversely impact the environment, rather than using ANZECC guideline values.

Baseline groundwater monitoring results indicate that baseline values of pH and EC in the vicinity of the Moolarben Coal Complex vary across a wide range and can be outside of the ANZECC (2000) guideline values for ecosystem protection. Therefore, site specific investigation trigger levels based on the baseline data, and in consideration of applicable post baseline data, have been developed for monitoring the impact of the Moolarben Coal Complex (Attachment 2).

Salinity Investigation Triggers

Table 1 of the *NSW Aquifer Interference Policy* (AIP) described in (NOW, 2012) sets out the minimal impact considerations for aquifer interference activities for less productive groundwater sources (refer Section 3), including (inter alia):

> *Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity*;

The alluvial WSP that regulates the alluvial water sources does not designate beneficial uses for the alluvial aquifers in the vicinity of the Moolarben Coal Complex. The fractured and porous rock WSP does not designate beneficial uses for the groundwater (i.e. groundwater within the porous rock water groundwater system) in the vicinity of the Moolarben Coal Complex.

The following beneficial uses were recommended by the *National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia* for major (or significant) aquifers and have been adopted by the NOW in its *Groundwater Quality Protection Policy* (Department of Land and Water Conservation, 1998):

- ecosystem protection;
- recreation and aesthetics;
- raw water for drinking water supply; and
- agricultural water and industrial water.

The *National Land and Water Resources Audit* (Murray Darling Basin Commission, 2005) specified groundwater quality ranges for beneficial use categories based on salinity (Table 5). These salinity-based categories generally align with the beneficial uses within the *NSW Groundwater Quality Protection Policy*.

Table 5: Groundwater Quality Categories: Electrical Conductivity

Beneficial Use	Quality Range	Description
Potable	Up to 800 µS/cm (500 mg/L TDS)*	Suitable for all drinking water and uses.
Marginal Potable	800-2,350 µS/cm (500-1,500 mg/L TDS)*	At the upper level this water is at the limit of potable water, but is suitable for watering of livestock, irrigation and other general uses.
Irrigation	2,350-7,800 µS/cm (1,500-5,000 mg/L TDS)*	At the upper level, this water requires shandying for use as irrigation water or to be suitable for selective irrigation and watering of livestock.
Saline	7,800-22,000 µS/cm (5,000-14,000 mg/L TDS)*	Generally unsuitable for most uses. It may be suitable for a diminishing range of salt-tolerant livestock up to about 6,500mg/L [~10,150 µS/cm] and some industrial uses.
Highly Saline	> 22,000 µS/cm (14,000 mg/L TDS)*	Suitable for coarse industrial processes up to about 20,000 mg/L [~31,000 µS/cm].

**Approximate EC ranges derived from TDS ranges, with conversion Factor of 1.5625 applied.*
Source: National Land and Water Resources Audit (Murray Darling Basin Commission, 2005).

Salinity investigation triggers have been developed based on the 95th percentile baseline salinity level recorded at each relevant bore location[3]. Should a measured salinity level exceed the investigation trigger for two consecutive monitoring events the groundwater trigger action response plan will be initiated (Section 8.2).

The salinity triggers for each relevant bore are presented in Attachment 2. It can be observed that trigger levels are well below the beneficial use category threshold in all circumstances.

pH Investigation Triggers

pH investigation triggers have been developed based on the 5th and 95th percentile baseline pH levels recorded at each relevant bore location[4]. Should a measured pH investigation trigger level exceed the trigger for two consecutive monitoring events, the groundwater Trigger Action Response Plan will be initiated (Section 8.2).

8.1.2 Groundwater Level Investigation Triggers

Investigation triggers for measured groundwater levels have been reviewed taking into account minimal impact considerations in the AIP.

There is no 'highly productive' groundwater, as defined in the AIP, mapped in the vicinity of the Moolarben Coal Complex. The nearest 'highly productive' groundwater is a portion of the alluvial aquifer associated with Wilpinjong Creek downstream of the Wilpinjong Coal Mine.

[3] 90th percentile salinity level used to develop salinity trigger at PZ103C, due to an anomalously high maximum at the monitoring location.
[4] 10th and 90th percentile pH level used to develop pH trigger at PZ103C, due to an anomalously high maximum at the monitoring location.

The AIP describes the following minimal impact considerations for less productive groundwater sources:

> *Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any:*
>
> *(a) high priority groundwater dependent ecosystem; or*
>
> *(b) high priority culturally significant site;*
>
> *listed in the schedule of the relevant water sharing plan.*
>
> *A maximum of a 2m decline cumulatively at any water supply work.*

There are no high priority GDEs or high priority culturally significant sites identified in the alluvial WSP or fractured and porous rock WSP in the vicinity of the Moolarben Coal Complex. Notwithstanding, specific monitoring for 'The Drip' feature is discussed in Section 7.

Groundwater level triggers have been developed for triassic and alluvium monitoring bores (refer Attachment 2, Tables A7 and A8) to identify drawdown trends that could potentially lead to a private bore being impacted (i.e. experiencing greater than 2 m drawdown). These water level triggers are based on baseline monitoring data to date and have been developed by the suitably qualified secretary approved hydrogeologist. Trigger values are set at 50% of the minimum saturated bore depth of designated groundwater trigger monitoring bores to enable detection of any significant adverse mining related impacts to other groundwater users (Section 8.2).

The Trigger Action Response Plan would be implemented following two consecutive monthly monitoring rounds to determine whether the cause of the water level/pressure decline is a result of MCO's mining activity, including borefield pumping, and to recommend an appropriate response action, if required (Section 8.2).

8.2 GROUNDWATER TRIGGER ACTION AND RESPONSE PLAN

An investigation will be initiated where the groundwater monitoring identifies two consecutive monthly monitoring results outside the trigger levels (or ranges) described in Sections 8.1.1 and 8.1.2. Details of trigger events, investigations required, notifications to be undertaken and management actions for different aspects of the water management system are provided in Table 6.

Table 6: Groundwater Trigger Action Response Plan

Performance Criteria	Trigger	Action	Response
Groundwater Quality			
No greater than minimal impact for water users or high priority GDEs (as defined in the AIP for less productive groundwater) due to mining-related activities (i.e no change in beneficial use category).	Two consecutive groundwater quality monitoring results exceed (or below in the event of a lower pH trigger limit) investigation triggers at monitoring location. It is noted trigger levels are based on baseline data (e.g. 95th %ile) and as such baseline levels naturally exceed the triggers for a portion of the time.	1. Check and validate data. 2. Notify ECM or delegate. 3. Undertake investigation to confirm if investigation trigger exceedance is mining-related: a. If necessary, engage a suitably qualified person. b. Consider relevant recent conditions, including climate and land-use activities. c. Consider relevant monitoring data, e.g. other monitoring bores. d. If investigation confirms trigger exceedance is not mining-related, record data and cease investigation. 4. If trigger exceedance is mining-related, confirm if mining-related activities have caused, or have the potential to cause, material environmental harm (i.e. exceedance of performance criteria). a. If so, notify DPIE and other relevant agencies immediately. b. If not, notify DPIE and other relevant agencies as soon as practicable. 5. Notify DPIE and other relevant agencies if performance measures are exceeded as soon as practicable. 6. Complete Preliminary investigation report and provide to DPIE and relevant agencies within 7 days of identifying the incident.	Where mining-related impacts have resulted in trigger exceedances, implement contingency and remedial measures based on investigation. Measures may include: • Review and if necessary, revise Monitoring Program. • Review and revise if necessary GWMP and re-submit to DPIE. • Investigate reasonable and feasible remedial measures. • Review and repair/replace water management infrastructure if required.

Performance Criteria	Trigger	Action	Response
Groundwater Level			
No greater than minimal impacts to water users or high priority GDEs (as defined in the AIP for less productive groundwater) due to mining impacts.	Two consecutive groundwater level monitoring results exceed investigation trigger at monitoring locations.	1. Check and validate data. 2. Notify ECM or delegate. 3. Undertake investigation to confirm if investigation trigger exceedance is mining-related: a. If necessary, engage a suitably qualified person. b. Consider relevant recent conditions, including climate and land-use activities. c. Consider relevant monitoring data, e.g. other monitoring bores. d. If investigation confirms trigger exceedance is not mining-related, record data and cease investigation. 4. If trigger exceedance is mining-related, confirm if mining-related activities have caused, or have the potential to cause, material environmental harm (i.e. exceedance of performance criteria). a. If so, notify DPIE and other relevant agencies immediately. b. If not, notify DPIE and other relevant agencies as soon as practicable. 5. Notify DPIE and other relevant agencies if performance measures are exceeded as soon as practicable. 6. Complete Preliminary investigation report and provide to DPIE and relevant agencies within 7 days of identifying the incident.	Where mining-related impacts have resulted in trigger exceedances, implement contingency and remedial measures based on investigation. Measures may include: • Review and if necessary, revise Monitoring Program. • Review and revise if necessary GWMP and re-submit to DPIE. • Implement reasonable and feasible remedial measures. • Provide compensatory groundwater supply or other water supply. • Review and repair/replace water management infrastructure if required. • In the event of dispute, implement the Resolution process outlined in Section 5.5 of the Environmental Management Strategy.

ECM = Environment & Community Manager, DPIE = Department of Planning and Environment, EPA = Environment Protection Authority

8.3 PROTOCOL FOR COORDINATION WITH ULAN MINE COMPLEX AND WILPINJONG COAL MINE

In accordance with the conditions of the original Stage 1 Project Approval (05_0117), MCO engaged a qualified and independent expert to undertake a Regional Water Supply and Monitoring Investigation in consultation with the EPA, NOW (now DPIE - Water), DTIRIS, Ulan Coal Mines Pty Ltd and Wilpinjong Coal Pty Limited. The Regional Water Study is discussed further in Section 2.4.4 of the WAMP.

Key outcomes of the study (e.g. data sharing, modelling of cumulative impacts, joint trigger investigations and water sharing) relevant to Condition 33(b)(iv), Schedule 3, and Condition 29(e)(iv), Schedule 3 of the NSW Project Approvals (05_0117 and 08_0135, respectively) are summarised below.

Monitoring data obtained at the Moolarben Coal Complex is supplemented with data from the Wilpinjong Coal Mine and the Ulan Mine Complex obtained under data sharing agreements with Wilpinjong Coal Pty Limited and Ulan Coal Mines Limited, respectively.

The Moolarben Coal Complex groundwater model domain includes the adjacent Ulan Mine Complex and Wilpinjong Coal Mine. All modelling undertaken includes the past and approved future mine plans and schedules from the Ulan Mine Complex and Wilpinjong Coal Mine, as well as the Moolarben Coal Complex.

As a component of the groundwater investigation protocol, MCO will liaise with Ulan Coal Mines Limited and Wilpinjong Coal Pty Limited to review mining activities in the area as soon as the groundwater monitoring identifies results outside the trigger levels (or ranges) described in Sections 8.1.1 and 8.1.2 and where cumulative impacts are considered likely. In addition, MCO would continue to liaise with the environmental managers at the Ulan Mine Complex and Wilpinjong Coal Mine approximately every 6 months.

Where practical, MCO seeks to use surplus mine water from other mines. MCO has an agreement with Ulan Coal Mines Limited for the supply of 1,000 ML/year of surplus mine water from its operations. MCO and Wilpinjong Coal Mine have, and will continue to, liaise and implement opportunities for physical water sharing between the two sites.

9.0 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

Annual Review reporting requirements are described in Section 4.1 of the WAMP. Triggers for review, and if necessary revision, of the Groundwater Management Plan are described in Section 4.2 of the WAMP.

10.0 REPORTING SYSTEMS

Reporting, of incidents, complaints, non-compliances and performance criteria exceedances are described in Section 5.0 of the WAMP.

11.0 REFERENCES

Aquaterra Consulting Pty Ltd, 2008. *Moolarben Stage 2 Groundwater Assessment*. Dated 24 November 2008.

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

Australasian Groundwater & Environmental Consultants Pty Ltd, 2013. *Moolarben Coal Project – Stage 1 Optimisation Modification Groundwater Assessment.* Dated May 2013.

Barnett B, Townley L R, Post V, Evans R E, Hunt R J, Peeters L, Richardson S, Werner A D, Knapton A and Boronkay A, 2012. *Australian Groundwater Modelling Guidelines.* Waterlines Rpt 82, Nat Water Commission, Canberra.

Department of Land and Water Conservation, 1998 *The NSW Groundwater Quality Protection Policy.*

Doherty, J., Muffels, C., Rumbaugh, J., Tonkin, M., 2017. *Model-Independent Parameter Estimation and Uncertainty Analysis*.

Dundon Consulting Pty Ltd, 2015. *Moolarben Coal Complex – UG1 Optimisation Modification – Groundwater Assessment.*

HydroAlgorithmics (2017). *AlgoMesh for Mesh Generation*. Website: http://www.hydroalgorithmics.com

HydroSimulations, 2017. *Moolarben Coal Complex Optimisation Modification Groundwater Assessment*.

Mackie Environmental Research, 2009. *Ulan Coal Mines Continued Operations Groundwater Assessment.*

Moolarben Coal Operations Pty Ltd (2015) Surface Water Management Plan.

Murray Darling Basin Commission, 2001. *Groundwater Flow Modelling Guideline.* Murray-Darling Basin Commission. URL: http://www.mdbc.gov.au/nrm/groundwater/groundwater_guides/

Murray Darling Basin Commission, 2005. *National Land and Water Resources Audit*

NSW Office of Water, 2012. *NSW Aquifer Interference Policy.*

Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., and Hughes, J.D., 2013. *MODFLOW–USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation*. U.S. Geological Survey techniques and Methods. Book 6.

Peter Dundon and Associates Pty Ltd, 2006. *Moolarben Coal Project – Groundwater Assessment.* Dated 8 September 2006.

RPS Aquaterra, 2011. *Moolarben Coal Complex Stage 2 – Preferred Project Report – Groundwater Impact Assessment, November 2011*. Dated 30 November 2011.

Attachment 1 – Project Approval (05_0117) and (08_0135) Reconciliation

Table A-1: Groundwater Management Plan Requirements in Project Approval (05_0117)

NSW Project Approval Condition	GWMP Section
Water Management Plan	
33. (b) in addition to the standard requirements for management plans (see condition 3 of Schedule 6), this plan must include a:	
...	
(iii) Groundwater Management Plan, that includes:	
• detailed baseline data on groundwater levels, yield and quality in the region and privately-owned groundwater bores that could be affected by the project;	Sections 4.1 and 4.2
• groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts and detailed justification for those trigger levels;	Section 8.1
• a program to monitor and report on:	
- groundwater inflows to the underground and open cut mining operations;	Section 6.1.1
- the seepage/leachate from water storages, emplacements, backfilled voids and final voids;	Section 6.1.4
- background changes in groundwater yield/quality against mine-induced changes;	Section 8
- impacts of the project on:	Sections 6, 7 and 8
▪ regional and local (including alluvial) aquifers;	
▪ groundwater supply of potentially affected landowners; and	
▪ groundwater dependent ecosystems (including the Drip) and riparian vegetation;	
• brine emplacement in underground workings and potential changes to groundwater and surface water quality;	Section 6.5, *Brine MP
• a program to validate the groundwater model for the project, and compare against monitoring results with modelled predictions; and	Section 5.1
• a plan to respond to any exceedances of the groundwater assessment criteria.	Section 8.2

*Brine MP = Brine Management Plan

Table A-2: Groundwater Management Plan Requirements in Project Approval (08_0135)

NSW Project Approval Condition	GWMP Section
Water Management Plan	
29. (e) in addition to the standard requirements for management plans (see condition 3 of Schedule 6), this plan must include a:	
...	
(iii) Groundwater Management Plan, that includes:	
• detailed baseline data on groundwater levels, yield and quality in the region and privately-owned groundwater bores that could be affected by the project;	Section 4
• groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	Section 8.1
• a program to monitor and report on:	
- groundwater inflows to the underground and open cut mining operations;	Section 6.1.1
- the seepage/leachate from water storages, emplacements, backfilled voids and final voids;	Section 6.1.4
- background changes in groundwater yield/quality against mine-induced changes;	Section 8
- brine emplacement in underground workings and potential changes to groundwater and surface water quality; and	Section 6.5, Brine MP
- the permeability, hydraulic gradient, flow direction and connectivity of the palaeochannel and flows within Wilpinjong Creek (requires 3 additional monitoring piezometers within the main trunk of the paleochannel between the open cut 4 boundary and Wilpinjong Creek);	Section 6.4
- impacts of the project on:	Sections 6, 7 and 8
▪ regional and local (including alluvial) aquifers;	
▪ groundwater supply of potentially affected landowners; and	
▪ groundwater dependent ecosystems (including the Drip) and riparian vegetation;	
- a program to validate the groundwater model for the project, and compare against monitoring results with modelled predictions; and	Section 5.1
• a plan to respond to any exceedances of the groundwater assessment criteria.	Section 8.2

Table A-3: General Management Plan Requirements

NSW Project Approval Condition	GWMP Section
3. *The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:*	
(a) detailed baseline data;	Section 4
(b) a description of:	
• *the relevant statutory requirements (including any relevant approval, licence or lease conditions);*	Section 2
• *any relevant limits or performance measures/criteria;*	Section 8
• *the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;*	Section 8
(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 8.2
(d) a program to monitor and report on the:	Sections 6, 7, 8, 10 and WAMP
• *impacts and environmental performance of the project;*	
• *effectiveness of any management measures (see c above);*	
(e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 6
(f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 9 & WAMP
(g) a protocol for managing and reporting any:	WAMP
• *incidents;*	
• *complaints;*	
• *non-compliances with statutory requirements; and*	
• *exceedances of the impact assessment criteria and/or performance criteria; and*	
(h) a protocol for periodic review of the plan.	Section 10

Table A-4: Statement of Commitments Relating to Groundwater

Commitment	GWMP Section
NSW Project Approval (05_0117) Commitments	
1. ***Protect The Drip and Goulburn River Corner Gorge*** *The Drip and the Goulburn River Corner Gorge are shown on the plan titled "Moolarben Coal Mine – Preferred Mine Plan General Layout" contained in Appendix A9 to the Moolarben Coal Project Response to Submissions". Moolarben will conduct its underground mining operations consistent with the Preferred Project Underground No. 4 layout to protect the Goulburn River features known as The Drip, the Goulburn River Corner Gorge and associated cliffs so that there is no damage whilst seeking to maximise recovery of coal resources and as may be required by any condition of project approval for the Moolarben Coal Project.*	Section 7
3. ***Replace Water*** *Moolarben will compensate or replace waters (similar quality and quantity) lost by a private landholder as a consequence of the Moolarben Coal Project in accordance with the adopted protocols and procedures contained in the Moolarben Coal Project Environmental Management System and as may be required by any conditions of project approval for the Moolarben Coal Project.*	Section 8.2
18 ***Additional Management and Mitigation – Modification of Stage 1 (Water)*** • *Management and monitoring of surface water and groundwater will be undertaken in accordance with an approved Water Management Plan, which will be reviewed and updated, as necessary, to include the Open Cut 1 and Open Cut 2 extension areas and additional surface water management infrastructure. As part of this review. MCO will liaise with the NOW on the water licensing requirements for the open cut extension areas.* … • *MCO will abide by the rules of any relevant water sharing plan and return water where required.*	Section 6 Section 8.3 and WAMP
NSW Project Approval (08_0135) Commitments	
18 *MCM will continue to monitor groundwater impacts on surrounding privately owned bores. In the event that it is demonstrated that water levels in existing landholder bores decline as a consequence of the MCC, leading to adverse impact on groundwater supply, MCM will:* • *Engage an appropriately qualified and experienced hydrogeologist to investigate the cause of the impact and recommend an appropriate action response plan; and* • *Provide an alternate interim water supply or commensurate compensation as agreed to with the landholder.*	Section 6.1 Section 8.2 Section 8.2
22 *Collated groundwater monitoring data will be reviewed annually to assess the impacts of the MCC on the groundwater environment and to compare observed impacts with those predicted from groundwater modelling.*	Section 9
23 *The groundwater monitoring program will be revised to include additional piezometers in alluvial areas, including palaeochannel areas, potentially affected by the MCC.*	Complete
24 *A groundwater modelling post-audit and model recalibration (where required) will be carried out 2 years (and 5 yearly thereafter) after commencing Stage 2 coal extraction. Should any groundwater review or post-audit indicate a significant variance from the model predictions, an appropriate response will be implemented in consultation with NOW and DP&I.*	Section 5
25 *MCM will acquire relevant licences under the Water Act 1912 and Water Management Act 2000 as required (or implement other such ameliorative measures as agreed with relevant regulators, such as return flows or such other reasonable and feasible mitigation measures to reduce the total direct and indirect water take of the MCC from alluvial and connected surface water sources).*	Section 2.2

Attachment 2 – Groundwater Monitoring Program

Table A-5: Groundwater Monitoring Program

Bore	Type	Depth (m)	Screened interval (m)	Lithology screened	Water Level Monitoring Frequency	Historic Water Level range (mbgl)	Water Quality Monitoring Frequency	Easting (m)	Northing (m)	RL (mAHD)
PZ003	Stand Pipe Piezometer	21	9-15	Ulan seam	Manual monthly	3.13-7.74	6-monthly	762714	6417964	474.92
PZ040B	Stand Pipe Piezometer	45	38-44	Permian OB	Manual monthly	6.06-14.93	6-monthly	763928	6423743	428.40
PZ044	Stand Pipe Piezometer	23	20-23	Ulan Granite	Manual monthly	7.84-12.61	6-monthly	759906	6417069	491.30
PZ055	Stand Pipe Piezometer	15	11-14	Marrangaroo Conglomerate	Manual monthly	3.33-7.63	6-monthly	758773	6423995	429.46
PZ58a	Stand Pipe Piezometer	12	8-11	Tertiary Aged Sediment	Manual monthly	10.79-11.38	6-monthly	761622	6418359	478.39
PZ101C	Stand Pipe Piezometer	30	24-30	Lower Triassic	Manual monthly	21.34-22.63	6-monthly	762646	6431445	403.00
PZ101B	Stand Pipe Piezometer	60	54-60	Permian OB	Manual monthly	27.29-39.8	6-monthly	762646	6431445	403.28
PZ102B*	Stand Pipe Piezometer	86	80-86	Ulan seam	Manual monthly	32.96-53.46	6-monthly	761117	6429147	408.23
PZ102A*	Stand Pipe Piezometer	125	116-125	Marrangaroo Conglomerate	Manual monthly	33.27-52.91	6-monthly	761118	6429150	408.54
PZ103C	Stand Pipe Piezometer	30	24-30	Lower Triassic	Manual monthly	22.70-27.78	6-monthly	762397	6429264	425.00
PZ103B	Stand Pipe Piezometer	87	81-87	Permian OB	Manual monthly	24.55-58.6	6-monthly	762397	6429264	425.00
PZ103A	Stand Pipe Piezometer	128	118-127	Ulan seam	Manual monthly	50.66-70.79	6-monthly	762410	6429261	425.21
PZ104	Stand Pipe Piezometer	160	151-160	Ulan seam	Manual monthly	50.22-63.77	6-monthly	766832	6426451	438.93
PZ105C	Stand Pipe Piezometer	28	20-28	Lower Triassic	Manual monthly	10.86-15.1	6-monthly	763987	6431607	389.00
PZ105A	Vibrating Wire Piezometer	133	28	Permian OB	Datalogger Recorded monthly	TBC	N/A	763988	6431610	388.93
	Vibrating Wire Piezometer		80	Permian OB	Datalogger Recorded monthly	TBC				
	Vibrating Wire Piezometer		118	Ulan Seam	Datalogger Recorded monthly	TBC				

Bore	Type	Depth (m)	Screened interval (m)	Lithology screened	Water Level Monitoring Frequency	Historic Water Level range (mbgl)	Water Quality Monitoring Frequency	Easting (m)	Northing (m)	RL (mAHD)
	Vibrating Wire Piezometer		130	Ulan Seam	Datalogger Recorded monthly	TBC				
PZ106A	Stand Pipe Piezometer	131.5	125-131	Permian OB	Manual monthly	58.89-87.08	6-monthly	765128	6418275	510.69
PZ109	Stand Pipe Piezometer	254	246-252	Permian OB	Manual monthly	52.68-57.7	6-monthly	766123	6435558	437.12
PZ111	Stand Pipe Piezometer	83	71-77	Ulan seam	Manual monthly	23.67-41.92	6-monthly	767082	6423096	404.78
PZ112B	Stand Pipe Piezometer	12	6-12	Permian OB	Manual monthly	3.71-6.51	6-monthly	766139	6419517	485.67
PZ127	Vibrating Wire Piezometer	152	43	Triassic	Datalogger Recorded monthly	Dry	N/A	762799	6424948	494.55
	Vibrating Wire Piezometer		68	Permian OB	Datalogger Recorded monthly	47.2-52.98	N/A			
PZ128	Vibrating Wire Piezometer	61	20	Triassic	Datalogger Recorded monthly	Dry	N/A	763227	6432120	409.52
	Vibrating Wire Piezometer		36	Permian OB	Datalogger Recorded monthly	28.6-34.55	N/A			
	Vibrating Wire Piezometer		55	Permian OB	Datalogger Recorded monthly	28.6-38.85	N/A			
PZ129	Vibrating Wire Piezometer	74	35	Triassic	Datalogger Recorded monthly	25.2-35.23	N/A	763624	6432251	417.95
	Vibrating Wire Piezometer		53	Permian OB	Datalogger Recorded monthly	27.1-41.2	N/A			
	Vibrating Wire Piezometer		74	Permian OB	Datalogger Recorded monthly	36.0-43.09	N/A			
PZ130	Vibrating Wire Piezometer	111	38.5	Permian OB	Datalogger Recorded monthly	37.7-40.4	N/A	760940	6422438	535.07
	Vibrating Wire Piezometer		64	Permian OB	Datalogger Recorded monthly	51.6-64.29	N/A			
PZ137	Stand Pipe Piezometer	23	20-23	Permian OB	Manual monthly	16.38-18.93	6-monthly	764002	6420285	479.01
PZ170*	Stand Pipe Piezometer	31	26-29	Permian OB	Manual monthly	14.68-17.39	6-monthly	763591	6424306	437.49

Bore	Type	Depth (m)	Screened interval (m)	Lithology screened	Water Level Monitoring Frequency	Historic Water Level range (mbgl)	Water Quality Monitoring Frequency	Easting (m)	Northing (m)	RL (mAHD)
PZ179	Vibrating Wire Piezometer	145	29	Triassic	Datalogger Recorded monthly	24.6-31.2	N/A	764688	6426599	444.75
	Vibrating Wire Piezometer		33	Permian OB	Datalogger Recorded monthly	25.8-33.5	N/A			
	Vibrating Wire Piezometer		145	Ulan seam	Datalogger Recorded monthly	28.9-107.4	N/A			
PZ184	Stand Pipe Piezometer	9	6-9	Tertiary paleochannel	Manual monthly	6.19-9.11	6-monthly	765410	6423142	419.40
PZ186	Vibrating Wire Piezometer	126	40	Upper Permian	Datalogger Recorded monthly	TBC	N/A	764788	6425865	418.76
	Vibrating Wire Piezometer		65	Middle Permian	Datalogger Recorded monthly	TBC	N/A			
	Vibrating Wire Piezometer		86	Lower Permian	Datalogger Recorded monthly	TBC	N/A			
	Vibrating Wire Piezometer		118	Ulan Seam	Datalogger Recorded monthly	TBC	N/A			
PZ186a	Vibrating Wire Piezometer	18	13.5	Tertiary paleochannel	Datalogger Recorded monthly	TBC	N/A	764788	6425865	418.76
PZ188	Stand Pipe Piezometer	18.5	12-18	Tertiary paleochannel	Manual monthly	6.01-9.97	6-monthly	764478	6426084	423.62
PZ189	Stand Pipe Piezometer	65	59-95	Permian OB	Manual monthly	10.41-22.7	6-monthly	764503	6426089	424.17
PZ191*	Stand Pipe Piezometer	72	60-72	Ulan seam	Manual monthly	30.96-54.93	6-,monthly	761776	6426772	417.69
PZ192	Vibrating Wire Piezometer	180	68	Triassic	Datalogger Recorded monthly	47.5-54.25	N/A	763787	6429831	453.70
	Vibrating Wire Piezometer		166	Ulan seam roof	Datalogger Recorded monthly	72.9-97.72	N/A			
	Vibrating Wire Piezometer		178	Ulan seam base	Datalogger Recorded monthly	80.9-115.7	N/A			
PZ193	Vibrating Wire Piezometer	186	80	Permian OB	Datalogger Recorded monthly	42.12-43.94	N/A	763733	6429326	461.40
	Vibrating Wire Piezometer		162	Ulan seam roof	Datalogger Recorded monthly	90.84-101.8	N/A			
	Vibrating Wire Piezometer		184	Ulan seam base	Datalogger Recorded monthly	96.2-110.9	N/A			

Bore	Type	Depth (m)	Screened interval (m)	Lithology screened	Water Level Monitoring Frequency	Historic Water Level range (mbgl)	Water Quality Monitoring Frequency	Easting (m)	Northing (m)	RL (mAHD)
PZ203	Stand Pipe Piezometer	21	14-20	Tertiary paleochannel	Manual monthly	5.6-9.0	6-monthly	766296	6423545	409.40
PZ211	Stand Pipe Piezometer	20	17-20	Tertiary paleochannel	Manual monthly	Dry	6-monthly	763442	6426146	453.05
PZ213	Stand Pipe Piezometer	22	20-22	Tertiary paleochannel	Manual monthly	12.45-14.9	6-monthly	764341	6425229	427.57
PZ214	Stand Pipe Piezometer	25	22-25	Tertiary paleochannel	Manual monthly	15.08-17.9	6-monthly	764135	6425720	430.69
PZ217	Stand Pipe Piezometer	18	7-13	Ulan Seam	Manual monthly	TBC	6-monthly	763874	6415749	495.30
PZ221	Stand Pipe Piezometer	66	49-58	Ulan Seam	Manual monthly	TBC	6-monthly	763771	6417730	499.76

*NB. To be decommissioned prior to extraction for safety of underground operations. Sites will continue to be monitored until decommissioned.

Table A-6: Salinity and pH Trigger Levels

Bore	Depth (m)	Lithology screened	Salinity Triggers			Beneficial Use Category Change Threshold (µS/cm)	pH Trigger Level (5th to 95th percentile)*
			Historical lab EC (5th to 95th percentile) (µS/cm)*	EC Trigger Level (µS/cm)	Beneficial Use Category Based on Lab EC 95th Percentile		
PZ044	23	Ulan Granite	2728-3000 (2910)	3000	Irrigation	7800	5.7 – 7.2 (6.4)
PZ055	15	Indurated Conglomerate	1321 - 2756 (2380)[a]	2756	Irrigation	7800	5.1 – 6.3 (5.5)[a]
PZ058a	12	Tertiary Aged Sediment	9405-14765 (11100)[d]	14765	Saline	22000	2.8 – 4.7 (3.7)[d]
PZ101C	30	Lower Triassic	610-810 (655)	810	Marginal Potable	2350	6.1 – 7.7 (6.7)
PZ101B	60	Permian OB	736-928 (761)	928	Marginal Potable	2350	6.2 – 7.7 (7.0)
PZ103C	30	Lower Triassic	310-448 (350)[b]	448	Potable	800	5.2 – 6.8 (5.6)[c]
PZ105C	28	Lower Triassic	198-319 (265)	319	Potable	800	5.3 – 7.4 (6.1)
PZ109	254	Permian OB	660-1145 (1040)	1145	Marginal Potable	2350	6.3 – 8.4 (7.3)[e]
PZ188	18.5	Tertiary paleochannel	198-394 (245)	394	Potable	800	4.7 – 6.9 (5.5)

* NB. Historical values in brackets are median values.
[a] Statistics and revised trigger level at PZ55 are based on post mining data from 2010 to 2018.
[b] Revised trigger level at PZ103C is based on the 90th percentile of historical lab EC data.
[c] Revised trigger levels at PZ103C are based on the 10th and 90th percentile of historical field pH data.
[d] PZ058a triggers to be developed following collection of 12 quality monitoring rounds.
[e] Revised trigger levels at PZ109 are based on the 5th and 90th percentile of historical field pH data.

Table A-7: Investigation Trigger Levels – Triassic Bores

Triassic Piezometer Number	TOC	Minimum Observed Groundwater Level/Pressure		Bottom of Hole/VWP sensor		Saturated Thickness Lowest to 31 Dec	Trigger Level	
	mAHD	mbgl	m AHD	mbgl	mAHD	m	mbgl	mAHD
PZ101C	403.0	22.5	380.5	30	373.0	7.5	26.3	376.8
PZ105C	389.0	15.1	373.9	28	361.0	12.9	21.6	367.4
PZ129 (35m)*	418.0	29.6	388.4	35	383.0	5.4	32.3	385.7

Note: mbgl = metres below ground level, m AHD = metres Australian Height Datum

** PZ129 is a VWP drilled in Triassic strata to a depth of 74 m. Pressure transducers have been installed at 35 m, 53 m and 74 m (refer Table A5).*

[a] Revised trigger levels at PZ105C are based on data since the start of 2016 and are in line with the NSW Aquifer Interference Policy.

Table A-8: Investigation Trigger Levels – Alluvium and Tertiary Bores

Triassic Piezometer Number	TOC	Minimum Observed Groundwater Level/Pressure		Bottom of Hole/VWP sensor		Saturated Thickness Lowest to 31 Dec	Trigger Level	
	mAHD	mbgl	m AHD	mbgl	mAHD	m	mbgl	mAHD
PZ055	429.5	7.6	421.8	15	414.5	7.4	11.3	418.1
PZ058A	478.1	11.4	466.7	12	466.1	0.6	11.7	466.4
PZ188	423.6	10.0	413.7	18.5	405.1	8.5	14.2	409.4
PZ203	409.4	9.0	400.4	21	388.4	12.0	15.0	394.4
PZ213	427.6	13.7	413.8	22	405.6	8.3	17.9	409.7
PZ214	430.7	16.8	413.9	25	405.7	8.2	20.9	409.8

Attachment 3 – Private Landholder Bore Baseline Data

NSW Office of Water
Work Summary

GW800279

Licence: 80BL236762 **Licence Status:** ACTIVE

Authorised Purpose(s): STOCK,DOMESTIC
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Rot. Rev. Circ. Air
Owner Type: Private

Commenced Date:
Completion Date: 27/11/1995
Final Depth: 24.40 m
Drilled Depth: 24.40 m

Contractor Name: Watermin Drillers Pty Ltd
Driller: Clayton Lee Jones
Assistant Driller:

Property: GLENISTON CASSILIS ROAD MUDGEE 2850
GWMA: 010 - CUDGEGONG VALLEY
GW Zone: -
Standing Water Level:
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PHILL	PHILL.029	PORTION 1
Licensed:	PHILLIP	LENNOX	Whole Lot 1//755439

Region: 80 - Macquarie-Western
River Basin: 421 - MACQUARIE RIVER
Area/District:
CMA Map: 8833-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6431971.0
Easting: 765208.0
Latitude: 32°13'03.4"S
Longitude: 149°48'50.2"E

GS Map: -
MGA Zone: 0
Coordinate Source: Map Interpretation

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	24.40	165			Rotary
1	1	Casing	Pvc Class 9	-0.30	24.40	152			Seated on Bottom, Glued
1	1	Opening	Slots - Vertical	9.10	21.03	152		1	Sawn, PVC Class 9, SL: 457.0mm, A: 2.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

9.10	15.20	6.10	Unknown	5.50		1.26	15.20		
20.70	21.03	0.33	Unknown	5.50		0.25	21.03		

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	24.40	24.40	SANDSTONE	Unknown	

Remarks

***** End of GW800279 *****