Muswellbrook Coal

MP 38
Water Management Plan

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TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

Muswellbrook Coal Company (MCC) is a wholly owned subsidiary of the Idemitsu Kosan Company Ltd. Group. MCC has a long association with coal mining at Muswellbrook, with underground coal mining commencing in 1907 and open cut operations in 1944. The mine is located on Muscle Creek Road, approximately 3 kilometres to the north-east of Muswellbrook.

On September 1, 2003, Development Consent for DA 205/2002 was granted by Muswellbrook Shire Council (MSC) to extend the former MCC No.1 Open Cut. The No.1 Open Cut Extension commenced operations in March 2005 and has a capacity to produce up to 2,000,000 tonnes coal per annum. This approval has subsequently been modified on several occasions with the latest modification granted in 2016 to allow mining in an area known as the "Continuation Project" and to extend the life of the mining operations to 2022. Rehabilitation activities will continue past this date. A modification to the approval was granted on 20 December 2022 to allow the storage, handling, and transport of coal to continue until the end of March 2023. An additional modification to the consent was granted on 27 February 2024 to align rehabilitation requirements with updated mining lease conditions and other administrative changes.

Mining activities ceased at MCC in December 2022 with the last coal hauled from site in March 2023. Rehabilitation of the site and completion of mine closure activities are ongoing.

1.1 SCOPE

The Development Consent requires the preparation, approval, and implementation of an Environmental Management Strategy (EMS) and subordinate Environmental Management Plans (EMP). One of these EMPs is the Water Management Plan (WMP). This WMP also addresses environmental protection licence conditions and water licence conditions that relate to water management at MCC. Whilst this plan specifically addresses issues related to water management on site, it should be read in conjunction with other EMP's. This plan is transitional, with amendments pending based on outcomes from ongoing mine closure studies.

This WMP has been prepared by MCC and reviewed by a suitably qualified person in consultation with Department of Climate Change, Energy, the Environment and Water (NSW) (DCCEEW) to the satisfaction of MSC (see **Appendix 1** for copies of correspondence).

1.2 OBJECTIVES

The primary objective of the WMP is to enable the effective management of on-site waters to minimise the impact of operations on surface and groundwater resources both on and adjacent to the site. The WMP will achieve this objective through the implementation of the following strategies:

- Meeting the water supply needs of the project,
- Separating clean water runoff produced by undisturbed catchments from dirty (sediment-laden) and contaminated runoff from disturbed catchments,
- Using appropriate sedimentation controls for dirty water,

- Where possible, recycling and reusing dirty and contaminated water for dust suppression and wash down activities,
- Allowing clean water to flow through the catchment,
- Where possible, and where site safety permits and there are no potential adverse impacts/impact pathways, using disused open cuts and underground mines as water storages,
- Nil discharge of saline water by containing all saline water on site and minimising the risk of accidental off-site discharge,
- Monitoring surface water and groundwater to determine significant impacts to water quality or beneficial use, and undertaking trigger action responses where required, and
- Monitoring the surface water and groundwater to support mine closure planning.

2.0 LEGISLATION AND STATUTORY REQUIREMENTS

Generally, the WMP considers the principles, regulations and guidelines contained in:

- Water Management Act, 2000.
- Water Act, 1912.
- Protection of the Environment Operations Act, 1997.
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA 2004).
- Australian Standards for water monitoring: AS5667.1:1998 (*Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples*), AS5667.4:1998 (*Guidance on the Sampling from Lakes, Natural and Man Made*), AS5667.6:1998 (*Guidance on the Sampling of Rivers and Streams*), AS5667.11:1998 (*Guidance on the Sampling of Groundwaters*).

MCC holds three licences to extract ground water. These licences have been issued in accordance with the Water Management Act 2000. The extraction entitlements are shown **Table 1**. The volume of groundwater extracted from the authorised works shall not exceed the extraction entitlement in a 12-month period commencing 1 July.

Table 1: Groundwater Extraction

Legislation	Licence No.	Extraction Entitlement (ML per Annum Limit)
Water Management Act	Small borehole – WAL39806, 20WA216928	1,000
Water Management Act	Large borehole – WAL41503, 20WA216982	2,200
Water Management Act	Open cut voids – WAL41521, 20WA218978	1,400

The water related approval and licence conditions are shown in **Table 2** along with information on where they are addressed in this plan.

Table 2: Statutory Requirements

Approval/ Licence Condition No.	Condition	Section
Development Consent		
25	The Applicant must prepare a Water Management Plan for the development to the satisfaction of Council, and carry out the development in accordance with this plan. The plan must be prepared or reviewed by a suitably qualified person. The plan must be prepared in consultation with DCCEEW and submitted to Council for approval and include:	This plan
25 (a)	A Site Water Balance that: a) Includes details of: i. Sources and security of water supply, including contingency planning for future reporting periods; ii. Water use and management on site; iii. Any offsite water transfers and discharges; iv. Reporting procedures, including the preparation of a site water balance for each AEMR reporting year; and b) Investigates and implements all reasonable and feasible measures to minimise water use on site;	7.0
25 (b)	Surface Water Management Plan that includes: a) Detailed baseline (2016) data on surface water quality in the watercourses that could potentially be affected by the development	8.3
25 (b)	b) a description of the water management system on site, including the: i. Clean water diversion systems; ii. Erosion and sediment controls (mine water system); and iii. Mine water management systems including water infusion for Spontaneous Combustion.	8.1.1 8.1.2 8.1.3
25 (b)	c) plans, including design objectives and performance criteria, for: i. design and management of final voids; ii. design and management for the emplacement of coal reject materials; iii. reinstatement of drainage lines on the rehabilitated areas of the site; and iv. control of any potential water pollution from the rehabilitated areas of the site	8.2
25 (b)	d) performance criteria for the following, including trigger levels for investigating any potential adverse impacts associated with the development: i. surface water quality of Muscle Creek and Sandy Creek catchments; and	8.5

Approval/ Licence Condition No.	Condition	Section
25 (b)	e) a program to monitor and report on: i. the effectiveness of the mine water management system; and ii. surface water quality, in Muscle Creeks and Sandy Creeks, potentially affected by the development;	8.4
25 (b)	f) a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the development; and	10.0
25 (c)	Groundwater Management Plan, which includes: a) baseline data on groundwater levels, and quality, of privately-owned registered groundwater bores within 2.5km of the development, that could be affected by the development;	9.1, Appendix 3
25 (c)	b) groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	9.3
25 (c)	c) a program to monitor and report on: i. ground water inflows to the open cut pits; ii. the impacts of the development on: 1. regional and local (including alluvial) aquifers; 2. groundwater supply of privately registered groundwater bores; iii. a plan to respond to any exceedances of the groundwater assessment criteria; and iv. a program to validate the groundwater model for the development, including an independent review of the model with every Independent Environmental Audit, and compare the monitoring results with modelled predictions.	9.2
Environmental Protection Licence EPL656		
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the POEO Act (1997).	Noted
Water Access Licence WAL39806, WAL41503, and WAL41521		
MW6629-00001	The maximum water allocation that can be carried over from one water year to the next water year in the water allocation account for this access licence is equal to: A. 100 % of the access licence share component for access licences with share components expressed as ML/year, or B. 1 ML/unit share of the access licence share component for access licences with share components expressed as a number of unit shares	Noted

Approval/ Licence Condition No.	Condition	Section
MW8237-00001	"The volume of water taken under this access licence in any water year must not exceed: A. the sum of water allocations accrued to the water allocation account of this access licence from available water determinations in that water year, plus; B. the water allocations carried over in the water allocation account of this access licence from the previous water year, plus; C. the net amount of water allocations assigned to or from the water allocation account of this access licence under a water allocation assignment in that water year, plus; D. any water allocations re-credited by the Minister to the water allocation account of this access licence in that water year."	2.0
MW8295-00001	A. The access licence holder must record the following information in a logbook for each period of time that water is taken: i. date, start and end time when water was taken, volume of water taken, and ii. the water supply work approval number under which the water was taken, and iii. the purposes for which water was taken. B. The access licence holder must record the following information in the logbook at the end of each water year: i. the volume of water taken in the water year, and ii. the maximum volume of water permitted to be taken in that water year. C. This condition ceases to apply to this access licence on the day on which the relevant mandatory metering equipment condition applies as specified in clause 230(1) in the Water Management (General) Regulation 2018. D. This condition does not apply to this access licence if the licence nominates only water supply works that have: i. a meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and ii. a data logger.	7.5
MW6612-00001	A logbook used to record water take information must be retained for five (5) years from the last date recorded in the logbook.	Noted

Approval/ Licence Condition No.	Condition	Section
MW8241-00001	A. The water access licence holder must produce the Logbook to the Minister for inspection when requested. B. This condition does not apply to this access licence if the licence only nominates water supply works that have: i. a meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and ii. a data logger.	7.5
MW6983-00024	A. Once the water access licence holder becomes aware of a breach of any condition on this water access licence, the water access licence holder must notify the Minister as soon as practicable. B. If the initial notification was not in writing, written notice must be provided within seven days of becoming aware of the breach by: i. email: nrar.enquiries@nrar.nsw.gov.au, or ii. mail: - DPE Water, PO Box 2213, Dangar NSW 2309, or - DPE Water, Locked Bag 10, Grafton NSW 2460.	12.0
Works Approvals 20WA216928, 20WA216982 and 20WA218978		
MW8248-00001	If contaminated water is encountered during the construction of the water supply work, the approval holder must: A. notify the Minister within 48 hours of becoming aware of the contaminated water, B. take all reasonable steps to minimise contamination and environmental harm, C. ensure that the contaminated water is sealed off by inserting casing to a depth sufficient to exclude the contaminated water from the work, D. if specified by the Minister, place an impermeable seal between the casing and the walls of the work from the bottom of the casing to ground level, and E. comply with any other written requirements specified by the Minister. F. Written notice to the Minister must be provided by: i. email: water.enquiries@dpie.nsw.gov.au, or ii. mail: - DPE Water, PO Box 2213, Dangar NSW 2309, or - DPE Water, Locked Bag 10, Grafton NSW 2460.	12.0
MW8298-00001	If construction of the water supply work is not completed within 3 years then the approval to construct the water supply work expires.	Noted

Approval/ Licence Condition No.	Condition	Section
MW8296-00001	The water supply work authorised by this approval must be constructed so that it is: A. screened in the groundwater source specified in the share component of the access licence that nominates the work, and B. sealed off from other water sources.	Noted
MW8297-00001	The construction of a new water supply work authorised by this approval must: A. comply with the construction standards for the type of bore being constructed as prescribed in the Minimum Construction Requirements for Water Bores in Australia (2012), B. prevent contamination between aquifers, and C. as directed by the Minister, prevent the flow of saline water between aquifers	Noted
MW8246-00001	A. The approval holder must produce the Logbook to the Minister for inspection when requested. B. This condition does not apply to this approval if this approval only authorises water supply works that have: i. a meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and ii. a data logger.	Noted

Approval/ Licence Condition No.	Condition	Section
MW8245-00001	A. The approval holder must record the following information in a logbook for each period of time that water is taken: i. date, start and end time when water was taken, and the volume of water taken, and ii. the access licence number or the authority (such as a licence exemption) under which the water was taken, and iii. the purposes for which water was taken, and iv. details of any cropping carried out using the water taken through the water supply work including the type of crop, area cropped, and dates of planting and harvesting, and v. where metering equipment has been installed for use in connection with the water supply work, the meter reading before water is taken, and vi. where metering equipment has not been installed for use in connection with the water supply work, details of all pumping activities for the water supply work including pump running hours, pump power usage or pump fuel usage, pump start and stop times and pump capacity per unit of time. B. This condition ceases to apply to this approval on the day that the recording and reporting requirements apply to this approval under the Water Management (General) Regulation 2018. C. This condition does not apply to this approval if this approval only authorises water supply works that have both: i. a meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and ii. a data logger.	7.5
MW6612-00001	A logbook used to record water take information must be retained for five (5) years from the last date recorded in the logbook.	7.5

Approval/ Licence Condition No.	Condition	Section
MW8247-00001	When a water supply work authorised by this approval is no longer to be used permanently: A. The approval holder must notify the Minister in writing of their intention to decommission the work at least 90 days before the start of decommissioning. The written notice must include a work plan for decommissioning in accordance with the Minimum Construction Requirements for Water Bores in Australia 2012. B. If the approval holder receives notice in writing from the Minister within 60 days of the notice referred to in paragraph A, the approval holder must proceed in accordance with any requirements in the notice. C. If no notice is received within 60 days, the approval holder must only decommission the work in accordance with the submitted work plan. D. Within 60 days of the water supply work being decommissioned, the approval holder must notify the Minister in writing that the work has been decommissioned and provide the name of the driller who decommissioned the work. E. Written notice to the Minister must be provided by: i. email: water.enquiries@dpie.nsw.gov.au, or ii. mail: - DPE Water, PO Box 2213, Dangar NSW 2309, or - DPE Water, Locked Bag 10, Grafton NSW 2460.	Noted
MW6983-00026	A. Once the approval holder becomes aware of a breach of any condition on this approval, the approval holder must notify the Minister as soon as practicable. B. If the initial notification was not in writing, written notice must be provided within seven days of becoming aware of the breach by: i. email: nrar.enquiries@nrar.nsw.gov.au, or ii. mail: - DPE Water, PO Box 2213, Dangar NSW 2309, or - DPE Water, Locked Bag 10, Grafton NSW 2460.	12.0
Works Approval 20WA218978		
DK7212-00001	Native vegetation must not be impacted by the construction of the works authorised by this approval.	Noted

Approval/ Licence Condition No.	Condition	Section
DK7423-00001	The approval holder must not allow any tailwater/drainage to discharge into or onto: - any adjoining public or crown road; - any other person's land; - any crown land; - any river, creek or watercourse; - any native vegetation; - any wetlands.	Noted
DK7483-00001	The bores authorised by this approval must be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia, 4th edition (NUDLC, 2020).	Noted
DK7484-00001	The Water Management Plan (WMP) must be updated to include the new bore locations, proposed water uses and extraction volumes and must be reviewed by DPIE Water.	This plan
DK7485-00001	The volumes of groundwater extracted from the proposed water supply works on Lot 3 DP 1220491 must be managed in accordance with the groundwater level triggers outlined in the Water Management Plan under DA 205/2002.	2.0

3.0 REFERENCES

- *Environmental Planning and Assessment Act 1979.*
- *Protection of the Environment Operations Act 1997.*
- *Water Management Act, 2000.*
- *Water Act, 1912.*
- Development Consent DA 205/2002.
- Environmental Protection Licence 656.
- Continuation Project Statement of Environmental Effects (EMM) 2016.
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA 2004).
- Australian Standards for water monitoring: AS5667.1:1998 (*Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples*), AS5667.4:1998 (*Guidance on the Sampling from Lakes, Natural and Man Made*), AS5667.6:1998 (*Guidance on the Sampling of Rivers and Streams*), AS5667.11:1998 (*Guidance on the Sampling of Groundwaters*).

4.0 DEFINITIONS/ACRONYMS

AS	Australian Standard
DA	Development Application
EPA	Environmental Protection Authority
EPL	Environmental Protection Licence
MCC	Muswellbrook Coal Company Ltd
MSC	Muswellbrook Shire Council
NSW	New South Wales
WA	Works Approval
WAL	Water Access Licence

5.0 SUPPORTING DOCUMENTS

- Development Consent DA 205/2002.
- Environmental Protection Licence 656.
- Water Access Licences 39806, 41503 and 41521.
- Works Approvals 20WA216928, 20WA216982 and 20WA218978
- MP 30 Environmental Management Strategy.
- MOP 15-01 Complaint Handling Procedure.
- F1553 Community Complaint Record Form.

6.0 INFORMATION AND TRAINING

All workers required to work at the site must undertake the relevant site Induction. This includes information on water management at the site.

The requirements of MOP 15-01 Complaint Handling Procedure will be communicated to workers involved in responding to complaints.

Training records will be maintained for each worker at the site.

7.0 SITE WATER BALANCE

7.1 WATER INPUTS AND OUTPUTS

The inputs of water for the mine water balance during operations are:

- Groundwater inflows to the operations determined from analytical modelling,
- Surface water runoff into site dams,
- Pumping water from the underground bores in accordance with water licence conditions, and
- Supply of potable water from MSC.

The outputs of water for the site water balance are:

- Water cart usage for dust suppression,
- Water infusion for spontaneous combustion management,
- Evaporation from dams, and
- Effluent being pumped from site.

MCC has access to a significant resource in groundwater via the two boreholes located immediately to the north of the operation, which is adequate for the rehabilitation operations and there is no requirement to identify any contingency measures for the operation.

7.2 WATER USAGE

Numerous groundwater assessments involving analytical modelling have been undertaken at MCC. A water balance model has been developed by comparison of pumped volumes, analytical modelling of groundwater inflows, estimated groundwater through flows, surface water inflows and evaporation rates. Typical water usage in an average rainfall year (mean annual rainfall 619.6 mm/year) is shown in **Table 3**. This data indicates results when mining was at full production with water usage decreasing during rehabilitation operations. However, groundwater conditions will change with post closure recovery and the final landform design. Further work is being undertaken to assess the post closure groundwater conditions and long-term licensing considerations.

Table 3: Typical Water Usage

Source	Volume (ML/year)
Inputs	
Groundwater Inflows	100
Surface Water Runoff	175
Average Groundwater Abstraction	2,000
Potable Water	5
Total	**2,280**
Outputs	
Dust Suppression	450
Water Infusion – spontaneous combustion management	1,400
Dam Evaporation	130
Septic Pump Out	1
Total	**1,981**

Total water balance inputs and outputs vary depending on rainfall variability. During wet periods, surface water runoff and retention increases, resulting in a decrease in dust suppression demand. During periods of water stress, groundwater abstraction volumes increase, meeting the deficit of surface water demand. The yearly site water balance will be reported in the Annual Environmental Management Report.

7.3 WATER MANAGEMENT STRATEGY

The water management system at MCC is a closed system. MCC do not source mine water from external sources or discharge water off site. The groundwater extraction is from old underground workings and there is adequate on-site storage for the water. More details on the water management strategy can be found in **Section 8.0**.

7.4 OFFSITE TRANSFERS AND DISCHARGES

There are no offsite transfers or discharges of water from MCC.

7.5 FLOW MONITORING

Flow monitoring is an integral part of monitoring the site water requirements and allows the calculation of accurate water balances. The following monitoring will allow the assessment of water make and usage.

Flow meters have been installed on the following pipelines:

- Pipeline from Borehole Pump 1 and Borehole Pump 2 to Dam No. 2,
- Pipeline from Dam No. 2 to Workshop,
- Pipeline that supplies water for dust suppression, and
- Pipeline from Final Settling Dam to Open Cut 1.

Each flow meter is read and recorded on a regular basis (minimum 6 monthly). This data will be kept in a logbook or electronic recording system and will be maintained for at least 5 years.

The water levels in Dam No. 2, OC Voids and the Final Settling Dam will be recorded on a regular basis (minimum quarterly) by survey.

7.6 MINIMISING WATER USE ON SITE

MCC has reviewed the current water use on site and have not identified any reasonable or feasible options to reducing the water usage on site. Water usage on site will decrease now that mining operations have ceased. MCC have water licences in place to extract up to 3,200ML/year from two boreholes and as shown in **Table 3** the typical groundwater extraction is 2,000ML/year from these two boreholes, which indicates that MCC are minimising the water usage on site. MCC are a self-sufficient site with regards to water management and have adequate water available for the operation.

8.0 SURFACE WATER MANAGEMENT

8.1 SURFACE WATER CHARACTERISATION AND MANAGEMENT

The two main catchments in the vicinity of the site are associated with Muscle and Sandy Creeks, both of which discharge into the Hunter River. Drainage from the site is to the north to Sandy Creek, south to Muscle Creek, and west to the Hunter River. The site is well beyond the boundary of the alluvial floodplain and the 100-year flood limit of the Hunter River.

The water management system at MCC principally consists of:

- The use of Open Cut 2 as storage, which will gradually reduce as overburden is emplaced in Open Cut 2, reducing the amount of water entering the site water system,
- The use of the underground workings as water storage, and
- The storage of water in the site water dams (Dams 1/2 and Final Settling Dams) for use as dust suppression.

In the event of a significant rainfall event, the open cuts have significant available storage capacity to contain runoff with pumping infrastructure in place to transfer water around the site as required.

8.1.1 Clean Water Diversion Systems

Clean water is classified as storm water which runs off from undisturbed catchments. Where practicable, clean water will be kept separate from dirty water, mine water or contaminated water streams.

8.1.2 Erosion and Sediment Controls

The key considerations for erosion and sediment control at MCC include:

- restricting the extent of disturbance to the minimum that is practical and in accordance with the Rehabilitation Management Plan,
- progressive rehabilitation of disturbed land, where possible, and the construction of drainage controls to improve the stability of rehabilitated land,
- protection of natural drainage lines and watercourses by the construction of erosion

control devices such as diversion banks and channels and sediment retention dams as necessary,
- restriction of access to rehabilitated areas,
- management of erosion and sediment control of affected surface watercourses/ water bodies, including creek lines within or adjacent to the development consent boundary,
- regular inspection of dams to monitor their efficiency and any required maintenance, and
- inspection and maintenance, if required, of sediment and erosion controls including dams and drainage lines following storm events.

8.1.3 Saline Water

Saline water is water with elevated salinity and suspended sediment, generated from disturbed catchments where coal was mined or handled such as the open cuts, the underground mines, coal stockpiles, the CHPP, workshop and haul roads.

The strategy for the management of saline water is as follows:
- Saline water will be kept separate from clean water runoff and will be collected and re-used for process water in preference to other water sources,
- Saline water will be used in the water infusion process to assist with spontaneous combustion management,
- Potential sub-surface seepage pathways will be investigated as part of mine closure planning; and
- Saline surface water is not discharged from the site.

8.1.4 Contaminated Waters and Wastewater

Contaminated waters from the workshop and hardstand areas that may contain oils and greases are diverted to a three-staged silt trap and oil/water separator, where the water is separated from the oils and greases and heavy sediment. Sewage effluent is stored in septic tanks and pumped into road tankers and taken offsite. Groundwater quality and potential impact pathways are being considered as part of mine closure studies.

8.2 DESIGN OBJECTIVES

8.2.1 Final Voids

In accordance with the Blue Book, contour banks will be required at a spacing of 60–100m (depending upon the slope gradient) within the voids to safely convey runoff down the slopes. Subsequently, drop structures will also be required to convey concentrated flow captured by these contour banks into the base of the final voids. Without such drainage control structures, it is expected that rilling and gullying would occur on the landform which would destabilise the soils and reduce the overall effectiveness of rehabilitation. The contour drains and drop structures are designed by appropriately trained personnel.

8.2.2 Coal Reject Materials

Coal reject material is no longer handled at MCC.

As part of mine closure planning, the location and storage method/capping of rejects materials will be considered as part of the impact pathway assessment.

8.2.3 Rehabilitated Areas

Based on the principles of the Blue Book, disturbed landforms require benching in the form of contour drains and drop structures to safely convey runoff and reduce the potential for erosion (rilling and gullying) to develop. The final landform would have maximum slope gradients less than or equal to14 degrees within the final shaped voids with slope lengths of between 200–700m from the void crest to the base of the void. It is noted that the lower portion of the voids would fill with water over time, and therefore the slope lengths would be reduced to a maximum length of approximately 600m. A highwall will be left in Open Cut 2 with slopes up to 65 degrees.

Water from areas undergoing active rehabilitation will be considered as dirty water and managed in the erosion and sediment control structures on site. Testing of this water will be ongoing until it is demonstrated that the water quality meets any standards specified in the Rehabilitation Management Plan.

Once successful rehabilitation has been achieved, the various sediment dams at MCC will no longer be considered as pollution control dams under the *Water Management Act.* Consideration has been given to the Maximum Harvestable Rights Design Capacity (MHRDC) of the dams proposed to be left on site. The dams that are to be left on site comply with the requirements of the MHRDC and therefore will not require licensing to remain in the final landform.

8.3 BASELINE WATER QUALITY DATA

A review of the water quality in Muscle Creek has been undertaken to develop detailed baseline data, which has been used to calculate trigger levels and performance criteria for Muscle Creek. The baseline data has been calculated since the sites were first sampled in August 2011 through to December 2016. Data collected since 2016 hasn't been used in this calculation as the development consent specified that the baseline was 2016. The detailed baseline data is shown in **Appendix 2**. There is more information on the trigger levels and the performance criteria developed from this baseline data in **Section 8.5**.

8.4 SURFACE WATER MONITORING PROGRAM

The locations of the current surface water monitoring program are shown in **Figure 1.** The current frequency of monitoring and the analysis required are summarised in **Table 4**. Changes have been made to the water sampling program following an initial review of monitoring requirements for rehabilitation and closure activities.

Table 4: Surface Water Monitoring Program

Site	Monitoring Frequency	Analysis
No 1 Void	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
No 2 Void	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
Dam 1/2	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC7 – Muscle Creek Upstream	Monthly	pH, EC, TSS, flow
	Quarterly	Comprehensive
MCC8 – Muscle Creek Downstream	Monthly	pH, EC, TSS, flow
	Quarterly	Comprehensive
MCC9 – Brickworks Dam	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC12 – Final Settling Dam	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC23 – E. Emplacement Dam South	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC24 – East Haul Road Dam	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC25 – E. Emplacement Dam North	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC26 – Blues Crusher Dam	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC27 – Dam 3	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC28 – Weighbridge Dam	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC29 – Old Pit Top Downstream	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
MCC30 – Muscle Creek Upper Upstream	Monthly	pH, EC, TSS
	Quarterly	Comprehensive
Comprehensive analysis monitors for the following: pH, electrical conductivity (EC), total suspended solids (TSS), oil and grease, dissolved iron, total iron, manganese, aluminium, arsenic, barium, boron, cadmium, chromium, cobalt, copper, nickel, lead, zinc, mercury, selenium, (all metals total and dissolved), sulphate total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, acidity, and alkalinity		
Quarterly analysis is undertaken in March June, September, and December each year		

All sampling is conducted in accordance with relevant Australian Standards for water monitoring: AS5667.1:1998 (*Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples*), AS5667.4:1998 (*Guidance on the Sampling from Lakes, Natural and Man Made*), and AS5667.6:1998 (*Guidance on the Sampling of Rivers and Streams*).

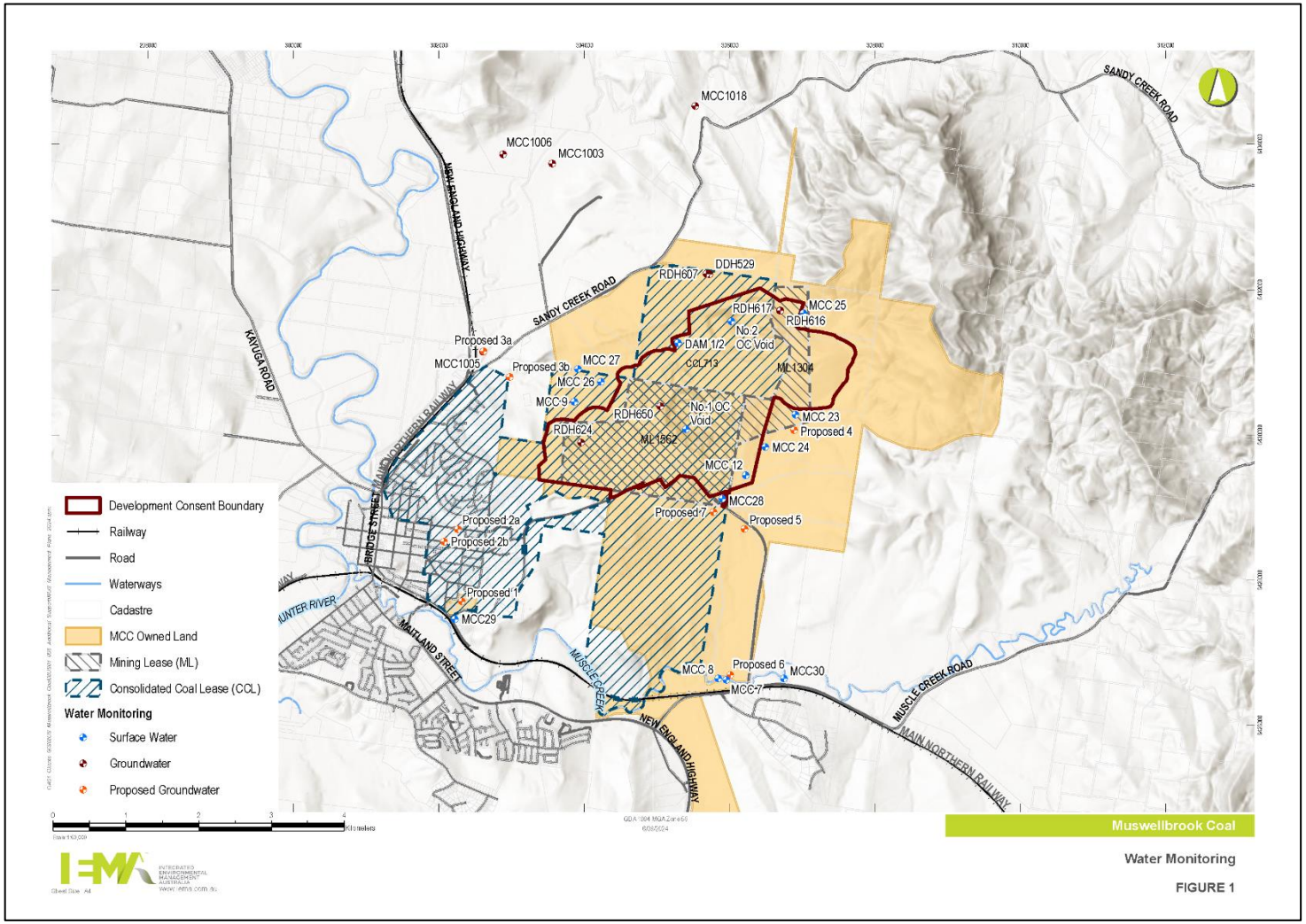

Figure 1: Current Water Monitoring Locations

8.5 SURFACE WATER TRIGGER VALUES

8.5.1 Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) (Water Quality Guideline) aim to protect and manage the environment supported by a water resource whilst maintaining economic and social development. The Water Quality Guideline provide guidance on site specific assessment criteria and general numerical values to assess water quality.

The Water Quality Guideline recommend that wherever possible, site-specific data is used to define trigger values for physical and chemical factors which can adversely impact the environment. This is a much more rigorous and accurate approach to assess potential project related impacts rather than application of the generic water quality values.

If suitable site-specific trigger values cannot be developed, the default (acceptable limit) values defined by the Water Quality Guideline for upland rivers in slightly disturbed ecosystems in south-east Australia are adopted.

Trigger values have been developed and monitoring results outside calculated trigger value levels are not necessarily indicative of impacts associated with the mining operation and could be due to other influences such as rainfall.

8.5.2 Surface Water Quality Trigger Values

The approach recommended by the Water Quality Guideline for developing site-specific trigger values for slightly to moderately disturbed ecosystems is to formulate trigger values based on the 80th percentile (and the 20th percentile values where applicable) of the site-specific monitoring data. Using these percentiles removes outliers that are outside of the normal range (defined as 20–80% of values). This approach recommends the reference data set should be calculated from a minimum of two years of monthly data (i.e., 24 data points).

There is sufficient baseline data from Muscle Creek to calculate trigger values in accordance with the Water Quality Guideline for pH, EC and TSS (see **Appendix 2** for historic results). Where baseline results were below the laboratory limit of reporting a conservative approach was adopted and the value was halved and included in the calculations for the trigger vales. The trigger values for water quality in Muscle Creek are presented in **Table 5**.

Table 5: Trigger Values for Muscle Creek Water Quality

Site	pH 20th/80th Percentile Trigger Values	EC (µS/cm) 80th Percentile Trigger Values	TSS (mg/L) 80th Percentile Trigger Values
SW07 – Muscle Creek – Upstream	7.7–8.0	4,048	13
SW08 – Muscle Creek – Downstream	7.8–8.0	5,136	10

9.0 GROUNDWATER MANAGEMENT

9.1 GROUNDWATER CHARACTERISATION

9.1.1 Hydrogeology Background

The geology present at the mine site and within the immediate vicinity of the mine site includes:

- Quaternary alluvium localised along Muscle Creek, Sandy Creek, and the Hunter River. Comprising heterogeneous distribution of silt, clay, sand, and gravels. CSIRO (2015) regolith mapping indicates the depth of unconsolidated sediments is around 4 m to 20 m along Muscle Creek and Sandy Creek, with the depth of unconsolidated highest at the confluence with the Hunter River.
- Tertiary dykes and sills, intruded into the Permian coal measures.
- Permian age Greta Coal Measures and Dalwood Group, comprises interbedded sequences of siltstone, mudstone, sandstone, and coal. The coal measures dip in a west to north-west direction at the southern end of the site (No.1 Underground and No.1 Open Cut) and in a north-west to north-north-east direction at the northern end of site (St. Heliers, Sandy Creek Underground and No.2 Open Cut). Present at outcrop along the Muswellbrook Anticline on the eastern side of site.
- Carboniferous age sequences of the New England Fold Belt occur on the immediate north to north-east of site, along the Aberdeen Thrust Fault. The Carboniferous units are highly metamorphosed and comprise fine-grained ignimbrites, vitric lithic tuff and interbedded lithic sandstone and conglomerate.

The main groundwater bearing units within the site and surrounding region includes the Quaternary alluvium and Greta Coal Measures. A summary of the groundwater bearing units and the Aberdeen Thrust Fault is included below. MCC is continuing to undertake groundwater investigations as part of the mine closure studies, including installation of additional bores as outlined in **Section 9.2** and numerical groundwater modelling to predict post closure groundwater conditions. When these investigations are complete, the WMP will be updated with the findings.

9.1.1.1 Quaternary Alluvium

Quaternary alluvium exhibits unconfined groundwater conditions, with recharge from rainfall and streamflow. There are two bores or wells (MCC1003 and MCC1005) constructed within alluvium along Sandy Creek. Bore MCC1006 is located outside of the extent of mapped alluvium and may intersect the shallow weathered Permian aged Wittingham Coal Measures (regolith). Water level and water quality data has been collected at the bores since 2004, with the summary baseline data shown in **Appendix 3**. Groundwater levels range between 1.6m to 10.9m below casing, with the highest groundwater elevations at MCC1003 of on average 150.5mAHD. This indicates a gradient of flow following topography along Sandy Creek towards the Hunter River.

The results in **Appendix 3** illustrate that groundwater level trends in the shallow alluvium and regolith generally follow climate trends, which is presented as cumulative rainfall departure (CRD) in the graphs. It is noted that where groundwater levels rise during periods of average to below average rainfall, this likely reflects influence from local agricultural land use activities (i.e. irrigation).

Water quality in the Sandy Creek alluvium at MCC1003 is generally brackish, with an EC of between 1,074µS/cm to 1,849 µS/cm (5th and 95th percentile). Salinity is higher in the downstream alluvial bore MCC1005 of 1,720µS/cm to 5,980µS/cm, potentially influenced

by irrigation in the area. All bores in the alluvium and regolith record relatively neutral pH of between 6.8 to 7.6 (5th and 95th percentile combined).

There is currently no site-specific data on the alluvium along Muscle Creek. Additional monitoring bores will be constructed within alluvium along Muscle Creek as outlined in **Section 9.2**.

9.1.1.2 Greta Coal Measures

The presence of groundwater in the Greta Coal Measures is associated with secondary porosity, including fractures and cleats in the coal seams, faults, and weathering of the surficial geology (regolith). The interburden sequences of siltstone, mudstone and sandstone are generally considered to be hydraulically 'tight'.

The results in **Appendix 3** illustrate that groundwater level trends in bores MCC1017 and MCC1018, which are potentially constructed in the shallow Branxton Formation located over 1 km from the mine area. The bores are also located near the Aberdeen Thrust Fault zone. A bore audit conducted in 2022 by external contractors confirmed that bore MCC1018 is 48m deep and likely intersects the Branxton Formation. The results for MCC1017 and MCC1018 show groundwater levels generally follow long-term climatic conditions, with similar trends to the CRD. With recent above average rainfall experienced in the region, groundwater levels have risen since 2020.

Historical data is presented in **Appendix 3** on water levels within the underground workings and spoil in the western area of the site (RDH529, RDH650 and RDH624). Groundwater levels in the underground workings are influenced by depressurisation of the coal measures during active mining, with groundwater levels down to around 103mAHD. Groundwater levels are around 160mAHD within the spoil at RDH624, indicating a gradient of flow from the western area of the site towards Open Cut 2.

Available groundwater quality data for the hardrock units indicate saline water quality, with an EC between 5,959µS/cm and 16,282µS/cm (5th and 95th percentile) for MCC1017 and 10,692µS/cm and 11,689µS/cm (5th and 95th percentile) for MCC1018. The two bores recorded relatively neutral pH of between 5.8 to 8.2 (5th and 95th percentile combined), with MCC1017 showing a gradual rise in pH over time that may relate to degradation of the bore.

9.1.1.3 Aberdeen Thrust Fault

The Aberdeen Thrust Fault extends to the north and east of the site along the Muswellbrook Anticline and intersecting through the Permian coal measures. Faults can act as conduits or barriers to flow. As reported in HLA (2002) water inflows were noted historically where faults were intersected. An additional bore is proposed to be constructed to target the Aberdeen Thrust Fault to the south-east of Open Cut 2 (refer to **Section 9.2**) to confirm historical observations of water draining from a sump during mining in Open Cut 2.

Existing site bore RDH617 is constructed along the Aberdeen Thrust Fault, north of Open Cut 2. Groundwater level trends for RDH617 are shown in **Appendix 3**. Results shows a gradual rise in water levels at the bore, and no influence from the mining within 50m of the bore. This indicates that at this location to the north of Open Cut 2, the fault may be acting as a barrier to groundwater flow.

9.1.2 Background Water Quality on Private Bores

A review of the Bureau of Meteorology (BoM) National Groundwater Information System (NGIS) database indicates there are 46 registered bores within 2.5km of the DA205/2002 boundary. Of these, 11 are noted as being monitoring bores and one bore has been decommissioned. One bore (GW078907) is also within the mine area and likely mined out, and two (GW200715 and GW201055) correspond with site water supply bores RDH607 and RDH529.

A summary of the 31 registered bores (excluding monitoring bores, site bores and decommissioned bores) is included in **Table 6**. The inferred geology is based on the mapped surface geology at the bore location and bore depth.

The table shows that within 2.5km of site, one registered bore (GW017904) potentially accesses groundwater from Muscle Creek alluvium, seven from Sandy Creek alluvium and 14 from Hunter River alluvium. Groundwater is used for irrigation, stock and domestic water supply and commercial and industrial uses. Bore MCC1003 is located upgradient of the registered bores within Sandy Creek alluvium. Site monitoring bore MCC1005 is also located within 100m of registered bores GW027410 and GW027411 and is considered representative of groundwater quality at these bores.

There are six bores constructed within the shallow regolith that represents weathered Permian (Saltwater Creek Formation, Mulbring Siltstone, Branxton Formation and Rowan Formation). One bore targeting the Rowan Formation (GW004900) is noted as having been constructed in 1912 in what is now a residential area, this bore is unlikely to still be in use.

There are two bores (GW204519 and GW204185) within an area mapped as comprising Mulbring Siltstone. The Mulbring Siltstone is typically considered a low permeability unit, so the bores may not be in use or may be targeting different geology. Site monitoring bore MCC1018 is located between the mine area and the registered bores.

There are currently no site monitoring bores in Muscle Creek alluvium, and additional bores are proposed to be installed as outlined in **Section 9.2**.

Table 6: Registered Bores

Registered Bore	Easting	Northing	Bore Depth (m)	Use	Inferred Geology
GW017904	306168	6426542	6.7	Unknown	Muscle Creek alluvium overlying Branxton Formation
GW011361	302351	6431267	7.9	Commercial and Industrial	Sandy Creek alluvium
GW080181	302236	6431392	-	Irrigation	Sandy Creek alluvium
GW027410	302614	6431211	12.2	Irrigation	Sandy Creek alluvium
GW024727	302115	6431263	-	Stock and Domestic	Sandy Creek alluvium
GW011360	302403	6431268	7.9	Commercial and Industrial	Sandy Creek alluvium
GW015083	302783	6431923	8.5	Unknown	Sandy Creek alluvium
GW045484	301512	6431313	9.1	Water Supply	Hunter River alluvium

Registered Bore	Easting	Northing	Bore Depth (m)	Use	Inferred Geology
GW037828	301554	6430512	11.8	Irrigation	Hunter River alluvium
GW024728	301853	6431288	-	Stock and Domestic	Hunter River alluvium
GW043981	301681	6430700	9.1	Water Supply	Hunter River alluvium
GW062274	301232	6429582	15.2	Water Supply	Hunter River alluvium
GW043571	301749	6431256	9.1	Water Supply	Hunter River alluvium
GW011536	301025	6429424	12.5	Commercial and Industrial	Hunter River alluvium
GW011537	300946	6429484	12.8	Commercial and Industrial	Hunter River alluvium
GW037827	301340	6430724	11.2	Irrigation	Hunter River alluvium
GW080182	301791	6431596	-	Irrigation	Hunter River alluvium
GW024729	301459	6431342	-	Stock and Domestic	Hunter River alluvium
GW064016	301972	6431876	12	Water Supply	Hunter River alluvium
GW037826	301058	6430410	9.7	Irrigation	Hunter River alluvium
GW037964	300949	6429330	12.4	Irrigation	Hunter River alluvium
GW078468	308348	6428230	7	Stock and Domestic	Regolith of Saltwater Creek Formation
GW078465	308223	6428077	13	Stock and Domestic	Regolith of Saltwater Creek Formation
GW013973	303455	6432367	12.2	Stock and Domestic	Regolith of Mulbring Siltstone
GW013971	303877	6433608	9.1	Unknown	Regolith of Mulbring Siltstone
GW204185	306335	6434217	72	Stock and Domestic	Mulbring Siltstone
GW204519	306335.9	6434326	120	Stock and Domestic	Mulbring Siltstone
GW011667	302176	6429477	8.5	Irrigation	Regolith of Branxton Formation
GW004900	302497	6427819	57.9	Unknown (likely destroyed)	Rowan Formation
GW078907	305713	6431138	5.18	Water Supply	Regolith of Rowan Formation

Note: *Coordinates in GDA94 Z56*

9.1.3 Groundwater Dependant Ecosystems

No listed high priority groundwater dependent ecosystems (GDEs) have been identified within the mines surrounds in the applicable water sharing plan (*Water Sharing Plan for the Hunter Regulated River and Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources*).

DPIE (2022) Probable Vegetation Groundwater Dependent Ecosystems - Hunter / Central Rivers mapping shows terrestrial vegetation communities that have a probability of being GDEs. There are no areas of moderate to high probability GDEs within the immediate area. However, localised areas of moderate and high probability GDEs are mapped in areas associated with alluvium along Muscle Creek, Sandy Creek, and the

Hunter River. High probability GDEs are also mapped along a tributary of the Hunter River along Karoola Park.

Site monitoring bores MCC1003 and MCC1005 monitor groundwater levels in Sandy Creek alluvium and indicate a shallow depth to water, between 1.6m to 10.9m below casing, with brackish to saline water quality (refer **Appendix 3**). Similar conditions are likely to occur along Muscle Creek alluvium.

9.2 GROUNDWATER MONITORING PROGRAM

9.2.1 Current Groundwater Monitoring Program

MCC has been monitoring groundwater levels and quality from site monitoring bores for several years. The location of the groundwater monitoring network is shown on **Figure 1**. Monthly monitoring commenced across the groundwater monitoring network in 2004 and has been ongoing at all locations except MCC1017 and MCC1018 where water quality monitoring ceased in 2010.

The groundwater monitoring network currently consists of ten bores, as follows:

- two Sandy Creek alluvial sites (MCC1003 and MCC1005);
- regolith bore near Sandy Creek (MCC1006);
- two hardrock monitoring sites (MCC1017 and MCC1018);
- two bores intersecting mine workings (RDH529 and RDH650);
- two bores targeting the Aberdeen Thrust Fault near Open Cut No. 2 (RDH616 and RDH617); and
- one bore within spoil on western location of site (RDH624).

The current frequency of monitoring and the analytical suite are summarised in **Table 7**. Changes have been made to the water sampling program following an initial review of monitoring requirements to inform rehabilitation and closure planning activities. Further updates will be made with completion of the groundwater closure study.

Table 7: Groundwater Monitoring Program

Site	Target formation	Monitoring Frequency	Analysis
RDH607/ RDH529	St Heliers Seam in No. 2 Underground	Continuous	Depth
		Bi-Monthly	Comprehensive
RDH616	Aberdeen Thrust Fault – Mulbring Siltstone	Bi-Monthly	Depth
RDH617	Aberdeen Thrust Fault – Mulbring Siltstone	Bi-Monthly	Depth
RDH624	Spoil	Bi-Monthly	Depth
		Bi-Monthly	Comprehensive
RDH650	Lower Lewis Seam at North No.2 Underground	Bi-Monthly	Depth
		Bi-Monthly	Comprehensive
MCC1003	Sandy Creek alluvium	Bi-Monthly	Depth
		Bi-Monthly	Comprehensive
MCC1005	Sandy Creek alluvium	Continuous	Depth
		Bi-Monthly	Comprehensive
MCC1006	Regolith	Bi-Monthly	Depth
MCC1018	Permian hardrock –	Continuous	Depth

Site	Target formation	Monitoring Frequency	Analysis
	Branxton Formation	Bi-Monthly	Comprehensive
Comprehensive analysis monitors for the following: pH, EC, hardness, calcium, magnesium, sodium, potassium, sulphate, chloride, fluoride, carbonate, bicarbonate, nitrate, oil and grease, ammonia, iron, manganese, aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, molybdenum, nickel, lead, zinc, mercury, selenium, (all metals total and dissolved), total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, acidity, and alkalinity			
Bi-monthly sampling is undertaken in February, April, June, August, October, and December each year			

2022 bore audit identified that MCC1017 is a former exploration hole with steel casing and no visible slots, so is unsuitable for monitoring. This site has been removed from the monitoring program.

All monitoring will be conducted in accordance with the relevant Australian Standards for water monitoring: AS5667.1:1998 (*Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples*) and AS5667.11:1998 (*Guidance on the Sampling of Groundwaters*).

9.2.2 Proposed Additional Groundwater Monitoring

MCC is continuing to undertake groundwater investigations as part of the mine closure studies. A summary of the proposed locations of additional groundwater wells, indicative depth, target geology and purpose are included in **Table 8**. Installation of these monitoring sites will commence in 2024.

The bore locations are indicative only, pending approval and accessibility of the sites. The target depth and geology are indicative only also as conditions may vary based on the location and local ground conditions. The proposed bores and vibrating wire piezometer (VWP) will be geologically logged during drilling, and hydraulic testing undertaken to characterise the key hydrogeological units/features.

Following construction and during the closure study, the bores will be equipped with loggers to collect daily water levels, and bi-monthly (every two months) water quality monitoring for the comprehensive suite. The data will be utilised as part of the closure study and will inform closure monitoring and management measures in future.

Table 8: Proposed Groundwater Sites

Site	Type	Easting	Northing	Depth	Target Geology	Purpose
Proposed 1	MB	302318	6427705	~40	Muswellbrook Seam mine workings	Located within the Old Pit Top area - above the Muswellbrook, St Heliers and Lewis seam workings. To verify groundwater levels and quality in workings and inform flow gradient and monitor recovery.
Proposed 2	MB	302261 Or 302076	6428702 Or 6428532	~ 100	St Heliers Seam mine workings	Located within No.1 Colliery - St Heliers Seam workings to the west of No.1 Open Cut. To verify groundwater levels and quality in workings and inform flow gradient and monitor recovery.

Site	Type	Easting	Northing	Depth	Target Geology	Purpose
Proposed 3	MB or VWP	302613 Or 302977	6431151 Or 6430796	~ 200	Greta Coal Measures	Located near MCC1005 approx. 1.2 km from the mine area. Verify groundwater levels in the coal measures and Branxton Formation, inform vertical connectivity, regional flow gradient and monitor recovery.
Proposed 4	MB	306885	6430066	~ 12	Muscle Creek alluvium	Downgradient of Eastern Emplacement and MCC23, along tributary of Muscle Creek. To characterise alluvium and groundwater conditions and identify any potential impacts to alluvium.
Proposed 5	MB	306208	6428707	~ 12	Muscle Creek alluvium	Downgradient of Final Settling Dam along tributary of Muscle Creek. Located near Proposed 7 to verify assumptions on hydraulic connectivity and interaction. To characterise alluvium and groundwater conditions and identify any potential impacts to alluvium.
Proposed 6	MB	306010	6426698	~ 15	Muscle Creek alluvium	Alluvium at confluence with Muscle Creek, near MCC07 and MCC08. Characterise alluvium and groundwater conditions and identify any potential impacts to alluvium.
Proposed 7	MB	305779	6428938	~ 60	Greta Coal Measures/ Aberdeen Thrust Fault	Eastern side of the Muswellbrook Anticline and the Aberdeen Thrust Fault. To verify assumptions on hydraulic connectivity and interaction to mine area and along fault zone and inform approach to assessing Aberdeen Thrust Fault.

Note: *Coordinates in GDA2020 Z56, locations are approximately only, pending finding field check of accessibility and relevant approvals*

MB: Monitoring bore *VWP: Vibrating Wire Piezometer*

9.3 GROUNDWATER TRIGGER VALUES

9.3.1 Groundwater Level

Baseline groundwater level data has been collated and statistically analysed (**Appendix 3**). The mean baseline average, standard deviation and the 20th percentile average has been calculated with the objective of establishing trigger values.

Based on the observed results, groundwater level typically displays a greater range in the shallower alluvial groundwater system when compared with the deeper hardrock

groundwater system.

The following equation has been used for identifying groundwater drawdown in response to mining greater than previously predicted:

$$Trigger\ Level = (2 \times Stdev) + Mean \qquad \text{(Equation 1)}$$

The groundwater trigger levels are shown in **Table 9**, and the trigger level exceedance criteria is based on three consecutive monthly readings above the trigger level. The groundwater level trigger approach will be varied in future for the post closure conditions, to be based on outcomes of the groundwater mine closure study.

Table 9: Groundwater Level Trigger Values

Monitoring Location	Target Formation	Historical Water Level Range (m)BTOC	Historical Water Level Range (m)AHD	Lower Trigger Values (m)BTOC	Lower Trigger Values (m)AHD
MCC1003	Alluvial	2.0-7.9	147.2-153.1	8.6	146.5
MCC1005	Alluvial	4.3-10.9	139.3-146.3	11.3	138.9
MCC1006	Alluvial	4.0-9.7	145.3-150.9	10.3	144.6
MCC1018	Hardrock	14.8-18.8	182.1-186.1	19.0	181.9

BTOC = below top of casing, AHD = Australian Height Datum

9.3.2 Groundwater Inflow During Mining

The Groundwater Assessment for the Continuation Project confirmed that the groundwater inflow into the Open Cut area is approximately 100ML/year. During the groundwater model validation process this value will be confirmed and the water balance updated if required.

Pit inflow and groundwater abstraction from bores is reported annually in the Annual Environmental Management Report. MCC has a current entitlement of 4,600 ML/year groundwater, with average take totalling approximately 2,100ML/year (combining groundwater abstraction and pit inflows). Therefore, groundwater is adequately licensed.

9.3.3 Groundwater Quality Trigger Values

The approach recommended by the Water Quality Guideline for developing site-specific groundwater quality trigger values is based on the 80th percentile (and the 20th percentile values for pH) of the site-specific monitoring data (outlined in **Section 5.4.2**).

There is sufficient data from up to 16 years of monitoring to calculate groundwater quality trigger values in accordance with the Water Quality Guideline for pH and EC (**Appendix 3** for historical data). The groundwater quality trigger values are presented in **Table 10** and the trigger level exceedance criteria is based on three consecutive readings outside of the trigger level.

Table 10: Groundwater Quality Trigger Values

Site	pH 20th/80th Percentile Trigger Values	EC (µS/cm) 80th Percentile Trigger Values
MCC1003	7.1-7.3	1,666
MCC1005	6.9-7.2	5,584
MCC1006	7.1-7.4	1,152

µS/cm = micro Siemens per centimetre

9.4 GROUNDWATER MODEL VALIDATION

Work is being undertaken to develop a numerical groundwater model that captures historical and recent mining activities, in order to predict post closure groundwater conditions.

With every Independent Environmental Audit, an independent review of the groundwater model performance will be undertaken by a suitably qualified person. This will include verification of the groundwater model predictions for post closure recovery compared to observed monitoring results.

10.0 TRIGGER ACTION RESPONSE PLAN

The ongoing water monitoring will be used to identify potential project-related impacts on the receiving waters and to inform the appropriate response. All studies completed to date indicate no adverse effects on surface water or groundwater, however a trigger action response plan will be implemented to manage any potential adverse impacts on surface water and groundwater quality, and groundwater levels.

Trigger value exceedances will initiate a preliminary investigation and additional water quality sampling if exceedances are related to water quality. Further investigations and possible management responses may be required as per **Figure 2** and **Figure 3**.

The water quality trigger action response plan (**Figure 2**) will be activated if exceedances of water quality trigger value criteria for surface water (**Table 5**) and/or groundwater (**Table 10**) occurs. A trigger action response plan (**Figure 3**) will be initiated for groundwater levels and/or groundwater flow if groundwater inflow exceedance (50% of quarterly take) or groundwater level triggers are exceeded (**Table 10**).

It is important to note that data generated from environmental sampling are inherently “noisy”. The occasional excursion beyond a trigger value may be encountered due to a variety of factors or may indicate a potential project-related impact. The method used to calculate trigger values for the project recognises the inherent variability of natural systems by acknowledging natural and sampling induced variation.

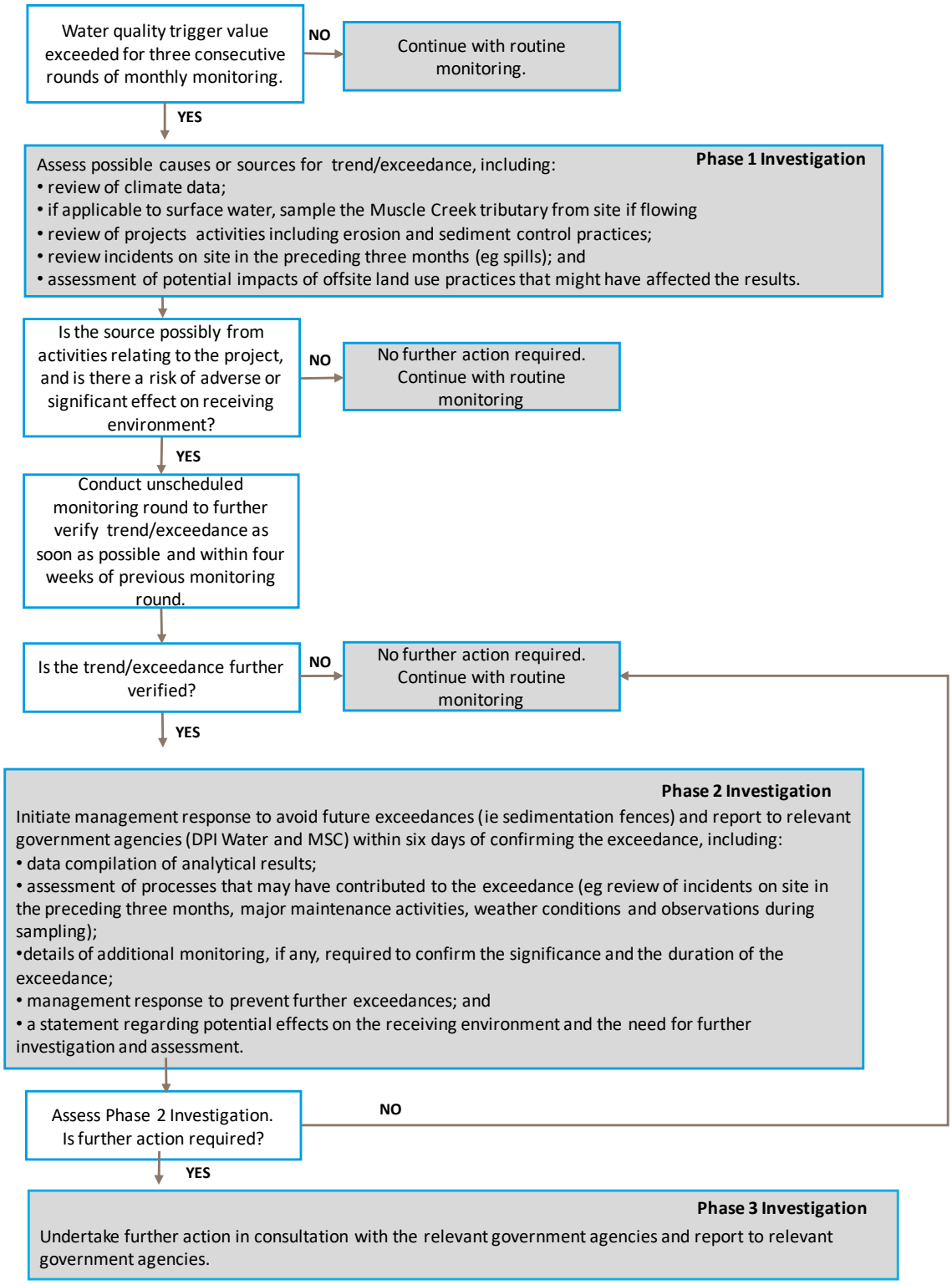

Figure 2: Trigger Action Response Plan for Water Quality

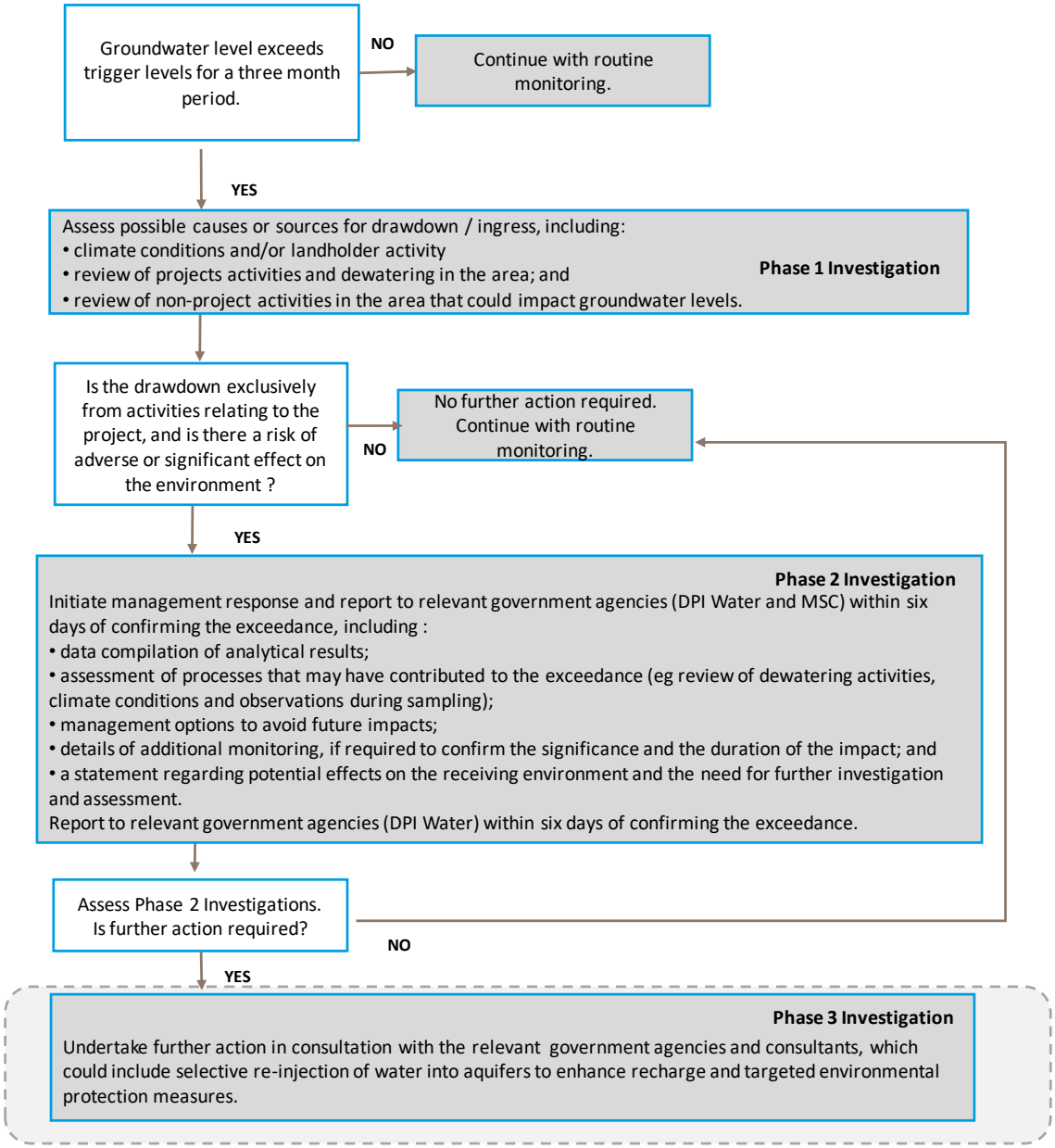

Figure 3: Trigger Action Response Plan for Groundwater Level

11.0 COMPLAINT MANAGEMENT

Water related complaints by the community can be directed to the 24-hour toll free telephone Environmental Contact Line 1800 600 205. More details on the complaints management at MCC are found in the Environmental Management Strategy.

12.0 INCIDENT REPORTING

In the event that the trigger response action plan concludes that a water related incident has occurred the incident will be reported to MSC and DCCEEW within 24 hours of confirming the incident.

Within six days of the incident being confirmed MCC will notify MSC and DCCEEW of an incident via a written report that:

a) Describes the date, time, and nature of the incident;
b) Complies the analytical results relating to the incident;
c) Identifies the cause (or likely cause) of the incident;
d) Describes what action and additional monitoring has been taken to date;
e) Describes the proposed measures and management responses to address the incident and prevent further exceedances, and
f) Includes a statement regarding the potential effects on the receiving environment and the need for further investigation and assessment.

13.0 EXTERNAL REPORTING

Within 2 weeks of approval of this WMP, a copy will be made available for public viewing via the MCC website.

The performance of MCC's WMP will be reported through a number of external reporting requirements, which include;

- Annual Environmental Management Report (AEMR);
- EPL Annual Licence Return;
- Regular updates of monitoring results on the MCC website; and
- CCC Meetings.

13.1 ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

The AEMR will include a summary of:

- The site water balance,
- Water monitoring results and comparison to the trigger levels and monitoring results from previous years,
- Identification of any trends in the monitoring results,
- Review of the performance of management measures and the monitoring program,
- Identification of any non-compliance against approval and licence conditions, and management measures undertaken to address any non-compliance, and
- Summary of water related complaints and management measures undertaken.

14.0 REVIEW OF THE WMP

The WMP will be reviewed:

- Within 6 months of changes to Development Consent or licence conditions relating to water management or monitoring,
- Following the completion of the mine closure studies,
- Following reportable incidents at MCC relating to water management,
- Following an independent environmental audit which recommends changes to the WMP, and
- If there is a relevant change in technology or legislation.

15.0 ACCOUNTABILITIES

Table 11 outlines the responsibilities relating to the WMP.

Table 11: Organisational Responsibilities

Role	Accountability
Head of Muswellbrook Site	• Provide adequate resources to implement the requirements of the WMP.
Maintenance Superintendent	• Maintain water meters. • Coordinate calibration of water meters.
Environmental Superintendent	• Notify regulatory authorities of any water related incidents. • Coordinate response to all water related complaints. • Coordinate reviews of the WMP. • Coordinate monitoring as required in WMP. • Coordinate reporting as required in WMP.
Rehabilitation Operations Manager	• Undertake regular inspections of dam levels and arrange pump out if required. • Undertake regular inspections of drains on site and arrange maintenance if required.

16.0 LIST OF APPENDICIES

Appendix 1: Correspondence Regarding Water Management Plan
Appendix 2: Detailed Baseline Data for Muscle Creek Surface Water
Appendix 3: Detailed Baseline Data for Groundwater Monitoring

17.0 REVISION DETAILS

Revision No.	Date	Reviewed By	Details/Reason for Revision
1	March 2005	MCC Technical Services Department, Carbon Based Environmental	Original Management Plan
2	December 2010	MCC Technical Services Department, Carbon Based Environmental	5 Yearly Review
3	December 2015	MCC Environmental, Technical Services and Production Departments	5 Yearly Review
4	June 2017	MCC Environmental, Technical Services and Production Departments	Update following modification for Continuation Project
5	October 2020	MCC Environmental Department	3 Yearly Review
6	October 2023	Environmental, Production, Administration and Maintenance Departments	End of mining operations
7	August 2024	Environmental and Production Departments	Consent Modification 9

Appendix 1: Correspondence Regarding Water Management Plan

muswellbrook shire council

Enquiries
Please ask for Tracy Ward
Direct 02 6549 3700
Our reference CM 24/68529

24 October 2024

Julie Thomas
Environmental Superintendent
Muswellbrook Coal

Dear Ms Thomas,

Muswellbrook Coal Mine Water Management Plan (MP38) – Approval Letter

Reference is made to the '*Muswellbrook Coal Mine Water Management Plan v7*'.

Council Staff note that the Plan has been reviewed and edited by Umwelt's National Leader Hydrological Services, who is satisfied with the updates. Council staff are pleased to see inclusion of the groundwater section of the plan.

Accordingly, Council Staff approve the '*Muswellbrook Coal Mine Water Management Plan v7*'.

Please ensure that the approved plan is placed on the project website at the earliest convenience.

Should you need to discuss the above, please contact Tracy Ward (Sustainability Officer) on 02 6549 3700 or email council@muswellbrook.nsw.gov.au.

Yours faithfully

Sharon Pope
Director Environment and Planning

Muswellbrook Shire Council (02) 6549 3700 council@muswellbrook.nsw.gov.au
Campbell's Corner 60-82 Bridge Street Muswellbrook NSW 2333 PO Box 122 Muswellbrook 2333
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Julie Thomas

From: Claire Stephenson <cstephenson@umwelt.com.au>
Sent: Monday, 26 August 2024 3:30 PM
To: Julie Thomas
Subject: RE: WMP
Attachments: MP 38 Water Management Plan draft post consent modification review tracked changes_JT_CS_JT_CS.docx

[WARNING: This email originated outside of Our Company. DO NOT CLICK links or attachments unless you recognize the sender and know the content is safe.]

Hi Julie,

I have reviewed and provided input on the updates to the current Water Management Plan for Muswellbrook Coal (MP38). Thank you for providing the final draft copy (attached), I have no further changes to this document.
The plan is transition, with amendments pending based on outcomes from the ongoing mine closure studies. For this transitional period I'm satisfied with the updates made and addressed with regards to groundwater in the plan.

Kind Regards,

Claire

Claire Stephenson
National Leader, Hydrogeology Services

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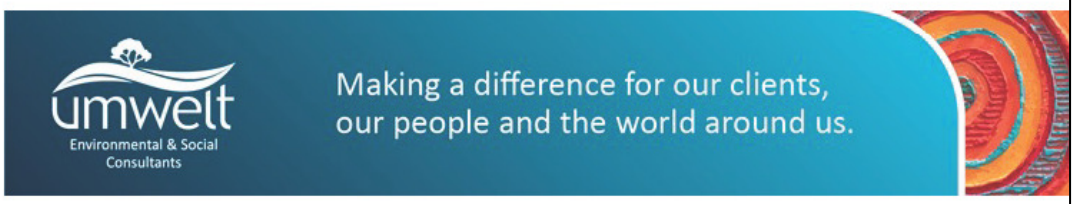
Please note my work days are Monday, and Wednesday to Friday.



1

Julie Thomas

From: Julie Thomas
Sent: Wednesday, 7 August 2024 4:22 PM
To: Environment Line
Subject: Muswellbrook Coal - Water Management Plan for Review
Attachments: MP 38 Water Management Plan draft post consent modification review clean.pdf; 2023 Review Response to Comments from DPE on WMP.pdf; 230516 DPE Water advice - Muswellbrook Coal WMP.pdf

Hello

Muswellbrook Coal Company (MCC) has a requirement in our development consent to develop Water Management Plan (WMP) in consultation with the Department of Climate Change, Energy, the Environment and Water (DCCEEW). MCC has recently received a modification to our consent, which has triggered a review of this document. The WMP has recently been reviewed and updated and a draft copy is attached for your review and comment.

DPE-Water provided comments on our WMP in May 2023. A copy of these comments and MCC's response to these comments are also attached for reference.

If there are any comments DCCEEW would like to make on this plan, please provide them to me by 22nd August 2024.

When the plan is approved by MSC, a final version of the plan will be sent to DCCEEW.

If you have any questions regarding this plan, please let me know.

Regards
Julie

Julie Thomas
Environmental Superintendent

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Please note my working days are Monday-Thursday.

1

No comments have been received from DCCEEW.

Appendix 2: Detailed Baseline Data for Muscle Creek Surface Water

	pH		EC (µS/cm)		TSS (mg/L)	
Report Month	MCC07 Muscle Creek - upstream	MCC08 Muscle Creek - downstream	MCC07 Muscle Creek - upstream	MCC08 Muscle Creek - downstream	MCC07 Muscle Creek - upstream	MCC08 Muscle Creek - downstream
Aug-11	7.62	7.65	297	459	14	12
Sep-11	8.10	8.08	943	1,220	19	21
Oct-11	7.95	7.98	891	886	16	<5
Nov-11	7.92	7.88	1,320	1,820	7	5
Dec-11	7.70	7.80	1,195	1,551	11	7
Jan-12	no sample	no sample	no sample	no sample	no sample	no sample
Feb-12	7.97	7.97	1,190	1,180	18	19
Mar-12	7.98	7.95	1,360	1,870	8	8
Apr-12	7.50	7.50	1,675	1,671	1	4
May-12	7.97	7.97	1,820	2,580	6	6
Jun-12	8.00	7.99	1,520	1,950	6	5
Jul-12	8.01	8.01	1,130	1,460	8	6
Aug-12	7.89	7.93	1,750	2,320	6	8
Sep-12	no sample	no sample	no sample	no sample	no sample	no sample
Oct-12	7.88	7.91	2,910	4,210	<5	6
Nov-12	7.83	7.83	3,580	5,250	11	8
Dec-12	7.97	7.97	4,520	5,360	<5	8
Jan-13	7.30	7.42	438	615	48	50
Feb-13	7.76	7.79	923	1,070	9	14
Mar-13	8.00	8.06	1,310	1,920	7	7
Apr-13	7.89	7.94	1,760	2,480	11	<5
May-13	8.00	8.02	2,100	2,920	16	<5
Jun-13	7.79	7.86	2,280	3,200	6	5
Jul-13	7.94	7.96	2,240	3,010	7	5
Aug-13	7.81	7.81	2,400	3,510	9	10
Sep-13	7.74	7.86	3,110	3,930	8	10
Oct-13	7.84	7.87	5,800	5,760	5	5
Nov-13	7.70	7.73	800	900	32	32
Dec-13	7.60	7.66	1,750	2,560	30	5
Jan-14	7.97	7.91	3,570	4,700	<5	<5
Feb-14	7.67	7.62	3,740	4,710	22	<5
Mar-14	7.73	7.66	2,550	2,960	18	17
Apr-14	7.94	8.01	2,360	3,690	14	20
May-14	7.62	7.67	2,360	3,610	13	17
Jun-14	7.95	8.00	3,430	4,720	<5	<5
Jul-14	7.65	7.83	4,820	5,040	<5	<5
Aug-14	7.66	7.78	3,110	4,220	11	10
Sep-14	7.86	7.93	4,060	4,750	<5	<5
Oct-14	7.91	7.97	5,220	5,520	<5	<5
Nov-14	8.07	8.03	5,900	6,060	<5	<5
Dec-14	7.87	7.89	5,570	5,650	<5	<5
Jan-15	8.01	7.86	5,320	5,480	5	10
Feb-15	7.95	7.98	9,130	9,120	<5	<5
Mar-15	8.01	7.93	6,790	6,140	<5	7
Apr-15	7.70	7.74	1,210	1,410	<5	<5
May-15	7.86	7.88	1,340	1,770	<5	<5

	pH		EC (µS/cm)		TSS (mg/L)	
Report Month	**MCC07 Muscle Creek - upstream**	**MCC08 Muscle Creek - downstream**	**MCC07 Muscle Creek - upstream**	**MCC08 Muscle Creek - downstream**	**MCC07 Muscle Creek - upstream**	**MCC08 Muscle Creek - downstream**
Jun-15	7.87	7.85	827	995	6	6
Jul-15	7.88	7.90	1,270	1,470	<5	<5
Aug-15	7.85	7.84	1,840	2,350	<5	6
Sep-15	8.04	8.04	1,010	1,320	<5	<5
Oct-15	8.12	8.01	1,810	2,340	<5	<5
Nov-15	7.58	7.61	2,060	2,960	<5	<5
Dec-15	7.65	7.73	2,040	2,870	14	10
Jan-16	7.95	7.95	934	1,120	<5	<5
Feb-16	8.22	8.22	2,100	2,970	<5	<5
Mar-16	8.03	7.98	4,030	5,240	<5	5
Apr-16	8.07	8.03	4,770	5,410	6	8
May-16	7.95	7.98	4,390	5,580	<5	10
Jun-16	7.90	7.19	2,380	3,350	6	<5
Jul-16	7.83	7.86	987	1,530	16	7
Aug-16	7.84	7.81	1,590	2,230	6	6
Sep-16	7.96	7.99	1,010	1,110	5	7
Oct-16	7.93	7.95	1,840	2,560	<5	<5
Nov-16	7.86	7.72	2,670	3,760	<5	<5
Dec-16	7.86	7.89	4,430	5,200	<5	<5
20th Percentile	7.7	7.8	NA	NA	NA	NA
80th Percentile	8.0	8.0	4048.0	5136.0	13.6	10.0
Minimum	7.3	7.2	297	459	1	2.5
Maximum	8.2	8.2	9130	9120	48	50
Water Quality Guideline*	6.5-7.5		30-350		50	

* = values for upland rivers

Appendix 3: Detailed Baseline Data for Groundwater Monitoring

	pH						EC (µS/cm)					
Report Month	**MCC 1003**	**MCC 1005**	**MCC 1006**	**MCC 1015**	**MCC 1017**	**MCC 1018**	**MCC 1003**	**MCC 1005**	**MCC 1006**	**MCC 1015**	**MCC 1017**	**MCC 1018**
Mar-04	7.0	6.7		6.8	5.3	6.5	1,900	5,670		3,000	9,890	11,690
Jul-04	7.0	6.5	7.2	7.0	6.3		2,140	5,670	1,220	2,370	6,450	
Sep-04		6.9	7.4	7.1	6.1	6.7		5,720	1,300	2,120	6,840	11,500
Dec-04	7.0	6.7	6.9	6.9	6.3	6.6	1,820	5,530	1,210	1,940	6,690	11,680
Apr-05	7.1	6.5	6.8	7.0	5.8	6.5	1,880	6,150	1,270	2,090	6,650	11,840
Jun-05	6.8	6.6	6.7	6.8	5.7	6.4	1,840	5,620	1,270	1,900	6,300	11,480
Sep-05	7.1	6.7	7.1	6.9	6.1	6.5	1,880	5,830	1,370	1,860	5,940	11,040
Dec-05				7.0	6.5	6.5				1,790	5,360	10,690
Mar-06	6.9	7.4	7.0	7.2	6.3	6.9	1,850	6,550	1,330	2,000	6,420	11,200
Jun-06	7.0	7.0		7.3	6.2	6.6	1,970	6,330		2,030	9,920	10,960
Sep-06	6.9	6.8	7.4	7.4	6.3	6.7	1,880	6,040	1,340	1,920	6,260	11,660
Dec-06	6.9	6.8		7.6	6.2	6.8	1,940	6,360		1,870	6,120	11,440
Mar-07	7.4	6.4		7.5		6.7	1,970	6,370		2,140		11,230
Jul-07	7.5	6.9	7.3	7.2	6.7	7.1	1,030	6,380	1,150	3,170	12,560	10,280
Sep-07	7.3	6.8	7.2	6.9	6.8	6.6	1,450	5,870	1,030	3,220	16,210	10,920
Dec-07	7.3	6.9	7.3	7.0	6.9	6.7	1,610	5,940	1,100	3,190	16,180	10,980
Mar-08	7.3	6.9	7.3	7.0	6.9	6.8	1,670	5,960	1,190	3,170	16,170	11,010
Jun-08	7.5	7.0	7.5	7.0	7.0	6.8	1,530	5,980	1,240	3,240	16,290	11,220
Sep-08	7.5	7.0	7.6	7.0	7.0	7.0	1,590	5,930	1,310	2,930	16,340	11,410
Dec-08	7.1						1,680					
Mar-09	7.2	7.2	7.3	7.2	7.7	6.6	1,620	1,780	960	2,160	14,000	10,740
Jun-09	7.0	7.0	7.1	7.2	8.3	6.8	1,410	1,880	910	2,050	13,150	10,810
Sep-09							1,400	1,870	900	2,070	13,130	10,800
Jan-10	7.1	7.0	7.1	7.3	8.3	6.7	1,410	1,870	900	2,090	13,190	10,760
Mar-10	7.0	7.0	7.0	7.2	8.3	6.7	1,410	1,870	900	2,140	13,170	10,710
Jun-10	7.2	6.4		7.6			1,387	3,180		1,758		
Sep-10	8.3	7.8	7.6	7.5			1,447	3,030	1,258	2,378		
Dec-10	7.1	7.0	7.1	7.0			1,468	2,240	1,006	2,540		
Mar-11	7.1		7.2	7.3			1,629		1,040	2,640		
Jun-11	7.2		7.5	7.2			1,190		1,075	2,110		
Jul-11	7.1		7.2	7.1			1,412		1,065	2,450		
Aug-11	7.2		7.3	7.0			1,381		998	2,520		
Sep-11	7.5		7.6	7.5			1,450		842	2,470		
Oct-11	8.2		7.4	7.2			1,349		919	2,640		
Nov-11	7.1		7.2	7.0			1,416		914	2,720		
Dec-11	7.1		7.2	7.0			1,471		928	2,810		
Jan-12												
Feb-12	7.1		7.4	7.1			1,415		844	2,360		
Mar-12	7.2		7.4	7.0			1,404		850	2,710		
Apr-12	7.1		7.2	7.0			1,448		941	2,510		
May-12	7.2		7.4	7.3			1,415		965	2,370		
Jun-12	7.2	7.4	7.3	7.2			1,353	1,579	1,001	2,280		
Jul-12	7.1		7.1	7.0			1,360		1,050	2,250		
Aug-12	7.1	7.1	7.1	7.0			1,317	1,738	1,075	2,140		
Sep-12	7.6	7.6	7.6	7.6			1,360	1,840	1,140	2,270		
Oct-12	7.4	7.2	7.2	7.0			1,300	1,701	1,084	2,220		
Nov-12	7.1	7.0	7.0	7.0			1,412	1,800	1,125	2,140		

	pH						EC (µS/cm)					
Report Month	MCC 1003	MCC 1005	MCC 1006	MCC 1015	MCC 1017	MCC 1018	MCC 1003	MCC 1005	MCC 1006	MCC 1015	MCC 1017	MCC 1018
Dec-12	7.1	7.1	7.1	7.0			1,443	1,776	1,106	2,350		
Jan-13	7.2	6.9	7.0	7.1			1,579	1,856	1,081	1,985		
Feb-13	7.2		7.0	7.0			1,260		1,115	2,030		
Mar-13	7.2		7.1	7.1			1,169		1,125	1,923		
Apr-13	7.0	6.9	7.0	7.2			1,366	2,400	1,098	1,995		
May-13	7.0	7.0	7.0	7.0			1,344	2,200	1,030	2,300		
Jun-13	7.2	7.1	7.2	7.2			1,392	2,215	1,018	2,420		
Jul-13	7.2	7.3	7.2	7.1			1,364	2,290	1,066	2,590		
Aug-13	7.5	7.4	7.4	7.3			1,377	2,270	1,062	2,530		
Sep-13	7.5	7.5	7.6	7.0			1,430	2,350	1,120	2,570		
Oct-13	7.3	7.3	7.2	7.1			1,447	2,310	1,156	2,460		
Nov-13	7.3			7.0			1,328			2,220		
Dec-13	7.2	7.0	7.0	6.9			1,315	2,580	1,218	2,460		
Jan-14	7.1	7.0	7.1	7.0			1,450	2,600	1,124	2,460		
Feb-14	7.1	7.0	7.1	7.1			1,463	2,620	1,087	2,530		
Mar-14	7.3	7.1	7.2	7.1			1,588	2,760	1,106	2,600		
Apr-14	7.4	7.0		7.0			1,644	2,770		2,440		
May-14	7.2	7.2		7.1			1,671	2,740		2,160		
Jun-14	7.2	7.0		7.0			1,687	2,690		2,400		
Jul-14	7.2	7.2		7.2			1,656	2,640		2,400		
Aug-14	7.1	7.1		7.1			1,665	2,640		2,380		
Sep-14	7.5	7.7		7.5			1,740	2,700		2,350		
Oct-14	7.1	7.1		7.0			1,715	2,640		2,380		
Nov-14	7.0	7.0		6.8			1,657	2,700		2,420		
Dec-14	7.2	7.1		7.1			1,770	2,860		2,480		
Jan-15	7.1	7.0		7.2			1,544	2,710		3,750		
Feb-15	7.1	7.0		7.6			1,640	2,760		3,230		
Mar-15	7.1	7.0		7.7			1,604	2,980		2,140		
Apr-15	7.4			6.9			1,020			1,930		
May-15	7.4	6.9		7.2			969	3,750		1,912		
Jun-15	7.2			7.2			1,325			2,006		
Jul-15	7.2			7.2			1,270			2,450		
Aug-15	7.2	7.1		7.2			1,272	3,200		2,670		
Sep-15	7.3	7.1		7.1			1,480	2,810		3,070		
Oct-15	7.1	7.1		7.0			1,340	2,550		3,060		
Nov-15	7.2	7.2		7.1			1,321	2,130		2,930		
Dec-15	7.1	7.2		7.0			1,350	2,020		2,760		
Jan-16	7.1	7.1	7.2	7.1			1,508	1,966	1,013	2,660		
Feb-16	7.0	7.0	7.0	7.0			1,673	1,927	1,024	2,350		
Mar-16	7.0	7.1	7.2	7.0			1,383	1,609	935	2,280		
Apr-16	7.1	7.1	7.1	7.2			1,592	1,994	1,023	2,270		
May-16	7.6	7.7	7.7	7.7			1,700	2,260	1,060	2,320		
Jun-16	7.1			7.3			1,641			1,758		
Jul-16	7.2	7.3		7.2			1,666	1,959		1,676		
Aug-16	7.3	7.2		7.3			1,078	2,250		1,570		
Sep-16	7.1	7.1	7.2	6.9			1,304	2,780	1,010	1,792		
Oct-16	7.1	7.1	7.2	7.0			1,426	2,480	940	1,997		
Nov-16	7.0	7.0	7.1	7.0			1,304	2,350	901	2,430		

	pH						EC (µS/cm)					
Report Month	**MCC 1003**	**MCC 1005**	**MCC 1006**	**MCC 1015**	**MCC 1017**	**MCC 1018**	**MCC 1003**	**MCC 1005**	**MCC 1006**	**MCC 1015**	**MCC 1017**	**MCC 1018**
Dec-16	7.1	7.0	7.2				1,377	2,300	928			
Jan-17	7.2	7.0	7.3				1,415	2,190	904			
Feb-17	7.2	7.0	7.1				1,417	2,220	880			
Mar-17	7.6	7.6	7.5				1,660	2,330	956			
Apr-17	7.5	7.2	7.4				1,092	2,120	955			
May-17	7.0	6.9	7.1				1,314	2,100	947			
Jun-17	6.9	7.0	7.1				1,396	2,150	948			
20th Percentile	7.1	6.9	7.1	7.0	6.1	6.5	1,342	1,982	932	2,015	6,348	10,776
80th Percentile	7.3	7.2	7.4	7.2	7.0	6.8	1,667	5,640	1,152	2,640	15,302	11,492
Minimum	6.8	6.4	6.7	6.8	5.3	6.4	969	1,579	842	1,570	5,360	10,280
Maximum	8.3	7.8	7.7	7.7	8.3	7.1	2,140	6,550	1,370	3,750	16,340	11,840
Water Quality Guideline*	6.5-7.5						30-350					

* = values for upland rivers