MIDDLEMOUNT COAL MINE

WESTERN EXTENSION PROJECT

ENVIRONMENTAL ASSESSMENT REPORT



PREPARED BY
RESOURCE STRATEGIES PTY LTD

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Middlemount Coal Mine is an existing mine located approximately 90 kilometres (km) north-east of Emerald and approximately 3 km to the south-west of the Middlemount Township, Queensland (Qld) (Figure ES-1). The Western Extension Project (the Project) provides for the continuation of open cut coal mining operations at the Middlemount Coal Mine (Figure ES-2).

Middlemount Coal Pty Ltd (MCPL) is seeking approval of the Project through a major amendment of Environmental Authority (EA) EPML00716913 in accordance with Chapter 5, Part 7 of the Qld *Environmental Protection Act, 1994* (EP Act). On the 14 March 2018, Department of Environment and Science (DES)' issued a request for additional information from MCPL to enable DES to make a decision on the application. This Environmental Assessment Report (EAR) presents MCPL's response to DES request for additional information.

MCPL is separately seeking approval of the Project under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (EPBC 2017/8130) via assessment by Preliminary Documentation.

ES.2 PROJECT OVERVIEW

Full scale operations at the Middlemount Coal Mine commenced July 2011. Middlemount Coal Mine extracts run-of-mine (ROM) coal up to 24 hours per day, seven days per week, using a conventional truck and shovel fleet supported by dozer mining at a rate of up to 5.7 million tonnes per annum (Mtpa). The currently approved general arrangement of the mine within Mining Lease (ML) 70379, ML 70417 and ML 700014 is shown on Figure ES-2.

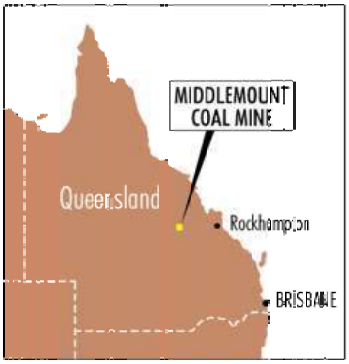
In May 2017, ML 70379 was extended to the north-west of currently approved operations at the Middlemount Coal Mine (via a realignment of the ML 70379 boundary) in an area previously covered by ML 1831, a lease held jointly by Anglo Coal (German Creek Pty Ltd), Mitsui German Creek Investment Pty Limited and Jena Pty Limited (collectively, Anglo Coal)[1].

The Project involves extension of operations within the extended portion of ML 70379 and extension of the East Dump within MLA 700027. The Project includes the following main activities:

- extension of the open cut pit within ML 70379 and ML 70417 to the north-west;
- continued extraction of ROM coal at up to 5.7 Mtpa using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (including the East Dump) and within the mined-out void;
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility (TSF) cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure (including CHPP and ROM and product stockpiles);

[1] Anglo Coal's ML 1831 was for sub-surface rights only in the extended portion of ML 70379. In June 2018, MCPL intend to apply for surface rights in the extended portion of ML 70379.





LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Local Government Area Boundary
- Approved/Operating Coal Mine
- Under Care and Maintenance

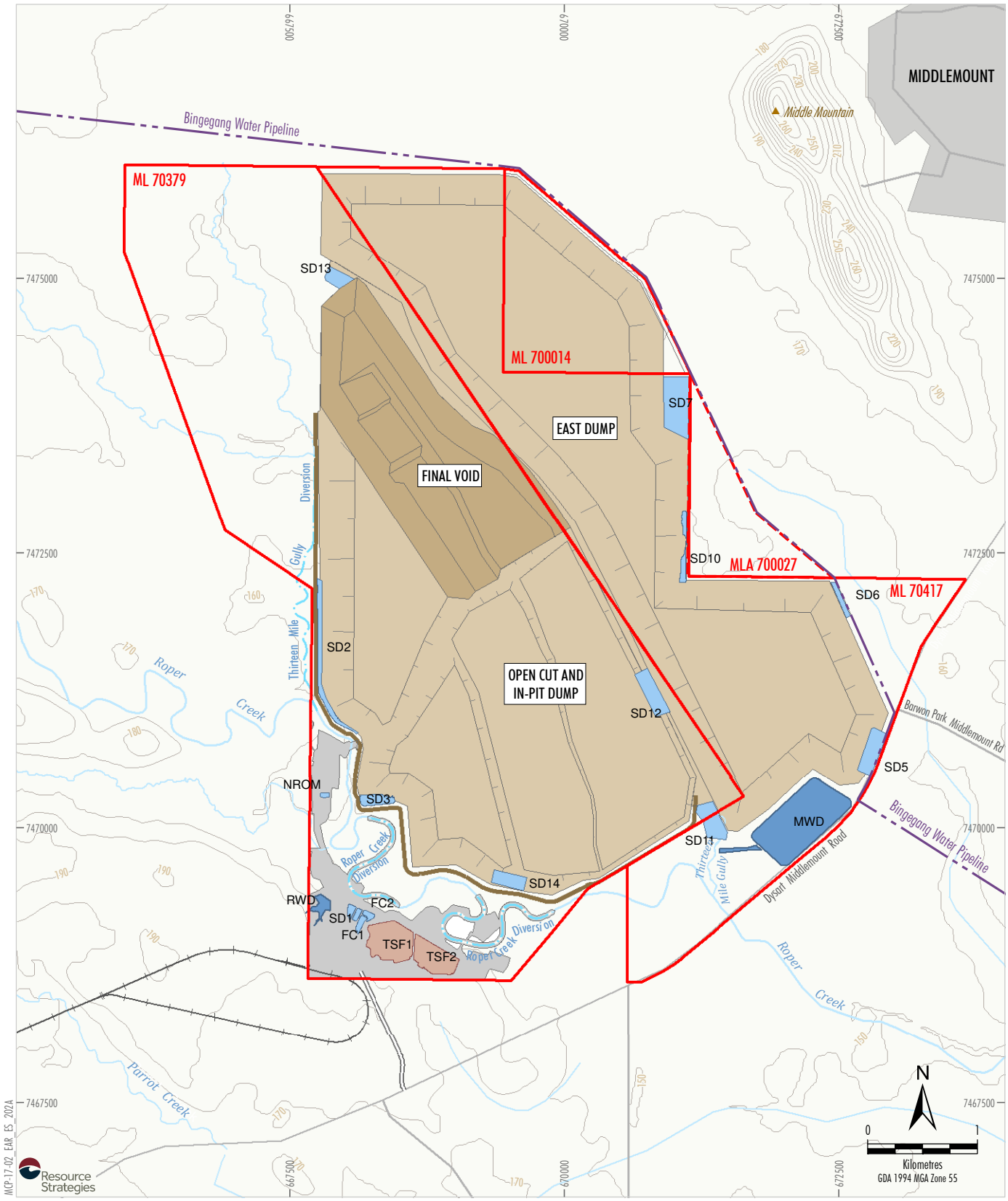
Source: Department of Natural Resource and Mines (2017); Geoscience (2011)

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Regional Location

Figure ES-1



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)

Currently Approved General Arrangement

- Mine Infrastructure Area
- Mining Pit and Spoil
- Final Void
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

Source: MCPL (2018); Department of Natural Resources and Mines (2017); Environmental Authority (EPML00716913) MCPL

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Existing/Approved Middlemount Coal Mine General Arrangement

Figure ES-2

- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

The approximate extents of the Project open cut mining components (including open cut pits, waste rock emplacements, coal rejects emplacement structures and final voids) are shown on Figure ES-3.

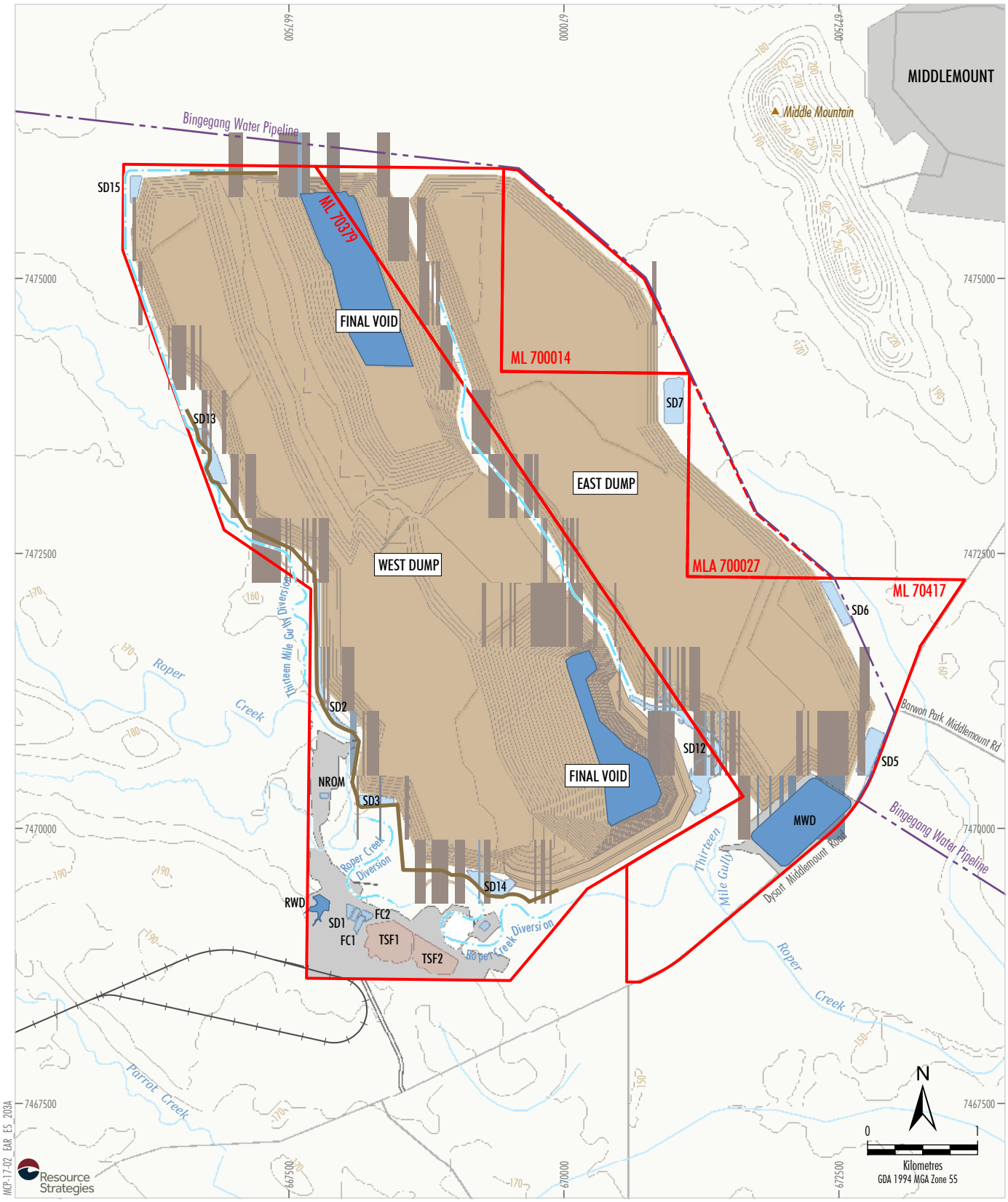
ES.3 ENVIRONMENTAL ASSESSMENT

A number of environmental assessment studies were completed to assess the potential environmental impacts of the Project.

A summary of the key findings of these studies and key commitments with respect to managing potential impacts is provided in Table ES.1.

Table ES.1
Key Outcomes of Environmental Assessment

Summary of Environmental Assessment Conclusions	Key Management, Mitigation or Monitoring Measures for the Project
Land	
• The Project would alter the landforms and topography within the Project area. Some topographic changes would be temporary (e.g. temporary infrastructure) and some would be permanent (e.g. final mine landforms). However, these landforms would be similar in elevation to the existing/approved mine landform and existing surrounding topography. • Potential impacts to soils would relate to direct disturbance of soil resources, increased erosion and sediment movement due to construction activities and alteration of physical and chemical soil properties due to soil stripping and stockpiling. • The Project would result in the disturbance or alteration of some existing low intensity grazing areas; however the rehabilitation strategy for the Project would include the rehabilitation of agricultural land suitable for the project. • The Project is not likely to potentially disturb areas where evidence of contamination or historical contaminating activities exists. • The development of the Project would alter the visual landscape of the Project area similar to the impacts associated with the existing/approved Middlemount Coal Mine. The impacts to visual amenity are not anticipated to be significant given the limited number of sensitive public viewpoints in the vicinity of the Project landforms.	• The Project would be rehabilitated to be safe, stable and non-polluting and able to support and sustain the proposed post-mining land use of low density beef cattle grazing or native ecosystem. Progressive rehabilitation (with selected tree and pasture species) of Project landforms would reduce the contrast between the Project landforms and the surrounding environment. • Continued implementation of soil resource management measures to maximise soil resources available for rehabilitation. • On-site consumable storage areas would be operated, where applicable, in compliance with the requirements of AS 1940-2017 The Storage and Handling of Flammable and Combustible Liquids and AS 2187.1 Explosives – Storage, Transport and Use – Storage. • Off-site light emissions from the Project would be minimised by select placement, configuration and direction of lighting.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Mine Pit and Spoil
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Levee
- Diversion Structure
- Mine Access Road
- Middlemount Rail Spur and Loop

Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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Project General Arrangement

Figure ES-3

Table ES.1 (Continued)
Key Outcomes of Environmental Assessment

Summary of Environmental Assessment Conclusions	Key Management, Mitigation or Monitoring Measures for the Project
Surface Water	
• A contemporary surface water assessment has been prepared. • Generally, the existing water management system objectives and principles at the Middlemount Coal Mine would remain unchanged as a result of the Project, with the exception of additional sediment dams and the progressive installation of up-catchment diversions and highwall dams proposed as part of the Project. • Based on the site water balance prepared for the Project, the following conclusions were made: – groundwater inflows are generally consistent across the life of the Project, with a reduction towards the end of the Project; – there were no modelled spillway overflows from the mine water system over the life of the Project; and – the Project would have minimal impact on the overall water balance for the mine. • Hydrologic modelling indicates that for a 100 year Annual Recurrence Interval (ARI) flood event, peak flood levels are generally unchanged from approved conditions. • No changes to the surface water trigger levels presented in the EA are proposed for the Project.	• Site water management and monitoring would be conducted in accordance with a revised Water Management Plan. • Surface water quality monitoring would continue to be undertaken for receiving waters when applicable and additional locations monitored. • Consistent with the approved mine, the flood protection levee that would exist during mining operations would be incorporated into the waste rock emplacement to form a stable and self-sustaining final landform that does not require long-term maintenance. This final landform would be designed to be considerably higher (approximately 6.5 m) than the probable maximum flood (PMF) Level. • The stability of the final landform relative to Roper Creek would be enhanced by incorporating erosion resistant material (e.g. rock gabion) into the batter slope to approximately 2 m height (to the PMF Level) and rehabilitating the surface of the landform with rock mulch and seeding/planting with tree, shrub and grass species characteristic of RE 11.5.3.
Groundwater	
• A contemporary groundwater assessment has been prepared and peer reviewed by Dr Noel Merrick of Hydroalgorithmics. • A contemporary bore census of the surrounding locality was also undertaken. • Groundwater levels are generally in excess of 25 m below ground surface and separated from surface waters, limiting potential to support Groundwater Dependant Ecosystems (GDEs). There are no springs from these deep confined aquifers within the Project area or surrounds that would support GDEs. • The groundwater quality data indicates that groundwater quality in the locality is brackish to saline and not suitable for stock or human consumption. Groundwater is not used for irrigation or farm supply within (and neighbouring) the Project area. • Exceedances in Total Dissolved Solids (TDS), sodium, silver, selenium and total petroleum hydrocarbon (TPH) would not be expected to have any impact on the potential groundwater use or environmental values relevant to the Project area.	• Ongoing groundwater level and quality monitoring within and surrounding the mine site. • Expansion of existing groundwater level and quality monitoring program to include additional bores outside of the current mine area.

Table ES.1 (Continued)
Key Outcomes of Environmental Assessment

Summary of Environmental Assessment Conclusions	Key Management, Mitigation or Monitoring Measures for the Project
Biodiversity	
• An ecological assessment has been prepared, based on contemporary field surveys in accordance with State and Commonwealth relevant guidelines. • Relevant Matters of State Environmental Significance and Matters of National Environmental Significance have been identified. • The Project would result in the clearance of approximately 190.5 ha of remnant vegetation, after consideration of avoidance and impact mitigation measures. • Overall, the additional clearance associated with the Project is considered to represent a minor increase in cumulative vegetation loss. Accordingly, the Project is not anticipated to have a significant cumulative impact on terrestrial ecology. • Indirect impacts on the woodland habitat would likely be minor. • A biodiversity offset strategy has been prepared to offset impacts on Matters of State Environmental Significance and Matters of National Environmental Significance, based on contemporary field surveys in accordance with relevant State and Commonwealth guidelines.	• Continued implementation of land clearance measures to minimise impacts on fauna. • The upper surface of the waste rock emplacements would be revegetated with species characteristic of RE 11.5.3, as it is the most predominant RE within the Project area. • Implementation of a Species Management Program under section 332 of the *Nature Conservation [Wildlife Management] Regulation, 2006* as required. • Implementation of weed and feral animal control measures in accordance with a revised Environmental Management Plan. • A biodiversity offset strategy (in addition to the existing strategy for the existing/approved Middlemount Coal Mine) would greatly exceed the area of remnant vegetation proposed to be cleared.
Air Quality	
• The estimated dust emissions inventory for the Project indicates that dust emissions would be lower than those previously assessed and approved for the equivalent year of the North-Eastern Extension Project and Stage 2 Project EIS. This is because overburden extraction rates would be lower for the Project than previously assessed and approved; and the haulage fleet would be optimised. • Air quality impacts at nearby sensitive receptors are therefore not anticipated to be greater than the impacts approved for the North-Eastern Extension Project and Stage 2 Project EIS. • The Project Greenhouse gas emissions have been estimated.	• Continued implementation of dust management and mitigation measures such as watering of haul roads and stockpiles, and progressive rehabilitation. • In the event of an air quality-related complaint, air quality monitoring would be conducted at the relevant sensitive place to validate the model predictions and inform the implementation of air quality mitigation measures, if required. • MCPL would continue to implement measures to minimise the generation of GHG emissions including procurement policies that require the selection of energy efficient equipment and vehicles, monitoring and maintenance of mobile equipment and optimisation of diesel consumption through logistics analysis and planning.
Noise and Vibration	
• Operational noise levels for Years 2028 and 2032 under adverse weather conditions are predicted to comply with the noise criteria for daytime, evening and night time periods. • The nearest receiver “Tralee 2”, was modelled to have a possible noise exceedance of 8 dB(A) under adverse weather conditions. This assumes the worst-case scenario with all plant operating simultaneously.	• Continued implementation of noise management and mitigation measures including maintaining all equipment in good order. • In the event of a noise-related complaint, noise monitoring would be conducted to validate the model predictions and inform the implementation of noise mitigation measures, if required, where noise objectives are exceeded. In this instance, noise mitigation measures would be investigated in consultation with the noise sensitive receptor. • With regard to the predicted possible noise exceedance at the “Tralee 2” receiver, simple noise reduction strategies would be investigated, such as limiting the use of the nearest haul routes and fixed plant items during night time periods.

Table ES.1 (Continued)
Key Outcomes of Environmental Assessment

Summary of Environmental Assessment Conclusions	Key Management, Mitigation or Monitoring Measures for the Project
Aboriginal Cultural Heritage	
• Cultural Heritage Management Plans (CHMPs) are in place with the Barada Barna People and BBKY #4, and cover the majority of the Project area. MCPL met with the Barada Barna People in February 2018 regarding the Project and expect to finalise a new CHMP in June 2018 for the area of the Project (approximately 75 ha) that is not covered by the existing CHMPs.	• Potential impacts to indigenous cultural heritage would be managed in accordance with the CHMPs.
Social (Community) Values	
• The Project would provide continued employment for the existing workforce for the life of the Project. A workforce of approximately 400 personnel is expected but may fluctuate over the life of the mine to over 500 personnel during particular mining or processing activities, shut downs or maintenance activities • Potential impacts to the community such as the demand for housing and community resources are not expected to increase as a result of the Project, given that no significant increase to the existing workforce is proposed for the Project.	• MCPL would continue to engage with community and track consultation activities in a Consultation and Complaint/Incident Register.

1 INTRODUCTION

Middlemount Coal Pty Ltd (MCPL) owns and operates the Middlemount Coal Mine, an existing open cut coal mine located approximately 90 kilometres (km) north-east of Emerald and approximately 3 km to the south-west of the Middlemount Township, Queensland (Qld) (Figures 1.1 and 1.2). The Western Extension Project (the Project) provides for the continuation of open cut coal mining operations at the Middlemount Coal Mine (Figure 1.3).

MCPL is seeking approval of the Project through a major amendment of Environmental Authority (EA) EPML00716913 in accordance with Chapter 5, Part 7 of the Qld *Environmental Protection Act, 1994* (EP Act). An EA amendment application and the *Middlemount Coal Mine Western Extension Section 226 Consideration Report* (Section 226 Consideration Report) (MCPL, 2017a) were lodged with the Department of Environment and Heritage Protection (DEHP) (now the Department of Environment and Science [DES]) on 17 January 2018. DES subsequently made its Assessment Level Decision on 31 January 2018 and the proposed amendment is a Major EA Amendment application.

On the 14 March 2018, DES issued a request for additional information from MCPL to enable DES to make a decision on the application. This Environmental Assessment Report (EAR) presents MCPL's response to the DES request for additional information. Appendix A contains a table that reconciles DES requested information to the relevant sections of the EAR where the information is provided.

This EAR provides a detailed description of the Project, an assessment of the potential environmental impacts, as well as proposed management practices and mitigation strategies.

MCPL is separately seeking approval of the Project under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (EPBC 2017/8130) via assessment by Preliminary Documentation.

1.1 PROJECT PROPONENT

MCPL is the proponent for the Project. MCPL is an incorporated joint venture between Peabody Energy Australia Pty Ltd (50.003%) and Yancoal Australia Ltd (49.997%). The registered address for the proponent is:

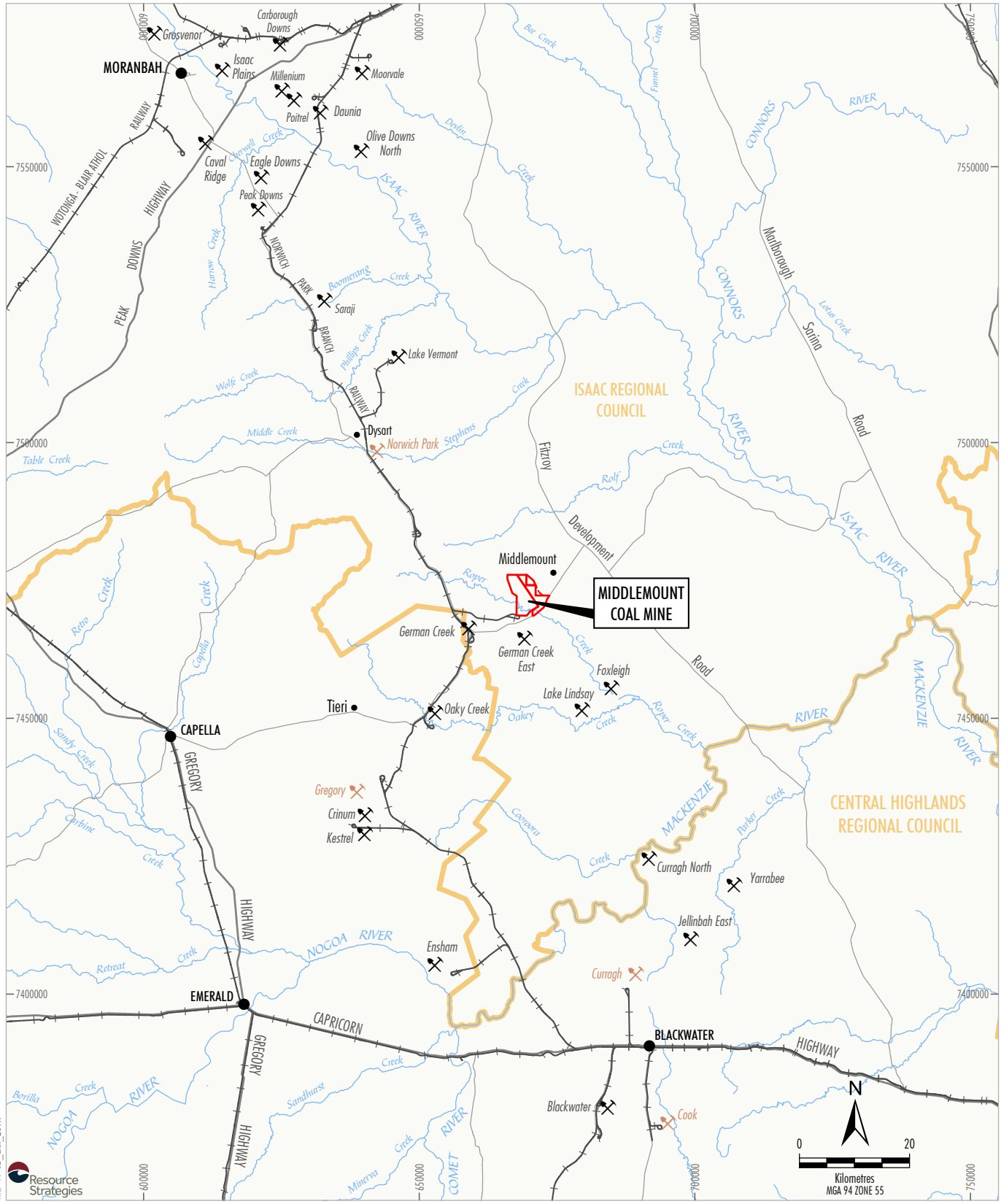
Middlemount Coal Pty Ltd
Level 17, 444 Queen St,
BRISBANE CITY Qld 4000

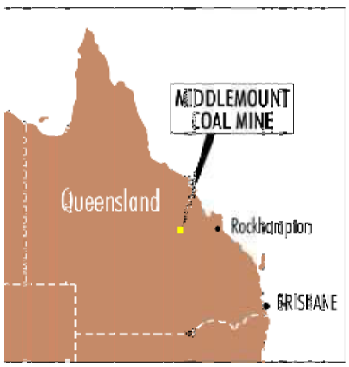
1.2 THE EXISTING MIDDLEMOUNT COAL MINE

Full scale operations at the Middlemount Coal Mine commenced July 2011. Middlemount Coal Mine extracts run-of-mine (ROM) coal up to 24 hours per day, seven days per week, using a conventional truck and shovel fleet supported by dozer mining at a rate of up to 5.7 million tonnes per annum (Mtpa). The currently approved general arrangement of the mine within Mining Lease (ML) 70379, ML 70417 and ML 700014 is shown on Figure 1.2.

Three primary seams of the Rangal Coal Measures are targeted for mining, specifically the Middlemount, Pisces and Tralee Seams. ROM coal is mined in a general west to east direction within ML 70379 and ML 70417. Overburden and interburden material is emplaced in-pit behind the advancing open cut operations, and within the East Dump, located within ML 70417 and ML 700014.

ROM coal is processed through a coal handling and preparation plant (CHPP) to produce approximately 4.1 Mtpa of pulverised coal injection (PCI) and coking coal for the export market. Product coal is transported by rail to the Dalrymple Bay Coal Terminal, Abbot Point Port or Wiggins Island Coal Export Terminal. The existing Middlemount Coal Mine will operate until approximately 2031.





LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Local Government Area Boundary
- Approved/Operating Coal Mine
- Under Care and Maintenance

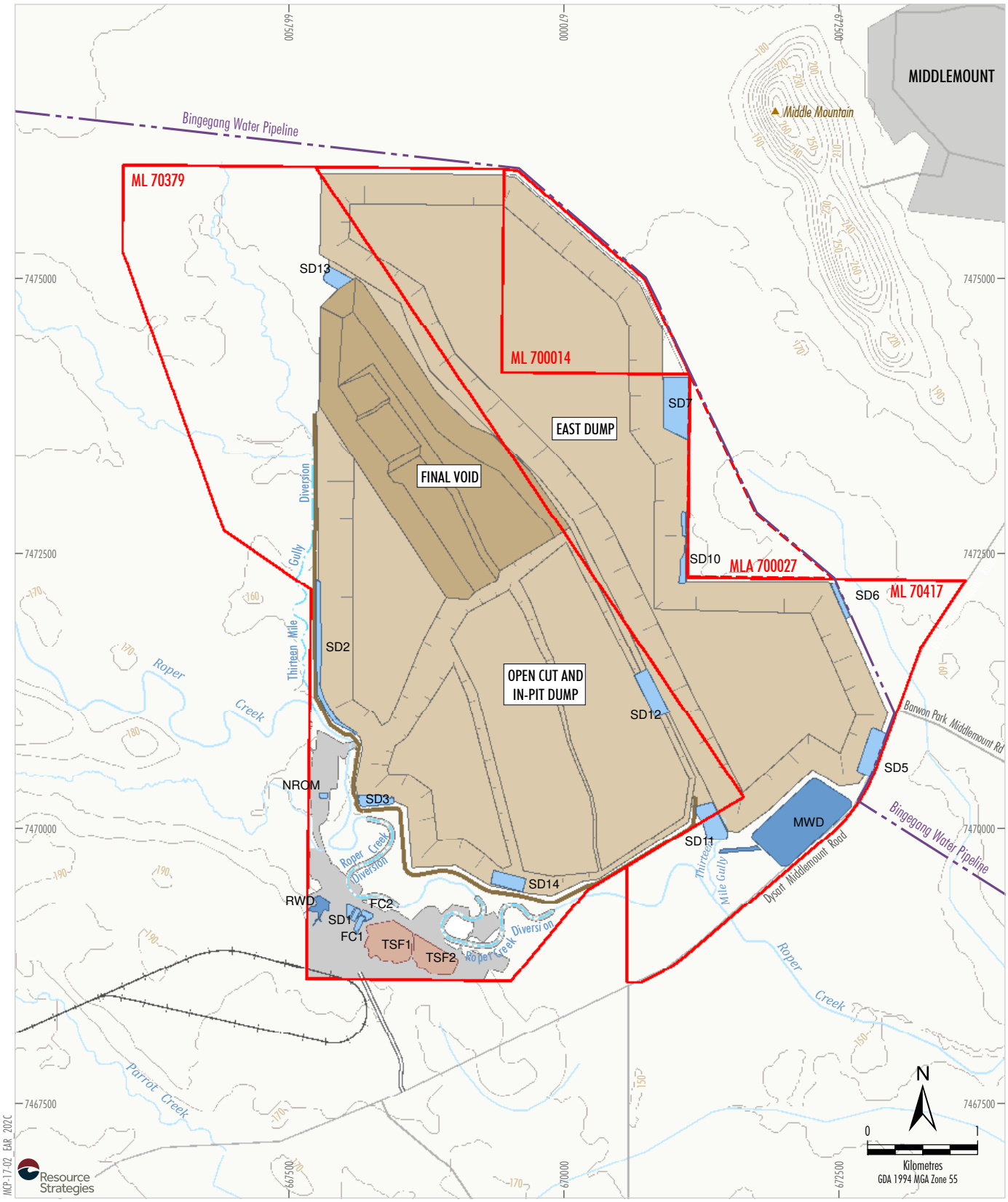
Source: Department of Natural Resource and Mines (2017); Geoscience (2011)

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WESTERN EXTENSION PROJECT

Regional Location

Figure 1.1



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)

Currently Approved General Arrangement

- Mine Infrastructure Area
- Mining Pit and Spoil
- Final Void
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

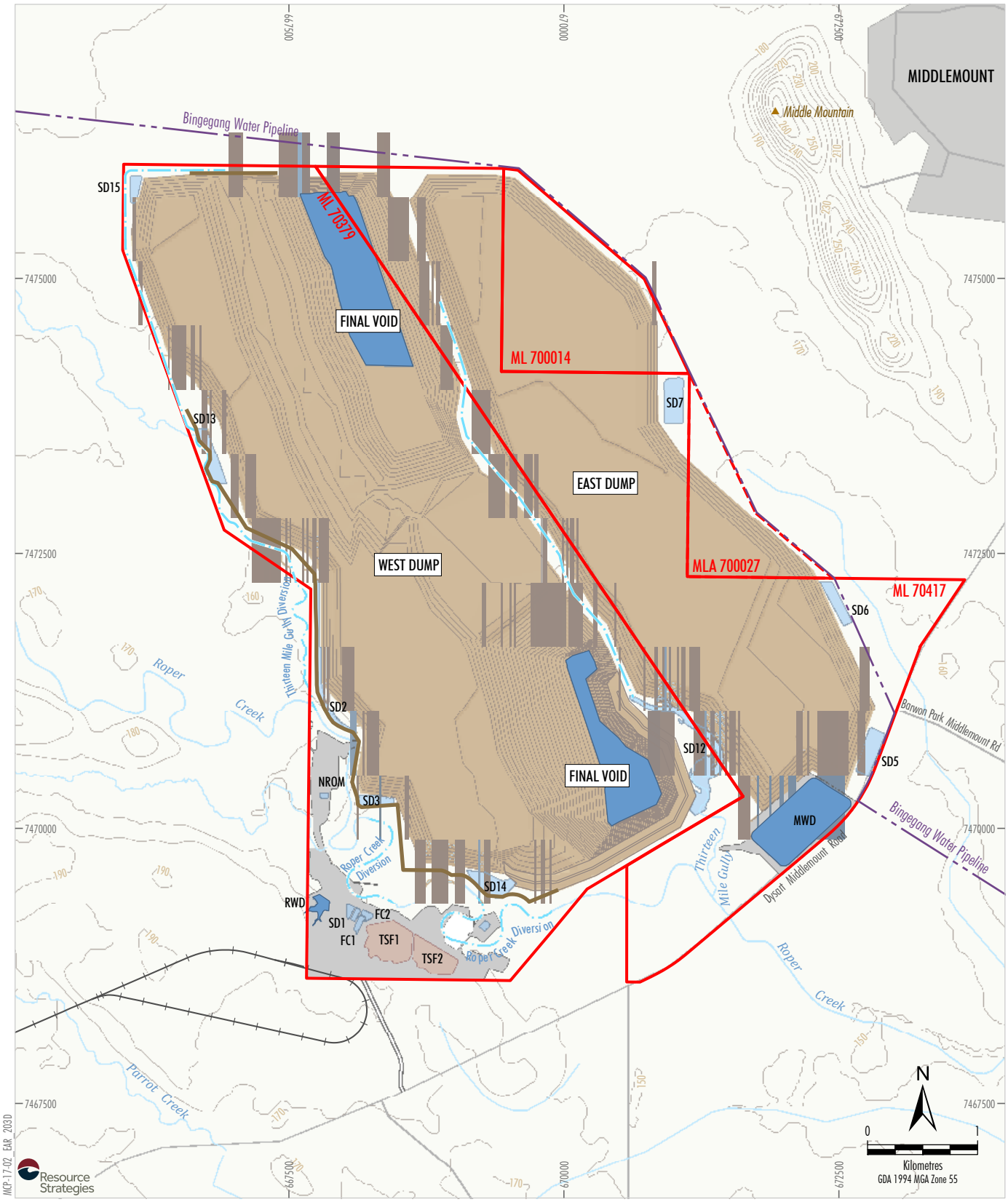
Source: MCPL (2018); Department of Natural Resources and Mines (2017); Environmental Authority (EPML00716913) MCPL

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WESTERN EXTENSION PROJECT

Existing/Approved Middlemount Coal Mine General Arrangement

Figure 1.2



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Mine Pit and Spoil
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Levee
- Diversion Structure
- Mine Access Road
- Middlemount Rail Spur and Loop

Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Project General Arrangement

Figure 1.3

1.3 APPROVAL HISTORY

Stage 1 of the Middlemount Coal Mine was initially approved for the production of 1.8 Mtpa of ROM coal, designated under ML 70379, and an amended EA (Mining Activities) Non-Code Compliant Level 1 MIN100646307 – Middlemount Coal Mine, effective from 24 November 2009.

On 29 June 2012, EA EPML00716913 was amended to approve the expansion of open cut mining operations within ML 70379 and ML 70417 (referred to as "Stage 2" of the Middlemount Coal Mine), including a ROM coal production rate increase from 1.8 to 5.4 Mtpa. On 7 September 2012, Middlemount Coal Project Stage 2 was approved under the EPBC Act.

Subsequent minor amendments to the EA were made on the 8 February and 12 July 2016 for various minor changes, including an increase in the ROM coal production rate from 5.4 to 5.7 Mtpa.

On 23 September 2016, EA EPML00716913 was amended for the North-eastern Extension, involving an extension of the East Dump into ML 700014. On 29 March 2017, the North-eastern Extension was approved under the EPBC Act.

Minor amendments to the EA were more recently made on 22 August 2017 and 21 May 2018 for various minor changes, including conditions to enable exploration activities in the extended north-west portion of ML 70379.

The Thirteen Mile Gully Diversion was approved under the Qld *Sustainable Planning Act, 2009* (SP Act) in July 2013 as it mostly occurs outside of the former boundary of ML 70379 (Development Permit 608153).

1.4 PROJECT OVERVIEW

In May 2017, ML 70379 was extended to the north-west of currently approved operations at the Middlemount Coal Mine (via a realignment of the ML 70379 boundary) in an area previously covered by ML 1831, a lease held jointly by Anglo Coal (German Creek Pty Ltd), Mitsui German Creek Investment Pty Limited and Jena Pty Limited (collectively, Anglo Coal)[2].

The Project involves extension of operations within the extended portion of ML 70379 and extension of the East Dump within MLA 700027. The Project includes the following main activities:

- extension of the open cut pit within ML 70379 and ML 70417 to the north-west;
- continued extraction of ROM coal at up to 5.7 Mtpa using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (including the East Dump) and within the mined-out void;
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility (TSF) cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure (including CHPP and ROM and product stockpiles);

[2] Anglo Coal's ML 1831 was for sub-surface rights only in the approved extended portion of ML 70379. In September2018, MCPL intend to apply for surface rights in the extended portion of ML 70379.

- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

The approximate extents of the Project open cut mining components (including open cut pits, waste rock emplacements, coal rejects emplacement structures and final voids) are shown on Figure 1.3.

The ownership of land in the Project area and immediate surrounds is shown on Figure 1.4.

A detailed description of the Project is provided in Section 2.

1.5 CONSULTATION

Consultation has been conducted with relevant stakeholders during the preparation of this EAR. A summary of this consultation is provided below. It is anticipated that consultation with these stakeholders will continue during the assessment of the Project by the Qld and Commonwealth Governments.

Department of Environment and Science

MCPL met with DEHP (now DES) on 20 July 2017 to discuss the Project and approval process prior to submission of the EA amendment application and the Section 226 Consideration Report (MCPL, 2017a). MCPL subsequently met with DES on 22 February and 2 March 2018 to discuss the Project, environmental studies and scope for this EAR.

Department of Natural Resources and Mines

MCPL has existing Qld and Commonwealth approved biodiversity offset areas under an existing Voluntary Declaration (VDec) under the Qld *Vegetation Management Act, 1999* (VM Act) (Declared Area Map 2013/003919), and new biodiversity offset areas are proposed as part of the Project.

MCPL consulted with the Department of Natural Resources and Mines (DNRM) in February 2018 regarding the security of the offset areas under a new VDec.

Commonwealth Department of the Environment and Energy

MCPL met with the Commonwealth Department of the Environment and Energy (DEE) in July 2017 for an EPBC Act referral pre-lodgement meeting. An EPBC Act referral for the Project was lodged on 7 January 2018. A controlled action decision was received on 8 February 2018 (EPBC 2017/8130) and assessment is to be via Preliminary Documentation assessed by the Commonwealth Government.

MCPL hosted representatives from the DEE for a site visit on 23 May 2018.

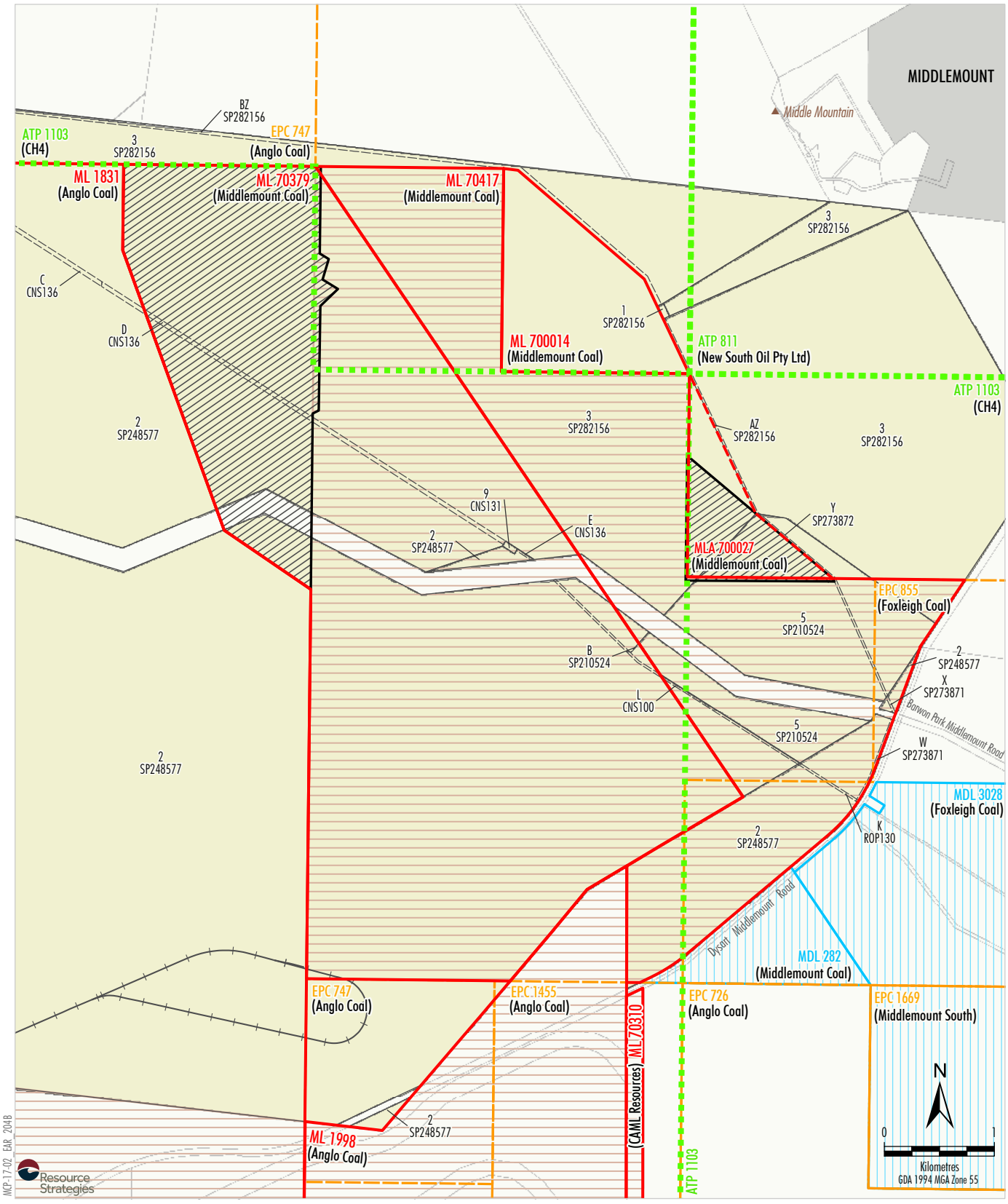
Isaac Regional Council

The Barwon Park - Middlemount Road traverses the Middlemount Coal Mine. This is an unformed road that is mapped as a travelling stock reserve (Figure 1.2). MCPL has previously reached compensation agreements with the Isaac Regional Council to close part of the travelling stock reserve within ML 70379 and ML 70417.

MCPL met with the Isaac Regional Council in February 2018 regarding the Project and a compensation agreement has been signed by the Isaac Regional Council in relation to the part of the travelling stock reserve that traverses ML 70379 within the Project area.

Aboriginal Community

Cultural Heritage Management Plans (CHMPs) are in place with the Barada Barna People and BBKY #4, and cover the majority of the Project area. MCPL met with the Barada Barna People in February 2018 regarding the Project and a new CHMP was executed in May 2018 for the area of the Project (approximately 75 hectares [ha]) that was not covered by the existing CHMPs.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Exploration Permit for Petroleum (EPP)
- Exploration Permit for Coal (EPC)
- Mineral Development Licence (MDL)
- Mining Lease Surface Area
- Middlemount Coal Owned Land
- Easement
- Middlemount Rail Spur and Loop
- Western Extension Project
- Approximate Extent of Additional Surface Disturbance

Source: MCPL (2018); Department of Natural Resources and Mines (2018)

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Mining and Exploration Tenements and Relevant Land Tenure

Figure 1.4

1.6 RELEVANT LEGISLATION AND POLICY REQUIREMENTS

Table 1-1 describes the principal statutory approvals relevant to mining projects and establishes their relevance to the Project. The list of approval requirements in Table 1-1 is confined to principal approval requirements and is not an exhaustive list of all approval requirements for the Project.

1.7 DOCUMENT STRUCTURE

This EAR comprises a main text component and supporting appendices. An overview of the main text is presented below:

Section 1 Introduction

Provides an introduction to the proponent, the Project and the function of this EAR as part of the assessment and approvals process.

Section 2 Project Description

Describes the various components and stages of development of the Project, as well as a description of the Project workforce and the community.

Section 3 Environmental Assessment

Details the environmental assessment.

Section 4 Rehabilitation and Biodiversity Offset Strategy

Describes the rehabilitation and offset strategy for the Project.

Section 5 Summary of Environmental Management Commitments

Provides a consolidated description of the commitments to implement management measures for the Project.

Section 6 References

Lists documents referenced in Sections 1 to 5 of the EAR, including guidelines and policies.

Appendix A contains a table that reconciles DES' requested information to the relevant sections of this EAR where the information is provided.

Appendices B to F contain supporting documentation, including a number of specialist/technical reports:

Appendix B	Surface Water Assessment
Appendix C	Groundwater Assessment
Appendix D	Ecological Impact Assessment
Appendix E	Air Quality and Greenhouse Gas Assessment
Appendix F	Noise and Vibration Assessment

Appendix G contains the proposed rehabilitation goals, objectives, indicators and completion criteria for each domain of the Middlemount Coal Mine (incorporating the Project).

Table 1-1
Principal Statutory Approvals

Requirement	Purpose	Applicable Act	Administering Authority/Parties
Mining Approvals			
Mining Lease (ML)	A ML is required to permit the undertaking of specified mining activities within the defined lease location. MLA 700027 covers the proposed East Dump extension. In May 2018, MCPL applied for surface rights in the extended portion of ML 70379.	Qld *Mineral Resources Act, 1989*	DNRM
Environmental Authority (EA) (Mining Activities) and related documents, including: – Plan of Operations – Financial Assurance	The Project requires a major EA amendment.	Qld *Environmental Protection Act, 1994*	DES
Regional Interests Development Approval (RIDA)	A RIDA is required when a resource activity is proposed to be located in an area of regional interest. The Project is not required to obtain a RIDA.	Qld *Regional Planning Interests Act, 2014*	Department of Local Government, Racing and Multicultural Affairs
Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) Approval	The EPBC Act is triggered where an action will have, or is likely to have, a significant impact on a Matter of National Environmental Significance. A controlled action decision was received on 8 February 2018 (EPBC 2017/8130) and assessment is to be via Preliminary Documentation.	EPBC Act	DEE
Planning Act, 2016 Approval	The Thirteen Mile Gully Diversion was approved under the *Sustainable Planning Act, 2009* (SP Act) (now repealed) in July 2013 as it mostly occurs outside of the former boundary of ML 70379 (Development Permit 608153).	*Planning Act, 2016*	Department of State Development, Manufacturing, Infrastructure and Planning

Table 1-1 (Continued)
Principal Statutory Approvals

Requirement	Purpose	Applicable Act	Administering Authority/Parties
Biodiversity Approvals			
Offset approval	The *Environmental Offsets Act, 2014* (EO Act) provides methods to determine the environmental offsets required for significant residual impacts on Matters of State Environmental Significance (MSES). The Project would result in significant residual impacts on some MSES. An offset proposal has been prepared to offset the predicted significant residual impacts on MSES.	EO Act	DES
Offset Security	Existing offset areas have been secured via a Voluntary Declaration (VDec). Proposed offset areas would also be secured via a VDec.	*Vegetation Management Act, 1999*	DNRM
Licences/Permits/Approvals	The *Nature Conservation Act, 1992* (NC Act) regulates the disturbance of listed and protected flora and fauna.	NC Act	DES
Native Title Approvals/Cultural Heritage Approvals			
The majority of the Project land is freehold and therefore Native Title rights are not applicable. However, the *Native Title Act, 1993* is relevant to the Project for areas of land where Native Title may apply, such as road reserves, drainage features and easements.	The *Native Title Act, 1993* provides for the recognition and protection of Native Title rights in Australia. The Act provides a mechanism for determining Native Title rights and to establish a way in which dealings affecting Native Title rights may proceed. Native Title has been extinguished across the entire Project area.	*Native Title Act, 1993*	Commonwealth Attorney-General's Department
Preparation of: – Duty of Care Statement – CHMP	When constructing the Project, all reasonable and practicable measures must be taken to ensure it does not harm Aboriginal cultural heritage. Activities at the Project would be undertaken in accordance with the CHMPs, which would be reviewed and amended to reflect the Project (Section 1.5).	*Aboriginal Cultural Heritage Act, 2003*	DES

2 PROJECT DESCRIPTION

2.1 GEOLOGY AND COAL RESOURCE

The coal resource at the Middlemount Coal Mine is located within the Permian age Rangal Coal Measures of the Bowen Basin. The Rangal Coal Measures form a relatively narrow (approximately 3 km wide) structure, striking from the north-northwest to south-southeast within and adjacent to the mine tenements. In the locality, a veneer of more recent Tertiary geology and Quaternary geology typically overlies the Bowen Basin strata.

The target coal seams for the Project are the Middlemount and Pisces coal seams of the Rangal Coal Measures. These coal seams dip to the east-northeast at between 3 and 7 degrees (^{o}), where they are truncated by the Jellinbah Fault, which is mapped to be generally coincident with the north-eastern boundary of ML 70379.

The additional target coal resource for the Project (in the north-west of ML 70379) has been estimated at approximately 24.5 million tonnes (Mt), comprising approximately 21 Mt of recoverable coal.

2.2 PROJECT GENERAL ARRANGEMENT

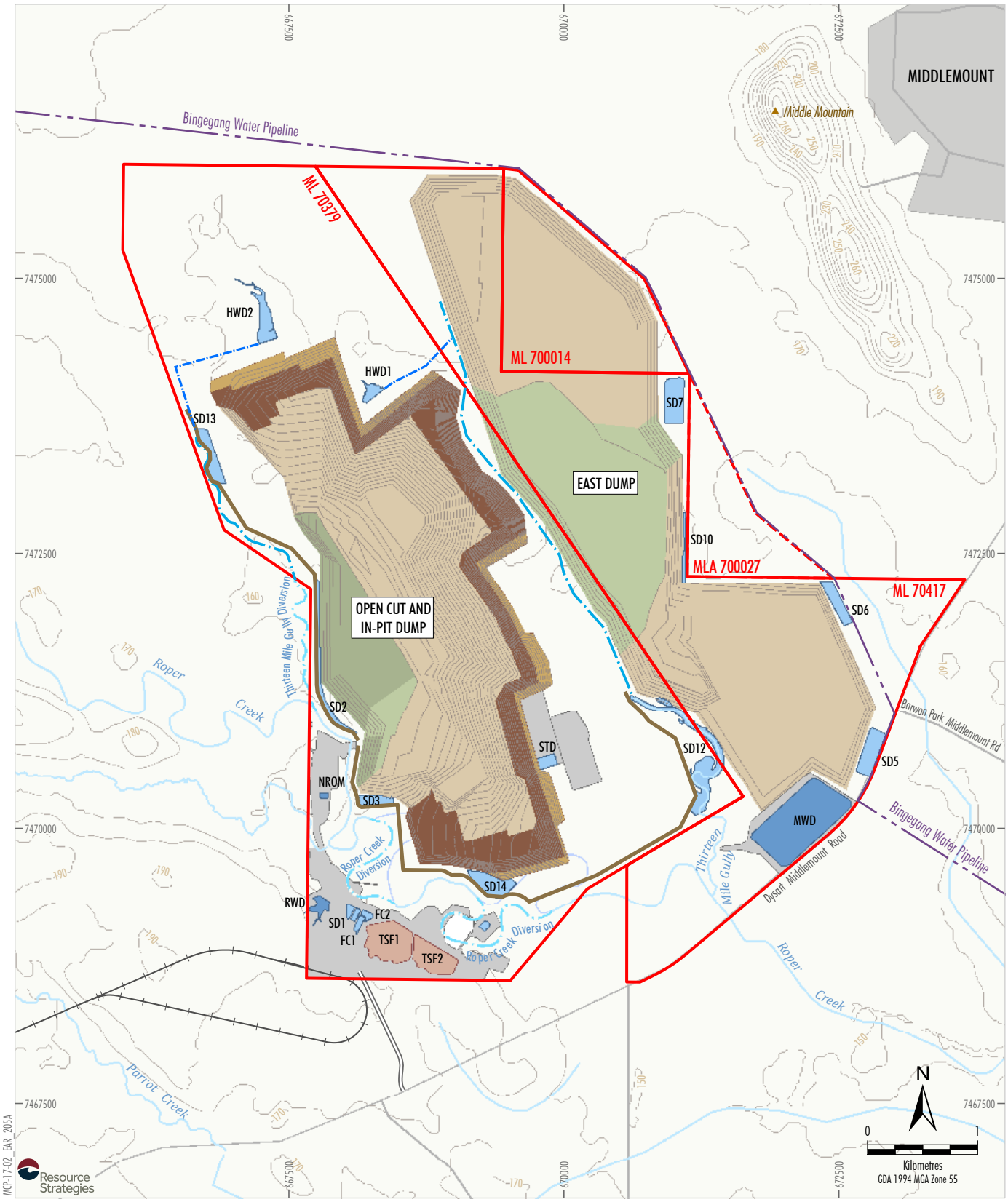
The Project would involve the use of existing infrastructure and service facilities of the Middlemount Coal Mine. The Project includes the following activities:

- extension of the open cut pit within ML 70379 to the north-west;
- continued extraction of ROM coal at up to 5.7 Mtpa using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (East Dump and to the north-west) and within the mined-out void;
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing TSF cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of topsoil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure (including CHPP and ROM and product stockpiles);
- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

A proposed general arrangement is shown on Figure 1.3. The approximate extent of additional surface development area associated with the Project is approximately 575 ha.

Indicative general arrangements for Year 6 (2023), Year 11 (2028) and Year 15 (2032) of the Project are shown on Figures 2.1 to 2.3. These indicative general arrangements are based on planned maximum production and mine progression. The mining layout and sequence may vary to take account of localised geological features, coal market volume and quality requirements, mining economics and detailed engineering design.

The final landform and rehabilitation concept for post mining is shown on Figure 2.4 and discussed further in Section 4.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Topsoil Stripped
- Active Open Cut Mining Area
- Active Waste Rock Emplacement
- Initial Rehabilitation
- Established Rehabilitation
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Water Transfer Pipeline
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

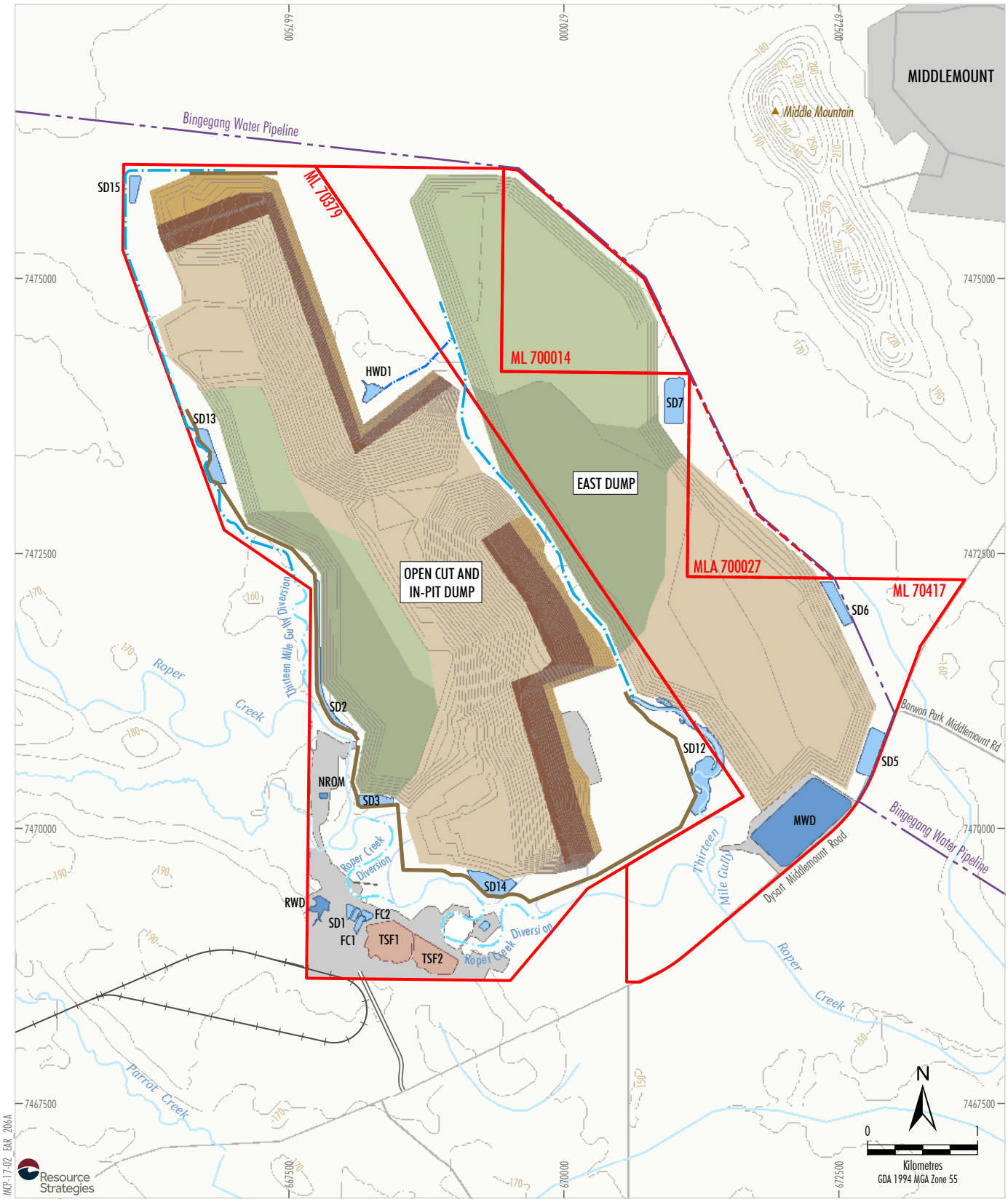
Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Year 6 (2023)

Figure 2.1



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Topsoil Stripped
- Active Open Cut Mining Area
- Active Waste Rock Emplacement
- Initial Rehabilitation
- Established Rehabilitation
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Water Transfer Pipeline
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

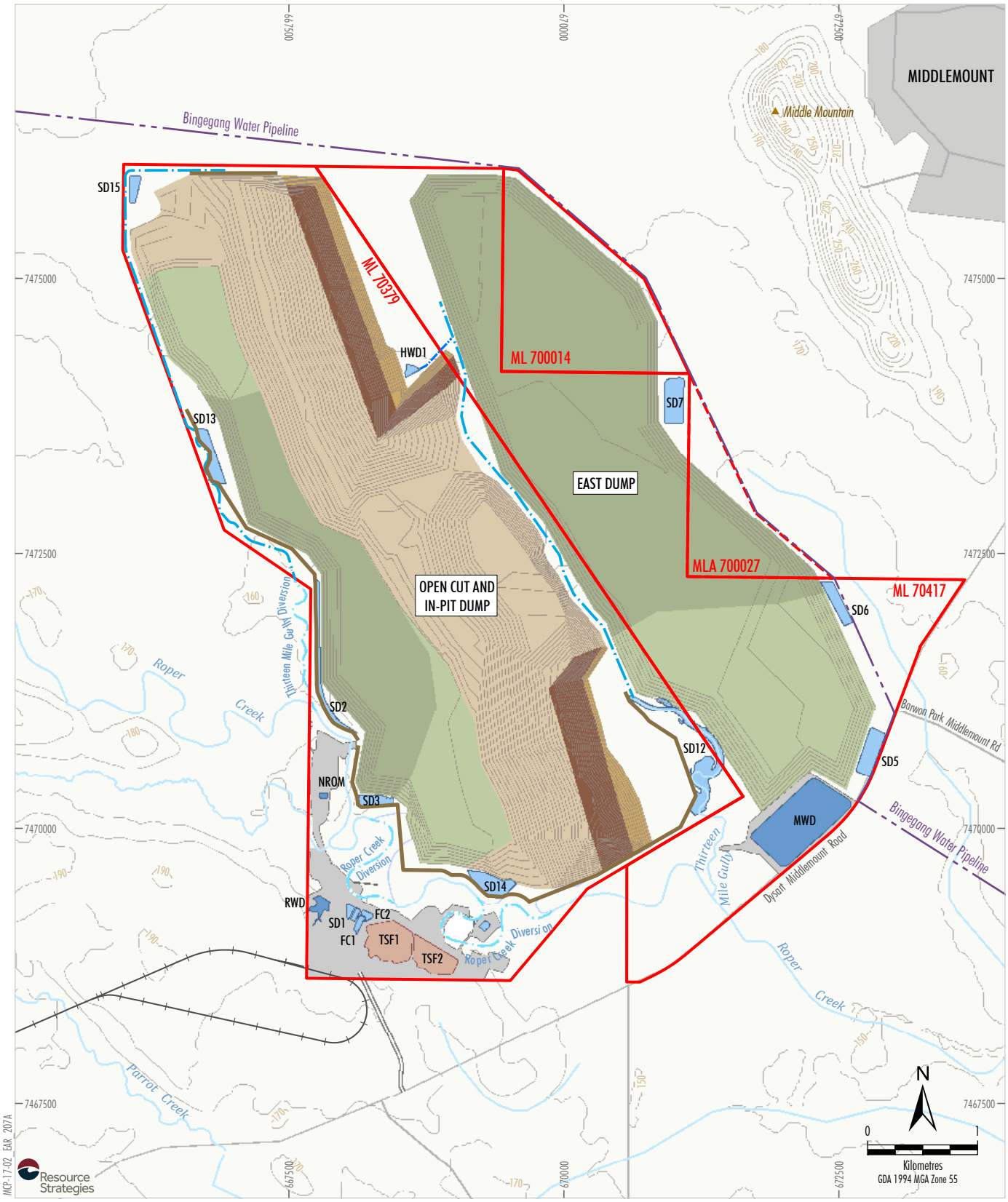
Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Year 11 (2028)

Figure 2.2



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Topsoil Stripped
- Active Open Cut Mining Area
- Active Waste Rock Emplacement
- Initial Rehabilitation
- Established Rehabilitation
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Water Transfer Pipeline
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

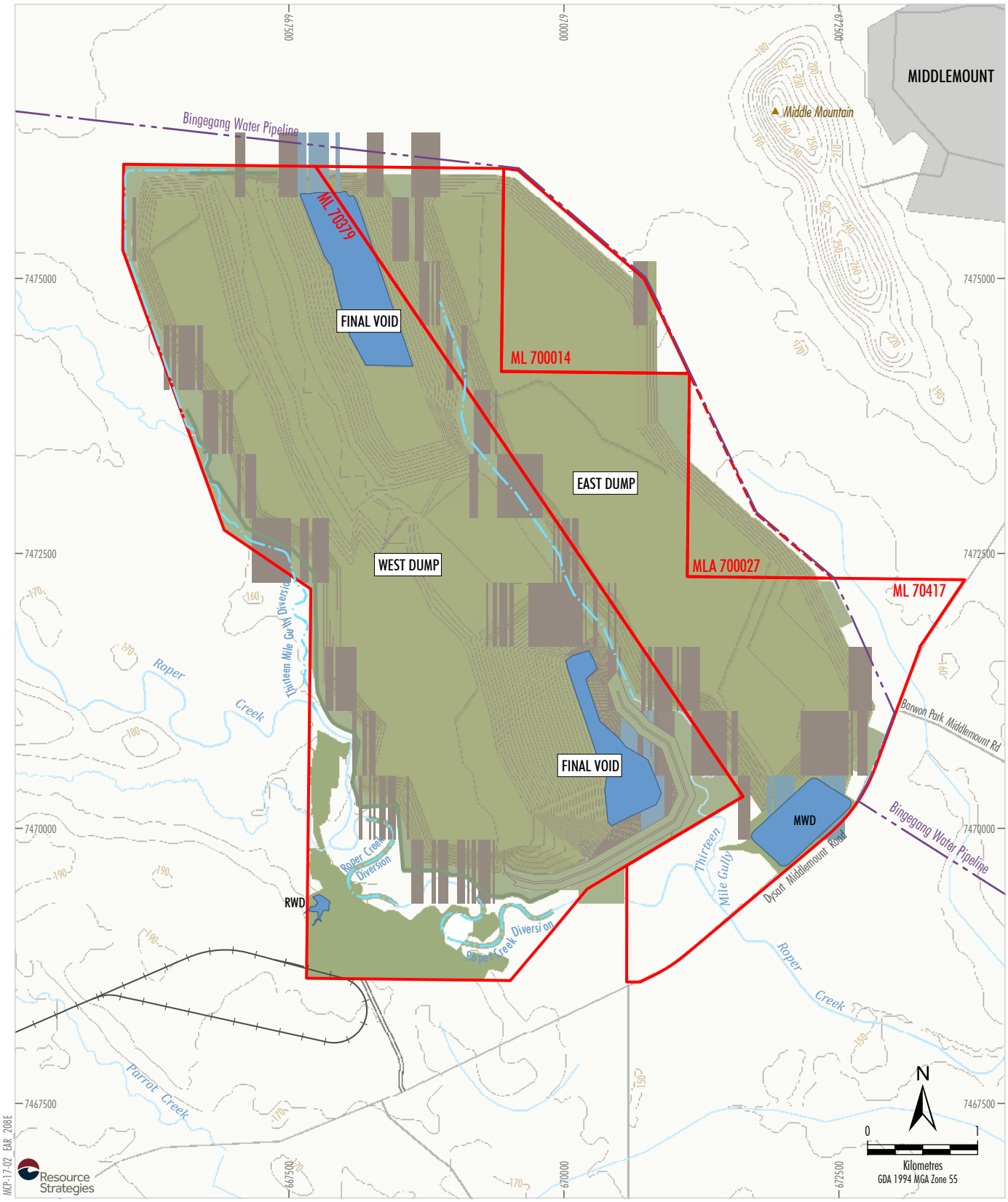
Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Year 15 (2032)

Figure 2.3



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Established Rehabilitation
- Water Storage
- Diversion Structure
- Removed Levee (Rehabilitated)
- Mine Access Road (Retained or Rehabilitated)
- Middlemount Rail Spur and Loop (Retained or Rehabilitated)

Source: MCPL (2018); AGE (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Post-mining

Figure 2.4

2.3 PROJECT SCHEDULING

An indicative mine schedule for the Project is provided in Table 2-1. As described in Section 2.2, the mining layout, sequence and coal extraction rates may be adjusted during the mine life to take account of localised geological features, coal market volume and quality requirements and mining economics.

2.4 OPEN CUT MINING ACTIVITIES

The Project would not result in a change to the open cut mining methods or the currently approved maximum annual ROM coal extraction rate (up to 5.7 Mtpa). Mining at the Middlemount Coal Mine is by conventional open cut strip mining methods, and generally progresses from the shallowest coal in the west toward the east.

Approved operations include open cut mining of ROM coal up to 24 hours per day, seven days per week, using a conventional truck and shovel fleet supported by dozer mining. The Project would not result in a change to the above.

Vegetation Clearing and Topsoil Salvage

The Project would not result in a change to the vegetation clearing and topsoil salvage methods used at Middlemount Coal Mine. Vegetation would be progressively cleared ahead of the active open cut and waste rock emplacement areas. Topsoil would be stripped prior to excavation of underlying overburden or emplacement of waste rock. Where the topsoil cannot be directly used for progressive rehabilitation it would be stockpiled for use at a later date.

Table 2-1
Indicative Mine Schedule

Project Year	Waste Rock (Mbcm)	ROM Coal (Mtpa)	Rejects (Mt)	Product Coal (Mt)
Year 1 (2018)	53.8	5.5	1.5	4.0
Year 2 (2019)	52.0	5.4	1.6	3.8
Year 3 (2020)	53.0	5.1	1.3	3.8
Year 4 (2021)	56.6	5.4	1.5	3.9
Year 5 (2022)	65.9	5.4	1.5	3.9
Year 6 (2023)	64.5	5.4	1.5	3.9
Year 7 (2024)	68.4	5.4	1.5	3.9
Year 8 (2025)	66.7	5.7	1.9	3.8
Year 9 (2026)	66.0	5.4	1.4	4.0
Year 10 (2027)	65.2	5.4	1.5	3.9
Year 11 (2028)	66.6	5.4	1.5	3.9
Year 12 (2029)	64.0	5.4	1.4	4.0
Year 13 (2030)	64.1	5.4	1.6	3.8
Year 14 (2031)	66.3	5.4	1.6	3.8
Year 15 (2032)	73.2	5.4	1.7	3.7
Year 16 (2033)	72.3	4.9	1.5	3.4
Year 17 (2034)	73.7	5.0	1.5	3.5
Year 18 (2035)	71.7	5.0	1.8	3.2
Year 19 (2036)	43.8	4.7	1.2	3.5
Year 20 (2037)	34.3	2.8	0.5	2.3

* Assumed Project commencement date is 2018, or otherwise upon grant of relevant approvals.

Mbcm = Million bank cubic metres.

Mt = Million tonnes.

Waste Rock Removal and Handling

The Project would not result in a change to the method of waste rock removal and handling at the Middlemount Coal Mine. The upper unconsolidated overburden would continue to be removed using excavators, trucks and dozer mining. The remaining overburden and interburden (weathered Tertiary and upper Permian material) would be drilled and blasted prior to removal by the same methods.

The overburden and interburden would be emplaced in both out-of-pit and in-pit waste rock emplacements (including emplacement in new areas proposed as part of the Project). Disposal of waste rock in-pit minimises the size of the final voids (Section 2.8).

Consistent with existing operations, testing of overburden would be conducted to confirm a low to negligible risk of acid mine drainage and identify material with a high susceptibility for dispersion and slaking. Potentially acid forming material would not be used as capping material and would continue to be buried within the waste emplacements with material that has a positive acid neutralising capacity. Less dispersive material would be used as capping material, where possible.

Coal Rejects Management

The Project would not result in a change to coal (coarse and fine) rejects management. Coarse reject material from the CHPP would only be placed within in-pit waste emplacements. Fine rejects would be temporarily stored in existing TSF cells for drying and reclaim for in-pit co-disposal.

ROM Coal Mining and Handling

The mined ROM coal would be trucked from the open cut pit to the existing CHPP consistent with current operations. Extensions to existing ROM coal haul roads and access roads would be constructed as required.

Mobile Equipment

The mobile equipment used for the Project would vary according to the equipment requirements of the advancing open cut mining operations. The existing mobile equipment used at the Middlemount Coal Mine would continue to be used, with some replacement and additional fleet items as required throughout the Project life. There would be increases and decreases in fleet items, however a small increase (6 fleet items) in the total number of major mobile mining fleet from that described in the *Middlemount Coal Project Stage 2 Environmental Impact Statement* (Stage 2 Project EIS) (MCPL, 2011) (Table 2-2).

Table 2-2
Indicative List of Major Mobile Equipment Proposed for the Project

Mining Equipment	Indicative Fleet Stage 2 Project EIS (MCPL, 2011)	Indicative Project Fleet
Excavators	7	12 (+5)
Trucks	59	50 (-9)
Drills	2	3 (+1)
Dozers	12	17 (+5)
Graders	4	7 (+3)
Water Trucks	4	5 (+1)
Total	**88**	**94 (+6)**

2.5 COAL HANDLING AND TRANSPORT

The Project would not result in a change to the method of coal handling and transport. As is currently approved, ROM coal would be excavated then transported by truck for stockpiling or direct loading to the crusher before being conveyed to the existing CHPP for processing.

Product coal (both coking and PCI coal) would be stockpiled and reclaimed into a train loading bin for rail transport to the Dalrymple Bay Coal Terminal, Abbot Point Port or Wiggins Island Coal Export Terminal for export.

2.6 WATER MANAGEMENT

The existing water management systems at the existing/approved Middlemount Coal Mine would be progressively augmented as water management requirements change over the life of the Project.

The Project water management system is described below. Figure 2.5a provides a schematic of the existing water management system. Figure 2.5b provides a schematic of the indicative water management system incorporating the Project.

A detailed description of the Project water management system is provided in the Surface Water Assessment prepared by WRM Water and Environment (WRM) (2018) (Appendix B).

2.6.1 Existing Water Management System

A suite of existing management plans and protocols are used during operations at the Middlemount Coal Mine for the purposes of water management including:

- *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017b);
- *Water Management Plan* (WRM, 2016);
- *Site Water Balance* (WRM, 2014);
- *Receiving Environment Monitoring Design Plan* (MCPL, 2017c); and
- *Erosion and Sediment Control Plan* (MCPL, 2016a).

The general principles to manage surface water for the site include (WRM, 2016):

- The separation of clean, dirty, mine affected, tailings and contaminated water runoff.
- Minimise the area of surface disturbance, thus minimising the volume of dirty or contaminated runoff.
- Collect and contain on site all potential mine affected water pumped from the open cut pits in dedicated mine water storages. The mine water storages will be used as the primary water source for the CHPP and for dust suppression.
- Retain and reuse on site any dirty water runoff that has high sediment concentrations whenever possible. If not, release it in a controlled manner in accordance with the EA.
- Maximise the use of on-site water and thus minimise the need for importing external water.
- Prioritise the use of poorer quality water over better quality water.
- Flood mitigation works to provide a minimum of 1,000 year Average Recurrence Interval (ARI) immunity from Thirteen Mile Gully and Roper Creek floods.

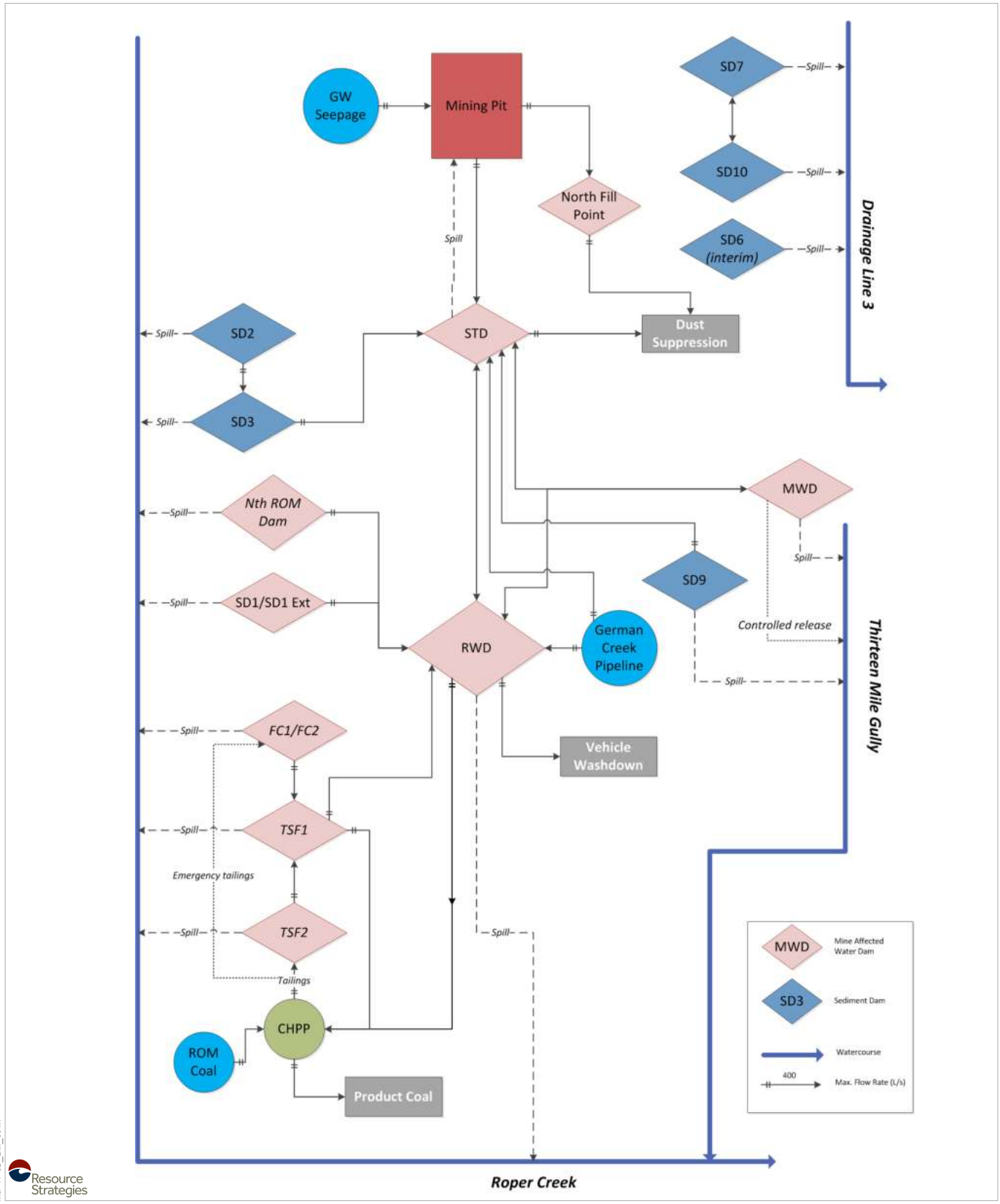
Up-Catchment Runoff Control

Up-catchment runoff controls divert runoff from undisturbed areas around mining activities (where possible).

The Thirteen Mile Gully Diversion was constructed to divert water from an unnamed drainage feature (upstream of Thirteen Mile Gully) to Roper Creek (Figure 1.2). The Thirteen Mile Gully Diversion was approved under the SP Act in July 2013 as it mostly occurs outside of the former boundary of ML 70379 (Development Permit 608153).

Roper Creek Diversions

Two diversions of Roper Creek are approved at the Middlemount Coal Mine. The locations of the approved (yet to be constructed) Roper Creek diversions are shown on Figure 1.2.



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Resource Strategies

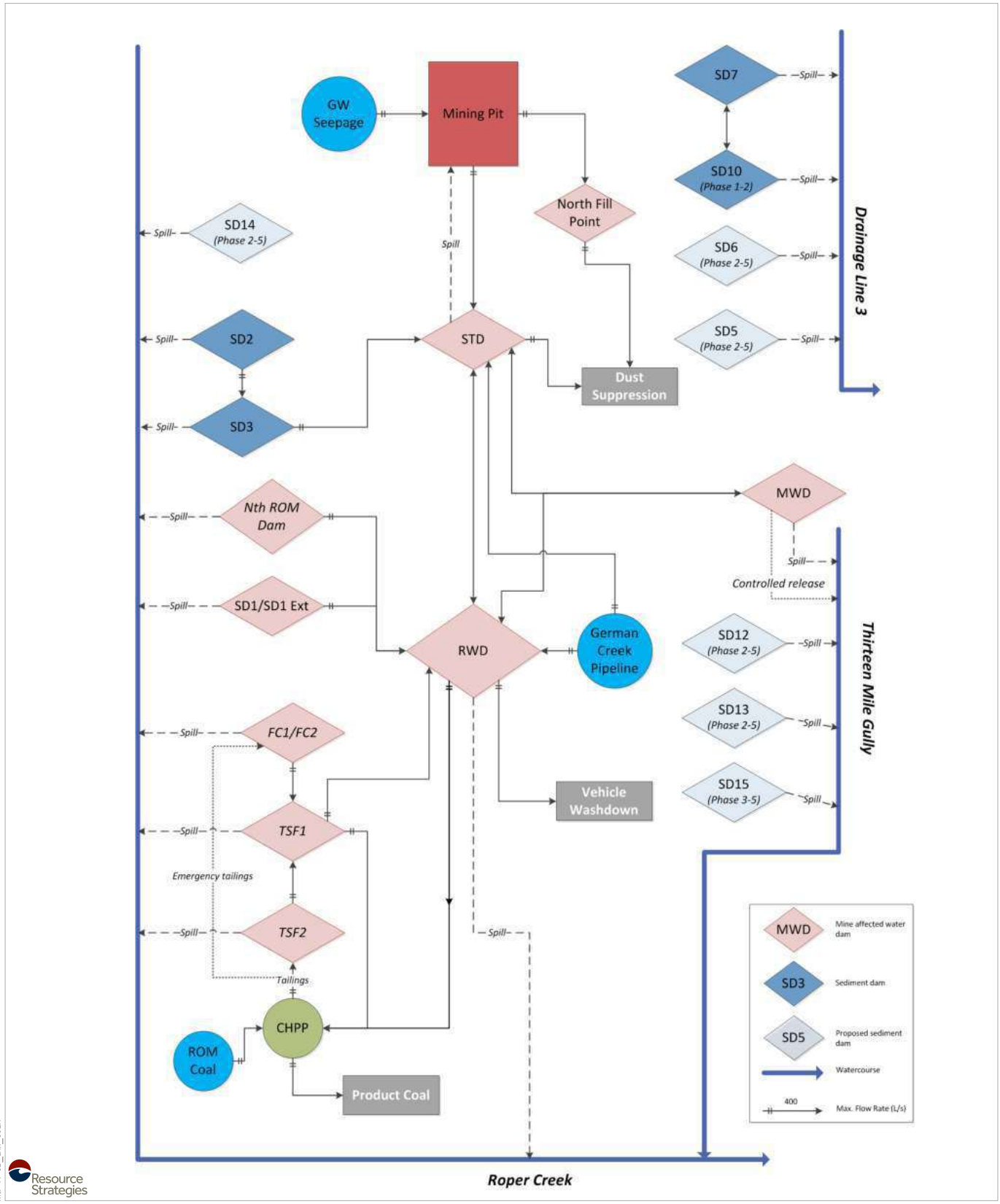
Source: WRM Water & Environment (2018)

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WESTERN EXTENSION PROJECT

Existing Water Management Schematic

Figure 2.5a



MCP-17-02_EAR_002A

Resource Strategies

Source: WRM Water & Environment (2018)

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WESTERN EXTENSION PROJECT

Proposed Water Management Schematic

Figure 2.5b

Sedimentation Control

Sedimentation control for the existing Middlemount Coal Mine involves the construction of sediment dams to manage runoff from waste rock emplacements. Sediment generation is also controlled by timely progressive rehabilitation and vegetation establishment on disturbed areas (e.g. completed sections of waste rock emplacements) to minimise the area exposed to erosion.

Flood Management

A flood protection levee is progressively constructed at the Middlemount Coal Mine as mining advances (Figure 1.2). The flood protection levee is designed to prevent clean floodwater from Roper Creek and Thirteen Mile Gully from entering the mine water management system. The flood protection levee is designed to at least 1,000 year ARI as per the DES guideline - *Structures which are Dams or Levees Constructed as Part of Environmentally Relevant Activities* (DEHP, 2017d).

Tailings Water Management System

There are two approved TSFs at the Middlemount Coal Mine (TSF1 and TSF2) (Figure 1.2). TSF2 has been divided into four flocc cells with a further two cells (FC1 and FC2) providing emergency capacity, which have not been required to date. All tailings facilities are constructed with earthen embankments on all sides and do not receive runoff from external catchments.

Fine rejects from the CHPP are comprised mostly of fine silt, clay, water and coal material. The fine rejects are pumped to the flocc cells and flocculant is added prior to deposition. Decant water is pumped to TSF1 then returned to the CHPP and Raw Water Dam (RWD) for reuse.

Mine Affected Water Release Points, Sources and Receiving Waters

Mine affected water release points, sources and receiving waters are listed in Table 2-3.

Table 2-3
Mine Affected Water Release Points, Sources and Receiving Waters

Release Point (RP)	Easting (MGA94)	Northing (MGA94)	Mine affected water source and location	Receiving waters
RP 1	667,725	7,469,370	Raw Water Dam	Roper Creek
RP 2	671,743	7,469,842	Mine Water Dam	Thirteen Mile Gully
SD 1	668,008	7,469,218	Sediment Dam 1	Roper Creek
SD2	668,093	7,470,858	Sediment Dam 2	Roper Creek
SD3	668,457	7,470,213	Sediment Dam 3	Roper Creek
SD7	671125	7474067	Sediment Dam 7	Roper Creek
NROM	667,858	7,470,294	North ROM Dam	Roper Creek

Mine affected water is released in accordance with water quality and flow requirements in EA EPML00716913.

Transfer dams (such as the Southern Transfer Dam [STD]) are located in the vicinity of the mining pit and used to transfer mine water to the RWD or Mine Water Dam (MWD) and as a source of water for dust suppression. The transfer dams are of turkey's nest or sump type construction with no external catchment area. The transfer dams discharge to the mining pit.

2.6.2 Proposed Water Management System

Generally, the existing water management system objectives at the Middlemount Coal Mine would remain unchanged as a result of the Project, with the exception of additional sediment dams and the progressive installation of up-catchment diversions and highwall dams (Figures 1.2 and 1.3).

Up-Catchment Runoff Control

Consistent with the existing water management strategy, runoff from undisturbed areas would be diverted around mining activities (where possible) via a series of up-catchment diversion structures (e.g. bunds and drains) and temporary dams.

As part of the Project, two new dams (Highwall Dam 1 [HWD1] and Highwall Dam 2 [HWD2]) would be constructed by 2023 to capture overland flows which would otherwise enter the open cut pit (Figure 2.1). The water captured in these dams would be either be pumped through a water transfer pipeline or free drained by a temporary drain (Figure 2.1). By 2028, HWD2 would be mined through as a new permanent drain would be constructed to divert the overland flow from the north of the mining area (Figure 2.2). This up-catchment diversion structure would remain a feature at the end of mining.

As part of the Project, MCPL proposes to realign the Thirteen Mile Gully Diversion to allow for access to additional coal resources within ML 70379 and provide additional surface footprint for out-of-pit waste rock emplacement (Figure 2.1).

The realigned section of the Thirteen Mile Gully Diversion would still divert runoff following rainfall events from an unnamed drainage feature (confirmed by DNRM to not be a watercourse defined under the Qld *Water Act, 2000*) to Roper Creek as per the approved Thirteen Mile Gully Diversion. The southern portion of the Thirteen Mile Gully Diversion would remain unchanged (Figure 2.1).

WRM (2018) (Appendix B) has prepared a conceptual design for the realigned section of the Thirteen Mile Gully Diversion.

Roper Creek Diversions

The two approved diversions of Roper Creek (Section 2.6.1) would remain unchanged for the Project.

Sedimentation Control

The proposed sediment dams have been sized in accordance with the *Best Practice Erosion and Sediment Control Guidelines* (International Erosion Control Association Australasia [IECA], 2008). Consistent with the existing water management strategy, runoff collected in the sediment dams would be released to the downstream environment or pumped back into the mine water system to maintain capacity. Existing and proposed sediment dams are listed in Table 2-4.

It is noted that sediment dams SD9[3] and SD10 would be no longer required by 2023 and 2028 respectively (Figures 2.1 and 2.2).

Table 2-4
Sediment Dams

Sediment Dam	Easting (MGA94)	Northing (MGA94)	Receiving Waters
SD1	668,008	7,469,218	Roper Creek
SD2	668,093	7,470,858	Roper Creek
SD3	668,457	7,470,213	Roper Creek
SD5	672,771	7,470,669	An unnamed drainage feature
SD6	672,488	7,472,021	An unnamed drainage feature
SD7	671,125	7,474,067	An unnamed drainage feature
SD9	669,506	7,473,118	Thirteen Mile Gully
SD10	670,870	7,472,707	An unnamed drainage feature
SD12	671,261	7,470,516	Thirteen Mile Gully
SD13	666,826	7,473,281	Thirteen Mile Gully Diversion
SD14	669,367	7,469,428	Roper Creek
SD15	666,116	7,475,874	Thirteen Mile Gully Diversion

* Note: Sediment dam numbering follows that previously used at the mine. There are currently no sediment dams labelled SD 4, SD 8, and SD11. These would be replaced with the re-designed SD12 (Figure 2.1).

[3] The location of this dam is shown in Appendix B.

Flood Management

The northern section of the existing flood protection levee (Figure 1.2) would be realigned and extended as part of the Project (Figure 1.3). The extended flood protection levee would be designed and constructed in accordance with accepted engineering standards, and hazard assessed by a Registered Professional Engineer of Qld against DES guidelines for assessing regulated structures (DEHP, 2017d).

A sufficient flood protection capacity (i.e. for a 1000 year ARI flood event) would be provided as per engineered design flood protection.

Tailings Return Water Management System

The tailings return water management system would remain unchanged for the Project.

Mine Affected Water Release Points, Sources and Receiving Waters

The mine affected water release points, sources and receiving waters as listed in Table 2-3 would remain unchanged for the Project.

2.7 WATER SUPPLY

Runoff captured in the mine water management system is preferentially used within the CHPP or used for haul road and stockpile dust suppression.

To supplement the water supply requirements, MCPL have a Water Supply Agreement with Anglo Coal to supply excess water from the German Creek Mine located south of the Middlemount Coal Mine. Water is pumped from the German Creek Mine on an 'as needed' basis and placed in the RWD, STD and MWD, up to a limit of 250 megalitres (ML) per month and 1,800 ML per year.

The Middlemount Coal Mine OPSIM water balance model was reviewed and updated to incorporate the Project, and concluded the existing water management system (including the external supply via the pipeline) can meet all mine site demands over the mine life (Section 3.2.2).

Potable water is supplied via truck from Middlemount township to the Middlemount Coal Mine.

In addition to the above, if required, MCPL also have water allocations from the Bingegang Pipeline, which runs between the Bingegang Weir and the town of Dysart (Figure 1.3).

2.8 REHABILITATION AND POST-MINING LAND USE

All land subject to mining activities would be rehabilitated to a non-polluting, safe, stable and self-sustaining landform. Rehabilitation and revegetation of the post mine landforms would continue to be undertaken progressively (Figures 2.1 to 2.4) (Section 4).

Final Voids

The nature of open cut mining results in the formation of voids when the open cut reserve is fully extracted. A final void is approved at the Middlemount Coal Mine in the northern area of the open cut extent (Figure 1.2). The approved final void would cover approximately 375 ha.

The Project mining schedule would result in changes to the existing/approved final void in the northern area of the open cut extent, and creation of an additional final void in the southern area of the open cut extent (Figure 1.2). The proposed north void would be approximately 373 ha in area, and the south void area would be approximately 222 ha.

The proposed final void arrangement is generally consistent with the *Residual Void Study* (MCPL, 2014b) submitted to DEHP (now DES) in January 2015. The proposed final void arrangement is required because:

- the cost to rehandle spoil material from the out of pit emplacements to the final voids (to fill the voids or make them smaller) would be prohibitive;
- rehandling spoil material from the out of pit emplacements to the final voids (to fill the voids or make them smaller) would delay rehabilitation; and
- two final voids would result from the two separate active mining areas that would occur later in the mine life (Figure 2.4).

Disposal of waste rock in-pit would minimise the size of the final voids where reasonable and practicable. It is proposed that the final voids would be left in a geotechnically stable condition upon completion of mining activities.

The final voids are further described in Section 4.

Flood Protection

The southern final void is located on the pre-mine floodplain of Roper Creek. At the completion of mining the flood protection levee in place during operation of the mine would be incorporated into the final landform to provide flood immunity up to the probable maximum flood (PMF) level from Roper Creek. The PMF is defined as the largest flood that could conceivably occur at a particular location and is estimated from probable maximum precipitation.

The conceptual final landform would be incorporated into the rehabilitated final landform to form a self-sustaining structure that does not require long term maintenance (Figure 2.4). Further details are provided in Section 4.2.3.

2.9 WASTE MANAGEMENT

General waste minimisation principles would be applied at the Project in accordance with the Qld *Waste Reduction and Recycling Act, 2011* waste management hierarchy to minimise the quantity of wastes that require off-site disposal. In accordance with the Qld *Environmental Protection (Waste Management) Regulation, 2000*, MCPL would monitor all trackable wastes.

2.10 WORKFORCE

The Project would result in an extension of the approved mine life by approximately six years (to 2037) providing job security for local mine employees and contractors. The Project would not result in any significant additional employees/contractors.

2.11 JUSTIFICATION FOR THE PROJECT

The additional surface development areas for the Project are on company-owned land. In May 2017, ML 70379 was extended to the north-west of currently approved mining operations at the Middlemount Coal Mine, providing an opportunity for MCPL to access additional coal resources within the same coal seams targeted by approved mining operations.

The Project would:

- extend the approved mine life by approximately six years (to 2037) to recover an additional 21 Mt of coal from the Middlemount and Pisces seams;
- provide job security for local mine employees and contractors;
- result in an incremental net benefit of approximately $202 million (M) (in net present value [NPV] terms);
- result in additional tax revenue to the State of Qld of approximately $97.5 M (in NPV terms);

- stimulate demand in the local and regional economy; and
- result in the establishment of additional biodiversity offset areas.

The Project would include the implementation of mitigation and management measures to minimise potential impacts on the environment.

Were the Project not to proceed, the following consequences are inferred:

- The existing Middlemount Coal Mine would continue to operate, as approved, until 2031.
- An incremental net benefit of approximately $202M (in NPV terms) to MCPL would be foregone.
- Additional tax revenue to the State of Qld of approximately $97.5M (in NPV terms) would not be generated.
- The additional potential environmental impacts for the Project described would not occur.
- The additional surface development area would not be disturbed and therefore the additional biodiversity offset areas would not be established.

3 ENVIRONMENTAL ASSESSMENT

This section presents the environmental assessment of the Project to address the requirements of the DES's Information Request (Appendix A).

3.1 LAND

Section 3.1.1 provides a description of the relevant environmental values, including a description of the existing environment relating to land. Section 3.1.2 describes the potential impacts on the Project on land and Section 3.1.3 outlines the proposed management practices and mitigation strategies.

3.1.1 Environmental Values

The environmental values relevant to land at the Project area have been identified with consideration of the DES Guideline *Application Requirements for Activities with Impacts to Land (ESR/2015/1839)* (DEHP, 2017e).

Landforms and Topography

The natural topography is relatively flat, with an elevation ranging from approximately 160 to 170 m AHD. Approximately 1.5 km to the east of the Project, Middle Mountain rises to an elevation of approximately 280 metres (m) Australian Height Datum (AHD) (Figure 1.3).

Land Use

The Project is located on freehold land owned by MCPL which is currently used for low intensity cattle grazing under an agistment agreement (Figure 1.4). The land within the Project area is considered to be agricultural land "Class C", which represents pasture land (i.e. land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production) (MCPL, 2011). No Strategic Cropping Land is mapped within, or in the vicinity of the Project (DNRM, 2018).

The Barwon Park - Middlemount Road, an unformed road mapped as a travelling stock reserve, traverses the Project area (Figure 1.4). MCPL has previously reached compensation agreements with the Isaac Regional Council to close part of the travelling stock reserve within Mining Leases associated with the Middlemount Coal Mine. MCPL has consulted with Isaac Regional Council to reach a similar compensation agreement to address the part of the travelling stock reserve that traverses the Project area.

The Bingegang Pipeline, a water supply pipeline between the Bingegang Weir and the town of Dysart and nearby mining operations, has been realigned around the Middlemount Coal Mine and is located adjacent to the east of the Project area (Figure 1.3).

Soils

The geology in the vicinity of the Middlemount Coal Mine comprises a Quaternary and Tertiary age sequence overlying older Permian age coal measures as described in Section 3.3.1. Soil types at the Middlemount Coal Mine (within ML 70417, ML 700014, ML 70417 and MLA 700027) were described by Parsons Brinkerhoff (2010a). Four soil units were identified in the Project area:

- Yellow Duplex - sandy loam or sand soils on the flat plains away from drainage lines and on very gently inclined slopes with neutral to moderate acidity, very low salinity and very low organic carbon content.
- Grey-Brown Duplex – sandy to clay loam soils on the flat plains and on very gently inclined slopes with neutral to slight acidity, very low salinity and low organic carbon content. The subsoils of Grey-brown duplex soils are saline.
- Warwick Soils – clay soils on topographically higher areas with neutral to very strong acidity and very low salinity.
- Alluvial Soils – clay loam soils along drainage features with very low salinity and medium organic carbon content.

The Yellow Duplex and Grey-Brown Duplex soils have moderate alkalinity, sodicity within the subsoils and are moderately to highly dispersive (Parsons Brinkerhoff, 2010a). Warwick soils have subsoils with high dispersivity potential.

Parsons Brinkerhoff (2010a) concluded that there is a low to negligible risk of acid mine drainage from the overburden at the Middlemount Coal Mine.

Contaminated Land

Lot 3, SP282156 and Lot 2, SP248577, which partially overlap the Project area, are listed on the Environmental Management Register (DES, 2018a) as having livestock dips or spray races. However, plans of these lots indicate that the Project is not likely to potentially disturb areas where evidence of contamination or historical contaminating activities occur as the closest record (a dip site) is located approximately 2 km west of the Project area (DES, 2018a).

Visual Amenity

The Project area comprises a number of distinct land use types and landscape units including the agricultural activities (grazing on unimproved pasture), the existing Middlemount Coal Mine, rural residences, drainage lines and remnant and regrowth vegetation. The visual character of the Project area and surrounds reflects these distinct land use types and landscape units.

Topographic features in the vicinity of the Project are described above.

3.1.2 Potential Impacts

Landforms and Topography

The Project would alter the landforms and topography within the Project area. Some topographic changes would be temporary (e.g. temporary infrastructure) and some would be permanent (e.g. final mine landforms). However, these landforms would be similar in elevation to the existing/approved mine landform and existing surrounding topography.

Land Use

The Project would result in the disturbance or alteration of approximately 571 ha of existing low intensity grazing areas. The rehabilitation strategy for the Project would however include the rehabilitation of agricultural land suitable for grazing (Section 4).

Soils

Potential impacts to soils would relate to direct disturbance of soil resources, increased erosion and sediment movement due to construction activities and alteration of physical and chemical soil properties due to soil stripping and stockpiling.

Contaminated Land

The Project is not likely to potentially disturb areas where evidence of contamination or historical contaminating activities have occurred.

In addition, land uses that may result in land becoming contaminated are known as 'Notifiable Activities' and are listed in Schedule 3 of the EP Act. The following Notifiable Activities are listed in the Plan of Operations:

- Notifiable Activity 1 – Abrasive blasting;
- Notifiable Activity 7 – Chemical storage;
- Notifiable Activity 14 – Engine reconditioning works;
- Notifiable Activity 15 – Explosives production and storage;
- Notifiable Activity 24 – Mine wastes; and
- Notifiable Activity 29 – Petroleum product or oil storage, storing petroleum products or oil.

Visual Amenity

The development of the Project (e.g. vegetation clearance and development of out-of-pit emplacements) would alter the visual landscape of the Project area similar to the impacts associated with the existing/approved Middlemount Coal Mine.

Middlemount Coal Mine is located approximately 3 km to the south-west of the Middlemount Township. It is anticipated that potential visual amenity impacts at receivers at the Middlemount township would be minimal considering the distance from the Middlemount Coal Mine and the presence of intervening topography (i.e. Middle Mountain).

Land ownership, homesteads and mines in the wider locality are shown on Figure 1.1 and Figure 1.4. The impacts to visual amenity are not anticipated to be significant given the limited number of sensitive public viewpoints in the vicinity of the Project landforms (the waste emplacement extension to the north-west and East Dump extension to the east).

3.1.3 Management Practices and Mitigation Strategies

Land Use

The rehabilitation strategy for the Project would include the rehabilitation of agricultural land suitable for grazing (Section 4).

Soils

Topsoil would be stripped prior to excavation of underlying overburden or emplacement of waste rock. Where the topsoil cannot be directly used for progressive rehabilitation, it would be stockpiled for use at a later date.

The *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017b) provides:

- topsoil stripping timing and conditions (e.g. after seed set where possible and soil maintained in a slightly moist condition during stripping);
- topsoil stripping depths in consideration of the soil units;
- topsoil stripping planning for direct placement or stockpiling and cleaning of weeds from machinery used in topsoil stripping operations;
- topsoil stockpiling methods (e.g. soil transport, stockpile height, management of stockpiles); and
- topsoil reapplication (e.g. weed management, topsoil respreading depths and water flow paths).

The topsoil inventory is provided in the Plan of Operations, which would be revised to include the Project.

The *Erosion and Sediment Control Plan* (MCPL, 2016a) would be updated to incorporate the Project.

Contaminated Land

General waste minimisation principles would be applied at the Project in accordance with the Qld *Waste Reduction and Recycling Act, 2011* waste management hierarchy to minimise the quantity of wastes that require off-site disposal. In accordance with the Qld *Environmental Protection (Waste Management) Regulation, 2000*, MCPL would monitor *all trackable wastes.*

On-site consumable storage areas would be operated, where applicable, in compliance with the requirements of AS 1940-2017 The Storage and Handling of Flammable and Combustible Liquids and AS 2187.1 Explosives – Storage, Transport and Use – Storage.

Visual Amenity

Progressive rehabilitation of Project landforms would reduce the contrast between the Project landforms and the surrounding environment. This would include progressive rehabilitation with selected tree and pasture species.

Whilst ensuring that operational safety is not compromised, MCPL would minimise light emissions from the Project by select placement, configuration and direction of lighting so as to reduce off-site nuisance effects where practicable.

3.2 SURFACE WATER

Section 3.2.1 provides a description of the relevant environmental values, regional and local hydrology, and the existing surface water management system. Section 3.2.2 describes the potential impacts of the Project on surface water resources (including potential releases to receiving environment and flooding impacts) and describes updates to the surface water management system and water balance model. Section 3.2.3 outlines the proposed management practices and mitigation strategies, including conceptual designs of the drainage feature diversions.

The assessment of potential surface water impacts is supported by the Surface Water Assessment (WRM, 2018) included in Appendix B, with integration of the outcomes of the Groundwater Assessment by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) (AGE, 2018) included in Appendix C.

3.2.1 Environmental Values

The EP Act seeks to protect Qld's water resources while allowing ecologically sustainable development through the *Environmental Protection (Water) Policy, 2009* (EPP Water). The EPP Water achieves this within a framework that includes:

- identifying EVs for aquatic ecosystems and for human uses; and
- determining water quality guidelines (WQGs) and water quality objectives (WQOs) to enhance or protect the EVs.

EVs are the qualities of waterways to be protected from activities in the catchment. Protecting EVs aims to ensure healthy aquatic ecosystems and waterways that are safe and suitable for community use. EVs reflect the ecological, social and economic values and uses of the waterway (such as stock water, swimming, fishing and agriculture).

The EVs relevant to surface water at the Project area have been identified with consideration of the DES Guideline *Application requirements for activities with impacts to water (ESR/2015/1837)* (DEHP, 2017a) and include (WRM, 2018) (Appendix B):

- aquatic ecosystem protection: Level 2 – disturbed ecosystems (Queensland Water Quality Guidelines [DEHP, 2009]);
- stock watering;
- human consumption;
- primary, secondary and visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual values.

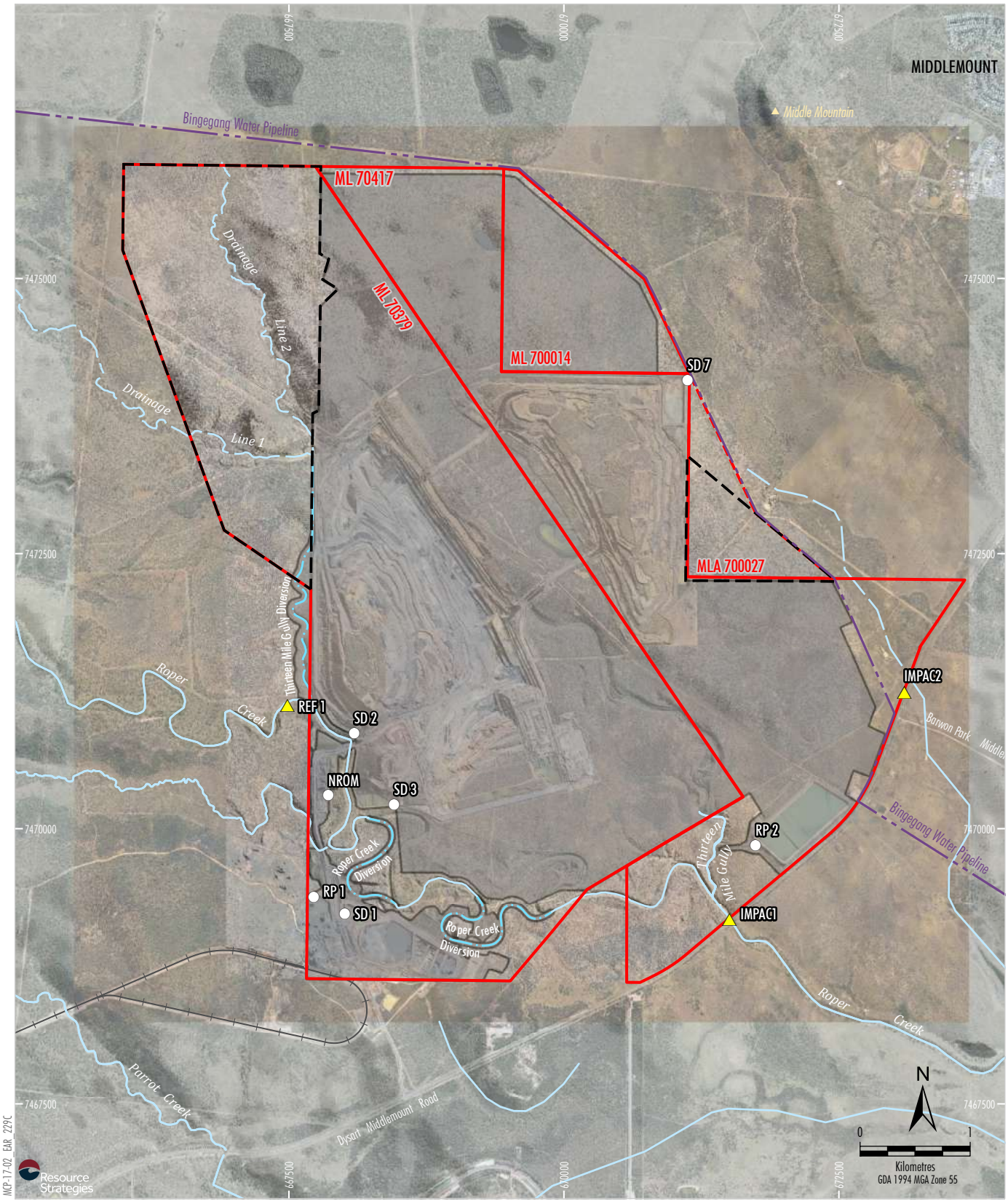
Surface water quality results from monitoring at the Middlemount Coal Mine are compared to the site specific trigger levels provided in the EA, which are based on EVs, WQGs and WQOs relevant to the Project. Monitoring locations are shown on Figure 3.1.

Regional and Local Hydrology

The Project is located within the Roper Creek catchment, within the Mackenzie River Sub-basin of the greater Fitzroy Basin. The Project lies within the plan area of the *Water Plan (Fitzroy Basin) 2011* (within the Upper Mackenzie Sub-catchment).

Local drainage in the vicinity of the Project includes (Figure 3.1):

- Roper Creek including its approved diversions (Section 2.6.2);
- The Thirteen Mile Gully Diversion (including associated upstream drainage features) which diverts the upstream sub-catchments of Thirteen Mile Gully (north and west of the ML 70379 boundary) to Roper Creek; and
- an unnamed tributary of Roper Creek located immediately east of the Project, which joins Roper Creek about 4.2 km downstream of Dysart Middlemount Road.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Rail Spur and Loop
- Approved Disturbance Footprint
- Diversion Structure
- Watercourse
- Drainage
- Minor
- Surface Water Reference Site
- Surface Water Release Point
- Western Extension Project
- Approximate Extent of Additional Surface Disturbance

Source: MCPL (2018); Department of Natural Resources and Mines (2017)
Orthophoto: MCPL (June 2017, 2014)

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WESTERN EXTENSION PROJECT

Local Drainage Characteristics and Surface Water Monitoring Locations

Figure 3.1

Roper Creek is an ephemeral watercourse that flows for short periods following rainfall. The catchment commences about 35 km to the west of the Project area. Roper Creek flows into the Mackenzie River some 40 km to the south-east of the Project.

The total catchment area of Roper Creek to the downstream boundary of the Middlemount Coal Mine tenements, including the Thirteen Mile Gully catchment, is approximately 389 square kilometres (km^2).

The upstream sub-catchments of Thirteen Mile Gully were diverted along the eastern boundary of ML 70379 in late 2014. A licence to divert the flow of water of Thirteen Mile Gully was issued under the Qld *Water Act, 2000* in May 2013 and a SPA approval was granted in June 2013. The existing Thirteen Mile Gully Diversion is shown on Figure 3.1.

Upstream of the diversion, the sub-catchments of Thirteen Mile Gully drain via two drainage features; Drainage Line 1 (to the north-west) and Drainage Line 2 (to the north) (Figure 3.1). DNRME confirmed that these drainage lines are not watercourses, but rather drainage features defined under the Qld *Water Act, 2000* that facilitates overland flow (DNRM, 2017).

A small portion of Thirteen Mile Gully (approximately 1 km) remains in its pre-mining location to the south-east of the Project, which drains south to Roper Creek.

No water resource development, such as dams or major irrigation infrastructure, is located within the Roper Creek catchment.

The Department of State Development, Manufacturing, Infrastructure and Planning (2018) regional mapping indicates that a wetland of high ecological significance occurs in the northern extent of the Project area. Flora surveys by Biodiversity Australia (2018) (Appendix D) confirmed this wetland is present (Section 3.4.1).

Surface Water Quality

The background water and sediment quality data for Roper Creek and the downstream catchment is described in the *Middlemount Coal Mine Receiving Environment Monitoring Plan* (REMP) (MCPL, 2016b). Water quality in Roper Creek is characterised by high and variable turbidity, moderate and variable electrical conductivity (EC) and low dissolved oxygen concentrations at times. Nutrient levels are generally low with the exception of total nitrogen which exceeded the trigger value at most sites.

Given the ephemeral nature of the upstream sub-catchments of Thirteen Mile Gully, no water quality data is available for Drainage Line 1 and Drainage Line 2 (WRM, 2018) (Appendix B).

Surface Water Management System

The overall objective of the mine water management system is to manage all types of water on site to meet operational, social and environmental objectives encapsulated by the EA (WRM, 2018) (Appendix B). The key water management system objectives are:

- have a strategy that ensures Middlemount Coal Mine minimises mine affected water spills and has sufficient water available for operation in dry times; and
- to be a good custodian of society's water resources.

The existing principles to manage surface water at the Middlemount Coal Mine are described in Section 2.6.1.

A comparison of surface water monitoring results from individual water storages at the Middlemount Coal Mine against the water quality release criteria in the EA is provided in WRM (2018) (Appendix B).

3.2.2 Potential Impacts

Surface Water Management System

Some minor updates to the existing water management system are proposed for the Project, including the progressive installation of up-catchment diversion and highwall dams and the development of additional sediment dams (Section 2.6.2).

Site Water Balance Model Updates

The existing Middlemount Coal Mine OPSIM water balance model was reviewed and updated to incorporate the Project to assess the performance of the proposed mine affected water management system.

The updated OPSIM model was used to predict the performance of the following (WRM, 2018) (Appendix B):

- overall water balance – the average inflows and outflows of the water management system for a number of representative realisations;
- mine water inventory – the risk of accumulation (or reduction) of the overall mine water inventory;
- in-pit storage – the risk of accumulation of water in the mining pit, and the associated water volumes;
- external water demand – the risk and associated volumes of requiring imported external water (via the Anglo Coal pipeline) to supplement site mine water supplies;
- uncontrolled spillway discharges – the risk of uncontrolled discharge from the site storages to the receiving environment; and
- controlled releases – the risk and associated volumes of controlled release water to the receiving environment.

Key outcomes from the overall water balance are (WRM, 2018) (Appendix B):

- Minor on-site water accumulation is generally predicted for most of the mine life (i.e. from 2021 onwards), increasing towards the end of the Project as the total mine catchment increases and dust suppression demands reduce.
- The groundwater inflows based on the calibrated model predictions by AGE (2018) are generally consistent between Stage 1 and Stage 4, with a reduction towards the end of the Project in Stage 5.
- Average annual external water supply requirements vary between 510 to 750 ML/annum over the life of the Project.
- There were no modelled spillway overflows from the mine water system over the life of the Project.
- The Project would have minimal impact on the overall water balance for the Middlemount Coal Mine. The key change is an increase in overall catchment runoff volumes associated with the additional catchment area captured within the mine water management system.

Surface Water Flow Regimes

The Project would result in changes to flows in local creeks due to the progressive extension of open cut mining operations to the north-west and associated subsequent capture and re-use of drainage from operational catchment areas. A detailed breakdown of captured catchment areas is provided in WRM (2018) (Appendix B) and summarised below for the incremental change (Project alone) and final landform.

The additional surface disturbance area associated with the Project alone would excise a maximum of 495.1 ha during operations from the catchment area of the former Thirteen Mile Gully and other associated drainage features, and 77.9 ha from the catchment area of an unnamed drainage line to the east of the East Dump.

This represents approximately 9% of the total catchment area of the former Thirteen Mile Gully (approximately 5,600 ha) (of which the majority has already been diverted to Roper Creek by the existing/approved Thirteen Mile Gully Diversion) and approximately 4% of the total catchment area of the unnamed drainage line to the east of the Project (approximately 1,920 ha) (WRM, 2018) (Appendix B).

The maximum loss of catchment due to the Project alone is only 573 ha, which represents less than 1.5% of the Roper Creek catchment to the downstream boundary of the Middlemount Coal Mine. The loss of catchment flows in Roper Creek would be indiscernible, and as such the potential impact on water quantity in Roper Creek due to the Project is considered negligible (WRM, 2018) (Appendix B). It is also noted that no water resource development, such as dams or major irrigation infrastructure is located within the Roper Creek catchment.

At the completion of mining, permanent drainage of waste rock emplacement areas would be installed to minimise capture of surface runoff into the final voids at the Middlemount Coal Mine and areas rehabilitated allowed to drain back to Roper Creek.

Conceptual Design of Drainage Feature Diversions

The Project would require realignment of the existing Drainage Line 1 and the upper reach of the Thirteen Mile Gully Diversion shown on Figure 1.2. The new alignment is shown in Figure 1.3 and would be constructed prior to 2023.

Although Drainage Line 1 is not a watercourse, the proposed diversion realignment has been designed in accordance with the key principles and outcomes outlined in the *Queensland Watercourse Diversion Guidelines* (DNRM, 2014) (WRM, 2018) (Appendix B).

The existing hydraulic and geomorphic characteristics of Drainage Line 1 (downstream of the proposed diversion realignment) has been used as the 'template' for the design of the proposed diversion realignment. Therefore, the proposed diversion realignment is expected to perform in a similar manner during runoff events to the existing drainage feature and be stable in the long term (WRM, 2018) (Appendix B).

External Water Supply

The Project's water supply arrangements are described in Section 2.7. Modelling results from WRM (2018) shows that the existing mine water management system (including the external water supply via the Anglo Coal pipeline from the German Creek Mine) can meet all mine site demands over the mine life. Further to this, the modelling indicates that (WRM, 2018) (Appendix B):

- an external water supply source (i.e. the Anglo Coal pipeline) is required in almost all years to satisfy demand;
- there is a 50% chance that between 420 ML/annum and 990 ML/annum water would be required from an external water source over the Project life; and
- the maximum annual demand for external water was modelled at 1,530 ML/annum. This remains within the current 1,800 ML/annum (250 ML/month) cap of the external Water Supply Contract with Anglo Coal.

Releases to the Receiving Environment

The water balance model prepared by WRM (2018) (Appendix B) shows that there are no modelled uncontrolled discharges from the mine affected water dams over the simulation period. Therefore, the Project would continue to achieve the assessment criteria objective of a less than 10% chance of uncontrolled offsite discharges from the mine affected water dams (WRM, 2018) (Appendix B).

The water balance model prepared for the Project simulates releases from the MWD to Roper Creek based on the conditions of the EA. WRM (2018) (Appendix B) concluded:

- There are opportunities to release water from the MWD to Roper Creek around 50% of the time, in any year during the Project. These opportunities are based on the flow in Roper Creek, the modelled salinity in MWD and the inventory in MWD being above 500 ML.
- For very wet climatic conditions (1%ile), the model simulated between 363 ML and 2,093 ML of releases from MWD each year.
- For wet climatic conditions (10%ile), the model simulated between 181 ML and 1,192 ML of releases from MWD each year.
- For median climatic conditions (50%ile), the model simulated between 0 ML and 181 ML of releases from MWD each year.
- For the dry (90%ile) and very dry (99%ile) climatic conditions, there were no modelled releases from MWD.

Controlled releases would continue to be undertaken at Middlemount Coal Mine for the Project in accordance with the EA. The predicted annual controlled release volumes are provided in WRM (2018) (Appendix B). Controlled release points are shown on Figure 3.1.

Existing surface water trigger levels presented in the EA would continue to be used for the Project.

Flooding Impacts

An URBS hydrological model and a TUFLOW two-dimensional hydraulic model was developed by WRM (2018) (Appendix B) to simulate the flood behaviour of Roper Creek and the Thirteen Mile Gully Diversion (including its proposed realignment described in Section 3.2.2) in the vicinity of the Project.

The URBS and TUFLOW models were calibrated to recorded water levels and surveyed peak flood levels for the January 2013 ex-tropical Cyclone Oswald flood event. The calibrated existing conditions TUFLOW model was reconfigured to represent:

- approved (Stage 2) mine conditions;
- proposed mine conditions; and
- final landform conditions (post-mining).

Peak food levels, extents and depths were determined for the 20 year ARI and 100 year ARI flood events for the approved and proposed mine conditions models to assess the flood impacts of the Project.

A 1,000 year ARI design flood was also modelled to define the crest height of the proposed flood protection levees for the proposed mine conditions, and the PMF was used to assess the immunity of the final void under the final landform conditions (Section 3.2.3).

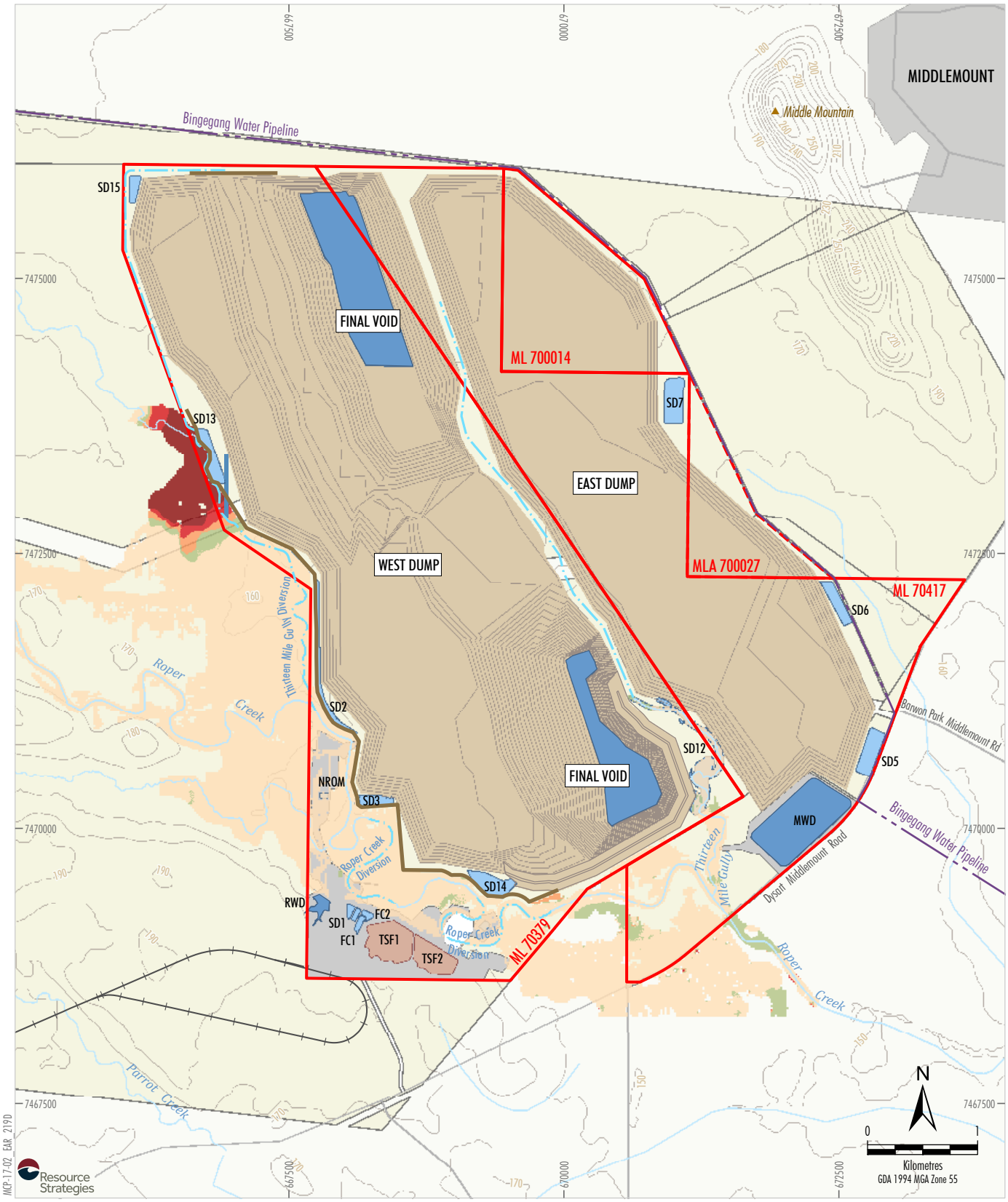
Flood modelling results (WRM, 2018) (Appendix B) indicate that for the 100 year ARI event, peak flood levels for the Project are effectively unchanged relative to approved conditions except along the realigned portion of the Thirteen Mile Gully Diversion, where predicted flood levels are up to 0.2 m higher (Figure 3.2).

EPBC Act Controlling Provisions

On February 2018, the DEE determined that the Middlemount Coal Mine – Western Extension Project is a controlled Action. The DEE's Referral decision (Reference 2017/8130) identified "*A water resource, in relation to coal seam gas development and large coal mining development*" as a relevant controlling provision, which will be considered in the Project Preliminary Documentation.

Cumulative Impacts

The Project does not require any additional raw water allocations and therefore does not contribute to cumulative impacts in relation to extraction of surface water resources from the catchment (WRM, 2018) (Appendix B).



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Coal Owned Land
- Mine Pit and Spoil
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Levee
- Diversion Structure
- Mine Access Road
- Middlemount Rail Spur and Loop

Change in Water Level

- Less than -100 mm
- -100 mm to -25 mm
- -25 mm to -10 mm
- -10 mm to +10 mm
- +10 mm to +25 mm
- +25 mm to +50 mm
- + 50 mm to +100 mm
- Greater than +100 mm

Source: MCPL (2018); Department of Natural Resources and Mines (2017); WRM (2018)

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100 Year ARI Flood Impact Due to the Project

Figure 3.2

The Project would locally impact flows in Roper Creek and its minor tributaries due to water being captured within the site water management system (as described above), however no other projects have been identified which would further increase these local impacts.

WRM (2018) (Appendix B) also concluded that given the Middlemount Coal Mine affected water releases are being managed within an overarching strategic framework for management of cumulative impacts of mining activities, the proposed management approach for mine affected water from the Project is expected to have negligible cumulative impact on surface water quality and associated environmental values.

3.2.3 Management Practices and Mitigation Strategies

Existing and proposed surface water management practices for the Middlemount Coal Mine are described in Section 2.6 and WRM (2018) (Appendix B).

In summary, the Project would require:

- A series of up-catchment water diversions and temporary highwall dams to capture and divert catchment runoff water around the mining areas throughout the mine life.
- Additional sediment dams to capture runoff from the expanding overburden dump.
- Changes to the existing flood protection levee to prevent inundation of the open cut throughout the life of the Project.

Final Landform

The Project would result in the creation of a northern and southern void at the completion of mining (Figure 1.3). Once mining operations cease, groundwater inflows to the final voids would no longer be collected and pumped out, and as a result, the final voids would gradually begin to partly fill with groundwater.

Inflows into the final voids would comprise incident rainfall, runoff within the final void catchment area and groundwater (including spoil dump infiltration). The catchment area of the final voids would be minimised and is defined by the surrounding landform including safety bunds and/or upslope diversion channels. More details regarding the final voids is provided in Section 4.2.3.

A GOLDSIM model was used to assess the likely long-term water level behaviour of the final voids. The final void modelling indicates the following for the north void (WRM, 2018) (Appendix B):

- The water level reaches equilibrium between 60 m AHD and 65 m AHD relatively quickly and varies between these levels and empty throughout the simulation.
- The maximum modelled water level is around 95 m below the north void full supply level.

The final void modelling indicates the following for the south void (WRM, 2018) (Appendix B):

- The water level reaches equilibrium between -70 m AHD and -25 m AHD relatively quickly and generally remains at these levels throughout the simulation.
- The maximum modelled water level is around 175 m below the south void full supply level.

The modelling also indicates that there would be no interaction between the long-term water levels within the northern and southern void.

Consistent with the approved/existing mine, the flood protection levee that would exist during mining operations would be incorporated into the waste rock emplacement to form a stable and self-sustaining landform that does not require long-term maintenance. This final landform would be designed to be considerably higher than the PMF level. Further details on the final landform are provided in Section 4.2.3.

The stability of the final landform in this location (and batters) would be enhanced by incorporating erosion resistant material (e.g. rock gabion) into the batter slope to approximately 2 m height (the PMF Level) and rehabilitating the surface of the landform with rock mulch and seeding/planting with tree, shrub and grass species characteristic of regional ecosystem (RE) 11.5.3 (*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces). Native vegetation cover between the final landform and Roper Creek would be retained.

Surface Water Monitoring

Surface water quality monitoring for receiving waters would continue to be undertaken in accordance with the EA.

Sediment Dam Monitoring

Sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams. Initially, sediment dam monitoring would occur on a regular (e.g. quarterly) basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur when required. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the sediment dam monitoring would be reviewed and updated accordingly (e.g. to be sampled only when releases occur).

An operation and monitoring plan would be developed for the proposed realignment of the Thirteen Mile Gully Diversion as part of detailed design. This plan would be consistent with the monitoring programme developed for the existing Thirteen Mile Gully Diversion.

Surface Water Management Plan

The Water Management Plan (WRM, 2016) would be updated to reflect any changes to the water management system and monitoring locations resulting from the Project.

3.3 GROUNDWATER

Section 3.3.1 provides a description of the relevant groundwater environmental values and a description of the hydrogeological systems and groundwater users. Section 3.3.2 describes the calibrated numerical groundwater model used to predict the potential impacts of the Project on groundwater resources (including groundwater levels, groundwater quality, groundwater users, and associated impacts to groundwater dependent ecosystems [GDEs]) as well as post-mining recovery groundwater levels and cumulative impacts. Section 3.3.3 outlines the proposed management practices and mitigation strategies, including the proposed groundwater monitoring network and trigger values.

The assessment of potential groundwater impacts is based on the modelling and assessment conclusions presented in the Groundwater Assessment (AGE, 2018) included in Appendix C.

The Groundwater Assessment (AGE, 2018) has been peer reviewed by Dr Noel Merrick of HydroAlgorithmics Pty Ltd and the peer review letter is included in Attachment A. Dr Noel Merrick concluded the Groundwater Assessment addressed the objectives satisfactorily, the model underpinning the groundwater assessment is “fit for purpose”, and the proposed mitigation and monitoring measures are satisfactory (HydroAlgorithmics, 2018).

3.3.1 Environmental Values

The environmental values relevant to groundwater within the Project area and surrounds have been identified with consideration of the DEHP Guideline *Application Requirements for Activities with Impacts to Water (ESR/2015/1837)* (DEHP, 2017a).

The EPP Water provides a framework to protect and enhance the environmental values and hence suitability of Qld waters (including groundwater) for various beneficial uses.

Groundwater resources within the Project area lie within the Mackenzie River Sub-basin (DEHP, 2011), in which the environmental values for groundwaters that need to be considered include:

- aquatic ecosystem;
- irrigation;
- farm supply/use;
- stock water;
- drinking water;
- industrial use; and
- cultural and spiritual values.

The *Mackenzie River Sub-basin Environmental Values and Water Quality Objectives* (DEHP, 2011) provides general WQOs to support and protect the various environmental values identified for waters. The WQOs are long-term goals for water quality management. Each of the environmental values listed above are discussed below to identify those that are relevant to the Project. WQOs for the broader Fitzroy Basin groundwaters are also provided in the Groundwater Assessment (AGE, 2018) (Appendix C).

Environmental Values – Aquatic Ecosystem

Regionally, groundwater flow within the underlying aquifers is towards the south-east of the Project. Groundwater levels are generally in excess of 25 m below ground level (mbgl) and separated from surface waters, limiting potential to support GDEs. There are no springs from these deep confined aquifers within the Project area or surrounds that would support GDEs (AGE, 2018) (Appendix C).

Environmental Values – Irrigation and Farm Supply/Use

4T Consultants Pty Ltd (4T) undertook a bore census of nearby groundwater users on privately owned lands surrounding the Project in September 2017 (4T, 2017). The results of the bore census are provided as an attachment to the Groundwater Assessment (AGE, 2018) (Appendix C).

Groundwater is not used for irrigation or farm supply within the Project area or neighbouring properties. There are no known irrigation bores located within 10 km of the Project area. During the course of the bore census, it was noted that dryland cropping activities in the vicinity of the Project do not rely upon groundwater as the quality is considered brackish to saline (4T, 2017).

Environmental Values – Stock Water

There is no significant groundwater usage within the Project area or neighbouring properties. The primary agricultural purpose of land within and surrounding the Project area has previously been low intensity stock (cattle) grazing (AGE, 2018) (Appendix C).
The WQOs for Mackenzie River Sub-basin groundwaters are provided for tolerances of livestock to total dissolved solids (salinity) in drinking water and are adapted based on the guidelines presented in Australian and New Zealand Environment and Conservation Council and Agriculture (ANZECC) and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000).

The existing groundwater quality data recorded for TDS at the site monitoring bores identifies this water would be unsuitable for stock watering based on the naturally elevated Total Dissolved Salts (TDS) levels (i.e. averaging 13,071 milligrams per litre (mg/L) in Tertiary aquifers and 9,758 mg/L in Permian aquifers) when compared to the tolerance of livestock to TDS in drinking water (AGE, 2018) (Appendix C).

Environmental Values – Drinking Water

Groundwater is not used for drinking water purposes within the Project area or neighbouring properties, and was confirmed during the bore census (4T, 2017).

Groundwater quality data collected from the site monitoring bores indicates that groundwater quality in the Project area is brackish to saline and not suitable for human consumption (AGE, 2018) (Appendix C).

Environmental Values – Industrial Use

Groundwater inflows reporting to the open cut pit during mine operations would be pumped to holding dams/sumps, where it would then be preferentially used as an input to the mine water balance.

No WQOs are provided for industrial use as water quality requirements for industry vary within and between industries. Similarly, ANZECC and ARMCANZ (2000) does not provide guidelines to protect industries, and indicates that industrial water quality requirements need to be considered on a case-by-case basis.

Groundwaters intercepted and used for the Project would therefore provide a beneficial industrial use (AGE, 2018) (Appendix C).

Environmental Values – Cultural and Spiritual Values

There are no known environmental values in relation to cultural and spiritual values of groundwater within the Project area (AGE, 2018) (Appendix C).

Hydrogeological Systems

The geology in the vicinity of the Middlemount Coal Mine comprises a Quaternary and Tertiary age sequence overlying older Permian age coal measures (Figure 3.3). These geological units can be separated into three key hydro-stratigraphic units based on their hydraulic properties and lithology. From youngest to oldest, these units are (AGE, 2018) (Appendix C):

- Quaternary aged units:
  - Alluvial aquifer: consists of localised stream channel deposits and associated flood plain deposits. These units comprise a temporary (rainfall dependent) aquifer that is limited to the immediate vicinity of Roper Creek, Thirteen Mile Gully and drainages within the mining tenements. Neither Roper Creek nor Thirteen Mile Gully is targeted for water supply within the near vicinity of the Middlemount Coal Mine.
- Tertiary aged units:
  - Duaringa Formation: consists of thick clay-rich laterite which is sourced from highly weathered Permian sandstones and siltstones, and occasional basalt. The Duaringa Formation is not typically targeted for agricultural water supply and is (at best) a low yielding aquifer that would more commonly be regarded as an aquitard.
- Permian aged units:
  - Interburden/overburden: the bulk of the Permian coal measure strata is sandstone, siltstone, and mudstone that typically have low permeability and generally form aquitards.
  - Coal seams (principally the Middlemount and Pisces Seams): form low to moderate yielding aquifers confined by interburden / overburden units.

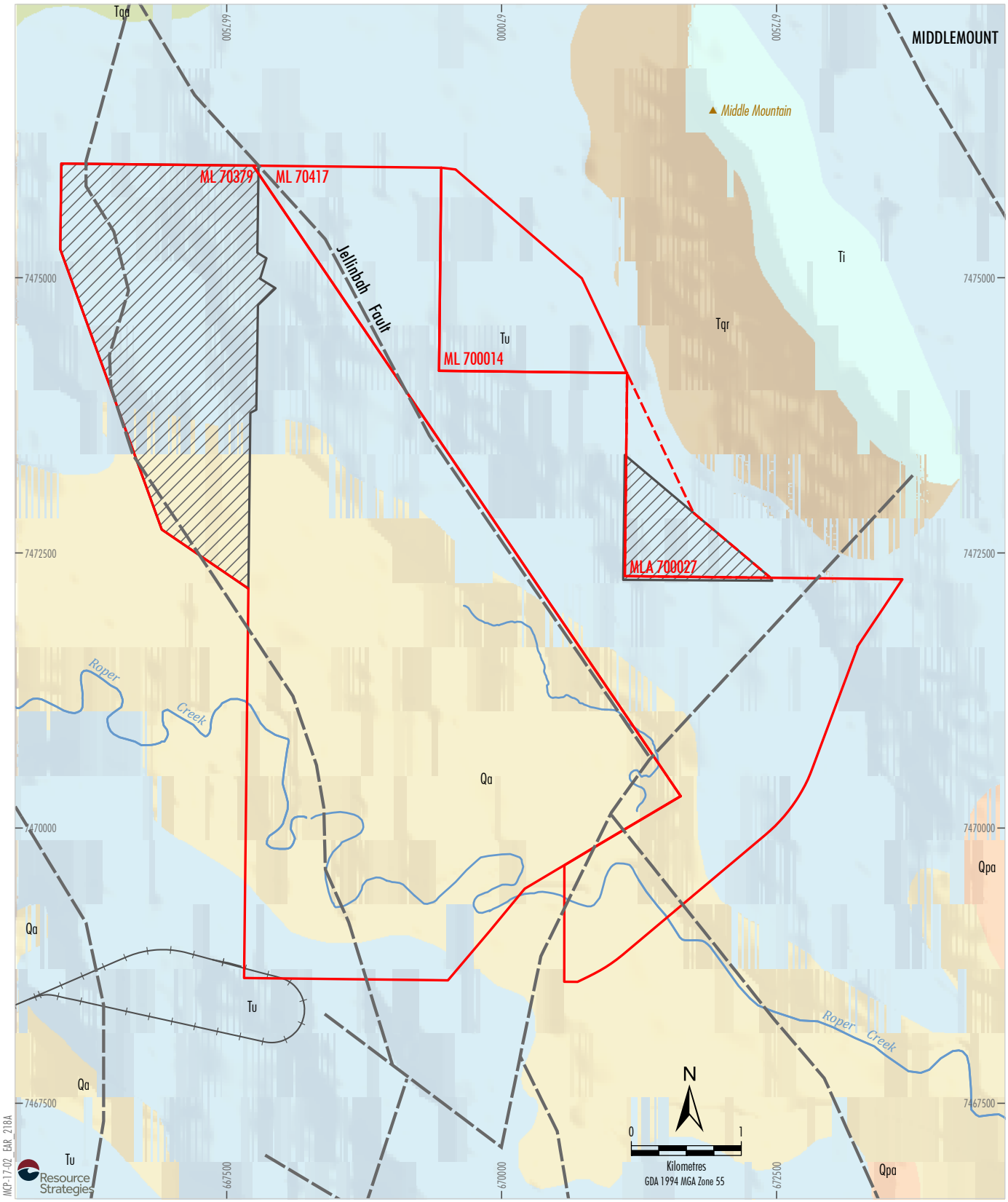
The summary of the physical and chemical properties of each of the above hydrogeological systems are described in the following sub-sections. Further details are provided in AGE (2018) (Appendix C).

Quaternary Sediments

The Quaternary alluvium is estimated to have a highly variable range of hydraulic conductivity values owing to its variable lithology of sand, clay, and occasional gravel bands. The sandy to gravelly creek beds are expected to have higher values of hydraulic conductivity compared to the floodplain deposits, because the latter would be expected to have a more clayey nature.

Where saturated, recharge to the alluvium would occur either:

- via direct rainfall on to the alluvium; or
- via seepage through the stream bed, when the creeks are flowing.



Source: MCPL (2018); Department of Natural Resources and Mines (2017)

LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Rail Spur and Loop

Western Extension Project

- Approximate Extent of Additional Surface Disturbance

GEOLOGY MAPPING

- Bowen Basin Structure

Lithology Summary		Age
Qa	Mud, sand and minor gravel; alluvium	QUATERNARY
Qpa	Clay, silt, sand, gravel; flood plain alluvium on high terraces	PLEISTOCENE
Tqa	Clay, silt, sand and and gravel: high-level alluvium and colluvium	TERTIARY - QUATERNARY
Tqr	Clay, silt, sand, gravel, soil; colluvial and residual deposits	LATE TERTIARY - QUATERNARY
Ti	Intrusive rhyolite, trachyte and microsyenite	EARLY TERTIARY
Tu	Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite, basalt	EARLY TERTIARY

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Surface Geology and Structures

Figure 3.3

Stream gauging data for Roper Creek indicates surface water flow dissipates quickly after flow events. Therefore recharge from stream flow would occur over short time periods as the water infiltrates relatively rapidly into the alluvium. When saturated, the groundwater flow direct in the Quaternary alluvium would be expected to be generally from northwest to southeast, following the regional topography and drainage network (AGE, 2018) (Appendix C).

In the vicinity of the Middlemount Coal Mine, discharge could occur from the alluvium via seepage to the underlying Tertiary sediments. However, this would only occur in areas where the alluvium is saturated and a downward vertical hydraulic gradient to the underlying strata occurs.

The Quaternary alluvium is not targeted by landholders as a groundwater supply within the study area which supports the general understanding that the Quaternary alluvium is not a productive aquifer in the vicinity of the Middlemount Coal Mine (AGE, 2018) (Appendix C).

Tertiary Sediments

Tertiary sediments of the Duaringa Formation cover large areas of the Middlemount Coal Mine MLs and surrounds. The Duaringa Formation consists of deeply weathered mudstone, sandstone, pebbly sandstone/conglomerate and siltstone, gravel, and some interbedded oil shale and basalt. This formation unconformably overlies the Permian coal measures.

Recharge to the Tertiary Formation occurs via direct infiltration from rainfall in areas where the unit crops out and via seepage from the overlying Quaternary where present. However, recharge is expected to be low due to the predominately clayey nature of the formation.

Middlemount Coal Mine monitoring bores installed within the Duaringa Formation indicate depth to water in the monitoring bores ranges from 7.7 m below ground level (mbgl) (MW14A) to 28.9 mbgl (MW9A), with an average depth of 20.4 mbgl (AGE, 2018) (Appendix C).

Permian Sediments

The Permian strata includes coal seams interbedded with less permeable rock units such as sandstone, siltstone, and mudstones that are typically 'tight' and low yielding.

Recharge of the Permian coal measures occurs in areas where they sub-crop beneath the Tertiary cover. The coal seams all sub-crop within the western portions of the Middlemount Coal Mine MLs.
Bores do not commonly access the Permian aquifer due to the depth of water bearing strata and the typical high salinity of this type of water. However, where more attractive shallower aquifers do not exist, bores are installed on occasion into the Permian coal measures where yield and water quality meet the intended purpose (AGE, 2018) (Appendix C).

Monitoring bores have been installed by MCPL to monitor groundwater drawdown in the Permian to the Middlemount Coal Mine (AGE, 2018) (Appendix C).

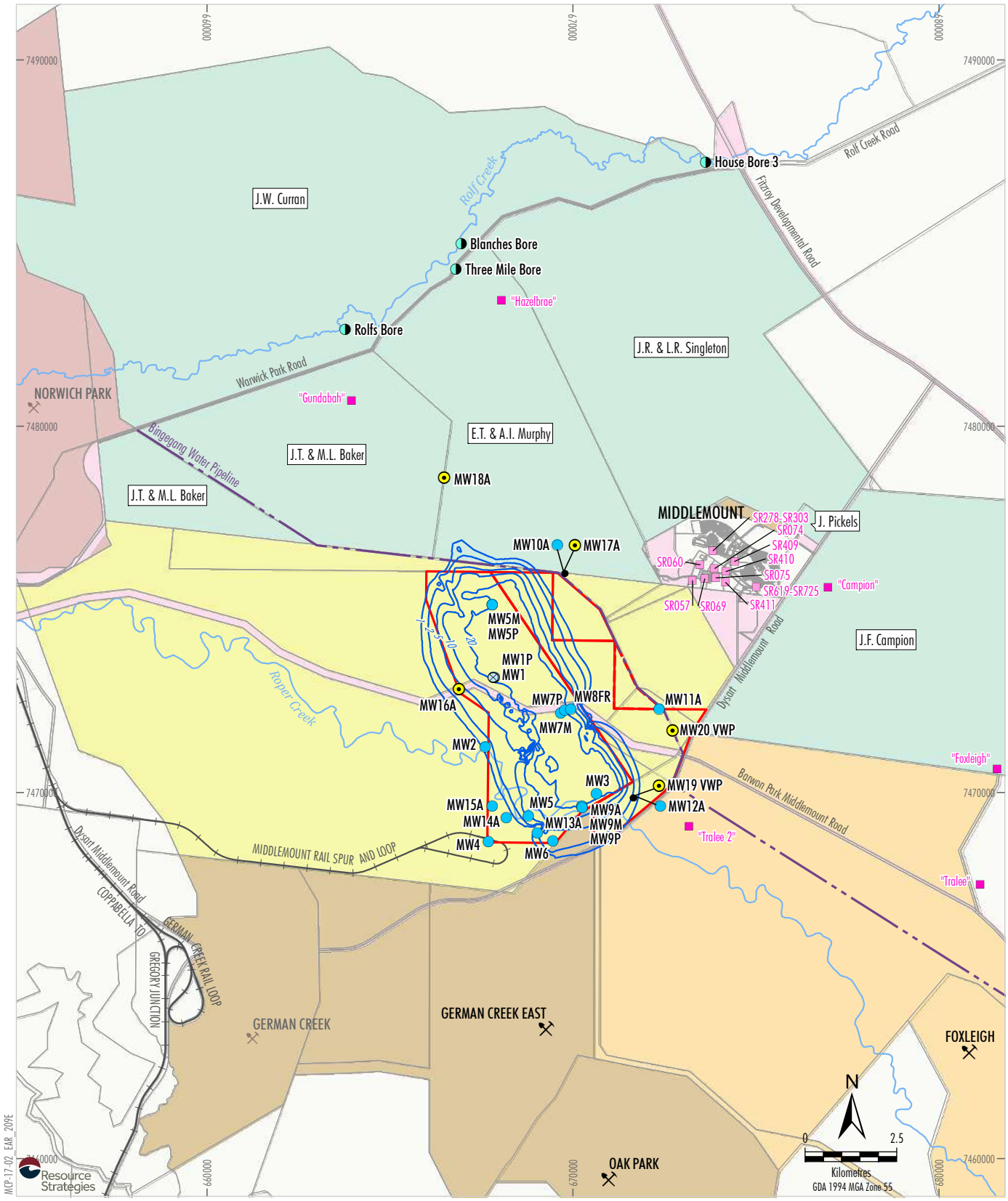
Groundwater Users

The bore census (4T, 2017) identified that there is limited groundwater use of brackish to saline groundwater in the locality.

The bore census (4T, 2017) assessed six privately-owned properties, the Middlemount landfill and the Middlemount Jockey Club in a study area covering approximately 457 km^2 surrounding the Middlemount Coal Mine.

The bore census indicated a total of five landholder water supply bores on two of the privately-owned lands (Figure 3.4). All five bores are located in excess of 5 km from the Middlemount Coal Mine (including the Project area).

The bore census also confirmed three groundwater monitoring bores located at the Middlemount Landfill established for the landfill operation. All three monitoring bores were dry when assessed for the bore census (4T, 2017).



LEGEND

- Middlemount Coal Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Cadastral Boundary
- Railway
- Active Coal Mine
- Inactive Coal Mine

LANDHOLDER

- Middlemount Coal Owned Land
- Anglo Coal (Capcoal Management) Pty Limited
- BHP Coal Pty Ltd; QCT Mining Pty Ltd; Mitsubishi Development Pty Ltd; QCT Investment Pty Ptd; BHP Queensland Coal Investments Pty Ltd; Umal Consolidated Pty Ptd; QCT Resources Pty Limited
- Foxleigh Land Pty Ltd
- Crown Land
- Relevant Private Landholder
- Owner not Referenced

Private Landholder Bores

- Bore Identified During Bore Census

Middlemount Coal Groundwater Monitoring Bores

- Proposed Additional Bore
- Existing Bore
- Bore Abandoned/Destroyed

Maximum Zone of Groundwater Drawdown

- Drawdown Contour (m)

Source: MCPL (2018); AGE (2018); Department of Natural Resources and Mines (2017)

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Maximum Zone of Groundwater Drawdown (Tertiary and Weathered Permian)

Figure 3.4

3.3.2 Potential Impacts

Calibrated Numerical Groundwater Model

A new three dimensional numerical groundwater flow model was developed for the Project which was designed to account for the current and proposed mine plan and potential for cumulative impact from nearby operational mines such as German Creek East, Foxleigh, Foxleigh Plains, and Norwich Park. Coal Seam Gas (CSG) production as part of the Bowen Gas Project (Arrow Energy Pty Ltd [Arrow Energy], 2012) within the Rangal Coal Measures approximately 7 km to the north of the Project in 2034 is also incorporated into the groundwater model.

The model represents the key geological units within the model domain as 17 layers, and extends approximately 30 km from northwest to southeast, and 21 km from northeast to southwest, and was divided into variable sized cells comprising up to 19,412 cells per layer.

The model also incorporates the Jellinbah Fault, a thrust fault in the Project area that dips towards the east and truncates the Middlemount, Tralee and Pisces coal seams near the north-eastern limit of the approved open cut (Figure 3.3). More detail on the Jellinbah Fault and how it is considered in the groundwater model is provided in AGE (2018) (Appendix C).

Calibration

The model was calibrated and verified to existing groundwater levels, using reliable measurements from representative bores within the model domain. A detailed description of the calibration method is provided in AGE (2018) (Appendix C). The objective of the calibration was to replicate the observed groundwater levels in accordance with the modelling guidelines developed by Barnett *et al.,* (2012). The transient calibration successfully achieved an 8.6% scaled root mean square (SRMS) error, which is less than the 10% SRMS error (maximum) suggested by the modelling guidelines as constituting a calibrated model.

Groundwater Inflow Predictions

The average predicted pit inflow rate for the Project (i.e. from 2018) is approximately 2.1 ML/day (766.5 ML/annum), and ranges between approximately 0.7 ML/day and 2.8 ML/day (266 ML/annum and 1,030 ML/annum) (AGE, 2018) (Appendix C).

In comparison, the average daily pit inflows over the last five years (2013-2017) has been predicted in the groundwater model to be approximately 2.3 ML/day (AGE, 2018) (Appendix C) and is generally consistent with the estimated monthly groundwater inflow ranges between approximately 1 ML/day and 5 ML/day during a 10 month period which included data assessed for October 2015, May 2016 and between February and September 2017 (WRM, 2017).

Groundwater Levels (Predicted Drawdown/Depressurisation)

The predicted drawdown extents due to the Project in the shallow Tertiary and Weathered Permian layers in the groundwater model is shown on Figure 3.4. The drawdown extent generally decreases within the underlying layers, which is not unexpected given the presence of lower permeability interburden strata (aquitards) between these geological units (AGE, 2018) (Appendix C).

The zone of depressurisation within the deeper Rangal Coal Measures and Fort Cooper Coal Measures from the Project is predicted to extend beyond the ML boundaries to a maximum of up to 1.4 km to the northwest and southeast of the Project (AGE, 2018) (Appendix C). The extent of drawdown within the Rangal Coal Measures (Middlemount and Pisces Seams) is constrained by the limited lateral extents of the coal measures.

Drawdown contours for each of the groundwater model layers are presented in AGE (2018) (Appendix C).

Groundwater Quality

Although the majority of overburden could be managed as non-acid forming material, there is a risk that some of the coal rejects may have a capacity to generate acid over time if left unmanaged during mining operations (RGS Environmental, 2016). Therefore, coal rejects would continue to be placed with overburden within the open cut pits and progressively rehabilitated during mining. Surface water runoff and accumulated rainfall seepage would drain towards the voids, and local groundwater would flow from the surrounding geological units towards the voids.

Evaporation from the void lake surfaces would maintain a water level below the surrounding aquifer water levels, forming a groundwater sink in the local environment. Evaporation from the lake surfaces would also slowly concentrate salts in the pit lake over time. The increasing salinity would not pose a risk to other aquifers and surface water features as the final voids would remain a permanent sink.

There is limited potential for groundwater contamination to occur as a result of hydrocarbon and chemical contamination with provision for immediate clean-up of spills. All chemicals would be transported, handled and stored in accordance with relevant Australian Standards. These controls represent standard practice and a legislated requirement at mine sites for preventing the contamination.

Groundwater Users

No landholder water supply bores are located within the predicted drawdown/ depressurisation extents attributable to the proposed mine plan for the Project (AGE, 2018) (Appendix C).

Groundwater Dependent Ecosystems

The Project is not predicted to impact any aquatic or terrestrial GDEs since GDEs are assessed as being unlikely to occur within and surrounding the Project area on the basis that:

- the majority of the terrestrial vegetation associated with Roper Creek and Drainage Line 1 also occurs more widely across the landscape and is not restricted to areas where it could potentially access groundwater;
- Roper Creek and Drainage Line 1 are ephemeral and the depth to groundwater in these areas is typically around 20 m depth;
- the depth to groundwater within the palustrine wetlands north of ML 70417 and ML 70379 is in excess of 12 m depth; and
- there is no evidence of vegetation dieback resulting from existing operations at the Middlemount Coal Mine.

Stygofauna

The presence of stygofauna in groundwater within the Action area was assessed from a desktop review of optimal conditions for stygofauna habitat and results of sampling. The review concluded that the potential for optimal stygofauna habitat at Middlemount Coal Mine is unlikely given to average salinity in both the Tertiary and Permian aquifers being in excess of 20,000 µS/cm, and the average depth to groundwater in the Permian aquifer being greater than 30 m below ground surface (AGE, 2018) (Appendix C).

The Project is not predicted to significantly impact stygofauna considering the Project would only incrementally increase the groundwater drawdown from the approved mine, the groundwater aquifer (similar stygofauna habitat) is extensive outside of the maximum zone of drawdown, and the sampling indicates there is a low diversity of stygofauna in and outside the maximum zone of drawdown (AGE, 2018) (Appendix C).

Post-Mining Recovery

Post closure conditions were simulated for a period of 500 years by WRM (2018) (Appendix B) to predict the void lake level recovery following cessation of mining. The final voids are predicted to reach pit lake equilibrium levels between 60 to 65 mAHD in the north void, and -70 to -25 mAHD in the south void. Based on the modelled predictions, the North and South voids would gradually fill over time from direct rainfall occurring across each void and groundwater seepage before reaching an equilibrated level well below the pre-mining groundwater levels. The modelling demonstrates that the voids would act as permanent sinks and therefore any coal rejects with the capacity to generate acid that is placed with overburden within the open cut pits would not pose a risk to other aquifers.

Cumulative Impacts

The numerical groundwater model was used to assess the cumulative impact between the Project and nearby operational and closed mines which include German Creek East, Foxleigh, Foxleigh Plains, and Norwich Park as well as CSG production as part of the Bowen Gas Project (Arrow Energy, 2012).

Modelling indicates that drawdown in the Tertiary and Weathered Permian due to the Project does not overlap with drawdowns from any other nearby mines or CSG operations (AGE, 2018) (Appendix C). Depressurisation/drawdown in the deeper Middlemount and Pisces seams has some (albeit limited) interaction with depressurisation/drawdown effects from other mines and CSG production.

EPBC Act Controlling Provisions

On February 2018, the DEE determined that the Middlemount Coal Mine – Western Extension Project is a controlled Action. The DEE's Referral decision (Reference 2017/8130) identified "*A water resource, in relation to coal seam gas development and large coal mining development*" as a relevant controlling provision, which will be considered in the Project Preliminary Documentation.

3.3.3 Management Practices and Mitigation Strategies

Groundwater Monitoring Network and Trigger Values

A groundwater monitoring network has been established at the Middlemount Coal Mine, which includes groundwater level and quality monitoring locations within and surrounding the mine site, in accordance with the EA. The locations of groundwater monitoring bores are shown on Figure 3.4.

With the updates to the mine plan, some of the monitoring bores would be destroyed over the life of the Project. The existing bores would provide a good indication of groundwater response to mining and should be monitored while they are accessible.

Installation of additional bores (MW16A, MW17A, MW18A, MW19VWP, and MW20VWP) outside of the current mine area (Figure 3.4), is proposed to provide groundwater data within the:

- Tertiary/Weathered Permian strata west of the proposed extension area (MW16A);
- Tertiary/Weathered Permian strata adjacent to MW10A where groundwater levels have declined below the base of MW10A (MW17A);
- Tertiary/Weathered Permian strata to the north-west of the proposed extension area overlying the deeper coal measures subject to depressurisation (MW18A) and
- long-term groundwater drawdown response within the Fort Cooper Coal Measures east of the Jellinbah Fault (MW19VWP and MW20VWP).

The installation of these additional bores would serve to capture additional groundwater monitoring where data gaps within the current monitoring network have been identified (including the peer review comments on the Groundwater Assessment). These monitoring bores would be used to verify predicted groundwater model drawdown responses in these areas that are attributable to mining.

All groundwater monitoring, water level measurements and sample collection, storage and transportation would be undertaken in accordance with the procedures outlined by the Murray Darling Basin Commission (1997) and the DES (2018b).

Groundwater Levels

Groundwater level monitoring would continue to be undertaken at an appropriate frequency (e.g. quarterly or as defined in the EA conditions), to develop a long-term dataset, and would be extended to the additional bores proposed upon installation.

Water level loggers would also be installed in select monitoring bores to record groundwater level measurements at regular intervals. These would also enable continuous measurement of groundwater level fluctuations for determining to what extent these are attributable to rainfall recharge or from potential water level declines from depressurisation resulting from open cut mining.

Groundwater Triggers – Levels

Table 3-1 presents groundwater level trigger thresholds as defined in Table C10 of the EA for the existing monitoring bores, outside of normal seasonal fluctuations. These are provided either as a change in water level per year, or as a total change in the groundwater elevation (m AHD) as determined from the total predicted drawdown from the initial water level at bores MW3, MW5 and MW9A.

Bore MW4 has not been included in Table 3-1, as AGE (2017a) recommends that this bore should not be subject to groundwater level change restrictions (in EA Table C10) as it is not screened in the Tertiary unit (i.e. it should be removed from the EA).

Review of the maximum drawdown levels for the monitoring bores listed in the EA (dated 21 May 2018) also indicates the trigger level for MW5 would need to be revised to <116.9 m AHD to reflect the predicted change in groundwater elevation at this location (Table 3-1).

Groundwater level triggers for the proposed monitoring bores would be determined after these bores are installed, and their locations and aquifer intersected confirmed.

When groundwater level monitoring results are compared to the groundwater level trigger thresholds, if the results:

- do not exceed the level trigger thresholds then no further action is required; or
- exceed the level thresholds, an exceedance investigation and response would be initiated in accordance with the EA conditions.

Groundwater Quality

Groundwater quality sampling of the existing monitoring bores (and proposed bores once installed, with the exception of VWPs) would continue in accordance with EA conditions (i.e. monitoring frequency and suite of parameters) in order to provide long-term groundwater quality dataset, and to detect any changes in groundwater quality during and post mining.

Groundwater Triggers – Quality

Groundwater quality triggers are defined in Table C8 of the EA and presented in Table 3-2.

Review of the EA triggers (AGE, 2017b) identified several inappropriate or unsuitable conditions in the EA in relation to the groundwater triggers, and recommended changes that would ensure a greater level of compliance, while maintaining the protection of environmental values.

Recommendation was provided for adopting the median-type trigger value for all other parameters (except pH) as this would be more appropriate for eliminating false exceedances that are isolated occurrences.

Table 3-1
Amended Groundwater Level Trigger Thresholds

Monitoring Location	Trigger Level Threshold*	Predicted Maximum Drawdown (m)*
MW2	> 2 m per year	3.8
MW3^	Total groundwater level of < 115.39 m	11.8
MW5	Total groundwater level of < 116.9 m	17.3
MW6	> 2 m per year	8.2
MW9A	Total groundwater level of < 118.17 m	13.5
MW10A	> 2 m per year	0.0
MW11A	> 2 m per year	0.0
MW12A	> 2 m per year	6.6
MW13A	> 2 m per year	0.0

** The level trigger threshold is equal to the groundwater level drawdown observed within each monitoring bore measured from the commencement of mining.*

^ MW3 will continue to be monitored until mine progression prevents monitoring. MW9A installed as a replacement well for MW3.

Table 3-2
Amended Groundwater Investigation Trigger Levels

Parameter	Unit	Trigger value	Limit type
pH	pH units	6.5-8.5	Minimum/ Maximum
Electrical Conductivity	µS/cm	35,000	Median
Total Dissolved Solids	mg/L	24,000	Median
Calcium	mg/L	1,000	Median
Magnesium	mg/L	2,000	Median
Sodium	mg/L	6,700	Median
Potassium	mg/L	43	Median
Chloride	mg/L	12,700	Median
Sulfate (SO_4)	mg/L	2,000	Median
Carbonate (CO_3)	mg/L	7.7	Median
Bicarbonate (HCO_3)	mg/L	800	Median
Iron	mg/L	14	Median
Mercury	mg/L	0.002	Median
Total Petroleum Hydrocarbons (C10-C14)	µg/L	50	Median
Total Petroleum Hydrocarbons (C15-C28)	µg/L	185	Median
Total Petroleum Hydrocarbons (C29-C36)	µg/L	90	Median

A review of recent trigger exceedances (AGE, 2017b) included analysis of the potential causes of the exceedances and the potential for any resultant environmental harm, and indicated the exceedances in relation to:

- TDS and sodium were a result of naturally occurring fluctuations that were most likely attributable to changes in climate that would have no change in the environmental values of the groundwater;
- silver and selenium were related to sample dilution and at very low concentrations; and
- TPH were short term that were probably not represent of petrogenic hydrocarbons linked to mining activities, and were therefore were false exceedances that would probably be removed using the silica-gel clean-up method recommended by Australian Laboratory Services Pty Ltd (ALS code EP071-SG). This was subsequently confirmed with the groundwater monitoring undertaken in December 2017 (AGE, 2018) (Appendix C).

The report concluded that the exceedances in these parameters were not expected to have any impact on the potential groundwater use or environmental values, and provided recommendations for:

- removing silver as there is no ANZECC/ARMCANZ guideline for this parameter[4];
- removing selenium as the water is unsuitable for stock watering due to high TDS; and
- keeping the EC and TDS trigger values at their current levels but amending these to median instead of maximum limit types.

The assessment also recommended rounding off the trigger levels for total dissolved solids, carbonate, bicarbonate, iron and total petroleum hydrocarbons. These recommendations are also provided in Table 3-2.

Mine Groundwater Inflows

MCPL currently assesses groundwater pit inflows through review of pumping records of pit de-watering and the site water balance model to identify inflow/seepage rates. Water samples would also be collected of any pumped seepage and include laboratory analysis for same suite of parameters for the groundwater monitoring bores.

The groundwater pit inflow monitoring program would include:

- recording of any unexpected or significantly increased groundwater inflows directly to the pits;
- measurement of water pumped from the pits;
- sampling of water quality pumped from the pits;
- monitoring of rainfall (to allow for correlation with pumping/pit inflow records); and
- records of ROM and product coal moisture content.

Annual Reporting

Annual monitoring reports would continue to be prepared for the Project and would include:

- records of groundwater levels and quality in the monitoring bores of the approved groundwater monitoring network; and
- details of any review undertaken of the groundwater model since the previous annual monitoring report.

Water License

MCPL has a water licence authorising the taking of, or interfering with, underground water in the area of ML 70379 in circumstances where the taking or interfering happens in the course of, or results from, the carrying out of an authorised activity for the lease, in accordance with section 1283 of the Water Act 2000 (Qld). MCPL does not require a water licence for the aspects of the Project that will be carried out on MLA 700027.

[4] This recommendation was accepted in a minor amendment to EA EMPL 00716913 on 21 May 2018.

3.4 BIODIVERSITY

Background information relevant to biodiversity is provided in Section 3.4.1. Section 3.4.2 describes the potential impacts of the Project on biodiversity, while Section 3.4.3 outlines relevant management practices and mitigation strategies. An overview of the offset strategy is provided in Section 4.4.

3.4.1 Environmental Values

Regional and Local Setting

The Project area is located in the Isaac-Comet Downs subregion of the Brigalow Belt North Bioregion. This bioregion extends from Townsville in Qld to the south of Dubbo in central-western New South Wales. The nearest protected area is Junee National Park which occurs approximately 30 km to the east. Bundoora State Forest is located approximately 25 km to the south-west of the Project area.

In a local context, the Project area is situated predominantly in the Roper Creek catchment within the Fitzroy Basin, which drains an area of approximately 150,000 km^2 (Section 3.2). Clearing for cattle grazing in the region has been extensive, and, as such, the Project area contains cleared areas that are currently grazed or have been grazed in the past. Cattle grazing has also resulted in the establishment of fences and stock dams within the Project area (Appendix D).

Terrestrial Ecology Surveys

The terrestrial flora and fauna in the Project area and surrounds has been subject to multiple studies since 2009. The first surveys were undertaken by Parsons Brinkerhoff (2010b) for the Middlemount Coal Mine Stage 1 Project in November 2009 and February/March 2010.

These surveys have since been supplemented by surveys over the existing offset areas undertaken by Ecology and Heritage Partners (2012) in July and August 2012, and across the Project area and adjacent offset areas by Naturecall Environmental (Naturecall) (2014a; 2015a) in July 2014 and October 2015. Naturecall (2013, 2014b, 2015b, 2016a, 2017a) has also conducted annual monitoring in the existing MCPL offset areas to the west of the Project, which provides additional information on the likely occurrence of flora and fauna in the Project area.

Most recently, Biodiversity Australia undertook additional flora and fauna surveys in a study area covering the Project area and surrounds (Appendix D). Flora surveys were undertaken in May and July 2017 and the fauna surveys were undertaken in May, July and September 2017 (Appendix D).

The flora surveys were undertaken in accordance with the Qld Herbarium vegetation survey methods described in Neldner *et al.* (2017). Survey techniques included a combination of secondary and quaternary surveys, ground-truthing of regional ecosystems, identification of threatened ecological communities under the EPBC Act, targeted searches for conservation significant species listed under the NC Act and EPBC Act and random meanders. Terrestrial habitat quality data was also collected in accordance with the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP, 2017b).

The fauna surveys were conducted in consideration of the relevant Qld and Commonwealth survey guidelines (Eyre *et al.,* 2014; Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC], 2011a, 2011b, 2011c; Department of the Environment, Water, Heritage and the Arts [DEWHA], 2010a, 2010b; Department of the Environment [DotE], 2014). Survey methods included trapping (i.e. harp traps), bat detection devices, herpetofauna surveys, passive infrared detection cameras, spotlighting, diurnal bird surveys, active searches, call playback, searches for scats and other signs and habitat assessments (Appendix D).

Targeted searches for threatened fauna species listed under NC Act and EPBC Act were also conducted (Appendix D).

Aquatic Ecology Surveys

An Aquatic Ecology Assessment Report was developed by FRC Environmental (FRC) (2010) for the Stage 2 Project EIS (MCPL, 2011). The scope of the assessment included an assessment of aquatic habitat, aquatic flora and fauna distribution and biological values of Roper Creek and Drainage Line 1.

Aquatic habitat, flora and fauna was assessed over the early wet season of 2009 (i.e. December 2009), and the late wet season of 2010 (i.e. February 2010). A total of nine sites were surveyed including sites upstream and downstream of the Project area.

In addition, annual monitoring of the watercourses and drainage features relevant to the Project area, including Roper Creek and Drainage Line 1, commenced in 2010 as part of MCPL's Receiving Environment Monitoring Program (MCPL, 2016b).

As part of this annual monitoring, the following sampling is undertaken (MCPL, 2016b):

- water quality measurements;
- physical habitat assessment; and
- macroinvertebrate sampling.

Regional Ecosystems

Due to past and ongoing agricultural activities (e.g. clearing, grazing, logging, thinning), the Project area predominately comprises of grasslands and regrowth vegetation (non-remnant) (approximately 66%, 380.5 ha) (Figure 3.5) (Appendix D).

A total of six individual regional ecosystems were ground-truthed within the Project area (Table 3-3; Figure 3.5), represented by Eucalypt woodlands (mostly Poplar Box woodlands) and small occurrences of Acacia dominated woodlands (RE 11.3.1 and RE 11.4.9) (Appendix D).

The most predominant regional ecosystems is RE 11.5.3 – a Poplar Box and Bloodwood Woodland (Appendix D). A detailed description of each vegetation community is provided in Appendix D. Examples of each RE identified within the Project area is shown on Plates 3-1 to 3-6.

Endangered and Of Concern Regional Ecosystems

Of the six regional ecosystems within the Project area, two have a conservation status of 'Endangered' and two have a conservation status of 'Of Concern' under the VM Act (Table 3-3; Figure 3.5) (Appendix D).

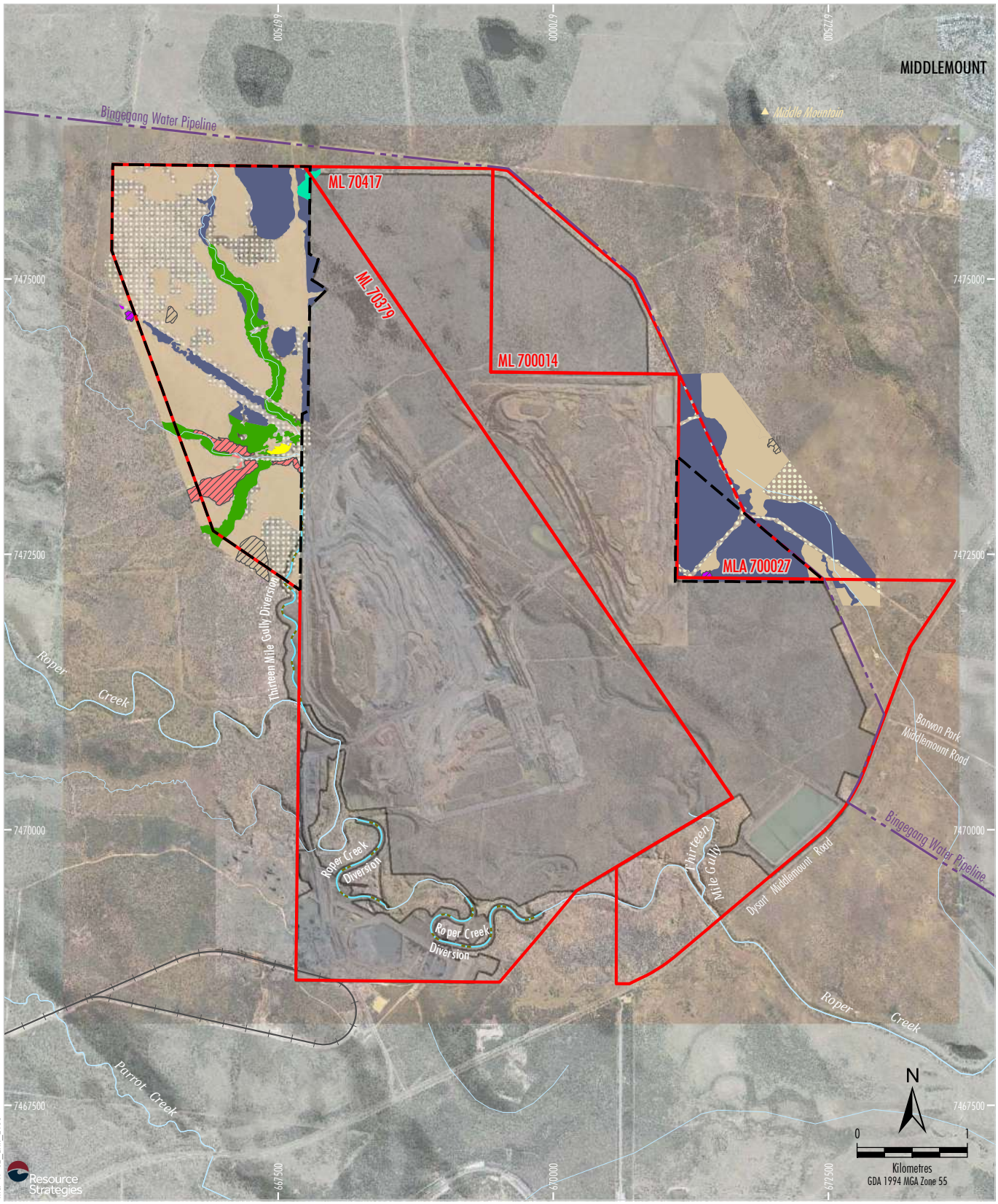
Table 3-3
Regional Ecosystems

Regional Ecosystem	Short Description	BVG	VM Act Status
RE 11.3.1*	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	25a	Endangered
RE 11.3.2	*Eucalyptus populnea* woodland on alluvial plains	17a	Of Concern
RE 11.3.2/11.3.4	*Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains.	17a/16c	Of Concern
RE 11.3.27d	*Eucalyptus camaldulensis* and/or *E. tereticornis* woodland	34a	Least Concern
RE 11.4.9*	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	25a	Endangered
RE 11.5.3	*Eucalyptus populnea* ± *E. melanophloia* ± *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces.	17a	Least Concern

Source: Appendix D.

* Listed as *Brigalow (Acacia harpophylla Dominant and Co-dominant) Threatened Ecological Community* under the EPBC Act.

BVG = Broad Vegetation Group.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Rail Spur and Loop
- Approved Disturbance Footprint
- Diversion Structure

Western Extension Project

- Approximate Extent of Additional Surface Disturbance

Regulated Vegetation
(Biodiversity Australia, 2018)

- 11.3.1
- 11.3.2
- 11.3.2/11.3.4
- 11.3.27d
- 11.4.9
- 11.5.3
- Non-remnant
- Cleared land

Threatened Ecological Community
(Biodiversity Australia, 2018)

- Brigalow

Source: MCPL (2018); Biodiversity Australia (2018); © State of Queensland (Department of Science, Information Technology and Innovation, 2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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Ground-truthed Regional Ecosystem Mapping

Figure 3.5



Plate 3-1 – Example of RE 11.3.1 within the Project Area



Plate 3-4 – Example of RE 11.3.27d within the Project Area



Plate 3-2 – Example of RE 11.3.2 within the Project Area



Plate 3-5 – Example of RE 11.4.9 within the Project Area



Plate 3-3 – Example of RE 11.3.2/RE 11.3.4 within the Project Area



Plate 3-6 – Example of RE 11.5.3 within the Project Area

Groundwater Dependent Ecosystems

Desktop Groundwater Dependent Ecosystem (GDE) mapping over the Project area (Bureau of Meteorology [BoM], 2018) indicates:

- Terrestrial vegetation associated with watercourses (Roper Creek) and a drainage line (Drainage Line 1) is mapped as having a high potential to be associated with subsurface presence of groundwater.
- Aquatic habitat associated with watercourses (Roper Creek) and a drainage line (Drainage Line 1) is mapped as having a moderate potential to be reliant on surface expression of groundwater.
- Terrestrial vegetation and aquatic habitat associated with palustrine wetlands outside of ML 70417 and ML 70379 is mapped as having a high potential to be associated with subsurface presence of groundwater.

All other terrestrial vegetation (regional ecosystems mapped by Department of Science, Information, Technology and Innovation [DSITI], 2017a), is broadly mapped as having a low to moderate potential of being associated with subsurface presence of groundwater (BoM, 2018).

The accuracy of the desktop GDE mapping (BoM, 2018) of the Project locality has been reviewed by AGE (2018) (Appendix C) and Biodiversity Australia (2018) (Appendix D), with the following conclusions made in relation to the presence/absence of GDEs based on detailed site surveys and assessments:

- The majority of the terrestrial vegetation associated with Roper Creek and Drainage Line 1 within the maximum zone of groundwater drawdown is unlikely to be dependent on groundwater. The vegetation along drainage features (e.g. Drainage Line 1) also occurs more widely across the landscape and is not restricted to areas where it could potentially access groundwater (Appendix D).

  There are small areas of RE 11.3.25 along Roper Creek which contains Queensland Blue Gum (*Eucalyptus tereticornis*) and River Oak (*Casuarina cunninghamiana*) which are in other locations reliant on access to groundwater, however, the groundwater levels adjacent to Roper Creek range between 18.9 mbgl and 22.7 mbgl (AGE, 2018) (Appendix C). Based on the depth to groundwater surrounding Roper Creek being around 20 mbgl it is unlikely that these communities would be reliant on access to groundwater (Appendix D).
- Aquatic habitat associated with Roper Creek and Drainage Line 1 is unlikely to be dependent on groundwater given the ephemeral nature of the drainage features.
- Terrestrial vegetation and aquatic habitat associated with palustrine wetlands north of ML 70417 and ML 70379 (DSITI, 2017b) could potentially be reliant on groundwater given the RE mapped in these areas by DSITI (2017a). DSITI (2017a) has mapped these areas as RE 11.3.27d, which contains River Red Gum (*Eucalyptus camaldulensis*) and Queensland Blue Gum, *both species that could* be reliant on *subsurface expression of* groundwater to some degree. However, given groundwater levels in this area have been identified as being in excess of 12 mbgl, it is likely that these communities would have limited reliance on groundwater (Appendix D).
- All other terrestrial vegetation is unlikely to be dependent on groundwater given that there is no evidence that any vegetation surrounding the Project area has experienced any impacts (i.e. dieback) from the existing operations.

Terrestrial Fauna Habitat

The Project area predominantly comprises cleared land and regrowth vegetation (non-remnant) (approximately 66%) (Appendix D). Most of the regrowth consists of juveniles of the dominant species which occurred prior to clearing and fast growing species such as exotic grasses (Appendix D).

Native fauna habitats within the Project area were categorised and mapped into four broad habitat types by Biodiversity Australia (2018) (Appendix D). The native fauna habitat types present in the Project area are (Appendix D):

- Eucalypt woodland/forest.
- Wetlands.
- *Acacia harpophylla* woodland/forest.
- Regrowth/derived grassland.

A detailed description of each fauna habitat type is provided in Appendix D, along with a description of habitat values and photos.

Aquatic Ecology

FRC (2010) found that no threatened aquatic flora or fauna species listed under the NC Act and EPBC Act were recorded, or are likely to occur within their study area (including the Project area).

The biological values of the aquatic ecosystems within the Project area were found to be relatively low which is consistent with those of the wider catchment (FRC, 2010). The physical parameters of the waterways were dictated primarily by their ephemeral nature, with flow being largely dependent upon wet season rainfall (Appendix D).

Creeks within the catchment were described by FRC (2010) as being in moderate condition, and are characterised by low habitat diversity, existing access areas for cattle and road crossings restricting passage for fish and other aquatic fauna, and the presence of weed species (Appendix D).

Aquatic habitat assessments were undertaken by Biodiversity Australia (2018) at the drainage features within the Project area during the survey. Biodiversity Australia (2018) determined that the drainage features were in a similar condition as was reported in FRC (2010). Given that there has been little change in the physical attributes of the drainage features in Project study area, the conclusions of the FRC (2010) assessment remain valid and as such, the aquatic habitat on site would not be considered to be capable of supporting any threatened aquatic species (Appendix D).

In addition to the above, the results of the annual monitoring undertaken as part of MCPL's Receiving Environment Monitoring Program (MCPL, 2016b) indicate the following:

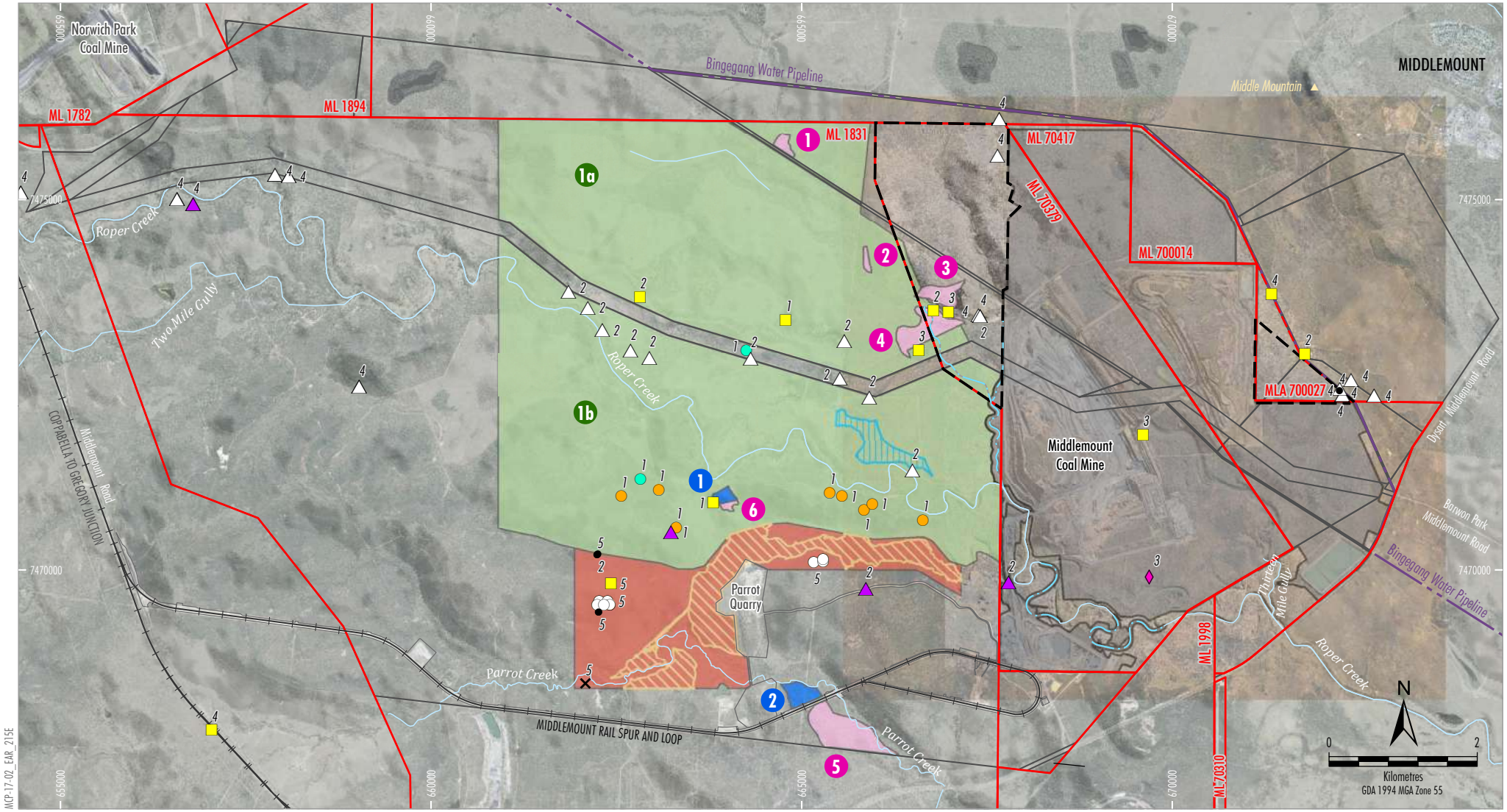
- in-situ water quality results recorded in February 2016 were consistent with long term trends, and was generally of good quality across all sites;
- cattle access to pools has also been noted on a number of occasions over the past sampling events, which may have contributed to the suspension of sediments;
- of the sites that could be sampled, there were very few differences in in-situ water quality between the reference and impact sites; and
- overall, the results indicate that Middlemount Coal Mine operations are currently not impacting on the macroinvertebrate community which is to be expected given that there have been no recent discharges.

Conservation Significant Species listed under the NC Act

A total of four conservation significant fauna species have been recorded within the Project area during the previous and more recent fauna surveys, namely (Appendix D):

- Squatter Pigeon (southern) (*Geophaps scripta scripta*) – listed as 'Vulnerable' under the EPBC Act and NC Act;
- Greater Glider (*Petauroides volans*) – listed as 'Vulnerable' under the EPBC Act and NC Act;
- Koala (*Phascolarctos cinereus*) – listed as 'Vulnerable' under the EPBC Act and NC Act; and
- Short-beaked Echidna *(Tachyglossus aculeatus*) - Special Least Concern (NC Act).

The Squatter Pigeon (southern), Greater Glider and Koala records are shown on Figure 3.6.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Coal Owned Land
- Railway
- Approved Disturbance Footprint
- Diversion Structure

Western Extension Project

- Approximate Extent of Additional Surface Disturbance

Existing/Approved Offset Areas

- Middlemount Coal (Stage 2 Project) Commonwealth Offset Area (EPBC 2010/5394)
- North-eastern Extension Commonwealth Offset Area (EPBC 2016/7717)
- North-eastern Extension State Offset Area
- Parrot Quarry Offset Area (Declared Area Map 2013/3919)
- Rail Loop and Spur Offset Area
- Thirteen Mile Gully Diversion Offset Area (Declared Area Map 2013/3919)

Threatened Species Records

- Native Frangipani
- Large-podded Trefoil
- Squatter Pigeon (southern)
- Ornamental Snake
- Greater Glider
- Koala
- Koala Scats
- Koala Scratches

Reference: 1 *Ecology and Heritage Partners (2012)* 3 *Parsons Brinkerhoff (2010)*
2 *Naturecall Environmental (2014)* 4 *Biodiversity Australia (2018)*
5 *Naturecall Environmental (2017)*

Note: Additional Greater Glider records occur within the extent of this figure, however coordinates were not recorded (Naturecall, 2017).

Source: MCPL (2018); © State of Queensland (Department of Science, Information Technology and Innovation, 2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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Threatened Species Records

Figure 3.6

In addition to the above the Ornamental Snake (*Denisonia maculata*), listed as 'Vulnerable' under the NC Act and EPBC Act, has been previously recorded by Parsons Brinkerhoff (2010b) in the Middlemount Coal Mine Stage 1 Project area (Figure 3.6).

The above species are Matters of State Environmental Significance and are further discussed below.

No conservation significant flora species have been recorded within the Project area during any previous or more recent flora surveys (Appendix D).

Matters of State Environmental Significance

Matters of State Environmental Significance prescribed under the *Environmental Offsets Regulation 2014* are listed in Table 3-4 along with an assessment of the relevance to the Project area. Matters of State Environmental Significance are shown on Figures 3.7a and 3.7b.

Matters of National Environmental Significance

Three threatened species and one ecological community listed under the EPBC Act have been recorded in the Project area (Appendix D) (Figure 3.6):

- Squatter Pigeon (southern);
- Koala;
- Greater Glider; and
- Brigalow (*Acacia harpophylla* dominant and co-dominant) Endangered Ecological Community (Brigalow EEC).

In addition to the above the Ornamental Snake (*Denisonia maculata*), listed as 'Vulnerable' under the EPBC Act, has been previously recorded by Parsons Brinkerhoff (2010b) in the existing/approved mine area (Figure 3.6).

Environmentally Sensitive Areas

The Environmentally Sensitive Areas (ESA) mapping tool (DEHP, 2014a) does not identify any Category A or C ESAs within the Project area, however it show a small patch of Category B ESA within the Project area. This patch is located within ML 70379, where the proposed Thirteen Mile Gully Diversion and West Dump are proposed to be located (DEHP, 2014b).

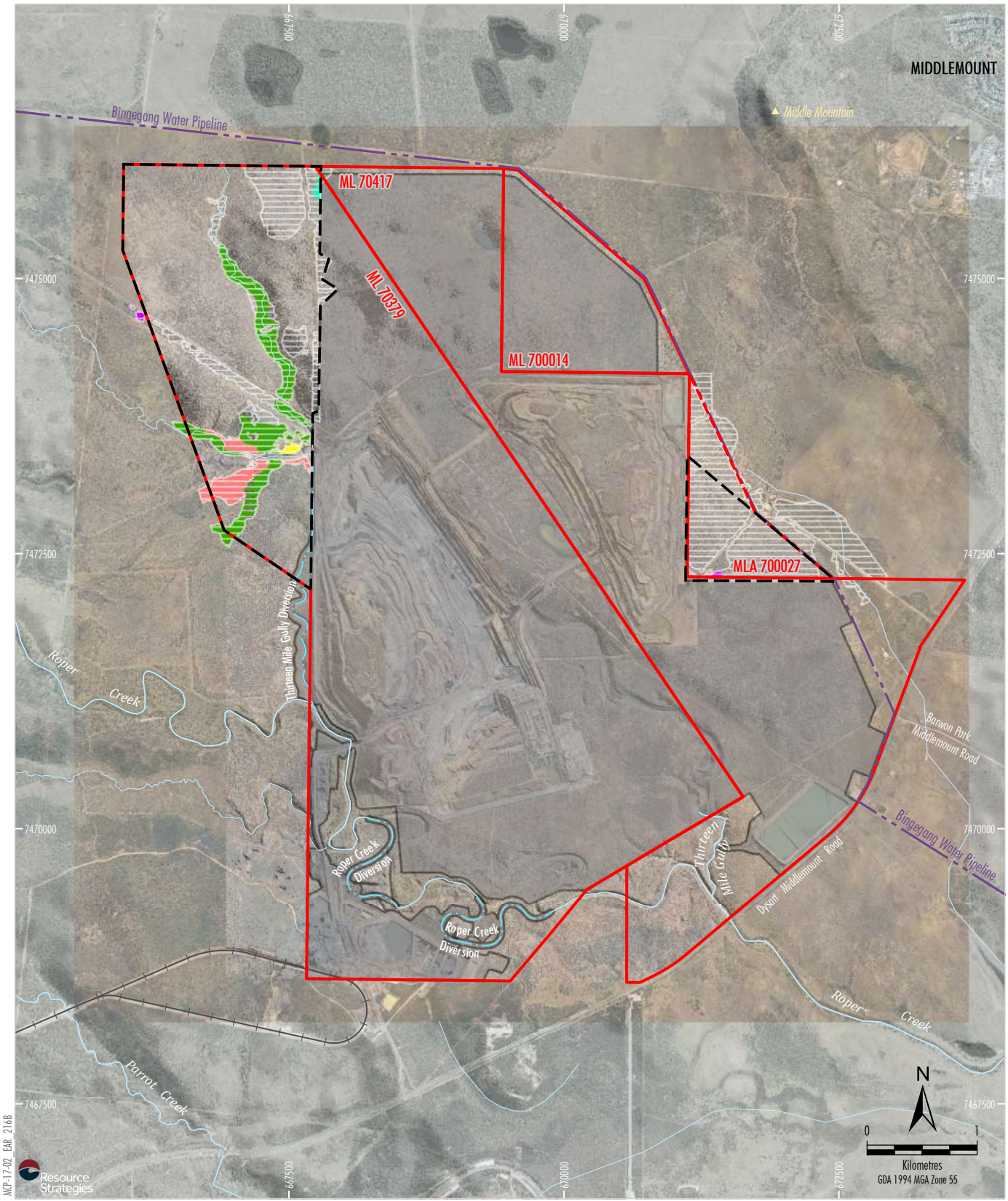
Recent ground-truthing of the regional ecosystems within the Project area by Biodiversity Australia (2018) confirmed the presence of two 'Endangered' regional ecosystems (classed as Category B ESA) in the Project area (i.e. RE 11.3.1 and RE 11.4.9) (Figure 3.7a) (Appendix D).

These regional ecosystems (RE 11.3.1 and RE 11.4.9) have been confirmed to meet the criteria to be mapped as Brigalow EEC listed under the EPBC Act (Figure 3.5) (Appendix D).

3.4.2 Potential Impacts

The Ecology Impact Assessment (Appendix D) provides an assessment of the potential impacts on biodiversity associated with the Project. This assessment was prepared in consideration of the DES Information Request (Appendix A) and DES *Guideline (EM961) Application Requirements for Activities with Impacts to Land* (DEHP, 2017e).

Potential impacts on biodiversity were considered in terms of: land clearance, aquatic ecology, GDEs, surface water impacts, weeds and pest animals, noise, dust and artificial lighting, vehicular traffic, interaction with the final void, impacts to ESAs and MSES, and cumulative impacts, as described below.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Rail Spur and Loop
- Approved Disturbance Footprint
- Diversion Structure
- Western Extension Project
- Approximate Extent of Additional Surface Disturbance
- Regulated Vegetation (Biodiversity Australia, 2018)
  - 11.3.1
  - 11.3.2
  - 11.3.2/11.3.4
  - 11.4.9
- High Ecological Significance Wetland
- Connectivity Area

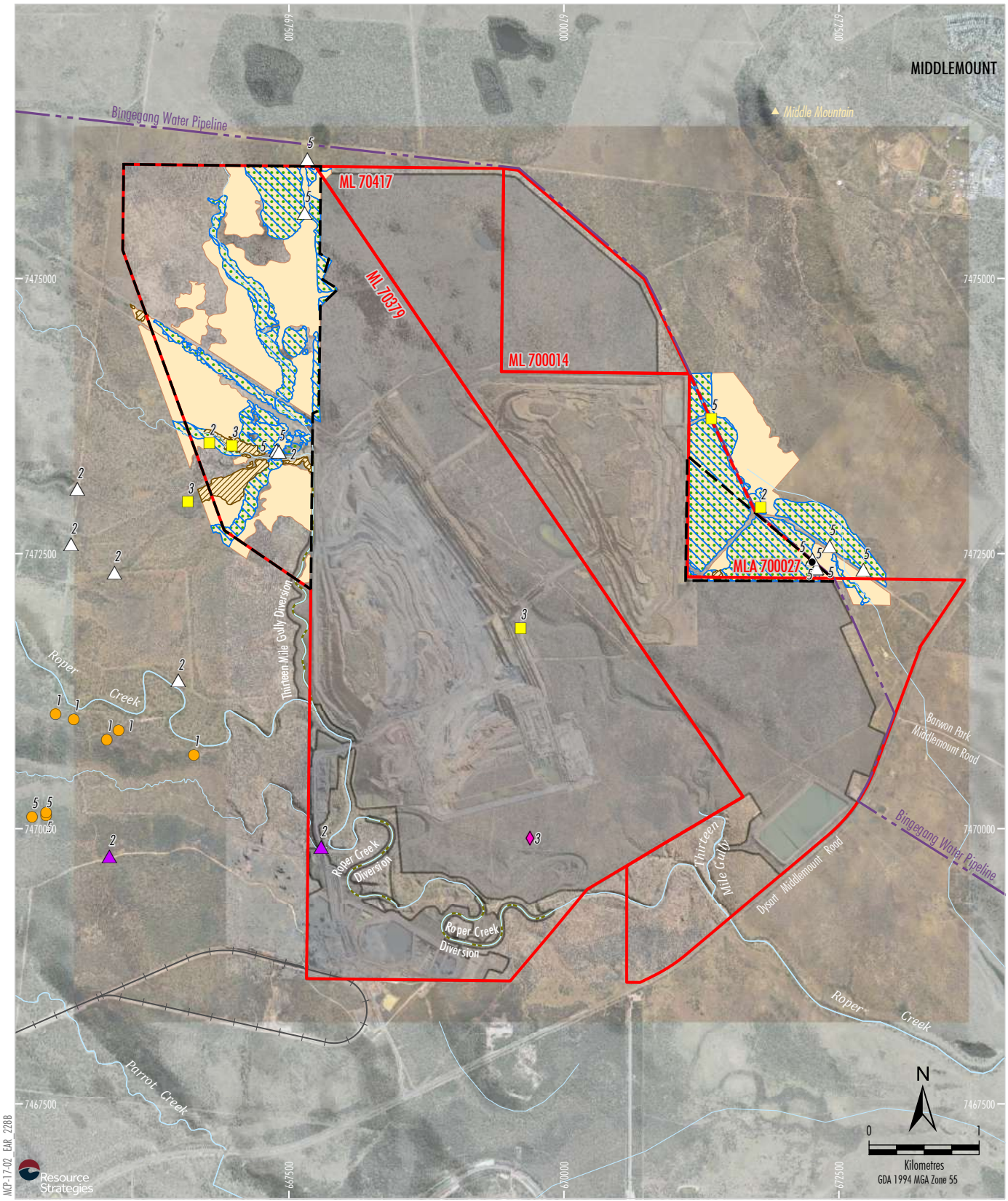
Source: MCPL (2018); Biodiversity Australia (2018); © State of Queensland (Department of Science, Information Technology and Innovation, 2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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Matters of State Environmental Significance
Mine Site
- Regulated Vegetation and Connectivity Area

Figure 3.7a



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Rail Spur and Loop
- Approved Disturbance Footprint
- Approved Diversion Structure

Western Extension Project

- Approximate Extent of Additional Surface Disturbance

Protected Wildlife Habitat Areas

- Ornamental Snake Habitat
- Greater Glider Habitat
- Koala Habitat
- Squatter Pigeon (southern) Habitat

Threatened Species Records

- Native Frangipani
- Squatter Pigeon (southern)
- Ornamental Snake
- Greater Glider
- Koala
- Koala Scats

Reference:
1 *Ecology and Heritage Partners (2012)*
2 *Naturecall Environmental (2014)*
3 *Parsons Brinkerhoff (2010)*
4 *Biodiversity Australia (2018)*
5 *Naturecall Environmental (2017)*

Source: MCPL (2018); Biodiversity Australia (2018); © State of Queensland (Department of Science, Information Technology and Innovation, 2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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Matters of State Environmental Significance
Mine Site
- Protected Wildlife Habitat Areas

Figure 3.7b

Table 3-4
Relevance of Matters of State Environmental Significance to the Project

Matters of State Environmental Significance			Relevance to the Project area
Regulated Vegetation	'Endangered' or 'of concern' regional ecosystems; or	RE 11.4.9 'Endangered'[1]	RE 11.4.9 has been mapped in two locations within the Project area by Biodiversity Australia (2018) (Appendix D) (Figure 3.7a)
		RE 11.3.1 'Endangered'[1]	RE 11.3.1 has been mapped in three patches within the Project area by Biodiversity Australia (2018) (Appendix D) (Figure 3.7a)
		RE 11.3.2 'Of Concern'	RE 11.3.2 occurs within the Project area, to the west of the existing Middlemount Coal Mine (Figure 3.7a)
		RE 11.3.2/RE 11.3.4 'Of Concern'	RE 11.3.2/RE 11.3.4 occurs in a single patch (approximately 1.5 ha) within the Project area (Figure 3.7a)
	Regional ecosystems within mapped vegetation management wetlands	RE 11.3.27d	Approximately 1.9 ha of 11.3.27d has been mapped as being associated with a vegetation management wetland in the northern extent of the Project area (Figure 3.5).
	Regional ecosystems within the defined distance of a vegetation management watercourse		The Project area does not contain any vegetation management watercourses (Section 3.2.1).
Connectivity Areas			The *Landscape Fragmentation and Connectivity Tool* (DEHP, 2016) was applied to the Project area and concluded that impacts of the Project on landscape connectivity would be significant (Appendix D) (Figure 3.7a).
Wetlands and Watercourses			DSITI (2017b) regional mapping indicates that a wetland of high ecological significance occurs in the northern extent of the Project area. Flora surveys by Biodiversity Australia (2018) confirmed this wetland is present and ground-truthed the extent of the wetland (Figure 3.7a).
Designated Precinct in a Strategic Environmental Area			The Project area is not in a designated precinct in a strategic environmental area (Appendix D).
Protected Wildlife Habitat	Ornamental Snake[1]		A single Ornamental Snake was recorded by Parsons Brinkerhoff (2010b) approximately 3 km south of the Project area (Figure 3.7b). Potential habitat for the Ornamental Snake is shown on Figure 3.7b.
	Squatter Pigeon (southern)[1]		The Squatter Pigeon (southern) has been recorded at a number of locations within the Project area (Figure 3.7b). Potential habitat for the Squatter Pigeon (southern) is shown on Figure 3.7b.
	Greater Glider[1]		The Greater Glider has been recorded at a number of locations within the Project area (Figure 3.7b). Potential habitat for the Greater Glider is shown on Figure 3.7b.
	Koala[1]		The Koala has been recorded at a number of locations within the Project area (Figure 3.7b). Potential habitat for the Koala is shown on Figure 3.7b.
	Short-beaked Echidna		The Short-beaked Echidna has been recorded at a number of locations within the Project area (Appendix D).
Protected Areas			There are no protected areas in the Project area.
Highly Protected Zones of State Marine Parks			There are no State marine parks in the Project area.
Fish Habitat Areas			There are no areas of declared fish habitat in the Project area (Appendix D).

Table 3-4 (Continued)
Relevance of Matters of State Environmental Significance to the Project

Matters of State Environmental Significance		Relevance to the Project area
Waterways Providing for Fish Passage		There are no Waterways Providing for Fish Passage in the Project area (Appendix D).
Marine Plants		Marine plants do not occur in the Project area.
Legally Secured Offset Area	Stage 2 Offset Area[1]	The Project area includes approximately 32 ha of the approved Middlemount Coal Mine Stage 2 Offset Area (Section 4.4).
	Rail Loop and Spur Offset Area	The Project area includes approximately 22 ha of the approved Middlemount Coal Mine Rail Loop and Spur Offset Area (Section 4.4).

[1] indicates that this MSES is also identified as Matters of National Environmental Significance (MNES) listed under the EPBC Act.

Table 3-5
Clearance of Regional Ecosystems

Regional Ecosystem	Short Description	BVG	VM Act Status	Clearance (ha)
RE 11.3.1*	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	25a	Endangered	15
RE 11.3.2	*Eucalyptus populnea* woodland on alluvial plains	17a	Of Concern	43.5
RE 11.3.2/11.3.4	*Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains.	17a/16c	Of Concern	1.5
RE 11.3.27d	*Eucalyptus camaldulensis* and/or *E. tereticornis* woodland	34a	Least Concern	1.9
RE 11.4.9*	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	25a	Endangered	0.5
RE 11.5.3	*Eucalyptus populnea* ± *E. melanophloia* ± *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces.	17a	Least Concern	128
			Total	**190.5^**

Source: Appendix D.

* Listed as *Brigalow (Acacia harpophylla Dominant and Co-dominant) Threatened Ecological Community* under the EPBC Act.

^ Number has been rounded.

BVG = Broad Vegetation Group

Land Clearance

MCPL has minimised potential impacts associated with land clearance through the use of existing infrastructure and facilities (where possible) and minimising out-of-pit waste emplacements via backfilling of the open cut pit void. Further detail regarding avoidance of land clearance is provided in Section 3.4.3.

After consideration of avoidance and impact minimisation measures, the Project area would be approximately 571 ha in size, comprising approximately 190.5 ha of remnant vegetation (Table 3-5) and 380.5 ha of non-remnant vegetation and cleared land (Figure 3.6) (Appendix D).

All of the native vegetation communities/regional ecosystems to be cleared occur more widely in the surrounding landscapes and subregions (Appendix D). Of note, all remnant vegetation would be offset as part of the Project as described in Section 4.

Aquatic Habitat Removal

The Project would remove ephemeral drainage features (Figure 3.1) and farm dams. As described in Section 3.4.1, these features are of moderate condition and are characterised by low habitat diversity (Appendix D).

In addition, the Project would not remove aquatic habitat that is expected to support aquatic species of conservation significance listed under the NC Act or EPBC Act (Appendix D).

Groundwater Dependent Ecosystems

The Project is not predicted to impact any aquatic or terrestrial GDEs since GDEs are assessed as being unlikely to occur within and surrounding the Project area as described in Section 3.4.1. Further, there is no evidence that any vegetation surrounding the Project area has experienced impacts (i.e. dieback) from the existing operations/groundwater drawdown (Appendix D).

As detailed in Section 3.3.2, the potential for stygofauna habitat at Middlemount Coal Mine is unlikely given to average salinity in both the Tertiary and Permian groundwater aquifers are in excess of 20,000 µS/cm, and the average depth to groundwater in the Permian aquifer being greater than 30 m below ground surface.

Changes to Hydrology

Changes to surface water quality and quantity can have an indirect impact on ecosystems surrounding a development site. A decrease in the quality of surface water to habitats surrounding the Project could occur if runoff from disturbed areas, stockpiles and/or waste emplacements is uncontrolled or through accidental release of contaminants.

The Project would result in changes to the natural flow regimes of the local drainage features due to the capture and re-use of drainage from operational disturbance areas. The Project water management system would generally be based on the existing water management system with revisions undertaken progressively over the life of the Project (WRM, 2018) (Appendix B).

As described in Section 3.2.3, no measurable impacts on surface water quality are likely to occur from the Project (Appendix B):

- no uncontrolled spills of mine affected water from the mine water dam are predicted;
- release of treated water from sediment dams (designed in accordance with the *Best Practice Erosion and Sediment Control* [IECA, 2008]) to the downstream environment would only occur in accordance with the existing *Erosion and Sediment Control Plan* (MCPL, 2016a), which is unlikely to have a measurable impact on receiving water quality; and
- there is a predicted negligible impact on the downstream water quality through controlled releases from the Project in accordance with the existing EA.

In addition, WRM (2018) (Appendix B) has concluded that the diversion of Drainage Line 1 is unlikely to result in a change to the natural flow regime of the receiving waters, given it would:

- be designed in accordance with the relevant guidelines;
- replicate the geomorphic characteristics of Drainage Line 1; and
- have the same hydrological characteristics of Drainage Line 1.

Based on the implementation of management strategies and measures described in WRM (2018) (Appendix B) it is unlikely that the Project would result in significant hydrological regime changes that would adversely impact native flora and/or fauna within, or downstream of the Project area.

MCPL would continue to conduct annual monitoring of the water quality, habitat characteristics and macroinvertebrate diversity of the receiving waters as described in their Receiving Environment Monitoring Program (MCPL, 2016b).

Weeds and Animal Pests

Biodiversity Australia (2018) (Appendix D) describes that weed invasion is common throughout the Project area, especially in disturbed areas. Prickly Pear (*Opuntia stricta*), Velvety Tree Pear (*Opuntia tomentosa*) and Harrisia Cactus (*Harrisia martini*) which are identified as restricted matters under the Qld *Biosecurity Act, 2014* are present (Appendix D). MCPL would aim to restrict or reduce existing infestations and avoid introducing new weeds to the Project area.

There is a low likelihood of weeds spreading into adjoining native woodland/forest vegetation as a result of the Project because MCPL currently implements weed control measures at the existing operations in accordance with the *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017b) that would be continued for the Project (Appendix D).

A number of animal pests have been recorded in the Project area, such as the European Feral Cat (*Felis catus*), European Rabbit (*Oryctolagus cuniculus*), Feral Pig (*Sus scrofa*), Domestic Dog (*Canis lupis*) (Appendix D). Each of these are listed as restricted matters under the Qld *Biosecurity Act, 2014.*

Feral pests that are already present in the Project area are likely to displace into adjoining areas during construction, however, the number of feral pests that would be displaced would be reduced by controlling feral pests. As outlined in Section 3.4.3, the control of feral pests is an existing measure that would be continued for the Project.

Noise, Dust and Artificial Lighting

The Project may result in an increase in noise, dust and artificial lighting on habitats within the Project and surrounding habitats.

The indirect noise impacts on the woodland habitat outside the overall surface disturbance area would likely be localised and minor given fauna often readily habituate to continuous noise and sudden noises from blasting would only occur in intervals (Appendix D).This has been evidenced during the current, and previous, survey work surrounding the existing operations through sightings of fauna using habitat adjacent to active mining areas (Biodiversity Australia, 2018).

While the potential dust impacts on flora and/or fauna in surrounding habitats associated with the Project may increase in comparison to the existing operations, it is expected that the Project would result in a reduction in potential dust impacts in comparison to the existing/approved Middlemount Coal Mine operations (Katestone Environmental Pty Ltd [Katestone], 2018) and this would in turn decrease the potential impacts on native species (Appendix D).

The Project would result in an increase (relative to the existing operations) in the use of artificial lighting within the Project locality. Despite this, the incremental impact of this additional night-lighting is expected to be minor.

Given the potential incremental noise, dust and artificial lighting impacts associated with the Project are anticipated to be minor, there is not expected to be any significant impact on the native vegetation and fauna habitat within the existing offset areas located adjacent the Project.

Vehicle Strike

The Project would contain new haul roads. However, all roads in the Project area would be limited to a 40 kilometres per hour (km/h) speed limit which would reduce the risk of any potential vehicle strike.

Interaction with the Final Void

Owen Foley (2014) prepared a *Residual Void Flora and Fauna Capability Study for the Residual Void Study* (MCPL, 2014c). As per the approved final void, the base of the proposed final voids would gradually begin to fill with water which would gradually increase in salinity over time (WRM, 2018) (Appendix B). The high walls of the final void would not contain vegetative cover but rather steep rock slopes and cliffs (Owen Foley, 2014).

Environmentally Sensitive Areas

As described in Section 3.1.1, RE 11.3.1 and RE 11.4.9 are equivalent to Category B ESAs (Figure 3.5). The clearance of these Endangered' regional ecosystems would therefore be offset as part of the Project (Section 4).

These regional ecosystems (RE 11.3.1 and RE 11.4.9) have been confirmed to meet the criteria to be mapped as Brigalow EEC listed under the EPBC Act (Appendix D).

Matters of State Environmental Significance

Biodiversity Australia (2018) (Appendix D) conducted an assessment of potential impacts to threatened species and ecological communities, and determined that the Project has the potential to result in a significant impact on the Greater Glider, Koala and Brigalow EEC. As such, potential impacts on these entities would be mitigated and offset. The Squatter Pigeon (southern) and Ornamental Snake are not considered to be significantly impacted by the Project, but potential impacts on these species would also be mitigated and offset.

Potential impacts to some MSES would not require an offset as the impacts would not be classed as 'significant' in accordance with DES's *Significant Residual Impact Guideline* (DEHP, 2014c).

These include potential impacts to (Table 3-6):

- 'Of Concern' regional ecosystem RE 11.3.2/RE 11.3.4;
- regional ecosystems within mapped vegetation management wetlands; and
- potential habitat for the Short-beaked Echidna.

Cumulative Impacts

Cumulative impacts are considered to be the total impact (direct and indirect) on the environment that would result from the incremental impacts of the Project added to other existing impacts and were considered in Appendix D.

Removal of vegetation and habitat for the Project would add to cumulative loss of vegetation from past landuses and clearing associated with the existing/approved Middlemount Coal Mine. The Project would also contribute to the cumulative impacts of vegetation clearance associated with a number of operational mines within the wider locality, these include:

- German Creek East – located approximately 5 km south of the Project area;
- Foxleigh – located approximately 15 km south-east of the Project area;
- Lake Lindsay – located approximately 15 km south south-east of the Project area; and
- Norwich Park – located approximately 20 km north-west of the Project area.

At a site level, the proposed clearance associated with the Project would result in an increase in remnant vegetation clearance of approximately 43% when compared to the existing/approved Middlemount Coal Mine (Appendix D). Approximately 440 ha of native vegetation is approved to be cleared for the Middlemount Coal Mine, however, the loss of vegetation associated with the approved mining operations has already been offset in accordance with the relevant State and Commonwealth legislation (Appendix D.

Table 3-6
Matters of State Environmental Significance

Matters of State Environmental Significance			Area of Clearance (ha)	Residual Significant Impact Test[A]	Significant Residual Impact
Regulated Vegetation	'Endangered' or 'of concern' regional ecosystems; or	RE 11.4.9 'Endangered'[1]	0.5	> 0.5 ha (where in a dense to mid-dense [structural category] regional ecosystem)	Yes
		RE 11.3.1 'Endangered'[1]	15	> 0.5 ha (where in a dense to mid-dense [structural category] regional ecosystem)	Yes
		RE 11.3.2 'Of Concern'	43.5	> 0.5 ha (where in a dense to mid-dense [structural category] regional ecosystem)	Yes
		RE 11.3.2/RE 11.3.4 'Of Concern'	1.5	> 2 ha (where in a sparse [structural category] regional ecosystem)	No
	Regional ecosystems within mapped vegetation management wetlands	RE 11.3.27d	1.9	> 2 ha (where in a sparse [structural category] regional ecosystem)	No
Connectivity Areas			190.5	Refer to footnote B	Yes
Wetlands and Watercourses			0.75	Areas of the wetland or watercourse being destroyed or artificially modified	Yes
Protected Wildlife Habitat	Ornamental Snake[1]		15.5	Project likely to result in any of the significant impact criteria outlined in DEHP (2014b)	No
	Squatter Pigeon (southern)[1]		388.5		No
	Greater Glider[1]		175		Yes
	Koala[1]		175		Yes
	Short-beaked Echidna		190.5		No
Legally Secured Offset Area	Stage 2 Offset Area [1]		32	Reduce Extent	Yes
	Rail Loop and Spur Offset Area		22	Reduce Extent	Yes

[1] this MSES is also identified as MNES listed under the EPBC Act.

[A] As outlined in DEHP (2014c).

[B] Application of the DEHP (2016) *Landscape Fragmentation and Connectivity Tool* showed that impacts of the Project on landscape connectivity would be significant.

On a larger scale, the native vegetation communities/regional ecosystems to be cleared during the life of the Project all occur more widely in surrounding landscapes and subregions (after Accad *et al.,* 2017). The Project would result in the loss of approximately 0.03% of the remnant vegetation remaining within the Isaac Comet Dows Subregion (Accad *et al.,* 2017) (Appendix D).

The proposed offset areas for the Project would significantly increase the area of protected habitat that would be managed for conservation (bringing the total to 5,861 ha [Section 4]). The existing and proposed offset areas provide habitat for a number of common and threatened species as demonstrated from monitoring surveys (Ecology & Heritage Partners, 2012; Naturecall 2014-2017) and their continued regeneration would help offset biodiversity losses from the Middlemount Coal Mine.

In addition, the progressive rehabilitation of mining areas over the life of the Project would provide habitat in the medium to long term (Appendix D).

Given the above, Biodiversity Australia (2018) concluded that the additional clearance associated with the Project is considered to represent only a minor increase in cumulative vegetation loss. Accordingly, the Project is not anticipated to have a significant cumulative impact on terrestrial ecology (Appendix D).

3.4.3 Management Practices and Mitigation Strategies

Refinement of the Mine Design to Avoid Land Clearance

The following refinements to the mine design have resulted in minimising additional land disturbance:

- use of existing infrastructure and facilities at the Middlemount Coal Mine, where possible, to avoid the need for additional clearance works;
- optimising the backfilling of the open cut pit to minimise the overall mine footprint (i.e. reduce the size of the out-of-pit waste emplacement); and
- locating the proposed waste emplacements to be continuous with the existing/approved waste emplacements to minimise the total disturbance footprint.

Land Clearance Procedures

The following measures described in the *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017b) would continue to be implemented to manage land clearing required for the Project:

- The clearing limit would be clearly marked (e.g. via pegging, temporary plastic mesh fencing or flagging tape) before clearing in order to prevent any inadvertent clearance beyond what is required and has been assessed.
- The area of clearing work is to be inspected for fauna by a fauna spotter immediately prior to commencement of any vegetation removal. Pre-clearing checks would include searches of habitat and bird nests.
- A fauna spotter is to remain on site to supervise clearing to retrieve any fauna detected during works and undertake appropriate action.

Management of Conservation Significant Species

The Project would potentially disturb animal breeding places and therefore MCPL would implement a Species Management Program under section 332 of the *Nature Conservation [Wildlife Management] Regulation, 2006* as required (Appendix D). Measures described in the Middlemount Coal Species Management Program (MCPL, 2016c) would continue to be followed (e.g. vegetation clearance procedures and use of a fauna spotter catcher during clearing works) (Appendix D).

Invasive Plant Prevention and Control

MCPL currently implements weed control measures at the existing operations in accordance with the *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017b). These measures would be continued for the Project and include spot spraying of *Biosecurity Act, 2014* listed weed species (Appendix D).

Invasive Animal Prevention and Control

MCPL currently implements feral animal control measures at the existing operations in accordance with the *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017b). These measures would be continued for the Project and include wild dog and cat control (Appendix D).

Dust Management

Management of dust is detailed in Section 3.5 and Appendix E.

Erosion and Sediment Controls

Management of erosion and sediment is detailed in WRM (2018) (Appendix B) and the *Erosion and Sediment Control Plan* (MCPL, 2016a).

Bushfire Prevention and Management

MCPL would aim to maintain vegetation structure and composition, protect mine assets and safeguard human life through the implementation of bushfire management techniques, including (Appendix D):

- physical protection of assets through clean firebreaks;
- active fire suppression of unplanned and potentially destructive fires (to vegetation and built assets); and
- pro-active fuel and ecosystem management to sustain ecological fire regimes as much as possible.

Project Rehabilitation

Project rehabilitation is described in Section 4.

Biodiversity Offset Strategy

The biodiversity offset strategy is described in Section 4.4. With the impact avoidance, mitigation and offset measures proposed there not expected to be a significant residual impact on biodiversity from the Project (Appendix D).

3.5 AIR QUALITY AND GREENHOUSE GAS

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by Katestone and is presented in Appendix D.

The environmental values for air quality are provided in Section 3.5.1. Section 3.5.2 describes the potential air quality impacts of the Project, and Section 3.5.3 outlines the proposed management practices and mitigation strategies. Estimated greenhouse gas (GHG) contributions as a result of the Project are discussed in Section 3.5.4.

3.5.1 Environmental Values

The environmental values relevant to surface water at the Project area have been identified with consideration of the DES Guideline *Application requirements for activities with impacts to air (ESR/2015/1840)* (DEHP, 2017f).

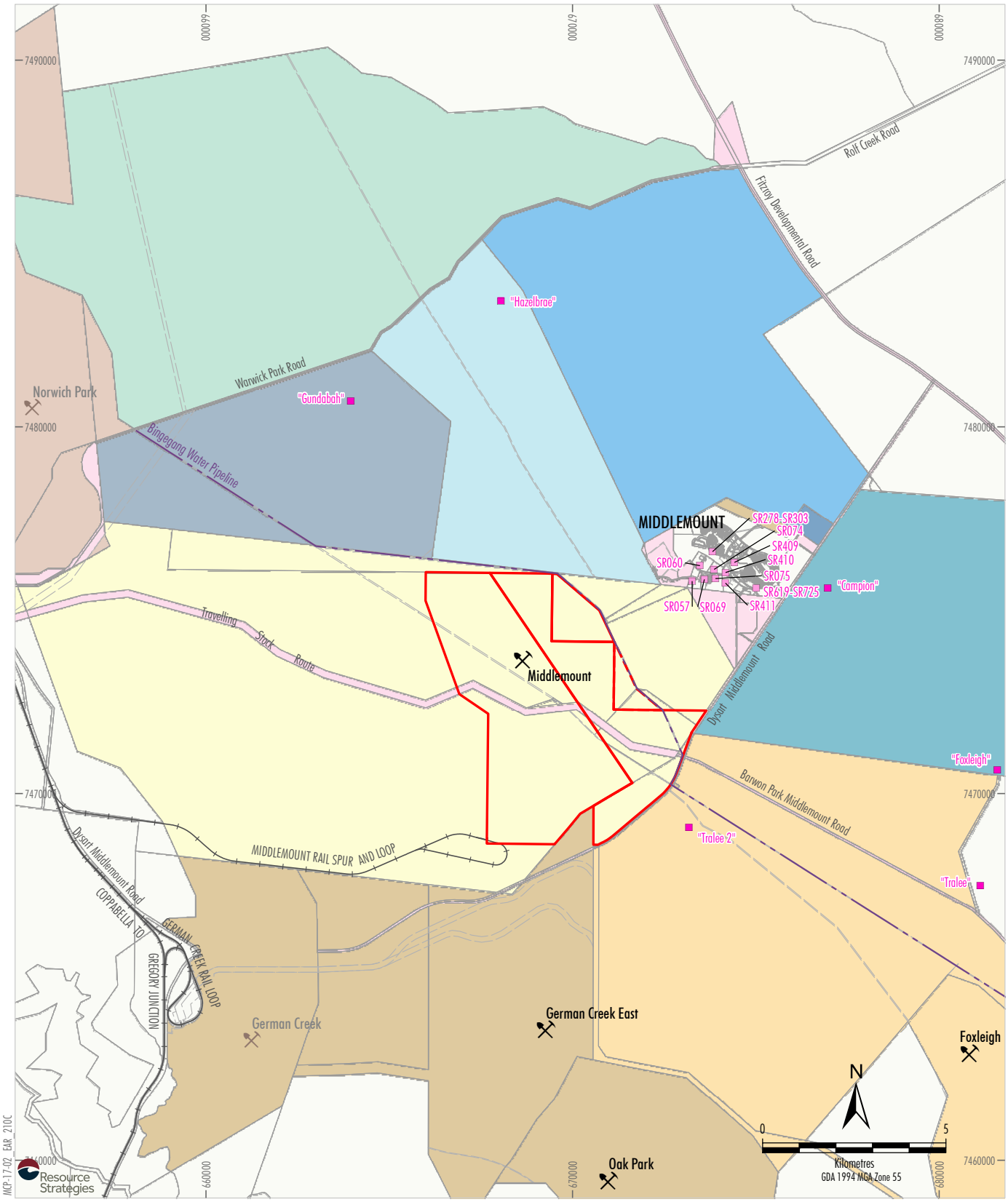
The Project area experiences a sub-humid to semi-arid climate, with annual average rainfall in the order of 600 millimetres (mm) per year and significantly higher evaporation levels, in the order of 2,000 to 2,400 mm per year (MCPL, 2016b).

Easterly to north-easterly winds prevail during spring and summer, with calmer winds from the south to south-east being dominant during winter and autumn (i.e. prevailing winds are away from the Middlemount township).

Meteorological stations have been established at the Middlemount Coal Mine in accordance with EA EPML00716913. Two continuous, real time meteorological monitoring stations monitor wind speed, wind direction, temperature, rainfall and relative humidity (Figure 3.9). A portable, real time PM_{10} air quality monitor and a network of five dust gauges are available (Figure 3.9) to monitor air quality impacts if required in accordance with Schedule B of the EA.

The nearest sensitive places to the Middlemount Coal Mine are within the Middlemount township, approximately 3 km to the east of the Project, with some scattered homesteads outside of the township (the closest being approximately 1,250 m south-east of the Project) (Figure 3.8).

The *Environmental Protection (Air) Policy, 2008* (EPP [Air]) lists the environmental values and the air quality objectives to enhance or protect the environmental values. As described in the EPP (Air), environmental values for air have been developed to protect the health and biodiversity of ecosystems, human health and wellbeing, aesthetics and agricultural use.



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Cadastral Boundary
- Easement
- Railway
- Approved/Operating Coal Mine
- Coal Mine Under Car and Maintenance

Sensitive Receivers

- New Sensitive Receiver
- Previously Identified Sensitive Receiver

LANDHOLDER

- Middlemount Coal Owned Land
- Anglo Coal (Capcoal Management) Pty Limited
- BHP Coal Pty Ltd; QCT Mining Pty Ltd; Mitsubishi Development Pty Ltd; QCT Investment Pty Ptd; BHP Queensland Coal Investments Pty Ltd; Umal Consolidated Pty Ptd; QCT Resources Pty Limited
- Foxleigh Land Pty Ltd
- Australian Telecommunications Commission
- Qld Electricity Transmission Corporation Limited
- Crown Land
- Edward Thomas Murphy and Alison Isobel Murphy
- James Pickels
- John Frederick Campion
- John Ronald Singleton and Lynette Robyn Olive Singleton
- John Thomas Baker and Marni Louise Baker
- James William Curran
- Owner not Referenced

Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Potential Sensitive Receivers

Figure 3.8



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Rail Spur and Loop

Sensitive Receivers

- New Sensitive Receiver
- Previously Identified Sensitive Receiver

Monitoring Sites

- Dust Gauge
- PM_{10} Monitor
- Meteorological Station

SENSITIVE PLACES

Receiver	Location
SR075	Accommodation Village 1
SR074	Accommodation Village 2
SR410	Accommodation Village 3
SR411	Accommodation Village 4
SR278-SR303	Alfred Quinn Drive Residences
SR619-SR725	Centenary Drive South Residences
SR069	Industrial Estate
SR409	Middlemount Community School
SR060	Norm Blache Oval
SR057	Treatment Plant

Source: MCPL (2018); Department of Natural Resources and Mines (2017)
Orthophoto: MCPL (June 2017, 2014)

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WESTERN EXTENSION PROJECT

Nearby Sensitive Receivers and Air Quality Monitoring Sites

Figure 3.9

The EPP (Air) specifies objectives for air pollutants. Mining activities during the life of the Project have the potential to generate particulate matter (i.e. dust) emissions in the form of:

- total suspended particulate matter (TSP);
- particulate matter with an equivalent aerodynamic diameter of 10 micrometres (µm) or less (PM_{10}) (a subset of TSP); and
- particulate matter with an equivalent aerodynamic diameter of 2.5 µm ($PM_{2.5}$) (a subset of TSP and PM_{10}).

Table 3-7 summarises the air quality objectives in the EPP (Air) that are relevant to the Project.

Table 3-7
Ambient Air Quality Objectives

Pollutant	Environmental Value	Averaging Period	Objective[1]
PM_{10}	Health and wellbeing	24 hours	50 µg/m³ [2]
$PM_{2.5}$	Health and wellbeing	24 hours	25 µg/m³
		Annual	8 µg/m³
TSP	Health and wellbeing	Annual	90 µg/m³

[1] Each objective is for total impacts (i.e. including background levels).

[2] Five allowable exceedance days each year.

Note: The EPP (Air) objective applies to sensitive locations and does not apply to locations within the ML.

µg/m³ = micrograms per cubic metre.

The air quality objectives typically relate to the total dust burden in the air and not just the dust generated from the Project. Background particulate matter levels therefore need to be considered when using these goals to assess potential cumulative impacts.

Although the EPP (Air) does not specify an objective for deposited matter, the DES has adopted an objective for deposited dust, relevant to coal dust, of 120 milligrams per square metre per day (mg/m²/day) (DES, 2018b).

The Middlemount Coal Mine currently operates in accordance with EA EPML00716913. Schedule B of EA EPML00716913 includes the following criteria for air quality:

- 24 hour average PM_{10} concentration – 50 µg/m³; and
- dust deposition – 120 mg/m²/day, averaged over a month.

Previous monitoring at the site indicates general compliance with the EPP (Air) conditions, and no complaints from sensitive places in the town of Middlemount have been received to date. Although no complaints have been received, they would be managed in accordance with the existing *Environment Complaints and Incidents Management Plan* (MCPL, 2014d).

3.5.2 Potential Impacts

The dust emissions inventory for the Project has been prepared using the same methodology as the *Middlemount Coal Mine North-eastern Extension Project Air Quality Assessment* (Katestone, 2015) and the Stage 2 Project EIS (MCPL, 2011). Dust emissions have been calculated using emission factors published by the US Environmental Protection Agency (US EPA) in its Compilation of Air Pollution Emission Factors Volume 1 (AP-42) (US EPA, 1998; 2004; 2006a; 2006b) and by the DEE in its National Pollutant Inventory Handbooks (NPI, 2012).

A dust inventory has been estimated for Year 2028 and Year 2032 of the Project. The worst case dust inventory has been estimated based on the proposed full extent of the Project. This is nominally represented as Year 2032 (i.e. the year where the Project is at full development). The generally equivalent dust emissions inventory modelled in the North-eastern Extension Project was Year 2029 (Katestone, 2015) and in Stage 2 Project EIS was Year 14.

Detailed breakdowns and comparisons of the dust emission inventories (TSP, PM_{10} and $PM_{2.5}$) for Years 2028 and 2032 of the Project, Year 2029 of the North-eastern Extension Project and Year 14 of the Stage 2 Project EIS are provided in Appendix E.

The estimated dust emissions inventory for the Project detailed in Appendix E indicates that dust emissions would be lower than those previously assessed and approved for the equivalent year of the North-eastern Extension Project (Year 2029) and Stage 2 Project EIS (Year 14) as:

- the material (overburden) extraction rates would be lower for the Project than previously assessed and approved; and
- the haulage fleet would be optimised (larger trucks resulting in fewer trips and lower associated wheel-generated dust emissions).

Air quality impacts at nearby sensitive receptors are therefore not anticipated to be greater than the impacts approved for the North-eastern Extension Project and Stage 2 Project.

3.5.3 Management Practices and Mitigation Strategies

Dust control measures would continue to be implemented at the Middlemount Coal Mine for the Project in accordance with the Plan of Operations, including:

- watering of haul roads;
- watering of stockpiles;
- dust collectors during drilling activities;
- watering of material transfer areas; and
- progressive rehabilitation of exposed areas following the completion of mining operations.

In the event of an air quality-related complaint, air quality monitoring would be conducted at the relevant sensitive place to validate the model predictions and inform the implementation of air quality mitigation measures, if required, where objectives are exceeded. In this instance, air quality mitigation measures would be investigated in consultation with the landholder, and could include modification of Project operations or at-receiver mitigation measures.

MCPL would continue to conduct air quality and meteorological monitoring at Middlemount Coal Mine using (Figure 3.9):

- One PM_{10} monitor (Dustrak).
- Five dust deposition gauges.
- Two meteorological monitoring stations.

3.5.4 Greenhouse Gases

The Commonwealth *National Greenhouse and Energy Reporting Act, 2007* (NGER Act) established a national framework for corporations to report GHG emissions and energy consumption.

The *National Greenhouse and Energy Reporting Regulation, 2008* (NGER Regulation) recognises Scope 1 and Scope 2 emissions as follows:

- Scope 1 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.
- Scope 2 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

Other indirect GHG emissions are classified as Scope 3 emissions. National GHG reporting requires the quantification of Scope 1 and Scope 2 emissions only. As such, for the purpose of this assessment, emissions generated in Scopes 1 and 2 have been quantified (Appendix E). Therefore Scope 3 emissions, including those associated with the end-use of product coal, have not been considered.

Estimating Greenhouse Gas Emissions

The methodologies used to estimate the GHG emissions resulting from the Project are consistent with:

- The *National Greenhouse and Energy Reporting (Measurement) Determination, 2008.*
- The *National Greenhouse Accounts Factors* (DEE, 2017a).

Estimated quantities of material contributing to GHG emissions for the Project are presented in Appendix E.

Contribution of Greenhouse Gas Emissions

The estimated annual average Scope 1 and 2 GHG emissions for the life of the Project is 289 kilotonnes of carbon dioxide equivalent (kt CO_2-e). The estimated maximum annual contribution represents approximately 0.06% of the annual Australia GHG emissions for the year ending 30 June 2016 (DEE, 2016) and approximately 0.24% of the estimated annual Qld GHG emissions for 2015 (DEE, 2017b) (Appendix E).

Management, Mitigation and Monitoring

MCPL would continue to implement measures to minimise the generation of GHG emissions including procurement policies that require the selection of energy efficient equipment and vehicles, monitoring and maintenance of mobile equipment and optimisation of diesel consumption through logistics analysis and planning.

3.6 NOISE AND VIBRATION

A Noise Impact Assessment for the Project was undertaken by Renzo Tonin Ron Rumble and is presented in Appendix F.

The environmental values relevant to noise and vibration are provided in Section 3.6.1. Section 3.6.2 describes the potential noise and vibration impacts of the Project, and Section 3.6.3 outlines the proposed management practices and mitigation strategies.

3.6.1 Environmental Values

The environmental values relevant to surface water at the Project area have been identified with consideration of the DES Guideline *Application requirements for activities with noise impacts (ESR/2015/1838)* (DEHP, 2017g).

As described in Section 3.5.1, easterly to north-easterly winds prevail during spring and summer, with calmer winds from the south to south-east being dominant during winter and autumn (i.e. prevailing wind direction is typically away from the nearest sensitive receivers).

The nearest sensitive places to the Middlemount Coal Mine are within the Middlemount township, approximately 3 km to the east of the Project, with some scattered homesteads outside of the township (the closest being approximately 1,250 m south-east of the Project).

The *Environmental Protection (Noise) Policy, 2008* (EPP [Noise]) lists the environmental values and the acoustic quality objectives to enhance or protect the environmental values. As described in the EPP (Noise), environmental values of the acoustic environment have been developed to protect the health and biodiversity of ecosystems, human health and wellbeing and community amenity.

The noise criteria for the Project were selected based on the relevant legislation and guidelines, and the background noise monitoring data collected as part of the Stage 2 Project EIS (MCPL, 2011) noise assessment and additional monitoring conducted in 2013. Table 3-8 presents a summary of the noise criteria and the adopted Project Noise Criteria for dwellings and other noise sensitive receivers.

Table 3-8
Project Noise Criteria

Location	Period	Project Noise Criteria dB(A)
Dwellings	Daytime	32 – 38*
	Evening	32 – 41*
	Night-time	30 – 36*
Schools	Operating Hours	40
Parks^	Daytime	42
Community Buildings#	Operating Hours	50

Source: After Appendix E.

* Based on the RBL determined at various locations +5 dB(A).

^ Due to higher measured background noise levels the amenity level has been adopted.

Assumed equivalent to commercial or retail receiver.

3.6.2 Potential Impacts

A Noise Impact Assessment was conducted by Renzo Tonin Ron Rumble (Appendix F) including prediction of potential noise levels at the Middlemount township using a CadnaA noise prediction model. Two operational scenarios have been selected for noise modelling purposes, Years 2028 and 2032. These scenarios were selected in consideration of the scale of mining operations in each year of the Project, number of major mobile equipment and proximity of operations to sensitive receivers.

A summary of the potential noise impacts at sensitive receivers under adverse weather conditions (worst case scenario) is provided in Table 3-9.

Table 3-9 shows operational noise levels for Years 2028 and 2032 under adverse weather conditions are predicted to comply with the noise criteria for daytime, evening and night-time periods. The exception is the nearest receiver “Tralee 2”, with a possible noise exceedance of 8 dB(A) under adverse weather conditions. This assumes the worst-case scenario with all plant operating simultaneously.

It is noted the “Tralee 2” receiver was recently built in close proximity to the existing operations of the Middlemount Coal Mine.

3.6.3 Management Practices and Mitigation Strategies

Noise mitigation and management measures for the Middlemount Coal Mine would continue to be implemented the Project, including:

- all equipment will be well maintained;
- all non-vexatious noise complaints will be investigated expeditiously and a response will be provided to the complainant;
- all complaints will be recorded into the site Complaints Register; and
- any noise monitoring carried out in response to any non-vexatious noise complaint will be undertaken in accordance with the requirements of the Noise Measurement Manual, and the results of the noise monitoring will be assessed against the relevant noise criteria.

In the event of a noise-related complaint, noise monitoring would be conducted to validate the model predictions and inform the implementation of noise mitigation measures, if required, where noise objectives are exceeded. In this instance, noise mitigation measures would be investigated in consultation with the noise sensitive receptor

With regard to the predicted noise exceedances at the “Tralee 2” receiver, simple noise reduction strategies will be investigated, such as limiting the use of the nearest haul routes and fixed plant items during night time periods.

Table 3-9
Potential Noise Impacts at Sensitive Receivers

Receiver ID	Receiver	Noise Criteria dB(A)			Year 2028 - Adverse Weather		Year 2032 - Adverse Weather	
		Day	Evening	Night	Noise Level	Compliant	Noise Level	Compliant
SR075	Accommodation Village 1	36	38	34	31	Yes	30	Yes
SR074	Accommodation Village 2	36	38	34	31	Yes	30	Yes
SR410	Accommodation Village 3	36	38	34	31	Yes	30	Yes
SR411	Accommodation Village 4	36	38	34	31	Yes	30	Yes
SR278-SR303	Alfred Quinn Drive Residences	36	38	34	31	Yes	30	Yes
SR619-SR725	Centenary Drive South Residences	36	38	34	30	Yes	30	Yes
SR069	Industrial Estate	50	50	50	31	Yes	30	Yes
SR409	Middlemount Community School	40	40	40	30	Yes	29	Yes
SR060	Norm Blanche Oval	50	50	50	31	Yes	30	Yes
SR057	Treatment Plant	50	50	50	32	Yes	30	Yes
Gundabah	Gundabah	32	36	35	29	Yes	29	Yes
Hazelbrae	Hazelbrae	32	36	35	26	Yes	26	Yes
Campion	John Frederick Campion	33	32	30	28	Yes	27	Yes
Foxleigh	Foxleigh	33	32	30	22	Yes	21	Yes
Tralee	Tralee	33	32	30	22	Yes	21	Yes
Tralee 2	Tralee 2	33	32	30	38	No	36	No

Source: After Appendix E.

[1] See Figure 3.8 for receiver locations.

3.7 SOCIAL (COMMUNITY) VALUES

The Project would provide continued employment for the existing workforce for the life of the Project. A workforce of approximately 397 personnel is then expected but may fluctuate over the life of the mine to over 500 personnel during particular mining or processing activities, shut downs or maintenance activities (MCPL, 2011).

Middlemount was established as a mining town in the 1980s and is primarily supported by the surrounding mining operations to this day.

Potential impacts to the community such as the demand for housing and community resources are not expected to increase as a result of the Project, given that no significant increase to the existing workforce is proposed for the Project.

MCPL would continue to engage with community and track consultation activities in a Consultation and Complaint/Incident Register.

3.8 INDIGENOUS CULTURAL HERITAGE

CHMPs were formed with the Barada Barna People and the BBKY #4, respectively. The Project is only relevant to the CHMP with the Barada Barna People, which would be reviewed and amended where required to include the Project.

Consultation would be undertaken with the Barada Barna People who MCPL would engage to conduct cultural heritage surveys over the Project areas. The surveys would be conducted in accordance with the CHMP ahead of any disturbance in the Project area. Any potential impact to indigenous cultural heritage would be managed in accordance with the CHMP.

In a hierarchy of cultural heritage management options, the first and best strategy is to avoid impact on sites. However, given that the majority if not all sites would be or are likely to be directly impacted by the Project, relevant mitigation measures described in the CHMP would be implemented.

4 REHABILITATION AND BIODIVERSITY OFFSET STRATEGY

This section provides a description of the:

- mine site rehabilitation relevant to the existing/approved Middlemount Coal Mine (Section 4.1);
- the proposed mine site rehabilitation relevant to the Project (Section 4.2);
- the proposed general mine site rehabilitation practises and measures (Section 4.3); and
- the existing and proposed biodiversity offset strategy (Section 4.4).

4.1 REHABILITATION AT THE MIDDLEMOUNT COAL MINE

The *Middlemount Coal Mine Plan of Operations* (MCPL, 2018) and the *Middlemount Coal Mine Rehabilitation Management Plan* (MCPL, 2012 and 2014a) describe the strategy for progressing towards the rehabilitation outcomes required under EA EPML00716913. A summary of the current rehabilitation strategy for the Middlemount Coal Mine is provided below.

4.1.1 Rehabilitation Goal

The rehabilitation goal for the existing Middlemount Coal Mine is to rehabilitate all land subject to mining activities to a non-polluting, safe, stable and self-sustaining landform.

4.1.2 Post-Mining Land Use

The Middlemount Coal Mine is surrounded by land primarily used for grazing livestock and mining (with the exception of the MCPL biodiversity offset areas). The post mining land use of all post-mine landforms, except the final void[5], will be low density beef cattle grazing or native ecosystem as existed prior to mining.

The final void will be a safe, stable, non-polluting saline groundwater sink. Further discussion on the proposed final void arrangement is provided in Section 4.2.3.

4.1.3 Final Landform

The approved Middlemount Coal Mine final landform consists of the following:

- in-pit and out-of-pit waste rock emplacements (slopes and upper surface);
- low wall spoil (above natural ground level);
- a single final void;
- water storage/water management dams;
- rehabilitated infrastructure areas (including mine infrastructure area [MIA], CHPP and roads);
- rehabilitated Roper Creek Diversions;
- rehabilitated Thirteen Mile Gully Diversion; and
- rehabilitated TSF and flocc cells (FC1 and FC2).

A description of each of these landforms is provided below.

In-Pit and Out-of-Pit Waste Rock Emplacements

The upper surface of the waste rock emplacements would be topsoiled (at least 0.2 m layer) and seeded (MCPL, 2014a). The upper surface of the waste rock emplacements will be revegetated with species characteristic of RE 11.5.3 (*Eucalyptus populnea* +/- *Eucalyptus melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces). RE 11.5.3 is the most predominant RE within the Project area (Section 3.4.1).

[5] While Table F1 in EA EPML00716913 currently describes that the final void would be for re-creation of RE 11.5.3 where possible, it would not be possible to revegetate the final void at the base of the proposed final voids. Post-mining, the final voids would gradually fill with water (i.e. groundwater recovery and incident rainfall and runoff) and be subject to evapo-concentration effects which would result in the salinity gradually increasing over time (WRM, 2015). The high walls of the final void would also not contain vegetative cover but rather steep rock slopes and cliffs (Owen Foley, 2014).

A significant proportion of topsoil resources at the Middlemount Coal Mine and surrounds comprise duplex soils with sandy topsoil (MCPL, 2012). These topsoils are generally non-cohesive and have high erosion potential on slopes greater than about 2% (MCPL, 2012). The slopes of the waste rock emplacements (external slope of the low wall dump and East Dump) will be re-contoured to a slope of up to 18.5^{o} with the use of rock mulch for greater stability (MCPL, 2014a). MCPL are undertaking monitoring on the North and South Dump to assess the stability of rock mulching with grass cover (MCPL, 2018).

Final Void

A single final void[6] is approved at the Middlemount Coal Mine in the northern area of the open cut extent (Figure 1.2). The final void is to be designed to not cause any serious environmental harm to land, surface water or groundwaters outside of the void in accordance with Condition F20 of EA EPML00716913. A *Residual Void Study* was prepared by MCPL (2014b), as described in Section 4.2.3. The final void would partly fill with water (i.e. groundwater recovery and incident rainfall and runoff) and be subject to evapo-concentration effects which would result in the salinity gradually increasing over time.

Water Storage/Water Management Dams

Water storage/water management dams will be:

- removed and rehabilitated; or
- retained for beneficial use if the post-mining landholder agrees and the dam complies with the limits detailed in ANZECC and ARMCANZ (2000, or its revision) for a period of at least 5 years post mining.

Infrastructure Areas

Infrastructure areas will be rehabilitated in accordance with outcomes outlined in Condition F9 of EA EPML00716913:

> *All infrastructure, constructed by or for the environmental authority holder during the licensed activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post mining land owner / holder.*

The mine infrastructure (e.g. CHPP, buildings) will be removed and the sites rehabilitated as required. Some infrastructure may be retained for alternate post-mining uses (e.g. roads) subject to the agreement of the post mining land owner / holder.

Rehabilitated Roper Creek Diversions

Two diversions of Roper Creek are approved at the Middlemount Coal Mine. The locations of the approved (yet to be constructed) Roper Creek diversions are shown on Figure 1.2. The diversions of Roper Creek will be designed in accordance with EA EPML00716913 and revegetated with species characteristic of RE 11.3.25 (*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage features).

Rehabilitated Thirteen Mile Gully Diversion

The Thirteen Mile Gully Diversion was approved under the SP Act in July 2013 (Development Permit 608153) as it is predominantly outside of the former boundary of ML 70379 (Figure 1.2). The rehabilitation requirements for the Thirteen Mile Gully Diversion are described in the *Middlemount Coal Thirteen Mile Gully Diversion Design Report* (Parsons Brinkerhoff, 2012).

[6] The extent of the final void rehabilitation domain is defined as the void below natural ground level.

The Thirteen Mile Gully Diversion will be revegetated with species characteristic of RE 11.3.1b (Open forest dominated by *Acacia harpophylla* and/or *Casuarina cristata*), RE 11.3.2c (*Eucalyptus populnea* woodlands on floodplains) and RE 11.3.25 (*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage features) (Parsons Brinkerhoff, 2012).

Rehabilitated TSFs and TFCs

In October 2017, DES requested the target RE for the TSFs and tailings flocc cells (TFCs) be revised from RE 11.5.9 (*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. Woodland on Cainozoic sand plains/remnant surfaces) as it may not be able to be recreated on the TSFs and TFCs. The revised target RE for the TSFs and TFCs is further discussed in Section 4.2.3.

4.1.4 Existing Rehabilitation Management and Monitoring

Once rehabilitation activities are commenced at the Middlemount Coal Mine, the area specifically undergoing rehabilitation is monitored. Monitoring and assessment of progressive rehabilitation will be undertaken throughout the construction, operational and decommissioning phases of the Project in accordance with a Rehabilitation Management Plan, Topsoil Management Plan and Post Closure Management Plan as required by EA EPML00716913.

If rehabilitation monitoring and assessment results indicate that the rehabilitation objectives may not be achieved, then the rehabilitation strategy will be modified to ensure that rehabilitation objectives are met. Rehabilitation progress and rehabilitation activities will be regularly re-evaluated and the results used to inform future rehabilitation initiatives and refinement, and amendment to the practices and measures in the Rehabilitation Management Plan.

4.1.5 Rehabilitation Status

Rehabilitation at the Middlemount Coal Mine is undertaken progressively within 2 years of areas becoming available within the operational land. Rehabilitation commenced at the Middlemount Coal Mine in 2015. As of January 2018, approximately 32.5 ha is under rehabilitation in the south dump lower and upper tiers and north dump upper surface (MCPL, 2018) (Plates 4-1 and 4-2).

Rehabilitation of the north dump upper surface was undertaken by levelling spoil, establishing drains, grading the surface and placing topsoil by a scraper. Vegetation establishment was undertaken by deep ripping, fertilising and seeding.

Construction and rehabilitation of the Thirteen Mile Gully Diversion commenced in 2013. An example of regrowth along the Thirteen Mile Gully Diversion is shown in Plate 4-3. The northern section of the Thirteen Mile Gully Diversion would be realigned as part of the Project (Section 3.2.2).

4.2 REHABILITATION OF THE PROJECT

MCPL has reviewed the current rehabilitation strategy to incorporate the Project. The review has made use of MCPL's rehabilitation experience to date at the Middlemount Coal Mine and considered leading guidelines and standards including:

- *Rehabilitation Requirements for Mining Resource Activities* (DEHP, 2014b);
- *Planning for Integrated Mine Closure: Toolkit* (International Council on Mining and Metals, 2008);
- *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000); and
- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure* (Department of Industry, Innovation and Science, 2016).



Plate 4-1 Land Undergoing Rehabilitation on the South Dump and North Dump - 2018



Plate 4-2 Example of Land Undergoing Rehabilitation (Rock Mulching and Grass) - 2018



Plate 4-3 Example of Regrowth along the Thirteen Mile Gully Diversion - 2018

The *Better Mine Rehabilitation for Queensland Discussion Paper* (Queensland Government, 2017) has also been considered.

Figure 4.1 provides the Project conceptual general arrangement post mining and Figure 4.2a and 4.2b provide conceptual cross-sections through the final landform.

4.2.1 Rehabilitation Goals

The rehabilitation goals at the Middlemount Coal Mine (Section 4.1.1) would remain unchanged for the Project. All land subject to mining activities would be rehabilitated to a non-polluting, safe, stable and self-sustaining landform.

4.2.2 Post-Mining Land Use

Consistent with the intended post mining land use at the Middlemount Coal Mine (Section 4.1.2), the post mining land use of all post-mine landforms, except the final voids, would be low density beef cattle grazing or native ecosystem as existing prior to mining.

Table 4-1 provides a revised summary of the proposed final land use and rehabilitation incorporating the Project. Domains for mine rehabilitation are provided in Table 4-1.

DES requested (Appendix A) a table of the rehabilitation goals and objectives, indicators and rehabilitation success criteria (completion criteria) for each domain incorporating the Project in accordance with DEHP (2014b). Appendix G provides the proposed rehabilitation goals, objectives, indicators and completion criteria.

4.2.3 Conceptual Final Landform

A description of each of the proposed conceptual final landforms is provided below.

In-Pit and Out-of-Pit Waste Rock Emplacements

The Project waste rock emplacements would be rehabilitated consistent with the description in Section 4.1.3.

Consistent with the approved mine, the flood protection levee that would exist during mining operations would be incorporated into the waste rock emplacement to form a stable and self-sustaining landform that does not require long-term maintenance.

A conceptual final landform design (of the southern overburden spoil dump) relative to the southern final void and the Roper Creek floodplain is shown on Figure 4.2b. In this location, the final landform would be designed to be considerably higher (approximately 6.5 m) than the 1,000 year ARI level and PMF level (Appendix B). This conceptual final landform would be at least 8.5 m high and 150 m wide with a batter slope of 1:8.

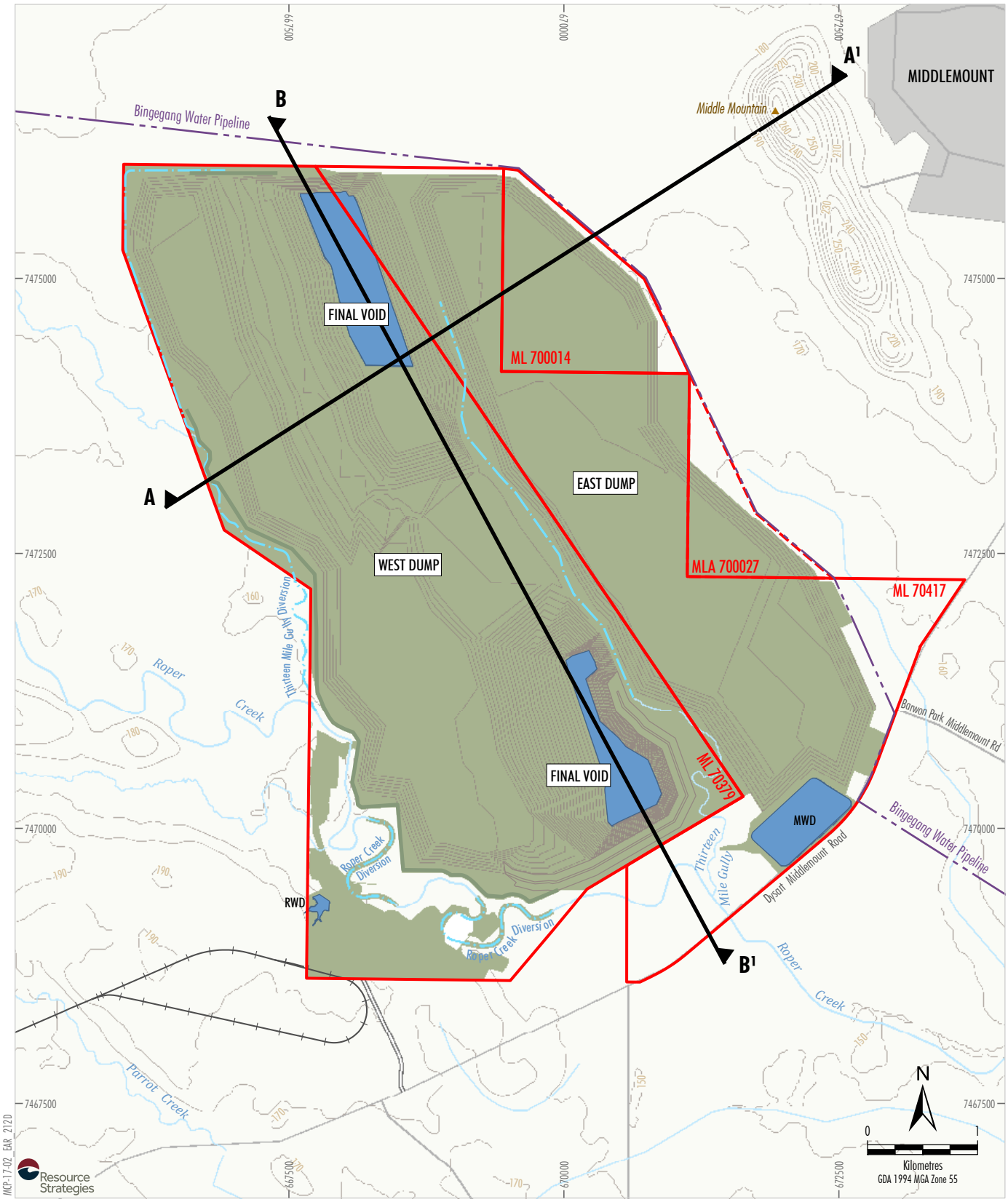
The stability of the final landform in this location (and batters) would be enhanced by incorporating erosion resistant material (e.g. rock gabion) into the batter slope to approximately 2 m height (the PMF Level) and rehabilitating the surface of the landform with rock mulch and seeding/planting with tree, shrub and grass species characteristic of RE 11.5.3 (*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces). Native vegetation cover between the final landform and Roper Creek would be retained.

Low Wall Spoil (Above Natural Ground Level)

The low wall spoil (above natural ground level, and above the final void) will be designed to be safe, non-polluting and stable. The benches of the low wall spoil will be revegetated with species characteristic of RE 11.5.3 (*Eucalyptus populnea* +/- *Eucalyptus melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces).

Final Voids

The Project also requires two final voids located at either end of the mine path (Figure 1.3), instead of a single final void as currently approved (Figure 1.2).



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Established Rehabilitation
- Water Storage
- Diversion Structure
- Removed Levee (Rehabilitated)
- Mine Access Road (Retained or Rehabilitated)
- Middlemount Rail Spur and Loop (Retained or Rehabilitated)
- Cross Section Location

Refer Figure 4.2 for Cross Sections.

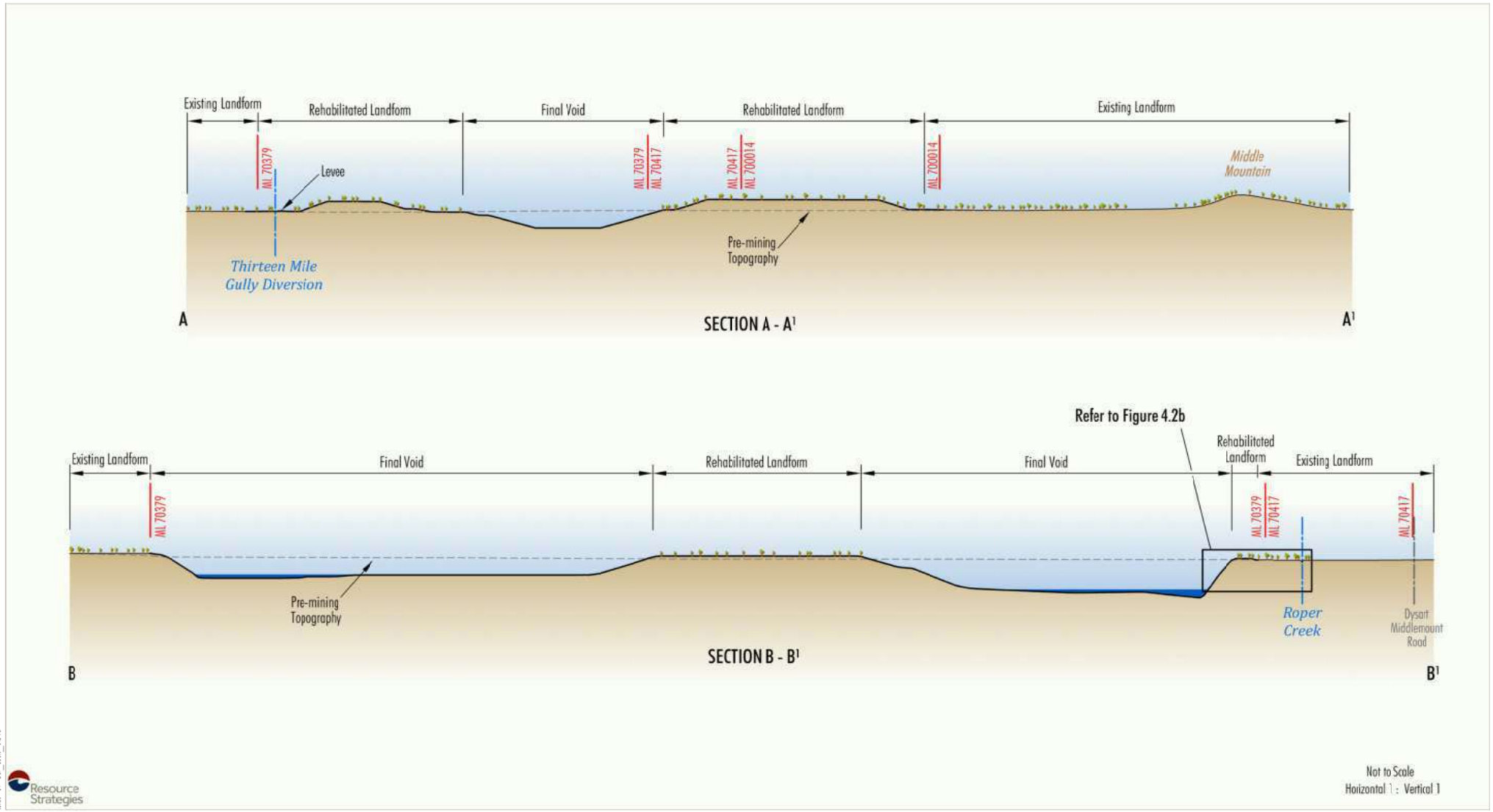
Source: MCPL (2018); AGE (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement Post-mining - Cross Section Locations

Figure 4.1



Source: MCPL (2018)

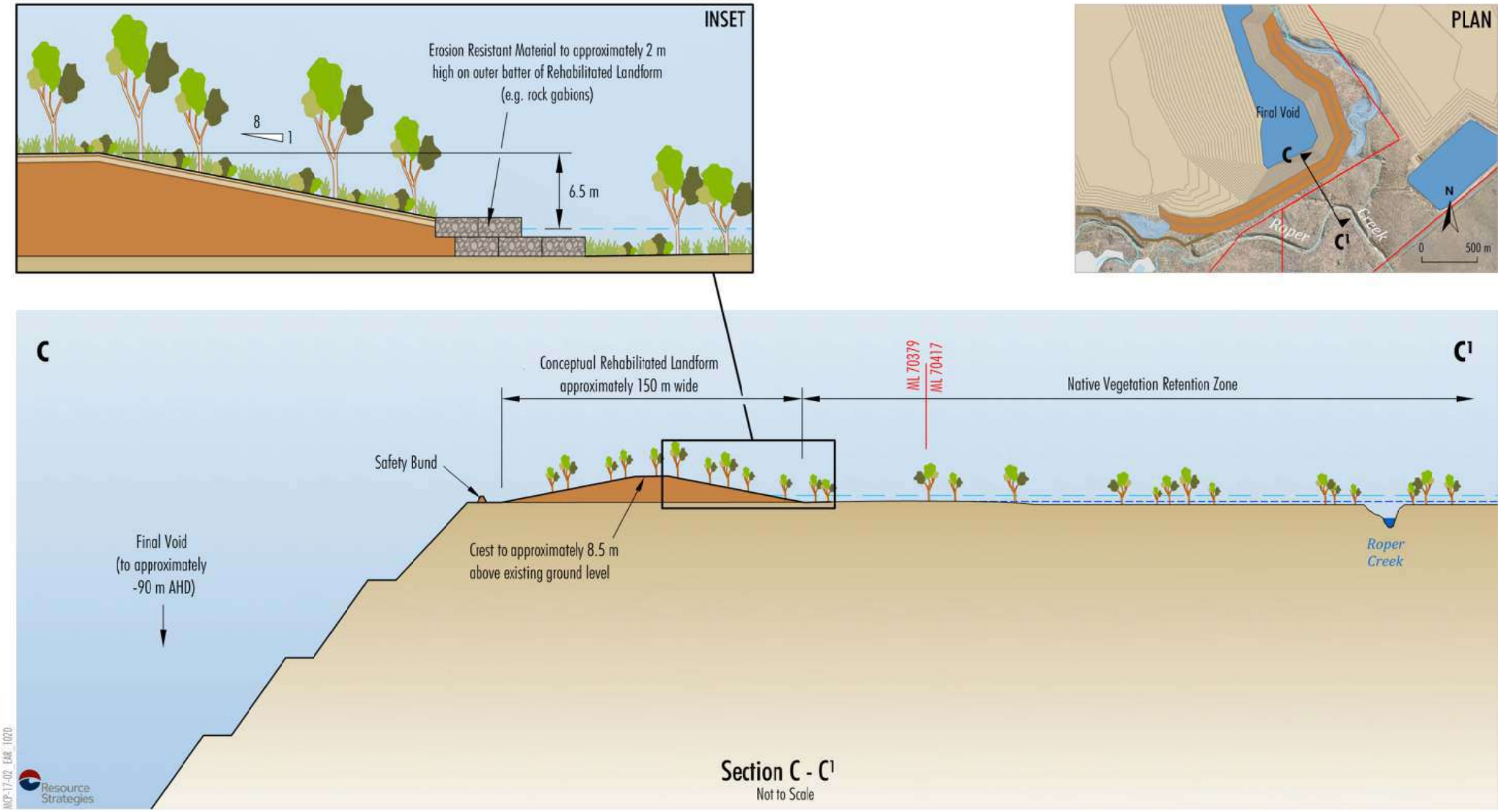
Refer Figure 4.1 for Cross Section locations.

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WESTERN EXTENSION PROJECT

Conceptual Cross Sections of the Rehabilitated Mine Landform

Figure 4.2a



LEGEND

1000 Year Flood Level (approximately 155 m AHD) (WRM, 2018)

Probable Maximum Flood (PMF) Level (approximately 156.5 m AHD) (WRM, 2018)

Source: MCPL (2018); WRM (2018)

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WESTERN EXTENSION PROJECT

Conceptual Final Landform Design Relative to the Roper Creek Floodplain

Figure 4.2b

Table 4-1
Proposed Final Land Use and Rehabilitation Criteria

Mine Domain	Projective Surface Area (ha)*	Pre-mine Land Use	Post-mine Land Suitability Classification for Cattle Grazing*	Proposed Post-mine Land Use
MIA, CHPP and roads • MIA and CHPP Area	105	Stage 1 MIA and CHPP Area	3 to 5 (as per pre-mining)	Low density beef cattle grazing or recreated Regional Ecosystem 11.5.9 (*Eucalyptus corymbia* spp. Woodland on Cainozoic sand plains/remnant surfaces).
• Roads including haul roads	48	Stage 1 roads and sparse cattle grazing on native vegetation	3 to 5 (as per pre-mining)	Retained for beneficial reuse where appropriate, or a land use conducive to the surrounding land use including recreation of: RE 11.3.2 (*Eucalyptus populnea* woodland on alluvial plains) RE 11.7.2 (*Acacia* spp. Woodland on Cainozoic lateritic duricrust. Scarp retreat zone) RE 11.5.9 (E*ucalyptus corymbia* spp. Woodland on Cainozoic sand plains/remnant surfaces).
In-pit and out-of-pit overburden spoil dumps (slopes)	495	Low density cattle grazing on native vegetation and Stage 1 bulk sample pit	5	Rock mulched surface with native grass, with exception of the slope of the southern overburden spoil dump relative to the Roper Creek Floodplain which would be native ecosystem with recreated RE 11.5.3 (*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces)
In-pit and out-of-pit overburden spoil dumps (upper surface)	1,250	As above	As above	Native ecosystem with recreated RE 11.5.3 (*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces)
Low wall spoil (above natural ground level)	229	As above	As above	Native ecosystem with recreated RE 11.5.3 on benches (*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces)
Water storage/ water management dams	85	Low density cattle grazing on native vegetation	3-4 (where rehabilitated) 5 (where retained)	Retained for beneficial reuse where appropriate, or a land use conducive to the surrounding land use, including wetlands, recreated RE 11.3.27 (Freshwater wetlands)
Creek diversions and levee banks	249	Low density cattle grazing on native vegetation	5	Retained, with recreated RE 11.3.25 (*Eucalyptus terticornis* or *E. camaldulensis* woodland fringing drainage lines) Thirteen Mile Gully Diversion would be revegetated with species characteristic of RE 11.3.1b (Open forest dominated by *Acacia harpophylla* and/or *Casuarina cristata*), RE 11.3.2c (*Eucalyptus populnea* woodlands on floodplains) and RE 11.3.25 (*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines)
TSF and TFC	24	Stage 1 TSF and TFC	5	RE 11.7.2 (*Acacia* spp. Woodland on Cainozoic lateritic duricrust. Scarp retreat zone)
Final Voids below natural ground level and all ramps	595	Low density cattle grazing on native vegetation	N/A	Final void

Highlighted cells = the proposed changes to the approved criteria under EA EPML00716913.

Note: *based on conceptual design details

**where native ecosystem is defined as reinstating land to a natural ecosystem as similar as possible to the original ecosystem.

Low density cattle grazing is assumed to be up to 3 hectare/head. Stocking rates would be revised based on field trials and establishment of reference sites during mine operation.

The DES requested (Appendix A) an assessment of how the final voids meet the existing EA conditions and the rehabilitation goals of safe, stable, non-polluting and are able to achieve a self-sustaining landform. To

this end, the following information is provided below:

- options explored to minimise the final void area and volume;
- design criteria for final voids;
- a description of the final void hydrology water level and quality and flood protection;
- a description of the final void pit wall stability; and
- description of the post closure management.

Options to Minimise the Final Void Area and Volume

The *Residual Void Study* was prepared by MCPL in 2014 to address Condition F22 of EA EPML00716913. The *Residual Void Study* (MCPL, 2014b) identified a need for two final voids located at either end of the mine path. Through detailed mine planning MCPL found that the location of the approved final void was sub-optimal because:

- the southern portion of the mine path, which would need to be mined first, has a higher strip ratio of coal, this presents the following issues:
  - ex-pit dump space would be consumed prior to mining to the final south pit highwall being completed, necessitating either additional ex-pit dumping (footprint or height) or early cut-off of mining in the south to provide an in-pit dump location, forgoing a significant portion of the coal resource; and
  - higher operational costs.
- the southern portion of the mine path would need to be mined to a final high wall, and then backfilled preventing access to any future potential coal resources to the south from the pit void (subject to relevant approvals).

The *Residual Void Study* (MCPL, 2014b) identified that the preferred option was to locate a final void at either end of the mine path and this finding remains applicable to the Project. The key reasons for this final void arrangement are to:

- maximise resource utilisation (e.g. preferential extraction of low strip ratio coal);
- produce a higher Project NPV; and
- avoid coal sterilisation as it enables access to potential coal resources to the north and south from the residual voids.

The design of the final landform has taken in to consideration the disposal of waste rock in-pit to minimise the size of the final voids where reasonable and practicable. It is not reasonable or practical to further fill in the voids because:

- the cost to rehandle spoil material from the out of pit emplacements to the final voids (to fill the voids or make them smaller) would be prohibitive; and
- rehandling spoil material from the out of pit emplacements (e.g. East Dump) (Figure 2.3) to the final voids (to fill the voids or make them smaller) would delay rehabilitation.

Design Criteria for Final Voids

The DES requested (Appendix A) details of the final area and volume of the proposed residual voids. Table 4-2 provides the approved and proposed landform design criteria, with the only changes to the characteristics of the final voids.

The proposed north void is 373 ha in area and the south void area is 222 ha. The basement rock in the void would be the same as the approved final void (i.e. base of the extracted coal seams) with the differences in void depth reflecting the change in position in the landscape (i.e. the northern void depth is 120 mbgl and the southern void depth is 240 mbgl).

Table 4-2
Approved and Proposed Landform Design Criteria

Disturbance Type	Maximum Projective Surface Area (ha)	Maximum Slope Range	Vertical Height Range (m)
Approved Criteria			
Elevated Landforms	853	< 18.5%	0-64
Infrastructure Areas	112	< 5%	0-15
Ramps into Voids	16	10%	0-250
Voids	375*	53-75%	210
Proposed Criteria			
Elevated Landforms	1,884	< 18.5%	0-64
Infrastructure Areas	112	< 5%	0-15
Ramps into Voids	16	10%	0-250
Voids	595 ha total (north void 373 ha, south void 222 ha)	53-75%	north void 120 m, south void 240 m

Highlighted cells = the proposed changes to the approved landform design criteria under EA EPML00716913.

* Note: this number is incorrect in Table F1 of EA EPML00716913 and correctly reported as 375 ha in Table F2.

Final Void Hydrology

The DES requested (Appendix A) details of how the proposed residual voids and the water contained within the proposed residual voids would not cause environmental harm. WRM has prepared a final void water balance (including groundwater input by AGE) to assess the water quality, long-term risk of discharge and flooding as part of the Surface Water Assessment (Appendix B). A summary of the outcomes of the assessment are provided below.

Water Quality

Final void water recovery analyses have been conducted as part of the Surface Water Assessment (Appendix B). The final void water recovery analyses include simulations of the long-term salinity of the final void waterbodies (Appendix B). The salinity of the final voids would gradually increase over time, however as described further below would be contained within the voids (i.e. the voids would remain as long-term groundwater sinks and would not spill [Appendix B]).

Water Level

Once mining operations cease, groundwater inflows to the final voids would no longer be collected and pumped out, and as a result, the final voids would gradually begin to fill with groundwater.

Inflows into the final void would comprise incident rainfall, runoff within the final void catchment area and groundwater (including spoil dump infiltration). The catchment area of the final void would be minimised and is defined by the surrounding landform including safety bunds and/or upslope diversion channels. The final void catchment area is shown in Surface Water Assessment (Appendix B).

Final void water recovery analyses have been conducted as part of the Surface Water Assessment (Appendix B) based on predicted groundwater inflows developed as part of the Groundwater Assessment (Appendix C). The final void waterbodies are not predicted to spill under any of the simulated climatic sequences, and the voids would remain as long-term groundwater sinks (Appendix B).

Flood Protection

The northern final void is located well beyond the current floodplain of Roper Creek.

The southern final void is located partially on the pre-mine floodplain of Roper Creek (Appendix B). As described earlier, at the completion of mining the operational flood protection levee in the south would be incorporated into the final landform to provide flood immunity up to the PMF level from Roper Creek consistent with Condition F21 of EA EPML00716913.

Figure 4.2b provides a cross-section of the conceptual final landform design relative to the Roper Creek floodplain. The conceptual final landform south of the final void would be approximately 8.5 m high and approximately 150 m wide[7] and be incorporated into the rehabilitated final landform to form a self-sustaining structure that does not require long term maintenance (Appendix B). There is at least 150 m of out-of-pit overburden area between the floodplain and the final void, which WRM (2018) (Appendix B) has assessed as more than adequate to prevent floodwater from entering the final void.

As described above, it is not reasonable or practical to further fill in the southern final void because:

- the cost to rehandle spoil material from the out of pit emplacements to the final voids (to fill the voids or make them smaller) would be prohibitive; and
- rehandling spoil material from the out of pit emplacements to the final voids (to fill the voids or make them smaller) would delay rehabilitation.

Final Void Pit Wall Stability

The *Residual Void Study* (MCPL, 2014b) included a *Residual Void Slope Stability Study* by Geotechnical Consulting Services (2014). The study included an investigation of geotechnical stability of highwall and low wall slopes, environmental stability and provides an indication of the remedial measures needed to achieve geotechnical stability. The target coal seams are truncated by the Jellinbah Fault, which is mapped to be generally coincident with the north-eastern boundary of ML 70379. It is recognised that geological faults, such as the Jellinbah Fault, can create instability where the highwall is cut in proximity to the Jellinbah Fault (Geotechnical Consulting Services, 2014). For this reason, MCPL would stand off mining from the Jellinbah Fault leaving a sufficiently thick buttress of undisturbed material.

Post Closure Management

A safety bund wall consisting of competent rock and/or fencing would be constructed to limit human and livestock/animal access. The bund wall would have a minimum height of 2 m, with a minimum base width of 4 m and be located at least 10 m beyond the area potentially affected by any instability of the open cut pit edge.

Consistent with Conditions F26 and 27 of EA EPML00716913, a Post Closure Management Plan would be prepared for the site prior to final coal processing and implemented for at least 30 years. The Post Closure Management Plan would include monitoring the integrity and stability of the final void.

Water Storage/Water Management Dams

The water storage/water management dams would be rehabilitated consistent with the description in Section 4.1.3.

Infrastructure Areas

The infrastructure areas would be rehabilitated consistent with the description in Section 4.1.3.

[7] The conceptual landform design would be finalised as part of the Post Closure Management Plan.

Rehabilitated Roper Creek Diversions

The Roper Creek Diversions would be rehabilitated consistent with the description in Section 4.1.3.

Rehabilitated Thirteen Mile Gully Diversion

The portion of Thirteen Mile Gully Diversion within ML 70379 would be rehabilitated in a manner consistent with the *Middlemount Coal Thirteen Mile Gully Diversion Design Report* (Parsons Brinkerhoff, 2012).

The portion of Thirteen Mile Gully Diversion within ML 70379 would also be revegetated with species characteristic of RE 11.3.1b (Open forest dominated by *Acacia harpophylla* and/or *Casuarina cristata*), RE 11.3.2c (*Eucalyptus populnea* woodlands on floodplains) and RE 11.3.25 (*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage features).

Rehabilitated TSFs and TFCs

In October 2017, DES requested the proposed post-mine land use for the TSFs and TFCs be revised from RE 11.5.9 (*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. Woodland on Cainozoic sand plains/remnant surfaces) as it may not be able to be recreated on the TSFs and TFCs.

The TSFs and TFCs would be covered with 1.8 m of subsoil and 200 mm of topsoil (MCPL, 2014a). The TSFs and TFCs would be revegetated with species characteristic of RE 11.7.2 (*Acacia* spp. Woodland on Cainozoic lateritic duricrust scarp retreat zone).

4.2.4 Rehabilitation Hierarchy

DES requested (Appendix A) an assessment of how the proposed rehabilitation strategy for the Project achieves the rehabilitation hierarchy detailed within the *Rehabilitation Requirements for Mining Resource Activities* (DEHP, 2014b).

The rehabilitation hierarchy is as follows, in order of decreasing capacity to prevent or minimise environmental harm (DEHP, 2014b):

1. *avoid disturbance that will require rehabilitation*
2. *reinstate a "natural" ecosystem as similar as possible to the original ecosystem*
3. *develop an alternative outcome with a higher economic value than the previous land use*
4. *reinstate previous land use (e.g. grazing or cropping)*
5. *develop lower value land use*
6. *leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.*

Table 4-3 provides an assessment of how the proposed rehabilitation strategy for the Project achieves the rehabilitation hierarchy.

4.3 GENERAL REHABILITATION PRACTICES AND MEASURES

General rehabilitation practices and measures that would be implemented for the Project are described in the following sub-sections. Rehabilitation progress and rehabilitation activities would regularly be re-evaluated and the results would inform future rehabilitation initiatives, and refinement or amendment to the practices and measures described below.

4.3.1 Vegetation Clearance Procedures

As described in Section 3.4.3, consistent with the approach currently in place at the Middlemount Coal Mine, the following measures would be implemented to manage clearing on site:

- The clearing limit would be clearly marked before clearing in order to prevent any inadvertent clearance beyond what is required and has been assessed.
- The area of clearing work is to be inspected for fauna by a fauna spotter immediately prior to commencement of any vegetation removal.

Table 4-3
Application of the Rehabilitation Hierarchy to the Project

Rehabilitation Hierarchy (DEHP, 2014b)	Existing Middlemount Coal Mine	Application to the Project
1. *avoid disturbance that will require rehabilitation*	-	Measures to avoid land clearance are described in Section 3.4.2.
2. *reinstate a "natural" ecosystem as similar as possible to the original ecosystem*	As described in Section 4.1.2, the post mining land use of all post-mine landforms, except the final void, will be low density beef cattle grazing or native ecosystem as existed prior to mining.	As per the existing Middlemount Coal Mine.
3. develop an alternative outcome with a higher economic value than the previous land use	Not proposed.	Not proposed.
4. reinstate previous land use (e.g. grazing or cropping)	As described in Section 4.1.2, the post mining land use of all post-mine landforms, except the final void, will be low density beef cattle grazing or native ecosystem as existed prior to mining.	As per the existing Middlemount Coal Mine.
5. develop lower value land use	Refer to 6.	Refer to 6.
6. leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.	As described in Section 4.1.3, the final void would partly fill with water (i.e. groundwater recovery and incident rainfall and runoff) and be subject to evapo-concentration effects which would result in the salinity gradually increasing over time. No part of the Middlemount Coal Mine following closure (including the final void which acts as a sink) is proposed to generate future pollution or adversely affect environmental values.	As per the existing Middlemount Coal Mine, with two final voids instead of one final void. The final voids would be safe, stable and non-polluting groundwater sinks and are not predicted to fill and spill. The final voids would be designed to not cause any serious environmental harm to land, surface water or groundwaters beyond the void.

- A fauna spotter is to remain on site to supervise clearing to retrieve any fauna detected during works and undertake appropriate action.

Measures described in the Middlemount Coal Species Management Program would continue to be followed.

4.3.2 Topsoil Management

Topsoil would be stripped prior to excavation of underlying overburden or emplacement of waste rock. Where the topsoil cannot be directly used for progressive rehabilitation, it would be stockpiled for use at a later date. The topsoil inventory is provided in the Plan of Operations, which would be revised to include the Project.

4.3.3 Overburden Management

Geochemical testwork has found that there is a low to negligible risk of acid mine drainage from overburden at the Middlemount Coal Mine. Notwithstanding, laboratory characterisation of overburden material during operations would be conducted to confirm acid generation potential, consistent with existing operations. Any material that is found to be potentially acid forming will not be used as capping material and would continue to be buried within the overburden dump with material that has some acid neutralising capacity (MCPL, 2011).

Overburden at the Middlemount Coal Mine has been found to be susceptible to dispersion and is erosion prone. Consistent with existing operations, testing of overburden would be conducted to identify material with a high susceptibility for dispersion and slaking. Less dispersive material would be used as capping material, where possible.

The management, placement and monitoring of mining by-products at the Middlemount Coal Mine (including overburden, tailings and other mining wastes) is undertaken in accordance with the existing *Mining By-Products Management Plan* (MCPL, 2013c).

4.3.4 Erosion and Sediment Control

Operational sediment and erosion control works would be maintained during the establishment of revegetation. However, once self-sustaining stable final landforms have been achieved within an area, key elements of the operational sediment control structures would either be retained for beneficial use or would be removed and the area would become free-draining.

4.3.5 Revegetation Program

All post-mine landforms, except final voids, would have a self-sustaining vegetation cover. Regional ecosystems proposed to be established are described in Table 4-1 and summarised in Table 4-4.

Native species to be planted in revegetation areas would be selected on a site by site basis depending on soil types, aspect and site conditions. The list of suitable plant species to be used in the revegetation of disturbance areas would be documented in the Rehabilitation Management Plan.

The rehabilitation strategy for the Project would include the rehabilitation of agricultural land suitable for grazing.

4.3.6 Land Contamination Management

Investigations would be undertaken at mine closure to identify and remediate any contaminated soil materials that may exist in accordance with the requirements under Part 8 of Chapter 7 of the EP Act or equivalent statutory provision in force at the time.

4.3.7 Rehabilitation Management

The existing *Middlemount Coal Mine Rehabilitation Management Plan* (MCPL, 2012 and 2014a) would be reviewed and revised to incorporate the Project.

4.3.8 Invasive Plant and Animal Management

Project invasive plant and animal control measures are described in Section 3.4.3. The revised Rehabilitation Management Plan would include invasive plant and animal control measures.

Table 4-4
Regional Ecosystem Targets for Mine Site Rehabilitation

RE Code	RE 11.3.1	RE 11.3.2	RE 11.5.3	RE 11.3.25	RE 11.3.27	RE 11.5.9	RE 11.7.2
Short Description	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	*Eucalyptus populnea* woodland on alluvial plains	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces	*Eucalyptus terticornis* or *E. camaldulensis* woodland fringing drainage features	Freshwater wetlands	*Eucalyptus crebra* and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains and/or remnant surfaces	*Acacia* spp. Woodland on Cainozoic lateritic duricrust scarp retreat zone

4.3.9 Bushfire Management

Bushfire management measures for the Project are described in Section 3.4.3. The revised Rehabilitation Management Plan would include bushfire management measures.

4.3.10 Post-closure Maintenance

Consistent with Conditions F26 and 27 of EA EPML00716913, a Post Closure Management Plan would be prepared for the site prior to final coal processing and implemented for at least 30 years.

4.3.11 Revegetation Schedule

In Appendix A, DES requested a schedule of progressive rehabilitation for the existing Middlemount Coal Mine and the Project that includes the total area of disturbance and all rehabilitation activities required to be completed at the existing Middlemount Coal Mine and the Project (ML70379, ML70417, ML700014 and ML700027) for the life of mine. The schedule of progressive rehabilitation is provided in Table 4-5 and shown on Figures 2.1 to 2.4.

4.3.12 Rehabilitation Monitoring

Rehabilitation monitoring would be conducted in accordance with the Rehabilitation Management Plan.

4.4 BIODIVERSITY OFFSET STRATEGY

4.4.1 Existing Offset Areas

MCPL currently has a number of existing offset areas on company-owned land which were established for various components of the Middlemount Coal Mine, including the following (Figure 4.3):

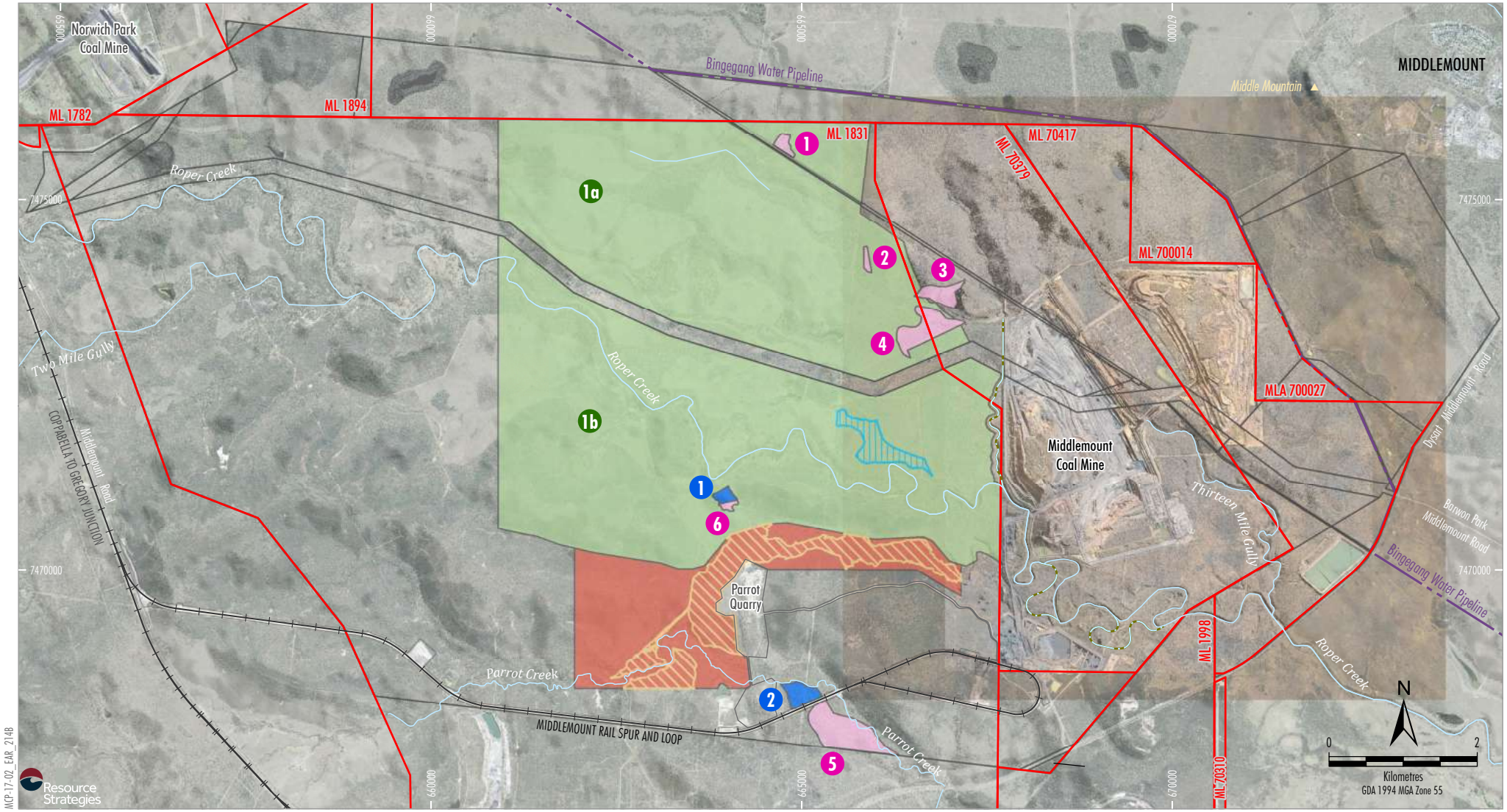
- Middlemount Coal (Stage 2) Project (EPBC 2010/5394).
- Middlemount Coal Mine Rail Loop and Spur.
- Parrot Quarry.
- Thirteen Mile Gully Diversion.
- Middlemount North-eastern Extension.

The Middlemount Coal (Stage 2) Project (EPBC 2010/5394) Offset Area is located adjacent to, and to the west of, the Middlemount Coal Mine and is comprised of two designated areas totalling approximately 3,280 ha (Plate 4-4).

The Middlemount Coal Mine Rail Loop and Spur Offset Area is comprised of six separate patches of land, five of which are connected to, or surrounded by, the Middlemount Coal (Stage 2) Project (EPBC 2010/5394) Offset Area (Figure 4.3), with the sixth area located to the south (Plate 4-5). These six areas total approximately 84.6 ha.

Table 4-5
Schedule of Progressive Rehabilitation

Calendar Year	Approved Mine		Western Extension Project (Figures 2.1 to 2.4)	
	Total Area of Disturbance (ha)	Area of Active Rehabilitation (ha)	Total Area of Disturbance (ha)	Area of Active Rehabilitation (ha)
2020	1,668	222	-	-
2023	-	-	2,265	348
2027	2,317	447	-	-
2028	-	-	2,700	821
2032	-	-	2,850	1,398
2035	2,418	641	-	-



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Coal Owned Land
- Railway

Existing/Approved Offset Areas

- Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394)
- North-eastern Extension Commonwealth Offset Area (EPBC 2016/7717)
- North-eastern Extension State Offset Area
- Parrot Quarry Offset Area (Declared Area Map 2013/3919)
- Rail Loop and Spur Offset Area
- Thirteen Mile Gully Diversion Offset Area (Declared Area Map 2013/3919)

Source: MCPL (2018); © State of Queensland (Department of Science, Information Technology and Innovation, 2017); Department of Natural Resources and Mines (2017)
Orthophoto: MCPL (June 2017, 2012)

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Existing Offset Areas

Figure 4.3



Plate 4-4 Example of Habitat in the Middlemount Coal (Stage 2) Project Commonwealth Offset Area



Plate 4-5 Example of Habitat in the Rail Loop and Spur Offset Area

Similarly, the Parrot Quarry Offset Area is comprised of two separate areas totalling approximately 15.4 ha of land and the Thirteen Mile Gully Offset Area is located wholly within the Middlemount Coal (Stage 2) Project (EPBC 2010/5394) Offset Area (Figure 4.3).

The North-eastern Extension Offset Areas are located directly to the south of the Middlemount Coal (Stage 2) Project (EPBC 2010/5394) Offset Area and comprises 532 ha of land (including 181 ha of non-remnant vegetation within the North-eastern Extension State Offset Area) (Figure 4.3).

A summary of the area of each of these existing offset areas is provided in Table 4-6.

All of the existing offset areas (except the North-eastern Extension Offset Areas) are secured via a VDec under the VM Act (Declared Area Map 2013/003919).

4.4.2 Proposed Biodiversity Offset Strategy

A proposed biodiversity offset strategy to address residual significant impacts from the Project on MSES is described in this section. The offset strategy has been developed to meet requirements under the EO Act (and subordinate legislation) and the EPBC Act.

Relevant MSES

Table 4-7 identifies the MSES relevant to the proposed biodiversity offset strategy along with the extent of clearance associated with the Project.

The MSES which are also listed under the EPBC Act (i.e. the MNES) have also been identified (and highlighted) within Table 4-7. The MNES would be offset under EPBC 2017/8130 in accordance with the *EPBC Act Environmental Offsets Policy* (DSEWPaC, 2012a) and the *EPBC Act Offsets Assessment Guide* (DSEWPaC, 2012b) as described further in Sections 4.4.2.3 and 4.4.2.4. In accordance with the *Queensland Environmental Offsets Policy* (DEHP, 2017c), the offsets for MNES are not required to be assessed by the State Government as the offsets will be assessed by the Commonwealth Government via Preliminary Documentation prepared under EPBC 2017/8130.

Table 4-6
Existing Middlemount Coal Mine Offset Areas

Offset Area (Figure 4.3)	Source of Offset Requirement	Size (ha)	Security
Middlemount Coal (Stage 2) Project Commonwealth Offset Area	EPBC 2010/5394	3,280	Declared Area Map 2013/003919
Rail Loop and Spur Offset Area	Decision Notice IC0410MKY003 Deed of Agreement	84.6	
Parrot Quarry Offset Area	DERM Permit number: 2010/003611 Deed of Agreement	15.4	
Thirteen Mile Gully Diversion Offset Area	SPA and EPBC 2010/5394*	31	
North-eastern Extension Commonwealth Offset Area	EPBC 2016/7717	532	Security due March 2019
North-eastern Extension State Offset Area	EPML00716913	181	
	Total	**4,124**	

Table 4-7
Significant Residual Impact on Matters of State Environmental Significance

Matters of State Environmental Significance		Extent of Impact (ha)
Regulated Vegetation		
Endangered (Brigalow Woodland – Category B)	RE 11.4.9 *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	0.5
Endangered (Brigalow Woodland – Category B)	RE 11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	15
Of concern	RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains	43.5
Of concern	RE 11.3.2/RE 11.3.4 *Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus tereticornis* and/or Eucalyptus spp. woodland on alluvial plains	1.5
Connectivity areas		190.5
Wetlands and watercourses		
A wetland of high ecological significance		0.75
Protected wildlife habitat		
Habitat for an animal that is vulnerable wildlife		
Ornamental Snake	Potential habitat	15.5
Greater Glider	Present	175
Koala	Present	175
Squatter Pigeon (southern)	Present	388.5
Legally secured offset area		
Stage 2 Offset Area		32
Rail Loop and Spur Offset Area		22

Table 4-8
Proposed Middlemount Coal Mine Offset Areas

Offset Area	Overall Size (ha)	Additional Area (ha) (Figure 4.4)
Western Extension Commonwealth Offset Area (EPBC 2017/8130)	1,220	1,220
Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394)	3,318	115
Western Extension State Offset Area	454	454
Modified Rail Loop and Spur Offset Area	110	45
	5,102	**1,834**

* Highlighting indicates offset areas that will be assessed under the EPBC Act (EPBC 2017/8130)

4.4.2.1 Proposed Middlemount Coal Mine Offset Areas

The proponent-driven land-based offset areas are proposed approximately 10 km south-west of the Middlemount township (Figure 4.3). All of the proposed offset areas occur within the Isaac-Comet Downs subregion of the North Brigalow Belt Bioregion, within the Fitzroy catchment and are adjacent to (or in close proximity to) the existing offset areas.

The closest State Government reserves are Bundorra State Forest located approximately 10 km south-west and Junee National Park located approximately 20 km north-east. The multiple additional areas proposed to be included in the offset strategy for the Middlemount Coal Mine cover a combined total of approximately 1,843 ha (Table 4-8), which greatly exceeds and is more than nine times the area of remnant vegetation proposed to be cleared (approximately 190.5 ha [Section 3.4.2]).

Table 4-9 provides a summary of the details of the proposed offset areas relevant to the Project. MCPL has a registered interest in the land on which the offset areas are proposed and there are no other relevant parties with registered interests under the Qld *Land Act, 1994* or the Qld *Land Title Act, 1994*.

Table 4-9
Relevant Offset Area Details

Reference	Landholder Details
Registered Owner on Title	Middlemount Coal Pty Ltd
Real Property Description	Lot 2, SP 210524 [part of]

Biodiversity Australia (2018) (Appendix 15 of Appendix D) undertook flora and fauna surveys in accordance with contemporary Qld and Commonwealth survey guidelines to assess the suitability of the proposed offset areas. Field surveys were undertaken in July and November 2017.

The flora surveys were undertaken in accordance with the Qld Herbarium vegetation survey methods described in Neldner *et al.,* (2017). Survey techniques included a combination of secondary and quaternary surveys, identification of threatened ecological communities, targeted searches for conservation significant species and random meanders.

Habitat Quality Assessments were also conducted across the offset areas in accordance with the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP, 2017b), including an assessment of required number of sampling sites, site condition assessment, site context assessment and fauna species habitat assessment. The field survey methodologies are further described in detail in Appendix 15 of Appendix D.

Table 4-10 provides a reconciliation of each MSES relevant to the Project and the extent of each matter within the proposed offset areas. As demonstrated in Table 4-10, each of the MSES relevant to the Project have been identified within the proposed offset areas at an impact to offset ratio which exceeds the minimum requirements of the *Queensland Environmental Offsets Policy* (DEHP, 2017c).

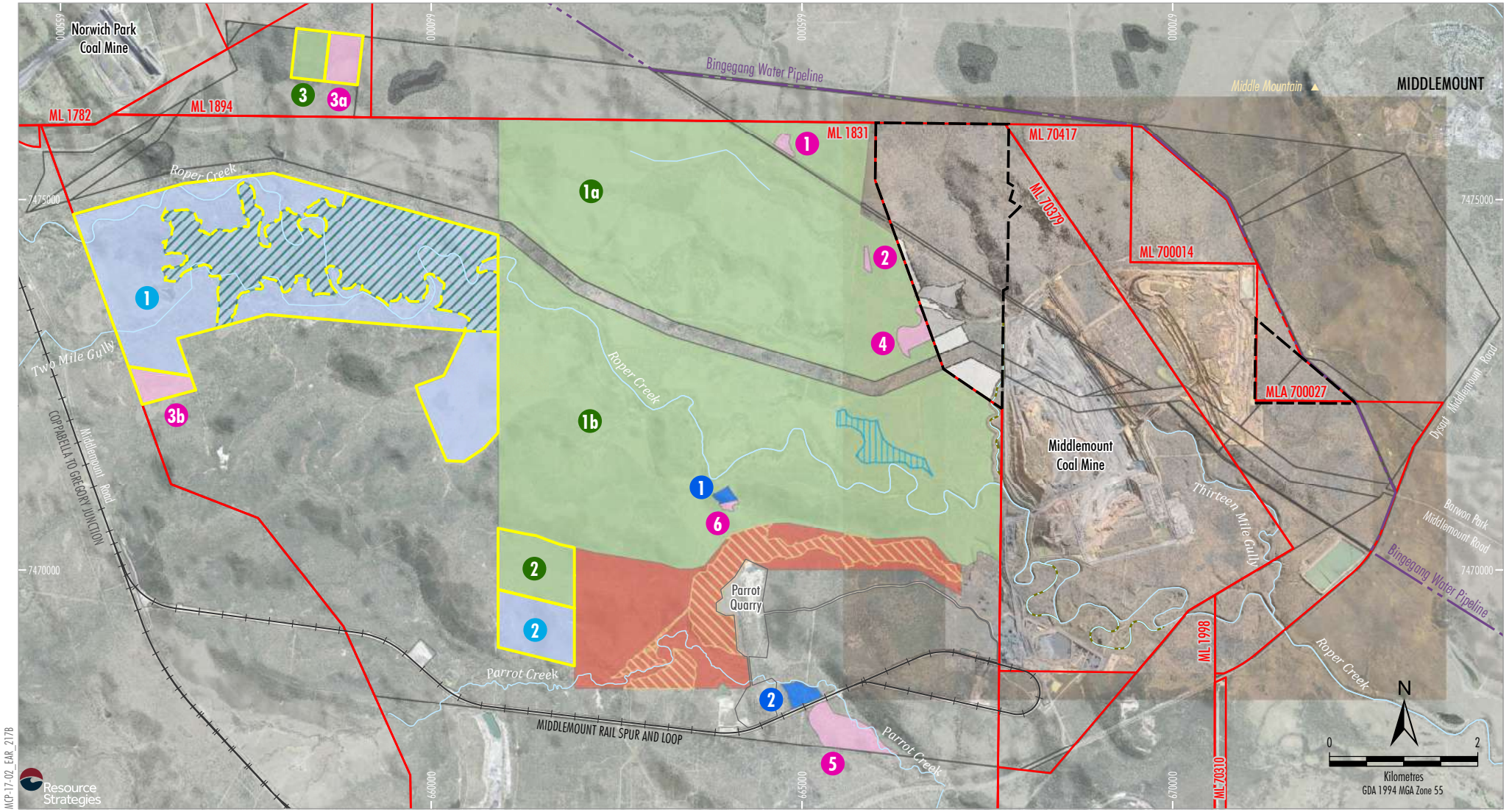
The highlighted cells in Table 4-10 indicate those MSES which are also MNES and therefore would be offset under the *EPBC Act Environmental Offsets Policy* (DSEWPaC, 2012a). For these MNES, the size of the offset was developed in accordance with the *EPBC Act Offsets Assessment Guide* (DSEWPaC, 2012b).

A description of each offset area listed in Table 4-8 is provided below.

4.4.2.2 Western Extension Commonwealth Offset Area (EPBC 2017/8130)

The proposed Western Extension Commonwealth Offset Area is located to the west and south of the existing Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394) (Figure 4.4). The Western Extension Commonwealth Offset Area is approximately 1,220 ha in size, comprising approximately 752.5 ha of remnant vegetation and approximately 444 ha of non-remnant vegetation, with the remainder of the area being mapped as cleared land.

The Western Extension Commonwealth Offset Area would offset the clearance of 22 ha of Brigalow EEC (represented by 15.5 ha of RE 11.4.9 and RE 11.3.1 as well as 6.5 ha of regrowth). The Western Extension Commonwealth Offset Area contains approximately 76 ha of Brigalow EEC (represented by RE 11.3.1, RE 11.4.8, RE 11.4.9 and RE 11.4.9a) (Figure 4.5).



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Middlemount Coal Owned Land
- Railway
- Approximate Extent of Additional Surface Disturbance

Existing/Approved Offset Areas

- North-eastern Extension Commonwealth Offset Area (EPBC 2016/7717)
- North-eastern Extension State Offset Area
- Parrot Quarry Offset Area (Declared Area Map 2013/3919)
- Thirteen Mile Gully Diversion Offset Area (Declared Area Map 2013/3919)

Removed Offset Portions

- Portion of the Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394)
- Portion of the Rail Loop and Spur Offset Area

Proposed Offset Areas

- Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394)
- Modified Rail Loop and Spur Offset Area
- Western Extension Commonwealth Offset Area (EPBC 2017/8130)
- Western Extension State Offset Area

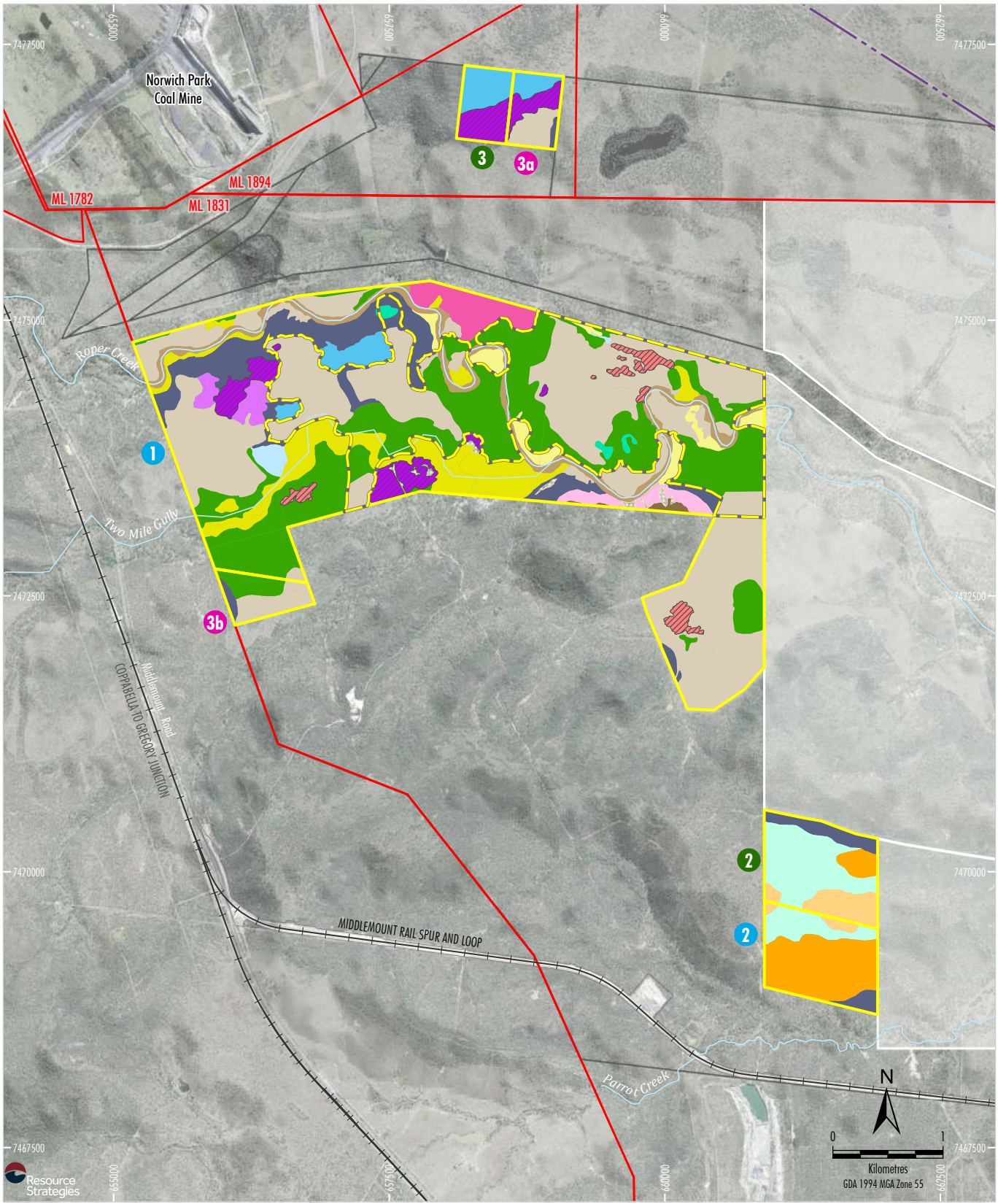
Source: MCPL (2018); Department of Natural Resources and Mines (2017); © State of Queensland (Department of Science, Information Technology and Innovation, 2017)
Orthophoto: MCPL (June 2017, 2012)

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Existing and Proposed Offset Areas

Figure 4.4



MCP-17-02_EAR_227B

Resource Strategies

LEGEND

- Mining Lease Boundary (ML)
- Railway
- Existing Offset Area
- Proposed Offset Area
- Western Extension Project State Offset Area

Regulated Vegetation
(Biodiversity Australia, 2018)

- 11.3.1
- 11.3.2
- 11.3.25
- 11.3.27d (Wetland)
- 11.3.4
- 11.3.4a
- 11.3.7
- 11.4.8
- 11.4.9
- 11.4.9a
- 11.5.18
- 11.5.2a
- 11.5.3
- 11.5.9
- 11.7.2
- 11.7.4
- Non-remnant
- Dam
- Erosion/Bare Ground

Threatened Ecological Community
(Biodiversity Australia, 2018)

- Brigalow

Source: MCPL (2018); Biodiversity Australia (2018); © State of Queensland (Department of Science, Information Technology and Innovation (2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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Proposed Offset Areas - Ground-truthed Regional Ecosystem Mapping

Figure 4.5

Table 4-10
Offset Area for Matters of State Environmental Significance

Matters of State Environmental Significance		Extent of Impact (ha)	Offset	Ratio
Regulated Vegetation				
Endangered (Brigalow Woodland – Category B)	RE 11.4.9 *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	0.5	46 ha of RE 11.4.8 and RE 11.4.9 in the Western Extension Commonwealth Offset Area	1:4
Endangered (Brigalow Woodland – Category B)	RE 11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	15	16.5 ha of RE 11.3.1 in the Western Extension Commonwealth Offset Area	
Of concern	RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains	43.5	185 ha of RE 11.3.2 within the Western Extension State Offset Area	1:4.3
Of concern	RE 11.3.2/RE 11.3.4 *Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus tereticornis* and/or Eucalyptus spp. woodland on alluvial plains	1.5	11.5 ha of RE 11.3.4 within the Western Extension State Offset Area	1:7.7
Connectivity areas		190.5	213.5 ha of non-remnant vegetation within the Western Extension State Offset Area	1:1
Wetlands and watercourses				
A wetland of high ecological significance		0.75	3 ha of wetlands within the Western Extension State Offset Area	1:4
Protected wildlife habitat				
Habitat for an animal that is vulnerable wildlife				
Ornamental Snake	Assumed presence	15.5	76 ha of habitat for this species in the Western Extension Commonwealth Offset Area	1:4.9
Greater Glider	Present	175	590 ha of habitat for this species in the Western Extension Commonwealth Offset Area	1:3.4
Koala	Present	175	683.5 ha of habitat for this species in the Western Extension Commonwealth Offset Area	1:3.9
Squatter Pigeon (southern)	Assumed presence	388.5	1,155 ha of habitat for this species in the Western Extension Commonwealth Offset Area	1:3
Legally secured offset area				
Stage 2 Offset Area		32	114 ha within the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394)	1:3.6
Rail Loop and Spur Offset Area		22	43.5 ha within the Modified Rail Loop and Spur Offset Area	1:2

Source: Appendix D.

* Highlighting indicates MNES listed under the EPBC Act

The Western Extension Commonwealth Offset Area provides an offset for the four threatened species listed in Table 4-7. Two threatened species, the Koala and Greater Glider, were recorded by Biodiversity Australia (2018) (Appendix 15 of Appendix D) within the Western Extension Commonwealth Offset Area. The other two threatened species, the Ornamental Snake and Squatter Pigeon (southern) have both been recorded in the general locality and both are considered likely to occur within the Western Extension Commonwealth Offset Area.

Table 4-11 provides a reconciliation of the area (in ha) of each MNES being impacted by the Project and the area of land which would be included in the Western Extension Commonwealth Offset Area. The *EPBC Act Offsets Assessment Guide* (DSEWPaC, 2012b) was applied by Biodiversity Australia (2018) (Appendix 15 of Appendix D).

4.4.2.3 Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394)

As detailed in Table 4-6, the Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394) covers an area of approximately 3,280 ha (Figure 4.3).

This offset area was established for the following MNES:

- Brigalow EEC;
- Squatter Pigeon (southern); and
- Ornamental Snake.

The Project would result in the removal of a small portion (approximately 32 ha, 1%) of the Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394) (Table 4-10).

The proposed Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area is shown on Figure 4.4. Two additional areas are proposed to be added to the offset area (Areas 2 and 3), located to the north-west, and south of the Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394) (Figure 4.4).

The *EPBC Act Offsets Assessment Guide* (DSEWPaC, 2012b) was applied by Biodiversity Australia (2018) (Appendix 15 of Appendix D).

Table 4-11
Suitability of the Western Extension Commonwealth Offset Area for Relevant MNES

Matters of National Environmental Significance	Conservation Status[1]	Area of Habitat to be Impacted (ha)[2]	Total Area of Existing Habitat in Offset Area (ha)[3]		Recorded in Offset Area
			Remnant Vegetation	Non-Remnant Vegetation	
Brigalow EEC	E	22	76	0	Yes
Ornamental Snake	V	15.5	76	0	No
Squatter Pigeon (southern)	V	388.5	759.5	395.5	No
Koala	V	175	683.5	0	Yes
Greater Glider	V	175	590	0	Yes

Source - Appendix D

[1] Threatened species status under the EPBC Act (current as at June 2018). E = Endangered, V = Vulnerable.

[2] Area based on ground-truthed vegetation mapping (Appendix 15 of Appendix D).

[3] Area based on ground-truthed vegetation mapping (Appendix 15 of Appendix D).

Table 4-12 provides a reconciliation of the area of MNES within the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area against the requirements of EPBC 2010/5394. With the additional offset areas, the existing requirement under the Commonwealth Approval (EPBC 2010/5394) is exceeded.

4.4.2.4 Western Extension State Offset Area

The Western Extension State Offset Area is located wholly within the Western Extension Commonwealth Offset Area. The Western Extension State Offset Area is 454 ha in size, comprising approximately 240.5 ha of remnant vegetation and 213.5 ha of non-remnant vegetation (Table 4-13).

The Western Extension State Offset Area would offset the Project's impact on:

- approximately 43.5 ha of RE 11.3.2 (an Of Concern RE);
- approximately 0.75 ha of a wetland of high ecological significance; and
- approximately 190.5 ha of remnant vegetation resulting in a significant impact on Connectivity (as determined by the DES Landscape Fragmentation and Connectivity tool).

MSES in the Western Extension State Offset Area are shown on Figures 4.6a and 4.6b.

Table 4-12
Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area

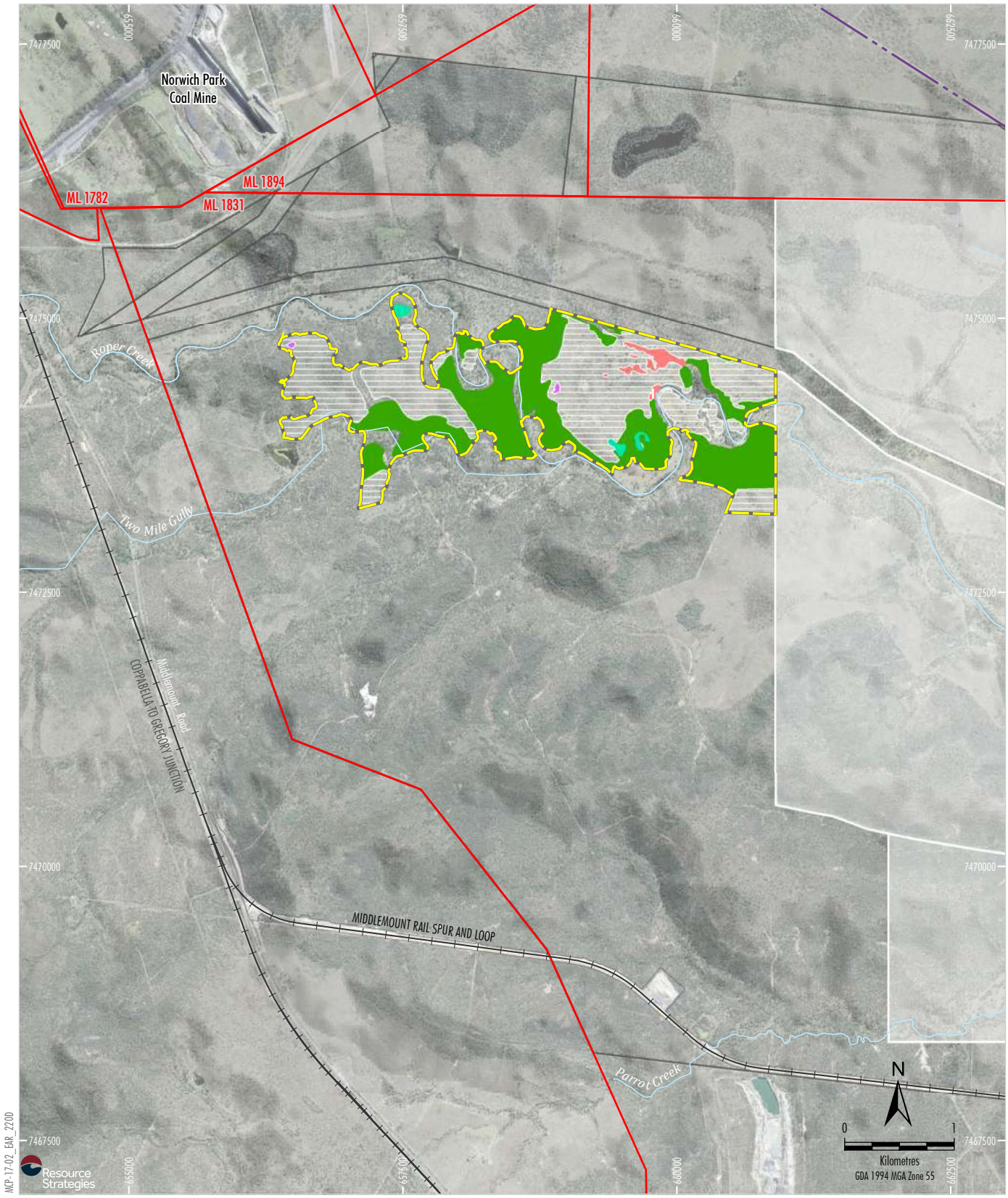
Matters of National Environmental Significance	Requirement (EPBC 2010/5394) (ha)	Revised Commonwealth Middlemount Coal (Stage 2) Project Offset Area (ha)	Additional Area provided Exceeding Requirement (EPBC 2010/5394)
Brigalow EEC	150	168.5	18.5
Ornamental Snake	1,670	1,692.5	22.5
Squatter Pigeon (southern)	3,280	3,318	38

Source - Appendix D

Table 4-13
Regional Ecosystems Mapped within the Western Extension State Offset Area

Regional Ecosystem	Short Description	Area Mapped (ha)
RE 11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open-forest on alluvial plains	8
RE 11.3.2	*Eucalyptus populnea* woodland on alluvial plains	185
RE 11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage features	17.5
RE 11.3.27d	*Eucalyptus camaldulensis* and/or *E. tereticornis* woodland. A range of sedges and grasses occur in the ground layer including *Fimbristylis vagans*, *Myriophyllum striatum, Nitella pseudoflabellata* and *Pseudoraphis sp*. Occurs fringing large lakes. Palustrine wetland (e.g. vegetated swamp).	4
RE 11.3.4/11.3.4a	*Eucalyptus tereticornis* and/or *Eucalyptus spp*. woodland on alluvial plains and *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage features	17
RE 11.4.9/11.4.9a	*Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains; and *Acacia harpophylla, Lysiphyllum carronii +/- Casuarina cristata* open forest to woodland	0.5
RE 11.5.3	*Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	8.5
	otal remnant vegetation	240.5
	Total non-remnant vegetation	213.5
	Total	**454**

Source - Appendix D



LEGEND

- Mining Lease Boundary (ML)
- Railway
- Existing Offset Area
- Western Extension Project State Offset Area

Regulated Vegetation (Biodiversity Australia, 2018)

- 11.3.1
- 11.3.2
- 11.3.27d (Wetland)
- 11.4.9
- Connectivity Area

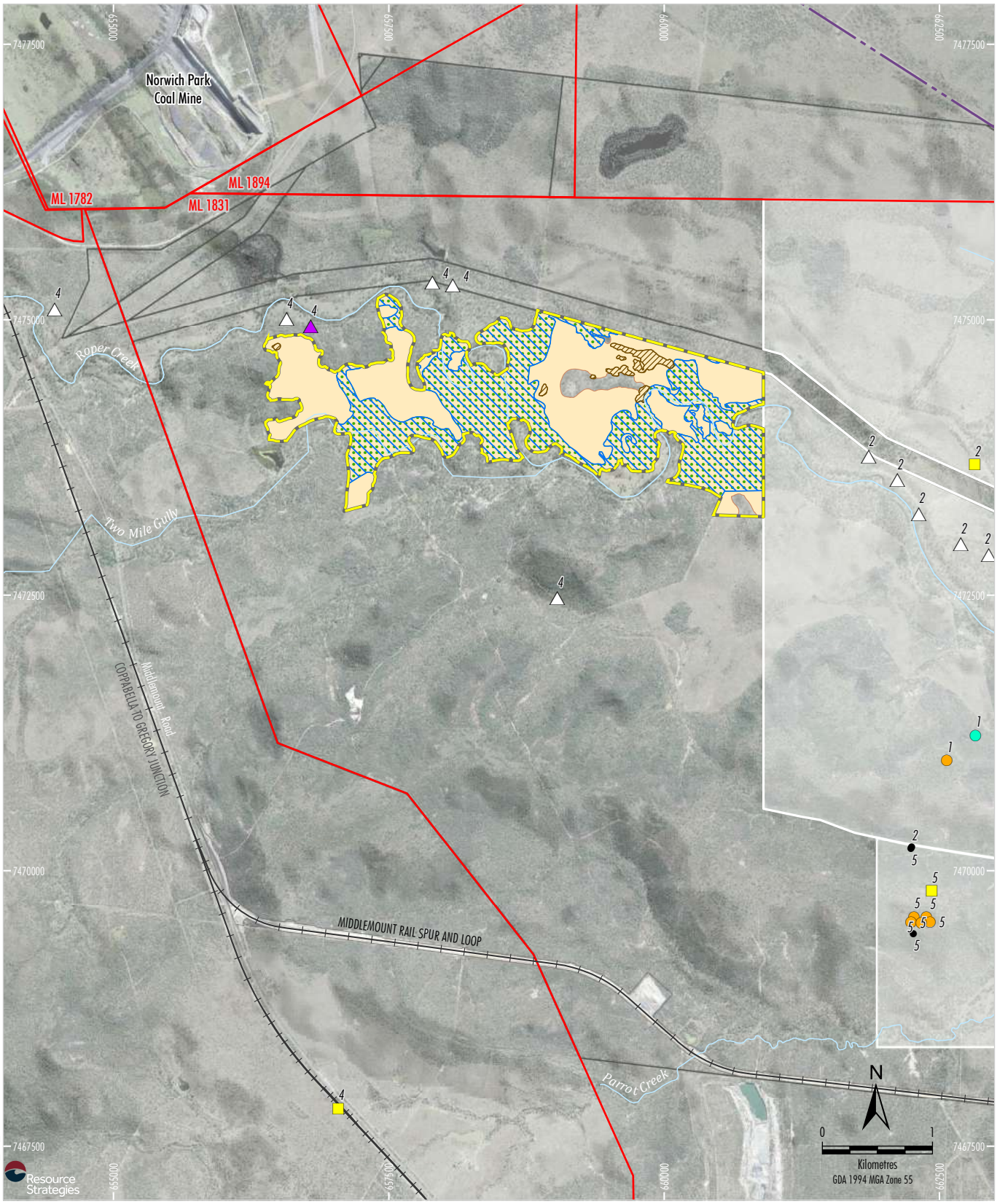
Source: MCPL (2018); Biodiversity Australia (2018); © State of Queensland (Department of Science, Information Technology and Innovation, 2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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WESTERN EXTENSION PROJECT

Matters of State Environmental Significance
Western Extension State Offset Area
- Regulated Vegetation and Connectivity Area

Figure 4.6a



LEGEND

- Mining Lease Boundary (ML)
- Railway
- Existing Offset Area
- Western Extension Project State Offset Area

Protected Wildlife Habitat Areas

- Ornamental Snake Habitat
- Greater Glider Habitat
- Koala Habitat
- Squatter Pigeon (southern) Habitat

Threatened Species Records

- Native Frangipani
- Large-podded Trefoil
- Squatter Pigeon (southern subspecies)
- Greater Glider
- Koala
- Koala Scats

Reference:
1 *Ecology and Heritage Partners (2012)*
2 *Naturecall Environmental (2014)*
3 *Parsons Brinkerhoff (2010)*
4 *Biodiversity Australia (2018)*
5 *Naturecall Environmental (2017)*

Source: MCPL (2018); Biodiversity Australia (2018); © State of Queensland (Department of Science, Information Technology and Innovation (2017); Department of Natural Resources and Mines (2016)
Orthophoto: MCPL (June 2017, 2012)

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WESTERN EXTENSION PROJECT

Matters of State Environmental Significance
Western Extension Project State Offset Area
- Protected Wildlife Habitat Areas

Figure 4.6b

As described in the *Queensland Environmental Offsets Policy* (DEHP, 2017c), the offset needs to provide:

- 1:4 ratio of an 'Of Concern' regional ecosystems:
  - of the same *broad vegetation group* as the impacted regional ecosystem;
  - of the same regional ecosystem status; and
  - within the same bioregion.
- 1:4 ratio of a wetland:
  - within the same wetland habitat type as the impacted wetland; and
  - within the same bioregion.
- 1:1 ratio of a non-remnant area (which has been previously cleared) to be revegetated in the same subregion.

Table 4-10 provides a reconciliation of the area of impact to MSES and the area of each matter located within offset areas, including the Western Extension State Offset Area. As demonstrated by Table 4-10, the Western Extension State Offset Area provides sufficient offset for the Project's significant residual impact on MSES in accordance with the *Queensland Environmental Offsets Policy* (DEHP, 2017c)[8]. The Western Extension State Offset Area contains:

- approximately 185 ha of RE 11.3.2 (greater than 1:4 ratio) (Plate 4-6);
- approximately 3 ha of wetlands (a 1:4 ratio); and
- approximately 213.5 ha of non-remnant vegetation (greater than 1:1 ratio).

Biodiversity Australia (2018) (Appendix D) (Appendix D) document that natural regeneration is occurring extensively throughout the proposed Western Extension State Offset Area.

The size of the offset areas were informed by habitat quality analysis in accordance with the *Guide to Determining Terrestrial Habitat Quality – Version 1.2* (DEHP, 2017b). In summary, the overall Habitat Quality Score for the Western Extension State Offset Area was calculated to be 6.94 in accordance with the *Guide to Determining Terrestrial Habitat Quality – Version 1.2* (DEHP, 2017b) (Appendix 15 of Appendix D). The details of this analysis are provided in Appendix 15 of Appendix D.

After 20 years, the intended conservation outcome for the non-remnant vegetation within the proposed Western Extension State Offset Area is the regeneration and re-vegetation (where needed) of approximately 190.5 ha of non-remnant vegetation to achieve:

- a habitat quality score at least 1 point greater than the impact site habitat quality score (at the time of impact);
- a habitat quality score gain of 2 points; and
- remnant status.

The habitat quality score of the impact site ranges from 5.65 to 6.92 (Appendix D) and the current habitat quality score of the proposed Western Extension State Offset Area is 6.94 (Appendix D). Given this, along with reaching remnant status, the proposed offset area would need to achieve a habitat quality score of 8.94 within 20 years.

4.4.2.5 Modified Rail Loop and Spur Offset Area

As detailed in Table 4-6, the existing Rail Loop and Spur Offset Area covers an area of approximately 84.6 ha (Figure 4.3). This offset area was established to compensate for potential significant residual impacts on the following regional ecosystems associated with the Middlemount Rail Loop and Spur:

- RE11.3.2; and
- RE 11.4.8.

[8] Also in accordance with the minor updates to the *Queensland Environmental Offsets Policy* (Department of Environment and Science, 2018c).



Plate 4-6 Example of RE 11.3.2 within the Western Extension State Offset Area



Plate 4-7 Example of RE 11.3.2 within the Modified Rail Loop and Spur Offset Area

The Project would result in the removal of approximately 22 ha of the Rail Loop and Spur Offset Area (Table 4-7), comprising approximately 10 ha of RE 11.3.2 and 12 ha of RE 11.4.8. In accordance with the *Queensland Environmental Offsets Policy* (DEHP, 2017c), MCPL would be required to provide a replacement offset (compensating for the original impact) for the clearance within the Rail Loop and Spur Offset Area.

The Modified Rail Loop and Spur Offset Area is approximately 110 ha in size. Two additional areas are proposed to be located in the Modified Rail Loop and Spur Offset Area (Areas 3a and 3b on Figure 4.4), to the north-west and west of the Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394) (Figure 4.4). The two additional areas comprise of approximately 32 ha of remnant vegetation (including approximately 10.5 ha of RE 11.3.2 [Plate 4-7], and 16 ha of RE 11.4.8/RE 11.4.9) and 11.5 ha of non-remnant vegetation (Appendix D).

Biodiversity Australia (2018) (Appendix D) also conducted a habitat quality analysis of the vegetation communities within the Modified Rail Loop and Spur Offset Area in accordance with the *Guide to Determining Terrestrial Habitat Quality – Version 1.2* (DEHP, 2017b). The details of this analysis are provided in Appendix D.

In summary, the overall Habitat Quality Score for the Modified Rail Loop and Spur Offset Area is 5.91 in accordance with the *Guide to Determining Terrestrial Habitat Quality – Version 1.2* (DEHP, 2017b) (Appendix D).

4.4.3 Offset Security

MCPL has consulted with DNRM regarding the long-term security of the proposed offset areas. Consistent with the existing offset area, MCPL would seek to secure the proposed offset area through a VDec under the VM Act. It is intended that the VDec would cover all of the existing and proposed offset areas (Figure 4.4; Table 4-14).

4.4.4 Offset Management

It is intended that the existing/approved *Middlemount Coal Mine Offset Management Plan/Vegetation Management Plan* (MCPL, 2013a) (covering all existing/approved offset areas except north-eastern extension offset areas [Table 4-6]) would be reviewed and revised to include all of the existing and proposed offset areas (Table 4-14).

Consistent with the existing/approved offset areas, the primary method for regenerating the proposed offset area would be through the management of threatening processes that inhibit natural regeneration. In this regard, the likely management measures that would be developed for the proposed offset area include (but are not limited to) the following:

- On-ground set up of the proposed offset area (e.g. fencing, installing locked gates, signage, access tracks).
- Weed Management Strategy.
- Vertebrate Pest Management Strategy.
- Fire management.
- Management of livestock.

In the unlikely event that natural regeneration is not readily occurring or species composition is poor, active seeding/planting would be undertaken as needed.

Table 4-14
Existing and Proposed Middlemount Coal Mine Offset Areas

Offset Area (Figure 4.4)	Source of Offset Requirement	Size (ha)	Source
Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area	EPBC 2010/5394	3,318	Table 4-8
Modified Rail Loop and Spur Offset Area	Decision Notice IC0410MKY003 Deed of Agreement	110	Table 4-8
Parrot Quarry Offset Area	DERM Permit number: 2010/003611 Deed of Agreement	15.4	Table 4-6
Thirteen Mile Gully Diversion Offset Area	SPA and EPBC 2010/5394*	31	Table 4-6
North-eastern Extension Commonwealth Offset Area	EPBC 2016/7717	532	Table 4-6
North-eastern Extension State Offset Area	EPML00716913	181	Table 4-6
Western Extension Commonwealth Offset Area	EPBC 2017/8130	1,220	Table 4-8
Western Extension State Offset Area	EPML00716913	454	Table 4-8
	Total	**5,861**	

5 SUMMARY OF ENVIRONMENTAL MANAGEMENT COMMITMENTS

This section provides a consolidated summary of proposed environmental management commitments, including mitigation, monitoring and reporting for the Project.

The existing environmental management systems at the Middlemount Coal Mine include environmental management plans and programs that have been developed and implemented since operations commenced. Existing management plans and programs include:

- Environmental Management Plan;
- Risk Management System;
- Emergency Response/Contingency Plan;
- Plan of Operations;
- Topsoil Management Plan;
- Rehabilitation Management Plan;
- Residual Void Study;
- Residual Void Water Quality Management Study;
- Post Closure Management Plan;
- Water Management Plan;
- Receiving Environment Monitoring Program;
- Erosion and Sediment Control Plan;
- Offset Management Plan/Vegetation Management Plan;
- Species Management Program; and
- CHMPs.

MCPL would continue to implement the existing plans and programs and where necessary, review, revise and build on them. A summary of these measures and the associated reporting is provided in Table 5-1.

Table 5-1
Summary of Management, Monitoring and Reporting Commitments

Proposed Management, Monitoring and Reporting	EAR Section Reference
Land	
• The Project would be rehabilitated to be safe, stable and non-polluting and able to support and sustain the proposed post-mining land use of low density beef cattle grazing or native ecosystem. Progressive rehabilitation (with selected tree and pasture species) of Project landforms would reduce the contrast between the Project landforms and the surrounding environment. • Continued implementation of soil resource management measures to maximise soil resources available for rehabilitation. • On-site consumable storage areas would be operated, where applicable, in compliance with the requirements of AS 1940-2017 The Storage and Handling of Flammable and Combustible Liquids and AS 2187.1 Explosives – Storage, Transport and Use – Storage. • Off-site light emissions from the Project would be minimised by select placement, configuration and direction of lighting.	Section 3.1.3
Surface Water	
• Site water management and monitoring would be conducted in accordance with a revised Water Management Plan. • Controlled releases would continue to be undertaken for the Project in accordance with the EA criteria. • Routine surface water quality monitoring would continue to be undertaken for receiving waters and additional locations monitored. • Consistent with the approved mine, the flood protection levee that would exist during mining operations would be incorporated into the waste rock emplacement to form a stable and self-sustaining final landform that does not require long-term maintenance. This final landform would be designed to be considerably higher (approximately 6.5 m) than the probable maximum flood (PMF) Level.	Sections 3.2.3 and 4.2.3

Table 5-1 (Continued)
Summary of Management, Monitoring and Reporting Commitments

Proposed Management, Monitoring and Reporting	EAR Section Reference
Surface Water (Continued)	
• The stability of the final landform relative to Roper Creek would be enhanced by incorporating erosion resistant material (e.g. rock gabion) into the batter slope to approximately 2 m height (to the PMF Level) and rehabilitating the surface of the landform with rock mulch and seeding/planting with tree, shrub and grass species characteristic of RE 11.5.3.	Sections 3.2.3 and 4.2.3
Groundwater	
• Ongoing groundwater level and quality monitoring within and surrounding the mine site. • Expansion of existing groundwater level and quality monitoring program to include additional bores outside of the current mine area.	Section 3.3.3
Biodiversity	
• Implementation land clearance measures to minimise impacts on fauna. • The upper surface of the waste rock emplacements would be revegetated with species characteristic of RE 11.5.3, as it is the most predominant RE within the Project area. • Implementation of a Species Management Program under section 332 of the *Nature Conservation [Wildlife Management] Regulation 2006* as required. • Implementation of weed and feral animal control measures in accordance with a revised Environmental Management Plan. • A biodiversity offset strategy (in addition to the existing strategy for the existing/approved Middlemount Coal Mine) would greatly exceed the area of remnant vegetation proposed to be cleared.	Sections 3.4.4 and 4.4.2
Air Quality	
• Continued implementation of dust management and mitigation measures such as watering of haul roads and stockpiles, and progressive rehabilitation. • In the event of an air quality-related complaint, air quality monitoring would be conducted at the relevant sensitive place to validate the model predictions and inform the implementation of air quality mitigation measures, if required. • MCPL would continue to implement measures to minimise the generation of GHG emissions including procurement policies that require the selection of energy efficient equipment and vehicles, monitoring and maintenance of mobile equipment and optimisation of diesel consumption through logistics analysis and planning.	Section 3.5.3
Noise and Vibration	
• Continued implementation of noise management and mitigation measures including maintaining all equipment in good order. • In the event of a noise-related complaint, noise monitoring would be conducted to validate the model predictions and inform the implementation of noise mitigation measures, if required, where noise objectives are exceeded. In this instance, noise mitigation measures would be investigated in consultation with the noise sensitive receptor. • With regard to the predicted possible noise exceedance at the "Tralee 2" receiver, simple noise reduction strategies would be investigated, such as limiting the use of the nearest haul routes and fixed plant items during night time periods.	Section 3.6.3
Aboriginal Cultural Heritage	
• Any potential impacts to indigenous cultural heritage would be managed in accordance with the CHMPs.	Section 3.8
Community	
• MCPL would continue to engage with community and track consultation activities in a Consultation and Complaint/Incident Register.	Section 1.5

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APPENDIX A

MIDDLEMOUNT COAL – DEPARTMENT OF ENVIRONMENT & SCIENCE INFORMATION REQUEST

Table 3-7-1
Middlemount Coal – Department of Environment & Science Information Request

Section	Requested Information	Reference
1	*Environmental Values* *Middlemount Coal Mine has included a brief assessment of the environmental values proposed to be impacted by the Extension project in the section 226 report supporting the amendment application. The section 226 report outlines the environmental values that have the potential to be impacted by the activities associated with the extension, however details of how these impacts will be managed are minimal.* *Further to the information provided within the section 226 report, provide a detailed assessment of the Extension project's impacts to environmental values, including:*	
	a) An assessment of water (surface and groundwater) environmental values impacted or that have potential to be impacted by the Extension project, including any proposed management practices and impact mitigation strategies.	Sections 3.2 and 3.3, Appendices B and C, Attachment A
	b) An assessment of land environmental values impacted or that have potential to be impacted by the Extension project, including any proposed management practices and impact mitigation strategies.	Section 3.1
	c) An assessment of biodiversity environmental values impacted or that have potential to be impacted by the Extension project, including any proposed management practices and impact mitigation strategies.	Section 3.4, Appendix D
	d) An assessment of air environmental values impacted or that have potential to be impacted by the Extension project, including any proposed management practices and impact mitigation strategies.	Section 3.5, Appendix E
	e) An assessment of noise (acoustic) environmental values impacted or that have potential to be impacted by the Extension project, including any proposed management practices and impact mitigation strategies.	Section 3.6, Appendix F
	f) An assessment of social (community) environmental values impacted or that have potential to be impacted by the Extension project, including any proposed management practices and impact mitigation strategies.	Section 3.7
2	*Rehabilitation* *Middlemount Coal Mine's existing rehabilitation requirements and criteria are proposed to extend to the Extension project, with minor amendments to final land use and rehabilitation approval schedules and associated Middlemount Coal Mine procedures and management plans.* *Further to the information supplied as part of the section 226 report, provide:*	
	a) An assessment of how the proposed rehabilitation strategy for the Extension project achieves the rehabilitation hierarchy detailed within the Departmental Guideline, Rehabilitation requirements for mining resource activities (EM1122)	Section 4.2.4
	b) Details of any areas that are not likely, or are unable, to meet the requirements of the existing EA conditions.	Sections 4.1.2, 4.1.3 and 4.2 (particularly Tables 4-1 and 4-2)
	c) An assessment of how the proposed residual void option meets the existing EA conditions and the rehabilitation goals of safe, stable, non-polluting and are able to achieve a self-sustaining landform.	Section 4.2.3

Table 3-7-1 (Continued)
Middlemount Coal – Department of Environment & Science Information Request

Section	Requested Information	Reference
	d) A table of the rehabilitation goals and objectives, indicators and rehabilitation success criteria (completion criteria) for each domain, and incorporating the Extension project, in accordance with the Departmental Guideline, Rehabilitation requirements for mining resource activities (EM1122).	Appendix G
	e) Details of the final area and volume of the proposed residual voids.	Section 3.2.3, Table 4-2, Appendix B
	f) A schedule of progressive rehabilitation for the existing Middlemount Coal Mine and the proposed Extension Project that includes: *i. The total area of disturbance and all rehabilitation activities required to be completed at the existing Middlemount Coal Mine and the Extension project (ML70379, ML70417, ML700014 and ML700027) for the life of mine.* *ii. Timeframes associated with the rehabilitation activities in section 2, part f (i) of this information request.*	Section 4.3.11, Table 4-5
3	*Biodiversity & Offsets* *The Extension project proposes to impact on existing offset areas, Matters of State Environmental Significance (MSES) and Matters of National Environmental Significance (MNES). Further to the information supplied as part of the Section 226 report, provide:*	
	a) An assessment of the impacted MSES and MNES, outlining the actions taken to meet requirements under the Environmental Offsets Act, 2014 (and subordinate legislation) and Environmental Protection Biodiversity Conservation Act, 1999.	Section 4.4 and Appendix D
	b) Shapefiles of the ground-truthed MSES and MNES, shape files of the proposed MSES and/or MNES offset areas and shape files of the modified existing offset areas.	Provided separately to DES
	c) An assessment of the availability of suitable offset areas for the MNES and MSES to be impacted.	Section 4.4 and Appendix D
4	*Surface Water & Groundwater* *Further to the information supplied in the section 226 report, provide:* *a) Details of how the Extension project will be incorporated into the existing site water management plan.*	Section 3.2.3
	b) A revision of the site water balance model that incorporates the Extension project.	Section 3.2 and Appendix B
	c) Existing and predicted mine affected water quality within individual water storages and the level to which this water quality achieves the existing mine affected water quality release criteria.	Section 3.2 and Appendix B
	d) Details of how the proposed residual voids and the water contained within the proposed residual voids will not cause environmental harm.	Section 4.2.3, Appendices B and C
	e) Details of how residual voids will be protected from flood inundation.	Sections 3.2, 3.3 and 4.2.3, Appendices B and C
	f) Total volume of water expected within each residual void at the end of mining.	Section 3.2.3 and Appendix B
	g) Revised flood modelling data incorporating the Extension project.	Section 3.2 and Appendix B
	h) Conceptual water management infrastructure designs incorporating the Extension project.	Figure 1.3 and Appendix B

Table 3-7-1 (Continued)
Middlemount Coal – Department of Environment & Science Information Request

Section	Requested Information	Reference
	i) A surface water assessment that identifies the chemical and physical properties of surface water within the Extension project area and evaluates data against existing release criteria.	Appendix B
	j) A groundwater assessment that identifies the chemical and physical properties of ground water within the Extension project area and evaluates data against existing trigger criteria.	Appendix C and Attachment A

APPENDIX B

SURFACE WATER ASSESSMENT

Middlemount Coal Mine

Western Extension Project
Surface Water Impact Assessment

Middlemount Coal Pty Ltd

0469-17-E10, 3 September 2018

Report Title	Middlemount Coal Mine Western Extension Project Surface Water Impact Assessment
Client	Middlemount Coal Pty Ltd
Report Number	0469-17-E10

For and on behalf of WRM Water & Environment Pty Ltd
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703 Brisbane Adelaide St Qld 4000
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Greg Roads
Director

NOTE: This report has been prepared on the assumption that all information, data and reports provided to us by our client, on behalf of our client, or by third parties (e.g. government agencies) is complete and accurate and on the basis that such other assumptions we have identified (whether or not those assumptions have been identified in this advice) are correct. You must inform us if any of the assumptions are not complete or accurate. We retain ownership of all copyright in this report. Except where you obtain our prior written consent, this report may only be used by our client for the purpose for which it has been provided by us.

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1 Introduction

1.1 BACKGROUND

Middlemount Coal Pty Ltd (MCPL) owns and operates the Middlemount Coal Mine, an existing open cut coal mine, located approximately 7 kilometres (km) to the south-west of the Middlemount township within the Isaac Regional Local Government Area, Queensland. The location of the mine is shown in Figure 1.1.

The Middlemount Coal Mine Environmental Authority (EA) was amended on 29 June 2012 to approve the expansion of open cut mining operations within Mining Leases (ML) 70379 and 70417 (referred to as "Stage 2" of the Middlemount Coal Mine).

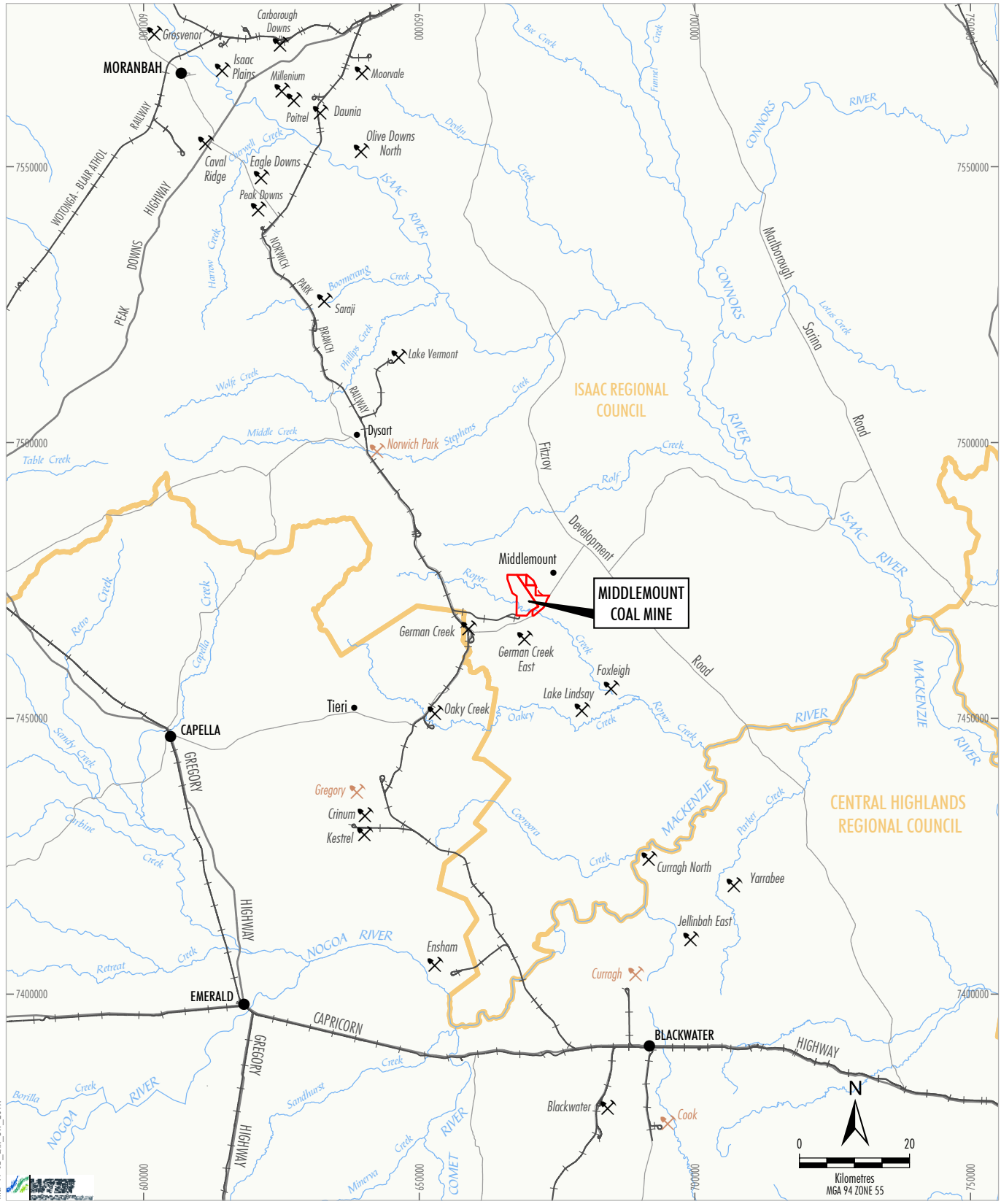
Stage 2 allows for open cut mining of run-of-mine (ROM) coal up to 24 hours per day, seven days per week, using a conventional truck and shovel fleet at a rate of up to 5.4 million tonnes per annum (Mtpa). ROM coal is mined in a general west to east direction within ML 70379, with overburden and interburden material emplaced in-pit behind the advancing open cut operations, and within the East Dump, located within ML 70417. ROM coal is processed through a coal handling and preparation plant (CHPP) to produce up to 4.1 Mtpa of Pulverised Coal Injection (PCI) and coking coal for the export market. Product coal is transported by rail to the Dalrymple Bay Coal Terminal and Abbot Point Coal Terminal.

An amendment to the Middlemount Coal Mine EA was granted on 23 September 2016 to extend the East Dump beyond part of the eastern extent of ML 70417 to alleviate the "saw tooth" layout of the currently approved dump design. This was the granting of ML700014 in February 2017. The layout of the approved final landform for Middlemount Coal Mine is shown in Figure 1.2.

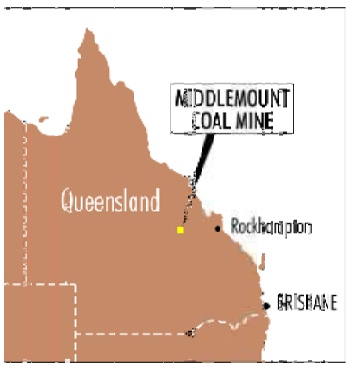
1.2 PROJECT DESCRIPTION

MCPL is seeking Queensland Government and Commonwealth Government approval for changes to the approved Middlemount Coal Mine, herein referred to as the Western Extension Project (the Project). The main activities associated with the development of the Project would include:

- extension of the open cut pit within ML 70379 to the north-west;
- continued extraction of ROM coal at up to 5.7 Mtpa using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (Eastern Dump) and within the mined-out void;
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility (TSF) cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure (including a CHPP and ROM and product coal stockpiles);
- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;



MCP-17-02_EAR_SW_201A



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Local Government Area Boundary
- Approved/Operating Coal Mine
- Under Care and Maintenance

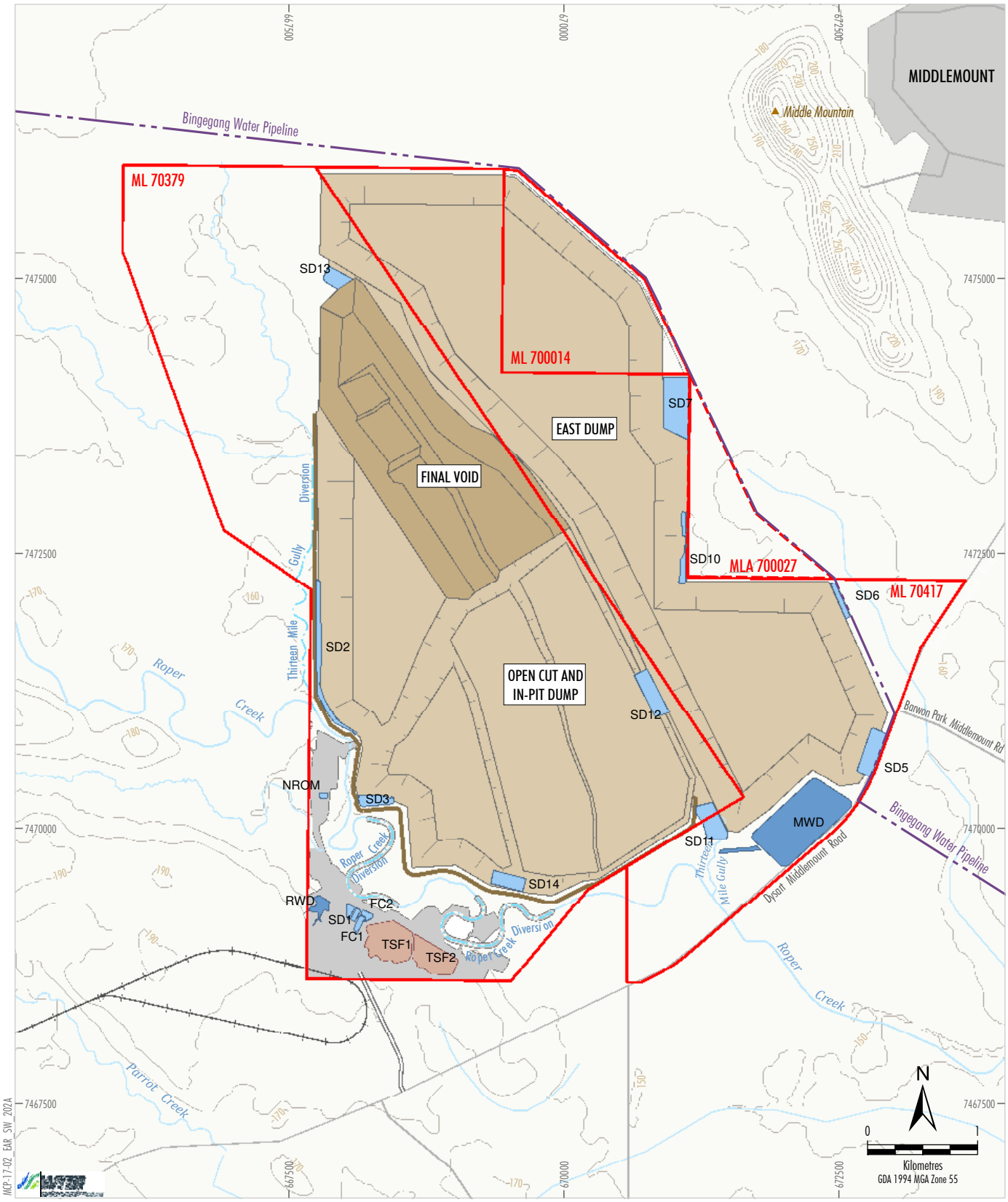
Source: Department of Natural Resource and Mines (2017); Geoscience (2011)

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WESTERN EXTENSION PROJECT

Regional Location

Figure 1.1



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)

Currently Approved General Arrangement

- Mine Infrastructure Area
- Mining Pit and Spoil
- Final Void
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

Source: MCPL (2018); Department of Natural Resources and Mines (2017); Environmental Authority (EPML00716913) MCPL

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WESTERN EXTENSION PROJECT

Existing/Approved Middlemount Coal Mine General Arrangement

Figure 1.2

- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

The proposed general layout of Middlemount Coal Mine in 2023, 2028, 2033 and for the final landform are shown in Figures 1.3 to 1.6.

1.3 INDEPENDENT EXPERT SCIENTIFIC COMMITTEE GUIDELINES

The Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development gas information guidelines (IESC, 2018) for advice on coal seam gas and large coal mining development proposals. The report sections where the IESC information requirements for individual proposals have been addressed are outlined in Table 1.1

Table 1.1- IESC information requirements

Project information	Report section
Description of the proposal	
Provide a regional overview of the proposed project area including a description of the geological basin; coal resource; surface water catchments; groundwater systems; water-dependent assets; and past, current and reasonably foreseeable coal mining and CSG developments.	Sections 1, 2, 3 & 4
Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Sections 1, 4 & 5
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies.	Refer to Main Report
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 2.7 & 2.8
Surface water - context and conceptualisation	
Describe the hydrological regime of all watercourses, standing waters and springs across the site including:	
• geomorphology, including drainage patterns, sediment regime, and floodplain features;	Section 2.2
• spatial, temporal and seasonal trends in streamflow and/or standing water levels;	Section 2.3
• spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides); and	Section 2.6
• current stressors on watercourses, including impacts from any currently approved projects.	Section 2.7
Describe the existing flood regime, including flood volume, depth, duration, extent and velocity for a range of annual exceedance probabilities. Provide flood hydrographs and maps identifying peak flood extent, depth and velocity. This assessment should be informed by topographic data that has been acquired using lidar or other reliable survey methods with accuracy stated.	Appendix B Section 7

Provide an assessment of the frequency, volume, seasonal variability and direction of interactions between water resources, including surface water/groundwater connectivity and connectivity with sea water.	Refer to Groundwater Report
Surface water – analytical and numerical modelling	
Provide conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	Appendix A, Appendix B, Sections 5 & 7
Use methods in accordance with the most recent publication of *Australian Rainfall and Runoff* (Ball et al. 2016).	Appendix B
Develop and describe a program for review and update of the models as more data and information becomes available.	Appendix A1
Describe and justify model assumptions and limitations, and calibrate with appropriate surface water monitoring data.	Appendix A8 & Appendix B2.3
Provide an assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	Section 5.5
Provide a detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Models verified against historical data Appendix A8
Surface water – impacts to water resources and water-dependent assets	
Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact to the resource, the resultant impact to any assets dependent on the resource (including water-dependent ecosystems such as riparian zones and floodplains), and the consequence or significance of the impact. Consider:	
• impacts on streamflow under the full range of flow conditions.	Section 7
• impacts associated with surface water diversions.	Section 6
• impacts to water quality, including consideration of mixing zones.	Section 8
• the quality, quantity and ecotoxicological effects of operational discharges of water (including saline water), including potential emergency discharges, and the likely impacts on water resources and water-dependent assets.	Section 5.3 & 8
• landscape modifications such as subsidence, voids, post rehabilitation landform collapses, onsite earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks) and how these could affect surface water flow, surface water quality, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	Section 5.4 & 7.5
Discuss existing water quality guidelines, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	Section 2.8
Identify processes to determine surface water guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts to assets.	Section 4.2 & 4.3
Propose mitigation actions for each identified significant impact.	Section 4
Describe the adequacy of proposed measures to prevent or minimise impacts on water resources and water-dependent assets.	Section 5

Describe the cumulative impact of the proposal on surface water resources and water-dependent assets when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 9
Provide an assessment of the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power), and impacts to ecosystems, project infrastructure and the final project landform.	Section 7
Surface water – data and monitoring	
Identify monitoring sites representative of the diversity of potentially affected water-dependent assets and the nature and scale of potential impacts, and match with suitable replicated control and reference sites (BACI design) to enable detection and monitoring of potential impacts.	Section 3.4
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 3.4
Identify data sources, including streamflow data, proximity to rainfall stations, data record duration and a describe of data methods, including whether missing data has been patched.	Section 2.3
Develop and describe a surface water monitoring programme that will collect sufficient data to detect and identify the cause of any changes from established baseline conditions, and assess the effectiveness of mitigation and management measures. The program will: • include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g. metals); • comparison of physico-chemical data to national/regional guidelines or to site-specific guidelines derived from reference condition monitoring if available; and, • identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction if required.	Section 3.4
Describe the rationale for selected monitoring parameters, duration, frequency and methods, including the use of satellite or aerial imagery to identify and monitor large-scale impacts.	Section 3.4
Develop and describe a plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate.	Not required
Identify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology throughout the life of the proposed project and beyond.	Section 3.4
Water-dependent assets – context and conceptualisation	
Identify water-dependent assets, including:	Section 2.8
• water-dependent fauna and flora and provide surveys of habitat, flora and fauna (including stygofauna) (see Doody et al. [in press]). • public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.	Refer to Ecology report
Identify GDEs in accordance with the method outlined by Eamus et al. (2006). Information from the GDE Toolbox15 (Richardson et al. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody et al. [in press]).	Refer to Groundwater Report
Describe the conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	Refer to Groundwater Report

Estimate the ecological water requirements of identified GDEs and other water-dependent assets (see Doody et al. [in press]).	Refer to Groundwater Report
Identify the hydrogeological units on which any identified GDEs are dependent (see Doody et al. [in press]).	Refer to Groundwater Report
Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Section 2.8
Describe the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	Section 4.5.2
Water-dependent assets – impacts, risk assessment and management of risks	
Provide an assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs (see Doody et al. [in press]).	Refer to Groundwater Report
Describe the potential range of drawdown at each affected bore, and clearly articulate the scale of impacts to other water users.	Refer to Groundwater Report
Indicate the vulnerability to contamination (e.g. from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	Section 2 & 3
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	Section 5.4
Provide estimates of the volume, beneficial uses and impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	Section 8.3
Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Section 8
Identify the proposed acceptable level of impact for each water-dependent asset based on leading-practice science and site-specific data, and ideally developed in conjunction with stakeholders.	Section 4.5.2
Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	Section 8
Water-dependent assets – data and monitoring	
Identify an appropriate sampling frequency and spatial coverage of monitoring sites to establish pre-development (baseline) conditions, and test potential responses to impacts of the proposal (see Doody et al. [in press]).	Section 4.5.2 and Section 10
Consider concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design, see Doody et al. [in press]).	
Develop and describe a monitoring program that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in ecological responses and detects whether ecological responses are within identified thresholds of acceptable change (see Doody et al. [in press]).	
Describe the process for regular reporting, review and revisions to the monitoring program.	

Ensure ecological monitoring complies with relevant state or national monitoring guidelines (e.g. the DSITI guideline for sampling stygofauna (QLD Government 2015)).	
Water and salt balance, and water management quality	
Provide a quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc.), including all sources and uses.	Section 7 & Appendix A
Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Section 7 & Appendix A
Provide estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	Section 7 & Appendix A
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	Section 7 & Appendix A
Cumulative impacts – context and conceptualisation	
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 9
Consider all past, present, and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 9
Cumulative impacts – impacts	
Provide an assessment of the condition of affected water resources which includes: • identification of all water resources likely to be cumulatively impacted by the proposed development; • a description of the current condition and quality of water resources and information on condition trends; • identification of ecological characteristics, processes, conditions, trends and values of water resources; • adequate water and salt balances; and • identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	Section 9
Assess the cumulative impacts to water resources considering: • the full extent of potential impacts from the proposed project, (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally; • all stages of the development, including exploration, operations and post closure/decommissioning; • appropriately robust, repeatable and transparent methods; • the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts; and	Section 9

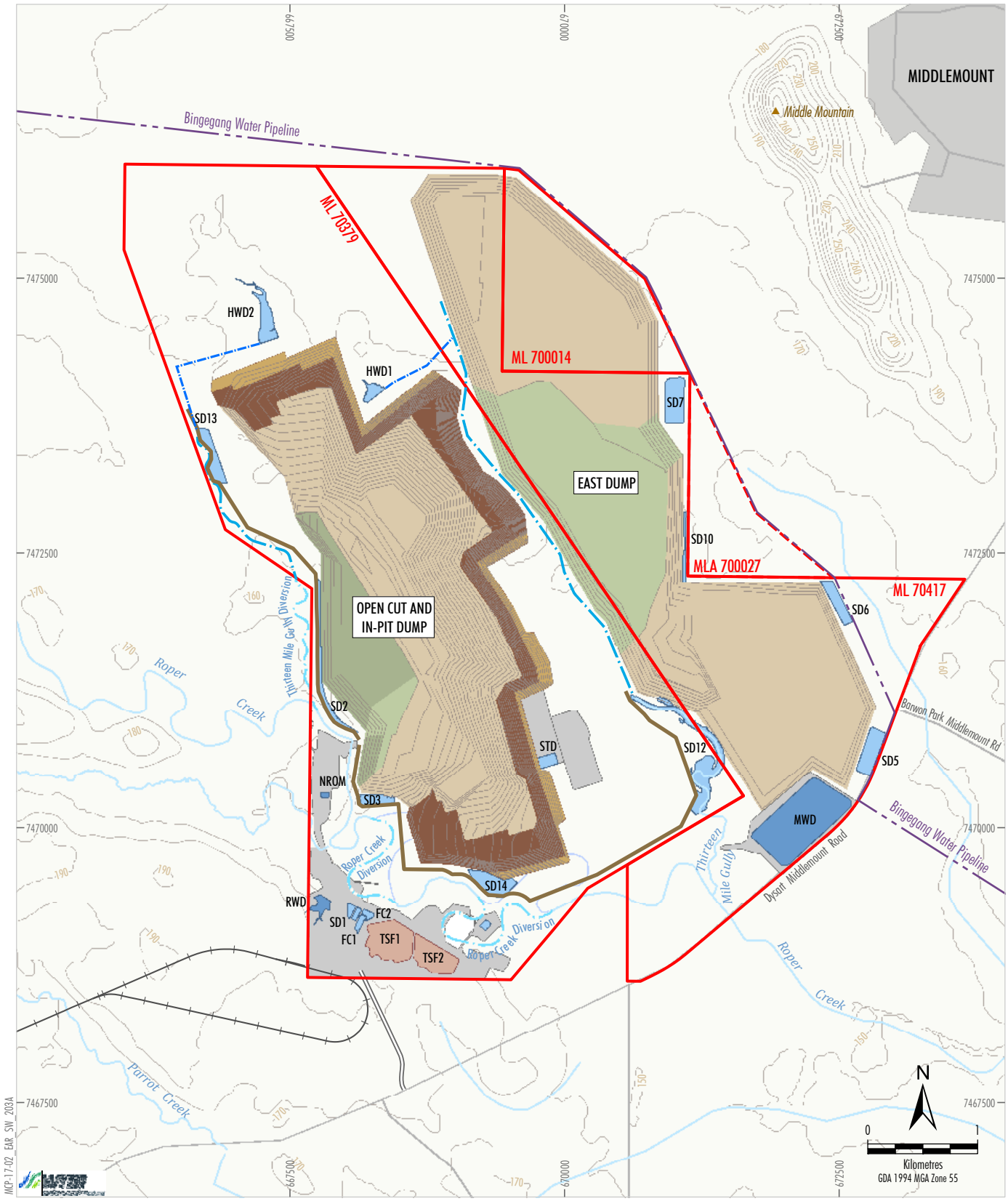
• opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.	
Cumulative Impacts – Mitigation, monitoring and management	
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (e.g. case studies) should be provided.	
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Section 9
Identify cumulative impact environmental objectives.	
Describe appropriate reporting mechanisms.	
Propose adaptive management measures and management responses.	
Final landform and voids – coal mines	
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	
Assess the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	
Provide an assessment of the long-term impacts to water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should considers: • groundwater behaviour – sink or lateral flow from void. • water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation). • seepage – geochemistry and potential impacts. • long-term water quality, including salinity, pH, metals and toxicity. • measures to prevent migration of void water off-site.	Section 5.4
For other final landform options considered sufficient detail of potential impacts should be provided to clearly justify the proposed option.	
Assess the probability of overtopping of final voids with variable climate extremes, and management mitigations.	
Acid-forming materials and other contaminants of concern	
Identify the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	
Identify the presence and volume of potentially acid-forming waste rock, fine-grained amorphous sulphide minerals and coal reject/tailings material and exposure pathways.	
Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	Refer to Groundwater Report
Describe handling and storage plans for acid-forming material (co-disposal, tailings dam, encapsulation).	
Assess the potential impact to water-dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	

Describe proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.

1.4 REPORT STRUCTURE

This report is structured as follows:

- Section 2 describes the Environmental Values of the regional and local drainage receiving waters;
- Section 3 presents the surface water characteristics of the mine site;
- Section 4 describes the surface water management system including the management objectives and principles;
- Section 5 provides a summary of the water balance model results for the mine water management system;
- Section 6 provides details of the proposed Thirteen Mile Gully realignment;
- Section 7 describes the outcomes from the flood modelling assessment;
- Section 8 describes the outcomes from the impact assessment for surface water;
- Section 8.6 describes the outcomes from the cumulative impact assessment for surface water;
- Section 9 gives a list of references;
- Appendix A summarises the recent water quality monitoring data as time-series graphs;
- Appendix B describes the mine water balance model configuration; and
- Appendix C describes the existing conditions flood modelling.



MCP-17-02_EAR_SW_203A

LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Topsoil Stripped
- Active Open Cut Mining Area
- Active Waste Rock Emplacement
- Initial Rehabilitation
- Established Rehabilitation
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Water Transfer Pipeline
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

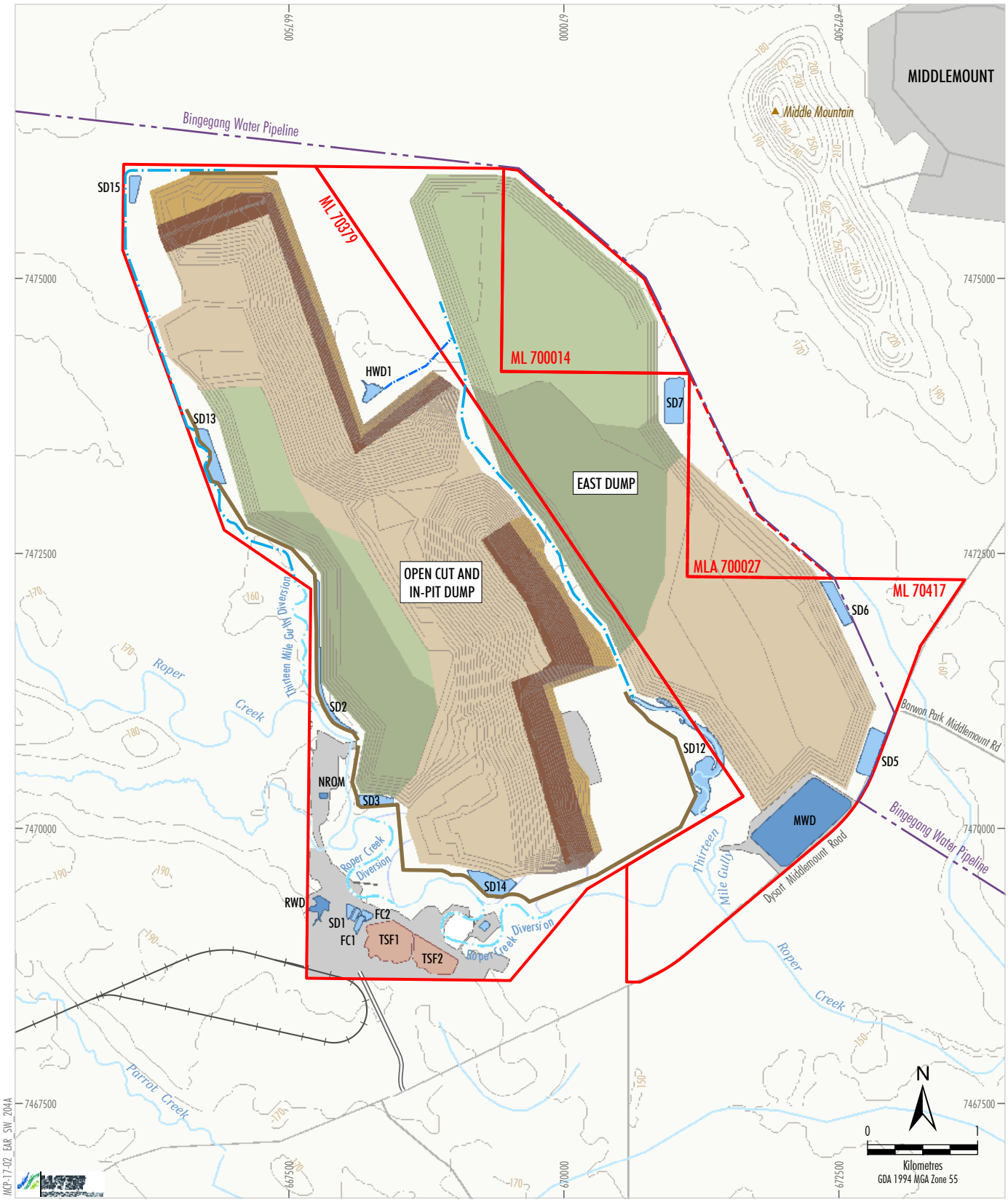
Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Year 6 (2023)

Figure 1.3



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Topsoil Stripped
- Active Open Cut Mining Area
- Active Waste Rock Emplacement
- Initial Rehabilitation
- Established Rehabilitation
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Water Transfer Pipeline
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

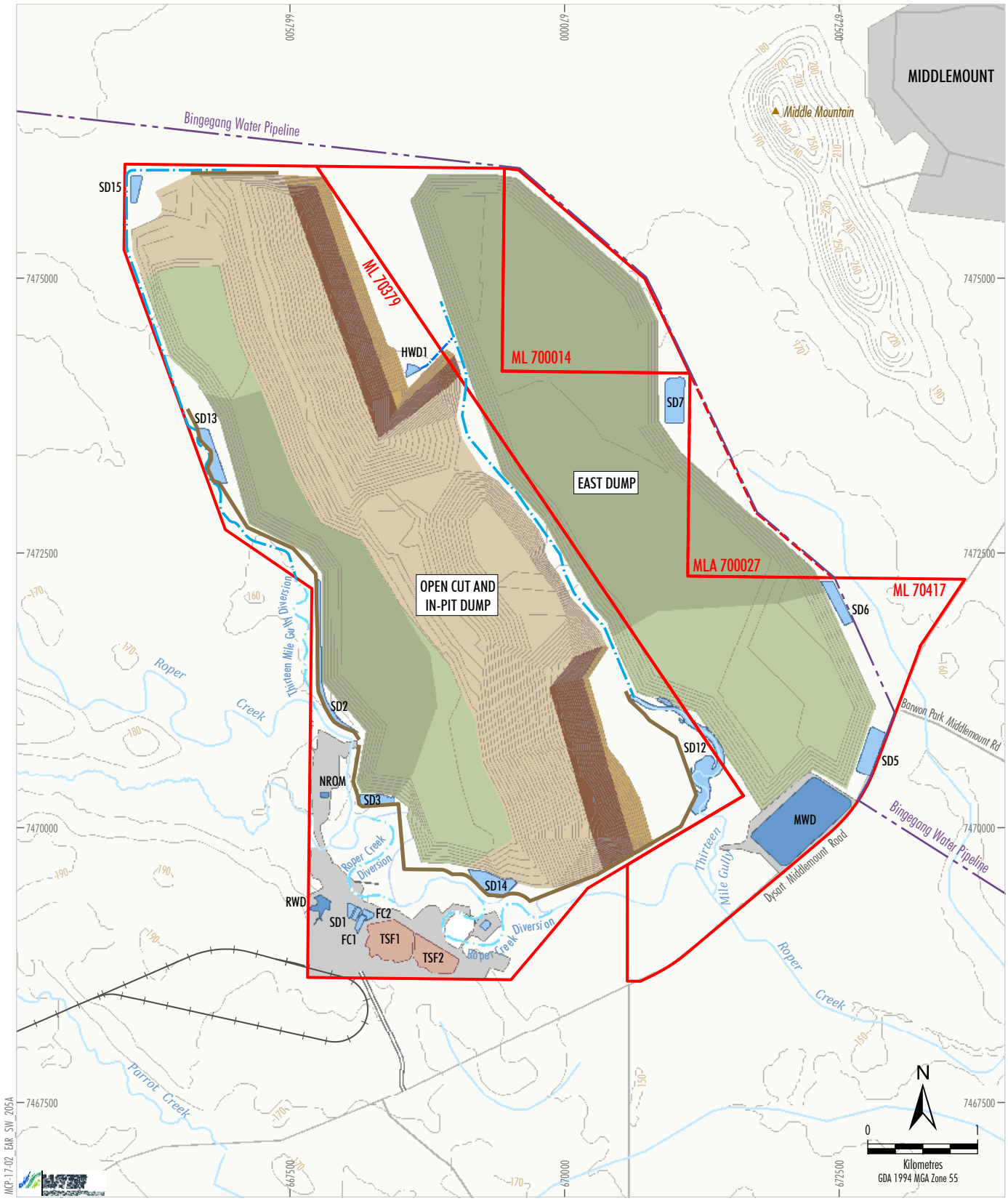
Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Year 11 (2028)

Figure 1.4



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Topsoil Stripped
- Active Open Cut Mining Area
- Active Waste Rock Emplacement
- Initial Rehabilitation
- Established Rehabilitation
- Mine Infrastructure Area
- Tailings Storage Facility
- Sediment Dam
- Water Storage
- Water Transfer Pipeline
- Diversion Structure
- Levee
- Mine Access Road
- Middlemount Rail Spur and Loop

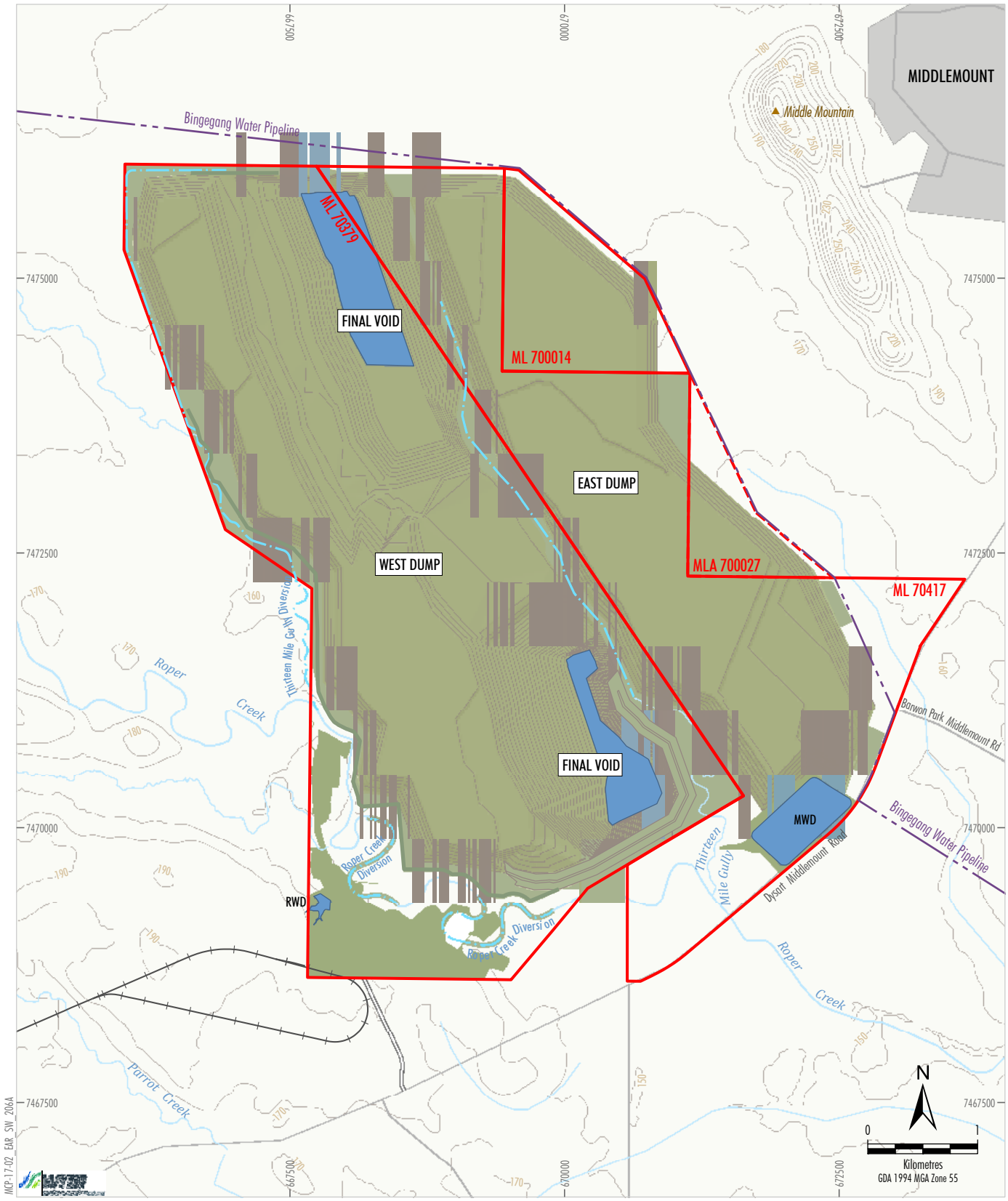
Source: MCPL (2018); Department of Natural Resources and Mines (2017)

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Year 15 (2032)

Figure 1.5



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Established Rehabilitation
- Water Storage
- Diversion Structure
- Removed Levee (Rehabilitated)
- Mine Access Road (Retained or Rehabilitated)
- Middlemount Rail Spur and Loop (Retained or Rehabilitated)

Source: MCPL (2018); AGE (2018); Department of Natural Resources and Mines (2017)

MCP-17-02_EAR_SW_206A

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WESTERN EXTENSION PROJECT

Conceptual General Arrangement
Post-mining

Figure 1.6

2 Catchment hydrology and environmental values

2.1 GENERAL

This section describes the regional drainage characteristics in the vicinity of the Middlemount Coal Mine. The environmental values as defined by the Queensland *Environmental Protection Act 1994* (EP Act), Environmental Protection Policies (EPPs), Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (Australian and New Zealand Environment and Conservation Council [ANZECC] & Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000) (ANZECC 2000 Guidelines) and regulations of these waterways are also described.

2.2 CATCHMENT HYDROLOGY

Middlemount Coal Mine tenement areas are drained by:

- Roper Creek;
- Thirteen Mile Gully Diversion which diverts the upstream sub-catchments of Thirteen Mile Gully (north and west of the ML 70379 boundary) to Roper Creek; and
- an unnamed tributary of Roper Creek which intersects the eastern extent of ML 70417, beyond the extent of the East Dump and joins Roper Creek about 4.2 km downstream of Dysart Middlemount Road.

Figure 1.1 shows the wider locality of the Roper Creek catchment and Figure 2.1 shows the drainage characteristics in the vicinity of the Project. Roper Creek is an ephemeral watercourse flowing for short periods following rainfall. The catchment commences about 35 km to the west of the Project area. The creek traverses in an easterly direction across ML 70379 and ML 70417 before turning south-east to cross Dysart-Middlemount Road, and eventually into the Mackenzie River some 40 km to the south-east of the Project. The Mackenzie River is a major tributary of the Fitzroy River.

The total catchment area of Roper Creek to the downstream boundary of the Middlemount Coal Mine tenements, including the Thirteen Mile Gully catchment, is approximately 389 square kilometres (km^2). The catchment area of Thirteen Mile Gully to its confluence with Roper Creek is approximately 55 km^2. ML 70379, ML 70417 and ML700014 cover an area of approximately 33.8 km^2, or 9% of the Roper Creek catchment to the downstream boundary of ML 70417 and 1.3% of the Roper Creek catchment to its confluence with the Mackenzie River. No water resource development, such as dams or major irrigation infrastructure, is located within the Roper Creek catchment.

The Roper Creek catchment upstream of Dysart-Middlemount Road to the west of ML 70379 generally consists of moderately disturbed native forests with some cleared grazing land along the waterway corridor. The catchment downstream of Dysart Middlemount Road has been mostly cleared for grazing. Several operating coal mines also exist in the catchment as shown on Figure 1.1.

Figure 2.1 shows the drainage characteristics of Thirteen Mile Gully in the vicinity of the Project. In its natural state, Thirteen Mile Gully drained the runoff from upstream sub-catchments in a south-easterly direction across ML 70379 and ML 70417 and discharged into Roper Creek within ML 70417 about 350 metres (m) upstream of Dysart Middlemount Road. The upstream sub-catchments of Thirteen Mile Gully were diverted along the western boundary of ML 70379 in late 2014. A licence to divert the flow of water of Thirteen Mile Gully was issued under the Queensland *Water Act 2000* in May 2013.

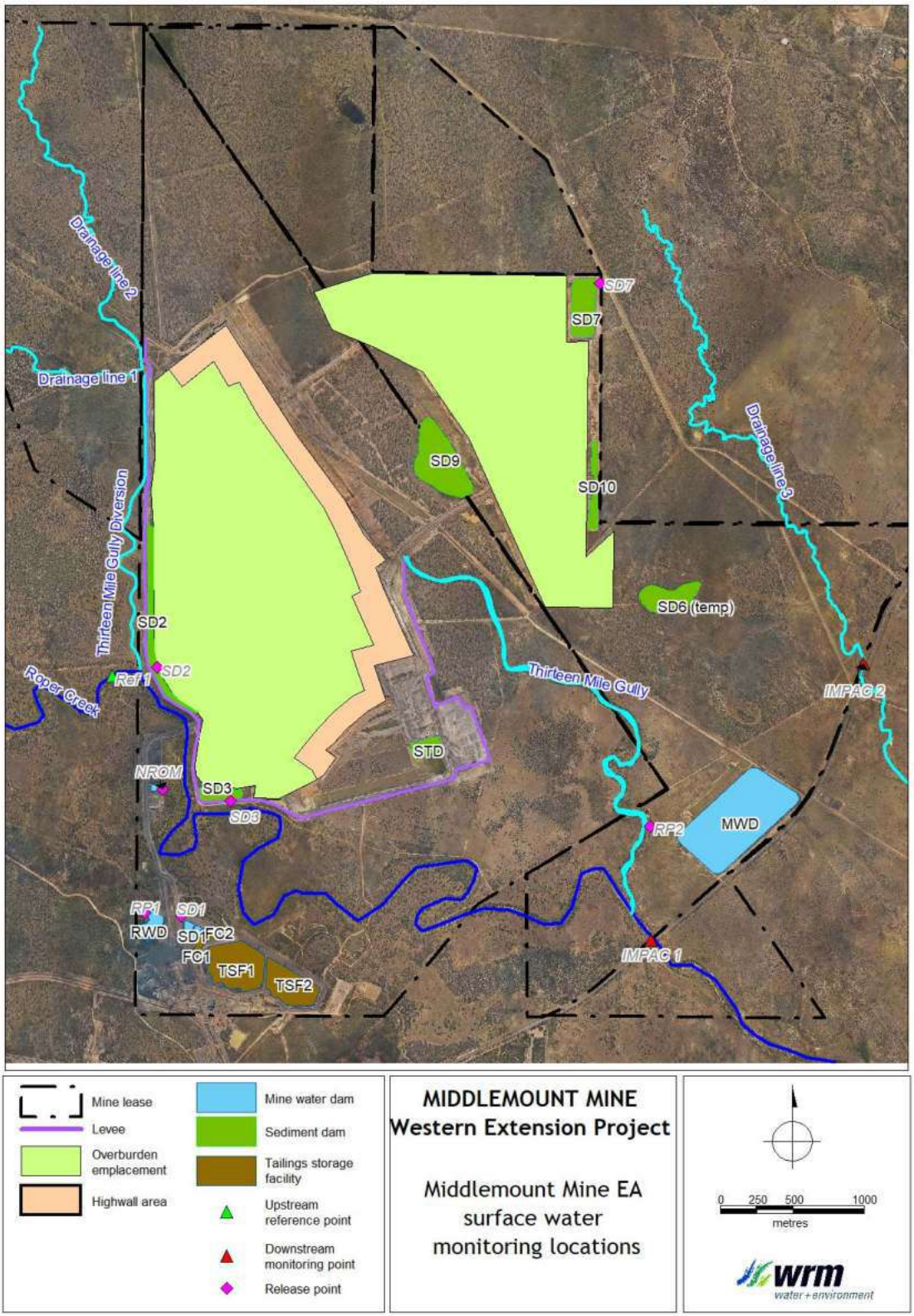


Figure 2.1 – Middlemount Coal Mine existing site characteristics and surface water monitoring locations

Upstream of the diversion, the sub-catchments of Thirteen Mile Gully drain via two drainage features; Drainage Line 1 (to the west) and Drainage Line 2 (to the north).

The Department of Natural Resources and Mines (DNRM) confirmed that these drainage lines are not watercourses, rather they are drainage features defined under the *Water Act 2000* that facilitates overland flow (DNRM, 2017).

2.3 STREAMFLOW

From 1971 to 1988, the Queensland Government operated a streamflow gauge on Roper Creek at Barwon Park (Station No. 130107A), located approximately 28 km downstream of the Project. The total catchment area draining to the Barwon Park streamflow gauge is 2,126 km^2. The maximum recorded flow rate at this station was 922 m^3/s in December 1973.

Table 2.1 shows the annual recorded runoff volume at the Barwon Park streamflow gauge for the period of record, as well as total annual rainfall taken from the SILO rainfall data. The annual volumetric runoff coefficient is low, ranging from 0.3% to 14.6% with an average of 3.7%.

Table 2.1 – Annual rainfall and runoff volumes for Roper Creek at Barwon Park gauging station

Year commencing	Annual rainfall[a] (mm)	Annual runoff volume at Barwon Park gauging station		Volumetric runoff coefficient
		(ML)	(mm)	
Oct 1971	553	12,513	5.9	0.011
Oct 1972	628	3399	1.6	0.003
Oct 1973	976	202,462	95.2	0.098
Oct 1974	840	58,052	27.3	0.033
Oct 1975	989	248,180	116.7	0.118
Oct 1976	584	18,313	8.6	0.015
Oct 1977	834	157,530	74.1	0.089
Oct 1978	584	17,894	8.4	0.014
Oct 1979	524	10,520	4.9	0.009
Oct 1980	641	34,080	16.0	0.025
Oct 1981	567	22,229	10.5	0.018
Oct 1982	805	249,154	117.2	0.146
Oct 1983	527	20,029	9.4	0.018
Oct 1984	510	3,833	1.8	0.004
Oct 1985	697	15,766	7.4	0.011
Oct 1986	519	11,152	5.2	0.010
Oct 1987	683	11,942	5.6	0.008
Mean	**674**	**64,532**	**30.4**	**0.037**

a/ Based on SILO rainfall at Middlemount Coal Mine
mm = millimetres

Figure 2.2 shows a plot of monthly runoff versus rainfall for Roper Creek at the Barwon Park stream gauge. Very little runoff is generated by the catchment for monthly rainfall below about 100 mm. Once monthly rainfall exceeds about 200 mm, the volume of surface runoff increases substantially.

Figure 2.3 shows a ranked plot of daily flows at the Barwon Park gauging station over the period of record and with all zero flows omitted. Stream flows are ephemeral with flows recorded on approximately 34% of all days. Of the days when flows were recorded, the median flow is 10 ML/day and the 20th percentile flow is 200 ML/day.

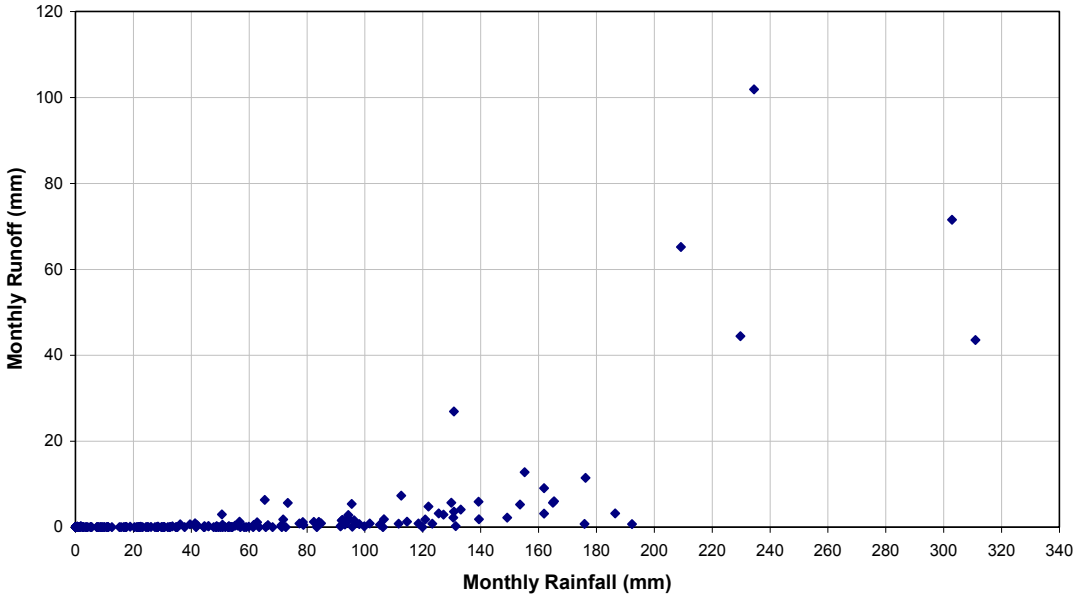


Figure 2.2 – Monthly runoff versus rainfall for Roper Creek at Barwon Park gauging station

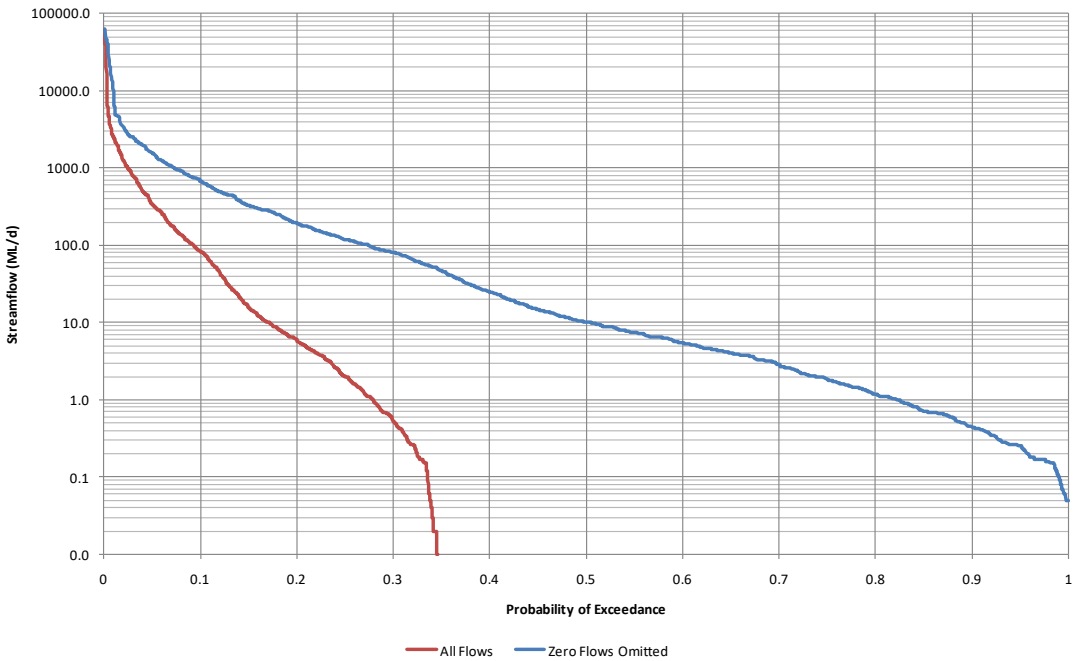


Figure 2.3 – Roper Creek at Barwon Park flow frequency curve, all flows and zero flows omitted

The magnitude of stream flows along Roper Creek near the Project would be much less than that recorded at Barwon Park as the catchment area draining to the Barwon Park streamflow gauge downstream is more than 50% larger. However, the stream flows recorded at Barwon Park provide a good indication of the behaviour of streamflow in Roper Creek following rainfall events.

2.4 GEOLOGY AND GEOCHEMISTRY

Middlemount Coal Mine is located on the northern extension of the Rangal Coal Measures on the western flank of the Bowen Basin, which is a sedimentary basin comprising Triassic and Permian aged geology. Regionally, a veneer of more recent Tertiary geology and Quaternary geology typically overlies the Bowen Basin strata.

The target coal seams at the Middlemount Coal Mine are the Middlemount, Tralee, and Pisces coal seams of the Rangal Coal Measures, a faulted and folded Permian sequence of calcareous sandstone, shale, mudstone, and coal. The main target seams are the Pisces Seam and the overlying Middlemount Seam. The depth of cover for the Pisces Seam ranges from about 30 m near the limit of oxidation (lox) line to 200 m at the eastern boundary of ML 70379. Geochemical assessment (RGS, 2013) of overburden material identified that the majority of coal and mining waste rock materials are classified as Non-Acid Forming, have excess acid buffering capacity, and a high factor of safety with respect to potential for acid generation. A recent study (RGS, 2016) did however conclude that based on the results of a number of the coal reject samples, there is some risk of acid generation over time, if left unmanaged. MCPL currently implements the management practices outlined in the *Mine By-Products Management Plan* and *Mining By-Product In-Pit Disposal Site Practice* for the Middlemount Coal Mine. Therefore, it is expected that the current management measures for coal rejects materials are sufficiently robust to avoid significant potential impacts to surface water and groundwater resources at site.

Water quality monitoring in mine affected water storages shows that runoff and seepage from the coal stockpiles, mining pits and TSF is brackish with moderate sulphate concentrations and pH levels have historically fluctuated from acidic to alkaline. However, all recent samples taken since late 2012 have been generally neutral to moderately alkaline, and not shown any evidence of acid generation.

Surface water runoff from overburden dumps is fresh to brackish with lower sulphate levels than those recorded in mine affected water dams and pH levels are moderately alkaline. Again, there has not been any evidence of acid generation, which supports the above geochemical assessment conclusions.

Salinity levels in the mine water management system may increase over time due to evapo-concentration (e.g. due to the large evaporative surface of the MWD) of on-going salt loads from coal and mining waste rock materials.

2.5 GROUNDWATER

Three hydro-stratigraphic units have been identified by AGE (2018) based on their hydraulic properties and lithology at the Middlemount Coal Mine and surrounds. From youngest to oldest, these units are:

- Quaternary aged units:
    - Alluvial aquifer – consists of localised stream channel deposits and associated flood plain deposits. These units comprise a temporary (rainfall dependent) aquifer that is limited to the immediate vicinity of Roper Creek, Thirteen Mile Gully and drainage lines within the mining leases. Neither Roper Creek or Thirteen Mile Gully are targeted for water supply within the near vicinity of the Middlemount Coal Mine. Two other creeks containing alluvial deposits also occur further afield, Rolf Creek to the north and Oaky Creek to the far south of Middlemount Coal Mine.

- Tertiary aged units:
  - Duaringa Formation – consists of thick clay-rich laterite which is sourced from highly weathered Permian sandstones and siltstones, and occasional basalt. The Duaringa Formation is not typically targeted for agricultural water supply and is (at best) a low yielding aquifer that would more commonly be regarded as an aquitard.
- Permian aged units:
  - Interburden / overburden – the bulk of the Permian coal measure strata is sandstone, siltstone, and mudstone that typically have low permeability and generally form aquitards.
  - Coal seams (principally the Middlemount and Pisces Seams) – form low to moderate yielding aquifers confined by interburden / overburden units.

Quaternary Alluvium

The Quaternary alluvium is not targeted by landholders as a groundwater supply within the study area. This outcome supports the general understanding that the Quaternary alluvium is not a productive aquifer within the study area.

Similarly, no monitoring bores have been installed within the Quaternary alluvium.

Tertiary Aquifers

MCPL has implemented an extensive groundwater monitoring bore network, located both within and outside of the Middlemount Coal Mine tenements. A number of groundwater monitoring bores focus on the Tertiary aquifers (MW2, MW3, MW6, MW9A, MW10A, MW11A, MW12A, MW13A, MW14A and MW15A). Depth to water in the monitoring bores ranges from 7.7 metres below ground level (mbgl) (MW15A) to 25.3 mbgl (MW9A), with an average depth of 17.5 mbgl.

Groundwater quality in the Tertiary aquifers is generally poor and either unsuitable or marginal for beneficial uses. This is supported by no records (within approximately 10 km of the Middlemount Coal Mine) in the DNRM registered bore database of any bores screened within the Tertiary aquifer. The average EC is greater than 20,000 microSiemens per centimetre (µS/cm) and contains elevated chloride, sodium and total dissolved solids (TDS).

Permian Aquifers

The groundwater monitoring bore network also includes monitoring of the Permian aquifers (MW1P[1], MW4, MW5, MW5M/P, MW7M/P, MW8FR and MW9M/P).

The average depth to groundwater in the Permian aquifer is greater than 30 mbgl.

Similar to the tertiary aquifers, groundwater quality is generally poor and either unsuitable or marginal for beneficial uses. The average EC is greater than 20,000 µS/cm and contains elevated chloride, sodium and TDS.

2.6 WATER QUALITY

The background water and sediment quality data for Roper Creek and the downstream catchment is described in the *Middlemount Coal Mine Receiving Environment Monitoring Plan* (REMP) (GHD, 2016). Water quality in Roper Creek is characterised by high and variable turbidity, moderate and variable EC and low dissolved oxygen concentrations at times. Nutrient levels are generally low with the exception of total nitrogen which exceeded the trigger value at most sites.

[1] Excavated within the advancing open cut.

The concentrations of most metals were very low within Roper Creek and did not exceed the EA trigger values, with the exception of aluminium. The results however demonstrated the natural variability in metals and nutrients in Roper Creek.

GHD (2016) found that the macroinvertebrate community of Roper Creek exhibited signs of stress. Given the ephemeral nature of waterways in central Queensland and the low rainfall in the region in the preceding years (i.e. 2014-15), this was to be expected. Given the lack of discharges from the Middlemount Coal Mine, there had been no indication of impacts from Middlemount Coal Mine operations on the macroinvertebrate community of Roper Creek.

Given the ephemeral nature of the upstream sub-catchments of Thirteen Mile Gully, no water quality data is available for Drainage Line 1 and Drainage Line 2.

Time series graphs of the historical water quality sampling data at the upstream and downstream surface water monitoring sites are provided in Appendix A.

2.7 EXISTING WATER USE ENTITLEMENTS

Advice from the Queensland Government indicates that there are no licensed surface water users along Roper Creek. That is, there are no users with an extraction volume issued under the provisions of the *Water Act 2000*.

There are two registered Self-Assessed Riparian Access Works located on Roper Creek which authorise stock and domestic supplies only. Section 20 of the *Water Act 2000* provides that an owner of land adjoining a watercourse may take water for domestic and stock purposes without the need for a permit or licence.

A permit to take water from Roper Creek, Connors River, Murray Creek, Lotus Creek, Clive Creek and an unnamed tributary of Isaac River (Eungy Waterhole) has been issued under the provisions of the *Water Act 2000*. Such permits are typically granted to a corporate entity, such as local government, for temporary supply of water to construction or similar projects. A total entitlement of 8.5 ML per water year is attached to this permit. The above information indicates that there is currently minimal use of surface water from Roper Creek.

2.8 ENVIRONMENTAL VALUES

The *Environmental Protection (Water) Policy 2009* (EPP (Water)), which is subordinate legislation to the EP Act, provides a framework for identifying environmental values for a waterway and determine WQOs to protect or enhance those. Environmental values (EVs) for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These environmental values are to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flow to ensure healthy aquatic ecosystems and waterways that are safe for community use.

Roper Creek is located within the Mackenzie River north-western tributaries region and is classified as a 'fresh' water source (Department of Environment and Heritage Protection [DEHP], 2011). The environmental values selected for protection include: aquatic ecosystem protection (Level 2 – disturbed ecosystems, Queensland Water Quality Guidelines (DEHP, 2009));

- stock watering;
- human consumption;
- primary, secondary and visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual values.

In summary, the key environmental values for water that are to be protected are:

- physical, chemical and biological integrity of the watercourses within the catchment and their amenity as potential water sources for human use and to support aquatic ecosystems;
- the qualitative and quantitative integrity of local groundwater as a potential water source for agricultural or other suitable uses; and
- the integrity of raw water supplies and associated infrastructure in the region.

3 Site characteristics

3.1 OVERVIEW

This section describes the activities at the existing and proposed Middlemount Coal Mine that could potentially generate contaminants that may impact on the environmental values of the receiving waters, if not managed. The source of the contaminants has been identified and evaluated based on water quality data that has been collected on site since 2010. The proposed changes to the water management system due to the Project are also provided.

3.2 EXISTING SITE OPERATING ACTIVITIES

The major components of the existing Middlemount Coal Mine are shown in Figure 2.1 and include:

- an open cut mining pit;
- out-of-pit spoil dumps (south, north and east);
- access and haul roads;
- mine infrastructure areas including:
  - office buildings and workshops;
  - ROM coal stockpiles; and
  - a CHPP including crushing facility, a product coal stockpile pad, a rail loop and rail loading facilities;
- TSF and In-line Flocculation Cells;
- sewerage treatment;
- flood protection levees;
- stream diversion; and
- mine water management structures.

3.3 SURFACE WATER TYPES

The surface water generated on the mine site has been categorised into types, based on water quality:

- 'Tailings return water' – water that has been used to wash coal in the CHPP. Tailings water potentially has a lower pH and higher concentrations of TDS and metals than 'Mine affected' water.
- 'Mine affected water' – surface water that has generally come in contact with coal such as in the pit, or from the ROM coal stockpile. This water may contain high TDS and metals above relevant guideline trigger values defined by ANZECC & ARMCANZ (2000).
- 'On-site stormwater' – surface runoff water from areas that are disturbed by mining operations (including out-of-pit overburden dumps and haul roads). This runoff may contain high sediment loads but is generally of neutral pH and does not contain high salt concentrations or metals.
- 'Catchment runoff water' – surface runoff from catchment areas where water quality is unaffected by mining operations. Catchment runoff water includes runoff from undisturbed areas and any fully rehabilitated areas.

- ‘Contaminated water’ – surface water from areas potentially containing chemicals of various types used in the mining operations (e.g. hydrocarbons). Contaminated water areas include sumps, service bays and fuel storage areas. Rainfall and resulting runoff from these areas is also potentially contaminated.
- ‘External water’ – External water is water sourced external to the mining operation.

3.4 SITE WATER QUALITY

Water quality data has been collected from the on-site water storages since May 2010. The parameters tested have been defined by the Queensland Government to cover the range of constituents that could impact on the environmental values of the receiving waters.

Table 3.1 shows the time periods that water quality samples have been collected in each of the water storages at Middlemount Coal Mine. The locations of the dams are shown in Figure 2.1. Table 3.2 and Table 3.3 shows the water quality of the tailings and mine affected dams.

Table 3.4 shows the water quality of sediment dams that have historically been mine water affected as they have been used for the transfer and storage of mine water.

Table 3.5 shows the water quality in the sediment dams that have not been affected by mine water. Sediment dams that are not mine affected collect runoff from the East Dump, as well as SD2. A description of the water quality draining the various areas on the mine site is given in the following section.

According to Table C3 of the Middlemount Coal Mine EA, trigger values for metals and metalloids only apply when the dissolved concentrations exceed the trigger values. The majority of the water quality sampling for metals has been reported as total concentrations, and regular reporting of dissolved concentrations has only occurred since 2015.

Time series graphs of the historical water quality sampling data is provided in Appendix A.

Table 3.1 – Water quality sampling periods

Water storage	ID	Start date	End date (latest sample)
Raw Water Dam	RWD	May 2010	October 2016
Tailings Storage Facility 1	TSF1	October 2010	October 2016
Tailings Storage Facility 2	TSF2	January 2011	January 2016
Mine Water Dam	MWD	January 2015	October 2016
North ROM Dam	NROM	January 2015	October 2016
Mining Pit		July 2015	April 2016*[1]
Sediment Dam 1	SD1	October 2010	October 2016
Sediment Dam 2	SD2	November 2010	October 2016
Sediment Dam 3	SD3	May 2010	October 2016
Sediment Dam 7	SD7	April 2015	April 2016
Sediment Dam 9	SD9	April 2013	January 2015
Sediment Dam 10	SD10	January 2014	October 2016

*[1] Water quality from South Transfer Dam (STD) is assumed to represent mining pit water quality

Table 3.2 - Water quality summary, mine affected water dams (1 of 2)

Parameter	Units	Middlemount EA conditions		RWD				TSF 1				TSF 2			
		End of pipe limit/release contaminant trigger level	Receiving water trigger	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile
pH	-	6.5 - 9.0	6.5 - 8.5	36	6.4	8.3	8.8	28	3.8	7.9	8.9	24	7.6	7.9	8.6
EC	µs/cm	700 - 6,000	700	36	1,595	4,305	9,610	28	1,045	5,160	10,860	24	1,669	3,725	7,769
Suspended solids	mg/L	562 - 1,062	562 - 1,062	11	5	6	12	8	6	11	39	7	7	14	440
Sulphate ($SO4^{2-}$) (dissolved)	mg/L	250 - 500	250	16	254	288	379	15	203	538	822	11	235	287	457
Fluoride	mg/L	2	-	29	0.4	0.8	1.0	24	0.3	0.8	1.2	20	0.6	0.8	1.0
Aluminium (dissolved)	mg/L	0.055	-	5	0.010	0.010	0.010	4	0.010	0.015	0.034	4	0.010	0.010	0.010
Arsenic (dissolved)	mg/L	0.013	-	5	0.001	0.001	0.002	4	0.001	0.002	0.003	4	0.001	0.001	0.001
Cadmium (dissolved)	mg/L	0.0002	-	4	0.0001	0.0001	0.0001	3	0.0001	0.0001	0.0001	3	0.0001	0.0001	0.0001
Cobalt (dissolved)	mg/L	0.090	-	4	0.001	0.001	0.001	3	0.002	0.002	0.036	3	0.001	0.001	0.003
Copper (dissolved)	mg/L	0.002	-	4	0.001	0.002	0.003	3	0.001	0.002	0.003	3	0.001	0.001	0.001
Lead (dissolved)	mg/L	0.004	-	4	0.001	0.001	0.001	3	0.001	0.001	0.001	3	0.001	0.001	0.001
Nickel (dissolved)	mg/L	0.011	-	4	0.008	0.012	0.018	3	0.012	0.013	0.051	3	0.004	0.007	0.014
Zinc (dissolved)	mg/L	0.008	-	4	0.005	0.016	0.029	3	0.005	0.005	0.011	3	0.005	0.005	0.005

Table 3.3 - Water quality summary, mine affected water dams (2 of 2)

Parameter	Units	Middlemount EA conditions		MWD				NROM				Mining Pit			
		End of pipe limit/release contaminant trigger level	Receiving water trigger	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile
pH	-	6.5 - 9.0	6.5 - 8.5	8	8.4	9.1	9.7	6	7.6	9.0	9.4	2	8.7	9.0	9.3
EC	µs/cm	700 - 6,000	700	6	5,755	8,575	10,150	6	837	1,376	2,144	2	7,087	8,955	10,823
Suspended solids	mg/L	562 - 1,062	562 - 1,062	6	7	11	60	4	11	28	30	-	-	-	-
Sulphate ($SO4^{2-}$) (dissolved)	mg/L	250 - 500	250	-	-	-	-	-	-	-	-	1	1240	1240	1240
Fluoride	mg/L	2	-	6	0.9	1.05	1.2	1	1.8	2.3	3.0	-	-	-	-
Aluminium (dissolved)	mg/L	0.055	-	2	0.010	0.010	0.010	1	-	0.020	-	1	-	0.010	-
Arsenic (dissolved)	mg/L	0.013	-	2	0.002	0.002	0.002	1	-	0.001	-	1	-	0.001	-
Cadmium (dissolved)	mg/L	0.0002	-	2	0.0001	0.0001	0.0001	1	-	0.0001	-	-	-	-	-
Cobalt (dissolved)	mg/L	0.090	-	2	0.001	0.001	0.001	1	-	0.001	-	-	-	-	-
Copper (dissolved)	mg/L	0.002	-	2	0.001	0.002	0.002	1	-	0.001	-	-	-	-	-
Lead (dissolved)	mg/L	0.004	-	2	0.001	0.001	0.001	1	-	0.001	-	-	-	-	-
Nickel (dissolved)	mg/L	0.011	-	2	0.008	0.010	0.011	1	-	0.001	-	-	-	-	-
Zinc (dissolved)	mg/L	0.008	-	2	0.005	0.005	0.005	1	-	0.009	-	-	-	-	-

Table 3.4 - Water quality summary, mine affected sediment dams

Parameter	Units	Middlemount EA conditions		SD1				SD3			
		End of pipe limit/release contaminant trigger level	Receiving water trigger	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile
pH	-	6.5 - 9.0	6.5 - 8.5	32	4.8	8.3	9.1	31	8.0	8.7	9.7
Electrical conductivity	µs/cm	700 - 6,000	700	32	418	2,815	10,756	30	692	4,680	7,646
Suspended solids	mg/L	562 - 1,062	562 - 1,062	10	7	19	66	9	10	28	144
Sulphate ($SO4^{2-}$) (dissolved)	mg/L	250 - 500	250	14	120	302	471	11	26	250	643
Fluoride	mg/L	2	-	25	0.3	0.6	1.2	22	0.7	0.9	1.4
Aluminium (dissolved)	mg/L	0.055	-	4	0.010	0.010	0.010	4	0.016	0.040	0.274
Arsenic (dissolved)	mg/L	0.013	-	4	0.001	0.001	0.0017	4	0.001	0.002	0.003
Cadmium (dissolved)	mg/L	0.0002	-	3	0.0001	0.0001	0.0001	3	0.0001	0.0001	0.0001
Cobalt (dissolved)	mg/L	0.090	-	3	0.001	0.001	0.001	3	0.001	0.001	0.001
Copper (dissolved)	mg/L	0.002	-	3	0.001	0.001	0.002	3	0.001	0.002	0.002
Lead (dissolved)	mg/L	0.004	-	3	0.001	0.001	0.001	3	0.001	0.001	0.001
Nickel (dissolved)	mg/L	0.011	-	3	0.004	0.006	0.006	3	0.001	0.001	0.001
Zinc (dissolved)	mg/L	0.008	-	3	0.005	0.005	0.006	3	0.005	0.005	0.006

Table 3.5 - Water quality summary, on-site stormwater sediment dams

Parameter	Units	Middlemount EA conditions		SD2				SD7				SD9				SD10			
		End of pipe limit/release contaminant trigger level	Receiving water trigger	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile	No. of samples	10th %ile	Median	90th %ile
pH	-	6.5 - 9.0	6.5 - 8.5	38	3.8	8.1	9.4	6	9.1	9.7	9.9	8	8.1	8.4	9.1	9	8.4	9.0	10.0
Electrical conductivity	µs/cm	700 - 6,000	700	24	708.9	1,335	2,156	6	583	986	4,865	4	228	325	451	10	365	537	1,648
Suspended solids	mg/L	562 - 1,062	562 - 1,062	9	7	21	41	5	15	19	56	1	-	44	-	3	42	62	90
Sulphate ($SO4^{2-}$) (dissolved)	mg/L	250 - 500	250	13	100	158	320	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/L	2	-	23	0.2	0.8	1.6	5	1.0	1.5	2.8	3	0.2	0.3	0.4	4	0.7	1.1	1.8
Aluminium (dissolved)	mg/L	0.055	-	4	0.010	0.010	0.010	2	0.012	0.020	0.028	2	1.56	3.08	4.60	-	-	-	-
Arsenic (dissolved)	mg/L	0.013	-	4	0.001	0.001	0.002	2	0.001	0.002	0.003	2	0.001	0.001	0.001	-	-	-	-
Cadmium (dissolved)	mg/L	0.0002	-	3	0.0001	0.0001	0.0001	2	0.0001	0.0001	0.0001	1	-	0.0001	-	-	-	-	-
Cobalt (dissolved)	mg/L	0.090	-	3	0.001	0.001	0.001	2	0.001	0.001	0.001	1	-	0.005	-	-	-	-	-
Copper (dissolved)	mg/L	0.002	-	3	0.001	0.001	0.002	2	0.001	0.002	0.003	1	-	0.005	-	-	-	-	-
Lead (dissolved)	mg/L	0.004	-	3	0.001	0.001	0.001	2	0.001	0.001	0.001	1	-	0.005	-	-	-	-	-
Nickel (dissolved)	mg/L	0.011	-	3	0.001	0.001	0.001	2	0.001	0.001	0.001	1	-	0.004	-	-	-	-	-
Zinc (dissolved)	mg/L	0.008	-	3	0.005	0.005	0.006	2	0.005	0.006	0.007	1	-	0.013	-	-	-	-	-

3.4.1 Tailings return water

Tailings (i.e. fine rejects) from the CHPP comprise mostly of fine silt, clay, water and coal material. Water quality monitoring of the TSF cells (TSF1 and TSF2) since October 2010 (see Table 3.2) indicates that the stored water exceeds the EPP Water WQOs and has the following characteristics:

- Brackish with a median EC of 4,145 µS/cm and 10% exceeding 10,510 µS/cm;
- Moderate sulphate with a median of 400 mg/l and 10% exceeding 790 mg/l;
- Generally slightly alkaline, with a median pH of 7.9, 10% exceeding 8.8 and 10% less than 5.2; and
- Metals (dissolved) less than the default trigger values with the exception of copper, nickel and zinc.

The tailings return water management system will remain unchanged for the Project.

3.4.2 Mine affected water

Mine affected water includes runoff collected within the open cut pit (includes groundwater), which is pumped to the MWD and runoff from the ROM and product coal stockpiles, which drains to SD1, NROM and the RWD. It also includes external water pumped in from German Creek Mine. Water quality monitoring of all mine affected water storages exceeds the EPP Water WQOs for pH, salinity, sulphate, aluminium and zinc.

For surface runoff draining coal stockpile areas only including SD1 and the NROM, the data in Table 3.2 and Table 3.3 indicates that the stored water has the following characteristics:

- Brackish with a median EC of 1,995 µS/cm and 10% exceeding 9,725 µS/cm;
- Moderate sulphate with a median of 300 mg/l and 10% exceeding 470 mg/l;
- Generally slightly alkaline, with a median of 8.3, 10% exceeding 9.2 and 10% less than 5.1; and
- Metals (total) generally below the default trigger values with the exception of zinc.

Mine affected water has historically been pumped to SD3. SD3 also temporarily received desludged pit material after the January 2013 storm event. It is no longer used for mine affected water and the recent water quality samples indicate that the residual salts and contaminants are largely removed.

The mine affected water management system will remain generally unchanged (i.e. continued collection of water, including groundwater, in the open cut pit as it advances) for the Project with augmentations as necessary. Further details are provided in Section 4.

3.4.3 On-site stormwater

On-site stormwater includes runoff from the overburden dumps and haul roads. On-site stormwater is managed under the site's Erosion and Sediment Control Plan (ESCP) (WRM, 2016a). Water quality monitoring of sediment dams (that have not been historically affected by mine water (SD2, SD7, SD9 and SD10)) since April 2013 indicates that the collected runoff has the following characteristics:

- Fresh to brackish with a median EC of 855 µS/cm and 10% exceeding 2,455 µS/cm;
- Moderate sulphate with a median of 158 mg/l and 10% exceeding 320 mg/l;
- Moderate suspended solids with a median of 32 mg/l and 10% exceeding 76 mg/l; and
- Moderately alkaline, with a median pH of 8.9, 10% exceeding 9.8 and 10% less than 7.9.

Review of Table 3.4 shows that the metals (dissolved) are generally below the release contaminant trigger levels, with the exception of:

- One copper reading in SD7; and
- Arsenic, copper, lead and zinc readings in SD9.

A further review of the sediment dam data showed that salinity values vary between seasons with elevated levels recorded during the dry season when dam levels are low and evapo-concentration has occurred. Salinity concentrations are generally lower during the wet season when surface runoff is highest.

The recorded total suspended solids concentrations are also lower than what would be otherwise expected for surface runoff from overburden waste rock material. Almost all suspended solid concentration readings were taken during the dry season, which suggest that the total suspended solids data represents water quality after long periods of settlement. It is therefore possible that the suspended solids concentrations of surface runoff to the sediment basins could be greater than recorded values to date.

Water quality monitoring of three release events from sediment dams has occurred in the months:

- January 2013 – SD1;
- January 2013 – SD3; and
- February 2014 – SD2.

Investigations into all three release events were completed to ensure compliance with the EA conditions. The release events complied with the EA conditions with the exception of the February 2014 release from SD2 which showed elevated zinc and copper concentrations. The investigation found that copper and zinc concentrations were also elevated at the upstream reference site and could be attributed to naturally higher background levels from the upstream catchment area of Roper Creek (MCPL, 2013b).

The monitoring results show that although total aluminium exceeded the trigger value in all three release events, the dissolved aluminium concentration was significantly lower than both the trigger value and the reference sites in Roper Creek. The highest dissolved aluminium concentration recorded in the three events was 0.02 mg/L.

Suspended solids concentrations were also low across all three release events with the highest concentration of 23 mg/L recorded at SD3 during the January 2013 event.

The additional disturbance footprint associated with the Project (575 hectares [ha]) will increase the volume of stormwater requiring to be contained and managed on the mine site. Notwithstanding the on-site stormwater management system will remain generally unchanged (i.e. continued collection of runoff from the overburden dumps) for the Project with augmentations as necessary. Further details, including additional sediment dams, are provided in Section 4.7.2.

3.4.4 External water

MCPL have an arrangement with Anglo American plc to supply water from the German Creek Mine for use on the mine site. Water is pumped from German Creek Mine on an 'as needed' basis and placed in the RWD, Southern Transfer Dam and MWD, up to a limit of 250 ML per month and 1,800 ML per year. Water is supplied in accordance with the Water Supply Agreement between MCPL and Anglo Coal (Capcoal Management) Pty Ltd dated 22nd December 2010.

Water captured on-site is however used in preference to the German Creek Mine water supply.

Water quality monitoring of the external water supply from German Creek Mine indicates that the water exceeds the EPP Water WQOs and has the following characteristics:

- Brackish with a median EC of 5,770 µS/cm and 10% exceeding 6,990 µS/cm;
- Moderate to high sulphate with a median of 735 mg/l and 10% exceeding 1,217 mg/l;
- Moderately alkaline with pH ranging from 8.3 to 8.8; and
- Metals (total) generally below the default trigger values with the exception of nickel and zinc.

Potable water is currently supplied via truck from Middlemount to the Middlemount Coal Mine.

External water will continue to be pumped to site on an 'as needed' basis for the Project.

4 Existing surface water management system

4.1 OVERVIEW

Middlemount Coal Mine is operated under the MCPL Environmental Management System. The documents related to the mine water management system include:

- Middlemount Coal Mine Environmental Management Plan (MCPL, 2017);
- Water Management Plan (WRM, 2016b);
- Water Management Site Practice (MCPL, 2014a);
- Site Water Balance (WRM, 2014);
- Regulated Structures Operational Management Plan (MCPL, 2014b);
- Receiving Environment Monitoring Design Plan (GHD, 2016);
- Erosion and Sediment Control Plan (WRM, 2016a); and
- Severe Weather Site Practice (MCPL, 2013a).

The location of the existing mine water management infrastructure is shown Figure 2.1, and is shown schematically in Figure 4.1. Descriptions of the tailings return water management system, mine affected water, on-site stormwater, contaminated and catchment runoff water management systems for the Project are provided below. The mine water management system framework will generally not change as a result of the Project. However, a number of additional sediment dams are proposed as part of the Project.

4.2 SURFACE WATER MANAGEMENT OBJECTIVES

The objective of the mine water management system is to manage all types of water on site to meet operational, social and environmental objectives encapsulated by the sites EA (EPML00716913).

There are two key water management system objectives:

- have a strategy that ensures Middlemount Coal Mine minimises mine affected water spills and has sufficient water available for operation in dry times; and
- to be a good custodian of society's water resources.

Specific objectives for each water type are as follows:

- External water: Ensure that external water allocation and associated infrastructure is sufficient to meet site demands under low rainfall conditions.
- Mine affected water: Minimise uncontrolled discharges in wet periods and to ensure adequate water supplies are maintained for site demand during dry periods.
- Groundwater: Understand, manage and minimise the potential impact of the water management system on the regional groundwater system.
- On-site stormwater: Maintain water quality leaving the Erosion and Sediment Control (ESC) structures to a quality as close to background levels as reasonably possible.
- Catchment runoff water: Ensure that it is separated from the mine affected and on-site stormwater systems and allowed to pass uninterrupted down the catchment.

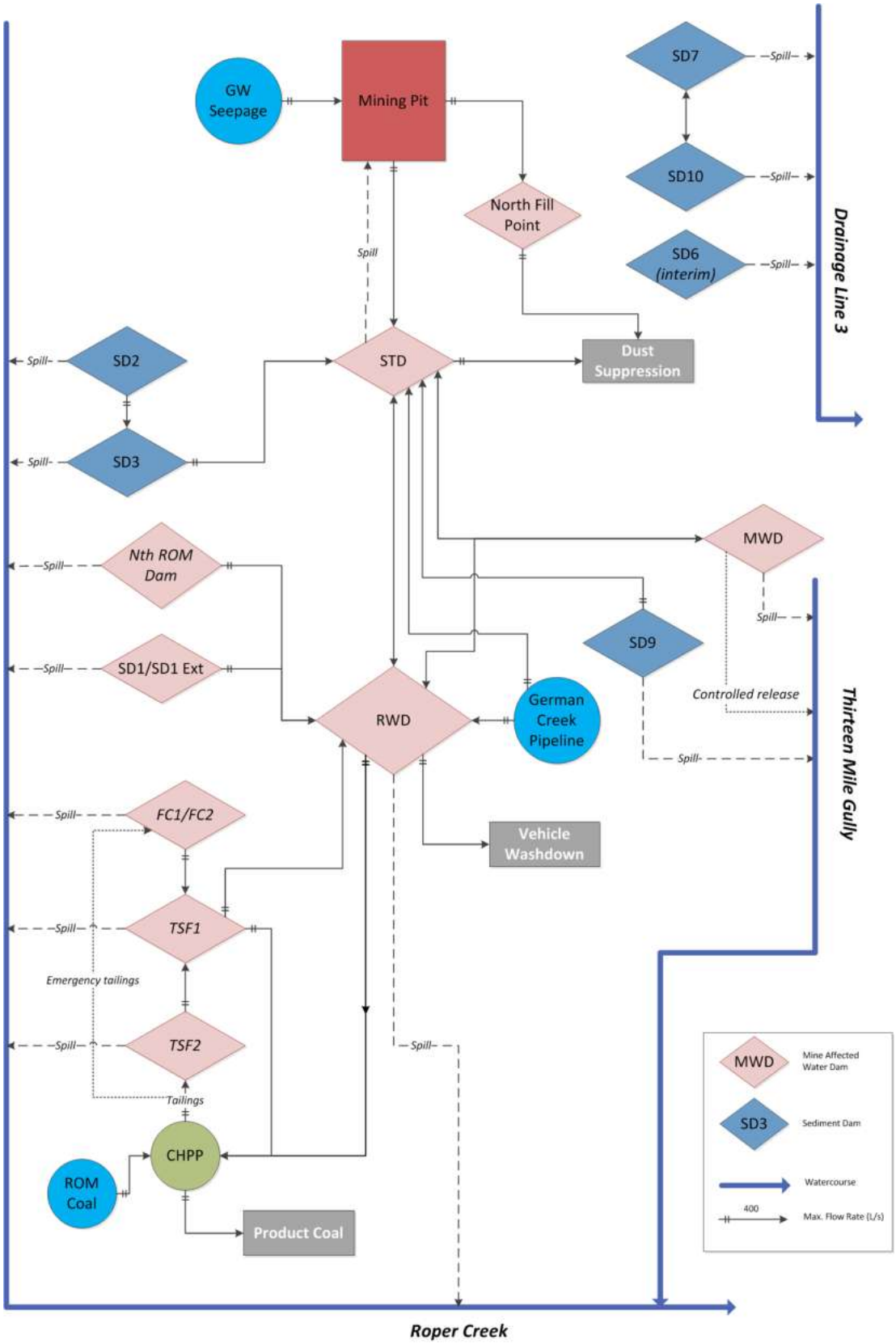


Figure 4.1 – Existing water management system schematic

4.3 SURFACE WATER MANAGEMENT PRINCIPLES

The general principles to manage surface water for the site are as follows:

- The separation of catchment runoff, on-site stormwater, mine affected water, tailings return water and contaminated water.
- Minimise the area of surface disturbance, thus minimising the volume of on-site stormwater capture or contaminated water runoff.
- Collect and contain on site all potential mine affected water pumped from the open cut pits in dedicated mine water storages. The mine water storages will be used as the primary water source for the CHPP and for dust suppression.
- Retain and reuse on site any on-site stormwater runoff that has high sediment concentrations whenever possible. If not, release it in a controlled manner (i.e. following settlement) in compliance with the ESCP.
- Minimise the potential for generation of contaminated water by installing a roof over the bunded areas. Where this is not possible, use oil and water separators or collect and contain the potentially contaminated water within the bunds and pump it to the mine affected water storages.
- Maximise the use of on-site water and thus minimise the need for importing external water.
- Prioritise the use of poorer quality water over better quality water.
- Complete flood mitigation works to provide a minimum of 0.1% AEP immunity from Thirteen Mile Gully and Roper Creek floods.

4.4 TAILINGS AND REJECTS CIRCUIT

The TSFs at the Middlemount Coal Mine comprise a series of 4 in-line flocculation cells (ILF cells) (within TSF2), emergency ILF cells (at FC1/FC2) and the inactive TSF (TSF1). All tailings facilities are constructed with earth embankments on all sides and do not receive runoff from external catchments. The tailings circuit is managed as follows:

- Fine rejects are pumped to the ILF cells at TSF2 (or emergency cells FC1/FC2).
- Flocculant is added prior to removal of water from the TSFs.
- Decant water is pumped to TSF1 then returned to the CHPP and RWD for reuse.
- Fine tailings are dried and reclaimed for in-pit disposal.

The inactive TSF (TSF1) is only used for the temporary storage of decant water. FC1 and FC2 have not been utilised for tailings since the construction of the ILF cells within TSF2.

Coarse rejects are managed separately to the fine rejects and disposed of within overburden emplacements.

Refer to Figure 2.1 and Figure 4.1 for the locality and configuration of the tailings circuit.

4.5 MINE AFFECTED WATER MANAGEMENT

Mine affected water is managed as follows:

- There are two main mine water management dams: RWD; and MWD. Mine water in excess of the Raw Water Dam capacity is stored in the MWD.
- Transfer dams located in the vicinity of the mining pit are used as staging dams to transfer mine water to the RWD or MWD and as a source of water for dust suppression. The transfer dams are of turkey's nest or sump type construction with no external catchment area.

- Water captured in the mining pit may also be pumped directly to the RWD or the MWD (via the transfer dams).
- Runoff from a section of the haul road immediately north of the CHPP and portions of the ROM and coal stockpile area drains to SD1. SD1 is dewatered to the RWD for reuse in the CHPP. Any overflow from SD1 drains to the SD1 extension dam.
- A dedicated pump is permanently situated at SD1 to minimise the chance of uncontrolled releases during rain events.
- Runoff from the northern ROM and hardstand area is captured in the NROM and transferred to the RWD for reuse in the CHPP.
- Controlled releases can be made from the MWD, Sediment Dams 1, 2, 3, 7, the RWD, and the NROM.

4.5.1 Mine affected water management storages

Figure 2.1 shows the location of the mine water management storages. A summary of the mine affected water storages, their capacities and surface areas are provided in Table 4.1.

Table 4.1 – Existing mine affected water management storages

Dam Name	Storage volume at FSL (ML)	Surface area at FSL (ha)	Maximum water depth (m)	Catchment area (ha)	Releases to
RWD	191	2.7	13.0	25.5	Roper Creek
MWD	1,928	28.6	8.1	30.0	Thirteen Mile Gully
SD1	46	0.7	2.9	16.2	Roper Creek
STD	26	2.0	3.0	36.1	Mining Pit
NROM	4	0.2	3.0	5.5	Roper Creek
Mining Pit	24,500	104.5	68.0	463.5	-
TSF 1	187^	14.3	12.8	15.5	Roper Creek*
TSF 2 (4 ILF cells)	535^	9.1	8.9	9.7	Roper Creek*
FC1/FC2	52	1.4	7.1	3.1	Roper Creek*

^Excludes volume of tailings placed within storage.
* No releases are expected to occur from either of the TSFs or FC1/FC2.

4.5.2 Environmental Authority (EA) – release conditions

The current MCM EA (EPML00716913) took effect on 21 May 2018. The EA conditions require that mine affected water may only be released from designated release points when water quality is within defined end-of-pipe limits. A description of these compliance conditions is given below.

Table 4.2 lists all the mine affected water release points and associated receiving water for the current water management system (Table C1 in the MCM EA). The locations of the release points are shown in Figure 2.1.

Table 4.3 shows the mine affected water release limits given in the MCM EA. Condition C4 requires that water is only released when the water quality is within these limits.

Condition C9 of the EA requires that the release of mine affected waters must only take place during periods of natural flow at a flow gauging station at Ref 1 as specified in Table 4.4. Further, Condition C10 requires that the release of mine affected water must not exceed the EC and sulphate release limits specified in Table 4.4.

Table 4.2 - Mine affected water release points (EA Table C1)

Release point	Easting	Northing	Mine affected water source and location	Monitoring point	Receiving waters
RP 1	667,725	7,469,370	RWD	Spillway/pipe	Roper Creek
RP 2	671,743	7,469,842	MWD	Spillway/pipe	Roper Creek
SD 1	668,008	7,469,218	SD1	Spillway/pipe	Roper Creek
SD 2	668,093	7,470,858	SD2	Spillway/pipe	Roper Creek
SD 3	668,457	7,470,213	SD3	Spillway/pipe	Roper Creek
SD 7	671,125	7,474,067	SD7	Spillway/pipe	Roper Creek
NROM	667,858	7,470,294	NROM	Spillway/pipe	Roper Creek

Table 4.3 - Mine affected water release limits (EA Table C2)

Quality characteristic	Units	Minimum	Maximum
EC	µs/cm		See Table 4.4
pH	pH units	6.5	9.0
Turbidity	NTU	N/A	No limit
Suspended solids	mg/L	N/A	Flow < 2m^3/s - 562 mg/L Flow > 2m^3/s - 1,062 mg/L
Sulphate	mg/L		See Table 4.4

Table 4.4 - Mine affected water release during flow events (EA Table C4)

Gauging station	Recording frequency	Flow criteria for release	Maximum release rate (for all combined RP flows)	Release limit	
				EC (µs/cm)	Sulphate (mg/L)
Ref 1	Continuous (minimum daily)	**Low flow** For a period of 28 days following natural flow events that exceed 2 m^3/s	0.4 m^3/s	700	250
		Medium flow >2 m^3/s	1.12 m^3/s	1,500	250
		High flow >10 m^3/s	5.6 m^3/s	1,500	250
		High flow >10 m^3/s	1.6 m^3/s	3,500	300
		Very high flow >25 m^3/s	2.1 m^3/s	6,000	500

4.6 CONTAMINATED WATER MANAGEMENT SYSTEM

4.6.1 Chemical storage

Primary chemical storage areas at Middlemount Coal Mine are located on the mine infrastructure area at the workshop and the CHPP workshop area. These storage facilities have been constructed and bunded generally in accordance with the relevant specifications of *AS1940 – Storage and Handling of Flammable and Combustible Liquids* (AS1940). Hazardous substances operating procedures are in place at these operations. A register is also maintained on site for all chemicals. Where appropriate, safety data sheets will be kept in storage areas or accessed online, as required.

4.6.2 Fuel storage

Fuel storage areas are a potential source of hydrocarbons. Primary fuel storage areas at the mine infrastructure area have been constructed and bunded in accordance with the relevant specifications of *AS1940 – Storage and Handling of Flammable and Combustible Liquids* (AS1940). Fuel storage areas have also been constructed at service and operational points across the mining lease.

Fuel storage areas associated with Middlemount Coal Mine operations are inspected regularly, with repair and maintenance work completed on an as-needs basis. Bunds filled with stormwater are drained (i.e. diesel/oil storage bunding at warehouse drains to oil sump and onto oil separator system) or pumped out by a licensed contractor as soon as practicable to maintain the bund volume.

4.6.3 Sewage

Middlemount Coal Mine has installed a sewerage treatment plant that collects effluent from the main administration building, workshop, project offices and CHPP. Treated effluent from the sewage treatment plant is discharged to TSF1 for re-use in the CHPP. All other sewerage generated on site is trucked off site by registered waste transport contractors.

4.7 ON-SITE STORMWATER MANAGEMENT SYSTEM

4.7.1 Overview

On-site stormwater runoff from the overburden dumps is managed in accordance with the ESCP. The ESCP adopts the three cornerstones of erosion and sediment control:

- Drainage control – prevention or reduction of soil erosion caused by concentrated flows and appropriate management and separation of the movement of diverted and surface water through the area of concern.
- Erosion control – prevention or minimisation of soil erosion (from dispersive, non-dispersive or competent material) caused by rain drop impact and exacerbated overland flow on disturbed surfaces.
- Sediment control – trapping or retention of sediment either moving along the land surface, contained within runoff (i.e. from up-slope erosion) or from windborne particles.

The Project will require a combination of the three control measures to effectively manage sediment and erosion at the site.

4.7.2 Sediment dam sizing

Sediment dams capture runoff from overburden dumps in accordance with the ESCP (WRM, 2016a). The proposed sediment dams have been sized in accordance with the Best Practice Erosion and Sediment Control Guidelines (IECA, 2008). Runoff collected in the dams will be released to the downstream environment in accordance with the Middlemount Coal Mine EA conditions or pumped back into the mine water system to maintain capacity.

The proposed sediment dams have been based on the following design standards and methodology:

- "Type D/F" sediment basins;
- total sediment basin volume = settling zone + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone is the minimum required free storage capacity that must be restored within 5 days after a runoff event;
- sediment basin settling volume based on 85th percentile 5-day duration rainfall of 33.6 mm) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.59 (Group D soils – clay); and
- solids storage volume = 50% of settling zone volume.

Table 4.5 shows the maximum contributing catchment areas and design volumes for each of the proposed sediment dams. The locations of the proposed sediment dams are shown in Figure 1.3 to Figure 1.5.

Five new sediment dams (SD5, SD6, SD12, SD13 and SD14) would be constructed by 2023 to capture runoff from the expanding overburden dump. By 2023, the temporary existing sediment dam SD6 would be removed and replaced with a permanent dam. By 2028, the existing sediment dam SD10 would be removed due to the expanding open cut and waste dump footprints. A new dam SD15 would also be required by 2028.

Table 4.5 – Proposed sediment dam sizes

Sediment Dam	Maximum catchment area (ha)	Sediment Basin Requirements			Overflows to
		Settling Volume (ML)	Sediment Storage Volume (ML)	Total Volume (ML)	
SD5	225.3	44.3	22.1	66.4	Drainage Line 3
SD6	216.5	42.6	21.3	63.8	Drainage Line 3
SD12	501.3	98.6	49.3	147.8	Thirteen Mile Gully
SD13	142.2	28.0	14.0	41.9	Thirteen Mile Gully Diversion
SD14	58.5	11.5	5.7	17.2	Roper Creek
SD15	28.4	5.6	2.8	8.4	Drainage Line 2

4.8 CATCHENT RUNOFF WATER MANAGEMENT SYSTEM

4.8.1 Flood protection levees

Flood levees are used across the Middlemount Coal Mine to prevent up-catchment floodwater from Roper Creek and Thirteen Mile Gully from entering the mine water management system. The location of the existing levee is shown in Figure 4.2. This levee has been progressively constructed since 2008 and is a regulated structure under the EP Act.

Further modification of this levee was proposed and assessed as part of the Stage 2 Project as mining progresses in a southerly and easterly direction. Diversions of Roper Creek are proposed as part of the construction of these levees. The location of the approved Stage 2 levee (and Roper Creek diversions) is shown in Figure 1.2.

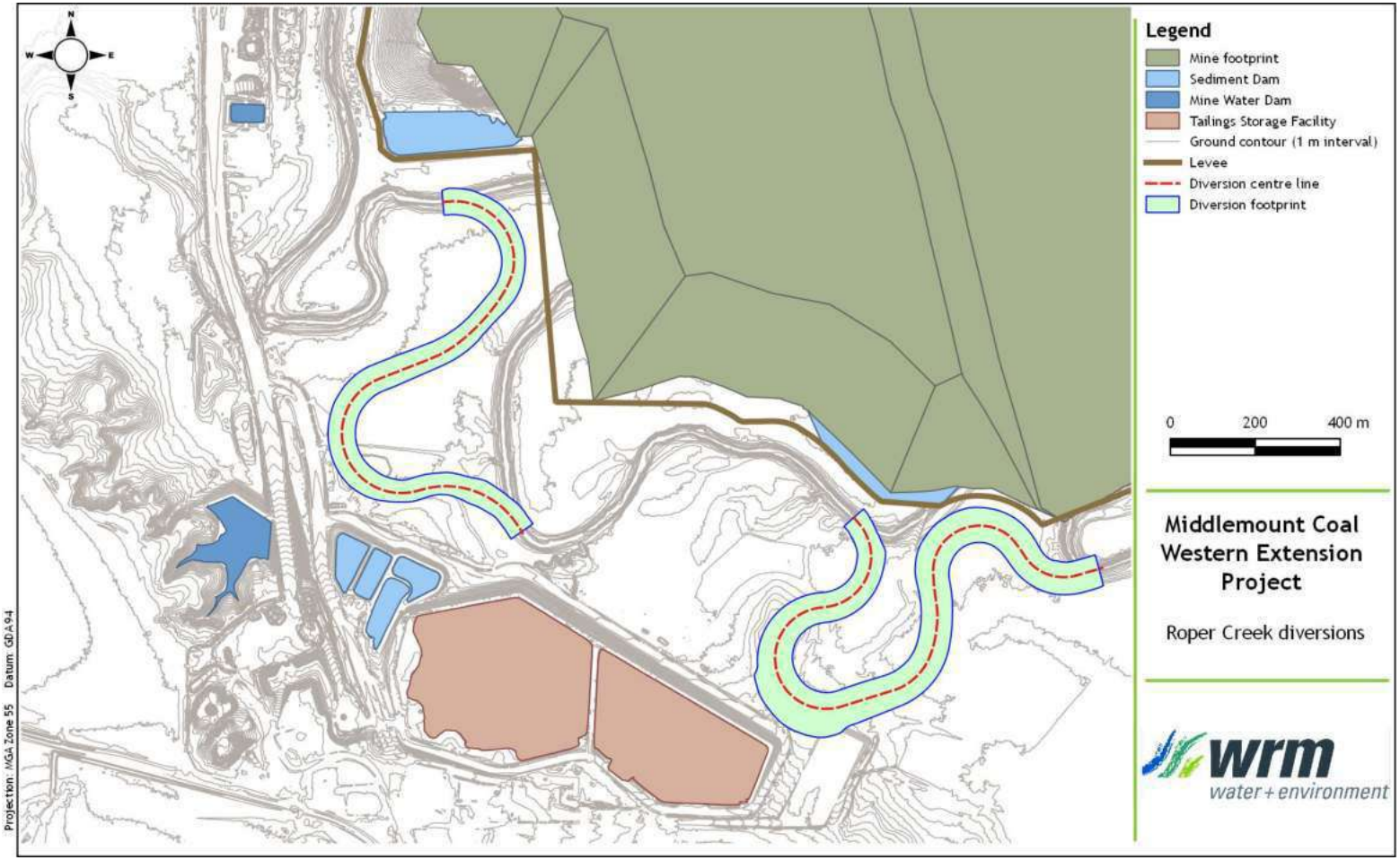


Figure 4.2 – Roper Creek diversions

The Project proposes to change the approved Stage 2 levee to allow mining of the western extension area. The alignment of the unconstructed sections around the southern end of the mining area (and the Roper Creek diversions) remain unchanged from that approved as part of Stage 2. The location of the proposed levee change is shown in Figure 1.3.

The modified levee will be a regulated structure under the EP Act and will therefore be required to have a crest above the 0.1% AEP event. An assessment of the levee against the requirements of the EP Act is given in Section 7.4.

4.8.2 Waterway diversions

Three waterway diversions were proposed as part of the Stage 2 Project; two diversions of Roper Creek and a diversion of Thirteen Mile Gully into Roper Creek along the eastern boundary of the mine.

MCPL holds approvals under the *Sustainable Planning Act 2009* (SPA) and licences under the *Water Act 2000* to divert the flow of water of Thirteen Mile Gully and Roper Creek. The Thirteen Mile Gully diversion has been constructed and its location is shown in Figure 1.2. The approved configurations of the proposed Roper Creek diversions are shown in Figure 4.2. The diversions are proposed to be constructed prior to 2023.

It is proposed to extend and realign the Thirteen Mile Gully diversion as part of the Project (see Figure 1.3). The diversion would commence about 1 km upstream of the commencement of the existing levee along Drainage Line 1 and drain into the existing diversion about 1 km downstream of the commencement of the existing diversion. A concept design and an assessment of the diversion realignment is given in Section 6.

4.8.3 Up-catchment runoff water diversions

A series of up-catchment water drains and temporary dams are proposed to capture and divert catchment runoff water around the mining areas. The indicative locations of the proposed drain and dams for the various mine Phases are shown in Figure 1.3 to Figure 1.5. Descriptions of the drains are as follows:

- By 2023, two dams (HWD1 and HWD2) will be constructed to the north of the mining areas to capture overland flows. The captured overland flows will either be pumped around the mining areas or a temporary drain constructed to free drain the captured flows.
- By 2028, the HWD 2 will be mined through and a new permanent up-catchment water drain constructed to divert the catchment to the north of mining area back to Drainage Line 1. This up-catchment water drain will remain a feature at the end of mining.

4.9 EXTERNAL WATER SUPPLY

MCPL have an arrangement with Anglo American to supply water from the German Creek Mine. Water is pumped from German Creek on an ‘as needed’ basis and placed in the RWD up to a limit of 250 ML per month and 1,800 ML per year.

Water is supplied in accordance with the Water Supply Contract between MCPL and Anglo Coal (Capcoal Management) Pty Ltd dated 22 December 2010.

External water will continue to be pumped to site on an ‘as needed’ basis for the Project. The modelling results presented in Section 5.3 0 show that the current agreement with Anglo American is more than sufficient to meet the mines external water supply requirements.

Water captured on-site will however continue to be used in preference to the German Creek Mine water supply.

5 Water management system assessment

5.1 OVERVIEW

The performance of the mine affected water management system was assessed using the OPSIM water balance model. OPSIM is a computer-based operational simulation model that has been developed to assess the dynamics of the water balance under varying rainfall and catchment conditions throughout the development of the Project. The model has been in operation since the conception of the mine and has been continually updated as data becomes available or mining operations have changed. The model will be continually updated throughout the life of the Project.

The OPSIM model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step. Full details of the configuration and calibration of the Middlemount Coal Mine OPSIM model, including input assumptions, are provided in Appendix B.

The Middlemount Coal Mine OPSIM model was used to predict the performance of the following:

- overall water balance – the average inflows and outflows of the water management system for a number of representative realisations (Section 5.3.1);
- mine water inventory and salinity – the risk of accumulation (or reduction) of the overall mine water inventory and associated water quality (Section 5.3.2);
- in-pit storage – the risk of accumulation of water in the mining pit, and the associated water volumes (Section 5.3.3);
- external water demand – the risk and associated volumes of requiring imported external water (via the Anglo pipeline) to supplement site mine water supplies (Section 4.9);
- uncontrolled spillway discharges – the risk of uncontrolled discharge from the mine affected water storages to the receiving environment (Section 5.3.5); and
- controlled releases – the risk and associated volumes of controlled release of mine affected water to the receiving environment (Section 5.3.5).

5.2 INTERPRETATION OF RESULTS

In interpreting the results of the water balance assessment, it should be noted that the results provide a statistical analysis of the water management system's performance over the 20 years of mine life, based on 109 realisations with different climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10^{th} percentile represents 10% probability of exceedance and the 90^{th} percentile results represent 90% probability of exceedance. There is an 80% chance that the result will lie between the 10^{th} and 90^{th} percentile traces.

Whether a percentile trace corresponds to wet or dry conditions depends upon the parameter being considered. For site water storage, where the risk is that available storage capacity will be exceeded, the lower percentiles correspond to wet conditions. For example, there is only a small chance that the 1 percentile storage volume will be exceeded, which would generally correspond to wet conditions.

For external site water supply volumes (for example), where the risk is that insufficient water will be available, there is only a small chance that more than the 1 percentile water supply volume would be required. This would generally correspond to dry climatic conditions.

It is important to note that a percentile trace shows the likelihood of a particular value on each day and does not represent continuous results from a single model realisation. For example, the 50th percentile trace does not represent the model time series for median climatic conditions.

5.3 WATER BALANCE MODEL RESULTS

5.3.1 Overall water balance

Water balance results for all of the 109 modelled realisations are presented in Table 5.1, averaged over each model phase. The results presented in Table 5.1 are the average of all realisations and will include wet and dry periods distributed throughout the mine life. Rainfall yield for each Phase is affected by the variation in climatic conditions within the adopted climate sequence.

Table 5.1 - Annual water balance - all realisations

Component	Process	Average annual volume (ML/year) per model Phase				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Inflows	Catchment runoff & direct rainfall	1,510	2,112	2,140	2,311	3,042
	Groundwater inflows	716	851	724	905	455
	External supply	745	574	703	571	514
	Total inflows	**2,972**	**3,537**	**3,568**	**3,787**	**4,010**
Outflows	Evaporation	916	963	956	965	1,005
	Dust suppression	1,143	1,143	1,143	1,143	1,143
	Net CHPP demand	604	608	610	577	424
	Controlled releases	204	296	263	310	388
	Spillway overflows - mine water dams	0	0	0	0	0
	Spillway overflows - sediment dams	147	457	585	776	805
	Total outflows	**3,013**	**3,467**	**3,557**	**3,772**	**3,766**
	Change in volume	**-41**	**70**	**11**	**15**	**244**

Table 5.2 presents representative long-term mine site water balance results based on simulation results for the wet (10th percentile), median (50th percentile) and dry (90th percentile) 20-year rainfall sequences.

Table 5.1 and Table 5.2 provide an indication of the long-term average annual inflows and outflows. Key outcomes from the overall water balance are as follows:

- With the exception of Phase 1, minor on-site water accumulation is predicted across the Phases, increasing towards the end of the Project (Phase 5) as the total mine catchment increases and dust suppression demands reduce;
- The groundwater inflows (which are based on the calibrated model predictions by AGE (2018)) are generally consistent between Phase 1 and Phase 4, with a reduction towards the end of the Project in Phase 5;
- Average annual external water supply requirements vary between 510 to 750 ML/year over the life of the Project.
- There were no modelled spillway overflows from the mine affected water dams over the life of the Project.
- The Project has minimal impact on the overall water balance for the mine. The key change is an increase in overall catchment runoff volumes associated with the additional catchment area captured within the mine water management system.

Table 5.2 – Average annual water balance – wet (10th percentile), median (50th percentile and dry (90th percentile) rainfall sequences

Component	Process	Representative 20-year climatic sequence		
		Wet (10th %ile)	Median (50th %ile)	Dry (90th %ile)
Inflows	Catchment runoff & direct rainfall	2,526	2,062	1,629
	Groundwater inflows	730	730	730
	External supply	587	596	704
	Total inflows	**3,843**	**3,388**	**3,063**
Outflows	Evaporation	919	944	886
	Dust suppression	1,089	1,089	1,089
	Net CHPP demand	554	554	554
	Controlled releases	364	290	186
	Spillway overflows – mine affected water dams	0	0	0
	Spillway overflows – sediment dams	800	515	312
	Total outflows	**3,726**	**3,392**	**3,027**
	Change in volume	**117**	**-4**	**36**

5.3.2 Mine site storage inventory and salinity

Figure 5.1 shows the modelled behaviour of the MWD over the 20-year simulation period. The MWD is the primary mine affected water storage on the site and is therefore indicative of the overall mine water storage behaviour. Although the capacity of the MWD is 1,928 ML, the maximum operating storage level of the MWD is set at 1,815 ML to prevent uncontrolled spills.

If the MWD is anticipated to exceed 1,815 ML, water will be managed within the individual dams rather than pumped to the MWD. Releases from the MWD are restricted when the stored volumes fall below 500 ML to maintain water for mine site use. The following is of note:

- The MWD does not empty over the simulation period due to the supply of water via the Anglo pipeline from German Creek Mine; and
- The maximum volume in the MWD stays within 20 ML of the maximum operating volume (1,815 ML).

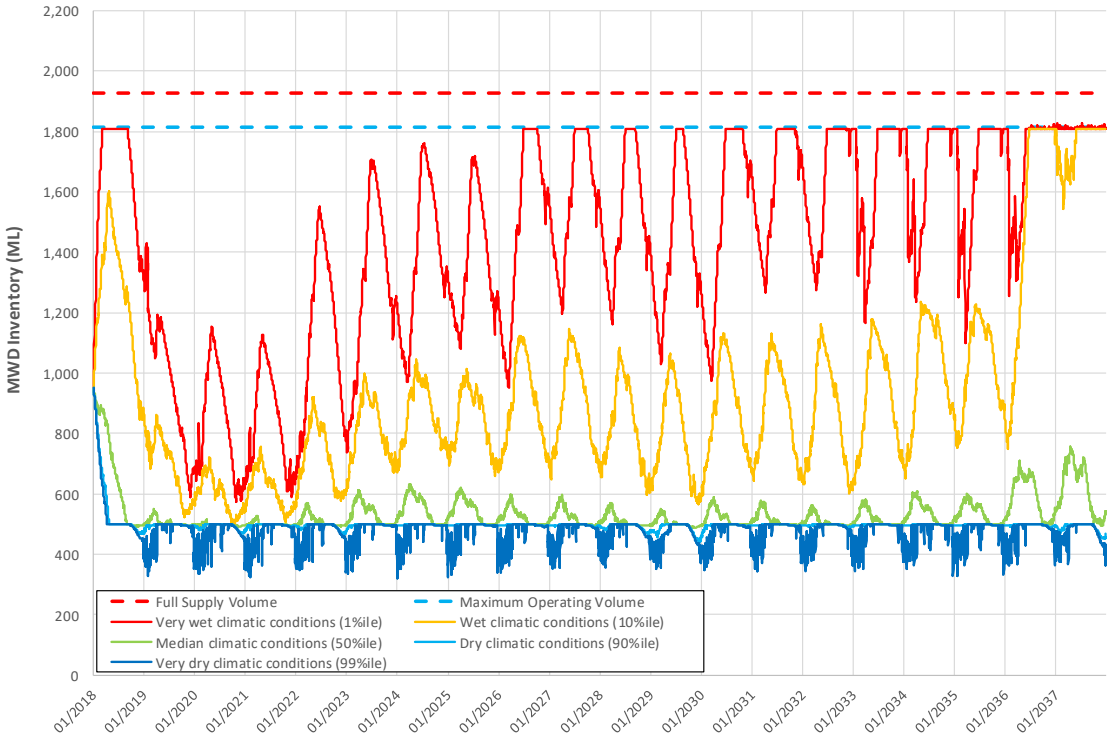


Figure 5.1 – Forecast MWD inventory

Figure 5.1 shows the modelled salinity of the MWD over the 20-year simulation period. The following is of note:

- The initial modelled salinity of 5,750 µs/cm reduces rapidly over the first two years of the simulation.
- During dryer climatic conditions, the salinity of MWD is expected to be around 2,500 to 4,500 µs/cm. This is due to the greater reliance on the water supply from the Anglo pipeline, which has a modelled salinity of 4,200 µs/cm.
- During median climatic conditions, the salinity of MWD is expected to be around 1,500 to 3,000 µs/cm.
- During wetter climatic sequences, the salinity of MWD is expected to reduce to around 1,000 to 2,500 µs/cm. This is due to the reduced reliance on the water supply from the Anglo pipeline.

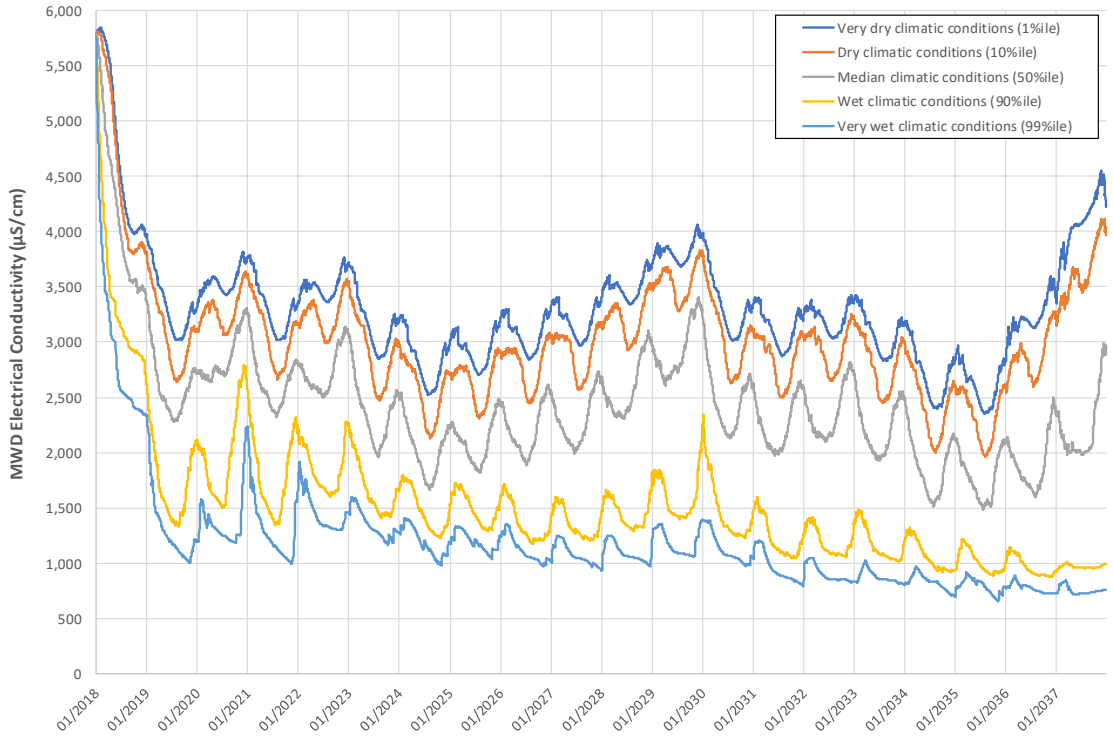


Figure 5.2 – Forecast MWD salinity

5.3.3 Pit inundation characteristics

Figure 5.3 shows the modelled behaviour of the mining pit over the 20-year simulation period.

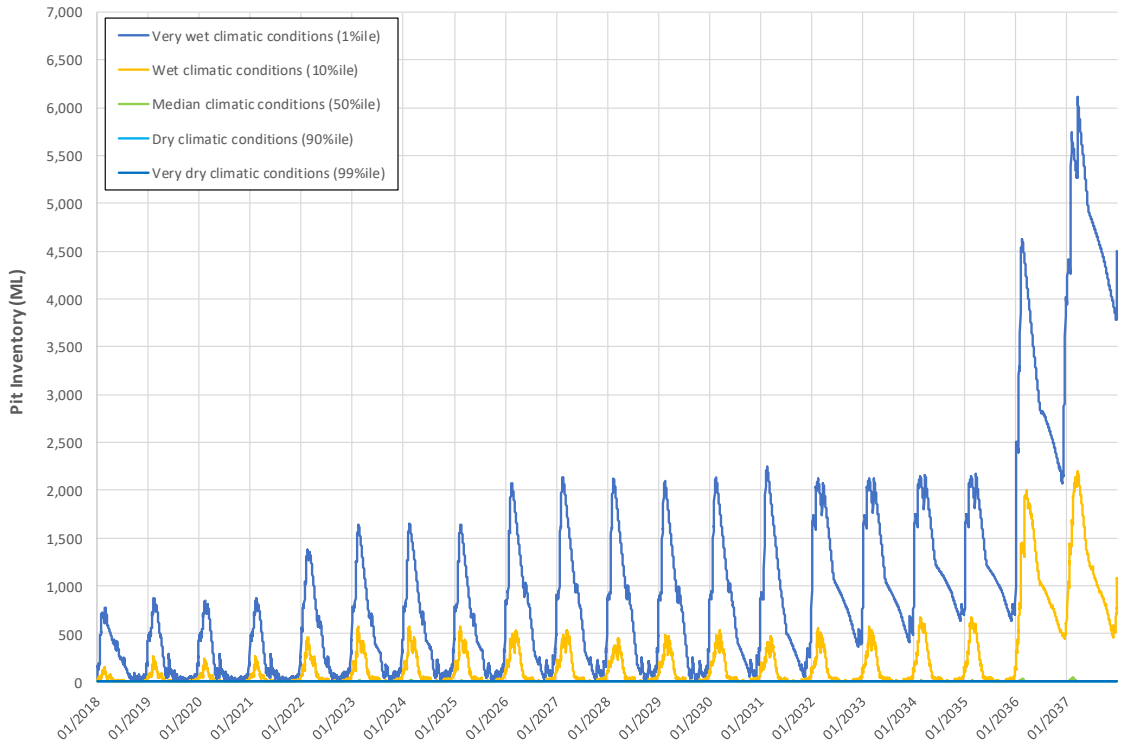


Figure 5.3 – Forecast mining pit inventory

The pit inundation characteristics provides an indication as to whether there is sufficient in-pit pumping infrastructure and out-of-pit storage volume to prevent operational problems. The following is of note:

- There is a relatively low risk of accumulating significant volumes of water in the pit up until Year 2036. After this time, the estimated volumes increase significantly due to the reduction in overall site demands as well as the increase in site catchments during the last few years of the Project (Phase 5).
- There is a 1% chance that the pit volume will not exceed 2,240 ML up until Year 2036 (Phases 1 to 4). This increases to 6,120 ML between Year 2036 and 2037 (Phase 5).
- There is a 10% chance that the pit volume will not exceed 680 ML up until Year 2036 (Phases 1 to 4). This increases to 2,200 ML between Year 2036 and 2037 (Phase 5).

These modelling results indicate that the risk of excessive pit inundation is relatively low up until Year 2036 (Phases 1 to 4) due to the storage capacity available in the MWD and the existing pit pump capacity. Between Year 2036 and 2037 (Phase 5) the risk of inundation is similar; however, the potential volume of inundation increases due to the reduction in site water demands and increased catchments captured within the mine water management system. However, the risk at this time is still relatively low with a 50% chance of having no pit inundation.

5.3.4 Water supply reliability

The model results show that the mine water management system including the external water supply via the Anglo pipeline from German Creek Mine can meet all mine site demands over the 20-year Project life. Further to this, the modelling indicates that:

- an external water supply source is required in almost all years to satisfy demand;
- there is a 50% chance that between 420 ML/year and 990 ML/year water will be required from an external water source over the Project life; and
- the maximum annual demand for external water was modelled at 1,530 ML/year. This remains within the current 1,800 ML/year (250 ML/month) cap of the external Water Supply Contract with Anglo.

That is, the existing external water supply arrangements with Anglo (via the pipeline from German Creek Mine) will remain unchanged for the Project.

5.3.5 Uncontrolled discharges

The water balance model shows that there are no modelled uncontrolled discharges from the mine affected water dams over the simulation period. Therefore, the operational procedures given in the Regulated Dams Operational Management Plan (MP214-001) achieve the assessment criteria objective of a less than 10% chance of uncontrolled discharges from the mine affected water dams.

That is, the Project will continue to achieve the assessment criteria objective of a less than 10% chance of uncontrolled discharges from the mine affected water dams.

5.3.6 Controlled releases

The water balance model simulates controlled releases from the MWD to Roper Creek based on the conditions of the EA. Although controlled releases can be made from other storages, it is only made from the MWD under the current mine affected water management system. The predicted annual controlled release volumes are provided in Table 5.3.

Table 5.3 – Summary of simulated controlled releases – annual volume

Year	Annual controlled releases (ML/year)				
	1%ile	10%ile	50%ile	90%ile	99%ile
2018	363	181	0	0	0
2019	1,183	907	181	0	0
2020	1,002	726	181	0	0
2021	1,045	726	181	0	0
2022	1,088	907	181	0	0
2023	1,270	907	181	0	0
2024	1,227	959	181	0	0
2025	1,270	959	181	0	0
2026	1,097	916	181	0	0
2027	1,183	959	181	0	0
2028	1,140	864	181	0	0
2029	1,097	864	181	0	0
2030	1,088	864	181	0	0
2031	1,183	959	181	0	0
2032	1,097	959	181	0	0
2033	1,194	959	181	0	0
2034	1,457	1,002	181	0	0
2035	1,539	1,054	181	0	0
2036	1,636	1,057	181	0	0
2037	2,093	1,192	181	0	0

The following of note:

- There are opportunities to release water from the MWD to Roper Creek around 50% of the time, in any year during the Project. These opportunities are based on the flow in Roper Creek, the modelled salinity in the MWD and the inventory in the MWD being above 500 ML.
- For very wet climatic conditions (1%ile), the model simulated between 363 ML and 2,093 ML of releases from the MWD each year.
- For wet climatic conditions (10%ile), the model simulated between 181 ML and 1,192 ML of releases from the MWD each year.
- For median climatic conditions (50%ile), the model simulated between 0 ML and 181 ML of releases from the MWD each year.
- For the dry (90%ile) and very dry (99%ile) climatic conditions, there were no modelled releases from the MWD.

The above results show that the existing mine affected water infrastructure at the Middlemount Coal Mine and the existing approved EA conditions are sufficient for the Western Extension Project without change.

5.3.6.1 Release scenarios

The water balance model results were analysed in further detail to assess the modelled controlled releases from the mine affected water management system. The release scenarios were investigated to include:

- Scenario 1 – The highest flow rate released from the site.
- Scenario 2 – The highest concentration of EC released from the site; and

The release events were compared to the approved flow criteria detailed in Table 4.4. The release scenarios were assessed against the following three conditions:

- Flow criteria – The flow criteria is based on the flow rate within the receiving waters. The flow criteria specify the maximum release rate and EC release limit for all release points;
- Maximum release rate – The maximum combined release rate from all release points for a given flow criteria; and
- EC release limit – The maximum EC for releases from mine water dams for a given flow criteria.

For a release scenario to comply with the release rules, the maximum release rate and EC release limit must be below the specified corresponding flow criteria in Table 4.4.

Scenario 1 – Highest release flow rate

The highest modelled release rate for the Project is 2.1 m^3/s, which is the maximum allowable discharge rate under the approved release strategy. Figure 5.4 and Figure 5.5 show the release rate and EC from the site compared to the flow rate in Roper Creek. The approved receiving water flow criteria and release conditions listed in Table 4.4 are also shown.

There is only one flow criteria and corresponding maximum release rate during this release:

- The Very High flow criteria of greater than 25 m^3/s at the start of the release. This flow criteria allows a maximum release rate of 2.1 m^3/s with a maximum EC of 6,000 µS/cm.
- When the receiving waters flow rates declines to zero, the modelled release from site ceases.

The OPSIM model predicts that during this Scenario 1 release, the controlled release from the site would be compliant in terms of release rates and EC using the proposed flow criteria in the receiving waters (Table 4.4).

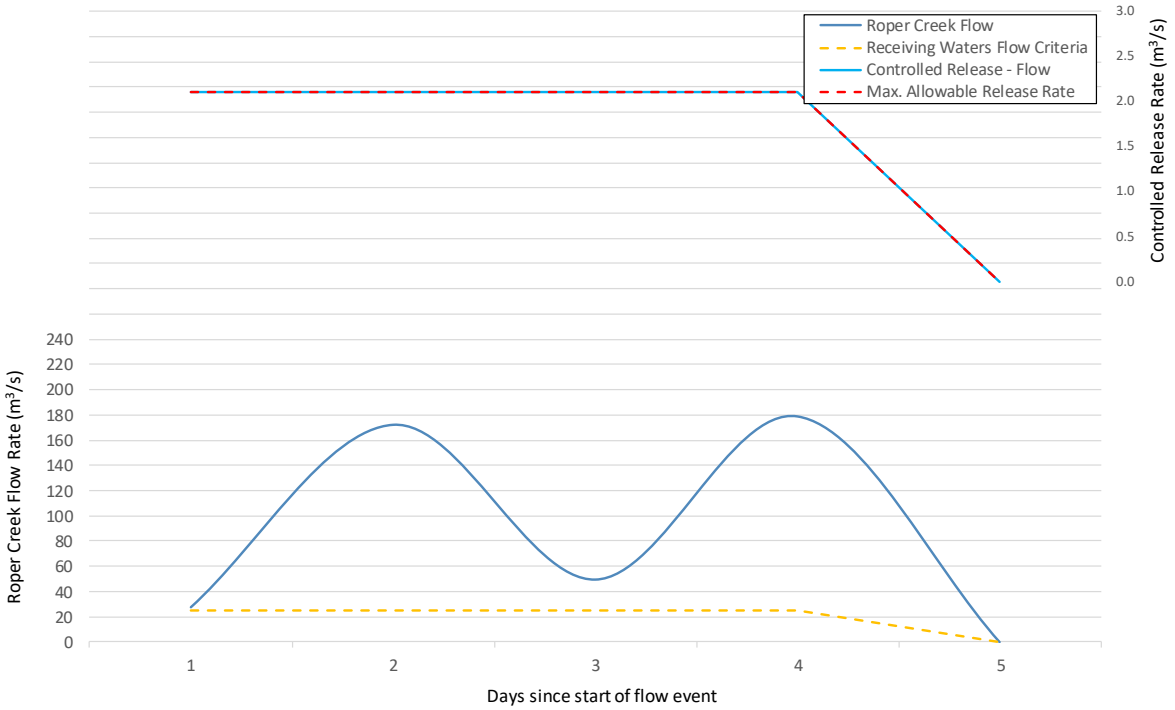


Figure 5.4 - Release rate compared to flow rate in Roper Creek and corresponding flow criteria and maximum release rate - Scenario 1

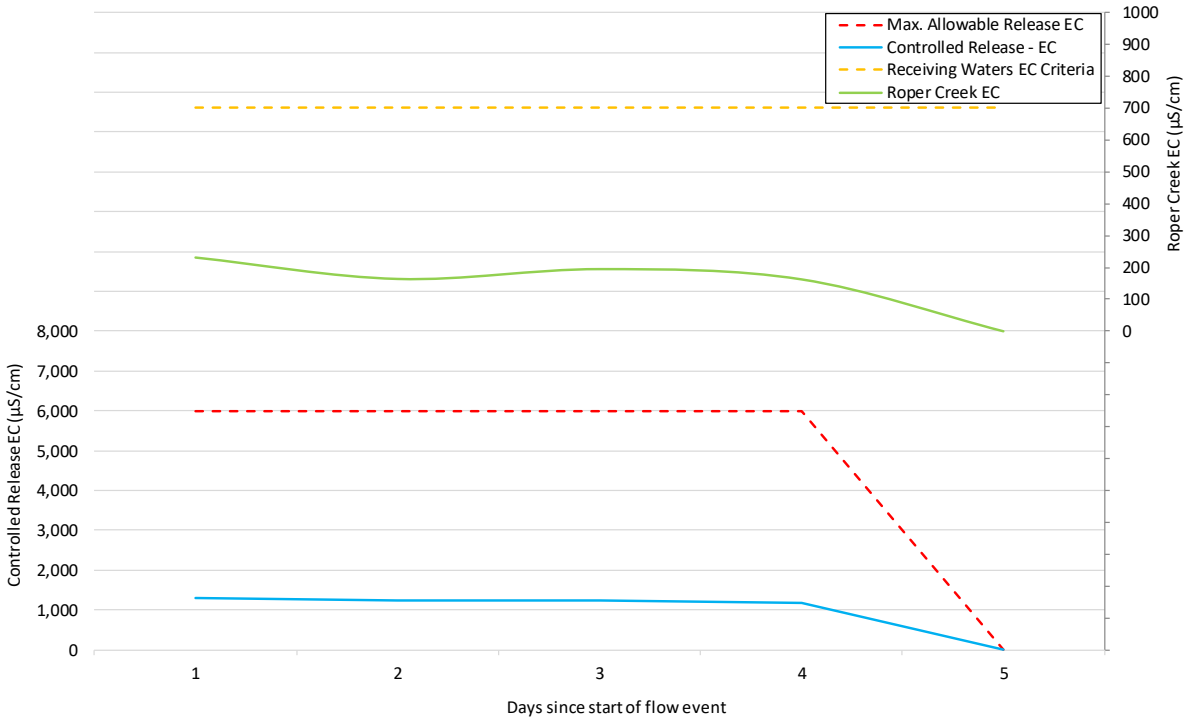


Figure 5.5 - Release water EC compared to EC in Roper Creek and corresponding EC criteria and maximum allowable release EC - Scenario 1

Scenario 2 – Highest concentration of EC released

The highest modelled release EC for the Project is around 3,500 µs/cm. Figure 5.6 and Figure 5.7 show the release rate and EC from the Project compared to the flow rate in Roper Creek. The proposed receiving water flow criteria and release conditions listed in Table 4.4 are also shown.

There are is only one flow criteria and corresponding maximum release rate during this release:

- The Very High flow criteria of greater than 25 m^3/s at the start of the release. This flow criteria allows a maximum release rate of 2.1 m^3/s with a maximum EC of 6,000 µS/cm;
- When the receiving waters flow rates declines to zero, the modelled release from site ceases.

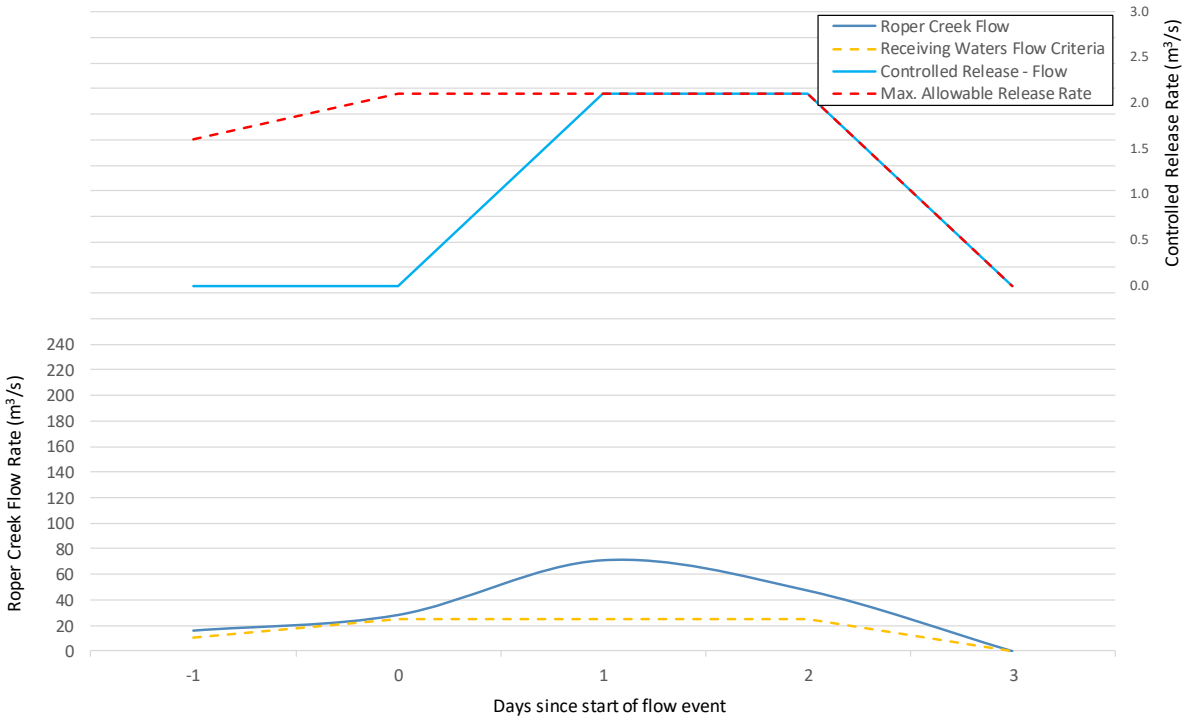


Figure 5.6 – Release rate compared to flow rate in Roper Creek and corresponding flow criteria and maximum release rate – Scenario 2

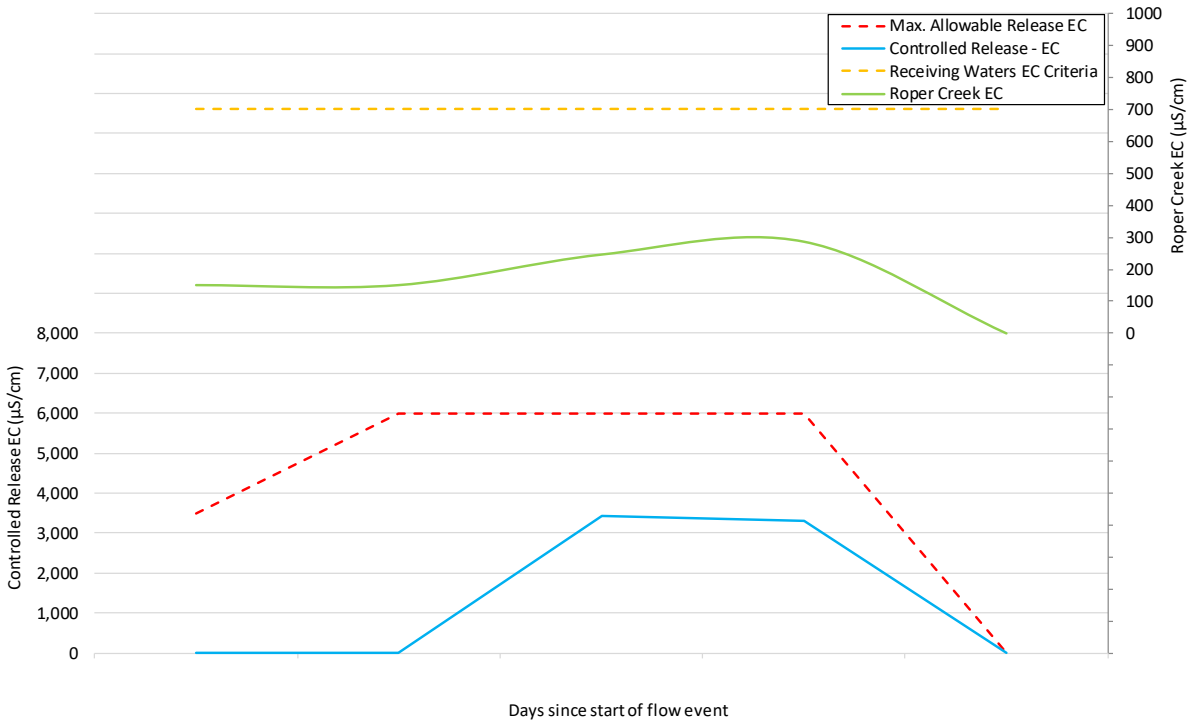


Figure 5.7 – Release water EC compared to EC in Roper Creek and corresponding EC criteria and maximum allowable release EC – Scenario 2

5.4 FINAL VOID BEHAVIOUR

5.4.1 Overview

Water levels in the final voids will vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater. A GOLDSIM model (separate to the OPSIM model used for the operational modelling) was used to assess the likely long-term water level behaviour of the final voids. The historical rainfall and evaporation sequences (128 years) were repeated 5 times to create an indicative long-term climate record.

The volume of water in the voids is calculated at each time step as the sum of direct rainfall to the water surface, catchment runoff and groundwater inflows, less evaporation losses.

5.4.2 Final void configuration

The final void configuration and contributing catchment areas are shown in Figure 5.8 and Table 5.4. The final catchment draining to the voids will be minimised using upslope diversion drains, as shown in Figure 5.8. A depth varying storage evaporation factor has been applied to each void to simulate the change in evaporation as void water levels increase. The storage evaporation factors are as follows:

- Bottom of void – 0.5
- 10 m from top of void – 0.95
- Top of void – 1.0

Table 5.4 – Contributing catchment to final void

Final void	Contributing catchment (ha)
North Void	390.5
South Void	345.4

5.4.3 Stage-storage characteristics

The stage-storage curve for North Void and South Void have been estimated from the final landform terrain model provided by MCPL. The geometries of the final voids are summarised in Table 5.5.

The depths of each void at the end of mining vary from north to south across both mine pits, with the pit floor elevation extending to the base of the coal seams mined within each void. The two voids are separated by spoil backfill that rises up to 180 mAHD.

Table 5.5 – Modelled final void geometry

Final void	Depth (m)	Top surface area (ha)	Full supply volume (ML)
North Void	120	302	15,770
South Void	240	272	12,100

5.4.4 Groundwater inflows

Groundwater inflows to the north and south void were provided by AGE (2018). These inflow rates take into account the movement of water between the North Void and South Void through the in-pit spoil which separates the voids. Groundwater inflows at water levels above the provided inflow curves have been assumed to be zero. This assumption is not expected to have a significant impact to the final void water level behaviour given that the predicted groundwater inflows to the final void are relatively small.

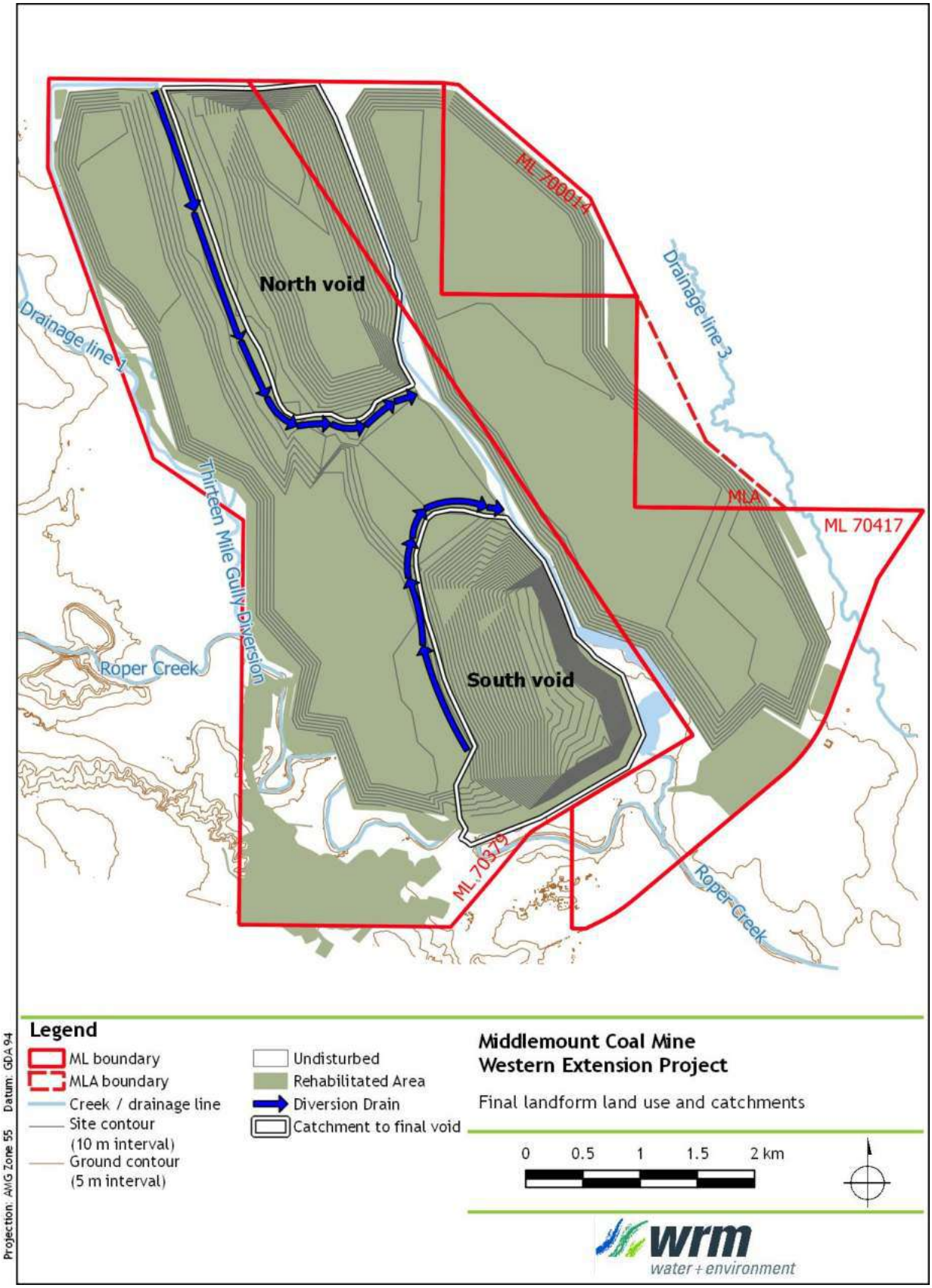


Figure 5.8 – Final void catchment plan

5.4.5 Model results

Figure 5.9 and Figure 5.10 show the simulated long-term water levels in the final voids. The model results show the following:

- North Void
  - The water level reaches a level between 60 mAHD and 65 mAHD relatively quickly and varies between these levels and empty throughout the simulation.
  - The average stored volume is predicted to be 460 ML.
  - The maximum modelled water level is around 95 m below the North Void full supply level.
  - Salt accumulates within the North Void at an average rate of around 63 tonnes per year. The void becomes hyper-saline within the first 100 years of the simulation.
- South Void
  - The water level reaches equilibrium between -70 mAHD and -30 mAHD relatively quickly and generally varies between these levels throughout the simulation.
  - The average stored volume is predicted to be 1,500 ML.
  - The maximum modelled water level is around 175 m below the South Void full supply level.
  - Salt accumulates within the South void at an average rate of around 155 tonnes per year. The void becomes hyper-saline within the first 100 years of the simulation.

The final void modelling indicates that the expected water levels are well below the full supply levels for each void, and the voids will remain as long-term groundwater sinks in perpetuity with no escape of contained water into the Rangal Coal Measures or Fort Cooper Coal Measures (AGE, 2018). As there is no mechanism to lose salt within the closed void system, the voids continually accumulate salt over time and become hypersaline within the first 100 years of the simulation.

The modelling also indicates that there would be no interaction between the long-term water levels within North Void and South Void. This is expected given the large difference in pit floor levels, as well as the small groundwater inflows. The water level response in each void is primarily driven by climatic conditions (rainfall runoff and evaporation) rather than interaction with the groundwater system. Further commentary on the interaction (or lack of) between the final voids is provided in the AGE groundwater assessment (AGE, 2018).

5.5 LIMITATIONS OF THE WATER BALANCE MODEL

The water balance model developed for the Project is based on the best information currently available and is expected to provide a reasonable representation of the performance of the mine water management system. The model will be updated and validated in the future when more suitable site-specific data becomes available. The performance of the actual system may differ from the model predictions for a variety of reasons, including different climatic sequences and hydrologic behaviour of catchments, as well as variations in operating procedures due to potential equipment failure or operation system error.

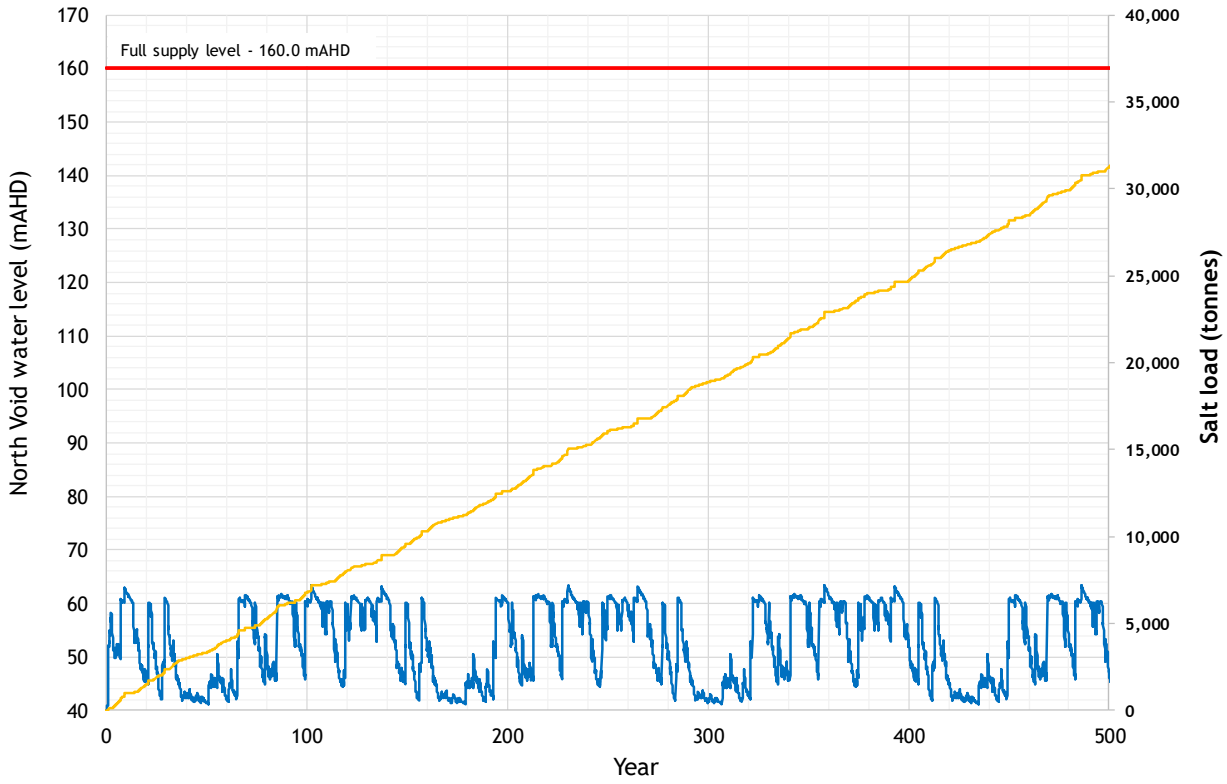


Figure 5.9 - Final void water levels and salt load- North Void

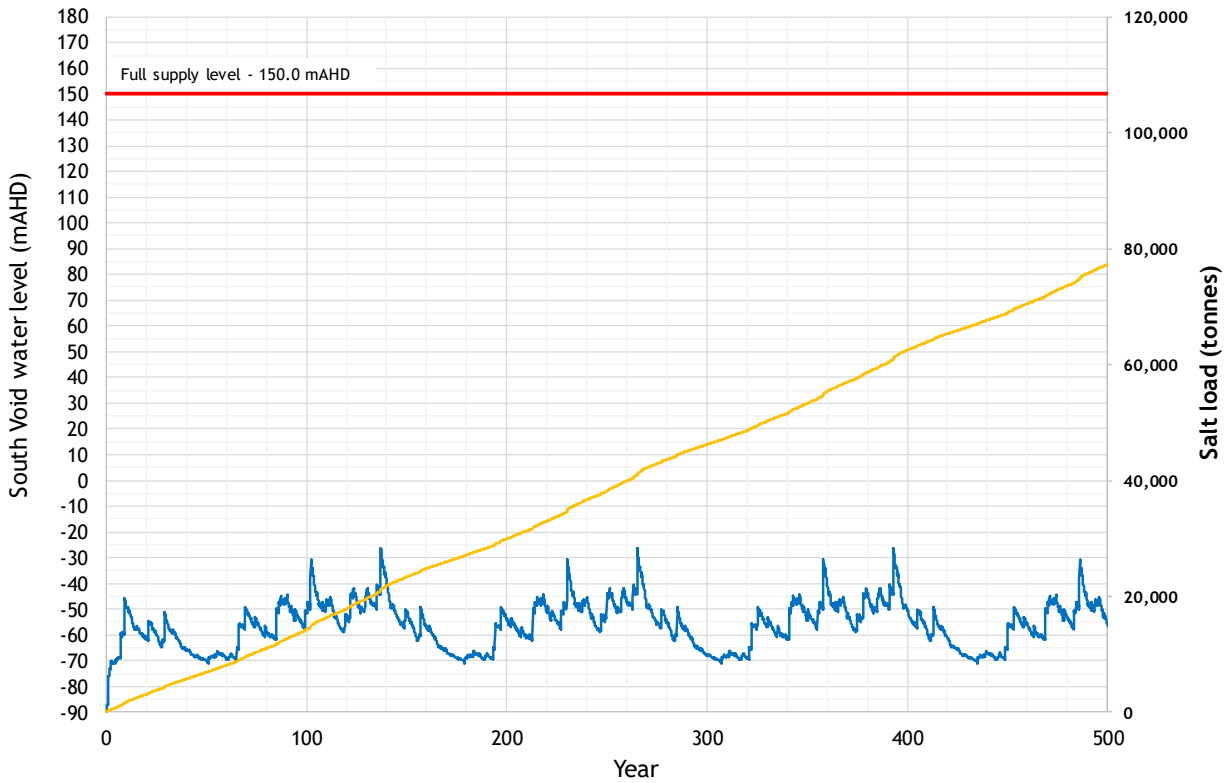


Figure 5.10 - Final void water level and salt load - South Void

6 Proposed Thirteen Mile Gully Diversion realignment

6.1 OVERVIEW

The upstream sub-catchments of Thirteen Mile Gully were diverted along the eastern boundary of ML 70379 in late 2014. A licence to divert the flow of water of Thirteen Mile Gully was issued under the *Water Act 2000* in May 2013 and a SPA approval was granted in July 2013. Upstream of the diversion, the sub-catchments of Thirteen Mile Gully drain via two drainage features; Drainage Line 1 (to the west) and Drainage Line 2 (to the north). The DNRM confirmed that these drainage lines are not watercourses, rather they are 'drainage features', as defined under the Water Act 2000 that facilitates overland flow (DNRM, 2017).

It is proposed to realign Drainage Line 1 and the upper reach of the Thirteen Mile Gully diversion as part of the Project. The new alignment is shown in Figure 6.1 and will be constructed prior to 2028.

6.2 ADOPTED DESIGN APPROACH

Although Drainage Line 1 is not a watercourse, the proposed diversion realignment has been designed in accordance with the key principals and outcomes outlined in the Queensland watercourse diversion guidelines (DNRM, 2014). These outcomes are as follows:

Outcome 1: The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.

Outcome 2: The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.

Outcome 3: The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and are suitable for the region in which the watercourse diversion is located.

Outcome 4: The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts to upstream and downstream reaches.

Outcome 5: The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

To achieve these outcomes, the hydraulic and geomorphic characteristics of the stream to be diverted, or an adjacent stream, have been used as a 'template' to assist with the design of the proposed diversion realignment. The proposed diversion is expected to perform in a similar manner during runoff events to the existing channel and be stable in the long term if it has similar hydraulic and geomorphic characteristics.

The existing hydraulic and geomorphic characteristics of Drainage Line 1 downstream of the diversion has been used as the 'template' for the design.

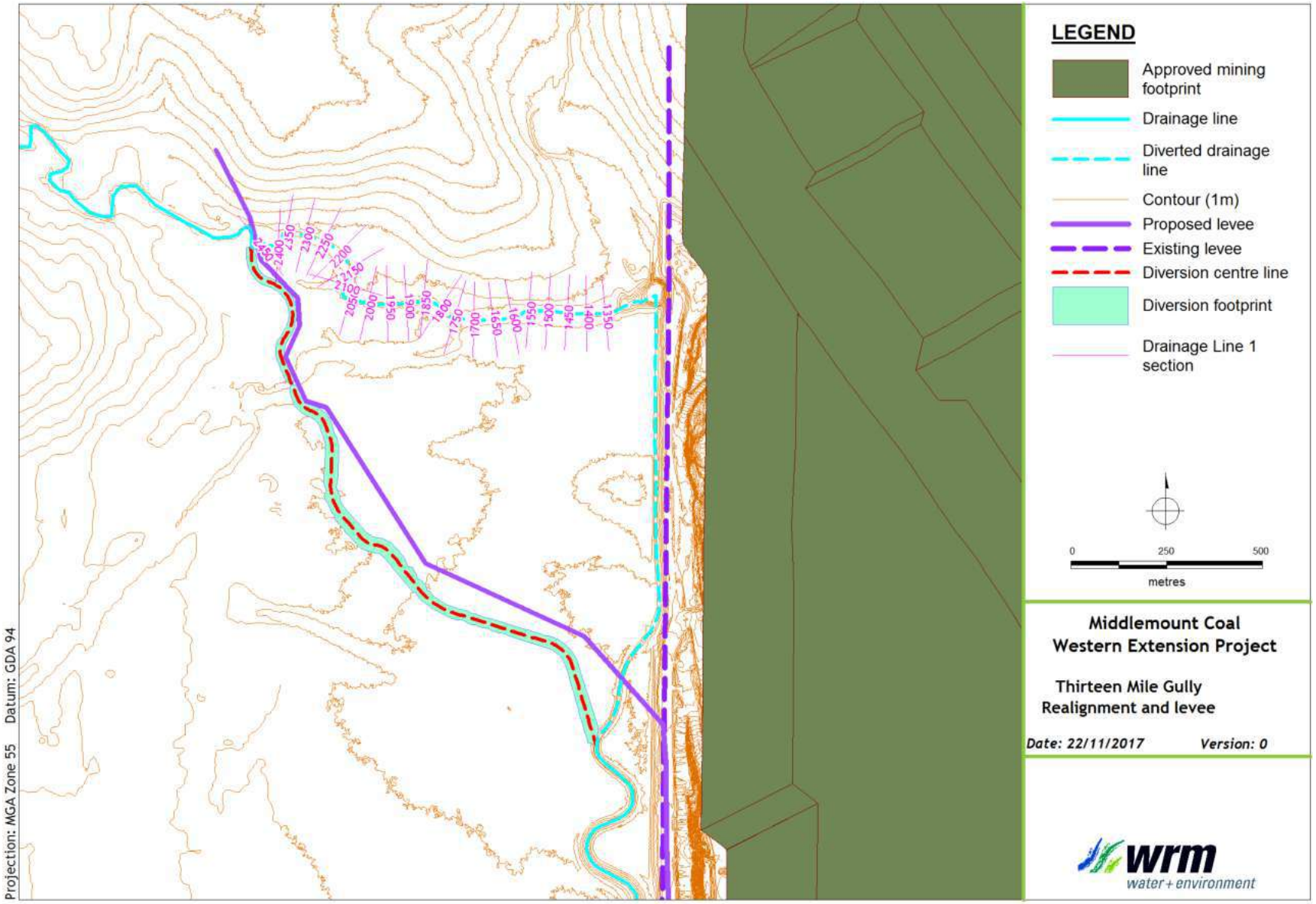


Figure 6.1 – Thirteen Mile Gully diversion realignment

6.3 DRAINAGE LINE 1 CHARACTERISTICS

6.3.1 Channel characteristics

Figure 6.2 shows typical cross sections of Drainage Line 1 from the commencement of the proposed realignment to the commencement of the existing diversion. The locations of the sections are shown in Figure 6.1. The elevations of the cross sections upstream of Section 1750 m have been adjusted to be approximately at the same elevation. Similarly, the cross sections downstream of Section 1750 m have been adjusted but at a level 3 m lower.

The results show that Drainage Line 1 is distinctly different upstream and downstream of Section 1750. At this section, the broader Roper Creek floodplain drains into Drainage line 1 increasing the catchment area by up to 50%. The initial overflows from Roper Creek also drain into Drainage Line 1 at this location. Although the channel depths are similar, the channel is more confined upstream of this location with typical bank slopes of 1V:4H. the downstream bank slopes are generally about 1V:10H and the bed is slightly wider.

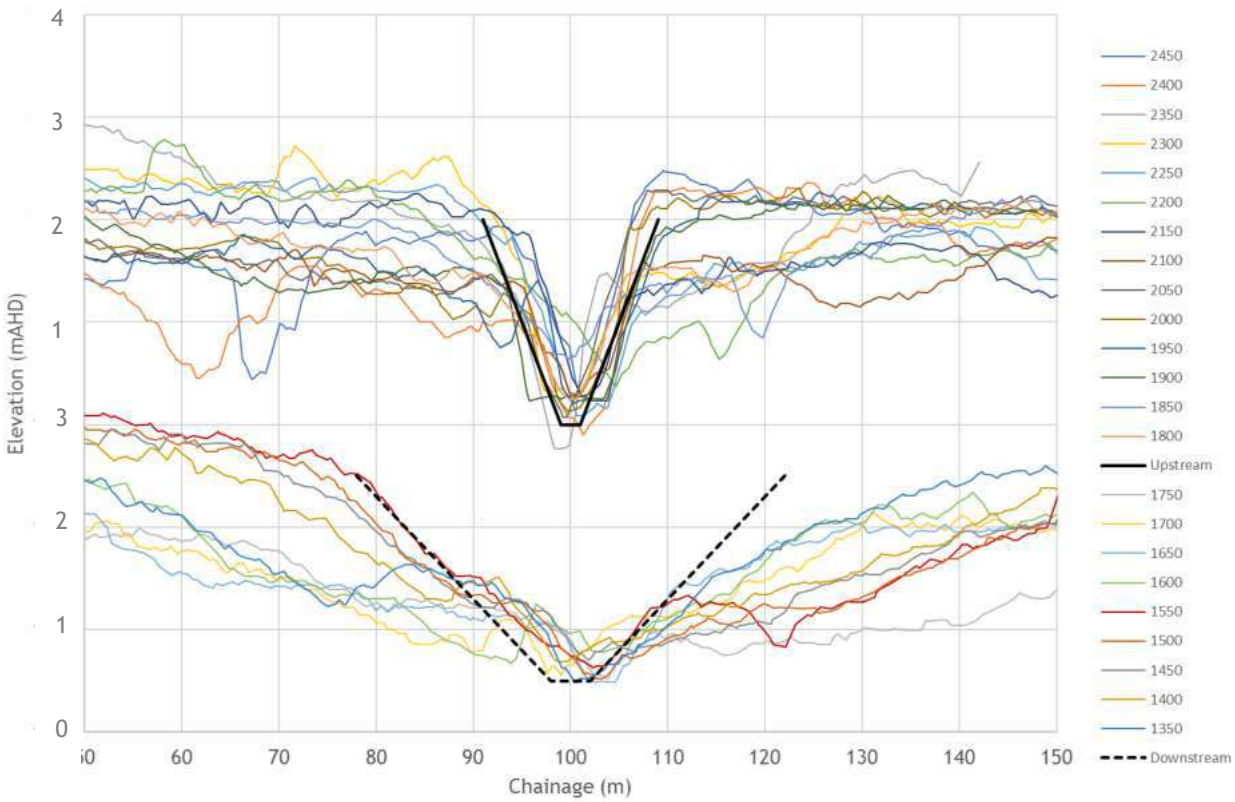


Figure 6.2 – Drainage Line 1 channel cross sections

6.3.2 Hydraulic and geomorphic characteristics

Table 6.1 shows the hydraulic and geomorphic characteristics of Drainage Line 1 from the commencement of the proposed realignment to the commencement of the existing diversion.

Table 6.1 – Drainage Line 1 hydraulic and geomorphic characteristics

Parameter		Drainage Line 1 characteristic	
		Upstream	Downstream
Grade (%)		0.18	0.18
Bed Width (m)		1 to 2	2 to 5
Mean Top Width (m)		28	50
Depth to Floodplain (m)		1.5 to 2.5	0.5 to 1.5
Meander Radius (m)		40 to 85	>500
Meander Sinuosity Index		1.24	1.02
Meander Wavelength (m)		100 to 300	300
Meander Amplitude (m)		40 to 100	4
2 Year ARI	Mean Velocity (m/s)	0.8	0.5
	Mean Bed Shear Stress (N/m^2)	12.6	5.9
	Mean Stream Power (N/m s)	9.9	3.0

The hydraulic characteristics were determined by developing a HEC-RAS one dimensional hydraulic model (USACE, 2016) of the channel. The HECRAS model was used to determine the bed shear stress (BSS), stream power and velocity of the existing Thirteen Mile Gully channel for a typical bank full flow event. The bank full flow is the maximum flow that the channel can carry before it overflows onto the adjacent floodplain. In geomorphologic studies, the bank full flow is often considered to be the stream forming flow because it often exerts the greatest influence on channel geometry. The channel shape, peak flood velocities, shear stresses and stream power for this event were used to define the characteristics of the diversion.

In this situation, it was not possible to accurately model a larger event because Drainage Line 1 floodwater overflows and drains along separate flow paths to the channel. Roper Creek floodwater also drains into the channel during large events. An assessment of the performance of the channel during overflow events including Roper Creek overflow events is given in Section 7.

6.4 PROPOSED REALIGNMENT CHARACTERISTICS

Figure 6.1 shows the configuration of the Thirteen Mile Gully diversion realignment. The proposed concept design will replicate the hydraulic and geomorphic characteristics of Drainage Line 1 channel as much as possible. Given that additional catchment from Drainage Line 2 will enter the diversion at this location, the downstream characteristics of Drainage Line 1 have been adopted for the entire length of the realignment with the exception of a steeper bank slope of 1V:6H. The following is of note with respect to the proposed realignment:

- the channel depth will vary from 0.5 m to 3 m deep (see Figure 6.3);
- the bed slope is 0.18% (see Figure 6.3); and
- the meander geometry will replicate the downstream drainage line 1 characteristics (see Table 6.1)

These parameters are similar to the existing characteristics of Drainage Line 1 and will therefore have similar hydraulic characteristics up to the bank full flow.

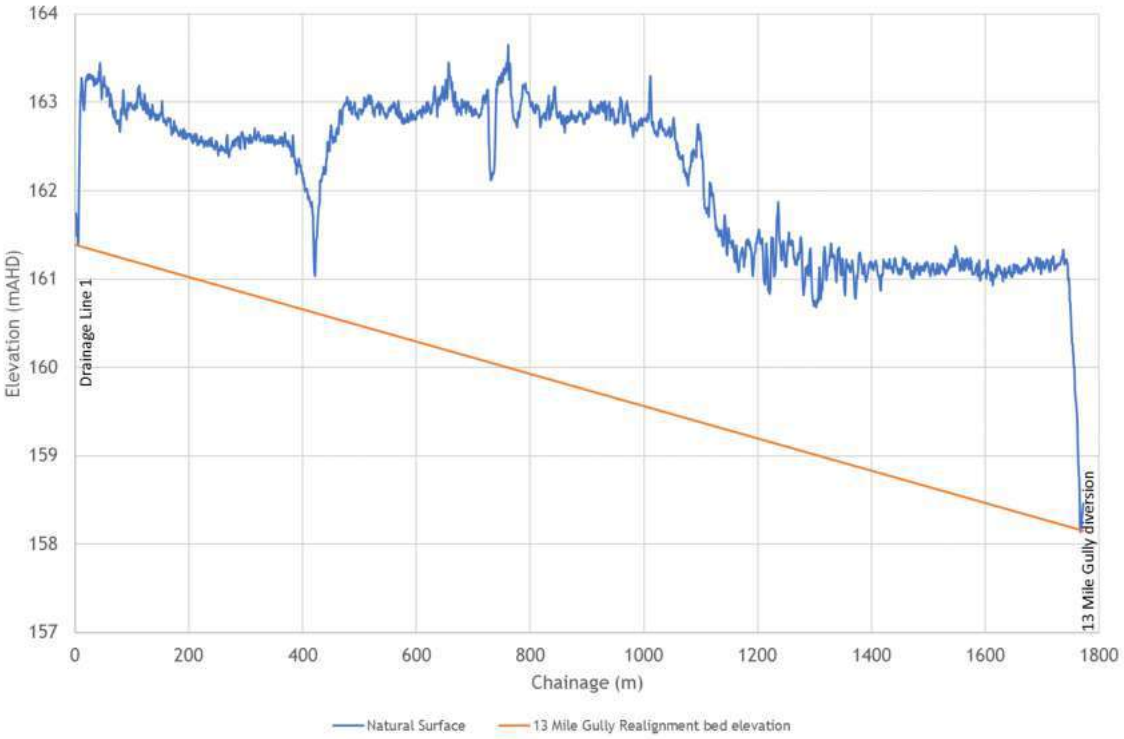


Figure 6.3 – Thirteen Mile Gully realignment longitudinal section

6.5 OUTCOME ASSESSMENT

An assessment of the proposed diversion against the outcomes in the Queensland watercourse diversion guidelines is as follows:

- **Outcome 1**: The proposed realignment will replicate the natural features of Drainage Line 1. A revegetation plan will be developed as part of the detailed design that will use vegetation characteristics seen in Drainage Line 1.
- **Outcome 2**: The proposed diversion realignment will receive the same catchment area as Drainage Line 1 and will therefore have the same hydrological characteristics. It also crosses the same flat floodplain topography at a shallow depth and will therefore not intersect groundwater systems.
- **Outcome 3**: The hydraulic characteristics of the diversion realignment are comparable with Drainage Line 1 as it has the same bed slope and channel characteristics. It also has an unconfined floodplain to allow for natural channel evolution processes to occur.
- **Outcome 4:** The diversion realignment will maintain sediment transport and water quality as it has the same bed slope (and therefore hydraulic gradient) and geomorphic characteristics as the existing Drainage Line 1.
- **Outcome 5:** Geotechnical and geological characteristics of the substrate material along the diversion realignment are expected to be similar to that encountered for the 13 Mile Gully Diversion as it crosses the same Roper Creek floodplain. Given this, the proposed diversion is expected to maintain equilibrium and functionality and is appropriate for the expected substrate conditions.

6.6 MONITORING

An operation and monitoring plan will be developed for the proposed diversion as part of detailed design that will be consistent with the monitoring programme developed for the existing Thirteen Mile Gully diversion. Collection of monitoring data will help identify any issues with the construction of the diversion and assist with relinquishment at mine closure. The monitoring plan will be prepared using the process documented in Queensland watercourse diversion guidelines (DNRM, 2014).

7 Flood modelling assessment

7.1 OVERVIEW

An Unified River Basin Simulator (URBS) hydrological model (Carroll, 2004) and a TUFLOW two-dimensional hydraulic model (WBM, 2017) were developed to simulate the flood behaviour of Roper Creek and Thirteen Mile Gully in the vicinity of the Project. The URBS and TUFLOW models were calibrated to recorded water levels and surveyed peak flood levels for the January 2013 ex tropical Cyclone Oswald flood event. Descriptions of the development and calibration of the models and the design discharges and flood levels under existing conditions are given in Appendix C. The calibrated existing conditions TUFLOW model was reconfigured to represent:

- approved (Stage 2) mine conditions;
- proposed mine conditions; and
- final landform conditions (post-mine).

The peak food levels, extents and depths were determined for the 5% and 1% AEP events for the approved and proposed mine conditions models. These events were used to assess the flood impacts of the Project.

The 0.1% AEP design flood was used to define the crest height of the proposed flood protection levees for the proposed mine conditions and the Probable Maximum Flood (PMF) was used to assess the immunity of the final void under the final landform conditions.

7.2 APPROVED CONDITIONS FLOODING

Figure 7.1 and Figure 7.2 show the flood levels, depths and extents across the Project area for the 5% AEP and 1% AEP events for the approved Stage 2 conditions. The following changes are proposed between the existing conditions (shown in Appendix C) and the approved Stage 2 conditions:

- Roper Creek will be diverted in two locations; and
- The flood levee will be extended around the south of the mining area.

Descriptions of the approved diversions and the levee are given in Section 4.8. The Roper Creek diversions were carved out of the two-dimensional grid and modelled as 1D sections, consistent with Roper Creek and the old sections of Roper Creek were filled in to match the surrounding ground levels. The flood levee was modelled as a high wall to ensure it provided flood immunity for all design floods.

7.3 PROPOSED CONDITIONS FLOODING AND FLOOD IMPACTS

Figure 7.3 and Figure 7.4 show the flood levels, depths and extents across the Project area for the 5% AEP and 1% AEP events for proposed conditions. The flood impacts for these events (proposed minus approved conditions) are shown in Figure 7.5 and Figure 7.6. The results show the following:

- For the 5% AEP event, peak flood levels in the Roper Creek channel increase by up to 0.1 m across the Project area but are generally unaffected further upstream of the mine. Overbank flood levels increase by up to 0.1 m along the Thirteen Mile Gully diversion with the exception of slightly higher increases along the Thirteen Mile Gully realignment. The minor increases would appear to be due to the change in flood storage and the change in location of the inflows from Drainage Line 2.



Figure 7.1 – Flood depths and extent, approved conditions, 5% AEP

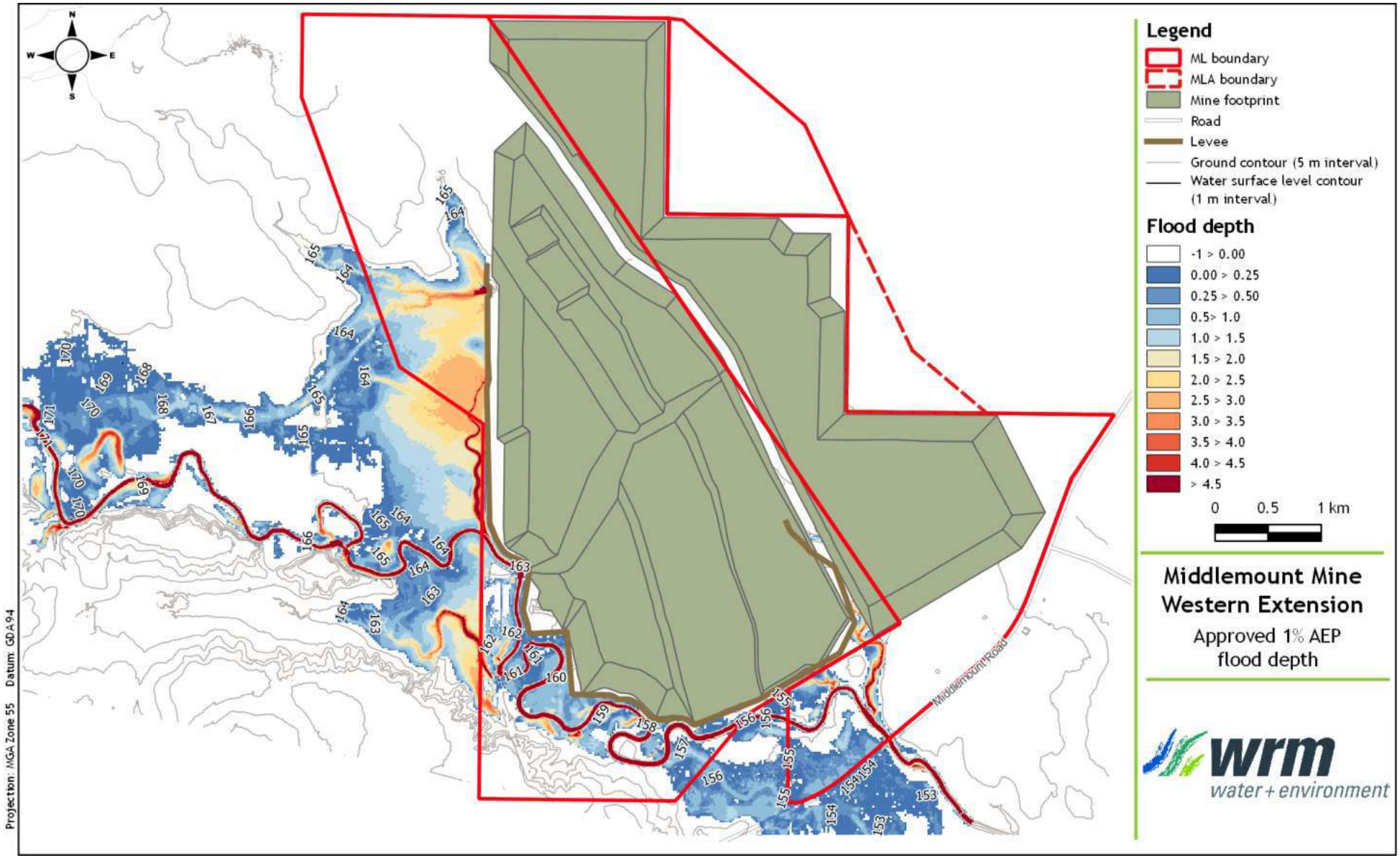


Figure 7.2 – Flood depths and extent, approved conditions, 1% AEP

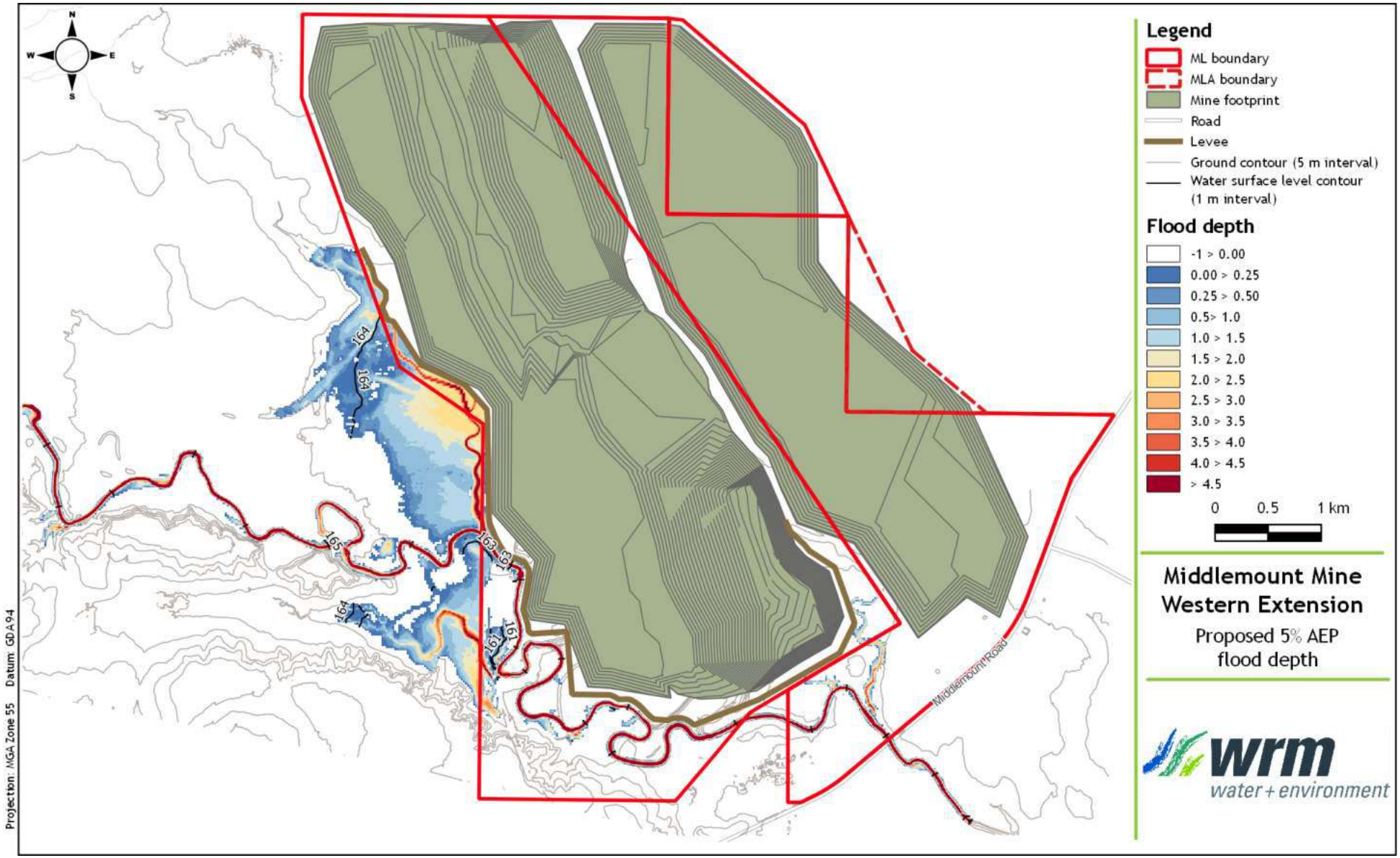


Figure 7.3 – Flood depths and extent, proposed conditions, 5% AEP

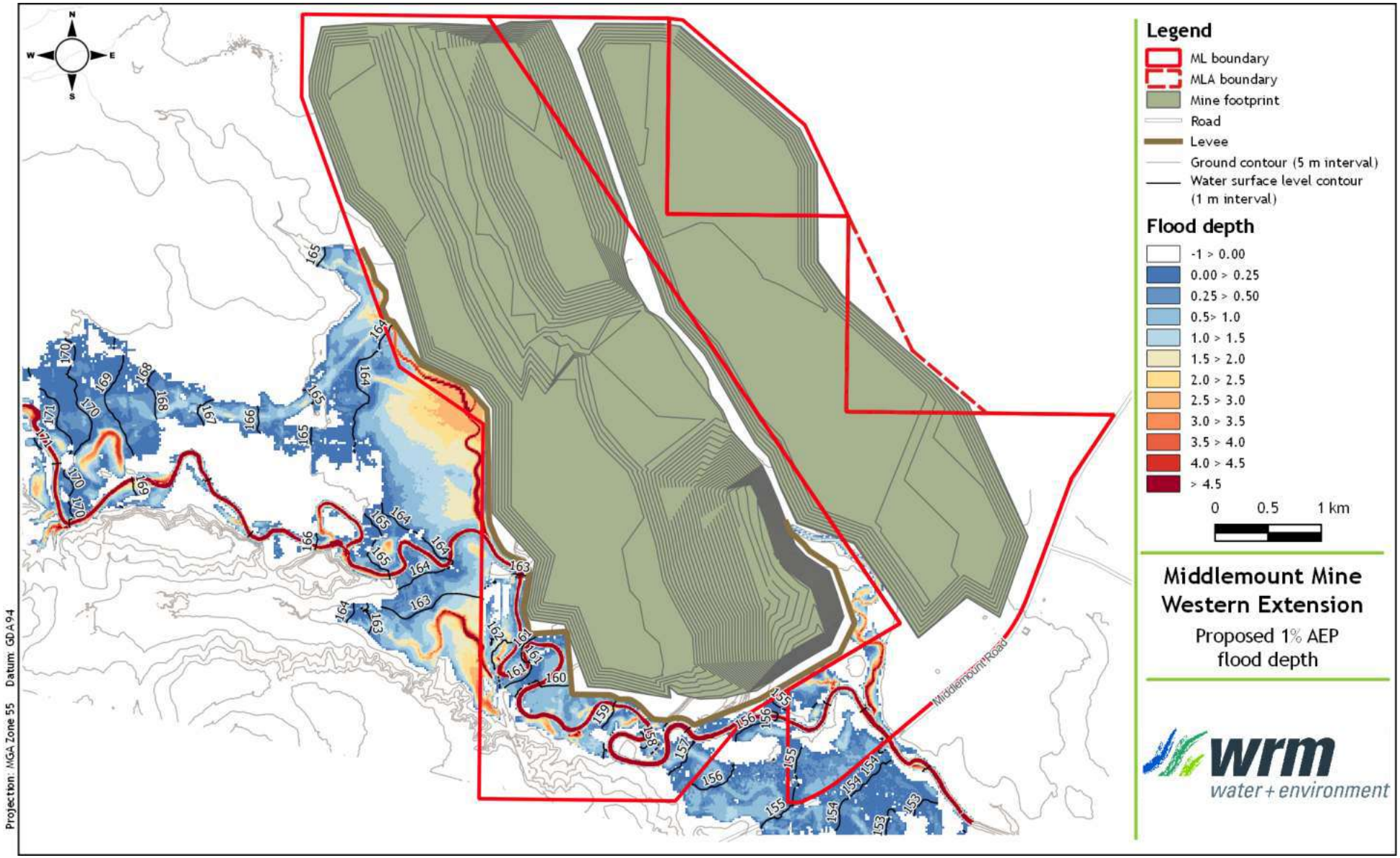


Figure 7.4 – Flood depths and extent, proposed conditions, 1% AEP

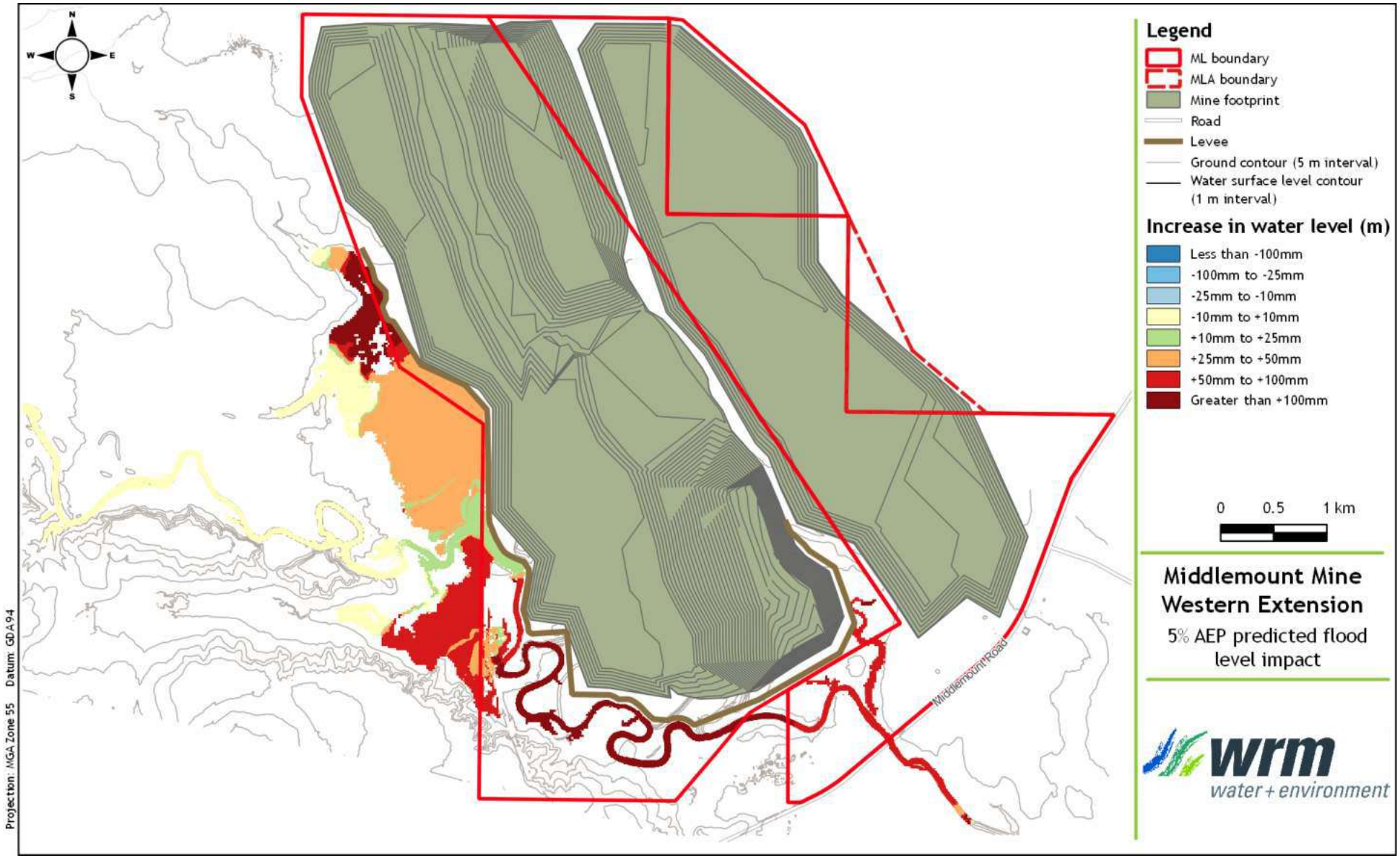


Figure 7.5 – Flood impacts, proposed minus existing conditions, 5% AEP

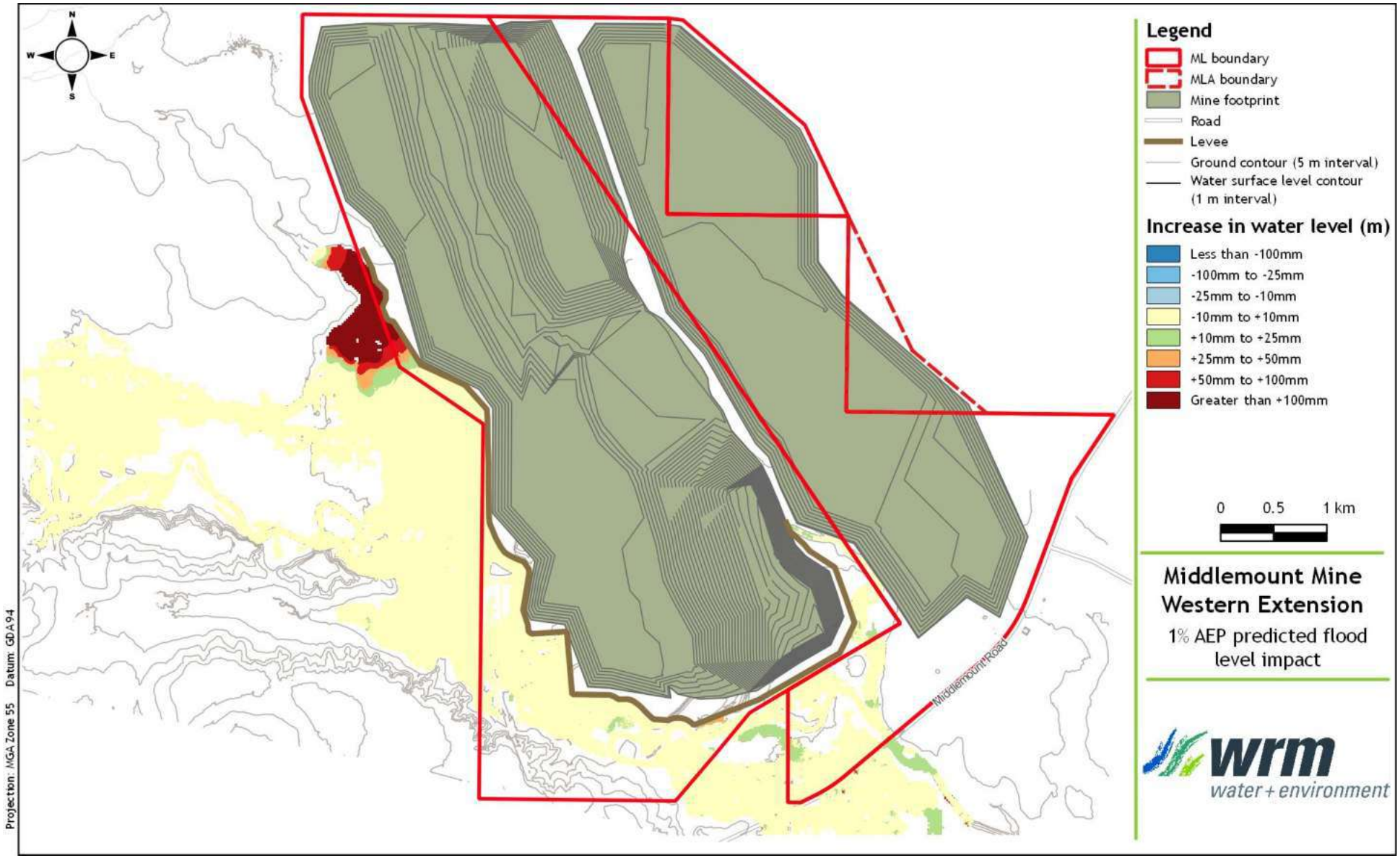


Figure 7.6 – Flood impacts, proposed minus existing conditions, 1% AEP

- For the 1% AEP event, peak flood levels are effectively unchanged from approved conditions except along the Thirteen Mile Gully realignment, which are up to 0.2 m higher and downstream of the mine with increases of up to 0.01 m due to the change in floodplain storage.

7.4 FLOOD LEVEE ASSESSMENT

The proposed realigned flood protection levee along the western extension area will be a regulated structure designed such that the crest level is above the 0.1% AEP design event. The extent and depth of inundation for the 0.1% AEP flood with the proposed levee in place is shown in Figure 7.7.

The results show that the proposed levee alignment and extent will sufficiently prevent the inundation of the open cut pit throughout the life of the Project. Detailed design plans of the proposed levee together with a consequence assessment and certification by a suitably qualified and experienced person(s) will be prepared prior to commencement of construction of the levee for assessment and approval by the administering authority.

7.5 FINAL LANDFORM ASSESSMENT

Figure 7.8 shows the final landform and the extent of the PMF from Roper Creek. The proposed final landform for the Project will include two final voids. The southern void is located on the pre-mine Roper Creek floodplain. A flood bund will be constructed around the southern void to prevent floodwater from entering. The flood bund will be up to 100 m wide at the crest and be incorporated into the rehabilitated final landform to form a self-sustaining structure that does not require long term maintenance. The bund will have a crest height above the PMF level from Roper Creek. The PMF is defined as the largest flood that could conceivably occur at a particular location and is estimated from probable maximum precipitation (PMP). Details of the methodology to define the PMF is given in Appendix C.

It is also proposed to remove the flood protection levees on the western side of the mine such that the rehabilitated out-of-pit overburden areas will prevent floodwater from entering the pit. There is at least 150 m of out-of-pit overburden area and 1 km of in-pit overburden between the floodplain and the final void, which is more than adequate to prevent floodwater from entering the final void.

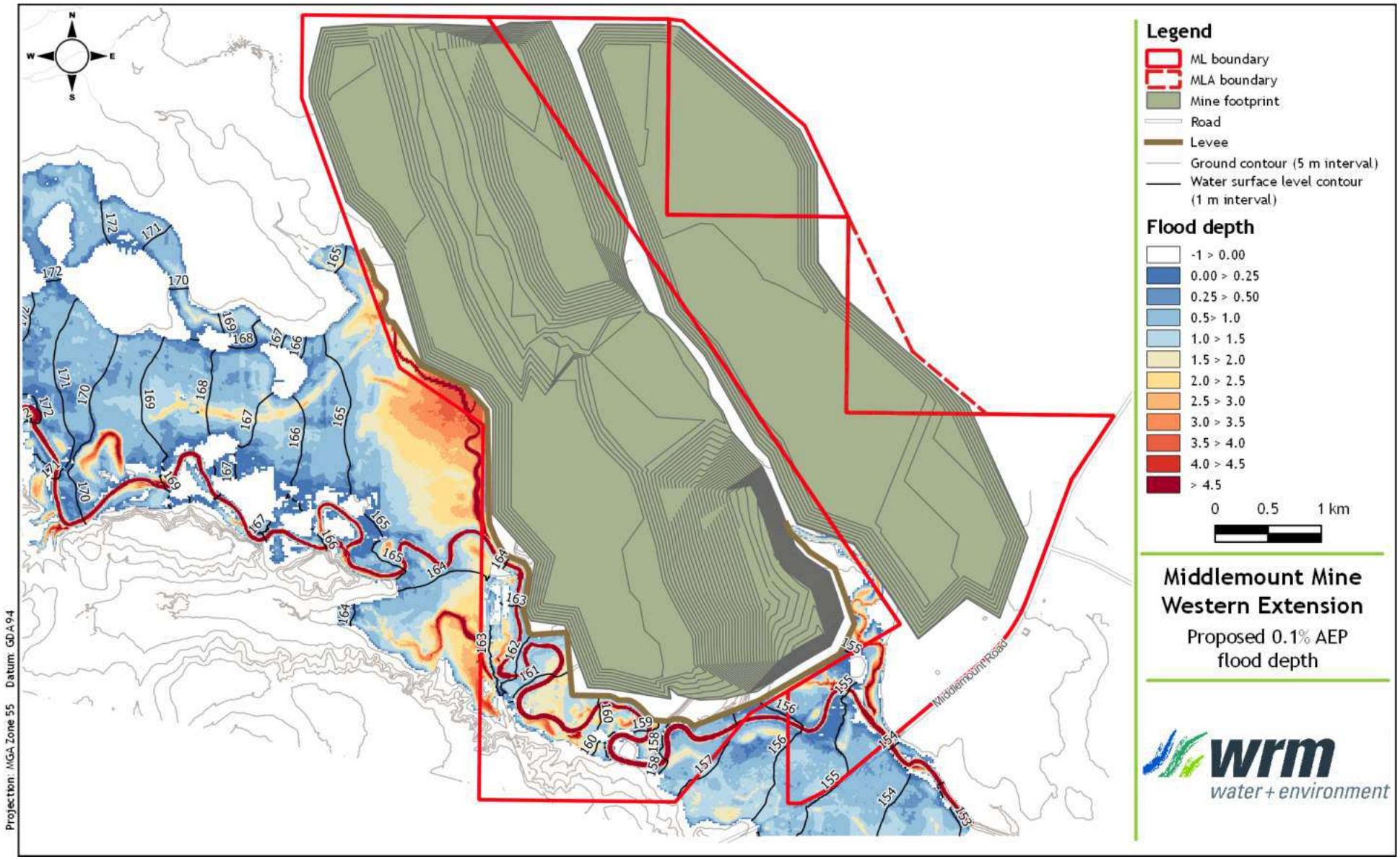


Figure 7.7 – Flood depths and extent, proposed conditions, 0.1% AEP

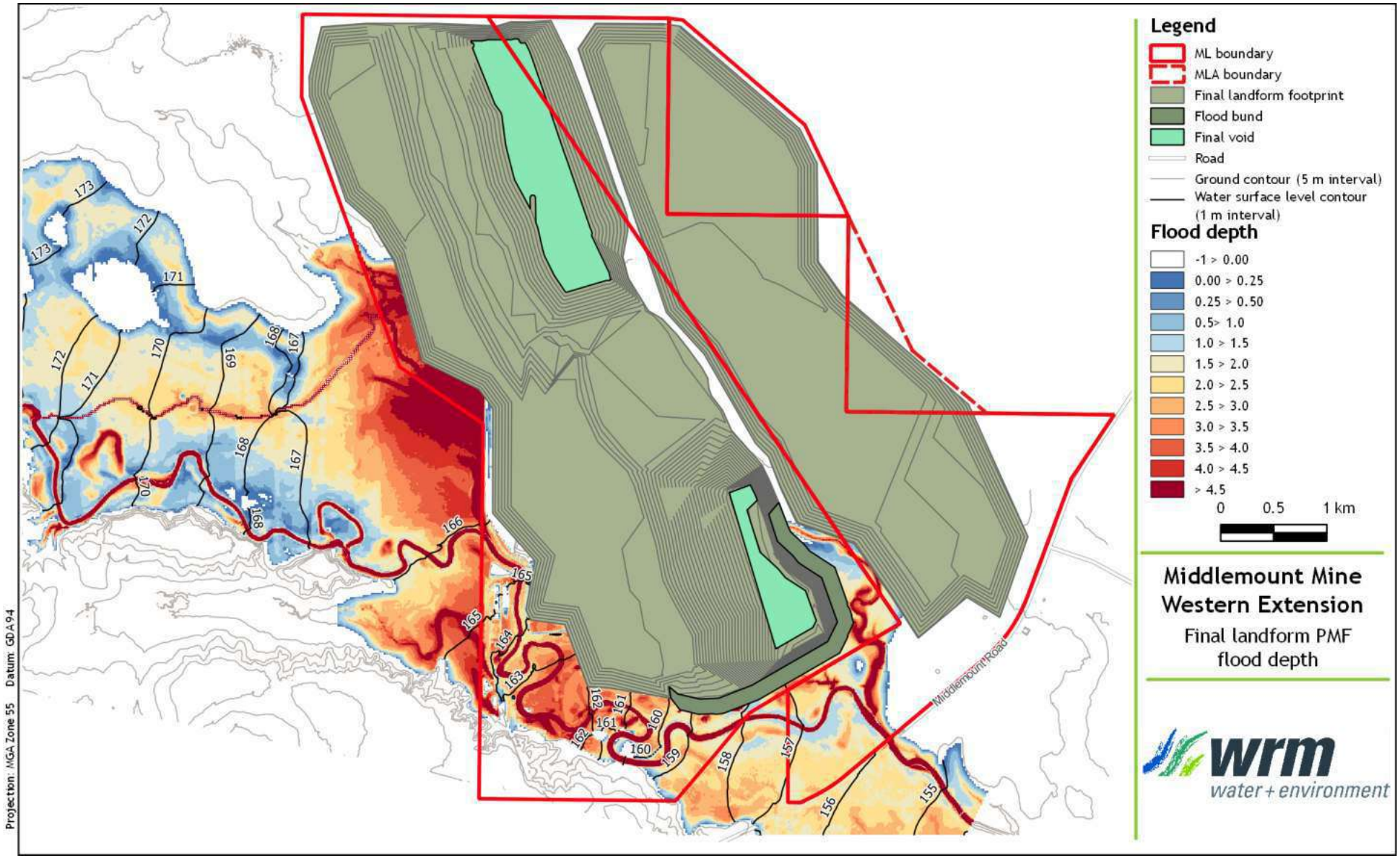


Figure 7.8 – Flood depths and extent, Final landform conditions, PMF

8 Mitigation and management measures

8.1 POTENTIAL IMPACTS

The potential impacts of the Project on surface water resources include:

- impacts on flows and the flooding regime of Roper Creek;
- impacts on regional water availability due to the potential need to obtain water from external sources to meet operational water requirements of mining operations;
- impacts on stream flows due to loss of catchment area draining to local drainage paths due to capture of runoff within onsite storages and the open cut pit;
- adverse impacts on the quality of on-site stormwater runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project;
- adverse impacts on environmental values in Roper Creek associated with controlled releases from the mine water management system; and
- cumulative impacts of all projects in the region on the environmental values of the receiving waters.

An assessment of each of these potential impacts of the Project is provided in the following sections.

The assessment of surface water impacts has been undertaken based on commonly applied methodologies for the simulation of hydrologic and hydraulic processes using currently available data. The adopted approach is considered suitable for quantifying impacts to a level of accuracy consistent with current industry practice. Certain aspects of the project, such as changes to landforms due to construction of overburden emplacements or mine subsidence, will create impacts that are irreversible, although this does not mean that any such impacts are necessarily detrimental to the environmental values of receiving waters.

8.2 FLOODING IMPACTS

Potential impacts of the Project on flood levels and flood velocities in Roper Creek are addressed in Section 7 of this report. There are no significant impacts in comparison to the approved conditions for either the operational or final landform phases of the Project.

8.3 REGIONAL WATER AVAILABILITY IMPACTS

The water balance modelling results indicates that around 700 ML/year will be required from the external supply (Anglo pipeline), under median climatic conditions. This is a reduction from previous modelling results undertaken as part of the North-eastern Extension Surface Water Assessment (WRM, 2016c), which predicted around 1,000 ML/year would be required under median climatic conditions.

This reduction is due to a combination of higher predicted groundwater inflows, the increase in overall catchment area as well as changes to the adopted CHPP and dust suppression demands.

As the external water supply is sourced from the mine affected water reserves of a neighbouring mine, the external supply requirements will have no impact on regional water availability.

8.4 STREAM FLOW IMPACTS

8.4.1 During active mining operations

8.4.1.1 Whole of mine

During active mining operations, the mine water management system will capture runoff from areas that would have previously flowed to the receiving waters of Roper Creek and Thirteen Mile Gully. The captured catchment area will change as the mine develops. A breakdown of the catchment areas reporting to the whole of mine water management system is provided in Table 8.1.

The total catchment area of Roper Creek to the downstream boundary of the Middlemount Coal Mine tenements, including the Thirteen Mile Gully catchment, is approximately 389 km^2. The maximum captured catchment areas represent:

- Between 3.2% and 7.6% of the Roper Creek catchment to the downstream boundary of the mine, depending on the Phase.
- Of the total Phase 5 captured catchment area, a maximum of 13.5 km^2 is captured in pits and mine affected dam catchments. This represents only 3.5% of the Roper Creek to the downstream boundary of the mine.
- The remaining catchment drains off site through the on-site stormwater management system.

Table 8.1 – Catchment area captured within the whole mine water management system

Catchment	Total catchment area (km^2)	Captured catchment area (km^2)				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Roper Creek (to d/s of site)	389	12.8	24.4	27.4	28.5	29.4

Given that the runoff volumes from the on-site stormwater management areas will be higher than under natural conditions, the loss of stream flows will likely be less than the loss of catchment area (proportionally).

On this basis, the loss of catchment flows in Roper Creek would be indiscernible. The potential impact on water quantity in Roper Creek due to the whole of mine is considered negligible, particularly given that no water resource development, such as dams or major irrigation infrastructure is located within the Roper Creek catchment.

8.4.1.2 Project only

The Project will result in changes to flows in local creeks due to the progressive extension of open cut mining operations to the north west and associated subsequent capture and re-use of drainage from operational catchment areas.

The additional surface disturbance area associated with the Project would excise a maximum of 495.1 ha during operations from the catchment area of the former Thirteen Mile Gully and other associated drainage features, and 77.9 ha from the catchment area of an unnamed drainage line to the east of the East Dump. This represents approximately 9% of the total catchment area of the former Thirteen Mile Gully (approximately 5,600 ha) (of which the majority has already been diverted to Roper Creek by the existing/approved Thirteen Mile Gully Diversion) and approximately 4% of the total catchment area of the unnamed drainage line to the east of the Project (approximately 1,920 ha).

The maximum loss of catchment due to the Project is only 573 ha (5.7 km^2), which represents less than 1.5% of the Roper Creek catchment to the downstream boundary of the mine. The loss of catchment flows in Roper Creek would be indiscernible, and as such

the potential impact on water quantity in Roper Creek due to the Project Only is considered negligible.

8.4.2 Final landform

At the completion of mining, permanent drainage of waste rock emplacement areas will be installed to minimise capture of surface runoff into the final voids in general accordance with the configuration shown in Figure 5.8. The majority of the disturbed area at the site will be rehabilitated and allowed to drain back to Roper Creek. A residual area of approximately 7.4 km^2 will continue to drain to the final voids.

The net change in catchment area draining from the site is summarised in Table 8.2. The changed topography as a result of the final landform will have the following impacts on catchment area:

- The catchment draining to Roper Creek (to the downstream of site) will reduce by around 7.4 km^2 (compared to pre-mining conditions), a decrease of less than 2%.
- The loss of catchment flows in Roper Creek would be indiscernible, and as such the potential impact on water quantity in Roper Creek due to the final landform is considered negligible.

Table 8.2 – Final landform – captured catchment areas

Catchment	Pre-mining catchment area (km^2)	Post-mining catchment area (km^2)	Pre-mining captured catchment area (km^2)
Roper Creek (to d/s of site)	389	381.6	7.4

8.5 REGIONAL WATER QUALITY AND ENVIRONMENTAL VALUES

8.5.1 Overview

Section 4 describes the objectives and principals of the water management system, which have been developed to protect water quality and the environmental values of the waterways potentially affected by the Project. No changes are proposed to these objectives and principals as part of the project and the water management system and infrastructure remains mostly unchanged.

The general principles of the water management system, are as follows:

- A **catchment runoff water management system** that separates clean water from mine affected, on-site stormwater wherever possible. Details of the proposed waterway diversions and associated levee infrastructure are provided in Section 7.
- An **on-site stormwater management system** that contains runoff that potentially has high sediment concentrations in sediment dams. Water collected in the sediment dams will be managed in accordance with the ESCP and used for dust suppression or will overflow to receiving watercourses after a period of settling. Details of the on-site water management system are provided in Section 4.7.
- A **mine affected water management system** that contains potentially saline runoff from the pit and Mine Infrastructure Area (including ROM coal stockpile) in mine affected water dams. Mine affected water will be used as a priority in meeting makeup demand in the CHPP (after supplies are used from the tailings water management system) and for road watering. Water from the mine affected water management system may only be released to the downstream environment in compliance with the EA conditions. Details of the existing and proposed mine affected water management system and its expected performance are provided in Section 4.5 and Section 5.

- A **tailings water management system** that contains and dewaters the tailings and allows for maximum recycle of water to the CHPP. Details of the tailings and rejects circuit are provided in Section 4.4.
- A **contaminated water management system** that collects and contains all potentially contaminated water on site. This water will be recycled for use on the mine site without releasing it to the natural watercourses. Details of the existing and proposed mine affected water management system and its expected performance are provided in Section 4.5.

8.5.2 Performance of the water management system

An assessment of the water management system is given in Section 5. The results of the water balance modelling indicate that, under the current model assumptions and configuration, there are no uncontrolled spills of mine affected water from the site to the receiving environment.

Some overflow of water from sediment dams may occur during wet periods that exceed the design standard of the sediment control system (Section 4.7). As described in Section 3.4.3, water quality monitoring of three release events from sediment dams over 2013/14 indicated that the releases complied with the EA conditions with the exception of zinc and copper. However, it should be noted zinc and copper concentrations were also elevated at the upstream reference site, which indicates that the elevated levels are due to naturally higher background concentrations.

The additional disturbance footprint associated with the Project (575 ha) will increase the volume of stormwater requiring to be contained and managed on the mine site. Notwithstanding, the on-site stormwater management system will remain generally unchanged (i.e. continued collection of runoff from the overburden dumps) for the Project with augmentations as necessary.

On this basis, it is unlikely that overflows from sediment dams will have a measurable impact on receiving water quality.

8.5.3 Controlled releases

There are no proposed changes to the current release conditions as prescribed in Condition C5 of the site's EA (EPML00716913, dated 21 May 2018).

EC has been used as an indicator of water quality impacts of mine discharges. Of the water quality parameters tested in both the local waterways and at the mine, EC was found to vary the most from the WQOs with no significant differences measured in metal toxicants between mine runoff and regional water quality.

Figure 8.1 shows a ranked plot the modelled EC in Roper Creek downstream of the controlled release point on days when there is a controlled release opportunity (i.e. when the Roper Creek flow exceeds the minimum flow criteria and there is water available for release). The plot shows the modelled EC in Roper Creek both with and without controlled releases from the Project (from 109 model realisations). That is, it shows the potential impact of controlled releases on the salinity of Roper Creek immediately downstream of the mine.

The results show that:

- The minimum EC in Roper Creek on a controlled release day is around 255 µs/cm, which is around 105 µs/cm higher than the modelled background salinity;
- There is a 50% chance that the downstream Roper Creek EC will be greater than 400 µs/cm during a controlled release (250 µs/cm above modelled background salinity);
- There is a 10% chance that the downstream Roper Creek EC will be greater than 540 µs/cm during a controlled release (390 µs/cm above modelled background salinity);

- The EC in Roper Creek is below the receiving water contaminant trigger level of 700 µs/cm on all release days.

The model predicts that the EC in Roper Creek would be affected by controlled or active releases from the site on around 11% of all Roper Creek flow days.

On this basis, the modelling demonstrates that the implementation of the water management system would mitigate any impacts of the Project on downstream water quality or impact on the environmental values of the downstream waterway.

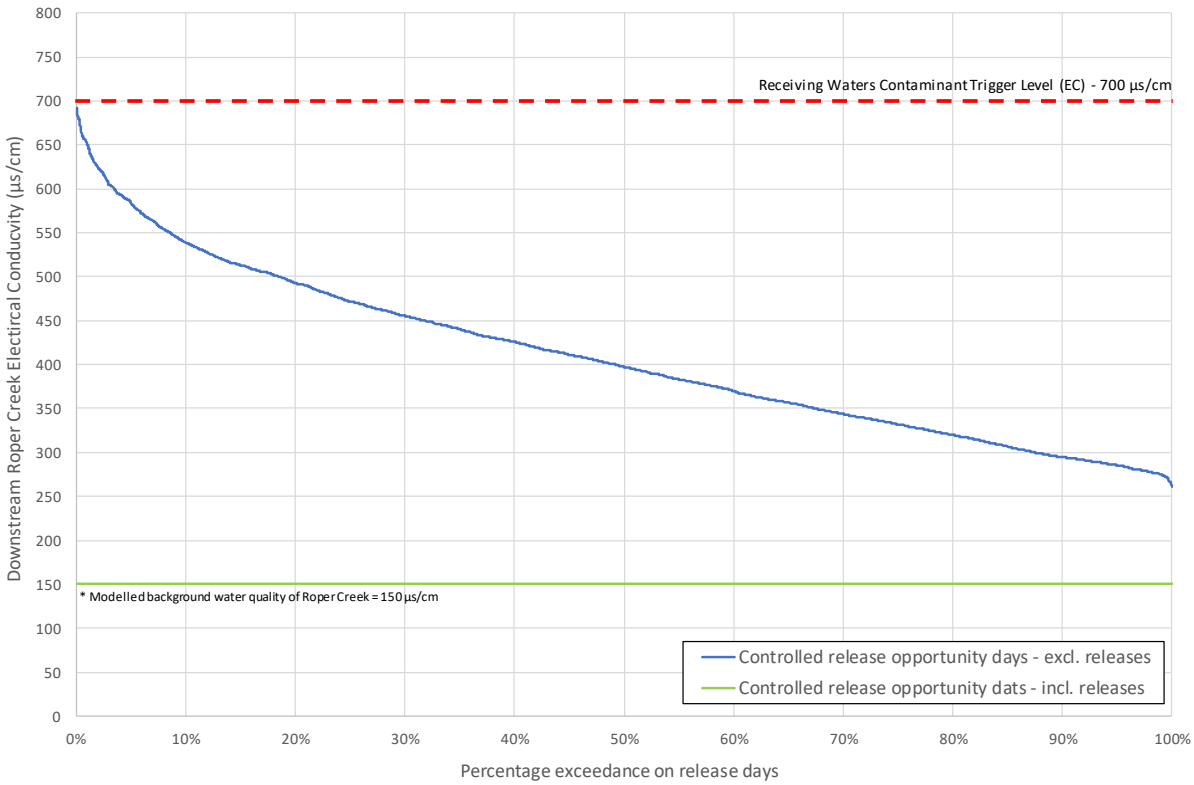


Figure 8.1 – Ranked plot of downstream receiving water quality – including and excluding modelled releases

8.5.4 Monitoring and maintenance

It will be necessary to manage each of these systems to ensure that they are operating as designed.

- Continual monitoring of water quality and storage volumes in the mine affected storages will be undertaken to ensure that uncontrolled spills do not occur and cause a downstream impact.
- The pit and MWD pumps will be inspected and operated regularly to ensure they will operate when required.
- Sediment dams will be cleaned out on a regular basis to maintain the available sediment storage volume.
- Sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams. Initially, sediment dam monitoring would occur on a quarterly basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur when required. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the sediment dam

monitoring would be reviewed and updated accordingly (e.g. to be sampled only when releases occur).

- Diversion drains will be monitored regularly to ensure they are operating as designed and do not allow mixing of clean and dirty water.
- Contaminated water sumps and interceptors are to be inspected and cleaned out regularly.
- Continual monitoring of potable water quality to ensure it meets potable water standards.

8.6 CUMULATIVE IMPACTS – SURFACE WATER

8.6.1 Overview

The objective of this assessment is to identify the potential for impacts from the Project to have compounding interactions with similar impacts from other projects, including activities proposed, under development or already in operation within a suitable region of influence of the Project.

There are three levels at which cumulative impacts may be relevant:

- Localised cumulative impacts – These are the impacts that may result from multiple existing or proposed mining operations in the immediate vicinity of the Project. Localised cumulative impacts include the effect from concurrent operations that are close enough to potentially cause additive effect on the receiving environment. For the purposes of this assessment, all existing and proposed projects located within the Roper Creek catchment have been included.
- Regional cumulative impacts – These include the Project's contribution to impacts that are caused by mining operations throughout the Bowen Basin region or at a catchment level. Each coal mining operations in itself may not represent a substantial impact at a regional level; however, the cumulative effect on the receiving environment may warrant consideration.
- Global cumulative impacts – These include impacts that the Project might contribute to at a global scale. The only potential global scale impact for the Project is greenhouse gas emissions, and as such has not been addressed in this assessment.

8.6.2 Existing projects

Projects which are currently operating within the Roper Creek catchment and have been included in the cumulative impacts assessment for the Project, and are listed in Table 8.3.

Note that all of the projects listed below are located on waterways which discharge into Roper Creek downstream of the Project, as follows:

- Parrot Creek discharges into Roper Creek approximately 14 km downstream of the Project.
- Oaky Creek discharges into Roper Creek approximately 32 km downstream of the Project.

There are no active projects located within the Roper Creek catchment upstream of the Project. The southern extent of Norwich Park Mine (which is currently closed) is located on Roper Creek upstream of the Project.

Table 8.3 - Existing projects considered in the cumulative impact assessment

Project Proponent	Description	Operational status	Relationship to the Project Mining Lease	
			Timing	Location
Capcoal Complex - Anglo Coal	Open cut and underground coal mine	Operating	May have overlapping operational phases with the construction and operations of the Project	• German Creek - located 10 km southwest of the Project on Parrot Creek • German Creek East - located 6 km south of the Project on Parrot Creek • Oak Park - located 14 km south of the Project on Parrot Creek • Lake Lindsay - located 24 km southeast of the Project on Oaky Creek
Foxleigh Mine - Middlemount South	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the Project	Located 15 km southeast of the Project on Roper Creek
Oaky Creek Mine - Glencore	Underground coal mine (with inactive open cut pits)	Operating	May have overlapping operational phases with the construction and operations of the Project	Located 25 km southwest of the Project on Oaky Creek
Norwich Park Mine- BMA	Open cut coal mine	Ceased production indefinitely	Unlikely to have overlapping operational phases with the construction and operations of the Project	Located 24 km northwest of the Project on Roper Creek

8.6.3 New or developing projects

Relevant projects that have been considered include:

- Projects within the predicted sphere of influence of the Project, as listed on the Department of State Development, Infrastructure and Planning website that are undergoing assessment under the Queensland *State Development and Public Works Organisation Act 1971* for which an Initial Advice Statement (IAS) or an Environmental Impact Statement (EIS) are available; and
- Projects within the predicted sphere of influence of the project, which are listed on the website of the DEHP that are undergoing assessment under the EP Act for which an IAS or an EIS are available.

There have been no projects identified as currently undergoing assessment or having recently completed assessment under these processes.

8.6.4 Cumulative impacts – surface water quality

The Project is located in the Mackenzie River catchment boundary, which is a major tributary within the Fitzroy basin. The Fitzroy basin is the largest catchment in Queensland draining into the Pacific Ocean and also the largest catchment that drains to the Great Barrier Reef, although it does not contribute significant freshwater flows to the coastal environment when compared to river systems further north.

In 2008, the Queensland Government undertook an investigation into the cumulative effects of coal mining in the Fitzroy River basin on water quality (Environmental Protection Agency [EPA], 2009). The investigation found that:

- There were inconsistencies in discharge quality limits and operating requirements for coal mine water discharges as imposed through environmental authorities.
- In some cases, discharge limits and operating conditions of coal mines were not adequately protecting downstream environmental values.

These conclusions led to a number of inter-related actions by the Queensland Government and other stakeholders:

- WQOs were developed for the Fitzroy Basin and added to Schedule 1 of the EPP (Water) in October 2011.
- Model water conditions were developed for coal mines in the Fitzroy basin (Department of Environment and Resource Management [DERM] February 2012). These model water conditions are designed to manage water discharges to meet the WQOs set out in the EPP (Water) and to provide consistency between mining operations in the Fitzroy basin.
- EAs for a number of mining operations were amended to introduce conditions consistent with the model water conditions.
- A number of mining operations entered into Transitional Environmental Programs (TEP) under the EP Act. These TEPs were focussed on actions that would allow mines to achieve compliance with new EA conditions and upgrade operating conditions.

With these measures in place, a strong strategic and policy framework is now in place for management of cumulative water quality impacts from mining activities. This framework allows for management of individual mining activities in such a way that overarching WQOs can be achieved.

Mine affected water from the proposed Project will be managed through the existing Middlemount Coal Mine mining complex water management system as this allows water to be reused in coal handling and preparation. The EA EPML00716913 is in line with the model water conditions, with discharge conditions and in-stream trigger levels aligned with WQOs in the EPP (Water). Using a water balance model, an analysis has been undertaken of the

effect of water from the Project on the ability of Middlemount Coal Mine to maintain compliance with environmental authority conditions. This analysis indicates that the addition of mine affected water from the Project makes no difference to the compliance profile for Middlemount Coal Mine and is negligible in terms of salt load to the Mackenzie River.

While the EPA cumulative impact assessment of mining in the Fitzroy Basin focussed on salinity as the key water quality issue related to mining activities, surface disturbance associated with mining activities can result in erosion and increased sediment levels in surface waters. The Great Barrier Reef outlook report also identified that the Fitzroy Basin contributed one of the highest sediment loads to the reef, largely attributing sediment loads to use of land for agricultural activities (Great Barrier Reef Marine Park Authority [GBRMPA], 2009).

The Queensland Government commissioned an assessment of mine affected water releases in the Fitzroy River basin during the 2012–2013 wet season (known as the Pilot Scheme).

The report (Gilbert and Sutherland and Marsden Jacob Associates, 2013) concluded that the Fitzroy River as a whole is not currently 'at capacity' in terms of salt load at a catchment or sub-catchment scale (Gilbert and Sutherland and Marsden Jacob Associates, 2013).

The operational policy of the Pilot Scheme aims to manage the cumulative impact of mine affected water releases across the Fitzroy Basin. To achieve this, trigger values have been derived for six monitoring locations across the basin. If in-stream EC triggers are exceeded during times when mine affected water releases are being undertaken upstream, the regulator has the ability to issue a "cease release" notification to all coal mines in the Fitzroy Basin with conditions that authorise the release of mine affected water.

The water quality assessment undertaken for the Project has identified that sediment inputs can be controlled through drainage, erosion and sediment control measures. On this basis, the proposed Project is not expected to make any significant contribution to cumulative sediment loads in the Fitzroy River Basin.

Given that the Middlemount Coal Mine affected water releases are being managed within an overarching strategic framework for management of cumulative impacts of mining activities, the proposed management approach for mine affected water from the Project is expected to have negligible cumulative impact on surface water quality and associated environmental values.

8.6.5 Cumulative impacts – surface water flows

In Queensland, the water resource planning process focussed on balancing water extraction and use with protection of ecosystems and takes into account cumulative impacts from major water storages and extraction. The Project does not require any additional raw water allocations and therefore does not contribute to cumulative impacts in relation to extraction of surface water resources from the catchment. The Project will locally impact flows in Roper Creek and its minor tributaries due to water being captured within the site water management system. The impacts of these changes in conjunction are outlined in Section 8.4. No other projects have been identified which would further increase these impacts.

8.7 PROPOSED EA AMENDMENTS

8.7.1 Authorised releases

There are no additional mine affected water dams proposed as part of the Project. As such, there are no new authorised release points as listed in Table C1 of the EA.

The additional sediment dams will be managed under the ESCP and therefore require no changes to the EA.

8.7.2 Mine affected water release limits and trigger levels

There are no proposed changes to the mine affected water release limits, release contaminant trigger investigations levels or mine affected water release conditions in Table C2, Table C3 and Table C4 of the Middlemount EA.

8.7.3 Mine affected water release events

There are no additional stream gauges proposed as part of the Project. The existing stream gauge is adequate to define the trigger release conditions from the existing mine water release points.

8.7.4 Receiving environment monitoring

There are no proposed changes to the receiving water monitoring locations given in Table C6 of the EA. In addition, the monitoring locations and regime given in the Middlemount REMP (GHD, 2016) does not change.

8.7.5 Location and basic specification of regulated dams

There are no new regulated dams proposed as part of the Project.

9 References

AGE, 2018	*Middlemount Coal Mine Western Extension Project – Groundwater Assessment,* Australasian Groundwater and Environmental Consultants Pty Ltd.
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Appendix A – Water quality sampling plots

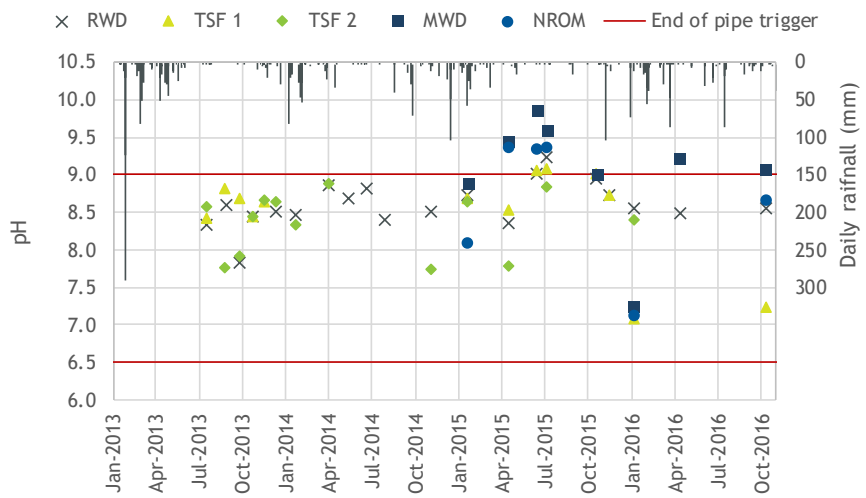


Figure A.1 - pH - Mine affected water dams

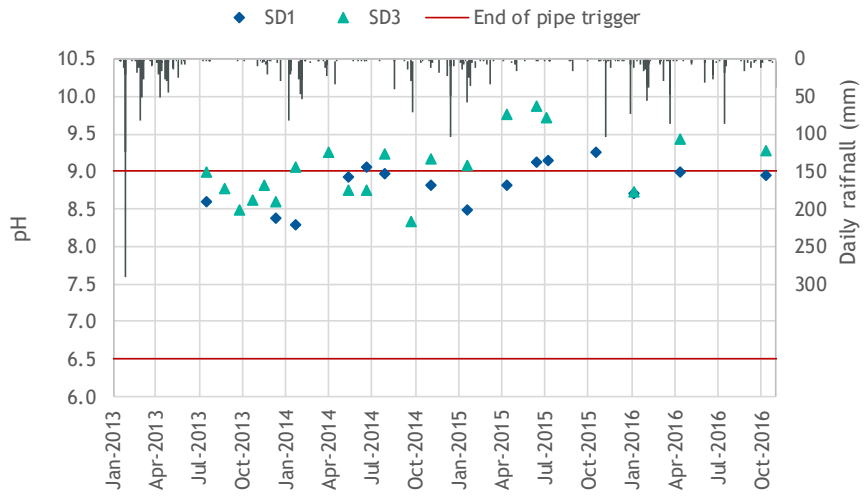


Figure A.2 - pH - Mine affected sediment dams

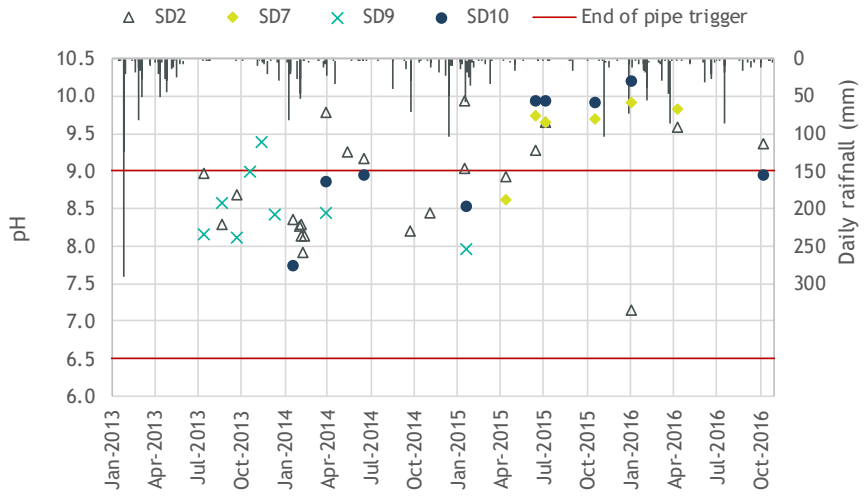
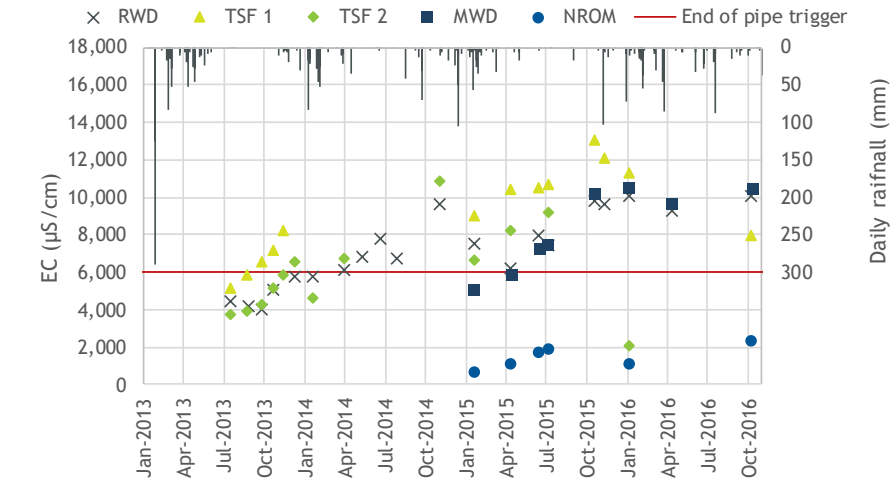
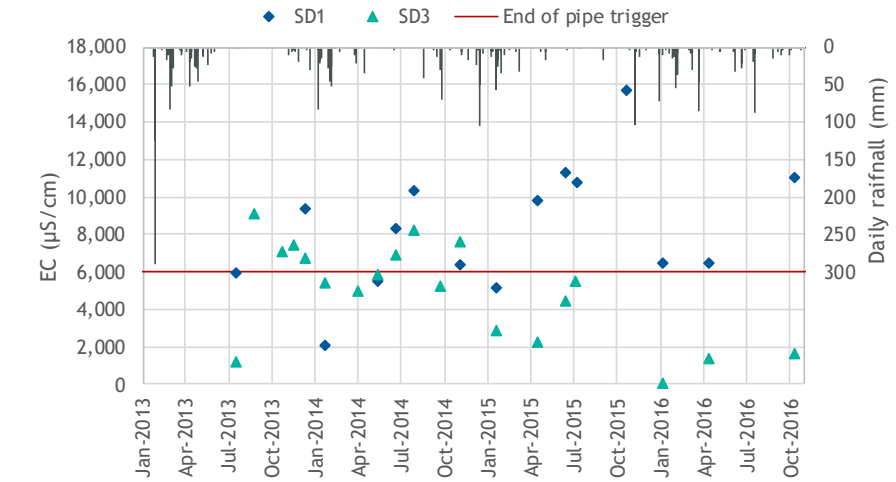


Figure A.3 - pH - On-site stormwater sediment dams



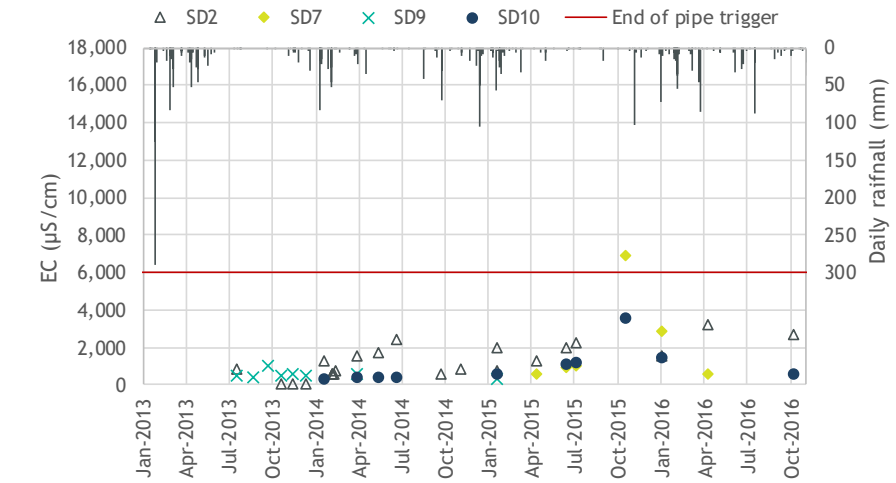
End of pipe trigger based on very high flow (see Table 4.4)

Figure A.4 - EC - Mine affected water dams



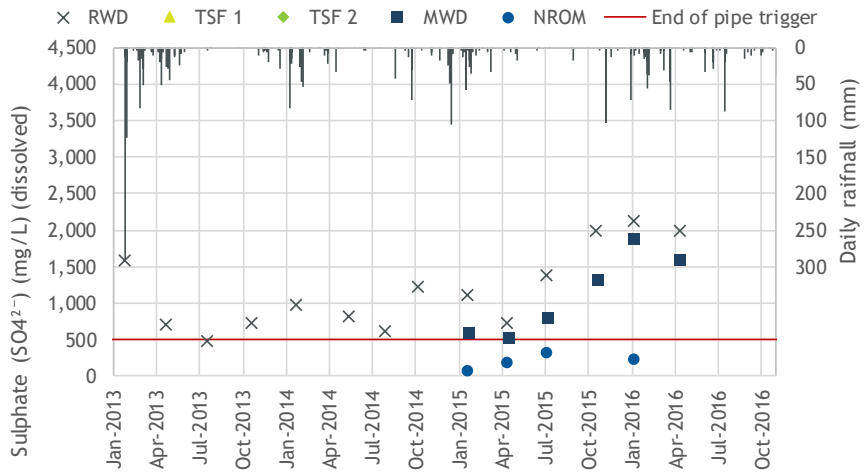
End of pipe trigger based on very high flow (see Table 4.4)

Figure A.5 - EC - Mine affected sediment dams



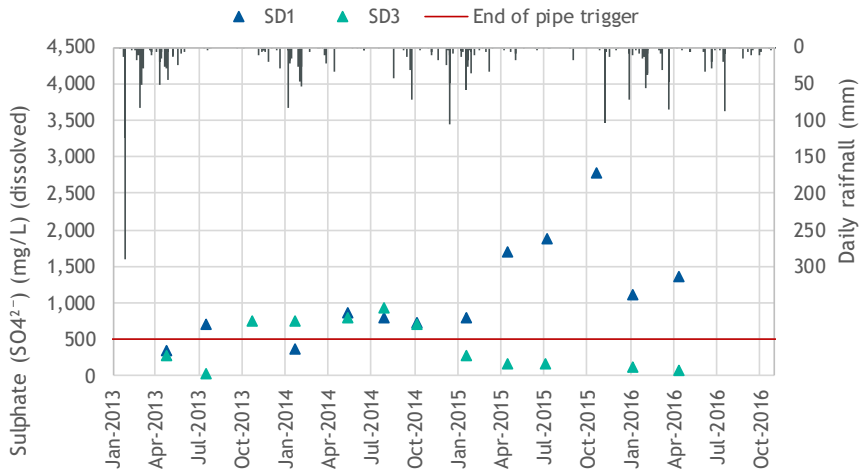
End of pipe trigger based on very high flow (see Table 4.4)

Figure A.6 - EC - On-site stormwater sediment dams



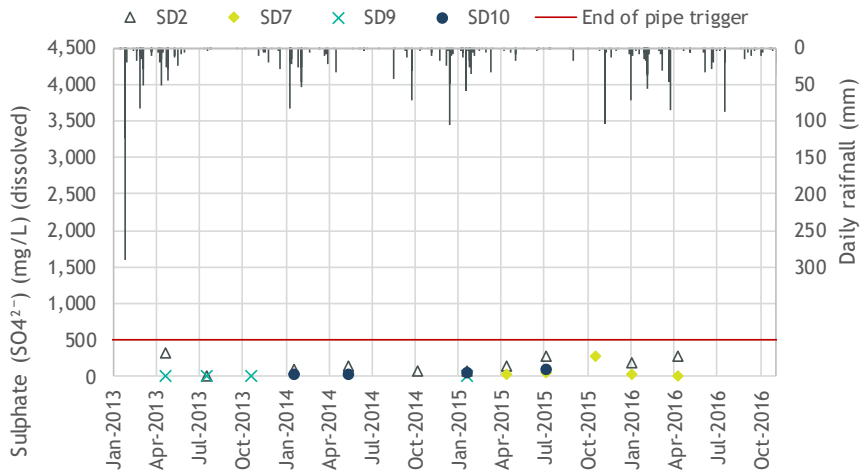
End of pipe trigger based on very high flow (see Table 4.4)

Figure A.7 - Suspended solids - Mine affected water dams



End of pipe trigger based on very high flow (see Table 4.4)

Figure A.8 - Suspended solids - Mine affected sediment dams



End of pipe trigger based on very high flow (see Table 4.4)

Figure A.9 - Suspended solids - On-site stormwater sediment dams

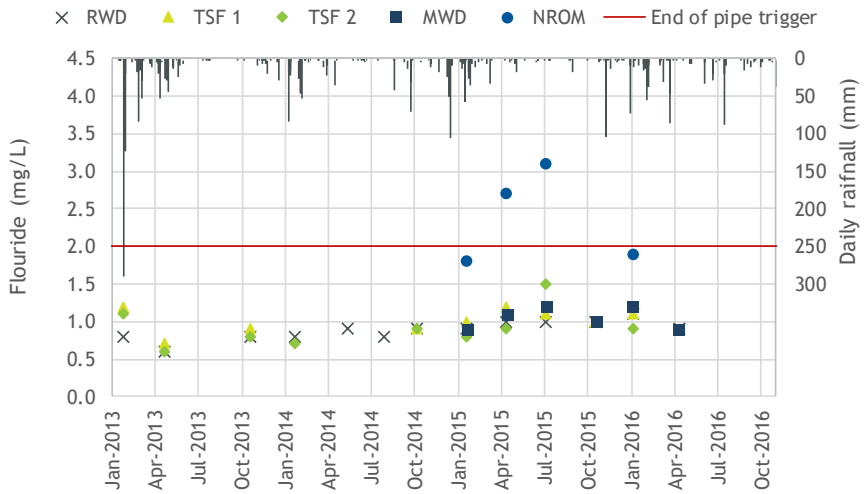


Figure A.10 - Fluoride- Mine affected water dams

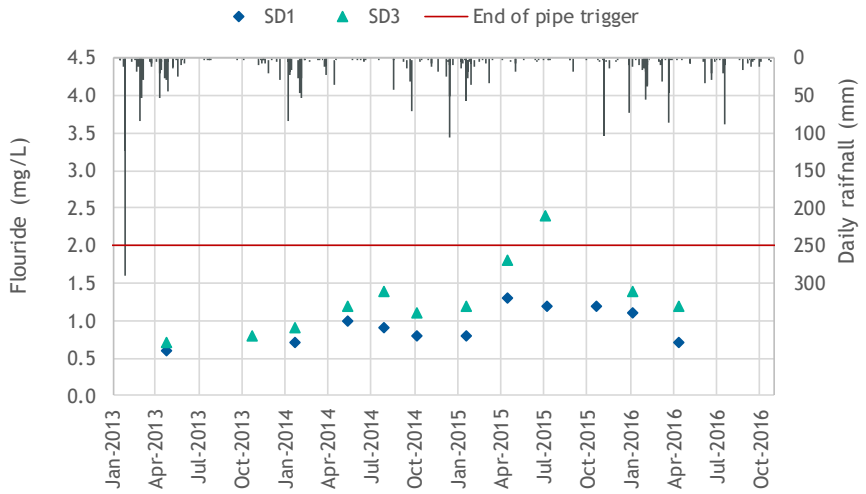


Figure A.11 - Fluoride - Mine affected sediment dams

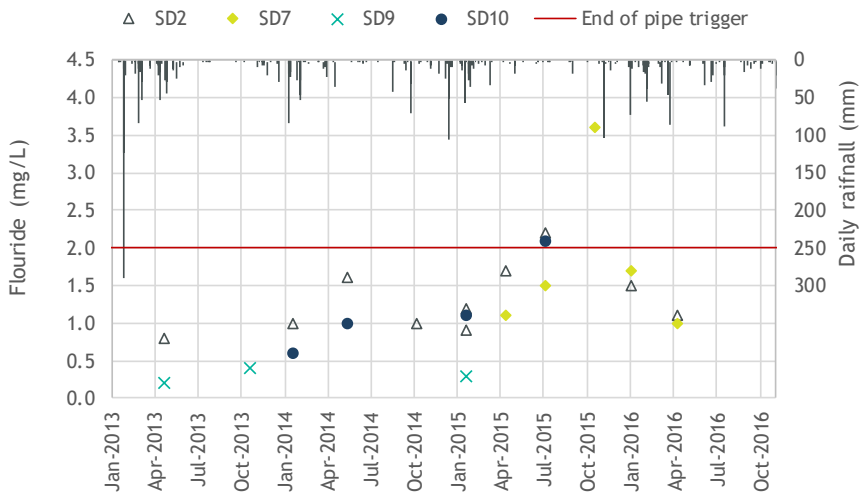


Figure A.12 - Fluoride - On-site stormwater sediment dams

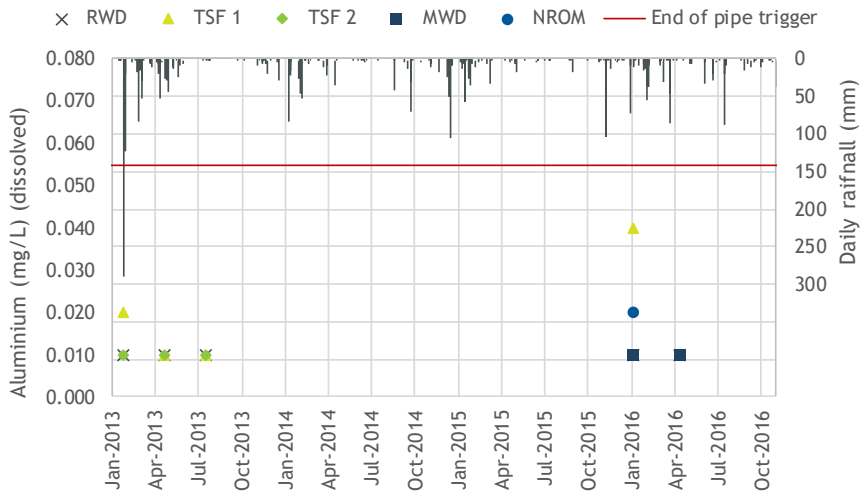


Figure A.13 - Aluminium (dissolved) - Mine affected water dams

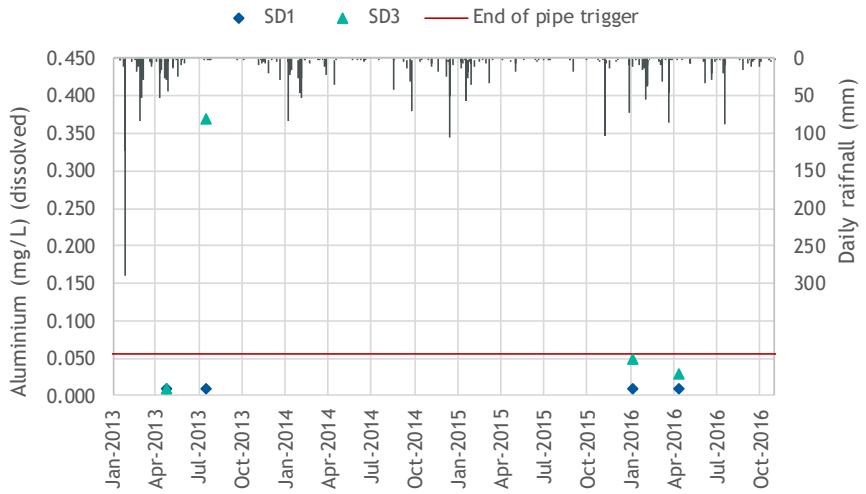


Figure A.14 - Aluminium (dissolved) - Mine affected sediment dams

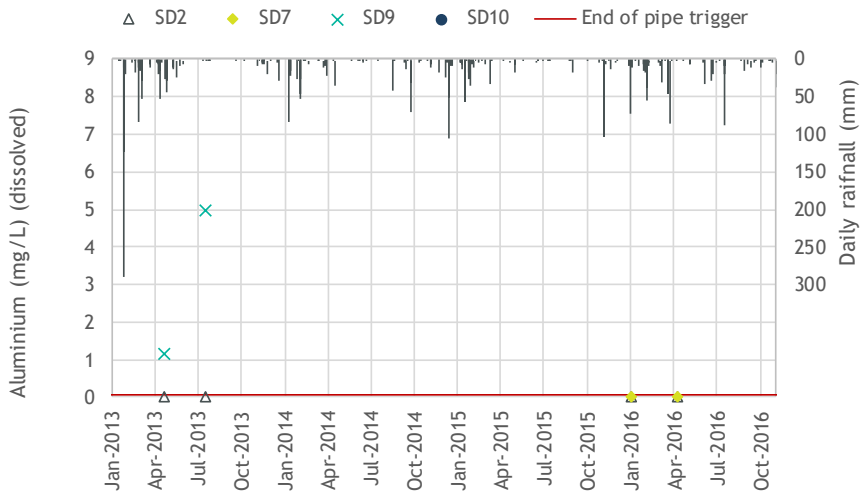


Figure A.15 - Aluminium (dissolved) - On-site stormwater sediment dams

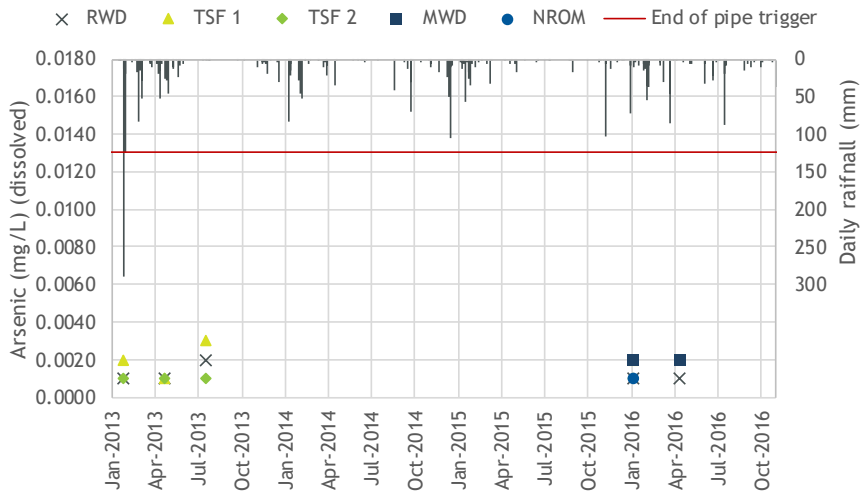


Figure A.16 - Arsenic (dissolved) - Mine affected water dams

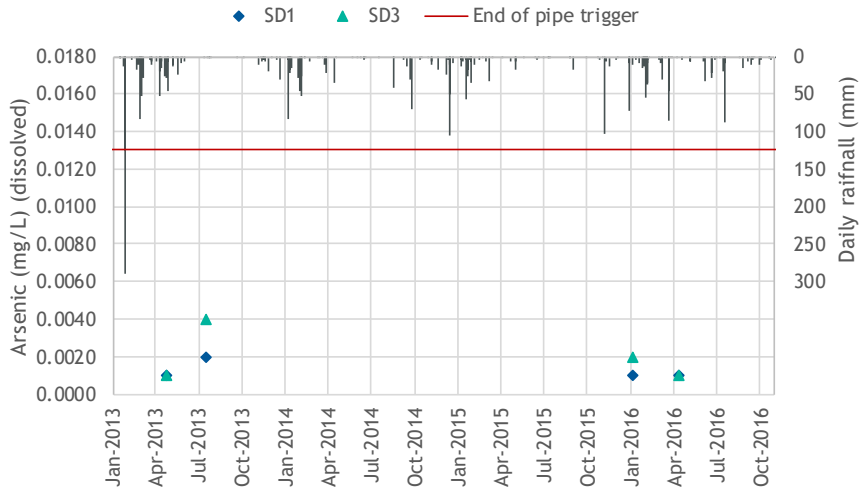


Figure A.17 - Arsenic (dissolved) - Mine affected sediment dams

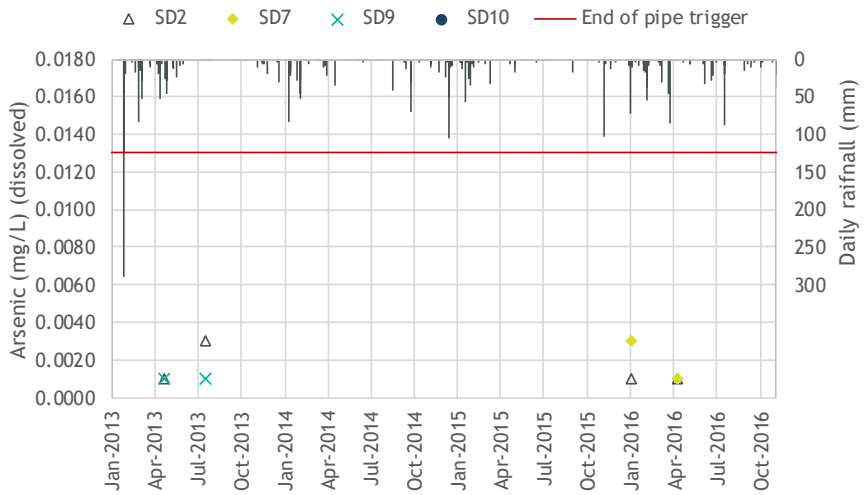


Figure A.18 - Arsenic (dissolved) - On-site stormwater sediment dams

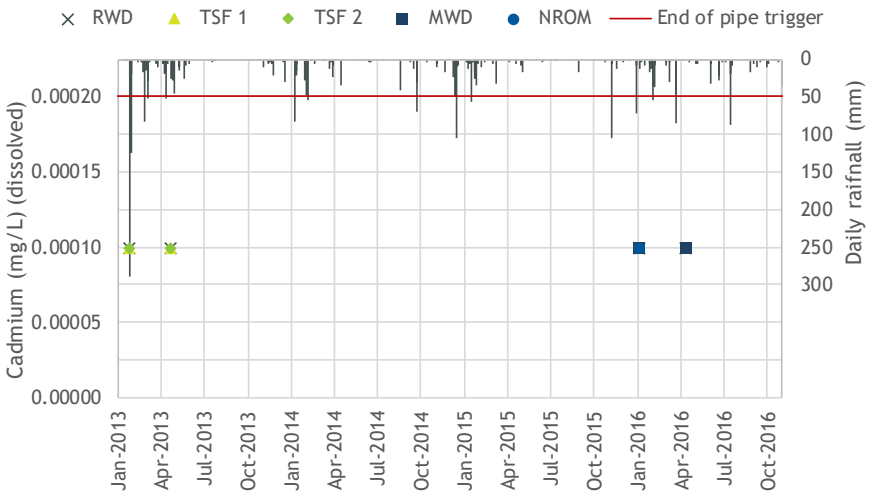


Figure A.19 - Cadmium (dissolved) - Mine affected water dams

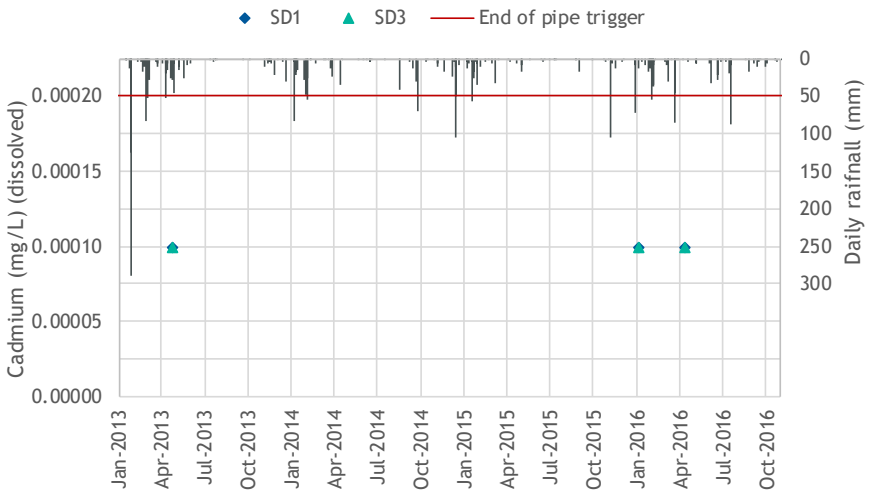


Figure A.20 - Cadmium (dissolved) - Mine affected sediment dams

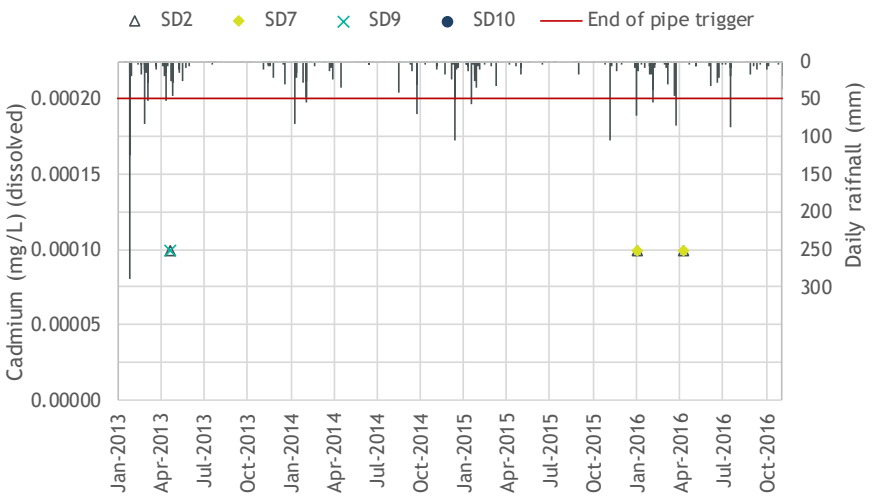


Figure A.21 - Cadmium (dissolved) - On-site stormwater sediment dams

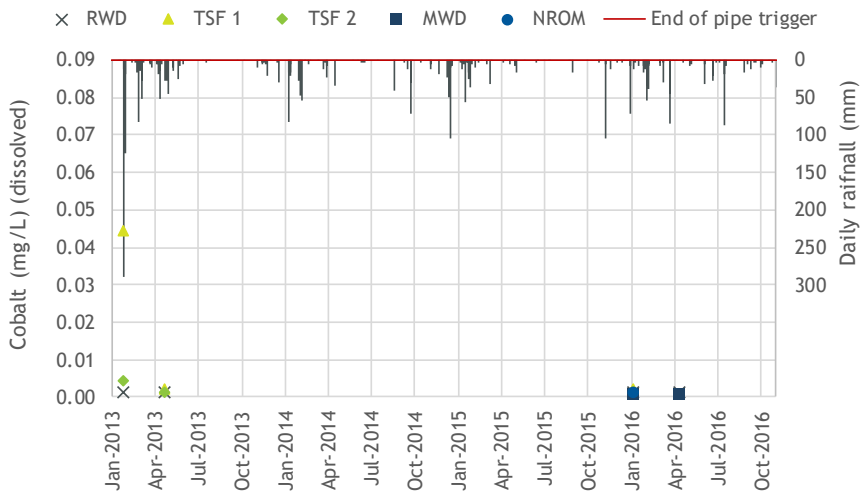


Figure A.22 - Cobalt (dissolved) - Mine affected water dams

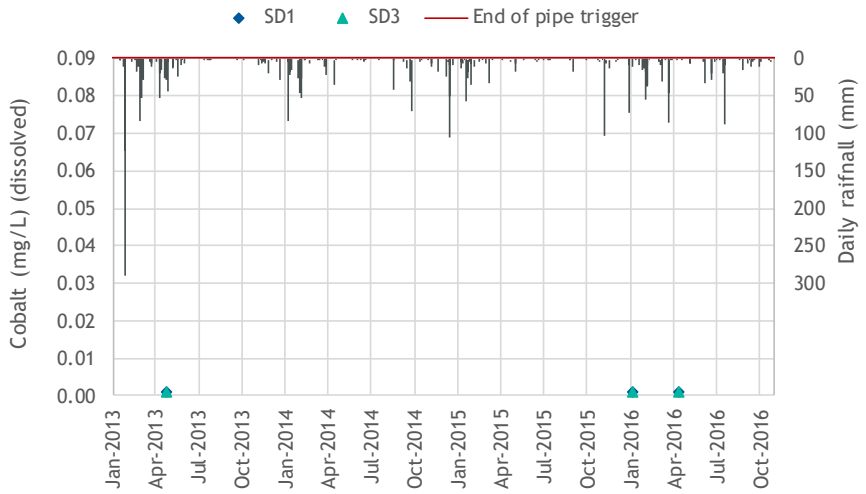


Figure A.23 - Cobalt (dissolved) - Mine affected sediment dams

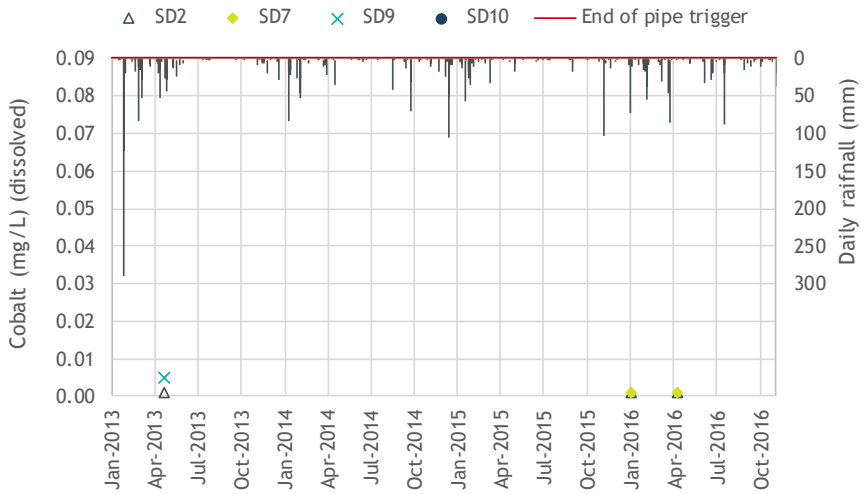


Figure A.24 - Cobalt (dissolved) - On-site stormwater sediment dams

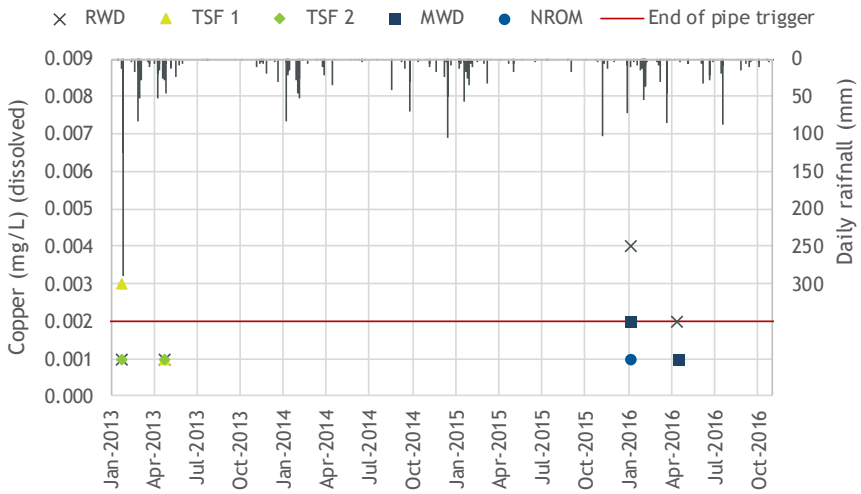


Figure A.25 - Copper (dissolved) - Mine affected water dams

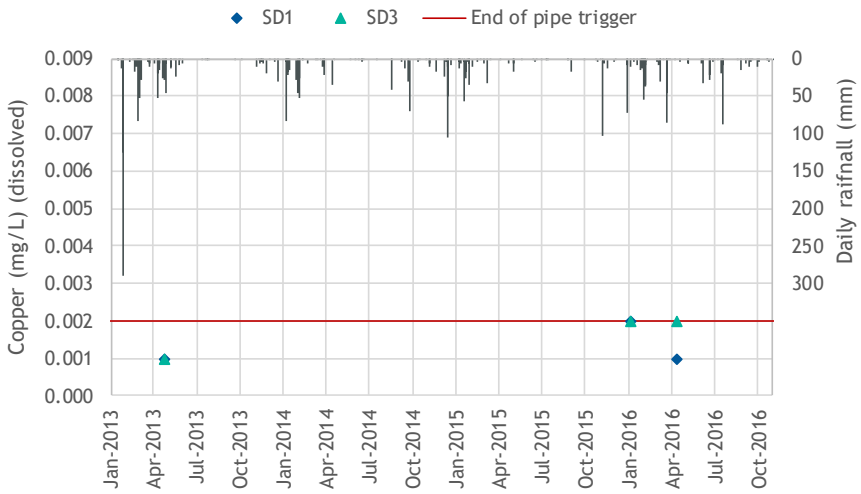


Figure A.26 - Copper (dissolved) - Mine affected sediment dams

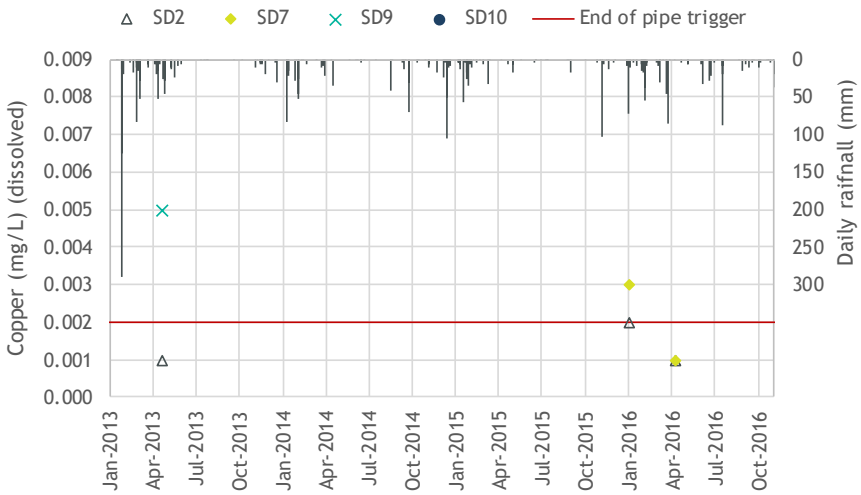


Figure A.27 - Copper (dissolved) - On-site stormwater sediment dams

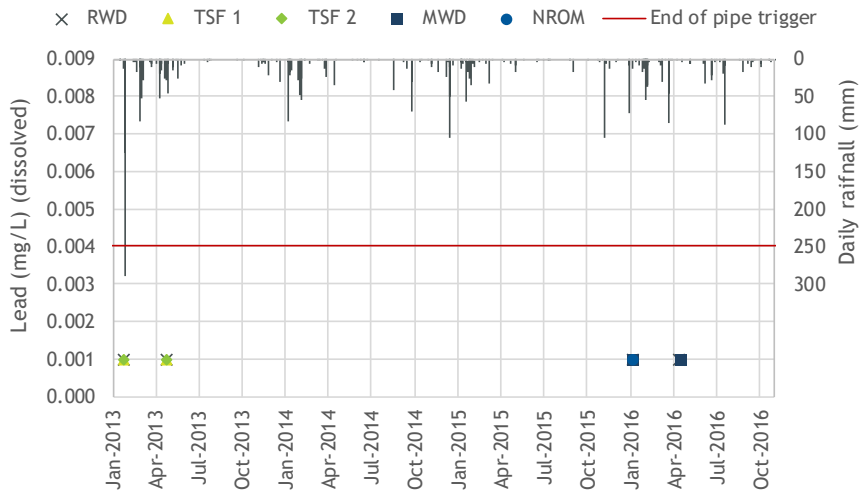


Figure A.28 - Lead (dissolved) - Mine affected water dams

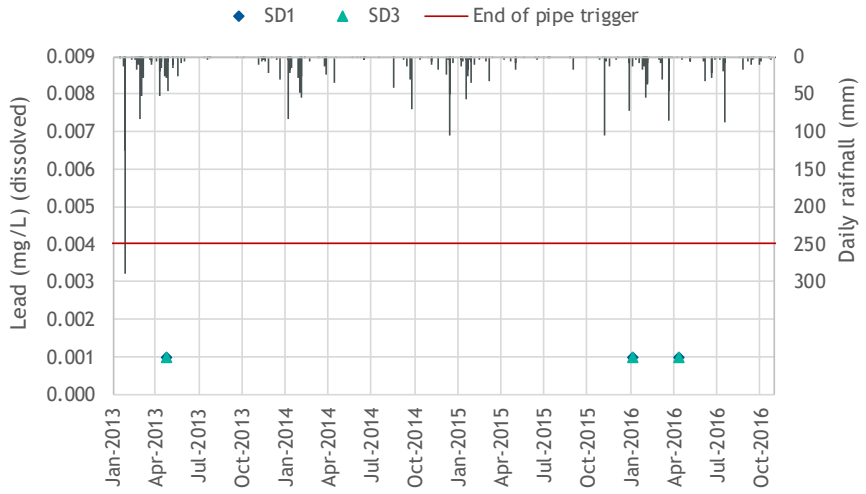


Figure A.29 - Lead (dissolved) - Mine affected sediment dams

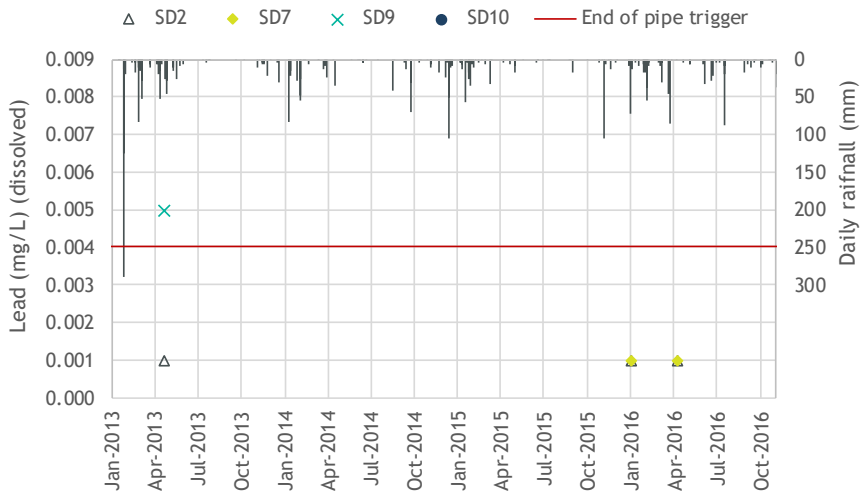


Figure A.30 - Lead (dissolved) - On-site stormwater sediment dams

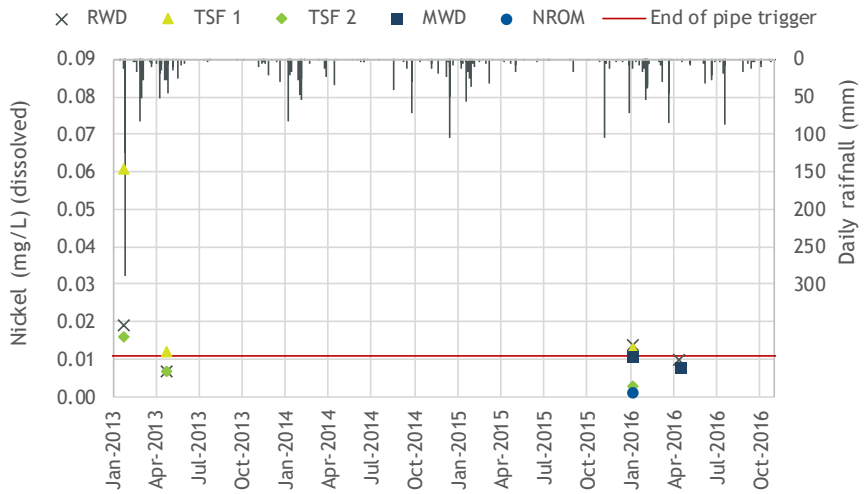


Figure A.31 - Nickel (dissolved) - Mine affected water dams

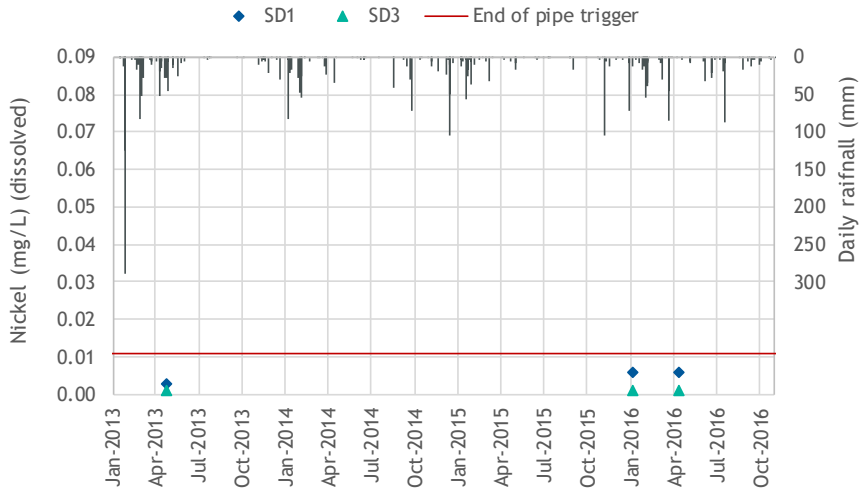


Figure A.32 - Nickel (dissolved) - Mine affected sediment dams

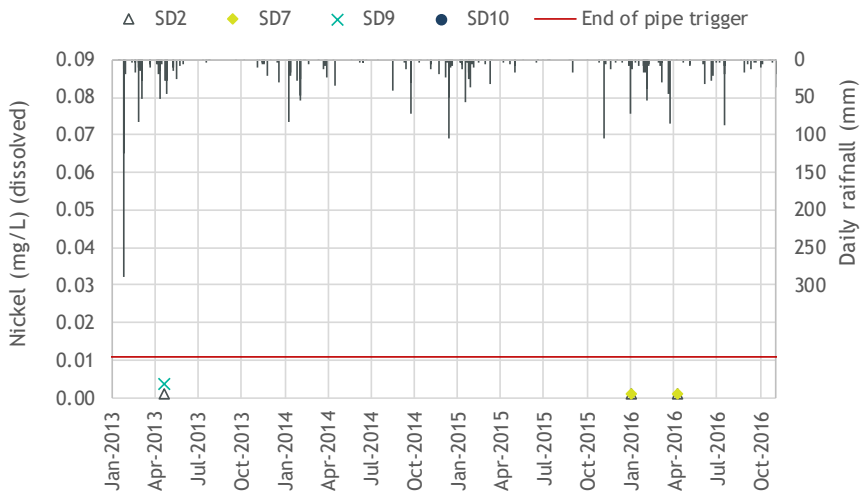


Figure A.33 - Nickel (dissolved) - On-site stormwater sediment dams

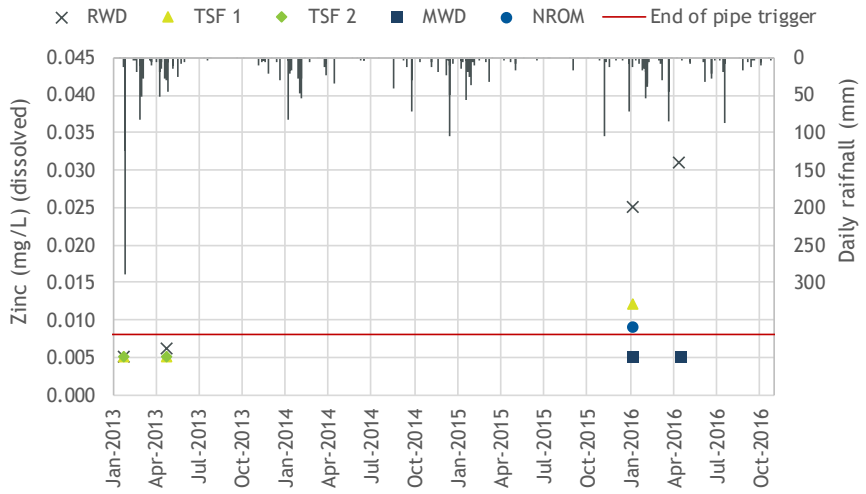


Figure A.34 - Zinc (dissolved) - Mine affected water dams

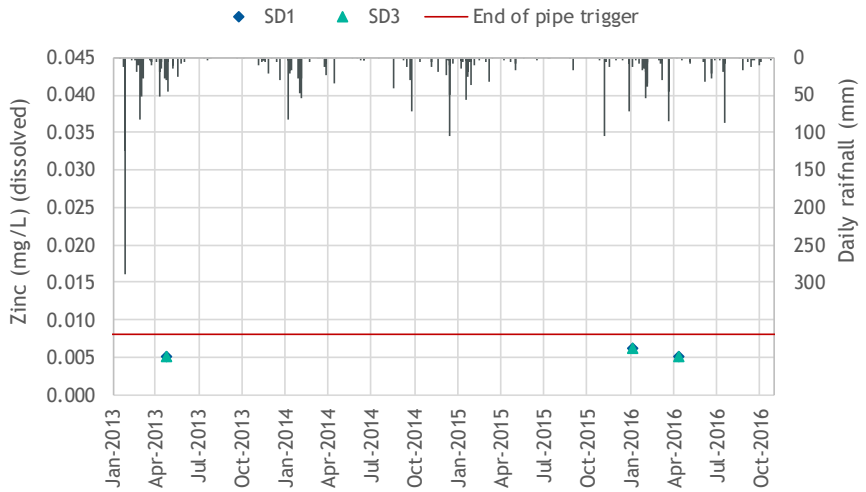


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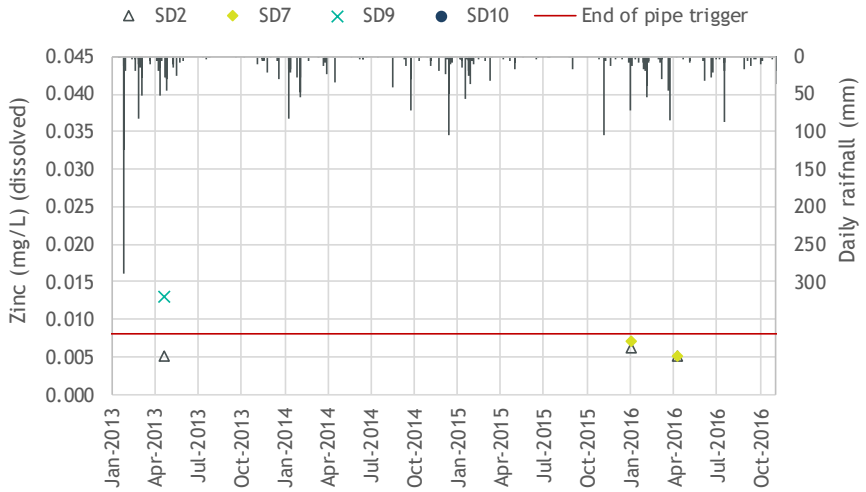


Figure A.36 - Zinc (dissolved) - On-site stormwater sediment dams

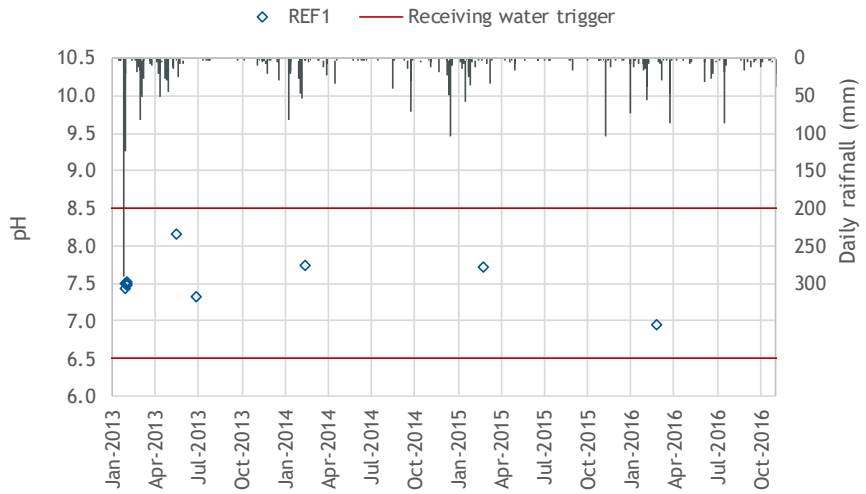


Figure A.37 - pH - Upstream surface water monitoring locations

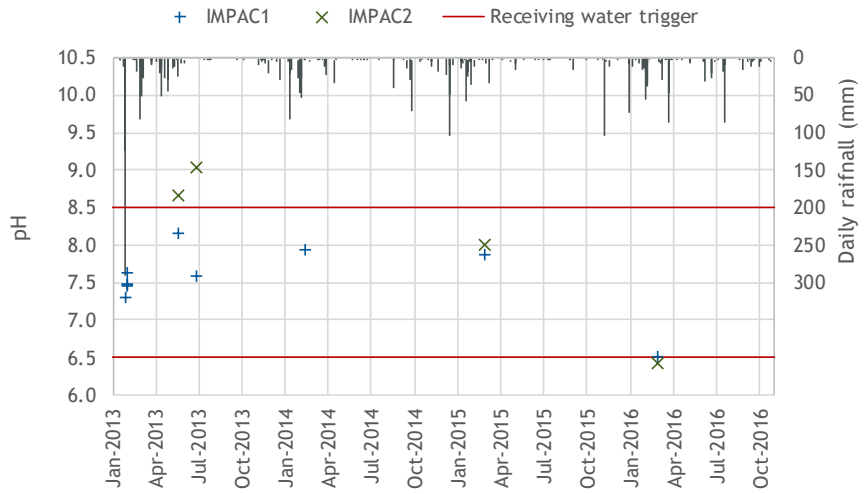
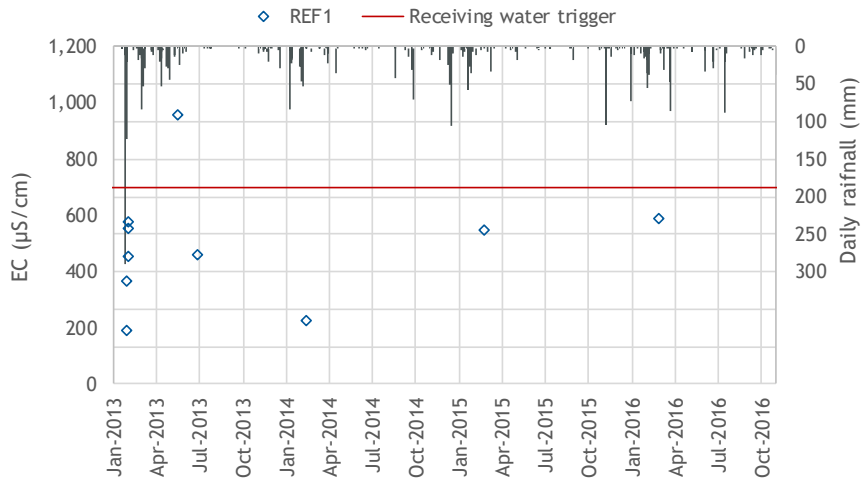
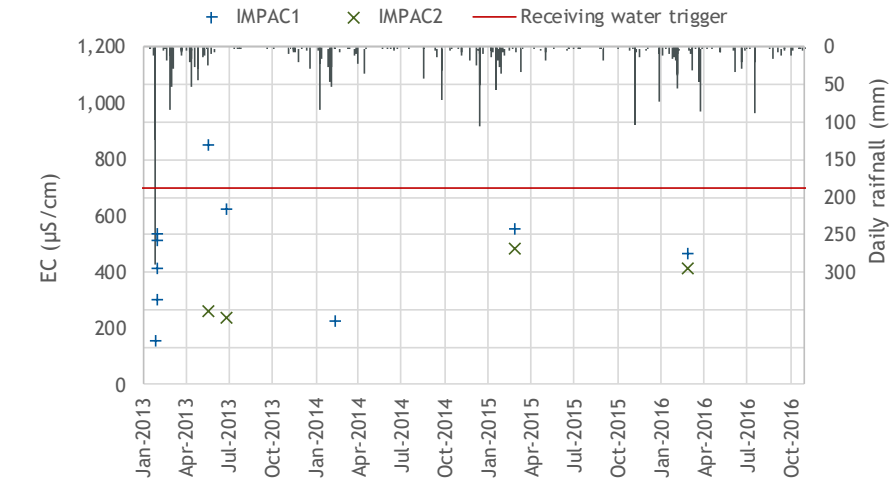


Figure A.38 - pH - Downstream surface water monitoring locations



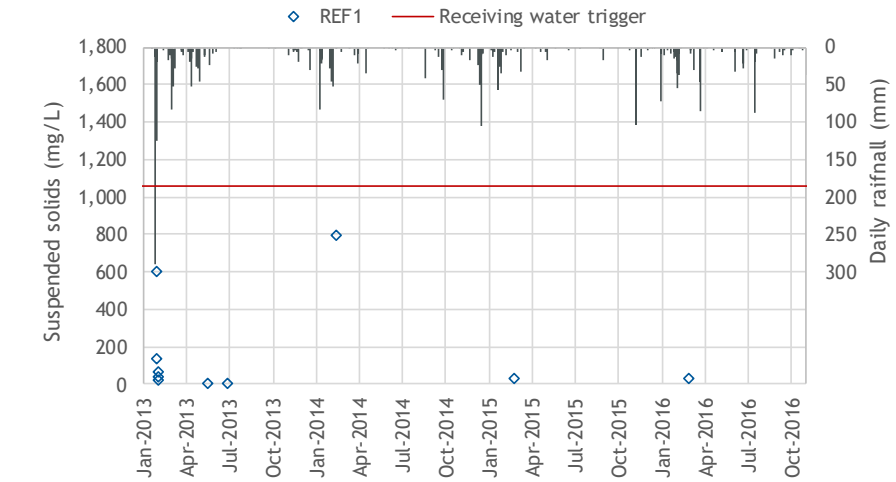
Receiving water trigger based on very high flow (see Table 4.4)

Figure A.39 - EC - Upstream surface water monitoring locations



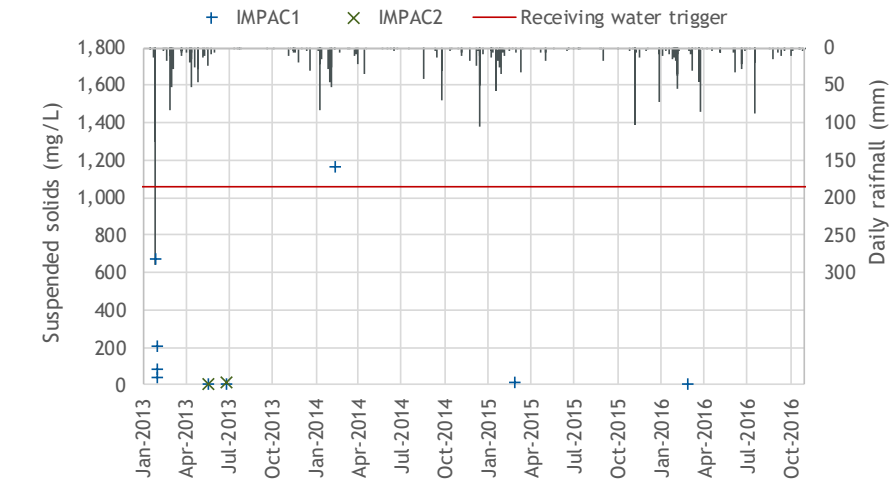
Receiving water trigger based on very high flow (see Table 4.4)

Figure A.40 - EC - Downstream surface water monitoring locations



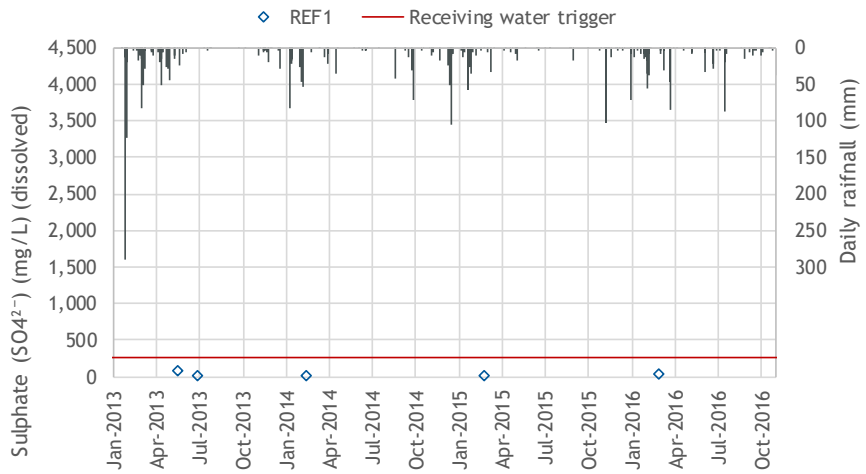
Receiving water trigger based on high flow (see Table 4.3)

Figure A.41 - Suspended solids - Upstream surface water monitoring locations



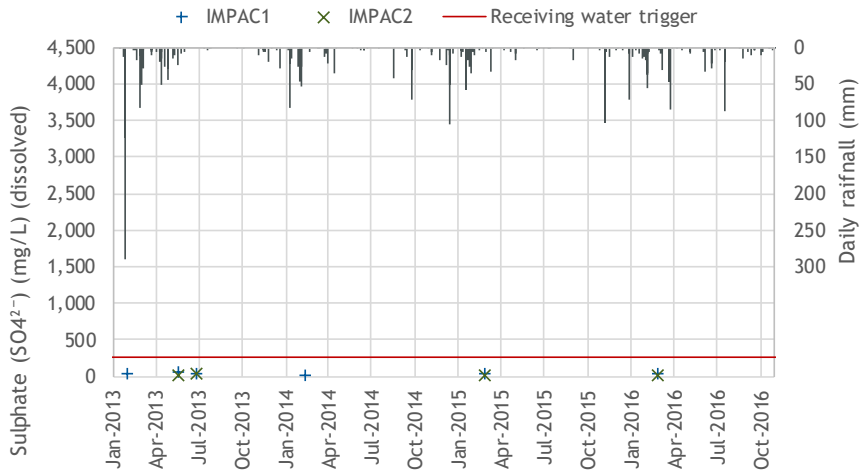
Receiving water trigger based on high flow (see Table 4.3)

Figure A.42 - Suspended solids - Downstream surface water monitoring locations



Receiving water trigger based on very high flow (see Table 4.4)

Figure A.43 - Sulphate - Upstream surface water monitoring locations



Receiving water trigger based on very high flow (see Table 4.4)

Figure A.44 - Sulphate - Downstream surface water monitoring locations

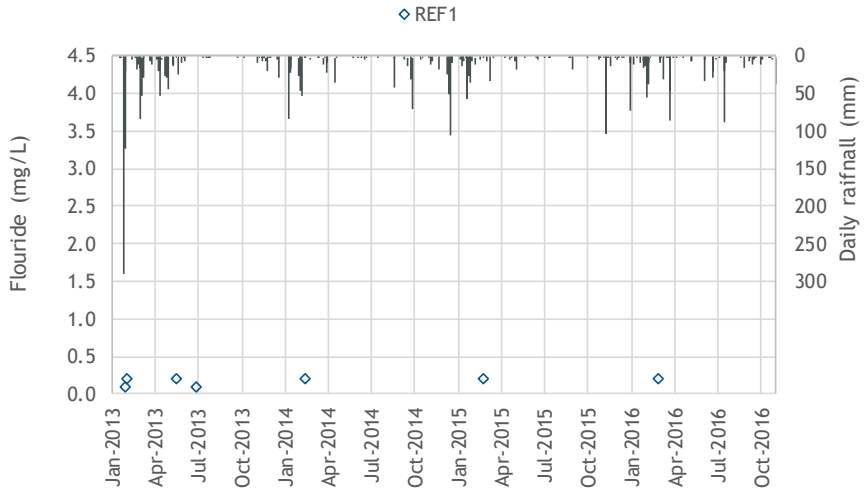


Figure A.45 - Fluoride - Upstream surface water monitoring locations

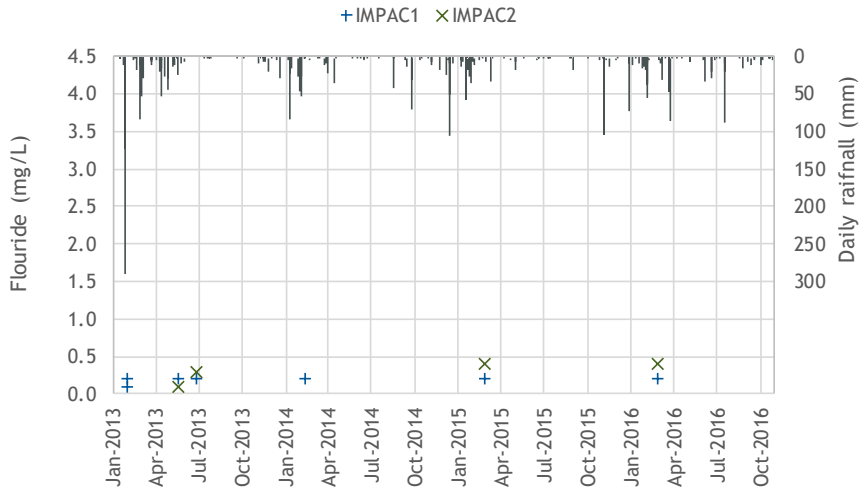


Figure A.46 - Fluoride - Downstream surface water monitoring locations

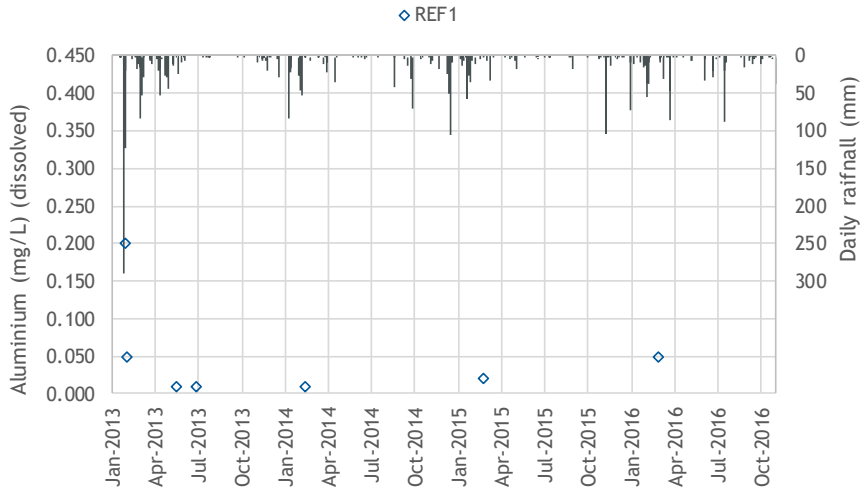


Figure A.47 - Aluminium (dissolved) - Upstream surface water monitoring locations

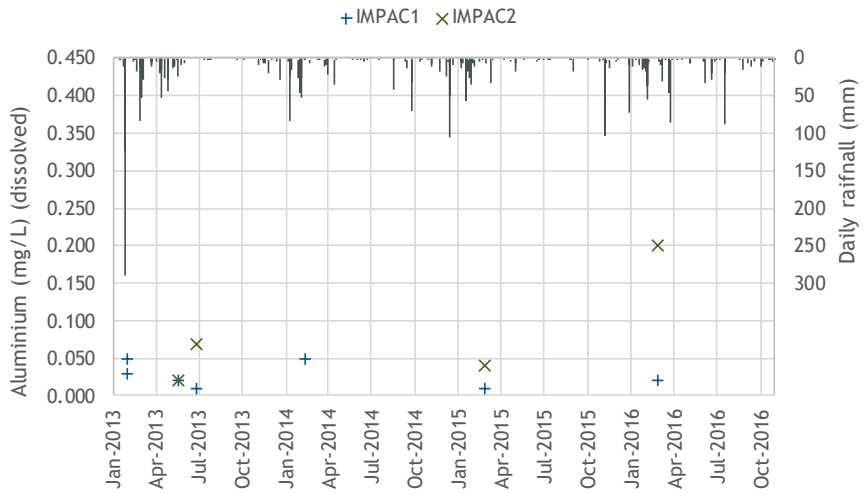


Figure A.48 - Aluminium (dissolved)- Downstream surface water monitoring locations

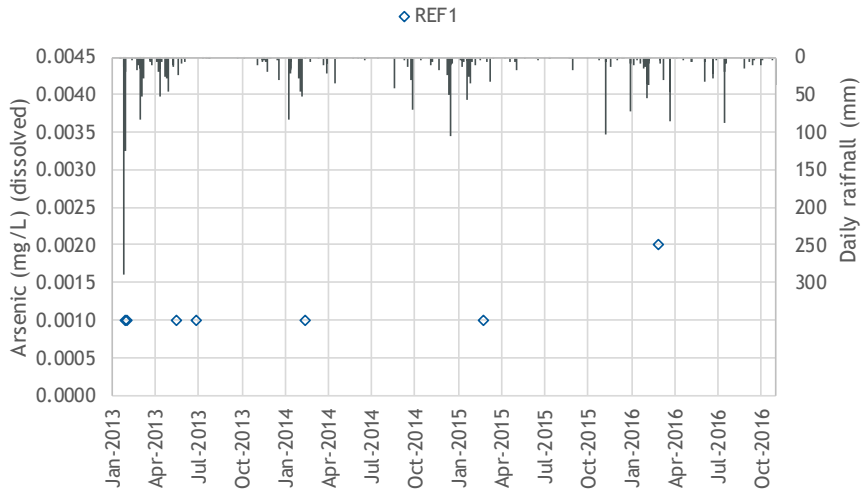


Figure A.49 - Arsenic (dissolved)- Upstream surface water monitoring locations

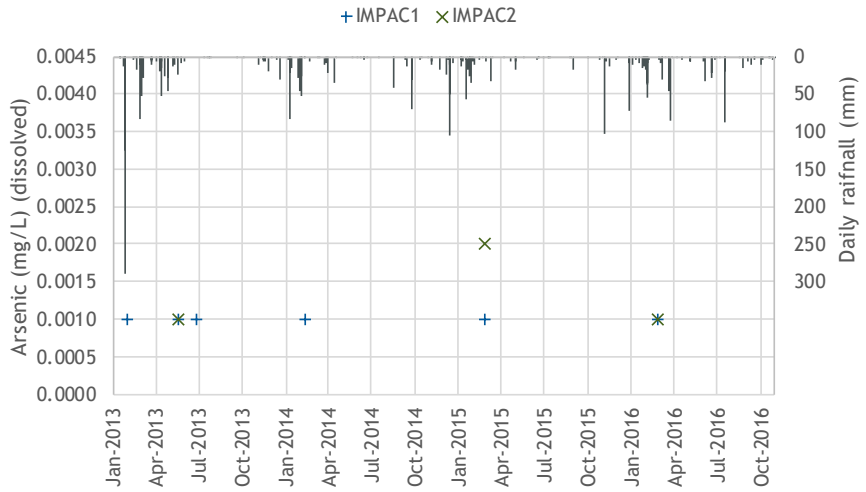


Figure A.50 - Arsenic (dissolved)- Downstream surface water monitoring locations

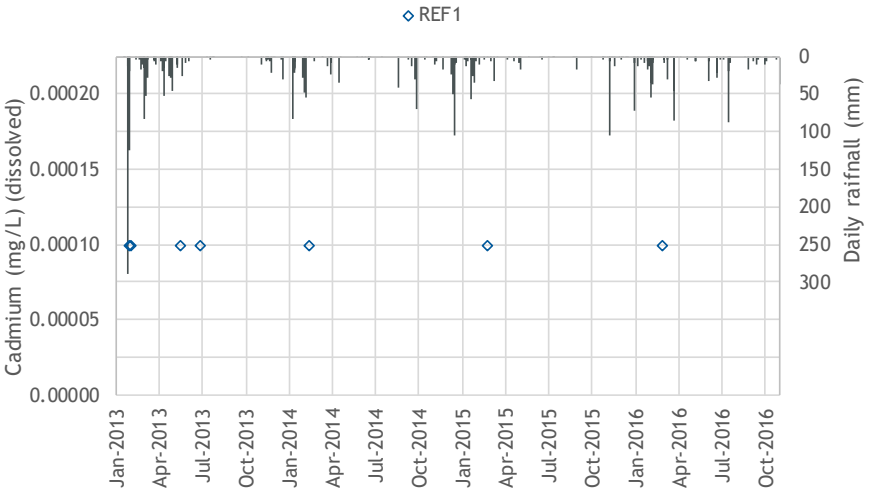


Figure A.51 - Cadmium (dissolved) - Upstream surface water monitoring locations

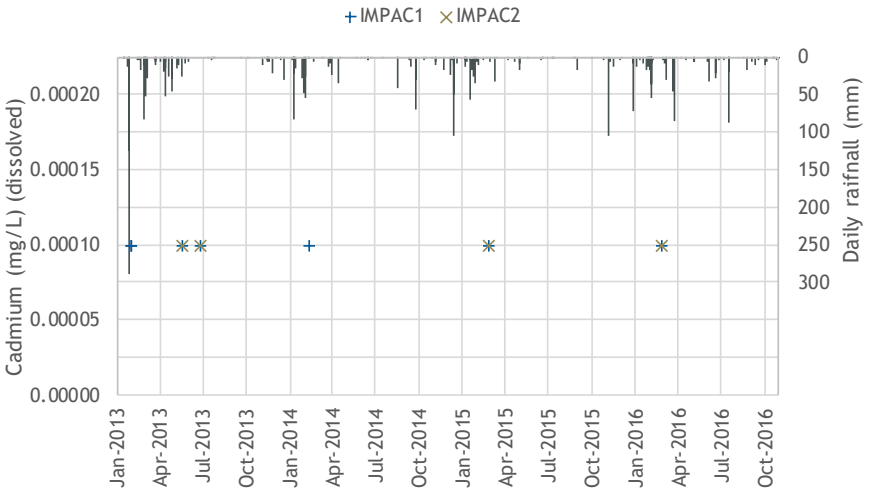


Figure A.52 - Cadmium (dissolved) - Downstream surface water monitoring locations

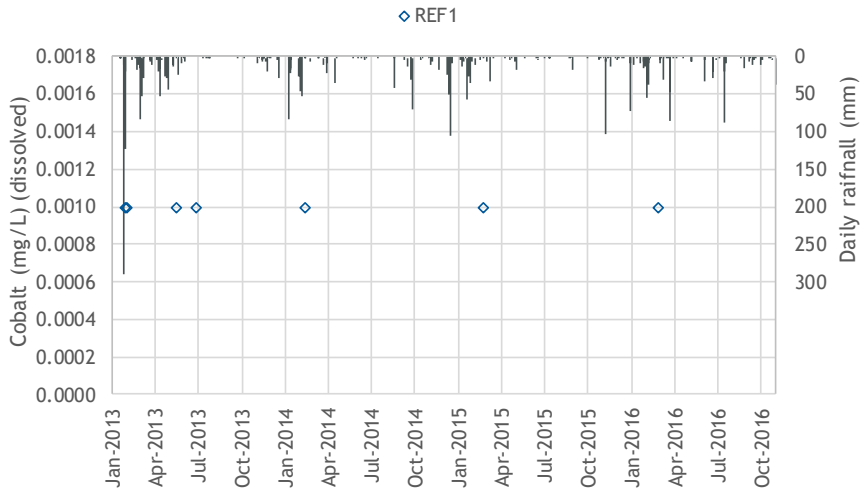


Figure A.53 - Cobalt (dissolved) - Upstream surface water monitoring locations

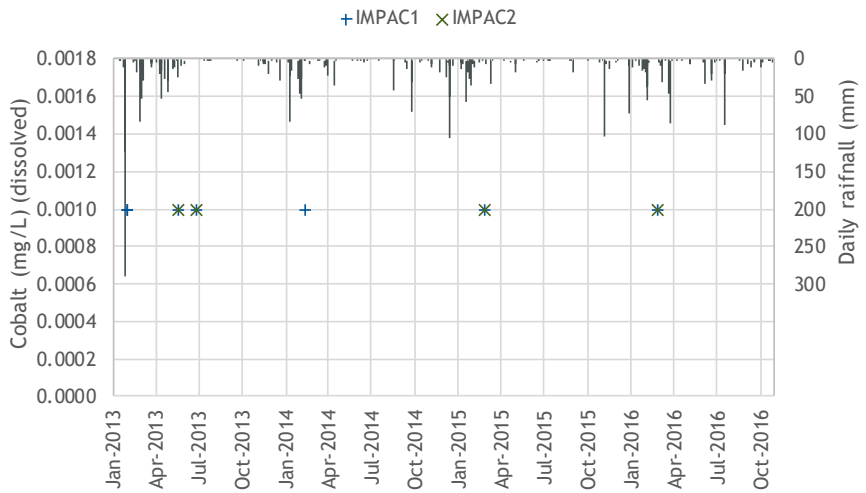


Figure A.54 - Cobalt (dissolved) - Downstream surface water monitoring locations

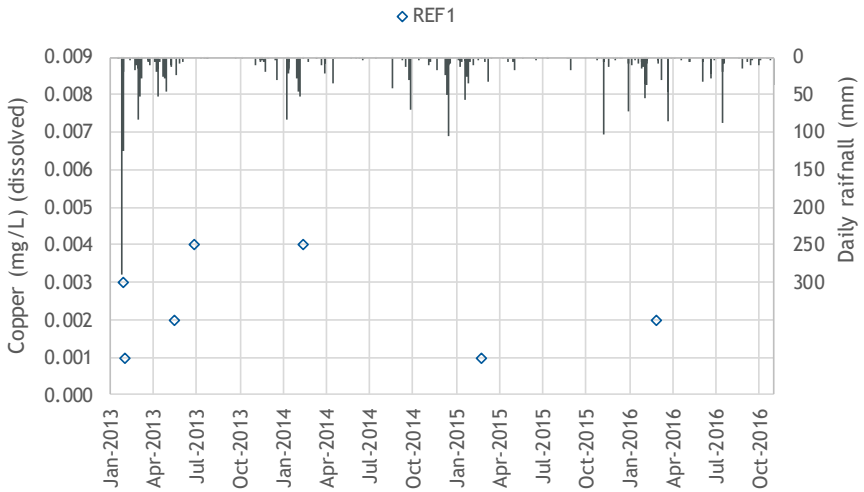


Figure A.55 - Copper (dissolved) - Upstream surface water monitoring locations

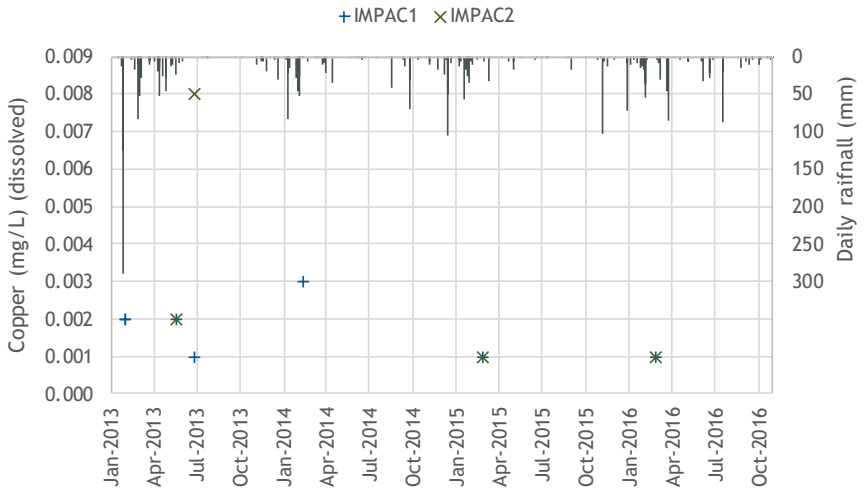


Figure A.56 - Copper (dissolved) - Downstream surface water monitoring locations

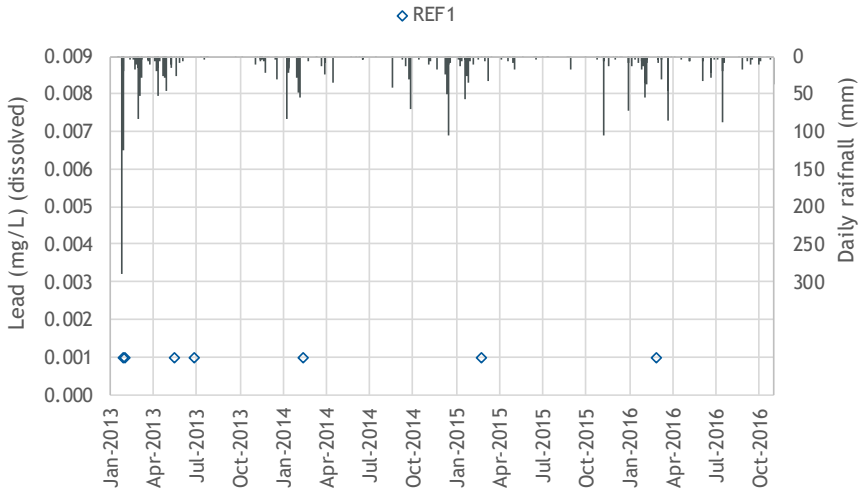


Figure A.57 - Lead (dissolved) - Upstream surface water monitoring locations

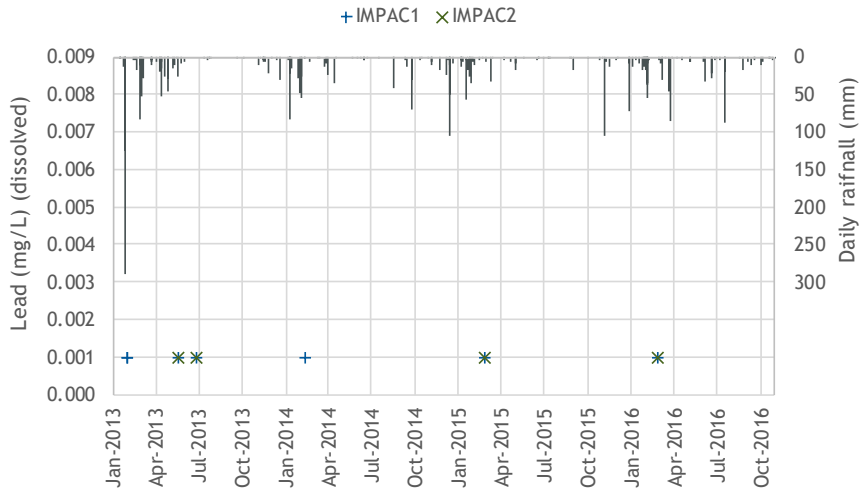


Figure A.58 - Lead (dissolved) - Downstream surface water monitoring locations

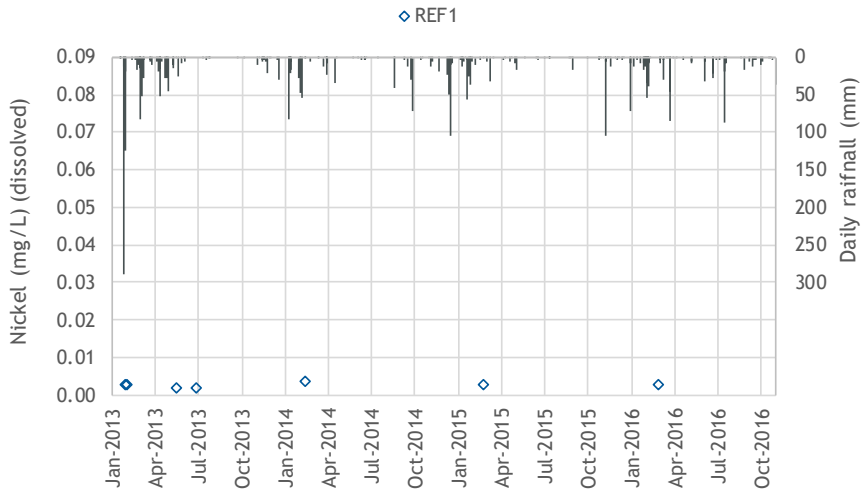


Figure A.59 - Nickel (dissolved) - Upstream surface water monitoring locations

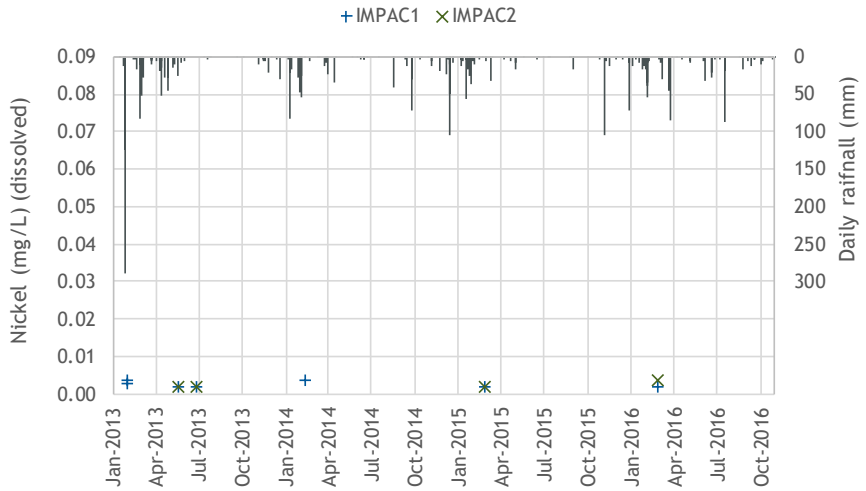


Figure A.60 - Nickel (dissolved) - Downstream surface water monitoring locations

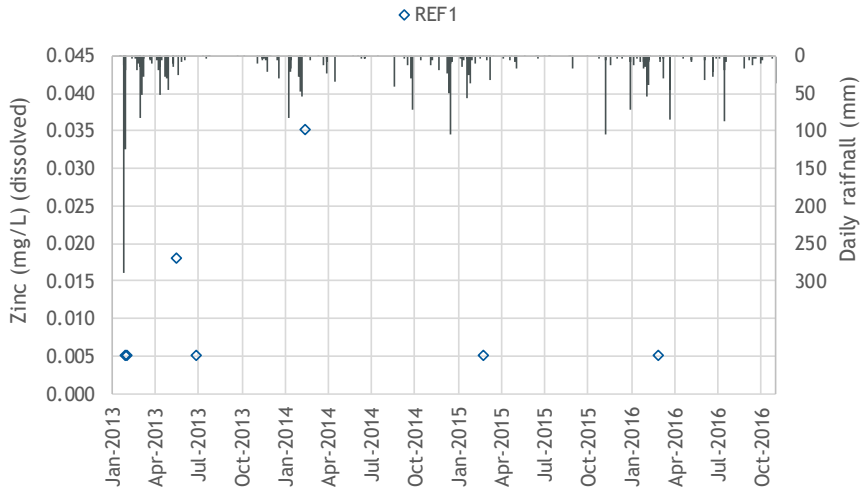


Figure A.61 - Zinc (dissolved) - Upstream surface water monitoring locations

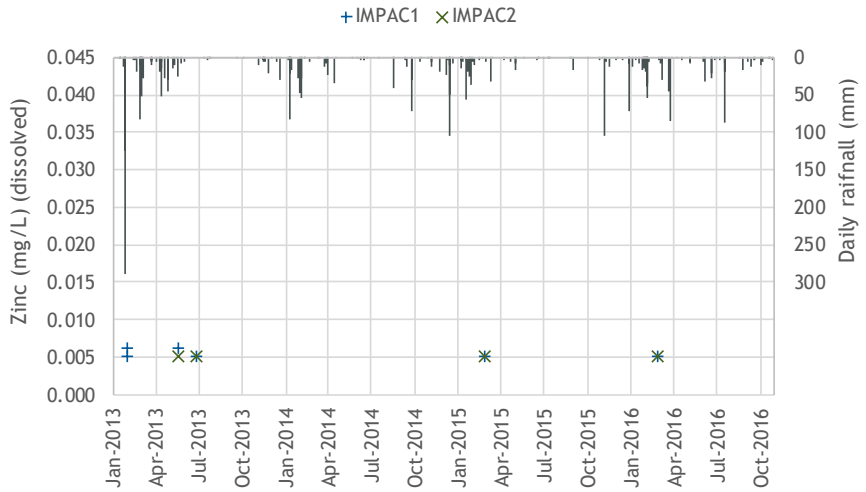


Figure A.62 - Zinc (dissolved) - Downstream surface water monitoring locations

Appendix B- Mine water balance model configuration

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B1 Overview

A computer-based operational simulation model (OPSIM) was used to assess the dynamics of the water balance under varying rainfall and catchment conditions throughout the development of the Project. This model has been in operation since the conception of the mine and has been continually updated as data becomes available or mining operations have changed. The model will be continually updated throughout the life of the Project.

The OPSIM model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

The model has been configured to simulate the operation of all major components of the water management system. The simulated inflows and outflows included in the model are given in Figure A.1.

Table B.1 – Simulated inflows and outflows to the mine affected water management system

Inflows	Outflows
Direct rainfall on water storage surfaces	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater inflows	Dust suppression demand
External water supply (Anglo)	Vehicle wash down
	Offsite spills from storages
	Controlled Releases

B2 Climate data

Rainfall is recorded on a daily basis at Middlemount Coal Mine and is available from January 2008 to July 2017. This dataset is too short for water balance model forecasting and therefore regional data is required to provide a long-term rainfall dataset.

A representative long-term rainfall dataset was obtained was obtained from the Queensland Government Department of Science, Information Technology and Innovation (DSITI) Datadrill service for the period January 1889 to December 2017 (129 years)(DSITI, 2017). Morton's Lake evaporation has been used to estimate evaporation losses from storages.

Table A.2 shows the long-term monthly averages for Morton's Lake evaporation and monthly Datadrill rainfall data.

Figure A.1 shows the annual distribution of average monthly rainfall and evaporation from the Datadrill dataset. The evaporation pattern indicates higher evaporation in the warmer months and less evaporation in the colder months. The rainfall pattern shows most rainfall occurring during the summer months. Mean monthly evaporation is significantly higher than mean monthly rainfall throughout the year.

Table B.2 – Long-term average rainfall and evaporation (1889 – 2017)

Month	SILO Datadrill rainfall (mm)	Morton's Lake evaporation (mm)
January	116.6	202.1
February	97.7	170.2
March	66.6	170.2
April	32.7	133.9
May	29.9	102.2
June	31.1	81.0
July	23.9	90.9
August	19.2	118.1
September	18.5	151.0
October	35.6	188.1
November	55.6	199.8
December	97.1	211.8
TOTAL	**625**	**1,819**

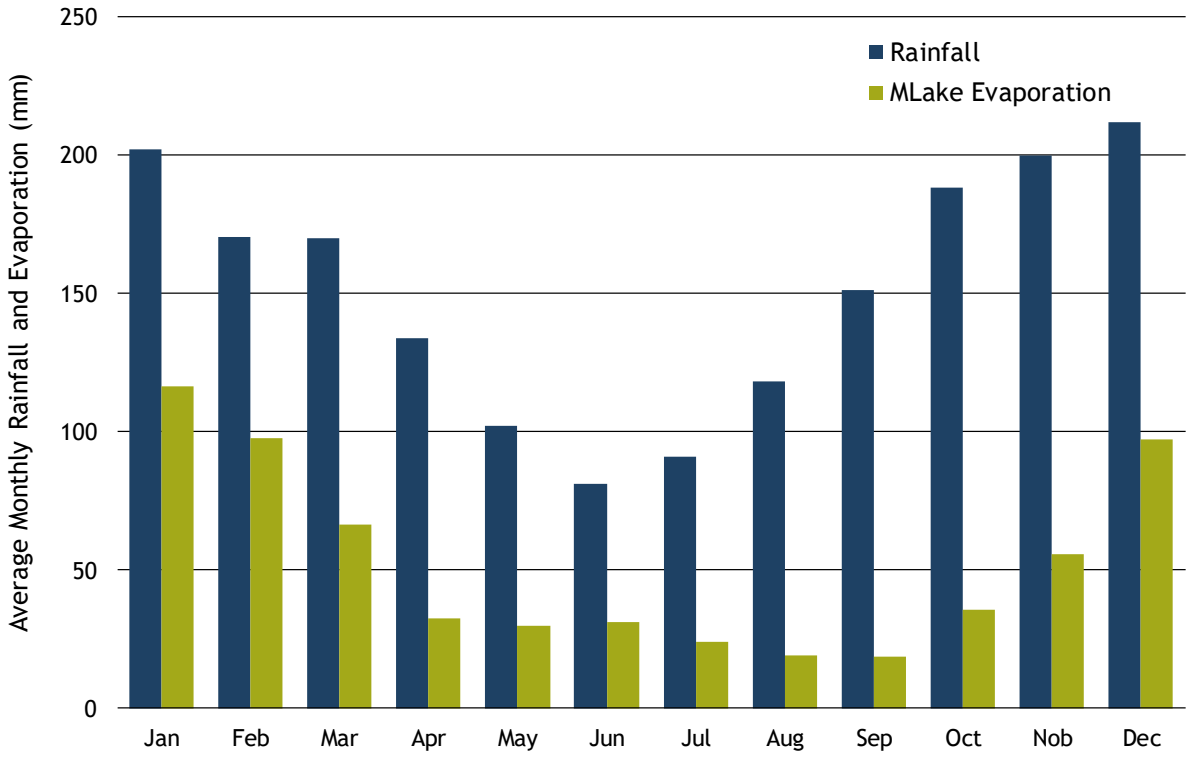


Figure B.1 – Distribution of monthly rainfall and evaporation (Data source: DSITI, 2017)

B3 Simulation methodology

The simulation used the 'forecast' simulation method in OPSIM. The model was run on a daily timestep for 20 years, to match the operational phase of the mine life, and incorporated five different representative Phases of the mine life. Although the catchment areas will continuously change as the mine progresses, the adopted approach of modelling discrete Phases will provide a reasonable representation of site conditions over the 20 year period. The adopted model Phases are summarised in Table A.3.

Table B.3 – Adopted model phases

Representative mine phase	Applied range of mine life	Phase duration
Phase 1	Year 2018 - 2021	4 years
Phase 2	Year 2022 - 2025	4 years
Phase 3	Year 2026 – 2030	5 years
Phase 4	Year 2031 – 2035	5 years
Phase 5	Year 2036 - 2037	2 years

The forecast simulation type allows the model configuration to change over the modelled 20 years by linking the representative phases, reflecting variations in the water management system over time such as catchment area, production and groundwater inflows.

The changes in the physical layout and site catchment areas are provided in Section A4. The adopted operating rules for the water balance model assessment are summarised in Table A.9.

To assess the effects of varying climatic conditions, the forecast model was run for 109 realisations (with each realisation corresponding to the 20-year mine life), using 129 years of climatic data available from January 1889 to December 2017. A different rainfall input sequence is applied to each realisation. The first realisation adopts climatic data from 1889 to 1908, the second from 1890 to 1909 and so on through the 129 years of simulated climatic data. A percentile analysis of the resultant realisations can then be undertaken at user-defined confidence intervals to assess the behaviour of the various storages over extended dry and wet periods, reflecting the full range of climatic conditions experienced in the last 129 years.

B4 Catchment area and land use classifications

To adequately simulate the site water balance, the mine site catchments were classified as either:

- Undisturbed, representing natural areas;
- Roads / hardstand, representing coal stockpile areas and mine infrastructure such as haul roads and plant area;
- Mining pit, representing the pit floor;
- Spoil dump, representing uncompacted dumped overburden material;
- Rehabilitated spoil, representing both initial and established rehabilitation areas;
- Tailings, representing the surface area of the TSF's / flocculation cells; and
- Cleared, representing pre-strip areas ahead of mining.

Catchment areas and associated land use classifications within the mine have been determined from topographic mapping (dated June 2017), aerial photography (dated June 2017) and plans of operations disturbance areas for each mine phase provided by Middlemount Coal Pty Ltd.

Figure A.2 to Figure A.6 shows the locations of catchment areas and land use classifications for the water balance model, which have been summarised in Table A.4 to Table A.8.

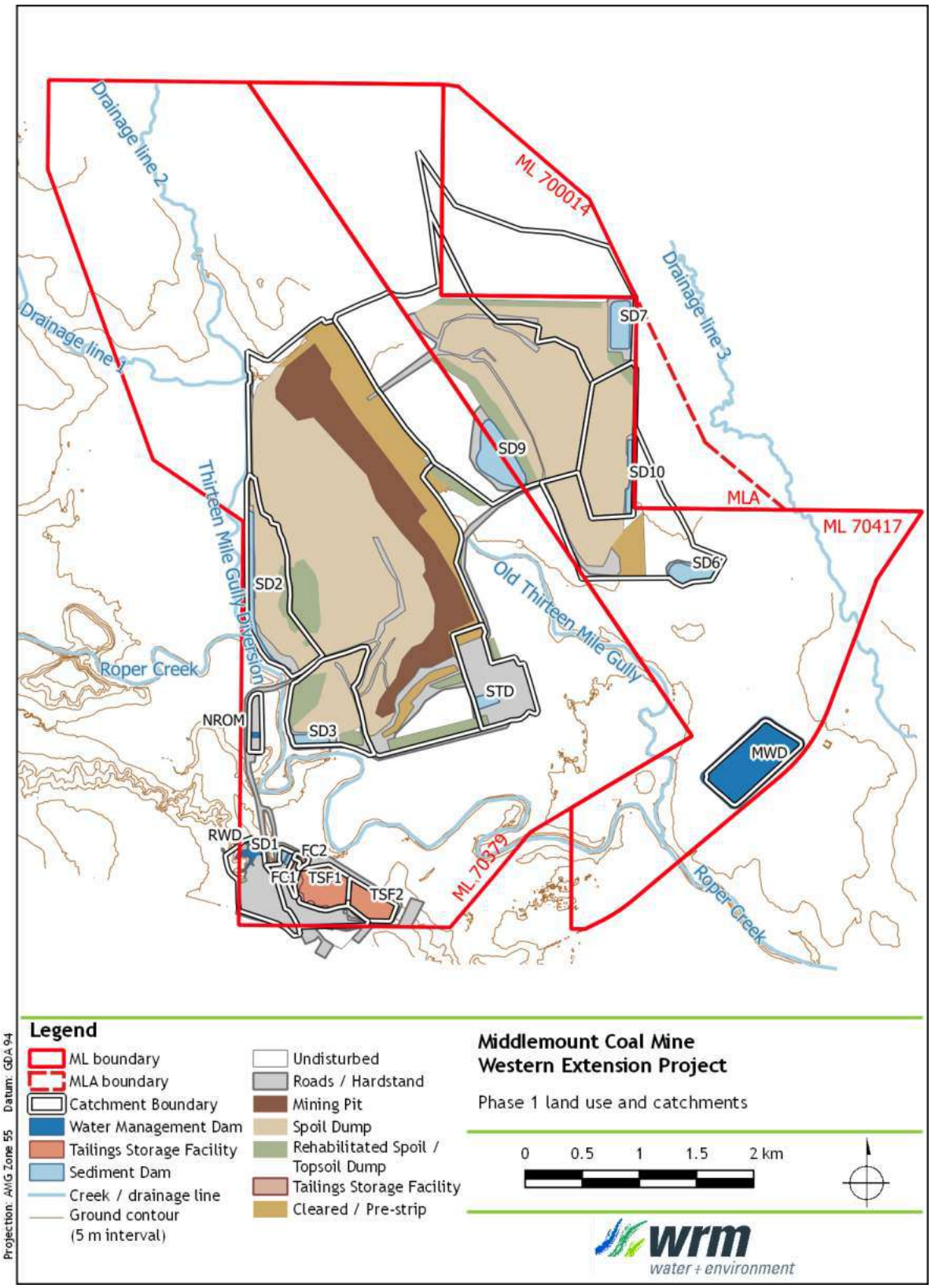


Figure B.2 – Catchment and land use breakdown – Phase 1

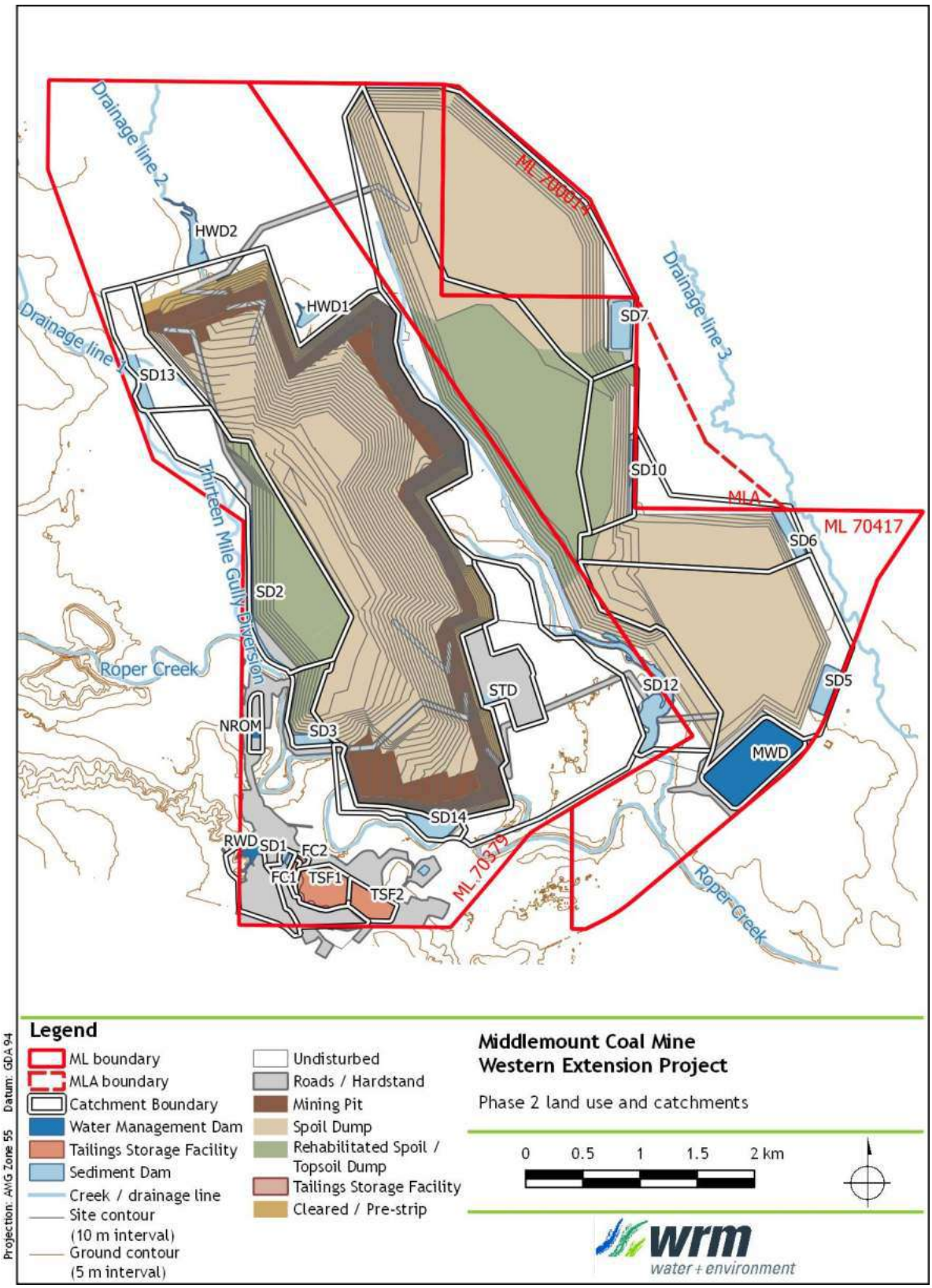


Figure B.3 – Catchment and land use breakdown – Phase 2

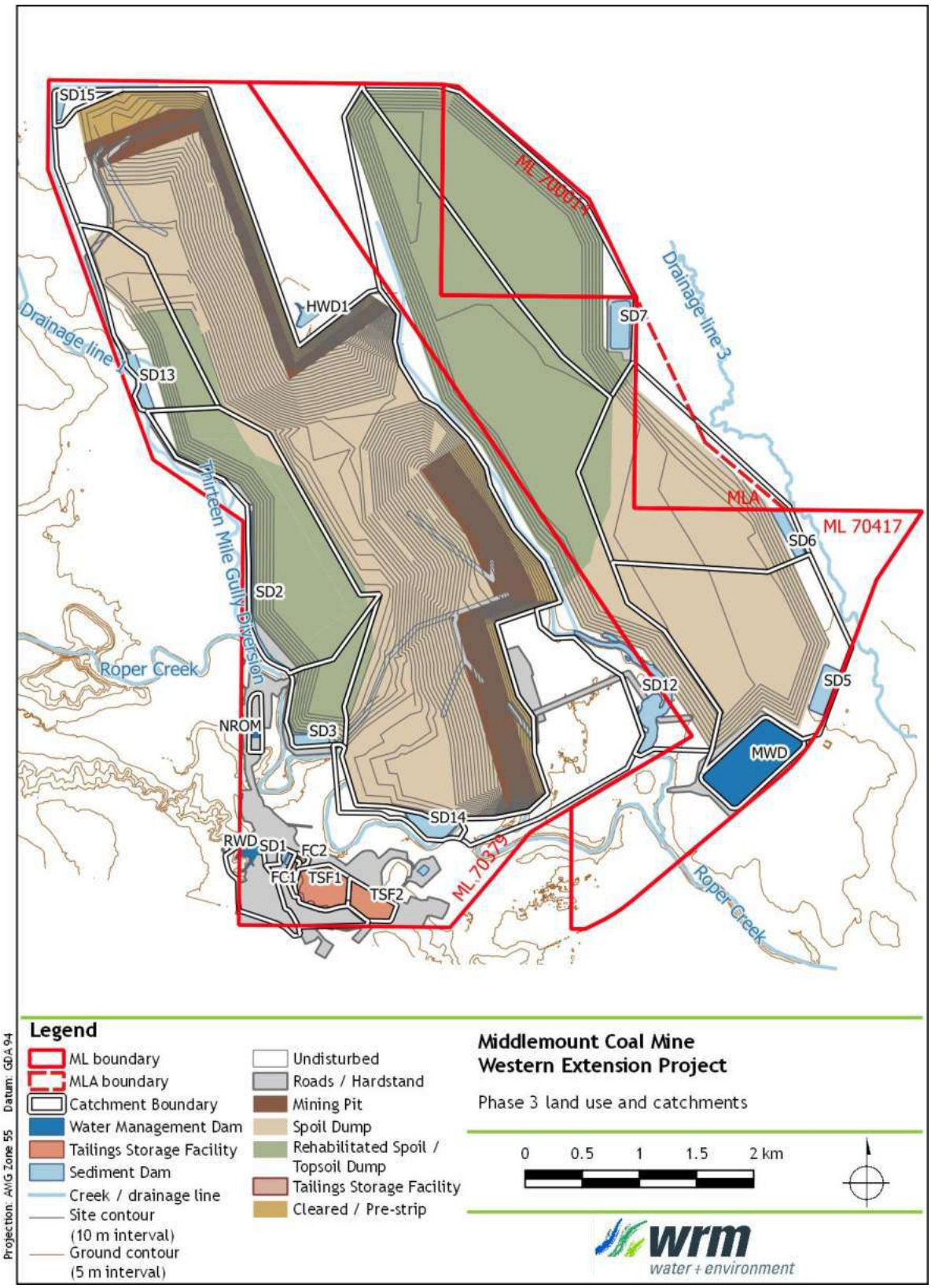


Figure B.4 – Catchment and land use breakdown – Phase 3

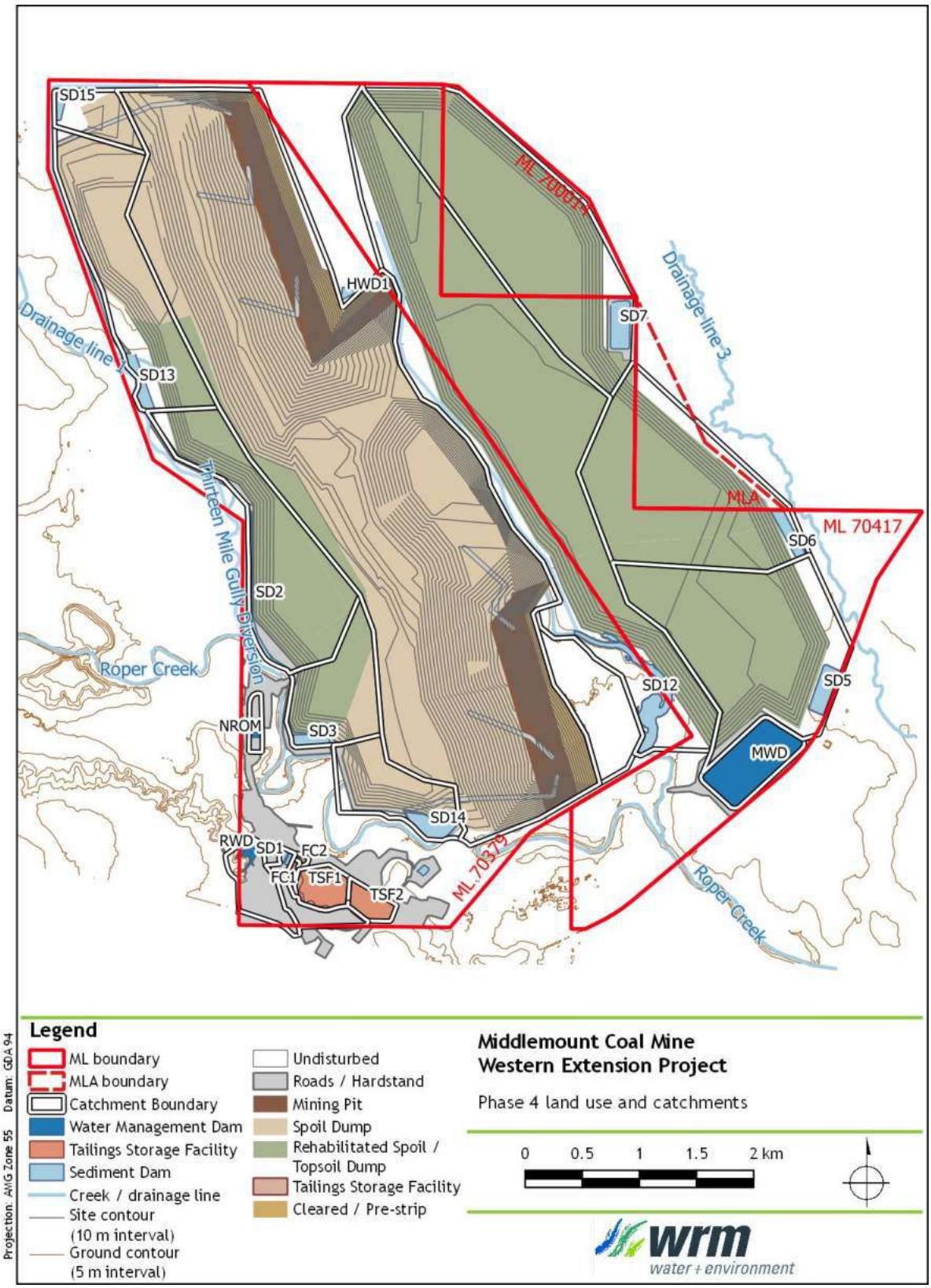


Figure B.5 – Catchment and land use breakdown – Phase 4

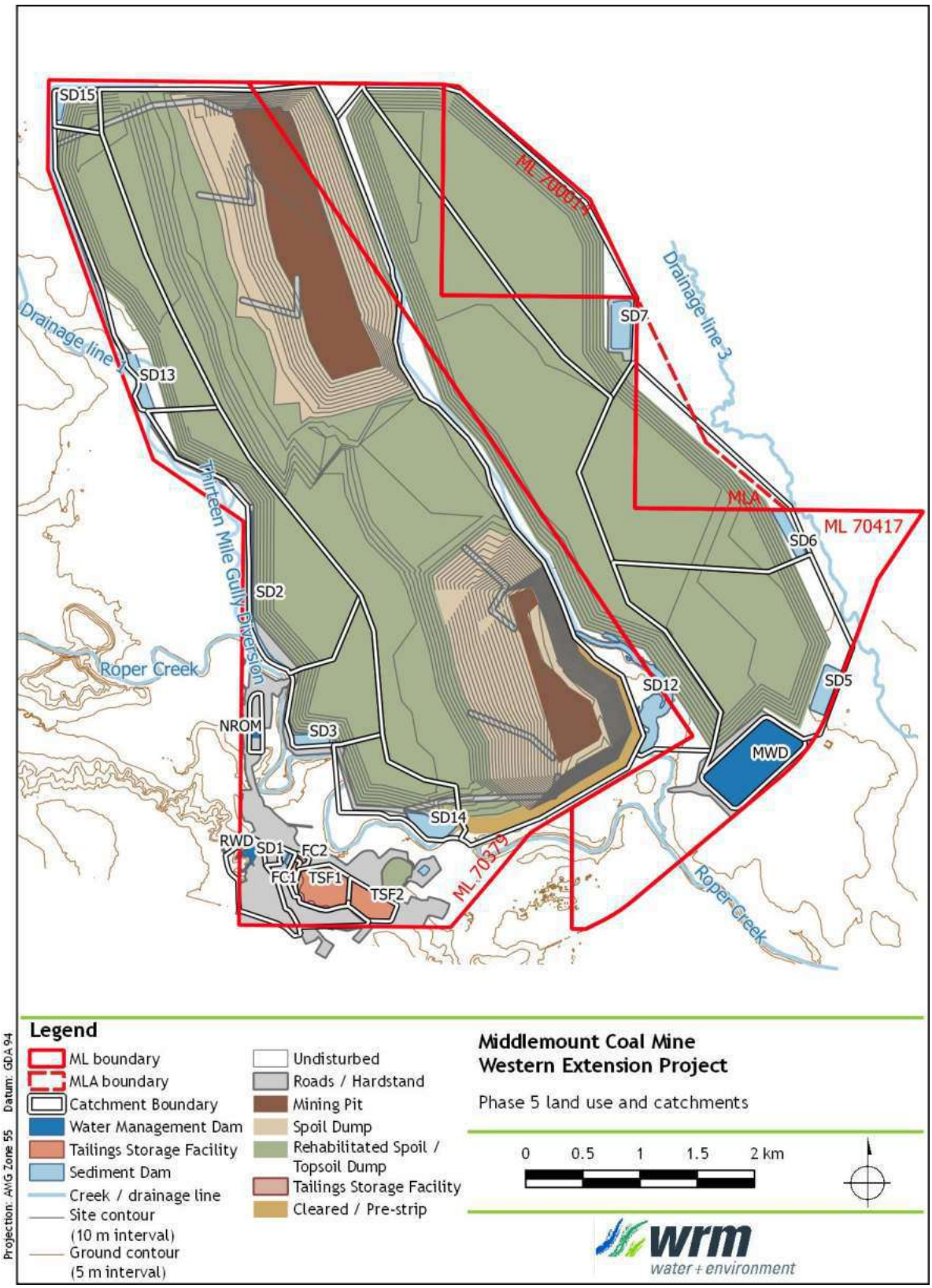


Figure B.6 – Catchment and land use breakdown – Phase 5

Table B.4 – MCM catchment area and land use breakdown – Phase 1 (existing)

Dam name	Catchment area (ha)							
	Undisturbed	Roads / Hardstand	Mining pit	Spoil Dump	Rehab	Tailings	Cleared / Pre-strip	TOTAL
Mine affected water dams								
Mining pit	24.5	30.6	99.8	212.0	24.8	0.0	71.8	463.5
STD	0.0	32.6	0.0	0.0	0.7	0.0	2.8	36.1
RWD	4.0	21.4	0.0	0.0	0.2	0.0	0.0	25.5
MWD	0.0	30.0	0.0	0.0	0.0	0.0	0.0	30.0
NROM	0.0	5.5	0.0	0.0	0.0	0.0	0.0	5.5
TSF1	0.0	0.1	0.0	0.0	0.0	15.4	0.0	15.5
TSF2	0.0	0.0	0.0	0.0	0.0	9.7	0.0	9.7
SD1	0.4	15.1	0.0	0.0	0.0	0.7	0.0	16.2
Sediment dams								
SD2	0.0	14.6	0.0	34.8	5.3	0.0	0.0	54.7
SD3	0.5	9.5	0.0	34.8	2.3	0.0	0.0	47.1
SD7	101.1	13.8	0.0	30.9	7.7	0.0	0.0	153.5
SD9	111.9	35.6	0.0	109.6	16.0	0.0	0.7	273.7
SD10	2.1	4.4	0.0	46.9	1.6	0.0	0.0	54.9
SD6 (interim)	38.1	14.7	0.0	26.0	0.0	0.0	11.2	90.0

Table B.5 – MCM catchment area and land use breakdown – Phase 2

Dam name	Catchment area (ha)							
	Undisturbed	Roads / Hardstand	Mining pit	Spoil Dump	Rehab	Tailings	Cleared / Pre-strip	TOTAL
Mine affected water dams								
Mining pit	29.0	27.4	182.6	435.4	6.0	0.0	54.6	735.1
STD	0.0	33.4	0.0	0.0	0.0	0.0	0.0	33.4
RWD	4.0	21.4	0.0	0.0	0.2	0.0	0.0	25.5
MWD	0.0	36.1	0.0	0.0	0.0	0.0	0.0	36.1
NROM	0.0	5.5	0.0	0.0	0.0	0.0	0.0	5.5
TSF1	0.0	0.1	0.0	0.0	0.0	15.4	0.0	15.5
TSF2	0.0	0.0	0.0	0.0	0.0	9.7	0.0	9.7
SD1	0.0	15.5	0.0	0.0	0.0	0.7	0.0	16.2
Sediment dams								
SD2	28.5	14.8	0.0	0.5	92.7	0.0	0.0	136.5
SD3	0.1	5.8	0.0	3.8	10.3	0.0	0.0	20.0
SD7	15.8	12.0	0.0	255.2	10.3	0.0	0.0	293.2
SD9	-	-	-	-	-	-	-	-
SD10	3.4	2.9	0.0	18.2	35.5	0.0	0.0	60.0
SD5	24.6	11.7	0.0	188.7	0.3	0.0	0.0	225.3
SD6	30.2	4.1	0.0	73.9	3.3	0.0	0.0	111.5
SD12	122.3	40.9	0.0	121.0	194.1	0.0	0.0	478.2
SD13	34.2	5.5	0.1	0.0	0.0	0.0	0.1	39.9
SD14	10.7	7.1	0.1	0.0	0.0	0.0	0.0	17.9
SD15	-	-	-	-	-	-	-	-

Table B.6 – MCM catchment area and land use breakdown – Phase 3

Dam name	Catchment area (ha)							
	Undisturbed	Roads / Hardstand	Mining pit	Spoil Dump	Rehab	Tailings	Cleared / Pre-strip	TOTAL
Mine affected water dams								
Mining pit	38.7	34.7	155.5	637.4	24.4	0.0	87.4	978.0
STD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RWD	4.0	21.4	0.0	0.0	0.2	0.0	0.0	25.5
MWD	0.0	36.1	0.0	0.0	0.0	0.0	0.0	36.1
NROM	0.0	5.5	0.0	0.0	0.0	0.0	0.0	5.5
TSF1	0.0	0.1	0.0	0.0	0.0	15.4	0.0	15.5
TSF2	0.0	0.0	0.0	0.0	0.0	9.7	0.0	9.7
SD1	0.0	15.5	0.0	0.0	0.0	0.7	0.0	16.2
Sediment dams								
SD2	3.0	15.6	0.0	8.9	151.6	0.0	0.0	179.1
SD3	0.5	5.9	0.0	1.9	35.6	0.0	0.0	43.9
SD7	15.8	12.0	0.0	0.0	225.4	0.0	0.0	253.2
SD9	-	-	-	-	-	-	-	-
SD10	-	-	-	-	-	-	-	-
SD5	24.6	11.6	0.0	174.5	0.0	0.0	0.0	210.7
SD6	25.7	4.1	0.0	165.9	20.8	0.0	0.0	216.5
SD12	69.6	37.2	0.0	61.1	333.3	0.0	0.1	501.3
SD13	15.5	7.5	0.0	29.6	34.4	0.0	0.0	87.0
SD14	11.0	6.7	0.0	0.1	0.0	0.0	0.0	17.9
SD15	4.9	2.7	0.0	0.0	0.0	0.0	0.8	8.4

Table B.7 – MCM catchment area and land use breakdown – Phase 4

Dam name	Catchment area (ha)							
	Undisturbed	Roads / Hardstand	Mining pit	Spoil Dump	Rehab	Tailings	Cleared / Pre-strip	TOTAL
Mine affected water dams								
Mining pit	23.7	27.8	121.3	795.7	34.6	0.0	55.6	1058.7
STD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RWD	4.0	21.4	0.0	0.0	0.2	0.0	0.0	25.5
MWD	0.0	36.1	0.0	0.0	0.0	0.0	0.0	36.1
NROM	0.0	5.5	0.0	0.0	0.0	0.0	0.0	5.5
TSF1	0.0	0.1	0.0	0.0	0.0	15.4	0.0	15.5
TSF2	0.0	0.0	0.0	0.0	0.0	9.7	0.0	9.7
SD1	0.0	15.5	0.0	0.0	0.0	0.7	0.0	16.2
Sediment dams								
SD2	3.0	15.3	0.0	0.0	128.5	0.0	0.0	146.9
SD3	0.5	5.4	0.0	17.6	43.6	0.0	0.0	67.1
SD7	15.8	12.0	0.0	0.0	225.4	0.0	0.0	253.2
SD9	-	-	-	-	-	-	-	-
SD10	-	-	-	-	-	-	-	-
SD5	24.6	11.6	0.0	0.0	174.5	0.0	0.0	210.7
SD6	25.7	4.1	0.0	0.0	186.7	0.0	0.0	216.5
SD12	67.0	34.0	0.0	0.0	394.6	0.0	0.0	495.6
SD13	15.7	8.1	0.0	87.3	31.1	0.0	0.0	142.2
SD14	6.6	13.2	0.0	38.6	0.0	0.0	0.0	58.5
SD15	8.4	4.6	0.0	15.3	0.0	0.0	0.0	28.4

Table B.8 – MCM catchment area and land use breakdown – Phase 5

Dam name	Catchment area (ha)							
	Undisturbed	Roads / Hardstand	Mining pit	Spoil Dump	Rehab	Tailings	Cleared / Pre-strip	TOTAL
Mine affected water dams								
Mining pit	12.6	29.1	157.2	997.3	0.0	45.4	12.6	1241.6
STD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RWD	4.0	21.4	0.0	0.2	0.0	0.0	4.0	25.5
MWD	0.0	36.1	0.0	0.0	0.0	0.0	0.0	36.1
NROM	0.0	5.5	0.0	0.0	0.0	0.0	0.0	5.5
TSF1	0.0	0.1	0.0	0.0	15.4	0.0	0.0	15.5
TSF2	0.0	0.0	0.0	0.0	9.7	0.0	0.0	9.7
SD1	0.0	15.5	0.0	0.0	0.7	0.0	0.0	16.2
Sediment dams								
SD2	3.0	15.3	0.0	128.5	0.0	0.0	3.0	146.9
SD3	0.5	5.1	0.0	61.5	0.0	0.0	0.5	67.1
SD7	15.8	12.0	0.0	225.4	0.0	0.0	15.8	253.2
SD9	-	-	-	-	-	-	-	-
SD10	-	-	-	-	-	-	-	-
SD5	24.6	11.6	0.0	174.5	0.0	0.0	24.6	210.7
SD6	25.7	4.1	0.0	186.7	0.0	0.0	25.7	216.5
SD12	58.6	34.0	0.0	394.7	0.0	0.0	58.6	487.3
SD13	14.7	7.6	0.0	110.1	0.0	0.0	14.7	132.5
SD14	7.1	13.0	0.0	36.6	0.0	1.7	7.1	58.5
SD15	1.0	3.2	0.0	9.9	0.0	0.0	1.0	14.0

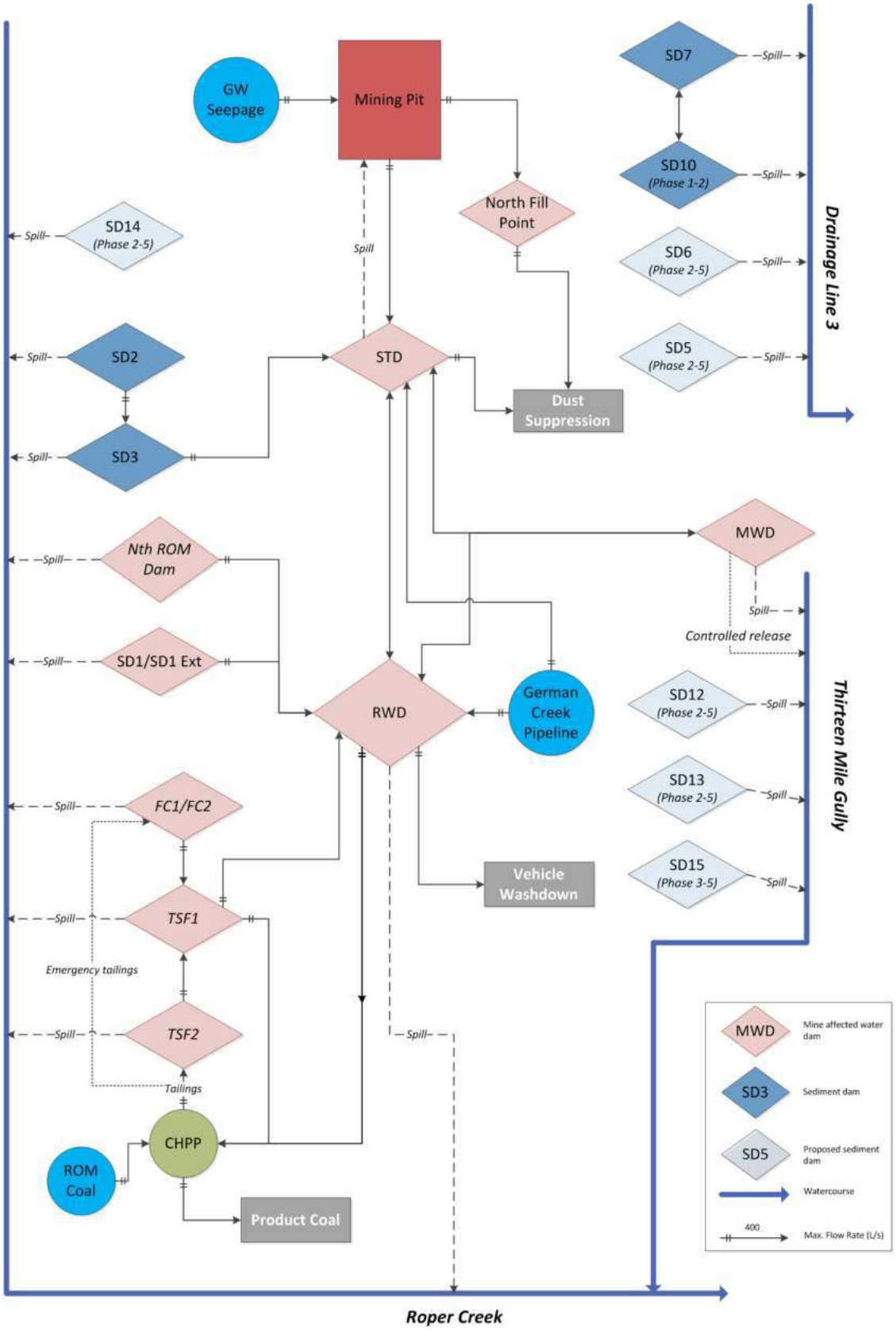


Figure B.7 – Water management system schematic – Phase 2 to Phase 5

Table B.9 – Water management system operating rules

Item	Node Name	Operating Rules
1.0	***External water supply***	
1.1	German Creek water supply	• Supplies water to RWD and STD as required, in accordance with the arrangement detailed in Section 4.10. • Water is imported if the combined inventory of RWD and MWD reduces below 500 ML.
2.0	***Water demands***	
2.1	CHPP	• Supplied from RWD and TSF1
2.2	Haul road dust suppression	• Supplied from STD and North Fill Point
2.3	Vehicle washdown	• Supplied from RWD
3.0	***Open-cut operations***	
3.1	Mining pit	• Receives groundwater inflows at the estimated rates shown in Section A7. • Continuous dewatering to STD at a maximum rate of 100 L/s, or 180 L/s if the pit water inventory exceeds 50 ML.
4.0	***Water storages***	
4.1	RWD	• Existing mine affected water dam • Receives pumped transfers from STD, TSF1, NROM, SD1 and MWD • Pumps to STD as required at a maximum rate of 100 L/s • Can receive inflows from German Creek water supply • Supplies water to the CHPP and vehicle washdown demands • Overflows to Roper Creek
4.2	MWD	• Existing mine affected water dam • Receives pumped transfers from STD • Pumps to STD as required at a maximum rate of 100 L/s • Pumps to RWD (bypassing STD) • Supplies water to dust suppression demand • Can make controlled releases to Thirteen Mile Gully • Overflows to Thirteen Mile Gully
4.3	STD	• Existing mine affected water dam – will be replaced/relocated in Phase 3 at a location to be determined at a later date • Can receive pumped inflows from the Mining pit, RWD, MWD, SD3 and SD9 • Pumps to RWD, MWD and SD3 at a maximum rate of 100 L/s as required • Supplies water to dust suppression demand • Overflows to the Mining Pit
4.4	NROM	• Existing mine affected water dam • Pumps to RWD at a maximum rate of 100 L/s • Overflows to Roper Creek
4.5	SD1/SD1 Extension	• Existing mine affected water dam • Pumps to RWD at a maximum rate of 100 L/s • Overflows to Roper Creek (via SD1 Extension)
4.6	SD2	• Existing sediment dam • Pumps to SD3 at a maximum rate of 100 L/s • Overflows to Roper Creek
4.7	SD3	• Existing sediment dam • Pumps to STD at a maximum rate of 100 L/s • Receives pumped transfers from SD2 • Overflows to Roper Creek

Item	Node Name	Operating Rules
4.8	SD7	• Existing sediment dam • Pumps to SD10 at a maximum rate of 100 L/s • Receives pumped transfers from SD10 • Overflows to Drainage Line 3
4.9	SD9	• Existing sediment dam • Active only in Phase 1 • Pumps to STD at a maximum rate of 100 L/s • Overflows to Thirteen Mile Gully
4.10	SD10	• Existing sediment dam • Active only in Phase 1 and 2 • Pumps to SD7 at a maximum rate of 100 L/s • Overflows to Drainage Line 3
4.11	SD5	• Proposed sediment dam (to be constructed by Phase 2) • Overflows to Drainage Line 3
4.12	SD6	• Proposed sediment dam (to be constructed by Phase 2) • Overflows to Drainage Line 3
4.13	SD12	• Proposed sediment dam (to be constructed by Phase 2) • Overflows to Thirteen Mile Gully
4.14	SD13	• Proposed sediment dam (to be constructed by Phase 2) • Overflows to Thirteen Mile Gully
4.15	SD14	• Proposed sediment dam (to be constructed by Phase 2) • Overflows to Roper Creek
4.16	SD15	• Proposed sediment dam (to be constructed by Phase 3) • Overflows to Thirteen Mile Gully
4.17	TSF1	• Receives decant water from TSF2 (active flocc cells) • Supplies water to Raw Water Dam and the CHPP as required • Overflows to Roper Creek
4.18	TSF2	• A series of 4 flocc cells • Receives the tailings waste stream, where flocculant is added to remove water • Decant water is pumped to TSF1 temporarily, before being pumped to RWD and the CHPP as required • Overflows to Roper Creek
4.19	FC1/FC2	• Emergency flocc cells • Pumps to TSF1 at a maximum rate of 100 L/s • Overflows to Roper Creek
5.0	***Receiving waters***	
5.1	Roper Creek	• Receives storage overflows from RWD, SD1, SD2, SD3, SD14, TSF1, TSF2 and FC1/FC2
5.2	Thirteen Mile Gully	• Receives storage overflows from MWD, SD9, SD12, SD13 and SD15
5.2	Drainage Line 3	• Receives storage overflows from SD7, SD10, SD5 and SD6
6.0	***All storages***	• All storages and pits receive local catchment runoff and lose water through evaporation

B5 Catchment yield (AWBM) parameters

The OPSIM model uses the Australian Water Balance Model (AWBM) (Boughton, 2004) to estimate daily runoff from daily rainfall. The AWBM is a saturated overland flow model which allows for variable source areas of surface runoff.

The AWBM uses a group of connected conceptual storages (three surface water storages and one ground water storage) to represent a catchment. Water in the conceptual storages is replenished by rainfall and is reduced by evapotranspiration. Simulated surface runoff occurs when the storages fill and overflow. Figure A.8 shows a conceptual configuration of the AWBM model.

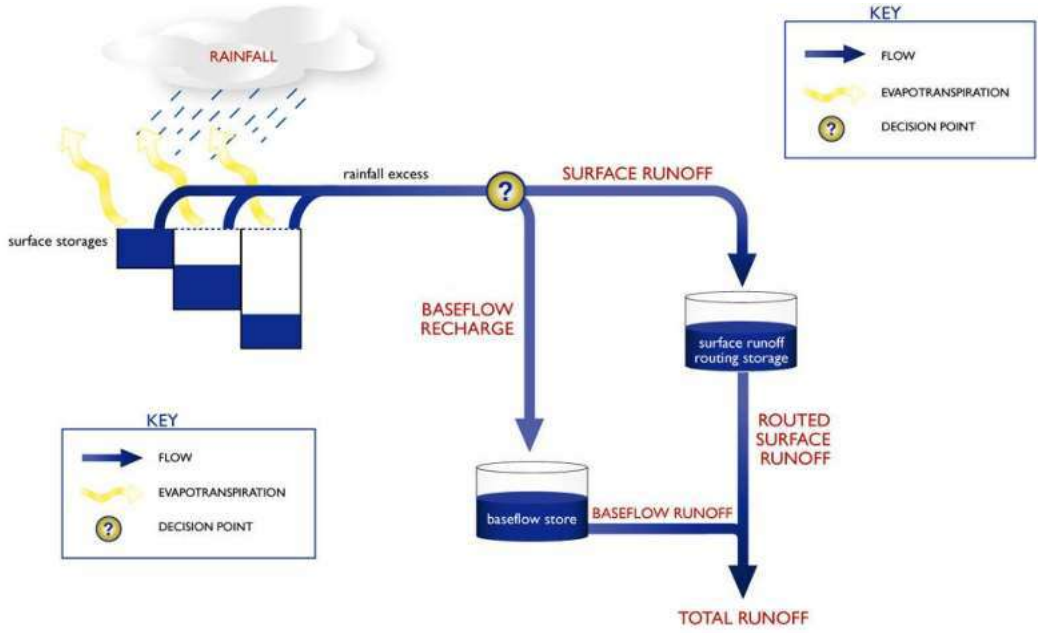


Figure B.8 – AWBM model configuration

The model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily balance of soil moisture. The model has a baseflow component which simulates the recharge and discharge of a shallow subsurface store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying by the contributing catchment area. The model parameters define the storage depths, the proportion of the catchment draining to each of the storages, and the rate of flux between them (Boughton & Chiew, 2003).

The adopted AWBM parameters for the various catchment types (given in Table A.4) on the mine site are shown in Table A.10.

Data was not available to calibrate the model for each of the individual on-site catchment runoff types. The AWBM model parameters were initially based on the latest Middlemount Coal Mine water balance model used as part of the North-eastern Extension Project (WRM, 2016). The adopted parameters were then adjusted so that the modelled MWD and mining pit inventory matched the recorded MWD and mining pit inventory.

The AWBM model was calibrated to recorded streamflow in Roper Creek as part of the EIS studies for the Stage 1 Middlemount Coal Mine. Details of this calibration can be found in WRM (2010).

To represent undisturbed areas on the mine site, the same parameters as Roper Creek were used, with the baseflow component removed, since baseflow is related to hydrological processes at a large scale. The simulated runoff coefficient for undisturbed areas expressed as a percentage was 6.5%, which is similar to the value for the Roper Creek catchment.

Disturbed catchments, which include hardstand, mining pit and tailings areas, are characterised by hard surfaces which inhibit water infiltration, resulting in much higher rates of surface runoff. To represent disturbed catchments, the depth of the model surface stores was substantially reduced and baseflow eliminated. The simulated volumetric runoff percentage for disturbed catchments was 39.5%, about 6 times higher than undisturbed catchments. This value is similar to typical values for urban catchments, which have similar characteristics.

The adopted model parameters for spoil dump areas have been based on the calibration outcomes presented in Table A.10. The simulated volumetric runoff percentage of 4.0% is slightly lower than undisturbed catchments.

Rehabilitated catchments have been assumed to have similar rainfall runoff characteristics as undisturbed catchments. We have adopted the 'undisturbed' parameter set for rehabilitated catchments. The adopted model parameters for cleared catchments have been selected based on experience with other coal mines in the area.

Table B.10 – AWBM parameters

AWBM Model Parameter		Roper Creek	Undisturbed catchments	Disturbed catchments	Spoil Dump	Rehab	Cleared
Surface Store Depth (mm)	C1	24	24	4	40	24	20
	C2	118	118	20	200	118	100
	C3	268	268	40	400	268	200
Partial Areas	A1	0.062	0.062	0.33	0.1	0.062	0.1
	A2	0.439	0.439	0.33	0.4	0.439	0.4
Base flow index	BFI	0.936	0	0	0.9	0	0
Base flow recession constant	Kb	0.53	0	0	0.8	0	0
Surface flow recession constant	Ks	0.73	0	0	0	0	0
Long-term runoff coefficient (%)	C_v	6.5%	6.5%	39.5%	4.0%	6.5%	9.5%

B6 Water demands

B6.1 COAL HANDLING AND PREPARATION PLANT (CHPP)

The projected annual coal production schedule at Middlemount Coal Mine over the Project life is summarised in Table A.11.

MCPL records CHPP water use as well as the volumes of water decant from the tailings disposal system and returned to the CHPP. The makeup water, supplied from the RWD, is the difference between the CHPP water use and the volume of water returned to the CHPP from TSF1. The tailings disposal system has been treated as a closed loop water circuit with the reuse of decant water taken into account with the provided CHPP water use data.

The adopted CHPP demand has been based on a net consumption rate of 113 L/ROM tonne (including return water from the TSF1), which is based on the historical net CHPP usage over 2016 and 2017. The forecast net CHPP consumption over the Project life is provided in Table A.11.

Table B.11 – Forecast annual production data and water usage

Phase	Year	CHPP production and water usage		
		Feed tonnage (Mt)	Net CHPP Usage (ML)	Net CHPP Usage (ML/day)
1	2018	5.46	617.7	1.69
	2019	5.39	610.0	1.67
	2020	5.09	575.6	1.58
	2021	5.38	609.4	1.67
2	2022	5.40	611.1	1.67
	2023	5.40	611.1	1.67
	2024	5.41	612.8	1.68
	2025	5.40	611.1	1.67
3	2026	5.40	611.1	1.67
	2027	5.40	611.1	1.67
	2028	5.41	612.8	1.68
	2029	5.40	611.1	1.67
	2030	5.40	611.1	1.67
4	2031	5.40	611.1	1.67
	2032	5.41	612.8	1.68
	2033	4.91	555.7	1.52
	2034	5.05	571.4	1.57
	2035	4.99	564.8	1.55
5	2036	4.75	537.5	1.47
	2037	2.82	318.9	0.87

B6.2 HAUL ROAD DUST SUPPRESSION

Mine site haul road dust suppression water is currently sourced from water cart fill points located at the MWD and STD. After the STD is mined through by Phase 3, dust suppression demand will be sourced from MWD or the STD replacement dam, at a location still to be determined. Dust suppression water is preferentially sourced from the lowest quality water that is available on site. This is controlled on a daily basis by site personnel. This has been represented in the water balance model by preferentially pumping water from the mining pit and MWD to the STD before pumping water from the sediment dams.

MCPL has supplied historical monthly dust suppression demand volumes based on truck fill counts and truck capacity over the period January 2016 to July 2017. MCPL also advised that there is also an approximate 25 ML/month of unmetered usage. The estimated average daily dust suppression demand over the period January 2016 to July 2017 was 3.05 ML/day, however the seasonal distribution of this demand varies.

Based on this information, the adopted average daily dust suppression water demand for each month is shown in Figure A.9.

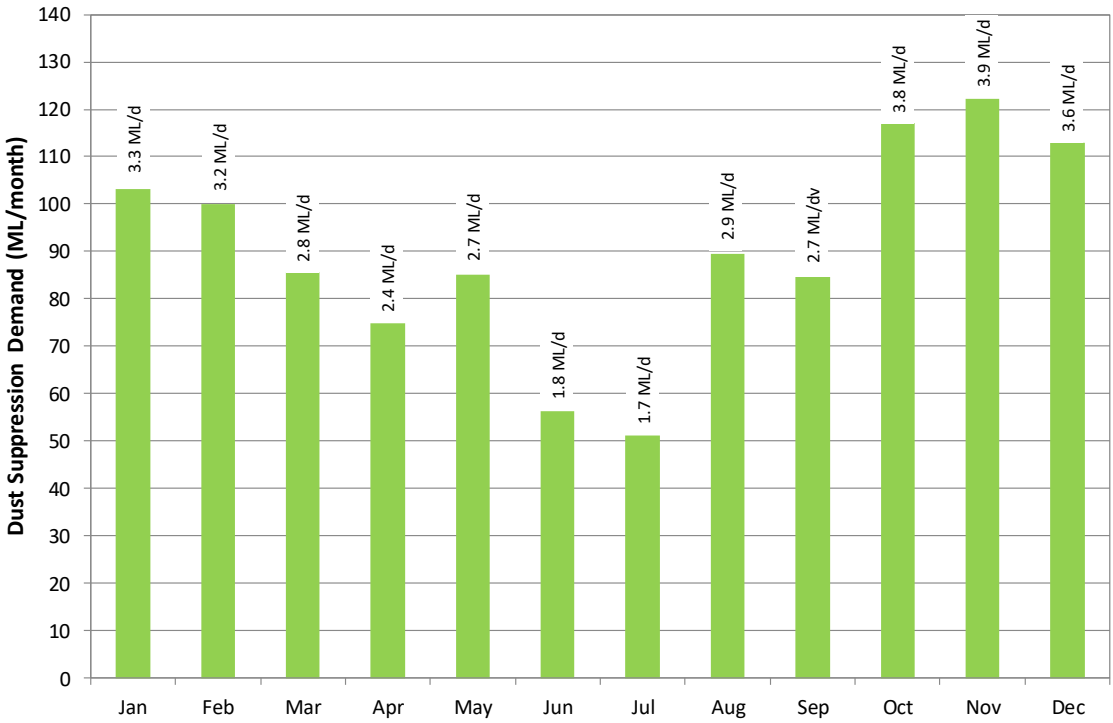


Figure B.9 – Adopted average monthly dust suppression demands

B7 Groundwater inflows

The adopted groundwater inflows to the open cut and underground mining areas are based on estimates provided by AGE (2018) and are summarised in Table A.12. No allowance has been made for residual groundwater losses associated with evaporation along the open cut face.

Table B.12 – Forecast groundwater inflows

Phase	Year	Total groundwater inflows	
		ML/year	ML/day
1	2018	605	1.66
	2019	837	2.29
	2020	605	1.66
	2021	819	2.24
2	2022	635	1.74
	2023	879	2.41
	2024	995	2.72
	2025	895	2.45
3	2026	845	2.31
	2027	799	2.19
	2028	642	1.76
	2029	510	1.40
	2030	828	2.27
4	2031	846	2.31
	2032	775	2.12
	2033	855	2.34
	2034	1,030	2.82
	2035	1,022	2.80
5	2036	640	1.75
	2037	266	0.73

B8 Model calibration

B8.1 MODEL OVERVIEW

Calibration of the Middlemount Coal Mine water balance model has been undertaken against recorded site data (including water storage volumes) over the period from January 2016 to August 2017. The model was configured to reflect the site operations during this period, with appropriate transfer rates, system configuration and water inflows and outflows. Site rainfall data was used for the calibration.

Calibration of the water balance model was undertaken against the recorded combined inventory for the MWD and the mining pit. To achieve a satisfactory calibration outcome, changes to a number of the previously adopted AWBM rainfall runoff parameters were required.

B8.2 CALIBRATION RESULTS

The initial model run using the previously adopted AWBM parameters resulted in a significant difference between modelled and observed inventory. The model substantially overestimated the inventory, particularly during periods of high rainfall. This suggests that the AWBM parameters required adjustment to better match the observed inventory.

The following changes were made to the AWBM parameters:

- Increase in the soil moisture capacity for the disturbed land use;
- Increase in the soil moisture capacity for the pit land use; and
- Increase in the soil moisture capacity for spoil dump land use.

The observed and modelled inventory for the combined MWD and mining pit inventory is presented in Figure A.10, along with the site rainfall for the calibration period.

Review of Figure A.10 indicates the following:

- The simulated combined inventory generally reproduces the observed inventory fluctuations over the calibration period between January 2016 and March 2017.
- The modelled increase in inventory at the end of March 2017 (due to Cyclone Debbie) of around 350 ML is not as evident in the recorded inventories. During this period, only 50 ML of pit water was recorded.
- Given the magnitude of the rainfall at this time (around 165 mm over two days), the volume of water collected in-pit would likely have been significantly higher. It is possible that water was stored in-pit but was not recorded. This would potentially account for the differences in modelled and observed inventory.
- The calibration results are considered to be within reasonable bounds given the potential variability in mine affected water movements about the site and water losses, and the constraints imposed on the water balance model by the operational guidelines.

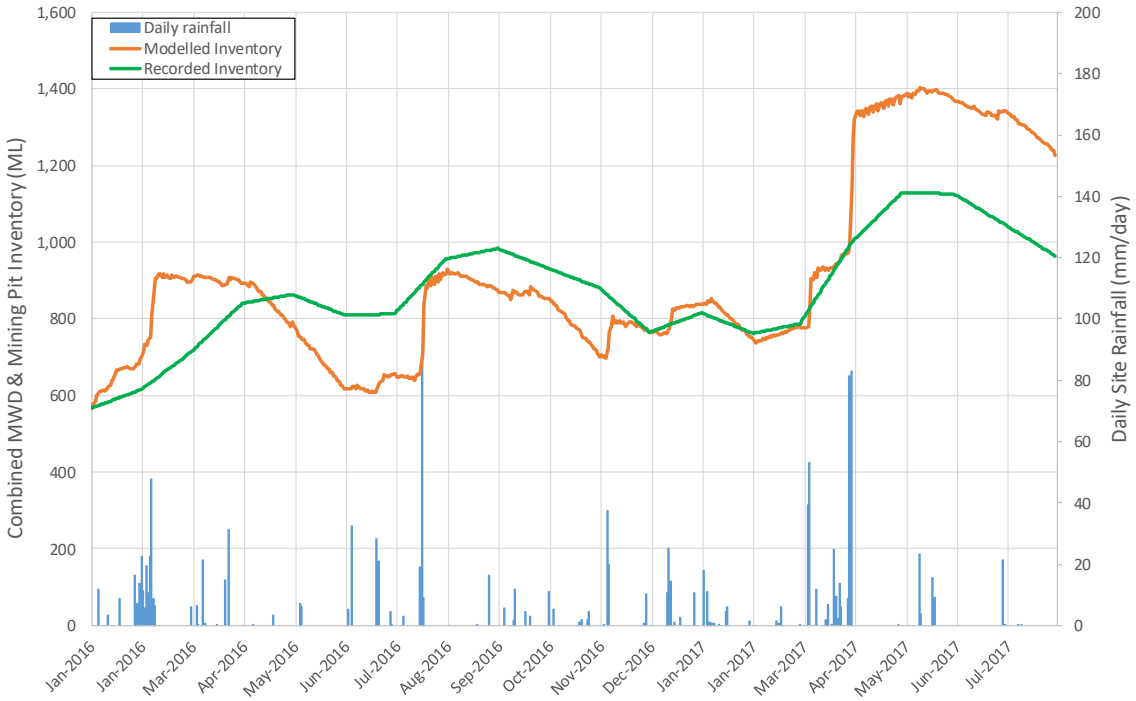


Figure B.10 – Model calibration – combined MWD and mining pit inventory

Appendix C – Existing conditions flood modelling

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C1 Introduction

This appendix outlines the development and calibration of the existing conditions hydrological and hydraulic models that have been developed of Roper Creek and Thirteen Mile Gully at Middlemount Coal Mine. These models have been used to estimate design discharges, flood levels, flood extents and velocities for existing conditions.

The hydrological and hydraulic models are based on the models previously developed for the Stage 1 and Stage 2 Environmental Assessments of Middlemount Coal Mine. These models have been refined to incorporate the Projects mine changes and have been calibrated to surveyed peak water level and rainfall data collected for the January 2013 ex-tropical cyclone Oswald event.

The calibration process used the recorded rainfalls to estimate discharges using the hydrological model. These discharges were then used in the hydraulic model to estimate peak water levels at surveyed water level locations.

C2 Hydrological modelling

C2.1 METHODOLOGY

The Unified River Basin Simulator (URBS) runoff-routing model (Carroll, 2004) was used to estimate flood discharges in the Roper Creek catchment. URBS is a runoff-routing computer model that uses a network of conceptual storages to represent the routing of rainfall excess through a catchment. URBS is used extensively throughout Australia by the Bureau of Meteorology (BoM) for flood forecasting on major river systems.

For this study, the URBS model was used in "split mode", which enables the simulation of separate catchment and channel routing. Adopted rainfall losses are subtracted from the total rainfall hyetograph to obtain rainfall excess. Rainfall excess is routed through a conceptual storage representing each sub-catchment of the model before being added to the creek or river channel. Routing through the creek or river system uses the Muskingum method.

C2.2 URBS MODEL CONFIGURATION

Figure B.1 shows the configuration of the URBS model. The model extends approximately 11.5 km upstream (west) of the Middlemount Coal Mine lease and consists of 20 sub-catchments. Summary details of sub-catchment areas are given in Table B.1.

Table C.1 – Adopted URBS model sub-catchment areas

Sub-catchment number	Area (km^2)	Sub-catchment number	Area (km^2)
1	46.1	11	8.8
2	26.4	12	8.4
3	26.7	13	7.9
4	8.9	14	4.7
5	36.9	15	9.8
6	59.3	16	3.4
7	29.0	17	1.4
8	20.2	18	4.5
9	24.7	19	2.6
10	18.7	20	8.9

C2.3 URBS MODEL CALIBRATION

C2.3.1 Methodology

The URBS model was calibrated to the recorded data available for the January 2013 ex-tropical cyclone Oswald event. Data was available for one stream gauge at the site; IMPAC1, located downstream of the Middlemount Coal Mine (see Figure B.1) as well as at a number of water level marks that were surveyed after the event. The hydraulic model, described in Section B.3 was used to derive a relationship between recorded water level and discharge at the IMPAC1 gauge.

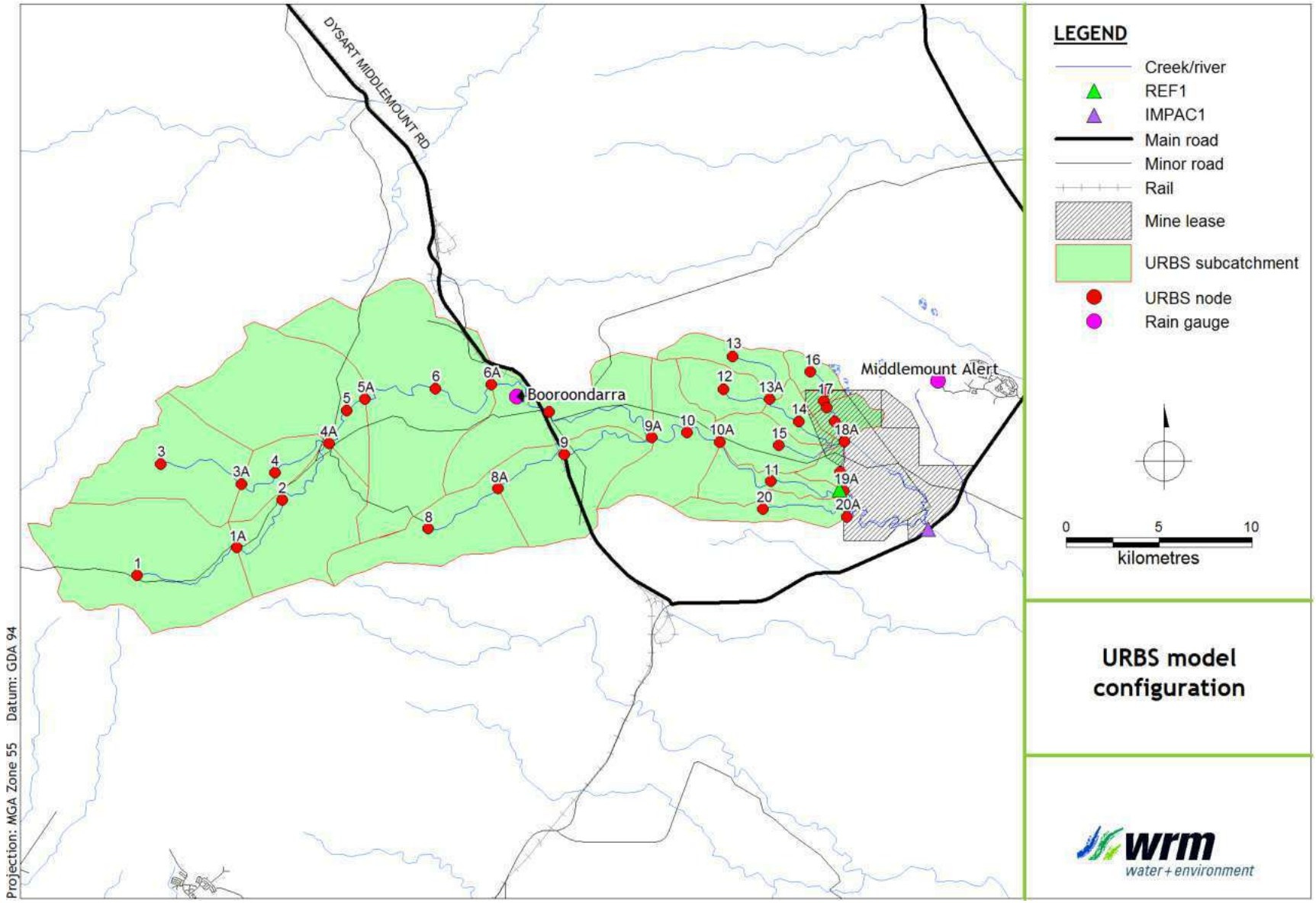


Figure C.1 – Roper Creek URBS model configuration

The calibration attempted to match the predicted and recorded flood peaks and volumes, and also the shape of the recorded and predicted hydrographs with a single (global) set of model parameters for the entire catchment. Each sub-catchment of the model was assigned the rainfall from the nearest rainfall station. A constant loss model (initial loss / continuing loss) was adopted uniformly for all sub-catchments.

C2.3.1 Available rainfall data

Rainfall data for the event was obtained from BoM rainfall stations in the vicinity of the Roper Creek catchment at the locations shown in Figure B.1 and listed in Table B.2.

Table C.2 – Rainfall data available for calibration events

Station no.	Station name	Observation interval	Recorded rainfall 3 days to 0900 hours 27 Jan 2013
035109	Booroondarra	Daily	258.6
534022	Middlemount Alert	Hourly	333.0

The Booroondarra daily rainfall was distributed using the hourly rainfall temporal pattern recorded at the Middlemount Alert station. The Booroondarra rainfall was adopted for the URBS subcatchments 1 to 9 and the Middlemount Alert rainfalls were adopted for the downstream subcatchments 10 to 20.

C2.3.1 URBS model parameters

The calibration of the URBS model was achieved by adjusting global parameters (**α, ß** and **m**) and adjusting initial and continuing rainfall losses to obtain the best fit between recorded and predicted discharge hydrographs. The adopted global URBS parameters and the initial and continuing losses for the January 2013 calibration event are shown in Table B.3. The initial loss rate reflects the antecedent conditions in the catchment prior the flood event.

Table C.3 – Adopted URBS model parameters

Parameter	Value
α (channel lag parameter)	0.4
ß (catchment lag parameter)	2
m (catchment non-linearity parameter)	0.7
Initial loss (mm)	105
Continuing loss (mm/hr)	3.5

C2.3.2 January 2013 calibration results

Figure B.1 shows a comparison of predicted and recorded flood discharge at the Middlemount Road (IMPAC1) station for the January 2013 calibration event. The magnitude of the peak discharge has been overestimated by the URBS model due to the volume of water that was lost entering the pit, however the timing and shape of the hydrograph are a relatively good fit.

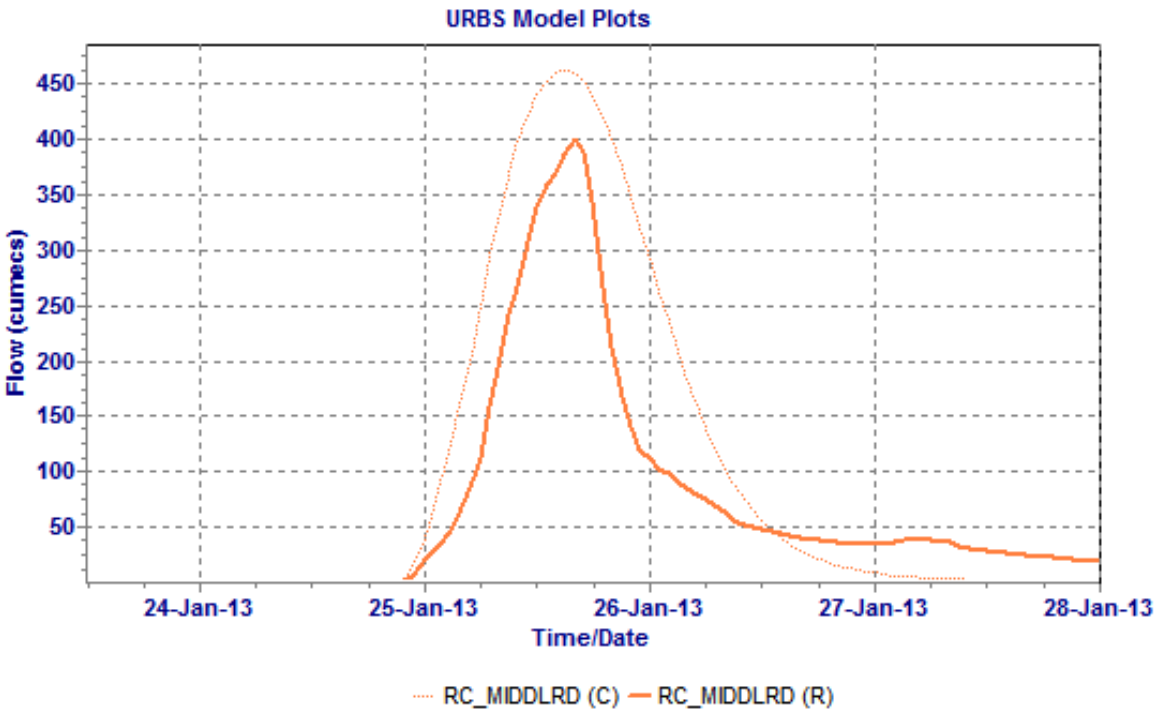


Figure C.2 – Comparison of calculated (C) and recorded (R) discharge hydrographs, Middlemount Road (IMPAC1 gauge), January 2013

C2.4 DESIGN DISCHARGES

The calibrated URBS model was used to estimate design flood discharges in Roper Creek in the vicinity of Middlemount Coal Mine for the 63%, 5%, 2%, 1%, 0.1% AEP events and for the PMF. The ensemble approach described in Australian Rainfall and Runoff (ARR) (Ball et al, 2016) was used to estimate design discharges. This method uses an 'ensemble' of 10 temporal patterns for each storm duration to derive a range of estimated flood peaks for each AEP. The magnitude of the design flood is then estimated from the weighted average of the flood peaks, where the weighting applied to each result reflects the relative likelihood of the selected input occurring. The 10 temporal patterns were obtained from the ARR data hub for events up to the 1% AEP event. Middlemount is located in the East Coast North Temporal Pattern region under the ARR.

For design events rarer than 1% AEP up to PMF, temporal patterns from Revised Generalised Tropical Storm Method (GTSMR) (BoM, 2005) were adopted, in accordance to ARR 2016.

C2.4.1 Design rainfalls

Table B.4 shows the design rainfalls for a range of storm durations for the Roper Creek catchment to Middlemount Coal Mine. Design rainfalls for events up to the 0.1% AEP event were obtained from the BoM. Rainfalls to estimate the PMF were determined using the Revised Generalised Tropical Storm Method (GTSMR) (BoM, 2005). Aerial reduction factors and rainfall losses (IL=49 mm CL=1.7 mm/hr), which were adjusted according to the median pre-burst depths and ratios, were obtained from the ARR data hub.

Table C.4 – Rainfall data available for calibration events

Duration (hours)	Design rainfall (mm)					
	63% AEP	5% AEP	2% AEP	1% AEP	0.1% AEP	PMP
6	57.2	110.4	133.2	150.6		
12	68.6	134.4	163.2	186.0	294.4	780.0
18	77.0	152.1	185.4	212.4	337.8	890.0
24	83.8	166.6	203.8	234.2	364.8	1000.0
36	94.7	189.4	233.3	269.3	416.8	1200.0
48	102.7	207.4	256.3	296.6	457.9	1390.0
72	115.2	234.0	290.2	336.2	514.8	1730.0
96	122.9	252.5	313.0	362.9	550.1	1940.0
120	128.4	265.2	328.8	379.2	571.2	2050.0

C2.4.2 Results

Figure B.3 to B.7 shows the distribution of peak discharges at Middlemount Coal Mine estimated from the ensemble of 10 temporal patterns for each storm duration and for each AEP. The distribution is represented as a box and whisker plot for each duration, which is a standardised way of presenting the distribution of data. For each duration, the rectangle box represents the 25%ile and 75%ile (1st and 3rd quartile, the interquartile range or IQR) bound of the estimate. The black horizontal line (whiskers) represents the upper and lower estimates for 1.5 times of the IQR. The red horizontal line within the box is the median value and the red dot represents the mean value. The peak discharges adopted from the analyses together with the critical duration and the adopted temporal pattern is shown in Table B.5.

Based on these results, the January 2013 event had an AEP of between 5% and 2% AEP.

Table C.5 – Roper Creek Design discharge at Middlemount Coal Mine

Event	Critical duration	Temporal pattern	Discharge (m^3/s)
63% AEP	72	8	65
5% AEP	24	3	374
2% AEP	24	10	550
1% AEP	24	3	689
0.1% AEP	18	7	1,283
PMF	24	3	4,250

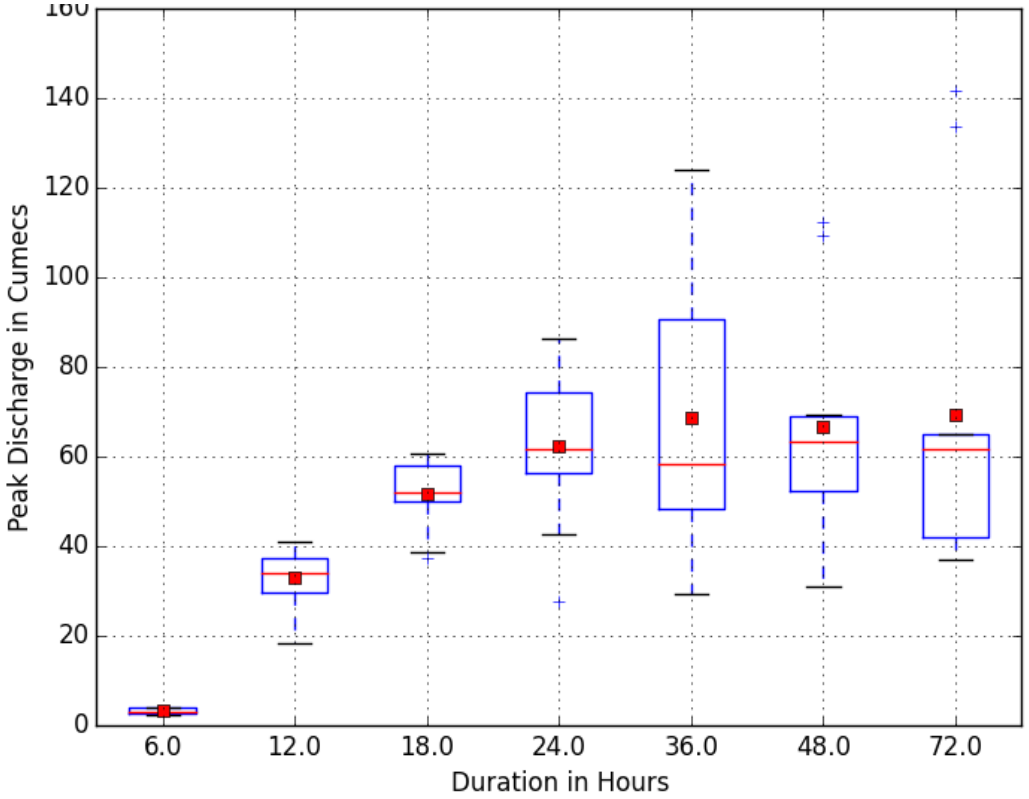


Figure C.3 - Roper Creek discharge box plots at Middlemount Coal Mine, 63% AEP event

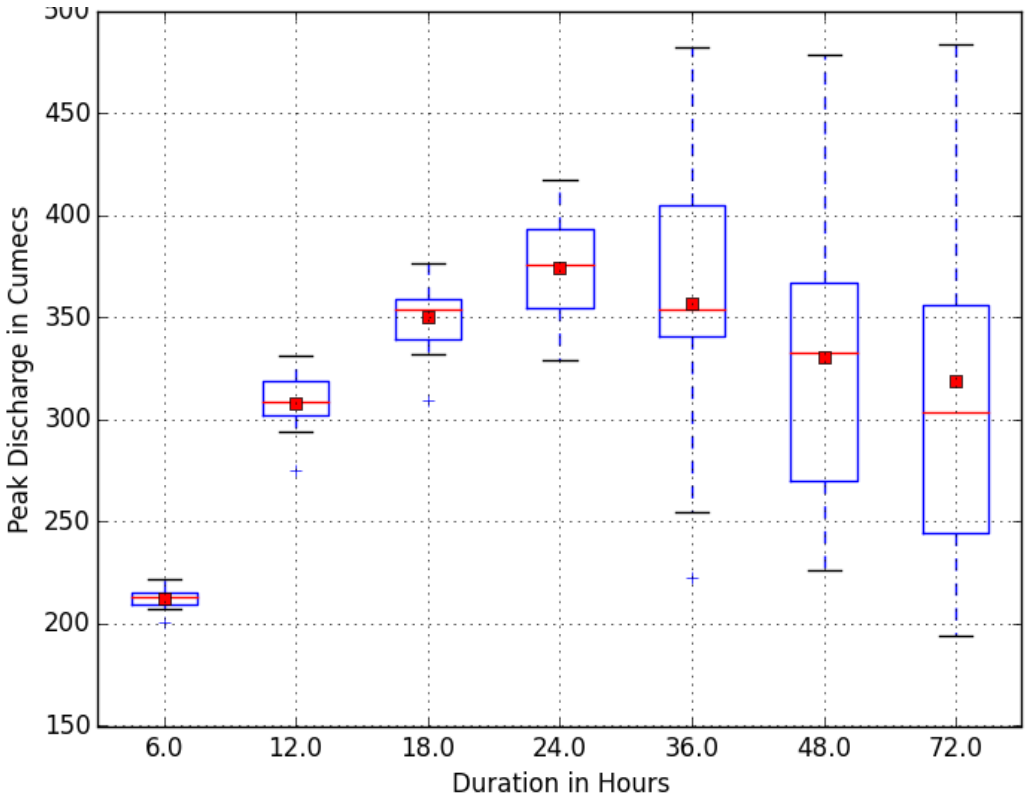


Figure C.4 - Roper Creek discharge box plots at Middlemount Coal Mine, 5% AEP event

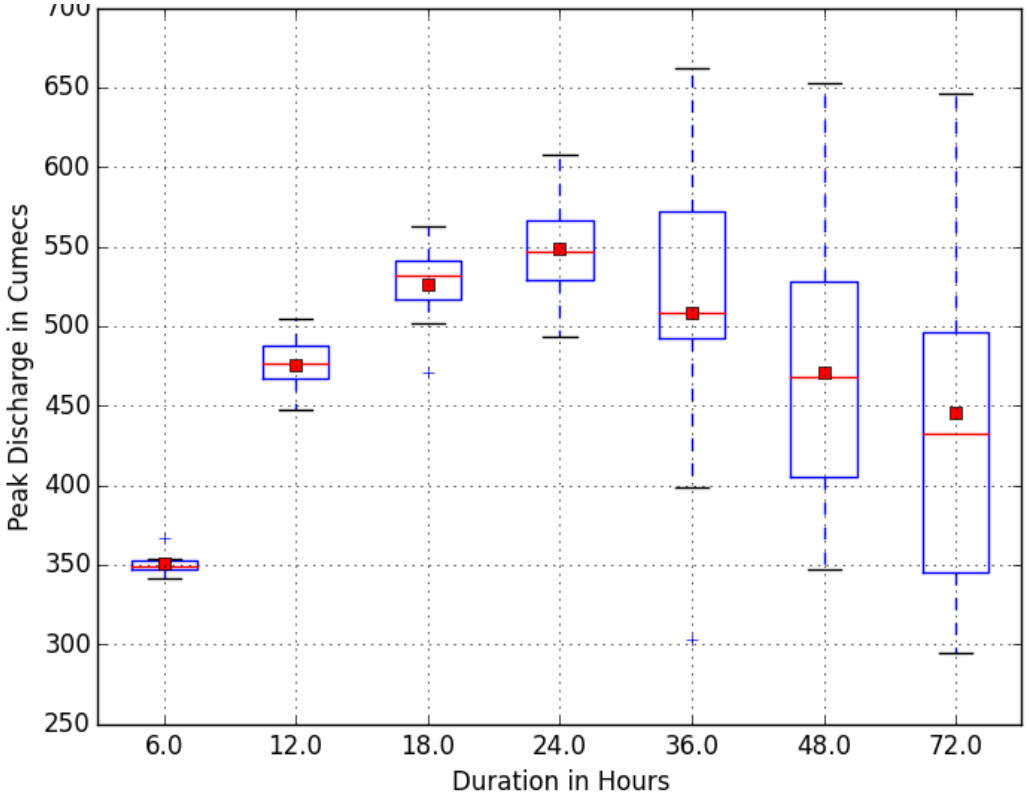


Figure C.5 – Roper Creek discharge box plots at Middlemount Coal Mine, 2% AEP event

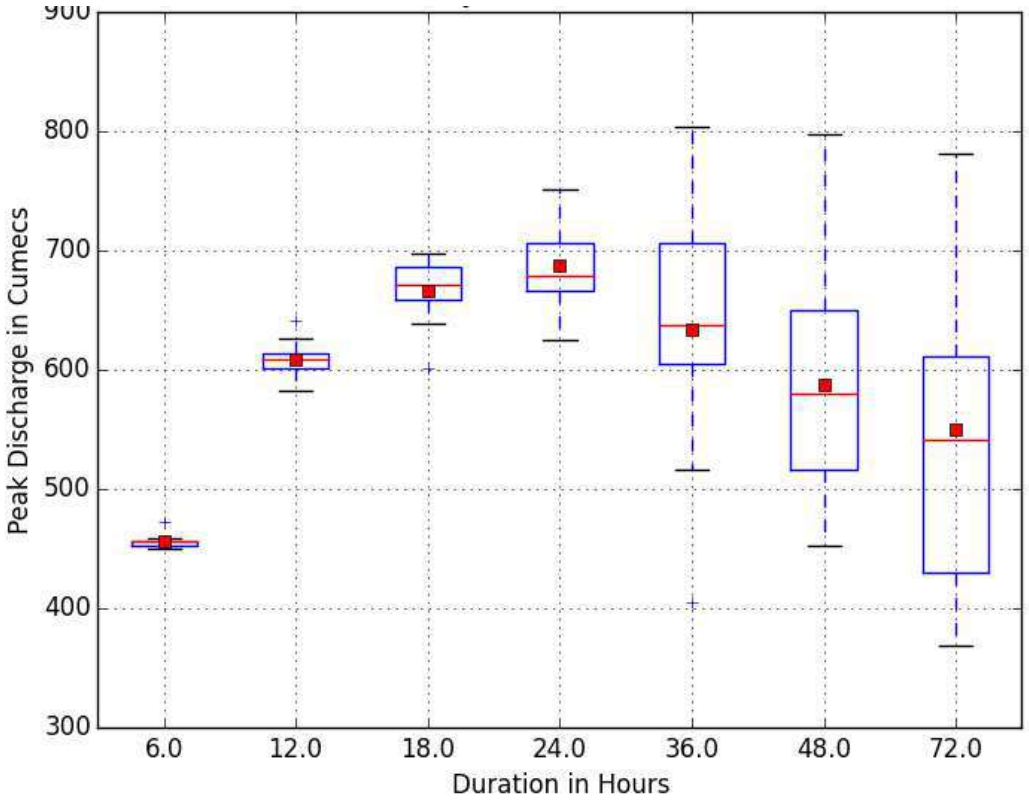


Figure C.6 – Roper Creek discharge box plots at Middlemount Coal Mine, 1% AEP event

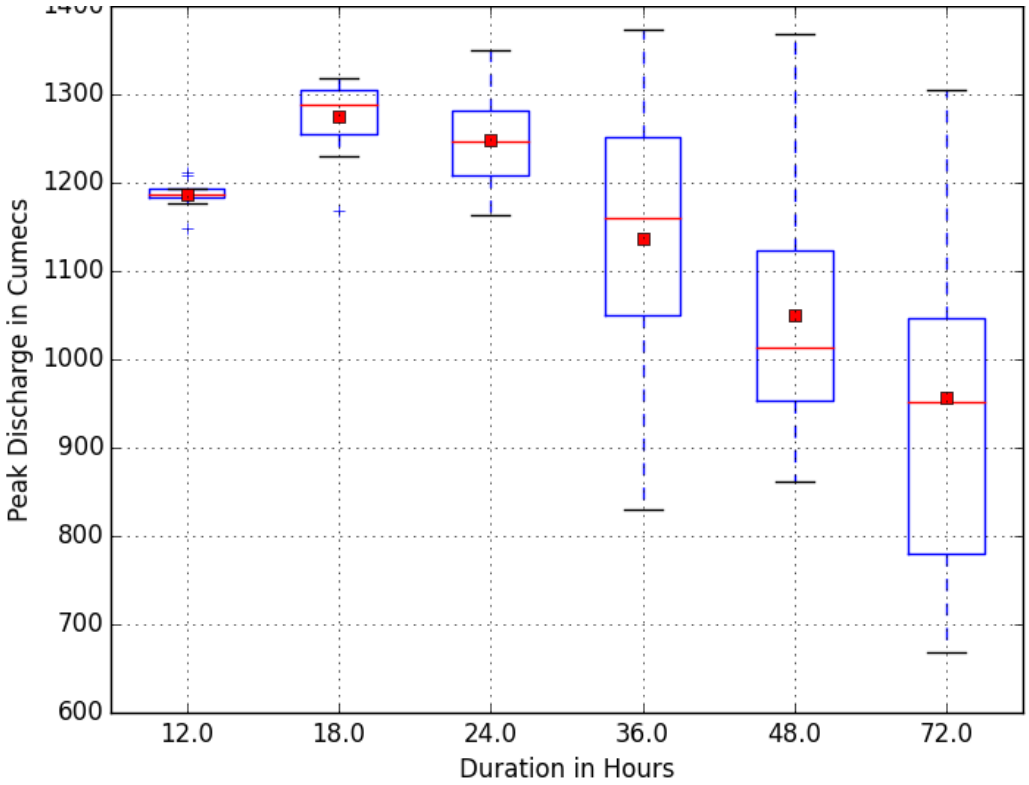


Figure C.7 – Roper Creek discharge box plots at Middlemount Coal Mine, 0.1% AEP event

C3 Hydraulic modelling

C3.1 GENERAL

The TUFLOW hydrodynamic model (WBM, 2016) was used to simulate the flow behaviour of Roper Creek and its tributaries at Middlemount Coal Mine. TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. The model automatically identifies breakout points and flow directions within the study area.

Modelling was undertaken for existing conditions as well as for the conditions that were in place during the January 2013 ex-tropical cyclone Debbie event. This has been used for model calibration.

C3.2 AVAILABLE TOPOGRAPHIC DATA

Topographic aerial survey data for the study area was provided by Middlemount Coal Pty Ltd. The underlying survey in the model area was performed in May/June 2008 and covers an area of some 90 km^2. Updated survey of the mine lease area was used as the primary ground level information across the mine lease for existing conditions and January 2013 conditions. The existing conditions mine survey was obtained in June 2017 and the January 2013 conditions was obtained in December 2012.

C3.3 MODEL CONFIGURATION

Figure B.8 and Figure B9 shows the extent of the existing conditions and January 2013 (calibration conditions) TUFLOW model. The location of the Roper Creek 1D channel and the location of the 1D and 2D inflow and outflow boundaries are also shown.

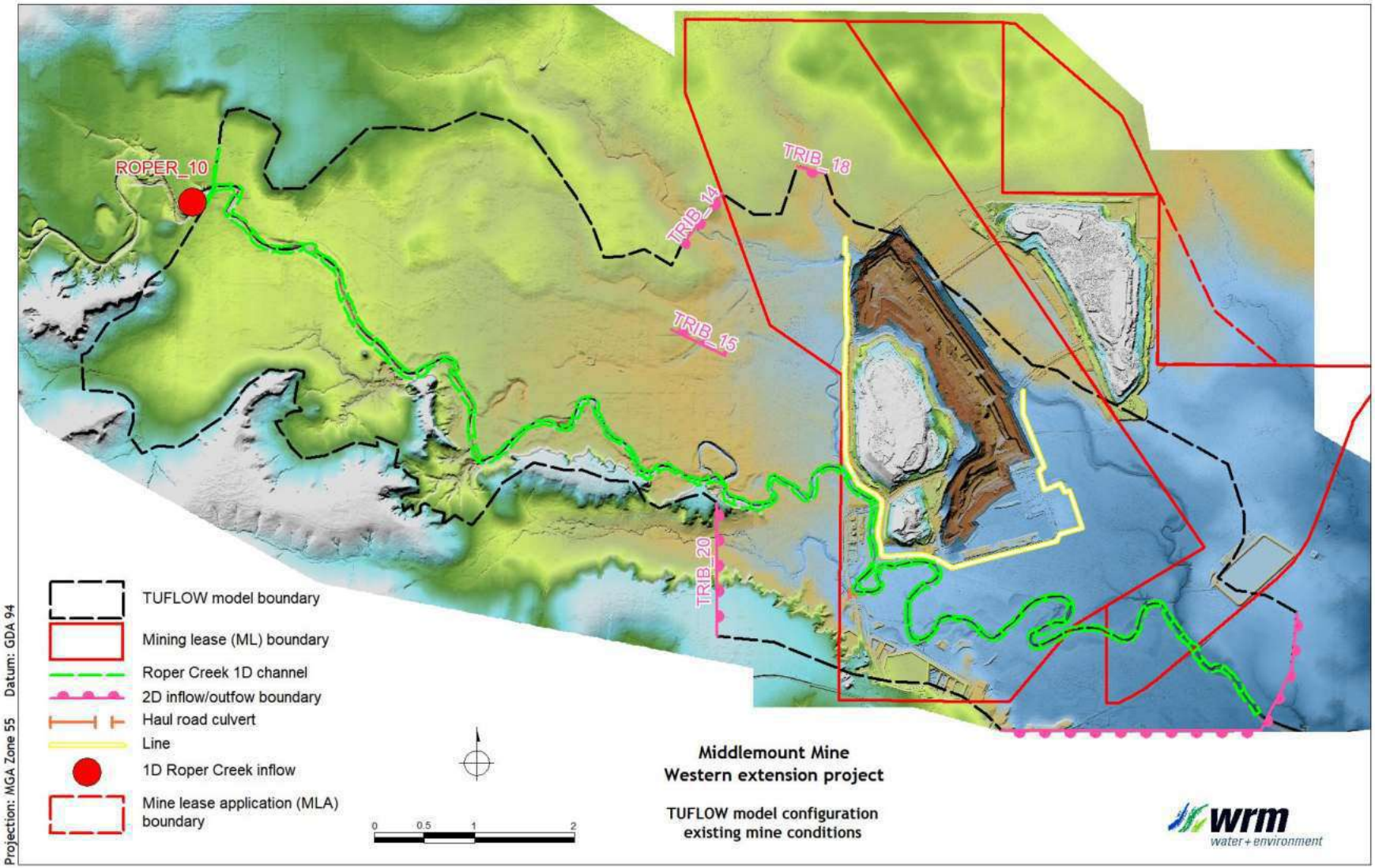


Figure C.8 – Existing Roper Creek TUFLOW model configuration

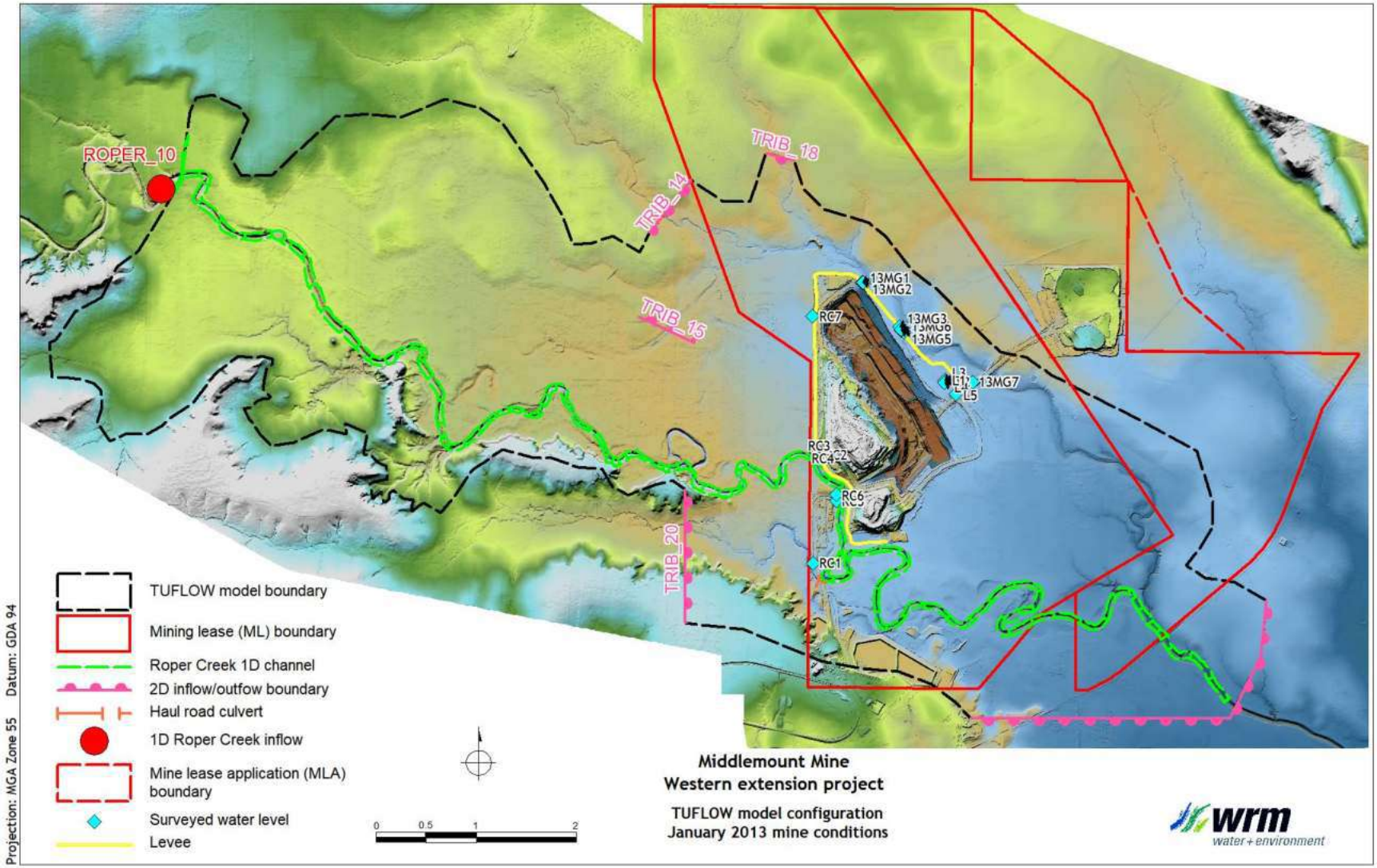


Figure C.9 – January 2013 Roper Creek TUFLOW model configuration

The modelled study area covers approximately 44.5 km^2, commencing approximately 11.5 km upstream of the mine lease area and extends to the east of the mine lease area to Middlemount Road. A 20 m grid size and 5 second time step were adopted for the two dimensional model areas.

C3.3.1 Roper Creek 1D channel

Roper Creek was modelled as a 1D channel carved through the 2D floodplain. Figure B.10 shows a conceptual illustration of the model representation of a typical section of Roper Creek and its floodplain.

The Roper Creek main channel is incised with a width of between 40 m and 80 m. The channel has significant flood capacity, ranging from Q10 to greater than Q100 at some locations. The storage and conveyance of the channel can be represented much more accurately in a 1D model. At some locations, the channel is perched above the floodplain, creating a natural levee along its banks.

A total of 106 cross-sections of the Roper Creek channel were generated from the survey Digital Elevation Model at an average spacing of 250 m. The MIKE 11 hydrodynamic 1D model was used to generate hydraulic information such as storage and conveyance data at each cross section location for input into the ESTRY model.

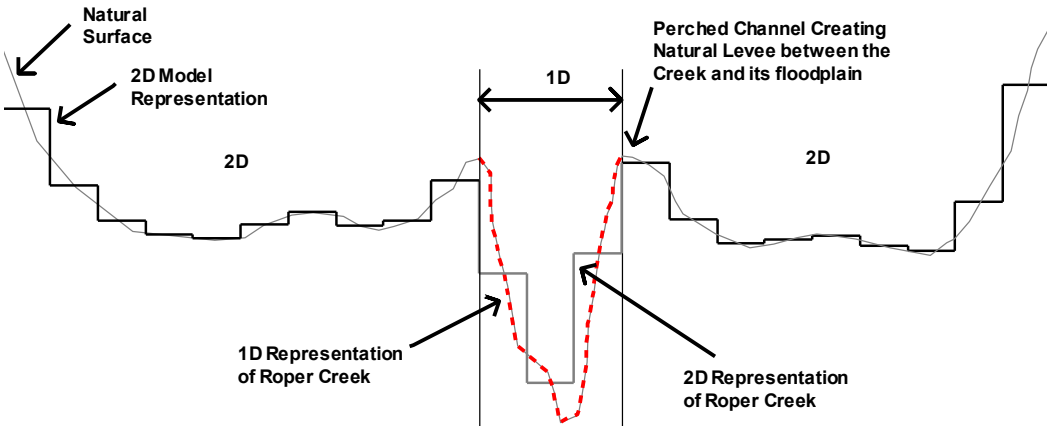


Figure C.10 – Typical cross-section of Roper Creek in 1D and floodplain in 2D (indicative)

C3.3.2 Adopted Manning's 'n' values

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness). Manning's 'n' values were initially selected based on typical published values (for example, those of Chow, 1959) and calibrated using recorded water level data in Roper Creek. The adopted Manning's n values for the TUFLOW model are:

- Roper creek channel: 'n' = 0.045
- Overbank areas: 'n' = 0.06

C3.3.3 Road crossings

The Middlemount Road crossing of Roper Creek downstream of the mine is a bridge which spans the main channel. The bridge forms only a very minor constriction to flood flows and has minimal impact on flow behaviour. Hence, this crossing was not explicitly represented in the TUFLOW model.

The haul road crossing of Roper Creek consists of 4 x 2.5 m diameter corrugated metal pipes and has been represented within the 1D network.

C3.4 MODEL CALIBRATION

The TUFLOW model was calibrated to the recorded water level at the IMPAC1 stream gauge located at Middlemount Road and surveyed flood marks obtained for the January 2013 event. The locations of the gauge and the surveyed flood marks are shown in Figure B.9. Section B.2.3 provides the discharges derived for the event.

Figure B.11 compares the recorded and predicted water level hydrographs at the IMPAC1 gauge and Table B.6 compares the surveyed and predicted peak water levels across the mine. Overall, a good calibration was achieved for the event and is therefore suitable to estimated design flood levels for the various mine Phases.

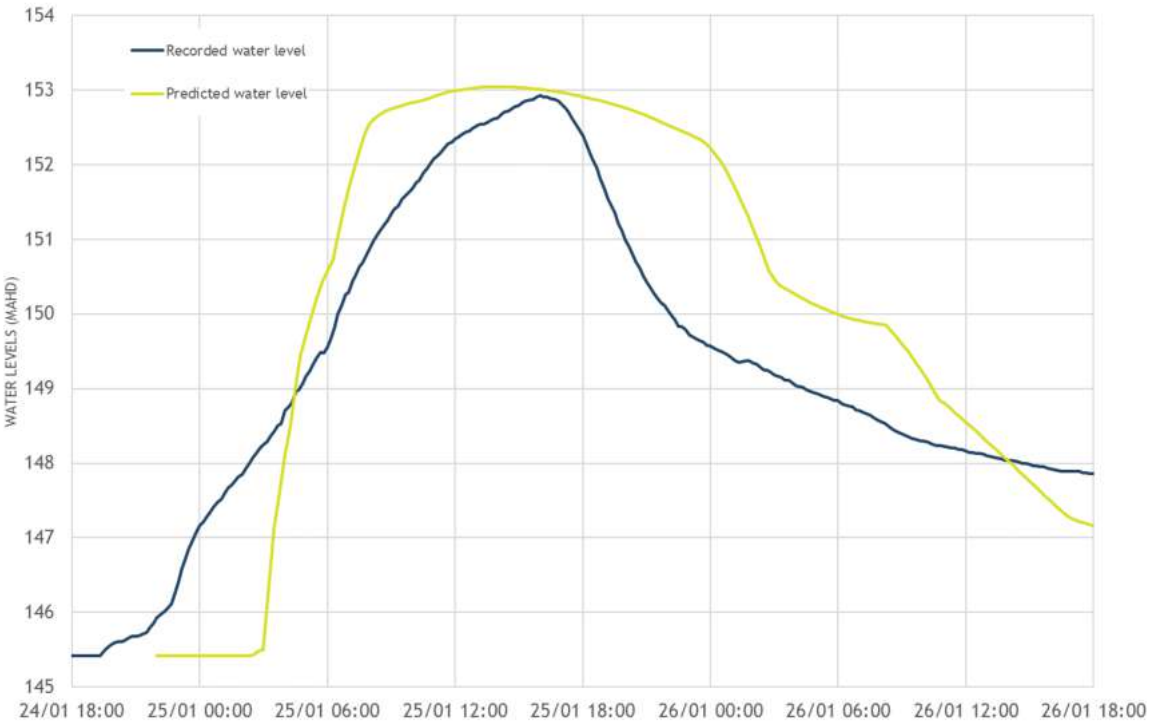


Figure C.11 – Recorded and predicted water level at the IMPAC1 gauge at Middlemount Road, January 2013 event.

Table C.6 – Comparison of surveyed and predicted flood levels, January 2013 event

Location	Surveyed (mAHD)	Predicted (mAHD)	Difference (m)
RC1	162.01	162.13	0.12
RC2	162.66	162.90	0.24
RC3	162.66	162.70	0.04
RC4	162.99	163.04	0.05
RC5	162.25	162.08	-0.17
RC6	162.26	162.32	0.06
RC7	161.79	162.20	0.41
13MG1	161.01	160.90	-0.11
13MG2	161.01	160.90	-0.11
13MG3	160.33	160.33	0.00
13MG4	160.82	160.78	-0.04
13MG5	160.83	160.77	-0.06
13MG6	160.83	160.71	-0.12
L1	160.70	160.76	0.06
L2	160.69	160.76	0.07
L3	160.75	160.76	0.01
L4	160.71	160.76	0.05
L5	160.76	160.76	0.00
13MG7	160.78	160.78	0.00

C3.5 EXISTING CONDITIONS FLOODING

Figure B.12 and Figure B.13 show the existing conditions flood levels depth and extent across the Project area for the 5% and 1% AEP event. The results show that the Roper Creek channel upstream of the Project area has capacity to convey the 5% AEP event. The channel overflows along the western boundary at the Thirteen Mile Gully diversion confluence for this event. The flood investigations undertaken for Stage 2 (WRM, 2010) show that the creek channel overflowed at this location prior to mining. The Roper Creek channel overflows upstream of the Project area for the 1% AEP event. The overflowing floodwater drains into Drainage Line 1, which then flows back to Roper Creek via the Thirteen Mile Gully diversion.

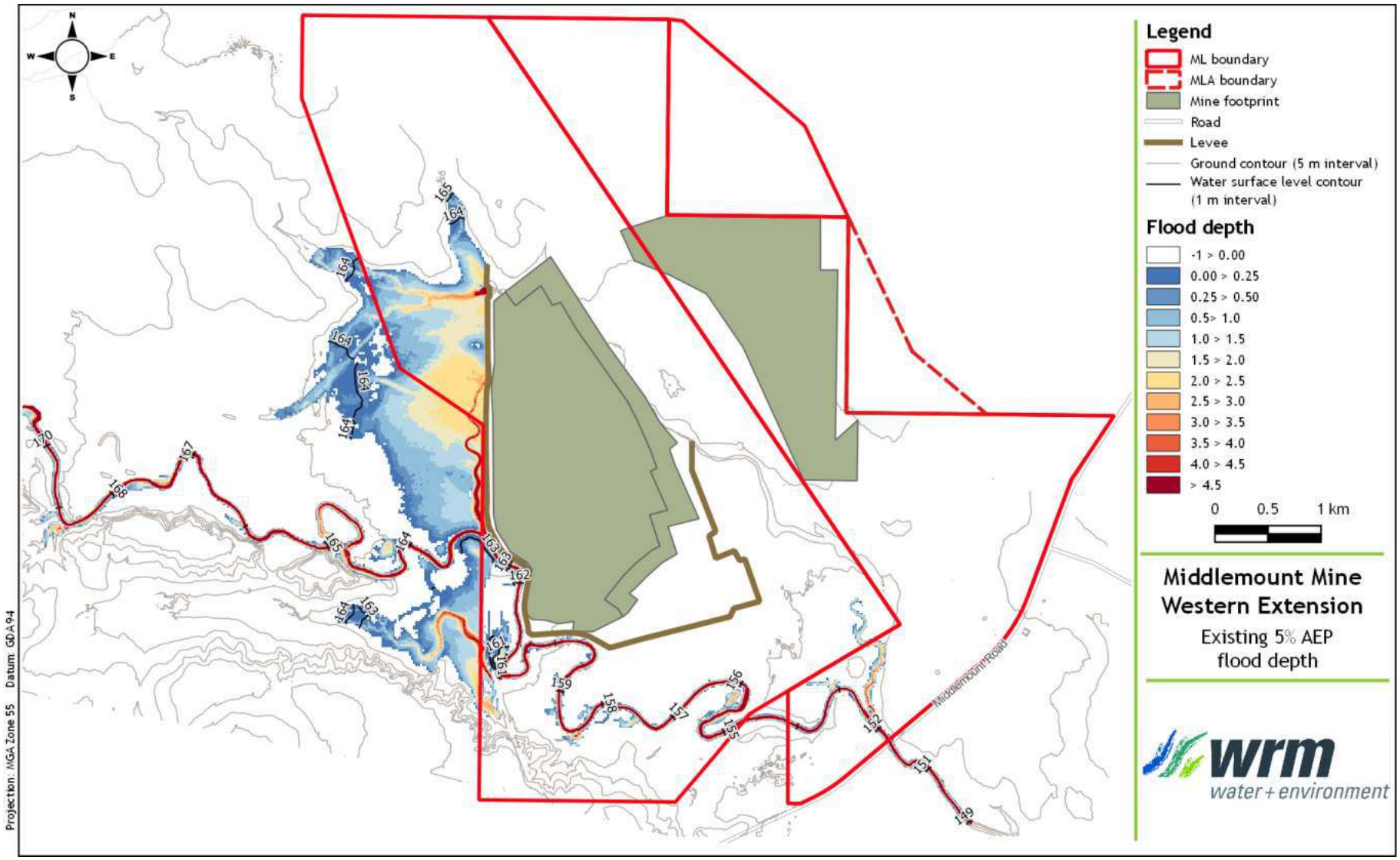


Figure C.12 – Existing conditions flood levels, depths and extent, 5% AEP event.

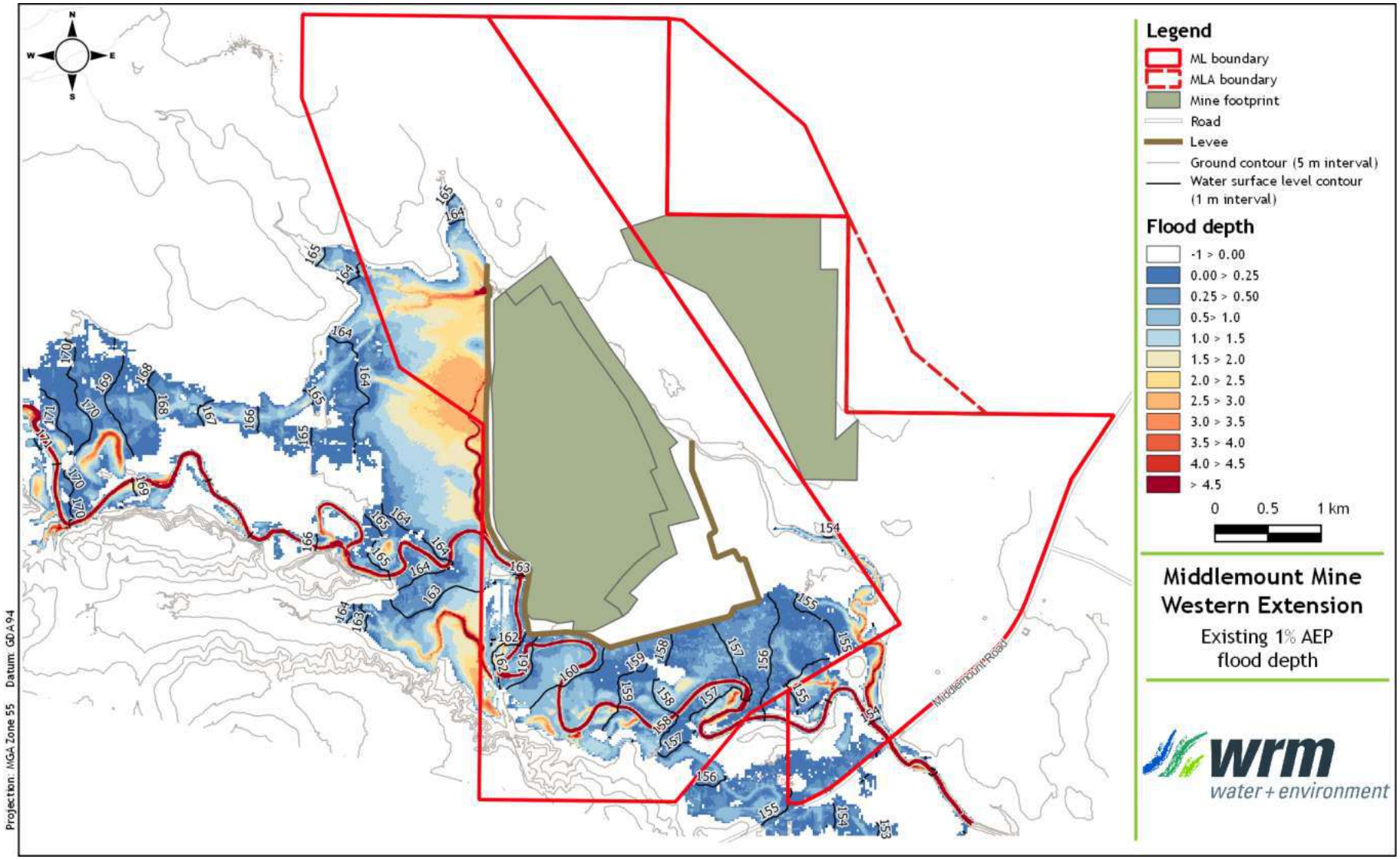


Figure C.13 – Existing conditions flood levels, depths and extent, 1% AEP event.

APPENDIX C

GROUNDWATER ASSESSMENT

Australasian Groundwater and
Environmental Consultants Pty Ltd



Report on

Middlemount Coal Mine Western Extension Project

Groundwater Assessment

Prepared for
Middlemount Coal Pty Ltd

Project No. G1840D September 2018
www.ageconsultants.com.au ABN 64 080 238 642

Document details and history

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Report on

Middlemount Coal Mine Western Extension Project
Groundwater Assessment

1 Introduction

Middlemount Coal Pty Ltd (MCPL) currently operates the Middlemount Coal Mine located approximately 3 kilometres (km) to the south-west of the Middlemount township within the Isaac Regional Local Government Area, Queensland. MCPL propose to seek Queensland Government and Commonwealth Government approval for changes to the approved Middlemount Coal Mine, herein referred to as the Western Extension Project (the Project). The location of Middlemount Coal Mine is shown in Figure 1.1.

The Middlemount Coal Mine currently operates under Environmental Authority (EA) EPML00716913 which permits those activities associated with mining to be undertaken within mining leases ML 70379, ML 70417, and ML 700014. The main activities associated with the development of the Project would include:

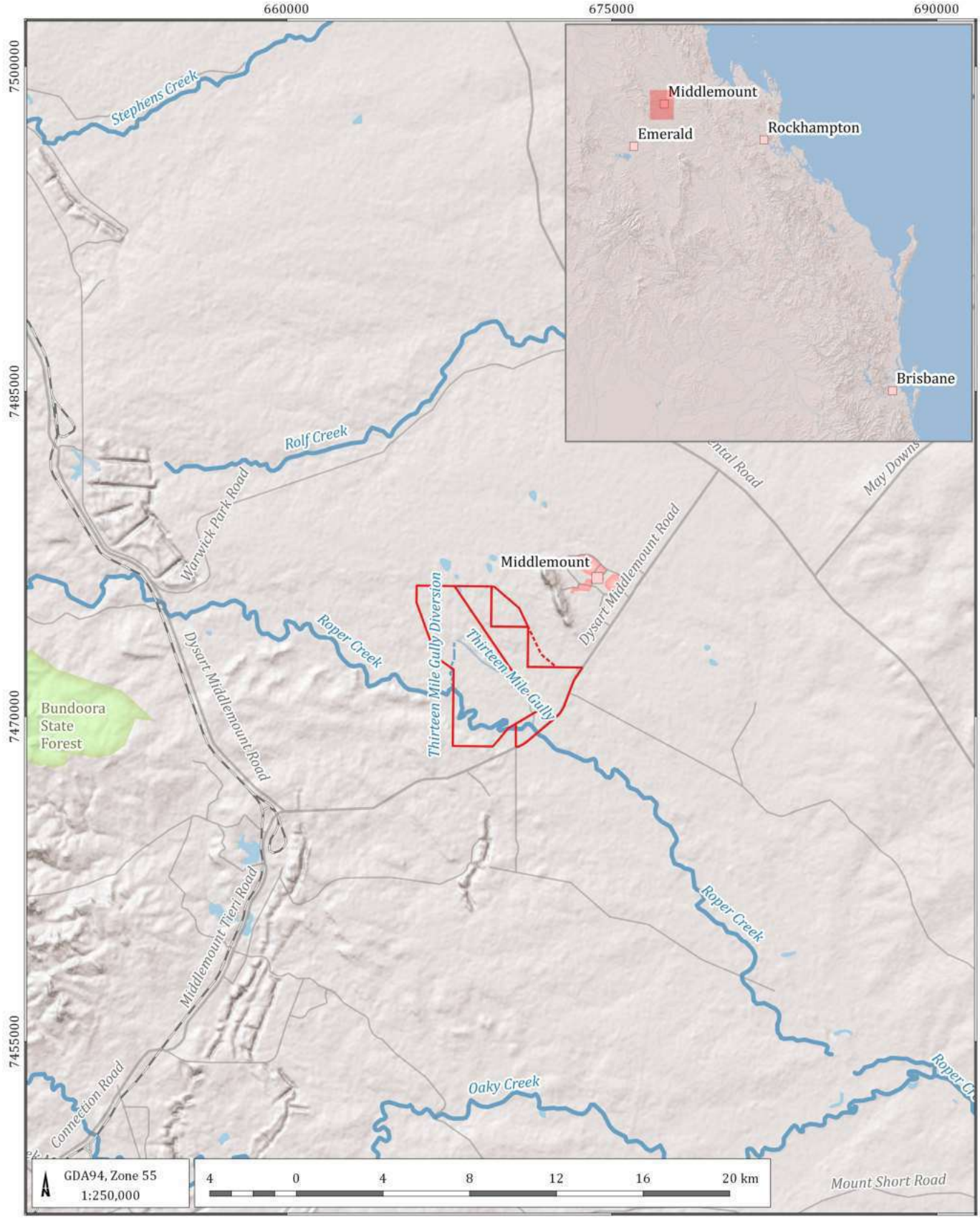
- extension of the open cut pit within ML 70379 to the north-west;
- continued extraction of run of mine (ROM) coal up to approximately 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (including the Eastern Dump) and within the mined-out void;
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure (including a coal handling and preparation plant [CHPP] and ROM and product stockpiles);
- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

The following groundwater assessment report has been produced by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to support the groundwater assessment for an EA amendment to the Project.

1.1 Scope of work and objective of report

The objective of this groundwater assessment report is to support the EA amendment application made by MCPL, by providing sufficient technical information about the Project activities and the potential impact to environmental values and groundwater quality. Amendments introduced by the *Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016* (EPOLA Act) have introduced new information requirements in the *Environmental Protection Act 1994* (EP Act), which require this groundwater assessment report to meet the requirements of sections 126A and 227AA of the EP Act.

The Department of Environment and Heritage Protection (DEHP, now The Department of Environment and Science [DES]) have produced a guideline that details the mandatory information that is required by the groundwater assessment (DEHP, 2016). Section 126A of the EP Act outlines a list of information requirements that must accompany a site-specific application where the resource activity or project involves the exercise of underground water (groundwater) rights.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Built up area
- Water area
- Reserve
- Road
- Watercourse
- Drainage feature
- Rail

Middlemount Coal Mine Western Extension Project (G1840D)

Middlemount Coal mine location

DATE 05/04/2018

FIGURE No: **1.1**

©2018 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/01.01_G1840D_Middlemount Coal mine location.qgs

Section 126A of the EP Act requires the groundwater assessment to include the following mandatory information:

- *state any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure;*
- *describe the areas in which underground water rights are proposed to be exercised;*
- *for each aquifer affected, or likely to be affected by the exercise of underground water rights, include-*
    - *a description of the aquifer;*
    - *an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water;*
    - *a description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights; and*
    - *the predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out.*
- *detail the environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values;*
- *detail any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out; and*
- *detail strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater.*

Section 227AA of the EP Act requires that this information also be included with an EA amendment application where the proposed amendment involves a change in the exercise of underground water rights.

1.2 Background to the report

A groundwater assessment was previously undertaken in 2010 (Parsons Brinkerhoff, 2010a) to support the Middlemount Mine Stage 2 project. Site specific hydrogeological, geological, and climatic data were used to inform the groundwater assessment. Additional data from the surrounding region was sourced from the Queensland Department of Natural Resources and Mines (DNRM) groundwater database (GWDB) and the Lake Lindsay Environmental Study – groundwater assessment (Parsons Brinkerhoff, 2010b), which was conducted immediately to the south of ML 70379 in 2005.

The groundwater data obtained from site were used to develop an eight-layer numerical groundwater flow model in 2010 (Parsons Brinkerhoff, 2010a). The model was used during the Middlemount Mine Stage 2 groundwater assessment to predict the rate of groundwater inflow to the open pit and the drawdown associated with mine dewatering.

The 2010 groundwater assessment concluded that shallow groundwater flow and recharge is expected to be limited by significant clay deposits within the alluvium and Tertiary units. Groundwater aquifers were identified with more sandy units where present within the Tertiary units, where groundwater was brackish to saline. Similarly, groundwater within the Permian strata is brackish to saline.

The 2010 groundwater model predicted:

- drawdown within the weathered Tertiary and weathered Permian zone would be limited in extent and during the active mining period is expected to remain within the Project boundaries;
- drawdown within the coal seams would propagate much further and was estimated to extend south of the Stage 2 mine area by up to 10 km during and post-mining; and
- the nearby creeks interact only intermittently with the groundwater system.

1.3 Report structure

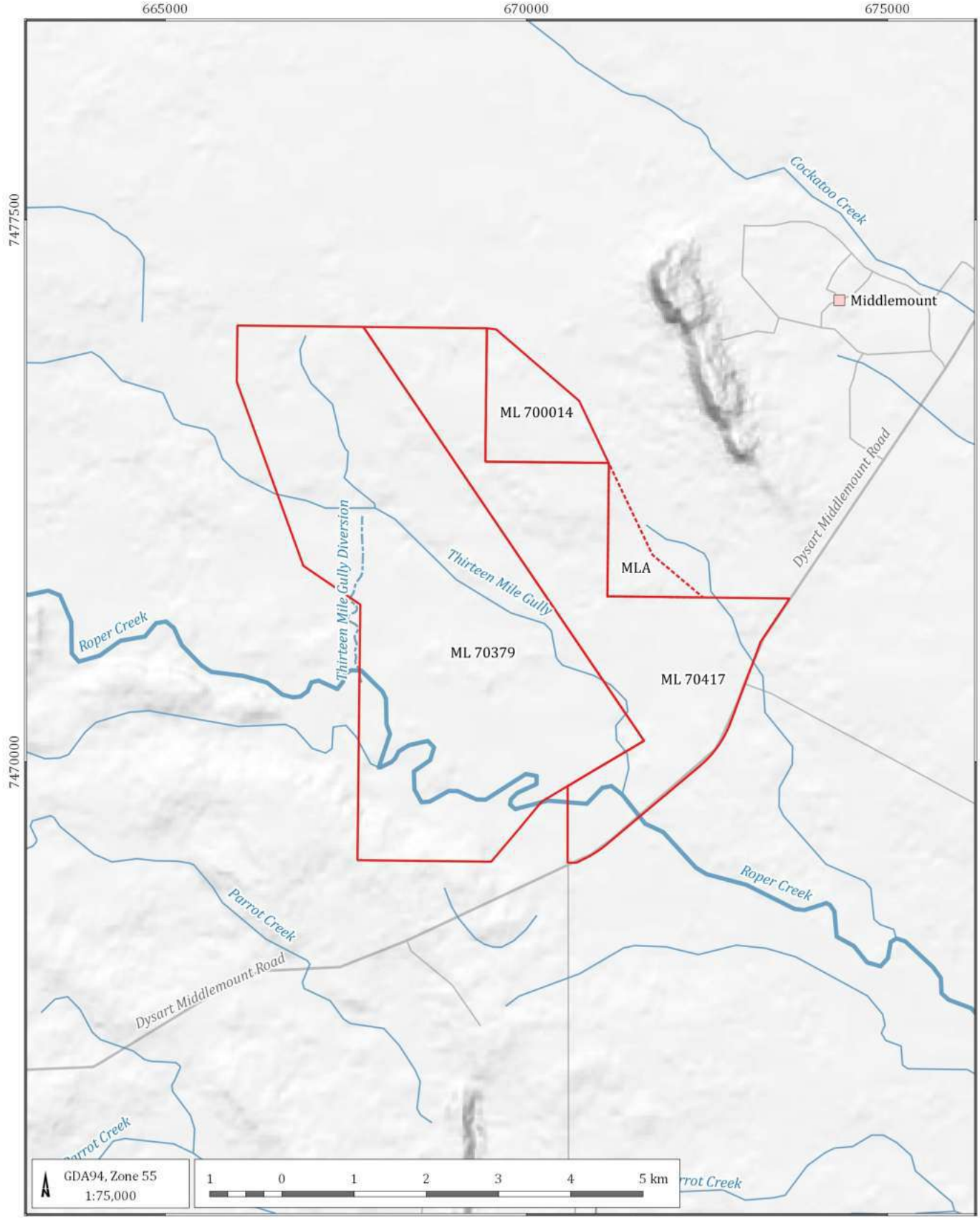
This report is structured as follows:

- **Section 1 – Introduction:** discusses the scope of the report and its objectives.
- **Section 2 – Mining history:** provides an overview of historical mining and the proposed mining activity within ML 70379, ML 70417, ML 700014, and MLA 700027.
- **Section 3 – Queensland regulatory framework:** summarises the Queensland groundwater legislation and policy relevant to the Project.
- **Section 4 – Environmental setting:** describes the climate, terrain, drainage, and land use within the study area.
- **Section 5 – Geology within study area:** describes the geological setting of the study area including the regional geology and local stratigraphy.
- **Section 6 – Conceptual groundwater model:** describes the groundwater regime surrounding the Middlemount Coal Mine including the Project.
- **Section 7 – Environmental value of groundwater:** describes the environmental values of the groundwater regime surrounding the Middlemount Coal Mine including the Western Extension Project.
- **Section 8 – Numerical Modelling:** details groundwater modelling completed for the assessment.
- **Section 9 – Groundwater monitoring strategy/program:** describes the proposed groundwater monitoring for the Project and provides recommendations for trigger levels.
- **Section 10 – Conclusions:** summarises the main aspects of the Project.
- **Section 11 – References:** lists the documents cited in this report.

2 Mining history

Stage 1 of the Middlemount Coal Mine was initially approved in 2009 for the production of 1.8 Mtpa ROM coal from ML 70379. The Middlemount Coal Mine EA was amended in 2012 to approve the expansion of open cut mining operations within ML 70379 and ML 70417, referred to as Stage 2 of the Middlemount Coal Mine. The currently approved Middlemount Coal Mine produces up to 5.7 Mtpa ROM coal.

Mining currently includes a single open cut operation within ML 70379 and an out of pit waste dump within ML 70417 and ML 700014 (Figure 2.1,).



LEGEND

- PopPlaces-clipped
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Major road
- Watercourse
- Drainage feature

Middlemount Coal Mine Western Extension Project (G1840D)

Middlemount Coal Mine-mining leases

DATE 05/04/2018

FIGURE No: **2.1**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/02.01_G1840D_Mining leases.qgs

3 Queensland regulatory framework for groundwater

The following sections summarise Queensland groundwater legislation and policy relevant to the Middlemount Coal Mine.

3.1 Acts, regulations, and plans

The *Water Act 2000*, supported by the subordinate *Water Regulation 2016* (Qld), is the primary legislation regulating groundwater resources in Queensland. The purpose of the *Water Act 2000* is to advance sustainable management and efficient use of water resources by establishing a system for planning, allocation, and use of water.

The water resource planning process provides a framework for development of catchment specific Water Resource Plans (WRP). A WRP provides a management framework for water resources in a plan area, and includes outcomes, objectives, and strategies for maintaining balanced and sustainable water use in that area. A Resource Operations Plan (ROP) implements the outcomes and strategies of a WRP.

Groundwater Management Areas (GMAs) and their component Groundwater Management Units (GMUs) are defined within a WRP. Authorisation is required from the DNRM to take water from a regulated GMA or GMU for specified purposes. The specified purposes are defined under a WRP, the *Water Regulation 2016,* or a local water management policy.

The *Water Reform and Other Legislation Amendment Act 2014* (Qld) (WROLA Act) was passed on 26 November 2014. The WROLA Act included a number of key changes to the *Water Act 2000*. However, commencement of these provisions was deferred under the *Water Reform and Other Legislation Amendment (Postponement) Regulation 2015* (Qld).

In November 2016, changes to the WROLA Act were made with the introduction of the *Water Legislation Amendment Act 2015* (Qld) and the EPOLA Act, which came into effect on 6 December 2016. The EPOLA Act amends the EP Act and *Water Act 2000* (Chapter 3), and aims to strengthen the powers of the DEHP in the environmental assessment process, as well as approval commitments to groundwater management.

The WROLA Act and the *Water Act 2000* bring the rights and obligations of ML and Mineral Development Licence (MDL) holders in respect of "associated water" in line with that existing for petroleum tenure holders under the petroleum legislation.

The changes establish a right for the holder of a MDL or ML to take or interfere with groundwater in the area of the licence or lease where the taking or interference happens during the course of, or results from, the holder's authorised activities (associated water).

MDL and ML holders are required to measure and report the volume of associated water taken and also advise the chief executive of the exercise of the holder's underground water rights immediately after the holder starts exercising those rights.

The exercise of these underground water rights is also subject to the holder complying with the obligations in the amended Chapter 3 of the *Water Act 2000,* which previously only applied to petroleum tenure holders, and has been amended to now also apply to mining tenure holders.

The aim of the Associated Water Licence (AWL) is to facilitate the management of the resource in terms of monitoring and mitigation requirements. In addition, AWLs also provide security (via make good clauses) to other parties potentially affected by the removal of groundwater from the aquifers.

3.2 Fitzroy Basin water resource and operation plans

The Middlemount Coal Mine is located within the Water Plan (Fitzroy Basin) 2011. This Water Plan applies to watercourses and lakes, water in springs, overland flow water, and groundwater. The area covered by the Water Plan (Fitzroy Basin) 2011 is shown on Figure 3.1.

The Water Plan (Fitzroy Basin) 2011 is divided into five GMAs. The Middlemount Coal Mine is located in the Highlands GMA (Figure 3.2). The WRP further divides the Highlands GMA into the following groundwater units:

- Highlands Groundwater Unit 1, containing Quaternary alluvium aquifers of Sandy Creek; and
- Highlands Groundwater Unit 2, containing all sub-artesian aquifers within the Highlands GMA other than the aquifers included in Highlands Groundwater Unit 1.

The Middlemount Coal Mine is entirely located within Highlands Groundwater Unit 2.

Section 116 (f) of the Water Plan (Fitzroy Basin) 2011 identifies that groundwater may be taken for stock and domestic purposes without an entitlement (i.e. water licence). Section 116 also identifies that an entitlement will be required for purposes other than stock or domestic purposes (i.e. mining use).



LEGEND

- Mining Lease (ML70379, ML700014, ML70379, MLA)
- Fitzroy Basin
- Weir
- Dam

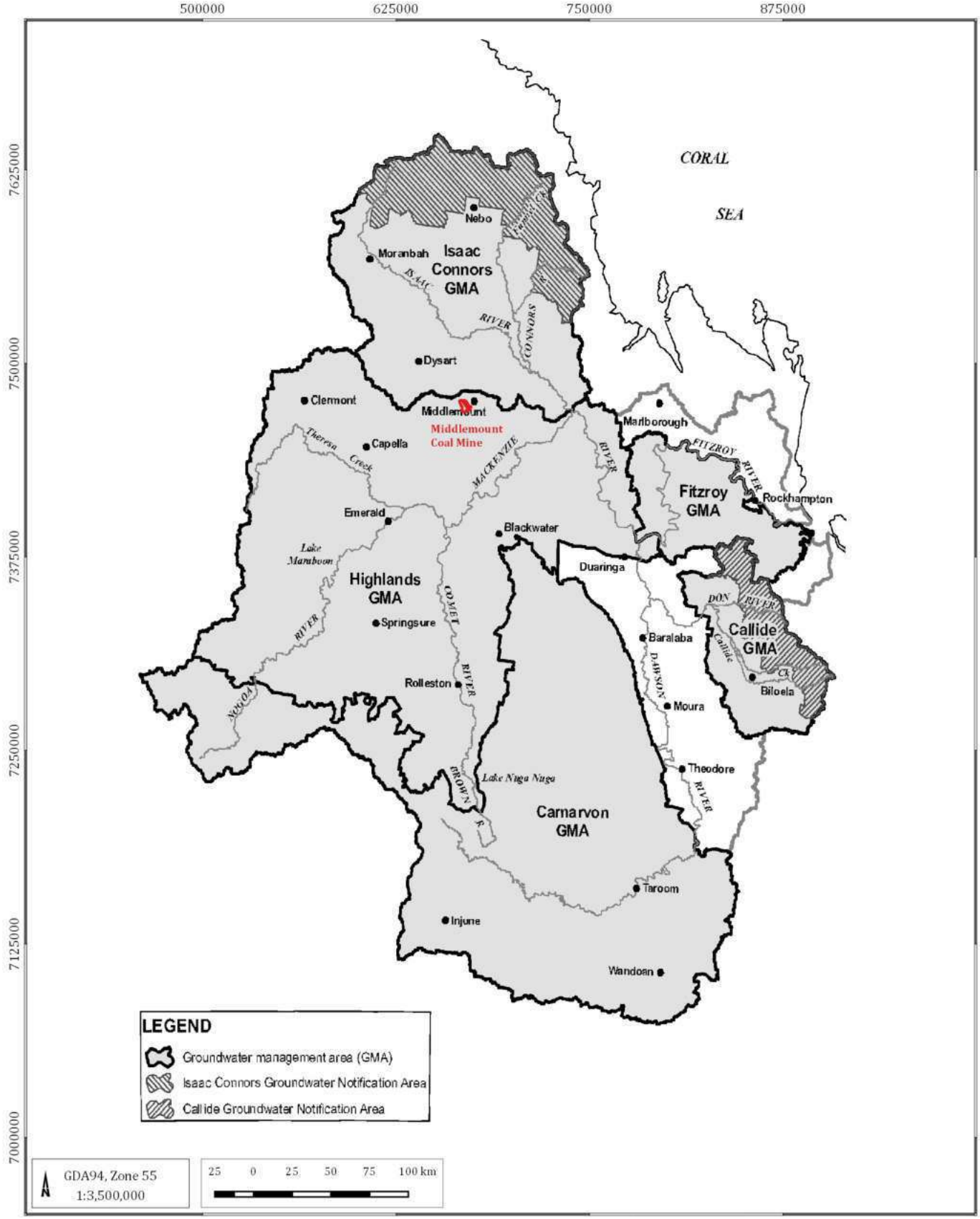
Middlemount Coal Mine Western Extension Project (G1840D)

Water Plan (Fitzroy Basin) 2011

DATE 05/04/2018

FIGURE No: **3.1**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/03.01_G1840E_Water Plan (Fitzroy Basin) 2011.qgs



LEGEND

Mining Lease (ML70379, ML700014, ML70379, ML700027, MLA)

Middlemount Coal Mine Western Extension Project(G1840D)

Highlands groundwater management area

DATE 05/04/2018

FIGURE No: **3.2**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/03.02_G1840D_Highlands groundwater management area.qgs

3.3 Queensland Environmental Protection Act 1994

The EP Act provides a regulatory framework for the protection and management of the Queensland Environment. The objective of the EP Act is to protect Queensland's environment while allowing for sustainable development.

The Environmental Protection (Water) Policy 2009 (EPP Water, [Queensland Government, 2009]) provides a framework to protect and/or enhance the environmental values and hence suitability of Queensland waters for various beneficial uses. Groundwater resources within the project area lie within the Mackenzie River Sub-basin as listed in Schedule 1 of the EPP Water. Schedule 1, Column 2 makes reference to a subordinate document prepared by DEHP (2011), which states that the environmental values for groundwaters within the Mackenzie River Sub-basin that need to be considered are for aquatic ecosystems, irrigation, farm supply/use, stock water, drinking water, industrial use, and cultural and spiritual values. The relevant local groundwater uses and associated values are described in Section 6.11.

The Water Quality Objectives (WQOs) specified by DEHP (2011) are "*numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated environmental values for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other inputs*".

The WQOs for Fitzroy Basin groundwaters are provided according to their chemistry zone and depth category (Table 14 of DEHP, 2011). In this instance, the chemistry zone that broadly covers the project area, which covers up-stream catchments of tributaries to the Mackenzie River, are classified as chemistry Zone 34 – characterised as "*Sodic sequence – saline: Na, Cl"* type water.

The groundwater WQOs for aquatic ecosystems in Zone 34 are summarised in Table 3.1 below.

Table 3.1 WQO (aquatic ecosystems) for groundwaters in the Mackenzie River sub-catchment (Zone 34)

Depth (±30 m)	Deep > 30 m			Shallow < 30 m		
Percentile	**20th**	**50th**	**80th**	**20th**	**50th**	**80th**
Electrical Conductivity (µS/cm)	3,419	6,100	16,000	498	2,150	8,910
Hardness (as $CaCO_3$)	359	919	3,208	163	674	2,228
pH	7.4	7.8	8.03	7.1	7.75	8.1
Alkalinity	156	275	536	154	435	752
Calcium	46	145	442	18	84	215
Magnesium	35	115	491	27	108	389
Sodium	480	1100	2,565	135	747	1,500
Chloride	753	1,900	5,905	171	1,309	3,185
Sulfate	25	138	398	12	140	318
Bicarbonate Alkalinity as $CaCO_3$	188	330	650	187	536	878
Nitrate	0.01	2.15	14.92	0	0.95	5.3

Depth (±30 m)	Deep > 30 m			Shallow < 30 m		
Percentile	**20th**	**50th**	**80th**	**20th**	**50th**	**80th**
Silica	16	25	36	21	36	52
Fluorine	0.02	0.155	0.4	0.1	0.28	0.5
Iron	0	0.05	0.246	0	0.03	0.14
Manganese	0	0.05	0.291	0	0.01	0.16
Zinc	0.01	0.025	0.317	0	0.015	0.06
Copper	0.017	0.03	0.03	0	0.01	0.03
Sodium Absorption Ratio	10.5	15.6	24.65	4.37	10.85	18.21
Residual Alkali Hazard (meq/L)	0	0.24	6.25	0	0	2.3
Redox (mV)	ID	ID	ID	ID	ID	ID

Notes: *All values as milligrams per litre (mg/L) unless specified.*
µS/cm = microsiemens per centimetre
meq/L = milliequivalents per litre
mV = millivolts
ID: insufficient data to perform statistical summaries, or the parameter was not tested

3.4 Environmental authority – groundwater conditions

Middlemount Coal Mine is currently authorised to operate as a mining project under the EA EPML00716913 dated 21 May 2018. The EA covers all of the Middlemount Coal Mine ML areas.

The purpose of the EA groundwater conditions is to ensure that any impacts of mining on the regional groundwater resources are appropriately monitored and managed. Groundwater conditions for Middlemount Coal Mine are contained in Schedule C (C33 to C41) of the EA, which are reproduced below in Table 3.2.

Table 3.2 Summary of the Middlemount Coal Mine EA groundwater conditions

Condition number	Condition
C32	**Groundwater** Groundwater affected by the mining activities must be monitored at the locations and frequencies specified in **Table C7: Groundwater Monitoring Locations and Frequency** for the parameters identified in **Table C8: Groundwater Investigation Trigger Levels**.
C33	The groundwater investigation trigger levels limit type "Median" referred to in **Table C8: Groundwater Investigation Trigger Levels** must be determined on the most recent three (3) consecutive routine monitoring samples.
C34	Subject to requirements of **Condition C32**, if the groundwater investigations trigger levels defined in **Table C8: Groundwater Investigation Trigger Levels** are exceeded then the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within twenty-eight (28) days of receiving the analysis result.

Condition number	Condition
C35	Groundwater levels affected by the mining activities must be monitored at the locations and frequencies defined in **Table C9: Groundwater Levels.**
C36	In the event that groundwater fluctuations exceed the groundwater level trigger values defined in **Table C10: Groundwater Level Trigger Values** at the groundwater monitoring locations nominated in **Table C9: Groundwater Levels**, an investigation must be undertaken within **fourteen (14) days** of detection to determine if the fluctuations are a result of: a) Mining activities; b) Pumping from licences bores; or c) Seasonal variation.
C37	If the results of the investigation undertaken in accordance with **Condition C36** identify that the groundwater fluctuations are a result of mining activities, the holder of the environmental authority must notify the administering authority and provide a copy of a report detailing the findings and outcomes of the investigation within **seven (7) days** of completing the investigation.
C38	The groundwater monitoring data must be reviewed on an annual basis. The review must include the assessment of groundwater levels and quality data, and the suitability of the monitoring network. The assessment must be submitted to the administering authority within **twenty-eight (28) days** of receiving the report.
C39	**Groundwater monitoring** The following information must be recorded in relation to all water sampling: a) The date on which the sample was taken; b) The time at which the sample was taken; c) The monitoring point at which the sample was taken; d) The results of all monitoring; e) Groundwater levels; and f) Sampling methodology.
C40	The method of water sampling required by this environmental authority must comply with that set out in the latest edition of the administering authority's *Water Quality Sampling Manual.*

Note: *Tables C7 to C10 are not provided here for brevity but can be viewed in EPML00716913.*

3.5 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Department of the Environment and Energy (DoEE). The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES). Under the 2013 amendment to the EPBC Act, impacts on groundwater resources were included, and are known as the 'water trigger'. The Project has been referred to the Commonwealth Minister for the Environment and has been determined to be a 'controlled action' under the water trigger provisions and will be assessed by preliminary documentation for approval under the EPBC Act.

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) is a statutory body under the EPBC Act that provides scientific advice to the Commonwealth Environment Minister and relevant state ministers. Guidelines have been developed in order to assist the IESC in reviewing Coal Seam Gas (CSG) or large coal mining development proposals that are likely to have significant impacts on water resources. A summary of the IESC guidelines and where they are addressed within the report is included in Appendix A.

4 Environmental setting

4.1 Climate and weather

4.1.1 Climate and weather data availability

The study area has a semi-arid to sub-tropical climate, typical for Central Queensland. The nearest Bureau of Meteorology (BoM) weather recording station with rainfall and pan evaporation data is the Clermont Post Office located in the township of Clermont. This station (#035019) is still open and has been in operation since 1870. The nearest BoM rainfall station is Booroondarra (#035109) which is located approximately 17 km west of the Project.

The Clermont Post Office weather dataset was complemented with data sourced from the Scientific Information for Land Owners (SILO) database. SILO is operated by the Queensland Department of Science, Information Technology and Innovation (DSITI), with data contributions from BoM.

The SILO database provides a weather record dataset which utilises neighbouring stations to infill missing data and accumulated days. The SILO dataset includes long-term rainfall, temperature, and evaporation readings from 1889 to present.

4.1.2 Rainfall and evaporation

Monthly interpolated rainfall, temperature, pan evaporation and evapotranspiration data was obtained from SILO for Middlemount Coal Mine and is presented in Table 4.1. It shows that majority of the annual total rainfall occurs in December and February. The mean annual rainfall is 616 millimetres (mm), while the evaporation rate is 2,027 mm and the potential evapotranspiration rate is 1,659 mm. That is, mean evaporation and evapotranspiration rates exceed rainfall for all months of the year.

Table 4.1 SILO climate averages for Middlemount Coal Mine 1901 - 2017

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total annual
Mean max temp (°C)	33.4	32.7	31.6	29.3	26.2	23.4	23.3	25.1	28.1	30.8	32.4	33.5	-
Mean rainfall (mm) -	111.8	98.1	65.8	32.1	28.9	29.9	23.7	18.0	17.4	34.9	57.0	98.0	615.7
Mean evaporation (mm)	224.6	183.4	190.8	150.1	117.7	96.3	104.2	131.2	170.4	208.0	219.2	230.5	2,026.5
Potential Evapotranspiration (mm)	175.1	144.6	147.2	120.9	98.3	80.8	89.4	111.2	138.3	170.1	177.5	185.7	1639.1

Figure 4.1 presents SILO rainfall data between 1901 and 2017, and the cumulative rainfall departure (CRD), also known as rainfall residual mass. The CRD can be used to identify periods of above average or below average rainfall for each month (cumulative departures from the arithmetic mean). A rising slope on the curve equates to a period of above average rainfall, while a falling slope shows to a period of lower than average rainfall. These trends indicate the cyclical nature of rainfall patterns for the Middlemount region. The CRD trends can also be used to assist in describing expected changes in regional groundwater levels. For example, below average rainfall can result in a lower groundwater table [e.g. prolonged dry/drought conditions and often corresponding increased anthropogenic use of groundwater], whereas above average rainfall can result in recovery (recharge) of the groundwater table/systems (e.g. wetter/surface flow conditions and often corresponding less anthropogenic use of groundwater).

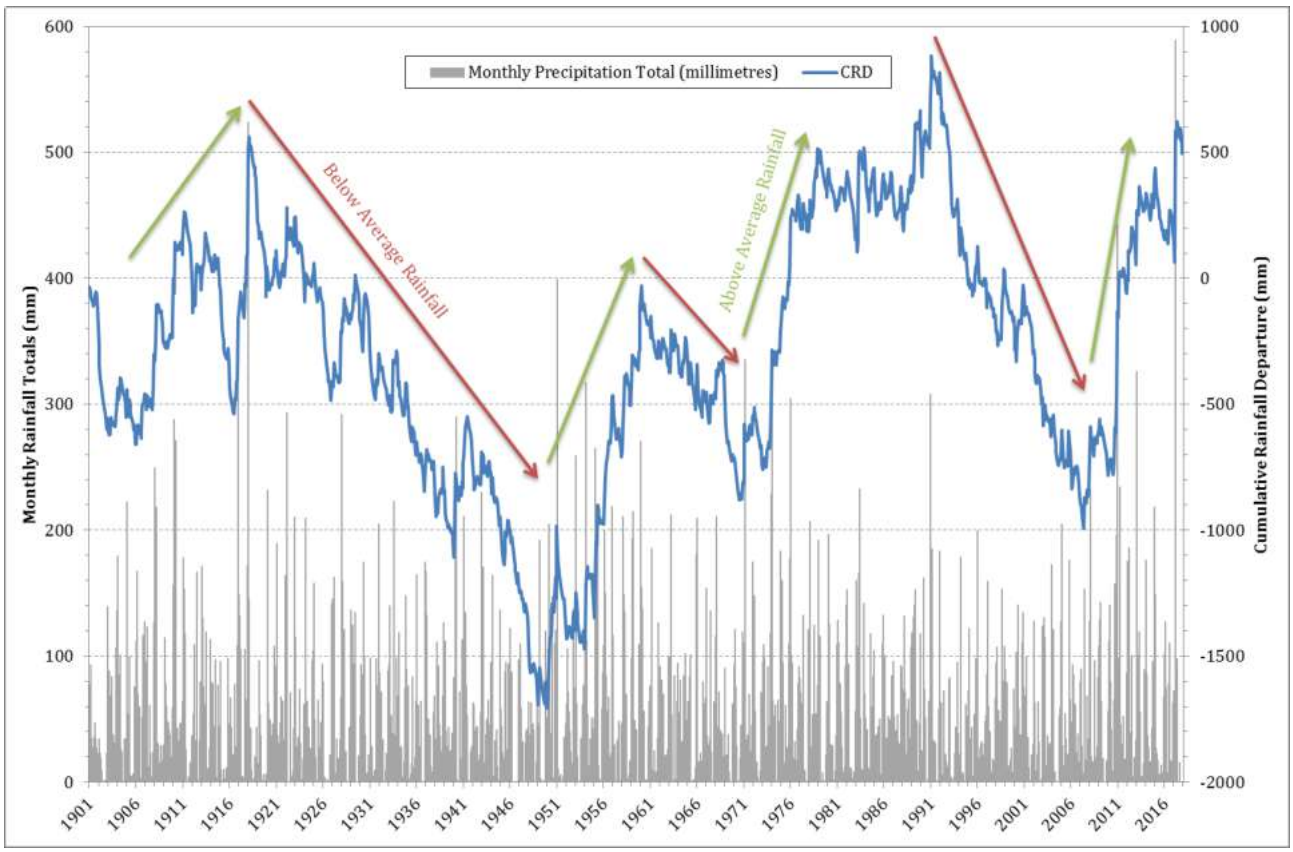


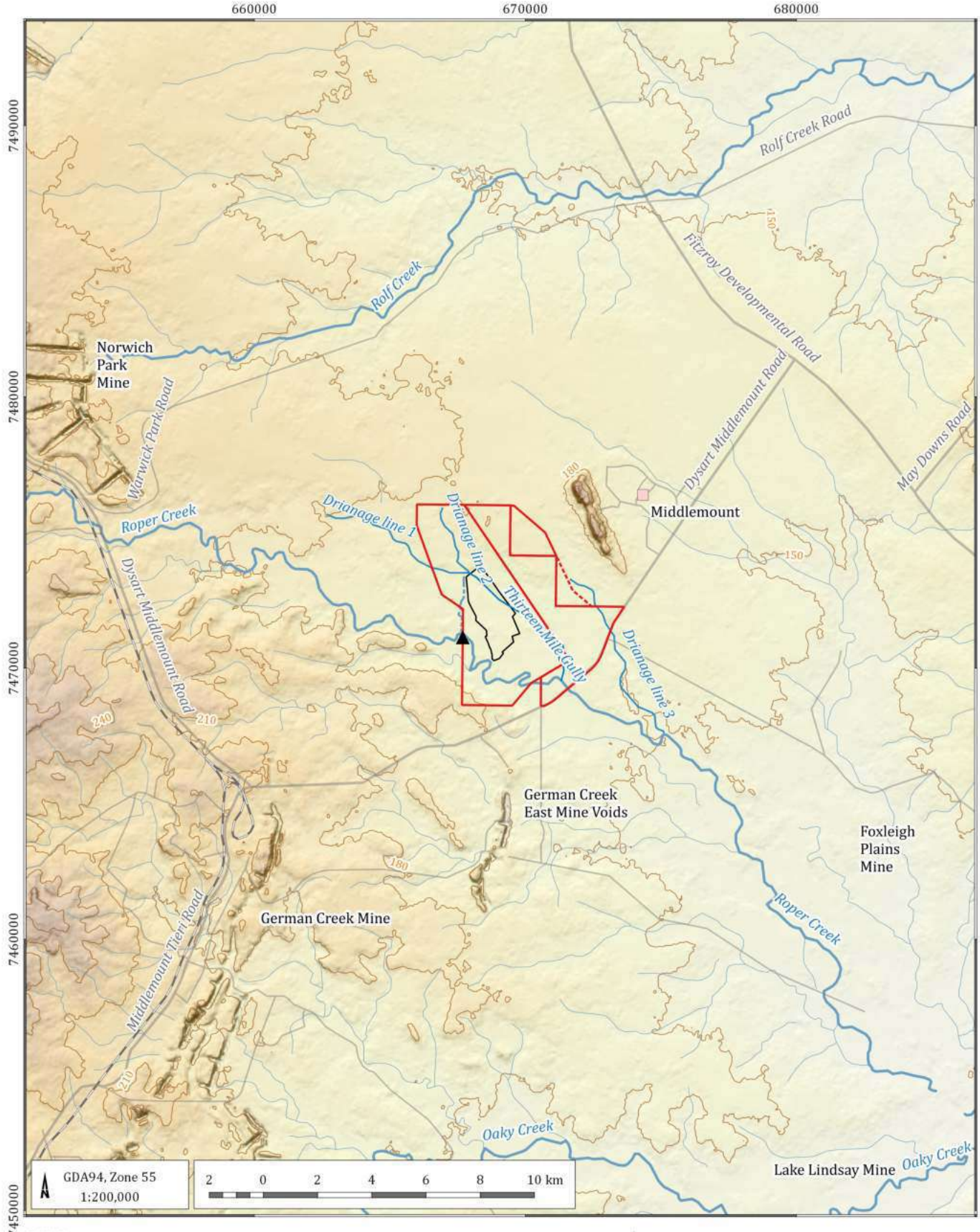
Figure 4.1 Monthly rainfall and cumulative rainfall departure – SILO Data for Middlemount Coal Mine 1901 - 2017

4.2 Terrain and drainage

The Middlemount Coal Mine is located in the Roper Creek catchment which drains into the Mackenzie River approximately 40 km to the south-east. The drainages in the area are shown on Figure 4.2.

In its natural state, Thirteen Mile Gully drained the runoff from upstream sub-catchments in a south-easterly direction across ML 70379 and ML 70417 and discharged into Roper Creek within ML 70417 about 350 m upstream of Dysart Middlemount Road. The upstream sub-catchments of Thirteen Mile Gully were diverted along the eastern boundary of ML 70379 in late 2014 (i.e. Thirteen Mile Gully Diversion). A licence to divert the flow of water of Thirteen Mile Gully was issued under the *Water Act 2000* in May 2013. All drainages overlying the current mine site and the proposed expansion area within ML 70379 are ephemeral, which means they do not permanently flow.

The topography surrounding Middlemount Coal Mine is gently undulating with elevations ranging from 178 m above the Australian Height Datum (mAHD) in the north, falling to 146 mAHD in the south along Roper Creek.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Mine pit footprint, 2017
- Road
- Watercourse
- Drainage feature
- Rail
- Stream gauge station

Terrain elevation (mAHD)

- 100
- 150
- 200
- 250
- 300
- 350
- Elevation contour (30 m interval)

Middlemount Coal Mine Western Extension Project (G1840D)

Terrain, drainage and stream gauge location within study area

DATE 10/04/2018

FIGURE No: **4.2**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/04.02_G1840D_Terrain, drainage and stream gauge location within study area.qgs

4.2.1 Surface water data availability

MCPL operate a gauging station (Ref 1) in Roper Creek, located just upstream of the confluence with the Thirteen Mile Gully diversion (Figure 4.2). The Ref 1 gauging station was installed in December 2012. Stream flow data is available for the period between July 2014 and August 2017. Details about the Ref 1 gauging station are provided below:

- data record commenced - 16/07/2014;
- coordinates and elevation – 667,484 mE; 7,471,112 mN (MGA94 Zone 55); 177 mAHD; and
- catchment area - 305.8 square kilometres (km^2).

Data from this gauging station is presented in Figure 4.3. This shows only periodic flows are recorded in Roper Creek which are in response to rainfall runoff flow events. These flows are then separated by long periods up to 11 months, of essentially zero flow within the creek.

DNRM had a gauging station on Roper Creek (#130107A at Barwon Park), which operated between August 1971 and September 1988 and is now closed. This gauging station was located approximately 30 km downstream of the Middlemount Coal Mine, which is outside of the study area and as such has not been considered any further for this assessment.

4.3 Regional land use

Mining and agriculture are the primary land uses within the vicinity of Middlemount Coal Mine. Private properties, which run cattle and conduct dryland cropping operations, are located to the north and east of the mine. Dryland cropping operations do not rely upon groundwater as confirmed during the Bore Census in 2017 (refer Section 6.4.2). Current mine operations include the German Creek and Lake Lindsay Mines (Anglo Coal [Capcoal Management Pty Ltd] Pty Limited), and Foxleigh Plains (Foxleigh Land Pty Ltd). These are underground and open coal mines located south and southeast of the Middlemount Coal Mine. Norwich Park Mine (BHP Billiton Mitsubishi Alliance) which is located north-west of the Middlemount Coal Mine ceased mining operations in 2012 and remains under care and maintenance.

The proponent owns all land within the footprint of the current and proposed open cut mining operations (ML 70379, ML 70417, and ML 700014). Portions of the land owned by the proponent are released for cattle grazing.

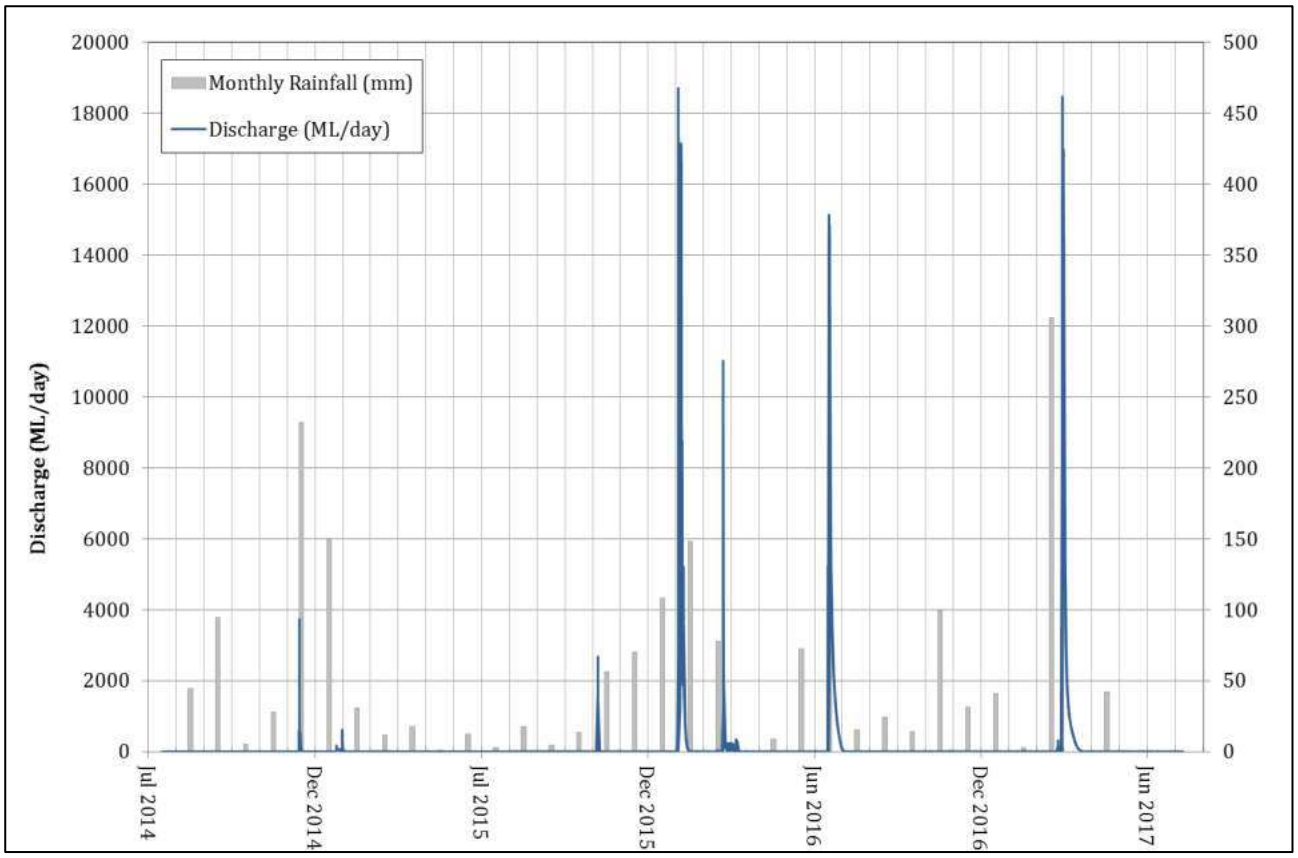


Figure 4.3 MCPL Roper Creek gauging station (Ref 1)

5 Geology within the study area

5.1 Geology data availability

The geological understanding has been informed by the following data sources:

- geological logs, geophysical logs, and data compiled from exploration drilling across the Middlemount Coal Mine area;
- geological model surfaces for the Middlemount Coal Mine;
- geological data from registered bores held on the DNRM GWDB; and
- publicly available geological mapping (St Lawrence 1:250,000 map sheet) and reports.

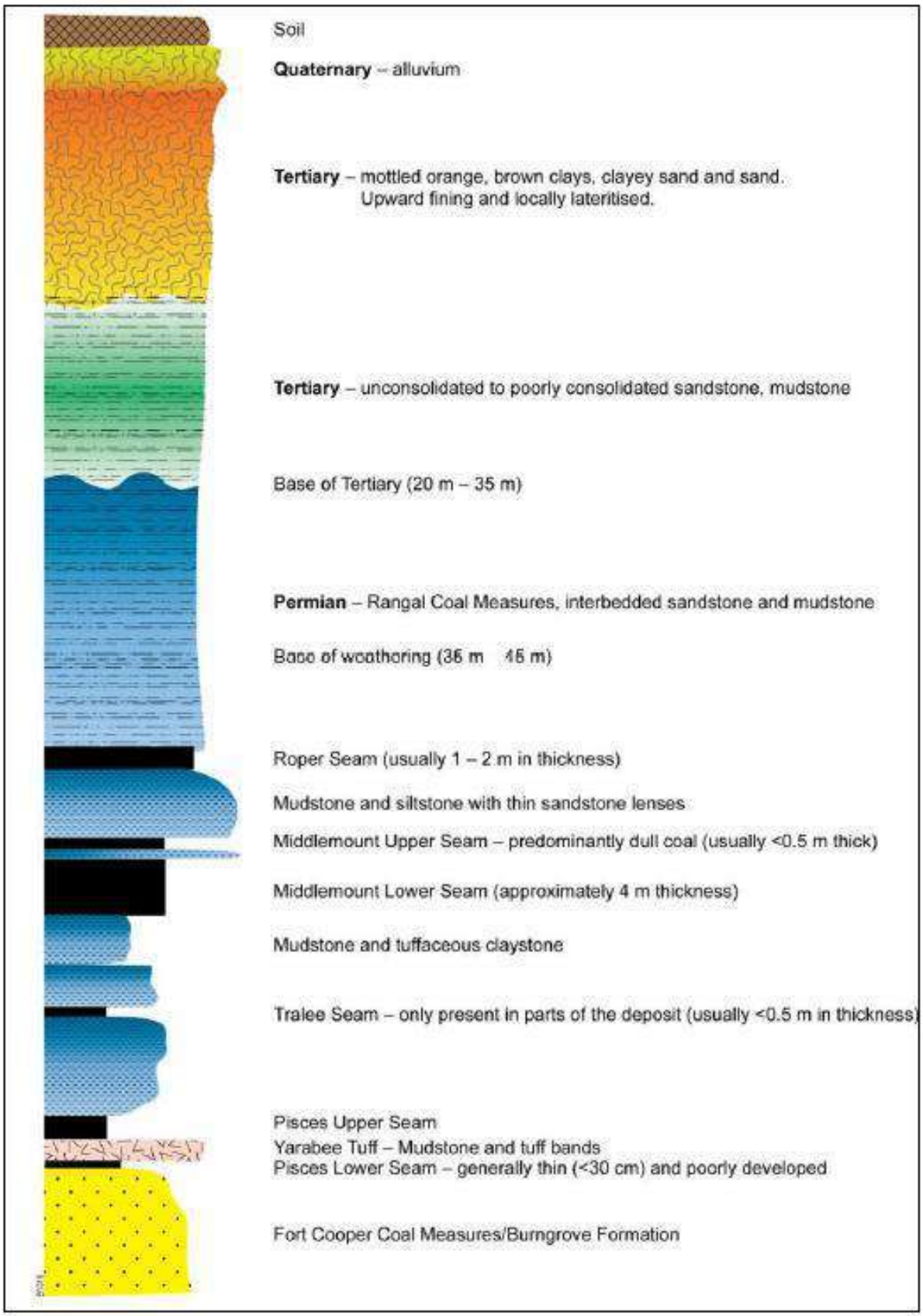
MCPL has undertaken exploration drilling across the Middlemount Coal Mine tenements. However, targeted exploration continues to define product coal structure and quality within the proposed expansion area. Exploration drilling has confirmed the geological units present in the ML areas and in the surrounds. MCPL has developed geological models from the exploration drilling data, which has been used to interpolate the stratigraphy and distribution of geological units across the Middlemount Coal Mine and immediate vicinity. The geological model provided the structural framework for developing the numerical groundwater model.

Geological data provided by DNRM and MCPL for the modelled area were analysed to provide elevations of the major stratigraphic interfaces. The DNRM data are important for developing the regional scale hydro-stratigraphic model. Ground elevations at many of the drill sites were not surveyed, and so ground elevations were estimated using a GIS topographic database (Geoscience Australia, 2011).

5.2 Bowen Basin geology

The Middlemount Coal Mine is located within the Rangal Coal Measures of the Bowen Basin, which is a sedimentary basin comprising Triassic and Permian aged geology. Regionally, a veneer of more recent Tertiary geology and Quaternary geology typically overlies the Bowen Basin strata. The Permian Bowen Basin rocks depositional environment formed a regular layered sedimentary sequence, while the Tertiary and Quaternary geology is more complex and irregular.

The target seams at the Middlemount Coal Mine are the Middlemount, Tralee, and Pisces coal seams of the Rangal Coal Measures, a faulted and folded Permian sequence of calcareous sandstone, shale, mudstone, and coal. In the mine area, the Rangal Coal Measures dip gently to the northeast, underlain conformably by the Permian Fort Cooper Coal Measures / Burngrove Formation (herein referred to as the Fort Cooper Coal Measures). The Fort Cooper Coal Measures are Late Permian age sedimentary rocks that comprise feldspathic and lithic sandstone, siltstone, carbonaceous mudstone, siliceous siltstone, banded coal seams, and tuff. These rocks do not outcrop within the site and have only been encountered in the exploration boreholes. Collectively, these Permian age geological units, are collectively referred to here as the Permian coal measures. The stratigraphy for Middlemount Coal Mine is shown Figure 5.1.



Source: *Stage 2 Environmental Impact Statement (EIS) (Parsons Brinkerhoff, 2010a)*

Figure 5.1 Stratigraphic sequence Middlemount Coal Mine

5.3 Mapped geology

The surface geology mapped across the study area (i.e. the geology that crops out at the ground surface) is shown in Figure 5.2. The majority of the study area is covered by Quaternary and Tertiary geological units. The Rangal Coal Measures do not outcrop within the Middlemount Coal MLs or within the study area. The only Permian coal measure units that do outcrop within the study area are stratigraphically older than the Rangal Coal Measures, and these units are exposed south and west of the Middlemount Coal Mine MLs.

The characteristics of the superficial Quaternary alluvium (Qa) reflect the nature of the source rocks, weathering, transport, and depositional conditions. Poorly sorted clay, silt, sand, and gravel represent the thin flood-plain alluvium.

Other minor Quaternary units mapped northeast of the Middlemount Coal Mine MLs, consist of colluvial and residual deposits (TQr) of clay, silt, sand, gravel.

The Duaringa Formation (Tu) outcrops across the northern portions of the MLs and includes thick clay-rich laterite, a result of intensive and long-lasting weathering of the underlying parent rock (the Permian coal measures) during the Tertiary period. Other minor clay-rich Tertiary sediments (TQa) occur locally.

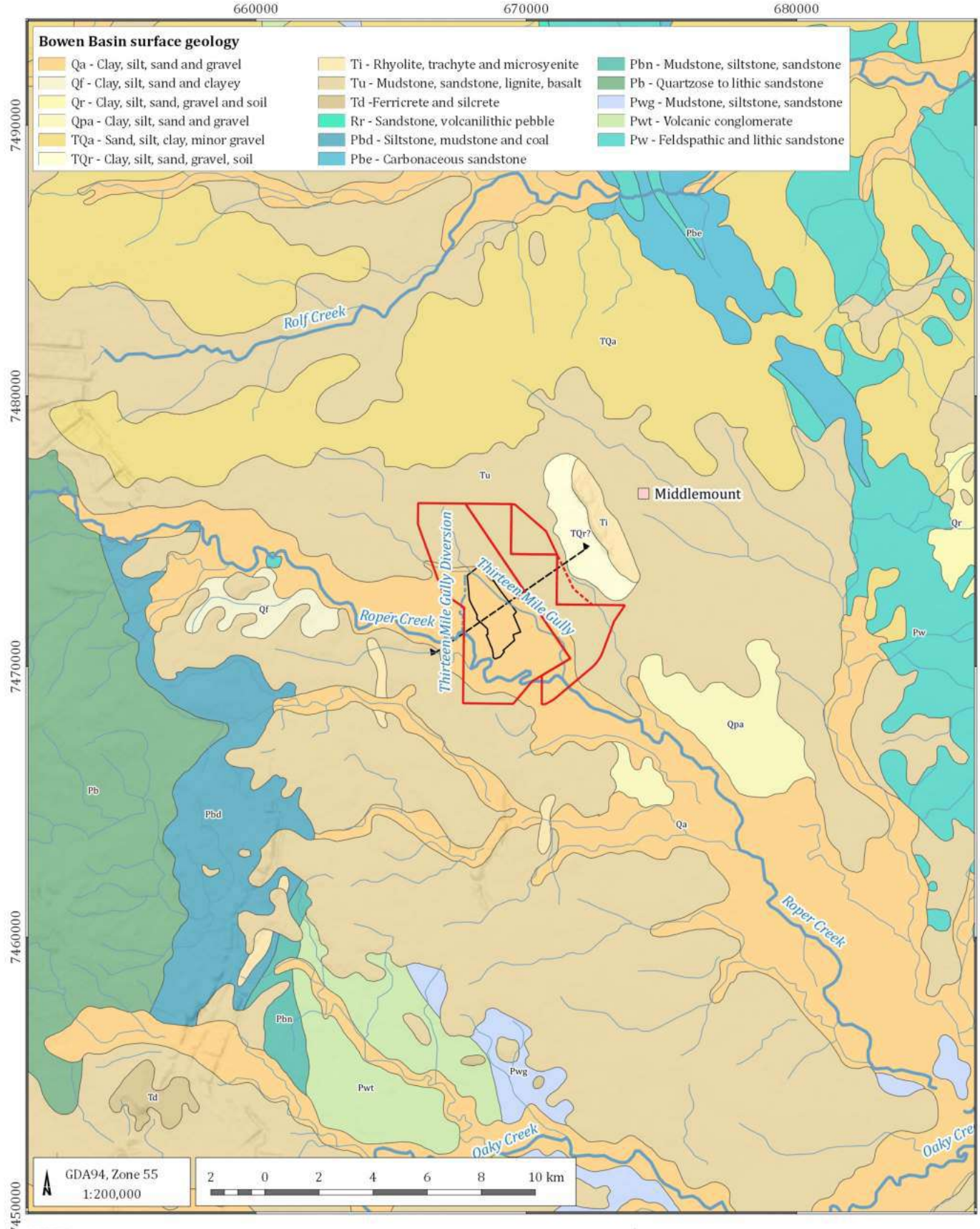
The Triassic Rewan Formation (Rr) does not outcrop within the study area, but does sub-crop within the study area beneath the Tertiary cover east of Middlemount township and southeast of the current mine footprint.

Outcrop of Permian coal measures are confined mainly to the western and southern parts of the study area and sub-crop beneath the Tertiary cover across the Middlemount Coal Mine MLs. The Permian coal measure units represented in surface outcrop include (from youngest to oldest) the:

- Burngrove Formation (Pwg);
- Fair Hill Formation (Pwt);
- MacMillan Formation (Pbn);
- German Creek Formation (Pbd);
- Blenheim Formation (Pbe); and
- Back Creek Group (Pb).

The Permian coal measures strike north-north-west and dip towards the east-north-east, generally at less than seven degrees. Local steeply dipping coals seams are anticipated to occur adjacent to the Jellinbah Fault. The extent of these geological features is shown conceptually as a northeast to southwest cross section in Figure 5.3.

The stratigraphy within the study area is summarised in Table 5.1.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Mine pit footprint, 2017
- Geology cross-section in Figure 5.3
- Watercourse
- Drainage feature

Middlemount Coal Mine Western Extension Project (G1840D)

Outcrop geology within study area

DATE 05/04/2018

FIGURE No: **5.2**

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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/05.02_G1840D_Outcrop geology within study area_qgs

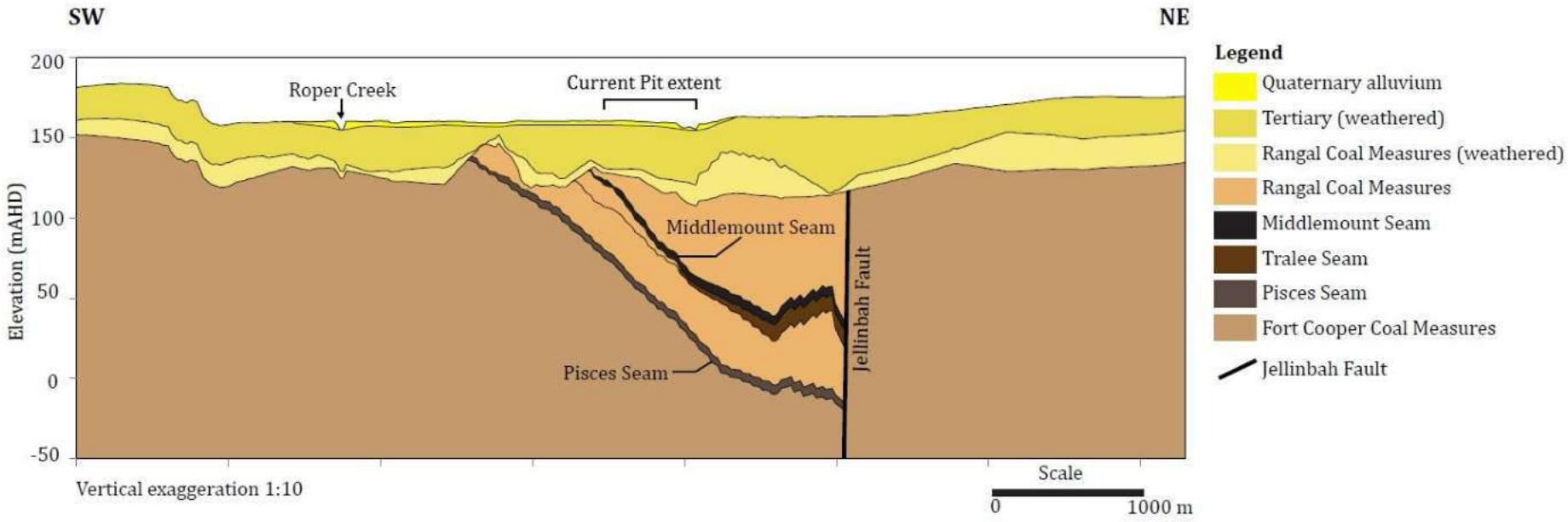


Figure 5.3 Northeast to southwest geological cross section

Table 5.1 Regional stratigraphy units

Age	Stratigraphic unit	Lithology description	Typical thickness (m)	Occurrence
Quaternary	alluvium	Clay, silts, sand, gravel, and floodplain alluvium	0 – 5	Confined to present day stream alignments and floodplains
Tertiary	Duaringa Formation	Claystone and siltstone, quartzose sandstone, pebbly sandstone, gravel, interbedded basalt; all deeply weathered	0 – 60	Surface covering that is extensive across the Middlemount Coal Mine MLs and much of the study area
Triassic	Rewan Formation	Green lithic sandstone, pebble conglomerate, red and green mudstone	-	Does not outcrop within study area and occurs east of Middlemount Township and southeast of current mining footprint.
Permian	Rangal Coal Measures	Calcareous sandstone, shale, mudstone, coal, limestone	0 - >150	Occurrence restricted to small area immediately west of the Jellinbah Fault, and extending south of the Middlemount Mine. Additional limited occurrence east under Middlemount Township
		Roper seam Middlemount upper seam Middlemount lower seam Tralee coal seam Pisces coal seam	1 -2 <0.5 ~4 0.5 – 1 2 - 6	
	Fort Cooper Coal Measures	Lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff	>100	West of Rangal Coal Measures and east of Jellinbah Fault
		Girrah coal seam	-	

(*adapted from Stage 2 EIS, Parsons Brinkerhoff, 2010a*)

5.4 Quaternary aged geological units

5.4.1 Alluvial deposits

Within the study area, the Quaternary alluvial floodplain deposits (Qa) unconformably overlie the Duaringa Formation. The alluvial flood plain deposits are confined to present day stream alignments and floodplains, as shown in Figure 5.2.

The Quaternary alluvium is distributed within the ML from Roper Creek in the south to Thirteen Mile Gully in the north of the pit, and is comprised of clay, silt, and sand. Where it occurs, the alluvium is thin, usually less than 5 m (Parsons Brinkerhoff, 2010a).

Groundwater levels at the site are typically deeper than 10 metres below ground level (mbgl), which is below the base of the Quaternary, indicating that the Quaternary sediments are typically unsaturated.

5.5 Tertiary aged geological units

5.5.1 Duaringa Formation

Tertiary sediments of the Duaringa Formation (Tu) cover the Middlemount Coal Mine MLs and much of the northern and southern parts of study area. The Duaringa Formation consists of deeply weathered mudstone, sandstone, pebbly sandstone / conglomerate and siltstone, gravel, and some interbedded oil shale and basalt. This formation unconformably overlies the Permian coal measures.

The thickness of the Duaringa Formation in the study area ranges from 0 m to 60 m and generally ranges between 25 m and 35 m within the MLs (Parsons Brinkerhoff, 2010a). Within the southwest portion of ML 70379, the Duaringa Formation is lateritised with a hard caprock that forms a topographic high in this area.

5.6 Triassic aged geology

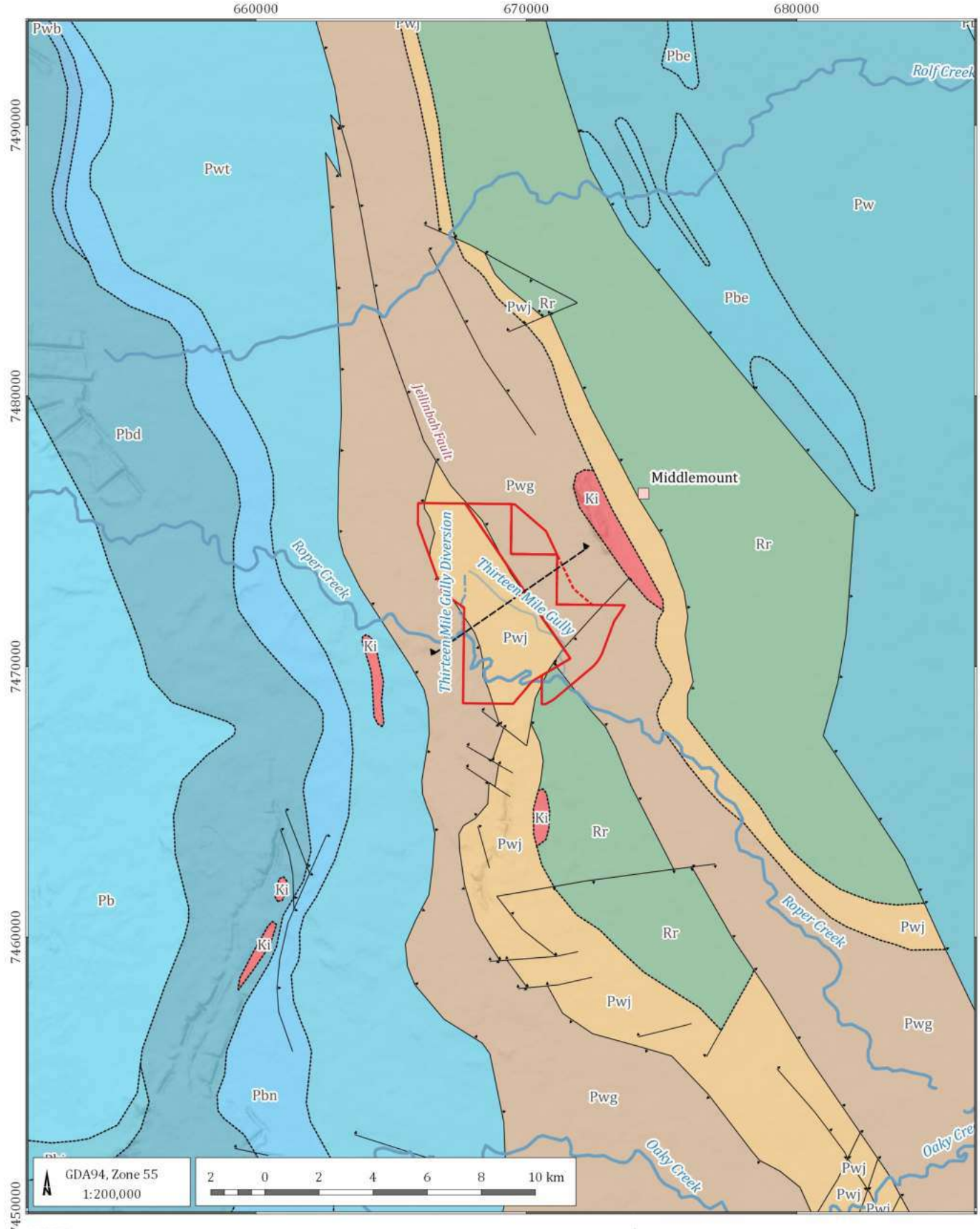
5.6.1 Rewan Formation

The Rewan Formation (Rr) comprises lithic sandstone, pebbly lithic sandstone, and green to reddish brown mudstone, siltstone, quartz sandstone, shale, and some volcanolithic pebble conglomerate at the base. The thickness of the Rewan Formation varies across the Bowen Basin up to 800 m thick.

The Rewan Formation sub-crops beneath the Tertiary cover in the very southeastern part of the Middlemount Coal Mine MLs and east of the Middlemount Township.

5.7 Permian aged geology

Figure 5.4 presents a map of the Bowen Basin Permian / Triassic geology located within the study area. Maps such as these are commonly referred to as showing the "*solid geology*" when the overlying Quaternary and Tertiary geology is not shown.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Regional mapped faults
- Contact
- Geology cross-section in figure 5.3
- Watercourse

Bowen Basin solid geology

- Ki-Ki-CQ
- Rr-Rewan Formation
- Pbd-German Creek Formation
- Pbe-Blenheim Subgroup
- Pbn-MacMillan Formation
- Pwg-Burngrove Formation
- Pwj-Rangal Coal Measures
- Pwt-Fair Hill Formation
- Pbi-Ingelara Formation
- Pw-Rannes beds

Middlemount Coal Mine Western Extension Project (G1840D)

Bowen Basin solid geology with publicly avialable fault interpretation

DATE 05/04/2018

FIGURE No: **5.4**

©2018 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/05.04_G1840D_Bowen Basin solid geology with publicly avialable fault interpretation.qgs

5.7.1 Rangal Coal Measures

The Rangal Coal Measures include the economic coal seams targeted at Middlemount Coal Mine. The Middlemount and Pisces seams are the thickest coal seams, which sometime double in thickness as a result of likely duplication from faulting. This occurrence is more evident nearer the Jellinbah Fault. These coal measures dip to the east between 3º and 7º, and are truncated by the Jellinbah Fault, which has been mapped roughly coincident with the north-eastern boundary of ML 70379.

The entire sequence was intruded by igneous rocks (gabbro, diorite, granodiorite, rhyolite, and trachyte) in the Cretaceous, and several sub-crops of these intrusions (Ki) are mapped in the solid geology (Figure 5.4). However, only one instance of igneous rocks was recorded in the drilling of monitoring bores at Middlemount Coal Mine in bore MW4 (Phi Ground Innovations, 2015).

Beyond the extent of exploration drilling, the structure of the Rangal Coal Measures has been extrapolated. As such, the extent of the coal seams adopted for the conceptual and numerical groundwater models show the coal seams dip towards the east, and inferred to sub-crop area beneath the Tertiary sediments and terminate at the Jellinbah Fault line.

The interburden between the various coal seams is dominated by weathered and fresh interbedded carbonaceous mudstone, siltstone, feldspathic and lithic sandstone, and tuff sequences. The depth of weathering is generally between about 35 m and 45 m.

5.7.2 Fort Cooper Coal Measures

Drilling along the eastern side of the Jellinbah Fault has intersected the Fort Cooper Coal Measures. The Fort Cooper Coal Measures are dominated by siltstone and alternating layers of very fine grained and fine grained sandstone, with numerous calcite veins and layers of coal and tuff. The Fort Cooper Coal Measures stratigraphically underlie the Rangal Coal Measures, including the Middlemount and Pisces seams.

5.8 Geological structure

5.8.1 Publicly available fault data

Geological structure (i.e. faults, folds, etc.) for the Bowen Basin is publicly available from the Queensland Government. The *Queensland geology and structural framework Geographical Information System* (GIS) dataset is a digital representation of the distribution of rock units and their structure in Queensland, which mirrors the DNRM's hard copy Queensland Geology map published in 2012.

The publicly available geological structure data is typically based on broad scale geological mapping interpretation. The result of this regional scale interpretation within the study area is shown in Figure 5.4. This data shows a series of northwest - southeast trending faults have previously been interpreted to exist:

- between the Burngrove Formation and underlying Fairhill Formation that trend southwest - northeast, west of the Middlemount Coal Mine MLs;
- roughly coincident with the north-eastern boundary of ML 70379 and referred to as the Jellinbah Fault;
- to the east between the Rangal Coal Measures and Rewan Formation beneath Middlemount Township; and
- further east of Middlemount Township between the Rewan Formation and Blackwater Group.

The mapping also shows a series of significantly shorter east-west and northeast-southwest cross faults that intersect these longer, more dominant northwest-southeast trending faults. Commonly, the accuracy of this publicly available data is improved greatly by site specific geological exploration. As such, the publicly available fault interpretation is considered within this report to be a useful guide for regional context, but is superseded where site specific fault interpretation exists.

5.8.2 Jellinbah Fault interpretation

The Stage 2 EIS Groundwater Technical Report (Parsons Brinkerhoff, 2010a) describes the Jellinbah Fault as a thrust fault that dips towards the east. The fault is interpreted as having a throw of over 300 m, with the western geological units being discontinuous across the fault with the stratigraphically older Girrah Coal Seam, which subcrops on the eastern side (upthrown block) of the fault. Secondary faulting is present on both sides of the Jellinbah Fault as part of the thrust complex, resulting in extensive brittle deformation, fractures, and faulting. A southwest-northeast cross-section through the site (Figure 5.3) shows the stratigraphic sequence and the Jellinbah Fault. This geological cross-section is oriented southwest-northeast, sub-perpendicular to the dip of the coal seams. The geological cross-section shows the Fort Cooper Coal Measures are thrust up against the Rangal Coal Measures by the Jellinbah Fault near the northeastern limit of the approved open cut. The Jellinbah Fault truncates the Middlemount, Tralee, and Pisces coal seams along this eastern margin (Figure 5.3).

5.9 Geochemistry of coal, overburden, and interburden

Geochemical assessment (RGS, 2013) identified the majority of coal and mining waste materials (overburden and interburden) are classified as non-acid forming, have excess acid buffering capacity, and a high factor of safety with respect to potential for acid generation. Heavy metal concentrations in all overburden samples tested for the Stage 2 project (Parsons Brinkerhoff, 2010c) were below environmental investigation levels. The excavation and dumping of overburden was predicted to have a low risk of producing heavy metal contamination from leachate seepage or surface water runoff from the overburden dumps.

The overburden and interburden within the Project area includes the same types of sedimentary units that occur within the current Middlemount Coal Mine area, and as such are considered to have the same geochemistry characteristics. Therefore, no additional geochemical assessment has been undertaken for the Project area, with the existing geochemical assessments valid for the overburden and interburden sequences that will be mined in the Project portion of the site.

6 Conceptual groundwater model

An understanding of the groundwater regime is presented in this section which provides the basis for the hydrogeological conceptualisation for the study area. The conceptual model describes the groundwater system and how it operates given the available data, and represents the natural system in a simplified way.

The following sections describe the conceptual groundwater model for the Middlemount Coal Mine. The conceptual groundwater model was based on publicly available geological and topographical maps, geological information from exploration bores drilled across MLs and its surrounds, groundwater level and quality data from monitoring bores and results from previous hydrogeological investigations.

6.1 Hydro-stratigraphic units

As previously discussed, the geology within the study area/model domain comprises a Quaternary and Tertiary age sequence overlying older Permian age coal measures. These geological units can be separated into three key hydro-stratigraphic units based on their hydraulic properties and lithology. From youngest to oldest, these units are:

- Quaternary aged units:
    - Alluvial aquifer – consists of localised stream channel deposits and associated flood plain deposits. These units comprise a temporary (rainfall dependent) aquifer that is limited to the immediate vicinity of Roper Creek, Thirteen Mile Gully and drainages within the MLs. Neither Roper Creek or Thirteen Mile Gully is targeted for water supply within the near vicinity of the Middlemount Coal Mine.
- Tertiary aged units:
    - Duaringa Formation – consists of thick clay-rich laterite which is sourced from highly weathered Permian sandstones and siltstones, and occasional basalt. The Duaringa Formation is not typically targeted for agricultural water supply and is (at best) a low yielding aquifer that would more commonly be regarded as an aquitard.
- Permian aged units:
    - Interburden/overburden - the bulk of the Permian coal measure strata is sandstone, siltstone, and mudstone that typically have low permeability and generally form aquitards.
    - Coal seams (principally the Middlemount and Pisces Seams) - form low to moderate yielding aquifers confined by interburden/overburden units.

6.2 Groundwater resources and concepts of groundwater flow

Groundwater is the component of the hydrological cycle that is stored below the earth's surface. If a geologic formation is capable of storing and transmitting groundwater in usable quantities it is called an aquifer. The groundwater sourced from aquifers within the study area are typically hosted within two general types of geologic formations:

- porous media – such as sand, gravel, and some sandstone; and
- fractured rock – such as fractured basalt (very limited occurrence in the study area), fractured/faulted/jointed sandstone and fractured coal seams.

Aquifers of both porous media and fractured rock occur within the study area. The most used aquifer in the vicinity of Middlemount Coal Mine are the coal seams (i.e. neighbouring mine dewatering).

In sand and gravel, water is stored in the pore spaces between the soil grains and can move quite freely in any direction. However, in a fractured rock aquifer water is stored in the fractures or crevices in an otherwise solid rock. A bore drilled into fractured rock has to intersect a fracture before water becomes available to the bore. For this reason, there is a greater chance of drilling an unsuccessful bore in fractured rock than in porous media.

Because the volume of the fractures is quite small compared with the total volume of the rock, fractured rock aquifers do not hold large volumes of water. They are also subject to large fluctuations in groundwater level both as a result of pumping and recharge.

A shallow Quaternary alluvium sand or gravel aquifer is generally unconfined meaning that its upper surface (i.e. the water table) is open to the atmosphere through permeable material. The water table in an unconfined aquifer system has no overlying impervious rock layer to separate it from the atmosphere.

An unconfined aquifer is one in which the permeable geologic formation storing the water is only partly filled with water and it overlies a relatively impervious layer. An unconfined aquifer contains water which is not subjected to any pressure other than its own weight (i.e. hydrostatic pressure). If a bore penetrates such an aquifer the water will rise within the bore no higher than the depth at which it was first encountered. The level at which water stands in a bore penetrating an unconfined aquifer (i.e. the standing water level) is known as the water table and is the depth at which water in the aquifer is at atmospheric pressure.

By contrast, the Tertiary Duaringa Formation and Permian coal seam aquifers are confined, meaning that they are overlain by a confining bed. The confining bed has a significantly lower permeability than the aquifer. A confined aquifer is a completely saturated permeable formation of which the upper and lower boundaries greatly restrict the vertical movement of groundwater. In a confined aquifer, groundwater is under sufficient pressure to cause it to rise above the top of the aquifer if given the opportunity (e.g. if penetrated by a bore). The level to which the water rises is referred to as the potentiometric head.

Groundwater in geologic formations flows from areas where the standing water level (or potentiometric head) is higher, to areas where it is lower, in much the same way that surface water flows from areas of higher elevation to areas of lower elevation. The difference in groundwater levels is generally referred to as the hydraulic gradient. However, unlike surface water, groundwater flows slowly, through pores and fractures in formations.

The flow of groundwater is controlled primarily by two hydraulic parameters of the material through which it flows; the permeability and the storativity. Permeability is a measure of the ease with which water can flow through the material. The term hydraulic conductivity is another term used for the coefficient of permeability. Storativity is a measure of the capacity of the material to store or release water in response to a pressure change.

Highly permeable materials, such as sand, let groundwater flow relatively easily, resulting in a gentle hydraulic gradient in response to groundwater extraction. In contrast, lower-permeability materials such as clay, although yielding relatively small amounts of water, result in much steeper hydraulic gradients.

Geologic formations with higher hydraulic conductivity/permeability are known as aquifers and formations with lower hydraulic conductivity/permeability are known as aquitards. The remainder of this report will refer to hydraulic conductivity for consistency.

Within a geologic formation, groundwater typically flows more easily along bedding planes (the surfaces that separate different layers) than vertically through them. As a result, horizontal hydraulic conductivity is normally substantially higher than vertical hydraulic conductivity.

In addition to extraction from bores, groundwater also flows naturally to surrounding formations, springs, and watercourses. At any given time, water pressure in a geologic formation reflects a balance, or in the case of rising or falling water levels, an imbalance between the volume of water entering the system (recharge) and the volume of water flowing out of the system (discharge).

Regular measurement of groundwater levels in monitoring bores enables a history of groundwater level response to various stresses to be documented and analysed. Such stresses could result in groundwater level rises resulting from recharge events or groundwater level declines resulting from groundwater extraction. If water levels are measured in a number of monitoring bores at the same time and reduced to the same datum, it is possible to draw a set of groundwater level contours which reflect the groundwater hydraulic gradient at that time. It is possible to use such contours to determine the direction of groundwater flow and to obtain an aerial response to stresses on the system.

6.3 General aspects of groundwater and mining

The Middlemount Coal Mine currently includes a single open cut pit from which mining activities take place and interfere with groundwater by intersecting and dewatering (removing water) as part of the mining process.

6.3.1 Mine dewatering impacts

During mining, the rate of groundwater seepage into the open cut pit from the coal seam (which is subsequently removed by pumping to dewater the pit) exceeds the rate of groundwater flow to the mined region and consequently the coal seam aquifer experiences a reduction in groundwater pressure. This pressure decline is quantified in terms of groundwater level drawdown. Drawdown radiates outwards from the mined areas to create a cone of depression. The area affected by such pumping is called the area of influence. The outer limit of the area of influence at a particular time is called the radius of influence. The radius of influence continues to expand as the time of pumping increases. Beyond the radius of influence the drawdown effect is zero.

The radius of influence at any particular time depends only on the ability of the aquifer to store and to transmit water. It is independent of the pumping rate. However, the magnitude of the drawdown within the cone of depression does depend on the pumping rate and on the ability of the aquifer to store water and to allow the water to move through it. The lower the hydraulic conductivity of the aquifer, the steeper the resulting drawdown. Accordingly, in the study area, where three aquifers occur and each has different storage and transmitting capabilities, the radius of influence of pumping will vary significantly depending on which aquifer the water is being extracted from.

Hence, modelling of this complex relationship is required to understand the potential for impact in the surrounding aquifers.

6.3.2 Post-mining groundwater recovery

Mining would be completed at Middlemount Coal Mine in 2037, after which groundwater would flow into the open pit final voids. There are two final voids proposed at the end of mining, the North Void and South Void (refer to Section 8.4). This filling process in each void will reduce the hydraulic gradient and magnitude of groundwater level drawdown immediately surrounding the mined areas. This process is referred to as “recovery”. The recovery process continues until the groundwater level and void water level reach an equilibrium where the volume of groundwater inflow and rainfall (runoff) is the same as the volume of void water lost through evaporation. This process typically does not result in groundwater levels that are fully recovered (or sometimes even partially recovered) to pre-mining conditions, as evaporation losses usually exceed inflows attributable to groundwater and rainfall.

6.4 Groundwater data availability

6.4.1 DNRM groundwater database bores

DNRM maintains information on water bores across Queensland in its GWDB. A search of the GWDB up to 10 km from the Middlemount Coal Mine indicated a potential 43 bores within the study area. Table 6.1 provide a summary of the expected use of these bores. Of the 43 bores, only six were identified as landholder bores, 28 bores for mine groundwater monitoring purposes, and nine associated with petroleum (CSG) exploration. Details of the bores identified in the GWD are provided in Appendix B.

Table 6.1 Summary of DNRM groundwater database bores in the study area

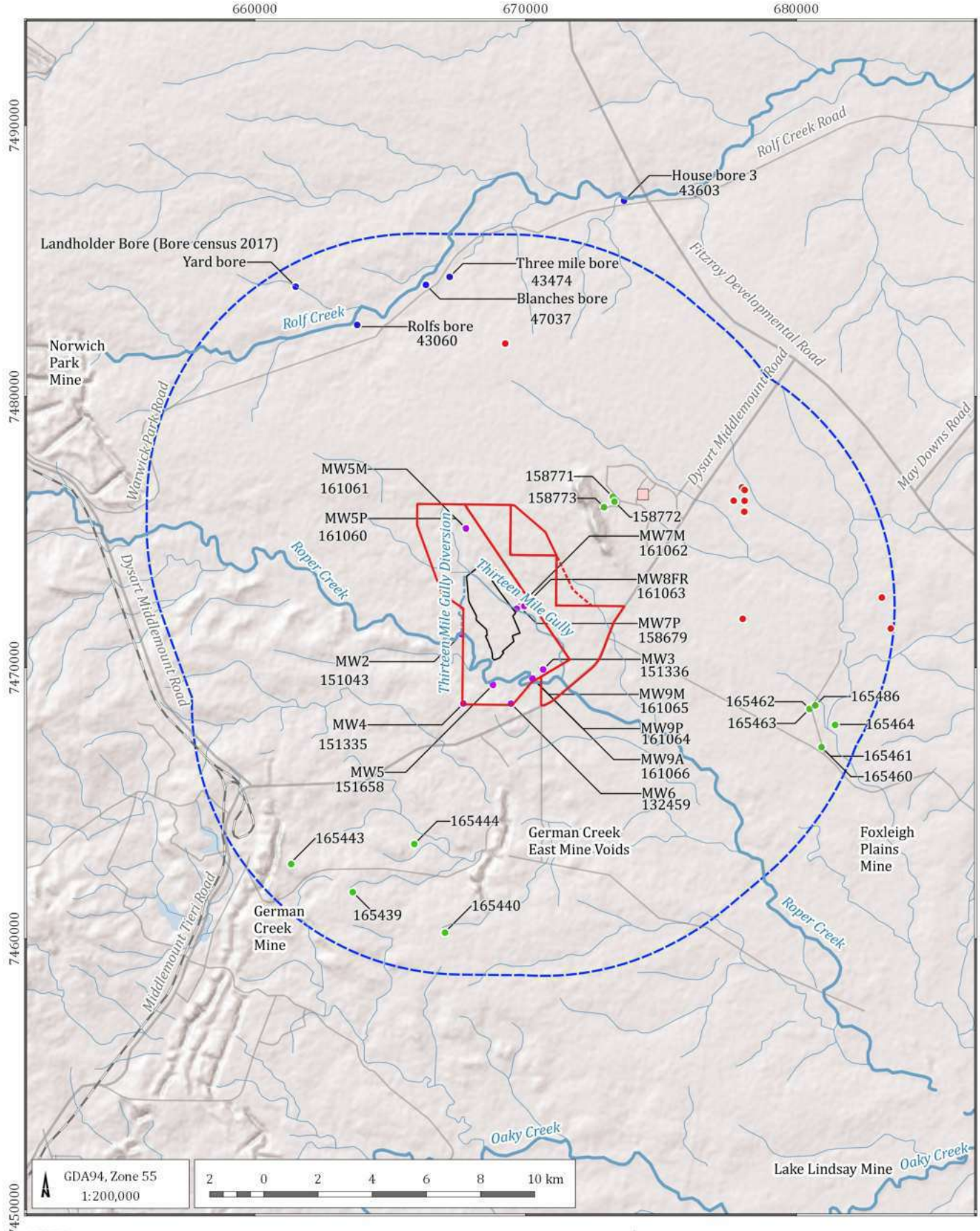
Roles of DNRM GWDB bores (2017)	Number of GWDB bores within the 10 km radius of MLs
Landholder water supply	
No specified role, but likely to be used for landholder water supply	6
Total number of bores used for landholder water supply	**6**
Monitoring bores	
Middlemount Landfill groundwater monitoring bores	3
Middlemount Mine groundwater monitoring bores	15
Foxleigh Mine groundwater monitoring bores	6
German Creek/Grasstree Mine groundwater monitoring bores	4
Total number of bores used for groundwater monitoring	**28**
Petroleum (CSG) exploration	
Petroleum or gas exploration	9
Total number of bores used for exploration	**9**
Total number of existing GWDB bores	**43**

Source: *(DNRM, 2017)*

The bore census undertaken by 4T Consultants Pty Ltd on surrounding privately owned land in September 2017 (refer Section 6.4.2) identified that two of the six landholder bores identified in the GWDB were no longer in use, and one additional bore was identified (i.e. a total of five [5] privately owned bores).

MCPL have also advised that two of the Middlemount Coal Mine groundwater monitoring bores (MW1 & MW1P) have since been consumed by the planned advance of the mining pit.

Based on this review, there are five landholder bores used for water supply purposes. The rest of the bores are either mine or landfill monitoring bores, or associated with petroleum (CSG) exploration. The locations of these GWDB bores are shown on Figure 6.1.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Mine pit footprint, 2017
- 10 km buffer zone
- Road
- Drainage feature
- Watercourse
- Rail
- CSG well bores
- Landholder bores
- Mine monitoring bores
- Other mine Monitoring bores

Middlemount Coal Mine Western Extension Project (G1840D)

DNRM GWDB and census bores within study area

DATE 11/04/2018

FIGURE No: **6.1**

©2018 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/06.01_G1840D_DNRM registered bores.qgs

6.4.2 *Landholder bores – bore census data*

A bore census of nearby groundwater users on privately owned properties was carried out by 4T Consultants Pty Ltd in September 2017 for the Western Extension Project. A copy of the bore census is provided in Appendix C.

The bore census assessed six privately-owned properties, the Middlemount landfill and the Middlemount Jockey Club covering an area of approximately 457 km^2 that surrounds the Middlemount Coal Mine. Following initial contact and establishing the presence of bores on four of the properties and Middlemount landfill, these properties were visited and the bores inspected and assessed.

A total of five landholder water supply bores were assessed on two of the privately owned properties (of which four were listed on the GWDB within 10 km of ML70379). Details of these bores are provided in Table 6.2 and their locations are shown in Figure 6.1. All five bores are located in excess of 5 km from the Middlemount Coal Mine including the Project. Bores initially identified on the other two properties were subsequently assessed to no longer exist.

The bore census also confirmed the three bores located at the Middlemount Landfill to be groundwater monitoring bores established for the landfill operation. All three monitoring bores were dry when assessed for the bore census.

The depth to groundwater in the landholder water supply bores inspected during the bore census was found to range between 11 m and 21 m below ground level (Table 6.2). No information relating to drawdown, recharge or seasonal variations in groundwater levels associated with abstraction was identified or provided during the census.

The drilling and construction logs for these bores were not made available for the bore census. However, review of the GWDB bore cards for the registered bores was used to identify the target aquifers (where available) for these bores. A geological map of the area, shown in Figure 5.2 and Figure 5.4, suggests that these bores are separated from the Middlemount Mine pit by significant faulting.

Table 6.2 Bore census landholder water supply bores

Monitoring bore	Property description	Registered number	Easting# (m)	Northing# (m)	Bore depth (m)	Screen depth (m)	Screen lithology	Standing water level (mbgl)
Yards Bore	Warwick Park	Not registered	661509	7484051	54	NA	NA	18.09
Rolfs Bore	Warwick Park	43060	663778	7482641	38.1	NA	NA	20.89
Blanches Bore	Warwick Park	43037	666941	7484987	35.7	NA	Back Creek Group	Not accessible
House Bore 3	Warwick Park	43063 *	673624 *	7487216 *	30.5 *	Open hole *	Sandstone *	11.61
Three Mile Bore	Hazelbrae	43474	666800	7484295	41	Open hole	Clay	Not accessible

Notes: *# - Coordinates in GDA94, Zone 55*
** - details for original House Bore 1, which was replaced with House Bore 3*
NA - Not available

6.4.3 *Mine groundwater monitoring bore networks*

MCPL has implemented an extensive groundwater monitoring bore network, located both within and outside of the Middlemount Coal Mine MLs. The groundwater monitoring focuses on the Tertiary Duaringa Formation aquifer and the Permian Rangal Coal Measures aquifer.

The first monitoring bores (MW1 to MW6) were installed in June 2008 for Stage 1 of the Middlemount Coal Mine. The monitoring network was subsequently expanded as part of the Stage 2 assessment for the EA amendment in 2012. This included installing nine monitoring bores principally into the Permian coal measures at four locations (MW1P, MW5M/P, MW7M/P and MW8FR, and MW9A/M/P). Six additional monitoring bores (MW10A, MW11A, MW12A, MW13A, MW14A, MW15A,) were installed into the Tertiary aquifer in December 2015 to augment the existing monitoring network and facilitate the mine development plan (Phi Ground Innovations, 2015). Details of the groundwater monitoring network are a summarised in Table 6.3, and the locations of these monitoring bores are shown in Figure 6.2. Copies of the monitoring bore logs are provided in Appendix D.

Monitoring bores MW1 and MW1P were consumed in mid-2015 as mining progressed northwards within the current open cut footprint. The current monitoring network consists of 17 bores both on lease and surrounding the MLs for the purpose of monitoring the groundwater response due to mining. The monitoring bores are located around the current mining area, and target the Tertiary aquifer and the Permian coal measures.

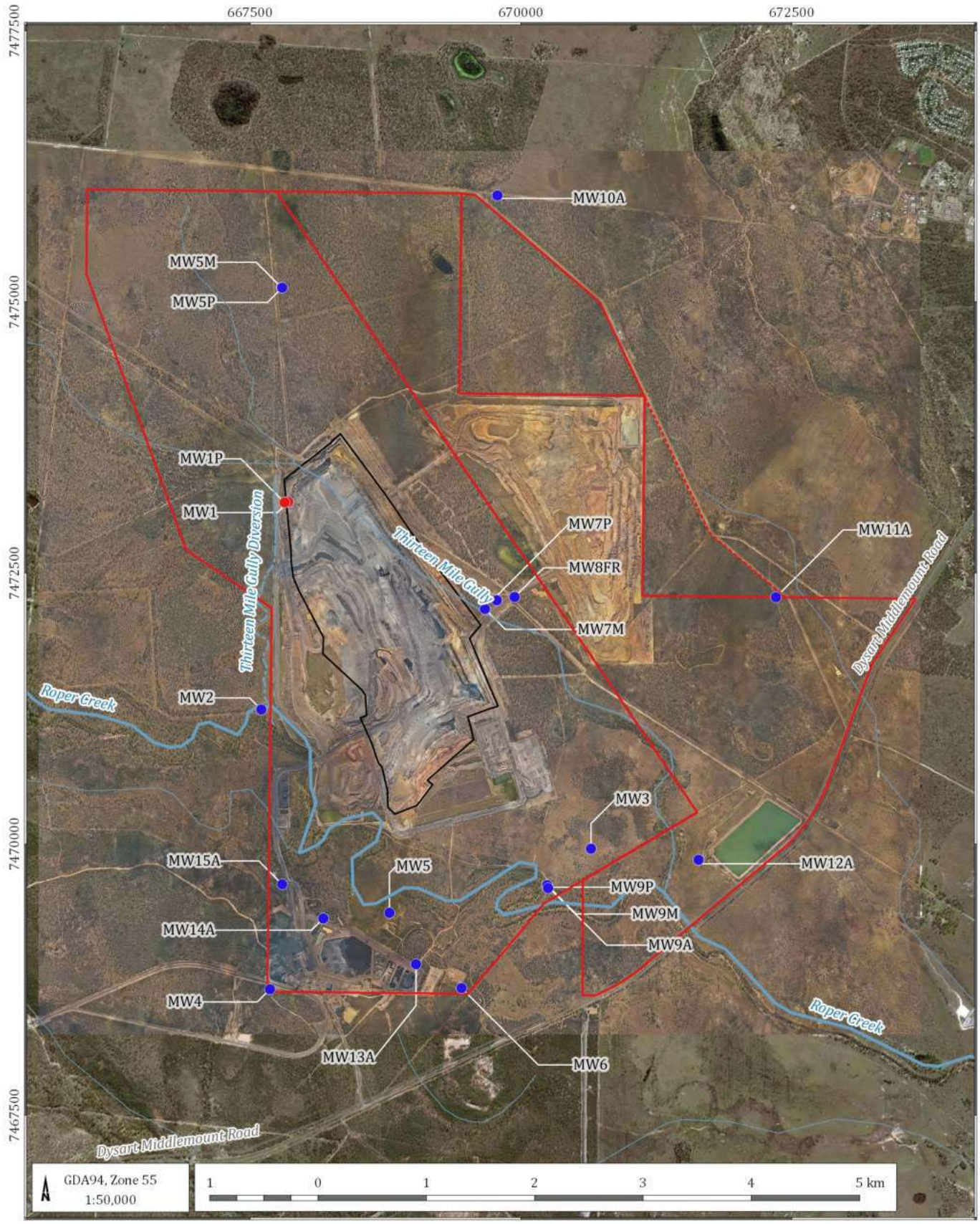
Groundwater monitoring has historically been conducted in accordance with the site's Plan of Operations and conditions within EA EPML00716913. The EA conditions are presented in Section 3.4.

Table 6.3 Mine monitoring bore network

Monitoring bore	Easting[1] (m)	Northing[1] (m)	Ground elevation (mAHD)	Bore depth (m)	Screen depth (m)	Screen lithology	Screen geology
MW1 (Mined out)	667851	7473155	161.5	30.0	21.0-29.0	Clay/sandy clay	Tertiary
MW1P (Mined out)	667818	7473149	161.1	77.2	72.0-75.0	Coal	Pisces coal seam
MW2	667603	7471239	163.12	30.0	21.0 – 29.0	Sandy Clay and Sand	Tertiary
MW3	670647	7469955	155.44	48.0	39.0 – 47.0	Clay and Sandy Clay	Tertiary
MW4	667683	7468659	183.11	50.0	41.0 – 50.0	Weathered igneous rock, Coal, and Sandy Coal	Intrusives and Girrah coal seam (Fort Cooper Coal Measures)
MW5	668786	7469364	157.68	46.0	40.0 – 46.0	Coal	Pisces coal seam
MW6	669452	7468670	158.26	42.0	37.0 – 42.0	Clay	Tertiary
MW5M	667790	7475131	174.52	131.0	127.0 – 130.0	Coal	Middlemount coal seam
MW5P	667796	7745130	174.66	169.0	165.0 – 168.0	Coal	Pisces coal seam
MW7M	669668	7472167	161.15	135.5	132.0 – 134.5	Coal	Middlemount coal seam

Monitoring bore	Easting[1] (m)	Northing[1] (m)	Ground elevation (mAHD)	Bore depth (m)	Screen depth (m)	Screen lithology	Screen geology
MW7P	669777	7472247	163.87	194.5	189.5 – 193.5	Coal	Pisces coal seam
MW8FR	669941	7472277	164.33	151.0	147.0 – 150.0	Shale, Siltstone, and Sandstone	Fort Cooper Coal Measures
MW9A	670246	7469610	156.32	52.0	40.0 – 52.0	Sandstone and Siltstone	Tertiary
MW9M	670243	7469619	156.36	139.5	135.0 – 138.0	Coal	Middlemount coal seam
MW9P	670251	7469592	156.26	204.0	200.0 – 203.0	Coal	Pisces coal seam
MW10A	669783	7475981	175.75	12.0	6.0 – 12.0	Sand, Silty Sand, and Clay	Tertiary
MW11A	672355	7472275	156.21	13.5	10.5 – 13.5	Clay and Mudstone	Tertiary
MW12A	671640	7469853	158.28	10.55	6.0 – 10.55	Fine Sand and Mudstone	Tertiary
MW13A	669032	7468890	162.79	15.0	9.0 – 14.95	Sandstone	Tertiary
MW14A	668175	7469312	159.653	14.0	6.0 – 9.0	Sand, Clayey Sand and Mudstone	Tertiary
MW15A	667796	7469627	161.569	12.5	7.0 -10.0	Sand, Sandy Clay and Mudstone	Tertiary

Note: *1 – Coordinates in GDA94, Zone 55*



LEGEND

- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Mine pit footprint, 2017
- Road
- Watercourse
- Drainage feature
- Abandoned/destroyed bores
- Middlemount Coal Mine monitoring bores

Middlemount Coal Mine Western Extension Project (G1840D)

Middlemount Coal Mine monitoring bore locations

DATE 05/04/2018

FIGURE No: 6.2

©2018 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D_Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/06.02_G1840D_Middlemount Coal Mine monitoring bore locations.qgs

6.5 Quaternary alluvial aquifer

6.5.1 Groundwater yield

The Quaternary alluvial aquifers are not well developed within much of the study area, and are regionally mapped across the central to southern parts of ML 70379 and the southern end of ML 70417 along Roper Creek and Thirteen Mile Gully. Drilling intersected sand in monitoring bores MW2, MW3, MW7M, MW7P, MW8FR and MW9A, between 0.5 mbgl and 14.5 mbgl. However, the borehole logs make no reference to whether these were Quaternary or Tertiary sediments, indicating the Quaternary sediments are most likely localised around the drainage alignments and not laterally extensive. No groundwater was intersected in these boreholes, other than the moist sand intersected in MW7M and MW8FR. No significant groundwater extraction areas are known elsewhere within the study area.

The Quaternary alluvium is not targeted by landholders as a groundwater supply within the study area. This outcome supports the general understanding that the Quaternary alluvium is not a productive aquifer within the study area.

Similarly, no monitoring bores have been installed within the Quaternary alluvium.

6.5.2 Hydraulic parameters

The Quaternary alluvium is estimated to have a highly variable range of hydraulic conductivity values owing to its variable lithology of sand, clay, and occasional gravel bands. The sandy to gravelly creek beds are expected to have higher values of hydraulic conductivity compared to the flood-plain deposits, because the latter would be expected to have a more clayey nature.

In lieu of site data, literature references can be used as useful guides for the expected range of hydraulic parameters for rocks and unconsolidated sediments. Literature values can be found in commonly cited references such as Fetter (1994), Kruseman and De Ridder (1994), Driscoll (1986), and Freeze and Cherry (1979), Domenico and Schwartz (1990).

Literature values of hydraulic conductivity for clayey sand are about 0.1 metres per day(m/day) and fine gravel are about 100 m/day. A geometric mean of about 1 m/day would be considered a reasonable estimate for the bulk hydraulic conductivity of the Quaternary alluvium within the study area.

As a comparison, Arrow Energy (2012) assigned a hydraulic conductivity value of 2 m/day to their base case numerical groundwater model to represent flood plain alluvium within the Bowen Basin.

In the field of hydrogeology, "storage properties" are physical properties that characterise the capacity of an aquifer to release groundwater.

Specific yield is primarily used to define the storage capacity of unconfined aquifers. Specific yield is also known as the drainable porosity, and is the volumetric fraction of the bulk aquifer volume that a given aquifer will yield when all the water is allowed to drain out of it under the forces of gravity.

In lieu of site data, literature references of specific yield range between 2% to 5% (i.e. 0.02 and 0.05) for clay, and 10% to 25% (i.e. 0.1 and 0.25) for sand / fine gravel. A geometric mean of about 10 % (0.1) would be considered a reasonable estimate for the bulk specific yield of the Quaternary alluvium within the study area.

Specific storage is primarily used to define the storage capacity of confined aquifers. Specific storage is the volume of water that an aquifer releases from storage, per volume of aquifer, per unit decline in hydraulic head (Freeze and Cherry, 1979). Specific storage uses the dimension of m^{-1}.

Literature values of specific storage range between 0.001 m^{-1} to 0.01 m^{-1} (i.e. 1.0E-3 m^{-1} to 1.0E-2 m^{-1}) for clay and 5.0E-4 m^{-1} to 1.0E-3 m^{-1} for loose sand (Batu, 1998).

As a comparison, Arrow Energy (2012) assigned a specific storage value of 5.0E-4 m^{-1} to their base case numerical groundwater model to represent flood plain alluvium within the Bowen Basin.

6.5.3 Groundwater recharge, levels, and flow

Groundwater level data is not available for the Quaternary alluvium within the vicinity of the Middlemount Coal Mine, as it is understood the regional groundwater table is below the depth of the alluvial sediments (i.e. greater than 10 mbgl) within the MLs.

Where saturated, recharge to the alluvium would occur as either:

- via direct rainfall on to the alluvium; or
- via seepage through the stream bed, when the creeks are flowing.

Stream gauging data for Roper Creek indicates surface water flow along this creek dissipates quickly after flow events. Therefore, recharge from stream flow would occur over short time periods as the water infiltrates relatively rapidly into the alluvium. When saturated, the groundwater flow direction in the alluvium would be expected to be generally from north-west to south-east, following the regional topography and drainage network.

In the vicinity of the Middlemount Coal Mine, discharge could occur from the alluvium via seepage to the underlying Tertiary sediments. However, this would only occur in areas where the alluvium is saturated and a downward vertical hydraulic gradient to the underlying strata occurs.

6.5.4 Groundwater quality

Groundwater quality data is not available for the Quaternary alluvium within the vicinity of the Middlemount Coal Mine, as the groundwater table is understood to be below the depth of the alluvial sediments (i.e. greater than 10 mbgl) within the MLs.

6.6 Tertiary Duaringa Formation aquifer / aquitard

6.6.1 Groundwater yield

The presence of significant clay within the Tertiary Duaringa Formation suggests that shallow groundwater flow and recharge from rainfall is likely to be minimal across much of these deposits. However, sandy / gravel layers within the Duaringa Formation deposits are likely to provide local aquifers, with the capacity to transmit and contain groundwater. However, the Duaringa Formation surrounding the Middlemount Coal Mine is not targeted for stock and domestic water supplies.

The degree of hydraulic connectivity between different sand units within the Duaringa Formation cannot be established from the available data. Importantly, determining the interface between the weathered sediments of the Duaringa Formation and the weathered profile of the Permian coal measures is not easily identified in the field. However, review of the borelogs for monitoring bores MW7M and MW7P indicate the groundwater discharge observed along the highwall in this portion of the Middlemount Coal Mine is from a perched water table that exists within the Duaringa Formation.

Intragranular flow is likely to be the dominant flow mechanism in the weathered Tertiary aquifer, which is likely to vary in nature between confined, semi-confined and confined across the Project area.

The results of the bore census indicate that no registered or existing bores are screened within the Duaringa Formation within the 10 km search radius of the MLs.

6.6.2 Hydraulic parameters

Site derived hydraulic parameters for the Tertiary Duaringa Formation are only available for MW9A. This indicates a hydraulic conductivity value for Tertiary sandstone around 2.8E-8 metres per second (m/s) or 2.4E-3 m/day.

The Duaringa Formation is estimated to have a wide range, but typically low hydraulic conductivity because it consists of deeply weathered claystone and siltstone, quartzose sandstone, pebbly sandstone, and gravel. The higher values of hydraulic conductivity will be associated with isolated sand units and gravel deposits, located in a predominantly low hydraulic conductivity bulk unit.

Literature values of hydraulic conductivity for clay are about 1.0E-6 m/day to 5.0E-4 m/day and for sandstone (fresh) are about 3.0E-5 m/day to 5.0E-1 m/day (Domenico and Schwartz, 1990). A hydraulic conductivity range of 5.0E-2 m/day to 5.0E-3 m/day would be considered a reasonable estimate for the bulk hydraulic conductivity of the Tertiary Duaringa Formation within the study area.

As a comparison, Arrow Energy (2012) assigned a hydraulic conductivity value of 5.0E-3 m/day to their base case numerical groundwater model to represent the Tertiary Duaringa Formation within the Bowen Basin.

Literature values of specific yield range between 0.02 and 0.06 for clay and 0.06 and 0.2 for sandstone (fresh) (Heath, 1983; Morris and Johnson, 1967). A geometric mean of about 0.05 would be considered a reasonable estimate for the bulk specific yield of the Tertiary Duaringa Formation within the study area.

Literature values of specific storage range between 1.0E-3 m^{-1} to 1.0E-2 m^{-1} for clay and 3.3E-6 m^{-1} to 6.9E-5 m^{-1} for competent to fractured rock (Batu, 1998), but could achieve lower values where clays occur at depth and are confined by overlying units. A geometric mean of about 5.0E-5 m^{-1} would be considered a reasonable estimate for the bulk specific storage of the Tertiary Duaringa Formation within the study area.

As a comparison, Arrow Energy (2012) assigned a specific storage value of 5.0E-5 m^{-1} to their base case numerical groundwater model to represent the Tertiary Duaringa Formation within the Bowen Basin.

6.6.3 Groundwater levels, recharge, and flow

Recharge to the Tertiary Formation occurs via direct infiltration from rainfall in areas where the unit crops out and via seepage from the overlying Quaternary flood plain alluvium, where present. However, recharge is expected to be low due to the predominately clayey nature of the formation.

The regional groundwater flow direction in the Tertiary Duaringa Formation is expected to be coincident with the regional surface drainage, being towards the southeast.

Middlemount Coal Mine monitoring bores installed within the Duaringa Formation indicate groundwater levels ranging from 162.9 mAHD (MW10A) at the northern side of the ML area to 131.0 mAHD (MW9A) adjacent to Roper Creek where this creek exits the MLs. Depth to water in the monitoring bores ranges from 7.7 mbgl (MW14A) to 28.9 mbgl (MW9A), with an average depth of 20.4 mbgl. Figure 6.3 presents hydrographs for monitoring bores in the Tertiary Duaringa Formation at the Middlemount Coal Mine. The water level data for bore MB10A indicate that this bore is has been dry since March 2017 (AGE, 2017a). A single water level was measured in MW11A in March 2016, after which this bore was dry. No groundwater level data have been recorded in MW12A and MW13A as these bores have been dry following construction.

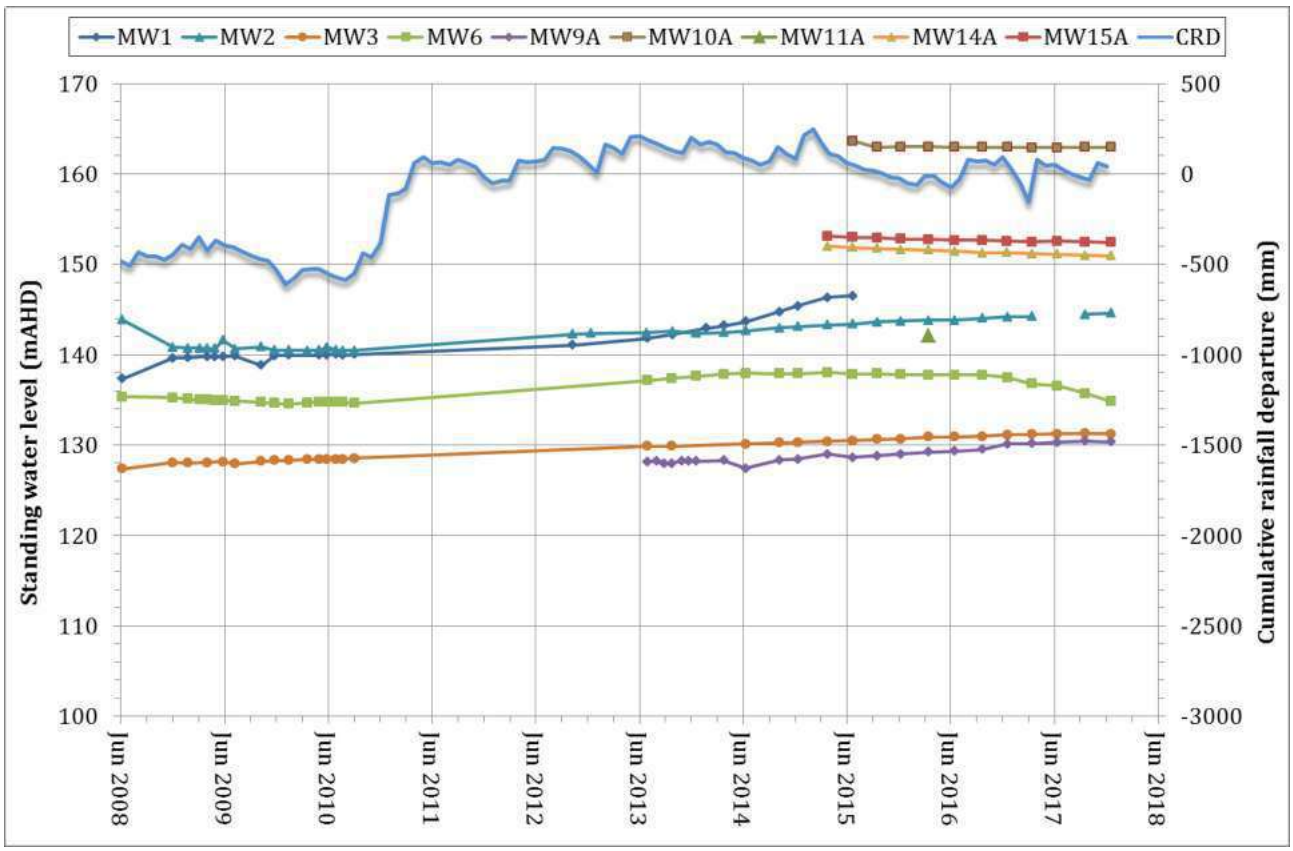


Figure 6.3 Measured groundwater levels in Tertiary aquifer monitoring bores

6.6.4 Groundwater quality

Salinity is a key constraint to water management and groundwater use, and can be classified by total dissolved solid (TDS) concentrations. Hence, salinity can be categorised based on the following TDS concentrations (Food and Agriculture Organization of the United Nations, 2013) for groundwater:

- Fresh water <500 mg/L
- Brackish (slightly saline) 500 to 1,500 mg/L
- Moderately saline 1,500 to 7,000 mg/L
- Saline 7,000 to 15,000 mg/L
- Highly saline 15,000 to 35,000 mg/L
- Brine >35,000 mg/L

The National Water Commission (December, 2011) more broadly defines brackish water as *"water that has a higher salt content than fresh water but a lower content than seawater"*. Based on this definition brackish water is considered that having a TDS concentration between 500 mg/L and 7,000 mg/L (equivalent to an EC of ~750 µS/cm to ~10,500 µS/cm). For the purpose of this groundwater assessment, a combination both definitions have been adopted providing for the following salinity classification for groundwaters intersected:

- Fresh water <500 mg/L (< ~750 µS/cm)
- Brackish 500 to 7,000 mg/L (~750 to ~10,500 µS/cm)
- Saline 7,000 to 35,000 mg/L (~10,750 to ~53,000 µS/cm)
- Hypersaline (brine) >35,000 mg/L (> ~53,000 µS/cm)

Table 6.4 summarises the maximum, minimum, and average values of groundwater chemical parameters for the Tertiary Duaringa Formation aquifer sampled between May 2013 and December 2017. This data indicates the Tertiary aquifer water quality is:

- slightly acidic to alkaline with field pH values ranging from 6.5 to 8.5;
- dominated by sodium and chloride; and
- brackish to saline with total dissolved solids ranging from 900 mg/L to 25,700 mg/L, with the majority of samples being saline.

Table 6.4 Summary of groundwater quality analyses – Tertiary aquifers

Parameter	Min	Max	Average	Stock water (ANZECC)	WQO Zone 34 Shallow <30 m (percentile)		
					20th	50th	80th
Field EC (µS/cm)	**28,000**	**32,700**	**30,482**	-	498	2,150	8,910
Laboratory EC (µS/cm)	1,370	**35,000**	**19,730**	-	498	2,150	8,910
Field pH	6.5	**8.5**	7.2	-	7.1	7.75	8.1
Laboratory pH	6.9	**8.6**	7.7	-	7.1	7.75	8.1
Total Dissolved Solids (mg/L)	919	**25,700**	**13,071**	4,000 (beef) 2,500 (dairy) 5,000 (sheep) 4,000 (horses) 4,000 (pigs) 2,000 (poultry)	-	-	-
Carbonate Alkalinity (mg/L)	<1	84	3.1	-	163	674	2,228
Bicarbonate Alkalinity (mg/L)	255	**1,320**	522	-	187	536	878
Total Alkalinity (mg/L)	258	**829**	525	-	154	435	752
Chloride (mg/L)	248	**12,200**	**6,875**	-	171	1,309	3,185
Calcium (mg/L)	33	**771**	**317**	1,000	18	84	215
Magnesium (mg/L)	16	**838**	**468**	2,000	27	108	389
Potassium (mg/L)	3	44	14	-	-	-	-
Sodium (mg/L)	213	**7,390**	**3,575**	-	135	747	1,500
Sulfate (mg/L)	23	**2,060**	**568**	1,000	12	140	318
Dissolved metals							
Aluminium (mg/L)	<0.001	0.18	0.18	5	-	-	-
Antimony (mg/L)	<0.001	<0.001	<0.001	-	-	-	-
Arsenic (mg/L)	<0.001	0.006	0.004	0.5	-	-	-
Iron (mg/L)	<0.05	**8.19**	**0.75**	-	0	0.03	0.14
Mercury (mg/L)	<0.0001	0.0011	0.0007	0.002	-	-	-
Molybdenum (mg/L)	<0.001	0.002	0.002	0.15	-	-	-
Selenium (mg/L)	<0.001	<0.001	<0.001	0.02	-	-	-

Parameter	Min	Max	Average	Stock water (ANZECC)	WQO Zone 34 Shallow <30 m (percentile)		
					20th	50th	80th
Silver (mg/L)	<0.001	0.006	0.002	-	-	-	-
Total metals							
Aluminium (mg/L)	<0.001	**286**	**24.2**	5	-	-	-
Antimony (mg/L)	<0.001	0.002	0.002		-	-	-
Arsenic (mg/L)	<0.001	0.022	0.007	0.5	-	-	-
Iron (mg/L)	<0.48	**494**	**31**	-	0	0.03	0.14
Mercury (mg/L)	<0.0001	**0.0912**	**0.016**	0.002	-	-	-
Molybdenum (mg/L)	<0.001	0.018	0.008	0.15	-	-	-
Selenium (mg/L)	<0.001	0.02	0.02	0.02	-	-	-
Silver (mg/L)	<0.001	0.002	0.002	-	-	-	-
Total Petroleum Hydrocarbons							
C10 - C14 (µg/L)	<50	130	52	-	-	-	-
C15 – C28 (µg/L)	<100	540	114	-	-	-	-
C29 - C36 (µg/L)	<50	520	70	-	-	-	-
Sum of C10 - C36 (µg/L)	<50	2,390	502	-	-	-	-
C10 - C16 (µg/L)	<100	<100	<100	-	-	-	-
C16 - C34 (µg/L)	<100	1,950	499	-	-	-	-
C34 - C40 (µg/L)	<100	940	400	-	-	-	-
Sum of C10 - C40 (µg/L)	<100	2,890	670	-	-	-	-
BTEX hydrocarbons							
Benzene (µg/L)	<1	<1	<1	-	-	-	-
Toluene (µg/L)	<2	<2	<2	-	-	-	-
Ethylbenzene (µg/L)	<2	<2	<2	-	-	-	-
Total Xylenes (µg/L)	<2	<2	<2	-	-	-	-
Naphthalene (µg/L)	<2	<2	<2	-	-	-	-

Notes: *- Not determined.*

µg/L = micrograms per litre

Red bold *values exceed the Stock water guidelines values.*

Black bold *values exceed the 80th % water quality objectives (WQO) values.*

These values are compared against the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines for stock watering (ANZECC, 2000), and the WQOs for the Mackenzie River Sub-basin shallow aquifers (<30 m depth)(DEHP, 2011). The following observations can be made with regard to the Tertiary aquifer water quality:

- The elevated maximum levels of sodium, calcium, magnesium, chloride, sulphate and alkalinity exceed the 80th percentile water quality objectives for shallow aquifers (<30 m depth).
- Detectable levels of total and dissolved metals concentrations are reported for aluminium, antimony, arsenic, iron, mercury, molybdenum, selenium and silver.
- The average and maximum total aluminium and mercury concentrations both exceed the stock watering guidelines and total and dissolved concentrations for iron exceed the and 80th percentile water quality objectives for shallow aquifers (<30 m depth).
- Detectable levels of total petroleum hydrocarbon (TPH) have been recorded in MW2, MW3, MW4, MW9A, and MW14A.
- Benzene, Toluene, Ethylbenzene and Xylene (BTEX) concentrations for all Tertiary monitoring bores were all below the laboratory detection levels.

The proportions of the major anions and cations were analysed to determine the hydrochemical facies of the Tertiary aquifer. The anion-cation balance is shown on the Piper diagram in Figure 6.4. The data shows that groundwater within the Tertiary aquifer ranges from a no dominant water to a sodium-chloride (Na-Cl) type water. The change in water type reflects a natural progression of water moving from a recharge zone into the shallow Tertiary aquifer.

Time series water quality data for the Tertiary aquifer bores are presented in Appendix E. Note that total and dissolved metals water quality is only presented for iron, mercury, selenium and silver as data for these parameters is available for the period 2013 to 2017. Data collected for aluminium, antimony, arsenic and molybdenum is not presented as this was only collected between 2013 and 2014.

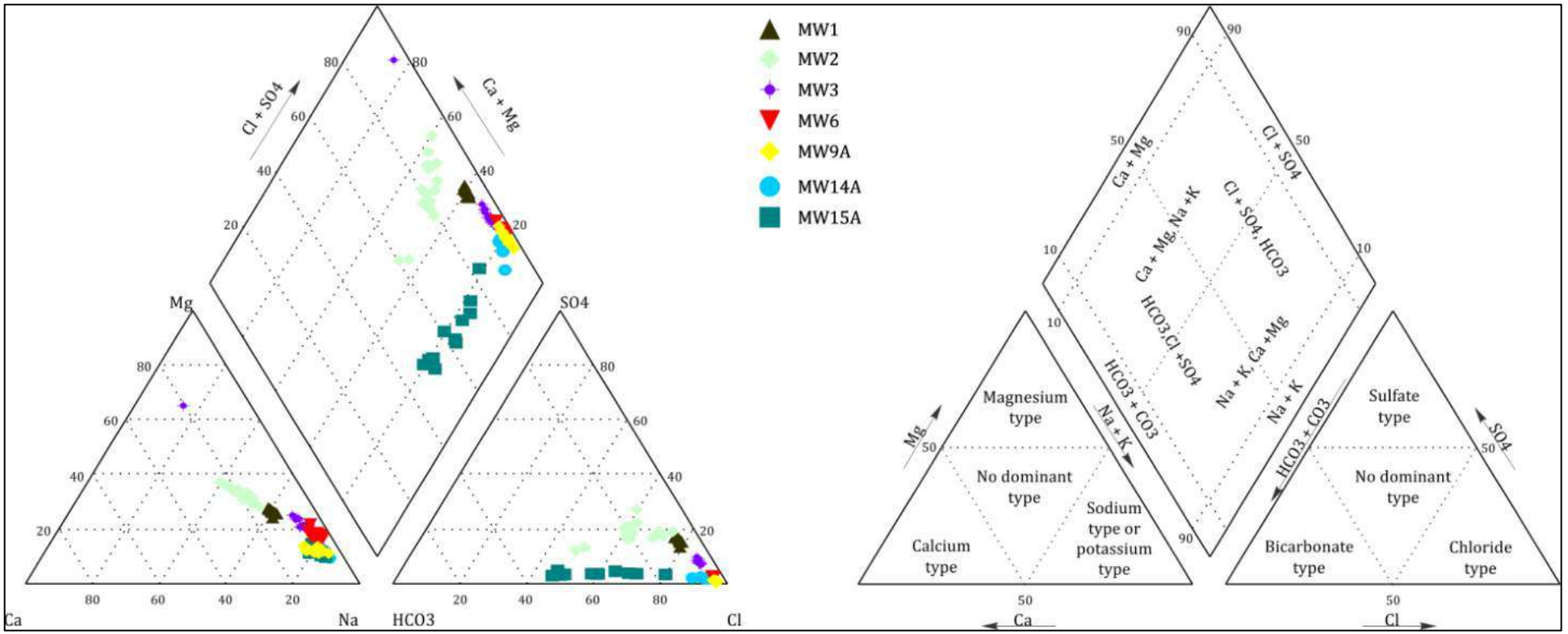


Figure 6.4 Piper diagram – Tertiary aquifer

6.7 Permian coal measures aquifer

6.7.1 Groundwater yield

The Permian strata includes coal seams interbedded with less permeable rock units such as sandstone, siltstone, and mudstones that are typically 'tight' and low yielding,

Bores do not commonly access the Permian aquifer due to the depth of water bearing strata and the typical high salinity of this type of water. However, where more attractive aquifers do not exist, bores are installed on occasion into the Permian coal measures where yield and water quality meet the intended purpose.

The DNRM GWDB and 2017 bore census indicates the potential for the Permian coal measures to be able to be moderately productive, and provide groundwater yields ranging between 0.04 litres per second (L/s) (Yard Bore) and 0.7 L/s (RN47037 – Blanches Bore). However, the Stage 2 EIS reported airlift yields in the Permian bores during drilling to be typically low and less than 1 litre per minute (L/min)(Parsons Brinkerhoff, 2010a).

6.7.2 Hydraulic parameters

The hydraulic parameters of the Permian coal seams have been determined at the Middlemount Coal Mine by in-situ falling and rising head slug tests that were performed by Parsons Brinkerhoff (2010a) on the Permian monitoring bores drilled for the Stage 2 EIS.

The tests indicated a hydraulic conductivity range of 4.9E-4 m/day to 1.6 m/day for the Middlemount Seam and 8.2E-2 m/day to 0.15 m/day for the Pisces Seam. This encompasses the generally accepted hydraulic conductivity for coal seams in the Bowen Basin of 1.0E-1 m/day near the coal seam sub-crop. The hydraulic parameter data obtained from these tests are summarised in Table 6.5.

Table 6.5 Summary of hydraulic parameters of Permian coal measures

Permian lithology	Hydraulic conductivity (m/day)		Number of tests
	Range	Average	
Middlemount Seam	4.9E-4 – 1.6	5.6E-2	6
Pisces Seam	8.2E-2 – 0.15	0.12	2
Fort Cooper Coal Measures	5.7E-5	5.7E-5	1

No assessment of aquifer storage parameters has been undertaken for Middlemount Coal Mine and literature values of specific yield for Bowen Basin coal seams are not common. Research undertaken by Mackie (2009) in the Hunter Valley estimated the specific yield in the Sydney Basin to range from less than 0.01 in dull weakly cleated coal to more than 0.03 in bright strongly cleated coal. Literature values of specific yield for siltstone and sandstone range between 0.06 and 0.2 (Heath, 1983; Morris and Johnson, 1967). A geometric mean of about 0.01 would be considered a reasonable estimate for the bulk specific yield of the Permian coal measure overburden / interburden within the study area.

Literature values of specific storage range between 1.0E-6 m^{-1} to 1.0E-4 m^{-1} for competent to fractured rock (Batu, 1998).

As a comparison, Arrow Energy (2012) assigned a specific storage value of 8.5E-5 m^{-1} to their base case numerical groundwater model to represent the main coal seams within the Bowen Basin.

6.7.3 *Groundwater recharge, levels, and flow*

Recharge of the Permian coal measures occurs in areas where they sub-crop beneath the Tertiary cover. The coal seams all sub-crop within the western portions of the Middlemount Coal Mine MLs.

Figure 6.5 presents hydrographs for a series of monitoring bores in the Permian coal measures at the Middlemount Coal Mine. The bores located nearest to the mining area (MW7M/7P, less than 300 m to east of the mine pit), show the greatest drawdown response was around 41 m in the Middlemount Seam and 25 m in the Pisces Seam. A 15 m drawdown was measured in MW1P before this bore was mined out in 2015. Permian coal measure monitoring bores MW5M/5P, which are located approximately 1,500 m north of the current mine area, show only a minor drawdown response of up to 5.9 m, whilst monitoring bores MW5 and MW9M/9P located between 900 m and 1,500 m south of the mining area show a drawdown to mining ranging between 0.2 m (MW9M) and 4 m (MW5).

The Permian monitoring bore within the Fort Cooper Coal Measures east of the mine pit (MW8FR) only shows a minor drawdown response of up to 5.7 m, whilst monitoring bore MW4 located between approximately 2,000 m south-west of the mining area shows no drawdown response to mining.

The variable decline observed in groundwater levels in these Permian monitoring bores provides an example of groundwater depressurisation that would be expected to be due to mining.

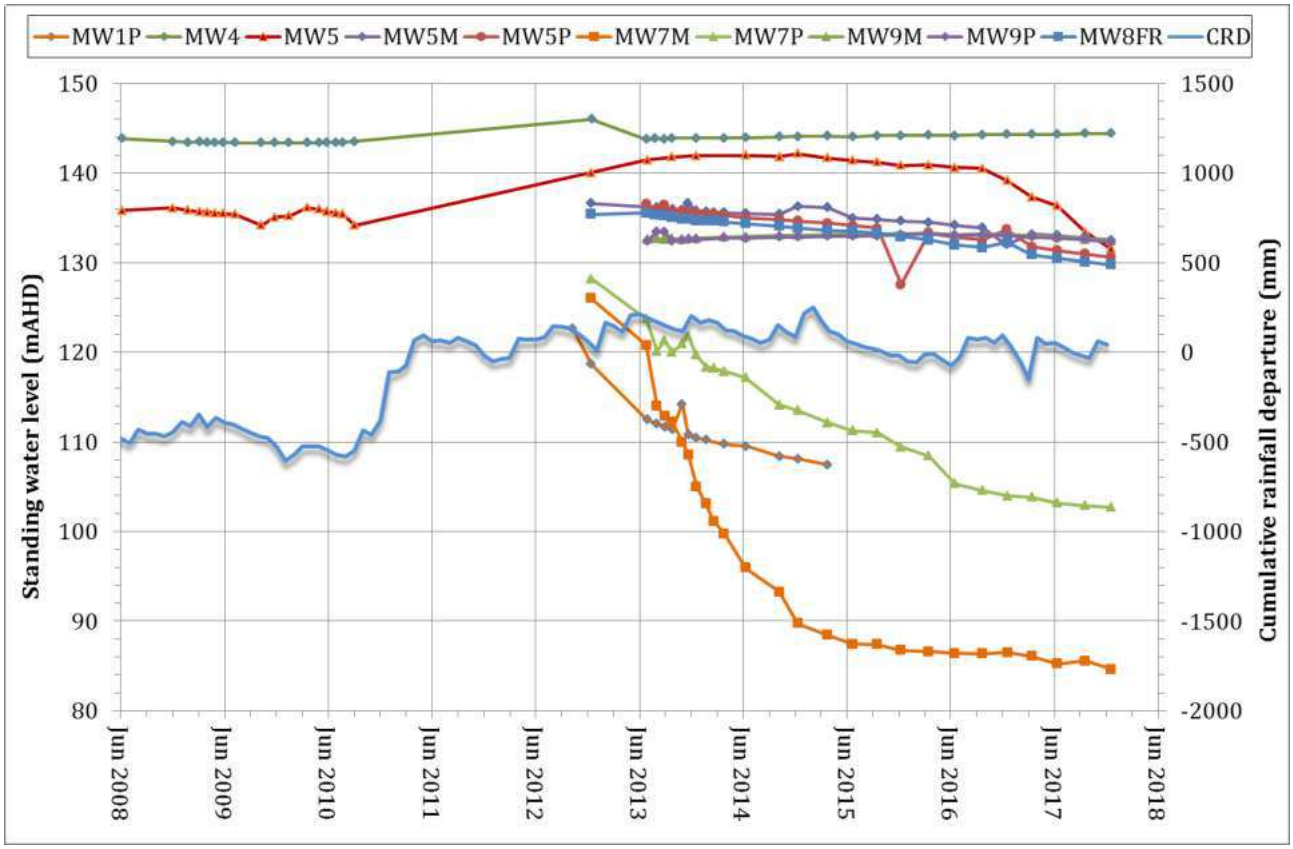


Figure 6.5 Measured groundwater levels in Permian coal measures monitoring bores

The similar groundwater levels observed in the paired monitoring bores MW5M/5P and MW9M/9P indicate no hydraulic gradient between the Middlemount and Pisces coal seams where located away from the current mine area, a common (Tertiary aquifer) recharge source to these coal seams. The diverging groundwater levels observed in MW7M/7P located nearest to the mining area suggest an initial depressurisation has occurred within the shallower Middlemount seam, followed by a more gradual depressurisation within the deeper Pisces seam as mining has progressed deeper.

6.7.4 *Groundwater quality*

The Permian coal measures water quality data identifies a similar quality groundwater to the overlying Tertiary aquifers. Table 6.6 summarises the maximum, minimum, and average values of groundwater chemical parameters for the Permian aquifer sampled between May 2013 and December 2017. This data indicates the Permian aquifer water quality is:

- slightly acidic to alkaline with field pH values ranging from 6.5 to 8.4;
- dominated by sodium and chloride; and
- brackish to saline with TDS ranging from 503 mg/L to 16,700 mg/L, with the majority of samples being saline.

Table 6.6 Summary of water quality analyses – Permian aquifers

Parameter	Min	Max	Average	Stock water (ANZECC)	WQO Zone 34 Deep >30 m (percentile)		
					20th	50th	80th
Field EC# (µS/cm)	868	**22,200**	**15,956**	-	3,419	6,100	16,000
Laboratory EC# (µS/cm)	816	**22,800**	**14,914**		3,419	6,100	16,000
Field pH	6.5	**8.4**	7.0	-	7.4	7.8	8.03
Laboratory pH	6.9	**8.3**	7.6		7.4	7.8	8.03
TDS (mg/L)	503	**16,700**	**9,758**	4,000 (beef) 2,500 (dairy) 5,000 (sheep) 4,000 (horses) 4,000 (pigs) 2,000 (poultry)	-	-	-
Carbonate Alkalinity (mg/L)	<1	10	1.2	-	359	919	3,208
Bicarbonate Alkalinity (mg/L)	282	**680**	517	-	188	330	650
Total Alkalinity (mg/L)	243	**878**	501	-	156	275	536
Chloride (mg/L)	63	**8,180**	5,404	-	753	1,900	5,905
Calcium (mg/L)	37	**489**	271	1,000	46	145	442
Magnesium (mg/L)	26	**578**	358	2,000	35	115	491
Potassium (mg/L)	1	29	14	-	-	-	-
Sodium (mg/L)	57	**4,050**	**2,666**	-	480	1100	2,565
Sulfate (mg/L)	3	**552**	281	1,000	25	138	398
Dissolved metals							
Aluminium (mg/L)	<0.01	0.15	0.12	5	-	-	-
Antimony (mg/L)	<0.001	<0.001	<0.001	-	-	-	-
Arsenic (mg/L)	<0.001	0.028	0.004	0.5	-	-	-
Iron (mg/L)	<0.05	**10.6**	**2.47**	-	0	0.05	0.246
Mercury (mg/L)	<0.0001	<0.0001	<0.0001	0.002	-	-	-

Parameter	Min	Max	Average	Stock water (ANZECC)	WQO Zone 34 Deep >30 m (percentile)		
					20th	50th	80th
Molybdenum (mg/L)	<0.001	0.007	0.002	0.15	-	-	-
Selenium (mg/L)	<0.001	<0.001	<0.001	0.02	-	-	-
Silver (mg/L)	<0.001	0.002	0.001	-	-	-	-
Total metals							
Aluminium (mg/L)	<0.01	**16.7**	0.63	5	-	-	-
Antimony (mg/L)	<0.001	0.003	0.003		-	-	-
Arsenic (mg/L)	<0.001	0.028	0.003	0.5	-	-	-
Iron (mg/L)	0.09	**63.9**	**4.7**	-	0	0.05	0.246
Mercury (mg/L)	<0.0001	0.0009	0.0004	0.002	-	-	-
Molybdenum (mg/L)	<0.001	0.007	0.003	0.15	-	-	-
Selenium (mg/L)	<0.01	<0.01	<0.01	0.02	-	-	-
Silver (mg/L)	<0.001	0.01	0.003	-	-	-	-
Total Petroleum Hydrocarbons							
C10 - C14 (µg/L)	<50	340	63	-	-	-	-
C15 – C28 (µg/L)	<100	1,870	202	-	-	-	-
C29 - C36 (µg/L)	<50	2,060	134	-	-	-	-
Sum of C10 - C36 (µg/L)	<50	4,010	793	-	-	-	-
C10 - C16 (µg/L)	<100	470	470	-	-	-	-
C16 - C34 (µg/L)	<100	2,990	700	-	-	-	-
C34 - C40 (µg/L)	<100	1,390	570	-	-	-	-
Sum of C10 - C40 (µg/L)	<100	4,850	1,063	-	-	-	-
BTEX hydrocarbons							
Benzene (µg/L)	<1	<1	<1	-	-	-	-
Toluene (µg/L)	<2	<2	<2	-	-	-	-
Ethylbenzene (µg/L)	<2	<2	<2	-	-	-	-
Total Xylenes (µg/L)	<2	<2	<2	-	-	-	-
Naphthalene (µg/L)	<2	<2	<2	-	-	-	-

Notes: *# EC – Electrical conductivity.*

- Not determined.

Red bold *values exceed the Stock water guidelines values.*

Black bold *values exceed the 80th % water quality objectives (WQO) values.*

Table 6.6 summarises the maximum, minimum, and average values of groundwater chemical parameters for samples collected from the Permian aquifer. These values are compared against the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines for stock watering (ANZECC, 2000) and the Mackenzie River Sub-basin water quality objectives for deep aquifers (>30 m depth)(DEHP, 2011). The following observations can therefore be made with regard to the Permian aquifer water quality:

- The elevated maximum levels of sodium, calcium, magnesium, chloride, sulphate, bicarbonate and alkalinity exceed the 80th percentile water quality objectives for deep aquifers (>30 m depth).
- Detectable levels of total and dissolved metals concentrations are reported for aluminium, antimony, arsenic, iron, mercury, molybdenum and silver.
- The maximum total aluminium concentrations exceed the stock watering guidelines and total and dissolved concentrations for iron exceed the 50th and 80th percentile water quality objectives for deep aquifers (>30 m depth).
- Detectable levels of TPH have been recorded in MW4, MW5, and MW7P.
- BTEX concentrations for all Permian monitoring bores were all below the laboratory detection levels.

The proportions of the major anions and cations were analysed to determine the hydrochemical facies of the Permian aquifer. The anion-cation balance is shown on the Piper diagram in Figure 6.6. The data shows that groundwater within the Permian coal seams ranges from a no dominant water type to a sodium-chloride type water, with both water types identified in bore MW5. Bore MW5 intersects the Pisces Seam where it subcrops below the Tertiary sediments. The change in water type most likely reflects a natural progression of carbonate dissolution in the shallow unsaturated zone during recharge, followed by precipitation of carbonates as groundwater moves downwards through the Tertiary sediments into the deeper coal seam.

Time series water quality data for the Permian aquifer bores are presented in Appendix E. Note that total and dissolved metals water quality is only presented for iron, mercury, selenium and silver as data for these parameters is available for the period 2013 to 2017. Data collected for aluminium, antimony, arsenic and molybdenum is not presented as this was only collected between 2013 and 2014.

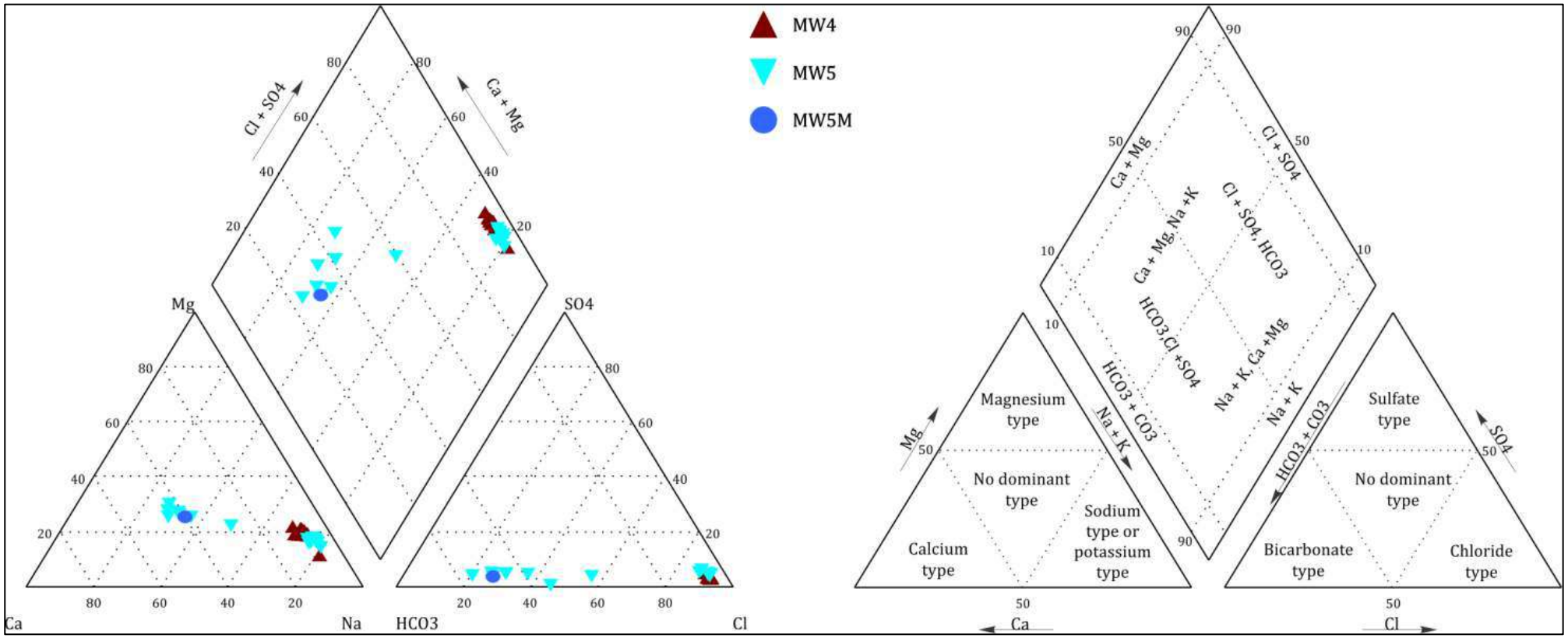


Figure 6.6 Piper diagram – Permian coal measures aquifer

6.8 Groundwater dependent ecosystems

A Groundwater Dependent Ecosystem (GDE) is one in which the plant and animal community is dependent on the availability of groundwater to maintain its structure and function. The BoMs GDE Atlas shows ecosystems including springs, wetlands, rivers, and vegetation that interact with the subsurface presence of groundwater, or the surface expression of groundwater (BoM, 2017). The Atlas categorises GDEs into two classes in Queensland. These are ecosystems that potentially rely on the:

- surface expression of groundwater - this includes all the surface water ecosystems which may have a groundwater component, such as rivers, wetlands, and springs; and
- subsurface presence of groundwater - this includes all vegetation ecosystems.

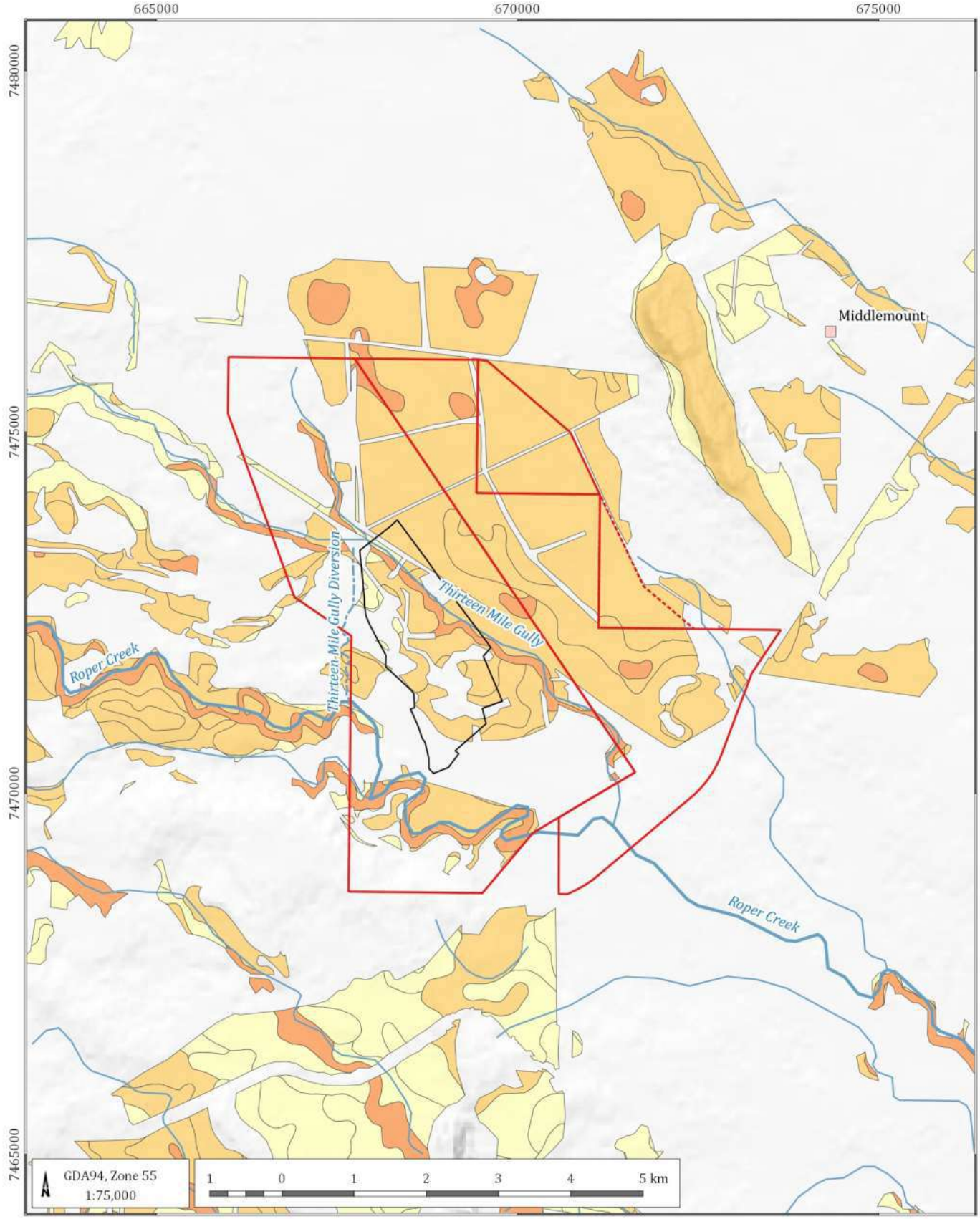
Figure 6.7 shows the potential GDE's identified by the BoM GDE mapping within and around Middlemount Coal Mine. This shows much of the surrounding land that is still treed has been mapped as a "terrestrial" GDE, and appears to be based heavily upon the extent of this existing treed vegetation within this area, which includes:

- Terrestrial vegetation associated with Thirteen Mile Gully and Roper Creek which is mapped as a high potential GDE that is *"marginally more likely to access an additional source of water than rely solely on rainfall"*;
- Terrestrial vegetation, tree swamps (Melaleuca and Eucalypt) associated with palustrine wetlands which is mapped as a high potential GDE that "*is possibly likely to access an additional source of water than rely solely on rainfall"* outside the MLs (ML 700417 and ML 70379); and
- Aquatic wetland/riverine habitat within watercourses associated with Thirteen Mile Gully and Roper Creek, which is mapped as a moderate potential GDE that is "*likely to access an additional source of water than rely solely on rainfall"*.

The depth to groundwater within the Tertiary sediments in these areas ranges between 12 mbgl (MW10A) and 40 mbgl (MW4), with an average depth of 25.5 mbgl. Groundwater levels within the Tertiary sediments at MW2 adjacent to Roper Creek have ranged between 18.9 mbgl and 22.7 mbgl. Based on the depth to groundwater within the Tertiary sediments being in excess of 10 mbgl, and around 20 mbgl adjacent to Roper Creek, and the ephemeral nature of Roper Creek and Thirteen Mile Gully, these mapped areas are considered as not being entirely dependent on groundwater interaction.

Desktop mapping of potential GDEs throughout Queensland (BoM, 2017[1]) indicates that areas of with possible high, moderate and low potential for groundwater interaction occur within the Project locality (Figure 6.7).

[1] DSITI (2017) GDE mapping covers a portion of the Project area, however contains data gaps in the surrounding area. The two data sources show consistent mapping for the extent which they overlap.



LEGEND

- PopPlaces-clipped
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Mine pit footprint, 2017
- Watercourse
- Drainage feature

GDE Atlas - Surface GDEs that rely on the subsurface presence of groundwater

- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction

Middlemount Coal Mine Western Extension Project (G1840D)

Groundwater Dependent Ecosystems - GDE Atlas

DATE 06/04/2018

FIGURE No: **6.7**

©2018 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/06.05_G1840D_Groundwater Dependent Ecosystems.qgs

The desktop GDE mapping (BoM, 2017) indicates:

- Terrestrial vegetation associated with watercourses (Roper Creek) and a drainage line (Drainage Line 1) is mapped as having a high potential to be associated with subsurface presence of groundwater.
- Aquatic habitat associated with watercourses (Roper Creek) and a drainage line (Drainage Line 1) is mapped as having a moderate potential to be reliant on surface expression of groundwater.
- Terrestrial vegetation and aquatic habitat associated with palustrine wetlands outside of ML 70417 and ML 70379 is mapped as having a high potential to be associated with subsurface presence of groundwater.

All other terrestrial vegetation (Regional Ecosystems mapped by DSITI, 2017), is broadly mapped as having a low to moderate potential of being associated with subsurface presence of groundwater (BoM, 2017).

The following conclusions can be made in relation to the presence/absence of GDEs in the Project locality based on the desktop review of the GDE mapping (BoM, 2017):

- The majority of the terrestrial vegetation associated with Roper Creek and Drainage Line 1 is unlikely to be dependent on groundwater given the vegetation along these drainage features also occurs more widely across the landscape and is not restricted to areas where it could potentially access groundwater (Naturecall Environmental, 2018). There are small areas of RE 11.3.25 along Roper Creek which contains Queensland Blue Gum (*Eucalyptus tereticornis*) and River Oak (*Casuarina cunninghamiana*) which are sometimes reliant on access to groundwater, however, the groundwater levels adjacent to Roper Creek range between 18.9 mbgl and 22.7 mbgl. Based on the depth to groundwater surrounding Roper Creek being around 20 mbgl it is unlikely that these communities would be reliant on access to groundwater (Naturecall Environmental, 2018).
- Aquatic habitat associated with Roper Creek and Drainage Line 1 is unlikely to be dependent on groundwater given the ephemeral nature of the drainage features (Plates 1 and 2).
- Terrestrial vegetation and aquatic habitat associated with palustrine wetlands north of ML 70417 and ML 70379 could potentially be reliant on groundwater given the regional ecosystem mapped in these areas by DSITI (2017). DSITI (2017) has mapped these areas as RE 11.3.27, which contains River Red Gum (*Eucalyptus camaldulensis*) and Queensland Blue Gum (*Eucalyptus tereticornis)*, both species that could be reliant on subsurface expression of groundwater to some degree. However, groundwater levels in this area have been identified as being in excess of 12 mbgl, it is unlikely that these communities would be reliant on groundwater (Naturecall Environmental, 2018).
- All other terrestrial vegetation is unlikely to be dependent on groundwater given that there is no evidence that any vegetation surrounding the Project area has experienced any impacts (i.e. dieback) from the existing operations.

6.9 Stygofauna

Stygofauna are small specialised subterranean aquatic invertebrates that are found in aquifers across Australia and the rest of the world. Stygofauna are predominantly found in aquifers with large (mm or greater) pore spaces, especially alluvial aquifers, and less frequently fractured rock aquifers (Hose *et al.*, 2015). Stygofauna have occasionally been recorded in coal seam aquifers, notably in coal seams that are hydraulically connected to a shallow alluvial aquifer.

The majority of stygofauna are found in locations where food supply and oxygen are more plentiful. The optimal conditions for stygofauna have been identified as:

- alluvial systems with large pore spaces;
- water levels within 20 m of ground surface for unconsolidated sediments and within 30 m for fractured rock aquifers;
- EC of less than <2,000 µS/cm for unconsolidated sediments and 5,000 µS/cm for fractured rock aquifers; and
- pH of approximately 6.5 – 8.5.

There is the potential for mining activities to impact on stygofauna habitats if they are present in the aquifer units near to the mines.

The Stygofauna assessment for the Foxleigh Plains Project EIS (ALS, 2012) included a desktop review of the likely potential and subsequent sampling for Stygofauna. The assessment concluded that water quality and depth to water limited the potential for Stygofauna habitat. Stygofauna sampling did not detect any Stygofauna species, and the site assessment confirmed the project was unlikely to impact on endemic Stygofauna species within the geology targeted by the project.

The Stygofauna assessment for the Bowen Gas Project (4T Consultants, 2012) identified that Roper Creek provided the best opportunity for suitable habitat for Stygofauna species in the region adjacent to Middlemount Coal Mine. That is, stygofauna could be more likely to occur in aquifers with a pH value between 6.5 and 8.5 and the EC is less <2,000 µS/cm. However, given the shallow Quaternary alluvium is considered to be predominantly dry in the vicinity of Middlemount Coal Mine, it is therefore unlikely to support any Stygofauna. Similarly, Stygofauna in coal seams was considered rare due to the low permeability and reduced connectivity to recharge and water quality.

A desktop review of the likely potential for stygofauna at the Middlemount Coal Mine based on the optimal conditions for stygofauna habitat is summarised in Table 6.7. This would suggest that the potential for optimal stygofauna habitat at Middlemount Coal Mine is unlikely given that average salinity in both the Tertiary and Permian aquifers exceeds 20,000 µS/cm, and the average depth to groundwater in the Permian aquifer is greater than 30 mbgl. This is in line with findings of similar studies undertaken for the Foxleigh Plains Project and the Bowen Gas Project.

Despite stygofauna being unlikely to be found at the Middlemount Coal Mine due to poor groundwater quality and otherwise lack of groundwater, a number of bores around the Middlemount Coal Mine were sampled for stygofauna in 2011. The sampling found what was likely a naturally low diversity of stygofauna (taxa from two Families[2] – Copepoda [a crustacean] and Oligochaeta [a worm]) from bores in and outside the maximum zone of drawdown (e.g. some 5-7 km north-west and south-east).

[2] The taxa could not be identified to species level.

Table 6.7 Potential stygofauna habitat at Middlemount Coal Mine

Aquifer	EC range and average EC (µS/cm)	pH range and average pH	Groundwater depth and average depth (m)	Strata	Stygofauna potential
Alluvial deposits	dry	dry	dry	Unconsolidated sediments	Unlikely as sediments are generally assessed to be dry
Tertiary	2,970 to 32,400. Average 21,139	6.5 to 8.5. Average 7.2	7.7 to 25.3. Average depth 17.5	Unconsolidated sediments	Unlikely due to elevated EC levels > 2,000 µS/cm
Permian	1,072 to 30,900. Average 20,055	6.5 to 7.9. Average 7.1	23.53 to 75.06. Average depth 41.01	Consolidated sediments	Possible where EC levels <5,000 µS/cm, and depth to water is less than 30 m. Unlikely due to elevated average EC levels > 5,000 µS/cm, and depth to water is greater than 30 m

6.10 Hydraulic influence of faults

The regional tectonic setting of the Bowen Basin is largely compressive and as a consequence faults and folds are more likely to be hydraulic barriers than conduits to lateral groundwater flow (Arrow Energy, 2012). Some faults may also limit flow by vertical displacement of strata (aquifers with aquitards) or by infilling within the fractures. The Stage 2 EIS (Parsons Brinkerhoff, 2010a) identified the Jellinbah Fault as being a barrier to groundwater flow east of the fault and mining area as a result of the 300 m displacement.

Fault delineation drilling by MCPL in 2017 included 36 boreholes drilled along the Jellinbah Fault which intersected sedimentary units from both the Rangal Coal Measures and Fort Cooper Coal Measures. Groundwater was intersected at 17 sites within either the base of the Tertiary sediments or the underlying Permian coal measures. Generally minor groundwater flows were intersected with measurable flows up to 0.2 L/s. Two boreholes that did intersect higher groundwater yields (0.4 L/s and 1.8 L/s) were considered to be associated with localised fracture zones of limited groundwater storage.

It is generally agreed amongst hydrogeologists that faults should not necessarily be represented in a groundwater flow model if there is evidence that they do not act as a barrier to groundwater flow. In the natural groundwater system, for example, a fault may act as a barrier to groundwater flow where the vertical offset results in coal seams (i.e. the main groundwater conduit) being truncated against lower-permeability interburden. However, where the vertical offset results in one coal seam being fully or partially connected to another coal seam, the hydraulic connection across the fault may be unimpeded with the potential for groundwater seepage (hydraulic loading) from the adjacent offset coal measures.

Hence, groundwater flow within the Permian coal measures may, or may not, be influenced by the hydraulic parameters of the Jellinbah Fault and the associated secondary faulting to the east and west as part of this thrust complex. These faults are orientated northwest-southeast, with the Middlemount Coal Mine open pit located southwest of the Jellinbah Fault (Figure 5.4).

6.11 Groundwater use and extraction

6.11.1 Landholder groundwater use

Limited details for landholder bores are available for construction, equipment, and operation, and landholder water requirements are not registered. For this reason, it is not possible to accurately determine the total landholder extraction rates. However, an estimate of groundwater extraction (based on DNRM GWDB bore reports and the bore census) was made by Parsons Brinkerhoff (2010a).

Available registered landholder bore yields obtained from the DNRM GWDB identifies these bores are mostly constructed into the Permian strata which indicates that the landholder bores take groundwater ranges between <0.1 L/s to 0.5 L/s. The hydrocensus undertaken for unregistered landholder bores indicated the three bores identified were only used in emergencies for stock watering. Whilst all could be used as a water supply, only one was equipped with a pump. The maximum estimated pumping usage for these bores was approximately 45 cubic metres per day (m^3/day) which converts to about 0.5 L/s (when pumping for 24 hours per day). The depth to water in these bores ranged between 15 mbgl and 41 mbgl. No information was provided regarding geology or source aquifer, bore construction, drawdown, and seasonal variations in pumping water levels, or recharge. All bores were identified to be located east of the Jellinbah Fault. The bore census has identified there are five number of active bores east of the Jellinbah Fault

The Stage 2 EIS groundwater model did not include landholder extraction (Parsons Brinckerhoff, 2010a).

6.11.2 Mine groundwater extraction

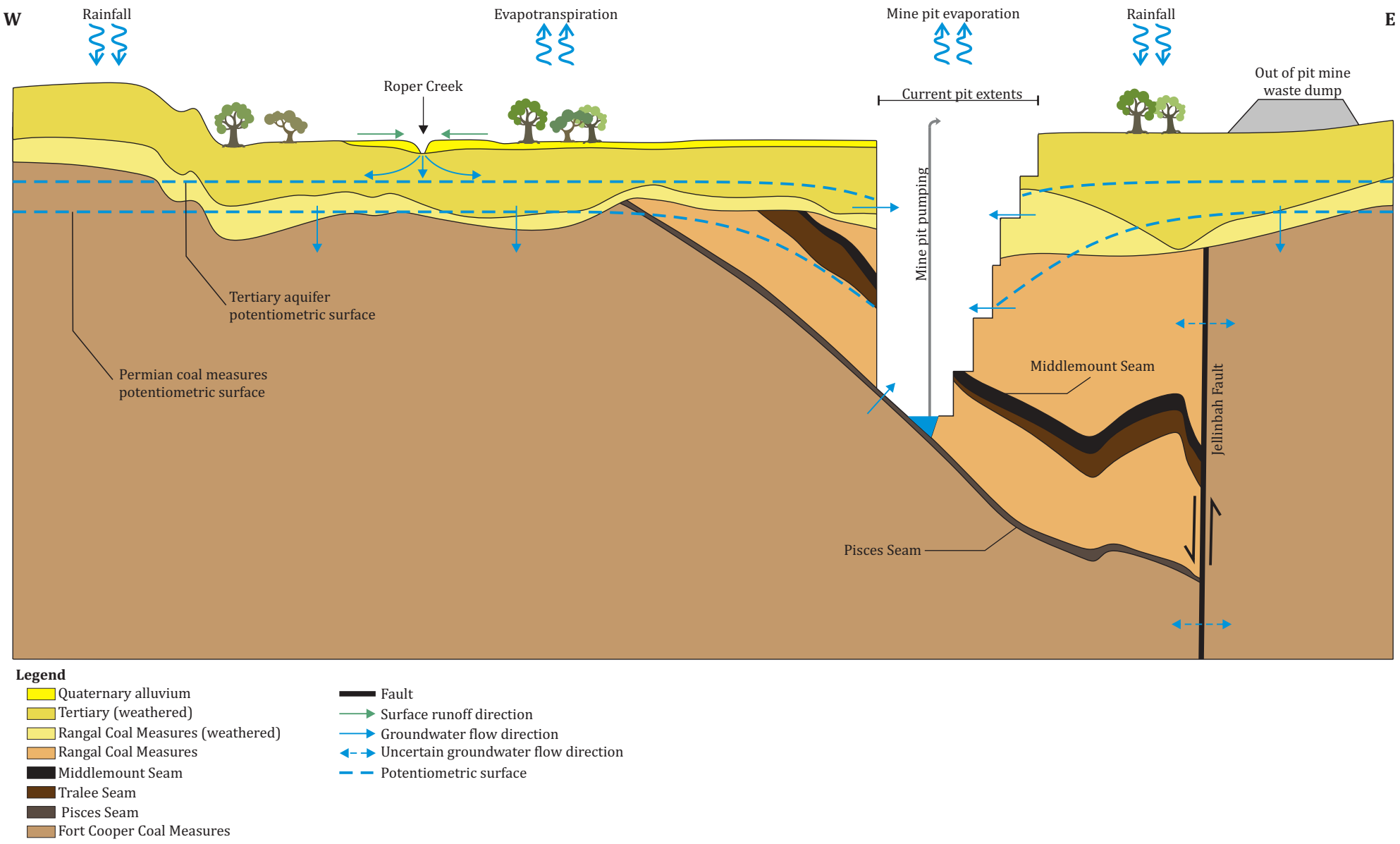
An assessment of the of the estimated monthly groundwater inflows to the Middlemount Coal Mine was undertaken by WRM Pty Ltd (WRM)(memorandum dated 5 October, 2017) for a 10 month period which includes data assessed for October 2015, May 2016 and between February and September 2017. Groundwater inflows have been assessed from metered pit dewatering data and a site water balance model.

The assessed groundwater inflows were calculated as the balance of the pumped volume after accounting for inflows from surface runoff and evaporation from the mining face. The calculated groundwater inflows exclude any losses due to evaporation and are therefore representative of groundwater seepage from the aquifer reporting to the pit face. Over the 10 month (304 days) reporting period, the total groundwater inflows were estimated at 697.2 megalitres (ML). The average daily pit inflows ranged from 1 megalitre per day (ML/day) to 5 ML/day, with an average inflow of 2.3 ML/day.

6.12 Summary of conceptual groundwater model

The conceptual groundwater model for the Middlemount Coal Mine is presented graphically in Figure 6.8. The conceptual groundwater model section illustrates the main hydrogeological processes and mechanisms within the Middlemount Coal Mine, including recharge, flow directions, discharge, and anthropogenic activities (i.e. mine dewatering).

The geology surrounding the Middlemount Coal Mine comprises a relatively thin cover of Quaternary and Tertiary sediments overlying Permian coal measures which dip to the east. The main groundwater bearing units at the Middlemount Coal Mine are the Tertiary (Duaringa Formation) aquifer, and the Rangal Coal Measures coal seams. The Quaternary alluvium is limited in extent to Roper Creek and part of Thirteen Mile Gully.



East to West Hydrogeological Conceptualisation

Figure 6.8

Middlemount Coal Mine Western Extension Project (G1840D)

Where saturated, recharge to the Quaternary alluvium can occur via direct rainfall onto the alluvium, and seepage through the stream bed, when the creeks are flowing.

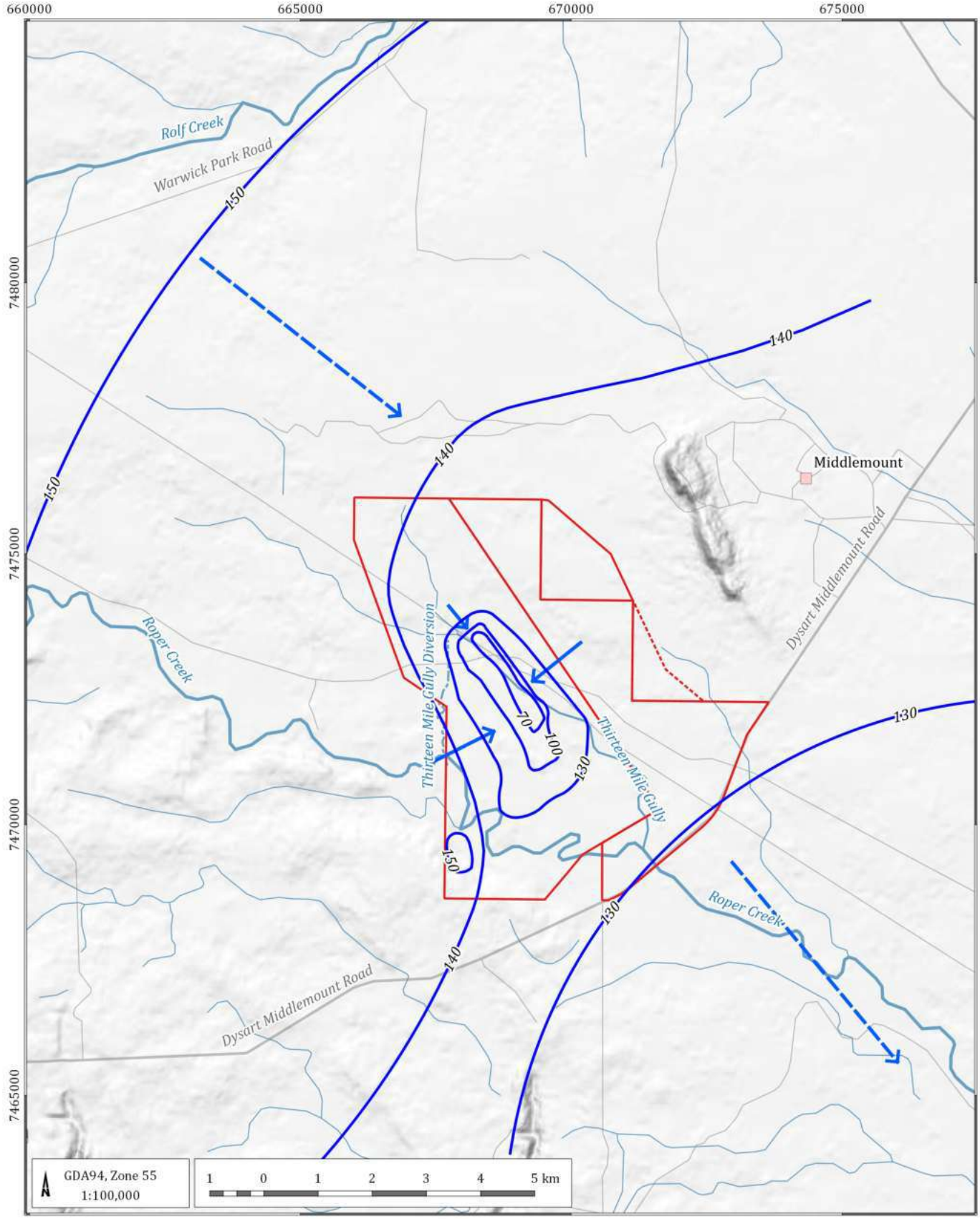
Recharge of the Tertiary aquifer occurs by direct infiltration of rainfall, via slow leakage through the overlying Tertiary clay sediments. Ephemeral watercourses such as Roper Creek would also contribute a proportion of recharge into the Tertiary aquifer through infiltration during periods of stream flow. Recharge of the Permian coal measures occurs in areas where the coal seams sub-crop beneath the Tertiary cover.

The depth to groundwater within the Tertiary sediments being in excess of 10 mbgl, and around 20 mbgl adjacent to Roper Creek, indicates Roper Creek to be a losing stream with limited to nil potential for a baseflow contribution from the Tertiary aquifer. This correlates with the extended periods of zero flow observed within Roper Creek (refer Section 4.2.1). Similarly, groundwater uptake by terrestrial vegetation from the Tertiary aquifer and loss through evapotranspiration is also considered unlikely, with the take of any water by vegetation most likely to be from soil moisture within the unsaturated zone.

The regional water table within the Tertiary aquifer is a subdued reflection of topography with a general flow towards the south-east. The exception to this is immediately around the mine where groundwater levels would have declined due to localised depressurisation resulting from mining. Figure 6.9 presents current groundwater levels inferred for the Tertiary aquifer.

The coal measures form confined groundwater systems and they sub-crop beneath the Tertiary aquifers. The direction of groundwater flow for the Permian coal measures is influenced by the local geomorphology and structural geology (i.e. faults), and around the mine where groundwater levels have declined as a result of depressurisation from mining. The regional water table within the Permian Rangal Coal Measures aquifer is therefore constrained within the lateral extents of these coal measures west of the Jellinbah Fault and within ML 70379 as shown in Figure 5.4. Where unaffected by mining, groundwater flow is assessed to roughly coincident with the Tertiary aquifer and generally towards the southeast. Similarly, the exception to this is immediately around the mine where groundwater levels have declined due to localised depressurisation resulting from mining. Figure 6.10 presents current groundwater levels inferred for the Permian Rangal Coal Measures aquifer.

Based on the fault delineation drilling by MCPL in 2017 (Section 6.10), it is assessed that vertical displacement along the Jellinbah Fault alignment has resulted in the Rangal Coal Measures coal seams being truncated against lower permeability Fort Cooper Coal Measures interburden. That is groundwater flow/movement to the east across the Jellinbah Fault is not halted, rather it is slowed as a result of the lower permeability Fort Cooper Coal Measures interburden sediments.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Road
- Watercourse
- Drainage feature
- Inferred groundwater contours (mAHD)
- Regional groundwater flow direction
- Local mine induced groundwater flow direction

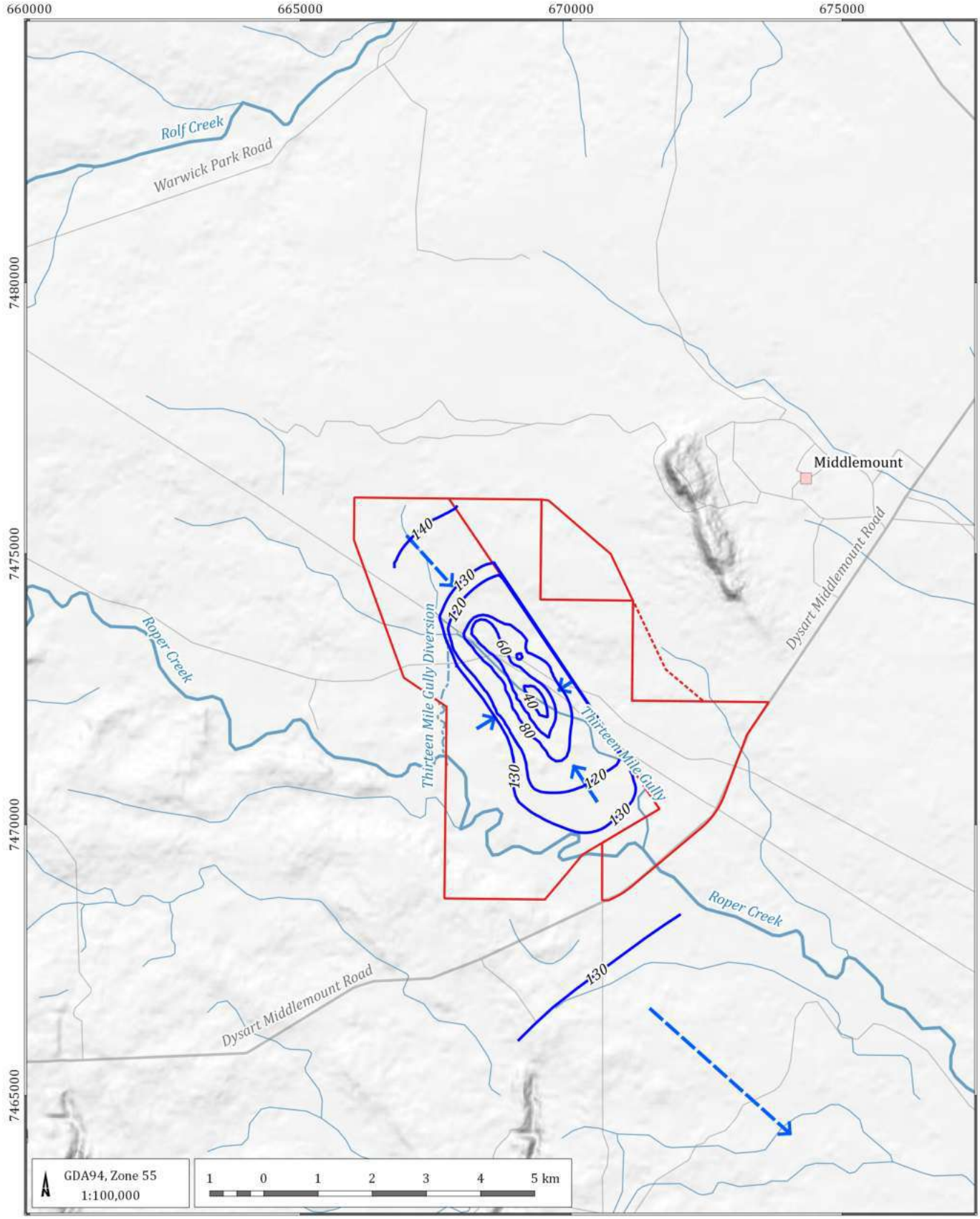
Middlemount Coal Mine Western Extension Project (G1840D)

Inferred 2017 Tertiary aquifer groundwater levels

DATE 04/06/2018

FIGURE No: **6.9**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/06.09_G1840D_Inferred 2017 Tertiary aquifer groundwater levels.qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Road
- Watercourse
- Drainage feature
- Inferred groundwater contours (mAHD)
- Regional groundwater flow direction
- Local mine induced groundwater flow direction

Middlemount Coal Mine Western Extension Project (G1840D)

Inferred 2017 Permian Rangal Coal Measures groundwater levels

DATE 04/06/2018

FIGURE No: **6.10**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/06.10_G1840D_Inferred 2017 Permian Rangal Coal Measures groundwater levels.qgs

7 Environmental value of groundwater

The EPP Water (Section 3.3) provides a framework to protect and/or enhance the environmental values and hence suitability of Queensland waters (including groundwater) for various beneficial uses. Groundwater resources within the Project area lie within the Mackenzie River Sub-basin (DEHP, 2011), in which the environmental values for groundwaters that need to be considered include:

- aquatic ecosystems;
- irrigation;
- farm supply/use;
- stock water;
- drinking water;
- industrial purposes; and
- cultural and spiritual values.

The Mackenzie River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2011) provides general WQO to support and protect the various environmental values identified for waters. The WQO are long-term goals for water quality management. Each of the environmental values listed above are discussed below to identify those that are relevant to the Project.

7.1 Aquatic ecosystem

As discussed in Section 6.8, there are no known springs or seeps within the Project area and no obligatory GDEs have been identified in within the Project area. The nearest mapped spring is associated with the Blackdown Tablelands National Park approximately 100 km south of the Project site.

Regionally, groundwater flow within the underlying aquifers is towards the south-east. Groundwater levels are generally in excess of 25 mbgl and separated from surface waters, limiting potential to support GDEs. There are no springs from these deep confined aquifers within the Project area or surrounds that would support GDEs.

7.2 Irrigation and farm supply/use

Groundwater is not used for irrigation or farm supply within (and neighbouring) the Project area. There are no known irrigation bores located within 10 km of the Project area.

7.3 Stock water

As discussed in Section 6.4, there is no significant groundwater usage within (and neighbouring) the Project area. The primary agricultural purpose of land within and surrounding the Project area has been low intensity cattle grazing.

The WQOs for Mackenzie River Sub-basin groundwaters are provided or tolerances of livestock to TDS (salinity) in drinking water and are adapted based on the guidelines presented in ANZECC (2000). Table 7.1 presents the tolerance of livestock to TDS in drinking water. The groundwater quality data for the site monitoring bores identifies this water would be unsuitable for stock watering based on the naturally elevated TDS levels (refer Section 6.6.4 and Section 6.7.4).

Table 7.1 Stock watering environmental values: Tolerance of livestock to TDS in drinking water[1]

Livestock	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0 – 4,000 mg/L	4,000 mg/L – 5,000 mg/L	5,000 mg/L – 10,000 mg/L
Dairy cattle	0 – 2,500 mg/L	2,500 mg/L – 4,000 mg/L	4,000 mg/L – 7,000 mg/L
Sheep	0 – 5,000 mg/L	5,000 mg/L – 10,000 mg/L	10,000 mg/L – 13,000 mg/L[2]
Horses	0 – 4,000 mg/L	4,000 mg/L – 6,000 mg/L	6,000 mg/L – 7,000 mg/L
Pigs	0 – 4,000 mg/L	4,000 mg/L – 6,000 mg/L	6,000 mg/L – 8,000 mg/L
Poultry	0 – 2,000 mg/L	2,000 mg/L – 3,000 mg/L	3,000 mg/L – 4,000 mg/L

Notes: *1 - From ANZECC (1992), adapted to incorporate more recent information.*

2 - Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.

Water quality objectives are also provided for trace metal (heavy metals and metalloids) concentrations in livestock drinking water, these are summarised in Table 7.2. Water quality data for dissolved metals reported for the Project monitoring bores is below these WQOs.

Table 7.2 Stock watering environmental values: Low risk trigger values for heavy metals and metalloids in livestock drinking water

Element	Trigger value (low risk)[1] (mg/L)
Aluminium	5
Arsenic	0.5 (up to 5[2])
Berylium	ND[3]
Boron	5
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry)
Fluoride	2
Iron	Not sufficiently toxic
Lead	0.1
Manganese	Not sufficiently toxic
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02

Element	Trigger value (low risk)[1] (mg/L)
Uranium	0.2
Vanadium	ND[3]
Zinc	20

Notes: *1 - Higher concentrations may be tolerated in some situations (details provided in AWQG, Volume 3, Section 9.3.5).*

2 - May be tolerated if not provided as a food additive and natural levels in the diet are low.

3 - ND – not determined, insufficient background data to calculate.

Metal values relate to the total concentration of the constituent.

7.4 Drinking water

Data indicates that groundwater quality in the Project area is brackish to saline and not suitable for human consumption.

7.5 Industrial purposes

The Project will recycle groundwater that seeps into the open cut pit. The water will be pumped to holding dams, where it will be incorporated into the mine water balance.

No WQOs are provided for industrial use as water quality requirements for industry vary within and between industries. Similarly, ANZECC (2000) does not provide guidelines for industry, and indicates that industrial water quality requirements need to be considered on a case-by-case basis. Based on this approach, groundwater accessed by the Project would provide a beneficial industrial use.

7.6 Cultural and spiritual values

No WQOs are provided for cultural and spiritual values, would need to be such that they *"protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans"* (DEHP, 2011). There are no known environmental values in relation to cultural and spiritual values of groundwater within the Project area.

8 Numerical modelling

A three-dimensional numerical groundwater flow model was developed for the Project and was designed to account for the current and proposed mine plan. The objective of modelling this groundwater system was to simulate the progressive development of the proposed open pit and provide a tool to predict potential groundwater level drawdown, aquifer depressurisation, and groundwater inflow to the open cut pits. The groundwater model has also been used to simulate the cumulative progression of the Project and the existing Middlemount Coal Mine, and the neighbouring mines.

The predictive model scenarios have been designed to estimate:

- ranges of groundwater inflow to the Project area as a function of mine position and timing, for operational and post mining phases for each aquifer;
- the extent of the zone of aquifer depressurisation due to:
    - the incremental impacts associated with the Project; and
    - the combined impacts associated with the Project, CSG operations and nearby existing mines.
- the level and rate of groundwater level drawdown (incremental and cumulative) surrounding the final voids; and
- incremental and cumulative impacts to the interaction of groundwater with surface water such as baseflow within Roper Creek.

8.1 Previous modelling

A groundwater model was developed as part of the groundwater assessment of the EIS for Stage 2 of the Middlemount Mine in 2010 (Parsons Brinckerhoff, 2010a). The model was constructed using MODFLOW SURFACT and comprised eight layers as shown in Table 8.1. In MODFLOW SURFACT, the model layers have to be continuous across the model domain. Where layers pinch out, the model cells are assigned the properties of the unit that is present in that area. The spatial extent of the model is approximately 38.8 km x 30 km, using a uniform grid of 100 m x 100 m cells.

The impact of geological structures, especially faulting, within the Project area was not considered due to limited data being available on their hydrogeological characteristics. The model was calibrated to steady state conditions. Transient calibration was not conducted as there was no suitable dataset to calibrate to. A sensitivity analysis was conducted on all model parameters and showed that the model was sensitive to several parameters. The resulting uncertainties in model predictions were considered to be acceptable although several recommendations were made for future model improvements.

With the level of information available at the time the model was given a complexity rating of low-medium according to the Murray-Darling Basin Commission (2000) modelling guidelines.

Table 8.1 2010 model layering

Layer	Hydrogeological unit
1	Tertiary
2	Weathered zone
3	Aquitard #1
4	Middlemount Coal Seams
3 - 5	Aquitard #2
6	Pisces Coal Seams
3 - 7	Fort Cooper Coal Measures
3 - 8	Fort Cooper Coal Measures/Fair Hill Formation

8.2 Overview of groundwater modelling

8.2.1 Model software and code selection

The industry standard in groundwater modelling is MODFLOW, which is released by the United States Geological Survey. The latest version, called MODFLOW-USG (USG), allows for the model to have an unstructured grid which means that model cell refinement can occur in areas within the model without requiring extended refinement to the edge of the model. This creates the opportunity to reduce the number of model cells in each model layer. Another key advantage of USG is the fact that model layers can be truncated where they cease to exist (such as sub-cropping geological units) and the model maintains its connections for layers above and below where the model layer has ceased. USG can also simulate unsaturated flow. These attributes have allowed the USG code using the model grid made up of Voronoi (polygon) cells particularly effective for the Middlemount numerical model.

8.2.2 Proposed mine plan

The Project involves the extension of open cut mining operations to the north-west, into ML 70379 (Figure 2.1) at the current maximum approved rate of 5.7 Mtpa until 2037, thereby allowing for a period of mining continuing for another 20 years. The mine plan which includes the extension to the approved open cut operation for the Project is presented in Figure F 4.3 in Appendix F.

Open cut mining will result in progressive depressurisation of the surrounding strata and subsequent recovery post mining. Appendix F describes how the groundwater model simulated the proposed mining and groundwater recovery.

8.2.3 Model design and calibration

Where appropriate, natural hydrogeological boundaries such as geological units and regional catchment boundaries, have been adopted in the model. The groundwater model was developed to include the proposed mine plan and potential for cumulative impact from nearby operational mines such as German Creek East, Foxleigh, Foxleigh Plains, and Norwich Park. CSG production as part of the Bowen Gas Project (Arrow, 2012) within the Rangal Coal Measures approximately 7 km to the north of the Project in 2034 is also incorporated into the groundwater model.

The model represents the key geological units within the model domain as 17 layers, and extends approximately 30 km from north-west to south-east, and 21 km from north-east to south-west, and was divided into variable sized cells comprising up to 19,412 cells per layer. The model was developed around the conceptual groundwater model summarised in Section 6.12, and this development is detailed in Appendix F. The model was calibrated and verified to existing groundwater levels, using reliable measurements from representative bores within the model domain. A detailed description of the calibration method is provided in Appendix F. The objective of the calibration was to replicate the observed groundwater levels in accordance with the modelling guidelines developed by Barnett *et al.,* (2012). The transient calibration achieved an 8.6% scaled root mean square (SRMS) error, which is less than the 10% SRMS error suggested by the modelling guidelines as constituting a calibrated model. Comparison of the predicted and observed hydrographs shows a good qualitative match in groundwater level trends.

Once calibrated, the model was used to predict the groundwater level response to the Project, including simulated mining of the open cut pit in accordance with the proposed mine plan. The model simulated mining to the base of the Pisces Seam within the Rangal Coal Measures, defined as layer seven in the groundwater model.

The following sections describe the predictions of the groundwater model.

8.3 Groundwater modelling predictions

8.3.1 Groundwater inflow to mining areas

The transient development of the mine was simulated initially on a quarterly basis for seven years between 2011 and 2017 for the simulation (and calibration) of mining to date, and then annually for the predictions between 2018 and 2037. The pit inflows determined from the calibration and predictive simulations are shown graphically in Figure 8.1. These predicted inflows represent seepage as time weighted averages of the annual totals for each stress period reporting to the open cut pits over the life of the proposed mine operations.

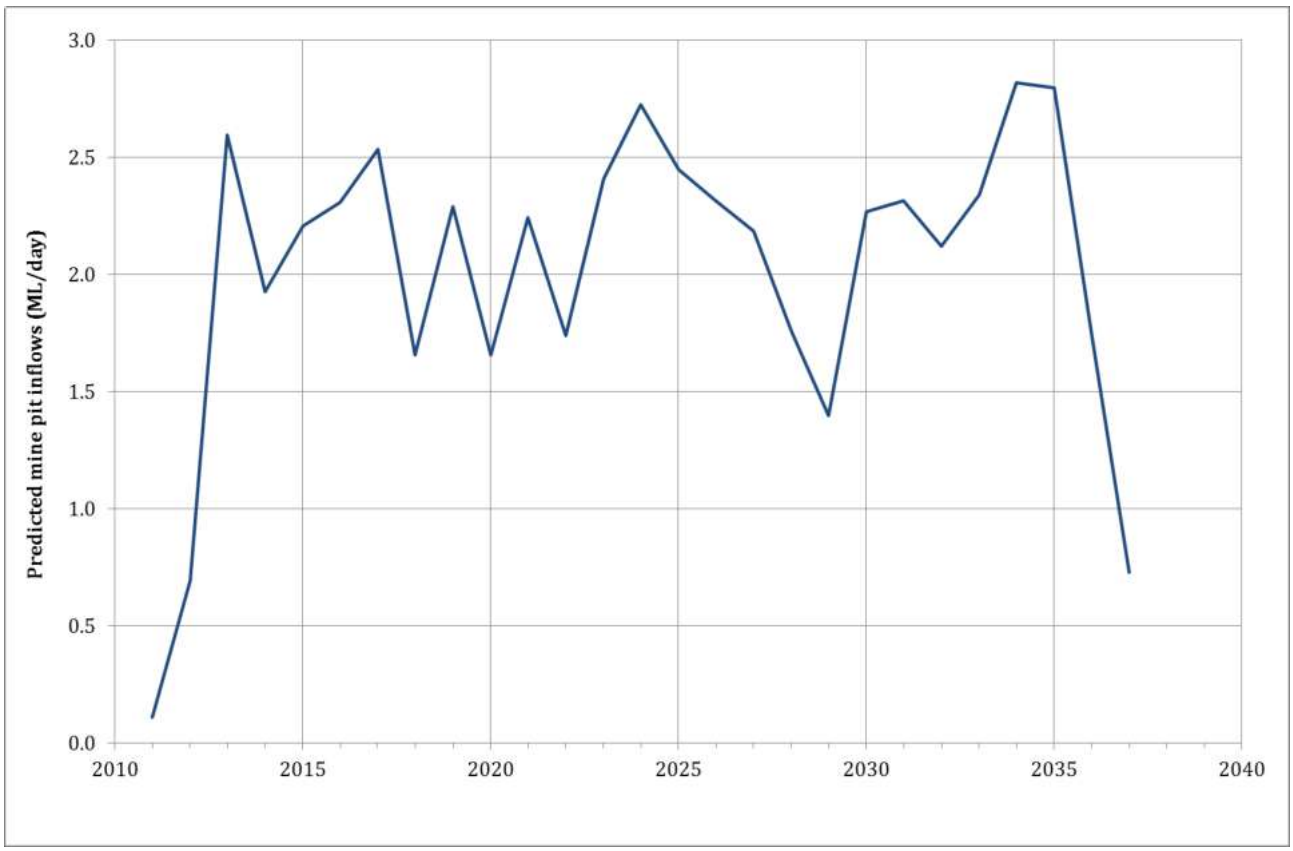


Figure 8.1 Predicted average annual pit inflows

Table 8.2 presents the predicted combined groundwater extraction as seepage reporting to the open pit for both the approved and proposed mine plans for each mining year between 2011 to 2037. The average daily predicted pit inflows between 2013 to 2017 are approximately 2.3 ML/day which is generally consistent with the estimated monthly groundwater inflow ranges between approximately 1 ML/day and 5 ML/day during a 10 month period assessed for October 2015, May 2016 and between February and September 2017 (WRM, 2017).

Table 8.2 Predicted groundwater inflow – 2011 to 2037

Calendar year	Combined (approved and proposed) predicted mine inflow	
	(ML/day)	(ML/year)
2011*	0.1	40
2012*	0.7	253
2013*	2.6	948
2014*	1.9	704
2015*	2.2	807
2016*	2.3	843
2017*	2.5	927
2018	1.7	605
2019	2.3	837
2020	1.7	605

Calendar year	Combined (approved and proposed) predicted mine inflow	
	(ML/day)	(ML/year)
2021	2.2	819
2022	1.7	635
2023	2.4	879
2024	2.7	995
2025	2.5	895
2026	2.3	845
2027	2.2	799
2028	1.8	642
2029	1.4	510
2030	2.3	828
2031	2.3	846
2032	2.1	775
2033	2.3	855
2034	2.8	1,030
2035	2.8	1,022
2036	1.8	640
2037	0.7	266

ML/year = megalitres per year
** Predictions from 2011 to 2017 that are for mining approved to date*

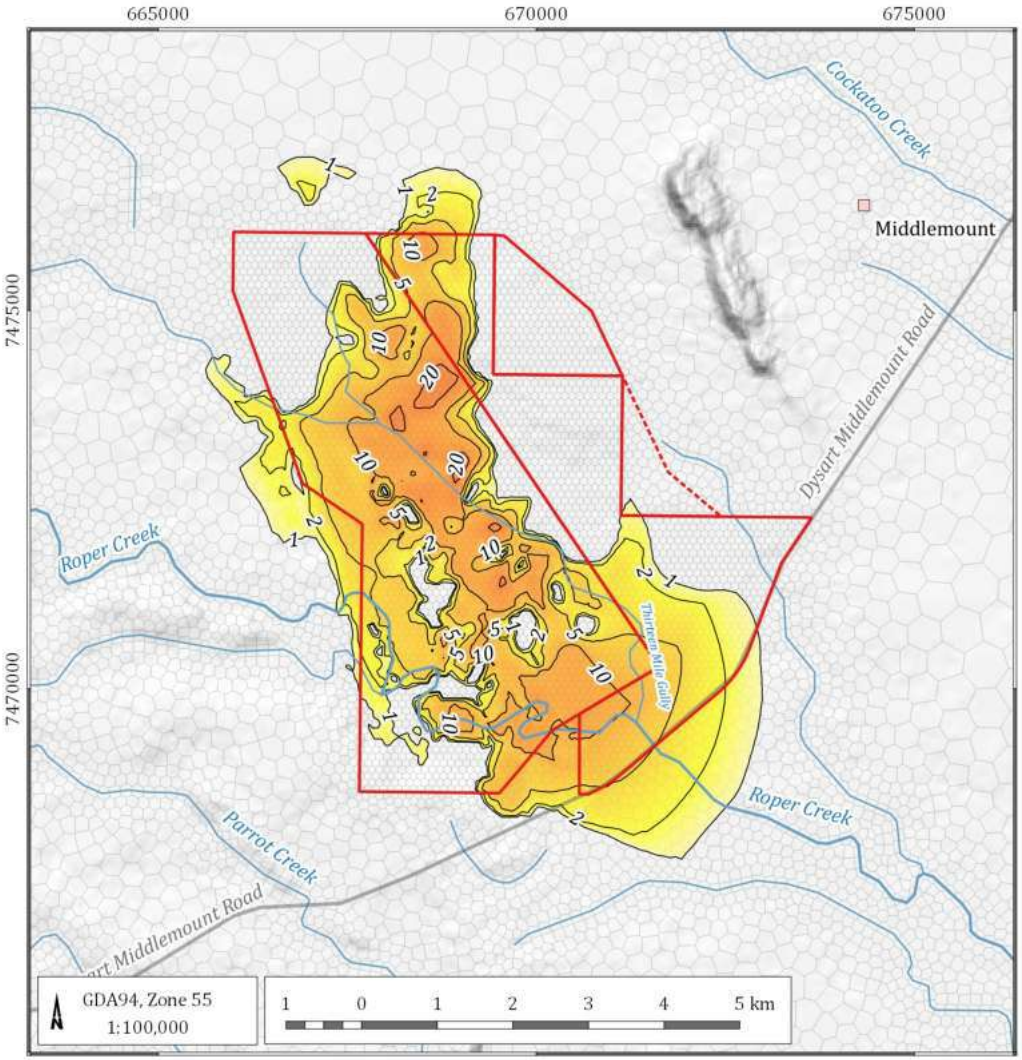
The predicted inflow rates presented in Figure 8.1 represent the take of water over the duration of the Project. Overall, the inflow rates are typically in line with the inflow rates currently experienced at the mine. It is noted that a proportion of these predicted groundwater inflows may be lost as moisture in the coal (entrained water), and at times, from direct evaporation from the exposed coal seam. However, given the variabilities in the extent of coal seams exposed at any one time, highwall angle and the height of exposed coal seams, in comparison to the surface area of the mine water storages to which the direct groundwater inflows would be pumped to, such losses are considered negligible for the purposes of this assessment. As the groundwater model inflow predictions are based on annual snapshots, such instantaneous losses are considered to be within the bounds of reasonable accuracy of the averaged groundwater model predicted inflow ranges.

8.3.2 Drawdown and depressurisation during mining operations

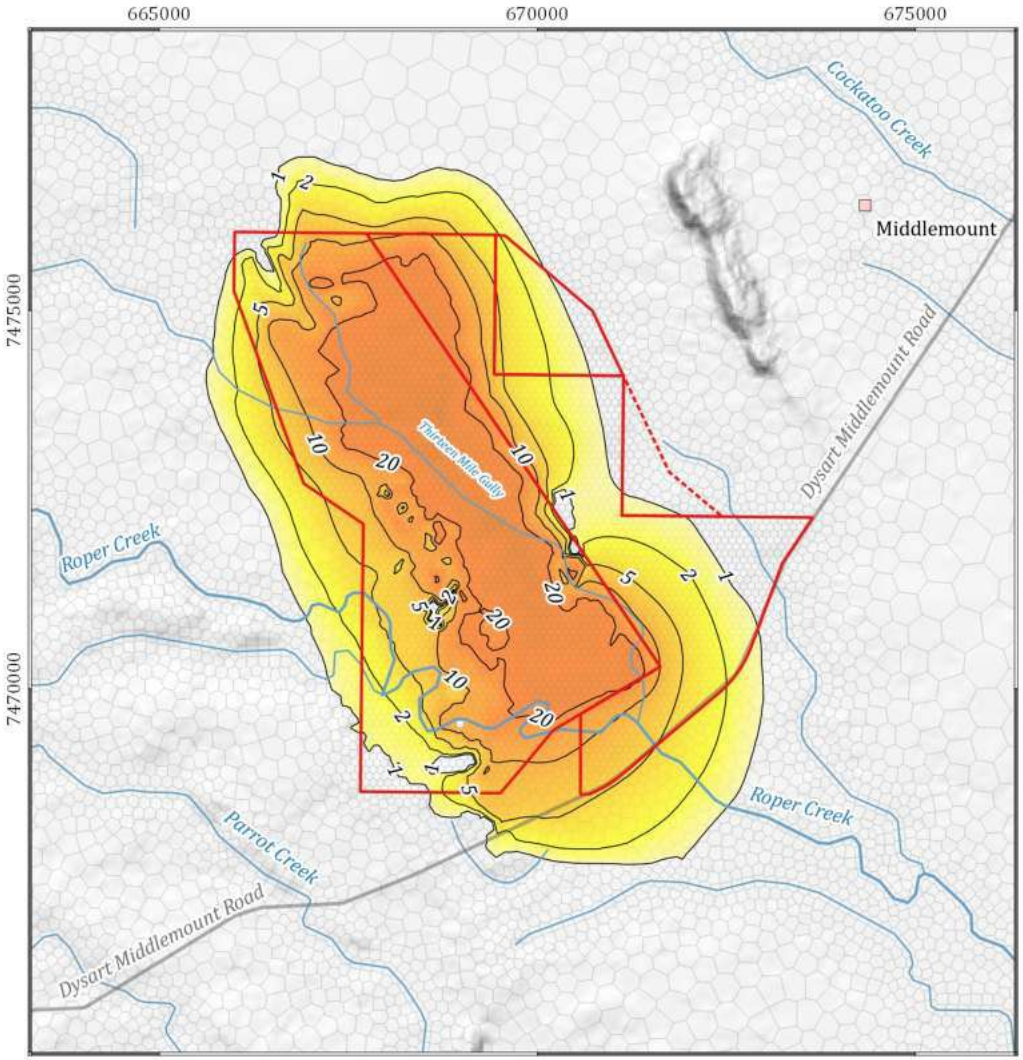
The zone of depressurisation due to the Project within the Tertiary and Weathered Permian (Layers 2 and 3), Middlemount Seam (layer 5), Pisces Seam (layer 7) and Fort Cooper Coal Measures (Layers 16 and 17), are shown in Figure 8.2, Figure 8.3, Figure 8.4, and Figure 8.5 respectively. The maximum drawdown for these layers during mining was determined from the 2011 pre-mining groundwater heads. These show that the overall drawdown extent is greatest within the Weathered Permian. The drawdown within the shallower Tertiary sediments is less and is constrained within that for the Weathered Permian due to this layer being partially saturated within and surrounding the mining leases. The drawdown extent generally decreases within the underlying layers, which is not unexpected given the presence of lower permeability interburden strata (aquitards) between these geological units, and the reduced lateral extents of these Middlemount and Pisces coal seam aquifer units within the Rangal Coal Measures. As discussed in Section 6.1, the sandstone and siltstone interburden and overburden of the Rangal Coal Measures form a confining aquitard over the floor and roof of the depressurised coal seams.

The resultant zone of depressurisation within the Weathered Permian (Rangal Coal Measures and Fort Cooper Coal Measures) from the Project is predicted to extend to the north, south-east and west beyond the ML boundaries (Figure 8.2). The maximum drawdown extents during mining are up to 1.4 km to the north-west and south-east of the Project. The extent of drawdown within the Rangal Coal Measures (Middlemount and Pisces Seams, Layers 5 and 7) is constrained by the limited lateral extents of the coal measures. These sub-crop just within the western ML70379 boundary and dip towards the north-east where they are truncated by the Jellinbah Fault, roughly coincident with the western ML70379 boundary (Figure 8.3 and Figure 8.4). Figure 8.5 shows the Jellinbah Fault is not assessed to be a barrier to groundwater flow, rather propagation of groundwater drawdown is limited east of the fault by the lower permeability Fort Cooper Coal Measures (Burngrove Formation, layer 16). Whilst mining does intersect the Fort Cooper Coal Measures (Burngrove Formation, layer 9) underlying the mine pit, vertical hydraulic connection between the Rangal Coal Measures and the Fort Cooper Coal Measures does result in drawdown extending downwards in layer 9 (Figure 8.5). The maximum extent of this drawdown during mining is largely contained within the ML boundaries.

Maximum zone of drawdown (Layer-2)



Maximum zone of drawdown (Layer-3)



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Model grid
- Road
- Watercourse
- Drainage feature
- Drawdown contour (m)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20

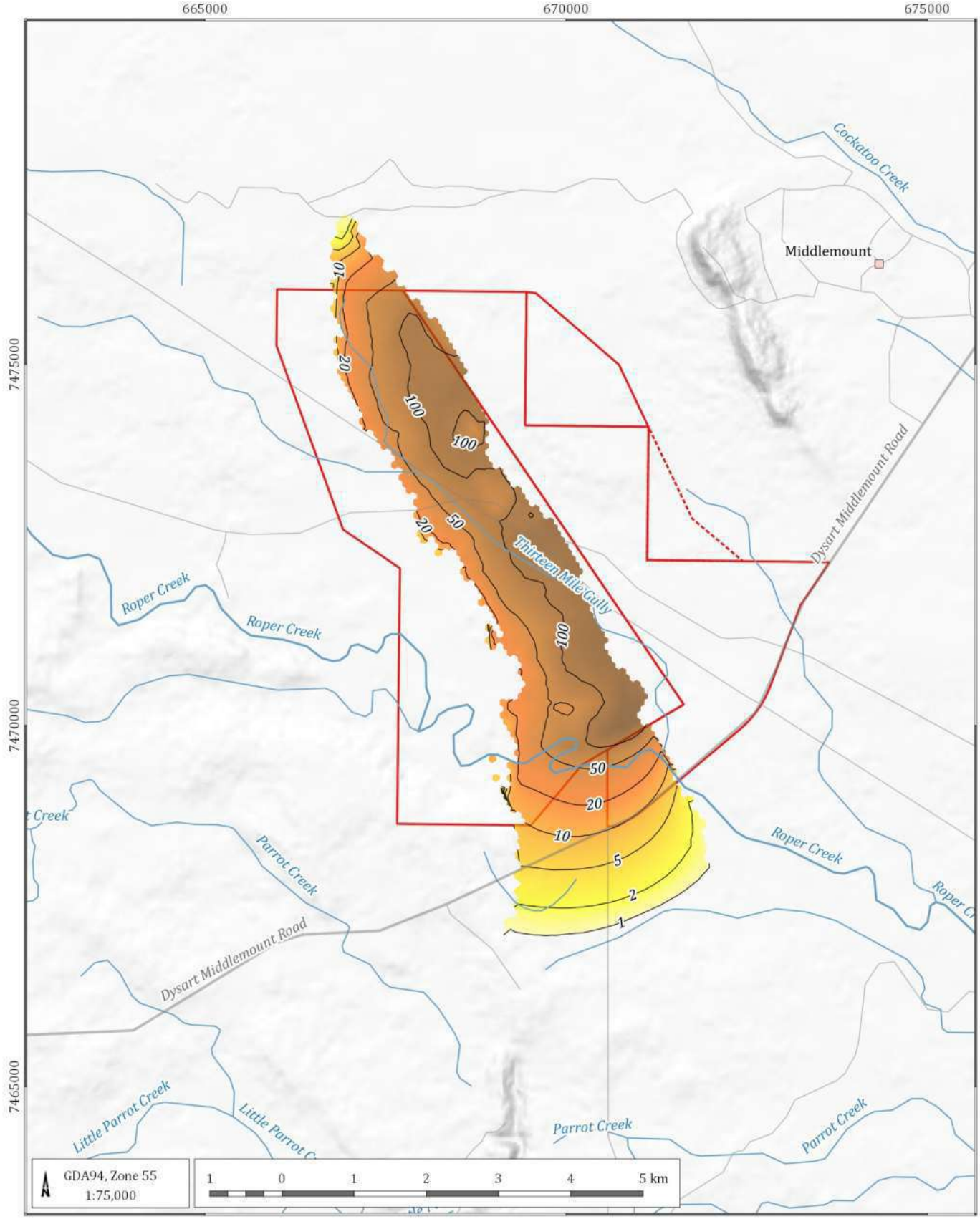
Middlemount Coal Mine Western Extension Project (G1840D)

Tertiary and Weathered Permian (Layer 2 & 3) – Maximum zone of drawdown during mining

DATE
27/04/2018

FIGURE No:
8.2

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.02_G1840D_Tertiary and Weathered Permian (Layers 2 & 3) – Maximum zone of drawdown.qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Road
- Watercourse
- Drainage feature

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- Drawdown contour (m)

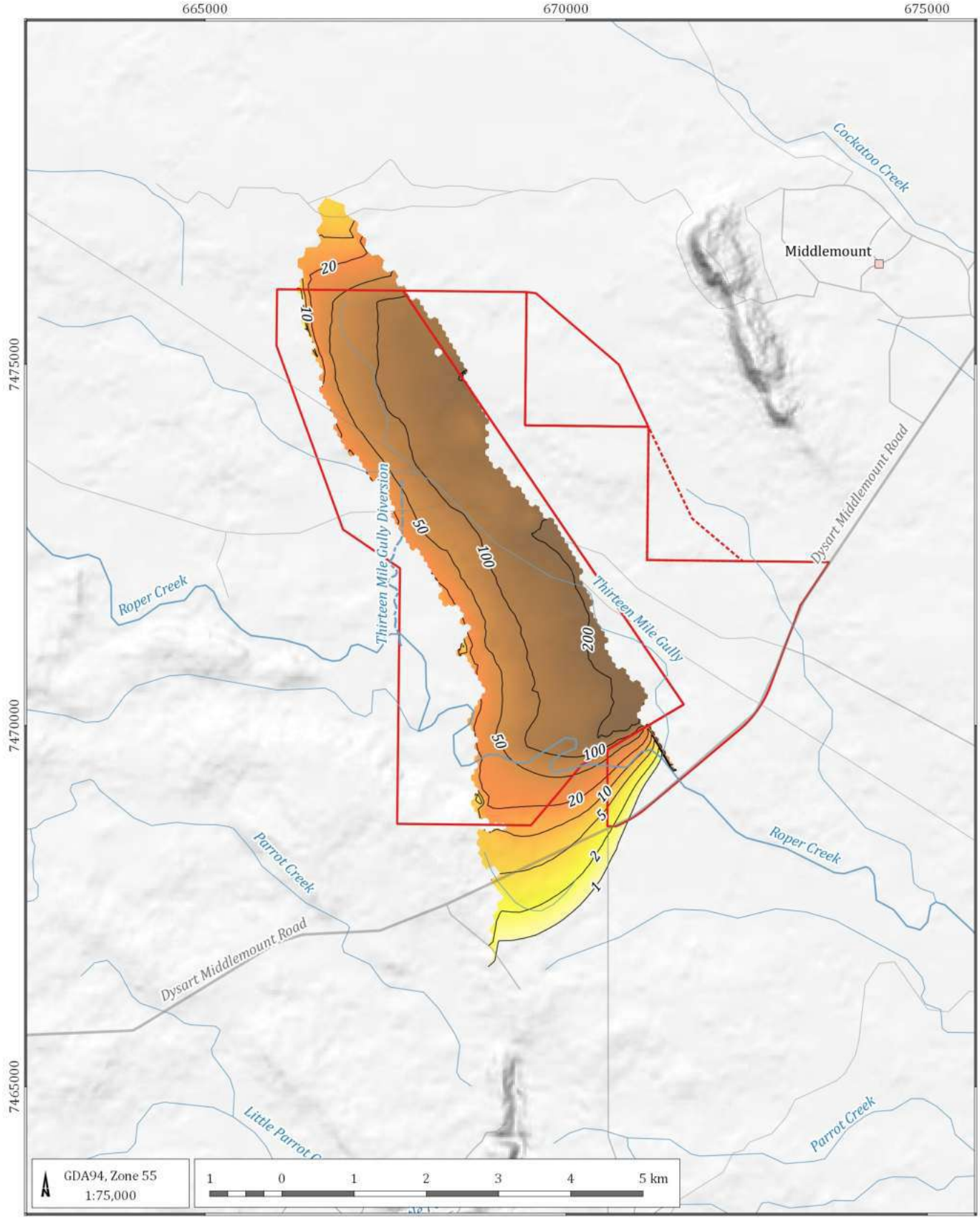
Middlemount Coal Mine Western Extension Project (G1840D)

Middlemount Seam (Layer 5) – Maximum zone of drawdown during mining

DATE 27/04/2018

FIGURE No: **8.3**

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G:/Projects/G1840D_Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.03_G1840D_Middlemount Seam (Layer 5) – Maximum zone of drawdown.qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Road
- Watercourse
- Drainage feature

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- Drawdown contour (m)

Middlemount Coal Mine Western Extension Project (G1840D)

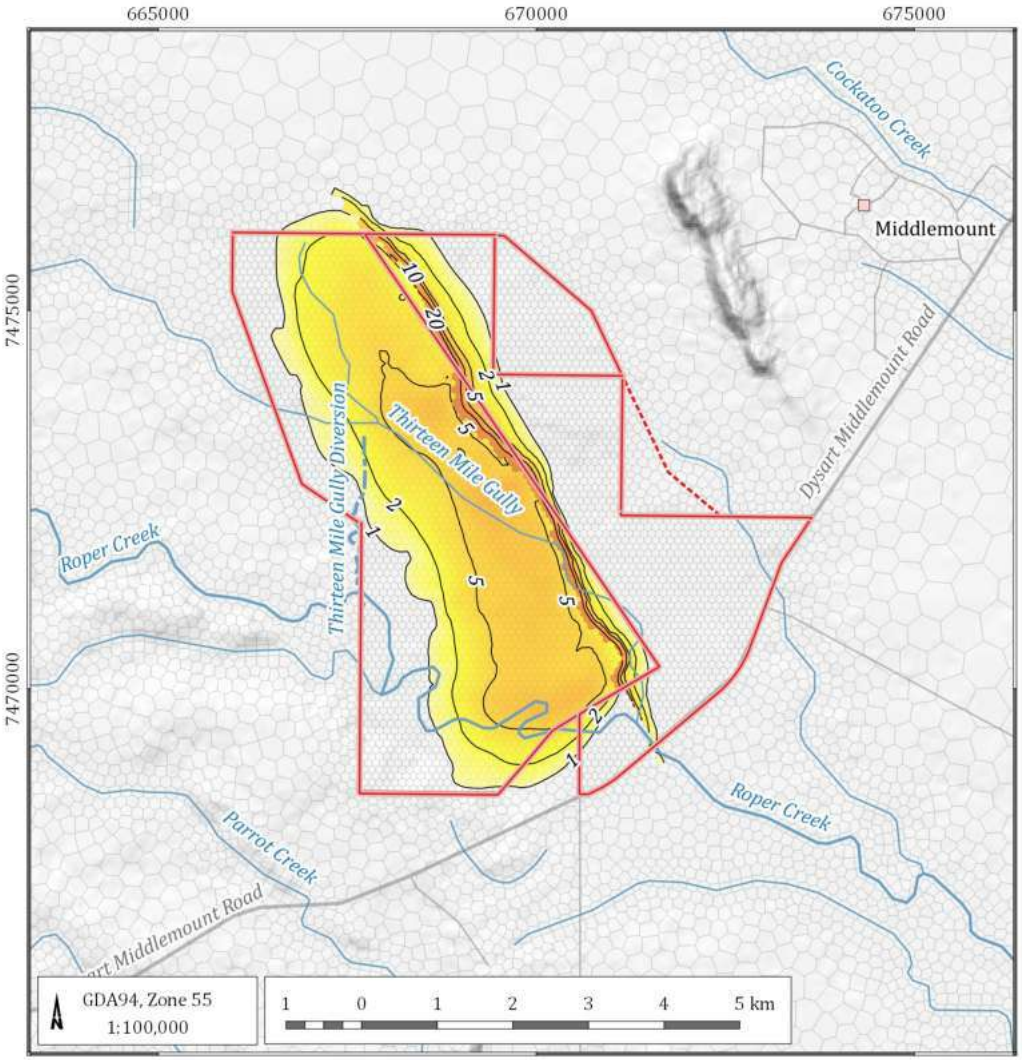
Pisces Seam (Layer 7) – Maximum zone of drawdown during mining

DATE 27/04/2018

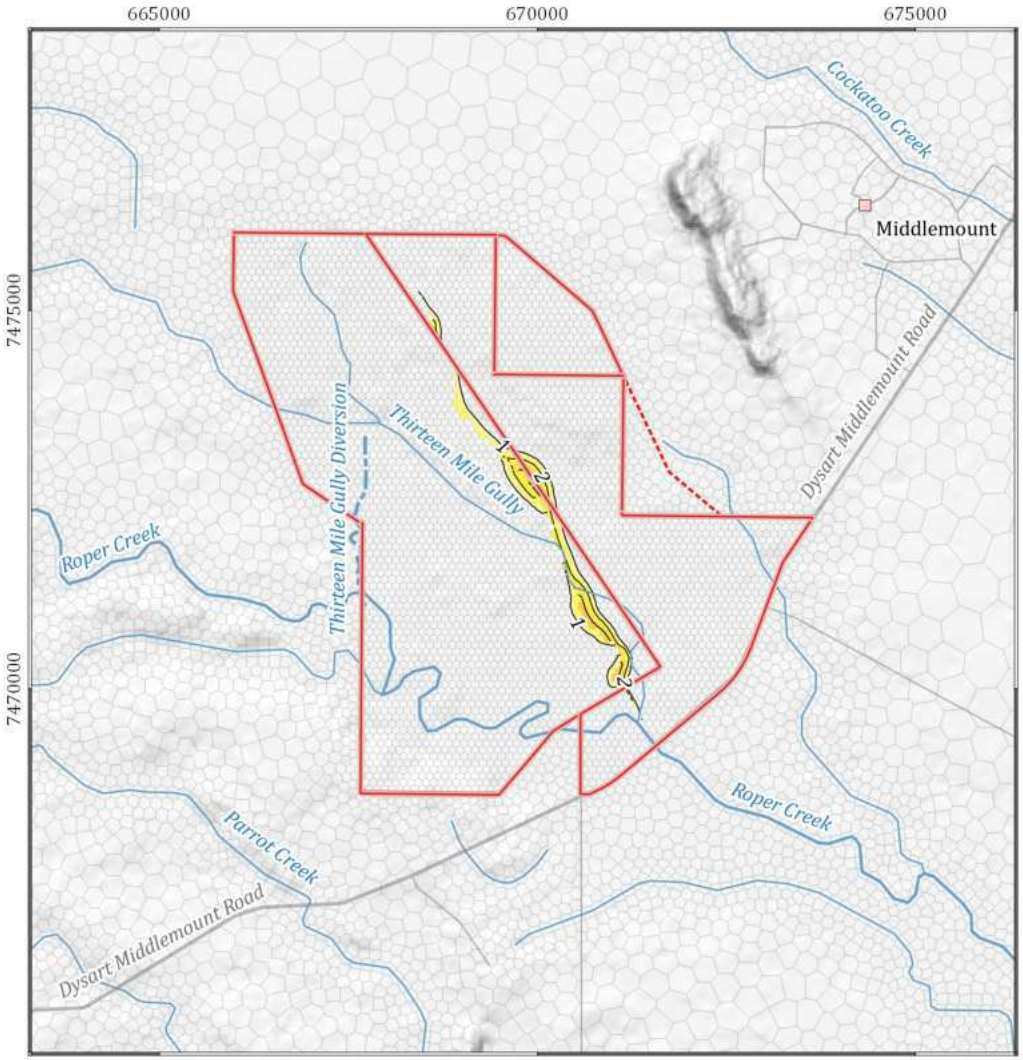
FIGURE No: **8.4**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.04_G1840D_Pisces Seam (Layer 7) – Maximum zone of drawdown.qgs

Maximum zone of drawdown (Layer-9 & 16)



Maximum zone of drawdown (Layer-10 & 17)



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Model grid
- Road
- Watercourse
- Drainage feature
- Drawdown contour (m)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50

Middlemount Coal Mine Western Extension Project (G1840D)

Fort Cooper Coal Measures (Layers 9, 16 & 10, 17) – Maximum zone of drawdown during mining

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27/04/2018

FIGURE No:
8.5

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.05_G1840D Fort Cooper Coal Measures (Layers 9 &16, 10 & 17) – Maximum zone of drawdown.qgs

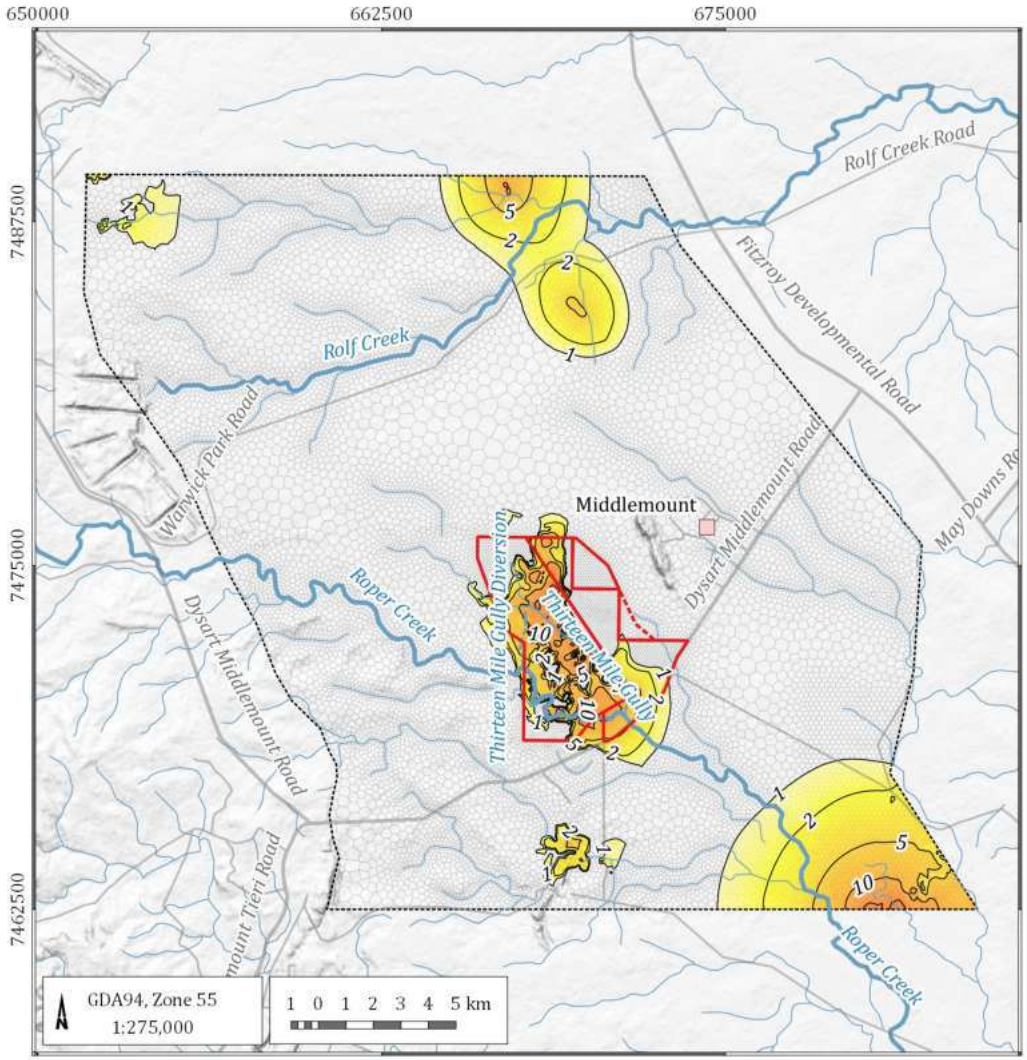
8.3.3 Cumulative impacts

The numerical groundwater model was used to assess the cumulative impact between the Project and nearby operational and closed mines which include German Creek East, Foxleigh, Foxleigh Plains, and Norwich Park. CSG production as part of the Bowen Gas Project (Arrow, 2012) was also simulated where this is proposed within the Rangal Coal Measures approximately 7 km to the north of the Project from 2034. Associated groundwater removed from the coal seams as a by-product of the CSG production, resulted in depressurisation of the Rangal Coal Measures to the north of the Project area.

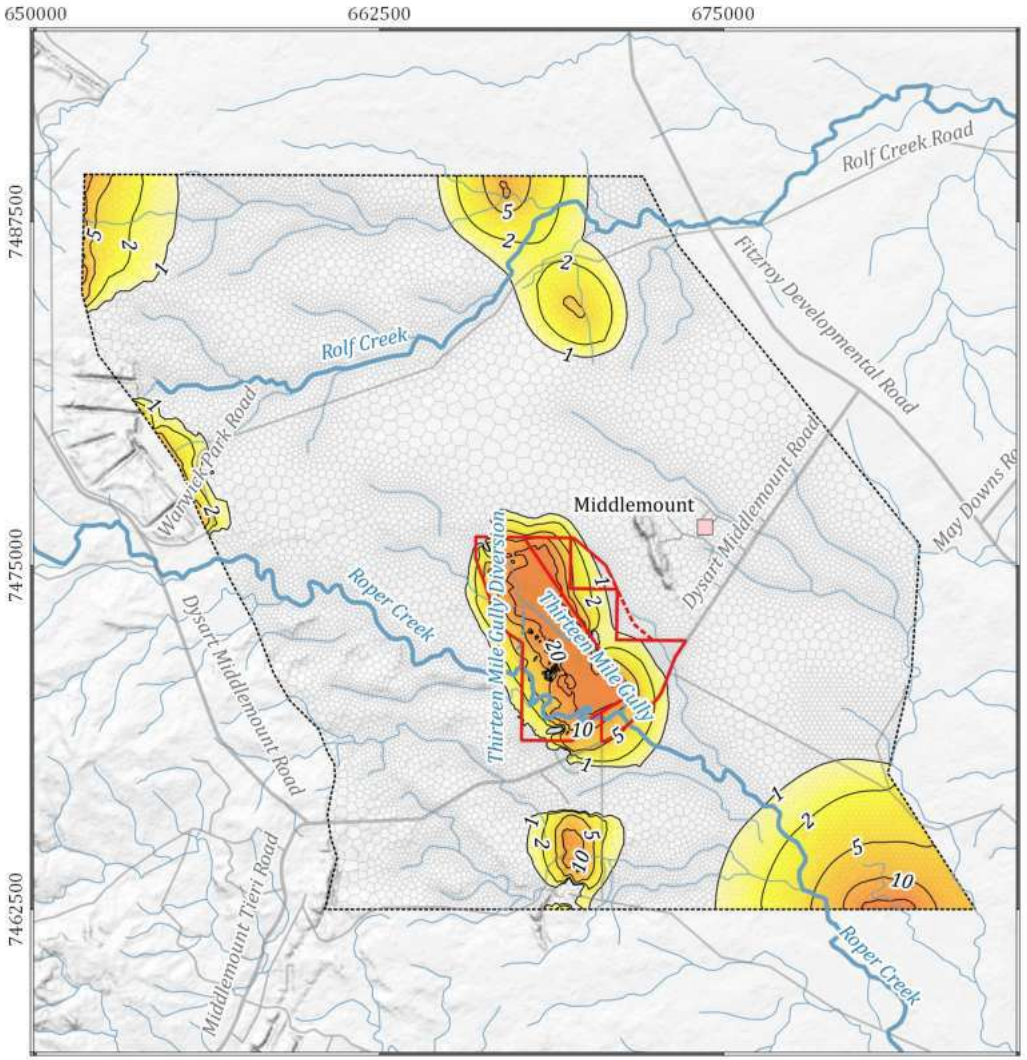
Figure 8.6 to Figure 8.9 show predicted drawdown extents for each of the adjacent mine and CSG projects. These show the maximum drawdown extents during mining:

- Within the Tertiary and Weathered Permian (Figure 8.6) for each site do not overlap resulting in there being no cumulative drawdown within model layers 2 and 3.
- For the Middlemount Seam (layer 5) 1 m contour, just intersects roughly midway between the Project and the German Creek East voids (Figure 8.7), but does not overlap or intersect the drawdown from the Leichhardt Seam (layer 12) from Foxleigh and Foxleigh Plains mines, and the Bowen Gas Project CSG production.
- For the Pisces Seam (layer 7) 2 m contour, overlaps roughly midway between the Project and the German Creek East voids (Figure 8.8), but does not overlap or intersect the drawdown from the Vermont Seam (layer 14) from Foxleigh and Foxleigh Plains mines, and the Bowen Gas Project CSG production.
- Within the Fort Cooper Coal Measures (Figure 8.9) for each site do not overlap resulting in no cumulative drawdown within model layers 9, 10, 16 and 17.

Maximum cumulative drawdown (Layer-2)



Maximum cumulative drawdown (Layer-3)



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Model boundary
- Model grid
- Road
- Watercourse
- Drainage feature
- Drawdown contour (m)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20

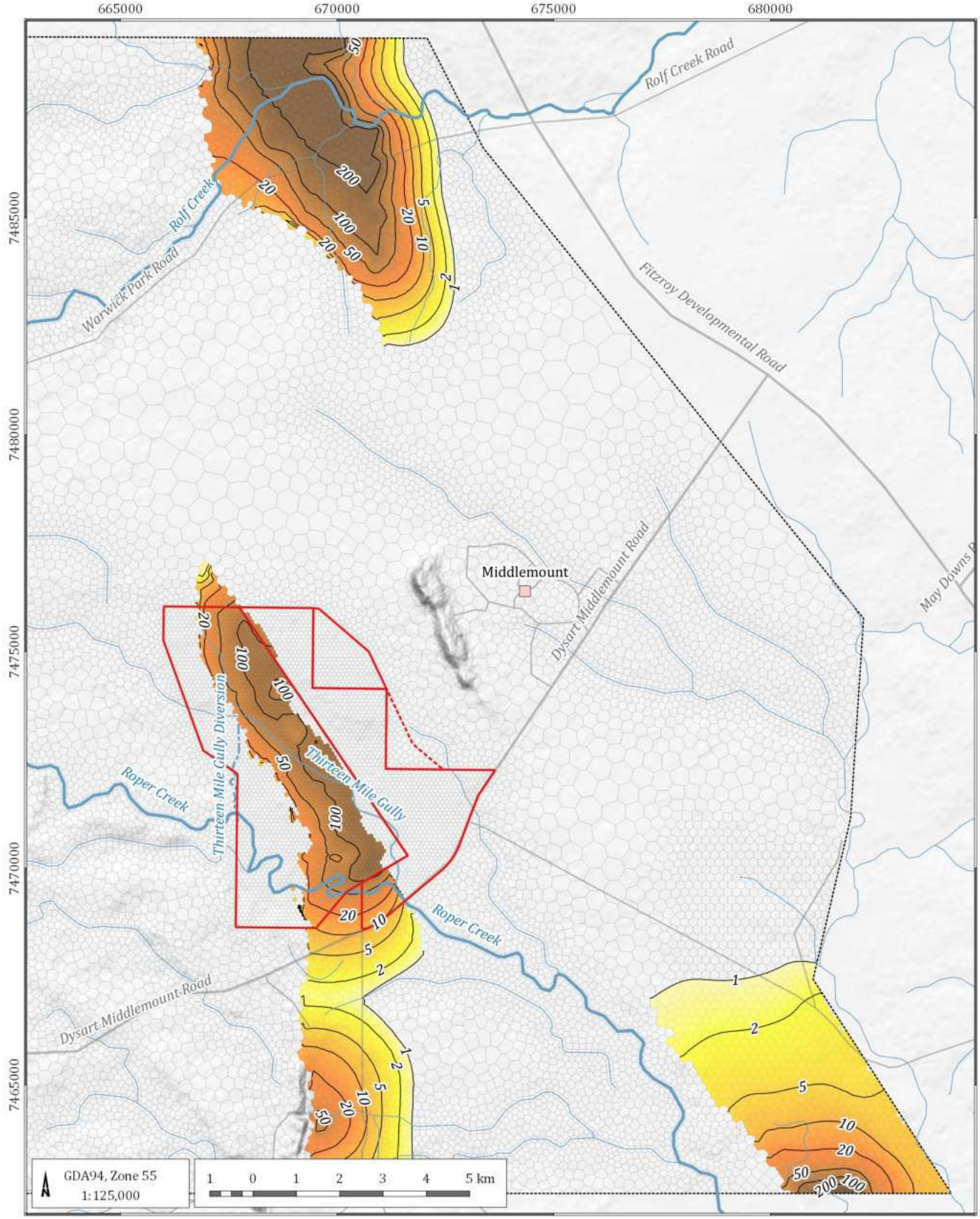
Middlemount Coal Mine Western Extension Project (G1840D)

Maximum cumulative drawdown Tertiary and Weathered Permian during mining – Layers 2 & 3 (CSG extraction, Foxleigh Mine, German Creek East Mine)

DATE
27/04/2018

FIGURE No:
8.6

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.06_G1840D_Maximum cumulative drawdown Tertiary and Weathered Permian – Layers 2 & 3 (CSG extraction, Foxleigh Mine, German Creek East Mine).qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Model boundary
- Model grid
- Road
- Watercourse
- Drainage feature
- Drawdown contour (m)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

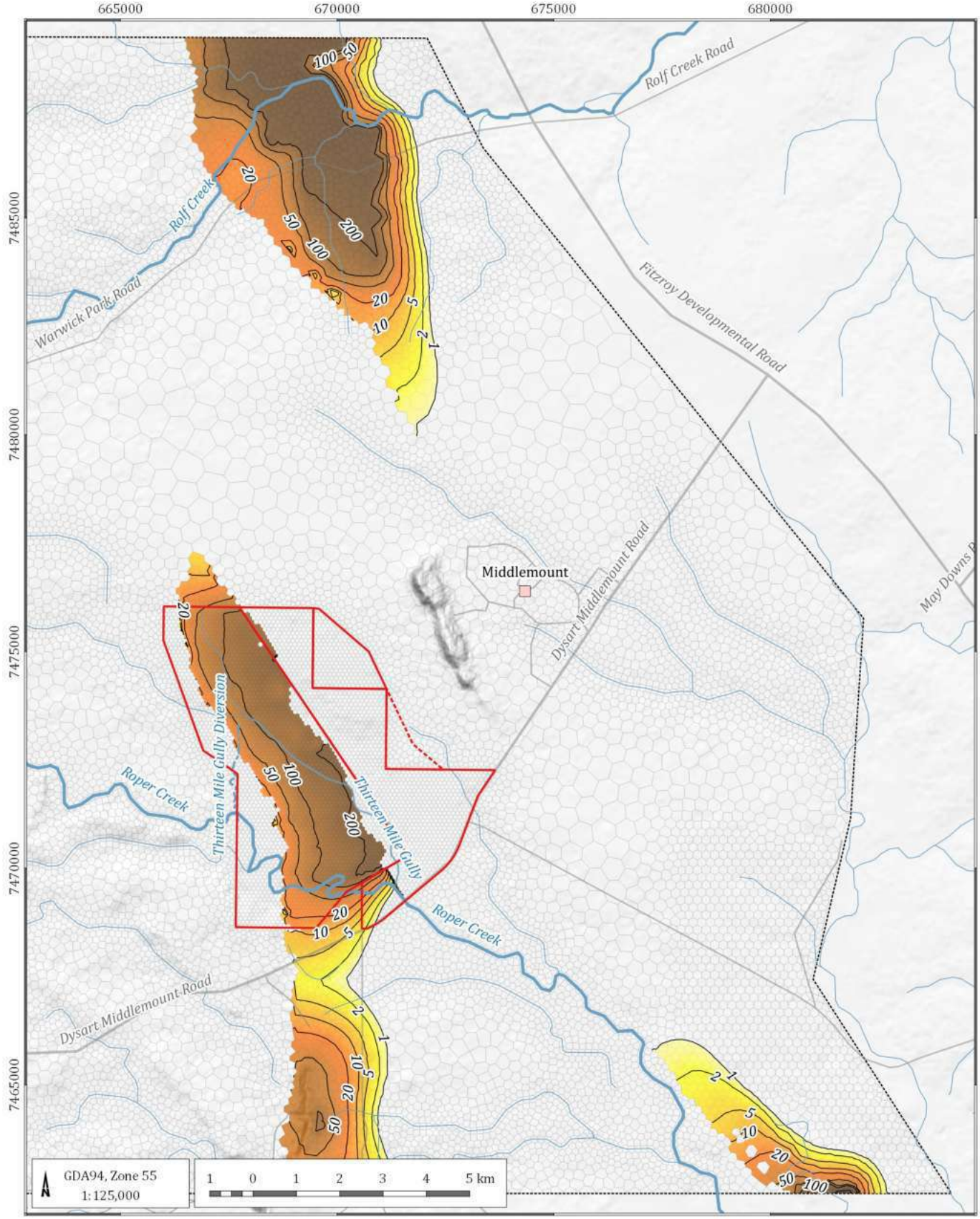
Middlemount Coal Mine Western Extension Project (G1840D)

Maximum cumulative drawdown Middlemount Seams and Leichhardt during mining – Layer 5 & Layer 12 (CSG extraction, Foxleigh Mine, German Creek East Mine)

DATE 27/04/2018

FIGURE No: **8.7**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.07_G1840D_Maximum cumulative drawdown Middlemount Seams and Leichhardt – Layer 5 & Layer 12 (CSG extraction, Foxleigh Mine, German Creek East Mine).qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (
- Model boundary
- Model grid
- Road
- Watercourse
- Drainage feature
- Drawdown contour (m)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200

Middlemount Coal Mine Western Extension Project (G1840D)

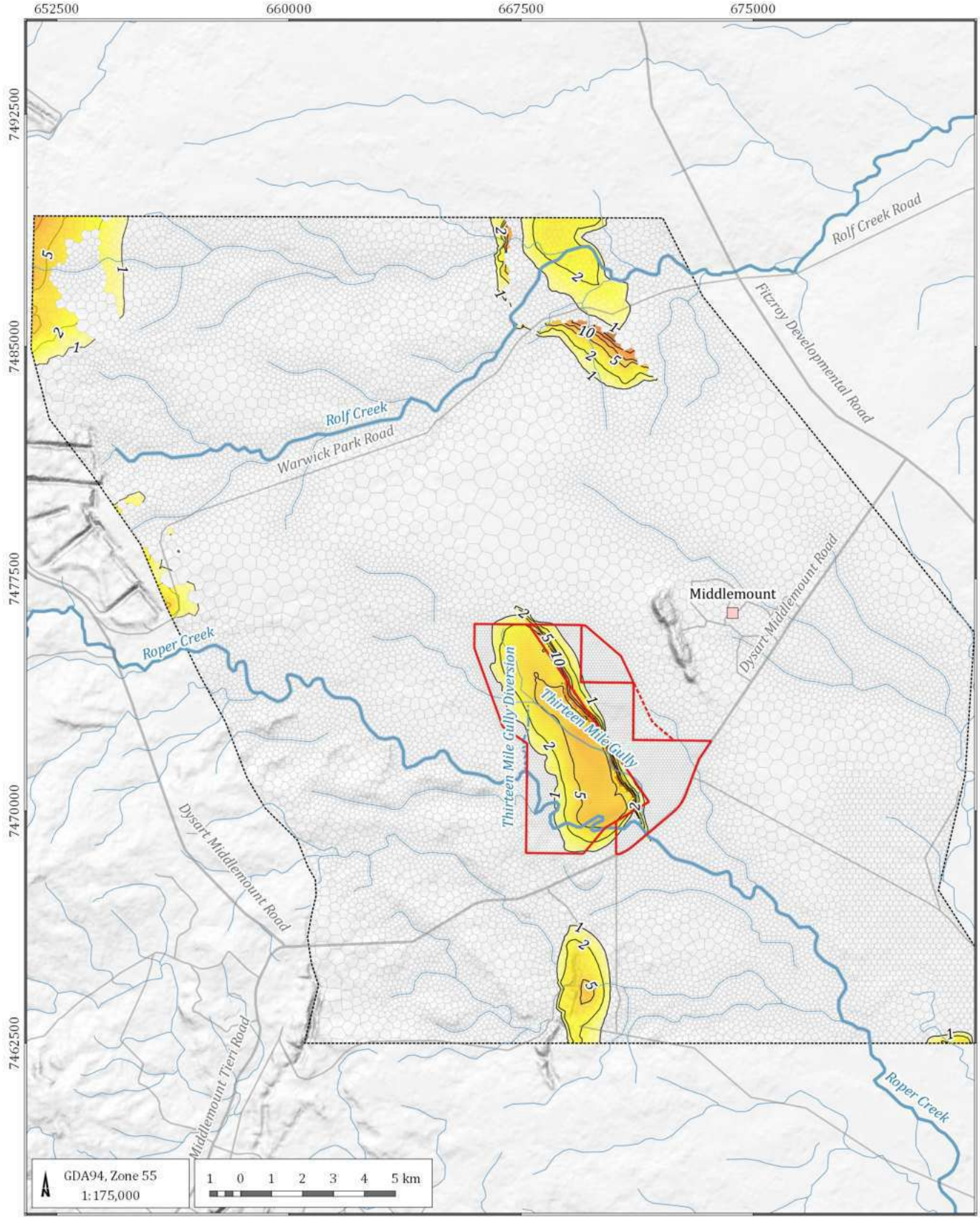
Maximum cumulative drawdown Pisces and Vermount Seam during mining – Layer 7 & Layer 14 (CSG extraction, Foxleigh Mine, German Creek East Mine)

AGE

DATE 27/04/2018

FIGURE No: **8.8**

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//bne01dc/Shared/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.08_G1840D_Maximum cumulative drawdown Pisces and Vermount Seam – Layer 7 & Layer 14 (CSG extraction, Foxleigh Mine, German Creek East Mine).qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Drawdown contour (m)
- Road
- Watercourse
- Drainage feature

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20

Middlemount Coal Mine Western Extension Project (G1840D)

Maximum cumulative drawdown Fort Cooper Coal Measures during mining – Layers 9, 10, 16 & 17 (CSG extraction, Foxleigh Mine, German Creek East Mine)

DATE 27/04/2018

FIGURE No: **8.9**

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//bne01dc/Shared/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.09_G1840D_Maximum cumulative drawdown Fort Cooper Coal Measures – Layers 9,10,16 & 17 (CSG extraction, Foxleigh Mine, German Creek East Mine).qgs

8.3.4 Water licensing

Under the *Water Act 2000* (current at 1 March 2017), the Project will require an AWL for this EA amendment application. The purpose of an AWL is provided in section 1250C, division 2 of the Water Act which states *"An associated water licence authorises the taking of or interference with underground water in the area of a mining tenure if the taking or interference happens during the course of, or results from, the carrying out of an authorised activity for the tenure*."

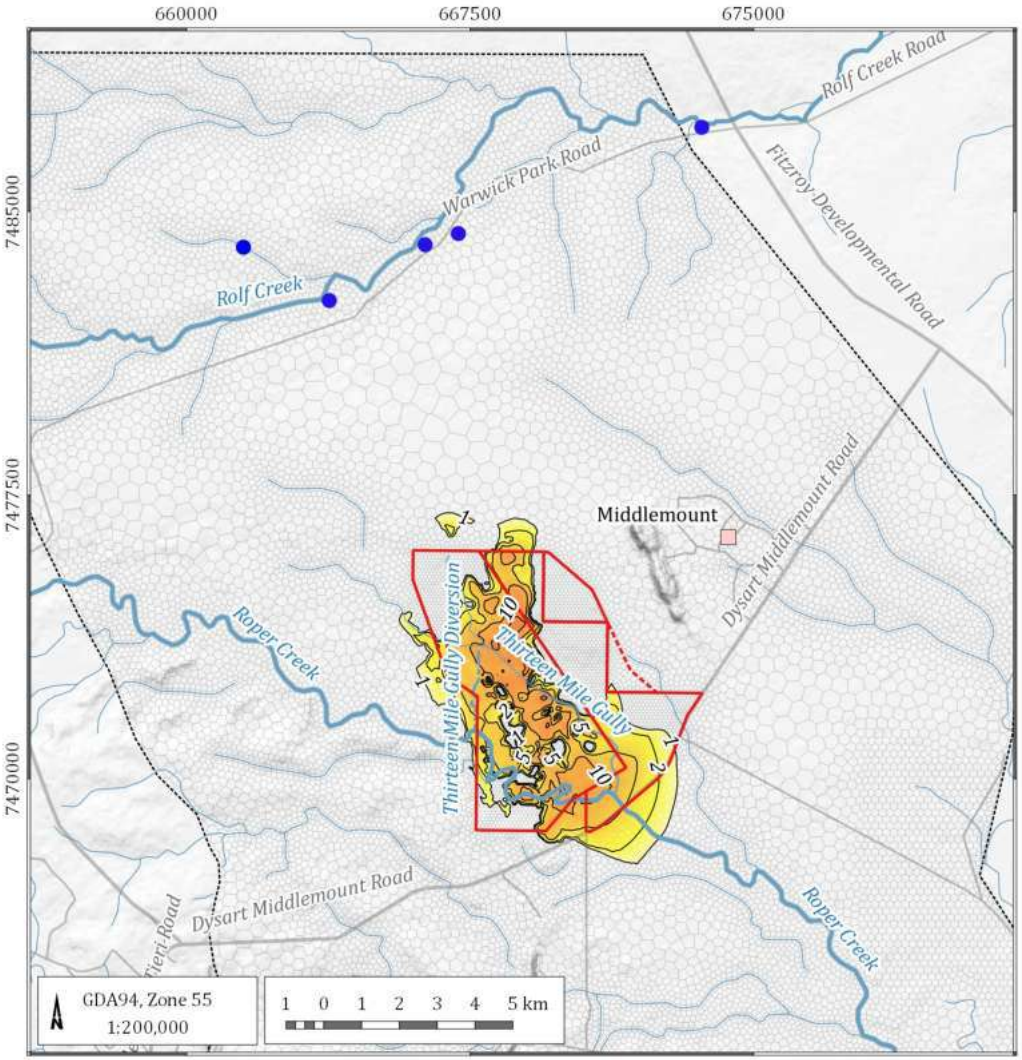
8.3.5 Impacts on groundwater users

As discussed in Section 8.3.2, the depressurised zone as a result of the Project in the Tertiary and Weathered Permian, and the Rangal Coal Measures extends up to 1.4 km towards the north-west and south-east of the Project area.

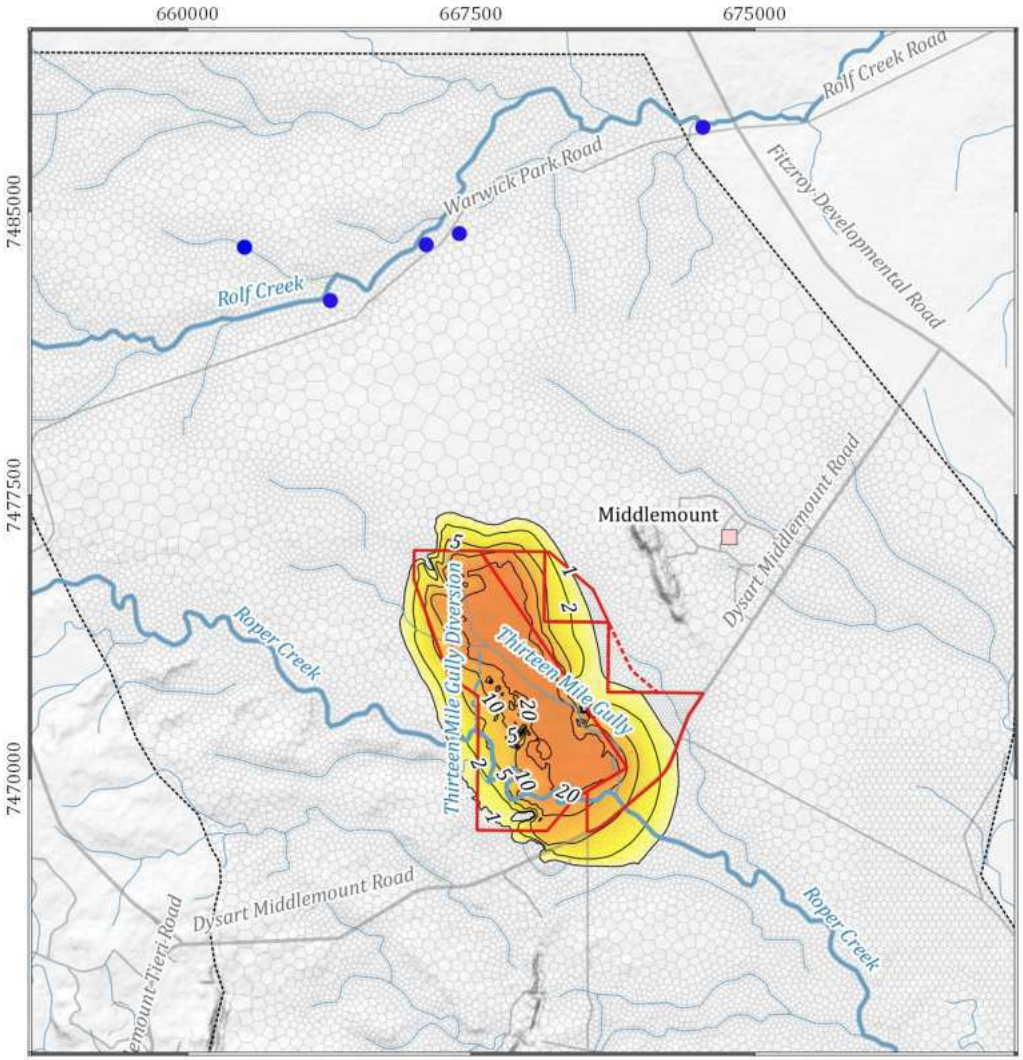
Figure 8.10 shows the locations of the registered bores identified in the DNRM GWDB in relation to the predicted zone of depressurisation for the Tertiary and Weathered Permian sediments. None of the existing registered bores on the DNRM GWDB are identified within this predicted zone of depressurisation. Therefore, no landholder water supply bores are located within the predicted drawdown extents attributable to the proposed mine plan for the Project.

It is important to note that a conservative approach has been adopted in the modelling, and the zone of influence is not expected to develop to the full extent predicted by the numerical modelling. That is, the model does not include any hydraulic heterogeneities in the area and simulates a continuous hydraulically connected aquifer system. Minor faults offset the coal seams and heterogeneities can act as barriers to groundwater flow, which limits the expansion of the zone of depressurisation.

Maximum zone of drawdown (Layer-2)



Maximum zone of drawdown (Layer-3)



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Model grid
- Road
- Watercourse
- Drainage feature
- Landholder bores
- Drawdown contour (m)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20

Middlemount Coal Mine Western Extension Project (G1840D)

Landholder bores within predicted maximum zone of drawdown during mining

DATE
17/05/2018

FIGURE No:
8.10

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.10_G1840D_Landholder bores within predicted maximum zone of drawdown during mining.qgs

8.3.6 *Impacts on groundwater dependent ecosystems*

The Project is not predicted to impact any aquatic or terrestrial GDEs, as GDEs are assessed as being unlikely to occur within and surrounding the Project area (Section 6.8), on the basis that:

- the majority of the terrestrial vegetation associated with Roper Creek and Drainage Line 1 also occurs more widely across the landscape and is not restricted to areas where it could potentially access groundwater;
- Roper Creek and Drainage Line 1 are ephemeral and the depth to groundwater in these areas is typically around 20 m;
- the depth to groundwater within the palustrine wetlands north of ML 70417 and ML 70379 exceeds of 12 m depth; and
- there is no evidence of vegetation dieback resulting from existing operations.

The presence of stygofauna in groundwater within the Project area was assessed from a desktop review of optimal conditions for stygofauna habitat and results of sampling. The review concluded that the potential for optimal stygofauna habitat at Middlemount Coal Mine is unlikely given to average salinity in both the Tertiary and Permian aquifers being in excess of 20,000 μS/cm, and the average depth to groundwater in the Permian aquifer being greater than 30 mbgl.

As discussed in Section 6.9, sampling in 2011 found a naturally low diversity of stygofauna (taxa from two Families). Stygofauna from the same two Families were found in bores that were located both in and outside the maximum zone of drawdown associated with the approved mine and Project (e.g. some 5-7 km north-west and south-east).

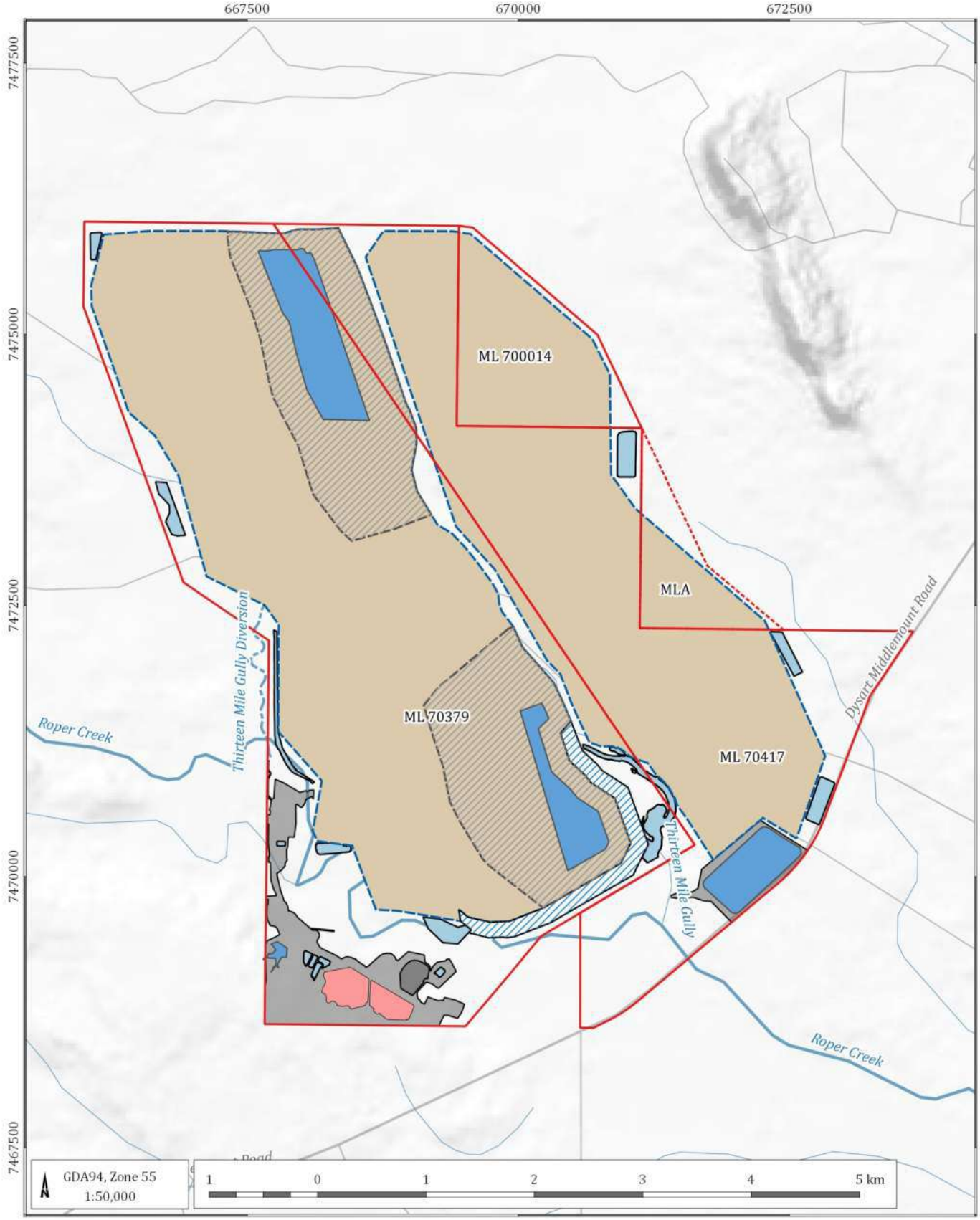
The Project is not predicted to significantly impact stygofauna considering the Project would only incrementally increase the groundwater drawdown from the approved mine, the groundwater aquifer (similar stygofauna habitat) is extensive outside of the maximum zone of drawdown, and the sampling indicates there is a low diversity of stygofauna in and outside the maximum zone of drawdown.

8.4 Post mining recovery conditions

Post mining conditions were also simulated using the numerical groundwater flow model. The locations of the final voids are shown in Figure 8.11 and Appendix F provides details of the model set up.

The sections below describe the post mining predictions of the pit lake levels, potentiometric surface and water table recovery, and water quality variation. These predictions are based on the Project development at the end of mining which includes the North Void and South Void. The depths of each void at the end of mining vary from north to south across both mine pits, with pit floor elevation extending to the base of the coal seams mined within each void. The two voids are separated by spoil backfill that rises up to 180 mAHD.

The recovery process is driven by inputs from groundwater seepage, direct rainfall across the void, and rainfall runoff from the catchment associated with each void. These inputs are eventually balanced against losses from evaporation, with the pit lake elevation reaching a stable equilibrium level. The simulation results show the North Void becoming saturated and the development of a void lake at the northern end of the void, and a larger void lake developing in the South Void. The difference in equilibrium water level for each void produces a gradient from the North Void into the South Void resulting in the North Void remaining mostly dry. Surface water runoff from rainfall is the principal filling mechanism that contributes to development of the void lake levels in each void, the extent of which is dominated by evaporation. As such, the volume of groundwater into the void lakes is a minor contributor to the equilibrium void recovery water levels.



LEGEND

- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Road
- Watercourse
- Drainage feature
- Flood Bund
- Final Void
- Established Rehabilitation
- Infrastructure Extent
- Tailings Storage Facility
- Water Management Dams
- Sediment Dam

Middlemount Coal Mine Western Extension Project (G1840D)

Western Extension Project final voids

DATE 11/04/2018

FIGURE No: **8.11**

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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.11_G1840D_Western Extension Project final voids.qgs

8.4.1 Post closure groundwater recovery

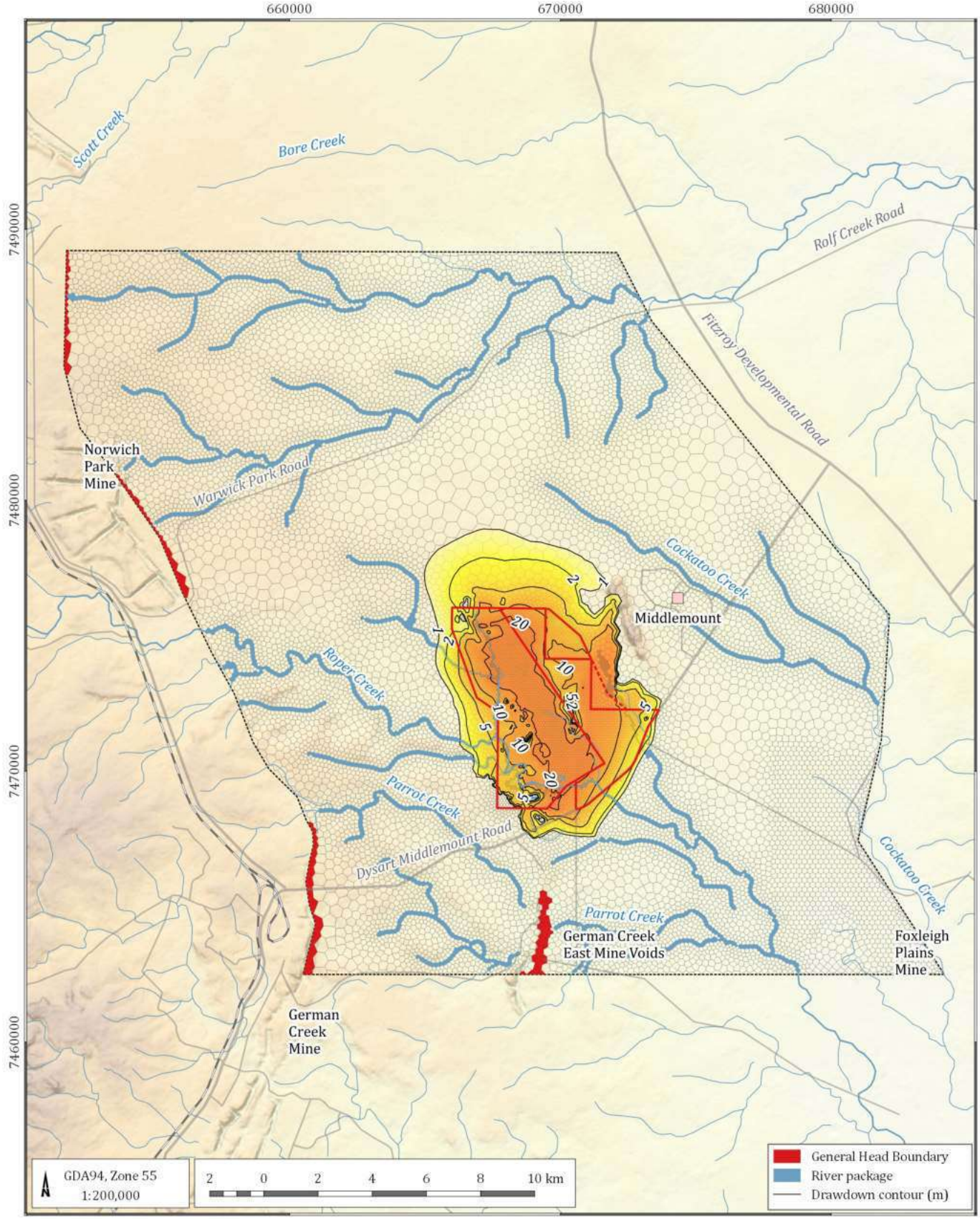
Post closure conditions were simulated over a period of 500 years by WRM to predict the extent of void lake level recovery following cessation of mining. WRM modelling indicates that the final voids would gradually fill over time from direct rainfall occurring across each void and groundwater seepage. Utilising the WRM modelling results, representative pit lake levels of approximately 65 mAHD in the northern portion of the North Void, and -39 mAHD in the South Void have been used for the purposes of post closure groundwater recovery modelling.

The representative pit lake levels were used to determine the long-term residual drawdown in the surrounding aquifers and establish a new equilibrium groundwater level around the final voids. This was achieved in a steady state simulation using the representative pit lake levels, consistent with the WRM modelling results, in each void.

Based on these predictions, the voids would act as sinks in perpetuity with no escape of contained void water into the Rangal Coal Measures or Fort Cooper Coal Measures.

Figure 8.12 to Figure 8.15 show the predicted extent and magnitude of post mining drawdown in the Tertiary and Weathered Permian (layer 3), Middlemount Seam (layer 5), Pisces Seam (layer 7) and the Fort Cooper Coal Measures (layer 16), respectively. As a result of the final voids remaining as groundwater sinks in perpetuity and the depth to the equilibrium level for the two final void lakes, the drawdown extents depicted by the 1 m contour is predicted to generally remain constrained around the mine footprint and mining leases. Predicted drawdown within the Tertiary and weathered Permian extends up to 2 km from the northern mining lease boundary. Conversely, predicted drawdown with the Middlemount Seam (layer 5) and Pisces Seam (layer 7) remains constrained by the limited lateral extents of the coal measures within the mining lease, and only extending up to 3.5 km southwards within the Rangal Coal Measures. This drawdown within the Rangal Coal Measures is predicted to continue to be propagated east of the Jellinbah Fault within the Fort Cooper Coal Measures, where it is predicted to extend up to 3 km to the north and northeast of the mining lease boundaries towards Middlemount township.

It should be noted that this drawdown extent was determined by steady state simulation, which creates predicted water levels that represent the ultimate long-term situation. It should also be noted that the model has been setup so there is a continuous and uninhibited hydraulic connection across the model domain for each model layer. In reality, this condition is unlikely to occur given the heterogeneity that most probably naturally occurs with each aquifer unit, and the potential for geological structures to inhibit groundwater movement. It is therefore assessed that the equilibrium groundwater drawdown predicted by the steady state groundwater model is conservative and provides a worst case scenario of the potential drawdown extents.



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Active model outline
- Model grid
- Road
- Rail
- Watercourse
- Drainage feature

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20

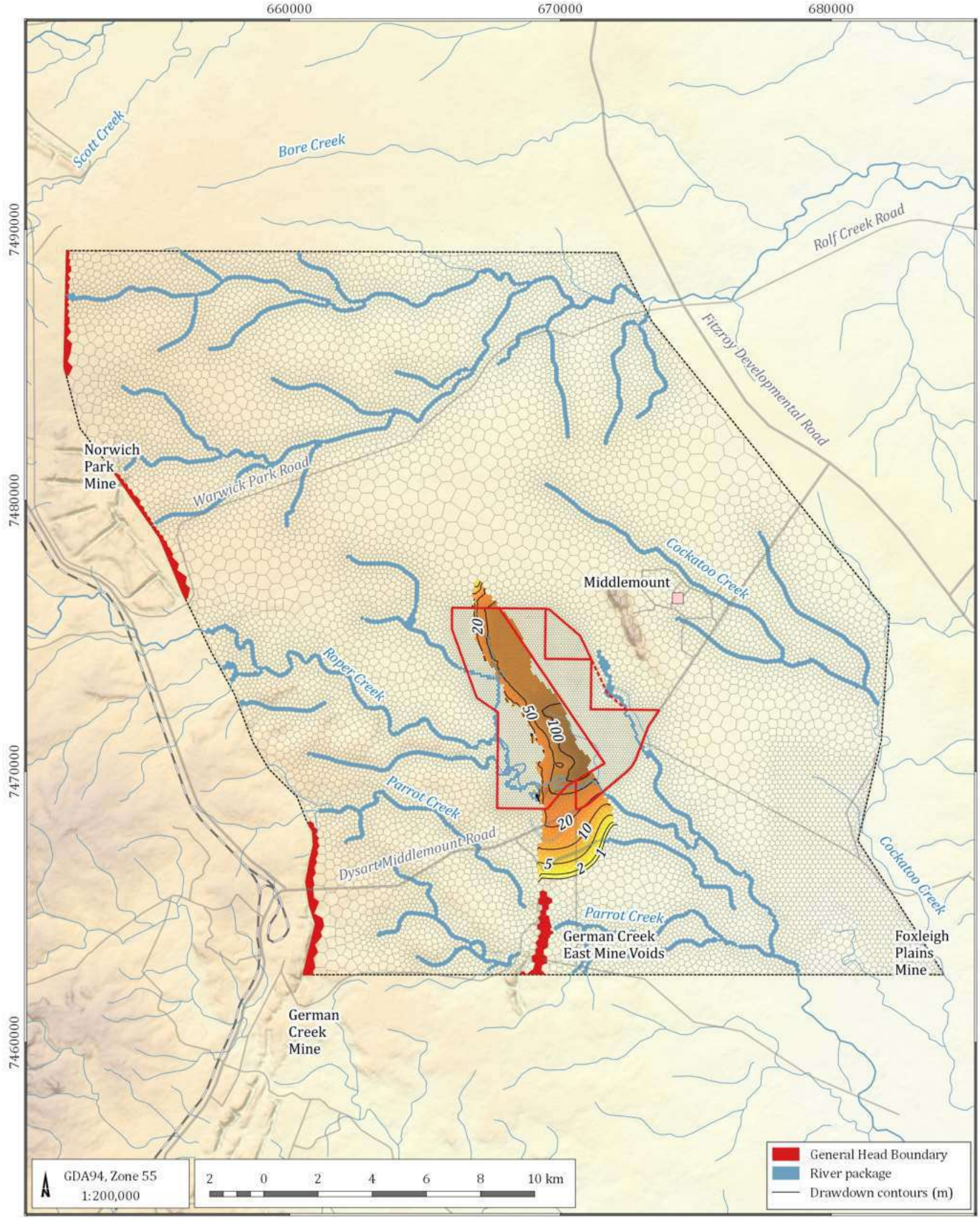
Middlemount Mine Extension (G1840D)

Post mining equilibrium drawdown – Tertiary and Weathered Permian (Layer 3)

DATE 04/06/2018

FIGURE No: **8.12**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.12_G1840D_Post mining equilibrium drawdown – Tertiary and Weathered Permian (Layer 3).qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Active model outline
- Model grid
- Road
- Watercourse
- Drainage feature
- Rail

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100

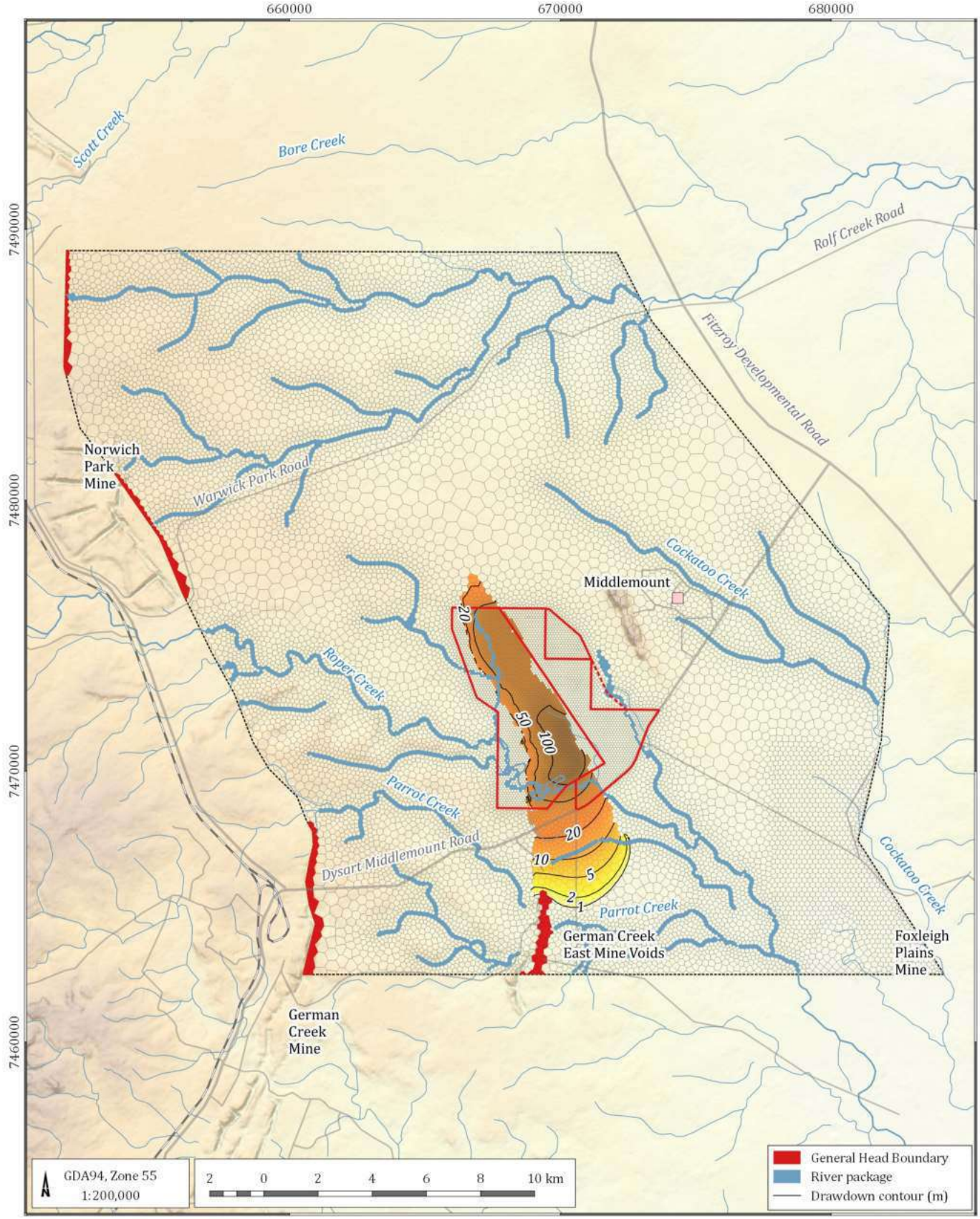
Middlemount Mine Extension (G1840D)

Post mining equilibrium drawdown – Middlemount Seam (Layer 5)

DATE 04/06/2018

FIGURE No: **8.13**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.13_G1840D_Post mining equilibrium drawdown – Middlemount Seam (layer 5).qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Active model outline
- Model grid
- Road
- Watercourse
- Drainage feature
- Rail

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100

Middlemount Mine Extension (G1840D)

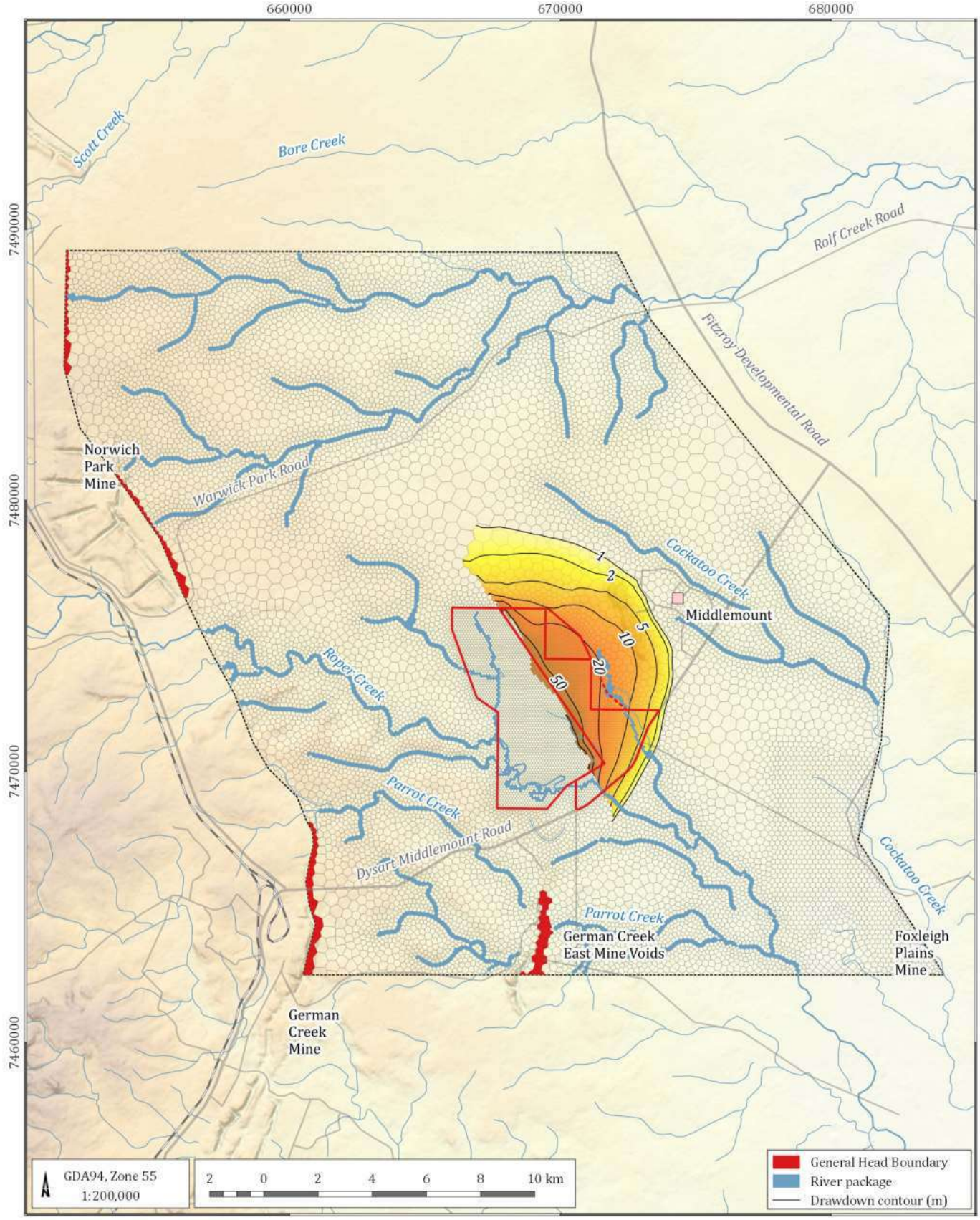
Post mining equilibrium drawdown – Pisces Seam (Layer 7)

AGE

DATE 04/06/2018

FIGURE No: **8.14**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.14_G1840D_Post mining equilibrium drawdown – Pisces Seam (Layer 7).qgs



LEGEND

- Populated place
- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Active model outline
- Model grid
- Road
- Watercourse
- Drainage feature
- Rail

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50

Middlemount Mine Extension (G1840D)

Post mining equilibrium drawdown – Fort Cooper Coal Measures (Layer 16)

DATE 04/06/2018

FIGURE No: **8.15**

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G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/08.15_G1840D_Post mining equilibrium drawdown – Fort Cooper Coal Measures (Layer 16).qgs

8.4.2 Groundwater intercepted post mining

The WRM modelling indicates the final voids will gradually fill with water over time and representative pit lake levels of approximately 65 mAHD in the northern portion of the North Void, and -39 mAHD in the South Void have been used for the purposed of post closure groundwater recovery modelling. As the predicted pit lake levels are below pre-mining groundwater levels, the voids would act as a sink and would have a long term 'water take'.

The Project is estimated to intercept approximately 0.07 ML/day (24 ML/year) of groundwater inflow to the final voids at equilibrium conditions (i.e. based on the modelled representative pit lake levels). This inflow supplements the rainfall and runoff in balancing the pit water level at an equilibrium level. This inflow is only a small component of the overall water balance on the void which is dominated by rainfall, runoff and evaporation.

8.5 Impacts on groundwater quality

This section describes the potential sources of groundwater quality changes associated with the Project.

8.5.1 Overburden emplacement areas and final void lakes

Although the majority of overburden could be managed as non-acid forming material, there is a risk that some of the coal rejects may have a capacity to generate acid over time if left unmanaged during mining operations (RGS, 2016). The Mining By-Products Management Plan (MCPL, 2013a) and Mining By-Products In-Pit Disposal Site Practice (MCPL, 2013b) describe how mining waste, coarse rejects and tailings will be managed during mining operations. Overburden will continue to be placed within the open cut pits and progressively rehabilitated during mining. Under the Project, surface water runoff and accumulated rainfall seepage will drain towards the voids. Similarly, groundwater will also be drawn in from the surrounding geological units towards the voids. Evaporation from the void lake surfaces will maintain a water level below the surrounding aquifer water levels, forming a groundwater sink in the local environment. Evaporation from the lake surfaces will also slowly concentrate salts in the pit lake over time. The increasing salinity will not pose a risk to other aquifers and surface water features as the final void will remain a permanent sink.

8.5.2 Hydrocarbons

There is limited potential for groundwater contamination to occur as a result of hydrocarbon and chemical contamination with provision for immediate clean-up of spills. All chemicals will be transported, handled and stored in accordance with relevant Australian Standards. These controls represent standard practice and a legislated requirement at mine sites for preventing contamination.

8.5.3 Coal rejects storage

Coarse rejects generated at the Middlemount Mine are co-disposed with fine rejects in-pit and encapsulated with waste rock. Fine rejects are currently pumped to one of four tailings cells operated under a rotating place/dry/excavate cycle before being reclaimed by excavators and trucks and trucked to in-pit disposal locations (RGS, 2016). Water from the fine rejects stream is decanted and returned to the site water management system for re-use. This process of managing coarse and fine rejects generated at the Project will continue over the Project life.

As such, coal rejects will need to be managed to control formation and release of any acid drainage. For example, where it is anticipated that placement of coarse and fine reject materials occurs hydraulically up-gradient of the final void, any resultant seepage from the emplaced rejects will need to report to the final voids. As the final voids are predicted to become sinks, any resultant seepage from the emplaced rejects will be captured and contained within the final voids. Similarly, utilisation of the final voids for in-pit rejects emplacement will be managed to ensure a groundwater sink post closure, provided that any in-pit rejects emplacement remains below the surrounding regional groundwater table.

As detailed in Section 8.4.1, the final voids would gradually fill over time from direct rainfall occurring across each void and groundwater seepage, however the water level in the final voids would remain well below the surrounding groundwater levels. As a result, it is predicted that the final voids would act as sinks to groundwater flow. Any poor quality water within the in-pit rejects emplacement would be captured in the final pit void lakes. Evaporation from the final pit voids would concentrate salts slowly over time. Therefore, there would be little potential for interaction of pit void water with other aquifers or surface water features.

8.5.4 Impacts on environmental values

As discussed in Section 70, the environmental values for groundwaters within the Mackenzie River Sub-basin (DEHP, 2011) that need to be considered include:

- aquatic ecosystems;
- irrigation;
- farm supply/use;
- stock water;
- drinking water;
- industrial purposes; and
- cultural and spiritual values.

The primary agricultural purpose of land within and surrounding the Project area has been for low intensity cattle grazing. However, the groundwater quality data identifies this water would be unsuitable for stock watering based on the naturally elevated TDS levels (Section 7.3). As discussed in Section 8.4.1 the predicted void levels are below pre-mining groundwater levels, and will therefore act as a sink to groundwater flow. Any increase in salinity due to the Project (as a result of evaporation, or from acid generation of rejects or overburden material) will be contained within the final void.

The Project would recycle groundwater that seeps into the open cut pit. The water would be pumped to holding dams, where it will be incorporated into the mine water balance. Therefore, the Project would provide a beneficial industrial use by supplying water for the Project.

9 Groundwater monitoring strategy / program

This section of the report provides a recommended groundwater monitoring program that will provide both an on-going assessment of the impact of the Project and a proactive indicator of any adverse impacts on the groundwater regime.

9.1 Monitoring bore network

The proponent currently maintains a groundwater monitoring program for the approved mining operations in accordance with under EA (EPML00716913). With the updates to the mine plan, some of the monitoring bores will be destroyed over the life of the Project. The existing bores will provide a good indication of groundwater response to mining and should be monitored while they are accessible. Installation of additional bores (MW16A, MW17A, MW18A, MW19VWP, and MW20VWP) outside of the current mine area, is proposed to provide groundwater data within the:

- Tertiary/Weathered Permian strata west of the proposed extension area;
- Tertiary/Weathered Permian strata adjacent to MW10A where groundwater levels have declined below the base of MW10A;
- Tertiary/Weathered Permian strata north of the Project between the northern boundaries for ML 70379 and ML 70417 and existing landholder bores along Rolf Creek: and
- Fort Cooper Coal Measures east of the Jellinbah Fault to assess groundwater drawdown response and the potential for hydraulic loading within these Permian sediments.

The installation of these additional bores will serve to capture additional groundwater monitoring where data gaps within the current monitoring network have been identified. These monitoring bores will be used to verify predicted groundwater model drawdown responses in these areas that are attributable to mining and the data used in any future model updates.

Details of the existing and proposed groundwater monitoring network are provided in Table 9.1 with their locations shown in Figure 9.1

Table 9.1 Proposed Middlemount Mine groundwater monitoring network

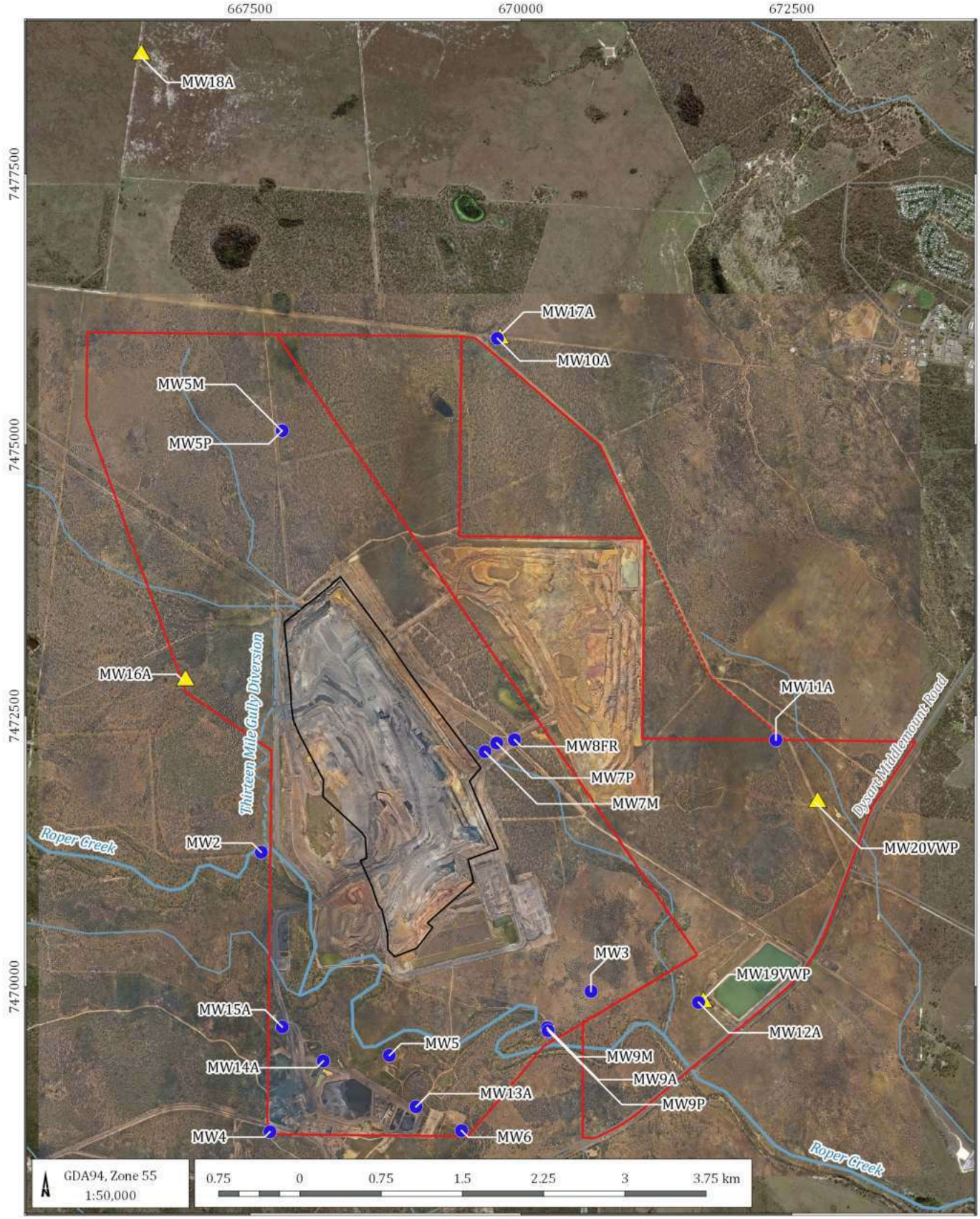
Monitoring bore	Easting (m)	Northing (m)	Bore depth (m)	Screen depth (m)	Screen lithology	Frequency
MW2	667603	7471239	30.0	21.0 – 29.0	Tertiary	SWL: quarterly * Quality: quarterly
MW3	670647	7469955	48.0	39.0 – 47.0	Tertiary	SWL: quarterly * Quality: quarterly
MW4	667683	7468659	50.0	41.0 – 50.0	Intrusives and Girrah coal seam (Fort Cooper Coal Measures)	SWL: quarterly * Quality: quarterly
MW5	668786	7469364	46.0	40.0 – 46.0	Pisces coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly
MW6	669452	7468670	42.0	37.0 – 42.0	Tertiary	SWL: quarterly Quality: quarterly
MW5M	667790	7475131	131.0	127.0 – 130.0	Middlemount coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly
MW5P	667796	7475130	169.0	165.0 – 168.0	Pisces coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly
MW7M	669668	7472167	135.5	132.0 – 134.5	Middlemount coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly

Monitoring bore	Easting (m)	Northing (m)	Bore depth (m)	Screen depth (m)	Screen lithology	Frequency
MW7P	669777	7472247	194.5	189.5 – 193.5	Pisces coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly
MW8FR	669941	7472277	151.0	147.0 – 150.0	Fort Cooper Coal Measures	SWL: quarterly * Quality: quarterly
MW9A	670246	7469610	52.0	40.0 – 52.0	Tertiary	SWL: quarterly * Quality: quarterly
MW9M	670243	7469619	139.5	135.0 – 138.0	Middlemount coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly
MW9P	670251	7469592	204.0	200.0 – 203.0	Pisces coal seam (Rangal Coal Measures)	SWL: quarterly * Quality: quarterly
MW10A	669783	7475981	12.0	6.0 – 12.0	Tertiary	SWL: quarterly Quality: quarterly
MW11A	672355	7472275	13.5	10.5 – 13.5	Tertiary	SWL: quarterly Quality: quarterly
MW12A	671640	7469853	10.55	6.0 – 10.55	Tertiary	SWL: quarterly Quality: quarterly
MW13A	669032	7468890	15.0	9.0 – 14.95	Tertiary	SWL: quarterly * Quality: quarterly
MW16A#	666878	7472826	~30	~15 - 30	Tertiary/Weathered Permian	SWL: quarterly * Quality: quarterly
MW17A#	669783	7475981	~30	~15 – 30	Tertiary/Weathered Permian	SWL: quarterly * Quality: quarterly
MW18A#	666470	7478600	~30	~15 – 30	Tertiary/Weathered Permian	SWL: quarterly * Quality: quarterly
MW19 VWP#	671660	7469855	~331.2	TBC	Girrah coal seam (Fort Cooper Coal Measures)	SWL: quarterly
MW20 VWP#	672714	7471701	~317.5	TBC	Girrah coal seam (Fort Cooper Coal Measures)	SWL: quarterly

Notes: *Coordinates in GDA94Z55*

** recommend installation of a datalogger in addition to manual quarterly water level measurements*

 # proposed additional monitoring bores to address gaps in monitoring network



LEGEND

- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Mine pit footprint, 2017
- Road
- Watercourse
- Drainage feature
- Middlemount Coal Mine monitoring bores
- Proposed monitoring bores

Middlemount Coal Mine Western Extension Project (G1840D)

Proposed Middlemount Coal Mine groundwater monitoring network

DATE 30/04/2018

FIGURE No: **9.1**

©2018 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:/Projects/G1840D.Middlemount_Extension/3_GIS/Workspaces/003_Deliverable3/09.01_G1840D_Proposed Middlemount Coal Mine groundwater monitoring network_v2.qgs

9.2 Water level monitoring plan

It is recommended that groundwater level monitoring is initially undertaken at a quarterly frequency to establish baseline data for groundwater levels in each monitoring bore. Manual monitoring is suitable for identification of long term trends in groundwater levels but does not provide data on short term events such as rainfall recharge that can occur within a monthly monitoring cycle.

It is therefore recommended that for the long term monitoring of groundwater levels, electronic water level loggers are installed in selected monitoring bores and set to record groundwater level measurements at regular intervals (i.e. at least daily or even every six-hours). This will enable continuous measurement of groundwater level fluctuations to determine to what extent these are attributable to rainfall recharge or from declining water level from depressurisation resulting from open cut mining. Quarterly manual measurements should still be conducted to verify the electronic water level data.

9.3 Water quality monitoring plan

Groundwater quality sampling of existing monitoring bores should continue in order to provide long-term groundwater quality dataset, and to detect any changes in groundwater quality during and post mining.

The full groundwater quality suite should include:

- physio-chemical parameters – pH, EC, TDS;
- major ions – calcium, magnesium, sodium, potassium, chloride, sulphate, alkalinity (carbonate and bicarbonate);
- total and dissolved metals –iron, silver, mercury, nickel, and selenium; and
- TPHs – C10-14, C15-28, and C29-36.

All groundwater monitoring, water level measurements and sample collection, storage and transportation should be undertaken in accordance with the procedures outlined by the Murray Darling Basin Commission (1997) and the DEHP (2009).

9.4 Groundwater triggers

The aim of trigger levels is to provide advanced warning of water quality and water level trends that may be departing from historical or predicted values. Once groundwater monitoring data has been accepted, processed, and input into the relevant GWDB, the data will be compared against the trigger limit values and thresholds for the various parameters prescribed by the EA conditions.

9.4.1 Groundwater quality trigger values

Groundwater quality trigger values developed for the Project provide a threshold, above which some further consideration of the data should be given. The trigger values are not a pass or fail assessment, but act as a warning system that initiates further investigation and response.

The water quality datasets collected between May 2013 and June 2017 identifies the water is typically saline making it unsuitable for stock watering, and supports the 2017 bore census which identified no significant use of groundwater by landholders surrounding the Project. Review of the environmental values identifies that groundwater accessed by the Project would only provide a beneficial use for industrial purposes.

Similar to water level trigger thresholds, groundwater quality triggers are defined in Table C8 of the EA EPML00716913 (dated 21 May 2018). These groundwater triggers are presented in Table 9.2.

Table 9.2 Groundwater investigation trigger levels

Parameter^	Unit	Trigger value	Limit type	Recommended amendments	
				Trigger value	Limit type
pH	pH units	6.5-8.5	Minimum / Maximum	6.5-8.5	Minimum / Maximum
EC	µS/cm	35,000	Maximum	35,000	Median
TDS	mg/L	23,548	Maximum	24,000	Median
Calcium	mg/L	1,000	Median	1,000	Median
Magnesium	mg/L	2,000	Median	2,000	Median
Sodium	mg/L	6,700	Median	6,700	Median
Potassium	mg/L	43	Median	43	Median
Chloride	mg/L	12,700	Median	12,700	Median
Sulfate (SO_4)	mg/L	2,000	Median	2,000	Median
Carbonate (CO_3)	mg/L	7.65	Median	7.7	Median
Bicarbonate (HCO_3)	mg/L	798	Median	800	Median
Iron	mg/L	13.984	Maximum	14.0	Median
Mercury	mg/L	0.002	Maximum	0.002	Median
Selenium	mg/L	0.034*	Maximum	Remove parameter	Remove parameter
TPHs (C10-C14)	µg/L	50	Maximum	50	Median
TPHs (C15-C28)	µg/L	184.8	Maximum	185.0	Median
TPHs (C29-C36)	µg/L	89.2	Maximum	90.0	Median

Notes: *^ Silver was removed from Table C8 of EA EMPL00716913 in a minor amendment dated 21 May 2018.*
** Trigger value changed from 0.02 to 0.034 in a minor amendment dated 21 May 2018.*

In 2017, a review of the EA triggers (i.e. in the EA dated 22 August 2017) identified several inappropriate or unsuitable conditions in the EA in relation to the groundwater triggers, and recommended changes that would ensure a greater level of compliance, while maintaining the protection of environmental values (AGE, 2017a). Recommendation was provided for adopting the median-type trigger value for all other parameters (except pH) which would be more appropriate for eliminating false exceedances that are isolated occurrences. The most recent review of recent trigger exceedances (AGE, 2017b) included analysis of the potential causes of the exceedances and the potential for any resultant environmental harm, and indicated the exceedances in relation to:

- TDS and sodium were a result of naturally occurring fluctuations that were most likely attributable to changes in climate that would have no change in the environmental values of the groundwater.
- Silver and selenium were related to sample dilution and at very low concentrations.
- TPH were short term that were probably not represent of petrogenic hydrocarbons linked to mining activities, and were therefore were false exceedances that would probably be removed using the silica-gel clean-up method recommended by Australian Laboratory Services Pty Ltd (ALS code EP071-SG). This was subsequently confirmed with the groundwater monitoring undertaken in December 2017 (AGE, 2018).

The report concluded that the exceedances in these parameters were not expected to have any impact on the potential groundwater use or environmental values, and provided recommendation for:

- removing silver as there is no ANZECC/ARMCANZ guideline for this parameter;
- removing selenium as the water is unsuitable for stock watering due to high TDS; and
- keeping the EC and TDS trigger values at their current levels but amending these to "median-type".

This assessment also recommended rounding off the trigger levels for TDS, carbonate, bicarbonate, iron and TPH (C15-28 and C29-36).

It is noted that a minor amendment to EA EMPL00716913 dated 21 May 2018 (i.e. subsequent to AGE [2017a; 2017b]) resulted in changes to Table C8 of the EA to reflect some of these recommendations (i.e. the removal of silver as a monitoring parameter, and modification of the selenium trigger value). The remaining recommendations from AGE (2017a) that were not implemented at the time of the minor amendment have been included in Table 9.2.

9.4.2 Groundwater level trigger thresholds

The existing monitoring bore network is located both within and surrounding the approved and proposed mining footprint. These bores are therefore expected to measure drawdown that will range from a few metres to tens of metres. Drawdown compared to the predictions of groundwater drawdown for the Project will be used to identify divergence between predicted and observed measurements, and assess the likely causes of these discrepancies.

Table 9.3 presents the current groundwater level trigger thresholds as defined in Table C10 of the EA EPML00716913 (dated 21 May 2018) for the existing monitoring bores, outside of normal seasonal fluctuations. These are provided either as a change in water level per year, or as a total change in the groundwater elevation (mAHD) as determined from the total predicted drawdown from the initial water level at for bores MW3, MW5 and MW9A. If the results, when compared to the groundwater level trigger thresholds, do not exceed the level trigger thresholds, then no further action is required. If they exceed the trigger level thresholds; an exceedance investigation and response will be initiated.

Table 9.3 Groundwater level trigger thresholds

Monitoring location	Current EA-EPML00716913 trigger level threshold [a]	Predicted maximum drawdown from groundwater model (m) [a]	Recommended amendments to trigger threshold
MW2	> 2 metres per year	3.8	No change to trigger
MW3[b]	Total groundwater level of < 115.39 metres AHD	11.8	No change to trigger
MW4	> 2 metres per year	0.0	No change to trigger or remove from EA
MW5	Total groundwater level of < 140.4 metres AHD	17.3	Total groundwater level of < 116.9 metres AHD
MW6	> 2 metres per year	8.2	No change to trigger
MW9A	Total groundwater level of < 118.17 metres AHD	13.5	No change to trigger
MW10A	> 2 metres per year	0.0	No change to trigger
MW11A	> 2 metres per year	0.0	No change to trigger
MW12A	> 2 metres per year	6.6	No change to trigger
MW13A	> 2 metres per year	0.0	No change to trigger

Notes: *a: The level trigger threshold is equal to the groundwater level drawdown observed within each monitoring bore measured from the commencement of mining.*

b: MW3 will continue to be monitored until progression prevents monitoring. MW9A installed as a replacement well for MW3.

Review of the maximum drawdown levels for the monitoring bores listed in the EA (dated 21 May 2018) indicates the trigger level for MW5 would need to be revised to reflect the predicted change in groundwater elevation (mAHD) at this location. AGE (2017a) also recommended bore MW4 should not be subject to groundwater level change restrictions (in EA Table C10) as it is not screened in the Tertiary unit and therefore be removed from the EA. This recommendation is included in Table 9.3. Groundwater level triggers for the proposed monitoring bores MW16A, MW17A and MW18A will be determined after these bores are installed, and their locations and aquifer intersected confirmed.

9.5 Mine groundwater inflow monitoring

MCPL currently assess groundwater pit inflows through review of pumping records of pit de-watering and the site water balance model to identify inflow/seepage rates. Water samples should also be collected of any pumped seepage and include laboratory analysis for same suite of parameters for the groundwater monitoring bores. The groundwater pit inflow monitoring program should include:

- recording of any unexpected or significantly increased groundwater inflows directly to the pits;
- measurement of water pumped from the pits;
- sampling of water quality pumped from the pits;
- monitoring of rainfall (to allow for correlation with pumping/pit inflow records); and
- records of ROM and product coal moisture content.

9.6 Data management and reporting

It is recommended that data management and reporting by the proponent includes an annual monitoring report which should include:

- records of groundwater levels and quality in the monitoring network bores; and
- details of any review undertaken of the groundwater model since the previous annual monitoring report (NB: A review of the groundwater model should be undertaken within five years of commencement of the Project by a suitably qualified hydrogeologist).

10 Conclusions

This report has evaluated the impact of the Project. The Project involves extending the continued operation of the Middlemount Coal Mine for approximately six years at the currently approved rate of 5.7 Mtpa, which requires an EA amendment. The study has built on results from the previous groundwater assessments (PB, 2010a; PB, 2010c; AGE, 2017a; and AGE, 2017b), groundwater level data, groundwater chemistry data and the geological data available for the Project area. The conclusions of the assessment of the Project on the groundwater resources are listed below:

- The primary groundwater units impacted by the Project are the Tertiary Duaringa Formation and weathered Permian Rangal Coal Measures where these sediments are saturated.
- There are no landholder water supply bores located within the predicted drawdown extents attributable to the proposed mine plan for the Project.
- The bore census undertaken for this assessment identified no use of groundwater from both the Tertiary Duaringa Formation and Permian Rangal Coal Measures surrounding the Project. This is due to the aquifers being either unsaturated or partially unsaturated in the vicinity of the Middlemount Coal Mine (as is the case with the shallower groundwater hosted within the Tertiary Duaringa Formation and weathered Permian Rangal Coal Measures), or saline as is the case for both the Tertiary Duaringa Formation and Permian Rangal Coal Measures.
- Assessment of the cumulative impacts with other nearby operating mines and the Bowen Gas Project CSG activities does not predict any cumulative drawdown within the Tertiary and weathered Permian, but does predict the Middlemount Seam 1 m contour and Pisces Seam 2 m contour just intersecting roughly midway between the Project and the German Creek East voids.
- The assessment identifies that there are no watercourses with associated productive alluvial aquifers within the Project area and there will be no impact from mining on localised shallow alluvial or perched aquifers that may be associated with minor surface drainage features within the Project area.
- The Project is not predicted to impact any aquatic or terrestrial GDEs, as mapped GDEs in the Project area are assessed unlikely to be restricted to areas where groundwater can potentially be accessed, the ephemeral nature of the drainage features, groundwater levels being in excess of 12 mbgl, and there being no evidence of any vegetation dieback attributable to the existing operations.
- This assessment predicts the final voids will act as long-term groundwater sinks post mining, This will result in the long-term water quality within the final voids being affected by evaporative concentration and becoming more saline. However, flow of this water into the groundwater systems will be prevented as a consequence of the lower water level within the voids.
- Although the overburden consists primarily of non-acid forming material, coal rejects and overburden material will be contained within in-pit storage emplacements, which will act as a sink to groundwater flow. As such, any resultant impact to void water quality will be contained at the site.
- Removing the selenium water quality trigger and adopting the median-type trigger value for all other parameters (except pH) to eliminate false exceedances that are isolated occurrences and, given the groundwater is unsuitable for stock watering, the overall lack of groundwater use by landholders surrounding the Project, and the only beneficial use of the groundwater being for industrial purposes.
- Revising the trigger level for MW5 to reflect the predicted change in groundwater elevation at this location.

- Removing bore MW4 from the EA as this bore is not screened in the Tertiary unit and should not be subject to groundwater level change restrictions in Table C10 of the EA.
- Rounding off the trigger levels for selected parameters.

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Appendix A **IESC Guidelines**

A1 Independent Expert Scientific Committee guidelines

The Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development has information guidelines for advice on coal seam gas and large coal mining development proposals. The following section specifies where the IESC information requirements for individual proposals have been addressed within this report.

A1.1 Description of the proposal

Project Information	Addressed in section
Provide a regional overview of the proposed project area including a description of the geological basin; coal resource; surface water catchments; groundwater systems; water-dependent assets; and past, present and reasonably foreseeable coal mining and CSG developments.	Sections 1, 2, 4, 5, & 6
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations..	Sections 1.1, 3, 7, & 8.3.4
Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Sections 1, 6 & 8
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 3 & 7

A1.2 Risk Assessment

Project Information	Addressed in section
Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Sections 6, 7, 8 & Appendix F
Assess risks following the implementation of any proposed mitigation and management options to determine if these will reduce risks to an acceptable level based on the identified environmental objectives.	Section 8 & Appendix F
Incorporate causal mechanisms and pathways identified in the risk assessment in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	Section 8 & Appendix F
The risk assessment should include an assessment of: • all potential cumulative impacts which could affect water resources and water-related assets; and, • mitigation and management options which the proponent could implement to reduce these impacts..	Sections 8 & 9

A1.3 Groundwater – Context and conceptualisation

Project Information	Addressed in section
Describe and map geology at an appropriate level of horizontal and vertical resolution including: • definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data. • geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	Section 5 Section 5
Define and describe or characterise significant geological structures (e.g. faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. • Site-specific studies (e.g. geophysical, coring / wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays). • Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.	Section 5.8, 6.10 & 6.12
Provide site-specific values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Section 6
Provide time series level and water quality data representative of seasonal and climatic cycles.	Section 6 & Appendix E
Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Section 6
Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations	Section 6
Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Section 6
Assess the frequency (and time lags if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water	Section 6

A1.4 Groundwater – Numerical modelling

Project Information	Addressed in section
Provide a detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Section 8 & Appendix F
Undertaken groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), including independent peer review.	Appendix F1.1
Calibrate models with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	Section 8.2.3 & Appendix F
Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	Appendix F4.4
Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	Appendix F4.8
Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the groundwater model. Provide predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps for all hydrogeological units..	Sections 8.3 & Appendix F
Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Section 8.3
Undertake model verification with past and/or existing site monitoring data.	Appendix F4
Provide an explanation of the model conceptualisation of the hydrogeological system or systems, including multiple conceptual models if appropriate. Key assumptions and model limitations and any consequences should also be described.	Section 6 & Appendix F2.3
Consider a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	Appendix F4.2
Undertake sensitivity analysis and uncertainty analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model (see Middlemis and Peeters [in press]).	Appendix F7
Provide an assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios.	Section 6
Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Middlemis and Peeters [in press]).	Appendix F7
Provide a program for review and update of models as more data and information become available, including reporting requirements.	Section 9
Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached.	Sections 8.3 & 8.4

A1.5 Groundwater – Impacts on water resources and water dependent assets

Project Information	Addressed in section
Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: • any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water. • the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance. • the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units. • the possible fracturing of and other damage to confining layers. • For each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal	Section 8.3.2 Section 8.3 N/A N/A N/A
Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining..	Section 8.3.3
For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Section 8.3
Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Sections 7
Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 8.3.3
Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	Section 9
Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 9 and refer to Receiving Environment Monitoring Program

A1.6 Groundwater – Data and monitoring

Project Information	Addressed in section
Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Sections 6 & 9
Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	Section 9
Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	Section 9
Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Section 9
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 9

A1.7 Water dependent assets – Context and conceptualisation

Project Information	Addressed in section
Identify water-dependent assets, including: • water-dependent fauna and flora and provide surveys of habitat, flora and fauna (including stygofauna) (see Doody et al. [in press]). • public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.	Sections 6.8, 6.9 & 7
Identify GDEs in accordance with the method outlined by Eamus *et al*. (2006). Information from the GDE Toolbox (Richardson *et al*. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody *et al*. [in press]).	Section 6.8
Describe the conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	Section 6. 8
Estimate the ecological water requirements of identified GDEs and other water-dependent assets (see Doody *et al*. [in press]).	Section 6. 8
Identify the hydrogeological units on which any identified GDEs are dependent (see Doody *et al*. [in press]).	Section 6. 8

Project Information	Addressed in section
Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Section 8.3.6
Describe the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	Section 8.3.6

A1.8 Water dependent assets – Impacts, risk assessment and management of risks

Project Information	Addressed in section
Provide an assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs (see Doody *et al*. [in press]).	Section 8.3.6
Describe the potential range of drawdown at each affected bore, and clearly articulate of the scale of impacts to other water users.	Section 8.3.5
Indicate the vulnerability to contamination (e.g. from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	Sections 8.5
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	Section 8.4
Provide estimates of the volume, beneficial uses and impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	Refer to Surface Water Assessment
Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Section 8.3.6
Identify the proposed acceptable level of impact for each water-dependent asset based on leading-practice science and site-specific data, and ideally developed in conjunction with stakeholders.	Section 8.3.6
Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	Section 9

A1.9 Water dependent assets – Data and monitoring

Project Information	Addressed in section
Identify an appropriate sampling frequency and spatial coverage of monitoring sites to establish pre-development (baseline) conditions, and test potential responses to impacts of the proposal (see Doody *et al*. [in press]).	Section 9

Project Information	Addressed in section
Consider concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design, see Doody *et al*. [in press]).	Section 9
Develop and describe a monitoring program that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in ecological responses and detects whether ecological responses are within identified thresholds of acceptable change (see Doody *et al*. [in press]).	Section 9
Describe the proposed process for regular reporting, review and revisions to the monitoring program.	Section 9
Ensure ecological monitoring complies with relevant state or national monitoring guidelines (e.g. the DSITI guideline for sampling stygofauna [QLD Government 2015]).	Refer to Receiving Environment Monitoring Program

A1.10 Water and salt balance and water management strategy

Project Information	Addressed in section
Provide a quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc.), including all sources and uses.	Refer to Surface Water Assessment
Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Refer to Surface Water Assessment
Provide estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	Refer to Surface Water Assessment
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	Refer to Surface Water Assessment

A1.11 Cumulative Impacts – Context and conceptualisation

Project Information	Addressed in section
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 8.3.3
Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 8.3.3

A1.12 Cumulative Impacts – Impacts

Project Information	Addressed in section
Provide an assessment of the condition of affected water resources which includes: • identification of all water resources likely to be cumulatively impacted by the proposed development; • a description of the current condition and quality of water resources and information on condition trends; • identification of ecological characteristics, processes, conditions, trends and values of water resources; • adequate water and salt balances; and, • identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	Section 8.3.3
Assess the cumulative impacts to water resources considering: • the full extent of potential impacts from the proposed project, (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally; • all stages of the development, including exploration, operations and post closure / decommissioning; • appropriately robust, repeatable and transparent methods; • the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts; and, • opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.	Sections 8.3 & 8.4

A1.13 Cumulative Impacts – Mitigation, monitoring and management

Project Information	Addressed in section
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (e.g. case studies) should be provided..	Refer to Surface Water Assessment
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Refer to Surface Water Assessment
Identify cumulative impact environmental objectives.	Refer to Surface Water Assessment
Describe appropriate reporting mechanisms.	Refer to Surface Water Assessment
Propose adaptive management measures and management responses.	Refer to Surface Water Assessment

A1.14 Final landform and voids – coal mines

Project Information	Addressed in section
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	Section 8.4
Assess the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	Section 8.4
Provide an evaluation of stability of void slopes where failure during extreme events or over the long term (for example due to aquifer recovery causing geological heave and landform failure) may have implications for water quality.	Section 8.5
Evaluate mitigating inflows of saline groundwater by planning for partial backfilling of final voids.	Section 8.5
Provide an assessment of the long-term impacts to water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should consider: • groundwater behaviour – sink or lateral flow from void. • water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation). • seepage – geochemistry and potential impacts. • long-term water quality, including salinity, pH, metals and toxicity. • measures to prevent migration of void water off-site. For other final landform options considered sufficient detail of potential impacts should be provided to clearly justify the proposed option.	Sections 8.4 & 8.5
Assess the probability of overtopping of final voids with variable climate extremes, and management mitigations.	Sections 8.4 & 8.5

A1.15 Acid-forming materials and other contaminants of concern

Project Information	Addressed in section
Identify the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	Sections 5.9 & 8.5
Identify the presence and volume of potentially acid-forming waste rock, fine-grained amorphous sulphide minerals and coal reject/tailings material and exposure pathways.	Section 8.5
Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	Sections 6.6.4 & 6.7.4

Project Information	Addressed in section
Describe handling and storage plans for acid-forming material (co-disposal, tailings dam, and encapsulation).	Section 8.5.3
Assess the potential impact to water-dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	Section 8.3.6
Describe proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	Section 8.5

Appendix B DNRM groundwater data base bores

Table B.1 Summary of DNRME existing registered bores within a 10 km buffer zone

RN	Bore name	Date drilled	Screen/perforation/ open hole (from... mbGL to... mbGL)	Drilling depth (mbGL)	SWL (mbGL)	Yield (L/s)	Water quality (µS/cm)	Aquifer
43060	Rolfs bore	1/02/1973	-	54	21.2	0.7	14,360	-
43474	Three mile bore	2/07/1965	Open hole 21.3 - 41.0m	41.1	18.1	no data	no data	Clay[a]
43063	House Bore 3*	-	-	-	12.09	0.7	4,430	Coal *
47037	Blanches bore	19/11/1972	Open hole 23.2 - 35.7m	35.7	15.1	0.38	2,290	Back Creek Group
132459	MW6	3/06/2008	37.0 – 42.0 (screen)	42.0	43.5	1.0	Potable	Duaringa Formation
151043	MW2	5/06/2006	21.0 – 29.0 (screen)	30.0	no data	no data	no data	Duaringa Formation
151335	MW4	4/06/2008	41.0 – 50.0 (screen)	50.0	no data	no data	no data	Fort Cooper Coal Measures
151336	MW3	4/06/2008	39.0 – 47.0 (screen)	48.0	no data	no data	no data	Duaringa Formation
151658	MW5	4/06/2008	40.0 – 46.0 (screen)	46.0	no data	no data	no data	Pisces coal seam
158679	MW7P	24/07/2010	189.5 – 193.5 (screen)	194.5	no data	no data	no data	Pisces coal seam
158771	no data	17/04/2014	23.5 – 26.5 (screen)	27.0	no data	no data	no data	Sandstone/siltstone
158772	no data	18/04/2014	9.2 – 12.2 (screen)	12.2	no data	no data	no data	Sandstone
158773	no data	17/04/2014	37.5 – 40.5 (screen)	41.0	no data	no data	no data	Granite
161060	MW5M	24/07/2010	127.0 – 130.0 (screen)	131.0	43.5	1.0	Potable	Middlemount coal seam
161061	MW5P	24/07/2010	165.0 – 168.0 (screen)	169.0	no data	no data	no data	Pisces coal seam
161062	MW7M	19/06/2010	132.0 – 134.5 (screen)	135.5	no data	no data	no data	Middlemount coal seam
161063	MW8FR	25/07/2010	147.0 – 150.0 (screen)	151.0	no data	no data	no data	Fort Cooper Coal Measures
161064	MW9A	27/07/2010	40.0 – 52.0 (screen)	52.0	no data	no data	no data	Duaringa Formation

RN	Bore name	Date drilled	Screen/perforation/ open hole (from... mbGL to... mbGL)	Drilling depth (mbGL)	SWL (mbGL)	Yield (L/s)	Water quality (µS/cm)	Aquifer
161065	MW9M	27/07/2010	135.0 – 138.0 (screen)	139.5	no data	no data	no data	Middlemount coal seam
161066	MW9P	28/07/2010	200.0 – 203.0 (screen)	201.0	24.4	0.2	-	Pisces coal seam
165439	MB2	30/06/2017	50.0 – 62.0 (screen)	62.0	no data	no data	14,020	Coal / Sandstone
165440	MB3	2/07/2017	38.0 – 50.0 (screen)	50.0	37.0	no data	no data	Coal / Sandstone
165443	MB6	7/07/2017	45.0 – 54.0 (screen)	54.0	no data	no data	no data	Sandstone / Coal / Diorite (intrusion)
165444	-	8/07/2017	21.0 – 36.0 (screen)	36.0	22.2	0.41	Salty	Coal / Sandstone
165460	RDF1047_P2	5/08/2017	24.0 – 51.0 (screen)	51.0	no data	no data	3,074	Duaringa Formation
165461	RDF1047_P1	6/08/2017	181.0 – 190.0 (screen)	201.0	no data	7.1	3,072	Blackwater Group
165462	RDF1033 P1	8/08/2017	156.0 – 162.0 (screen)	170.0	no data	7.1	Salty	Blackwater Group
165463	RDF1033_P2	8/08/2017	12.0 – 30.0 (screen)	27.0	12.0	0.1	3,125	Duaringa Formation
165464	RDF1056_P1	9/08/2017	129.0 – 138.0 (screen)	138.0	no data	0.2	3,970	Blackwater Group
165486	-	31/10/2017	35.0 – 101.0 (screens)	115.0	no data	0.5	3,240	Blackwater Group

Notes:
Table A.1 excludes CSG bores
mbGL metres below ground level
\- *no information provided*
* *details for original House Bore 1, which was replaced with House Bore 3*

Appendix C **Bore census**

Middlemount Coal Mine Western Extension Project

Groundwater Bore Census

September 2017

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1 Executive Summary

4T Consultants Pty Ltd was contracted by Middlemount Coal Pty Ltd (MCPL) to undertake a census of existing bores surrounding the Middlemount Coal Mine, verified by ground-truthing, to support the groundwater modelling and impact assessment process for the Western Extension Project.

A total of six (6) landholder properties and the Middlemount landfill sites were assessed.

These are summarised in Table 1.

Table 1: Properties and possible bore sites identified during the census.

Property	Lot/Plan	Bore (RN)	Bore name	Located	Recorded	Sampled
Gundabah	L1 RP620006	RN44080	NA	✗	✗	✗
Gundabah	L1 RP620006	RN38997	Bore No 2	✗	✗	✗
Tuon Downs	L5 CNS232	NA	TD1	✗	✗	✗
Tuon Downs	L5 CNS232	NA	TD2	✗	✗	✗
Tuon Downs	L5 CNS232	NA	TD3	✗	✗	✗
Hazelbrae	L2 RP620006	RN43474	Three Mile Bore	✓	✓	✗
Warwick Park	L4 CNS38	NA	Yards Bore	✓	✓	✗
Warwick Park	L4 CNS38	RN43060	Rolfs Bore	✓	✓	✓
Warwick Park	L4 CNS38	RN47037	Blanches Bore	✓	✓	✓
Warwick Park	L4 CNS38	RN43063	House Bore 3*	✓	✓	✓
Middlemount Landfill	L49 CNS281	RN158771	MB03	✓	✓	✗
Middlemount Landfill	L49 CNS281	RN158772	MB02	✓	✓	✗
Middlemount Landfill	L49 CNS281	RN158773	MB01	✓	✓	✗

* Original House Bore recorded as RN3063 has been replaced with House Bore 3.

2 Introduction and Purpose

The purpose of this report is to present the findings of a census of existing bores surrounding the Middlemount Coal Mine, verified by ground-truthing, to support the groundwater modelling and impact assessment process for the Western Extension Project.

The bore census was conducted by 4T Consultants Pty Ltd (4T) with general consideration of the QLD DEHP (2017) *Guideline Baseline Assessments* for the minimum requirements for undertaking a baseline assessment on water bores.

3 Scope of Works

The following Scope of Works (SoW) was provided to 4T Consultants Pty Ltd (4T) by Middlemount Coal Pty Ltd (MCPL) and Resource Strategies Pty Ltd (RS).

3.1 Objectives

The overall purpose of this project is to complete a census of existing bores in the project area verified by ground truthing to support the groundwater modelling process.

Complete a borehole census for the above project with general consideration of the QLD DEHP (2017) minimum requirements for undertaking a baseline assessment on a water bore.

Preliminary review of existing groundwater bore records for the project area indicated the following properties were to be assessed during the census, (including but not limited to):

- Baker property
- Murphy property
- Singleton property
- Curran property (south side of Rolf Creek / 10 km radius)
- Middlemount Township (c. 3-5 bores).

The following assumptions were made as part of the SoW:

- The existing groundwater monitoring network on Middlemount Coal owned land will not be recorded as part of the bore census (only privately-owned bores).
- That there are no other known (historic) groundwater bores on the Middlemount Coal owned land.

- Other mine owned land (Foxleigh, Anglo, BHP) were not to be inspected (assumed validated by desktop means or email correspondence with mining companies).

3.2 Desktop Bore Census, Data Collation and Gap Analysis

Compile desktop maps and bore database supported by reviews of project records, landowner records, previous reports, government databases, regional topographic maps, and available groundwater data for the project area.

Identify data gaps to determine where supplementary site works are required.

Confirm the extent of the area to be covered by the census in context of the hydrogeological setting, bore distribution, site access, and the proposed mine operations in consultation with the client. Commence with 5 km radius and expand to 10 km as required.

3.2.1 Landowner Notification

Liaise with Middlemount Coal to contact landowners. Where landowner liaison confirms no bores are present, the specified land parcels may be removed from the register of sites requiring ground truthing.

This task is required to inform the extent of field truthing.

3.2.2 Field Validation and Bore Census

Conduct site visit with landholders in order to confirm:

- Bore site information;
- Bore construction details;
- Bore equipment and condition details;
- Photograph the bore and equipment;
- Bore supply information (e.g. use, licence, purpose, pump regime, capacity;
- Water level measurement and bore head measurements;
- Water quality assessment (sample, field testing, submit for laboratory analysis for suite of parameters); and
- Other general comments from discussions with the landholder (e.g. yield, extraction history, previous water level readings, construction details, etc.)

4 Bore Census Methodology

4.1 Identification of bore locations for assessment

Bores were initially identified surrounding the Middlemount Coal Mine based on desktop details extracted from the Queensland Department of Natural Resources and Mines (DNRM) database of registered groundwater bores (2012) are shown on Figure 1.

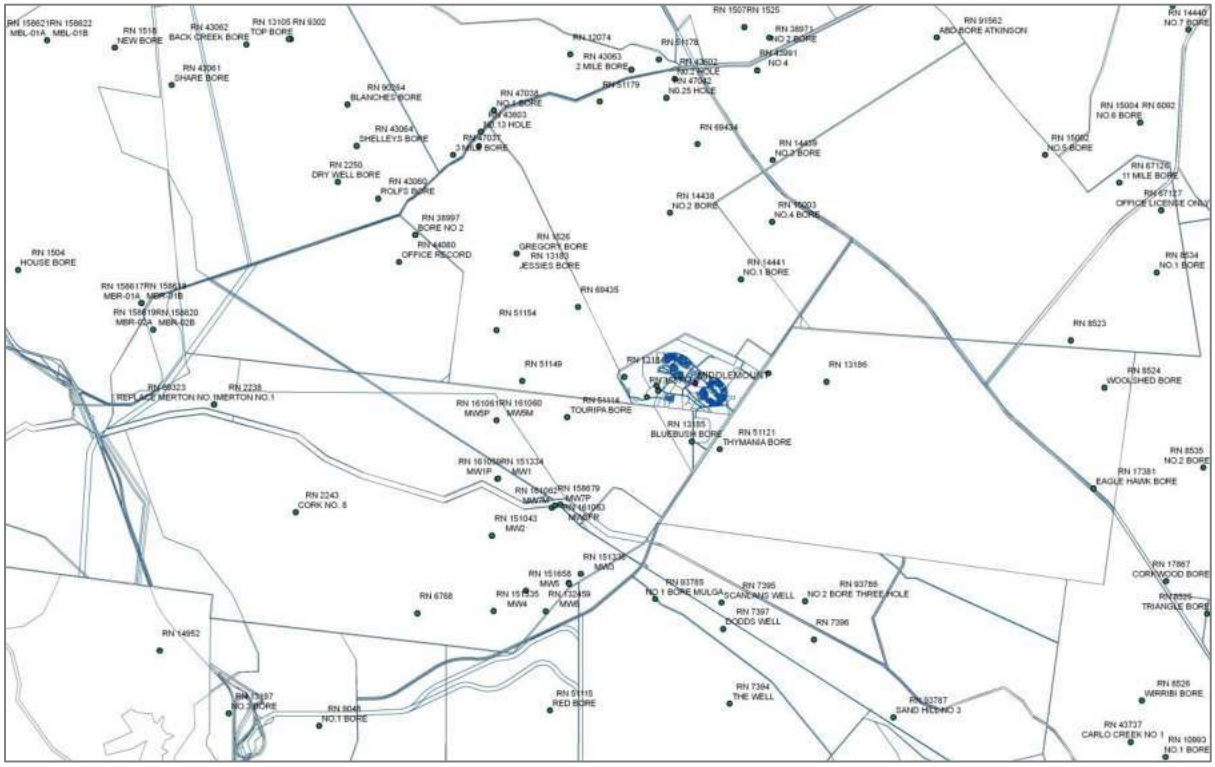


Figure 1: Draft map based on the 2012 DNRM database of registered groundwater bores.

Field surveys and a review of the DNRM data showed that a number of these bores were, in fact, in GDA Zone 54 (western Queensland), and not in Zone 55 (Area of Interest).

Bores that were ultimately identified and assessed (or discussed with landholders) within the 10 Km are shown in Figure 2. Bores TD1, TD2 and TD3 on Tuon Downs were discussed with the landholder, but the bores are not registered, and no coordinates were available to 4T to map the locations (Refer Section 5.5).

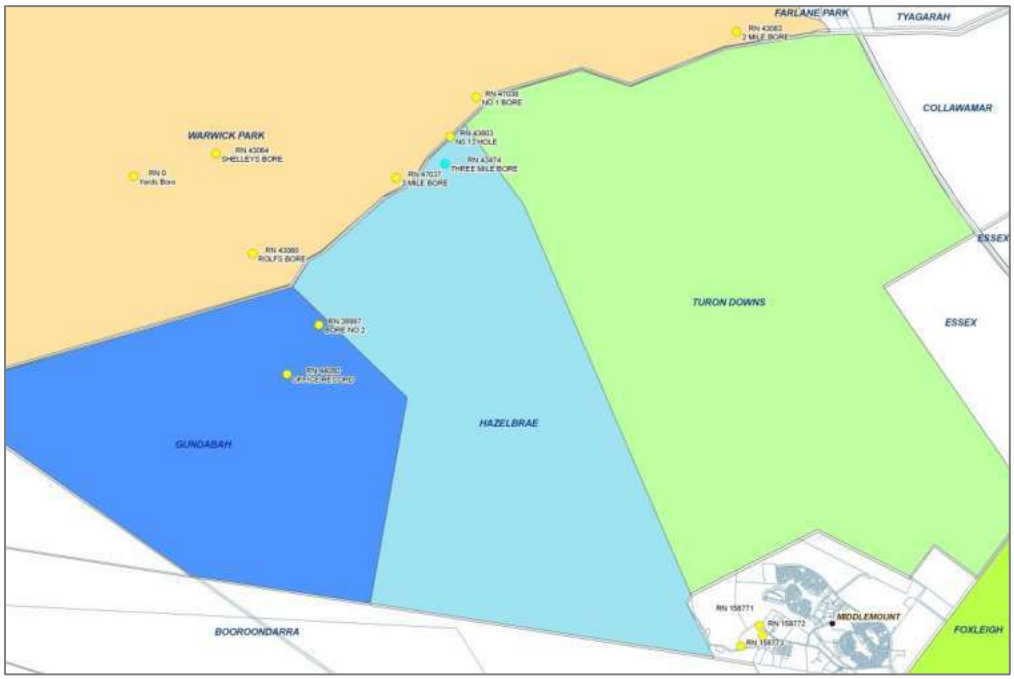


Figure 2: Bores that were assessed in the census.

4.2 Prior notice to landholders

All landholders were contacted by telephone, prior to field visits (when approval was obtained) and whilst accessing their properties (if personal contact was not possible during the field work).

4T met with John Baker (Gundabah), Jim Curran (Warwick Park) and John Singleton (Tuon Downs) during the field survey period to discuss the census.

4T visited the Isaac Regional Council offices in Middlemount and they contacted the responsible person in Moranbah to provide authorisation for access to the three monitoring bores at the Middlemount landfill site.

Telephone conversations were held with Ted Murphy ("Hazelbrae"), John Campion ("Foxleigh"), Matt Kenny ("Tralee"), and Don Black (Middlemount Jockey Club).

Details of the field assessment visits are in the following bore records for each property.

4.3 Location of bores

Initially the DNR database records were discussed with individual landholders, who indicated whether there were existing bores, abandoned bores or any collective recollection of previously existing bores.

Information provided by landholders is included in the detailed data sheets from each property.

In the field, bore coordinates were loaded into a vehicle GPS tracking system (GDA94 UTM) and this system used the map in Figure 2: Bores that were assessed in the census.**Error! Reference source not found.** as the basis to locate bores.

4.4 Bore census records

At each located bore, a field record based on the DEHP (2017) minimum requirements for undertaking a baseline assessment on a water bore were completed, and photographs were taken.

Any other general observations were recorded, and these are included in this report under individual property sections.

4.5 Sampling and analysis

Where water samples were obtained, they were sampled in accordance with the DERM Monitoring and Sampling Manual 2009 Version 2 (September 2010).

Samples for laboratory analysis were sent to Australian Laboratory Services (ALS) in Brisbane. ALS is a NATA accredited laboratory for all analytes required under the minimum requirements as indicated in the DEHP (2017) minimum requirements for undertaking a baseline assessment on a water bore.

5 Bore census information

The bores that were recorded during the census are listed in Table 2.

5.1 Summary of field surveys

Table 2: Bores that were recorded during the census

Property	Lot/Plan	Bore (RN)	Bore name	Located	Recorded	Sampled
Gundabah	L1 RP620006	RN44080	NA	×	×	×
Gundabah	L1 RP620006	RN38997	Bore No 2	×	×	×
Tuon Downs		Refer to comments in report regarding bores TD1, TD2 and TD3				
Hazelbrae	L2 RP620006	RN43474	Three Mile Bore	✓	✓	×
Warwick Park	L4 CNS38	NA	Yards Bore	✓	✓	×
Warwick Park	L4 CNS38	RN43060	Rolfs Bore	✓	✓	✓
Warwick Park	L4 CNS38	RN47037	Blanches Bore	✓	✓	✓
Warwick Park	L4 CNS38	RN43063	House Bore 3*	✓	✓	✓
Middlemount Landfill	L49 CNS281	RN158771	MB03	✓	✓	×
Middlemount Landfill	L49 CNS281	RN158772	MB02	✓	✓	×
Middlemount Landfill	L49 CNS281	RN158773	MB01	✓	✓	×

*Initial bore recorded as RN3063 has been replaced with House Bore 3.

Figure 3: Base information summary - Bores in the area of interest (Source: DNRM database)

Property	Bore Name	RN	Easting	Northing	Total depth (m)	Screen (m)	TOC_GL (m)	SWL (mBTOC)	SWL (mBGL)	Casing material	Casing size (mm)	Notes
Warwick Park	Yards Bore	NA	0661509	7484051	54.0 *	NA	0.33	18.42	18.09	Steel	150	* estimated by owner
Warwick Park	Rolfs Bore	43060	0663778	7482641	38.1	NA	0.32	21.21	20.89	Steel	125	
Warwick Park	Blanches Bore	47037	0666941	7484987	35.7	NA	0.32	NA		Steel	125	Could not insert depth sensor.
Warwick Park	House Bore 1	43063	0673624	7487216	30.5	Open hole	0.19	11.15	10.96	Steel	125	Open hole at 30.5
Warwick Park	House Bore 2	NA	0673615	7487207	NA	NA	0.70	12.1	11.4	Steel/PVC	150/125	125 mm PVC casing insert.
Warwick Park	House Bore 3	NA	0673625	7487204	NA	NA	0.48	12.09	11.61	Steel	150	Current house bore
Warwick Park	Shellys Bore	43064	0663042	7484421	79.3	Open hole	No longer exists refer to bore log for historical data.					
Warwick Park	No 13 Hole	43603	0667263	7484901	No longer exists. Owner has no recollection of bore location.							
Warwick Park	No 1 Bore	47038	0667707	7485630	42.7	Open hole	No longer exists refer to bore log for historical data.					
Gundabah	Bore No 2	38997	0665032	7481405	106.7	Open hole	No longer exists refer to bore log for historical data.					
Gundabah	NA	44080	0664487	7480492	64.6	Open hole	No longer exists refer to bore log for historical data.					
Hazelbrae	Three Mile Bore	43474	0666800	7484295	41.0	Open hole	0.17	NA	-	Steel	125	Open hole 21.3 - 41.0m
Tuon Downs	TD1	NA			Owner indicated that bore has been capped and abandoned.							
Tuon Downs	TD2	NA			Owner indicated that bore has been capped and abandoned.							
Tuon Downs	TD3	NA			Owner indicated that bore has been capped and abandoned.							
Middlemount Landfill	MB01	158773	0672779	7475733	31.6	37.5 - 40.5	0.66	Dry		PVC	60	Depth tape hit bottom at 31.63m
Middlemount Landfill	MB02	158772	0673170	7475942	12.5	9.2 - 12.2	0.73	Dry		PVC	60	Depth tape hit bottom at 12.51m
Middlemount Landfill	MB03	158771	0673109	7476116	26.6		0.65	Dry		PVC	60	Depth tape hit bottom at 26.57m

Property	Bore Name	RN	Sampled	Temp (°C)	pH	EC (uS/cm)	Lab analysis	Colour	Odour	CO_2 (%)	CH_4 (%)	H_2S (ppm)	Notes
Warwick Park	Yards Bore	NA	Not sampled	-	-	-	-	-	-	-	-	-	-
Warwick Park	Rolfs Bore	43060	Yes	27.9	7.00	14,360	Yes	Clear	H_2S smell	0.00	0.00	0.02	No particles in sample.
Warwick Park	Blanches Bore	47037	Yes	24.4	7.08	2,290	Yes	Clear	Nil	0.00	0.00	0.00	Near Rolf Creek.
Warwick Park	House Bore 3	43063	Yes	30.4	6.91	4,430	Yes	Clear	Nil	0.00	0.00	0.00	Two abandoned bores nearby.
Warwick Park	Shellys Bore	43064	Does not exist	-	-	-	-	-	-	-	-	-	-
Warwick Park	No 13 Hole	43603	Does not exist	-	-	-	-	-	-	-	-	-	-
Warwick Park	No 1 Bore	47038	Does not exist	-	-	-	-	-	-	-	-	-	-
Gundabah	Bore No 2	38997	Does not exist	-	-	-	-	-	-	-	-	-	-
Gundabah	NA	44080	Does not exist	-	-	-	-	-	-	-	-	-	-
Hazelbrae	Three Mile Bore	43474	Not sampled	-	-	-	-	-	-	-	-	-	-
Tuon Downs	TD1	NA	Not sampled	-	-	-	-	-	-	-	-	-	-
Tuon Downs	TD2	NA	Not sampled	-	-	-	-	-	-	-	-	-	-
Tuon Downs	TD3	NA	Not sampled	-	-	-	-	-	-	-	-	-	-
Middlemount Landfill	MB01	158773	Dry	-	-	-	-	-	-	-	-	-	-
Middlemount Landfill	MB02	158772	Dry	-	-	-	-	-	-	-	-	-	-
Middlemount Landfill	MB03	158771	Dry	-	-	-	-	-	-	-	-	-	-

Figure 4: In-situ water quality results – Bores in the area of interest that no longer exist [1]

[1] Excludes bores that were identified as located in Zone 54 during the census.

5.2 Bore census – 'Warwick Park'

The following bores were located and recorded:

- Yards Bore RN not available – not registered.
- Rolfs Bore RN43060
- Blanches Bore RN47037
  This bore is incorrectly named as 3 Mile Bore in the DNRM database. This may have been due to confusion with the Three Mile Bore across the road in Hazelbrae. Mr. Jim Curran advised that this bore has always been called Blanches Bore.
- House Bore 1 RN43063
  This bore is incorrectly named as 2 Mile Bore in the DNRM database.

Mr. Jim Curran advised that this bore is the original house bore. House Bore 1 was subsequently replaced by House Bore 2, followed by House Bore 3, which is currently in use. SWL indicates that the original bore is in the same aquifer as House Bore 3.

House bore 3 at Warwick Park is the currently active bore. The registered bore details for RN43063 refers to the original bore drilled at this site in 1973. The size and construction material of the bore casing (125mm steel) are consistent with the DNRM bore log for RN43063. The bore plinth has 1980 inscribed in the concrete. Discussions with the landholder indicated that yield from this bore reduced to a point where supply was inadequate.

Two other bores have been drilled very close to the original site. House bore 2 was drilled to replace the original bore which had stopped producing, but yield from this bore also subsequently reduced to a point where it could not be used. The casing in this bore was also 125mm steel but discussions with the landholder and the date inscribed on the plinth (1990) confirm that it was drilled later than 1973. When the bore performance reduced, it was sleeved with PVC but ultimately it was abandoned.

House Bore 3 was then installed to replace House Bore 2. This bore has 150mm steel casing and is the currently active bore (installed electric submersible pump).

Based on the observations and available information, House Bore 2 and House Bore 3 are not registered. Refer to Figure 5 for bore proximity.

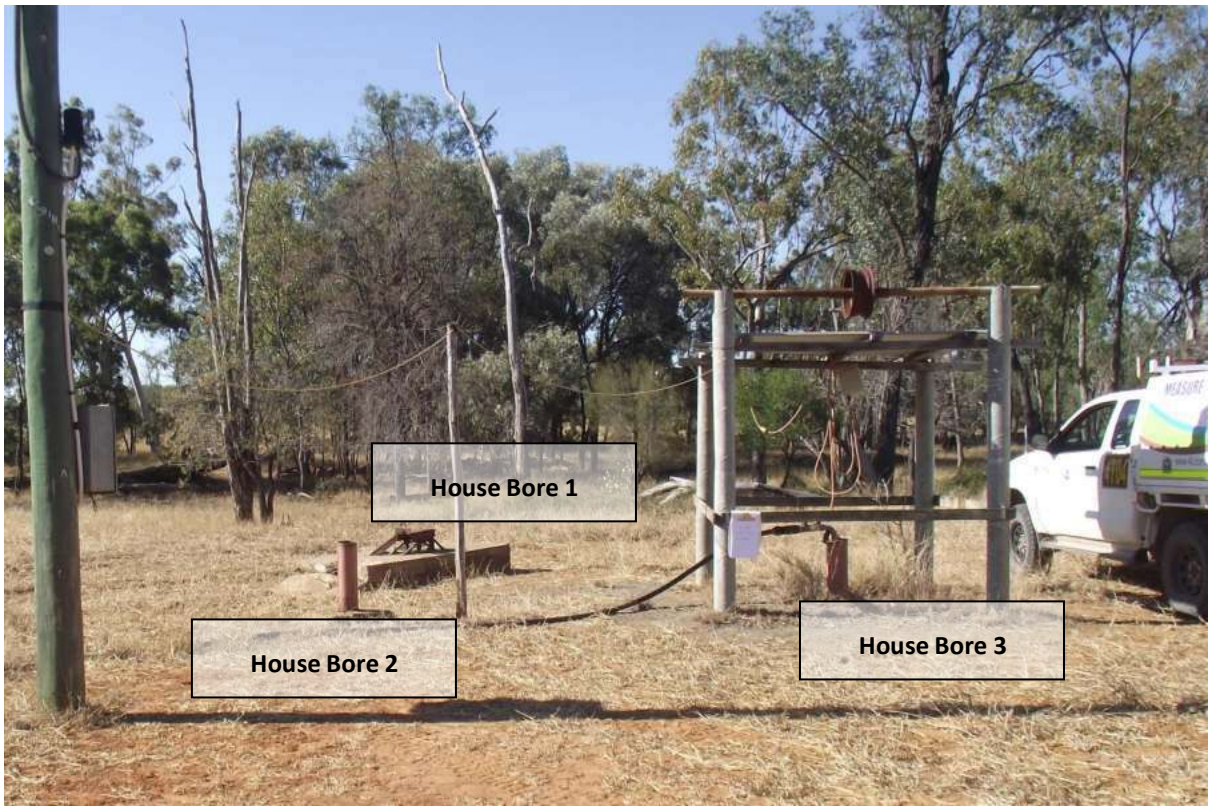


Figure 5: Bores at the original Warwick Park House Bore location.

Mr Curran also advised 4T that:

- RN43603 and RN 47038 had existed a long time ago but were now destroyed and no longer in existence. He indicated that these were not producing bores and were close to the Warwick Park road fence and had therefore likely been bulldozed and destroyed when fire breaks were pushed along the fence. No evidence of these bores was found during field assessments.
- Mr Curran did not have any recollection of RN43064 (Shelley's Bore) ever existing. He indicated that the paddock had been blade ploughed so if there was a bore there, it would have been destroyed during the blade ploughing.

An additional bore (Yards Bore) was located close to where RN2250 is indicated on Warwick Park (Figure 2).

5.3 Gundabah

Mr John Baker indicated that he had no knowledge of the existence of RN44080 and RN 38997. Detailed field surveys confirmed this and no evidence of these bores was located.

The conclusion from the survey is that these bores on Gundabah do not exist. The original bore logs are included in Appendix 1 for record only.

5.4 Hazelbrae

During discussions with Mr Ted Murphy, he indicated that he was only aware of Three Mile Bore (RN43474). This bore was located and recorded. Headworks prevented sampling for water quality.

Mr Murphy indicated that he had not seen any evidence of RN13183, RN1526, RN51154 or RN51149 on the property. Field surveys confirmed that these bores did not exist on Hazelbrae, and further investigations revealed that these bores were actually in (UTM) Zone 54 (Western Queensland).

5.5 Tuon Downs

During in-field discussions with 4T (Ian Rankine and Patrick Hopper), Mr John Singleton "Tuon Downs" indicated the following:

- TD3 has been filled and sealed.
- TD1 and TD2 have been capped and are unlikely to ever be used. The quality is poor and Mr Singleton believes that the bores were compromised in the past during exploration activities by Norton Gold.

There were no other bores on the property that were within approximately 10 km of the Middlemount Coal Mine.

Based on discussions with (and requests from) the landholder, these sites were not visited.

5.6 Foxleigh

Mr John Campion was contacted regarding possible bores on 'Foxleigh'. He indicated that he had no knowledge of bore in the vicinity of RN51121. This was confirmed by field survey.

5.7 Tralee

Mr Matt Kenny was contacted regarding possible location of bores on his property near RN93785 as indicated inFigure 2. He indicated that they had no knowledge of bores in that area. Field surveys confirmed this.

5.8 Middlemount Jockey Club and Racecourse

Mr Don Black from the Middlemount Jockey Club was contacted regarding RN13185 (**Error! Reference source not found.**) which was located adjacent to the Middlemount Racecourse.

Don indicated that there was no bore there and that he had no knowledge of a pre-existing bore. The field survey confirmed that there was no bore at that location.

5.9 Isaac Regional Council – Middlemount Landfill

Three monitoring bores have been installed at the Middlemount landfill to monitor leachate and potential groundwater impacts.

The three bores (RN158771, RN158772, and RN158773) were located and inspected.

None of the bores had free water available for sampling, so no samples were sent for laboratory analysis.

6 Census Information and Bore Logs

Census records and bore logs are shown in Appendix 1 - assembled by property name.

7 Laboratory analysis data

Sample analysis records from ALS are included in this report in Appendix 2.

8 Additional test reports

There were no additional tests (e.g. pump tests) conducted on the identified bores.

9 Health, Safety and Environment (HSE) summary.

There were no health, safety or environmental issues or incidents during the bore assessments.

APPENDIX 1

Bore Assessment Information and Bore Logs [2]

[2] Bore logs - as available from the DNRM Groundwater Database.

WARWICK PARK

1. Property and bore owner

Bore name:	Yards Bore	Property name:	Warwick Park
Registered No.:	NA	Owner/Contact:	Jim Curran
Lot/Plan:	L4 CNS38	Telephone:	07 49858250
Parish:		Mobile:	0429 858250
County:	Cairns	eMail:	

Residential address:	500 Warwick Park Road
	Middlemount 4746
	Queensland
	Australia
Postal address:	As above
Additional information:	Next to the back cattle yards at Warwick Park. Currently used by Warwick Park as emergency water supply during dry conditions. Could not sample on 13/9/17 as generator set required. Warwick Park generator set deployed elsewhere.

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0661509	EPE (m):	4
North:	7484051		
Zone:	55K	Photographs:	Yes
Elevation (m):	182		

Bore information:

Total depth:	NA	Date drilled:	NA
TOC to GL (m):	0.33	Driller name:	NA
Screened interval (m):	NA	Drilling company:	NA
SWL when drilled (mBTOC):	NA		
SWL at assessment (mBTOC):	18.42		
Pressure at assessment (psi)*:	-	Bore log:	No
Yield at drilling (l/sec):	NA	Geological formation:	NA
Historical level records:	No	Construction details:	NA
		Casing material:	Steel
Installed equipment:	Submersible pump	Casing diameter(mm):	150
		Casing length (m):	NA
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Submersible	Stock:	Cattle
Operational / non operational:	-	Stock type:	Beef
Currently in use:	Occasional	No. of stock:	100
Not in use but still usable:	Requires gen set	Grazing/intensive:	Grazing
Abandoned:	-		Short term while cattle in yards.
Pump type:	Subm ersible		
Make/model:	Grundfos MA2P	Domestic use:	No
Power source:	Gen set	No. of houses:	-
Depth in bore (m):			
Av. pump rate (L/sec)	0.4	Irrigation:	No
Max. pump capacity (L/sec)	1.0	Town/camp supply:	No
Meter fitted:	No	Industrial use:	No
Meter type:	-	Other:	No
Maintenance log available:	No		
Logger installed:	No		
Logger data available:	No		
Headworks:	See photos	Usage per day (Hrs):	N/A
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	30		
Discharge line size (mm):	30		
Distribution lines (mm):	30		

Equipment and maintenance notes:

Pump requires gen set to operate. Equipment in fair condition and only used occasionally if other water sources unavailable. Owner indicated that water was slightly brackish.

Headworks include Grundfos bore cover plate, pressure switch, one-way valve, blue oine poly 300mm delivery line. Pump has s/s safety wire.

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	0.10%
Odour:	-	CH4	0.00%
Particles:	-	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional notes:
Sample could not be taken because pump requires generator set and none available.

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:
Incorrectly labelled as RN2250 (Dry Well Bore) in photos.

6. Photographs













1. Property and bore owner

Bore name:	Rolfs Bore	Property name:	Warwick Park
Registered No.:	43060	Owner/Contact:	Jim Curran
Lot/Plan:	L4 CNS38	Telephone:	07 49858250
Parish:		Mobile:	0429 858250
County:	Cairns	eMail:	

Residential address:	500 Warwick Park Road
	Middlemount 4746
	Queensland
	Australia
Postal address:	As above
Additional information:	

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0663778	EPE (m):	4
North:	7482641		
Zone:	55K	Photographs:	Yes
Elevation (m):	182		

Bore information:

Total depth:	39.31	Date drilled:	01/02/1973
TOC to GL (m):	0.33	Driller name:	H D Rickert
Screened interval (m):	-	Drilling company:	
SWL when drilled (mBTOC):	18.30		
SWL at assessment (mBTOC):	21.21		
Pressure at assessment (psi)*:	-	Bore log:	Y
Yield at drilling (l/sec):	0.7	Geological formation:	N/A
Historical level records:	No	Construction details:	N/A
		Casing material:	Steel
Installed equipment:	Submersible pump	Casing diameter(mm):	125
		Casing length (m):	0 - 38.10m
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

3. Bore equipment / use

Equipment		Use	
Equipment installed:	None	Stock:	Cattle
Operational / non operational:	N/A	Stock type:	Beef
Currently in use:	-	No. of stock:	-
Not in use but still usable:	Requires pump installation	Grazing/intensive:	Grazing
Abandoned:	-		Only used if water shortage.
Pump type:	None		
Make/model:	-	Domestic use:	No
Power source:	-	No. of houses:	-
Depth in bore (m):	54		
Av. pump rate (L/sec)	0.6	Irrigation:	No
Max. pump capacity (L/sec)	1.0	Town/camp supply:	No
Meter fitted:	No	Industrial use:	No
Meter type:	No	Other:	No
Maintenance log available:	No		
Logger installed:	No		
Logger data available:	No		
Headworks:	See photos	Usage per day (Hrs):	N/A
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	-		
Discharge line size (mm):	-		
Distribution lines (mm):	-		

Equipment and maintenance notes:

No pumping infrastructure. Bore only used in emergencies (e.g. extreme drought). Very infrequently required.

4. Water quality

In-situ tests

Date:	13/09/2017	**Alkalinity**	
Time:	11:15	Bicarbonate:	735
pH:	7.00	Carbonate:	0
EC (µS/cm):	14360	Hydroxide:	0
Temperature (°C):	27.9	Total alkalinity:	735
		Bore head gas tests	
Colour:	Clear	CO2	0.10%
Odour:	H2S smell	CH4	0.00%
Particles:	Nil	H2S	0.0 ppm
Sampling point:	Top of casing	Sampled for analysis:	Yes
Equipment:	QED micropurge pump	Sent to lab:	Yes
Purge method:	Low flow / stabilisation	NATA laboratory:	ALS Brisbane

Additional notes:
Sample taken using low flow purge pump with stabilisation before sampling.

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs









BORE REPORT

REG NUMBER 43060

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-45-20	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-35-43	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	663778	**MAP-NO**	8652
D/O FILE NO.	50-1371	**LOT**		**NORTHING**	7482641	**MAP NAME**	WINDEYERS HILL
R/O FILE NO.	C598/E272	**PLAN**		**ZONE**	55	**PROG SECTION**	
H/O FILE NO.	L40772B	**ORIGINAL DESCRIPTION**	L4 CNS38	**ACCURACY**		**PRES EQUIPMENT**	WL
				GPS ACC			
GIS LAT	-22.755660646	**PARISH NAME**	2684-KIRKCALDY			**ORIGINAL BORE NO**	ROLFS BORE
GIS LNG	148.595258528	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/02/1973			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES		**DRILL COMPANY**					
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/02/1973	1	Steel Casing		WT	127	0.00	38.10

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	39.31	NO STRATA DETAILS AVAILABLE
2			DRILLER H D RICKERT
902			00/00/0000 SWL -18.30 M
903			00/00/0000 DISCH 60.0 M3D ESTIMAT

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

BORE REPORT

REG NUMBER 43060

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	18/11/1972	1	GCL	054777	27.00	PU	GB	8800	7.5		5946.17	5599.00	1521	560	0.4	17.7	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	18/11/1972	1	1586.0		312.0	180.0		683.0			2960.0	0.17		225.0				

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	01/01/1969	-18.30	N		NR												

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 43060

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 10/09/2017 12:46:36 PM ******

1. Property and bore owner

Bore name:	Blanches Bore	Property name:	Warwick Park
Registered No.:	47037	Owner/Contact:	Jim Curran
Lot/Plan:	L4 CNS38	Telephone:	07 49858250
Parish:		Mobile:	0429 858250
County:	Cairns	eMail:	

Residential address:	500 Warwick Park Road Middlemount 4746 Queensland Australia
Postal address:	As above
Additional information:	Recorded in DNRM as 3 mile bore. Confirmed with Jim Curran that this is Blanches Bore. Arrow Energy photos

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0666941	EPE (m):	4
North:	7484987		
Zone:	55K	Photographs:	Yes
Elevation (m):	166		

Bore information:

Total depth:	35.7	Date drilled:	19/11/1972
TOC to GL (m):	0.32	Driller name:	N/A
Screened interval (m):	Open hole 23.2 - 35.7m	Drilling company:	N/A
SWL when drilled (mBTOC):	15.10		
SWL at assessment (mBTOC):	N/A Fixed cover plate		
Pressure at assessment (psi)*:	-	Bore log:	Y
Yield at drilling (l/sec):	0.38	Geological formation:	Blenheim formation
Historical level records:	Limited	Construction details:	Rotary rig
		Casing material:	Steel
Installed equipment:	Submersible	Casing diameter(mm):	125
		Casing length (m):	0 - 23.2
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Submersible	Stock:	Cattle
Operational / non operational:	Operational	Stock type:	Beef
Currently in use:	Yes	No. of stock:	350
Not in use but still usable:	-	Grazing/intensive:	Grazing
Abandoned:	-		
Pump type:	Franklin		
Make/model:	-	Domestic use:	No
Power source:	Solar	No. of houses:	-
Depth in bore (m):			
Av. pump rate (L/sec)	0.7	Irrigation:	No
Max. pump capacity (L/sec)	1.0	Town/camp supply:	No
Meter fitted:	No	Industrial use:	No
Meter type:	No	Other:	No
Maintenance log available:	No		
Logger installed:	No		
Logger data available:	No		
Headworks:	See photos	Usage per day (Hrs):	
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	30		
Discharge line size (mm):	30		
Distribution lines (mm):	30		

Equipment and maintenance notes:

Submersible (electric) pump. C. 600W solar panels.

4. Water quality

In-situ tests

Date:	13/09/2017	**Alkalinity**	
Time:	13:30	Bicarbonate:	574
pH:	7.08	Carbonate:	0
EC (µS/cm):	2290	Hydroxide:	0
Temperature (°C):	24.4	Total alkalinity:	574
		Bore head gas tests	
Colour:	Clear	CO2	0.00%
Odour:	Nil	CH4	0.00%
Particles:	Nil	H2S	0.0 ppm
Sampling point:	Discharge line 3m from pump	Sampled for analysis:	Yes
Equipment:	Installed pump	Sent to lab:	Yes
Purge method:	Discharge was operating	NATA laboratory:	ALS Brisbane
	Purged 10 Lt then		

Additional notes:
Sample taken from coupling in discharge line about 3 m from bore head. Submersible pumping at time of sampling.

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs









GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 47037

REGISTRATION DETAILS

OFFICE	Rockhampton	**BASIN**	1304	**LATITUDE**	22-44-31	**MAP-SCALE**	104
DATE LOG RECD		**SUB-AREA**		**LONGITUDE**	148-37-11	**MAP-SERIES**	M
D/O FILE NO.	50-1371	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	666315	**MAP-NO**	8652
R/O FILE NO.	C598/E272	**LOT**	4	**NORTHING**	7484118	**MAP NAME**	WINDEYERS HILL
H/O FILE NO.	L40772B	**PLAN**	CNS38	**ZONE**	55	**PROG SECTION**	
		ORIGINAL DESCRIPTION	P4	**ACCURACY**		**PRES EQUIPMENT**	WL
				GPS ACC			
GIS LAT	-22.742049746	**PARISH NAME**	2684-KIRKCALDY			**ORIGINAL BORE NO**	3 MILE BORE
GIS LNG	148.619702353	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	19/11/1972			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	WS	**DRILL COMPANY**					
		METHOD OF CONST.	ROTARY RIG				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	19/11/1972	1	Steel Casing		WT	127	0.00	23.20
A	19/11/1972	2	Open Hole				35.70	35.70
A	19/11/1972	3	Grout					

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.40	SANDY SOIL
2	2.40	7.90	SANDY CLAY
3	7.90	14.90	SHALE AND SANDSTONE
4	14.90	16.20	PUG CLAY
5	16.20	16.50	SHALE
6	16.50	16.80	PUG SHALE

BORE REPORT

REG NUMBER 47037

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	16.80	18.30	SHALE
8	18.30	31.10	GREY SHALE
9	31.10	35.70	GREY SANDSTONE HARD AT BOTTOM

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			BLENHEIM FORMATION

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	21.00	24.00	SHLE SILT MDST	19/11/1972	-15.10	N	8850 US/CM	0.39	Y	FR	BACK CREEK GROUP

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	19/11/1972	1	47037	0.00	35.70		PUM							

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	19/11/1972	1	<1440	-15.10			24.40	0.38				0.38	24.40			

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

BORE REPORT

REG NUMBER 47037

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	19/11/1972	1	GCL	054776	26.00	PU	GB	8850	7.5		5816.20	5438.02	1446	610	0.4	18.2	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	19/11/1972	1	1590.0		154.0	258.0		744.0			2970.0	0.20		100.0				

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	19/11/1972	-15.10	N		NR												

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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- You must not use the data for direct marketing or in breach of the privacy laws.

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**** End of Report. Produced:** 10/09/2017 12:48:05 PM ******

1. Property and bore owner

Bore name:	House Bore 1	Property name:	Warwick Park
Registered No.:	43063	Owner/Contact:	Jim Curran
Lot/Plan:	L4 CNS38	Telephone:	07 49858250
Parish:		Mobile:	0429 858250
County:	Cairns	eMail:	

Residential address:	500 Warwick Park Road
	Middlemount 4746
	Queensland
	Australia
Postal address:	As above
Additional information:	Recorded in DNRM database as 2 mile bore. Confirmed with Jim Curran that this is the original House Bore. Arrow Energy photos. Bore log RN43063 is for this original house bore (House bore 1) - casing is 125mm but current bore in use (and other abandoned bore) have 150mm PVC casings.

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0673624	EPE (m):	4
North:	7487216		
Zone:	55K	Photographs:	Yes
Elevation (m):	151		

Bore information:

Total depth:	30.5	Date drilled:	18/11/1972
TOC to GL (m):	0.20	Driller name:	G Shelley
Screened interval (m):	Open hole 2.40m - 30.50m	Drilling company:	Shelly Well Boring Co
SWL when drilled (mBTOC):	24.40		
SWL at assessment (mBTOC):	11.15		
Pressure at assessment (psi)*:	-	Bore log:	Y
Yield at drilling (l/sec):	1.5	Geological formation:	Blenheim formation
Historical level records:	Limited	Construction details:	Rotary rig
		Casing material:	Steel
Installed equipment:	None	Casing diameter(mm):	125
		Casing length (m):	0 - 2.40m
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

Depth tape stopped at 18.26m during test on 13/09/2017 indicating that bore had collapsed. There was water detected at 11.15m.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	-	Stock:	No
Operational / non operational:	Non operational.	Stock type:	-
Currently in use:	No	No. of stock:	-
Not in use but still usable:	-	Grazing/intensive:	-
Abandoned:	Yes		
Pump type:	-		
Make/model:	-	Domestic use:	No
Power source:	-	No. of houses:	-
Depth in bore (m):	-		
Av. pump rate (L/sec)	-	Irrigation:	No
Max. pump capacity (L/sec)	-	Town/camp supply:	No
Meter fitted:	-	Industrial use:	No
Meter type:	-	Other:	No
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	See photos	Usage per day (Hrs):	
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	-		
Discharge line size (mm):	-		
Distribution lines (mm):	-		

Equipment and maintenance notes:
Original house bore.
Collapsed and was replaced by House bore 2 nearby. Same aquifer. House bore 2 subsequently replaced by House bore 3 which is current;y in use.

4. Water quality

In-situ tests

Date:	13/09/2017	**Alkalinity**	
Time:	16:45	Bicarbonate:	-
pH:	Not tested	Carbonate:	-
EC (µS/cm):	Not tested	Hydroxide:	-
Temperature (°C):	Not tested	Total alkalinity:	-
		Bore head gas tests	
Colour:	NA	CO2	0.00%
Odour:	NA	CH4	0.00%
Particles:	NA	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-
	-		

Additional notes:
Sample takne from House bore 3 which is currently in use and only c.10m away from this bore. SWL indicate that this bore in same aquifer as House Bore 3.

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs







GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 43063

REGISTRATION DETAILS

OFFICE	Rockhampton	**BASIN**	1304	**LATITUDE**	22-42-55	**MAP-SCALE**	104
DATE LOG RECD		**SUB-AREA**		**LONGITUDE**	148-40-42	**MAP-SERIES**	M
D/O FILE NO.	50-1371	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672366	**MAP-NO**	8652
R/O FILE NO.	C598/E272	**LOT**		**NORTHING**	7487004	**MAP NAME**	WINDEYERS HILL
H/O FILE NO.	L40772B	**PLAN**		**ZONE**	55	**PROG SECTION**	
		ORIGINAL DESCRIPTION	L4 CNS38	**ACCURACY**		**PRES EQUIPMENT**	JP
				GPS ACC			
GIS LAT	-22.715383774	**PARISH NAME**	2684-KIRKCALDY			**ORIGINAL BORE NO**	2 MILE BORE
GIS LNG	148.678312259	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/02/1973			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	G SHELLEY				
ROLES	WS	**DRILL COMPANY**	SHELLEY WELL BORING CO				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/02/1973	1	Steel Casing		WT	127	0.00	2.40
A	01/02/1973	2	Open Hole				30.50	30.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.43	WHITE SANDSTONE
2	2.43	6.09	YELLOW SANDSTONE
3	6.09	6.40	HARD WHITE SANDSTONE
4	6.40	7.01	SOFT BROWN SANDSTONE
5	7.01	8.22	WHITE SANDSTONE
6	8.22	9.14	BROWN SANDSTONE
7	9.14	23.16	BLUE SANDSTONE

BORE REPORT

REG NUMBER 43063

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
8	23.16	24.38	SHALE
9	24.38	26.82	BROKEN SANDSTONE WATER

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			BLENHEIM FORMATION

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	24.00	26.00	SDST	01/02/1973	-24.40	N	890 US/CM	1.50	Y	FR	TERTIARY - UNDEFINED

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
X	04/10/2006	156.72	EST	AHD	N	9 SECOND DEM

WATER ANALYSIS PART1

PIPE	DATE	RD ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	18/11/1972	1 GCL	054774	26.00	PU	GB	890	7.6		765.05	499.72	340	428	2.0	1.8	1.77

BORE REPORT

REG NUMBER 43063

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	18/11/1972	1	77.0		70.0	40.0		522.0			56.0	0.05		0.0				

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	01/01/1969	-24.40	N		NR												

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 05/10/2017 05:35:05 PM ******

1. Property and bore owner

Bore name:	House Bore 2	Property name:	Warwick Park
Registered No.:	43063	Owner/Contact:	Jim Curran
Lot/Plan:	L4 CNS38	Telephone:	07 49858250
Parish:		Mobile:	0429 858250
County:	Cairns	eMail:	

Residential address:	500 Warwick Park Road Middlemount 4746 Queensland Australia
Postal address:	As above
Additional information:	Confirmed with Jim Curran that this is the 'second' House Bore which was drilled after the original House Bore collapsed. Arrow Energy photos.

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0673615	EPE (m):	4
North:	7487207		
Zone:	55K	Photographs:	Yes
Elevation (m):	151		

Bore information:

Total depth:	-	Date drilled:	24/12/1980*
TOC to GL (m):	0.7	Driller name:	NA
Screened interval (m):	-	Drilling company:	NA
SWL when drilled (mBTOC):	-		
SWL at assessment (mBTOC):	12.10		
Pressure at assessment (psi)*:	-	Bore log:	NA
Yield at drilling (l/sec):	-	Geological formation:	-
Historical level records:	-	Construction details:	-
		Casing material:	Steel **
Installed equipment:	None	Casing diameter(mm):	150
		Casing length (m):	-
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

* 24/12/80 was date on monument plinth.

** 125mm inner PVC casing.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	-	Stock:	No
Operational / non operational:	Non operational.	Stock type:	-
Currently in use:	No	No. of stock:	-
Not in use but still usable:	-	Grazing/intensive:	-
Abandoned:	Yes		
Pump type:	-		
Make/model:	-	Domestic use:	No
Power source:	-	No. of houses:	-
Depth in bore (m):	-		
Av. pump rate (L/sec)	-	Irrigation:	No
Max. pump capacity (L/sec)	-	Town/camp supply:	No
Meter fitted:	-	Industrial use:	No
Meter type:	-	Other:	No
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	See photos	Usage per day (Hrs):	
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	-		
Discharge line size (mm):	-		
Distribution lines (mm):	-		

Equipment and maintenance notes:
Second house bore drilled after original collapsed - Jim Curran. Same aquifer.
House bore 2 subsequently replaced by House bore 3 which is currently in use.

4. Water quality

In-situ tests

Date:	13/09/2017	**Alkalinity**	
Time:	16:37	Bicarbonate:	-
pH:	Not tested	Carbonate:	-
EC (µS/cm):	Not tested	Hydroxide:	-
Temperature (°C):	Not tested	Total alkalinity:	-
		Bore head gas tests	
Colour:	NA	CO2	0.00%
Odour:	NA	CH4	0.00%
Particles:	NA	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-
	-		

Additional notes:
Sample takne from House bore 3 which is currently in use and only c.10m away from this bore. SWL indicate that this bore in same aquifer as House Bore 3.

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs









1. Property and bore owner

Bore name:	House Bore	Property name:	Warwick Park
Registered No.:	43063	Owner/Contact:	Jim Curran
Lot/Plan:	L4 CNS38	Telephone:	07 49858250
Parish:		Mobile:	0429 858250
County:	Cairns	eMail:	

Residential address:	500 Warwick Park Road Middlemount 4746 Queensland Australia
Postal address:	As above
Additional information:	Confirmed with Jim Curran that this is current House Bore. Nominated in this survey as House Bore 3 to distinguish it from the other two (abandoned) bores. All in same aquifer. Arrow Energy photos.

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0673625	EPE (m):	4
North:	7487204		
Zone:	55K	Photographs:	Yes
Elevation (m):	151		

Bore information:

Total depth:	-	Date drilled:	NA
TOC to GL (m):	0.48	Driller name:	N/A
Screened interval (m):	-	Drilling company:	N/A
SWL when drilled (mBTOC):	-		
SWL at assessment (mBTOC):	12.09		
Pressure at assessment (psi)*:	-	Bore log:	-
Yield at drilling (l/sec):	-	Geological formation:	-
Historical level records:	-	Construction details:	-
		Casing material:	Steel
Installed equipment:	-	Casing diameter(mm):	150
		Casing length (m):	-
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

Refer to House bore 1 (RN43063) bore log for depths, original SWL and aquifer details.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Submersible	Stock:	Cattle
Operational / non operational:	Operational	Stock type:	Beef
Currently in use:	Yes	No. of stock:	350
Not in use but still usable:	-	Grazing/intensive:	Grazing
Abandoned:	-		
Pump type:	Franklin		
Make/model:	-	Domestic use:	Yes
Power source:	Solar	No. of houses:	2
Depth in bore (m):			
Av. pump rate (L/sec)	0.7	Irrigation:	No
Max. pump capacity (L/sec)	1.0	Town/camp supply:	No
Meter fitted:	No	Industrial use:	No
Meter type:	No	Other:	No
Maintenance log available:	No		
Logger installed:	No		
Logger data available:	No		
Headworks:	See photos	Usage per day (Hrs):	
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	30		
Discharge line size (mm):	30		
Distribution lines (mm):	30		

Equipment and maintenance notes:
Mains powered submersible pump.

4. Water quality

In-situ tests

Date:	13/09/2017	**Alkalinity**	
Time:	15:45	Bicarbonate:	639
pH:	6.91	Carbonate:	0
EC (µS/cm):	4430	Hydroxide:	0
Temperature (°C):	30.4	Total alkalinity:	639
		Bore head gas tests	
Colour:	Clear	CO2	0.00%
Odour:	Nil	CH4	0.00%
Particles:	Nil	H2S	0.0 ppm
Sampling point:	Connection in discharge line 3m from pump	Sampled for analysis:	Yes
Equipment:	Installed pump	Sent to lab:	Yes
Purge method:	Pump operational.	NATA laboratory:	ALS Brisbane
	Purged 10 Lt then		
	Currently used for stock		

Additional notes:
Sample taken from coupling in discharge line about 3 m from bore head. Submersible pumping at time of sampling.

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs









GUNDABAH

1. Property and bore owner

Bore name:	Bore No 2	Property name:	Gundabah
Registered No.:	38997	Owner/Contact:	John Baker
Lot/Plan:	L1 RP620006	Telephone:	07 49857970
County/Parish:	Cairns	Mobile:	0428 857970
		eMail:	

Residential address:	1295 Warwick Park Road
	Middlemount 4746
	Queensland
	Australia
Postal address:	"Booroondarra"
	67 Booroondarra Capella Road
	Dysart 4745
	Queensland
Additional information:	Landholder indicated that this bore no longer existed. Bore log indicates that bore was cased to 11.6m with open hole to 106.7m. Log indicates that bore was abandoned and destroyed. Bore or original site not located at coordinates indicated in DNRM database. Search conducted by 4T in AGD66 and GDA94 datum but no evidence of bore found.

2. Bore - Base information

Geographic location

Datum:	Unknown	GPS:	Garmin GPS76 handheld
East:	0665032	EPE (m):	4
North:	7481405		
Zone:	55K	Photographs:	No
Elevation (m):			

Bore information:

Total depth:	106.7	Date drilled:	23/11/1972
TOC to GL (m):	-	Driller name:	Shelley Well Boring Company
Screened interval (m):	Open hole 11.6 - 106.7m	Drilling company:	L Bell
SWL when drilled (mBTOC):	99.99		
SWL at assessment (mBTOC):	-		
Pressure at assessment (psi)*:	-	Bore log:	No
Yield at drilling (l/sec):	0.3	Geological formation:	NA
Historical level records:	-	Construction details:	Rotary drill
		Casing material:	NA
Installed equipment:	-	Casing diameter(mm):	NA
		Casing length (m):	NA
Artesian/Sub-artesian:	-		

Additional notes: * *Artesian*

Refer to field survey method for search procedure.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Bore no longer exists	Stock:	-
Operational / non operational:	Non-operational	Stock type:	-
Currently in use:		No. of stock:	-
Not in use but still usable:		Grazing/intensive:	-
Abandoned:	Yes		
No longer in existence:	Yes		
Pump type:			
Make/model:		Domestic use:	-
Power source:		No. of houses:	-
Depth in bore (m):			
Av. pump rate (L/sec)		Irrigation:	-
Max. pump capacity (L/sec)		Town/camp supply:	-
Meter fitted:	-	Industrial use:	-
Meter type:	-	Other:	-
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	-	Usage per day (Hrs):	-
Photo of headworks:	-	Pump test done:	-
Pump outlet size (mm):	-		
Discharge line size (mm):	-		
Distribution lines (mm):	-		

Equipment and maintenance notes:
NA

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	-
Odour:	-	CH4	-
Particles:	-	H2S	-
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional notes:

5. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 38997

REGISTRATION DETAILS

OFFICE	Rockhampton	**BASIN**	1301	**LATITUDE**	22-46-00	**MAP-SCALE**	104
DATE LOG RECD		**SUB-AREA**		**LONGITUDE**	148-36-27	**MAP-SERIES**	M
D/O FILE NO.	50-0044	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	665032	**MAP-NO**	8652
R/O FILE NO.	C2706/E397	**LOT**		**NORTHING**	7481405	**MAP NAME**	WINDEYERS HILL
H/O FILE NO.	L40357B	**PLAN**		**ZONE**	55	**PROG SECTION**	
		ORIGINAL DESCRIPTION	L1 RP620006	**ACCURACY**		**PRES EQUIPMENT**	NE
				GPS ACC			
GIS LAT	-22.76677166	**PARISH NAME**	5200-WYNDHAM			**ORIGINAL BORE NO**	BORE NO 2
GIS LNG	148.607480691	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	23/11/1972			**DATA OWNER**	
STATUS	Abandoned and Destroyed	**DRILLERS NAME**	L BELL				
ROLES	WS	**DRILL COMPANY**	SHELLEY WELL BORING CO				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	23/11/1972	1	Steel Casing	4.760	WT	152	0.00	11.60
A	23/11/1972	2	Open Hole				11.60	106.70

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.60	SOIL
2	0.60	0.91	SAND
3	0.91	6.09	SANDY CLAY
4	6.09	6.40	CLAY & BOULDERS
5	6.40	7.62	SANDY CLAY
6	7.62	7.92	WHITE SANDSTONE
7	7.92	9.14	CLAY

BORE REPORT

REG NUMBER 38997

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION	
8	9.14	11.58	SHALE	
9	11.58	12.80	SANDSTONE	
10	12.80	14.32	SHALE	
11	14.32	24.38	SANDSTONE	
12	24.38	24.68	SHALE	
13	24.68	28.65	SANDSTONE	
14	28.65	30.48	SHALE	
15	30.48	30.78	SANDSTONE	
16	30.78	32.00	SANDY SHALE	
17	32.00	34.13	SANDSTONE	
18	34.13	39.31	SHALE	
19	39.31	39.62	COAL	
20	39.62	74.37	SHALE & COAL BROKEN	26 M3D
21	74.37	76.50	COAL	33 M3D
22	76.50	76.81	SHALE	
23	77.11	81.99	COAL & SHALE	
24	81.99	83.51	BROWN SHALE	
25	83.51	94.79	COAL & SHALE	
26	94.79	97.84	SANDSTONE	
27	97.84	98.45	HARD SHALE	
28	98.45	106.68	SANDSTONE	

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1	7.60		BLACKWATER GROUP

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	40.50	76.50	COAL	23/11/1972	-99.99	N		0.30	Y	FR	BLACKWATER GROUP

BORE REPORT

REG NUMBER 38997

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
			SHLE								
2	76.20	80.80		23/11/1972	-99.99	N	12500 US/CM	0.38	Y	FR	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
X	04/10/2006	179.37	EST	AHD	N	9 SECOND DEM

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	22/11/1972	1	DPI	054582		PU	GB				9911.90	9604.89	4790	495	1.2	11.9	
A	23/11/1972	1	GCL	54901	76.00	AI	GB	10500	7.4		9753.14	9604.21	4512	240	1.1	12.8	
A	23/11/1972	2	GCL	54902	80.00	AI	GB	12500	7.6		9733.12	9578.09	4849	250	1.2	11.5	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	22/11/1972	1	1889.6		717.4	728.4		604.0			5948.5			24.0				
A	23/11/1972	1	1970.0		755.0	638.0		293.0	0.00	0.0	5980.0	0.14	4.0	113.0				
A	23/11/1972	2	1839.0		725.0	738.0		305.0	0.00		6020.0	0.12		106.0				

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 38997

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 10/09/2017 01:39:50 PM ******

1. Property and bore owner

Bore name:	Unnamed bore	Property name:	Gundabah
Registered No.:	44080	Owner/Contact:	John Baker
Lot/Plan:	L1 RP620006	Telephone:	07 49857970
County/Parish:	Cairns	Mobile:	
		eMail:	

Residential address:	1295 Warwick Park Road
	Middlemount 4746
	Queensland
	Australia
Postal address:	"Booroondarra"
	67 Booroondarra Capella Road
	Dysart 4745
	Queensland
Additional information:	Landowner indicated that this bore no longer existed. Bore log indicates that no water was found. Bore was not screened and was abandoned and destroyed. Bore or original site not located at coordinates indicated in DNRM database. Search conducted by 4T in AGD66 and GDA94 datum but no evidence of bore found.

2. Bore - Base information

Geographic location

Datum:	Unknown	GPS:	Garmin GPS76 handheld
East:	0664487	EPE (m):	4
North:	7480492		
Zone:	55K	Photographs:	No
Elevation (m):			

Bore information:

Total depth:	52.73	Date drilled:	23/11/1972
TOC to GL (m):	-	Driller name:	Shelley Well Boring Company
Screened interval (m):	Not screened	Drilling company:	NA
SWL when drilled (mBTOC):	-		
SWL at assessment (mBTOC):	-		
Pressure at assessment (psi)*:	-	Bore log:	No
Yield at drilling (l/sec):	-	Geological formation:	NA
Historical level records:	-	Construction details:	Rotary drill
		Casing material:	NA
Installed equipment:	-	Casing diameter(mm):	NA
		Casing length (m):	NA
Artesian/Sub-artesian:	-		

Additional notes: * *Artesian*

Refer to field survey method for search procedure.

.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Bore no longer exists	Stock:	-
Operational / non operational:	Non-operational	Stock type:	-
Currently in use:		No. of stock:	-
Not in use but still usable:		Grazing/intensive:	-
Abandoned:	Yes		
No longer in existence:	Yes		
Pump type:			
Make/model:		Domestic use:	-
Power source:		No. of houses:	-
Depth in bore (m):			
Av. pump rate (L/sec)		Irrigation:	-
Max. pump capacity (L/sec)		Town/camp supply:	-
Meter fitted:	-	Industrial use:	-
Meter type:	-	Other:	-
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	-	Usage per day (Hrs):	-
Photo of headworks:	-	Pump test done:	-
Pump outlet size (mm):	-		
Discharge line size (mm):	-		
Distribution lines (mm):	-		

Equipment and maintenance notes:
NA

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	-
Odour:	-	CH4	-
Particles:	-	H2S	-
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional notes:

4. Assessment date and details:

Date of assessment:	13/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

5. Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs

BORE REPORT

REG NUMBER 44080

REGISTRATION DETAILS

		BASIN	1301	**LATITUDE**	22-46-30	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-36-08	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	664487	**MAP-NO**	8652
D/O FILE NO.	50-0044	**LOT**		**NORTHING**	7480492	**MAP NAME**	WINDEYERS HILL
R/O FILE NO.	C2796.E397	**PLAN**		**ZONE**	55	**PROG SECTION**	
H/O FILE NO.	L40357B	**ORIGINAL DESCRIPTION**	L1 RP620006	**ACCURACY**		**PRES EQUIPMENT**	NE
				GPS ACC			
GIS LAT	-22.775104855	**PARISH NAME**	5200-WYNDHAM			**ORIGINAL BORE NO**	OFFICE RECORD
GIS LNG	148.602203152	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	23/11/1972			**DATA OWNER**	
STATUS	Abandoned and Destroyed	**DRILLERS NAME**					
ROLES	WS	**DRILL COMPANY**	SHELLEY WELLBORING CO				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

****** NO RECORDS FOUND ******

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.61	SOIL
2	0.61	7.32	SANDY CLAY
3	7.32	11.58	SOFT SANDSTONE
4	11.58	12.50	WHITE SANDY CLAY
5	12.50	18.90	SANDSTONE
6	18.90	19.81	SANDY CLAY
7	19.81	21.95	PUG CLAY
8	21.95	24.99	SHALE
9	24.99	25.30	RED SHALE
10	25.30	25.91	SHALE
11	25.91	32.31	HARD SHALE

BORE REPORT

REG NUMBER 44080

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
12	32.31	41.76	GREY SANDSTONE
13	41.76	42.98	SHALE
14	42.98	45.42	COAL SOAK
15	45.42	52.73	SHALE AND COAL SOAK
16	52.73	64.62	HARD SANDSTONE - ABANDONED

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1	7.30		BLACKWATER GROUP

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	43.00	52.70	COAL			N		0.01	Y	FR	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 44080

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 10/09/2017 01:40:33 PM ******

HAZELBRAE

1. Property and bore owner

Bore name:	Three Mile Bore	Property name:	Hazelbrae
Registered No.:	43474	Owner/Contact:	Ted Murphy
Lot/Plan:	L2 RP620006	Telephone:	07 4958 1533
County/Parish:	Cairns	Mobile:	0419 653593
		eMail:	

Residential address:	905 Warwick Park Road
	Middlemount 4746
	Queensland
	Australia
Postal address:	"TayGlen"
	Lot 81 / Dysart Connection Road
	Dysart 4745
	Queensland
Additional information:	Comet windmill - not operational. See notes and photographs

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0666800	EPE (m):	4
North:	7484295		
Zone:	55K	Photographs:	Yes
Elevation (m):	158		

Bore information:

Total depth:	41.14	Date drilled:	N/A
TOC to GL (m):	0.17	Driller name:	N/A
Screened interval (m):	Open hole 21.3 - 41.0m	Drilling company:	N/A
SWL when drilled (mBTOC):	18.06		
SWL at assessment (mBTOC):	N/A		
Pressure at assessment (psi)*:	-	Bore log:	Yes
Yield at drilling (l/sec):	0.35	Geological formation:	N/A
Historical level records:	No	Construction details:	Rotary drill
		Casing material:	Steel
Installed equipment:	Windmill pump	Casing diameter(mm):	125
		Casing length (m):	0 - 21.3m
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

Windmill pump rods broken (photographs). Appeared to have been broken for some time. Tank had water in it but highly unlikely to have originated from the bore because the windmill equipment was disconnected. Headworks prevented use of sampling pumps, and no installed equipment to use to obtain sample. Tried to measure SWL but obstruction at c. 2.8m (packer/centraliser?) prevented SWL sensor from descending - multiple attempts but SWL could not be measured during visit.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Windmill pump	Stock:	Cattle
Operational / non operational:	Non-operational	Stock type:	Beef
Currently in use:		No. of stock:	250
Not in use but still usable:		Grazing/intensive:	Grazing
Abandoned:	Yes		
Pump type:	Comet windmill		
Make/model:		Domestic use:	No
Power source:	Wind	No. of houses:	-
Depth in bore (m):	Unknown		
Av. pump rate (L/sec)	N/A	Irrigation:	No
Max. pump capacity (L/sec)	N/A	Town/camp supply:	No
Meter fitted:	-	Industrial use:	No
Meter type:	-	Other:	No
Maintenance log available:	-		
Logger installed:	No		
Logger data available:	No		
Headworks:	See photos	Usage per day (Hrs):	N/A
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	30		
Discharge line size (mm):	30		
Distribution lines (mm):	30		

Equipment and maintenance notes:
Windmill in run down condition. Pump rods currently not attached to mill pump. Windmill head requires maintenance but still operational.

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	0.00%
Odour:	-	CH4	0.00%
Particles:	-	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional notes:
Sample could not be taken as headworks prevented use of sampling pumps/equipment. No installed equipment for sampling.

5. Assessment date and details:

Date of assessment:	14/09/2001		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs

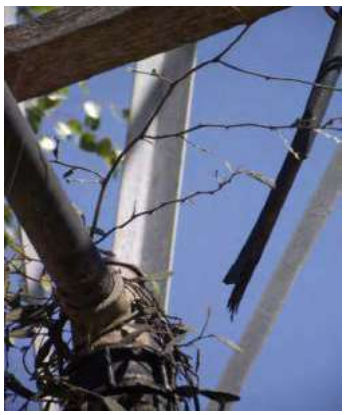












GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 47037

REGISTRATION DETAILS

OFFICE	Rockhampton	**BASIN**	1304	**LATITUDE**	22-44-31	**MAP-SCALE**	104
DATE LOG RECD		**SUB-AREA**		**LONGITUDE**	148-37-11	**MAP-SERIES**	M
D/O FILE NO.	50-1371	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	666315	**MAP-NO**	8652
R/O FILE NO.	C598/E272	**LOT**	4	**NORTHING**	7484118	**MAP NAME**	WINDEYERS HILL
H/O FILE NO.	L40772B	**PLAN**	CNS38	**ZONE**	55	**PROG SECTION**	
		ORIGINAL DESCRIPTION	P4	**ACCURACY**		**PRES EQUIPMENT**	WL
				GPS ACC			
GIS LAT	-22.742049746	**PARISH NAME**	2684-KIRKCALDY			**ORIGINAL BORE NO**	3 MILE BORE
GIS LNG	148.619702353	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	19/11/1972			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	WS	**DRILL COMPANY**					
		METHOD OF CONST.	ROTARY RIG				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	19/11/1972	1	Steel Casing		WT	127	0.00	23.20
A	19/11/1972	2	Open Hole				35.70	35.70
A	19/11/1972	3	Grout					

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.40	SANDY SOIL
2	2.40	7.90	SANDY CLAY
3	7.90	14.90	SHALE AND SANDSTONE
4	14.90	16.20	PUG CLAY
5	16.20	16.50	SHALE
6	16.50	16.80	PUG SHALE

BORE REPORT

REG NUMBER 47037

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	16.80	18.30	SHALE
8	18.30	31.10	GREY SHALE
9	31.10	35.70	GREY SANDSTONE HARD AT BOTTOM

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			BLENHEIM FORMATION

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	21.00	24.00	SHLE SILT MDST	19/11/1972	-15.10	N	8850 US/CM	0.39	Y	FR	BACK CREEK GROUP

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	19/11/1972	1	47037	0.00	35.70		PUM							

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	19/11/1972	1	<1440	-15.10			24.40	0.38				0.38	24.40			

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

BORE REPORT

REG NUMBER 47037

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	19/11/1972	1	GCL	054776	26.00	PU	GB	8850	7.5		5816.20	5438.02	1446	610	0.4	18.2	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	19/11/1972	1	1590.0		154.0	258.0		744.0			2970.0	0.20		100.0				

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	19/11/1972	-15.10	N		NR												

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 10/09/2017 12:48:05 PM ******

middlemount coal

ISAAC REGIONAL COUNCIL

1. Property and bore owner

Bore name:	MB01	Property name:	Middlemount Landfill
Registered No.:	158773	Owner/Contact:	Isaac Regional Council
Lot/Plan:	L49 CNS281	Telephone:	1300472227
Parish:	Wyndham	Mobile:	
County:	Cairns	eMail:	

Residential address:	c/o Isaac Regional Council
	Middlemount Shopping Centre
	Middlemount 4746
	Queensland
Postal address:	PO Box 97
	Moranbah 4744
	Queensland
Additional information:	Bore had moist mud in bottom. Moisture registered on depth sensor, but insufficient water to take a sample.

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0672779	EPE (m):	4
North:	7475733		
Zone:	55K	Photographs:	Yes
Elevation (m):	183		

Bore information:

Total depth (m):	41	Date drilled:	17/04/2017
TOC to GL (m):	0.66	Driller name:	Malcolm Scott
Screened interval (m):	37.5 - 40.50	Drilling company:	M & J Drilling
SWL when drilled (mBTOC):	NA		
SWL at assessment (mBTOC):	31.63		
Pressure at assessment (psi)*:	-	Bore log:	Y
Yield at drilling (l/sec):	NA	Geological formation:	NA
Historical level records:	No	Construction details:	Landfill monitoring bore
		Casing material:	PVC
Installed equipment:	Nil	Casing diameter(mm):	60
		Casing length (m):	26.5
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

Total depth from bore log.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Nil	Stock:	No
Operational / non operational:	-	Stock type:	No
Currently in use:	Landfill monitoring bore	No. of stock:	No
Not in use but still usable:	-	Grazing/intensive:	No
Abandoned:	-		
Pump type:	NA		
Make/model:	NA	Domestic use:	No
Power source:	NA	No. of houses:	-
Depth in bore (m):	-		
Av. pump rate (L/sec)	-	Irrigation:	No
Max. pump capacity (L/sec)	-	Town/camp supply:	No
Meter fitted:	-	Industrial use:	No
Meter type:	-	Other:	Landfill monitoring bore
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	See photos	Usage per day (Hrs):	N/A
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	NA		
Discharge line size (mm):	NA		
Distribution lines (mm):	NA		

Equipment and maintenance notes:

No equipment. Bore is used to monitor leachate and/or potential impact on GW near Middlemount Landfill

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	0.00%
Odour:	-	CH4	0.02%
Particles:	-	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional inotes:

No sample taken. Wet mud in bottom of bore but not enough water to take a sample. Three attempts to take sample but not successful.

5. Assessment date and details:

Date of assessment:	15/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs









GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 158773

REGISTRATION DETAILS

		BASIN	1301	**LATITUDE**	22-48-56	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-41-05	**MAP-SERIES**	
DATE LOG RECD	22-APR-14	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672894	**MAP-NO**	
D/O FILE NO.	LON/515/000(1733	**LOT**	49	**NORTHING**	7475913	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS281	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.81554792	**PARISH NAME**	5200-WYNDHAM			**ORIGINAL BORE NO**	
GIS LNG	148.6846234	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	17/04/2014			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MALCOLM, SCOTT				
ROLES	SM	**DRILL COMPANY**	M & J DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	17/04/2014	1	Polyvinyl Chloride	4.950	WT	60	0.00	41.00
A	17/04/2014	2	Perforated or Slotted Casing			60	37.50	40.50
A	17/04/2014	3	Gravel Pack	3.000	GR	125	36.00	41.00
X	17/04/2014	4	Grout			125	0.00	35.50
X	17/04/2014	5	Bentonite Seal			125	35.50	36.00
X	17/04/2014	6	Centraliser			125	7.00	35.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.40	CLAY, GRAVELLY, FILL
2	0.40	1.20	CLAY, PALE BROWN
3	1.20	11.00	GRANITE, PINK

BORE REPORT

REG NUMBER 158773

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	11.00	23.00	GRANITE, ORANGE
5	23.00	25.00	GRINITE, PINK
6	25.00	41.00	GRANITE, ORANGE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 158773

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 10/09/2017 01:16:20 PM ******

1. Property and bore owner

Bore name:	MB02	Property name:	Middlemount Landfill
Registered No.:	158772	Owner/Contact:	Isaac Regional Council
Lot/Plan:	L49 CNS281	Telephone:	1300472227
Parish:	Wyndham	Mobile:	
County:	Cairns	eMail:	

Residential address:	c/o Isaac Regional Council
	Middlemount Shopping Centre
	Middlemount 4746
	Queensland
Postal address:	PO Box 97
	Moranbah 4744
	Queensland
Additional information:	Dry. Depth tape stopped at 12.51m

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0673170	EPE (m):	4
North:	7475942		
Zone:	55K	Photographs:	Yes
Elevation (m):	181		

Bore information:

Total depth (m):	12.7	Date drilled:	18/04/2017
TOC to GL (m):	0.73	Driller name:	Malcolm Scott
Screened interval (m):	9.20 - 12.20	Drilling company:	M & J Drilling
SWL when drilled (mBTOC):	NA		
SWL at assessment (mBTOC):	Dry		
Pressure at assessment (psi)*:	-	Bore log:	Y
Yield at drilling (l/sec):	NA	Geological formation:	NA
Historical level records:	No	Construction details:	Landfill monitoring bore
		Casing material:	PVC
Installed equipment:	Nil	Casing diameter(mm):	60
		Casing length (m):	12.2
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

Total depth from bore log. Depth sensor stopped at 12.51m.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Nil	Stock:	No
Operational / non operational:	-	Stock type:	No
Currently in use:	Landfill monitoring bore	No. of stock:	No
Not in use but still usable:	-	Grazing/intensive:	No
Abandoned:	-		
Pump type:	NA		
Make/model:	NA	Domestic use:	No
Power source:	NA	No. of houses:	-
Depth in bore (m):	-		
Av. pump rate (L/sec)	-	Irrigation:	No
Max. pump capacity (L/sec)	-	Town/camp supply:	No
Meter fitted:	-	Industrial use:	No
Meter type:	-	Other:	Landfill monitoring bore
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	See photos	Usage per day (Hrs):	N/A
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	NA		
Discharge line size (mm):	NA		
Distribution lines (mm):	NA		

Equipment and maintenance notes:

No equipment. Bore is used to monitor leachate and/or potential impact on GW near Middlemount Landfill.

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	0.00%
Odour:	-	CH4	0.00%
Particles:	-	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional inotes:
No sample taken. Bore dry.

5. Assessment date and details:

Date of assessment:	15/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs









GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 158772

REGISTRATION DETAILS

		BASIN	1301	**LATITUDE**	22-48-49	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-41-18	**MAP-SERIES**	
DATE LOG RECD	22-APR-14	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	673279	**MAP-NO**	
D/O FILE NO.	LON/515/000(1733	**LOT**	49	**NORTHING**	7476120	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS281	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.81363908	**PARISH NAME**	5200-WYNDHAM			**ORIGINAL BORE NO**	
GIS LNG	148.6883504	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	18/04/2014			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MALCOLM, SCOTT				
ROLES	SM	**DRILL COMPANY**	M & J DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	18/04/2014	1	Polyvinyl Chloride	10.000	WT	60	0.00	12.70
A	18/04/2014	2	Perforated or Slotted Casing			60	9.20	12.20
A	18/04/2014	3	Gravel Pack			60	8.00	12.70
X	18/04/2014	4	Grout			150	0.00	7.00
X	18/04/2014	5	Bentonite Seal			150	7.00	8.00
X	18/04/2014	6	Centraliser			150	5.00	9.20

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	CLAY, DARK BROWN
2	1.00	3.50	CLAY, GREY SANDY
3	3.50	6.00	CLAY, ORANGE

BORE REPORT

REG NUMBER 158772

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	6.00	12.50	SAND
5	12.50	12.70	SNADSTONE WITH QUARTZ GRAINS

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 158772

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced:** 10/09/2017 01:18:42 PM ******

1. Property and bore owner

Bore name:	MB03	Property name:	Middlemount Landfill
Registered No.:	158771	Owner/Contact:	Isaac Regional Council
Lot/Plan:	L49 CNS281	Telephone:	1300472227
Parish:	Wyndham	Mobile:	
County:	Cairns	eMail:	

Residential address:	c/o Isaac Regional Council
	Middlemount Shopping Centre
	Middlemount 4746
	Queensland
Postal address:	PO Box 97
	Moranbah 4744
	Queensland
Additional information:	Dry. Depth tape stopped at 26.57m

2. Bore - Base information

Geographic location

Datum:	GDA94	GPS:	Garmin GPS76 handheld
East:	0673109	EPE (m):	4
North:	7476116		
Zone:	55K	Photographs:	Yes
Elevation (m):	177		

Bore information:

Total depth (m):	27	Date drilled:	18/04/2017
TOC to GL (m):	0.65	Driller name:	Malcolm Scott
Screened interval (m):	23.5 - 26.5	Drilling company:	M & J Drilling
SWL when drilled (mBTOC):	NA		
SWL at assessment (mBTOC):	Dry		
Pressure at assessment (psi)*:	-	Bore log:	Y
Yield at drilling (l/sec):	NA	Geological formation:	NA
Historical level records:	No	Construction details:	Landfill monitoring bore
		Casing material:	PVC
Installed equipment:	Nil	Casing diameter(mm):	60
		Casing length (m):	12.2
Artesian/Sub-artesian:	Sub-artesian		

Additional notes: * *Artesian*

Total depth from bore log. Depth sensor stopped at 26.57m.

3. Bore equipment / use

Equipment		Use	
Equipment installed:	Nil	Stock:	No
Operational / non operational:	-	Stock type:	No
Currently in use:	Landfill monitoring bore	No. of stock:	No
Not in use but still usable:	-	Grazing/intensive:	No
Abandoned:	-		
Pump type:	NA		
Make/model:	NA	Domestic use:	No
Power source:	NA	No. of houses:	-
Depth in bore (m):	-		
Av. pump rate (L/sec)	-	Irrigation:	No
Max. pump capacity (L/sec)	-	Town/camp supply:	No
Meter fitted:	-	Industrial use:	No
Meter type:	-	Other:	Landfill monitoring bore
Maintenance log available:	-		
Logger installed:	-		
Logger data available:	-		
Headworks:	See photos	Usage per day (Hrs):	N/A
Photo of headworks:	Yes	Pump test done:	No
Pump outlet size (mm):	NA		
Discharge line size (mm):	NA		
Distribution lines (mm):	NA		

Equipment and maintenance notes:

No equipment. Bore is used to monitor leachate and/or potential impact on GW near Middlemount Landfill.

4. Water quality

In-situ tests

Date:	-	**Alkalinity**	
Time:	-	Bicarbonate:	-
pH:	-	Carbonate:	-
EC (µS/cm):	-	Hydroxide:	-
Temperature (°C):	-	Total alkalinity:	-
		Bore head gas tests	
Colour:	-	CO2	0.00%
Odour:	-	CH4	0.00%
Particles:	-	H2S	0.0 ppm
Sampling point:	-	Sampled for analysis:	No
Equipment:	-	Sent to lab:	-
Purge method:	-	NATA laboratory:	-

Additional inotes:
No sample taken. Bore dry.

5. Assessment date and details:

Date of assessment:	15/09/2017		
Assessment Officer 1:	Ian Rankine	Company:	4T Consultants Pty Ltd
Address:	PO Box 1946	Telephone No.:	07 49824100
Sub urb:	Emerald 4720	eMail:	i.rankine@4t.com.au
State:	Queensland		
Country:	Australia		
Assessment Officer 2:		Company:	
Address:		Telephone No.:	
		eMail:	

Contact details for corporation conducting baseline assessment (if applicable)

Contact name:	Shane Flint	ACN:	
Occupation:	Environmental Manager	Activity:	Coal Mining
Company:	Middlemount Coal Pty Ltd		
Street address:		Telephone:	07 49850059
Postal address:	PO Box 24	Mobile:	0427 204083
Suburb:	Middlemount 4726	eMail:	sflint@middlemountcoal.com.au
State:	Queensland:		
Country:	Australia		

Additional information:

6. Photographs







GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 158773

REGISTRATION DETAILS

		BASIN	1301	**LATITUDE**	22-48-56	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-41-05	**MAP-SERIES**	
DATE LOG RECD	22-APR-14	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672894	**MAP-NO**	
D/O FILE NO.	LON/515/000(1733	**LOT**	49	**NORTHING**	7475913	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS281	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.81554792	**PARISH NAME**	5200-WYNDHAM			**ORIGINAL BORE NO**	
GIS LNG	148.6846234	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	17/04/2014			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MALCOLM, SCOTT				
ROLES	SM	**DRILL COMPANY**	M & J DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	17/04/2014	1	Polyvinyl Chloride	4.950	WT	60	0.00	41.00
A	17/04/2014	2	Perforated or Slotted Casing			60	37.50	40.50
A	17/04/2014	3	Gravel Pack	3.000	GR	125	36.00	41.00
X	17/04/2014	4	Grout			125	0.00	35.50
X	17/04/2014	5	Bentonite Seal			125	35.50	36.00
X	17/04/2014	6	Centraliser			125	7.00	35.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.40	CLAY, GRAVELLY, FILL
2	0.40	1.20	CLAY, PALE BROWN
3	1.20	11.00	GRANITE, PINK

BORE REPORT

REG NUMBER 158773

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	11.00	23.00	GRANITE, ORANGE
5	23.00	25.00	GRINITE, PINK
6	25.00	41.00	GRANITE, ORANGE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 158773

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

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**** End of Report. Produced:** 10/09/2017 01:16:20 PM ******

APPENDIX 2

Bore Assessment – Water Quality Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1719214**	Page	: 1 of 5
Client	: **4T CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR IAN RANKINE	Contact	: Jenny Bevan
Address	: PO BOX 1946 EMERALD QLD, AUSTRALIA 4720	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 7 49824100	Telephone	: +61-7-3243 7222
Project	: 745 GWQ	Date Samples Received	: 19-Sep-2017 09:20
Order number	: ----	Date Analysis Commenced	: 19-Sep-2017
C-O-C number	: ----	Issue Date	: 25-Sep-2017 15:54
Sampler	: ----		
Site	: ----		
Quote number	: BNBQ/001/16		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- **Methane analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rolf's Bore	House Bore	Blanches Bore	----	----
				Client sampling date / time	13-Sep-2017 11:15	13-Sep-2017 15:45	13-Sep-2017 13:30	----	----
Compound	CAS Number	LOR	Unit		EB1719214-001	EB1719214-002	EB1719214-003	--------	--------
					Result	Result	Result	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.23**	**7.25**	**7.37**	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**13600**	**4330**	**2270**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**9280**	**2510**	**1370**	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**764**	**719**	**614**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**764**	**719**	**614**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**21**	**168**	**196**	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**5200**	**1090**	**342**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**311**	**196**	**93**	----	----
Magnesium	7439-95-4	1	mg/L		**496**	**135**	**86**	----	----
Sodium	7440-23-5	1	mg/L		**2070**	**582**	**286**	----	----
Potassium	7440-09-7	1	mg/L		**3**	**5**	**3**	----	----
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		**2820**	**1040**	**586**	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.001**	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L		**0.213**	**0.192**	**0.115**	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	**0.012**	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L		**0.001**	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.006**	**0.007**	**0.019**	----	----
Manganese	7439-96-5	0.001	mg/L		**1.80**	**0.019**	**0.003**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rolf's Bore	House Bore	Blanches Bore	----	----
				Client sampling date / time	13-Sep-2017 11:15	13-Sep-2017 15:45	13-Sep-2017 13:30	----	----
Compound	CAS Number	LOR	Unit		EB1719214-001	EB1719214-002	EB1719214-003	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	**0.006**	**0.002**	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Boron	7440-42-8	0.05	mg/L		**0.30**	**0.40**	**0.19**	----	----
Iron	7439-89-6	0.05	mg/L		**19.7**	<0.05	<0.05	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.03**	<0.01	<0.01	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L		**0.240**	**0.210**	**0.122**	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	**0.0001**	----	----
Chromium	7440-47-3	0.001	mg/L		**0.001**	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	**0.015**	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L		**0.001**	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.007**	<0.005	**0.017**	----	----
Manganese	7439-96-5	0.001	mg/L		**1.80**	**0.022**	**0.004**	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	**0.005**	**0.002**	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Boron	7440-42-8	0.05	mg/L		**0.32**	**0.44**	**0.22**	----	----
Iron	7439-89-6	0.05	mg/L		**19.8**	<0.05	<0.05	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.5**	**0.2**	----	----
EK084: Un-ionized Hydrogen Sulfide									
Unionized Hydrogen Sulfide	----	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rolf's Bore	House Bore	Blanches Bore	----	----
				Client sampling date / time	13-Sep-2017 11:15	13-Sep-2017 15:45	13-Sep-2017 13:30	----	----
Compound	CAS Number	LOR	Unit		EB1719214-001	EB1719214-002	EB1719214-003	--------	--------
					Result	Result	Result	----	----
EN055: Ionic Balance - Continued									
Total Anions	----	0.01	meq/L		**162**	**48.6**	**26.0**	**----**	**----**
Total Cations	----	0.01	meq/L		**146**	**46.3**	**24.2**	**----**	**----**
Ionic Balance	----	0.01	%		**5.16**	**2.40**	**3.50**	**----**	**----**
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**6790**	<10	<10	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1719214**	Page	: 1 of 11
Client	: **4T CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR IAN RANKINE	Contact	: Jenny Bevan
Address	: PO BOX 1946 EMERALD QLD, AUSTRALIA 4720	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 7 49824100	Telephone	: +61-7-3243 7222
Project	: 745 GWQ	Date Samples Received	: 19-Sep-2017
Order number	: ----	Date Analysis Commenced	: 19-Sep-2017
C-O-C number	: ----	Issue Date	: 25-Sep-2017
Sampler	: ----		
Site	: ----		
Quote number	: BNBQ/001/16		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005P: pH by PC Titrator (QC Lot: 1122177)									
EB1719153-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.87	6.83	0.584	0% - 20%
EB1719214-001	Rolf's Bore	EA005-P: pH Value	----	0.01	pH Unit	7.23	7.24	0.138	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1122175)									
EB1719153-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	4140	4090	1.22	0% - 20%
EB1719214-001	Rolf's Bore	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	13600	13600	0.00	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1123893)									
EB1719208-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	662	672	1.55	0% - 20%
EB1719234-004	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	3360	3380	0.505	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1122176)									
EB1719153-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	465	468	0.738	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	465	468	0.738	0% - 20%
EB1719214-001	Rolf's Bore	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	764	765	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	764	765	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1128258)									
EB1719100-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	13	13	0.00	0% - 50%
EB1719214-002	House Bore	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	168	168	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1128259)									
EB1719100-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	4	5	0.00	No Limit
EB1719214-002	House Bore	ED045G: Chloride	16887-00-6	1	mg/L	1090	1090	0.346	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1123833)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 1123833) - continued									
EB1719140-012	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.00	No Limit
EB1718574-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	5	5	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	1	1	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	10	10	0.00	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1123830)									
EB1719140-012	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1718574-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.028	0.027	0.00	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.009	0.009	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.032	0.022	36.9	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.55	0.55	0.00	0% - 20%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1123830) - continued									
EB1718574-001	Anonymous	EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.27	0.28	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1123831)									
EB1718574-001	Anonymous	EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 1123839)									
EB1719202-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0002	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.010	0.010	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.010	0.011	0.00	0% - 50%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.04	0.02	83.8	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1719204-009	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.013	0.013	0.00	0% - 50%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.043	0.044	0.00	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.011	0.011	0.00	0% - 50%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	3.13	3.13	0.147	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.007	0.008	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.029	0.029	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	2.62	2.59	1.26	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	2.07	2.10	1.75	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	7.77	7.86	1.06	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 1123840)									
EB1719202-001	Anonymous	EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1719204-009	Anonymous	EG020B-T: Uranium	7440-61-1	0.001	mg/L	0.007	0.007	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 1123841)									
EB1719214-003	Blanches Bore	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.122	0.125	2.16	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.015	0.016	0.00	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.017	0.018	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.22	0.23	5.37	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1719263-004	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0002	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.022	0.022	0.00	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.185	0.186	0.00	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.030	0.030	0.00	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.899	0.905	0.650	0% - 20%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.19	0.20	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 1123834)									
EB1719140-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1719278-013	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1123844)									
EB1719186-066	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1719204-007	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 1122174)									
EB1719153-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	4.6	4.6	0.00	0% - 20%
EB1719214-001	Rolf's Bore	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EP033: C1 - C4 Hydrocarbon Gases (QC Lot: 1127457)									
EB1719214-001	Rolf's Bore	EP033: Methane	74-82-8	10	µg/L	6790	6740	0.762	0% - 20%
EM1712836-009	Anonymous	EP033: Methane	74-82-8	10	µg/L	<10	<10	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 1122177)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98	102
				----	7 pH Unit	101	98	102
EA010P: Conductivity by PC Titrator (QCLot: 1122175)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	220 µS/cm	98.2	91	107
				<1	12890 µS/cm	95.2	91	107
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1123893)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	99.8	88	112
				<10	2000 mg/L	94.6	88	112
ED037P: Alkalinity by PC Titrator (QCLot: 1122176)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	102	80	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1128258)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	103	85	118
				<1	100 mg/L	99.0	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 1128259)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	104	90	115
				<1	1000 mg/L	110	90	115
ED093F: Dissolved Major Cations (QCLot: 1123833)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 1123830)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	97.5	79	118
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	100	88	116
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	98.6	81	117
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	110	70	130
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	99.8	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	101	87	113
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	99.4	86	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	96.0	88	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	89.3	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	95.5	89	120
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	97.3	89	112
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	101	89	113

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1123830) - continued								
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	99.8	83	112
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	104	88	114
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	96.6	87	113
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	105	81	125
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	95.6	82	114
EG020F: Dissolved Metals by ICP-MS (QCLot: 1123831)								
EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 1123839)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	80	114
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	100	88	112
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	101	81	119
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	111	70	130
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.9	88	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	89	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	98.3	89	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	105	88	116
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	103	89	112
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.6	88	114
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	102	90	114
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.1	88	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	101	79	111
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	106	87	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	91.6	84	114
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	111	82	128
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	98.8	82	118
EG020T: Total Metals by ICP-MS (QCLot: 1123840)								
EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 1123841)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	108	80	114
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.9	88	112
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	107	81	119
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	114	70	130
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.9	88	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	89	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	96.0	89	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	102	88	116
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	89	112
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	102	88	114

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EG020T: Total Metals by ICP-MS (QCLot: 1123841) - continued								
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	99.7	90	114
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	94.7	88	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	98.2	79	111
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	111	87	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	90.8	84	114
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	121	82	128
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	103	82	118
EG035F: Dissolved Mercury by FIMS (QCLot: 1123834)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.1	84	118
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1123844)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	84	118
EK040P: Fluoride by PC Titrator (QCLot: 1122174)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	0.5 mg/L	100	80	117
EP033: C1 - C4 Hydrocarbon Gases (QCLot: 1127457)								
EP033: Methane	74-82-8	10	µg/L	<10	28.48 µg/L	91.4	86	114

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1128258)							
EB1719100-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1128259)							
EB1719100-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	110	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1123830)							
EB1718574-002	Anonymous	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	# Not Determined	70	130
		EG020A-F: Arsenic	7440-38-2	1 mg/L	97.5	70	130
		EG020A-F: Beryllium	7440-41-7	1 mg/L	97.4	70	130
		EG020A-F: Barium	7440-39-3	5 mg/L	108	70	130
		EG020A-F: Cadmium	7440-43-9	1 mg/L	97.7	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	92.4	70	130
		EG020A-F: Cobalt	7440-48-4	1 mg/L	97.6	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1123830) - continued							
EB1718574-002	Anonymous	EG020A-F: Copper	7440-50-8	2 mg/L	96.4	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	81.7	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	# Not Determined	70	130
		EG020A-F: Molybdenum	7439-98-7	1 mg/L	85.8	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	99.7	70	130
		EG020A-F: Selenium	7782-49-2	1 mg/L	96.3	70	130
		EG020A-F: Vanadium	7440-62-2	1 mg/L	99.6	70	130
		EG020A-F: Zinc	7440-66-6	2 mg/L	95.2	70	130
		EG020A-F: Boron	7440-42-8	5 mg/L	101	70	130
EG020T: Total Metals by ICP-MS (QCLot: 1123839)							
EB1719186-067	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	97.4	70	130
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	102	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	107	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	93.1	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	97.2	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	102	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	103	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	113	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	97.4	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	93.9	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	96.4	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	93.3	70	130
EG020T: Total Metals by ICP-MS (QCLot: 1123841)							
EB1719218-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	100.0	70	130
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	108	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	119	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	98.2	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	93.8	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	95.6	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	94.9	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	110	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	92.8	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	87.8	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	95.8	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	90.1	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 1123834)							
EB1719140-004	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	82.0	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1123844)							
EB1719186-067	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	88.4	70	130
EK040P: Fluoride by PC Titrator (QCLot: 1122174)							
EB1719174-001	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	99.8	70	130
EP033: C1 - C4 Hydrocarbon Gases (QCLot: 1127457)							
EM1712836-001	Anonymous	EP033: Methane	74-82-8	28.48 µg/L	126	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1719214**	Page	: 1 of 8
Client	: **4T CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR IAN RANKINE	Telephone	: +61-7-3243 7222
Project	: 745 GWQ	Date Samples Received	: 19-Sep-2017
Site	: ----	Issue Date	: 25-Sep-2017
Sampler	: ----	No. of samples received	: 3
Order number	: ----	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EB1719100--002	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EB1718574--002	Anonymous	**Aluminium**	7429-90-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EB1718574--002	Anonymous	**Manganese**	7439-96-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
Rolf's Bore, House Bore, Blanches Bore	----	----	----	19-Sep-2017	13-Sep-2017	**6**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Control Samples (LCS)					
Dissolved Metals by ICP-MS - Suite B	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	0	10	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**19-Sep-2017**	13-Sep-2017	×
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**19-Sep-2017**	11-Oct-2017	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**20-Sep-2017**	20-Sep-2017	✓
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**19-Sep-2017**	27-Sep-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**22-Sep-2017**	11-Oct-2017	✓
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**22-Sep-2017**	11-Oct-2017	✓
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**21-Sep-2017**	11-Oct-2017	✓
ED093F: SAR and Hardness Calculations								
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**21-Sep-2017**	11-Oct-2017	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG020B-F)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**----**	----	----	**21-Sep-2017**	12-Mar-2018	✓
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T)								
Rolf's Bore, Blanches Bore	House Bore,	**13-Sep-2017**	**20-Sep-2017**	12-Mar-2018	✓	**20-Sep-2017**	12-Mar-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F)							
Rolf's Bore, House Bore, Blanches Bore	**13-Sep-2017**	**----**	----	----	**21-Sep-2017**	11-Oct-2017	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)							
Rolf's Bore, House Bore, Blanches Bore	**13-Sep-2017**	**----**	----	----	**20-Sep-2017**	11-Oct-2017	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
Rolf's Bore, House Bore, Blanches Bore	**13-Sep-2017**	**----**	----	----	**19-Sep-2017**	11-Oct-2017	✓
EP033: C1 - C4 Hydrocarbon Gases							
Amber VOC Vial - Sulfuric Acid (EP033)							
Rolf's Bore, House Bore, Blanches Bore	**13-Sep-2017**	**----**	----	----	**21-Sep-2017**	27-Sep-2017	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
C1 - C4 Gases	EP033	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
C1 - C4 Gases	EP033	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	0	3	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	0	10	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
C1 - C4 Gases	EP033	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
C1 - C4 Gases	EP033	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Un-ionized Hydrogen Sulfide	EK084	WATER	In house: Referenced to APHA 4500-S2- H. Sulfide in the sample is reported as the ionised / unionised fractions by the use of a nomograph and the initial pH. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
C1 - C4 Gases	EP033	WATER	Technical Guidance for the Natural Attenuation Indicators: Methane, Ethane, and Ethene, US EPA - Region 1, EPA New England, July 2001. Automated static headspace, dual column GC/FID. A 12 mL sample is pipetted into a 20 mL headspace vial containing 3g of sodium chloride and sealed. Each sample is equilibrated with shaking at 40 degrees C for 10 minutes prior to analysis by GC/FID using a pair of PLOT columns of different polarity.

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

Appendix D **Monitoring bores**

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Drilling Log

Monitoring Well **MW1**

Project MEMS — Owner Middlemount Coal Pty Ltd

Location Middlemount Mine — Proj. No. ENVINEWS08629AA

Surface Elev. NA — Total Hole Depth 30.0 m. — North — East

Top of Casing NA — Water Level Initial ▽ 26.0 m. — Static ▼ 24.0 m. — Diameter 125 mm.

Screen: Dia NA — Length NA — Type/Size Class 18 UPVC

Casing: Dia NA — Length NA — Type Class 18 UPVC

Fill Material — Rig/Core

Drill Co. QLD Drilling — Method Air Rotary

Driller Corey Evetts — Log By M Weir — Date 5/6/08 — Permit # NA

Checked By — License No.

COMMENTS
Backfill used above bentonite plug.

Depth (m.)	Well Completion	PID (ppm)	Sample ID / % Recovery / Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure). Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0					CL	Sandy CLAY - non plastic, brown, dry, stiff, heterogeneous.
2					CL	Sandy CLAY - non plastic, grey, heterogeneous, sandy brown lenses, dry.
4					CL	CLAY - non plastic, orange, dry, stiff, homogeneous.
6						
8						
10						
12					CL	Sandy CLAY - orange, soft, dry.
14					CL	CLAY - non plastic, brown, dry, stiff, heterogeneous.
16					SP	SAND - grey, moist.
18					CL	CLAY - non plastic, brown, dry, stiff, heterogeneous.
20						
22					CL	CLAY - non pastic, grey, stratified, orange lenses, dry, very stiff.
24 ▼						
26 ▽					CL	Sandy CLAY - moderate plasticity, grey sand, orange clay, wet, heterogeneous.
28						
30						End of hole at 30.0m - Limit of investigation.

GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW1P

SHEET 1 OF 2

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 12.06.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 19.06.2010
Borehole Location:	MW1P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	161 m AHD
Borehole Diameter:	171mm to 121mm	Driller Lic No:	3046	Co-ords:	E 667818 N 7473149 MGA94 Zone 55
		TOC (RL):	162 m AHD	Local Co-ords:	

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD / DEPTH(m)	6 FIELD TEST	7 SAMPLE
RAB			TOC 1 m. Measured, cased with PVC cap. Cement 0 to 5m bgl (below ground level). 50mm ID, Class 18 uPVC casing 0 to 72m bgl. Backfill, 5 to 87m bgl.	160 (0); 158.00 (2); 156.00 (4); 154 (6); 8.00 (8); 152 (8); 10.00 (10); 150.00 (12); 148 (14); 146 (16); 144.00 (18); 142 (20); 140.00 (22); 138.00 (24); 136 (26); 134 (28); 132 (30); 130 (32); 128 (34); 126.00 (36); 124 (38); 122.00 (40); 120.00 (42); 118 (44); 116 (46); 114 (48); 112		

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY / CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
	SC	Clayey SAND: fine to medium grained, orange brown, dry.	D		171mm Diameter, 0 to 44m bgl
	CL	Sandy CLAY: grey, medium grained, sand component, soft, bands of iron staining.			
	CL	CLAY: grey, stiff, bands of iron staining.			
	SP	SAND: fine to medium grained, yellow, dry.			
		medium grained, yellow and red, with clay, dry.			
	CL	CLAY: grey and brown, stiff, banded.			
	CL/SP	grey, pink and orange, stiff and SAND: fine to medium grained, pink.			
	CL	CLAY: grey, pink and orange, stiff.			
	SC	Clayey SAND: fine to medium grained, orange red, soft, dry.			
	CL	CLAY: grey, pink and orange, soft to firm.			
	CL	Sandy CLAY: grey, fine grained sand component, soft.			
		COAL: black, distinctly weathered, (Middlemount Seam).			
		SANDSTONE: fine to medium grained, dark grey, carbonaceous, distinctly weathered.			
		SILTSTONE: dark grey, slightly weathered.			
	CL	Sandy CLAY: pale grey, fine to medium grained sand component, soft.			
	CL/SP	CLAY: grey, soft and SAND: fine to medium grained, yellow.			
		SANDSTONE: fine to medium grained, yellow, distinctly weathered.			
		fine to medium grained, grey, distinctly weathered, dry.			121mm Diameter, 44 to 77.2m bgl
		very fine to fine grained, grey, distinctly weathered, dry.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.
MW1P
SHEET 2 OF 2

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 12.06.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 19.06.2010
Borehole Location:	MW1P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	161 m AHD
Borehole Diameter:	171mm to 121mm	Driller Lic No:	3046	Co-ords:	E 667818 N 7473149 MGA94 Zone 55
		TOC (RL):	162 m AHD	Local Co-ords:	

Borehole Information

Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD / DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY / CONSISTENCY (VS FB VL L MD ST D VD H)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			TOC 1m	110 52					very fine to fine grained, grey, distinctly weathered, dry, (continued)	D		
				108.00 54					medium grained, grey, distinctly weathered, dry			
				106.00 56					medium grained, grey, fresh, dry			
				104 58								
				102 60								
				100 62.00					very fine grained, grey brown, fresh			
				98.00 64.00					SHALE: dark grey			
				96 66					SANDSTONE: fine grained, grey, fresh			
			Bentonite, 67 to 69.5m bgl	94 68								
			5mm Filter gravel, 69.5 to 72m bgl	92 70.00					COAL: black, moist, soft, (Fisces Seam)	M		
			50mm ID, Class 18 uPVC, 0.5mm Slotted screen from 72 to 75m bgl, 1m uPVC sump	90 72								
				88 74					CLAY: black, carbonaceous, firm			
			Bentonite, 76 to 77m bgl	86.00 76.00					SILTSTONE: grey, carbonaceous, fresh			
				84 78					END OF BOREHOLE AT 77.20 m			
				82 80								
				80 82								
				78 84								
				76 86								
				74 88								
				72 90								
				70 92								
				68 94								
				66 96								
				64 98								
				62								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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Drilling Log

Monitoring Well **MW2**

Project MEMS — Owner Middlemount Coal Pty Ltd

Location Middlemount Mine — Proj. No. ENVINEWS08629AA

Surface Elev. NA — Total Hole Depth 30.0 m. — North — East

Top of Casing NA — Water Level Initial ▽ 24.0 m. — Static ▼ 19.0 m. — Diameter 125 mm.

Screen: Dia NA — Length NA — Type/Size Class 18 UPVC

Casing: Dia NA — Length NA — Type Class 18 UPVC

Fill Material — Rig/Core

Drill Co. QLD Drilling — Method Air Rotary

Driller Corey Evetts — Log By M Weir — Date 5/6/08 — Permit # NA

Checked By — License No.

COMMENTS
Backfill used above bentonite plug.

Depth (m.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Blow Count / Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0						SC	Clayey SAND - brown, dry, loose.
2						SP	SAND - brown, compacted, dry.
4							
6						CL	Sandy CLAY - non plastic, grey, dry, stratified, yellow/orange, hard.
8							
10							
12							
14							
16							
18							
20							
22							
24 ▽						SP	SAND - grey, wet.
26						CL	Sandy CLAY - red/brown, moist.
28						CL	Sandy CLAY - black.
						SP	SAND - grey, wet.
30							End of hole at 30.0m - Limit of investigation.

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Drilling Log

Monitoring Well **MW3**

Project MEMS | Owner Middlemount Coal Pty Ltd

Location Middlemount Mine | Proj. No. ENVINEWS08629AA

Surface Elev. NA | Total Hole Depth 48.0 m. | North | East

Top of Casing NA | Water Level Initial ▽ 45.0 m. | Static ▼ 22.0 m. | Diameter 125 mm.

Screen: Dia NA | Length NA | Type/Size Class 18 UPVC

Casing: Dia NA | Length NA | Type Class 18 UPVC

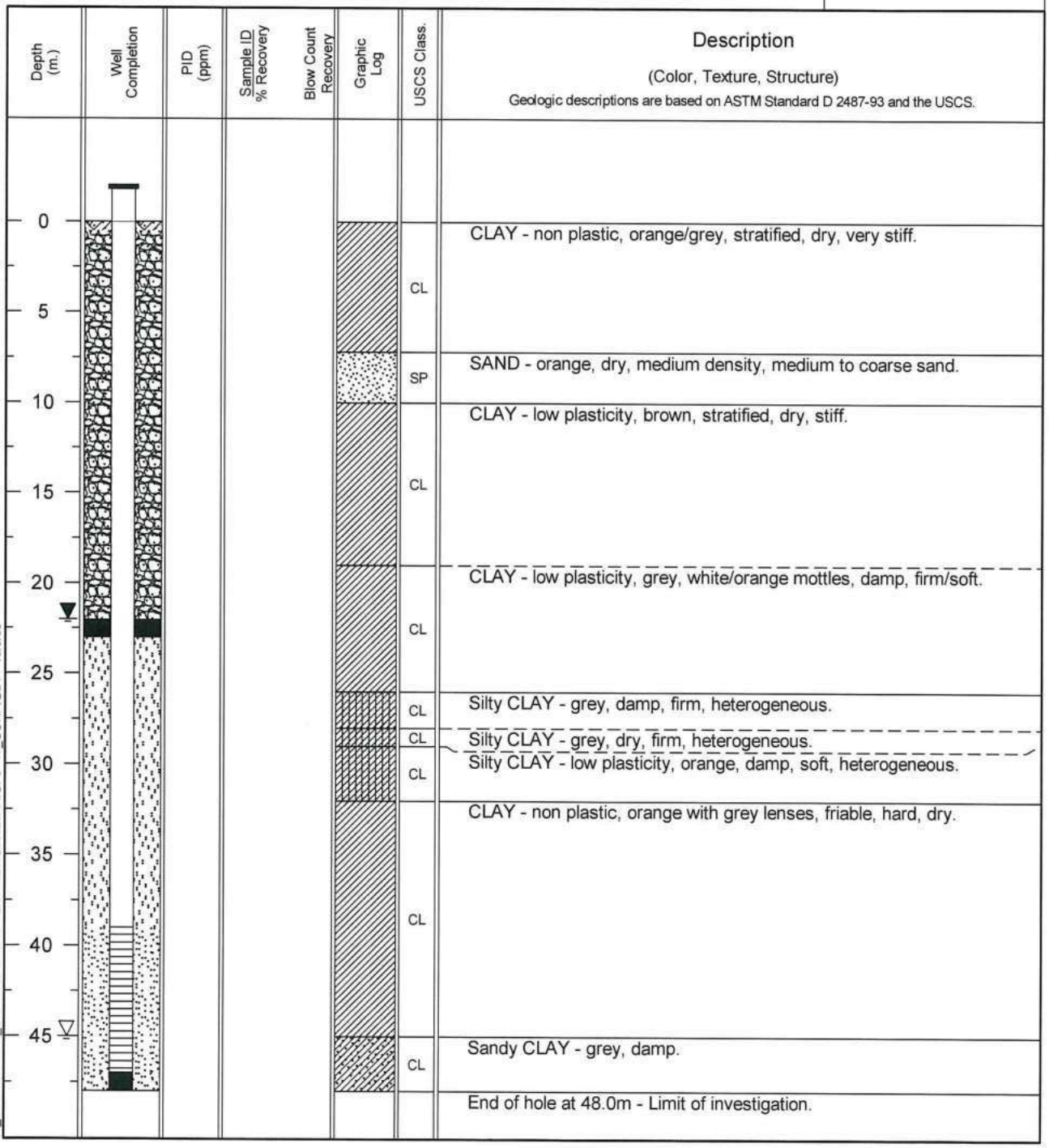
Fill Material | Rig/Core

Drill Co. QLD Drilling | Method Air Rotary

Driller Corey Evetts | Log By M Weir | Date 4/6/08 | Permit # NA

Checked By | License No.

COMMENTS
Backfill used above bentonite plug.



coffey environments

Drilling Log

Monitoring Well **MW4**

Project MEMS | Owner Middlemount Coal Pty Ltd

Location Middlemount Mine | Proj. No. ENVINEWS08629AA

Surface Elev. NA | Total Hole Depth 50.0 m. | North | East

Top of Casing NA | Water Level Initial ▽ 49.0 m. | Static ▼ 42.0 m. | Diameter 125 mm.

Screen: Dia NA | Length NA | Type/Size Class 18 UPVC

Casing: Dia NA | Length NA | Type Class 18 UPVC

Fill Material | Rig/Core

Drill Co. QLD Drilling | Method Air Rotary/Air Hammer

Driller Corey Evetts | Log By M Weir | Date 4/6/08 | Permit # NA

Checked By | License No.

COMMENTS

Backfill used above bentonite plug.

Depth (m.)	Well Completion	PID (ppm)	Sample ID / % Recovery / Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0						TOPSOIL.
						GRANITE ROCK.
5					CL	CLAY - brown, hard, friable, dry.
						CLAYSTONE - brown, rock, dry.
						CLAY - non plastic, grey/white, very hard, friable, dry.
10					CL	
15					CL	CLAY - non plastic, brown/white/orange mottled, stiff, dry, laminated.
						CLAY - non plastic, orange/white/grey/black, stratified, dry, damp.
20					CL	
						Weathered GRANITE/CLAYSTONE.
25						
30						Weathered BASALT - blue/grey, dry.
35						
					CL	CLAY - non plastic, brown, damp, stiff.
40	▼					Weathered BASALT - dry.
45						
	▽					COAL - hard, dry.
50					SP	Sandy COAL - wet.
						End of hole at 50.0m - Limit of investigation.

IT_COMMERCIAL_UK Rev: 21/8/07 ENVINEWS08629AA.GPJ IT_CORP.GDT 19/6/08

coffey environments

Drilling Log

Monitoring Well **MW5**

Project *MEMS* Owner *Middlemount Coal Pty Ltd*

Location *Middlemount Mine* Proj. No. *ENVINEWS08629AA*

Surface Elev. *NA* Total Hole Depth *46.0 m.* North _____ East _____

Top of Casing *NA* Water Level Initial ▽ *40.0 m.* Static *NA* Diameter *125 mm.*

Screen: Dia *NA* Length *NA* Type/Size *Class 18 UPVC*

Casing: Dia *NA* Length *NA* Type *Class 18 UPVC*

Fill Material _____ Rig/Core _____

Drill Co. *QLD Drilling* Method *Air Rotary*

Driller *Corey Evetts* Log By *M Weir* Date *3/6/08* Permit # *NA*

Checked By _____ License No. _____

COMMENTS
Backfill used above bentonite plug.

Depth (m.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0							TOPSOIL.
						CL	CLAY - non plastic, brown, hard, dry.
5							CLAY - non plastic, dark grey, hard, dry.
10						CL	
15							CLAY - non plastic, red/brown, hard, dry.
						CL	
20							CLAY - non plastic, brown, hard, dry.
25							
30						CL	
35							CLAY - non plastic, grey, dry, friable.
40 ▽						CL	
							COAL - black, moist.
							COAL - wet slurry.
45							End of hole at 45.0m - Limit of investigation.

GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW5M

SHEET 1 OF 3

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 10.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 24.07.2010
Borehole Location:	MW5M - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller: S Baker	Surface RL: 174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No: 3046	Co-ords: E 667790 N 7475131 MGA94 Zone 55
		TOC (RL): 175 m AHD	Local Co-ords:

Borehole Information

Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY / CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RB			TOC 1 m Monument cover with PVC cap. Cement 0 to 0.5m bgl (below ground level) 80 mm ID, Class 18 uPVC casing, 0 to 127m bgl Backfill 0.5 to 121.5m bgl	174	0				CL	Silty CLAY: brown, firm, moist.	M	VS S F St VSt H / VL L MD D VD	200mm Diameter, 0 to 46m bgl
				172	2				CL/SP	CLAY: grey, pink and brown, firm, moist and SAND: fine grained, brown, moist.			
				170	4								
				168.00	6					Clayey SANDSTONE: fine grained, brown, extremely weathered, moist.			
				166	8								
				164.00	10					SANDSTONE: fine to medium grained, brown, distinctly weathered, moist.			
				162	12								
				160.00	14					SILTSTONE: yellow, distinctly weathered, moist.			
				158	16								
				17.00						SANDSTONE: fine grained, brown, distinctly weathered, moist.			
				156	18								
				15.00						CLAYSTONE: brown, distinctly weathered, moist, calcite alteration,			
				154.00	20					grey and pink, extremely weathered, moist.			
				152	22								
				150.00	24					Sandy CLAYSTONE: black, grey and red, distinctly weathered, moist.			
				25.00						SANDSTONE: very fine grained, yellow, distinctly weathered, moist.			
				148	26								
				27.00						Sandy CLAYSTONE: grey, brown and pink, distinctly weathered, moist.			
				146.00	28					SANDSTONE: very fine grained, brown, distinctly weathered, moist.			
				28.00						Silty CLAYSTONE: grey and orange, distinctly weathered, moist.			
				144	30								
				142	32					SANDSTONE: very fine grained, red brown, distinctly weathered, moist.			
				33.00									
				140	34								
				138	36								
				136	38								
				39.00						SILTSTONE: red brown, distinctly weathered, moist.			
				134.00	40					SANDSTONE: very fine grained, red brown, distinctly weathered, moist.			
				132.00	42					grey and orange.			
				130.00	44					SILTSTONE: red, distinctly weathered, moist.			
				45.00						CLAYSTONE: grey and red, slightly weathered, moist.			
				128.00	46					SILTSTONE: grey and brown, distinctly weathered, moist.			140mm Diameter, 46 to 131m bgl
				126	48								
RAB				48.00						grey, slightly weathered.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.
MW5M
SHEET 2 OF 3

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 10.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 24.07.2010
Borehole Location:	MW5M - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No:	3046	Co-ords:	E 667790 N 7475131 MGA94 Zone 55
		TOC (RL):	175 m AHD	Local Co-ords:	

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY / CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			100.1 m	122	52					grey, slightly weathered, (continued)	M		
				120	54								
				118.600	56					fresh.			
				117.00						SANDSTONE: very fine grained, grey, fresh, moist.			
				116	58								
				114	60					SILTSTONE: grey, fresh, moist.			
				113.00									
				112	62					SANDSTONE: very fine grained, grey, fresh, moist.			
				111.00									
				110	64								
				108	66								
				106.000	68					SILTSTONE: grey, fresh, moist.			
				104.000	70					SANDSTONE: very fine grained, grey, fresh, moist.			
				103.00						SILTSTONE: grey, fresh, moist.			
				102.000	72					SANDSTONE: very fine grained, grey, fresh, moist.			
				100.000	74					SILTSTONE: grey, fresh, moist.			
				99.00						SANDSTONE: very fine grained, grey, fresh, moist.			
				98	76								
				96	78								
				94	80								
				92	82								
				91.00						distinctly weathered, wet.	W		
				90.000	84					fine grained			
				88.000	86					very fine grained, dark grey.			
				86.000	88					fine grained.			
				85.00						very fine grained.			
				84.000	90					SILTSTONE: dark grey, fresh, wet.			
				82	92								
				80	94								
				78.000	96					SANDSTONE: very fine grained, dark, grey, fresh, wet.			
				76.000	98					SILTSTONE: dark grey, fresh, wet.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW5M

SHEET 3 OF 3

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 10.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 24.07.2010
Borehole Location:	MW5M - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No:	3046	Co-ords:	E 667790 N 7475131 MGA94 Zone 55
		TOC (RL):	175 m AHD	Local Co-ords:	

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION (TOC 1 m)	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE
RAB			Bentonite, 121.5 to 120m bgl 3mm Filter gravel, 128 to 131m bgl 40mm ID, Class 18 uPVC, 0.5mm Slotted screen from 127 to 130m bgl, 1m uPVC sump	72 102 70 104 68 106 66 108 64 110 62 112 60 114 58 116 56 118 54 120 52 122 50 124 48 126 46 128 44 130 42 132 40 134 38 136 36 138 34 140 32 142 30 144 28 146 26 148		

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY/CONSISTENCY (VS, S, FR, VL, L, MD, ST, VST, H, VH)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
		SILTSTONE: dark grey, fresh, wet. (continued)	W		
		SILTSTONE: dark grey, fresh, wet.			
		CLAYSTONE: black, fresh, carbonaceous, wet.			
		SANDSTONE: fine grained, dark, grey, fresh, wet.			
		medium grained.			
		SILTSTONE: dark grey, fresh, wet.			
		SANDSTONE: medium grained, dark, grey, fresh, wet.			
		very fine grained.			
		fine grained.			
		very fine grained.			
		fine grained.			
		SILTSTONE: dark grey, fresh, wet.			
		COAL: black, fresh, wet, (Middlemount Seam).			Airlift yield: 0.21 L/S
		silty.			
		non-silty.			
		SILTSTONE: black, fresh, carbonaceous, wet.			Airlift yield: 0.76 L/S
		END OF BOREHOLE AT 131.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.
MW5P
SHEET 1 OF 4

Client:	MACARTHUR COAL	PB Borehole No.:	
Project:	MIDDLEMOUNT COAL PROJECT	Date Commenced:	06.07.2010
Borehole Location:	MW5P - MIDDLEMOUNT MINE	Date Completed:	24.07.2010
Project Number:	2117076B	Recorded By:	Malcolm Graham
		Log Checked By:	
Drill Model/Mounting:	IRTH 60	Driller: S Baker	Surface RL: 174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No: 3046	Co-ords: E 667796 N 7475130 MGA94 Zone 55
		TOC (RL): 175 m AHD	Local Co-ords:

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE
RB			TOC 1m Monument cover with PVC cap. Cement 0 to 0.5m bgl (below ground level) 80mm ID. Class 18 uPVC casing. 0 to 163m bgl Backfill, 6.5 to 160.5m bgl	172.00 170 168.00 166 164.00 162 160 158 156 154 152 150.00 148.00 146.00 144 142 140.00 138 136 134.00 132 130.00 128.00 126.00	2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48	

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY / CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
	CL	**Silty CLAY:** brown, moist, firm	M		200mm Diameter, 0 to 52m bgl
	CL	**CLAY:** grey and red, moist, firm			
	CL/SP	**CLAY:** grey and red, moist, firm and **SAND:** fine grained, brown,			
		SANDSTONE very fine grained, brown, extremely weathered, moist.			
		distinctly weathered			
		SILTSTONE: yellow-brown, distinctly weathered, moist.			
		SANDSTONE: fine grained, brown, distinctly weathered, moist.			
		CLAYSTONE: grey and red, distinctly weathered, moist.			
		Sandy CLAYSTONE: brown, distinctly weathered, very fine grained sand.			
		SANDSTONE: fine grained, brown, distinctly weathered.			
		Sandy CLAYSTONE: brown, distinctly weathered, very fine grained sand.			
		SANDSTONE: fine grained, yellow, extremely weathered, moist.			
		Clayey SANDSTONE: fine grained, yellow, extremely weathered, moist.			
		Silty CLAYSTONE: grey and brown, distinctly weathered, moist.			
		SANDSTONE: fine grained, red-brown, distinctly weathered, moist.			
		SILTSTONE: red-brown, distinctly weathered, moist.			
		SANDSTONE: fine grained, red-brown, distinctly weathered, moist.			
		grey			
		red			
		CLAYSTONE: grey and brown, distinctly weathered, moist.			
		SANDSTONE: fine grained, grey, slightly weathered, moist.			
		SILTSTONE: grey, slightly weathered, dry	D		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW5P

SHEET 2 OF 4

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 06.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 24.07.2010
Borehole Location:	MW5P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No:	3046	Co-ords:	E 667796 N 7475130 MGA94 Zone 55
		TOC (RL):	175 m AHD	Local Co-ords:	

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION (TOC 1 m)	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY/CONSISTENCY (VS VSOFT S SOFT F FB FIRM VST VSTIF H VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RB				122.00	52					SILTSTONE: grey, slightly weathered, dry. (continued)	D		
RAB				52.00						SANDSTONE: fine grained, grey, slightly weathered, dry.			140mm Diameter, 52 to 174m bgl
				120	54					SILTSTONE: grey, slightly weathered, dry.			
				55.00						SANDSTONE: fine grained, grey, fresh, dry.			
				118	56								
				117.00						SILTSTONE: grey, fresh, dry.			
				116.00	58					SANDSTONE: fine grained, grey, fresh, dry.			
				114	60								
				112.00	62					SILTSTONE: grey, fresh, dry.			
				52.00						SANDSTONE: very fine grained, grey, fresh, dry.			
				110	64								
				108	66								
				106	68								
				53.00									
				104	70					SILTSTONE: grey, fresh, dry.			
				102	72								
				33.00						SANDSTONE: fine grained, grey, dry.			
				100.00	74					SILTSTONE: grey, fresh, dry.			
				98	76								
				96.00	78					SANDSTONE: fine grained, grey, fresh, dry.			
				94.00	80					slightly weathered, wet.	W		
				92	82								
				90.00	84					fresh, wet.			
				88	86								
				87.00						SILTSTONE: grey, fresh, wet.			
				86.00	88					SANDSTONE: fine grained, fresh, wet.			
				84.00	90					SILTSTONE: dark grey, fresh, wet.			
				82	92								
				80	94								
				78.00	96					SANDSTONE: fine grained, grey, fresh, wet.			
				76.00	98					SILTSTONE: dark grey, fresh, wet.			
				75.00						SANDSTONE: fine grained, grey, fresh, wet.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.
MW5P
SHEET 3 OF 4

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 06.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 24.07.2010
Borehole Location:	MW5P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No:	3046	Co-ords:	E 667796 N 7475130 MGA94 Zone 55
		TOC (RL):	175 m AHD	Local Co-ords:	

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION (TOC 1 m)	RL(m) AHD / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS VL FB L MD ST VST D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				72 102					SANDSTONE: fine grained, grey, fresh, wet. (continued)	W		
									SILTSTONE: dark grey, fresh, wet.			
				70 104								
				69.96 406					CLAYSTONE: black, fresh, carbonaceous, wet.			
									SANDSTONE: fine grained, grey, fresh, wet.			
				66 108								
				64 110								
				63.12 412					SILTSTONE: dark grey, fresh, wet.			
				113.00					SANDSTONE: fine grained, grey, fresh, wet.			
				60 114								
				59.08 416					fine grained.			
				56 118								
				54 120								
				52 122								
				50.24 424					SILTSTONE: dark grey, fresh, wet.			
				128.00					CLAYSTONE: black, fresh, carbonaceous, wet.			
				48.26 426					SILTY COAL: black, fresh, wet, (Middlemount Seam)			Airlift yield: 0.12 L/S
				127.00					COAL: black, fresh, wet.			
				46 128								
				44 130								
				131.00					SILTSTONE: dark grey, fresh.			Airlift yield: 0.14 L/S
				42 132								
				133.00					SANDSTONE: fine grained, grey, fresh, wet.			
				40 134								
				38 136								Airlift yield: 0.14 L/S
				36 138								
				34 140								
				32 142								
				30 144								
				28 146								
				26 148								
				149.00					SILTSTONE: black, fresh, wet.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW5P

SHEET 4 OF 4

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 06.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 24.07.2010
Borehole Location:	MW5P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	174 m AHD
Borehole Diameter:	200mm to 140mm	Driller Lic No:	3046	Co-ords:	E 667796 N 7475130 MGA94 Zone 55
		TOC (RL):	175 m AHD	Local Co-ords:	

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE
RAB			TOC 1 m Bentonite, 160.5 to 164m bgl 3mm Filter gravel, 164 to 169m bgl 80mm ID, Class 18 uPVC, 0.5mm Slotted screen from 165 to 168m bgl, 1m uPVC sump Bentonite, 169 to 171m bgl Backfill, 171 to 174m bgl	22 20 18 16 14 12 10 8 6 4 2 0 -2 -4 -6 -8 -10 -12 -14 -16 -18 -20 -22 -24	152 154 156 158 160 162 164 166 168 170 172 174 176 178 180 182 184 186 188 190 192 194 196 198		

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
		SILTSTONE: black, fresh, wet, (continued)	W		
		SANDSTONE: fine grained, dark grey, fresh, wet			
		CLAYSTONE: black, fresh, carbonaceous, wet			Airlift yield: 0.29 L/S
		COAL: black, fresh, wet, (Pisces Seam).			Airlift yield: 0.31 L/S
		SILTSTONE: dark grey, fresh, carbonaceous, wet.			
		SANDSTONE: very fine grained, grey, fresh, wet.			
		fine grained.			Airlift yield: 0.34 L/S
		END OF BOREHOLE AT 174.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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coffey environments

Drilling Log

Monitoring Well **MW6**

Project *MEMS* Owner *Middlemount Coal Pty Ltd*

Location *Middlemount Mine* Proj. No. *ENVINEWS08629AA*

Surface Elev. *NA* Total Hole Depth *42.0 m.* North _____ East _____

Top of Casing *NA* Water Level Initial ▽ *38.0 m.* Static ▼ *24.0 m.* Diameter *125 mm.*

Screen: Dia *NA* Length *NA* Type/Size *Class 18 UPVC*

Casing: Dia *NA* Length *NA* Type *Class 18 UPVC*

Fill Material _____ Rig/Core _____

Drill Co. *QLD Drilling* Method *Air Rotary*

Driller *Corey Evetts* Log By *M Weir* Date *3/6/08* Permit # *NA*

Checked By _____ License No. _____

COMMENTS
Backfill used above bentonite plug.

Depth (m.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Blow Count / Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0							TOPSOIL - vegetation.
						CL	CLAY - non plastic, brown, hard, dry, homogeneous.
5						CL	CLAY - non plastic, brown/grey, hard, dry.
10						CL	CLAY - low plasticity, red, dry, homogeneous.
15						CL	CLAY - low plasticity, white, damp, firm, stiff.
20						CL	CLAY - low plasticity, white/brown, firm, dry, homogeneous.
25	▼					CL	CLAY - non plastic, black/grey, dry, friable.
30						CL	CLAY - non plastic, brown/white, dry, friable.
35						CL	CLAY - grey, hard, damp.
40	▽					CL	CLAY - non plastic, grey, wet, hard.
							End of hole at 42.0m - Limit of investigation.

GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW7M

SHEET 1 OF 3

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 15.06.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 19.06.2010
Borehole Location:	MW7M - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	160 mAHD*
Borehole Diameter:	171mm to 121mm	Driller Lic No:	3046	Co-ords:	E 669668 N 7472167 MGA94 Zone 55
		TOC (RL):	161 mAHD*	Local Co-ords:	

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE
RAB			TOC 1m Monument cover with PVC casing. Cement 0 to 6m bgl (below ground level) 50mm ID uPVC, Class 12 casing, 0 to 132m bgl Backfill, 9 to 129m bgl	2.00 3.00 4.00 5.00 6.00 7.00 12.00 13.00 14.00 17.00 22.00 25.00 26.00 27.00 28.00 29.00 32.00 35.00 36.00 38.00 45.00 46.00	2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48		

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY / CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
	CL	Sandy CLAY: brown, fine grained, sand component, firm, dry	D		* Elevations inferred from DTM 171mm Diameter, 0 to 55.5m bgl
	SP	Clayey SAND: fine to medium grained, orange, moist.	M		
	SP	SAND: fine to medium grained, orange, with clay			
		medium grained, yellow, moist, loose			
		medium grained, yellow, moist, trace coarse sand and gravel, loose			
		brown clay bands.			
	SP	Clayey SAND: fine to medium grained, orange and grey, bands of firm, grey clay, moist.			
	SP	SAND: medium grained, orange, with clay, moist			
		bands of 1m, brown clay.			
		medium to coarse grained, bands of 6m, grey clay, moist.			
	CL/ SP	CLAY: grey and brown, firm and SAND: fine grained, yellow.			
	SP/ CL	SAND: medium grained, orange and CLAY: grey, firm.			
	SP	SAND: medium grained, yellow.			
	CL	CLAY: brown and grey, soft, trace fine grained sand.			
	CL	Silty CLAY: grey and brown, firm.			
	CL	Sandy CLAY: grey and orange, fine to medium grained sand component, firm.			
	CL	CLAY: grey and brown, firm.			
	SP	SAND: medium grained, yellow, bands of firm, grey clay.			
	CL	CLAY: brown and grey, firm.			
	CL/ SP	CLAY: brown and grey, firm and SAND: fine to medium grained, yellow.			
	SP	SAND: medium grained, pale grey.			
	SP/ CL/ SP	SAND: medium grained, pale grey and Sandy CLAY: grey and brown, soft and SAND: medium grained, pale grey			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW7M

SHEET 2 OF 3

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 15.06.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 19.06.2010
Borehole Location:	MW7M - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	160 mAHD*
Borehole Diameter:	171mm to 121mm	Driller Lic No:	3046	Co-ords:	E 669668 N 7472167 MGA94 Zone 55
		TOC (RL):	161 mAHD*	Local Co-ords:	

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION TOC 1 m	RL(m) AHD / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS VL L MD St VSt H VH)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				52					medium to coarse grained, pale grey, trace gravel.	M		
				54				SC	SAND: medium to coarse grained, pale grey, trace gravel and Sandy CLAY: grey, soft.			
				56					SANDSTONE: very fine grained, dark grey, distinctly weathered, soft, moist.			121mm Diameter, 58.5 to 143m bgl
				58					fine grained, pale grey, slightly weathered, moist.			
				60					very fine grained, dark grey, distinctly weathered bands of dark grey clay, moist. very fine grained, grey, slightly weathered, moist.			
				62								
				64								
				66					distinctly weathered.			
				68					slightly weathered, dry.	D		
				70					fine grained, dark grey, slightly weathered, dry.			
				72					moist.	M		
									dry, fresh.	D		
				74								
				76					SILTSTONE: dark grey, fresh, dry.			
				78								
				80								
				82					SANDSTONE: fine grained, grey, fresh, dry. very fine grained, dark grey.			
				84					fine grained.			
				86					very fine grained. fine grained.			
				88					very fine grained, wet.	W		
				90					fine grained, grey, wet.			
				92					very fine grained, dark grey, wet. SILTSTONE: dark grey, fresh, wet.			
				94					SANDSTONE: very fine grained, dark grey, fresh, wet. SILTSTONE: dark grey, fresh, wet.			
				96					SANDSTONE: very fine grained, grey, fresh, wet.			
				98								
									SILTSTONE: dark grey, fresh, wet.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

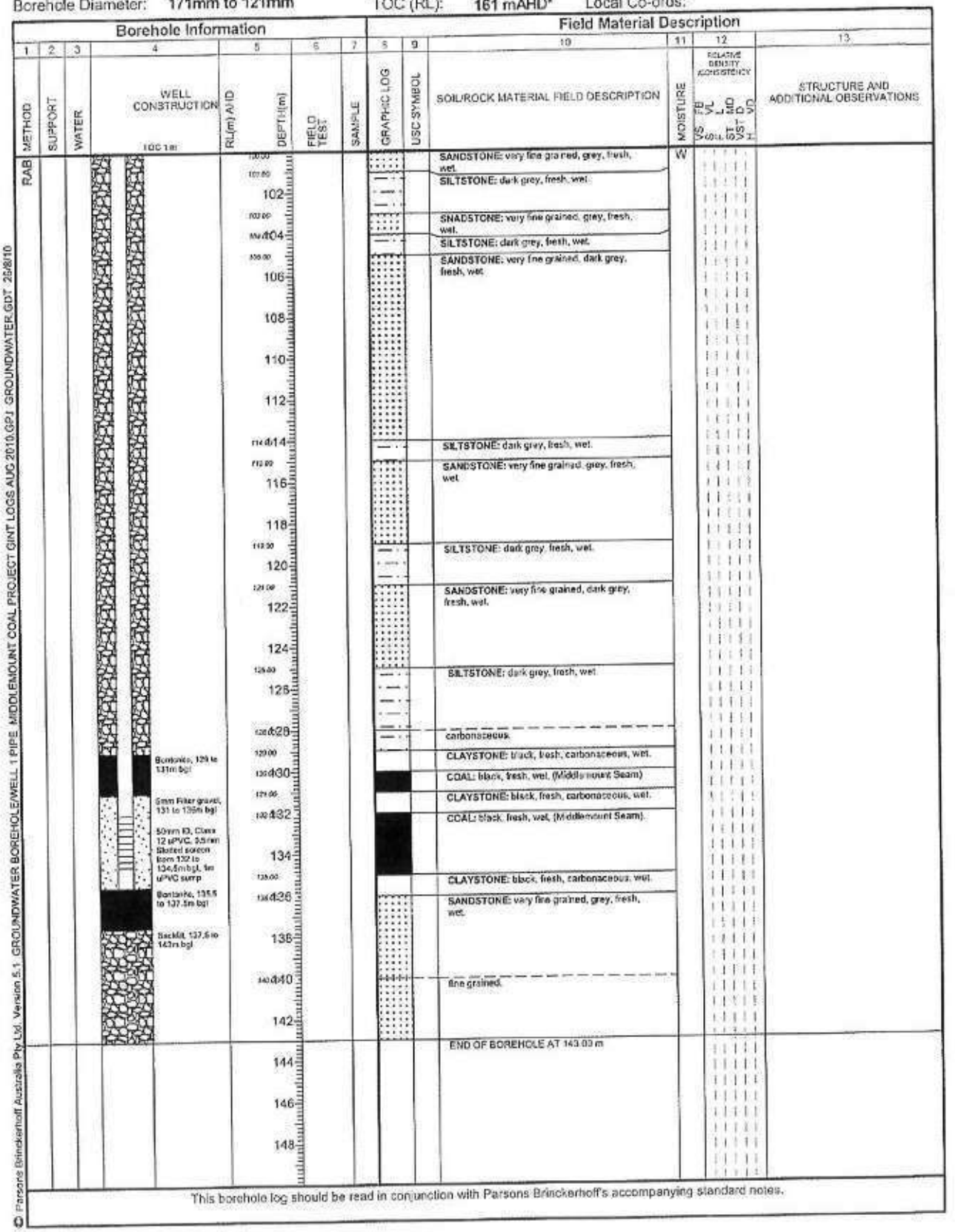
BOREHOLE NO.

MW7M

SHEET 3 OF 3

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 15.06.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 19.06.2010
Borehole Location:	MW7M - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	IRTH 60	Driller:	S Baker	Surface RL:	160 mAHD*
Borehole Diameter:	171mm to 121mm	Driller Lic No:	3046	Co-ords:	E 669668 N 7472167 MGA94 Zone 55
		TOC (RL):	161 mAHD*	Local Co-ords:	



This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW7P

SHEET 1 OF 5

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 21.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 28.07.2010
Borehole Location:	MW7P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	HYDROPOWER SCOUT	Driller:	E Schumacher	Surface RL:	164 m AHD
Borehole Diameter:	254mm to 140mm	Driller Lic No:	3127	Co-ords:	E 669777 N 7472247 MGA94 Zone 55
		TOC (RL):	165 m AHD	Local Co-ords:	

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) AHD	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE
RB			TOC 1 m Monument cover with PVC cap. Cement 0 to 1m bgl (below ground level) 50mm ID, Class 18 uPVC casing, 0 to 189.5m bgl Backfill, 5 to 186.5m bgl	162 160 158 156 154 152 150 148 146 144 142 140 138 136 134 132 130 128 126 124 122 120 118 116	2 4 5 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48		
RAB							

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY CONSISTENCY (VS FR VL S LO ST MD O VST D H VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
	CL	Silty CLAY: brown, firm, moist.	M		254mm Diamter, 0 to 45m bgl
	SP	SAND: medium grained, orange, moist.			
	SC	Clayey SAND: very fine grained, pale brown, moist.			
	SP	SAND: medium grained, orange, moist.			
		fine grained, pale grey.			
		medium grained, orange.			
	CL	CLAY: grey and brown, firm, moist.			
	CL/SP	CLAY: grey, black and orange, firm, moist and SAND: medium grained, orange, moist.			
	SP	SAND: medium grained, orange, moist.			
	CL/SP	Sandy CLAY: grey and brown, firm, moist and SAND: medium grained, grey and brown, moist.			
	CL	CLAY: grey and brown, firm, moist.			
		wet.	W		
		with fine grained brown sand.			
	CL/SP	Sandy CLAY: grey and brown, firm, wet and SAND: fine grained, brown, wet.			
		medium grained, yellow sand component.			
	SC	SAND: coarse grained, yellow, with firm grey clay, wet.			
		medium grained, pale yellow, trace gravel.			
		SANDSTONE: fine to medium grained, yellow, extremely weathered, wet.			200mm Diameter, 45m to 66m bgl

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.
MW7P
SHEET 2 OF 5

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 21.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 28.07.2010
Borehole Location:	MW7P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	HYDROPOWER SCOUT	Driller:	E Schumacher	Surface RL:	164 m AHD
Borehole Diameter:	254mm to 140mm	Driller Lic No:	3127	Co-ords:	E 669777 N 7472247 MGA94 Zone 55
		TOC (RL):	165 m AHD	Local Co-ords:	

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION (TOC 1.0m)	RL(m) AHD / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS FB, VL L, MD ST, D VST, VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				112 52					fresh, with very fine grained, pale yellow, sandstone	W		
									distinctly weathered, iron staining			
									SANDSTONE: very fine grained, grey and brown, slightly weathered, minor black carbonaceous siltstone, iron staining and quartz veins, wet.			
				110 54								
				108 56								
				106 58								
				104 60								
				102 62					SILTSTONE: dark grey, fresh, iron staining and calcite veins, wet.			
				100 64								
				98 66								140mm Diameter, 66 to 203m bgl
				96 68								
				94 70					SANDSTONE: very fine grained, grey, slightly weathered, pyrite alteration, wet.			
				92 72					fresh, no pyrite			
				90 74					fresh, calcite veins, no pyrite			
				88 76					fine grained, fresh, calcite veins			
				86 78					very fine grained, fresh, calcite veins			
				84 80								
				82 82								
				80 84					fine grained, fresh			
				78 86					very fine grained, black, fresh, carbonaceous.			
				76 88					SHALE: dark brown, fresh, carbonaceous, calcite alteration			
				74 90					SANDSTONE: very fine grained, pale brown, fresh, slightly metamorphosed, minor soft sandstone - fault gouge material.			
				72 92					grey, fresh, no evidence of metamorphosis or fault gouge material.			
				70 94					COAL: black, fresh, (Roper Seam).			
				68 96					SILTSTONE: grey, fresh.			
				66 98					pale, grey.			
									COAL: black, fresh, (Middlemount Seam fault repeated)			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW7P

SHEET 3 OF 5

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 21.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 28.07.2010
Borehole Location:	MW7P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	HYDROPOWER SCOUT	Driller: E Schumacher	Surface RL: 164 m AHD
Borehole Diameter:	254mm to 140mm	Driller Lic No: 3127	Co-ords: E 669777 N 7472247 MGA94 Zone 55
		TOC (RL): 165 m AHD	Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION TOC 1 m	RL(m) AHD / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY/CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				62 102					SILTSTONE: grey, fresh.	W		
				60 104					COAL: black, fresh. (Middlemount Seam fault repeated)			
				58 106								
				56 108								
				54 110								
				52 112					SILTSTONE: grey, fresh, carbonaceous.			
				50 114					non-carbonaceous.			
				48 116					SANDSTONE: very fine grained, grey, fresh, slightly carbonaceous.			
				46 118								
				44 120								
				42 122					SILTSTONE: grey, fresh.			
				40 124								
				38 126					SANDSTONE: very fine grained, grey, fresh.			
				36 128					SILTSTONE: grey, fresh.			
				34 130					COAL: black, fresh. (Middlemount Seam)			
				32 132								
				30 134								
				28 136								
				26 138								
				24 140					SILTSTONE: grey, fresh.			
				22 142					SANDSTONE: fine to medium grained, grey, fresh.			
				20 144								
				18 146								
				16 148					black, carbonaceous.			
									grey, non-carbonaceous.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW7P

SHEET 4 OF 5

Client:	MACARTHUR COAL	PB Borehole No.:	Date Commenced: 21.07.2010
Project:	MIDDLEMOUNT COAL PROJECT		Date Completed: 28.07.2010
Borehole Location:	MW7P - MIDDLEMOUNT MINE		Recorded By: Malcolm Graham
Project Number:	2117076B		Log Checked By:

Drill Model/Mounting:	HYDROPOWER SCOUT	Driller:	E Schumacher	Surface RL:	164 m AHD
Borehole Diameter:	254mm to 140mm	Driller Lic No:	3127	Co-ords:	E 669777 N 7472247 MGA94 Zone 55
		TOC (RL):	165 m AHD	Local Co-ords:	

Borehole Information

1	2	3	4	5		6	7
METHOD	SUPPORT	WATER	WELL CONSTRUCTION (TOC 1 m)	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE
RAB				12	152		
				10	154		
				8	156		
				6	158		
				4	160		
				2	162		
				0	164		
				-2	166		
				-4	168		
				-6	170		
				-8	172		
				-10	174		
				-12	176		
				-14	178		
				-16	180		
				-18	182		
				-20	184		
				-22	186		
			Bentonite, 180.5 to 189m bgl	-24	188		
			3mm Filter gravel, 189 to 195m bgl	-26	190		
			50mm ID, Class 18 uPVC, 0.5mm Slotted screen from 189.5 to 193.5m bgl, 1m uPVC sump	-28	192		
			Bentonite, 194.5 to 197m bgl	-30	194		
			Backfill, 197 to 203m bgl	-32	196		
				-34	198		

Field Material Description

8	9	10	11	12	13
GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS FR VL L MD ST D VST VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
		grey, non-carbonaceous. (continued)	W		
		very fine grained, black, carbonaceous.			
		grey, high strength, non-carbonaceous.			
		fine grained.			
		very fine grained.			
		fine grained.			
		fine to medium grained.			
		COAL: black, fresh, some very fine grained, white tuff, (Pikes Seam)			
		SANDSTONE: fine grained, grey.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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