

Boggabri Coal Operations Pty Ltd

Groundwater Management Plan

May 2017

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BOGGABRI COAL

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Abbreviations

Abbreviation	Term
AEMR	Annual Environmental Management Report
AIP	Aquifer Interference Policy
BCM	Boggabri Coal Mine
BCOPL	Boggabri Coal Operations Pty Limited
BTM Complex	Boggabri-Tarrawonga-Maules Creek Complex
CCC	Community Consultative Committee
CEMP	Construction Environmental Management Plan
DPI Water	NSW Department of Primary Industry – Water
DoEE	Department of Environment and Energy (Formerly - Department of Environment)
DP&E	NSW Department of Planning and Environment (formerly DP& Infrastructure)
EA	Environmental Assessment
EC	Electrical Conductivity
EMPs	Environmental Management Plans
EP&A Act	*Environmental Planning and Assessment Act, 1979*
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act, 1999*
EPL	Environment Protection Licence
GDE	Groundwater Dependent Ecosystem
GWMP	Groundwater Management Plan
IAR	Idemitsu Australia Resources Pty Limited
MCC	Maules Creek Coal Project
MDB	Murray-Darling Basin
MOD 5	Project Approval Modification 5
ML	Mega Litre
MOP	Mining Operations Plan
Mtpa	Million Tonnes Per Annum
NWLS	North West Land Services
PAC	NSW Planning Assessment Commission
ROM	Run of Mine
TCPL	Tarrawonga Coal Pty Ltd
VWP	Vibrating Wire Piezometer
WAL	Water Access Licence
WMP	Water Management Plan
WMS	Water Management Strategy
XRD	X-ray Diffraction
XRF	X-ray Fluorescence

1. Introduction

This Groundwater Management Plan (GWMP) has been developed for Boggabri Coal Operations Pty Ltd (BCOPL), a wholly owned subsidiary of Idemitsu Australia Resources Pty Limited (80%), Chugoku Electric Power Australia Resources Pty Ltd (10%) and NS Boggabri Pty Limited (10%).

Boggabri Coal Mine (BCM) is located 15 km north-east of the township of Boggabri in north-western New South Wales. BCM is an open cut coal mine that has been operating since 2006. Truck and excavator operations are used to mine a run-of-mine (ROM) coal which is crushed and screened to produce a thermal coal product or washed in the Coal Handling Preparation Plant (CHPP) to produce Coking or Pulverised Coal Injected (PCI) product. Product coal is loaded onto trains via a train loading facility at the mine site and transported by rail for overseas consumption via the Port of Newcastle.

BCM is managed by BCOPL who also operate the Coal Handling and Preparation Plant (CHPP). BCOPL engages a Mining Operator to undertake open cut mining activities.

Project Approval number 09_0182 for the Boggabri Coal Project, granted by the NSW Planning Assessment Commission (PAC) under Part 3A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) on 18 July 2012, as modified from time to time, (Project Approval) allows BCOPL to extend its mining operations for a further 21 years, and increase its production rate to 8.6 Mtpa of ROM coal from a total resource of 145 Mt.

In 2015, BCOPL lodged an application under Section 75W of the EP&A Act 1997 to modify PA 09_0182 (MOD 5). The modification was supported by an Environmental Assessment (Parsons Brinckerhoff, 2015a) for the conversion of existing test bores to operational production bores for the supply water to BCM and the installation of ancillary infrastructure on adjoining properties. The application was determined by the NSW Department of Planning and Environment, Executive Director under delegation by the Minister for Planning and approval was received on 30 August 2016.

Schedule 3, Condition 38(c) of the Project Approval requires the preparation of a Groundwater Management Plan (GWMP). This GWMP has been prepared in fulfilment of these requirements under the Project Approval which are listed in Table 2.2.

Conditions of approval under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) were granted by the then Federal Government Department of Sustainability, Environment, Water, Population and Communities (now the Department of Environment and Energy (DoEE)) on 11 February 2013 (EPBC Approval). Conditions 15 to 19 of the EPBC Approval apply to the GWMP. The specific EPBC Approval requirements are listed in Table 2.3.

1.1 Elements covered by the GWMP

This GWMP applies to all employees and contractors at the BCM and covers activities within the 'Project Approval' area as defined in the Project Approval. Figure A-1 showing the extent of Project Approval area approved by MOD 5 is provided in Appendix A. Operation of contingency production bores (subject of MOD 5) is not covered by this revision of the GWMP. The GWMP will be revised and approval obtained from DP&E to include relevant management measures for the operation of contingency production prior to their use.

1.2 Related water management documents

This GWMP has been prepared as an integral part of, and should be read in conjunction with, the documents listed in Table 1.1. The Water Management Plan (WMP) document hierarchy is shown in Figure 1-1.

Table 1.1 Related water management documents

Document	Description
BTM Complex Water Management Strategy (WMS)	Regional strategy prepared in consultation with Tarrawonga Coal Pty Ltd (TCPL) and Maules Creek Coal Project (MCC)
Water Management Plan (WMP)	Overarching document setting out water management framework, statutory requirements and procedural requirements
Surface Water Management Plan (SWMP)	Surface water baseline data, performance criteria, monitoring program, response plan, water management system description, erosion and sediment controls
Groundwater Management Plan (GWMP)	Groundwater baseline data, performance criteria, monitoring program, response plan, groundwater model validation program
Site Water Balance (SWB) report	Mine water sources, balance modelling methodology, assumptions and results, mine water management system operating philosophy

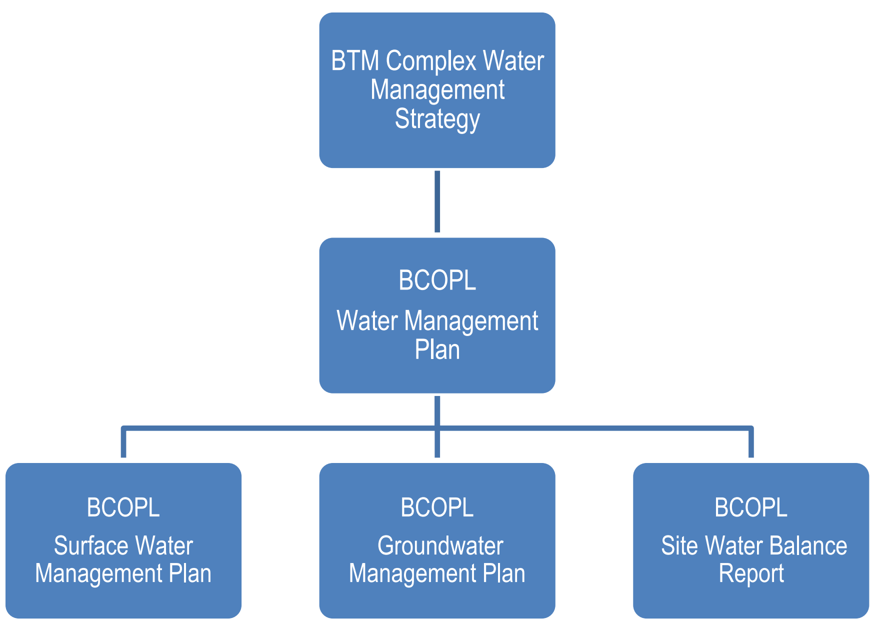

Figure 1-1 Document hierarchy

1.3 Agency consultation

Previous versions of this GWMP have been prepared in consultation with representatives from the NSW Office of Environment and Heritage, NSW Department of Primary Industry Water (DPIW), North West Land Services (NWLS) (Formerly Namoi Catchment Management Authority (NCMA) and the BCM Community Consultative Committee (CCC).

The GWMP has been prepared by suitably qualified persons, whose appointment to prepare this GWMP has been approved by the DP&E. The draft version of this GWMP has been reviewed by DP&E and comments have been addressed.

This GWMP has been submitted to regulators (EPA and DPIW), NWLS and the CCC. The final GWMP has been updated to incorporate feedback from regulators and the CCC. Evidence of consultation is presented in Appendix A of the WMP.

2. Planning and statutory requirements

2.1 Federal and state legislation

Details on relevant federal and state legislation are provided within the WMP.

2.2 NSW Water Management Act 2000

The objective of the *Water Management (WM) Act 2000* is to set out the arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. The *WM Act 2000* provides for the following types of approval:

1. Water use approval (Section 89 of the WM Act) which authorise the use of water at a specified location for a particular purpose;
2. Water management work approval (Section 90 of the WM Act 2000);
3. Controlled activity approval (Section 91 of the WM Act 2000); and
4. Aquifer interference activity approval (Section 91 of the WM Act) authorising the holder to conduct activities that affect an aquifer such as approval for extractive industries that intersect groundwater, other than water supply bores.

In accordance with Section 75U of the *Environmental Planning and Assessment (EP&A) Act 1979*, the above approvals (1 to 3) under the *WM Act 2000* do not apply to the BCM as an *approved project* under Part 3A of the *EP&A Act*. BCOPL will manage operation and impacts associated with the abstraction of groundwater from the borefield though the management measures in this GWMP.

The Aquifer Interference Policy (AIP) applies to extractive industries taking groundwater water incidentally during this activity. The AIP does not apply to the abstraction of groundwater from the water supply bores to be used for consumptive purposes. Notwithstanding the above, Water Access Licences (WAL) are required to be held under the relevant water sharing plan (WSP) for any water take that occurs as a result of open cut mining at BCM. The WSPs relevant to the Boggabri Coal Mine include:

- Upper and Lower Namoi Groundwater Sources WSP 2003 (Namoi Groundwater WSP); and
- Murray Darling Basin Porous Rock Groundwater Sources WSP (MDB Porous Rock WSP).

The boundaries for the Namoi Groundwater and MDB Porous Rock WSP's relative to the Project Area are shown on Figure A-1 in Appendix A.

2.3 Water sharing plans

2.3.1 Upper and Lower Namoi Groundwater Sources WSP

The Namoi Groundwater WSP commenced in November 2006 and establishes the rules for sharing groundwater within the catchments of the Upper and Lower Namoi alluvial aquifers in accordance with the requirements of the *WM Act 2000.* The Namoi Groundwater WSP applies to the ‘Upper and Lower Namoi Groundwater Sources’ which include all water contained in the unconsolidated alluvial aquifers associated with the Namoi River and its tributaries. BCM is located in the outcropping bedrock, with ancillary infrastructure including groundwater abstraction bores located in the surrounding alluvial sediments within Upper Namoi Management Zones 4 as defined in the WSP. The formal name of the management zone is Zone 4 – Namoi Valley (Keepit Dam to Gin’s Leap) Groundwater Source. The Namoi Groundwater WSP establishes an access regime for the extraction of water in accordance with the Available Water Determination set annually, allocating a share for extracted groundwater to different categories of access licences. At the time of commencement of the WSP, the share components of aquifer access licences authorised to extract water from Zone 4 was 21,040 ML/year (DPI Water, 2003).

The WAL entitlements held by BCOPL are shown in Table 2.1. BCOPL will obtain sufficient WAL entitlements in accordance with the *WM Act 2000* for the operation of the borefield. The GWMP further outlines the process to monitor and manage (refer to Sections 4 & 6) the abstraction of groundwater from the production borefield.

2.3.2 NSW Murray-Darling Basin (MDB) Porous Rock Groundwater Sources

Mining at Boggabri Coal Mine targets coal seams of the Maules Creek Formation within the Gunnedah-Oxley Basin Groundwater Source and the Namoi Management Zone. At the commencement of the WSP for the NSW MDB Porous Rock Groundwater Sources there were approximately 16,197 unit shares for aquifer access licences covered by the Gunnedah-Oxley Basin Groundwater Source (DPI Water, 2011b). (Note: Unit shares are equivalent to 1 ML per unit share of the share component for aquifer access licences, or such lower amount that results from the available water determinations as specified at the beginning of each water year).

The WAL entitlements held by BCOPL are shown in Table 2.1. BCOPL possesses sufficient WAL entitlements for the take of water from the MDB porous rock aquifer in accordance with the *WM Act 2000* for the operation of BCM. The GWMP further outlines the process to monitor and manage impacts on groundwater from BCM (refer to Sections 4 & 6).

2.4 Water licensing

BCOPL holds licences for accessing water from the Gunnedah – Oxley Basin MDB Groundwater Source and the Zone 4 – Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source. Details of these water access licences (WALs) are provided in Table 2.1.

Table 2.1 Summary of groundwater (aquifer) WALs currently held by BCOPL

Source	WAL No.	Unit shares	Associated Works approval No.	Description
Gunnedah - Oxley Basin MDB Groundwater Source	29473	142	90WA822528	Lovton Bore
	29562	700	90WA822528	Lovton Bore
			90CA822549	BCM Pit Ingress
Total unit shares		**842**		
Upper Namoi Zone 4 Groundwater Source	15037	172	90CA807034	Daisymede Bore
	24103	275		
	12691	457		
	37519	84		
	12767	3	90CA807126	River block opposite 'The Rock' property
	36547	37	90CA807018	Callander Property
Total unit shares		**1028**		

A total of 842 unit shares from the Gunnedah – Oxley Basin MDB Groundwater Source and 1028 unit shares from the Upper Namoi Zone 4 Groundwater Source are available to the BCM based on the WALs currently held by BCOPL. The actual volume of groundwater available during each year will depend on the Available Water Determinations (AWD) made annually under the respective WSP. These are likely to be at or close to 1 ML per unit share.

BCOPL currently utilises groundwater pumped from Lovton Bore (WAL 29473) and Daisymede Bore (WALs 15037, 24103, 12691 and 37519) for the supply of water to the existing operations as outlined in Section 3.4. These bores source water from the Gunnedah – Oxley Basin MDB Groundwater Source and the Upper Namoi Zone 4 Groundwater Source.

The operation of the borefield for the supply of water to BCM is outlined in Section 3.4. BCOPL's existing and proposed groundwater production bores are shown in Figure A-2 (refer to Appendix A).

Monitoring and production bores used by Boggabri shall be licensed in accordance with the requirements of section 112 of the *Water Act 1912*.

2.5 Groundwater policies

There are several overarching policies that apply to the development and management of groundwater systems across NSW. These include:

- **NSW State Groundwater Policy Framework** (Department of Land and Water Conservation (DLWC) 1997). The NSW State Groundwater Policy Framework introduces three policy documents:
  - NSW Groundwater Quality Protection Policy (DLWC, 1998)
  - NSW Aquifer Interference Policy (DPI, 2012)
  - NSW Groundwater Dependent Ecosystem Policy (DLWC, 2002)
- The **Groundwater Quality Protection Policy** (DLWC, 1998) aims to slow, halt or reverse degradation in groundwater resources, ensure long-term sustainability of the biophysical characteristics of the groundwater system, maintain the full range of beneficial uses of these resources and maximise the economic benefit to the region and state.
- The **Buried Groundwater Sources Policy** (DPI Water, 2011a), which has been developed to set out a framework for how access to water will be managed in groundwater sources that are fully buried or partly buried (such as deep sedimentary basins).
- The **Aquifer Interference Policy (AIP)** defines aquifer interference activities and describes how these will be managed under the licensing and approvals regime in the *Water Management Act 2000*. Under this legislation, the requirements for a licence and approval are determined based on a risk and minimal impact assessment process. The process for assessment is also influenced by the location of the activity with respect to designated 'Strategic Agricultural Land', and where the development is deemed to be 'State Significant'.

  The provisions of the AIP relating to Strategic Agricultural Land do not apply to BCM as the site is located outside these areas. The AIP does not apply to the abstraction of groundwater from the borefield as this policy applies to the take of groundwater incidentally encountered when conducting the primary activity, mineral extraction. The management of groundwater encountered during mining is discussed in Section 6.3.

2.6 Conditions of the Project Approval

Conditions of the Project Approval and the EPBC Approval and approval relating to groundwater management are summarised in Table 2.2 and Table 2.3.

Table 2.2 Project Approval conditions

Applicable Condition	Requirement	GWMP Reference
Schedule 3 Condition 38	The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with OEH, DPI Water, North West LLS and the CCC, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary, and be submitted to the Secretary for approval within 6 months of the date of this approval …(which shall include)…	This plan forms part of the WMP.
	(c) a Groundwater Management Plan, which includes:	
	▪ detailed baseline data of groundwater levels, yield and quality in the region, and privately-owned groundwater bores including a detailed survey/schedule of groundwater dependent ecosystems (including stygo-fauna), that could be affected by the project;	See Section 3
	▪ the monitoring and testing requirements specified in the PAC recommendations for groundwater management as set out in Appendix 6;	See Sections 4.1.6 & 4.1.7
	▪ detailed plans, including design objectives and performance criteria, for the design and management of the proposed final void;	Schedule 2, Condition 21 of the Project Approval allows for staged submission of 'any strategy, plan or program required by this consent on a progressive basis'. The GWMP will be updated when further information on the final void is available.
	▪ groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts;	See Section 5
	▪ a program to monitor and assess:	
	‣ groundwater inflows to the open cut mining operations;	See Section 4.1.5
	‣ the seepage/leachate from water storages, backfilled voids and the final void;	See Section 4.1.4.3
	‣ interconnectivity between the alluvial and bedrock aquifers; ‣ background changes in groundwater yield/quality against mine-induced changes ‣ the impacts of the project on: ○ regional and local (including alluvial) aquifers; ○ groundwater supply of potentially affected landowners; ○ aquifers potentially affected by the mine irrigation area ○ groundwater dependent ecosystems (including potential impacts on stygo-fauna) and riparian vegetation ‣ a program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and ‣ a plan to respond to any exceedances of the performance criteria	See Section 4.1.1. See Section 4.1.1 & 4.1.2 See Section 4.1.1 & 4.1.2 See Section 4.1.1 & 4.1.2 N.A (Not constructed) Section 3.5. & 4.1.1. Section 7.3 Section 6.

Table 2.3 Project conditions of approval – DOEE (formerly SEWPAC)

Applicable Condition	Requirement	GWMP Reference
15	The person taking the action must provide to the Minister for approval, the surface and groundwater management plans as identified in condition 38 of the NSW state government Project Approval dated 18 July 2012 (application no, 09-0182). The surface and groundwater management plans approved by the Minister must be implemented prior to the commencement of new mining operations	See Table 2.2
16	The surface and groundwater management plans must be consistent with the National Water Quality Management Strategy	See Section 2.1.2 of WMP
17	The person taking the action must within 6 months of this approval, in collaboration with the person taking the action to develop and operate the Maules Creek Coal Project (EPBC 2010/5566) and any other approved mines within 20km of the mine site provide written advice to the Minister demonstrating how the approved surface and groundwater management plans (specified in condition 15), addresses the cumulative impact of groundwater drawdown as a result of mining and how this may impact on the consequent health of the remnant native vegetation in the Leard State Forest, the Leard State Conservation Area and surrounding areas. In particular advice must address the following matters: a. maximum amount of allowable drawdown in the alluvial aquifer b. drawdown in hard rock aquifer c. trigger levels pertaining to drawdown in the alluvial aquifer when corrective actions will be required to be undertaken d. identify the depth of root zone of the native vegetation e. monitoring to assess the ongoing quality and quantity of both surface and groundwater to identify impacts on the native vegetation	a) See Section 2.3.1 b) See Section 2.4 c) See Section 5.1.1 & 5.1.2 d) See Section 3.5.3 e) See Section 4
18	The person taking the action must within 6 months of the date of this approval, or such other timeframe as specified by the Minister, provide to the Minister a report on: a. any updated modelling of surface and groundwater impacts that has been undertaken in preparing the surface and groundwater management plans b. how the surface and groundwater management plans address groundwater and surface water impacts on native vegetation	a) No additional modelling has been undertaken as part of this GWMP, other than that specified in Section 4.5 b) Section 3.5.3
19	A risk-based assessment of the disposal of mine water by irrigation on soils must be undertaken. The assessment must include the risk of metal and salinity accumulation on the soils	NA*

* An irrigation management area is not currently planned for the Boggabri Coal Mine. If this changes this plan will be updated to include a risk-based assessment.

3. Geological and hydrogeological setting

This section provides background information relating to geology and hydrogeology for the Project Area. Additional details are provided in the Environmental Assessment (Hansen Bailey, 2010).

3.1 Regional and local geology

BCM is located in the Gunnedah Basin, approximately 330km north-west of Sydney. The Gunnedah Basin forms the central part of the Sydney-Gunnedah-Bowen Basin system which extends along the eastern margin of Australia. The Gunnedah Basin covers an area of just over 15,000 square kilometres (km^2) and comprises rocks of Permian and Triassic age.

The exposed geology across the mine lease area is dominated by the Permian Maules Creek Formation, with minor Quaternary alluvium to the south-east and Permian Boggabri Volcanics to the south-west (DMR, 1998). Coal is extracted from the seams of the Maules Creek Formation.

Beyond the mine lease boundary extensive Quaternary alluvium deposits overlie the Boggabri Volcanic deposits to the west and south-west, and the Maules Creek Formation to the south, further south the alluvium directly overlies the Boggabri Volcanics. The surface geology is presented in Figure A-3 (refer to Appendix A).

The individual geological units relevant to this study are summarised below.

3.1.1 Quaternary alluvium

To the west and south of the mine lease the alluvial deposits are associated with the Namoi River and the lower reaches of Nagero and Bollol Creeks as shown in Figure A-3 (refer to Appendix A). Alluvial thickness along the Namoi River ranges from approximately 30 metres (m) to 120 m, decreasing from the paleochannel in the west to a thin cover in the east. The alluvial deposits comprise highly permeable sandy gravel and silty clays, and are underlain by the colluvial clays originating from the weathered Boggabri Volcanics, with varying amounts of sand and silt.

Minor alluvium is present on the south-eastern boundary of the mine lease area. Although not mapped, minor alluvial deposits associated with Nagero Creek are present in south west corner of the site (Parsons Brinckerhoff, 2009).

3.1.2 Permian Maules Creek Formation

The mining operations lie within the zone of outcrop of the Maules Creek Formation, which is of middle to late Permian age. The thickness of this formation increases from west to east (DMR, 1998) and is over 350 m thick within the area of the lease. The Maules Creek Formation comprises a number of coal seams, in ascending stratigraphic order; Merriown, Braymont, Bollol Creek and Jeralong seams. The overburden and interburden consists mainly of conglomerate, sandstone, siltstone and minor shale.

3.1.3 Permian Boggabri Volcanics

Underlying the Maules Creek Formation are the Boggabri Volcanics, which comprise basic and acidic lavas, trachytes and andesite, ignimbrites and ashflow tuffs with interbedded shale. These form the basement of the Gunnedah Basin and crop out in the south-western corner of the mine lease area. In outcrop areas, the Boggabri Volcanics is weathered to approximately 50 m in depth.

3.2 Regional hydrogeology

The aquifers in the region include an:

- alluvial aquifer; comprising alluvial deposits associated with the Namoi River and its tributaries
- Maules Creek Formation aquifer; the major transmissive units are within the coal seams, in particular the Merriown Seam
- minor colluvium associated with weathered Boggabri Volcanics

3.2.1 Alluvial aquifer

The main aquifer to the south and west of the BCM is within the Quaternary alluvium. It extends from south to north along the Namoi River and covers wide areas around Boggabri. It forms part of the Upper Namoi groundwater source. This aquifer is used extensively for irrigation, town water supply and stock and domestic purposes. The groundwater levels are typically within 10 m of ground surface and there is an established hydraulic connection with the surface water system.

Groundwater movement within the alluvium is via intergranular flow, where sandy lenses are interconnected and in hydraulic continuity with the creeks and drainage channels. The regional groundwater flow direction within the alluvium is generally to the north-northwest. South of BCM groundwater in the alluvium associated with Bollol Creek flows southwest towards the Namoi River.

The alluvial aquifer in the vicinity of the BCM is limited within thin valley infill deposits of generally low and variable permeability. The thin alluvium is associated with Nagero and Bollol Creeks, are downgradient of the mine lease. These creeks are ephemeral and flow only after high rainfall events. Groundwater in these sections of the alluvium is minor compared to the areas in the west and south.

Groundwater within the alluvial aquifer at the site has a pH close to neutral and an electrical conductivity of approximately 2,000 µS/cm, which is within irrigation guideline limits.

3.2.2 Coal seam aquifers (Maules Creek Formation)

The major transmissive units within the Maules Creek Formation are the coal seams, in particular the Merriown Seam. The coal measures have minor intergranular permeability compared to the interburden areas, which have negligible permeability. Flow within this aquifer is predominantly via fracture flow (secondary permeability). The Maules Creek Formation aquifers are confined to semi-confined bounded below by fresh volcanic bedrock and above by low permeability sandstones and conglomerates.

The vertical hydraulic properties of this aquifer restrict upward/downward leakage, both between coal seam layers and from the overlying and underlying sandstone, shale, conglomerate and siltstone.

Groundwater flow direction in the Maules Creek Formation is to the south-west consistent with the topographic gradient and groundwater levels are typically 40 – 70 metres below ground level (mbgl). The groundwater flow within the coal seams of the Maules Creek Formation is controlled primarily by lateral flow within the seams.

pH values within the Maules Creek Formation are typically neutral to slightly alkaline, with an Electrical Conductivity (EC) close to 2,000 µS/cm.

3.2.3 Colluvium aquifer

Residual volcanic soils associated with the Boggabri Volcanics (weathered profile), to the south-west of the BCM, are generally thick, however, their permeability is low. The colluvium aquifer is generally 40 m to 50 m thick and provides a hydraulic connection between the coal seam aquifers and the alluvium associated with ephemeral creeks (Nagero Creek and Bollol Creek) and Namoi River.

Groundwater levels within the colluvium aquifer are typically 10-25 mbgl. pH values within the aquifer are typically neutral to slightly alkaline, with typical EC values close to 2,000 µS/cm.

3.3 Groundwater regional baseline

A hydrocensus conducted by Parsons Brinckerhoff (2015b) surveyed private landholder bore information in the region of BCM. The bore hydrocensus encompassed the area surrounding the proposed alluvium borefield located approximately 7km west of the BCM, and private landholdings near the mine. The hydrocensus methodology (Parsons Brinckerhoff, 2015b) included a desktop information search of landholder bore or well information obtained from government sources, hydrocensus records from the adjoining Maules Creek and Tarrawonga Coal Projects, and liaison with landholders through the completion of a survey form. This was followed by a site visit to obtain information, inspect the bores and obtain groundwater data such as groundwater level and water quality samples for analysis.

The hydrocensus identified 63 registered bores and a number of unregistered bores in the study area (Parsons Brinckerhoff, 2015a). The majority of the 63 registered bores are located within the alluvial aquifer (53) on the Namoi River plain; the remaining bores (10) intersect the bedrock fractured aquifer systems on the edge of the alluvial plain or hill slopes to the south and east of BCM. Of the 48 bores that have not been abandoned or entitlements sold to BCOPL, 17 are used for crop irrigation (all from the alluvium aquifer source), 20 for stock or domestic use and 11 are of unknown usage. Groundwater levels were obtained from 21 bores/wells and water quality analysis was undertaken on 12 registered bores/wells and two unregistered bores. During the hydrocensus, Narrabri Council advised that water usage from the Boggabri town water supply bore (GW042875) which abstracts water from the alluvium aquifer located just south of the census area is approximately 0.5 ML/day (Parsons Brinckerhoff, 2015b).

Further information on groundwater levels, yields and quality from the hydrocensus is provided in the following sections.

3.3.1 Groundwater levels

Regional groundwater levels are typically 7 to 10 m below the ground surface on the alluvial plain, but can be deeper in places upslope towards the outcropping Boggabri Volcanics (11.2

m at Victoria Park test bore). Groundwater levels are shallower in the vicinity of drainage depressions and creeks, particularly during wetter months when they contain surface water.

A network of monitoring bores has been installed within the Namoi alluvium by the NSW government since the mid 1970's, providing a long record of aquifer responses to climatic conditions and pumping from landholders. The groundwater levels within these monitoring bores show a general decline of 1.5 to 2 m since the late 1970's, although groundwater levels appear to have steadied off and in some instances recovered slightly since the mid-2000's. This may coincide with the introduction of the restrictions on groundwater allocations and commencement of the Namoi Groundwater Resource WSP in 2003 (Parsons Brinckerhoff, 2015b).

Variations in the water levels occur seasonally and also across several years, possibly relating to wetter and drier periods. The water levels in the DPI Water monitoring bores also show fluctuations in groundwater level due to pumping for irrigation and water supply. Monitoring bore (GW030050), located east of Boggabri township and about 1.4km east of the town water supply bore, shows an increase in the magnitude of short term water level variations from the 1970's through to recent times which, is likely a response to increased pumping activity of nearby irrigation bores (Parsons Brinckerhoff, 2015b).

3.3.2 Groundwater yields

High yielding aquifers can be found across wide areas of the Namoi alluvial plain (DPI Water, 2010). However, the most productive aquifer is the Gunnedah formation and main palaeo channel which is generally limited to the central portions of the valley (DPI Water, 2010). The coarseness of the sediment that make up the palaeo channels allows for high groundwater extraction rates (DPI Water, 2010).

The MOD5 EA (Parsons Brinckerhoff, 2015a) identified the thickness of the alluvium aquifer in the vicinity of the groundwater production bores increases towards the centre of the Namoi Valley and this corresponds with higher sustainable yields. The Cooboobindi bore has the greatest alluvium aquifer thickness and a sustainable pumping rate (Parsons Brinckerhoff, 2015a) ranging from 7 to 7.5 ML/day. Daisymede has the lowest sustainable pumping rates (Parsons Brinckerhoff, 2015a) ranging from 0.5 to 1 ML/day as it is located closer to the margin of the alluvium aquifer and has the least available aquifer thickness.

3.3.3 Groundwater quality

Regional groundwater in the Upper Namoi Alluvium has a pH close to neutral and generally fresh to marginal shown by EC values less than 1500 µs/cm, with areas of slightly saline groundwater with EC readings of up to 7000 µs/cm (DPI Water, 2010).

3.3.4 Regional Groundwater Abstraction

The Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003 sets out the recharge, environmental water provisions, extraction requirements, share components and extraction limits for the Upper Namoi groundwater sources. The borefield is located in the Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source (hereafter Zone 4) and comprises the alluvial sediments associated with Namoi River, running roughly south east to north west from Keepit Dam to Gin's Leap (DPI Water, 2010).

At the commencement of the Namoi Water Sharing Plan (1st November 2006) groundwater entitlements in the Zone 4 were reduced from approximately 82 GL down to 25.7 GL.

Supplementary access was also provided to assist water users to progressively adjust to the reduced entitlement volumes. In 2010 (DPI Water, 2010) there were approximately 281 production bores in Zone 4. Yearly usage from 1997-1998 to 2010-2011 averaged over this period is 27,516 ML and average usage since commencement (2006) of the Plan is 21,918 ML (DPI Water, 2010).

3.4 Borefield Operation

Groundwater bores (Daisymede and Lovton) were nominated in the EA (Hansen Bailey, 2010) to supply groundwater water for dust suppression to BCM. BCOPL currently abstracts approximately 300ML's from the 'Daisymede' production bore and approximately 24ML's from the Lovton bore per 12 month period.

The Project Approval (MOD 5) permits an increase in groundwater abstraction for consumption at BCM via operation of an expanded groundwater production borefield. This borefield will include the existing Daisymede and Lovton production bores and two new production (Cooboobindi and Victoria Park) located on adjacent agricultural properties owned by BCOPL and have the capacity to abstract groundwater at the average daily rates shown in Table 3.1. The borefield has the capacity to supply up to 2104.59 ML per year of groundwater during average weather conditions and 3455.09 ML per year of groundwater during dry weather conditions to BCM.

These abstraction rates and the rates presented in Table **3.1** for production bores operated by BCOPL are indicative only. Boggabri Coal will only extract water from bores that have been subject to water dealing determinations. Boggabri Coal will abide by the extraction limits included in any water dealing determination and this plan modified to include those limits following receipt of the determination.

The approximate locations of the groundwater production bores are shown in Figure A-3 (refer to Appendix A).

Table 3.1 Abstraction rates for groundwater production bores

Bore	Abstraction Rate – average weather conditions (ML/day)	Abstraction Rate – dry weather conditions (ML/day)
Daisymede	0.8	0.9
Cooboobindi	3.0	5.5
Victoria Park	1.9	3.0
Lovton	0.066	0.066
Total	**5.766**	**9.466**

Victoria Park production bore is to be relocated so that it is compliant with the property boundary proximity restrictions required by the Namoi Groundwater WSP (NSW Government, 2003). The nominal maximum dry weather abstraction rate as modelled in the EA MOD 5 (Parsons Brinckerhoff, 2015a) is 3.0 ML/day. BCOPL will undertake a pump test to confirm the sustainable achievable pump rate of the relocated bore and if substantially different, incorporate this rate in a revision of the GWMP (refer to Section 7.2).

The potential drawdown impacts noted in the modelling assessment completed by Parsons Brinckerhoff (2015a) for the operation of the borefield, concluded that for average weather conditions the number of active landholder bores at which more than 2m drawdown is predicted, would be limited to 2 bores (on the Cooboobindi and Roma properties) within 1km of the operating production bores (Cooboobindi and Victoria Park). During an extended dry period, up to approximately 9.4 ML/day may be required from the borefield (assuming that no water would be available from surface water sources). Under this scenario drawdown would be likely to exceed 2m at six active (or presumed active) landowner bores, and is predicted to extend to over 2km from the above production bores (Cooboobindi and Victoria Park).

Where impacts to landholder water supply are reported to BCOPL as having been caused by the operation of the borefield, BCOPL will undertake the management measures described in Section 6.2.

Modelling of potential drawdown impacts on the Namoi River from the operation of the borefield during average and dry weather periods predicted an estimated loss of baseflow to the river of between approximately 975 ML/yr to 1133 ML/yr (Parsons Brinckerhoff, 2015a). This is based on the assumption that the river is hydraulically well-connected to the aquifer. During average weather conditions the loss of river flow occuring as a result of the borefield equates to less than 0.2% of the average annual flow in the Namoi River and less than 0.9% of the average annual flow in the Namoi River under a dry weather scenario (10^{th} percentile).

The potential for loss of baseflow in the Namoi River alluvium, from the drawdown effects of operating the borefield will be monitored by installing an additional monitoring bore (refer to Figure A-3, Appendix A) and assessing the monitoring results as described in Section 4.1.4.2.

3.5 BCM Groundwater Data

3.5.1 Groundwater levels

Groundwater levels in key monitoring bores within and surrounding the BCM have been measured since 2005. Groundwater levels for monitoring data collected between 2005 and 2015 are presented in Figures 3-1 and 3-2.

The hydrographs show an overall decrease in groundwater levels in all of the monitoring bores intersecting the Maules Creek Formation. This decline does not correlate with rainfall patterns over this period, and is therefore attributed to mine dewatering operations. The bores in closest proximity to the pit show the largest decline in groundwater levels (IBC2138, IBC2114 and IBC2115), with the magnitude of decline decreasing with distance from the pit.

Monitoring bores BC2181, IBC2104 and IBC2105 in the Maules Creek Formation, lie to the north of the pit (upgradient) and show a limited decrease in groundwater levels of approximately 1 m per year or less as shown in Figure 3-1.

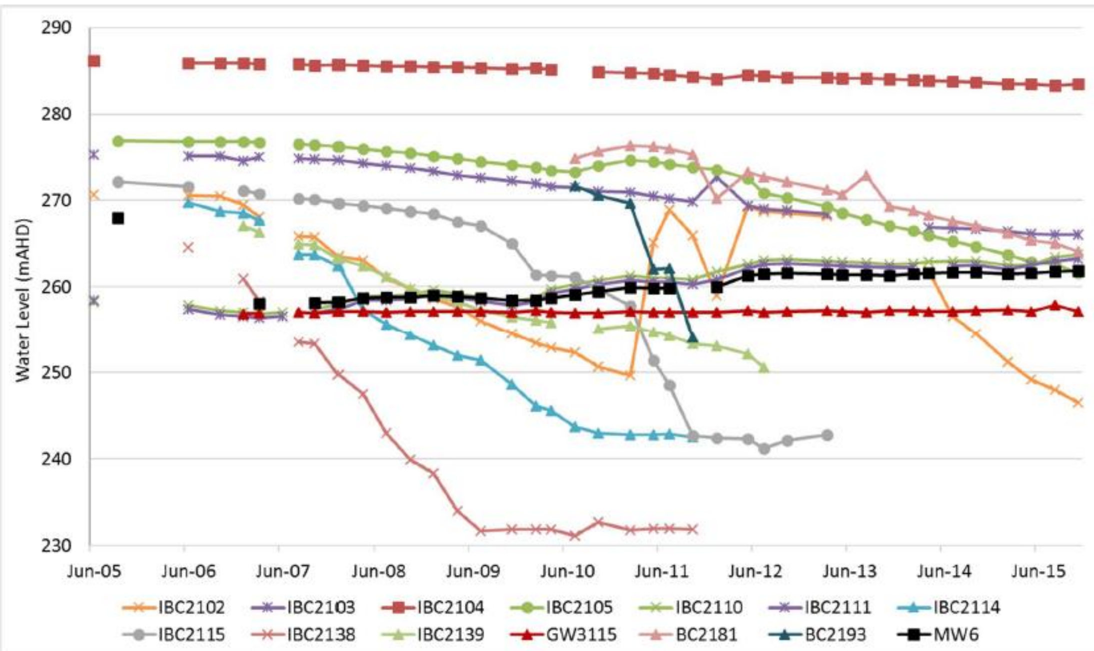

Figure 3-1 All groundwater levels at BCM groundwater monitoring bores

The monitoring bores downgradient of the mine site as shown in Figure 3-2 installed in the Boggabri Volcanics (IBC2110, IBC2111 & GW3115) and alluvial aquifer (MW6) do not appear to have been impacted by mining activities. Groundwater levels show a direct correlation with Cumulative Deviation of Mean Rainfall (CDFR), including a slight increase corresponding to higher than average rainfall from 2010 onwards. There appears to be no overall downward trend in water levels, as would be expected in bores affected by mine dewatering.

Observed groundwater levels have been compared with predictions developed by the hydrogeological model developed by AGE (2010). Observed levels generally fall within the model prediction for monitoring locations in the Maules Creek Formation, however the hydrogeological model tends to over predict impacts on the Boggabri Volcanics and the alluvium south-west of the mine.

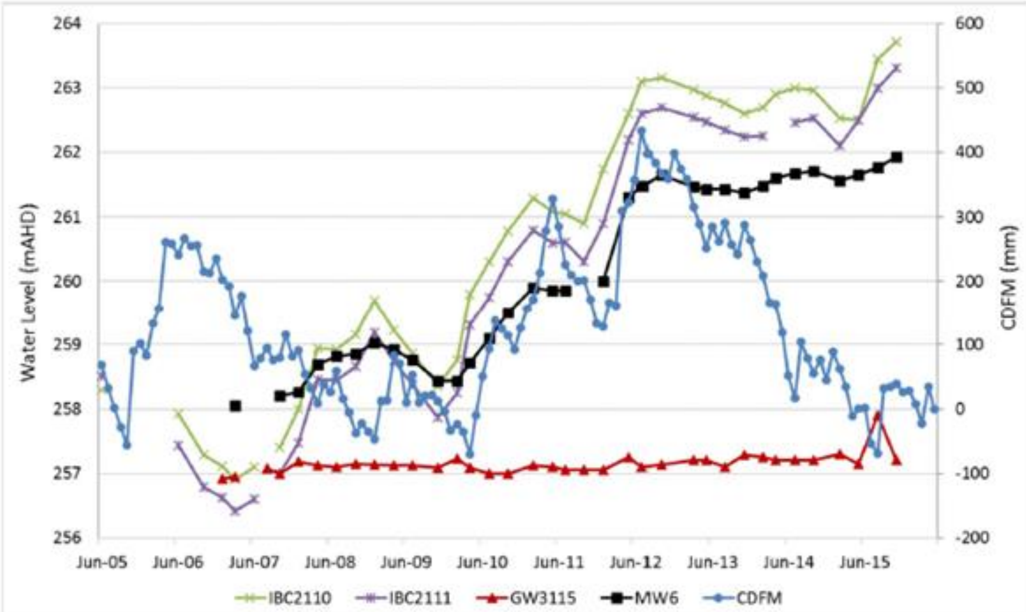

Figure 3-2 Groundwater levels in groundwater monitoring bores down gradient of BCM

3.5.2 Groundwater quality

The Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources states that the beneficial uses of the groundwater sources relevant to the BCM are raw water for drinking and agricultural use.

Land use overlying the Upper Namoi groundwater management area is dominated by sheep and cattle grazing. Wheat, cotton and other broad acre crops are grown along the alluvial floodplains (Green et al, 2011). The irrigated cropping areas are primarily used for cotton production (Green et al, 2011). Groundwater quality data collected from the monitoring bores has been subject to assessment against the ANZECC (2000) guidelines for stock and irrigation and Australian Drinking Water Guidelines (NHMRC, NRMMC, 2011) (presented in Table 3.2) and reported in the Annual Environmental Management Report. A summary of annual ground water monitoring assessments appears in sections 3.5.2.1 to 3.5.2.4 below.

Table 3.2 Groundwater assessment criteria

Parameter	Units	Upper limit for irrigation	Upper limit for livestock [b]	Upper limit for drinking water
EC	µS/cm	6,000-7,700 [a]	-	1,800[e]
pH	pH units	6-8.5	-	6.5-8.5[e]
TDS	mg/L	4,020-5,160 [c]	3,000-13,000	1,200[e]
Sodium	mg/L	460	-	180[e]
Potassium	mg/L	-	-	-
Calcium	mg/L	-	1,000	-
Magnesium	mg/L	-	600	-
Chloride	mg/L	700	-	250[e]

Parameter	Units	Upper limit for irrigation	Upper limit for livestock [b]	Upper limit for drinking water
Bicarbonate	mg/L	-	-	-
Sulphate	mg/L	-	1,000	250[e]/500[f]
Arsenic	mg/L	0.1 [d]	0.5	0.01[f]
Cadmium	mg/L	0.01 [d]	0.01	0.002[f]
Chromium	mg/L	0.1 [d]	1	0.05[f]
Copper	mg/L	0.2 [d]	0.4	1[e]/2[f]
Iron	mg/L	0.2 [d]	-	0.3[e]
Manganese	mg/L	0.2 [d]	-	0.1[e]/0.5[f]
Nickel	mg/L	0.2 [d]	1	0.02[f]
Lead	mg/L	2 [d]	0.1	0.01[f]
Zinc	mg/L	2 [d]	20	3[e]
Nitrogen	mg/L	5 [d]	-	-
Nitrate as N	mg/L	-	90	11[f]
Nitrite as N	mg/L	-	9	0.9[f]
Phosphorus	mg/L	0.05 [d]	-	-

Notes:
a: ANZECC (2000) - maximum trigger level for wheat and cotton
b: ANZECC (2000) - recommended trigger levels (low risk) for livestock drinking water
c: ANZECC (2000) - TDS value based on EC values for wheat and cotton (1 µS/cm = 0.67 mg/L)
d: ANZECC (2000) – Agricultural irrigation water long-term trigger values for heavy metals and metalloids, nitrogen and phosphorus
e: (NHMRC, NRMMC, 2011) – aesthetic criterion
f: (NHMRC, NRMMC, 2011) – health-based criterion

3.5.2.1 Field parameters

Groundwater quality sampling has been carried out since 2006. Groundwater monitoring trends for pH, electrical conductivity (EC) and temperature collected between 2006 and 2015 are presented in Figure 3-3, Figure 3-4 and Figure 3-5.

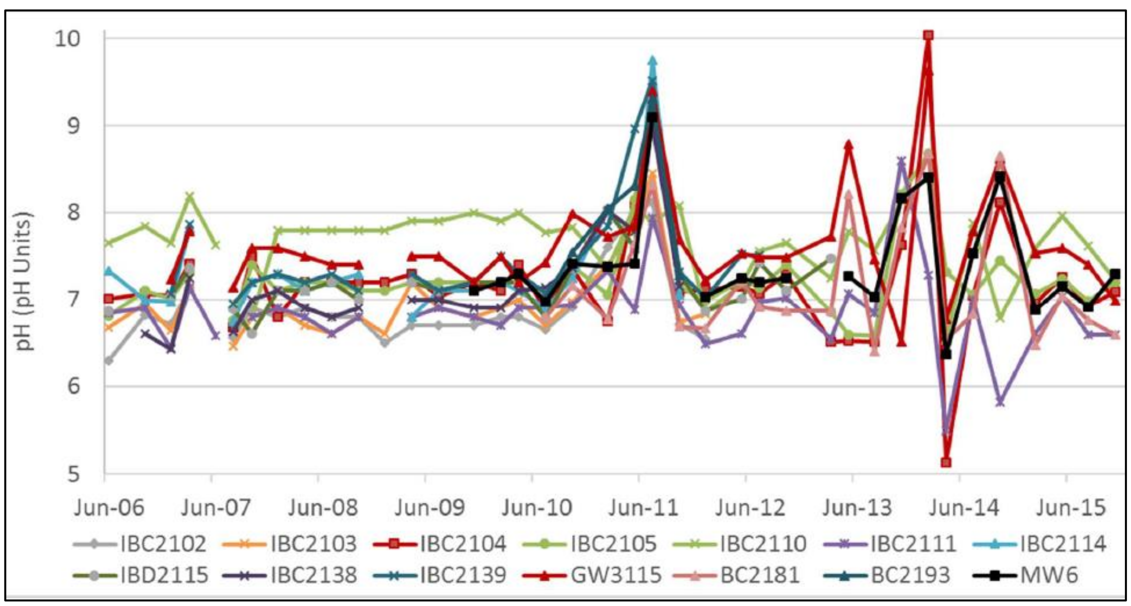

Figure 3-3 Groundwater quality trends –pH

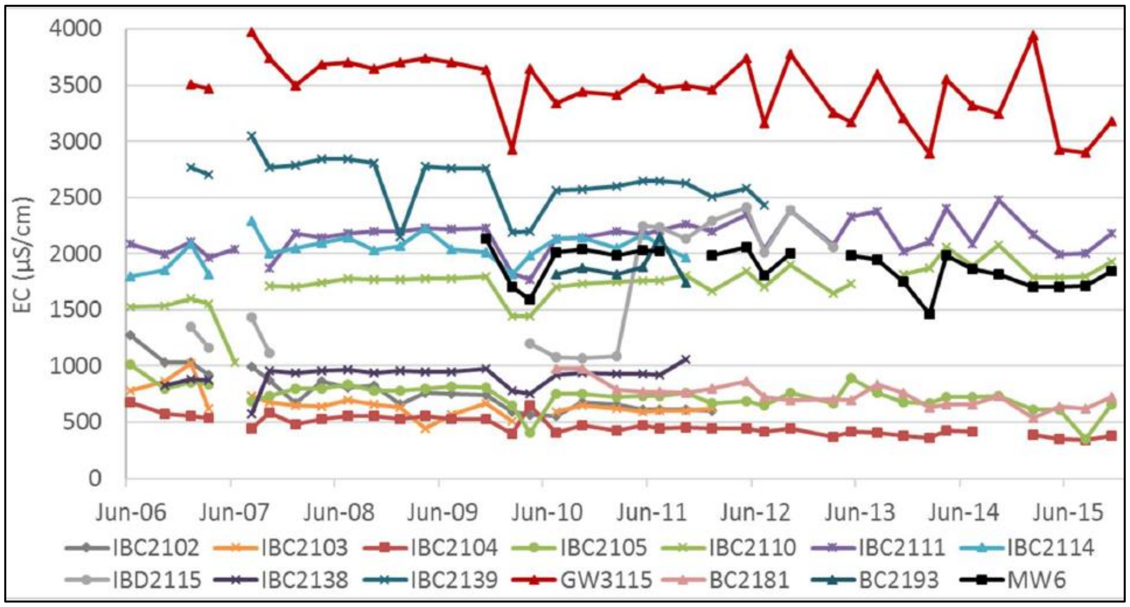

Figure 3-4 **Groundwater quality trends – EC**

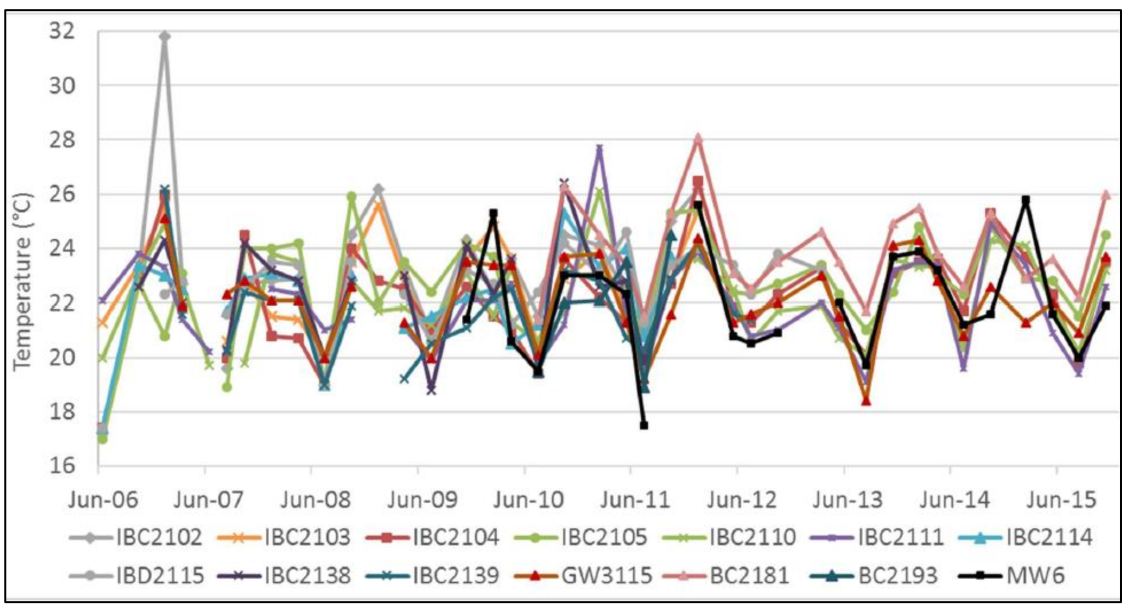

Figure 3-5 **Groundwater quality trends – temperature**

EC and pH values have consistently been recorded as either below or within the assessment criteria, with the exception of one monitoring event during 2011 and two in 2014.

The pH of groundwater in the alluvium ranges is generally neutral and typically within the ANZECC (2000) guideline limits for irrigation. Within the Boggabri Volcanics the pH range is generally neutral to alkaline and typically within ANZECC (2000) guideline limits for irrigation, with the exception of GW3115, which recorded a pH value outside guideline limits once in 2014. Within the Maules Creek Formation pH values are generally neutral to slightly alkaline and typically within ANZECC (2000) irrigation guideline limits, with the exception of one monitoring event in 2011 (IBC2114 and IBC2139), and two monitoring events during 2014 (IBC2104). These events are not considered to be representative of average groundwater conditions, as subsequent monitoring has consistently recorded a near neutral pH.

The highest EC values (2930-3970 µS/cm) have been measured at monitoring bore GW3115 (Boggabri Volcanics), located approximately 2.5 km west of mine workings. EC values at GW3115 are within ANZECC guidelines for irrigation use (tolerant crops) and have remained consistent since monitoring commenced. EC values in the alluvium range from 1450 to 2150 µS/cm, and EC in the Maules Creek Formation ranges from 300 to 3050 µS/cm.

3.5.2.2 Major ions

Groundwater in the alluvium is dominated by sodium, bicarbonate and chloride ions. There have been no significant long term trends identified for the major ions at MW6. Aesthetic criterion has previously been above for chloride and sodium ions (NHMRC, NRMMC, 2011), but has remained below the upper limit for irrigation.

The dominant water type for the coal seams of the Maules Creek Formation is sodium and bicarbonate and to a lesser extent calcium, magnesium and chloride. Sodium levels at monitoring bore IBC2139 have consistently been above the irrigation guideline upper limit of 460 mg/L (ANZECC, 2000). Historically, four of the eleven Maules Creek Formation monitoring bores have detected sodium levels consistently greater than the aesthetic criterion of 250 mg/L (NHMRC, NRMMC, 2011).

- The dominant water types for the Boggabri Volcanics are sodium, bicarbonate and chloride, with IBC2111 showing relatively high calcium concentrations. Sodium concentrations have consistently been above the aesthetic criterion of 180 mg/L (NHMRC, NRMMC, 2011) for the aquifer but only GW3115 has consistently recorded sodium concentrations higher than the upper guideline limit for irrigation (ANZECC, 2000). Recent major ions results above (ANZECC 2000) ground water assessment criteria noted in Table 3.2. Bicarbonate at GW3115 in February and August 2015;

- Chloride at GW3115 in February and August 2015; and IBC2110 and IBC2111 in January 2015; and

- Sodium at GW3115 in February and August 2015.

All results have been below the health based criterion for Sulphate as SO_4^{2-} (500 mg/L, NHMRC, NRMMC, 2011). IBC2115 has been the only monitoring bore that levels have been above the Table 3.2 value of the aesthetic criterion for Sulphate as SO_4^{2-} (250 mg/L, NHMRC, NRMMC, 2011).

3.5.2.3 Metals

Dissolved metal concentrations have historically been below the nominated ANZECC (2000) guidelines for all metals in MW6. They have also been below NHMRC & NRMMC (2011) health based criterion limits for the Maules Creek Formation monitoring bores, with the exception of two instances whereby spikes of arsenic and lead were recorded (although levels remained below the ANZECC (2000) guidelines for livestock. Iron levels have been recorded above the ANZECC (2000) guideline concentrations (<0.2 mg/L) for long-term irrigation for IBC2102, IBC2103, IBC2105, IBC2110, IBC2114, INC2115, IBC2138 and BC2181. Elevated iron concentrations are typical for the Boggabri area.

Dissolved metal concentrations have been below NHMRC & NRMMC (2011) criterion limits for all metals for the Boggabri Volcanics monitoring bores, with the exception of a single instance of manganese which, was above the aesthetic criterion (as well as irrigation criteria, ANZECC (2000). Iron levels have been recorded above the ANZECC (2000) guideline concentrations (<0.2 mg/L) for long-term irrigation at IBC2110, IBC2111 and GW3115. Iron concentrations have been highest in monitoring bore GW3115 (5.44 mg/l). GW3115 is significantly older than the other monitoring bores at the site and the high iron content may be due to the presence of rusting steel casing. Iron concentrations have been below ANZECC (2000) guideline values at IBC2111 since June 2006.

3.5.2.4 Nutrients

Ammonia exceeded the trigger value (as nominated in Rev5 of the GWMP) at alluvial bore MW6 during the August 2015 monitoring event. The trigger values for MW6 are based on a very limited historical dataset and therefore the concentrations reported in August 2015 may be attributable to natural variation.

No other monitoring bores have recorded nitrogen, nitrate or nitrite values over the nominated NHMRC & NRMMC (2011) guideline limits. Increasing trends for nitrate were recorded at monitoring bore IBC2111 (Boggabri Volcanics), but concentrations are still below the guidelines for health-based criteria (NHMRC, NRMMC, 2011). Increasing trends for ammonia were recorded at monitoring bores IBC2110 (Boggabri Volcanics) and IBC2103 and IBC2139 (Maules Creek Formation).

Monitoring bores MW6 (Alluvial), IBC2102, IBC2103, IBC2104, IBC2105, IBC2114, IBC2138, IBC2139, BC2193 (Maules Creek Formation), and IBC2110 and IBC2111 (Boggabri Volcanics) have been above the ANZECC (2000) guideline for total phosphorus (0.05 mg/l) in at least one sampling event.

3.5.3 Survey and assessment of impacts on groundwater dependent ecosystems

Condition 17 of the EPBC Approval refers to the identification of the depth of the root zone of native vegetation. Significant stands of groundwater dependent vegetation in the area are unlikely as water tables in the Namoi Valley are typically deeper than 2m and consequently direct groundwater evapotranspiration is not a significant part of the water balance (CSIRO, 2007).

A desktop review of the depth of root zone of native vegetation proximal to the BTM complex noted the majority of vegetation communities occur on slopes and ridges. The vegetation is associated with well drained soils characterised by shallow skeletal conglomerate on the steeper upper slopes and drainage lines, and deep basaltic derived fertile soils on the lower slopes. Such vegetation is disconnected from localised groundwater systems. Roots are unable to grow far into soil horizons that are of high bulk density (i.e. excessively stony soils). Consequently, rooting depth in areas of shallow bedrock is limited. Groundwater is not within the root zone of these vegetation types given their location in the landscape, and as such they are not groundwater dependent. These vegetation types, which include vegetation that occurs adjacent to ephemeral streams, rely on rainfall to support growth and photosynthesis.

Riparian forests such as the River Red Gum open forest on the banks of the Namoi River are considered to be stream fed ecosystems which rely upon lateral movement of surface water and some contribution from shallow groundwater. The loose, deep, well-drained alluvial soils with large pore spaces promote greater root depths as they are well aerated and provide less resistance to root penetration (rooting is not limited by underlying rock). Ironbark and Box eucalypts, such as those that dominate the lower slopes of the study area, are shallow rooted and allocate substantial biomass to above-ground parts at the expense of an expansive root system (Fensham & Fairfax, 2007). They are unlikely, therefore to be groundwater dependent.

While loamy soils allow considerable root development, the remnant vegetation communities (Pilliga Box – Popular Box – White Cypress Pine Grassy Open Woodland and Plains Grassland) that are restricted to the lower lying plain areas with these soils are generally associated with shallow perched water tables over impermeable clay lenses rather than groundwater fed by subsurface aquifers. This vegetation is likely to send roots to the perched water table but not through the impermeable clay lens. This also applies to Derived Native Grassland and Exotic Grassland vegetation types. Broad ecosystem scale studies have shown that sclerophyllous shrubland and forest (such as that in the study area) have a mean rooting depth of 5.2 ± 0.8 m (Canadell et al. 1996). Average rooting depth for temperate grassland has been shown to be 2.6 ± 0.2 m (Canadell et al. 1996).The creeks in the vicinity of the Boggabri Mine are ephemeral and not expected to support groundwater dependent ecosystems (GDEs).

The potential for impacts from operating the borefield on GDE's were assessed by PB (2016). The assessment (PB 2016) included aligning vegetation communities to GDE types, hydrological modelling, detailed analysis of groundwater depths based on existing boreholes, potential draw down assessments and field verification. In summary, the assessment concluded, no Endangered or Critically Endangered Ecological Communities (as listed under the EPBC Act) are considered to have groundwater dependency or be associated with a GDE within the study area (MOD5) and as such will not be impacted by groundwater extraction. Subsequently, a referral to the DoEE for potential impacts of MOD5 on biodiversity MNES is therefore not required.

Monitoring of the potential for impacts to GDE's from operating the borefield is outlined in section 4.1.8. If monitoring identifies potential poor vegetation health associated with the groundwater abstraction, these impacts will be assessed as outlined in section 6.4.

4. Groundwater Monitoring Program

The groundwater monitoring program has been designed to incorporate the available monitoring data and as the monitoring program continues it will assess the interconnectivity between the alluvial and bedrock aquifers, changes in natural variations in the groundwater system and how the system responds to anthropogenic influences, including mining operations and groundwater abstraction by irrigators.

4.1.1 Groundwater Monitoring Mining Area

Monitoring of groundwater levels and quality will be undertaken for the bores in proximity to the mining area (refer to Tables 4.1) to assess the effect BCM has on groundwater. Seven existing monitoring bores are screened across different geological units, including the Maules Creek Formation aquifer, the colluvial aquifer and the alluvial aquifer. A number of bores monitoring the Maules Creek Formation (IBC2102, IBC2103, IBC2115, IBC2114, IBC2138 & IBC2139) in proximity to BCM have been decommissioned due to the progression of mining.

The coordinates, screened geology, monitoring frequency and parameters for each of the mining area monitoring bores are set out in Tables 4.1 and 4.3. The locations of the existing monitoring bores for the mining area are shown in Figure A–3 (refer to Appendix A). The BTM Complex WMS should be referred to for further information as this includes a network of regional groundwater monitoring bores that monitor groundwater conditions for cumulative impacts from the mines within the BTM Complex (BCM, Tarrawonga Mine and Maules Creek Coal Mine).

4.1.2 Groundwater Monitoring Borefield

BCOPL will operate two new groundwater production bores (Cooboobindi and Victoria Park) and two existing production bores (Daisymede and Lovton) to supply water to BCM as discussed in Section 3.4. The groundwater model included in the EA (Parsons Brinckerhoff, 2015a) predicted the abstraction of groundwater from these bores may cause a drawdown of alluvium groundwater levels. The production bores and the groundwater monitoring bores will be monitored for the groundwater level and quality parameters outlined in Tables 4.2 and 4.3. The location of these bores is shown in Figure A–3 (refer to Appendix A).

The monitoring data will be analysed (refer to Section 5.2) to identify the potential for drawdown impacts on alluvium groundwater levels and registered groundwater bores from operating the borefield.

Where BCOPL has an access agreement with a private landowner for the purpose of conducting groundwater monitoring, the registered bore(s) on the property will be monitored biannually, for the parameters outlined in Table 4.3 where practicable.

Where a landowner reports impacts to their registered private bore from the operation of the borefield, BCOPL will undertake the investigation as outlined in Section 6.2.

4.1.3 Groundwater Sampling Methods

All water quality monitoring will be undertaken in line with AS/NZS 5667.1:1998 *Water quality- sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (Standards Australia, 1998). When obtaining a sample for water quality analysis monitoring, bores are purged prior to sampling of at least three bore volumes, or until stabilisation of field parameters, primarily pH and electrical conductivity, is reached. Laboratory analysis of water quality samples is carried out by NATA accredited environmental laboratories. Results are analysed and reported each year in an Annual Review as discussed in Section 7.1.

The groundwater monitoring parameters are detailed in Tables 4.1, 4.2 and 4.3

Table 4.1 Details of mining area monitoring bores (note all bores are open standpipe)

Bore	License	Easting	Northing	Depth (mBGL)	Screen Interval	Screened geology	Relative location	Frequency	Parameters
Mining Area Groundwater Monitoring									
IBC2104	**90BL253835**	228336	6612213	90	80-84	Braymont Coal Seam	Upgradient	Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
IBC2105	**90BL253844**	228325	6612215	160	151-157	Merriown Coal Seam	Upgradient	Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
IBC2110	**90BL253841**	225935	6607685	100	91-97	Boggabri Volcanics	Downgradient	Daily	Water levels automated logger
								Quarterly	Field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
IBC2111	**90BL253840**	225948	6607685	45	36-42	Boggabri Volcanics (weathered)	Downgradient	Daily	Water levels automated logger
								Quarterly	Field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
GW3115	**90BL253832**	224649	6608990	83	-	Boggabri Volcanics (weathered)	Downgradient	Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
MW6	**90BL254255**	225466	6608059	32	18-22	Alluvium	Downgradient	Daily	Water levels automated logger
								Quarterly	Field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
BC2181 (MW4)	**90BL255764**	226848	6612477	114	105-111	Merriown Coal Seam	Upgradient	Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity

Table 4.2 Details of borefield monitoring bores (note all bores are open standpipe)

Bore	License	Easting	Northing	Depth (mBGL)	Screen Interval	Screened geology	Relative location	Frequency	Parameters
Borefield Groundwater Monitoring									
Victoria Park Production Bore (PB)*	**90BL256305**	221961	6605011	60	34-37 50-57	Alluvium Alluvium	Victoria Park Property	Daily	Water volumes (during abstraction - ML or m^3)
								Quarterly	Field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
Victoria Park Monitoring Bore (MB)	**90BL256311**	221966	6604988	60	34-37 50-57	Alluvium Alluvium	Adjacent Victoria Park PB	Daily	Water levels (automated water level logger)
								Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
Cooboobindi PB	**90CA807015**	217917	6606240	89	18-31 34-45 48-64 66-76 78-89	Alluvium	Cooboobindi Property	Daily	Water volumes (during abstraction -ML or m^3)
								Quarterly	Field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
Cooboobindi MB	**90BL256299**	217939	6606232	89	23-89	Alluvium	Adjacent Cooboobindi PB	Daily	Water levels (automated water level logger)
								Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
Daisymede PB	**90CA807034**	217880	6607431	22	15-22	Alluvium	Daisymede Property	Daily	Water volumes (during abstraction -ML or m^3)
								Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
Belleview 3 MB	**90CA807034**	218887	6607064	42	24-30	Alluvium	Near Daisymede PB	Daily	Water levels (automated water level logger)
								Quarterly	Water levels, field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity
Lovton PB	**90WA822528**	226529	6608264	Historical bore, info not available	Historical bore, info not available	Merriown Coal Measures	MIA	Weekly	Water levels, water volumes (during abstraction - ML or m3)
								Quarterly	Field parameters
								Half yearly	Major ions, dissolved metals, nutrients, alkalinity

*Victoria Park Production Bore will be relocated outside of the property boundary proximity limits specified in the Namoi Water Sharing Plan. The new bore will target the same depth, screen interval and will be monitored as nominated in the Table 4.1. Details of the relocated bore will be provided in a revision of the GWMP.

Table 4.3 Monitoring parameters

Groundwater Monitoring	Parameters
Field parameters	pH, electrical conductivity, temperature,
Major ions	Sulphate as SO_4^{2-}, chloride, calcium, magnesium, sodium, potassium
Dissolved metals	Arsenic, cadmium, chromium, copper, lead, manganese, nickel, zinc, iron
Nutrients	Ammonia as N, nitrite as N, nitrate as N, nitrite + nitrate as N, total nitrogen as N, total phosphorus as P, reactive phosphorus as P
Alkalinity	Hydroxide alkalinity as $CaCO_3$, carbonate alkalinity as $CaCO_3$, bicarbonate alkalinity as $CaCO_3$, total alkalinity as $CaCO_3$

4.1.4 Proposed Groundwater Monitoring Bores

4.1.4.1 Proposed Monitoring Bores - Mining Area

An additional 11 monitoring bores (MB1 to MB11) were recommended by Australian Groundwater and Environment Consultants (AGE) (2010) as part of the EA process. The purpose of the additional monitoring bores was to fill gaps in the network by monitoring for depressurisation of the coal measures strata and drawdown in the alluvial aquifer on an ongoing basis (AGE, 2010), and to assess hydraulic connectivity between the Permian strata and the overlying alluvial sediments. Since 2010 a number of the recommended bores have been installed for the BTM Complex and BCM monitoring bore networks - namely Reg 5, Reg 7, MB4 and MB6.

MB4 and MB6 were subsequently decommissioned due to damage caused by the progression of mining.

A review by AGE, conducted in 2016, of the network surrounding the BTM complex concluded that sufficient alternative bores have been installed around the mines and many of the proposed MB bores are no longer required. The review showed that:

- To the north and south of the BCM the monitoring bore and VWP networks for the Maules Creek and Tarrawonga mines are sufficient to pick up any depressurisation effects generated by BCM.
- To the west of the BCM monitoring bores Reg 5 / Reg 5A have been installed close to the proposed MB11 site. The Reg 5 bores are a suitable substitute for the proposed MB11 bore. Additional Reg bores installed as part of the broader BTM Complex WMS will monitor for peripheral propagation of depressurisation effects through the volcanic bedrock towards the Namoi River alluvium.
- To the north-east and east of the BCM the Reg 8 and Reg 9 VWPs have been installed to monitor for pressure changes in the coal seams. The Reg 8 and Reg 9 sites are approximately 3.5 km and 5.5 km respectively from the BCM. It would be beneficial if two of the proposed MB sites closer to the mining area (MB9 and MB5) were installed to identify any changes occurring closer to the mine.

Review of the proposed monitoring bores recommended that the following monitoring bores should be installed:

- MB9 site – two bores, one installed as a shallow alluvial /weathered zone monitoring bore for water level and water quality, and an accompanying multi-level VWP string with the lowest sensor at the Merriown seam, to identify depressurisation effects in the underlying coal seams.

- MB5 site – one bore completed with multi-level VWP sensors down to the Merriown seam to identify depressurisation effects in the underlying coal seams. The bore location has been moved slightly to the east to a more accessible drilling location along the existing forest track.

The indicative locations, targeted geology and monitoring parameters of the proposed monitoring bores are described in Table 4.4 and the indicative site locations shown in Figure A-3. The VWPs sensors will be located adjacent to target aquifers/aquitards where appropriate, with groundwater pressures and water levels logged daily. Logging at this frequency will allow rainfall recharge and pumping to be distinguished from potential water level declines due to depressurisation as a result of mine operations (AGE, 2010). It will also allow the calibration of the model to be improved over time and the connectivity between the alluvium and coal measures to be directly recorded.

Table 4.4 Proposed additional mining area monitoring bores

<table>
<tr><th>Bore</th><th>Easting *</th><th>Northing*</th><th>Target geology</th><th colspan="2">Monitoring regime</th></tr>
<tr><td>MB5</td><td>231125</td><td>6612876</td><td>Merriown Seam and overlying aquifer(s)</td><td>Daily</td><td>Water levels (VWP)</td></tr>
<tr><td rowspan="2">MB9 (VWP) and MB9A (MB)</td><td rowspan="2">231468</td><td rowspan="2">6608167</td><td rowspan="2">shallow alluvial /weathered zone (MP9A) & Merriown Seam and overlying aquifer(s) (MP9)</td><td>Daily</td><td>MB9 - Water levels (VWP)</td></tr>
<tr><td>Six monthly</td><td>MB9A (MB)- Major ions, dissolved metals, nutrients, alkalinity (refer to Table 4.3)</td></tr>
</table>

*Coordinates are indicative and may be subject to change dependent on final site access arrangements

4.1.4.2 Proposed Monitoring Bores – Borefield

To monitor the potential for loss of baseflow in the Namoi River alluvium, as a result of operating the borefield, an additional groundwater monitoring bore will be installed between the Cooboobindi production bore and the Namoi River on land owned by BCOPL. The indicative location of the monitoring bore is shown in Figure A-3 (refer to Appendix A). The monitoring bore will target the alluvium aquifer to monitor for changes in alluvium groundwater water levels. A water level logger will be installed to record groundwater levels (at least daily) to distinguish between rainfall recharge and groundwater pumping. Monitoring will also include quarterly recording of the field parameters and a biannual sample of the water quality parameters listed in Table 4.3 to test for changes in the water quality.

The results will be used to assess the loss of baseflow in Namoi River and compare the assessed level of baseflow loss against the predicted levels in the EA MOD 5 (Parsons Brinkerhoff, 2015a). Further information on the assessment is described in Section 5.2.

4.1.4.3 Proposed Monitoring Bores - Mine Voids and Contaminated Water Dams

The shallow water table bores are installed at the locations shown in Figure A-3 to monitor for the potential for seepage to occur immediately down gradient of contaminated water storage dam(s). The bores are monitored quarterly to determine the occurrence of seepage by recording water levels. If monitoring indicates that seepage is occurring (i.e. water is detected), the parameters noted in table 4.3 will be sampled quarterly.

In 2017 a review will be conducted to determine the adequacy of existing shallow monitoring bore network including whether any additional shallow monitoring bores are required immediately down gradient of mine backfill or voids and contaminated water dam(s) to identify the occurrence of seepage into the local groundwater system. The shallow monitoring bores will aim to target relatively higher transmissive zones surrounding the dams and mine voids. Once installed, these monitoring bores will be added to the existing monitoring network.

Information on the installation of new shallow water table monitoring bores and an assessment of the monitoring results will be presented in the Annual Review (refer to Section 7.1). The GWMP will be revised as per the requirements of the Project Approval (refer to Section 7.2) to incorporate any new monitoring bores.

4.1.5 Mine groundwater Seepage

Monitoring of seepage inflows to the pit will be undertaken to estimate the groundwater inflows to the open cut mining operations. The monitoring will include:

- Monthly recording of water pumped from the pit using flow meters to estimatgroundwater seepage.
- Annual monitoring of water quality from pit water for the same analytical suite outlined in Table 4.3.

4.1.6 Core testing

Opportunistic testing of drill core will be carried out on unfractured samples of interburden (Maules Creek Formation) to quantify characteristic hydraulic conductivity, porous groundwater flow and storage parameters representative of the interburden intersected at BCM. BCOPL will use representative core samples to assess the distribution and variability of porous groundwater flow and storage contributions.

X-ray diffraction (XRD) and X-ray fluorescence (XRF) analysis will also be carried out on core samples, to assess the mineralogy of the interburden which may be exposed to re-saturation within the pit.

4.1.7 Hydrochemical modelling

Hydrochemical modelling will be conducted to assess the likely long term water quality in the void. Full saturation batch reaction trials on waste interburden will be conducted to confirm the likely hydrochemical modelling outcomes.

Results from the modelling will be considered in the development of the Final Void and Mine Closure Plan to be developed in accordance Condition 72, Schedule 3 of the Project Approval by the end of December 2025.

4.1.8 Monitoring Groundwater Dependent Ecosystems

To assess the impacts of the borefield on the native vegetation, monitoring of health and composition of the terrestrial vegetation, which will include biannual vegetation monitoring within the locality of MOD5 and proposed draw down impacts will be conducted to identify potential poor vegetation health associated with the groundwater extraction. If impacts are identified they will be assessed against water levels in groundwater monitoring bores and climatic conditions to identify any potential correlation between vegetation health and groundwater extraction. The result of the monitoring will be report in the Annual Review (refer to section 7.1). The management responses for GDEs are described in section 6.4.

5. Groundwater Trigger Values

5.1 Mining Area Groundwater Trigger levels

5.1.1 Groundwater quality

The Namoi Groundwater WSP (DPI, 2006) states that the beneficial uses of the groundwater sources relevant to the BCM are raw water for drinking and agricultural use. Where pre-development or current groundwater quality is insufficient to meet raw water for drinking standards, the identified beneficial use will be for agricultural purposes.

Beneficial uses for the porous rock aquifers are not specified in the Murray Darling Basin Porous Rock (Gunnedah-Oxley Basin) WSP. The report card in support of the development of the WSP identified the water quality as being 'generally poor'. It is likely, given the high salinity of the water, that the beneficial use is 'stock watering'.

BCOPL will use the monitoring results from the bores in proximity to the mining area (refer to Table 4.1) to assess the potential for impacts to groundwater from BCM using the control chart method. The groundwater quality data collected to date has been reviewed and used to develop revised site trigger values for groundwater quality as shown in refer Table 5.1.

The control chart method uses horizontal lines running parallel to the horizontal to show when the groundwater trigger levels are above statistically significant levels as shown in the non-related example in Figure 5-1. The method is described by Queensland Department of Environment and Heritage Protection (2012) and recommended as a method for monitoring for groundwater contamination. Trigger events occur when:

- one data point is greater than the mean + 3 x standard deviation (Upper trigger value - UTV);
- two consecutive data points are greater than the mean + 2 x standard deviation (Middle trigger value - MTV); and
- or five successive data points are greater than the mean + 1 x standard deviation (Lower trigger value - LTV).

As is the case with BCM the groundwater quality data dataset is skewed and the standard deviation cannot be applied equally either side of the mean. In this case, percentiles equivalent to the standard deviation are used as follows:

- one data point greater than the 99.87th percentile;
- two consecutive data points greater than the 97.73rd percentile; and
- five successive data points greater than the 84.13th percentile.

Figure 5-1 shows a non-related example of a control chart used to identify if groundwater quality is above a trigger level for a skewed distribution. This is considered the most suitable approach for the BCM as it recognises the significant variability that occurs between bores and within the same bore. Assessment of the historical groundwater quality data from the monitoring bores in proximity to the mining area has produced the groundwater quality trigger values for the monitored parameters shown in Table 5.1

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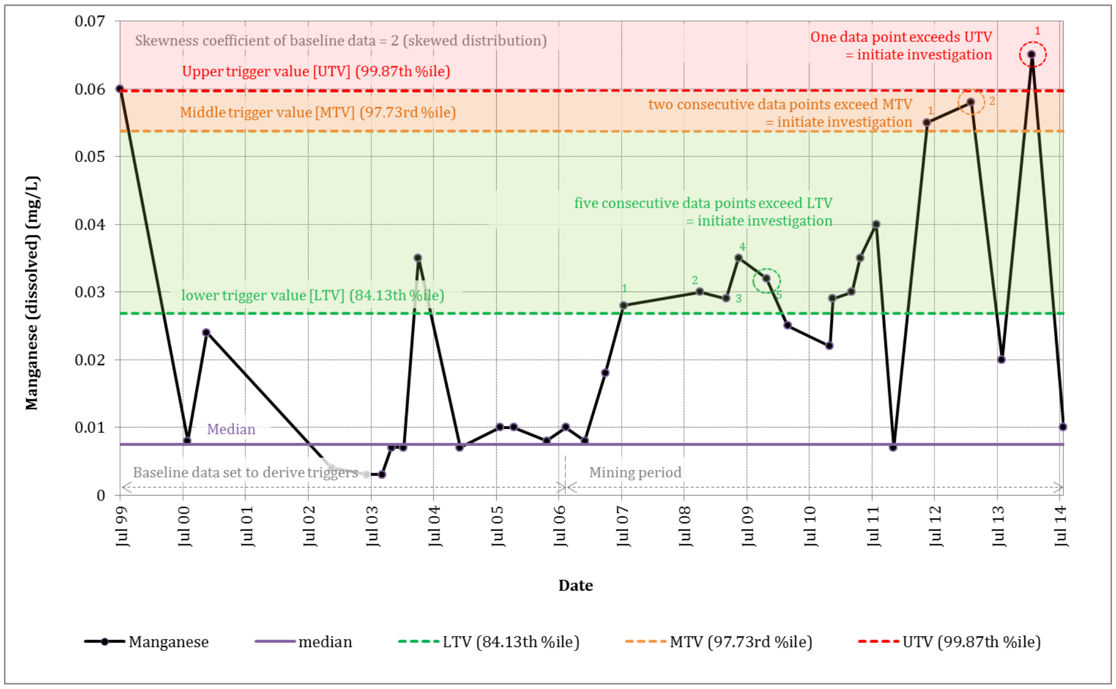

Figure 5-1 Example of statistical control charting – skewed baseline distribution

BCOPL will undertake an annual assessment of the groundwater quality trigger values to revise these with available groundwater data and identify if the groundwater quality in the mining area monitoring bores (refer to Table 4.1) is above these triggers values. In the event these trigger values are exceeded, BCOPL will respond by undertaking further investigation as outlined in Section 6.1.1.1.

Table 5.1 Groundwater quality trigger values

Analytes	Triggers values	Exceedance of trigger value	Coal Measures			Alluvium	Boggabri volcanics		
			IBC2104	IBC2105	BC2181	MW6	IBC2110	IBC2111	GW3115
pH	Median		7.0	7.3	7.0	7.4	7.9	7.0	7.7
	LTV (84.13th %ile)	Five consecutive data points	7.3	7.6	7.3	7.5	8.0	7.3	7.9
	LTV (15.87th %ile)	Five consecutive data points	6.8	7.1	6.9	7.3	7.7	6.8	7.4
	MTV (97.73rd %ile)	Two consecutive data points	7.9	7.9	8.0	7.6	8.1	7.9	8.2
	MTV (2.27th %ile)	Two consecutive data points	6.6	6.9	6.8	7.2	7.6	6.6	7.3
	HTV (99.87th %ile)	One data point	8.1	8.0	8.2	7.6	8.1	8.1	8.3
	HTV (0.13th %ile)	One data point	6.5	6.9	6.8	7.2	7.6	6.5	7.2
EC (µS/cm)	Median		426	736	748	1995	1735	2230	3450
	LTV (84.13th %ile)	Five consecutive data points	501	768	813	2029	2053	2326	3656
	MTV (97.73rd %ile)	Two consecutive data points	565	1013	1164	2080	2146	2385	3808
	HTV (99.87th %ile)	One data point	584	1137	1273	2089	2150	2399	3848
Sulphate (mg/L)	Median		16	12	25	44	12	54	188

Analytes	Triggers values	Exceedance of trigger value	Coal Measures			Alluvium	Boggabri volcanics		
			IBC2104	IBC2105	BC2181	MW6	IBC2110	IBC2111	GW3115
	LTV (84.13th %ile)	Five consecutive data points	33	19	31	49	66	63	203
	MTV (97.73rd %ile)	Two consecutive data points	49	61	47	57	81	74	212
	HTV (99.87th %ile)	One data point	53	81	52	59	83	76	212
Chloride (mg/L)	Median		29	24	65	251	121	298	654
	LTV (84.13th %ile)	Five consecutive data points	33	33	83	275	313	350	694
	MTV (97.73rd %ile)	Two consecutive data points	55	49	126	275	384	387.6	753
	HTV (99.87th %ile)	One data point	68	52	139	275	396	388.9	767
Sodium (mg/L)	Median		83	168	79	371	436	352	733
	LTV (84.13th %ile)	Five consecutive data points	109	180	90	393	469	371	781
	MTV (97.73rd %ile)	Two consecutive data points	146	221	152	408	495	382	803

5.1.2 Groundwater levels

For the monitoring bores located in the Boggabri Volcanics (IBC2110, BC2111 & GW3115) and alluvium (MW6) in proximity to the mining area the groundwater level triggers are based on the 5th percentile groundwater level calculated for each of individual monitoring bore. This is consistent with the trigger method adopted for the cumulative monitoring network within the BTM WMS.

If groundwater levels at the nominated bores fall below the 5th percentile water level for a period of 30 days or more (established from all existing monitoring data), a trigger level event occurs. Figure 5-2 shows a non-related example of a bore that falls below the calculated 5th percentile level for over 30 days and therefore would trigger an investigation.

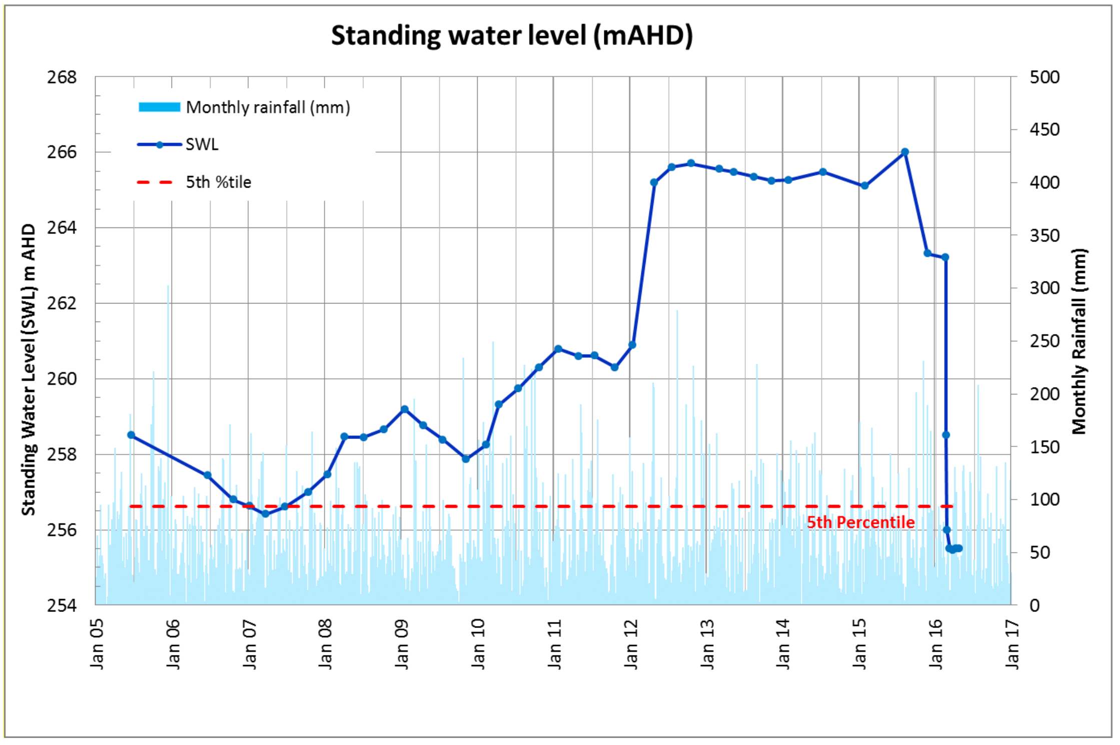

Figure 5-2: Example of a water level trigger event

Assessment of historical groundwater data has produced the 5th percentile water level calculated for the monitoring bores in proximity to mining installed within the Boggabri volcanics (IBC3115, IBC2110 & IBC2111) and alluvium (MW6) as described in Table 5.2. Bores within the Maules Creek Coal Measures at BCM are directly affected by dewatering from mining operations and the data cannot be used to set meaningful trigger levels.

The 5th percentile water level triggers will be revised annually to include the available groundwater results from the monitoring program. Where a trigger level event occurs in a monitoring bores listed in Table 4.1, BCOPL will initiate the management measures described in Section 6.1.1.2.

Table 5.2 Mining area monitoring bore triggers for groundwater levels

Monitoring bore	Screened lithology	Trigger water level (m AHD) 5th %tile
GW3115	Boggabri volcanics	256.98
IBC2110	Boggabri volcanics	257.11
IBC2111	Boggabri volcanics	256.62
MW6	Alluvium	258.48

5.2 Borefield Triggers

Groundwater levels recorded in production and monitoring bores in proximity to the borefield (refer to Table 4.2) will be assessed annually against the changes predicted to occur to groundwater in EA MOD 5 (Parson Brinkerhoff, 2015a). This assessment will take into consideration the borefield abstraction rates, climatic conditions, river flows, rainfall recharge and pump rates of other private bores to identify if the monitoring results are within the predicted drawdown effects for the alluvium and loss of baseflow in the River as described in the EA MOD 5.

If the assessment confirms the operation of the borefield has caused drawdown effects in the alluvium or loss of baseflow in the Namoi River greater than those predicted to occur in the EA MOD 5 (Parsons Brinkerhoff, 2015a) and/or a landowners privately owned water supply is adversely impacted, other than an impact that is negligible, BCOPL will undertake the investigation outlined in Section 6.2.

5.3 Mine groundwater seepage rates

Groundwater seepage rates will be monitored to assess compliance with the groundwater inflows predicted in the EA (Hanson Bailey, 2010) and groundwater extraction licences held by BCOPL.

6. Groundwater management measures

6.1 Exceedance of trigger levels

6.1.1 Mining area monitoring bores

The process for responding to exceedances of groundwater triggers for the bores listed in Table 4.1 in proximity to the mining area are further detailed in the following subsections.

6.1.1.1 Groundwater quality

Assessment of the groundwater quality monitoring results will be undertaken annually against the groundwater quality trigger values listed in Table 5.1 to identify if any trigger values have been exceeded.

Where any exceedance of a trigger level is confirmed a review of relevant monitoring information will be carried out by a suitably qualified hydrogeologist. The review will consider trends in monitoring data, mining activities, climatic conditions and may recommend management, monitoring and/or mitigation measures. If BCM is confirmed to have caused the impact, recommendations for monitoring or mitigation measures will be provided. BCOPL will consult with the DPIW (or relevant regulator) on the outcomes of the review prior to the implementation of any mitigation measures.

The annual groundwater quality assessment will detail reviews resulting from trigger level exceedences, and be reported in the Annual Review (refer to Section 7.1).

6.1.1.2 Groundwater level

Assessment of groundwater level monitoring data for bores in proximity to the mining area (refer to Table 4.1) will be undertaken annually to identify if the groundwater trigger values (refer to Section 5.1.2) have been exceeded.

In the event that groundwater levels readings for these monitoring bores (Table 4.1) fall below the historical 5th percentile (based on all previous data) for more than 30 days, a review of monitoring information will be carried out by a suitably qualified hydrogeologist. The review will consider trends in monitoring data, mining activities and climatic conditions and may recommend management, monitoring and/or mitigation measures.

The annual groundwater level assessment will detail reviews resulting from trigger level exceedences, and be reported in the Annual Review (refer to Section 7.1).

6.2 Impacts on water supply

Where a landowner of a privately registered bore reports that their water supply is adversely and directly impacted by the abstraction of groundwater from the borefield, an investigation will be undertaken by a suitably qualified hydrogeologist. The investigation will consider the potential causes of the impact including, private landowner and mining activities, local groundwater abstraction rates, climatic conditions, condition of water supply works and assess if the impact has occurred as a result of BCOPL’s operations.

Where the investigation confirms BCOPL has adversely and directly impacted the water supply, other than an impact that is negligible, a compensatory water supply will be provided to the landowner as per Schedule 3, Condition 34 of the Project Approval. The types of compensatory water supply to be made available may include financial provisions, alternative water supply provisions or other ‘make good’ provisions and will be developed in consultation with the landowner and DPIW.

6.3 Groundwater Seepage from BCM

The pump out volumes recorded from the pit will be assessed against rainfall and evaporation records so groundwater and surface water contributions are quantified. The estimation of groundwater seepage to BCM will be assessed against predictions in the EA (Parson Brinkerhoff, 2015a). The results of this assessment will be included in the Annual Review (refer to Section 7.1). Where groundwater seepage values significantly exceed the modelled predictions, a suitably qualified hydrogeologist will undertake a review of the potential cause(s) of the exceedance and provide recommendations for monitoring and management.

Reporting of any groundwater incidents and the outcomes of management measures will be included in the Annual Review (refer to Section 7.1).

6.4 Impacts on Groundwater Dependent Ecosystems

The Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources (DPI Water, 2003) notes that ‘there are no high priority groundwater dependent ecosystems identified and scheduled at the commencement of this Plan’. In addition significant stands of groundwater dependent vegetation in the area are unlikely as water tables in the Namoi Valley are typically deeper than 2 m and consequently direct groundwater evapotranspiration is not a significant part of the water balance (CSIRO, 2007).). The creeks in the vicinity of BCM are not expected to support GDE’s and the borefield contains no Endangered or Critically Endangered Ecological Communities (as listed under the EPBC Act) with a groundwater dependency or be associated with a GDE’s (PB, 2016). There is expected to be no impacts from groundwater effects on GDE’s.

If impacts to GDEs are identified through vegetation surveys these will be assessed against groundwater levels in monitoring bores and climatic conditions to identify the causes of the impacts. The results of the assessment will be reported in the Annual Review (refer to Section 7.1).

7. Reporting and plan revision

7.1 Reporting - Annual Review

BCOPL prepares and submits an Annual Review (formerly Annual Environmental Management Report), in accordance with Schedule 5, Condition 4 of the Project Approval, which outlines the monitoring, analysis and performance assessment for groundwater over the preceding calendar year.

The Annual Review is typically submitted to stakeholders by the end of March each year and will discuss the groundwater related activities, monitoring results and management measures of the previous calendar year.

The Annual Review will be submitted to the DP&E and be made publically available on the BCM website (Idemitsu Approvals, Plans & Reports - Idemitsu).

7.2 Review and revision

Review of the GWMP will be undertaken in accordance Schedule 5, Condition 5 of the Project Approval within 3 months of the submitting the following:

- Annual Review under condition 4 of the Project Approval;
- incident report under condition 8 of the Project Approval;
- audit under condition 10 of the Project Approval; and
- a modification to the Project Approval.

Where this review results in revisions to the GWMP, then within 4 weeks of the completion of the revision, unless the Secretary agrees otherwise, the revised document will be submitted to the Secretary for approval.

BCOPL will revise the groundwater trigger values in the GWMP annually to include the available groundwater results. In accordance with the provisions of the Project Approval (Schedule 5, Condition 5), BCOPL seeks approval of the Secretary to avoid the need to submit a revised GWMP for approval in the event that the revision relates only to the revision of annual groundwater quality and level trigger values in Section 5.1.1 and 5.1.2.

7.3 Independent model review

An independent review of the groundwater model for BCM will be carried out every 3 years in accordance with Schedule 3, Condition 38(c) of Project Approval with the aim of validating the model. At the time of independent review, a comparison of monitoring results with modelled predictions will be undertaken.

8. Roles and responsibilities

The roles and responsibilities for implementation of the GWMP are presented in Table 8.1.

Table 8.1 Roles and responsibilities

Role	Responsibility
BCOPL General Manager	▪ Provide sufficient environmental resources to ensure the effective implementation of this GWMP.
BCOPL Manager Operations	▪ Mining and groundwater management are to be undertaken in accordance with this GWMP.
BCOPL CHPP Manager	▪ Mining and groundwater management are to be undertaken in accordance with this GWMP.
BCOPL Health Safety and Environment manager	▪ Groundwater monitoring and mitigation measures are to be undertaken in accordance with this GWMP. ▪ Providing sufficient resources for the effective implementation of this GWMP.
BCOPL Environment Superintendent	▪ Respond to exceedances of groundwater triggers in accordance with this GWMP. ▪ Engaging specialist to undertake studies and environmental management activities in accordance this GWMP. ▪ Coordinate the groundwater monitoring program in accordance with this GWMP. ▪ Review and updating this GWMP where required. ▪ Respond to community complaints and liaise with regulatory authorities regarding groundwater management. ▪ Make relevant employees and contractors aware of their obligations under this GWMP.
Mining operator	▪ Develop and implementing specific procedures for the employees and subcontractors under their responsibility to ensure compliance with this GWMP. ▪ Ensure all employees and subcontractors under their control are aware of their obligations under this GWMP. ▪ Provide relevant environmental data to assist BCOPL with their reporting requirements, in accordance with this GWMP.
All BCOPL employees and contractors	▪ Undertake activities, as required, in accordance with this GWMP under instruction from their supervisor. ▪ Inform the BCOPL Environment Superintendent of any groundwater related issues as they arise.

9. References

9.1 Internal

BCOPL Water Management Plan

BCOPL Rehabilitation Management Plan

BCOPL Mining Operations Plan

BCOPL Pollution Incident Response Management Plan

BTM Complex Water Management Strategy

9.2 External

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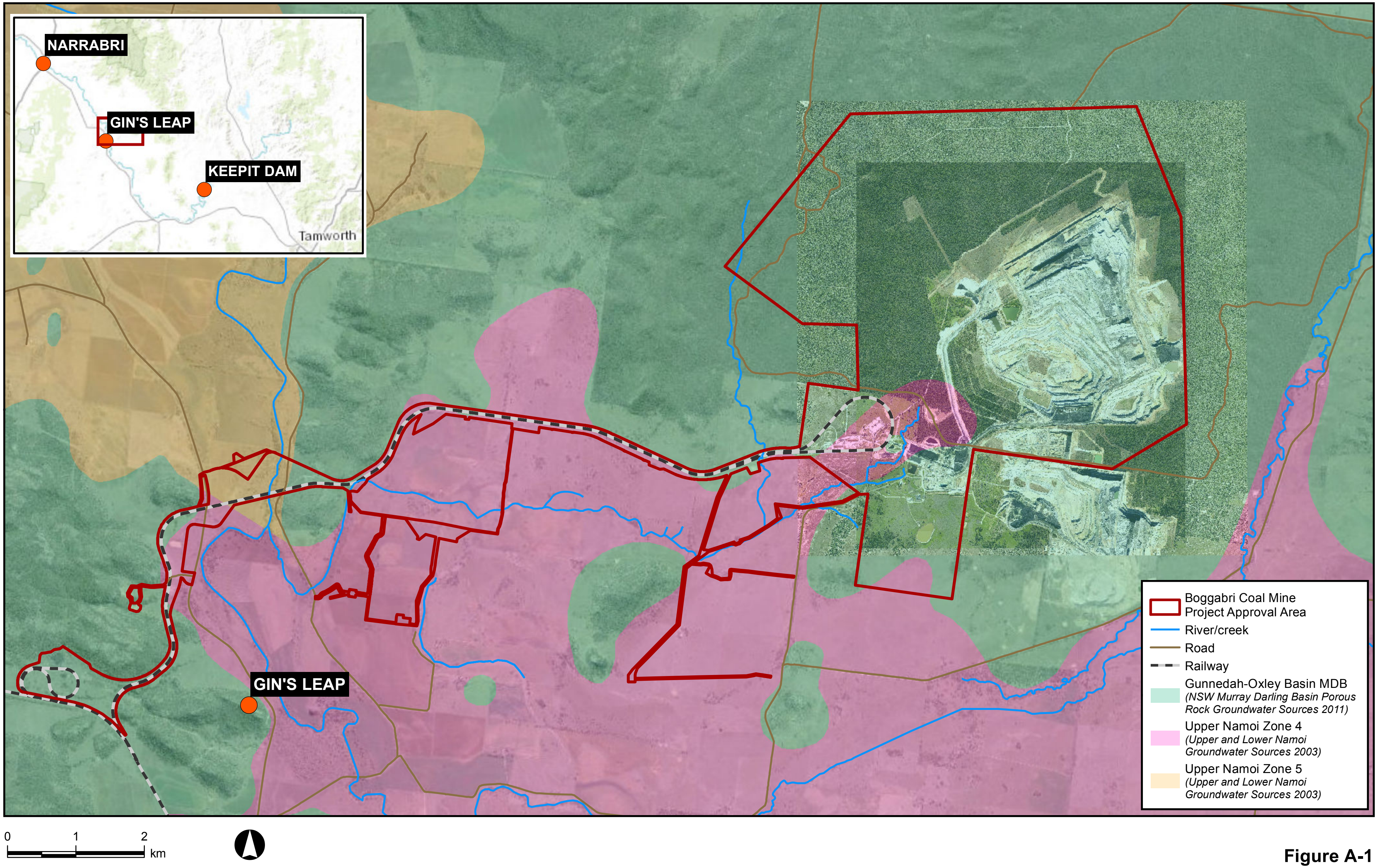
Appendix A

Figures



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Date: 7/12/2016
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Figure A-1
Water sharing plan boundary

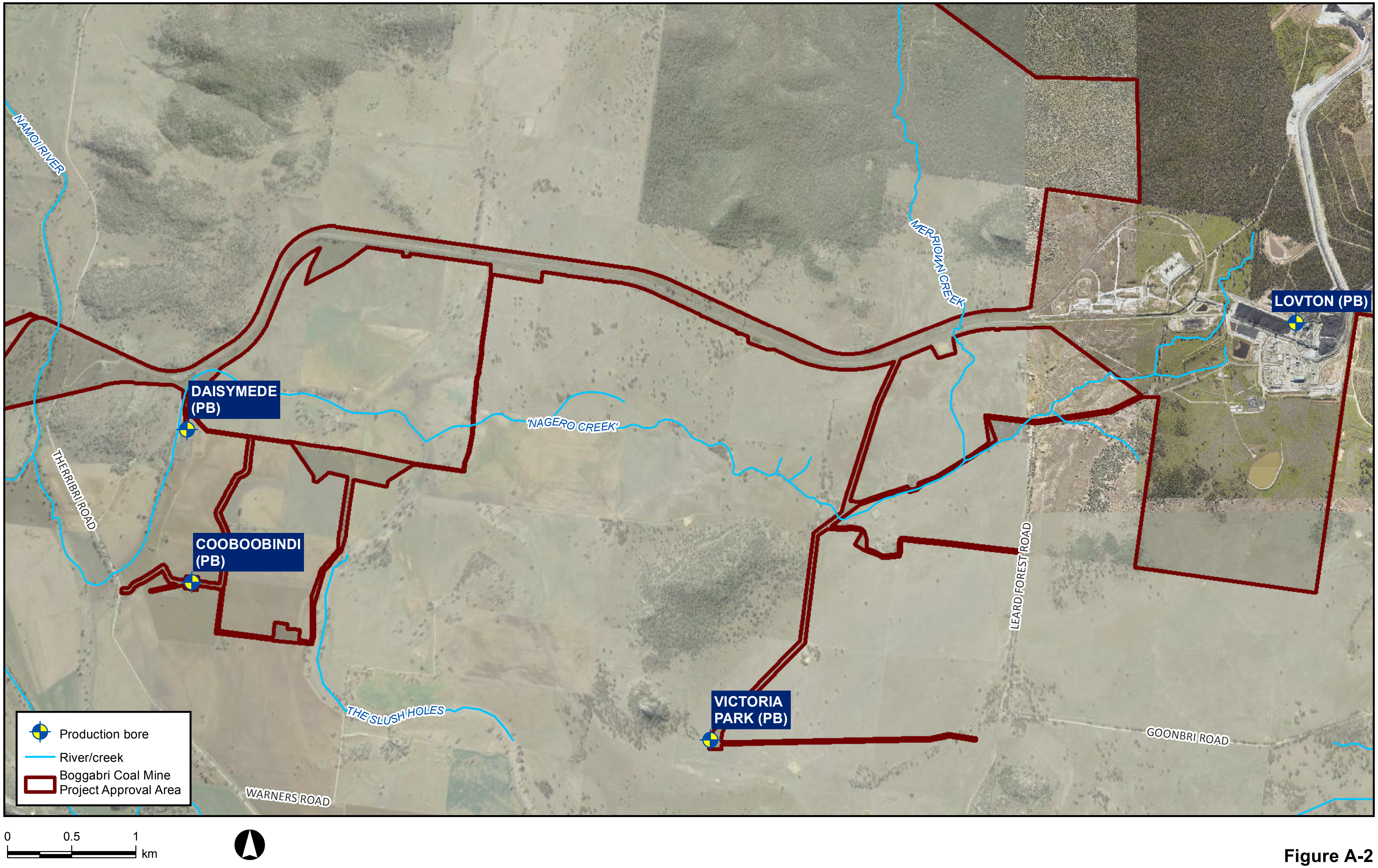

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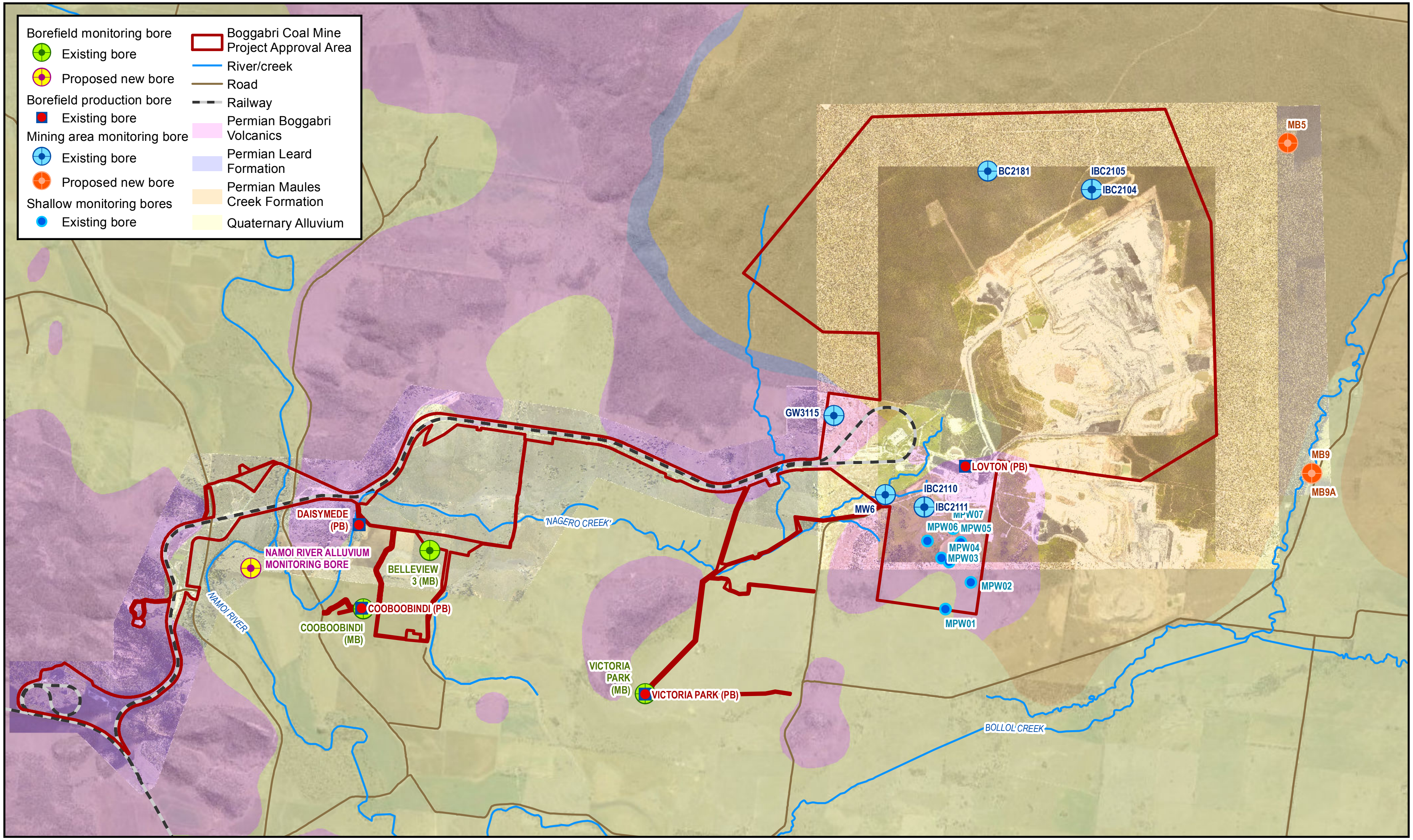
Figure A-2
Groundwater production bores



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Date: 19/12/2016
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Figure A-3
Surface geology and groundwater monitoring bores