Appendix H

Groundwater Impact Assessment

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Bloomfield Colliery Pty Ltd
17-Jan-2018

Groundwater Impact Assessment

Bloomfield Colliery - Life of Mine Extension

Groundwater Impact Assessment

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Client: Bloomfield Colliery Pty Ltd

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HydroSimulations

17-Jan-2018

Job No.: 60289290

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Quality Information

Document Groundwater Impact Assessment

Ref 60289290

Date 17-Jan-2018

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Reviewed by Graham Hawkes

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	21-Dec-2017	Draft	Simon Murphy Principal Environmental Planner	
0	17-Jan-2018	Final	Simon Murphy Project Manager	

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Glossary of Terms and Abbreviations

Term	Definition
AHD	Australian Height Datum
Alluvium	Sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains and alluvial fans.
Aquiclude	An aquiclude is a geological material through which zero flow occurs.
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
Aquitard	A low permeability unit that can store groundwater and also transmit it slowly from one aquifer to another.
DI-CLW	NSW Department of Industry – Crown Lands and Water Division (formerly DPI-Water)
DLWC	NSW Department of Land and Water Conservation now DI-CLW
DoP	NSW Department of Planning. Predecessor agency to the NSW Department of Planning and Environment.
DPI-Water	NSW Department of Primary Industries – Water. State agency responsible for managing groundwater and surface water. now DI-CLW
Drawdown	A lowering of the water table in an unconfined aquifer or the potentiometric surface of a confined aquifer caused by the groundwater extraction from mining or pumping of groundwater from wells.
DWE	NSW Department of Water and Energy
Ecosystem	As defined in the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth), an ecosystem is a 'dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'.
EC	Electrical Conductivity. A unit of measurement for water salinity. One EC equals one micro –Siemen per centimetre (µS/cm) measured at 25°C.
Environment	As defined within the *Environmental Planning and Assessment Act 1979* (NSW), all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.
EP&A Act	*Environmental Planning and Assessment Act (1979)* (NSW)
Hydraulic conductivity	The rate at which water of a specified density and kinematic viscosity can move through a permeable medium (notionally equivalent to the permeability of an aquifer to fresh water).
Hydraulic gradient	The change in total groundwater head with a change in distance in a given direction, which yields a maximum rate of decrease in head.
Hydrogeology	The study of subsurface water in its geological context.
Hydrology	The study of rainfall and surface water runoff processes.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
LTAAEL	Long Term Average Annual Extraction Limit as outlined in the water sharing plan
MNES	matters of national environmental significance

Term	Definition
NoW	NSW Office of Water. now DI-CLW
NSW EPA	Environmental Protection Authority (NSW)
OEH	Office of Environment and Heritage (NSW)
ROM	Run-of-mine. Raw mined coal resource that includes waste material such as rocks and minerals
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS). The conversion factor between EC and mg/L is dependent on the chemical composition of the water, but a conversion factor of 0.6 mg/L TDS = 1EC unit is commonly used as an approximation.
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
WM Act	*Water Management Act 2000* (NSW)

1.0 Introduction

1.1 Project Overview

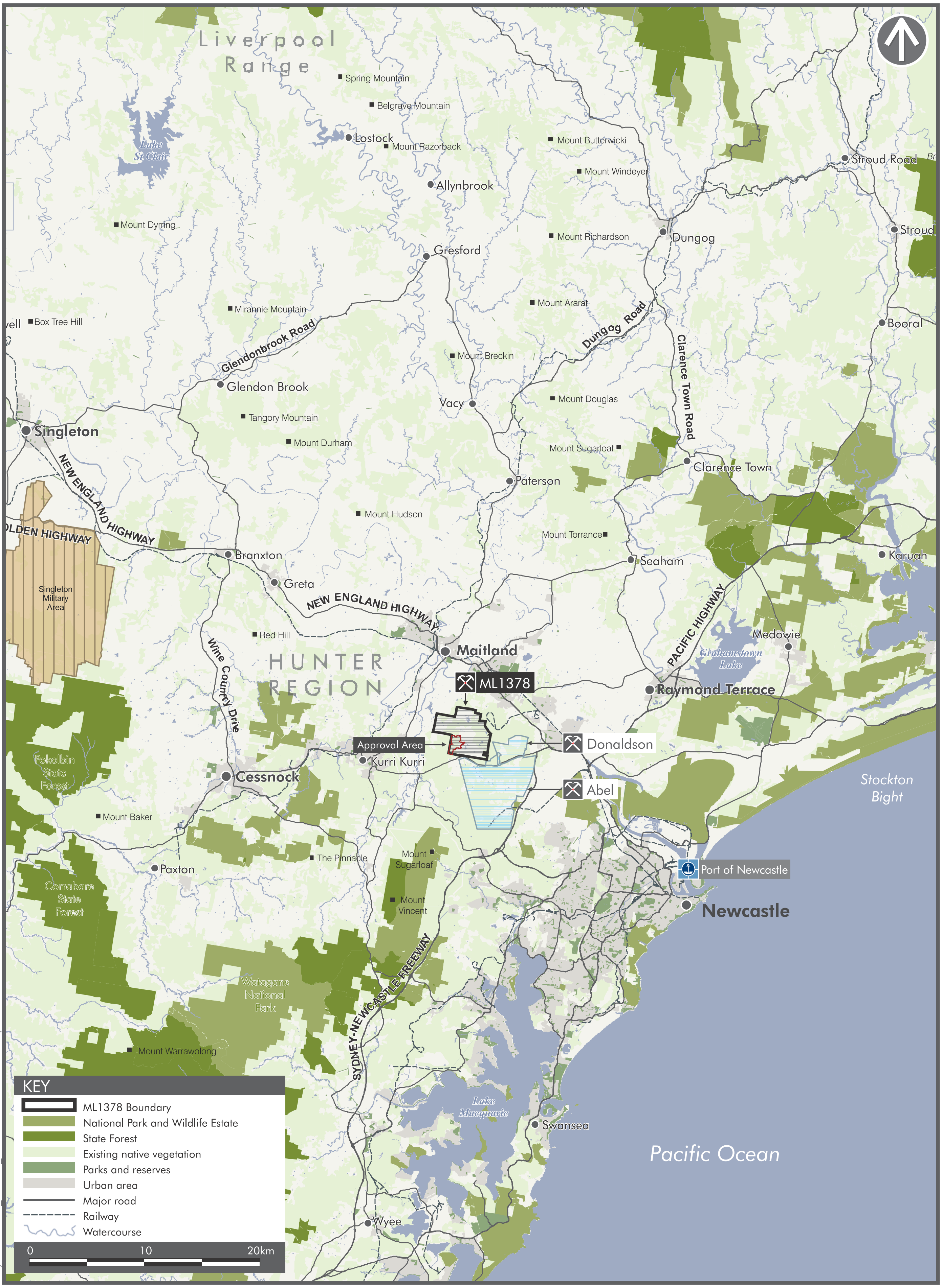
Bloomfield Colliery (the Colliery) is an open cut coal mine in the Hunter Valley, NSW, located approximately 25 kilometres (km) north-west of Newcastle and about 5 km south of Maitland. Open cut operations commenced in 1966. The Colliery currently operates in accordance with Project Approval 07_0087 under Part 3A (repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), granted on 3 September 2009. The Project Approval has been subsequently modified on three separate occasions (May 2011, March 2012 and February 2013). Under this approval, mining operation may take place until 31 December 2021. Bloomfield now predicts mining to extend beyond the end of 2021, having identified up to 13 million tonnes of ROM (run-of mine) coal remaining inside the approval area. Bloomfield is therefore seeking a modification to the Project Approval to allow for the continuation of mining within the existing mining lease (Consolidated Coal Lease (CCL) 761) beyond the life of its current consent to 31 December 2030. The Project includes a modification of the previously approved final landform by moving the final void approximately 200m to the west. The mining will include extraction of the Donaldson and Big Ben Seams although some of the Big Ben seam has been previously mined by underground mining methods. The mine location is shown in **Figure 1** and **Figure 2**.

In order to support the modification application to DP&E, Bloomfield requires a supporting Environmental Assessment (EA) to describe the Project and assess potential environmental impacts and statutory approval requirements. Key technical assessment areas have been identified for assessment within the EA including modelling and assessment of the hydrogeological impacts of the Project. A predictive groundwater model has been developed independently by HydroSimulations. The purpose of this report is to assess the potential impacts the Project will have on groundwater resources and changes to the site’s water balance and water management within the framework of relevant legislation and guidelines. HydroSimulations Groundwater Modelling Report is attached in **Appendix A**.

1.2 Interaction with Neighbouring Mines

Bloomfield Colliery adjoins three other mines; Donaldson open cut mine (in care and maintenance), Abel underground mine (in care and maintenance) and Tasman underground mine (closed). The four mines all washed coal through the Bloomfield Coal Handling and Preparation Plant (CHPP). Tailings from the CHPP were deposited into former underground workings at Bloomfield until mid-2007 and are now deposited in former open cut workings on the site. Water from tailings is recovered and recycled through the CHPP.

Modelling by HydroSimulations included all neighbouring underground and open cut mines for assessment of cumulative effects. **Figure 1** shows the regional location of Bloomfield Colliery and the vicinity of the surrounding mines.



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REGIONAL CONTEXT
Bloomfield Project

FIGURE 1

1.3 SEARs

The Secretary's Environmental Assessment Requirements (SEARs) for the Bloomfield Colliery Life of Mine Extension were issued by the Department of Planning on 16 November 2015 and revised on 22 March 2017. The SEARs relating to hydrogeological impacts and where these requirements have been addressed in this report are summarised in **Table 1**.

Table 1 How SEARs have been addressed in this report

SEARs Requirement	Section where addressed in the report
General Requirements	
A description of the existing environment likely to be affected by the development, using sufficient baseline data.	**Section 4.0** – Existing environment
An assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into consideration any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice.	**Section 5.0** – Assessment of potential impacts
A description of the measures that would be implemented to mitigate and/or offset the likely impacts of the development.	**Section 6.0** – Monitoring and management of impacts
A description of any measures that would be implemented to monitor and report on the environmental performance of the development if it is approved.	**Section 6.0** – Monitoring and management of impacts
Groundwater	
The EA is required to assess whether the recovery of deeper coal seams would cause any changes to the groundwater resources intercepted by the development and any resultant changes to the site's water balance and water management system.	**Section 5.0** – Assessment of potential impacts

1.4 Structure of this Report

This report is structured as follows:

- **Chapter 1** – **Introduction.**
- **Chapter 2** – **The project** describes the project features and mining activities on the site.
- **Chapter 3** – **Assessment inputs** describes the regulatory context and key inputs and assumptions for the impact assessment.
- **Chapter 4** – **Existing environment** describes the existing environment (natural and built) prior to project commencement.
- **Chapter 5** – **Assessment of potential impacts** describes the potential impacts on groundwater inflow, groundwater drawdown and groundwater quality resulting from the proposed project, during the mining and recovery phase.
- **Chapter 6** – **Monitoring and management** describes the infrastructure and methods to be put in place to further monitor the groundwater environment and management steps to be implemented.
- **Chapter 7** – **Policy compliance** outlines the relevant policy and compliance measures.
- **Chapter 8** – **Conclusions** summarises the outcomes of the groundwater impact assessment.
- **Chapter 9** – **References.**
- **Chapter 10 – Limitations.**

2.0 The Project

2.1 Project Location

The Colliery is owned and operated by Bloomfield Collieries Pty Limited (Bloomfield). The Colliery is an open cut operation located in the Hunter Valley, NSW and 25 km north-west of Newcastle (refer to Figure 1 and Figure 2). The Colliery is located approximately 3 kilometres west of the Sydney-Newcastle Motorway and immediately north of John Renshaw Drive (B68 Freeway).

2.2 Previous Mining

Coal has been mined on the site by both underground and open cut means for approximately 170 years. Bloomfield purchased the operation in 1937, and commenced underground mining of the Donaldson, Big Ben and Rathluba seams. Underground mining on the site ceased in 1992.

Bloomfield's open cut mine commenced in 1966, using bulldozers and tractor scrapers. CCL761 was granted on 20 November 1991 and ML 1738 granted June 2017 form the boundary of the Colliery. The open cut has continued to expand and develop with the introduction of new machinery and technology.

Mining operations at the adjacent Abel Underground Mine (now in care and maintenance) required the use of certain Bloomfield infrastructure (the CHPP and rail loading facility). To enable this use, the Abel Project Approval granted on 7 June 2007 includes approval for the operation of Bloomfield CHPP and rail loading facility, including associated water management and process waste management. An Integrated Water Management System for the three adjoining mines of Bloomfield, Abel and Donaldson was approved on 5 May 2008.

Project Approval (MP 07_0087) for the Colliery was granted on 3 September 2009 for the staged completion of mining and progressive rehabilitation of the disturbed land. Prior to this, the Colliery had operated pursuant to existing use rights.

Mining operations are currently undertaken in open cut pits known as S Cut and Creek Cut. Mining in S Cut is progressively moving west, while extraction within Creek Cut is moving towards the south and west. These pits mine a range of coal seams within the Tomago Coal Measures.

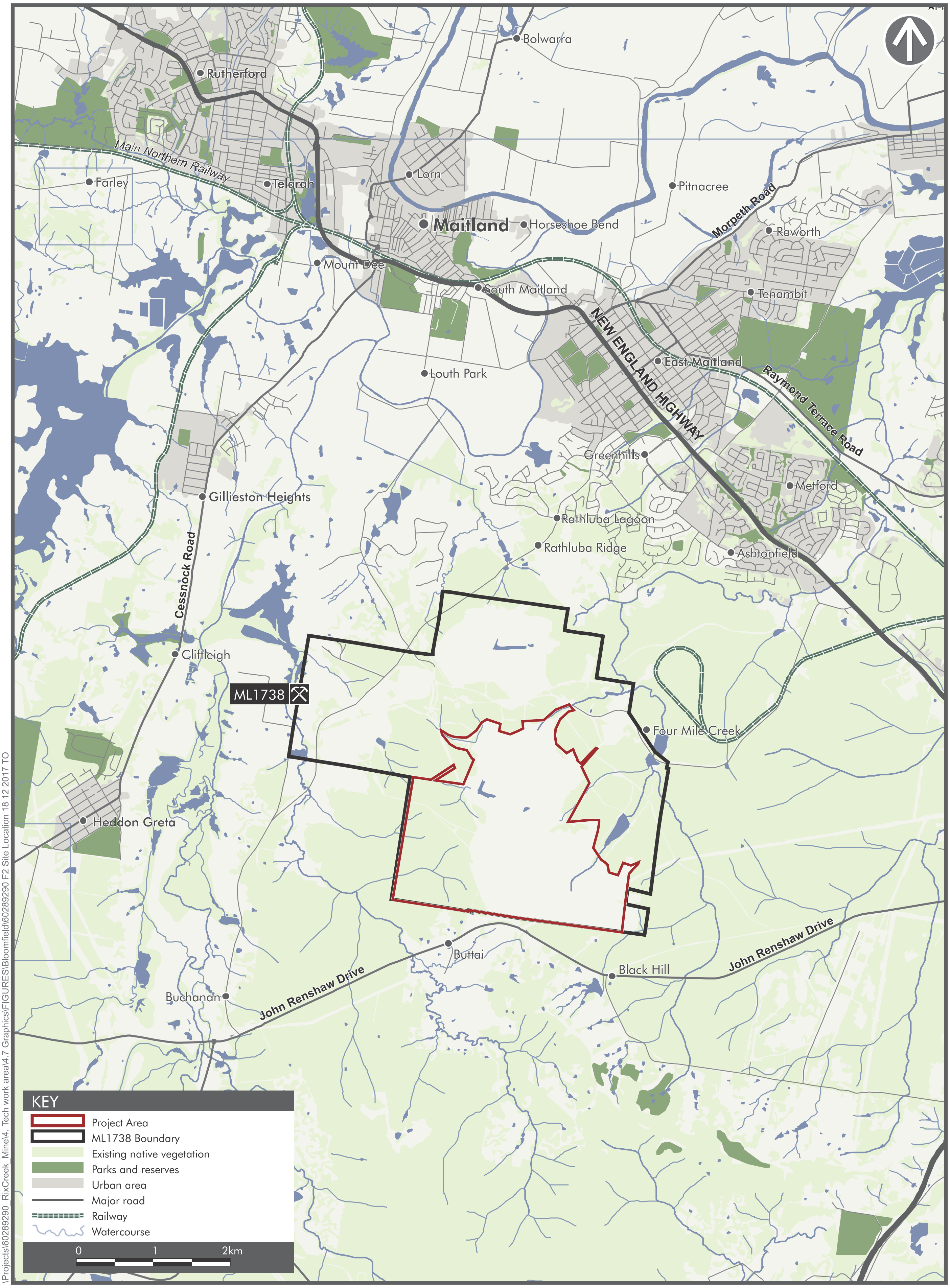
Areas within CCL 761 and ML 1738 where mining has been completed have been progressively stabilised and rehabilitated over time. To date, approximately 488 hectares of land within the Project Area has been rehabilitated. Areas of the rehabilitated land are being used for cattle grazing and for the control of surface runoff to water storage dams or natural watercourses.

2.3 Proposed Mining

Bloomfield Colliery currently operates in accordance with Project Approval 07_0087 under Part 3A (repealed) of the EP&A Act, granted on 3 September 2009. The project approval has been subsequently modified on three separate occasions (Modification No. 1 – 3). Pursuant to Schedule 5, Condition 2 of the Project Approval, mining operation under the existing consent may take place until 31 December 2021.

Changes to the mine fleet have allowed extraction of seams that were not previously considered to be a recoverable resource as part of the original 2008 EA. This has increased the amount of recoverable resource at the Mine and therefore the time required for extraction. Further exploration has been undertaken which has identified other previously unrecoverable resources that the new fleet can now access. As a result, Bloomfield has identified up to 13 million tonnes of ROM coal remaining inside the approval area. Mine planning has been undertaken for the extraction of this additional resource. The proposed change would result in a modification of the previously approved final landform by moving the final void approximately 200m to the west.

A consent modification is sought to align the Project Approval limit to coincide with the Abel consent limit of 31 December 2030. This would allow common infrastructure to be used by both mines until completion. Cumulative assessment of the potential groundwater impact has therefore been undertaken to incorporate the Project and operation of the Abel Underground Mine.



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SITE LOCATION
Bloomfield Project

FIGURE 2

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3.0 Assessment Inputs

3.1 EPA Licence Conditions

Environmental management at the Colliery is undertaken in accordance with the Environment Protection Licence (EPL) No 396 issued by the Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997*. EPL No. 396 is attached in **Appendix B**.

The EPL conditions for the Colliery relevant to this assessment are summarised in **Table 2** and **Table 3**.

Table 2 EPL 396 Condition P1.2 - water monitoring and discharge points

EPL Monitoring Point	Type of Monitoring Point	Type of Discharge Point	Location Description
1	• Volume monitoring • Discharge quality monitoring	• Volume monitoring • Discharge quality monitoring	Lake Forster pipe outlet labelled As EPA ID1 on document dated Dec-14 and registered in the EPA Records System as DOC 17/425999 Volume must not exceed 40 kL/day.
2	• Ambient water quality monitoring	N/A	Four Mile Creek located 500m upstream of the current New England Highway culvert for Four Mile Creek.

Table 3 EPL 396 Condition L2.4 – surface water daily concentration and discharge limits

100th Percentile Concentration Limits				Volume
Electrical Conductivity (EC) (µS/cm)	pH	Total Suspended Solids (TSS) (mg/L)	Filterable Iron (mg/L)	Limit (ML/day)
6,000	6.5-8.5	30	1.0	40

3.2 Water Licence

Bloomfield Colliery operates in accordance with the Water Act 1912, and licence number 20BL172035. Under this licence, the Colliery has a maximum groundwater inflow volume of 500 ML/year into the void.

3.3 Relevant Legislation, Policy and Guidelines

This groundwater impact assessment has considered relevant guidelines, policies and both Commonwealth and State legislation.

3.3.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the legal framework to protect and manage nationally important flora, fauna, ecological communities and water resources which are deemed to be matters of national environmental significance (MNES). An action that has, will have or is likely to have a significant impact upon MNES is declared a controlled action. Such actions require the approval of the Department of Environment and Energy (DoEE) as well as any requirements under NSW legislation.

Under the EPBC Act an expansion or modification to an existing facility may be within the definition of a large coal mining development if the activities are likely to have significant impact on a water resource (RPS, 2014)

The DoEE has provided the criteria for determining the significance of the impact that a large coal mining activity may have on a water resource. **Table 4** details the impact criteria and where these criteria have been discussed within this report.

Table 4 Impact Criteria

Assessment Criteria	Section(s) addressed
Valuation of the water resource	Section 4.0 – Existing Environment
Changes in water quantity, including the timing of variations in quantity	Section 5.0 – Assessment of potential impacts
Changes in the integrity of hydrological or hydrogeological connection, including substantial structure damage (e.g. large scale subsidence)	Section 5.0 – Assessment of potential impacts
Changes in the area or extent of a water resource	Section 5.0 – Assessment of potential impacts
The risk that the ability of relevant local or regional water quality objectives would be materially compromised	Section 5.0 – Assessment of potential impacts Section 7.0 – Policy compliance
A significant worsening of local water quality (where current local water quality is superior to local or regional quality objectives)	Section 5.0 – Assessment of potential impacts
Risk of high quality water being released into an ecosystem which is adapted to a lower quality of water.	Section 5.0 – Assessment of potential impacts
Cumulative impacts	Section 5.0 – Assessment of potential impacts

3.3.2 Environment Planning and Assessment Act 1979

The overarching environmental planning approval framework in NSW is provided by the EP&A Act. Supporting this primary piece of legislation is the *Environmental Planning and Assessment Regulation 2000* (the EP&A Regulation) and environmental planning instruments, including State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs).

The Colliery currently operates under Project Approval MP 07_0087, issued under Part 3A (repealed) of the EP&A Act. As it was for the purpose of coal mining, the original development was classified as a Major Project under the *State Environmental Planning Policy (Major Projects) 2005*, which triggered the former Part 3A approval pathway.

While Part 3A of the EP&A Act was repealed in 2011, transitional arrangements set out in Schedule 6A of the EP&A Act provide that Part 3A continues to apply to approved Part 3A projects, and that section 75W of the EP&A Act continues to apply for the purpose of modifications to Project Approvals. The current Project would therefore be undertaken as a modification to the existing Project Approval (MP 07_0087) under section 75W of the EP&A Act. The approval authority is the Minister for Planning.

3.3.3 Strategic Regional Land Use Policy

Residential and agricultural land across the state are protected from the impacts of mining and coal seam gas activities under the Strategic Regional Land Use Policy. The project is not located within the Upper Hunter Region of the Strategic Agricultural Land Map and is not on land classified as biophysical strategic agricultural land (NSW Government, 2012). The NSW Office of Environment and Heritage (OEH, 2012) indicate the project area is located on land that is classified as moderate to low capability in accordance with the Land and Soil Capability (LSC) assessment.

3.3.4 Water Management Act 2000

As part of the *Water Management Act 2000*, the Department of Primary Resources - Water (DPI Water) is in the process of developing Water Sharing Plans across the state for river and groundwater systems. At the time of writing water licencing is still administered under both the *Water Management Act 2000* and the *Water Act 1912*.

Surface water and alluvial licences are administered under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (DPI Water, 2016) via the *Water Management Act 2000*.

Hard rock licences are administered under the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources* (DPI Water, 2016) via the *Water Management Act 2000*.

3.3.4.1 Aquifer Interference Policy

The Aquifer Interference Policy (AIP) (NoW 2012) explains the process of administering water policy under the WM Act for activities that interfere with the aquifer. The AIP outlines the assessment process and modelling criteria that DPI Water apply to assess aquifer interference projects. This assessment process and modelling criteria have been adopted for this hydrogeological assessment. Minimum impact considerations required under the AIP, for example, have been assessed for the project and are outlined in **Section 7.1** of this report.

The AIP adopts the following definition of an aquifer interference activity from the Water Management Act 2000:

- The penetration of an aquifer;
- The interference of an aquifer;
- The obstruction of the flow of water in an aquifer;
- The taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations;
- The disposal of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations;
- The policy specifies that the volume of water taken from a water source(s) as a result of an activity is required to be predicted prior to project approval and that approval will not be granted unless adequate arrangements are in force to ensure that no more than the minimum harm will be done to an aquifer or its dependent ecosystems;
- Where an activity results in the loss of water from the environment, a water access licence (WAL) is required under the WM Act to account for this water take;
- An activity must address minimal impact considerations in relation to the water table, groundwater pressure and groundwater quality; and
- Where the actual impacts of an activity are greater than predicted, planning measures must be put in place ensuring there is sufficient monitoring.

3.4 Groundwater Numerical Model Development

A numerical groundwater model was developed independently by HydroSimulations using MODFLOW-SURFACT software. MODFLOW-SURFACT is a three-dimensional model used to simulate variably saturated flow. Numerical modelling was carried out using Groundwater Vistas (Version 6.96) in conjunction with MODFLOW-SURFACT. The Groundwater Modelling Assessment Report is attached in **Appendix A**.

This model was based on a groundwater model completed by Aquaterra (2008) as part of the Groundwater Impact Assessment (Peter Dundon & Assoc., 2008) which supported the 2009 approval (07_0087). This model was subsequently built on for more detailed assessments of the Abel, Donaldson and Tasman Mines and a more extensive groundwater model was developed from this for the Abel mine by RPS Aquaterra (2013) and again by HydroSimulations (2015 and 2016).

The model area extends 23.0 km west to east and 16.6 km south to north covering an area of 380 km^2. Simulation time period runs from 1 January 2006 to 31 December 2031. The model consists of 20 layers based on the lithology and separating the coal seams and interburden zones. The model includes the Donaldson, Abel and Tasman Mines for cumulative impact assessment. The revised model includes:

- A re-build of the model geometry in the Bloomfield area;
- Inclusion of the old Big Ben underground workings;
- Inclusion of a dyke in the Bloomfield area; and
- Removal of cells in the southern part of the model to allow the model to run more efficiently, stabilise the model and to not reduce the quality of the model predictions.

Time series groundwater level data from 2006 – 2017 was used to calibrate the model in steady state and transient modes. Reference to the calibration statistics indicates the model has achieved a good calibration.

The groundwater model was developed and calibrated to simulate the existing hydrogeological regime within the Tomago Coal Measures and existing coal mining workings. The model objectives were to:

- Predict groundwater inflows to the new open cut coal mine;
- Predict groundwater drawdown due to groundwater extraction from the open pit;
- Predict groundwater drawdown at registered bores; and
- Predict the impacts the final void will have on long term groundwater levels.

Two predictive model scenarios were run to replicate the long term operations groundwater impacts of the project as follows:

1. **Scenario 1:** A ‘No Mining’ or ‘Null’ run (as per Barnett *et al* 2012), without the past or future Bloomfield mining but with all other surrounding mines active; and
2. **Scenario 2:** A run with the modified Bloomfield mine plan and all other mines active.

Comparison of scenarios 1 and 2 allows the net impact on the hydrogeological environment to be evaluated separately from the effects of Bloomfield alone.

4.0 Existing Environment

4.1 Rainfall and Climate

The nearest long term Bureau of Meteorology (BoM) station to the Bloomfield Colliery is Raymond Terrace 610341, located approximately seventeen kilometres to the east. Rainfall monitoring has been continuous since 1894, although since 1999 the data has become less reliable. Evapotranspiration data has been derived from the BoM Climatic Atlas of Australia. Mean monthly rainfall (1894 – 2017), monthly rainfall for 2016 and monthly evapotranspiration is summarised on **Table 5**.

Mean rainfall is highest during late summer and autumn peaking in March and April. The lowest average rainfall is in late winter and early spring. Evapotranspiration is highest in December and January and lowest in June, exceeding mean monthly rainfall for the months of January to March and August to December. Average monthly rainfall and recorded 2016 monthly rainfall from Raymond Terrace are shown in **Figure 3**.

Mean monthly rainfall (since 1894) has been compared to the recorded 2016 monthly rainfall. Overall 2016 was a drier year with the 991.4 millimetres recorded compared to the mean annual rainfall of 1046.7 millimetres, a difference of 55.3 millimetres. January was an exceptionally wet month with 408 millimetres being recorded which compares to a monthly mean of 98.3 millimetres, a difference of 310.5 millimetres. With the exception of June and August the remaining months were below the mean monthly rainfall.

Table 5 Summary of Monthly Rainfall and Evapotranspiration (Station 610341)

Month	Rainfall mean (mm)	Rainfall 2016 (mm)	Evapotranspiration* (mm)
January	98.3	408.8	182
February	105.7	19.2	143
March	118.1	39.2	127
April	108.1	52.8	96
May	91.7	8.6	68
June	105.5	129.6	57
July	71.0	53.0	67
August	62.6	68.8	93
September	63.1	63.0	120
October	68.9	56.8	149
November	71.8	36.8	167
December	87.0	54.8	200
Total	1046.7	991.4	1470

*Source: Bureau of Meteorology (2001)

The long term data has been collated to calculate a cumulative residual rainfall analysis to assist in the identification of rainfall trends. Time series graphs of cumulative residual rainfall allow long term rainfall patterns to be assessed, with periods of above average rainfall indicated by upward trends and periods of below average rainfall by downward trends. A plot of rainfall residual mass from the Raymond Terrace BoM station for the period 1894 to the end of 2016 is presented as **Figure 4**.

The rainfall residual mass curve shows the Bloomfield area was subjected to relatively dry years from the 1890's to the 1910 followed by a relatively wet period until the late 1940's. The period between the 1940's top the present was relatively wet but punctuated with dry periods, most recently the millennium drought (2001 – 2009). The period from 2009 to 2015 has approximated long term average conditions.

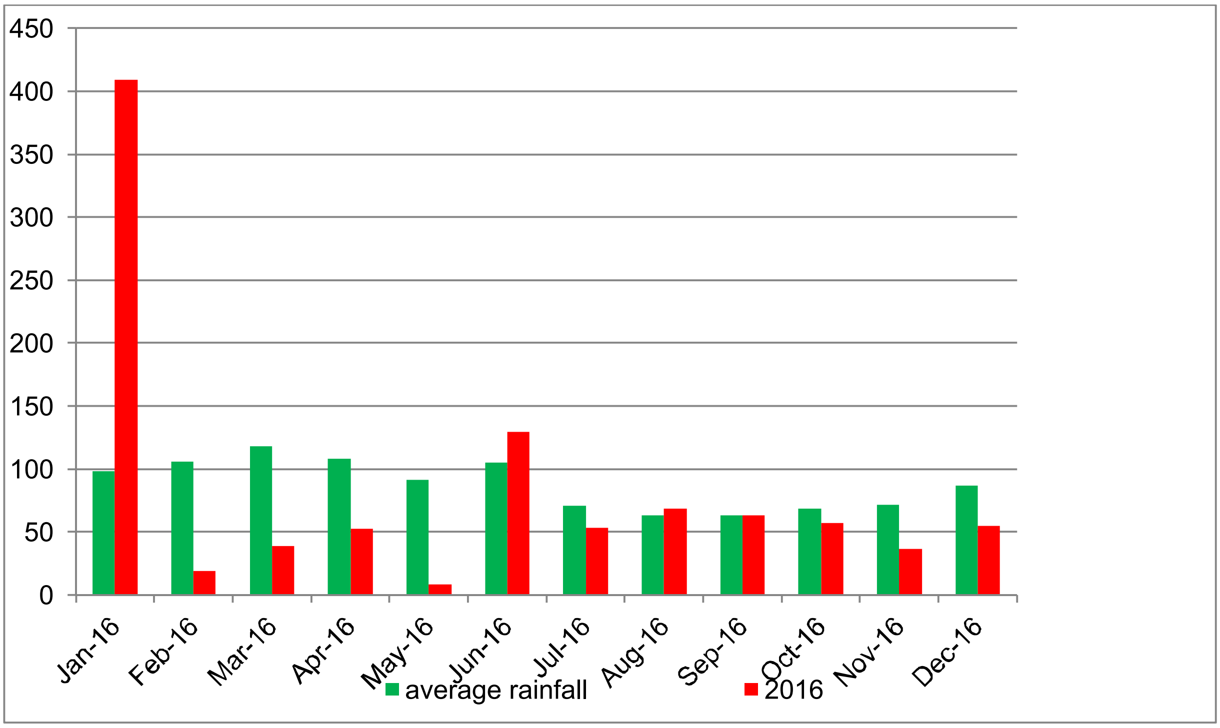

Figure 3 Average Monthly Rainfall compared to 2016 rainfall at Raymond Terrace

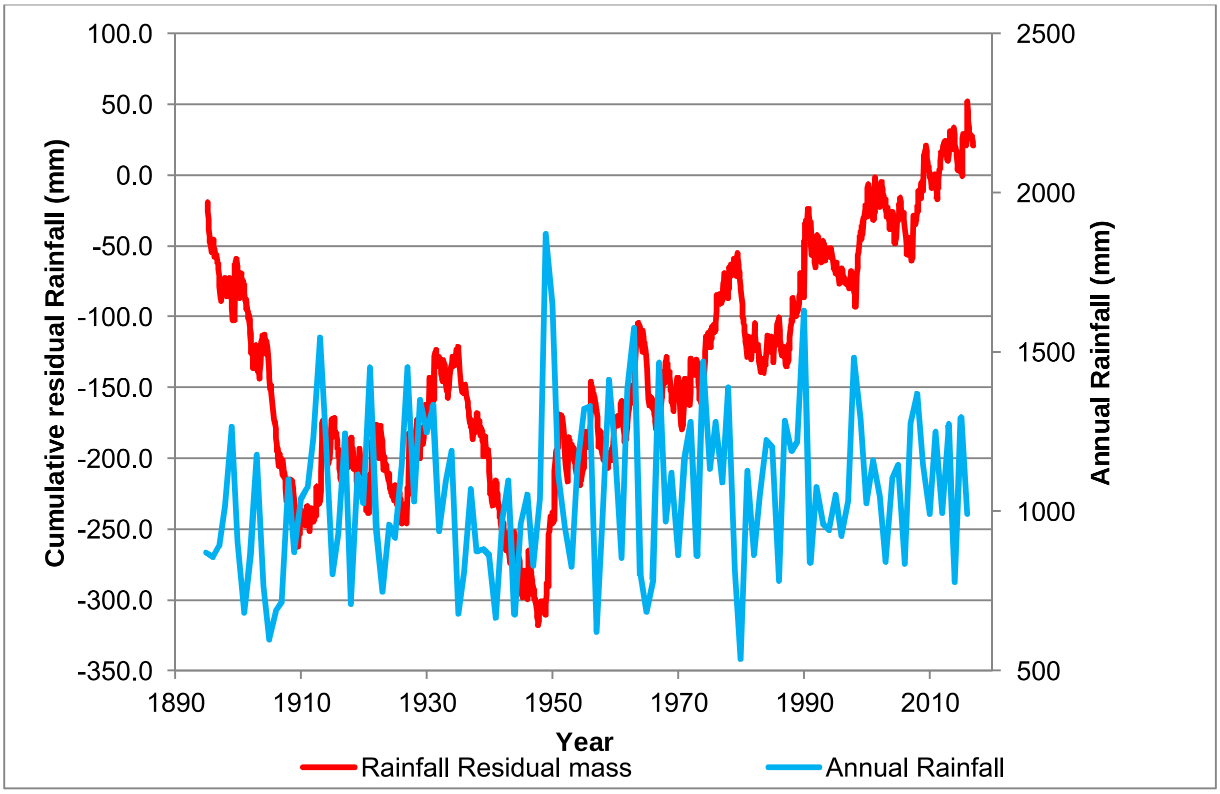

Figure 4 Rainfall Residual Mass – Raymond Terrace 1894 – 2016

The closest BOM station to Bloomfield is at the East Maitland Bowling Club (BOM Station 061034), located about 5 km north-east of the Site. The rainfall record for Raymond Terrace and the East Maitland Bowling Club are similar although Mean monthly rainfall at East Maitland is lower. The East Maitland rainfall record has been used to calculate rainfall recharge in the groundwater model as it is closer to the Mine.

4.2 Physiography

The topography surrounding the Colliery is dominated by gentle undulations to low hilly country. Surface drainage flows towards Whites Creek and Four Mile Creek that discharge into the Hunter River. Most of the operational mining areas at Bloomfield are located within the catchment of Four Mile Creek. Wallis Creek is located west of Bloomfield.

A series of drains and levees direct Four Mile Creek around Lake Foster (mine water storage) and into Possums Puddle (clean water storage). From Possums Puddle, clean water overflows, or is discharged, back into Four Mile Creek. The Colliery has two major mine water storage facilities, referred to as Lake Kennerson and Lake Foster.

The topography across the Colliery mine lease ranges from approximately 15 m AHD (Australian Height Datum) to more than 80m AHD.

4.3 Geology

The Colliery is located within the Permian Tomago Coal Measures of the Hunter Valley Coalfields within the Sydney Basin. The target coal seams are the Big Ben, Donaldson, Elwells Creek, Whites Creek and Upper and Lower Buttai seams (Aquaterra, 2008). Interburden between the coal seams consists of interbedded mudstone, siltstone and sandstone along with minor uneconomical coal seams. The overlying Newcastle coal measures do not outcrop at the site. The sediments dip to the south and south-west. Minor dykes and faults cross cut the strata.

To the west of the Colliery Quaternary alluvial deposits of gravel, sand, silt and clay are associated with Wallis Creek which in part forms a wetland system of disconnected ponds and swamps. To the east Quaternary sediments are associated with the Hunter River floodplain. Hexham Swamp has formed within the Quaternary sediments of the floodplain. Elsewhere across the site there are minor alluvial deposits associated with creeks such as Four Mile Creek and Buttai Creek.

4.4 Hydrogeology

4.4.1 Regional Hydrogeology

There are two aquifer groups that dominate the Upper Hunter Valley, the alluvial deposits of the Quaternary and consolidated sedimentary rocks of the Permian.

Alluvial deposits consisting of gravel, sand and clays where saturated can deliver reliable yields and good quality water which are used for domestic and agricultural purposes. These deposits are typically orders of magnitude more permeable than the Permian age coal seams.

Within the Permian age sedimentary rocks groundwater is typically of poor quality and of low yield. The coals seams represent the main water baring units of the Permian strata and can function as a semi-confined aquifer with vertical leakage from above and below interburden. Weathered zones near or at the surface can act as recharge zones and can form vertically and horizontally disconnected perched aquifers. Permeability’s within the coal seams range from 0.001 to 12 m/day and decrease exponentially with depth (AGE, 1984).

The sedimentary rock interburden has permeability’s in the range of 0.0013 m/ day to 0.4 m/day (AGE, 1984).

Regionally the potentiometric surface is a subdued reflection of the topography. At higher elevation features the potentiometric surface is typically deeper while at low lying features (e.g. valleys) it is typically closer to the ground surface. There is believed to be very limited hydraulic connectivity between the alluvium and Permian Coal Measures (Aquaterra, 2008).

4.4.2 Local Hydrogeology

The hard rock Permian coal measures are the main aquifer unit for the site, with the coal seams themselves representing the most permeable material within the formation. Groundwater typically is restricted to the cleat and fractures within the coal.

Groundwater is also present in the Quaternary alluvium, swamp, floodplain and estuarine sediments. The alluvial groundwater is shallow with groundwater levels being topographically controlled.

The Bloomfield groundwater monitoring network consists of five standpipe piezometers and five Vibrating Wire Piezometers. The potentiometric heads measured within the coal show a progressive decline with depth. There are stronger vertical gradients on the southern boundary and minimal gradients at the western sites (HydroSimulations, 2017). Piezometer logs are attached in **Appendix C**.

Groundwater in the region shows climatic trends where groundwater elevation drops in response to periods of decreased rainfall (Aquaterra, 2008). Long-term mining effects on the local groundwater system can be seen in the hydrographs prepared by HydroSimulations showing a decrease in groundwater elevation in piezometers monitoring the deeper coal seam aquifers, which isn't seen in the upper alluvial aquifer. This infers the alluvium/ weathered overburden and the deeper coal measures are not hydraulically connected.

The highest groundwater levels are in the northern part of the site where the coal measures outcrop. Pre mining the lateral hydraulic gradient would have been to the south and south east, however as a result of open cut mining, large sinks now exist and the natural gradient has been reversed (Aquaterra, 2008; HydroSimulations, 2017).

4.5 Recharge and Discharge

Recharge for the surficial alluvial aquifers and outcrop areas is dominated by rainfall. The alluvial aquifer is likely to be connected to Wallis Creek and Hexham Swamp, and would discharge to the streams. In wetter periods where the stream levels are higher than that of the water levels in the alluvium, they may contribute to stream flow or seepage from the streams into the aquifer may occur, although this would be short lived after rainfall events.

Coal seams are recharged by rainfall only at outcrop areas. At depth the coal seams are recharged by lateral flow down-gradient from outcrop areas and vertical flow through the overburden (HydroSimulations, 2017).

Groundwater discharge occurs by:

- Evapotranspiration in shallow water table areas;
- Spring flow;
- Baseflow contributions in wet periods;
- Evaporation from in-pit pools and seepage faces; and
- Direct pump out.

Due to naturally high salinity and low yields there is no other significant groundwater abstraction other than mining. There are only a few stock/ domestic bores registered in the government bore database (HydroSimulations, 2017). Bore logs for registered bores within a 4.5 km radius of the Mine are collated in **Appendix D**.

Average A Class pan evaporation for Cessnock (station 061242) and Paterson (061250) are presented below, and have a daily average of 4 mm/ day (1,460 mm/a).

Table 6 Mean Daily Evaporation Data for Cessnock and Paterson Stations (mm/d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cessnock (1966 – 2012)	5.7	4.9	3.9	2.8	1.9	1.5	1.7	2.5	3.5	4.3	5.0	5.7
Paterson (1967 – 2017)	6.2	5.3	4.2	3.2	2.4	2.1	2.4	3.3	4.4	5.2	5.8	6.6

The actual evapotranspiration (ET) in the district is approximately 800 mm/a according to BoM (2017). The definition for actual ET is "*the ET that actually takes place, under the conditions of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variation are integrated to an area average. For example, this represents the ET which occur over a large area of land under existing (mean) rainfall conditions*" (HydroSimulations, 2017).

4.6 Existing Groundwater Usage

A review of the DI-CLW registered groundwater database showed there were 22 registered bores within 4.5 km of the Colliery most of which were monitoring bores.

4.7 Groundwater Dependent Ecosystems

The *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources* (DPI Water, 2016) does not list any high priority groundwater dependent ecosystems (GDE's) in the vicinity of the site.

Similarly within the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources* (DWE, 2009) there are no high priority GDE's in the vicinity of the site.

4.8 Groundwater Quality

Groundwater in the vicinity of the mine is generally:

- Saline and of negligible beneficial use. Total Dissolved Solids (TDS) concentrations ranged from 1000 mg/L to 13,000 mg/L (Aquaterra, 2008); and
- pH is generally close to neutral (Aquaterra, 2008; Business Environment, 2008).

4.9 Groundwater Surface Water Interaction

The shallow alluvial aquifer, which is associated with Wallis Creek and the Hunter River floodplain, is inferred to be in direct hydraulic connection with the lower reaches of the major tributary streams in the area. This is based on a close correlation between the surface water and groundwater levels (Aquaterra, 2008) and groundwater baseflow in the ephemeral water courses, which is likely to reverse direction during periods of heavy surface water flow.

Groundwater in the localised surficial weathered bedrock is inferred to be in hydraulic connection with the high-level streams. These limited occurrences of surficial groundwater do not represent a significant or regionally extensive aquifer system, and are not considered to be part of the surface water flow system.

There is no evidence of connectivity between surface waters and the deeper aquifers of the coal measures (Aquaterra, 2008).

Modelling of the groundwater and surface water interactions for surface water systems surrounding Bloomfield found that all watercourses were inferred to be gaining systems with the exception of Buttai Creek and Hexham Swamp. The Surface Water Assessment conducted by AECOM (2017) found the final proposed landform will result in a reduction in the catchment area draining towards the final void to approximately 52 Ha, a decrease from the 103 Ha under the currently approved final landscape design. This increases the catchment to Buttai Creek by 41 hectares.

Figure 5 and **Figure 6** show the local and regional surface water system relative to the Colliery.

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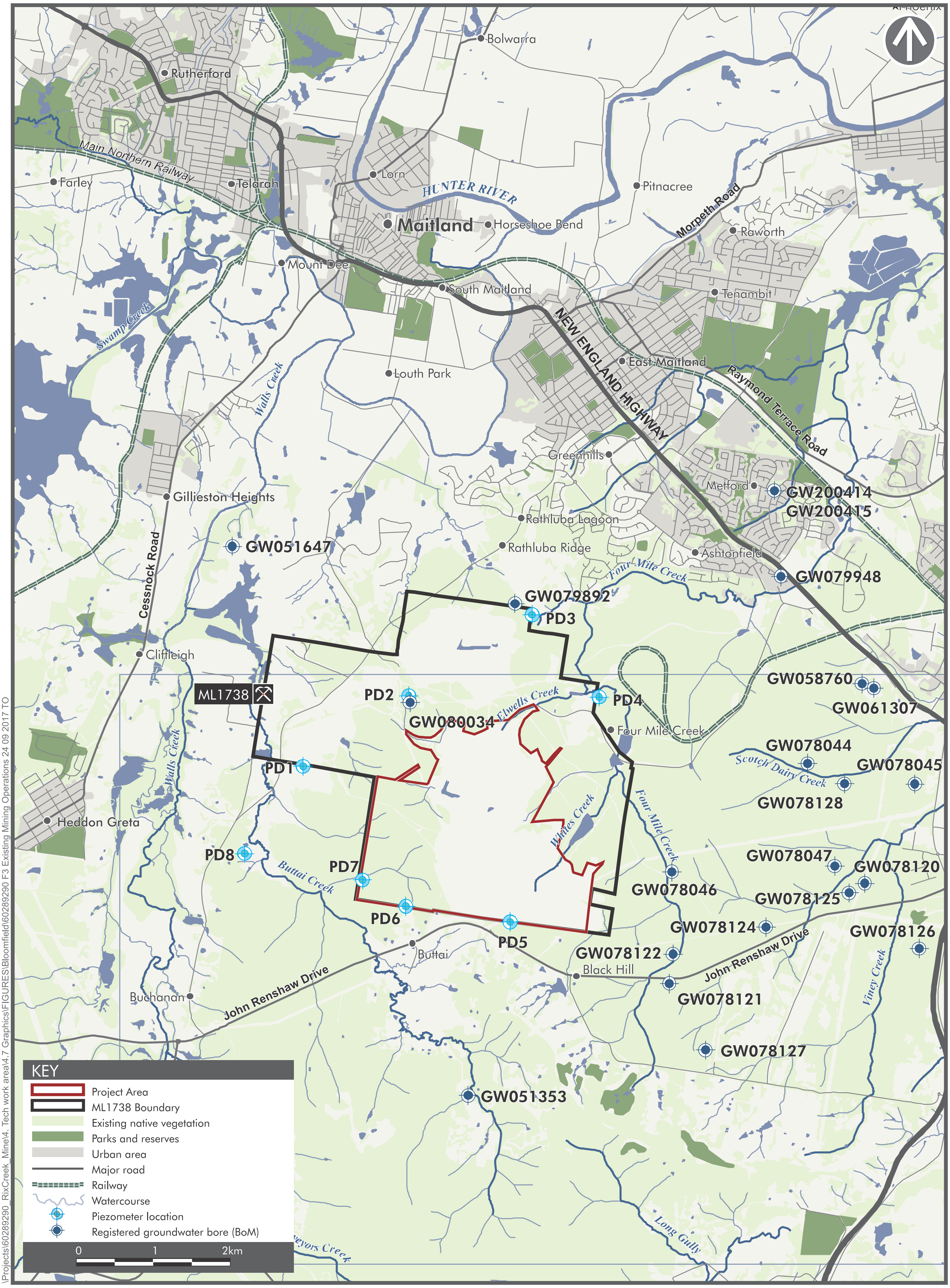
AECOM

EXISTING MINING OPERATIONS
Bloomfield Project

FIGURE 5



AECOM

GROUNDWATER MONITORING BORES AND SURROUNDING REGISTERED BORES

Bloomfield Project

FIGURE 6

5.0 Assessment of Potential Impacts

5.1 Groundwater Extraction

5.1.1 Predicted Mine Inflows

Predicted groundwater extractions via mine inflows are presented in **Table 7.** Inflows in 2006 are predicted to be 0.9 ML/d at the start of open cut mining and will peak around 1.6 ML/d (year 2013) in the calibration period and a peak of 1.5 ML/d in the prediction period. These rates do not incorporate evaporation losses that will occur when the groundwater is exposed to the atmosphere. In 2025 at the cessation of mining inflows are predicted to be approximately 1.0 ML/d.

Table 7 Bloomfield Mine inflow rates (2006 - 2132)

Mine year		Stress Period	Mine inflow (ML/d)	Mine inflow (ML/year)
Calibration	2006	2	0.88	322
	2007	4	0.82	300
	2008	6	0.85	312
	2009	8	0.87	318
	2010	10	0.92	336
	2011	11	1.18	430
	2012	12	1.4	513
	2013	13	1.57	572
	2014	14	1.51	551
	2015	15	1.4	511
	2016	16	1.2	440
	2017	17	1.24	455
Prediction	2018	18	1.42	520
	2019	19	1.42	520
	2020	20	1.54	561
	2021	21	1.53	559
	2022	22	1.16	423
	2023	23	0.69	253
	2024	24	1	367
	2025	25	1	367
	2026	26	0	0
	2027	27	0	0
	2028	28	0	0
	2029	29	0	0
	2030	30	0	0
	2031	31	0	0
Recovery	2032 - 2132	32	0	0

5.1.1.1 Mine Inflow Prediction Refinement

The groundwater model is conservative and applies higher rainfall recharge to the model at various locations across the model domain, resulting in higher predicted mine flows. Two areas of increased modelled recharge are as follows:

1. Mine spoil area; and

2. Catchments of surface water run-off diversions[1]

The mine spoil area (43.3 ha) and the hardstand workshop area (7.5 ha) west of the mine spoil area will receive no rainfall recharge as runoff is captured from these areas and discharged off-site. A recharge rate of 5% of annual rainfall was applied to these areas to keep the model stable. Removal of this water from the model will reduce the mine inflows by 22.61 ML/year.

Clean water catchments across the site divert clean surface water runoff to storage dams which are part of the natural surface water system limiting rainfall recharge. There are four clean water sub-catchments with a total surface area of 623 ha as follows:

1. Buttai Creek – 269 ha;
2. Four Mile Creek – 141 ha;
3. Possum Puddle west 135 ha; and
4. Possum Puddle east 78ha.

A reduction in groundwater recharge from 5% (modelled) to 4% across these catchments is considered realistic to account for the enhanced rainfall runoff. Removal of this water from the model will reduce the mine inflows by 55.4 ML/year.

Thus in total the mine inflow refinements which include a reduction in rainfall recharge from the mine spoil area and clean water sub-catchments would reduce mine inflows by a total of 78.0 ML/year.

The estimated annual water requirements for licensing is summarised in **Table 8** based on the revised mine inflows for the water year. The water year is assumed to be from July through to June.

Table 8 Modelled Mine and Refined Inflows for the Water Year

Water Year	Licence Requirement (ML/year)	
	Modelled	Refined inflow
2016/17	447.5	369.5
2017/18	487.5	409.5
2018/19	520	442
2019/20	540.5	462.5
2020/21	560	482
2021/22	491	413
2022/23	338	260
2023/24	310	232
2024/25	367	289
2025/26	183.5	105.5
2026/27	0	0

The predicted licence requirements from the refined inflows vary from 369.5 ML/year in 2016/17, reaching a maximum of 482 ML/year in 2020/21 and declining to zero in 2026/27. These predicted mine inflows are within the existing mine licence discharge licence of 500ML/year.

[1] The clean water catchment boundaries are defined by the contours, clean and dirty water drawings provided by Bloomfield. The mine lease boundary forms the edge of the catchment areas, where in some instances the actual catchment extends beyond the mine lease boundary. Further detail on the diversion works would assist in refining these catchments.

5.1.2 Alluvial Takes

The alluvial takes from the Wallis Creek Water Source and the Newcastle Water Source are presented in **Table 9**. These takes are only as a result of Bloomfield mining operations and have been considered in the overall mine inflow rates (HydroSimulations, 2017).

Table 9 Modelled Alluvial Takes

	Wallis Creek Water Source Take Extra Leakage (ML/ year)		Newcastle Water Source Take Less Upflow (ML/ year)	
	Calibration Period (2006 – 2017)	Prediction and Recovery Period (2018 – 2132)	Calibration Period (2006 – 2017)	Prediction and Recovery Period (2018 – 2132)
Maximum	8	26	0.2	8
Mean	4	12	0.0	2

5.1.3 Final Void

The final void will remain a sink and will have a wide spread effect of lowering water levels in the vicinity of the mine in the long term. A hypothetical monitoring point within the final void is predicted to only recover 15 m after 100 years, with a void water surface of -40 m AHD (HydroSimulations, 2017).

5.2 Groundwater Drawdown

Predicted groundwater heads have been modelled to show groundwater level and drawdown at the completion of mining in 2025.

Drawdown as a result of mining activities at the Colliery are expected to reach a maximum in the Mine Year 20 or 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and the groundwater levels would start to recover (HydroSimulations, 2017).

Drawdown of 100 m is predicted in the surficial aquifer layer 1 in the Bloomfield extraction area and final mine void (alluvial and regolith) although it is limited in extent. Significant drawdown is also evident within the lease area to the north-west of approved extraction area corresponding with historical open cut and underground mining. Drawdown from the open cut is propagating into the high permeability underground voids, although there is some spatial confinement with the north-westerly trending dyke.

Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek (HydroSimulations, 2017).

The predicted drawdowns are not expected to negatively impact GDE's as historical mining in the area has previously lowered water levels far below the ground surface.

The Donaldson open cut and final void are predicted to experience significant drawdown, however there is no overlap of the water table drawdowns produced by the various mines (HydroSimulations, 2017).

Predicted drawdowns at the end of mining in nearby registered bores (within 5 km) are shown in **Table 10**. All values are cumulative.

Most of the drawdown are predicted to be less than 1 m, however drawdowns between 1-2 m are predicted for three bores (GW078047, GW078128 and GW078044), which is within the Aquifer Interference Policy threshold of 2 m.

Larger drawdowns are predicted for GW078124 and GW078124 with 20 m and 17 m drawdown respectively due to the final void at the Donaldson mine.

Table 10 Predicted Drawdown in Registered Alluvial Bores at End of Mining 2025

Bore name	Easting (MGA)	Northing (MGA)	Bore depth (m)	Drilled year	Predicted drawdown (m)
GW200415	369986	6373738	20.1	2004	<1
GW078120	371176	6368590	24	1997	<1
GW080034	365222	6370959	NA	NA	<1
GW078125	370970	6368464	30	1997	<1
GW058760	371142	6371207	33	1983	<1
GW061307	371299	6371148	30	1984	<1
GW200414	369960	6373761	10	2004	<1
GW078123	369309	6386165	33	1997	17
GW051647	362896	6373006	12	1980	<1
GW078047	370784	6368800	54.3	1997	1.5
GW078122	368666	6367663	35.4	1997	<1
GW078124	369883	6368018	40	1997	20
GW078045	371836	6369892	30.5	1997	<1
GW078128	370912	6369893	30	1997	2
GW051353	365986	6365810	49.7	1997	<1
GW079892	366598	6372257	6.69	1980	<1
GW078046	368651	6368741	30.4	NA	<1
GW079948	370081	6372613	NA	1997	<1
GW078044	370428	6370151	30.1	NA	1.4
GW078127	369073	6366406	30	1997	<1
GW078126	371890	6367736	30	1997	<1
GW078121	368619	6367262	43	1997	<1

5.3 Groundwater Quality Impacts

Groundwater within the Bloomfield mine lease is saline and of negligible beneficial use. The potential impacts of Bloomfield's current and future operations relate to the risks of contamination from disturbed catchments, mine water, and process water being released off site to natural waterbodies.

Discharges to Four Mile Creek from Bloomfield occur from Lake Foster discharge pipe outlet and are monitored and reported in accordance with EPL 396. Since the approval of the Project there have been four unplanned discharges as a result of large rainfall events or pipe failure which resulted in water overflowing from storage dams and leaving the site. These incidents were reported to the EPA in accordance with Project Approval and EPL requirements.

The proposed modification being sought by Bloomfield will not increase or decrease the probability of unplanned discharges, or water quality risks, from Bloomfield's operations. However these risks will continue to exist up until the end of extraction (2030) and until such time as the site is rehabilitated noting that risks would decrease with the progressive rehabilitation of post mining areas across the life of the project. As part of the management measures described in Section 6.0 Bloomfield will update the environmental management systems as part of the project to further minimise the risk of unplanned discharges.

5.4 Baseflow Impacts

The model was set up to accept baseflow if groundwater levels exceeded riverbed elevations, but not to allow leakage as most streams in the area are ephemeral. The model was able to predict reduction to baseflow but was unable to predict increases in leakage from losing streams. Baseflow simulations were run for both mining and null simulations.

The predictions are:

- Four Mile Creek is predicted to be converted to a losing stream around 2011, therefore its average baseflow of 0.24kL/ day would be lost;
- The difference between mining and null runs for all other water courses was negligible, indicating that Bloomfield mining is having an insignificant effect on baseflow capture; and
- Leakages for Hexham Swamp differed by no more than 1 kL/ day between both mining and null. This would be within numerical error bounds.

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6.0 Monitoring and Management of Impacts

6.1 Monitoring

In order to monitor the drawdown effects from depressurisation of the regional aquifer ongoing quarterly monitoring of the onsite piezometer network and monthly surface water monitoring is recommended. In addition the installation of additional monitoring points will be considered if areas of predicted drawdown are significantly different to actual drawdown.

The frequency of water level measurements within the pit should be compatible with evaporation rates obtained from the site's weather station which will allow refinement of model calibration and inflow predictions.

6.2 Management

Bloomfield has an existing Water Management Plan (WMP) which details the monitoring and management measures which are currently in place for the management of groundwater (and surface water) at the Colliery. The WMP will be reviewed and updated in accordance with the conditions of consent to monitor groundwater levels in monitoring wells and in the pit. Groundwater discharge will be monitored to quantify pit inflows to ensure the discharge licence conditions are satisfied.

The monitoring data collected from groundwater and surface water systems enables management of groundwater impacts through the following recommendations:

- Establishment of groundwater and surface water trigger levels based on the beneficial use of each water body;
- Mitigation measures may include the provision of 'make good' measures in bores where excessive drawdown may be experienced. This could involve deepening a water supply bore or providing an alternative water supply. No surface water mitigation measures are proposed due to the minimal predicted impacts;
- Groundwater level data will be plotted as hydrographs and compared to rainfall; and
- The results of the groundwater monitoring program will be collated on an annual basis and presented in an annual report as required under the conditions of consent.

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7.0 Policy Compliance

7.1 Aquifer Interference Policy

The *Water Act 1912* (NSW) has been replaced by the WM Act and does not apply to areas of the state where water sharing plans are in place. Groundwater and surface water within the project footprint are covered by the *Water Sharing Plan for the Hunter Regulated River Water Source* and the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*.

The AIP explains the requirements of the WM Act. It clarifies the requirements for licences for aquifer interference activities and establishes the considerations required for assessing potential impacts on key water dependent assets. Any potential impact on local aquifers would be assessed under this policy.

A controlled activity approval (such as a water access licence or aquifer access licence) and/or an aquifer interference approval is required under the WM Act for any activity that results in interference to an aquifer. Under section 91F of the WM Act, approval is required for aquifer interference activities. These activities include the taking of groundwater. The policy applies to all aquifer interference activities, but has been developed to address a range of high risk activities.

7.2 Minimal Impact Assessment

The AIP outlines minimal impact considerations that must be met as a result of the proposal. The minimal impact considerations are dependent upon the impacted aquifer type (alluvial, coastal, fractured rock or special cases such as the Great Artesian Basin) and whether the aquifer is 'highly productive' or 'less productive groundwater'. The impacts to be considered are to groundwater levels (or water pressure in artesian basins) and water quality as follows:

- **Water table** (drawdown) – impact is considered to be minimal where there is less than a cumulative two metre decline at any water supply work. If the impact is greater than two metres than make good provisions apply;
- **Water table** (receptors) – impact is considered to be minimal where the water table change is less than 10 percent of the cumulative variation in the water table 40 metres from any high priority GDE or high priority culturally significant site listed in the water sharing plan;
- **Water pressure** – impact is considered to be minimal where the cumulative decline in head is less than two metres at any water supply work; and
- **Water quality** – impact is considered to be minimal where the change in groundwater quality is within the current beneficial use category of the groundwater beyond the 40 metres of the activity.

If the predicted impacts are less than Level 1 minimal impact considerations (as defined in the AIP) then these impacts are considered acceptable. If, however, the impacts are assessed as greater than Level 1 but these predicted impacts exceed the Level 1 thresholds by no more than the accuracy of a robust model, the project would be accepted as suitable with appropriate monitoring during operation. To reduce the impacts, mitigation measures such as make good provisions may be required to protect a resource or receptors. Where the groundwater impacts are deemed not acceptable the project may have to be modified to reduce the groundwater impacts on an acceptable level.

The majority of the project footprint is considered to be within a 'Less Productive Groundwater Source' within fractured rock, based on the low number of registered bores in the area. In outlining the Minimal Impact Considerations (Table 1, AIP) the policy considers porous and fractured rock water resources together.

A minimal impact assessment has been conducted for the groundwater potentially impacted by the project in accordance with the *NSW Aquifer Interference Policy Step by Step Guide* (NoW, 2013b). The minimal impact considerations for 'highly productive groundwater' in a fractured rock aquifer and for 'less productive groundwater' in a coastal aquifer are presented in **Table 11** and **Table 12** respectively.

Table 11 Minimal Impact Considerations for a 'highly productive groundwater alluvial aquifer"

Minimal Impact Considerations	Response
Water Table – Level 1 Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post water sharing plan' variations, 40 m from any: High priority groundwater dependent ecosystem; or High priority culturally significant site listed in the schedule of the relevant water sharing plan, or A maximum of a 2 m decline cumulatively at any water supply work.	There are no high priority groundwater dependent ecosystems listed under the *North Coast Fractured and Porous Rock Groundwater Sources* No culturally significant sites were identified within the *North Coast Fractured and Porous Rock Groundwater Sources* Groundwater modelling indicates that drawdown effects on the surficial aquifer are not expected to have any adverse impact on groundwater dependent ecosystems because the groundwater levels are already well below ground surface.
Water Table – Level 2 If more than 10% cumulative variation in the water table, allowing for typical climatic 'post water sharing plan' variations, 40 m from any: High priority groundwater dependent ecosystem; or High priority culturally significant site; listed in the schedule of the relevant water sharing plan, if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	The alluvium of both the Wallis Creek Water Source and the Newcastle Water Source (along the lower Hunter) are classified as 'Highly Productive' by DPI Water. The calculated alluvial takes (rounded to the nearest ML/a) for separate simulation phases are recorded in **Table 9**. These takes are due only to Bloomfield mining. The standpipe SP4-2 is located near Four Mile Creek. It is more likely that the water level in this bore is influenced by water level in the creek, when it flows. The simulated hydrograph shows a rising trend for some years, followed by stabilisation. SP7-1 is located at the western border of the Bloomfield mine. The prediction and recovery stages of the simulated hydrograph suggest that the water level will decline due to mining and not recover significantly. This bore would remain within the zone of influence of the final void. Most of the drawdown for registered bores calculated by the model are much less than 1 m, while drawdown greater than 1 m and up to 2 m are predicted at three bores (GW078047, GW078128 and GW078044), which is within the AIP's 2 m threshold. Large predicted drawdowns of 20 m and 17 m at bores GW078124 and GW078123 are due to the final void at the Donaldson mine. Mitigation measures have been recommended for GW078124 and GW078123 located near the Donaldson Mine where it has been predicted that the drawdown exceeds a water level decline of more than 2 m. The predicted groundwater level decline will not prevent the long term viability of the bore and make good provisions will be covered by the Donaldson Mine groundwater management plan.

Minimal Impact Considerations	Response
Water Quality – Level 1 Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Not applicable
Water Quality – Level 2 If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long term viability of the dependent ecosystem, significant site or affected water supply works.	Not applicable

Table 12 Minimal Impact Considerations for a 'Less Productive Fractured Rock Aquifer'

Minimal Impact Considerations	Response
Water Pressure – Level 1 A cumulative pressure head decline of not more than a two metre decline, at any water supply work.	Significant drawdown is also evident within the lease area to the north-west of the approved extraction area, coincident with historical open cut and underground mining. Drawdown from open cut mining is propagating into the high-permeability underground voids, with some spatial confinement offered by a north-westerly trending dyke. The drawdown is generally less than 0.5 m outside the Bloomfield lease boundary except for the south-west corner where a 2-m drawdown contour extends off-lease. The 2 m of drawdown extends beneath Buttai Creek for a distance of about 600 m.
Water Pressure – Level 2 If the predicted pressure head decline is greater than condition 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long term viability of the affected water supply works unless make good provisions apply.	Whites Creek Seam: All three vibrating wire piezometers (VWP) lie along the southern boundary of the Bloomfield lease. All simulated hydrographs show significant mining effects, with the degree of recovery being minimal but increasing from east to west, due to the effects of adjacent underground mining. Donaldson Seam: Four out of seven bores (SP2-1, VW1(35m), VW6(114m) and VW7(95m)) in this layer show slow water level recovery post-mining. Water levels at bores SP3-1 and VW5(71m) show no sign of recovery. Most bores are influenced by adjacent underground mining. Big Ben Seam: All simulated hydrographs show significant declines due to mining, with slow or negligible recovery in some cases. Most bores are influenced by adjacent or historical underground mining.
Water Quality – Level 1 Any change in the groundwater quality should not lower the beneficial use category of the	Not applicable

Minimal Impact Considerations	Response
groundwater source beyond 40 m from the activity.	
Water Quality – Level 2 If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long term viability of the dependent ecosystem, significant site or affected water supply works.	Not applicable

7.3 Compliance with the Water Sharing Plan

The project is covered by the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*, which applies to 13 groundwater sources. The Water Sharing Plan outlines a series of rules for granting access licences (Part 7), managing access licences (Part 8), water supply works approvals (Part 9), access licence dealings (Part 10) and mandatory conditions (Part 11). A summary of relevant rules and an assessment of project compliance are provided in **Table 13**, it was found that all rules are complied with.

Table 13 Project Compliance with the Water Sharing Plan

Rule	Assessment
Rules for granting access licences	Groundwater access is managed under Licence 20BL172035. There are no surface water licences.
Rules for managing access licences	The EPL and Water Management Plan detail the process in which water access is managed and discharged.
Distance restrictions to minimise interference between supply works	There are no supply works within the area of the Colliery.
Distance restriction from the property boundary is 50 m	Property boundary is outside the 50 m restriction.
Distance restriction from an approved water supply work is 100 m	No bores registered to property outside the Mine have been identified within 100 m of the project.
Distance restriction from a Department observation bore is 200 metres	There are no DPI Water observation bores within 200 m of the project footprint.
Distance restriction from an approved work nominated by another access license is 400 m.	There are no water supply works nominated by another access licence within 400 m of the project footprint.
Distance restriction from an approved water supply work nominated by a local water utility or major utility access licence is 1000 m	There are no local or major water utilities within 1000 m of the project footprint.
Part 9 – 40 Rules for water supply works located near contaminated sources	There are no identified contamination sources located near the project area.
Part 9 – 41 Rules for water supply works located near sensitive environmental	The project footprint is located outside the required distance for the following sensitive environmental areas:

Rule	Assessment
areas	• 200 m of a high priority groundwater dependent ecosystem; • 500 m of a karst groundwater dependent ecosystem; and • 40 m from a lagoon or escarpment. The project footprint is not located outside the required distance of the following sensitive environmental areas: • 40 m from third order streams or above. The non-compliance of the third order streams is considered acceptable as the creeks form part of the surface water discharge system under the Mines EPL.
Part 9 – 42 Rules for water supply works located near groundwater dependent culturally significant sites	The project footprint is not located near a groundwater dependent culturally significant site.
Part 9 – 44 Rules for water supply works located within distance restrictions	There are no water supply works that are located within restricted distances along the project footprint.
Part 10 – Access dealing rules	Groundwater access is managed under Licence 19027. There are no surface water licences.

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8.0 Conclusions and Recommendations

Bloomfield is seeking approval for modifications to Project Approval 07_0087, for the extension of mining operations up until 31 December 2030 and a revised final landform.

Mine scheduling to support the Project Approval identified that the resource would be exhausted by the end of 2021. However, Bloomfield now predicts mining to extend beyond 2021 due to:

- Actual run of mine (ROM) production levels have been lower than the predicted ROM production rates of 1.3 Mtpa, over the life of the project to-date;
- Changes to the mine fleet have allowed access to, and extraction of seams that were not previously considered to be a recoverable resource as part of the original 2008 EA; and
- Further exploration has identified other previously unrecoverable resources that the new fleet can now access.

Bloomfield has identified up to 13 million tonnes of ROM coal remaining inside the approval area. Based on current annual mining rates of approximately 1 million tonnes of ROM per year, mining will extend beyond 2021. The intention of this consent modification is to align the Bloomfield mining operations consent limit to coincide with the adjoining Abel Underground Mine consent limit of 31 December 2030. Maximum annual production levels will continue at 1.3 Mtpa ROM per year.

For licencing purposes the maximum inflow predicted by the model across the life of the proposed Project is 561 ML/a in 2020. However the groundwater model is conservative and applies higher recharge across parts of the model domain. The mine inflows have been recalculated reducing recharge to these areas and the resultant mine inflows are within the licence conditions of 500ML/a. The final void will remain a sink and will have a wide spread effect of lowering water levels in the vicinity of the mine in the long term. A hypothetical monitoring point within the final void is predicted to only recover 15 m after 100 years.

Groundwater drawdown as a result of mining activities are expected to reach a maximum in 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and groundwater levels would start to recover. A drawdown of 100 m is predicted in the surficial aquifer in the Bloomfield approved extraction area and final mine void. Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek. The predicted drawdowns are not expected to negatively impact GDE's as historical mining in the area has lowered water levels far below the ground surface.

Discharges to Four Mile Creek from Bloomfield occur from Lake Foster discharge pipe outlet and are monitored and reported in accordance with EPL 396. The proposed modification will not increase or decrease the probability of unplanned discharges, or water quality risks from Bloomfield's operations.

Predicted surface water impacts were considered negligible, indicating that Bloomfield mining is having an insignificant effect on stream baseflow. Four Mile Creek is predicted to have been converted to a losing stream around 2011, losing an average baseflow of 0.24kL/ day.

A minimal impact assessment has been conducted for the groundwater potentially impacted by the project in accordance with the AIP. All predicted impacts are less than Level 1 minimal impact considerations (as defined in the AIP) and are therefore considered acceptable with appropriate monitoring during operation.

The project is covered by the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*. An assessment of project compliance found that all rules are complied with.

Monitoring and Management Recommendations

In order to monitor the drawdown effects from depressurisation of the regional aquifer ongoing quarterly monitoring of the onsite piezometer network and surface water monitoring is recommended. In addition the installation of additional monitoring points will be considered where areas of predicted drawdown are significantly different to that of the actual drawdown.

The frequency of water level measurements within the pit should be compatible with evaporation rates obtained from the site's weather station which will allow refinement of model calibration and inflow predictions.

The monitoring data collected from groundwater and surface water systems enables management of groundwater impacts through the following recommendations:

- Establishment of groundwater and surface water trigger levels which require an assessment of the ongoing impact at each location;
- Mitigation measures may include the provision of 'make good' measures in bores where excessive drawdown may be experienced. This could involve deepening a water supply bore or providing an alternative water supply. No surface water mitigation measures are proposed due to the minimal predicted impacts; and
- Groundwater monitoring is to be undertaken in accordance with a groundwater monitoring plan developed in accordance with the approval consent conditions.

9.0 References

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