WATER MANAGEMENT PLAN

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FOREWORD

In accordance with Schedule 2, Condition 19 of Project Approval PA 11_0047, Tarrawonga Coal Pty Ltd may submit any strategy, plan or program required by the Project Approval on a progressive basis, with the approval of the Director-General. Until they are replaced by an equivalent strategy, plan or program approved under the consent, Tarrawonga Coal Pty Ltd will continue to implement the existing strategies, plans and programs that apply to any development on site in accordance with Schedule 2, Condition 20 of PA 11_0047.

This Water Management Plan will be submitted on a progressive basis.

In accordance with Schedule 3, Condition 39 of PA 11_0047 the Tarrawonga Coal Mine (TCM) Water Management Plan includes a:

- Site Water Balance;
- Surface Water Management Plan;
- Groundwater Management Plan; and
- Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) Water Management Strategy.

Whitehaven submitted a modification of the Project Approval, which included an update to the Tarrawonga Mine Operations Plan in 2020. This update Water Management Plan has been prepared following the approval of the modification in May 2021 and feedback provide by DPE on the Water Management Plan Addendum, approved by the Secretary in October 2022.

TCM have been in consultation with the nearby Boggabri Coal Mine and Maules Creek Project to develop a BTM Complex Water Management Strategy incorporating cumulative water impacts and management, as required under the conditions of PA 11_0047. The Strategy has been approved by the Department of Planning and Environment with conditions. The current Strategy has been appended to this Plan in Appendix E.

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ACRONYMS USED THROUGHOUT THIS DOCUMENT

AEMR	-	Annual Environmental Management Report
AR	-	Annual Review
AS	-	Australian Standard
CCC	-	Community Consultative Committee
DP&E	-	Department of Planning and Environment
EA	-	Environmental Assessment
EPA	-	Environment Protection Authority
EPL	-	Environment Protection Licence
GSC	-	Gunnedah Shire Council
MEG	-	Department of Regional NSW, Mining, Exploration and Geoscience
ML	-	Mining Lease
MOP	-	Mine Operations Plan
Mtpa	-	Million tonnes per annum
NRAR	-	Natural Resources Access Regulator
NSC	-	Narrabri Shire Council
TCM	-	Tarrawonga Coal Mine
TCPL	-	Tarrawonga Coal Pty Ltd
WAL	-	Water Allocation Licence
WMP	-	Water Management Plan
WMS	-	Water Management System

1 INTRODUCTION

1.1 Background

The Tarrawonga Coal Mine (TCM) is located approximately 15 km northeast of Boggabri, directly adjacent to, the Boggabri Coal Mine (BCM) (Figure 1). The mine site is contained within Mining Leases (ML) 1579, ML 1693, ML 1685 and ML 1749 as shown in Figure 1. The mine is operated by Tarrawonga Coal Pty Ltd (TCPL), which is owned by Whitehaven Coal Mining Limited, and operates under Environment Protection Licence (EPL) 12365 and Project Approval PA 11_0047.

In 2013 TCM received Project Approval (PA) 11_0047 from the Planning Assessment Commission (as delegate of the Secretary for Planning and Infrastructure) under Part 3A of the *Environmental Planning and Assessment (EP&A) Act* for the Tarrawonga Coal Project which provides for the continuation and extension of the mine. Since 2013, TCM have made nine modifications to PA_110047. The most recent Modification 9 was approved in May 2021.

This Water Management Plan (WMP) has been prepared with reference to relevant legislation, approvals and guidelines including the management plan requirements specified in Schedule 3, Condition 39 and Schedule 5, Condition 3 of PA 11_0047. This WMP is consistent with the Tarrawonga Coal Project Environmental Assessment, relating to surface water and groundwater water management and the Forward Program required under 13(1) Schedule 8A of the Mining Regulation 2016.

1.2 Project Description

During the current MOP term, open cut mining will continue eastward within the project boundary. Mine sequencing and overburden emplacement development is shown in the Forward Program.

Truck and shovel mining methods are utilised for pre-stripping and coal recovery.

Operations at TCM for the Life of Mine include:

- continued development of mining operations in the Maules Creek Formation to facilitate a Run of Mine (ROM) coal production rate of up to 3.5 Mtpa, including open cut extensions:
  - to the east within Mining Lease 1579 and Mining Lease 1693; and
  - to the north within Mining Lease 1685.

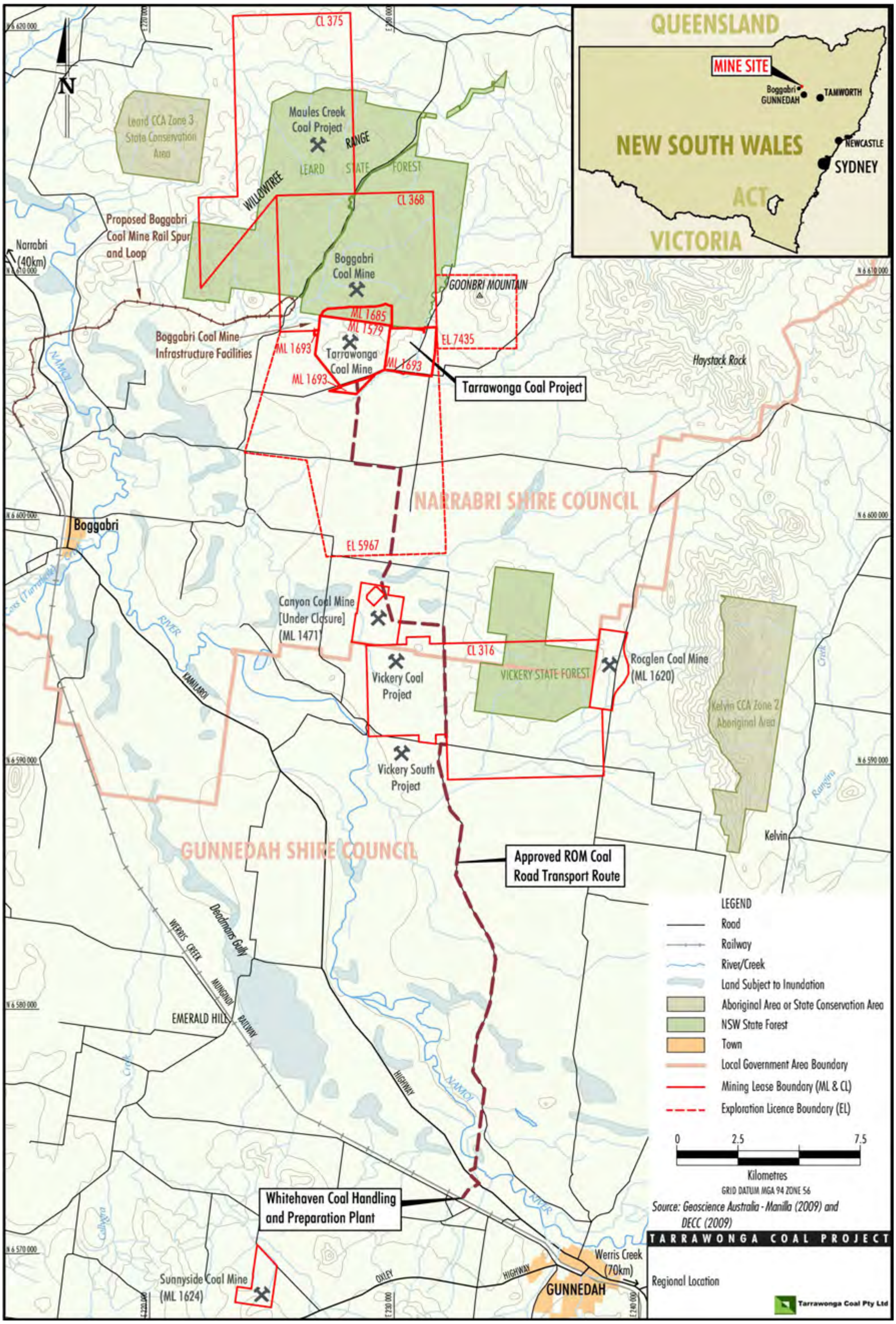


Figure 1 Tarrawonga Coal Mine Location

- ongoing exploration activities;
- continuation of transport of ROM coal via the approved haulage route to the Whitehaven CHPP, or to the Boggabri CHPP via internal haul roads, subject to a suitable commercial agreement between Boggabri and Tarrawonga Mines..
- use of an existing on-site mobile crusher for coal crushing and screening of up to 150,000 tonnes (t) of domestic specification coal per annum for direct collection by customers at the mine site for transport offsite;
- use an existing on-site mobile crusher to produce up to approximately 90,000 m^3 of gravel materials per annum for direct collection by customers at the mine site;
- progressive backfilling of the mine void behind the advancing open cut mining operation with waste rock and reject material from the Gunnedah CHPP;
- continued and expanded placement of waste rock in the Northern Emplacement (including integration with the BCM emplacement) and Southern Emplacement, as mining develops;
- progressive development of new haul roads and internal roads, as mining develops;
- progressive development of sediment basins and storage dams, pumps, pipelines and other water management equipment and structures;
- continued development of soil stockpiles, laydown areas and gravel/borrow areas;
- capture, treatment and discharge of sediment laden water from licensed discharge points;
- use of mechanical evaporators in the mine pit to aid water reduction;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

In addition to the above, the following activities associated with MOD 7 and MOD 8 can be undertaken:

- A reduction in the open cut extent to avoid mining the Upper Namoi alluvium and Goonbri Creek.
- Revision of the post-mining landform and land use;
- Construction of a new site access road and intersection to allow haulage of ROM coal along a section of Goonbri Road; and
- Construction and use of a water transfer pipeline between the Tarrawonga Coal Mine and the Vickery Coal Mine.

1.3 BTM Complex Water Management Strategy

The BTM Complex Water Management Strategy (WMS) was developed to manage and describe coordination of water matters across the Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) and cumulative impacts on water in the surrounding region. The aim of this strategy is to minimise cumulative impacts on the quality and availability of water resources in the catchment. The extent of the EA boundaries for each of the mines that comprise the BTM Complex are presented in Figure 1. In previous environmental assessments and approval documents, this group of mines has been referred to as the Leard Forest Mining Precinct. For the purposes of this WMP and all other relevant cumulative impact management documents, all references to the 'Leard Forest Mining Precinct' have been replaced with the term 'BTM Complex'.

Monitoring requirements and impact assessment criteria for the TCM have been developed to be consistent with those developed to achieve the objectives of the BTM Complex WMS (refer to Sections 3 and 5). The current BTM Complex WMS is provided in Appendix E. Representatives from each mine meet monthly to discuss cumulative impacts and monitoring data is coordinated and shared via an agreement between all three mines.

1.4 Structure and Purpose of this Document

This WMP describes the measures to be implemented to manage and mitigate the potential impacts of the TCM on water resources.

This Management Plan is structured as follows:

- Section 2 lists the project approvals where each relevant approval condition is addressed in the WMP;
- Section 3 is the Surface water Management Plan;
- Section 4 presents the Site Water Balance;
- Section 5 is the Groundwater Management Plan;
- Section 6 presents the Surface Water and Groundwater Response Plans;
- Section 7 describes the future water management elements of the WMP;
- Section 8 provides details of reporting and review requirements for the WMP; and
- Section 9 lists materials referenced within the WMP.

1.5 Consultation During the Preparation of this Document

In accordance with Schedule 3 Condition 39 of the PA 11_0047, this WMP will be prepared in consultation with the relevant agencies including the NSW Environment Protection Authority (EPA), Department of Planning, Industry and Environment (DPE Water), Biodiversity Conservation and Science (BCS) and the North West Local Land Services (LLS).

This WMP will be submitted to the Department of Planning and Environment (DPE) for approval.

Consultation undertaken as part of Edition 3 of the WMP includes:

- Revision 0 - updated to incorporate comments from the former Department of Planning Infrastructure and Environment (DPE) and the independent monitor (IM);
- Revision 1 - updated to incorporate comments from NRAR; and
- Revision 2 - updated to incorporate comments and feedback from DPE and the IM.
- Revision 3 - updated to incorporate the MOD 8 approval.
- Revision 4 - updated to incorporate the revised PA 11_0047.
- Revision 5 – updated to incorporate the most contemporary water management system configuration.
- Revision 6 – updated in response to consultation with BCS, DPE Water and LLS.
- Revision 7 – updated in response to DPE comments.
- Revision 8 – updated in response to further consultation with DPE.

The WMP has been provided to the relevant agencies for review following each revision of the document.

2 STATUTORY REQUIREMENTS

2.1 Project Approvals

This WMP has been developed to satisfy the requirements of the conditions of the Project Approvals. Table 1 and Table 2 presents the Project Approval conditions relevant to this management plan and the section(s) where these have been addressed in this plan.

The statutory requirements for the Tarrawonga Coal Project relating to water include:

- conditions in schedules 3 and 5 of the PA 11_0047 (Table 1); and
- conditions in the Environment Protection and Biodiversity Conservation (EPBC) 2011/5923 Project Approval relating to sections 130(1) and 133 of the *EPBC Act 1999* (Table 2).

Table 1 Water Related Conditions in Project Approval 11_0047

Condition	Refer to Sections
Schedule 3	
Water Supply 31. The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations on site to match its available water supply, to the satisfaction of the Secretary.	Section 4
Compensatory Water Supply 32. The Proponent shall provide a compensatory water supply to any owner of privately-owned land whose water supply is adversely and directly impacted (other than a negligible impact) as a result of the project, in consultation with DPE Water, and to the satisfaction of the Secretary. The compensatory water supply measures must provide an alternative long-term supply of water that is equivalent to the loss attributed to the project. Equivalent water supply should be provided (at least on an interim basis) within 24 hours of the loss being identified. If the Proponent and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution. If the Proponent is unable to provide an alternative long-term supply of water, then the Proponent shall provide alternative compensation to the satisfaction of the Secretary.	Section 5.5.2
Surface Water Discharges 33. The Proponent shall ensure that all surface water discharges from the site comply with the discharge limits (both volume and quality) set for the project in any EPL.	Section 4
Goonbri Creek Diversion and Upper Namoi Alluvium – Performance Objectives 34. The Proponent shall ensure that the project has no greater environmental consequences than predicted in the EA and complies with the performance objectives in Table 12 [of the EA], to the satisfaction of the Secretary.	Section 7.3
Goonbri Creek Flood Bund 37. The Proponent shall prepare an updated flood modelling assessment report to the satisfaction of the Secretary. The report must:	Section 7.3

Condition	Refer to Sections
Schedule 3	
a) be prepared in consultation with BCS, and be submitted and approved by the Secretary prior to undertaking any mining operations within an elevation of less than 0.5 metres above, or a lateral distance of 25 metres from, the Probable Maximum Flood extent as shown on the plans in Appendix 6 [of PA 11_0047]; and b) include; • detailed 2-dimensional flood modelling for events up to and including the Probable Maximum Flood, to determine the extent of flooding from Goonbri Creek; • additional assessment of the need, design and extent of the Goonbri Creek flood bund to prevent inundation of the mining operations and mining pit for all events up to and including the Probable Maximum Flood; • detailed construction design plans for the flood bund; and additional assessment of any flood-related impacts associated with construction of the flood bund. 38. Unless the additional flood assessment required under condition 37 demonstrates to the satisfaction of the Secretary that the flood bund is not required, then the Proponent shall: a) construct the flood bund prior to undertaking any mining operations within an elevation of less than 0.5 metres above, or a lateral distance of 25 metres from, the Probable Maximum Flood extent as determined in the updated flood modelling assessment report; and b) within 2 months of the construction of the flood bund, submit an as-executed report to the Secretary and BCS, certified by a practising engineer, confirming that the bund has been constructed: • in accordance with the design in the updated flood modelling assessment report and applicable Australian Standards; and • in a manner that achieves the performance objectives in Table 12	
Water Management Plan 39. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must: a) be prepared in consultation with BCS, DPE Water and LLS, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary, b) be submitted to the Secretary for approval by the end of May 2013; and c) in addition to the standard requirements for management plans (see condition 3 of schedule 5), include a:	This WMP has been prepared based on Regulator's past comments and will be issued to BCS, DPE Water Water and LLS for review.
(i) <u>Site Water Balance</u>, that includes • details of: o sources and security of water supply, including contingency for future reporting periods, incorporating commitments for minimising trucking of off-site water as identified in MOD8; o water use and management on site; o any off-site water discharges; o reporting procedures, including the preparation of a site water balance for each calendar year; • a program to validate the surface water model, including monitoring discharge volumes from the site and comparison of monitoring results with modelled predictions; and describes the measures that would be implemented to minimise clean water use on site;	Section 4
(ii) <u>Surface Water Management Plan</u>, that includes: • detailed baseline data on surface water flows and quality in the water-bodies that could potentially be affected by the project; • detailed baseline data on soils within the irrigation area;	Section 3.6, AEMR/AR Section 4.5.4

Condition	Refer to Sections
Schedule 3	
• detailed baseline data on hydrology across the downstream drainage system of the Namoi River floodplain from the mine site to the Namoi River, including Barbers Lagoon and The Slush Holes;	Section 1.3, 3.6.1
• a detailed description of the water management system on site, including the:	Section 3.3
o clean water diversion systems;	Section 3.1
o erosion and sediment controls (mine water system);	Section 3.5
o mine water management systems including irrigation areas;	Sections 3.3.6, 4.5.4
o discharge limits in accordance with EPL requirements; and	Section 3.7
o water storages and water transfer pipelines;	Section 3.3.2
• detailed plans, including design objectives and performance criteria for:	
o design and management of final voids;	Addressed in future revisions of this WMP following approval of future MOP.
o design and management for the emplacement of reject materials, sodic and dispersible soils and acid or sulphate generating materials;	Section 3.3.11
o the Goonbri Creek flood bund, based on additional 2-dimensional flood modelling;	Addressed in future revisions of this WMP following approval of future MOP.
o reinstatement of drainage lines on the rehabilitated areas of the site; and	Section 3.3.12, 3.6.5
o control of any potential water pollution from the rehabilitated areas of the site;	Sections 3.3.4, 3.3.12, 3.5
• performance criteria for the following, including trigger levels for investigating any potentially adverse impacts associated with the project:	
o the water management system;	Section 3.7, 5.5, 6
o soils within the irrigation area;	Section 4.5.4
o downstream surface water quality;	Section 3.7.3
o downstream flooding impacts, including flood impacts due to the flood bunds required for the project; and	Section 3.3.8, 3.6.2, 7.3
o stream and riparian vegetation health, including the Namoi River and its tributaries including Barbers Lagoon and The Slush Holes;	Section 3.6.5, 3.7.3, 6
• a program to monitor and assess:	
o the effectiveness of the water management system;	Sections 3.6.6, 5.5, 7
o soils within the irrigation area;	Goonbri Creek diversion and flood bund monitoring are not applicable.
o the effectiveness of the Goonbri Creek diversion and flood bunds (see conditions 28-31);	
o surface water flows and quality in the watercourses that could be affected by the project; and	This requirement will be addressed in future revisions of this WMP following approval of the Flood Assessment by the Planning Secretary.
o downstream flooding impacts;	
• reporting procedures for the results of the monitoring program; and	
• a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project;	
(iii) Groundwater Management Plan, that 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; • detailed plans, including design objectives and performance criteria, for the design and management of: o the proposed final void; and o coal reject and potential acid forming material emplacement;	Sections 5, 3.3.11

Condition	Refer to Sections
Schedule 3	
• groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts; • a program to monitor and assess: o groundwater inflows to the open cut mining operations; o the seepage/leachate from the water storages, emplacements and the final void; o interconnectivity between the alluvial and bedrock aquifers, including the potential for enhanced leakage as a result of fracturing due to blasting; o background changes in groundwater yield/quality against mine-induced changes; o the impacts of the project on: - regional and local (including alluvial) aquifers; - groundwater supply of potentially affected landowners; - groundwater dependent ecosystems (including potential impacts on stygofauna) 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; and	Section 5.4.6 Section 6.5
(iv) <u>Leard Forest Mining Precinct Water Management Strategy</u>, that has been prepared in consultation with other mines within the precinct, and the Vickery Coal Mine to: • minimise the cumulative water quality impacts of the mines; • review opportunities for water sharing/water transfers between mines; • co-ordinate water quality monitoring programs as far as practicable; • undertake joint investigations/studies in relation to complaints/exceedances of trigger levels where cumulative impacts are considered likely; and • co-ordinate modelling programs for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans. *Notes: • The Leard Forest Mining Precinct Water Management Strategy can be developed in stages and will need to be subject to ongoing review, dependent upon the determination of and commencement of other mining projects in the area. • The Department accepts that consultation and involvement of the Vickery coal mine in the Leard Forest Mining Precinct Water Management Strategy may be limited to issues in relation to water sharing/transfers between the mines, and associated water use and water quality matters..*	Section 1.3
Schedule 5	
Management Plan Requirements 3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: a) detailed baseline data; b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures; c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria; d) a program to monitor and report on the: • impacts and environmental performance of the project;	Section 3.6, AEMR/AR Sections 2 Sections 3.7, 5.5 Section 6 Sections 3.3, 3.4, 3.5, 5 Sections 3.6, 5.4, 6, 8

Condition	Refer to Sections
Schedule 3	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 6
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 6
g) a protocol for managing and reporting any:	
• incidents;	Section 8.3
• complaints;	Section 6.6
• non-compliances with statutory requirements; and	Sections 6.3, 8.3
• exceedances of the impact assessment criteria and/or performance criteria; and	Sections 6.2
h) a protocol for periodic review of the plan.	Section 8.1, 8.2

Table 2 Water Related Conditions in the EPBC 2011/5923 Project Approval

Condition	Refer to Sections
Surface and groundwater management plans 15. The person taking the action must provide *the Surface and Groundwater Management Plans* as identified in condition 39 of the NSW state government Project Approval dated 22 January 2013 (application number 11_0047) to the Minister for approval within one month of their approval by the NSW state government. The approved plans must be implemented.	Not applicable
16. The surface and groundwater management plans must be consistent with the National Water Quality Management Strategy.	Addressed throughout document.
17. The person taking the action must include with the Surface and Groundwater Management Plans (submitted for approval by the Minister as per condition 15) written advice demonstrating how the plans address the cumulative impacts of groundwater drawdown as a result of mining and how this may impact on the consequent health of the remnant vegetation in the Leard State Forest, the Leard State Conservation Area and surrounding areas., The advice must be developed in collaboration with the person taking the action to develop and operate the Boggabri Coal Mine Extension (EPBC 2009/5256) and the Maules Creek Coal Mine (EPBC 2010/5566). The advice must address the following matters: a) maximum amount of allowable drawdown in the alluvial aquifer b) drawdown in hard rock 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.	Sections 5, 5.5
18. The person taking the action must within 30 days of receiving a written request from 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 addressed groundwater and surface water impacts on matters of national environmental significance.	Sections 4, 5.4.6
Goonbri Creek Diversion and Low Permeability Barrier	Section 7.3

Condition	Refer to Sections
19. The person taking the action must provide to the **Minister** for approval, before **commencement of the construction of the permanent Goonbri Creek alignment, permanent flood bund and low permeability barrier**, a *Goonbri Creek Diversion and Flood Bund Concept Design Plan*. No construction activities in relation to the permanent Goonbri Creek alignment, permanent flood bund and/or low permeability barrier can commence until the *Goonbri Creek Diversion and Flood Bund Concept Design Plan* has been approved by the **Minister**. This approved Goonbri Creek Diversion and Flood Bund. The approved plan must be implemented.	
20. The Goonbri Creek Diversion and Flood Bund Concept Design Plan must include: a) an assessment of the surface water and groundwater quality, ecology, hydrological and geomorphic baseline conditions within the creek; b) a description of how restoration of the re-aligned riparian zone will be undertaken to best replicate the habitat of the existing creek, including plant species and fauna habitat features; c) water quality, ecology, hydrological and geomorphic performance and completion criteria for the creek diversion and low permeability barrier based on the assessment of the baseline conditions identified in condition 20 (a); and d) a risk assessment of the environmental consequences of the proposed low permeability barrier and the proposed Goonbri Creek realignment including the potential for impacts on groundwater and surface discharge. The risk assessment must be peer-reviewed. e) details for ongoing monitoring and management of downstream impacts on the adjacent floodplains and Namoi River floodplain.	Section 7.3
21. The person taking the action must ensure that dispersed waters downstream of the Goonbri Creek re-alignment do not adversely affect the downstream environment and avoid any impacts on matters of national environmental significance.	Section 7.3

2.2 Water Sharing Plans

TCM is covered by four Water Sharing Plans (WSPs) including the following:

- Water Sharing Plan for the Namoi Alluvial Groundwater Sources (2020);
- Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources (2020);
- Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources (2020); and
- Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources (2020).

TCM is located within the catchments of Nagero, Bollol and Goonbri creeks. These creeks are located within the Bluevale Water Source, administered under the WSP for the Namoi Unregulated and Alluvial Water Sources. The WSP for the Namoi Unregulated and Alluvial Water Sources includes rules for protecting the environment, water extractions, managing licence holders' water accounts and water trading in the plan area. Nagero, Bollol and Goonbri creeks flow into the Namoi River, which is administered under the WSP for the Upper and Lower Namoi Regulated River (Lower Namoi water source). Take of surface water by the TCM complies with the Water Management Act and relevant water sharing plans.

The TCM targets coal seams in the Maules Creek Formation within the ‘Gunnedah-Oxley Basin – Namoi’ Management Zone defined in the WSP for the NSW Murray-Darling Basin Porous Rock Groundwater Sources. TCM adjoins alluvial sediments that lie within the Upper

Namoi Management Zone 4 (Keepit Dam to Gin's Leap) defined in the WSP for the Upper and Lower Namoi Groundwater Sources. Figure 2 shows the extent of groundwater WSPs in the vicinity of TCM.

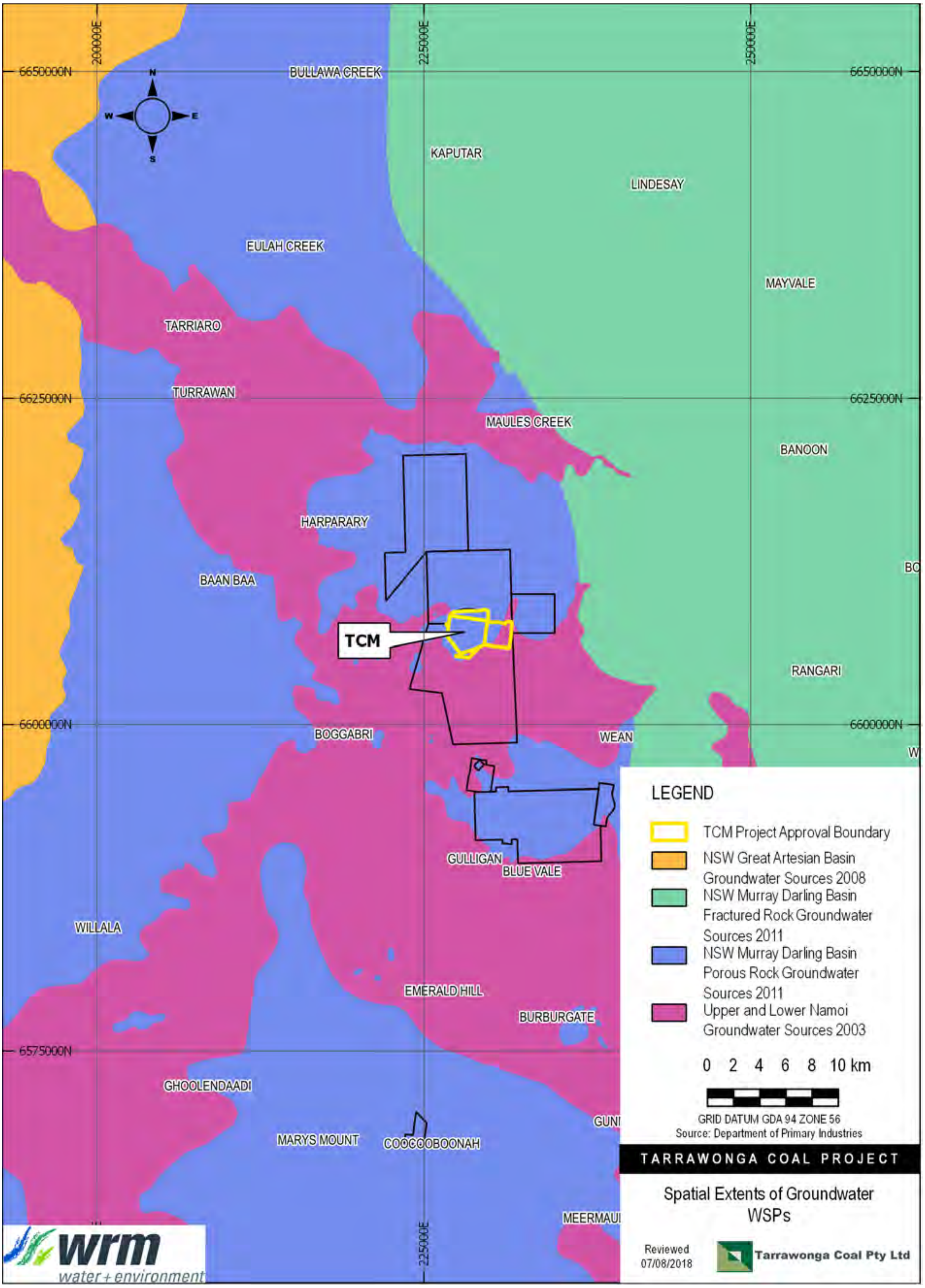


Figure 2 Spatial Extents of Groundwater WSPs

3 SURFACE WATER MANAGEMENT PLAN

3.1 Hydrological Setting

The TCM is located entirely within the Namoi River catchment. The Namoi River has a catchment area of approximately 42,000 km^2. The Namoi River is a tributary of the Barwon River, which ultimately flows into the Murray-Darling System. The local drainage catchments associated with the TCM are Nagero Creek, Goonbri Creek and Bollol Creek, which ultimately flow into the Namoi River just north of Boggabri (Figure 3). Two mines are located adjacent to the Namoi River upstream of TCM, including the Vickery Coal Mine (including the Vickery Extension Project) and Rocglen Coal Mine (currently in closure).

Bollol Creek begins to the east of the TCM and is an ephemeral waterway which flows south and west through a confined valley before dispersing onto the alluvial flats. The alluvial flats in this area are highly disturbed and are widely used for irrigated cropping. Flows in Bollol Creek generally continue as overland flow in a south-westerly direction to eventually reach Barbers Lagoon, which flows into the Namoi River.

Goonbri Creek begins to the north-east of TCM. The creek flows generally southward along the eastern boundary of the Leard State Forest. Downstream of TCM, Goonbri Creek flows generally westward and south-westward and ultimately disperses as overland flow on the adjacent alluvial flats and the Namoi River floodplain. Similar to Bollol Creek, the alluvial flats in this area are highly disturbed by agricultural landuses.

Nagero Creek begins in the Leard State Forest, to the north of TCM. BCM is also located in the Nagero Creek catchment and intersects the upper reaches of the creek, upstream of TCM. Nagero Creek is also an ephemeral waterway, which flows generally south-west into a series of lagoons known as The Slush Holes, before ultimately draining into the Namoi River. A portion of the catchment of Nagero Creek in the northern part of ML 1579 is captured within the existing/approved TCM water management system for on-site usage and to prevent sediment laden runoff entering the creek.

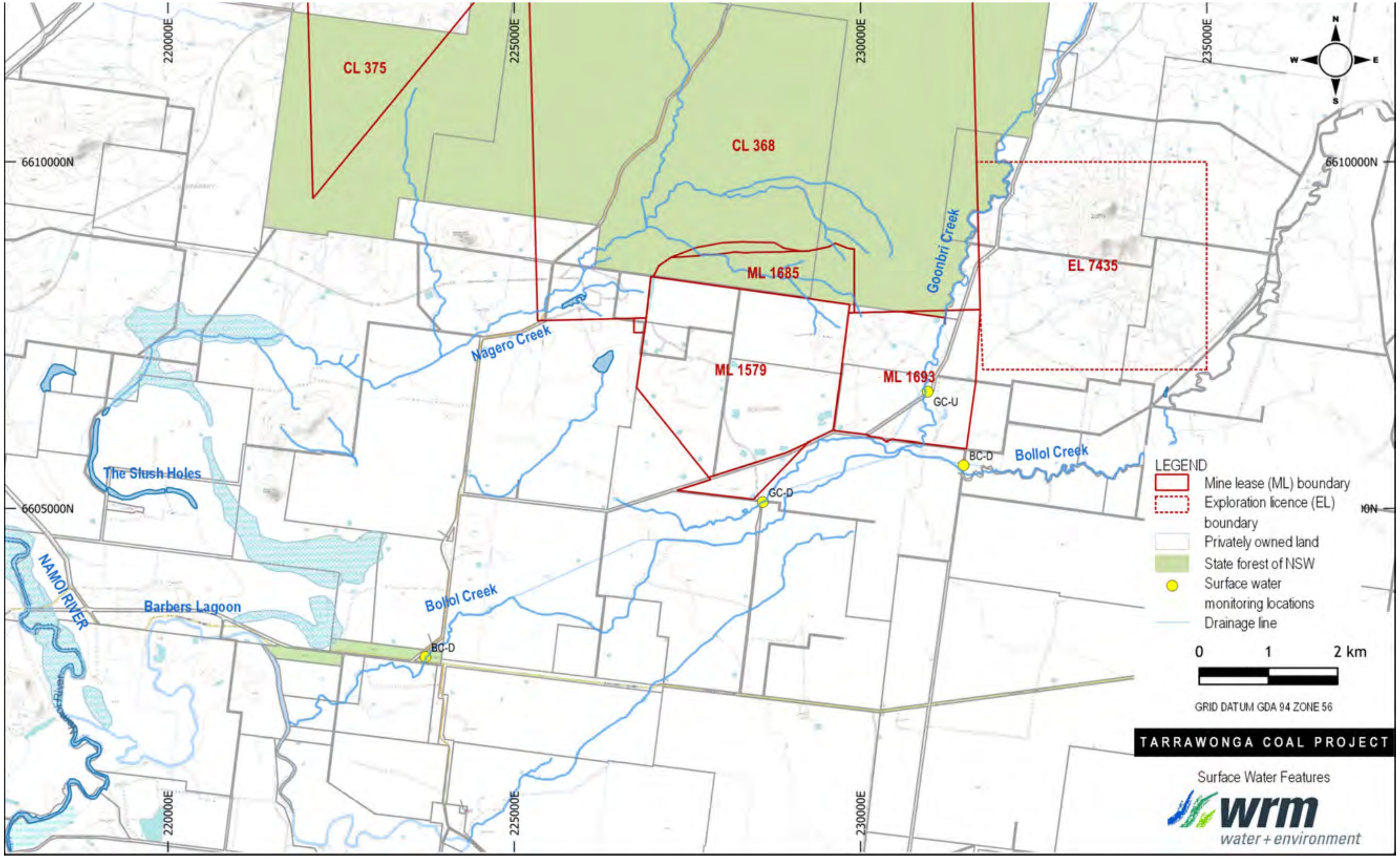


Figure 3 **Tarrawonga Coal Mine Surface Water Features**

3.2 Site Water Management System

Figure 5 shows the general Year 2022 (existing) layout of the TCM water management system. Figure 7 shows the conceptual water circuit schematic of the Year 2022 (existing) operations. The main components of water-related infrastructure include:

- sediment dams to capture sediment in sediment-laden runoff from emplacement areas;
- surface water drains to divert sediment-laden runoff from active mining areas and emplacement areas to sediment dams;
- surface water drains to divert runoff from undisturbed catchments around areas disturbed by mining; and
- a mine water system to store water pumped out of the mine pit and water laden with sediment from coal stockpile areas.

Figure 4 to Figure 6 show the indicative locations of water management infrastructure and mine catchments at TCM for Year 2022, Year 2023 and Year 2025 (based on current mine planning) respectively.

This Surface Water Management Plan describes the management strategies, management areas, erosion and sediment controls, monitoring program and trigger values for the TCM water management system.

A site water balance was developed for the TCM water management system (refer to Section 4). The site water balance includes water inputs/gains (e.g., rainfall runoff, groundwater inflow, external water, etc.) and water outputs/demands (e.g. evaporation, dust suppression, evaporation fans, discharges from LDPs, ROM coal, etc.).

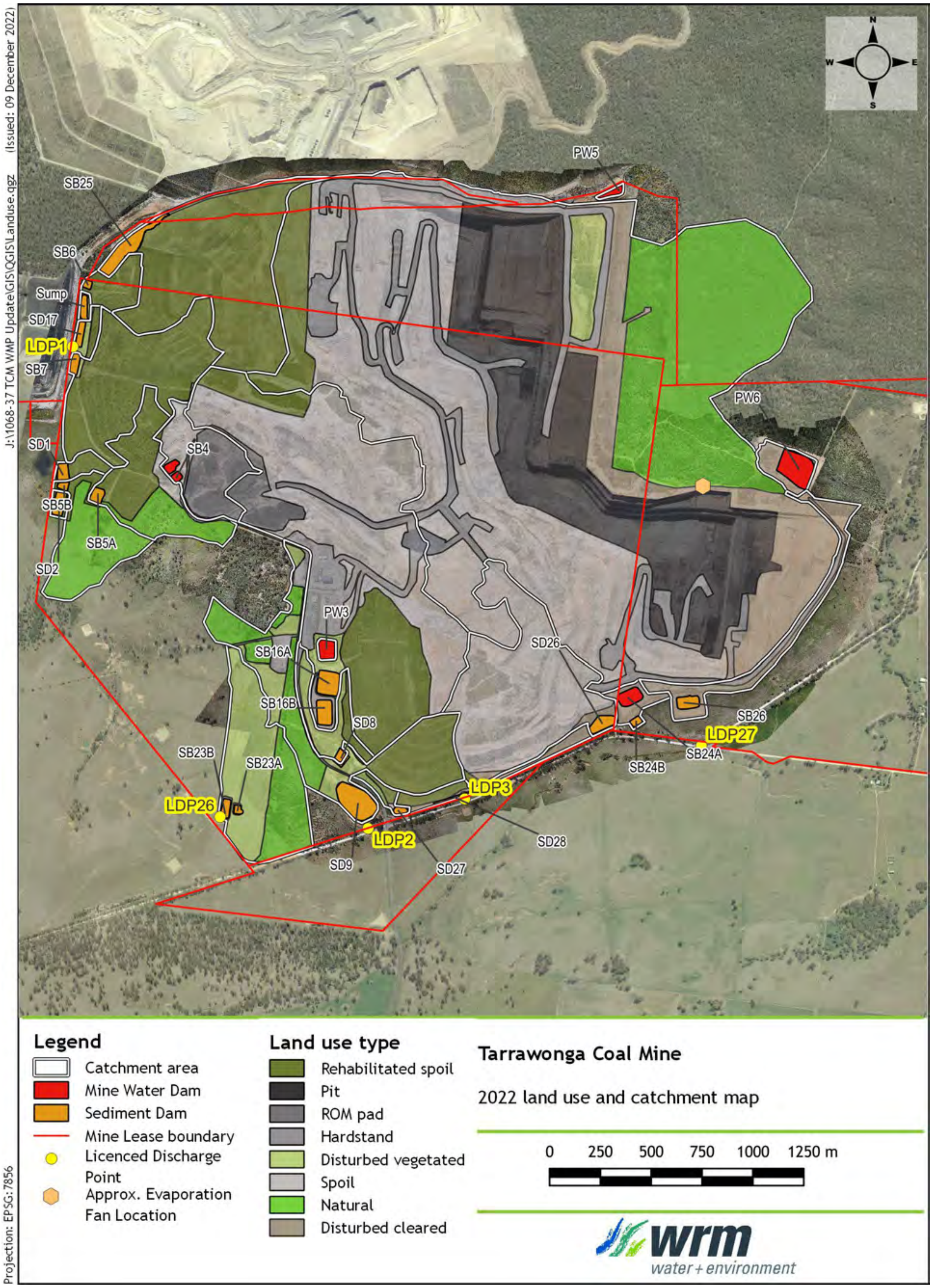


Figure 4 TCM Year 2022 Catchment Plan and Site Layout

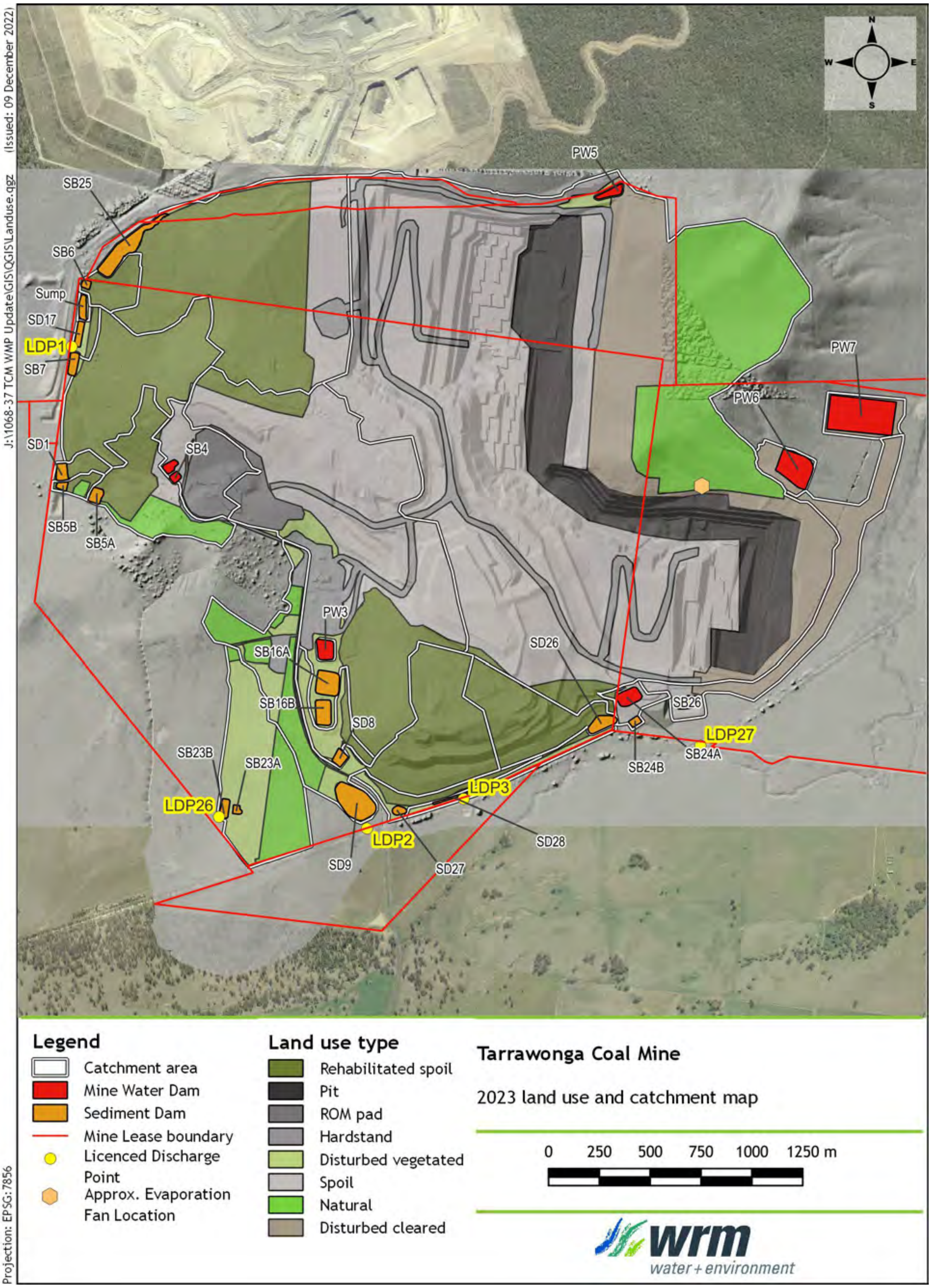


Figure 5 TCM Year 2023 Catchment Plan and Site Layout

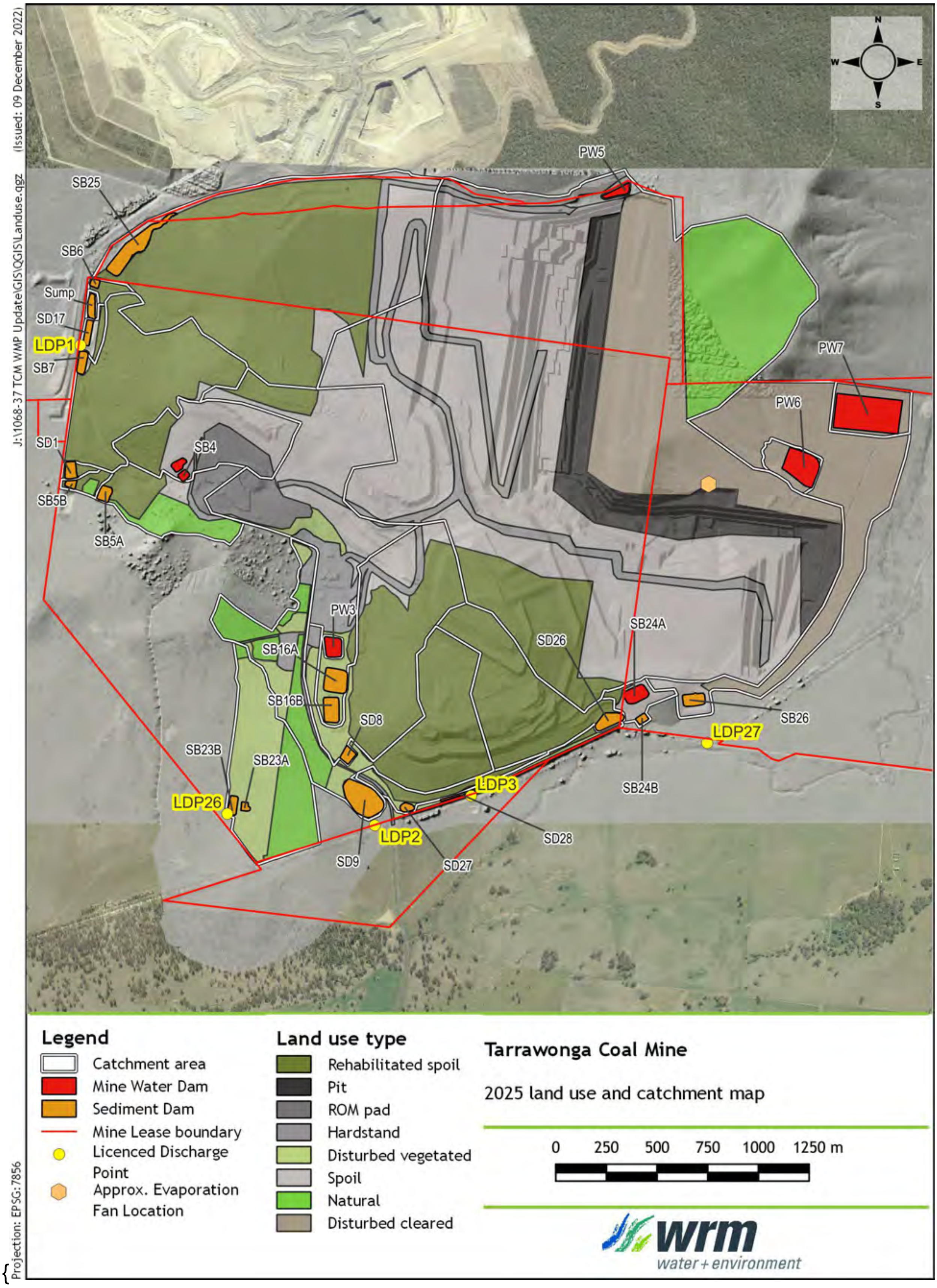


Figure 6 TCM Year 2025 Catchment Plan and Site Layout

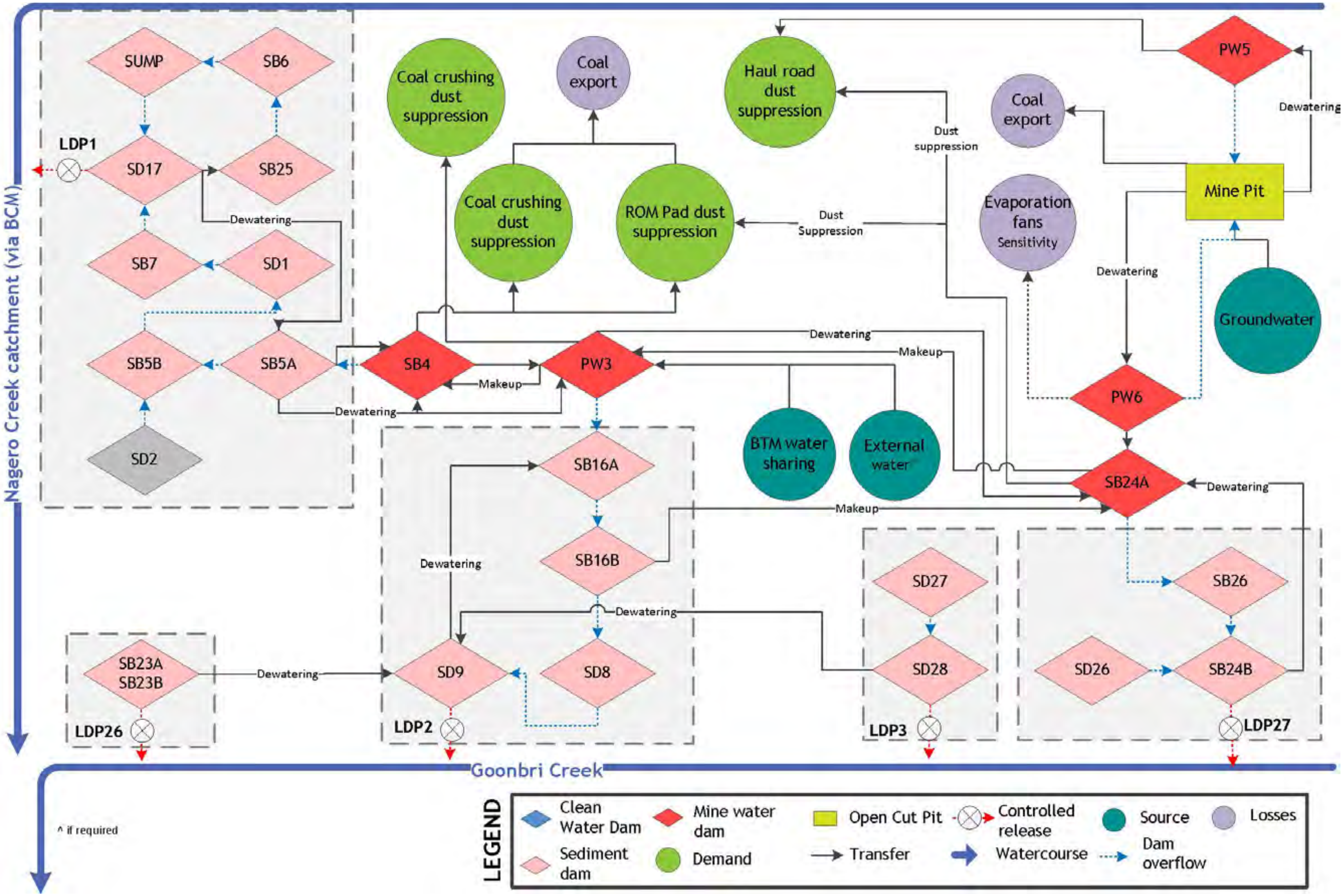


Figure 7 Year 2022 (Existing) Water Management Schematic

3.3 Surface Water Management Strategy

3.3.1 General

For the purposes of water management, the water generated at the TCM is divided into four types based on water quality, as detailed below:

- **'Clean'** – surface runoff from the mine site areas where water quality is unaffected by mining operations, primarily undisturbed catchments;
- **'Dirty'** – surface runoff from the mine site areas that are disturbed by mining operations. This runoff may contain silt and sediment, but does not contain contaminated material. Dirty water runoff must comply with the water quality criteria for Licensed Discharge Points (LDPs) in accordance with EPL conditions prior to discharge into natural water courses, if required;
- **'Contaminated'** – surface water from areas affected by mining operations that could potentially contain hydrocarbons. This water requires treatment (oil and water separation) before it can be re-used or discharged in accordance with LDP criteria; and
- **'Mine'** – surface water pumped from the mine pit which potentially contains raised concentrations of total dissolved solids (TDS), and other minerals. This water will not be discharged through LDPs.

The TCM surface water management system has been primarily designed in order to:

- manage clean, dirty, contaminated and mine water generated on the mine site to limit their interaction where possible;
- maintain adequate water supply for dust suppression, coal crushing and screening activities on-site;
- capture, store and manage surface water runoff from dirty water catchments and provide controlled release of these waters through LDPs in accordance with EPL conditions; and
- capture and store mine water generated from active mining areas, with no release off-site.

Drainage and storage of all water types complies with the Water Management Act 2000 (NSW) ('WM Act'). Figure 5 shows the surface water drainage system for the 2022 TCM site plan.

Water for haul road dust suppression and coal crushing is sourced from mine water storages where possible. Any shortfall is supplemented with dirty water from the sediment dams and then from external water sources as required. During extended wet periods (when dams are at or near capacity) controlled discharge occurs from LDPs and mine water is removed (in addition to use in dust suppression) through the use of mechanical evaporators (evaporator fans).

TCM will manage all the water onsite as far as practical. TCM will ensure that dirty water quality complies with the concentration limits in the EPL, prior to discharge from the LDPs. Dirty water will be treated prior to discharge, if required. If the dirty water quality does not comply with the EPL concentration limits, this water would be pumped to the mine water system or the pit to prevent discharge from the LDPs, noting that this may result in excess water stored in mine pits.

TCM is committed to managing on-site water storages in accordance with the surface water management strategy, which as far as practical, limits the risk of non-compliant off-site discharge.

3.3.2 Dams

The management of stored water at the TCM includes both dewatering of the dams when they reach a certain capacity and pumping water into the mine water dams from external water sources. 'Trigger' volumes related to the management of water dams at TCM are defined as follows:

- **Maximum Operating Volume** (MOV) is the volume that, when exceeded, triggers the dam to be dewatered (i.e. to another dam at the site). The operating volume determines the "operating water level" based on the specific surveys of the dams.
- **Full Storage Volume (FSV)** is the overall storage capacity of the dam from the base to the spillway level.
- **Dead Storage Volume** is the volume at which the dam cannot be dewatered with pumps and typically includes the sediment storage zone.

Table 3 shows approximate FSV for dams within the site water management system together with their site water management area and destination of spills.

Appendix A shows the current catchment area, operating volume and operating water level for each dam. The operating water level for each dam located at an LDP is surveyed and marked on a gauge board. The operating water level in other storages are marked with a peg within the wall of the dam. A description of each site water management area is provided in Section 3.4.

Table 3 TCM Dam Volumes – Year 2022 (existing) Conditions

Site Water Management Area	Storage	Full Storage Volume (ML)	Spills to
Dirty (Sediment-laden) Dams/Basins			
SD17 (LDP1)	SB25	35.0	SB6
	SB6	1.0	SUMP
	SD17	9.7	BCM via LDP1
	Sump	3.5	SD17
	SB7	2.7	SD17
	SD1	7.6	SB7
	SD2	29.4	SB5B
	SB5B	3.1	SD1
	SB5A	7.8	SD2
SD9 (LDP2)	SD9	52.0	Goonbri Creek via LDP2
	SB16A	36.4	SB16B
	SB16B	96.9	SD8
	SD8	3.5	SD9
SD27/SD28 (LDP3)	SD27	2	SD28
	SD28	1.8	Goonbri Creek via LDP3
SB23B (LDP26)	SB23A	2.5	SB23B
	SB23B	10.9	Goonbri Creek via LDP26
SB24B (LDP27)	SB24B	4.8	Goonbri Creek via LDP27
	SB26	35.5	SB24B
	SD26	15.0	SB24B
Mine (Pit) Water Dams			
-	Mine Pit	130[a]	-
SB24B (LDP27)	SB24A	10.7	SB26
SD9 (LDP24)	PW3	26.5	SB16A
n/a	PW5	0.5	-
n/a	PW6	280	-
SD17 (LDP1)	SB4	13.6	SB5A

[a] Reported volume is for the in-pit sump. Full Storage Volume of the mine pit is 40 GL

3.3.3 Clean Water

Clean water sources at the mine include rainfall and runoff from areas undisturbed by mining and infrastructure. Clean water catchments draining into the TCM WMS are minimised as much as possible and practical, through the strategic placement of water storages and/or the implementation of upslope clean water diversion infrastructure. Any clean water that is captured by the TCM WMS will be managed under the WM Act.

The capture of clean water in a dam must be authorised under the WM Act and comply with the following conditions of the WM Act:

1) The excluded works exemption;
2) Harvestable rights (HR) allowance; and
3) Mixed Rights (MR) allowance.

Water which cannot comply with these conditions, must be diverted in accordance with best practice.

The HR allowance for a mine site is the total allowed storage capacity of dams which capture clean water only. The HR allowance is calculated using the following formula:

*HR Allowance (ML) = Contiguous land area (ha) * 0.065*

- The land area must be a contiguous land holding
- If the contiguous land holding includes dams outside of the mines WMS, the dams must be accounted for in the allowance
- The take of water must be from a minor stream

Table 4 shows the harvestable rights dam at TCM which includes 8 “farm dams” which are located within the mine lease but not part of the WMS. These dams were built prior to the commencement of mining of TCM. TCM does not draw water from these dams, but their storage is accounted for under harvestable rights.

Table 4: Harvestable Rights Dams at TCM

Harvestable Rights Dam	
Dam	**Dam Capacity (ML)**
FD3	2.3
FD11	1.3
FD14	1.5
FD17	1.5
FD18	0.6
FD21	0.5
FD18	2.3
FD7	0.8
Total	**10.8**

Dams which have clean water catchments which are not diverted, but authorised for other activities can account for clean water take through Mixed Rights (MR). MR rules are detailed in the NSW Government Gazette Number 40 (31 March, 2006).

The MR allowance for TCM is determined by the following formula:

MR allowance = (HR Allowance – HR dams combined capacity)/1.3

To determine if the MR allowance of a mine site is compliant, the annual average runoff volume into each Mixed Rights Dam shall be calculated. The formula to determine the volume of clean runoff into a MR dam is:

*Annual runoff volume = Catchment Area *Annual Rainfall * runoff coefficient (10%)*

If the combined annual average runoff volume of all mixed rights dams exceeds the MR allowance, site is required to divert clean water catchments or increase its HR allocation through contiguous landholdings. Table 5 shows the mixed rights storages at TCM, the only MR allocation TCM accounts for is the clean water reporting to the pit.

Table 5: Mixed Rights dams

Mixed Rights Dams		
Dam	**Clean runoff Catchment (ha)**	**Runoff from clean water catchment (ML)**
Mining Pit	83.4	54.2
Total	**83.4**	**54.2**

Table 6 summaries TCM compliance with harvestable rights in the following ways

- The Harvestable rights allowance within the mine lease (1,249 ha) is 81.2 ML
- 8 farm dams have a HR capacity of 10.8 ML
- The MR allowance is 54.2 ML
- TCM requires 54.2 ML of MR allowance

TCM does not rely on any addition contiguous landholdings outside of the ML.

Table 6: Summary of TCM compliance with Harvestable rights

Summary	
Maximum Harvestable Rights Allowance (ML):	81.2
Harvestable Rights Dam Capacity (ML):	10.8
Available Harvestable Rights Allowance (ML):	70.4
Mixed Rights Allowance (ML):	54.2
Mixed Rights Used By Site (ML):	54.2
Available Mixed Rights (ML):	0.0
Land required in Ha to meet compliance (ha):	0

3.3.4 Dirty Water

The TCM water management system includes 20 sediment dams which capture and contain dirty water. Consistent with best practice, the purpose of these sediment dams is to prevent dirty water generated at TCM from contaminating downstream watercourses. The dirty water contained within these sediment dams is beneficially reused for operational purposes or released downstream, if of sufficient quality to do so.

The take of dirty water by these sediment dams is in accordance with the “excluded works”. The take of this dirty water is exempt due to the combined operation of cl 21(1), cl 12 in Part 1 of Schedule 4, and cl 3 in Schedule 1 of the *WM Regulation* which states:

> *Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.*

As these sediment dams fall within the scope of this "excluded work", these dams also fall within a class of dam which is exempt from the Harvestable Rights Order (HRO, paragraph 3 of Schedule 2). As such, these sediment dams do not capture water in reliance on harvestable rights.

Where it is not possible or practical to divert runoff from clean catchments, some sediment dams potentially receive some runoff from clean catchments, in addition to dirty water capture.

The site dirty water system is broadly split into two water management areas:

- runoff draining to the north/west leaves site through SD17 (LDP 1)
- Runoff draining south leaves site through SD9 (LDP 2), SD28 (LDP 24), SB23B (LDP 26) and SB24B (LDP 27).

Sediment dams within each of the LDP water management areas are collectively operated to contain runoff from a 5 day 90th percentile rainfall event (38.4 mm) in accordance with requirement L2.5 of EPL 12365. Sediment dams are actively managed via water transfer for dust suppression use and discharges via LDP's to achieve the EPL condition for re-establishing the design storage capacity within the sediment dams within 5 days following a rainfall event. All sediment dams at the site are managed in accordance with the Blue Book (Managing Urban Stormwater: Soils and Construction Vol. 1, 4th edition and Vol. 2E Mines and Quarries (Landcom, 2004 and DECC, 2008) – hereafter referred to as the 'Blue Book') as described in Section 3.5.

During large rainfall events, water can exceed the capacity of sediment dams, causing water to spill downstream. In many cases, there is a chain of sediment dams that progressively remove sediment from the water that flows through them. Water quality in the dams at LDPs is a significant element in the surface water monitoring program, described in Section 3.6.

All dirty water drainage structures are designed and constructed in accordance with criteria outlined within the Blue Book.

Due to the nature and scale of the mining operation, not all details required to be contained in an Erosion and Sediment Control Plan (ESCP) under the requirements of the Blue Book can be included on Figure 4. The required details are included on specific ESC Plans developed under the Land Disturbance Protocol.

TCM are currently working with the NSW EPA to address the key environmental risks from the ROM pad coal contact water (see Section 3.6.7). TCM has committed to considering and investigating the identified risks and if deemed appropriate explore actions to mitigate these risks in consultation with the EPA. The management of dirty water is further discussed within the site water balance documented in Section 4.

3.3.5 Contaminated Water

The facilities area is the primary area which may produce contaminated water. The specific locations within the facilities area that may produce runoff that contains hydrocarbons includes the:

- workshop; and
- fuel, oil and grease storages.

These areas are managed as follows:

- runoff from these areas drain to an oil/water separator to remove hydrocarbons. The oily fraction enters a containment system for pump out and removal from site as necessary.
- The oil water separator treated water is pumped to PW3 to reduce the risk of contamination of the dirty water system; and
- the workshop area has an impermeable surface with bunding that has been designed to direct all flows to the oil/water separator.

3.3.6 Mine Water

The TCM water management system includes 5 mine water dams and the mine pit which capture and contain mine water. Consistent with best practice, the purpose of these mine water dams is to prevent mine water generated at TCM from contaminating downstream watercourses. The mine water pumped into these mine water dams is beneficially reused to reduce reliance on external water.

The take of mine water is exempt due to the combined operation of cl 21(1), cl 12 in Part 1 of Schedule 4, and cl 3 in Schedule 1 of the *WM Regulation*. Clean water take into these dams, and the mine pit, is accounted for under mixed rights, which is shown in Table 5. TCM complies with all clean water take into the pit.

Mine water at TCM contains a mixture of groundwater that seeps into the pit, direct rainfall and runoff from areas immediately surrounding the pits and the ROM Pad. This water is potentially contains elevated TDS concentrations and therefore separated from all other water types.

Mine water runoff is pumped to the mine water dams SB24A, PW3, PW5, PW6 (and future PW7) and SB4 within the site.

The TCM water management system is designed such that no mine water will be released or discharged from the site. Mine water dams are actively managed via water transfers as well as used for dust suppression activities on haul roads and the ROM pad. A relatively small quantity of water is also used within the crusher. The beneficial reuse of captured mine water for dust suppression purposes minimises TCM's reliance on other sources of water.

During periods of high rainfall, TCM may rely on mechanical evaporators (Evaporation fans) to reduce the volume of mine water on site. Details on the operation of evaporation fans are in Appendix F.

Although using mine water for dust suppression can potentially introduce salts to the dirty water catchments, the quantities of salt are low as the majority of dust suppression occurs with the pit and therefore not considered to be an issue. Runoff from these areas report to sediment dams where the water quality is tested to ensure any discharges meet EPL conditions.

3.3.7 External Water Transfers and Water Access Licenses

Water captured and contained by TCM's sediment dams and mine water dams do not require a water access licence issued under the WM Act. TCM water management system may import water, which may require a water access licences, where considered necessary to meet operational demands from the following sources:

- Pumped transfers from Maules Creek or Boggabri Coal Mines in accordance with the BTM complex water sharing plan;
  - This water may originate from license extraction points which will be managed by the relevant license holder;
- Trucked Transfers from Canyon Mine; and
- Water pumped from the Vickery Extension Project
  - This water may originate from license extraction points which will be managed by the relevant license holder;

MOD7 includes construction and use of a water transfer pipeline between TCM and the proposed Vickery Extension Project (VEP).

3.3.8 Flooding

The Namoi River valley has experienced a number of significant floods. The largest confirmed flood occurred in February 1955, with a flood peak in the vicinity of TCM of about 264.5 m Australian Height Datum (AHD).

TCM is predominantly on elevations greater than 275 m AHD, and therefore would be above any conceivable flooding of the Namoi River.

3.3.9 Potable Water

Potable water at the TCM is sourced from the Gunnedah Shire Council potable water system which is transported to the site via water tankers.

3.3.10 Sewage Treatment and Disposal

Effluent from the sewage and ablutions facilities at the mine are managed through the Council-approved septic system which is serviced by a licenced contractor. Pump outs are undertaken by a licensed waste disposal contractor on an as-needed basis.

3.3.11 Emplacement of Materials

Results of geochemical characterisation testing of mine waste rock and site experience confirm that waste rock drainage is likely to be neutral to slightly alkaline Non-Acid Forming (NAF) material and hence presents a relatively low salinity risk. Waste rock materials are however generally sodic and dispersive and therefore present a risk of accelerated erosion if not adequately managed. The proposed emplacement area design involves the creation and rehabilitation of the final batters on the western side of the Northern Emplacement in the earlier years of the operations. Rehabilitation on the emplacement areas at the TCM can be seen in Figure 4.

The final design of the top of the emplacement area will involve several sub-catchment areas reporting to drop structures located at batter locations which minimise individual fall heights. This drainage strategy will be implemented progressively as the emplacement area is constructed and progressively rehabilitated. Geomorphic design principles including micro and macro relief will be incorporated into the landform design to improve the visual amenity of the landform and reduce the potential for erosion.

A key requirement for completion of the emplacement area will be to ensure that there are no dispersive or erodible materials left exposed at the surface. This will be achieved by selective placement of waste rock so that all sodic material is either buried at least 1 m beneath non-dispersive waste rock or the exposed sodic material is stabilised by gypsum treatment. Prior to capping of the specific final landform emplacement areas, visual inspections and sampling/soil testing (i.e. dispersion testing, soil testing of the Exchangeable Sodium Percentage (ESP), etc.) will be undertaken to identify all dispersive materials.

The results from the TCP-EA (Appendix N) (RS, 2012) indicate that if any Potentially acid forming (PAF) materials do occur within the strata they are likely to be located immediately above or below the coal seams. If localised zones of PAF material are identified within the final dump surface they will be either excavated and buried within the dump or covered with 15m of NAF material to reduce the risk of developing low pH conditions or acid rock drainage.

PA11_0047 Modification 2 allows TCM to receive and emplace any type of coal reject material. A risk assessment was undertaken as part of the modification process; this included a reject emplacement methodology, water quality monitoring, geochemical and spontaneous combustion test work, sampling and testing of cover material, and representative source sampling of reject materials. Sampling is further described in Section 3.5 and Section 5 of this WMP and the Rehabilitation Management Plan (RMP).

3.3.12 Rehabilitation

Rehabilitation Pollution Control

Rehabilitated areas may still contain elevated suspended sediment for a period of time following seeding. It is expected that the water quality of runoff from portions of the emplacement areas, which have been rehabilitated and where sufficient time has elapsed for vegetation to establish, would reflect runoff water quality from similar un-mined areas. The catchments of these areas of vegetated rehabilitation will remain within the dirty water system until the water quality reflects the receiving environment and appropriate approvals have been sought to remove them from the dirty water system (refer to Section 3.5.2 for design criteria).

Reinstatement of Drainage Lines

The final landform will be designed to generally recreate the natural drainage catchments as closely as possible and will be predominantly free draining. Sediment dams will remain in place until a stable landform is achieved.

The re-establishment of any ephemeral drainage lines would be undertaken in accordance with the Rehabilitation Manual for Australian Streams (LWRRDC and CRCCH), the Draft Guidelines for Designing Stable Drainage Lines on Rehabilitated Mine Sites, formulated by the former NSW Department of Land and Water Conservation (1999), as well as the Guidelines for Controlled Activities – In-Stream Works (DWE, 2008) (DWE guidelines).

Where required, additional stabilisation measures such as contour banks, check dams and rock armouring, designed in accordance with the Blue Book Volume 2E, would be utilised to achieve landform stability.

Keys design elements of drainage line establishment works would include the following:

- implementation of effective temporary erosion controls to provide for the short-term stabilisation of the drainage channel;
- design and construction of drainage channels so that they would be stable for the long-term and would minimise the potential for the migration of any erosion;
- use of natural meanders, where possible, instead of straight lines to reflect natural drainage characteristics; and
- where there are high erosive forces (such as high flow velocity or steep grades) the bed of the drainage channels should be rock lined, where required, and constructed in accordance with the Blue Book.

The key performance criteria used to ensure that the reinstated drainage lines are meeting their design objectives is related to their stability. The reinstated drainage lines should be free of both stream and lateral erosion with progressive improvement of the stream / riparian vegetation health observed over time (during regular monitoring of the drainage lines).

3.3.13 3.2.13 Measures for minimizing requirement for external water:

To minimize requirement for external water, in particular trucking water, TCM will:

- apply dust binder products for dust suppression of haul roads and operating areas when the available water on site is less than 250 ML;
- liaise with the BTM Complex mines (and other Whitehaven Coal mines) and discuss opportunities to share water in accordance with the BTM Water Management strategy when water stored onsite is below 100 ML;
- Consider construction of a pipeline to transfer extracted water from the Vickery Coal Mine bore to TCM as approved in Modification of PA11_0047 7 (MOD7);
- If despite all the above measures water available onsite falls below 100 ML, TCM will consider transferring water extracted from the Vickery Coal Mine (VCM) bore

via water haulage trucks that will travel on the approved TCM haulage routes in accordance with Modification of PA11_0047 (MOD8) granted on the 15th of June 2020.

3.4 Site Water Management Areas

3.4.1 General

The TCM water management system has seven distinct water management areas including five catchment areas reporting to LDPs and the catchment area reporting to the mine pit. These areas largely follow the topography of the site but also consider the disturbance of the catchments. The catchment areas reporting to each LDP and the mine pit are shown in Figure 4, the LDPs have sufficient design storage in accordance with the Blue Book.

These water management areas are explained in the following sections. Consideration is also paid to the changing requirements within these areas as the approved works progress.

3.4.2 SD17 (LDP 1) Water Management Area

The SD17 (LDP 1) water management area collects runoff from the partly rehabilitated Northern Emplacement, Northern Extension Emplacement, ROM pad and processing area and is located in the north-west corner of TCM. Runoff from these areas are collected in nine sediment dams that ultimately report to SD17. A mine water dam (SB4) is also located in the SD17 (LDP 1) water management area to collect runoff from the ROM pad and processing area. LDP 1 is located on the SD17 spillway. Overflows from SD17 spill offsite into the BCM water management system (BCM's sediment dam SD6).

Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the ten dams (SD17, SB5A, SD2, SB5B, SD1, SB7, SUMP, SB6 and SB25) currently located in the SD17 (LDP 1) water management area.

Runoff within the SD17 (LDP 1) water management area is currently managed as follows:

- Runoff from the southern face of the Northern Emplacement and surrounding areas is collected in SB5A. Overflows from SB5A spill into SB5B, which in turn spills into SD1, SB7 and SD17.
- SD2 is currently isolated and does not receive any runoff, this dam shall be decommissioned and rehabilitated..
- Runoff from the rehabilitation area on the western face of the Northern Emplacement is collected by contour drains and passed down a drop structure to SB7. Overflows from SB7 spill into SD17.
- Runoff from areas to the north of the Northern Emplacement is collected by a drain that flows in a westerly direction along the mine lease boundary to SB25. Overflows from SB25 spill into SB6, which in turn spill into SUMP and SD17.

- Runoff from the southern face of BCM's emplacement area immediately adjoining the TCM MLs is collected in SB25.
- Runoff from the ROM pad is collected in SB4. SB4 is managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows. TCM are in the process of enlarging SB4 to reduce its risk of spilling. In this way it is considered separate to the SD17 (LDP 1) water management area and is managed as part of the mine water management system and dewatered to PW3 or the mine pit. Overflows from SB4 spill into SB5A, if this occurs SB5A is pumped to PW3.

3.4.3 SB23B (LDP 26) Water Management System

The SB23B (LDP 26) water management area collects runoff from partially revegetated soil stockpiles and undisturbed area. Runoff from these areas reports to SB23A and SB23B which function as a combined dam. LDP 26 is located on the SB23B spillway. Overflows from SB23B flow off site in a westerly direction into an existing farm dam and towards Goonbri Creek. Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for SB23A and SB23B.

3.4.4 SD9 (LDP 2) Water Management Area

The SD9 (LDP 2) water management area currently collects runoff from the Southern Emplacement, southern portion of the Northern Emplacement, mine workshops, and site administration offices. Runoff from these areas are collected in four sediment dams that ultimately report to SD9. Overflows from SD9 spill across Goonbri Road and into Goonbri Creek. A turkey's nest mine water dam (PW3) is also located in the SD9 (LDP 2) water management area. Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the five dams (PW3, SB16A, SB16B, SD8 and SD9) currently located in the SD9 (LDP 2) water management area.

Runoff within the SD9 (LDP 2) water management area is currently managed as follows:

- Runoff from part of the mine workshop, south eastern face of the Northern Emplacement, part of the ROM Pad and adjacent areas is collected in SB16A and SB16B which act as a combined storage. Overflows from SB16A spill into SB16B, which in turn spills into SD8, and then SD9.
- PW3 is a turkeys nest (no external catchment) and is managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows. In this way it is considered separate to the SD9 (LDP 2) water management area and is managed as part of the mine water management system.

3.4.5 SD28 (LDP 3) Water Management Area

The SD28 (LDP 3) water management area currently collects runoff from the Southern Emplacement. Runoff from this area reports to SD28 and SD27, SD7 spills to SD28. LDP 3 is located on the SD28 spillway. Overflows from SD28 spill across Goonbri Road and into

Goonbri Creek. Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for SD28 and SB27.

3.4.6 SB24B (LDP 27) Water Management Area

The SB24B (LDP 27) water management area collects runoff from part of the Southern Emplacement and adjacent areas. Runoff from these areas are collected in four sediment dams that ultimately report to SB24B. Overflows from SB24B spill to Goonbri Road and into Goonbri Creek. A mine water dam (SB24A) is also located in the SB24B (LDP 27) water management. The SB24A mine water dam was previously a sediment dam until it was converted to a mine water dam in 2021 to supply the truck fill for dust suppression.

Runoff within the SB24B (LDP 27) water management area is currently managed as follows:

- Runoff from the Southern Emplacement is collected in SB26 and SD26. Overflows from SB26 and SD26 spill into SB24B.
- SB24A receives runoff from a relatively small catchment and is managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows. In this way it is considered separate to the SB24B (LDP 27) water management area and is managed as part of the mine water management system.

Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the six dams (SB24A, SB26, SD26 and SB24B) currently located in the SB24B (LDP 27) water management area.

3.4.7 Upslope Clean Water Management Area

As detailed in section 3.3.3, TCM water management system captures and diverts clean water in compliance with the WMA Act, A significant proportion of the upslope clean management area located to the east of the mine pit highwall will be mined out as part of approved future mining operations: compare Figure 4 against Figure 6. The clean catchment captured by the TCM WMS is compliant with the WM Act, and is expected to remain compliant over the life of mining. The topography ahead of mining to the east forms a 30 m deep valley, with the lowest point located in the middle of the progressing highwall. It is not practical or feasible to divert the small clean water catchment to the south towards Goonbri Creek.

A clean water diversion is in place around PW6, which diverts to an undisturbed catchment and into Goonbri Creek.

3.4.8 Mine Water Management Area

This area consists of the mine pit and areas that drain directly to it as well as the ROM Pad and processing area. No flow leaves the mine pit naturally with pumps moving water to the mine water dams SB24A, PW3, PW5 and PW6. Surface water that enters these areas is considered mine water. SB24A, PW3 and PW6 do not collect runoff from external catchments. SB4 collects surface runoff from part of the ROM Pad and processing area.

Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the five dams (PW3, PW5, PW6, SB24A and SB4) as well as the mine pit area currently located in the mine water management area.

Mine water dams are managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows to other water management areas.

3.4.9 Future Mining Areas

Future mining areas will progress to the east of the ridge that separates on site flows from those that reach Goonbri Creek. Once the mine has progressed beyond this ridge, clean water catchment areas will naturally drain off site towards Goonbri Creek. The following infrastructure are planned as part of future operations:

- dirty water infrastructure will be constructed to capture water from disturbance in advance of mining and active waste emplacement areas to prevent uncontrolled discharge; and
- mine water infrastructure will be constructed to manage mine pit water and allow mining access to the coal seam.

Details on future infrastructure beyond 2024 including catchment areas, dam sizing and diversion works will be addressed in future updates of this WMP. Further details on key planned water management infrastructure is provided in Section 7.

3.5 Erosion and Sediment Controls

3.5.1 Monitoring Activities

Erosion or sedimentation may potentially result from any of the following:

- surface runoff from areas disturbed as a result of vegetation or topsoil removal;
- surface runoff from topsoil or subsoil stockpiles prior to establishment of an adequate vegetative cover;
- surface runoff from rehabilitation areas prior to the establishment of a suitable ground cover;
- vehicle and equipment movements;
- construction of water management structures (i.e. dams, diversion drains);
- construction/maintenance of access roads;
- runoff from hardstand areas including roads and the main office area;
- excessive surface water runoff velocity within drainage lines and on disturbed surfaces; and
- surface runoff from ROM and product coal stockpile areas.

3.5.2 On-going Erosion and Sediment Management Practices

The practices implemented to minimise potential for erosion and sedimentation may include:

- installation of all ESC measures and water management structures prior to any disturbance of topsoil taking place;
- land disturbance will be minimised by clearing the smallest practical area ahead of disturbance activities;
- where practical, disturbance areas will be shaped so as to provide a free draining surface to direct dirty water runoff into the dirty water management system;
- ESC measures (including sediment dams, conveyance channels, temporary ESC structures, etc.) will be designed and managed (refer to Section 3.5.4) in accordance with the Blue Book. Sediment dams will be specifically sized to contain runoff from a 5 day, 90th percentile rainfall event (38.4mm) in accordance with the requirements documented in EPL 12365. The design criteria for water conveyance channels will be obtained from Table 6.1 of the Blue Book (Vol 2E);
- the erosion and sediment control structures will be inspected periodically or after a rainfall event of >38.4 mm in a 5 day period;
- as part of the surface water monitoring program, water flowing from all LDPs will be sampled in accordance with the EPL;
- if a high risk of non-compliant site discharge is identified, excess surface water will be pumped into the mine water dams. This would rely on the availability of storage capacity within the mine water dams and all water moved to them would be treated as mine water;
- if discharged water exceeds the LDP TSS limit 50 mg/L then the actions listed in the Surface Water Response Plan documented within Section 6.4 shall be followed;
- all discharge from flumes/drop structures will flow to sediment basins; and
- if, following heavy rain, significant erosion is identified on the rehabilitated landform, it will be remediated using one or a combination of the following, or similar:
  - filling the erosion channels;
  - cross-ripping (along the contour) to assist infiltration; and/or
  - installation of additional controls, e.g. banks sown with a cover crop; and
- where necessary, temporary ESC measures will be utilised to prevent and/or reduce the potential for adverse erosion developing. Temporary ESC structures will be constructed and managed in accordance with the principles outlined in the Blue Book.

3.5.3 Site Rehabilitation Management

Active mine processes require ground to be disturbed and re-disturbed on a regular basis. The total area of disturbed ground will be kept to a minimum, as far as practicable, with a programme of rehabilitation. Temporary groundcover is provided for areas where rehabilitation is temporary and final landform is not yet achieved.

Once rehabilitated areas achieve required surface runoff quality specified in the RMP any operational sediment control structures will either be removed or left as passive water storages.

3.5.4 Water Management and ESC Maintenance

Water management and ESC measures are maintained in a functioning condition until areas have been deemed rehabilitated (refer to Section 3.5.3). Where controls are observed not to be functioning correctly, they are reinstated/repaired to the required standard. Where significant erosion occurs on a regular basis, additional controls may be constructed.

Dams

Dams are to be regularly maintained as follows:

- dirty water dams shall be dewatered (Settling Zone) within 5 days of a rainfall event (as per the Blue Book) via:
    - re-use on site for dust suppression/watering vegetation; and/or
    - transferring water to larger storages; and/or
    - discharge off-site in compliance with the mine's EPL (refer to Section 3.7); and
- de-silting the sediment dams to maintain the sediment zone (refer to Section 3.3.2 and Appendix A).

Water level signage/gauge boards located within each of the authorised discharge dams (those required to contain runoff from a 5 day, 90th percentile rainfall event (38.4mm) will be used to assist in dam maintenance and operation by clearly displaying the Operating Volume so that it is clear to site personnel when the dams need to be dewatered/desilted.

Conveyance Channels

Conveyance channels will be inspected for signs of erosion along their length and any remedial works undertaken as required. Where significant erosion is observed, additional erosion controls may be constructed e.g. establishment of vegetation cover, use of temporary sediment devices until the vegetation is established, scour protection (rock-armouring or erosion blanket) of the channel surface.

Temporary ESC Structures

Disturbance at TCM primarily occurs within the catchment of dirty water dams and therefore does not require temporary ESC measures. During the construction phase of ESC measures, or in small areas of disturbance outside of the catchment of dirty water dam, temporary ESC measures are used. The temporary ESC measures used shall be in accordance with the Blue

Book and include sediment fences, temporary ground cover (hydro mulch), cross ripping, sediment traps/sumps etc. Regular visual inspections are made of any temporary erosion and sediment controls to confirm that they are functioning adequately and repaired where required.

Temporary ESC measures may also be used within the catchment of dirty water dams to minimise erosion, including temporary drainage and erosion controls during the construction of rehabilitation.

Access Roads

The access roads are inspected following large storm events, to determine maintenance requirements. Periodic maintenance will include checking the drainage systems to remove any debris that may block culverts, cross drain outlets and table drains.

3.6 Surface Water Monitoring Plan

3.6.1 General

TCM has a comprehensive surface water monitoring program in place across the mine site that incorporates the collection of:

- rainfall and meteorological data;
- water quality data in the onsite dams and surrounding creeks; and
- water quality and quantity data during any discharge events via any of the LDPs at the TCM.

The objective of the surface water monitoring program is to provide details of the monitoring undertaken on site to monitor the effects of the TCM on existing surface water bodies. The purpose of this monitoring is to assist in detecting if any significant off-site impacts occur as a result of mining and to trigger response plans to adverse impacts.

Note that the following surface water monitoring program has been developed so that it is consistent with the cumulative impact monitoring objectives of the BTM Complex WMS and so that it contributes, where necessary, to the BTM Complex cumulative impact monitoring network.

3.6.2 Monitoring Locations

Figure 8 shows the water quality sampling locations associated with the TCM. The water quality monitoring program has been designed to provide data on the flows leaving site as well as the flows in the receiving creeks.

As mining progresses there may be a need to review the current monitoring network to address potential future impacts to Goonbri Creek. At this time the surface water monitoring program will be updated in consultation with DPE Water and documented within future revisions of this WMP. The system will also be expanded to cover all new water storages that are constructed.

3.6.3 Historical Baseline Water Quality

The surrounding creeks (Nagero Creek, Bollol Creek and Goonbri Creek) have an ephemeral natural and only flow for very short periods following rainfall events. Barbers Lagoon and The Slush Holes generally do not contain significant volumes of water, and would be dry for the majority of the year. As evident from Google Earth, Barbers Lagoon and The Slush Holes are highly disturbed as they are often cropped and grazed and therefore not suitable locations for water quality sampling of the receiving environment.

Baseline data for the TCM including local surface water and groundwater quality monitoring, water discharge and level records are reported in the Environmental Assessment, Annual Review and Annual Return. The Environmental Performance at TCM, which is reported in the Annual Review and Annual Return, is compared against historical baseline data and commitments of the Environmental Assessment.

3.6.4 Water Quality Monitoring Schedule

The Water Quality Monitoring Schedule outlined in Table 7 defines the parameters to be sampled and the recommended sampling frequency at each sampling location. The Monitoring Schedule for TCM has been reconciled with the monitoring requirements documented within the BTM Complex WMS. The water quality monitoring program provides for the assessment of background data for flow events in the various creeks as well as regular grab samples from targeted mine water storages on-site. The samples shall be collected in a manner consistent with the Approved Method for Sampling and Analysis of Water Pollutants in NSW (EPA, 2022) which includes the following requirements:

- the event-based sampling should enable quantification of any pollutant loads from the mine site and their corresponding impact on the local creek water quality; and
- on-site regular sampling from the water storages allows for any potential problem areas with respect to pollutant generation on-site to be identified in advance ensuring appropriate remedial action can be taken.

Monitoring is conducted in accordance with the relevant Australian Standards.

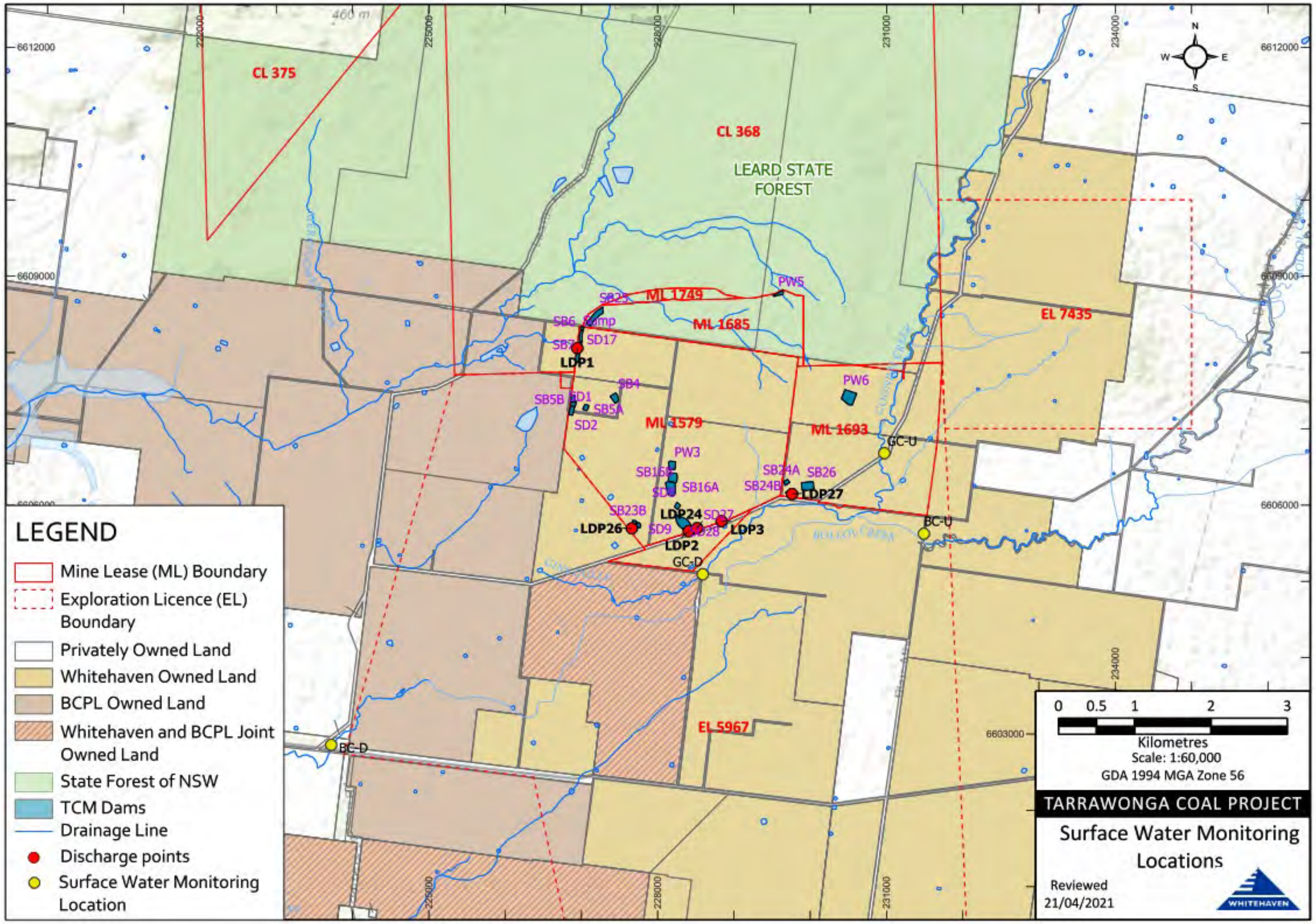


Figure 8 Tarrawonga Coal Mine Surface Water Monitoring Locations

Table 7 TCM Water Quality Monitoring Schedule

Location	Parameters	Frequency
Site (Meteorological Monitoring)	Rainfall Wind speed and direction Temperature (2m & 10m) Relative Humidity Solar Radiation	5 minute intervals
Sediment basins	Water level	Scheduled survey pickup
Select sediment basins; LDPs	EC Oil and grease pH TSS Total phosphorous Total Nitrogen Sulphate (SO_4) Total Alkalinity Total Acidity Aluminium Arsenic Cadmium Chromium (Cr VI) Iron Molybdenum Selenium (total) Zinc	Quarterly As soon as practical following site discharge, but not longer than 12 hours after discharge commences (for LDPs only).
Mine pit/ Void	EC Oil and grease pH TSS Antimony Arsenic Molybdenum Selenium	Quarterly
Surrounding Creeks (GC-U, GC-D, BC-U and BC-D)[a]	EC Oil and grease pH TSS Total phosphorous Sulphate (SO4) Total Nitrogen Aluminium Arsenic Cadmium Chromium (Cr VI) Iron Molybdenum Selenium (total) Zinc Photo monitoring of creek if flowing	Quarterly (if flowing) For BC-U and BC-D, as soon as practical following site discharge, but not longer than 12 hours after discharge commences (if flowing).

[a] NC-U and NC-D on Nagero Creek are monitored by BCM and results can be shared with TCM.

3.6.5 Stream / Riparian Vegetation Health Monitoring

A program to monitor creek line channel stability and health of riparian vegetation within downstream watercourses and reinstated drainage lines will be undertaken throughout the mine life. The monitoring of these conveyance structures and water courses will be undertaken to ensure that their stability is not impacted on by the Project.

Monitoring of the drainage lines is to include:

- a channel stability assessment encompassing:
  - documenting general observations of water quantity and quality;
  - documenting locations and dimensions of significant erosive or depositional features so that any subsequent changes can be evaluated quantitatively;
  - establishing multiple photographic points at representative locations, so that photos can be taken over multiple inspections in a repeatable manner; and
  - written descriptions of the stream at each of the photographic points, focussing on evidence of erosion and exposed soils;
- an AUSRIVAS assessment encompassing:
  - habitat assessments;
  - water quality monitoring; and
  - aquatic flora and fauna surveys.

Results of successive monitoring data will be reviewed and compared to previous rounds of baseline monitoring to assess whether there is any degradation of the riparian vegetation or stream channel. TARPs shown in Table 33 Table 34 detail additional investigations and actions that will be undertaken to assess whether impacts may be associated with the operation of the TCM and ameliorative actions undertaken if association is identified and as required.

3.6.6 Monitoring and Assessment of Existing Water Management System

Ongoing regular monitoring of the existing water management system is undertaken to ensure that the system is working effectively to meet the TCM water management objectives. This monitoring includes the following:

- visual inspections of water management structures (i.e. dams; conveyance structures and ESC measures) annually and after significant rainfall (>50 mm in a 24-hour period);
- review of the water quality monitoring program in Section 3.6.4 as required;
- review of the number of site discharges as part of the Annual Review; and

- assessment of past water takes under the existing groundwater licenses as part of the Annual Review.

Where issues are identified they will be investigated and rectified in accordance with the Surface Water and Groundwater Response Plan detailed in Section 6.

3.6.7 Coal Contact Water Study

The proposed plan for the coal contact surface water quality assessment has been provided to the EPA.

3.7 Surface Water Impact Assessment Criteria and Trigger Values

Surface water trigger value criteria have been adopted for:

- surface water quality discharged from the TCM;
- surface water quantity discharged from the TCM; and
- surface water quality downstream of the TCM.

3.7.1 Water Quality Discharged from TCM

Impact assessment criterion for surface water is only relevant to water actually discharged from the TCM. Surface water quality limits from EPL 12365 are shown in Table 8.

Table 8 Surface Water Quality Discharge Limits

Pollutant	Units of Measure	100 percentile concentration limit
Oil and Grease	mg/L	10
pH	pH	6.5-8.5
Total Suspended Solids (TSS)	mg/L	50

3.7.2 Water Quantity Discharged from TCM

To ensure consistency and achieve the surface water quantity objectives outlined in the BTM Complex WMS, the following triggers have been adopted for TCM:

- complaints regarding impacts on stock and domestic local surface water catchments; and
- complaints regarding perceived unacceptable flooding of downstream properties in local catchments.

Exceedance of the trigger values will initiate activation of the Response Plan as outlined in Section 6.

3.7.3 Water Quality Downstream of TCM

Proposed trigger levels for surface water quality downstream of TCM are based on the ANZECC (2000) guidelines and available monitoring data for the TCM. This section sets a broad range of trigger levels for all ephemeral creeks in the area based on ANZECC default values and from the broader precinct monitoring data that is available.

Table 9 shows a preliminary assessment of trigger values that will be used for assessing the surface water impacts from the TCM. These trigger values are consistent with those developed for achieving cumulative impact management objectives in the BTM Complex WMS. The adopted trigger values will be refined using locally derived values where appropriate based on sampling that has been undertaken in accordance with the monitoring programme documented within this WMP.

Exceedance of the trigger values at downstream sites with less than trigger values at upstream sites, will initiate activation of the Response Plan as outlined in Section 6.

Table 9 TCM Ambient Surface Water Quality Trigger Levels

Parameter	ANZECC[a,b]	Historical upstream[c]	Trigger
Total Phosphorus (µg/L)	20	110-360	110-360
Total Nitrogen (µg/L)	250	500-3000	500-3000
EC (µS/cm)	30-350	33-275	30-350
pH	6.6-8.0	5.9-7.8	5.9-8.0
Total suspended solids (mg/L)	NA	32-220[d]	32-220
Aluminium (µg/L)	150	2160	2160
Arsenic (µg/L)	360	NA	360
Cadmium (µg/L)	0.8	NA	0.8
Chromium (Cr VI) (µg/L)	40	NA	40
Iron (µg/L)	NA	1680	1680
Molybdenum (µg/L)	NA	NA	NA
Selenium (total) (µg/L)	34	<10	<10
Sulphate (µg/L)	NA	NA	NA
Zinc (µg/L)	31	NA	31

[a] Most sensitive EV is aquatic ecosystems.
[b] Trigger values for freshwater at a level of 80% of protection of species.
[c] Based on the envelope of BTM Complex available ambient monitoring data.
[d] TSS range does not include data from TCM available ambient monitoring data (1983/84), as it is significantly higher than levels recorded by BCM in 2008/09 and are at present considered to be outliers. Concentration levels to be reviewed once further ambient monitoring data becomes available.

4 SITE WATER BALANCE

4.1 Overview

The TCM water balance assessment is reviewed and updated on an annual basis, alongside the Annual Review reporting.

A detailed site water balance assessment over the full project life was undertaken as part of the surface water impact assessment (RS, 2012). The initial water balance assessment used the Goldsim software to simulate and assess the performance of the site water management system under varying climatic sequences, catchment conditions and operational stages. The model simulated the operations of all major components of the water management system on a daily time step.

A revised water balance model, which is reviewed and updated annually, has been developed using the Goldsim software to predict the likely performance of the site water management system. The site water management system has been assessed using the water balance model for the next 2 years of operations, consistent with the MOP (Year 2022 to Year 2023). The Goldsim water balance model was developed to simulate the behaviour of the site water management infrastructure and was validated by comparison to recorded site data during the Year 2021 operations. The simulated inflows and outflows included in the Goldsim model are given in Table 10.

Table 10 Simulated Inflows and Outflows to Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages including from mechanical evaporators
Catchment runoff	Dust suppression demand
Groundwater inflows	ROM coal crusher demand
External water supply	Coal moisture export loss
	Seepage from storages
	Controlled releases from storages
	Offsite spills from storages

The Goldsim model was used to assess the performance of the proposed water management system, including:

- mine storage inventory;
- water requirements from external sources;
- uncontrolled spills from the mine water and dirty water storages; and
- the overall water balance within the water management system.

Details of the water management system infrastructure and configuration are provided in Section 3.4. Details of the model configuration, modelling methodology and data inputs are provided in the water balance report (WRM, 2022).

Figure 7 shows the conceptualisation of the mine water management system adopted for the water balance model.

4.2 Water Balance Objectives

The principal objectives of the site water balance are associated with water security and the compliant discharge of water offsite. The specific objectives of the site water balance include the following:

- Maximise the re-use of water to ensure that there is sufficient water onsite to meet the mine water demands and to reduce reliance on external water;
- all mine water is to be contained on-site as much as practicable; and
- the number of offsite discharges occurring during an average rainfall year should be no greater than what is predicted for dams designed in accordance with the Blue Book.

4.3 Model Representation, Accuracy and Assumptions

Investigation outcomes are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/rainfall runoff, mining area groundwater inflows). These assumptions will be checked and refined against on-site observations through annual reviews of the WBM.

The TCM WBM for the forecast period (Year 2022 to Year 2023) was modelled in Goldsim as shown in the water schematic diagram presented in Figure 7. The following assumptions/simplifications were incorporated in the model:

- the model was run on a daily time step based on 132 years of Patch Point rainfall and Data Drill evaporation data for the BoM's Boggabri Post Office station (55007) obtained from the SILO service;
- modelled operating rules were based on advice from TCM. In reality, external influences may result in changes to the operating rules;
- all water storages were modelled individually in the forecast period;
- runoff from catchments was represented by the Australian Water Balance Model (AWBM) methodology, as described in Section 4.4.2;
- potable water and wastewater was not included in the site water balance;
- it was assumed that 20% of sediment dam capacity and 10% of mine water dam capacity is "dead storage" and therefore not available; and
- the Full Storage Volume, initial water volumes, maximum operating volumes and surface areas of the TCM dams were based on information provided by TCM.

4.4 Water Sources (Inputs)

4.4.1 Rainfall

Three BOM meteorological stations with long-term (greater than 100 years) daily rainfall records are located within the vicinity of TCM including:

- Boggabri Post office (station number 55007), which is located approximately 13.2 km to the southwest of TCM;
- Boggabri (Retreat) (station number 55044), which is located approximately 13.5 km to the southeast of TCM; and

- Turrawan (Wallah) (station number 55058)), which is located approximately 29.5 km to the northwest of TCM.

Table 11 shows the average monthly rainfall statistics at the above stations.

Table 11 Summary of Average Regional Monthly and Annual Rainfall and Rain Days

Month	Boggabri Post Office (55007) 1884 - 2021		Boggabri (Retreat) (55044) 1889-2022		Turrawan (Wallah) (55058) 1910-2022	
	Rainfall (mm)	Rain days	Rainfall (mm)	Rain days	Rainfall (mm)	Rain days
January	70.5	6.1	71.1	5.3	77.5	5.2
February	63.8	5.1	61.9	4.7	57.8	4.2
March	48.0	4.5	44.9	4.0	44.0	3.6
April	34.7	4.0	34.6	3.1	31.9	2.8
May	41.1	4.5	38.5	3.7	38.1	3.3
June	43.3	5.7	44.3	4.9	39.4	4.2
July	40.6	5.5	41.9	4.9	37.4	4.2
August	37.5	5.0	37.0	4.4	34.2	3.9
September	38.0	4.7	39.5	4.5	34.8	3.6
October	50.1	5.8	49.9	5.1	48.3	4.5
November	60.2	5.9	59.4	5.4	57.4	5.0
December	64.4	6.2	61.7	5.3	59.5	5.0
Annual	**592.2**	**63.1**	**584.8**	**55.2**	**560.2**	**49.6**

Table 11 shows the average annual rainfall from the three nearby stations are similar with the annual rainfall ranging from 560 to 590. mm/year. Rainfall data from the Boggabri Post Office station was adopted for the site water balance assessment due to its proximity to the TCM as well as length and completeness of the data.

Five years (2019, 2018, 2011, 1998 and 1950) were chosen to represent the 99th (very dry year), 90th (dry year), 50th (median year), 10th (wet year) and 1st (very wet year) percentiles respectively. These values are summarised in Table 12.

Table 12 Comparison of Total Annual Precipitation

Representative annual rainfall	Statistical Percentile Precipitation (mm)	Actual Precipitation (mm)	Difference (mm)
Very Dry Year (1st percentile, 2019)	244.2	236.2	8.0
Dry Year (10th percentile, 2018)	394.1	407	-12.9
Median Year (50th percentile, 2011)	587.3	584.7	2.6
Wet Year (90th percentile, 1998)	808.3	832.7	-24.4
Very Wet Year (99th percentile, 1950)	1211.0	1211	0.0

Table 12 shows the differences between the statistical and actual precipitation for the selected dry, median and wet years are minimal (less than 3%) and as such these years are considered to be appropriate for use within the Goldsim model.

In addition to the dry, median and wet rainfall years, the model was run for 132 climatic realisations developed using the 133 years of rainfall and evaporation data over the 2-year forecast period (Year 2022 to Year 2023) to assess the potential medium-term performance in the water management system.

4.4.2 Water Generated from Runoff

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across TCM. The AWBM is a nationally-recognised catchment water balance model that can relate runoff to rainfall with daily data, and calculates losses from rainfall for flood hydrograph modelling. Modelling of the following five different TCM sub-catchment types was undertaken (as shown in Figure 4):

- natural surface/undisturbed/rehabilitated;
- active waste rock emplacements;
- disturbed areas;
- hardstand; and
- open pit.

AWBM runoff parameters were determined from a review of literature based guideline values and validation of the water balance model to recorded water data from Year 2021 (see Section 4.8). The parameters used are shown in Table 13 below.

Table 13 Water Balance AWBM Parameters

Parameter	Natural/ Rehab	Active spoil	Disturbed	Hardstand	Mine Pit
C1 (mm)	13	15	10	2	2
C2 (mm)	127	50	65	10	20
C3 (mm)	255	110	65	30	0
A1	0.13	0.1	0.15	0.33	0.1
A2	0.43	0.3	0.60	0.33	0.9
A3	0.44	0.6	0.25	0.33	0
BFI	0	0.8	0	0	0
Kbase	0	0.98	0	0	0
Ksurf	0	0.2	0	0	0

4.4.3 Groundwater Inflow

Table 14 shows the predicted annual net groundwater inflow rate to the mine pit, adapted from the TCM groundwater model (Hydrosimulations, 2019). The predicted annual groundwater inflow rate is around 62.1 ML/yr (0.17 ML/d) between Year 2022 and Year 2023.

Table 14 Predicted groundwater inflows into the mine pit

Project year	Annual Pit inflow (ML/yr)	Daily Pit inflow (ML/day)
FY22	62.1	0.17

FY23	62.1	0.17
FY24	62.1	0.17

4.4.4 Water Obtained from External Sources

External water may be required if there is insufficient water onsite to supply demands. TCM can source external water from multiple locations including sharing within the BTM complex and transfers from the Vickery Coal Mine. External water is only required if the total available inventory is less than 100 ML. It has been assumed within the Goldsim model that external water is transferred to the TCM water management system at a rate of 1.6 ML/d.

In the event there is insufficient external water to meet operational needs, the mining operation will be adjusted to the available water supply.

4.5 Water Losses and Usage (Outputs)

4.5.1 Evaporation

Evaporation records are available from the Keepit Dam (station number 55276) and Gunnedah Resource Centre (station number 55024) meteorological stations, which have recorded average annual evaporation of approximately 1,825 mm and 1,853 mm, respectively. The average monthly pan evaporation rates from these meteorological stations can be seen in Table 15 below.

Table 15 Summary of Average Regional Class 'A' Pan Evaporation (mm)

Month	Keepit Dam (55276) 1972-2006	Gunnedah Resource Centre (55024) 1971 - 2010	SILO Data Drill data for Boggabri Post Office 1889 – 2022
January	255.7	248.4	258.5
February	204.5	202.1	208.3
March	182.1	196.4	190.7
April	124.1	138.2	131.5
May	80.6	90.4	85.1
June	56.1	61.7	59.4
July	63.9	64.8	65.2
August	89.2	91.8	92.9
September	129.3	127.4	132.8
October	172.7	174.9	183.5
November	207.7	206.1	219.7
December	259.4	250.5	260.3
Annual	**1825.3**	**1852.7**	**1887.9**

For the purpose of the water balance, SILO Patch Point daily evaporation data for Boggabri Post Office was used. The SILO Patch Point average annual pan evaporation is approximately 1,892 mm, which is similar to the Keepit Dam and Gunnedah Resource Centre averages (see Table 15).

Figure 9 shows the variation of mean monthly pan evaporation, Morton's Lake evaporation and evapotranspiration (actual and wet) at the Boggabri Post Office using SILO Data Drill data. Annual average pan evaporation rates are approximately 3.2 times the average annual rainfall. The evaporation rate is high throughout the year, with highest evaporation rates occurring in the months between October and March. Morton's Lake evaporation has been used to estimate evaporation loss from storages, which is on average 81% of pan evaporation in the vicinity of the project.

Soil moisture evapotranspiration losses in the AWBM model was estimated using Morton's Wet evapotranspiration, which is on average 98% of Morton's Lake evaporation in the vicinity of the project.

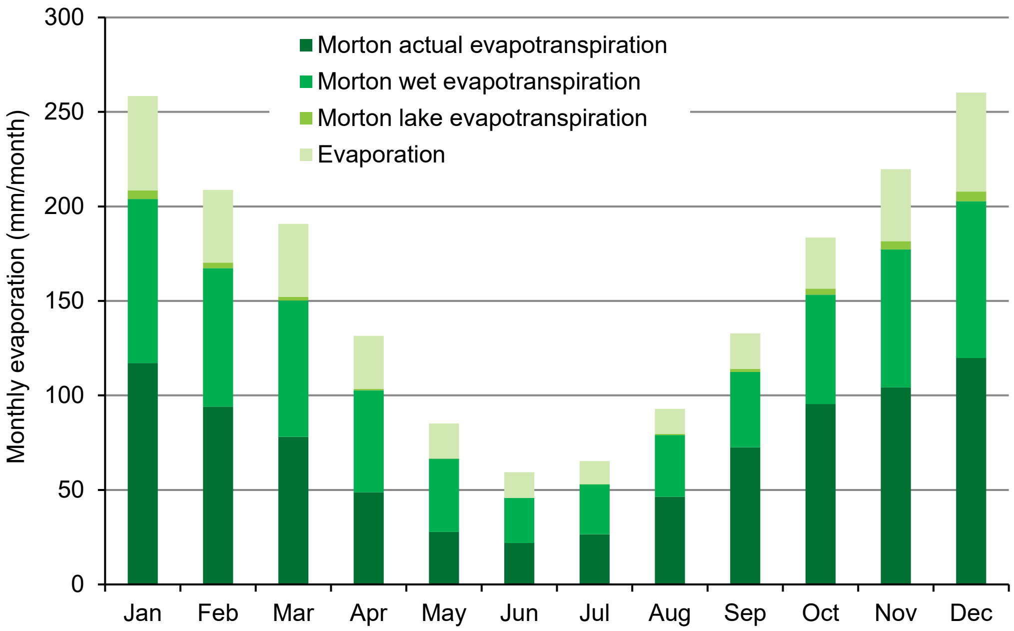


Figure 9 **Mean monthly evaporation and evapotranspiration at Boggabri Post Office based on 133 years of SILO Data Drill evaporation data**

4.5.2 Loss of Water Through Coal Export

Water within the processed ROM coal is exported off-site (lost) to the Whitehaven CHPP. Water within the coal is sourced from the pit floor (e.g. groundwater) and the ROM pad (e.g. water used for dust suppression and coal crushing). Based on site data, the estimated average ROM coal total moisture is approximately 9.8%w/w. This consists of 7.7% from pit floor sources and 2.0% from ROM pad and crushing sources.

This equates to a loss of water from TCM of up to 0.940 ML/d (or 343.0 ML/year) based on the maximum coal production rate of 3.5 Mtpa (242 ML/year based on current ROM totals of 2.4 Mtpa) (in accordance with the PA 11_0047 MOD 7).

4.5.3 Operational Water Demands

Dust Suppression

The majority of water use on site is for dust suppression activities of haul roads and on the ROM Pad. dust suppression volumes have been recorded since 2015. Water for dust suppression is sourced from PW6 via SB24A and PW5 storages. Other standpipes may be established as the mine progresses and to maximise the efficiency of dust suppression.

Haul road dust suppression rates for Year 2022 onwards were estimated using daily rainfall and evaporation data for the Boggabri Post Office from the SILO service and the haul road length. The haul road length for 2022 was measured from the provided aerial photographs and is approximately 16.0 km. This is expected to remain roughly the same through to Year 2023.

In 2018, TCM started using a commercial binder to reduce the haul road dust suppression requirements. The supplier of the binder has advised that the use of the binder could reduce haul road dust suppression requirements by up to 50%. Dust suppressant binders are only used when the total available site inventory is below 250 ML.

The following rules were used to determine the applied dust suppression rate on any given day of the historical rainfall record:

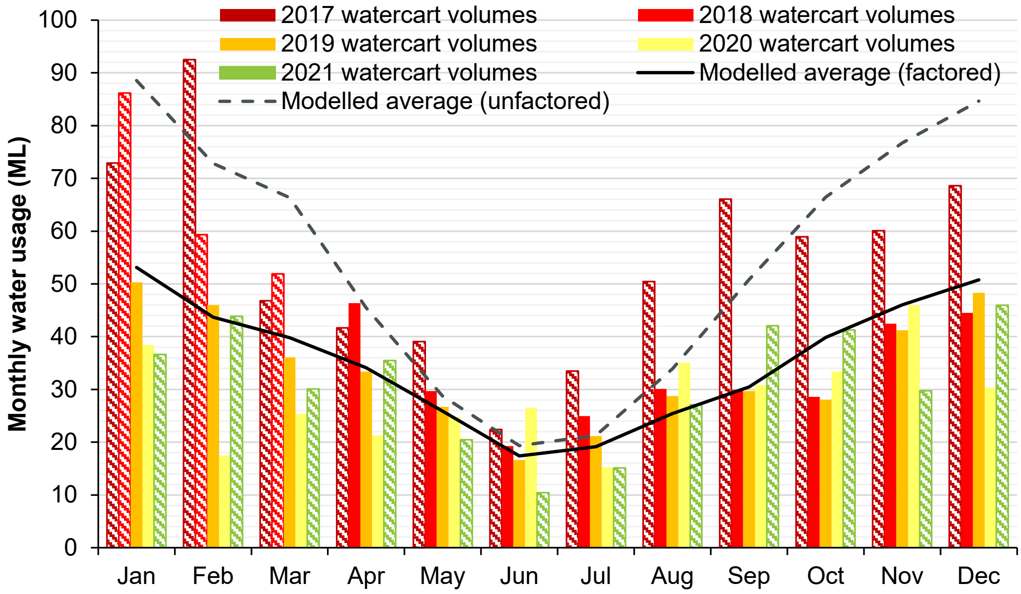
- for a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate;
- for a rain day when rainfall is less than the daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the daily evaporation rate;
- for a rain day when rainfall exceeds the daily evaporation rate, no haul road watering is required; and
- it was assumed that 27.5 metres of the haul road width would be watered.

Figure 10 also shows the factored dust suppression rates, considering the use of dust suppressant binders, for use in the sensitivity assessment. The average monthly usage rates for Year 2021 (measured) and predicted rates for Year 2022 to Year 2025 are summarised in Table 16.

Table 16 Estimated haul road dust suppression usage

Month	Haul road dust suppression water usage (ML)	
	Year 2021 (measured)	Year 2022 onwards (no binders) (calculated average)
January	37	89
February	44	73
March	30	66
April	35	45
May	20	29
June	10	19
July	15	21
August	27	34

September	42	51
October	41	66
November	30	77
December	46	85
Annual	**378**	**655**



Note:
Hatched columns represent months where dust suppressant binders were **not** used.

Figure 10 Comparison of estimated and actual monthly haul road dust suppression rates

Coal Crushing Demand

A crusher is used to pre-process ROM coal at TCM prior to its transport to Whitehaven's CHPP near Gunnedah. The crusher uses a relatively small quantity of water which it sources from the water management system. A significantly larger volume of water is required to be sprayed onto the ROM Pad to suppress dust from this area.

The coal crusher demand modelled in Goldsim is 35 ML/year. SB4 supplies water to the coal crusher.

4.5.4 Irrigation to Support Vegetation Establishment on Partially Rehabilitated Area

Appendix B of the TCP-EA (RS, 2012) refers to irrigation to support vegetation establishment on partially rehabilitated areas. However, water is rarely used for irrigation and there is no intention to undertake any large scale (area and or duration) irrigation unless there is such an excess of water that irrigation was required to avoid uncontrolled discharges. As such, no allowance for irrigation has been made within this site water balance investigation. If any long term irrigation is planned to be undertaken then consideration would be given to undertaking soil testing to confirm that it is suitable to accept the irrigated water. Additionally, in accordance with Project Approval (PA 11_0047), if any long term irrigation is planned then a program to monitor and assess the soils within the irrigation area would be developed in consultation with the Regulator, as would performance criteria and trigger values.

4.5.5 Site Discharges and Controlled Releases via Licensed Discharge Points

A number of existing LDPs have been included in the water balance model. These LDPs are associated with the following storages (refer to Figure 7); SD17 (LDP 1), SD9 (LDP 2), SD28 (LDP 3), SB23B (LDP26) and SB24B (LDP27). Controlled releases offsite from the authorised sediment dams occur when the dam volume exceeds the operating volume in compliance with the mine's EPL. When required, water treatment is used to achieve the EPL conditions. When required, sediment dams are dewatered to the mine water dams to be reused at the operation.

4.6 Water Management System Operating Rules

TCM operates under the following general operating rules:

- The mine pit is dewatered to the mine water dams. If the mine water dams are at their MOV, water will be stored in the pit;
- Operational demands are sourced from mine water dams prior to dirty water dams;
- External water is only used when the total available water inventory is below 100 ML;
- Sediment dams are dewatered within 5 days of rain in the following ways;
  - If the water quality complies with the EPL, they are discharged to the receiving environment;
  - If the water quality doesn't comply with the EPL, or the operation needs water, the sediment dams are dewatered to mine water dams.

Further definitions of the dam related terminology are provided in Section 3.3.2.

4.7 Spoil aquifer capacity

The Mine Pit at TCM stores a portion of the water in the mined overburden, referred to as in-pit spoil. The in-pit spoil is porous and hence has the capacity to store water. That is, for a given water level in the open cut, there would be water stored in the pit and within the in-pit spoil. The relative proportions of water stored within the pit and spoil would be dependent on the water level and the porosity of the in-pit spoil.

The volume of in-pit spoil was determined based on the pit floor data provided by WHC personnel. A spoil porosity of 5% has been assumed, to achieve the water balance model validation presented in the following section of the report. The adopted stage-storage curves for the open cut and in-pit spoil water storages is presented in Figure 11.

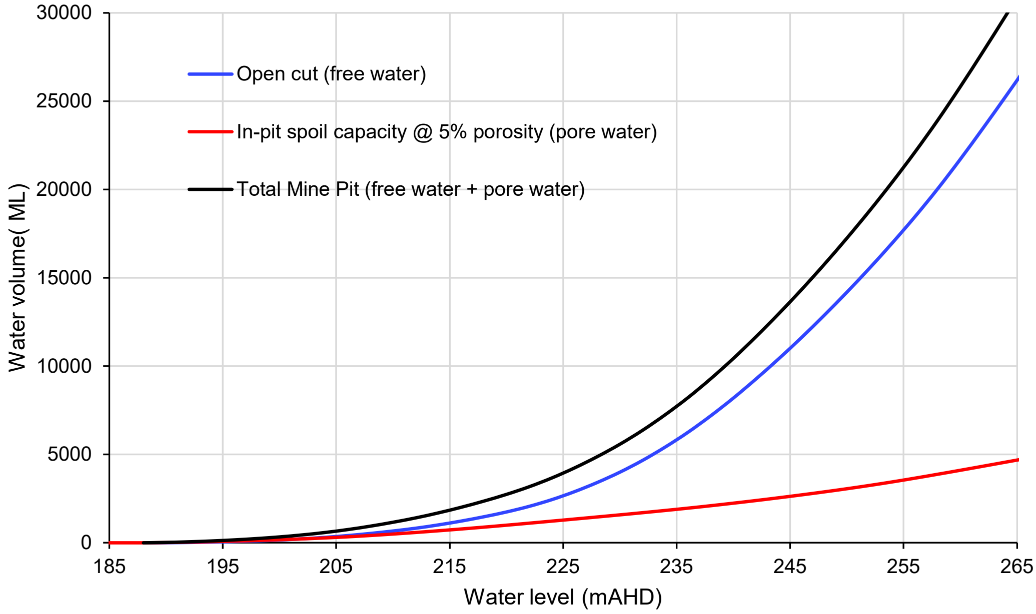


Figure 11 Mine Pit stage storage curves

4.8 Model Calibration and Verification

4.8.1 Overview

A validation assessment of the TCM WBM is undertaken by a consultant on an annual basis to improve the confidence of the forecast model predictions for Year 2022 onwards.

The WBM was run from 1 January 2021 to 31 December 2021 using the recorded rainfalls and dust suppression rates provided my TCM personnel. The WBM was validated by comparing the Year 2021 model outputs to recorded data, including site inventories and reported LDP discharge volumes. The validation was undertaken to refine parameters such AWBM (runoff) parameters and spoil porosity levels. That is, the modelled runoff generation rates and/or spoil capacity would be modified to match the modelled site inventory to the recorded site inventory over the historical period. The model may also be adjusted to match the modelled reported LDP discharge volumes to the reported discharge volumes over the annual period. The validation data used in this assessment is as follows:

- Metered Mine Pit dewatering rates. According to the mine pit dewatering data, approximately 73 ML was pumped out during 2020.
- Table 17 summaries storage volumes;
- No external water inputs.; and
- Spills from sediment dams. It is estimated that spills occurred via the LDPs during rainfall events on 23 March 2021 and 8 December 2021.

Table 17 TCM dam inventory for the Year 2021 (validation) period

Dam Name	Stored Volume (ML)					
	Pit Water Dams	LDP1 Dams	LDP2 Dams	LDP3 Dams	LDP26 Dams	LDP27 Dams
04-Feb-21	186.2	28.9	124.7	0.0	4.1	12.1
01-Mar-21	191.2	38.0	117.8	1.0	3.6	21.2
07-Apr-21	205.1	57.7	120.8	0.0	5.4	15.1
04-May-21	198.9	n.d.	n.d.	0.6	n.d.	11.8
07-Jun-21	221.0	37.2	132.9	0.7	4.2	14.2
08-Jul-21	241.3	52.0	154.9	0.3	5.7	12.6
05-Aug-21	246.7	50.4	130.1	0.2	6.6	15.6
01-Sep-21	284.5	27.1	129.8	0.8	2.5	16.3
01-Oct-21	283.5	39.9	124.5	1.9	3.0	20.0
04-Nov-21	243.1	30.1	126.3	0.4	1.6	7.0
29-Nov-21	254.5	57.3	166.5	2.0	7.3	26.6

4.8.2 Results

The water balance model was calibrated by adjusting the AWBM parameters for the active land use. The adopted AWBM parameters are shown in Table 13. A comparison of the modelled and recorded site water inventory is shown in Figure 12. In both cases, the modelled data appears to satisfactorily fit the recorded data.

The model results for the Year 2021 validation rare consistent with the Annual Review.

The adopted parameters were considered suitable for this assessment.

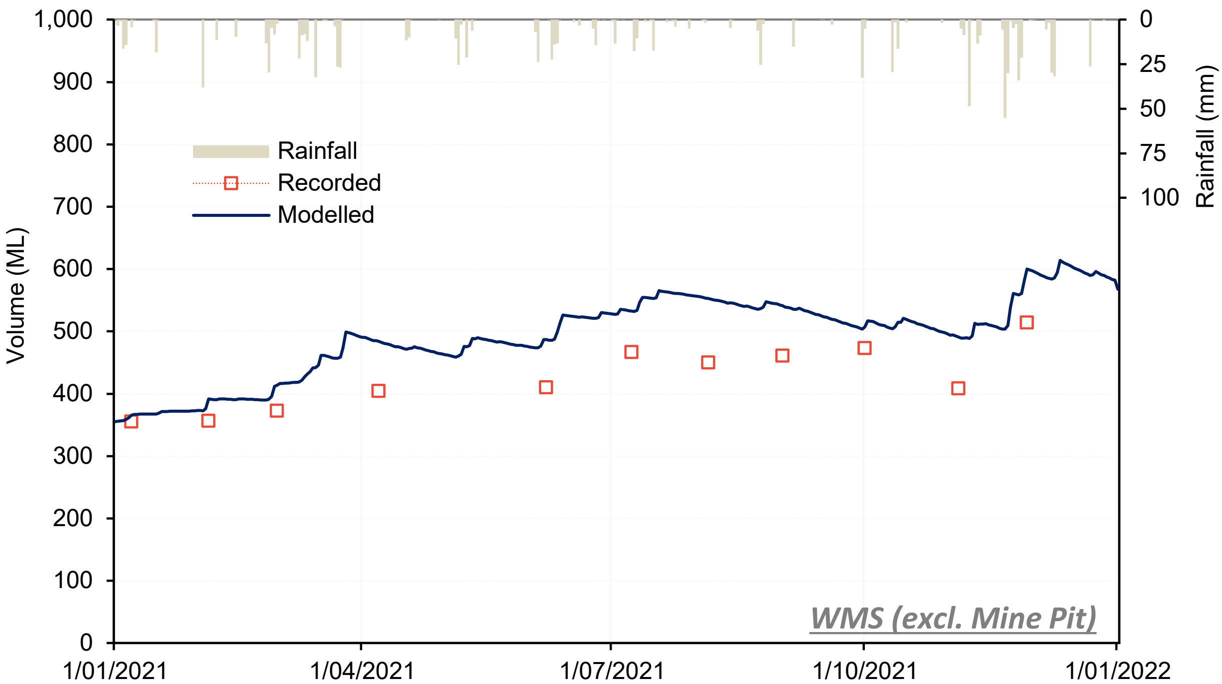


Figure 12 Validation of the TCM total site water inventory – January 2021 to December 2021

4.9 Modelled Water Management System Performance

4.9.1 General

The simulated performance of the water management system was assessed against its system objectives (as listed in Section 4.2). The forecast water volumes managed by the system will vary significantly because of the large range of different weather conditions modelled. The aspects of the system which enable it to operate effectively during drought are different to those that would accompany prolonged wet periods. The ability of the system to meet its design objectives under a range of climatic conditions has been assessed by simulating the system over the next 2 years for 132 simulations using 133 years of rainfall data.

4.9.2 Interpretation of model results

In interpreting the results of the water balance assessment, it should be noted that the results provide a statistical analysis of the water management system's performance over 2 years, based on 132 climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10th percentile represents 10% probability of exceedance and the 90th percentile results represent 90% probability of exceedance. There is an 80% chance that the result will lie between the 10th and 90th percentile traces.

Whether a percentile trace corresponds to wet or dry conditions depends upon the parameter being considered. For site water storage, where the risk is that available storage capacity will be exceeded, the lower percentiles correspond to wet conditions. For example, there is only a small chance that the 1 percentile storage volume will be exceeded, which would correspond to very wet climatic conditions. For off-site site water supply volumes (for example), where the risk is that insufficient water will be available, there is only a small chance that more than the 1 percentile water supply volume would be required. This would correspond to very dry climatic conditions.

It is important to note that a percentile trace shows the likelihood of a particular value on each day and does not represent continuous results from a single model realisation. For example, the 50th percentile trace does not represent the model time series for median climatic conditions.

4.9.3 Overall TCM Water Balance Results

Table 18 shows a summary of the Year 2022 site water balance results for a dry (90% confidence trace), median (50% confidence trace), wet (10% confidence trace) and average rainfall year. The following is of note for the Year 2022 site water balance:

- A starting inventory of 865 ML was adopted on 1 January 2022, based on advice from site personnel 350 ML was stored in the Mine Pit at the beginning of 2022.

- For representative dry and median years, the total site water inventory will experience a deficit. Conversely, for representative wet years, the total site inventory will experience a surplus.
- Mine water dams don't spill off site under any climate conditions;
- External water was not expected to be required in the next year under any of the climatic conditions assessed.
- There would be sufficient inventory on site to meet all site water demands for all of the climatic conditions assessed.
- Sediment dam spills are predicted to occur in most years in the absence of controlled (pumped) releases. The predicted annual spill volumes range from 0 ML for a very dry year to 510ML for a very wet year.

Table 18 Summary of Water Balance Results – Year 2022

Description	Dry Year 2019 (ML/year)	Median Year 2011 (ML/year)	Wet Year 1950 (ML/year)
Water Source (Inputs)			
Total runoff	274	680	3,462
Groundwater inflow	60	60	60
Moisture in coal	256	256	256
Total Input	**590**	**996**	**3,778**
Water Losses and Usage (Outputs)			
Evaporation (from water storage)	229	255	405
Moisture loss in coal	256	256	256
Crusher	35	35	35
Haul road & and ROM pad dust suppression	667	688	575
Vehicle washdown	1	1	1
Total Output	**1,189**	**1,236**	**1,273**
Water Surplus/Deficit			
Total Input minus Total Output	**-598**	**-240**	**2,505**
External water required	0	0	0
Off Site Release and Discharge			
Controlled release	0	0	0
Offsite overflow (wet weather discharge)	0	0	510
Total Offsite Release and Discharge	**0**	**0**	**510**

4.9.4 Risk of off-site overflows (spills)

The frequency of off-site spills from licensed discharge points (LDPs) in Year 2022 and Year 2023 (wet weather discharges) is shown in Table 19. This table shows that the sediment dam spills will occur for each of the LDPs, in the absence of controlled (pumped) releases.

Spills from LDPs are predicted to occur between 0.8 and 1.5 times per year on average. These results are generally within the Blue Book (Landcom, 2004) expectations of 2 – 4 times per year for a sediment dam sized based on a 5 day, 90th percentile rainfall event.

The three main mine water dams (PW3, PW6 and PW5) do not spill for any of the 133 modelled rainfall years, which was one of the objectives of the water balance. SB4 is predicted to spill on average 0.8 times per year. Based on information received from site personnel, there is not currently a permanent pump installed in SB4. SB4 overflows into SB5A which is then dewatered to PW3. SB5A would spill on average 0.2 times per year. It is understood that TCM are currently in the process of upgrading SB4, which would include a dedicated dewatering pump. Following the commissioning of this pump, it is likely that the forecasted spill risk from SB4 would be reduced.

Note that the predicted spill risk assumes that no controlled releases from authorised sediment dams are undertaken following storm events. If controlled releases are undertaken, the spill risk would be less than that shown in Table 19.

Table 19 Risk and Number of Dam System Offsite Spills per year for 2021

Dam System	Dry Year 2019	Median Year 2011	Wet Year 1950	Average of 132 simulations
LDP1	0	0	8	0.77
LDP2	0	0	7	0.42
LDP3	0	3	10	1.18
LDP26	0	0	16	3.27
LDP27	0	0	10	0.65
Mine water dams	0 (0)	0 (0)	9[a] (3)	0.81[a] (0.18)

a – SB4 only. SB4 spills internally to SB5A – the values in parenthesis represent the number of spills from SB5A.

4.9.5 Water Storage Behaviour

Figures B1 to B5 in Appendix B shows the dirty water inventories, Total Storage Volume and Operational Volumes for each LDP catchment. Figures B6 and B7 in Appendix B shows the mine water dam inventories and mine pit water inventories respectively. These figures show the range in storage volumes within the dirty water and mine water systems between Year 2022 and Year 2023 based on 132 climate simulations.

The following is of note regarding site storage behaviour between Year 2022 and Year 2023:

- The mine water dam water inventories are maintained at or below the Full Storage Volume for all climatic conditions assessed (see Figure B7).
- The mine pit would store more than 130 ML (the capacity of the current in-pit storage) during 2022 and 2023 for the majority of climatic conditions.
- The dirty water dam water inventories within all LDPs are generally maintained at or below the combined Full Storage Volume for all climatic conditions assessed (see Figures B1 to B5).

The risk of spills from LDPs is discussed further in Section 4.9.4.

4.9.6 Mine Pit Inundation Risk

Figure 13 shows the predicted annual maximum stored water inventories in the mine pit for a range of climatic conditions. Figure 14 shows the number of days per year that more than 130 ML would be stored in the mine pit.

The following is of note with respect to these results:

- Under very wet (1% confidence trace) climate conditions, the mine pit will have an inventory of up to 1,800 ML by January 2024;
- Under median (50% confidence trace) climate conditions, the mine pit will have an inventory of up to 260 ML by January 2024;
- There is a risk of extended mine pit inundation over the simulation period:
  - Aerial photography shows that there was water in the mine pit at the beginning of 2022. Advice provided WHC personnel suggests that 350 ML contained in the Open Cut in January 2022. Based on this starting water level in the Open Cut and the assumed 5% spoil porosity, there would be approximately 205 ML stored in the spoil aquifer at the start on the simulation.
  - There is an 90% exceedance probability that the mine pit would be inundated for the entirety of the 2022 period due to out of pit storage or pumping capacity limitations; and
  - There is a 96% probability that the maximum mine pit inventory will exceed 130 ML in 2023 and a 61% probability that the mine pit inventory will exceed 130 ML for the entire 2023 period due to out of pit storage or pumping capacity limitations.
  - The elevated mine pit inundation risk is a result of the following factors:
    - There is a significant volume of water in the Mine Pit at the beginning of the simulation; 350 ML in the Open Cut, 205 ML in the spoil aquifer, 555 ML in total.
    - There is limited dedicated out-of-pit storage available for pit dewatering (only about 306 ML in total), given the size of the mine pit catchment; and
    - Similar to previous years, the results of the water balance assessment show that TCM would generally accumulate water in wet climatic conditions. As the mine water storages are already at or above their operating volumes at the beginning of the simulation (and the pit contains water), there is limited opportunity to dewater the pit, unless conditions are median or dry.

The above results assume that the mine pit will be used to store excess mine water that cannot be used for operational water demands. If adequate storage capacity is not made available to dewater the mine pit, excess water would have to be held in an inactive part of the mine pit until spare out of pit storage becomes available. If water has to be held in the mine pit for prolonged periods of time, this may cause interruptions to coal production.

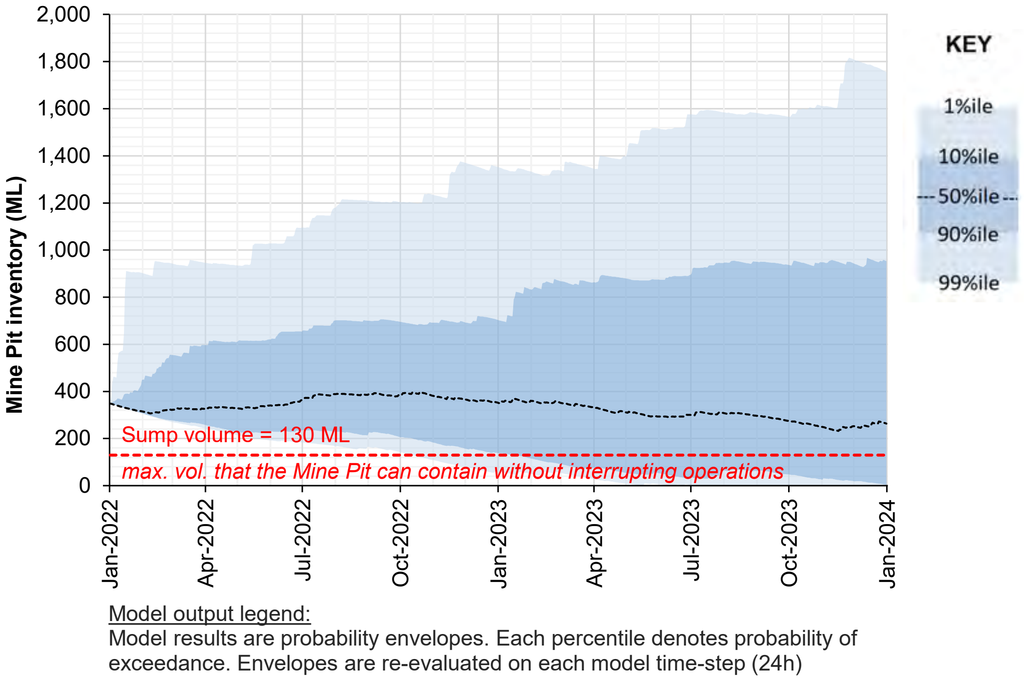


Figure 13 Predicted Annual Maximum Stored Water Volume in the Mine Pit

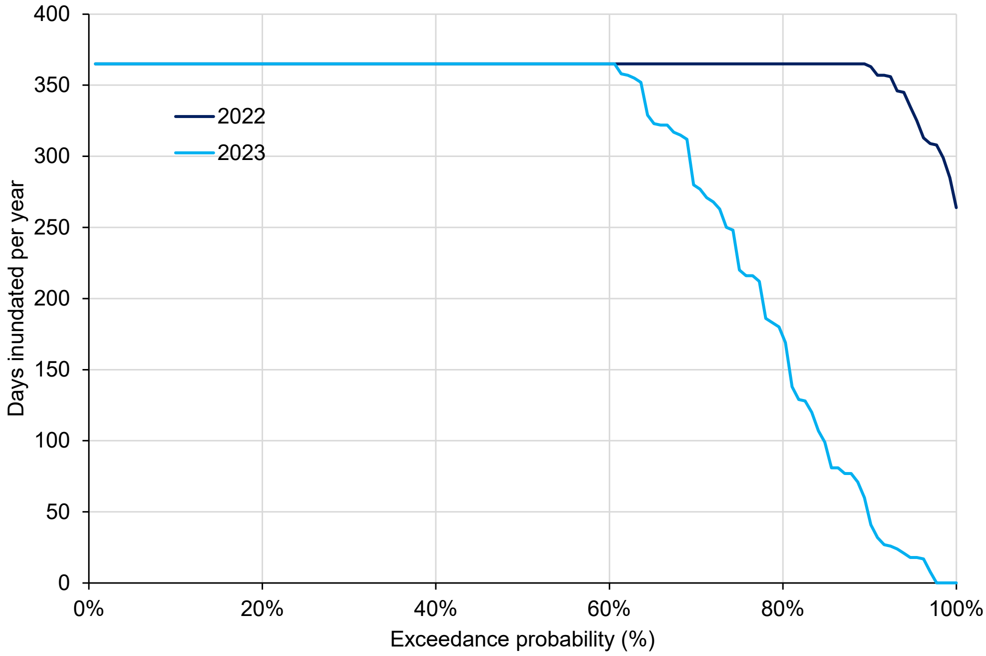


Figure 14 Predicted annual number of days the Mine Pit stores more than 130 ML

4.9.7 External water requirements

Figure 15 shows the estimated external water required to meet on-site water demands between in 2022 and 2023. Dust suppressant binders are assumed to be using during the reporting period, only when the total WMS inventory falls below 250 ML. No external water is expected to be required in 2022 or 2023, due to the surplus stored on site at the beginning of the simulation. That is, the modelling predicts that there is sufficient water onsite to meet demands during this period for all climatic conditions assessed.

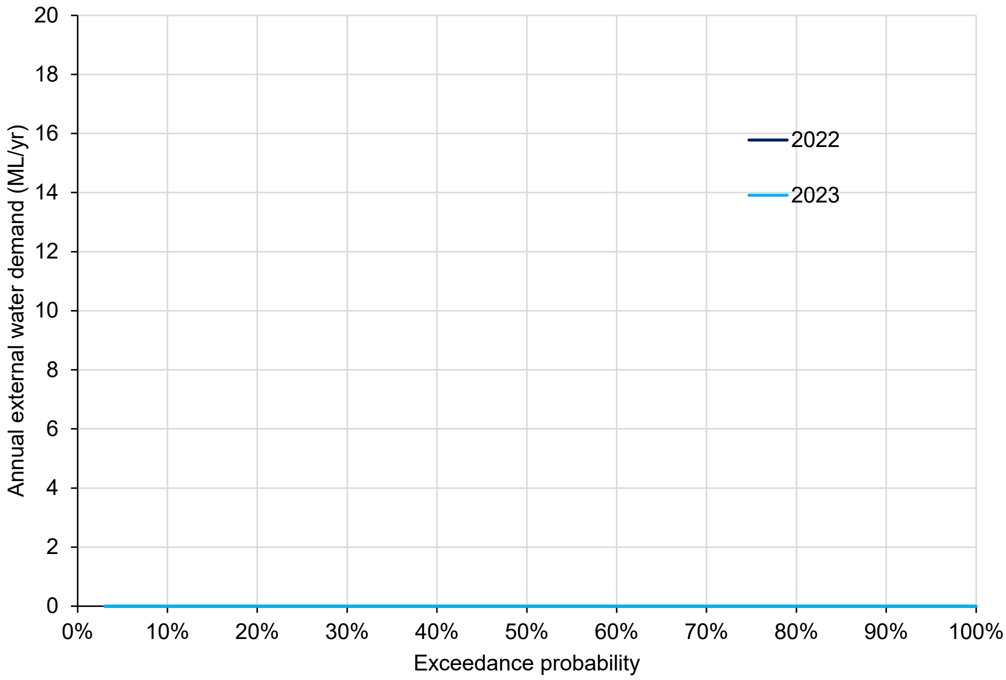


Figure 15 Predicted annual external water requirements -Year 2022 to Year 2023

4.10 Water Balance Review/Verification

The site water balance (including reporting procedures) will be reviewed annually and as part of the review process of this document. It should also be reviewed if changes to the mine layout occur or if the water management systems operating rules/procedures change in the future.

The water balance model is considered to be a good broad scale model which can be improved as assumptions are clarified and operational rules / procedures are refined or altered. Monitored dam water levels and offsite discharges will continue to be compared to the results of future updates of the Goldsim model to validate the data/assumptions used within the model.

Following the approval of future MOPs, the Goldsim model will be updated to include all future activities within the WMP period including the activities planned under the Project Approval (PA 11_0047). This will enable an ongoing programme to be developed to validate the Goldsim data/assumptions as the mine progresses.

Table 20 shows TCM's actions that have been undertaken, as well as planned actions to improve on future water balance assessments. The TCM WMS is constantly adapting to reflect mining progression and changing conditions. TCM's planned improvements will evolve alongside the WMS, facilitating an adaptive management approach in accordance with Schedule 5 Condition 2 of PA 11_0047.

Table 20 Proposed TCM Water Balance Improvements

Planned improvement	Actions undertaken to date	Future planned actions	Scheduled future planned action completion date
Detailed recording of pumped transfer volumes from the pit and dams. The installation of water flowmeters on pipelines could be undertaken to further improve this accuracy.	• One flowmeter has been installed at the mine pit sump.	• Develop and implement a flow monitoring system. • Investigate opportunities for installation of flowmeters or similar. • Assess preferred location to install a second flow meter.	• Additional flow meters have been purchased and installed. • Opportunities to purchase additional flow meters will be investigated in 2023 as part of upgrades to the 'ring main'.
Detailed recording of operational water use is collected (e.g. crusher, dust suppression, etc.).	• Dust suppression volume is estimated from water cart usage. • Two flowmeters have been purchased.	• Develop and implement a flow monitoring system • Investigate opportunities for installation of flowmeters or similar. • Assess suitable pipeline to install flowmeter (e.g. SB4 to ROM and crusher dust suppression).	• Additional flow meters have been purchased. • Opportunity to purchase additional flow meter will be investigated in 2023 as part of upgrades to the 'ring main'.
Accurate and up-to-date details on the dam operating volumes and the trigger volumes.	• The Water Management Plan was updated in Q3 2022, as per Schedule 5, Condition 3 of the Project Approval (PA11_0047)	• Refine operational levels and volumes based on future MOPs and water balances.	• Current/ongoing
Accurate estimation of dam leakage rates.	• SD1 was repaired to prevent an ongoing seepage issues. SD2 has been decommissioned.	• No requirement to continue	• Not required.
Monitoring of the ROM coal moisture content and loss of	• A sampling program has been developed.	• build a database for ROM coal moisture sampling data.	• Current/ongoing program

water through coal export.		• Refine and optimise the ROM coal moisture monitoring program.	
Monitoring TCM sediment dams water levels.	• Gauge boards were installed at the spillway of the licenced discharge dams. These gauge boards have been used in the operation and management of water level in these dams. • The water balance model calibration and update is undertaken on (at least) an annual basis.	• Develop a sediment dam monitoring program to monitor water levels and volumes. • Assess suitable water level monitoring technology for use onsite.	• Real-time monitoring system has been installed at the Licenced Discharge Dams (LDPs) in CY2021

5 GROUNDWATER MANAGEMENT PLAN

5.1 Groundwater Systems

The TCP-EA (RS, 2012) identified two groundwater systems in the vicinity of the mine, namely:

- Porous Rock groundwater system – including the coal measures of the Maules Creek Formation; and
- Alluvial groundwater system – associated with the low-lying floodplains of the Upper Namoi.

The coal resource and existing mining operations are located within the Maules Creek sub-basin of the Early Permian Bellata Group, which is within the porous rock (i.e. sedimentary rock) groundwater systems of the Gunnedah Basin, and lies within the boundary defined in the WSP for the Porous Rock Groundwater Source. The coal resource is wholly located within the Gunnedah-Oxley Basin – Namoi Management Zone.

The mine site is bordered by alluvial sediments which are associated with the Bollol Creek, Goonbri Creek and Nagero Creek surface drainages. These sediments are part of the Upper Namoi Alluvium and their groundwater's lie within the Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source, also known as the Upper Namoi Zone 4 water source. The mine extension will encroach into these alluvial sediments, thus monitoring and management of the alluvial groundwater system, as well as appropriate licences, will be required.

5.2 Groundwater Dependent Ecosystems

The locations of Groundwater Dependent Ecosystems (GDEs) are detailed in Appendix F of the TCP–EA and are shown in Appendix C. High priority GDEs are only listed in the Murray-Darling Basin Porous Rock WSP, at a distance of approximately 90 km to the south of the TCM. GDEs closest to the TCM occur approximately 30 km west of the site in the NSW Gunnedah-Oxley Basin groundwater source, comprising springs on Sandy Creek near Bulga Hill.

Additional GDEs, not listed as high priority in the WSPs, are noted in the BoM GDE Atlas for riparian ecosystems and terrestrial ecosystems shown in FIURE. The nearest are along Goonbri Creek, classified as high potential for groundwater interaction.

It should be noted that much of the neighbouring Leard State Forest has a low potential for groundwater interaction. This is because the groundwater table is relatively deep (up to 100 m) which is well below the remanent vegetation root zone.

5.3 Groundwater Licences

TCM is required to license passive take inflows into the mine workings. Passive take includes direct and indirect flows into the mine workings and therefore can only be determined by the use of a groundwater model. Passive take is significantly higher than the volume which enters the pit and is accounted for in the mine water management system. The BTM complex model (AGE, 2020) was developed in consultation with DPI and NRAR to model the predicted impact of the BTM complex mines and quantify passive take for each individual mine. TCM passive take is from three water sources, including:

- NSW Murray Darling Basin Porous Rock - Gunnedah Oxley Basin MDB;
- Upper and Lower Namoi Groundwater Sources - Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap); and
- Upper and Lower Namoi Groundwater Sources - Upper Namoi Zone 11 Namoi Valley (Keepit Dam to Gin's Leap).

The BTM Complex groundwater model final version was submitted DPE in December 2021. The TCM future predicted take as per the BTM complex model is shown in Table 21. TCM assigned WALs to three miscellaneous works approvals for each water source, as directed by NRAR in 2021. Table 21 shows TCM has sufficient WALs for the life of the mine when relying on carry over under the following rules for carry over water into another water year:

- Up to 2 ML/share unit for Zone 4 and Zone 11; and
- Up to 1.25 ML/share unit for Porous Rock.

Each year WaterNSW determines the Annual Water Determination (AWD) for each water source. If the AWD for a water source is less than 100% this shall be reported in the mines Annual Return and the available ML with carry over for each water source will be adjusted. If required, TCM will purchase additional allocation.

Groundwater monitoring boreholes owned by Whitehaven are also licensed under the existing Bore Licences (e.g. 90BL253276, 90BL253278, 90BL253841, 90BL253279, 90BL253280, 90BL254255, 90BL254254, 90BL254253, 90BL254220, 90BL102564, 90WA809087, 90BL116929, 90BL255930), which set out conditions of use for the monitoring bores. These monitoring bore licences are purely held by Whitehaven and not third parties

Table 21 Predicted Passive take (AGE, 2021)

Water Year (July to June)	Zone 4 take	Available ML (with carry over)	Zone 11 take	Available ML (with carry over)	Porous Rock take	Available ML (with carry over)
Share units	**79**		**39**		**540**	
2021/2022	36	79	1	39	228	540
2022	33	122	1	77	255	675
2023	39	158	1	78	303	675
2024	57	158	2	78	418	675
2025	91	158	4	78	483	675
2026	86	146	4	78	529	675
2027	73	139	4	78	322	675
2028	66	145	4	78	207	675
2029	55	158	4	78	184	675
2030	59	158	5	78	153	675
2031	59	158	5	78	138	675
2032	61	158	6	78	126	675
2033	62	158	6	78	120	675
2034	63	158	7	78	114	675
2035	71	158	8	78	98	675
2036	76	158	9	78	94	675

Table 22 Groundwater Licences

WAL No	Water Sharing Plan	Water Source	Work approval	Allocation (ML)
WAL29548	NSW Murray Darling Basin Porous Rock Groundwater Sources	Gunnedah - Oxley Basin MDB Groundwater Source	90WA822536 (replaced by 90MW833080)	50
WAL31084	NSW Murray Darling Basin Porous Rock Groundwater Sources	Gunnedah - Oxley Basin MDB Groundwater Source	90WA822536 (replaced by 90MW833080)	250
WAL29461	NSW Murray Darling Basin Porous Rock Groundwater Sources	Gunnedah - Oxley Basin MDB Groundwater Source	90MW833080	120
WAL29537	NSW Murray Darling Basin Porous Rock Groundwater Sources	Gunnedah - Oxley Basin MDB Groundwater Source	90MW833080	120
WAL12716	Upper and Lower Namoi Groundwater Sources	Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	90MW833070	43
WAL36548	Upper and Lower Namoi Groundwater Sources	Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	90CA807018 (replaced by 90MW833070)	36
WAL12479#	Upper Namoi Groundwater Sources	Upper Namoi Zone 11Namoi Valley	90MW8330716	78 (39)
			Total	**853**

 # Shared with Maules Creek Coal Mine, MCCM will use up to 15 ML/yr, TCM will use up to 9 ML/yr. Therefore, sufficient allocation to share.

5.4 Coal reject and Acid forming material

Coal rejects are co-disposed with spoil material in the pit emplacements. There is no evidence or history of acid generation at Tarrawonga from seepage or leachate from emplacements. This is evident from historical sampling of site dams and groundwater sites around the mine parameter.

Surface water sampling from site dams and pits (from 2006 to present) and Groundwater monitoring (2006 to present) reported in the Annual Return indicate:

- Groundwater is typically more saline than surface water captured at the mine;
- pH in the surface and groundwater is typically neutral to slightly alkaline; and
- There is no evidence in surface water or groundwater of any seepage or leachate from the emplacements.

The existing surface water and groundwater monitoring program is suitable for identifying any potential sources of leachate or seepage from site, in the event it is identified, the following will occur:

- Acid forming material that is identified will be dumped inside the pit footprint so any seepage/leachate drains to the pit and not surface water dams or the groundwater.
- Capping with at least 5 m of benign spoil to minimise air and water penetration.

No acid forming material has occurred to date at TCM and therefore no actions have been taken.

5.5 Final void

The TCM final void is designed with the following objectives:

- Safe, stable and non-polluting; and
- a groundwater sink in order to ensure no movement of potential contaminates from site, i.e. no seepage or leachate

The final void as assessed in the TCM Modification 8 meet these design objectives. Any changes to the final void geometry will be adopted in future updates to the BTM complex groundwater model to validate that the final void design is a groundwater sink. The final void design will be finalised within the last 5 years of mining.

The groundwater take from the final void will be assessed using the BTM Complex groundwater model to ensure sufficient licensing shall be allocated to the final void in perpetuity.

5.6 Groundwater Monitoring Program

5.6.1 General

TCM has a groundwater monitoring program in place that incorporates the collection of water quality and water level data from monitoring bores. The bores are a combination of standpipes and vibrating wire piezometers (VWPs). Occasional water level readings are taken in some private production bores and wells not specifically designed for monitoring.

The TCM network is supported by a number of neighbouring monitoring networks (Heritage Computing, 2012):

- DoI Water network;
- Maules Creek Coal Project network;
- Boggabri Coal Mine network; and
- Gins Leap Gap research network.

A groundwater assessment was carried out as part of the TCP-EA (RS, 2012) and this included the construction of a groundwater model (Heritage Computing, 2011). The model that was updated during the Groundwater Assessment for MOD7 (Hydrosimulations, 2019), investigated the effects of the mine operations both in isolation and in combination with surrounding mines. These results are referenced throughout this section.

5.6.2 Monitoring Objectives

The objectives of groundwater level monitoring are:

- to provide baseline pre-mining groundwater levels in space and time, recognising that measurements of pressure variations with depth are necessarily limited by the expense of surface-to-seam holes;
- to quantify natural time variations in groundwater levels;
- to record mining-induced changes in groundwater levels in space and time;
- to provide a foundation for characterisation of aquifer and aquitard properties by numerical model calibration;
- to facilitate groundwater model evolution through verification of simulated heads against those measured;
- to reveal mining-induced changes in groundwater flow directions and hydraulic gradients;
- to provide evidence for the degree of stream-aquifer interaction, especially losses of stream water, and whether the losses are permanent or temporary;
- to allow assessment of impacts on potential groundwater dependent ecosystems (GDEs) i.e. Bracteates Honeymyrtle low riparian forest (refer Appendix F of the TCP–EA), and stygo-fauna;
- to allow assessment of yield/drawdown impacts on other groundwater users; and
- to monitor post-mining rates of groundwater pressure recovery.

The objectives of groundwater quality monitoring are:

- to provide baseline pre-mining groundwater quality data in space and time, for a range of informative and diagnostic indicator species;
- to quantify natural changes in water quality in time and space;
- to record mining-induced changes in groundwater quality in space and time;
- to facilitate confirmation or revision of the conceptual model for chemical evolution and groundwater flow directions;
- to assess whether any changes in water quality with time occur during and after mining, and whether such changes are likely to have a material effect on beneficial uses;

- to establish whether enhanced rainfall recharge through backfill provides a freshening effect on groundwater, or instead mobilises latent chemicals;
- in the case of a water-filled final void, to assess the risk of migration of saline void waters during the post-mining recovery phase whenever such waters are not contained as a groundwater sink; and
- to assess whether acid rock drainage has occurred.

5.6.3 Monitoring Locations

The monitoring network consists of 8 standpipe piezometers, 8 additional locations for groundwater level monitoring, and a total of 12 VWPs installed in locations TA-60C (4) and TA-65C (8) (Figure 16).

The network monitors water level and water quality across the site and is targeted equally between the alluvial aquifer that interacts with the Namoi River, and the rocks hosting the coal seams. The locations of these monitoring bores (past and present) are shown in Figure 7 and a description of the monitoring program is given in Table 23. The additional monitoring, carried out for the investigation into the mine extension, will be formally incorporated into the site monitoring network as the mining operation progresses.

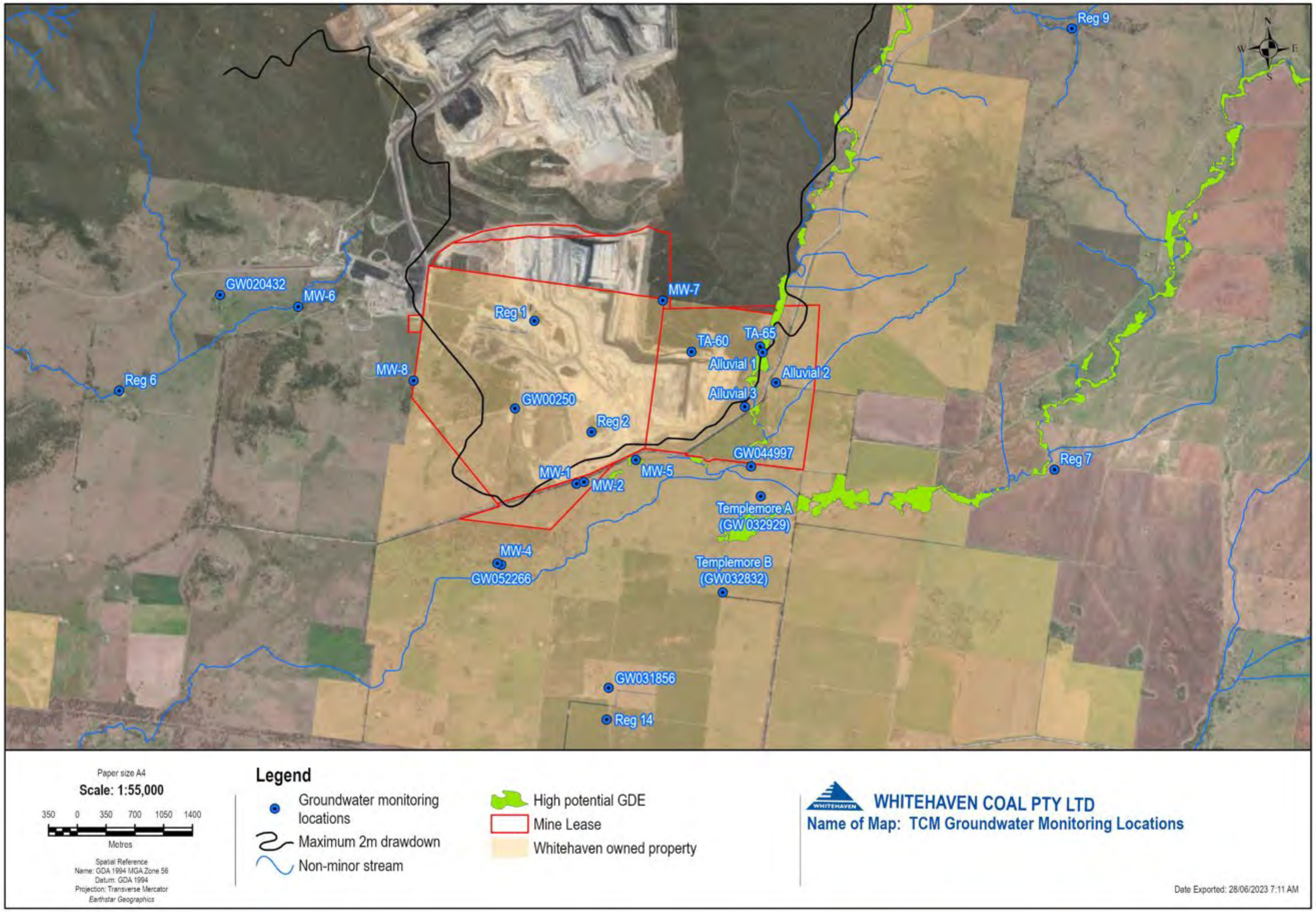


Figure 16 Tarrawonga Coal Mine Groundwater Monitoring Locations

The primary installed monitoring bores are:

- MW-1: located in the Permian coal measures (interburden) on the “Thuin” property;
- MW-2: located in the alluvial aquifer on the “Thuin” property;
- MW-4: located in the alluvial aquifer on the “Tarrawonga” property;
- MW-5: located in the surface water drainage line to the southwest of the mine. This location would also serve as an indicator to impacts on the alluvial aquifer servicing the “Bollol Creek Station” groundwater system;
- MW-6: located in the alluvial aquifer of Nagero Creek;
- MW-7: located in the Permian sediment up hydraulic gradient of the mine area; and
- MW-8: located on the western side of the mining lease and is the most recent monitoring point.

In addition to the above piezometers, TCM also has monitored groundwater levels within eight bores, three of which are now decommissioned:

- GW044997 – located in the alluvial aquifer on the “Templemore” property;
- Templemore A - located in the alluvial aquifer on the “Templemore” property;
- Templemore B - located in the alluvial aquifer on the “Templemore” property;
- GW031856 – located in the alluvial aquifer on the “Ambardo” property;
- GW052266 – located in the alluvial aquifer on the “Tarrawonga” property (data available for 2009);
- GW002501 – located within the mine site (data available from 2006 to 2008) but removed by the advancing open cut;
- GW002129 – located within the mine site (data available from 2006 to 2009) but removed by the advancing open cut;
- GW020432 – located in the volcanics groundwater system on the “Merriown” property (now decommissioned; measurements from 2006 to 2008).

The existing TCM network will be augmented. This network of monitoring bores would be installed in the alluvium for the purposes of monitoring:

- groundwater levels and water quality in the alluvial groundwater system on the western side of Goonbri Creek as mining advances (to validate the predicted mine inflow and dewatering rates);
- groundwater pressures in the porous rock groundwater system/coal measures where possible (to validate the predicted depressurisation effects at depth); and
- groundwater levels and water quality in the alluvial groundwater system on the eastern side of Goonbri Creek as mining advances (to validate the predicted negligible impacts).

If physically feasible, additional piezometers would be installed in mine waste rock behind the advancing open cut to provide information on recharge rates and mine waste rock permeability and to validate groundwater modelling assumptions and predictions with respect to the emplacements. The proposed TCM monitoring bores R1 and R2 which will be located in the spoil dumps (as shown in Figure 16) are anticipated to be installed following a feasibility assessment and installation of the alluvial monitoring bores.

Details of any additional future monitoring bores will be included in future revisions of this WMP.

5.6.4 Baseline Data

Baseline data for the TCM including surface water and groundwater quality monitoring, water discharge and level records are reported in the Environmental Assessment, Annual Review and Annual Return. The Environmental Performance at TCM, which is reported in the Annual Review and Annual Return, is compared against historical baseline data and commitments of the Environmental Assessment.

Appendix F of the TCP–EA assessed the potential for groundwater dependent vegetation to occur near the Project area noting a single community (Bracteates Honeymyrtle low riparian forest) as being potentially groundwater dependent.

5.6.5 Groundwater Monitoring Schedule

The Groundwater Monitoring Schedule outlined in Table 23 defines the parameters to be sampled for in the TCM groundwater monitoring network and the recommended sampling frequency at each sampling location. Continuous water level measurements are obtained at two standpipes and at two VWP sites. At other standpipes, water levels are measured quarterly at the same time as field measurements of pH, EC and water temperature. At six-monthly intervals, samples are collected from each standpipe for laboratory analysis of 16 metals and 9 anions, as well as laboratory measurement of pH, EC, TDS, ammonia, nitrite and nitrate.

External water sources are metered in accordance with NSW non-urban metering policy to allow accurate quantifying of the water take at TCM. This information also informs the Site Water Balance and to this end internal metering will be undertaken where necessary, such as on the pipeline to the evaporation fans and the proposed pipeline to the Vickery Expansion Project.

The proposed future local groundwater monitoring programme is summarised in Table 24. The groundwater monitoring programme will augment the existing TCM groundwater monitoring programme and utilise the results of neighbouring mine groundwater monitoring programmes (i.e. Boggabri Coal Mine and Maules Creek Coal Project), refer Table 25. TARPs for water quality and SWL will be developed after 2 years of baseline data is collected.

The groundwater monitoring programme will monitor groundwater conditions for changes as a result of mining and will include consideration of aquifer definition and interactions, strata hydraulic properties, expected drawdown extent and groundwater quality.

Table 23 Groundwater Monitoring Network

Site	Registered Bore No.	Licence Number	Property	Location		Parameter & Frequency			Screen/ sensor depth (mbgl)	Status
				Easting MGA-56	Northing MGA-56	Standing Water Level	EC, pH, Temp	Na, Ca, K, Mg, Fe, Mn, Al, As, Cl, SO_4, HCO_3, NO_3 and NO_2, TRH		
MW-1	GW967848	90BL253276	"Thuin"	228743	6605702	Continuous	Quarterly	Six monthly	52-56	Active monitoring bore
MW-2	GW967849	90BL253278	"Thuin"	228851	6605704	Continuous	Quarterly	Six monthly	4-7	Active monitoring bore
MW-4	GW967850	90BL253279	"Tarrawonga"	227848	6604708	Quarterly	Quarterly	Six monthly	17-20	Active monitoring bore
MW-5	GW967851	90BL253280	"Templemore"	229488	6605985	Quarterly	Quarterly	Six monthly	5.3-8.3	Active monitoring bore
MW-6^	GW967881	90BL254255	"Merriown"	225385	6607871	Quarterly	Quarterly	Six monthly	29-32	Active monitoring bore
MW-7	GW967883	90BL254254	"Mine Site"	229823	6607932	Quarterly	Quarterly until Sep.2012	Six Monthly until Sep.2012	102-105	Active monitoring bore
MW-8	GW976882	90BL254253	"Mine Site"	226795	6606958	Quarterly	Until Jul.2007	Until Jul.2007	23-26	Active monitoring bore
GW002501*†	GW002501		"Mine Site"	228013	6606613	Until Oct 2008	Until Oct.2008	Until Oct.2008	-	Decommissioned monitoring bore
GW002129*	GW002129	90BL254220	"Mine Site"	228724	6606271	Until Jan.2009	Until Apr.2008	Until Apr.2008	-	Decommissioned monitoring bore
GW044997	GW044997	90BL102564	"Templemore"	230870	6605895	Quarterly	Until Nov.2012	Until Sep.2012	-	Stock & domestic
GW031856	GW031856	90WA809087	"Ambardo"	229157	6603179	Quarterly	Quarterly	Six monthly	-	Stock & domestic
GW052266	GW052266	90BL116929	"Tarrawonga"	227848	6604674	Quarterly	Quarterly	Six monthly	-	Stock & domestic
GW020432*	GW020432		"Merriown"	224451	6607991	Until Oct.2008	Until Jan.2007	Until Jan.2007	-	Decommissioned monitoring bore
Templemore A†			"Templemore"	230997	6605537	Quarterly	Quarterly	Six monthly	-	Stock & domestic
Templemore B†			"Templemore"	230544	6604345	Quarterly	Quarterly	Six monthly	-	Stock & domestic
TA60*	90BL255930		"Mine Site"	230164	6607286	Continuous	-	-	69, 89, 109, 118	Decommissioned monitoring bore
TA65	90BL255930		"Mine Site"	230997	6607344	Continuous	-	-	30, 35, 47, 56, 97, 110, 136, 153	Active VWPs
Alluvium 1 'P1'		Exempt monitoring bore	"Mine Site"	231042	6607306	Continuous	Quarterly	Six monthly	8m	Active monitoring bore
Alluvium 2 'P2'		Exempt monitoring bore	Bollol Creek Station	231202	6606938	Continuous	Quarterly	Six monthly	29m	Active monitoring bore

Site	Registered Bore No.	Licence Number	Property	Location		Parameter & Frequency			Screen/ sensor depth (mbgl)	Status
				Easting MGA-56	Northing MGA-56	Standing Water Level	EC, pH, Temp	Na, Ca, K, Mg, Fe, Mn, Al, As, Cl, SO_4, HCO_3, NO_3 and NO_2, TRH		
Alluvium 3 'P3'		Exempt monitoring bore	"Mine Site"	230822	6606634	Continuous	Quarterly	Six monthly	25.5m	Active monitoring bore

* Bore no longer used. Monitoring undertaken until bore was removed by the advancing mine pit
† May not have been licensed. Stock/domestic bore from previous landowners on land acquired by Tarrawonga
TRH- Total Recoverable Hydrocarbons
^ Bore was damaged in early 2019

Table 24 Proposed Local Groundwater Monitoring Programme

Parameter	Location	Timing
Piezometers (Groundwater Levels – m AHD)	• Existing monitoring network (TCM and surrounding mines/projects).	• Quarterly - mine life.
	• Additional Alluvial groundwater system monitoring network on the eastern side of the Goonbri Creek to validate the predicted negligible impacts or trigger appropriate responses (one bore suggested);and in the alluvial groundwater system on the western side of Goonbri Creek (two bores suggested);	• Installed Q2 CY2023
	• Porous Rock groundwater system monitoring bores	• Years 10-17 and at least 2 years post-mining.
	• Additional bore installations in the waste emplacement (if feasible) behind the advancing open cut.	• Progressive over the mine life and when the top of Emplacement area has been shaped to allow installation of those bores.
Groundwater Quality Metals: • Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Mn, Hg, Ni, Se, V, Zn Cations: • Ca, Mg, Na, K. Anions: Cl, SO4, OH, CO3, HCO3 Nutrients: • NH3, NO2, NO3 Total Recoverable Hydrocarbons (TRH): • C6-C10 Fraction, C6-C10 Fraction Minus BTEX, >C10-C16 Fraction, >C10-C16 Fraction minus Naphthalene, >C16-C34Fraction, >c34-40 Fraction, >c10-C40 Fraction, Sum of BTEX,	• At piezometers above. • TRH only at MW1	• Quarterly for field pH and EC; six-monthly for laboratory analysis of full suite. • Six monthly for TRH

Parameter	Location	Timing
Total Xylenes, Naphthalene Other: • pH, EC, TDS.		
Mine Water Balance	• Measurement of volumes extracted from the open cut/sump to MWDs, pumped water, coal moisture, etc.	• Mine life.

Table 25 Regional Groundwater Monitoring Programme near the TCM

Bore	Easting (MGA 56)	Northing (MGA 56)	Piezometers	Reason
Reg6	223,196	6,606,862	Standpipes in alluvium and underburden (2)	Within predicted 1m water table drawdown zone in Nagero Creek alluvium. Adjacent old DoI Water bore GW036010.
Reg7a	234,594	6,605,841	Standpipes in alluvium and underburden (2)	On edge of predicted 1m water table drawdown in Bollol Creek alluvium. Adjacent bore BCS6.
Reg9	234,782	6,611,244	VWP interburden and coal seams (8)	In moderate drawdown zone to north-east of Tarrawonga mine and east of Boggabri mine. In Maules Creek Formation.
Reg14	229,139	6,602,836	VWP interburden and coal seams (8)	In Bollol Creek alluvium well outside any predicted drawdown. Adjacent bore GW031856 in Tarrawonga network.

The results of the groundwater monitoring programme would be compared with modelling predictions. If significant departures occur from predictions, the model would be re-calibrated at the next scheduled three-yearly update.

5.6.6 Evaluation of the Groundwater Model

The evaluation of model performance is tied to trigger exceedance protocols in Section 6.5. An independent review of the model and its performance will be conducted in accordance with PA 11_0047 Schedule 3 Condition 39(c)(iii), which requires: *"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."* The next Groundwater model review will be undertaken in 2024.

Other circumstances which may trigger further development or refinement of the groundwater model include:

- a significant change to the mine plan;
- acquisition of new hydrogeological information, such as groundwater levels and aquifer properties (i.e. hydraulic conductivity) which are significantly different from calibrated values used in the model; and

- groundwater drawdown and inflows which significantly exceed model predictions for that stage of mining.

The TCM groundwater model chronology includes:

- Developed for the Environmental Assessment in 2011 using MODFLOW-SURFACT software.
- Model performance assessed in 2015 and updated for actual mining sequence.
- Conversion to MODFLOW-USG in 2019.
- Development of the BTM complex model update using MODFLOW-USG, completed in 2021

5.7 Groundwater Trigger Values

Groundwater trigger value criteria have been adopted for:

- groundwater quality;
- impacts on existing licensed users;
- mine inflow rate; and
- mine pit water quality.

Specific triggers related to groundwater levels are addressed at Section 6.5.

5.7.1 Groundwater Quality Criteria

The EC levels within sampled water indicate that most groundwater's are at the limit of potable use but are suitable for livestock, irrigation and other general uses.

The groundwater quality objectives of the BTM Complex Water Management Strategy are:

- to maintain the most sensitive identified beneficial use of all groundwater systems potentially affected by the BTM Complex operations, consistent with the NSW State Groundwater Quality Protection Policy, and the Aquifer Interference Policy; and
- within this, to maintain the annual average EC values within the historical 95th percentile.

According to the Upper and Lower Namoi Groundwater Sources WSP, the beneficial uses of the alluvial groundwater sources surrounding the Complex are “raw water for drinking”, and “agricultural use”. No beneficial uses are specified for the porous rock aquifers in the Murray Darling Basin Porous Rock (Gunnedah-Oxley Basin) WSP. Given the typically high salinity of the water, the beneficial use is likely to be ‘stock watering’.

A performance indicator is developed in Section 6.5 for annual average EC values of groundwater samples.

In addition, compliance of other water quality parameters would be checked against National Environment Protection Council (NEPC) agricultural and livestock guidelines as shown in Table 26.

Table 26 Groundwater Quality Criteria

Analyte	Agricultural Irrigation (mg/L)	Livestock (mg/L)
Aluminium	5	5
Arsenic (total)	0.1	0.5
Boron	0.5	5
Cadmium	0.01	0.01
Chromium (total)	1.0	-
Chromium (VI)	0.1	1.0
Cobalt	0.05	1
Copper	0.2	0.5
Iron	0.2	-
Manganese	2.0	-
Mercury (total)	0.002	0.002
Nickel	0.02	1.0
Selenium	0.02	0.02
Zinc	2.0	20.0
Calcium	-	1000
Nitrate	-	400
Nitrite	-	30
Sulphate	-	1000
TDS (salinity)	600 (conversion from EC)	2400

- No published values
Source: Modified after NEPC (1999)

5.7.2 Impacts on Licensed Users

The groundwater modelling carried out for the TCP-EA (RS, 2012) indicates that the drawdown effects on groundwater users in the vicinity of the mine are not likely to be significant (that is, less than 1 m) and would not materially affect the existing or potential future beneficial use of groundwater. One bore located in the Leard State Forest (GW967859) that draws water from the shallow porous rock source is predicted to experience approximately 8m of drawdown as a result of the TCM and approximately 20m from all surrounding mines. The Boggabri Coal Mine groundwater network already includes a monitoring bore (IBC2139) adjacent to this location.

Two nearby privately owned bores on the Coomalgah property are predicted to have a maximum drawdown of about 1 m. Bore Reg7a has been sited on the Coomalgah property to monitor any approaching drawdown. If the water supply of any owner of privately-owned land is adversely and directly impacted (other than a negligible impact) as a result of the TCM then TCM will provide a compensatory water supply to the land owner in consultation with DoI Water, and to the satisfaction of the Secretary in accordance with Schedule 3 Condition 32 of the Project Approval.

At other sites where minimal impact is expected, baseline levels were established during the TCP-EA (RS, 2012) investigations. Measured hydrographs for each bore are presented in Appendix AB of Heritage Computing (2011).

The maximum drawdown expected at each non-mine monitoring or production bore is presented in Appendix AD of Heritage Computing (2011).

With respect to the Aquifer Interference Policy and impacts to licensed users; the minimal impact considerations of 2 m maximum drawdown at third-party production bores or wells are outlined below.

The TCP-EA (Appendix A, Figure A-44) (RS, 2012) notes that the predicted 2 m drawdown extent, due to the TCM alone, for the alluvium/regolith water table is expected to extend about 4 km to the north and east, about 2.5 km to the west, with no extension to the south (due to truncation of target coal seams by faulting). Of 121 registered bores within 5 km of the TCM, 67 are on land owned by Whitehaven or BCPL. There are no private bores within the 2 m drawdown zone of influence drawing water from alluvium. One bore in the Leard State Forest (GW967859) that would draw water from porous rock is expected to have a maximum drawdown of about 8 m due to the TCM alone and about 20 m cumulative impact from all three mines. If this bore is in use, a make-good arrangement is warranted.

5.7.3 Mine Pit Inflow Rates

The BTM groundwater model (2021) predicted gross groundwater passive take volumes required to be licensed over the Life of mine as discussed in section 5.3. These values include indirect take and direct take and do not represent the gross volume that enters the pit, after losses such as evaporation are accounted for. Table 27 shows the predicted net groundwater inflows to the pit that enter the mine water management system (HydroSimulations, 2019). These volumes are significantly less than the predicted passive take which the mine licenses. There is no way to quantify these volumes, as any groundwater that enters the pit mixes with surface water runoff and spoil within the pit.

Table 27 Predicted net groundwater inflows to the pit

Financial year	Annual Pit inflow (ML/yr)	Daily Pit inflow (ML/day)
2021/22	58.4	0.16
2022/23	62.1	0.17
2023/24	62.1	0.17
2026/25	62.1	0.17

The BTM Complex Water Management Strategy recommends that a trigger be established for groundwater take in excess of approved/licensed extraction as described in Table 34.

5.7.4 Mine Pit Water Quality

Groundwater quality within the site is highly variable, with measured EC ranging from 440 µS/cm to about 7,500 µS/cm in alluvium and from 530 µS/cm to about 2,800 µS/cm in coal. In general, the median values are about 1,000 µS/cm in coal, about 2,000 µS/cm in alluvium and volcanics and about 2,500 µS/cm in coal measures interburden (HydroSimulations, 2019).

The salinity and chemistry of mine inflow has an effect on site water management and water treatment, but does not raise any impacts of environmental concern. Accordingly, measurements of groundwater quality in bores and surface water quality in streams are more appropriate. Notwithstanding this, TCM will to continue monitoring surface water quality in the mine pit, and in particular pH, to monitor the potential for acid rock drainage related impacts.

6 SURFACE WATER AND GROUNDWATER RESPONSE PLAN

6.1 General

The Surface Water and Groundwater Response plan includes a protocol for managing and reporting any:

- incidents;
- complaints;
- non-compliances with statutory requirements;
- exceedances of the impact assessment criteria and or performance criteria; and
- a protocol for periodic review of the plan.

This surface water and groundwater response plan uses an adaptive management approach to limit the risk of a mine-related exceedance occurring/recurring in accordance with Schedule 5 Condition 2 of PA 11_0047.

6.2 Exceedance Response Protocol

Where an exceedance of the trigger values documented in Section 3.7 and Section 5.5 is identified, TCM will follow the procedure listed in Table 28. This procedure will also apply in the event of an exceedance of allocated water volumes under the site's Water Access Licences for groundwater sources (listed in Table 22) or the measurement of a substantial change in groundwater quality more than the trigger levels defined within this WMP.

All monitoring data including any exceedances are reported annually in the Annual Return.

Table 28 Exceedance Response Protocol

Stage	Procedure
1	Record the timing, location, environmental conditions and any contributing factors to the exceedance.
2	Assess the monitoring results for any anomalies or causes.
3	Inspect sampling point and areas upstream to ascertain cause of exceedance.
4	Repeat sampling if required to confirm results exceed trigger level.
5	Review operational practices in accordance with the Unforeseen Impacts Protocol in Table 29 to determine if any current operational practice contributed to the exceedance.
6	If safe then cease any controlled discharges which may be causing the non-compliance and/or contain contaminated water, where possible, to prevent environmental harm.
7	Remediate any environmental harm, where possible, and use an external contractor if required.
8	If mine related then inform relevant agencies (EPA and Resource Regulator) and community (if required) in accordance with Section 8.3 of this WMP and Schedule 5 Condition 8 of PA 11_0047.
9	Seek external support/ advice if required.
10	Provide a response to relevant agencies according to Schedule 5 Condition 8 of PA 11_0047.

11	Implement ameliorative measures on site in consultation with relevant agencies to minimise the potential for future exceedance.
12	Assess the performance of implemented measures against the respective trigger values given in Section 3.7 and Section 5.5

6.3 Unforeseen Impacts Protocol

The procedure outlined in Table 29 will be followed in the event that any unforeseen surface water or groundwater impacts (exceedances) occur. The procedure will be in general accordance with the Exceedance Response Protocol in Section 6.2.

Table 29 Unforeseen Impact Protocol Procedure

Stage	Procedure
1	Review the unforeseen impact, including consideration of: • Any relevant monitoring data; and • Current mine activities and land management practices in the relevant catchment.
2	Commission an investigation into the unforeseen impact by an appropriate specialist selected in consultation with appropriate regulatory authorities.
3	Develop appropriate ameliorative measures based on the results of the above investigations, in consultation with the relevant authorities.
4	Implement additional monitoring where relevant to measure the effectiveness of the ameliorative measures.

6.4 Surface Water Response Plan

Trigger action response plans (TARPs) to limit the risk of, and respond to, exceedances of surface water triggers is provided below for:

- mine water storage (Table 30);
- sediment dams (Table 31) and
- downstream water quality (Table 32)

Response plans for other surface water related events are provided in Table 33.

Table 30 Mine Water Storage TARP

Level	Trigger	Action	Response
Level 1 (Normal)	Mine water dam water level below 80% operating water level in Table A2 [a]	• Continue to monitor levels in accordance with monitoring plan	• No response required
Level 2 (Early warning)	Current or forecast rainfall greater than 25 mm/d	• Ensure inter-dam transfer pumping network is operational • Review options for water transfer if required	• Post-event review to confirm event was well managed with appropriate resources in place if required. Report and investigate as required.
Level 3A (Possible exceedance of operational level)	Mine water dam water level exceeds 80% operating water level in Table A2 (80% capacity) with inflows still occurring [a]	• Reduce process inflows if practical • Commence transfer from storages with highest risk of spill if possible	• Post-event review to confirm suitability of water transfer infrastructure & operational rules if required • Update operational rules if required • Prepare recommendations for modifications or upgrades to water transfer infrastructure if necessary • Report and investigate as required.
Level 3B (Possible discharge of mine water)	Mine water dam water level exceeds 95% operating water level in Table A2 (95% capacity) with inflows still occurring [a]	• Cease process inflows to storages with highest risk of spill • Maximise pumping capacity for dewatering of storages with highest risk of spill (e.g. relocate mobile pumps) where practical	• Post-event review to confirm suitability of water transfer infrastructure & operational rules • Update operational rules if required • Implement required modifications or upgrades to water transfer infrastructure if necessary • Report and investigate as required.
Level 4 (Discharge of mine water)	Discharge of mine water from one or more mine water storages	• Activate Exceedance Response Protocol actions in Section 6.2 • Collect water quality samples of spills at dam overflow point and in receiving watercourse in accordance with Section 3.6.4	• Activate Unforeseen Impacts Protocol in Section 6.3

[a] The SB4 operating water level is 20% of the Full Storage Capacity as it receives catchment inflows from the ROM Pad.

Table 31 Sediment Dam TARP

Level	Trigger	Action	Response
Level 1 (Normal)	Sediment dam water level below operational level in Table A1	• Continue ongoing inspection and maintenance of sediment dams in accordance with Section 3.6	• No response required • Check sediment levels in sediment dams and de-silt if required
Level 2A (Early warning)	Current or forecast rainfall greater than 25 mm/d	• Ensure transfer pumping network is operational • Review options for water transfer if required • Undertake inspection to check sediment accumulation if required	• Post-event review to confirm event was well managed if required • Check post-event sediment levels in sediment dams as required • Report and investigate as required.
Level 2B (Exceedance of operational level)	Sediment dam water level exceeds operating water level in Table A1 with inflows still occurring	• Dewater storages with highest risk of off-site discharge where possible • Take water quality sample and compare against triggers level in Table 8 if required • Consider options for controlled releases (e.g., pumping requirements, treatment)	• Review system configuration to ensure operating as designed if required • Check post-event sediment levels in sediment dams as required • Report and investigate as required.
Level 3B (Sediment dam discharge)	Off-site Discharge (e.g., controlled release, spills) from authorised sediment dams with TSS, pH or Oil and grease less than trigger level in Table 8	• Collect sample of LDP outflow in accordance with Section 3.6.4 • Confirm water quality in dam outflow less than trigger levels in Table 8	• Post-event review to confirm rainfall exceeded design standard • Review system configuration to ensure operating as designed • Check post-event sediment levels in sediment dams • Report and investigate as required.
Level 4 (Exceedance of water quality target)	Discharge from sediment dam with TSS, pH or Oil and grease greater than trigger level in Table 8	• Activate Exceedance Response Protocol actions in Section 6.2 • Check if event rainfall exceeds design standard • Notify relevant agencies and community if rainfall below design standard • Collect water quality samples of spills at dam overflow point and in receiving watercourse	• Check post-event sediment levels in sediment dams and de-silt if required • Activate Unforeseen Impacts Protocol in Section 6.3

Table 32 Downstream Water Quality TARP

Level	Trigger	Action	Response
Level 1 (Normal)	All surface water quality samples below trigger levels in Table 9	• No action	• Continue to monitor water quality in accordance with monitoring plans
Level 2 (Early warning)	Single value at downstream sampling site exceeds trigger level in Table 9	• Check upstream water quality to assess potential for impact from operations in accordance with Section 3.6 • Activate Exceedance Response Protocol actions in Section 6.2	• If upstream pollutant concentration is higher or within 5% of downstream value, then no further action required • Otherwise, assess whether operation could potentially have affected water quality and take remedial action, if appropriate
Level 3A (Potential water quality impact – no discharge)	Two or more sequential samples at a downstream sampling site exceed trigger level in Table 9	• Check upstream water quality to assess potential for impact from operations in accordance with Section 3.6 • Activate Exceedance Response Protocol actions in Section 6.2	• If upstream pollutant concentration is higher or within 5% of downstream values then consider need for review of trigger levels • Implement appropriate mitigation measures, if required
Level 3B (Potential water quality impact – sediment dam discharge)	Water quality at multiple downstream sampling sites exceeds trigger levels in Table 9 and discharge from site sediment dams has occurred	• Check upstream water quality to assess potential for impact from operations in accordance with Section 3.6 • Activate Exceedance Response Protocol actions in Section 6.2	• If upstream pollutant concentration is higher or within 5% of downstream values then no further action required • Implement appropriate mitigation measures, if required
Level 4 (Likely water quality impact – mine water dam discharge).	Single value at downstream sampling site exceeds trigger level in Table 9 and discharge from mine water dam has occurred	• Activate Exceedance Response Protocol in Section 6.2	• Activate Unforeseen Impacts Protocol in Section 6.3

Table 33 TARP – Stream Health

Level	Trigger	Action	Response
Level 1 (Normal)	Taxonomic richness, SIGNAL Score, EPT Score, AND invertebrate communities at sites downstream of the mine are all **similar to** sites upstream of the mine	Continue monitoring in accordance with monitoring plan	No response needed
Level 2 (Early warning)	Some of the above ecological indices are within ranges that are similar to sites upstream of the mine	Review existing water quality (Dissolved Oxygen, Electrical Conductivity, pH, turbidity) and flow data to see if there is a reason for loss of diversity or sensitive taxa. Inspect sediment control devices for proper function, inspect drainage lines for signs of erosion. Repair as needed. Continue monitoring in accordance with plan.	Visual inspection of sediment devices to ensure proper function. Assess follow-up monitoring data for improved condition.
Level 3 (Exceedance of trigger level)	Taxonomic richness, SIGNAL Score, EPT Score, or invertebrate communities at sites downstream of the mine are significantly less than (or outside the rang e of one standard deviation of) those sites upstream of the mine.	Review water quality data, flow data, and other site-specific information to see if there is a non-mining related explanation for the decline (e.g. drought, seasonal patterns). If not, examine sediment control structures and other infrastructure that may contribute to poorer macroinvertebrate communities.	Visual inspection of sediment devices to ensure proper function. Assess follow-up monitoring data for improved condition. Expand stream health monitoring to downstream water bodies including the Slush Hole and Barbers lagoon

Table 34 TARP – Riparian Vegetation

Level	Trigger	Action	Response
Level 1 (Normal)	There is no decline in NDVI for riparian vegetation along Goonbri Creek between survey periods. Diversity in tree and shrub layers, as measured in BAM plots at Goonbri Creek sites, remain consistent through time	Continue monitoring in accordance with monitoring plan Continue monitoring in accordance with monitoring plan	No response needed No response needed
Level 2 (Early warning)	There is a moderate decline in NDVI at some sites along Goonbri Creek, but not all There is a decline in vegetation diversity in shrub and tree layers at some sites along Goonbri Creek.	Compare to field-based assessments such as BAM and RARC and site photos. Review localised groundwater level and water quality data and creek gauging data. Consider supplementary watering of vegetation if necessary. Continue monitoring in accordance with monitoring plan Review groundwater level and water quality data and creek gauging data. Consider supplemental watering if necessary. Continue monitoring in accordance with monitoring plan	Assess follow-up NDVI data for improvement. Review follow-up monitoring data for signs of improvement and increased health in vegetation, including recruitment of shrub and tree species.
Level 3 (Exceedance of trigger level)	There is a severe decline in NDVI at some or all sites along Goonbri Creek There are indications of stress and a lack of recruitment in riparian vegetation communities. Death of several individual trees or shrubs.	Examine BAM data. Review water quality data from groundwater and surface water monitoring programs. Consider supplemental watering. Remediate riparian zone once cause of deaths have been determined and addressed. Review water quality data from groundwater and surface water monitoring programs. Consider supplemental watering. Remediate riparian zone once cause of deaths have been determined and addressed.	Continue monitoring. Follow up assessments on rehabilitation and remediation Continue monitoring. Follow up assessments on rehabilitation and remediation. Expand Riparian Vegetation monitoring to downstream water bodies including the Slush Hole and Barbers lagoon

Table 35 Surface Water Network and Infrastructure Contingency Actions

Trigger	Action/Response
Mechanical failure of pumping equipment prevents scheduled transfers	• Ensure adequate spares are available. Source temporary equipment if possible.
Damage to water storage infrastructure	• Regular visual inspection of infrastructure, especially following significant rainfall.
Failure of water storage structure	• Notify relevant agencies and/or communities in accordance with Section 8.3 of this WMP. • Investigate the downstream impacts of the failure and complete a detailed report on the impacts of the failure, including an assessment of likely water volume and quality, and required remedial actions. • Investigate the reason for failure of the structure and ensure the stability of other water storages at risk. • Assess the effects of the failure on the water management system and implement mitigation measures.
Water demands or catchment yield depart from assumed values used in modelling	• Investigate reasons. • Revisit site water balance modelling if required.
Short-term water demand forecast may approach the entitlement under high security water licences	• Further improvements in water use efficiency. • Investigate procurement of additional water licences. • Extraction of groundwater from existing or new bores (within licence conditions). • Increased retention of site runoff without discharge.
Stream and riparian vegetation health monitoring indicates measurable declining vegetation health.	• Undertake an investigation in accordance with the Unforeseen Impacts Protocol (Section 6.3).
Site inspections indicate unexpected erosion or sedimentation downstream of the mine.	• Undertake an investigation in accordance with the Unforeseen Impacts Protocol (Section 6.3).
Oil/chemical spill event	• Stop all work in the area where the spill occurred. • Deploy spill response kits if applicable and contain the spill if safe to do so. • Notify the Environmental Officer or representative and consult safety data sheet, if relevant. • Mitigate spill. • Notify potentially affected persons (where necessary). • Report incident internally. • Notify and report to the incident to the relevant agencies, if required. Refer to Section 8.3 for incident reporting requirements. • Complete Exceedance Response Protocol actions in Section 6.2, if required. • Undertake an investigation in accordance with the Unforeseen Impacts Protocol (Section 6.3).

6.5 Groundwater Response Plan

Specific trigger levels have been designed to alert TCM to observed parameter responses which are outside of normal variation and predicted responses, or where observed parameter values do not follow anticipated trends.

The triggers for instigation of response actions would occur when observed changes to monitored parameters exceed specified levels. Such changes in observed parameters or conditions include:

- sudden inrush of groundwater into the mine pit in exceedance of predicted inflows;
- significant change in observed water quality or groundwater levels between sampling rounds;
- changes in trends over an extended period for groundwater levels and quality; and
- a significant increase or variation from model predictions

The BTM Complex Water Management Strategy supports the performance indicators proposed by Heritage Computing (2012) for detection of far-field and mid-field regional groundwater impacts. An additional performance indicator has been developed for near-field effects. The four performance indicators and response actions are defined in Table 34.

Note that the use of a 5th percentile rule for far-field effects means that groundwater elevations can be expected to be below this threshold for 5 percent of measurements, if future climatic conditions match what has occurred during the baseline monitoring period. To counteract spurious measurements, which could occur for example during maintenance of a sensor or downloading or water sampling, a 7-day average is proposed to cover such events. In addition, to ensure any exceedance of a trigger is sustained and is therefore significant, a 1-month exceedance duration is proposed to allow water levels to stabilise. This would "trigger" an investigation in the first instance, not an immediately reportable incident.

A specific groundwater Trigger Action Response Plan (TARP) is provided in Table 34.

Specific monitoring and assessment of impacts to GDE's are detailed in the TCM's Biodiversity Management Plan.

Table 36 Groundwater Performance Indicators and Response Actions

Effects	Performance Measure	Performance Indicator	Assessment	Monitoring Sites (in proximity to TCM)	Control Sites (in proximity to TCM)	Action
Far-field	Tolerable reduction in water table level in alluvium fringing the BTM complex	Groundwater level hydrographic response based on 7-day moving average data compared with rainfall and the historical 5th percentile water levels established for the preceding 24 months of data.	The performance indicator is exceeded if groundwater levels are lower than the 5th percentile for more than one month, or more than 1.5 m below the minimum recorded historical level1.	Reg6, Reg7a	Reg14	If the performance indicator is exceeded, comparison will be made with the control site(s) very far from mining to establish whether the exceedance is due to natural seasonal variations. If the cause cannot be ascribed clearly to climate, a groundwater specialist will be engaged to determine the reason for the exceedance.
Mid-Field	Expected reduction in deep groundwater pressures within the Maules Creek Formation coal measures.	Vertical hydraulic head profiles and time-varying reductions in groundwater head.	The performance indicator is exceeded if the measured groundwater heads and vertical head differences depart substantially from model predictions, or if the uppermost sensor has a head more than 1.5 m below the minimum recorded historical level1.	Reg9	NA	If the performance indicator is exceeded, a groundwater modelling specialist will be engaged to determine the reason for the exceedance. A check would first be made for alignment of actual mine progression with that assumed for model predictions. A decision would be made as to whether model re-calibration is warranted.

[1] This will provide advance warning of a groundwater level approaching the 2m impact threshold of the Aquifer Interference Policy.

Effects	Performance Measure	Performance Indicator	Assessment	Monitoring Sites (in proximity to TCM)	Control Sites (in proximity to TCM)	Action
Chemical	Tolerable increase in shallow groundwater electrical conductivity (EC) in alluvium fringing the BTM complex	Groundwater EC average data compared with the historical 95th percentile EC established for the full length of record (greater than 24 months).	The performance indicator is exceeded if the annual average EC value at the time of the annual review is higher than the historical 95th percentile.	Reg6, Reg7a	NA	If the performance indicator is exceeded, comparison will be made between sites to establish whether the exceedance is due to natural seasonal variations. If the cause cannot be ascribed clearly to climate, a groundwater specialist will be engaged to determine the reason for the exceedance.
Near-Field	Expected reduction in deep groundwater pressures within the Maules Creek Formation coal measures between the mine and Goonbri Creek.	Vertical hydraulic head profiles and time-varying reductions in groundwater head.	The performance indicator is exceeded if the measured vertical head differences and rate of decline of groundwater heads depart substantially from model predictions (>1.5m of the greatest modelled impact).	TA60C, TA65C	NA	If the performance indicator is exceeded, TCM will seek external advice and a groundwater modelling specialist may be engaged to determine the reason for the exceedance. A check would first be made for alignment of actual mine progression with that assumed for model predictions. A decision would be made as to whether model re-calibration is warranted.
Groundwater Dependent Ecosystems	Vegetation stress in groundwater dependent vegetation	Groundwater level records in monitoring bores in proximity to high potential GDEs	The performance indicator is exceeded if both vegetation stress and declining alluvial	Alluvial 1, Alluvial 3	NA	If the performance indicator is exceeded, TCM will seek external ecological and hydrogeology advice on the significance

Effects	Performance Measure	Performance Indicator	Assessment	Monitoring Sites (in proximity to TCM)	Control Sites (in proximity to TCM)	Action
	(including stygofauna and riparian vegetation) is correlated to declines in alluvial groundwater levels occurring due to mining		groundwater levels in selected monitoring bores attributed to mining are recorded for a period of more than six months			of impacts and the need for management/mitigation measures.
interconnectivity between the alluvial and bedrock aquifers, including the potential for enhanced leakage as a result of fracturing due to blasting	Declining alluvial water table levels correlated with declining water pressures within underlying Permian coal measures attributed to mining	Declining water levels in both alluvial and Permian coal measures monitoring bores	The performance indicator is exceeded if both water levels in selected alluvial monitoring bores and groundwater pressures in adjacent underlying Permian coal measures bores/VWPs are declining due to mining for a period of more than six months	Alluvial 1, Alluvial 3 + 2 new Permian VWPs installed adjacent to the alluvial bores	NA	If the performance indicator is exceeded, TCM will seek external hydrogeology advice to determine influence of both climatic conditions and mining on groundwater levels, the significance of any impacts and the need for management/mitigation measures.

Table 37 Groundwater Monitoring Network

System / measure	Monitoring		Response		
	Methodology	**Purpose**	**Trigger**	**Action**	**Responsibility**
Groundwater Levels – Namoi River alluvial aquifer	• Sites: • Local groundwater bores in alluvium: MW2, MW4, MW5, MW6, GW031856, GW044997, GW052266 • Regional groundwater bores in alluvium: Reg6, Reg7a, Reg14. • Parameters: • Water level. • Analysis: • Comparison to predicted drawdown taking into account natural variations observed in background reference sites.	• To provide baseline water level data and to identify water level impacts. • To verify that drawdown impacts on specified Namoi River Alluvium bores are consistent with model predictions and compliant with the AIP impact threshold. • To re-calibrate and validate model with additional data.	• Performance Measure: Tolerable reduction in water table level in alluvium fringing the BTM complex. • Performance Indicator: Groundwater level hydrographic response based on 7-day moving average data compared with rainfall and the historical 5th percentile water levels established for the preceding 24 months of data. • Assessment: The performance indicator is exceeded if groundwater levels are lower than the 5th percentile for more than one month, or more than 1.5 m below the minimum recorded historical level.	• Engage a suitable specialist to undertake an investigation within 30 days on any identified changes or likely causes for the event, including recommendations in accordance with Section 6.5. • Notify agencies of the results of the investigation within 40 days of the engagement of the specialist, at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.
Groundwater Levels – Coal Measures and Boggabri volcanics	• Sites: • Local groundwater bores: MW1, MW7, MW8. • Mine site vibrating wire piezometers: TA60C, TA65C. • Regional groundwater bores: Reg9	• To provide baseline water level data and to identify water level impacts. • To verify that impacts at specified monitoring bores are consistent with model predictions.	• Performance Measure: Expected reduction in deep groundwater pressures within the Maules Creek Formation coal measures. • Performance Indicator: Vertical hydraulic head profiles and time-varying reductions in groundwater head.	• Engage a suitable specialist to undertake an investigation within 30 days on any identified changes or likely causes for the event, including recommendations in accordance with Section 6.5.	Environmental Officer or representative.

System / measure	Monitoring		Response		
	Methodology	Purpose	Trigger	Action	Responsibility
	• Parameters: • Water level • Analysis: • Comparison to predicted drawdown taking into account natural variations.	• To re-calibrate and validate model with additional data.	• Assessment: The performance indicator is exceeded if the measured groundwater heads and vertical head differences depart substantially (>1.5m of the greatest modelled impact) from model predictions. • At TA60C and TA65C, the performance indicator is exceeded if the measured vertical head differences and rate of decline of groundwater heads depart substantially (>1.5m of the greatest modelled impact) from model predictions.	• Notify agencies of the results of the investigation within 40 days of the engagement of the specialist, at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	
Mine water inflows – volume/rate	• Sites: • Water pumped out of the pit. Includes rainfall that collects in the pit. • Parameters: • Volume. • Analysis: • Comparison to predicted volumes in mine water management and groundwater models. Estimated by back-calculating groundwater inflow annually from full water balance taking into account rainfall, runoff, transfers, dam leakage, moisture and evaporation. •	• To verify that groundwater inflows are consistent with model predictions. • To provide inflow data that can be used to re-calibrate and validate the groundwater model.	• Groundwater take in excess of approved/licensed extraction, assessed annually	• TCM to back-calculate groundwater inflow from water balance annually for Annual Review reporting. • Engage a suitable specialist to undertake investigation and report on any identified changes /likely causes and recommendations in accordance with Section 6.5. • Notify agencies when exceedance becomes known, and provide updates throughout investigation above, and at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.

System / measure	Monitoring		Response		
	Methodology	Purpose	Trigger	Action	Responsibility
Groundwater Quality	• Sites: • Local groundwater bores in alluvium: MW2, MW4, MW5, MW6, GW031856, GW044997, GW052266 • Regional groundwater bores in alluvium: Reg6, Reg7a. • Parameters: • Water quality – laboratory analysis suite. • Analysis: • Comparison to NEPM and baseline water quality.	• To provide baseline water quality data and to identify water quality impacts or changes in beneficial use of groundwater in alluvium.	• Performance Measure: Tolerable increase in shallow groundwater electrical conductivity (EC) in alluvium fringing the BTM complex. • Performance Indicator: Groundwater EC average data compared with the historical 95th percentile EC established for the full length of record (greater than 24 months). • Assessment: The performance indicator is exceeded if the annual average EC value at the time of the annual review is higher than the historical 95th percentile.	• Engage a suitable specialist to undertake investigation and report on any identified changes /likely causes and recommendations in accordance with Section 6.5. • Notify agencies when exceedance becomes known, and provide updates throughout investigation above, and at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.

6.6 Complaints

Whilst all endeavours will be made by TCM to avoid adverse water impacts on local landowners / residents, it is acknowledged that from time to time such impacts may occur. In order to ensure an appropriate and consistent level of reporting, response and follow-up to any complaints is adopted by TCM, the following complaints management protocol will be followed:

- A publicly advertised telephone complaints line will be in place to receive complaints during operating hours and record complaints at other times.
- Each complaint received will be recorded on a Complaints Register, which will include the following details:
  - The date and time of complaint.
  - Any personal details the complainant wishes to provide or if no such details are provided a note to that effect.
  - The nature of the incident that led to the complaint.
  - The action taken by TCM in relation to the complaint, including any follow-up contact with the complainant.
  - If no action was taken by TCM, the reason why no action was taken.
- The Environmental Officer or representative will be responsible for ensuring that an initial response is provided generally within 24 hours of receipt of a complaint (except in the event of complaints recorded when the mine is not operational).
- Data from the site weather station will be obtained for the time applicable to the complaint for use in determination of cause and identification of future remedial actions.
- Additional measures will be undertaken as required to address the complaint. This may include visiting the complainant, or inviting the complainant to the mine site.
- Once the identified measures are undertaken, the Environmental Officer or representative will update the Complaints Register.
- If necessary, follow-up monitoring will take place to confirm the source of the complaint is adequately mitigated.
- A copy of the Complaints Register will be kept by TCM and made available to the CCC and the complainant (on request). A summary of complaints received every 12 months will be included in the Annual Review.

Based on the nature of individual complaints, specific contingency measures may be implemented to the (reasonable) satisfaction of the complainant. The Environment Officer or representative retains responsibility to ensure that complaints received are properly recorded and addressed appropriately.

7 FUTURE WATER MANAGEMENT ELEMENTS

7.1 General

There are a number of aspects of the approved future works that have the potential to affect water quality leaving the site, or watercourse stability around the site. These factors are briefly discussed in the following sections however they will be covered in more detail in future revisions of this WMP and MOP, once more detailed work has been carried out on these specific future water management elements.

7.2 Final Void

The plan for mine closure includes leaving a final void that would achieve a water level close to pre-mine water levels in the coal measures. The final void design would ensure that water does not spill from the void, affecting the downstream watercourses. A previous water balance model of the final void, developed for the TCP-EA (RS, 2012), was used to show that an equilibrium state would be reached. It was found that by partially backfilling the void, the water level could be controlled and raised to the desired, pre-mining level. This was one of several options that could be used in the design of the final structure; however this would be further developed during the detailed planning of mine closure as would considerations regarding how the hydrostatic pressure will be reduced in the alluvium immediately adjacent to the void. The final void structure would be determined within five years of closure.

7.3 Goonbri Creek Diversion, Low Permeability Barrier and Permanent Flood Bund

Condition 37 of PA 11_0047 requires Whitehaven to prepare an updated flood modelling assessment report to the satisfaction of the Secretary. The report must:

> *a) be prepared in consultation with BCS, and be submitted and approved by the Secretary prior to undertaking any mining operations within an elevation of less than 0.5 metres above, or a lateral distance of 25 metres from, the Probable Maximum Flood extent as shown on the plans in Appendix 6; and*
>
> *b) include:*
>
>> *(i) detailed 2-dimensional flood modelling for events up to and including the Probable Maximum Flood, to determine the extent of flooding from Goonbri Creek;*
>>
>> *(ii) additional assessment of the need, design and extent of the Goonbri Creek flood bund to prevent inundation of the mining operations and mining pit for all events up to and including the Probable Maximum Flood;*
>>
>> *(iii) detailed construction design plans for the flood bund; and*
>>
>> *(iv) additional assessment of any flood-related impacts associated with construction of the flood bund.*

WRM Water & Environment Pty Ltd (WRM) completed a hydraulic assessment Goonbri Creek to satisfy Condition 37 of PA 11_0047 (WRM, 2021a). The hydraulic model was run for a Probable Maximum Flood (PMF) event in Goonbri Creek and Bollol Creek, which represents the maximum possible flood extent that could conceivably be expected to occur in this location. The modelled creek flood depths and velocities for the PMF in the vicinity of TCM are shown in Figure 17 and Figure 18, respectively.

Based on the assessment, it was found that the Goonbri Creek flood bund would no longer be required due to the MOD 7 changes. This report will be provided to DPE and BCS for review in 2023. A summary of the hydraulic modellings results is as follows:

- Goonbri Creek PMF is at least 25 m from the Mod 7 approved pit crest.
- Peak flood depths on the indicative surface areas do not significantly change between the 20% AEP event and the PMF due to:
  - Goonbri Creek floodwater overflowing from the channel onto the western floodplain; and
  - Bolloll Creek floodwater overflowing from the channel onto the southern floodplain (some of which drains to Driggle Draggle Creek).
- Design PMF flood levels in the vicinity of open pit on TCM range from 278 to 286 mAHD;
- The PMF flood does not extend to the open pit as the topography rises towards the pit within the indicative surface area. As such, a flood bund to protect the open pit is not required.
- Maximum flood velocities at the location of maximum depth on the indicative surface area adjacent to the open pit range from 0.2 m/s for the 20% AEP event to 0.8 m/s for the PMF. Flood velocities closer to the open pit are less than 0.2m/s for all events which is significantly less velocity than required to be erosive.

The TCM flood model will be periodically reviewed and if required updated to determine if there are any potential impacts. In accordance with PA Condition 39, if any downstream flooding impacts are identified by the updated flood model, a monitoring program will be established to monitor downstream flooding impacts.

Further details regarding the development of the WRM hydraulic model and flood assessment will be provided with the submission of the Flood Assessment to the DPE in 2023.

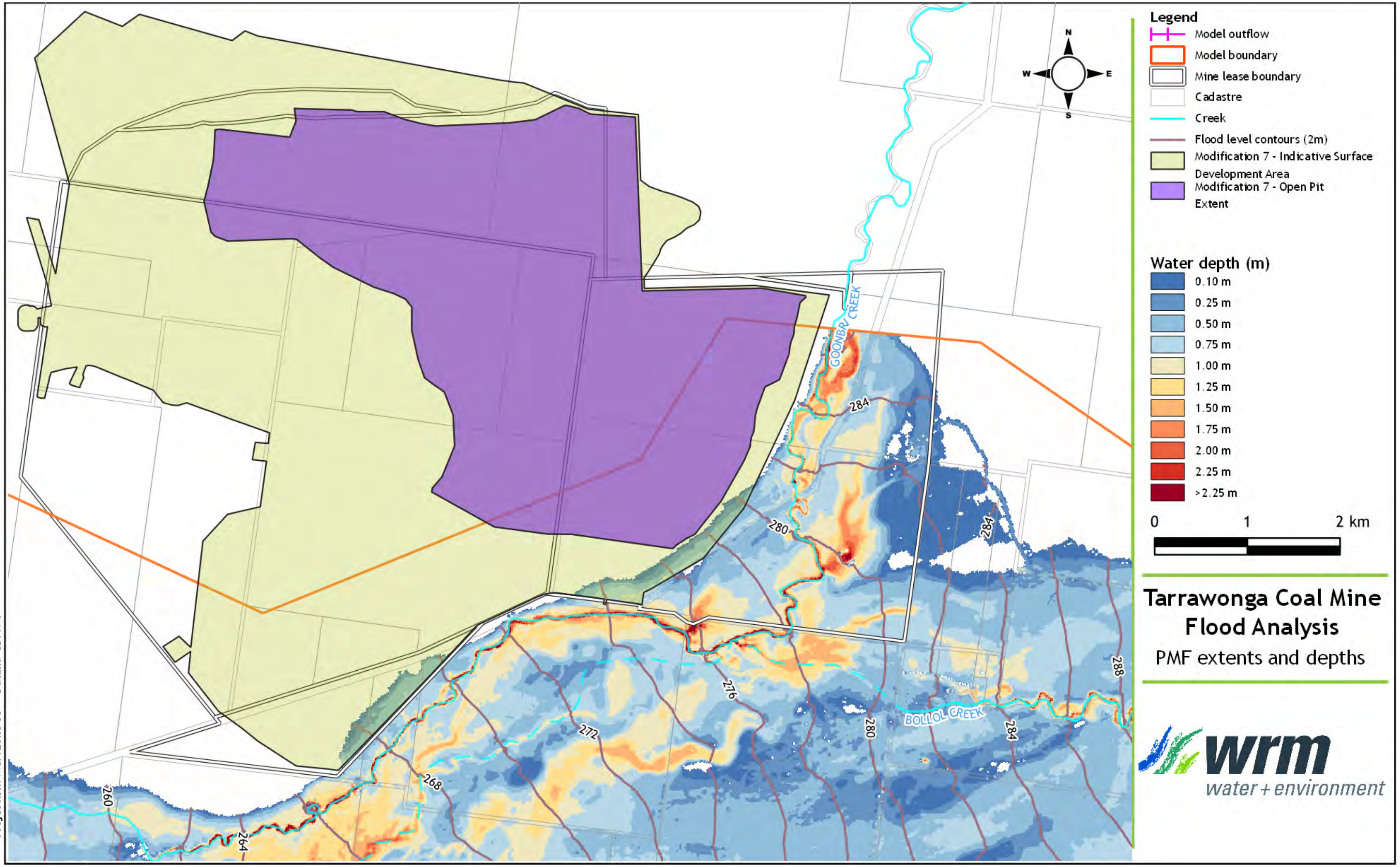


Figure 17 Flood Levels, Depths and Extent, PMF

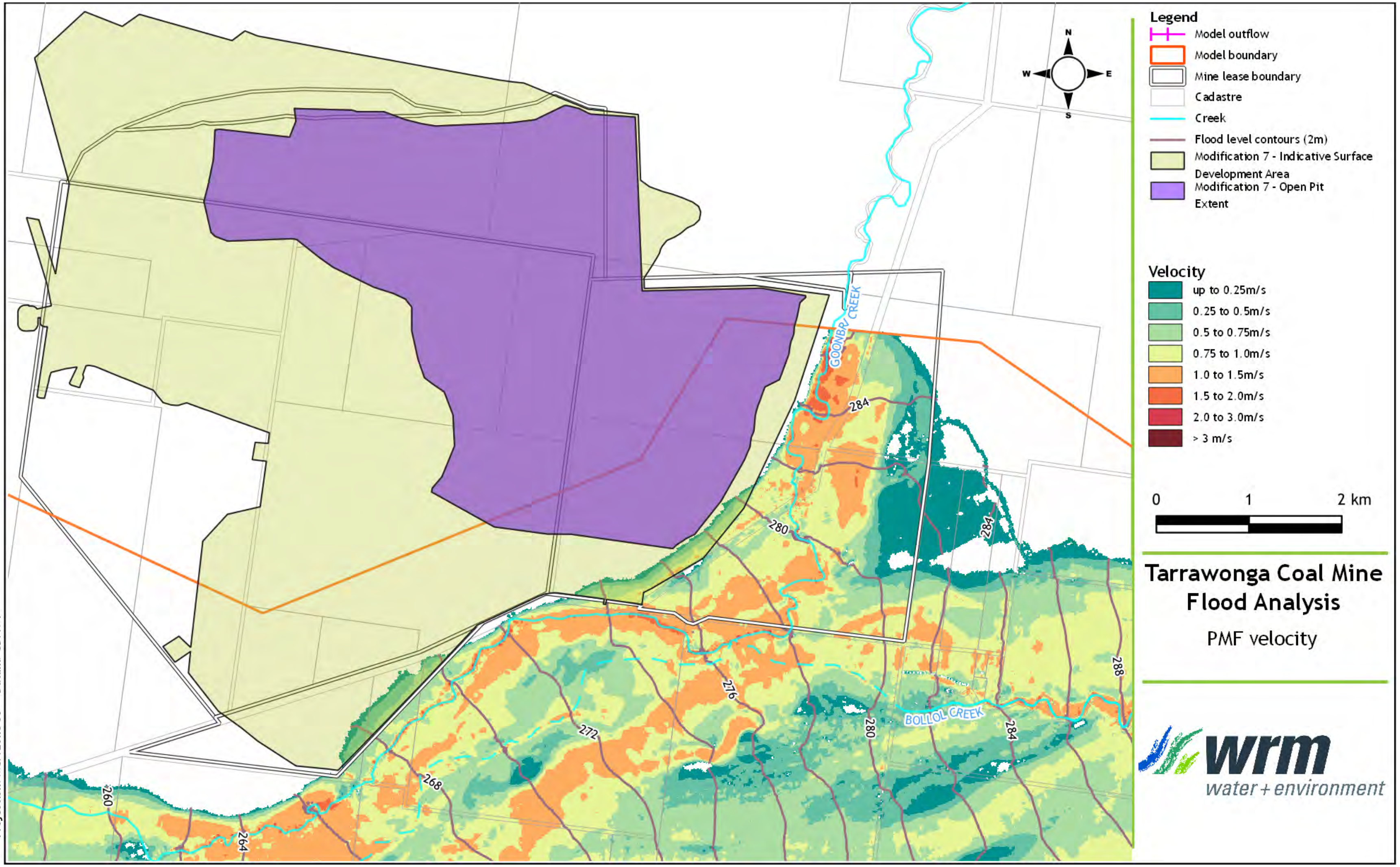


Figure 18 Flood Velocities and Extent, PMF

7.4 Rejects Disposal Area

Reject material from the Whitehaven CHPP will be returned via truck to TCM for disposal. All reject material will be co-disposed within the footprint of the void with waste rock material. Reject material will be "mixed" with the waste overburden and interburden. This will primarily be achieved through the alternating of reject and mine waste dumping at the reject disposal areas. Generally, this material will be layered within the overburden material evenly to minimise any stability impacts.

An assessment of a concept cover system that would be required for the rejects disposal area(s) at TCM is described in the RMP. A refined design will be presented in future revisions of the RMP that includes the final rehabilitation of the rejects disposal area(s). The following reject emplacement methodology will be employed to limit sulphide oxidation and acid generation and/or the migration of any acid or sulphate species that may be generated from migrating beyond the pit shell:

- The acid forming potential of reject will be minimised through the dilution effect of co-disposal with overburden (including ongoing cover of overburden as part of the operational overburden emplacement process).
- Reject will be placed at least 30m inside the pit shell footprint.
- A setback angle of 30° will be utilised for 'supercharged' co-disposed rejects and overburden material (i.e. for areas where the backfill is higher than the original topography).
- The final cover of 5m of NAF material will be emplaced within a targeted maximum of 1 month from the time of co-disposal in the final lift of the waste emplacement that contains co-disposed reject (i.e. 5m below final landform). The 5m cover will sufficiently reduce oxygen diffusion and/or water infiltration and provides sufficient thickness for a base for the growth medium, which will overlie the cover.
- In line with RMP commitments, growth medium will be provided above the cover for rehabilitation to support successful long-term revegetation.

The risk of spontaneous combustion at TCM will be managed according to Section 3.2.5 of the MOP. The risk of a spontaneous combustion event at Tarrawonga is considered to be low. Testing was conducted on each coal seam to be exposed by mining at Tarrawonga, with 0.44% sulphur content being the highest recorded value (Velyama Seam). The low percentage of inorganic sulphur is indicative of a low potential for exothermic oxidation reactions. TCM conducts Annual sampling and analysis of representative source reject material from the CHPP to assess for spontaneous combustion potential, as per Section 3.2.5 of the MOP.

Operational checks and controls to be implemented to ensure compliance with this methodology would include:

- water quality monitoring;

- survey and mine planning controls (to identify where reject material has to be placed and to confirm appropriate placement of rejects material);
- annual geochemical and spontaneous combustion test work; and
- sampling and testing of cover material.

8 REPORTING AND REVIEW

8.1 Regular Reporting

TCM will provide regular reporting on the environmental performance of the mine, CCC reports and Annual Reviews on Whitehaven's website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of PA 11_0047.

8.2 Audit and Management Plan Review

In accordance with the requirements of Schedule 5 Condition 5 of PA 11_0047, this document will be reviewed within three months of the submission of an:

- Annual Review;
- Incident Report (see Section 8.3);
- Independent Environmental Audit under Schedule 5 Condition 10 of PA 11_0047;
- any modification to the MOP; or
- any modification to PA 11_0047.

TCM will investigate and implement ways to improve the environmental performance of the project over time. This will be achieved by keeping abreast of best practice in the industry for water management and monitoring options and reporting on the performance of the TCM water management system in the Annual Review.

8.3 Incident Reporting

In accordance with the requirements of Schedule 5 Condition 8 of PA 11_0047, TCM will notify, at the earliest opportunity, the Secretary and any other relevant agencies of any incident that has caused, or threatens to cause, material harm to the environment.

For any other incident associated with the project, TCM shall notify the Secretary and any other relevant agencies as soon as practicable after TCM becomes aware of the incident.

Within 7 days of the date of the incident, TCM shall provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

Where any exceedance of a trigger value in Section 3.7 or Section 5.5 occurs, TCM will also submit a report to DPE in accordance with the requirements of Schedule 5 Condition 2 of PA 11_0047.

The outcomes of any Unforeseen Impacts Protocol (Section 6.3) will be reported in the Annual Review. The implementation of any mitigation measures will be undertaken in consultation with relevant agencies and will be reported in the Annual Review.

9 REFERENCES

Allan Watson Associates (2011), 'Concept Design for Low Permeability Barrier and Permanent Goonbri Creek Alignment'.

ANZECC (2000), 'Australia and New Zealand Guidelines for Fresh and Marine Water Quality', Vol 1, October 2000

Boughton, W.C. (1999), '*A Daily Rainfall Generating Model for Water Yield and Flood Studies',* CRC for Catchment Hydrology, Report 99/9, June.

Boughton, W.C. (2004), 'The Australian Water Balance Model. Environmental Modelling & Software', Vol. 19, pp 943-956.

Bureau of Meteorology. (2015). Climate Statistics – Boggabri.

Ecological Australia (2015), *'Tarrawonga Mine Biodiversity Management Plan'*, Prepared for Whitehaven Coal Limited

Environment Protection Authority of New South Wales. (2011). '*Environment Protection License 12365'*.

Environment Protection Authority of New South Wales. (2022). '*Approved methods for the sampling and analysis of water pollutants in NSW*'.

Environment Protection Authority of New South Wales (2007), '*EPA Guidelines. Bunding and Spill Management*', EPA 080/07 Updated June 2007

Gilbert & Associates Pty Ltd. (2011). 'Surface Water Assessment. Tarrawonga Coal Project'.

Heritage Computing Pty Ltd (2011), '*A Hydrogeological Assessment in Support of the Tarrawonga Coal Project Environmental Assessment*', Report HC2011/11 prepared for Tarrawonga Coal Pty Ltd. October 2011.

Heritage Computing Pty Ltd (2012), '*Cumulative Groundwater Management Protocol for Boggabri Coal Mine, Tarrawonga Coal Mine and Maules Creek Coal Project'*, Report HC2011/15 prepared for Boggabri Coal Pty Ltd, Tarrawonga Coal Pty Ltd and Aston Resources Ltd. September 2012.

AGE on behalf of Idemitsu Australia Resources and Whitehaven Coal Pty Ltd (2021) '*BTM Complex Water Management Strategy*', Version 3.02, 2021.

Landcom (2004), and Department of Environment and Climate Change (DECCW) (2008), '*Managing Urban Stormwater: Soils and Construction (the Blue Book)'*, Volume 1 and Volume 2E – Mines and Quarries;

Lloyd Consulting (2011), '*Land Contamination Assessment*', for the Tarrawonga Coal Project.

Mackenzie Soil Management Pty Ltd (2011), 'Soil Survey and Land Resource Assessment – Tarrawonga Coal Project Boggabri NSW'.

McNeilage (2006), '*Upper Namoi Groundwater Flow Model: Model Development and Calibration*', NSW Department of Natural Resources, draft report.

NEPC (1999), 'National Environment Protection (Assessment of Site Contamination) Measure', NEPC, Adelaide.

Parsons Brinckerhoff (2014), '*BTM Complex Water Management Strategy*', prepared on behalf of Whitehaven Coal and Idemitsu Australia Resources.

RCA Australia (2005), '*Groundwater Assessment for the Proposed East Boggabri Coal Mine*', Prepared on behalf of the East Boggabri Joint Venture.

Resources Strategies (2012), '*Tarrawonga Coal Project – Environmental Assessment*', dated January 2012

R.W. Corkery & Co. (2006), '*Site Water Management Plan for the Tarrawonga Coal Mine*', Report prepared by R.W. Corkery & Co. Pty. Limited

URS (2013), '*Tarrawonga Coal Mine Water Management Plan*', prepared on behalf of Whitehaven Coal.

Whitehaven Coal Limited (2013), '2012-2013 Annual Environmental Management Report for the Tarrawonga Coal Mine'.

Whitehaven Coal Limited (2014), '2013-2014 Annual Environmental Management Report for the Tarrawonga Coal Mine'.

Whitehaven Coal Limited (2016), '2016 Annual Review for the Tarrawonga Coal Mine'.

Whitehaven Coal Limited (2016) 'Pollution Incident Response Management Plan'.

Whitehaven Coal Limited (2017), '2017 Annual Review for the Tarrawonga Coal Mine'.

Whitehaven Coal Limited (2018), '*Mining Operations Plan – Tarrawonga Coal Mine*', Amendment C, 1 November 2015 to November 2020.

WRM Water & Environment (2022), '*Site Water Balance, Tarrawonga Coal Mine*', prepared on behalf of Whitehaven Coal.

WRM Water & Environment (2021a), '*Flood Assessment, Tarrawonga Coal Mine*', prepared on behalf of Whitehaven Coal.

APPENDIX A –DAM TRIGGER VOLUMES, SURFACE AREAS AND LEVELS

Table A1 Current (Year 2022) TCM Sediment Dam Trigger Volumes, Surface Areas and Levels

Dam System	Dam Name	Catchment area (ha)	Total Storage Trigger			Operating Trigger	
			Volume (ML)	Level (spillway) (mAHD)	Surface Area (m^2)	Volume (ML)	Water Level (mAHD)
LDP1	SB25	53.3	35.0	287.0	22,480	16.7	285.9
	SB6	5.4	1.0	281.0	1,222	0.9	280.9
	SD17	2.3	9.7	273.9	4,239	0.6	272.1
	Sump	0.7	3.5	279.0	4,326	1.4	278.0
	SB7	33.5	2.7	280.7	6,138	1.3	280.1
	SD1	2.3	7.6	282.6	3,198	1.0	279.6
	SD2	1.0	29.4	282.6	4,650	10.0	280.5
	SB5B	20.9	3.1	281.5	2,184	0.6	279.8
	SB5A	16.4	7.8	288.0	3,504	1.6	286.0
LDP2	SD9	38.7	52.0	273.0	24,950	40.0	272.0
	SB16A	126.4	36.4	283.4	6,641	34.6	283.2
	SB16B		96.9	283.6	11,020	92.1	283.3
	SD8	7.6	3.5	276.5	2,200	1.0	274.7
LDP3	SD27	1.9	2	272.0	1,490	0.2	271.0
	SD28	5.2	1.8	270.6	1,640	0.1	269.6
LDP26	SB23A	30.3	2.5	270.3	1,200	1.0	269.0
	SB23B		10.9	269.3	3,514	3.0	266.9
LDP27	SB24B	3.3	4.8	275.3	1,937	1.0	263.0
	SB26	10.5	35.5	276.4	14,669	16.0	274.1
	SD26	46.6	15.0	277.8	8,900	3.7	276.9

Table A2 Current (Year 2022) TCM Mine Water Dam Trigger Volumes, Surface Areas and Levels

Dam Name	Catchment area (ha)	Total Storage Trigger			95% Operating Trigger*		80% Operating Trigger	
		Volume (ML)	Level (spillway) (mAHD)	Surface Area (m^2)	Volume (ML)	Water Level (mAHD)	Volume (ML)	Water Level (mAHD)
SB24A	0.3	10.7	279.0	7,970	10.2	278.8	8.6	278.6
PW3	0.9	26.5	287.7	7,430	25.2	287.5	21.2	286.8
PW5	0.4	0.5	337.7	5,080	0.4	336.8	0.4	336.2
PW6	4.9	280	301.0	2,101	265	300.2	225	298.2
SB4	15.9	13.6	302.5	5,150	1.2	300.7	-	-

* Operational triggers are 95% of the total storage triggers except for SB4. SB4 operational triggers are 20% of the total storage triggers as it receives catchment runoff from the ROM Pad.

APPENDIX B – INDIVIDUAL DAM SYSTEM WATER BALANCE RESULTS

The modelled LDP and mine water storage volumes over the 2-year forecast period (Year 2022 to Year 2023) are provided below in Figures B1 to B7. These figures also show the Total Storage Volume and Operational Volume for each LDP and mine water system.

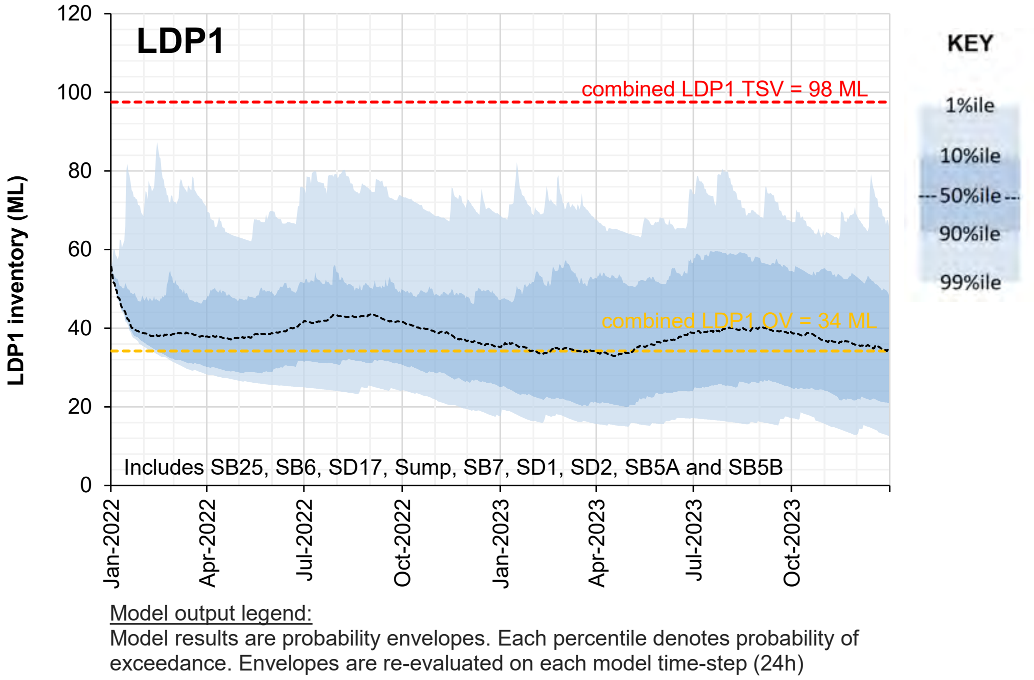


Figure B1 Forecast LDP1 Catchment Stored Inventory Results

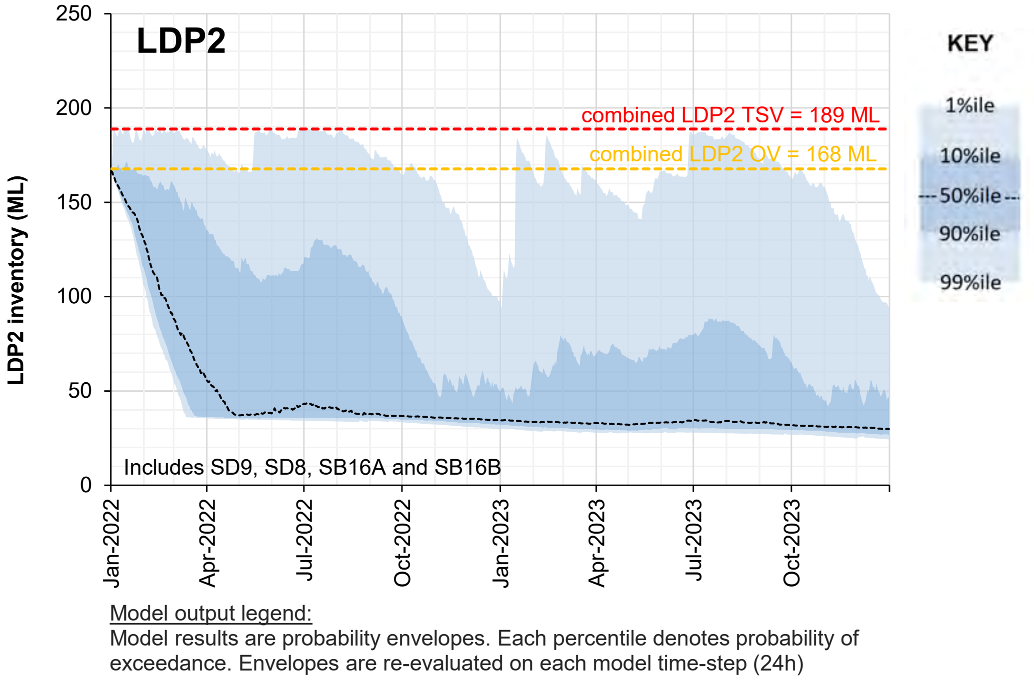


Figure B2 Forecast LDP2 Catchment Stored Inventory Results

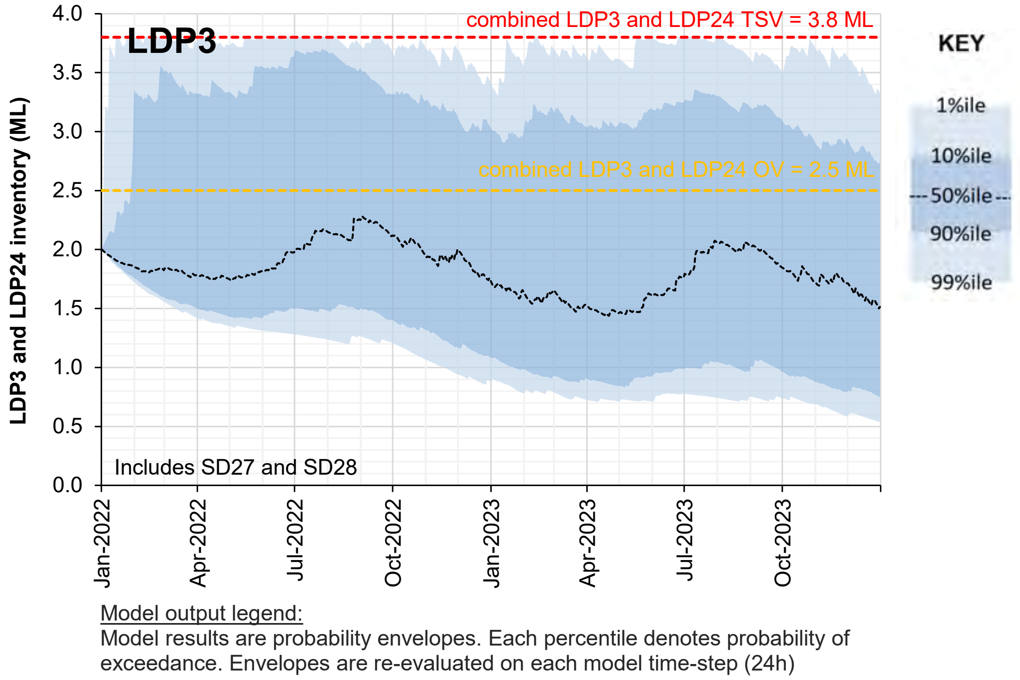


Figure B3 Forecast LDP3 Catchment Stored Inventory Results

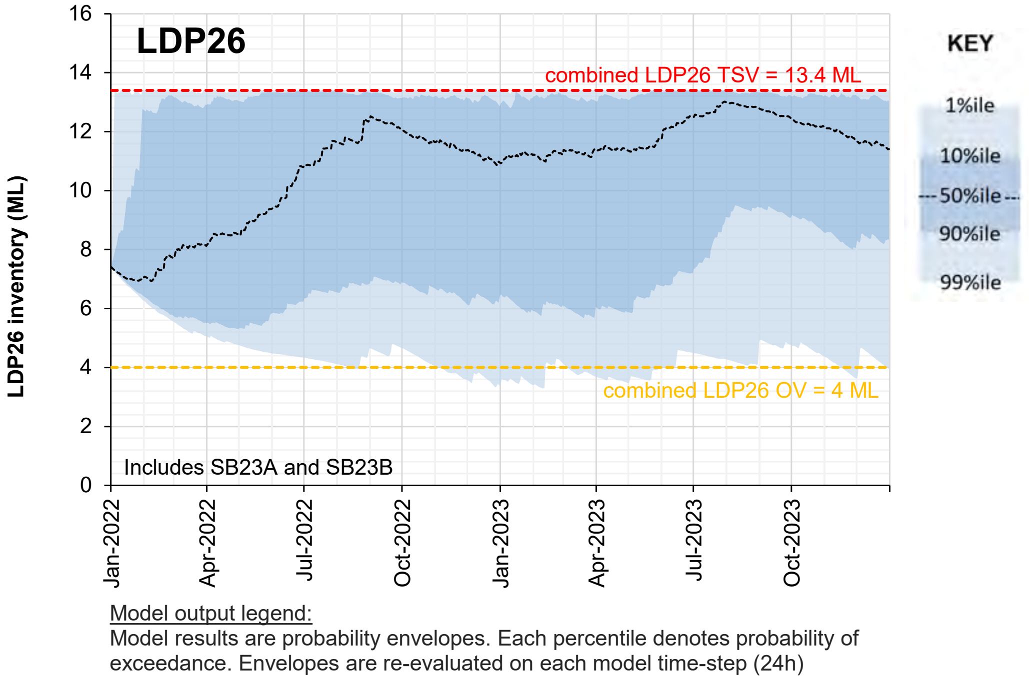


Figure B4 Forecast LDP26 Catchment Stored Inventory Results

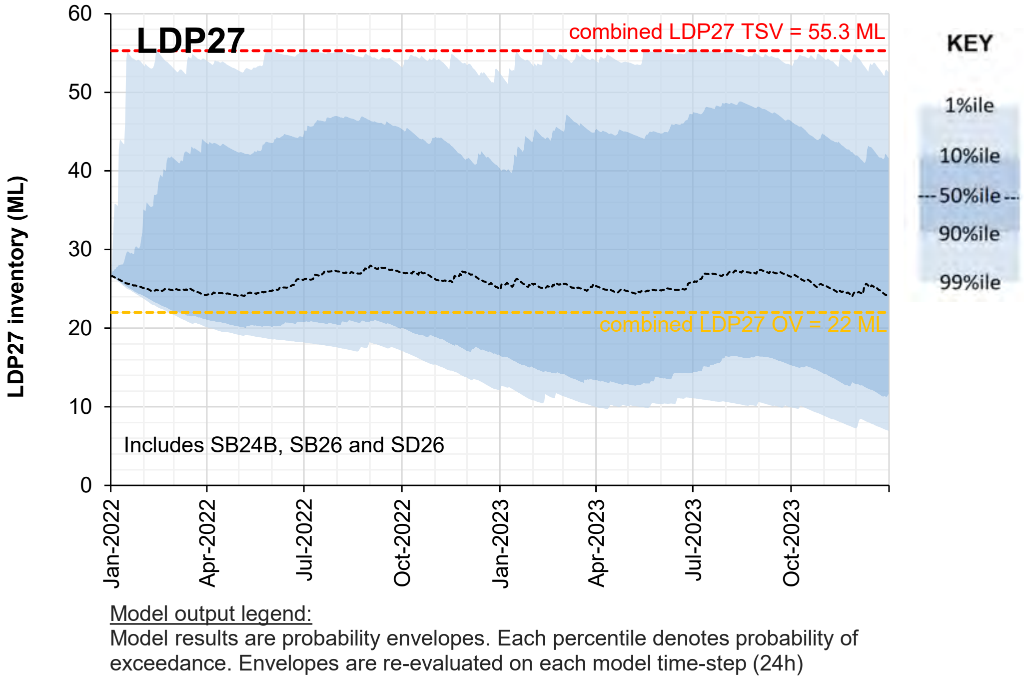


Figure B5 Forecast LDP27 Catchment Stored Inventory Results

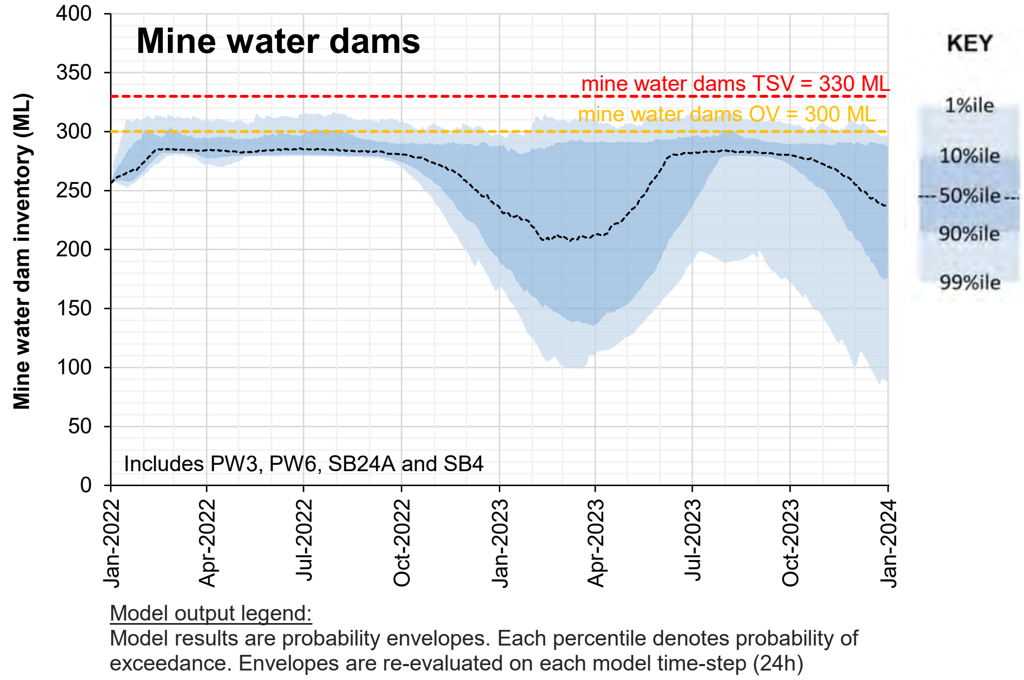
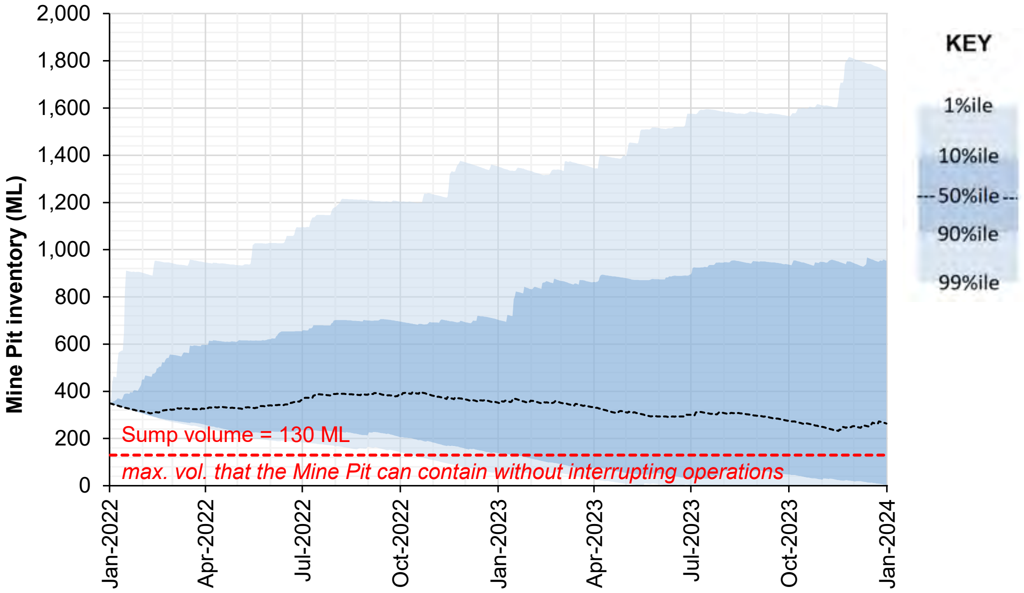


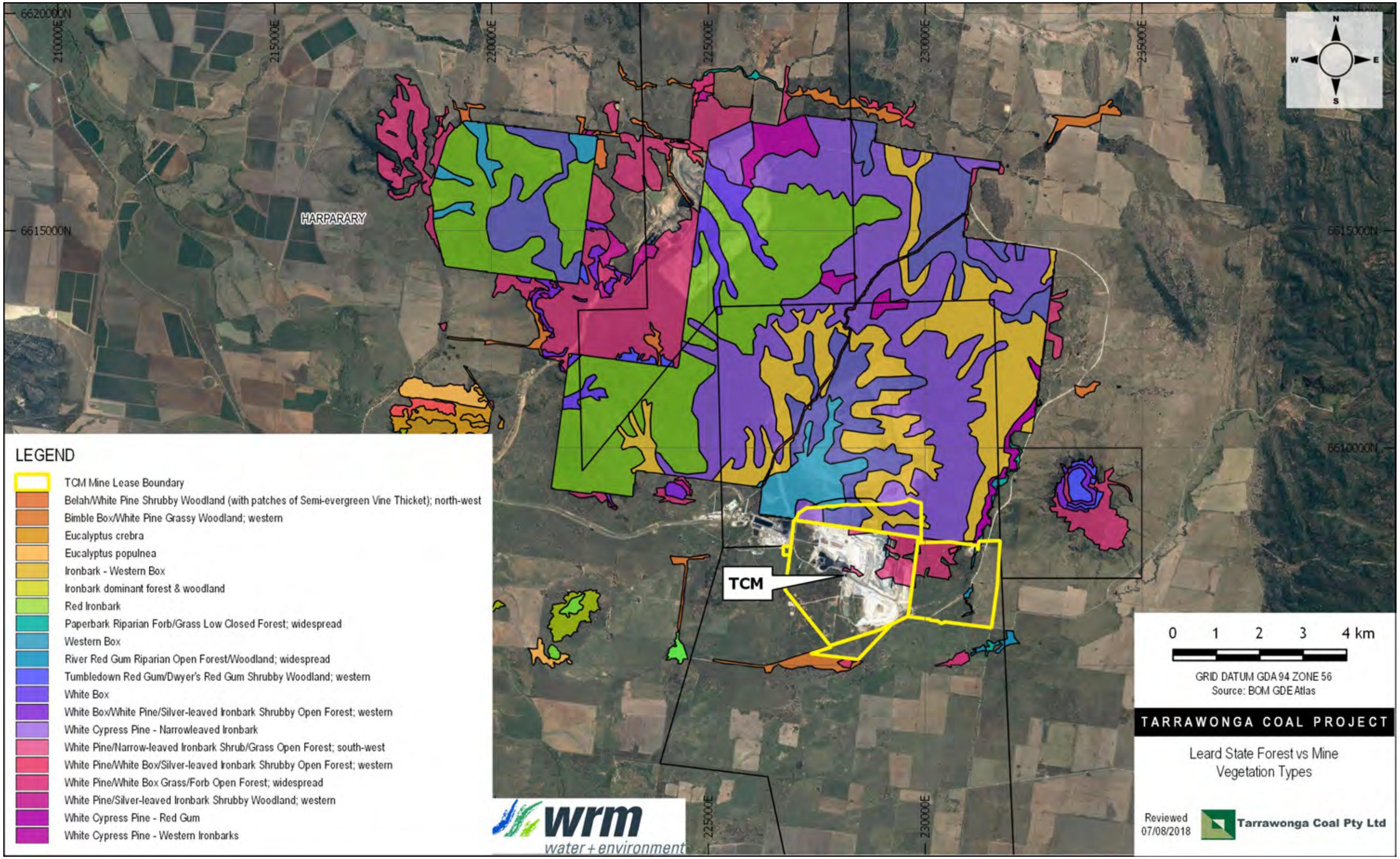
Figure B6 Forecast Mine Water Inventory Results (Excluding the Mine Pit)



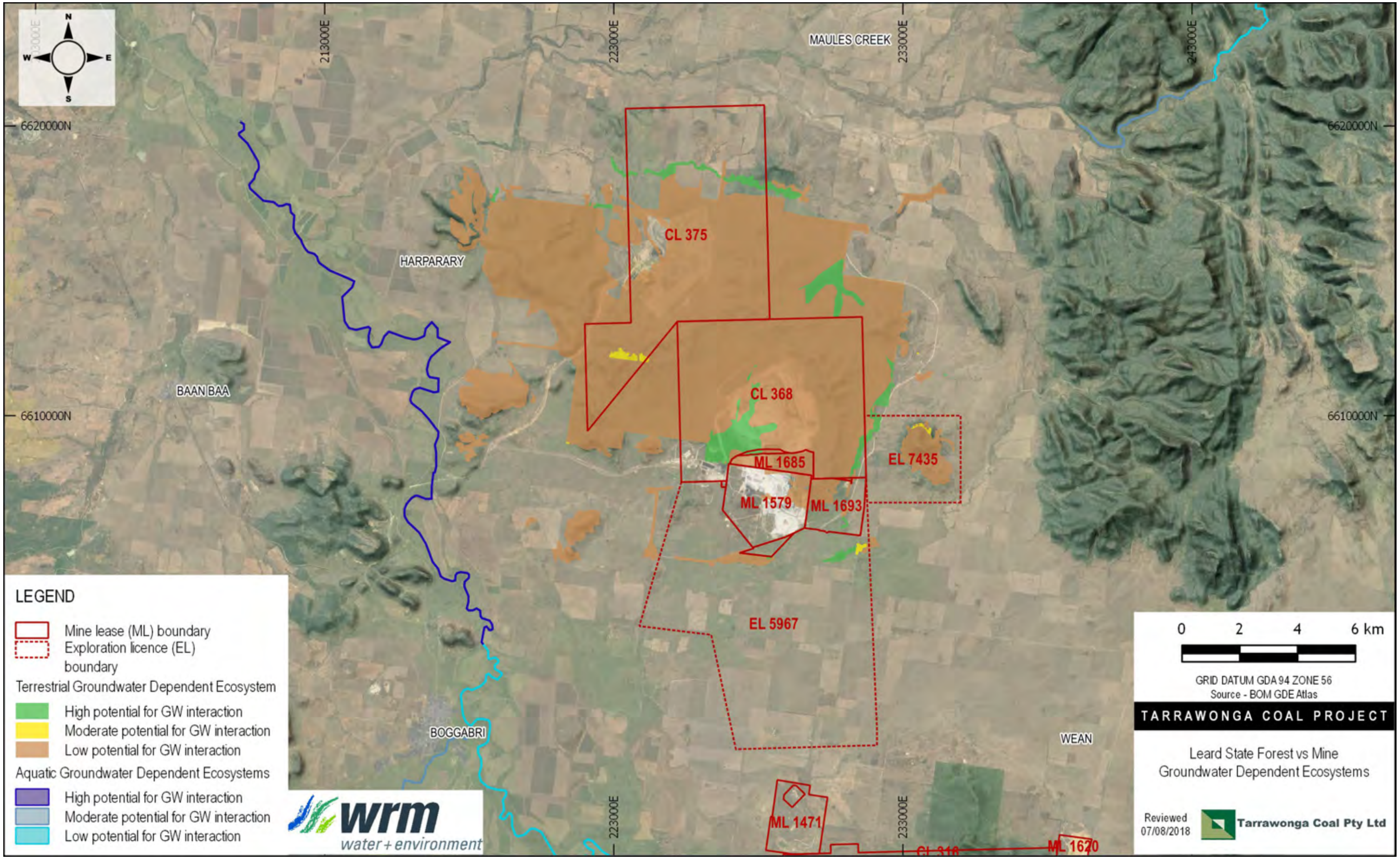
Model output legend:
Model results are probability envelopes. Each percentile denotes probability of exceedance. Envelopes are re-evaluated on each model time-step (24h)

Figure B7 Forecast Mine Pit Water Inventory Results

APPENDIX C – GROUNDWATER DEPENDANT ECOSYSTEM DETAILS



LEGEND
TCM Mine Lease Boundary
Belah/White Pine Shrubby Woodland (with patches of Semi-evergreen Vine Thicket); north-west
Bimble Box/White Pine Grassy Woodland; western
Eucalyptus crebra
Eucalyptus populnea
Ironbark - Western Box
Ironbark dominant forest & woodland
Red Ironbark
Paperbark Riparian Forb/Grass Low Closed Forest; widespread
Western Box
River Red Gum Riparian Open Forest/Woodland; widespread
Tumbledown Red Gum/Dwyer's Red Gum Shrubby Woodland; western
White Box
White Box/White Pine/Silver-leaved Ironbark Shrubby Open Forest; western
White Cypress Pine - Narrowleaved Ironbark
White Pine/Narrow-leaved Ironbark Shrub/Grass Open Forest; south-west
White Pine/White Box/Silver-leaved Ironbark Shrubby Open Forest; western
White Pine/White Box Grass/Forb Open Forest; widespread
White Pine/Silver-leaved Ironbark Shrubby Woodland; western
White Cypress Pine - Red Gum
White Cypress Pine - Western Ironbarks
HARPARARY
TCM
6620000N
6615000N
6610000N
210000E
215000E
220000E
225000E
230000E
235000E
0 1 2 3 4 km
GRID DATUM GDA94 ZONE 56
Source: BOM GDE Atlas
TARRAWONGA COAL PROJECT
Leard State Forest vs Mine Vegetation Types
Reviewed 07/08/2018
Tarrawonga Coal Pty Ltd
wrm water + environment



MAULES CREEK
HARPARARY
BAAN BAA
BOGGABRI
WEAN
CL 375
CL 368
ML 1685
ML 1579
ML 1693
EL 7435
EL 5967
ML 1471
ML 1620
6620000N
6610000N
213000E
223000E
233000E
243000E
LEGEND
Mine lease (ML) boundary
Exploration licence (EL) boundary
Terrestrial Groundwater Dependent Ecosystem
High potential for GW interaction
Moderate potential for GW interaction
Low potential for GW interaction
Aquatic Groundwater Dependent Ecosystems
High potential for GW interaction
Moderate potential for GW interaction
Low potential for GW interaction
wrm water + environment
0 2 4 6 km
GRID DATUM GDA 94 ZONE 56
Source - BOM GDE Atlas
TARRAWONGA COAL PROJECT
Leard State Forest vs Mine Groundwater Dependent Ecosystems
Reviewed 07/08/2018
Tarrawonga Coal Pty Ltd

APPENDIX D – LETTER OF ENDORSEMENT

NSW GOVERNMENT | Planning & Environment

Planning Services
Resource Assessments
Contact: Stephen Shoesmith
Phone: 9274 6164
Email: Stephen.shoesmith@planning.nsw.gov.au

Mr Sebastien Moreno
Environmental Superintendent
Whitehaven Coal Ltd
PO Box 600
GUNNEDAH NSW 2380

Dear Mr Moreno

Tarrawonga Coal Mine (MP 11_0047)
Appointment of Water Experts

I refer to your letter dated 4 June 2018 seeking the Secretary's approval for WRM Water & Environment (WRM) to review and revise the Water Management Plan for the Tarrawonga Coal Mine.

The Department has reviewed the curricula vitae of Mr Julian Orth and Mr Greg Roads of WRM and considers that they are suitably qualified and experienced to undertake the work.

Accordingly, the Secretary approves the appointment Mr Orth and Mr Roads of WRM to update the Water Management Plan.

Should you have any enquiries in relation to the above, please contact Stephen Shoesmith on 9274 6164.

Yours sincerely

5/6/18.

Mike Young
Director
Resource and Energy Assessments
as nominee of the Secretary

Department of Planning and Environment
320 Pitt Street Sydney 2000 | GPO Box 39 Sydney 2001 | planning.nsw.gov.au

APPENDIX E – CURRENT BOGGABRI-TARRAWONGA-MAULES CREEK COMPLEX (BTM COMPLEX) WATER MANAGEMENT STRATEGY

BOGGABRI - TARRAWONGA - MAULES CREEK COMPLEX

WATER MANAGEMENT STRATEGY

MAY 2019

Project No. WHC-13-15

Document No. 00972624-004

DOCUMENT CONTROL				
Version	Date	Prepared by	Reviewed by	Approved by
A	29 September 2012	C. Callipari & V. O'Keefe	L. Doeleman	J. Green
B	6 March 2013	R. Rollins & N. Harcombe	S. Trott, B. Bird	J. Green, D. Martin, D. Young
C	10 December 2014	N. Harcombe, R.Rollins & V. O'Keefe	S. Crick	
D	9 August 2017	A. Blakeney & J. McDonough	D. Martin & H. Russell	P. Forbes, L. Johnson, S. Mitchell
E	20 June 2018	BTM	BTM	BTM
F	9 May 2019	Resource Strategies	BTM	BTM

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Company	Position
BCOPL	Environment Superintendent
Whitehaven Coal (Tarrawonga) Whitehaven Coal (Maules Creek)	Environmental Superintendent Environmental Superintendent
Department of Planning and Environment	Senior Project Officer
Contractors	Project Manager

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Appendix A	Site-specific Contribution to Cumulative Groundwater Drawdown (from AGE [2018])

1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The purpose of the cumulative Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex)[1] Water Management Strategy is to document the approach that will be taken by mines within the BTM Complex to monitor and collectively manage the cumulative surface water and groundwater impacts of their operations. The Water Management Strategy details the relevant water resources, the potential cumulative impacts on those water resources, and the cumulative water management protocols within the BTM Complex.

The BTM Complex is an existing mining precinct located within and around the Leard State Forest, approximately 15 kilometres (km) north-east of Boggabri in the Narrabri Local Government Area (LGA) (Figure 1.1). The BTM Complex includes the Tarrawonga Coal Mine (TCM) in the south, the Boggabri Coal Mine (BCM) to the north and the Maules Creek Coal Mine (MCCM) to the north-west. The extent of the relevant tenements for each of the mines that comprise the BTM Complex are presented in Figure 1.1.

BCM is managed by Boggabri Coal Operations Pty Limited (BCOPL), a wholly owned subsidiary of Idemitsu Australia Resources Pty Limited (IAR).

MCCM is managed by Maules Creek Coal Pty Ltd, a wholly owned subsidiary of Whitehaven Coal Mining Limited (Whitehaven).

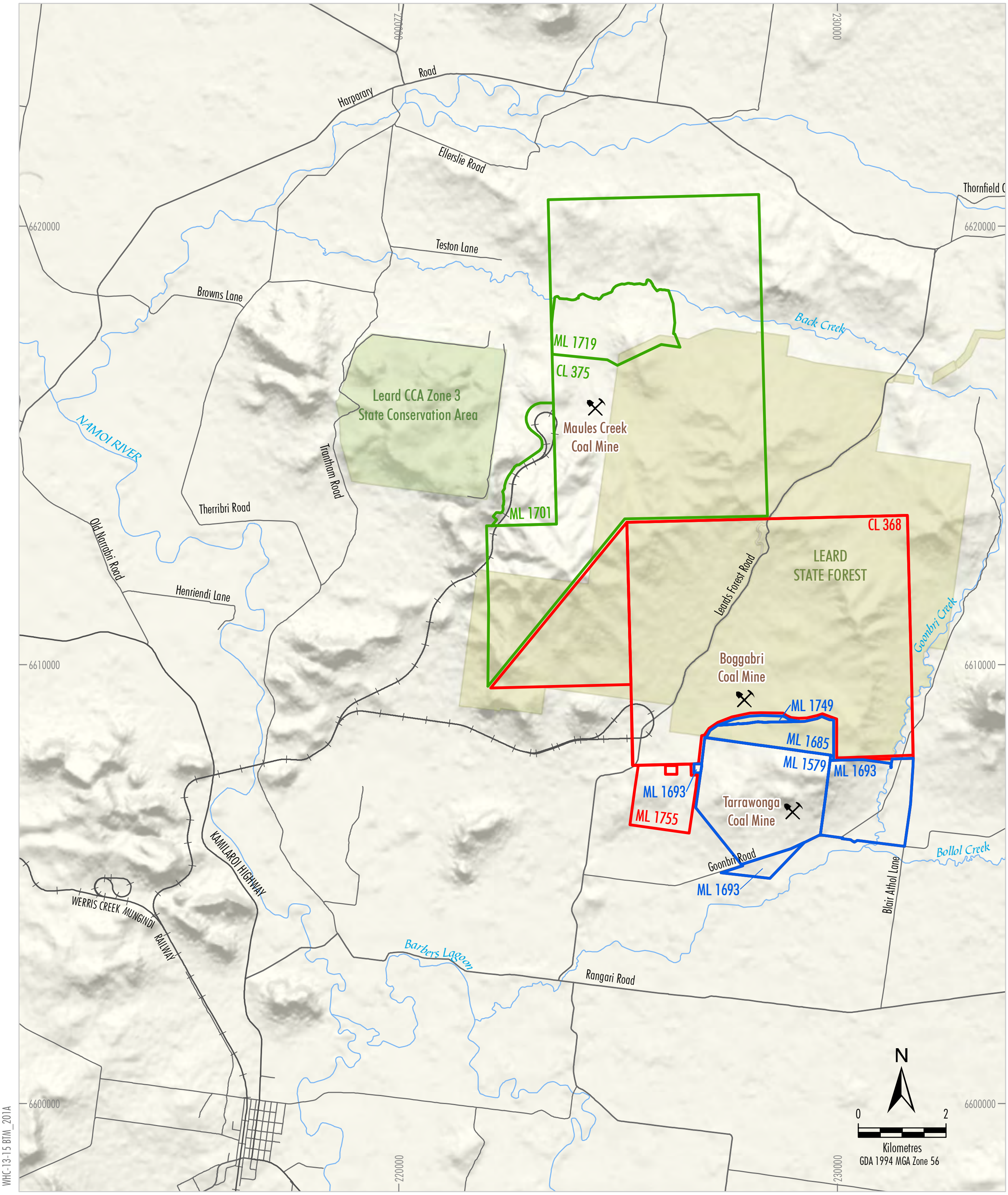
TCM is managed by Tarrawonga Coal Pty Ltd, a wholly owned subsidiary of Whitehaven.

A summary of the ownership details for each mine within the BTM Complex is provided below in Table 1.1.

Table 1.1
Management and ownership of BTM Complex Mines

Mine	Management	Ownership	Share
Boggabri Coal Mine	Boggabri Coal Operations Pty Limited	Idemitsu Australia Resources Pty Ltd	80%
		Chugoku Electric Power Australia Resources Pty Ltd	10%
		NS Boggabri Pty Ltd	10%
Maules Creek Coal Mine	Maules Creek Coal Pty Ltd	Aston Coal 2 Pty Limited (owned 100% by Whitehaven Coal Limited)	75%
		Itochu Coal Resources Australia Maules Creek Pty Ltd (ICRA MC)	15%
		J-Power Australia (J-Power) Pty Ltd	10%
Tarrawonga Coal Mine	Tarrawonga Coal Pty Ltd	Whitehaven Coal Mining Limited	100%

[1] In previous environmental assessments and approval documents this group of mines has been referred to as the Leard Forest Mining Precinct. For the purposes of the Water Management Strategy and all other relevant cumulative impact management documents, all references to the 'Leard Forest Mining Precinct' have been replaced with the term 'BTM Complex'.



LEGEND

- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine
- NSW National Parks and Wildlife Services (NPWS) Estate
- State Forest
- Railway

Source: Whitehaven Coal Limited (2016); NSW Department of Land and Property Information (2016); NSW Department of Industry (2016); Office of Environment and Heritage NSW (2016)

BTM WATER MANAGEMENT STRATEGY

Regional Location

Figure 1.1

Development applications for the continued operation of the BCM (Project Approval 09_0182) and the development of the MCCM (Project Approval 10_0138) were determined by the NSW Planning Assessment Commission (PAC) in July and October 2012 respectively, under delegation by the NSW Minister for Planning and Infrastructure. Subsequent to this, the Department of the Environment and Energy (DoEE) (formerly the Commonwealth Department of Environment [DoE]), granted conditional approval for both the BCM (EPBC 2009/5256) and the MCCM (EPBC 2010/5566) on 11 February 2013. These projects were granted approval subject to stringent conditions related to the management of cumulative impacts.

The TCM application for continuation of mining was approved on 22 January 2013, with similar cumulative impact management conditions to those detailed in the BCM and MCCM approvals.

Approval conditions require the preparation of a suite of environmental strategies developed in partnership by all three mines of the BTM Complex. This Water Management Strategy has been developed to satisfy each mine's project approval conditions. Approval conditions relevant to the management of cumulative water impacts within the BTM Complex are detailed in Table 1.2.

Table 1.2
Approval requirements for a Water Management Strategy

BCM PA 09_0182	MCCM PA 10_0138	TCM PA 11_0047	Details	Section
Sch. 3 Cond. 38 (d)	Sch. 3 Cond. 40 (d)	Sch. 3 Cond. 39 (c)(iv)	*The Proponent shall prepare and implement a Water Management Plan for the project… this plan must include:* *"… a Leard Forest Mining Precinct Water Management Strategy that has been prepared in consultation with other mines within the Precinct to:*	
			▪ *minimise the cumulative water quality impacts of the mines;*	Section 1.1
			▪ *review opportunities for water sharing/water transfers between mines;*	Sections 1.1, 3 and 4.3
			▪ *co-ordinate water quality monitoring programs as far as practicable;*	Sections 1.1 and 6.2
			▪ *undertake joint investigations/studies in relation to complaints/exceedances of trigger levels where cumulative impacts are considered likely; and*	Sections 1.1 and 8
			▪ *co-ordinate modelling programs for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans.* *Note: The Leard Forest Mining Precinct Water Management Strategy can be developed in stages and will need to be subject to ongoing review dependent upon the determination of and commencement of other mining projects in the area."*	Section 4

1.2 SCOPE

This document is the overarching strategy for cumulative surface water and groundwater management at the BTM Complex.

Individual mines manage their ongoing operations and associated surface water and groundwater management in accordance with their site-specific Water Management Plans (WMPs). Statutory requirements relating to water quality are considered in each site-specific WMP. Table 1.3 outlines the status of the site-specific WMPs for the BTM Complex at the time of writing this document.

Table 1.3
Status of Site-Specific Water Management Plans

Mine	Site-specific WMP Status
BCM	Last published May 2017. Available on the Idemitsu website (https://www.idemitsu.com.au/mining/operations/boggabri-coal/approvals-plans-reports/)
MCCM	Last published March 2019. Available on the Whitehaven website (http://www.whitehavencoal.com.au/sustainability/environmental-management/maules-creek-mine/)
TCM	No approved WMP. A draft WMP was submitted to DoI -Water (then DPI – Water) in August 2018 for review and TCPL is currently addressing comments from DoI – Water at the time of writing this document.

DoI - Water – NSW Department of Industry – Water.

DPI - Water – NSW Department of Primary Industries – Water.

1.3 SUMMARY OF PREVIOUS STUDIES

Previous environmental studies carried out for individual BTM Complex projects have been used in preparation of this document. A summary of these studies is presented in Table 1.4. These studies are publically available on the respective company websites and on the Major Projects database.

Given the location of the BTM Complex within the Namoi Catchment, reference is also made to findings of the Namoi Catchment Water Study (Schlumberger, 2012), commissioned by the NSW Government in August 2010. The study involved a strategic assessment of the likelihood of potential impacts from coal and gas development in the Namoi Catchment on the quantity and quality of surface and groundwater resources.

Table 1.4
Summary of Previous Water Impact Assessment Studies

Surface Water	Groundwater
Boggabri Coal Mine	
Parsons Brinckerhoff, *Continuation of Boggabri Coal Mine Project – Surface Water Assessment*, prepared for Hansen Bailey as part of the Environmental Assessment, October 2010*	Australasian Groundwater & Environmental Consultants Pty Ltd (AGE), *Continuation of Boggabri Coal Mine Groundwater Assessment*, prepared for Boggabri Coal Pty Ltd, October 2010
WRM, *Continuation of Boggabri Coal Mine- Namoi River Flood Impact Assessment*, prepared for Hansen Bailey, December 2009	Parsons Brinckerhoff, Boggabri Coal Mine - *Project Approval Modification Environmental Assessment (MOD 5)*, November 2015
Tarrawonga Coal Mine	
Gilbert and Associates Pty Ltd, *Tarrawonga Coal Project-Surface Water Assessment*, prepared for Whitehaven Coal Pty Ltd, March 2010	Heritage Computing Pty Ltd, *A Hydrogeological Assessment in Support of the Tarrawonga Coal Project Environmental Assessment,* prepared for Tarrawonga Coal Pty Ltd, January 2012*
Gilbert and Associates Pty Ltd, *Tarrawonga Coal Project-Surface Water Assessment*, prepared for Whitehaven Coal Pty Ltd, November 2011	GeoTerra Pty Ltd, *Surface Water and Groundwater 2006/2009 Monitoring Tri-annual Review,* prepared for Tarrawonga Coal Pty Ltd, November 2009
GeoTerra Pty Ltd, *Surface Water and Groundwater 2006/2009 Monitoring Tri-annual Review*, prepared for Tarrawonga Coal Pty Ltd, November 2009	
Maules Creek Coal Mine	
WRM, *Surface Water Impact Assessment for Maules Creek Coal Project*, prepared for Aston Resources, 9 February 2011	Australasian Groundwater & Environmental Consultants Pty Ltd (AGE), *Maules Creek Coal Project Groundwater Impact Assessment,* prepared for Aston Resources Ltd, June 2011*

Table 1.4 (Continued)
Summary of Previous Water Impact Assessment Studies

Surface Water	Groundwater
NSW Planning Assessment Commission, *Review Report- Maules Creek Coal Project,* March 2012	Heritage Computing Pty Ltd, *Peer Review of the Maules Creek Coal Project Groundwater Impact Assessment,* prepared for Aston Resources Ltd, February 2011
NSW Planning and Environment, *Director General's Environmental Assessment Report- Major Project Assessment Maules Creek Coal Project,* August 2012	NSW Planning Assessment Commission, *Review Report- Maules Creek Coal Project*, March 2012
	NSW Planning and Environment, *Director General's Environmental Assessment Report- Major Project Assessment Maules Creek Coal Project*, August 2012
	AGE Pty Ltd, *Installation of Monitoring Bore Network & Updating Groundwater Model*, 2014
BTM Complex	
	AGE, *Boggabri; Tarrawonga Maules Creek Complex Numerical Model Update*, August 2018*

* Study details the potentially cumulative impacts of the BTM Complex.

1.4 AGENCY CONSULTATION

The Water Management Strategy draws upon the site-specific WMPs and site water balance reports for the three mines. These documents have undergone extensive review by DP&E on numerous occasions and subsequent approval.

The site-specific mine WMPs which form the basis of the Water Management Strategy have been prepared in consultation with representatives from the NSW Office of Environment and Heritage (OEH), DoI – Water and North West Local Land Services (NWLLS) (formerly Namoi Catchment Management Authority).

The draft version of the Water Management Strategy has been reviewed by DP&E and comments have been addressed. A draft version of this BTM Complex Water Management Strategy has also been provided to DoI – Water, and a final draft version will also be provided to DoI – Water.

1.5 DOCUMENT STRUCTURE

The structure of this report is as follows:

Section 1 Provides an introduction to the Water Management Strategy, including the background and scope of the Water Management Strategy. A list of previous studies is also included.

Section 2 Provides an overview of the BTM Complex mines (BCM, TCM, MCCM).

Section 3 Briefly outlines the existing surface water and groundwater resources of the area and the administrative context of their management.

Section 4 Summarises the existing site-specific surface water and groundwater models for each mine, and cumulative modelling for the BTM Complex.

Section 5 Describes potential cumulative impacts and issues associated with the BTM Complex.

Section 6 Describes surface water and groundwater monitoring networks relevant to the BTM Complex.

Section 7	Describes surface water and groundwater impact mitigation and response to triggers.
Section 8	Describes how the Water Management Strategy will be implemented and the complaint management strategy.
Section 9	Outlines the requirements for reviewing and revising the Water Management Strategy.
Section 10	Lists the references used in this document.

2. THE BTM COMPLEX

The BTM Complex is located in the Narrabri LGA in the Northwest Slopes and Plains of New South Wales. The BTM Complex is located within and adjoining the Leard State Forest, north-east of Boggabri and south of Maules Creek. The major regional centres of Narrabri and Gunnedah are located approximately 50 km north-west and 40 km south-east of the BTM Complex, respectively.

2.1 BOGGABRI COAL MINE

BCM is an existing open cut mine that consists of an open cut pit, overburden dump, infrastructure area including coal processing facilities, water management structures, and a rail spur.

BCM obtained NSW State Government approval on the 18 July 2012, and Commonwealth Government approval on 11 February 2013. These approvals (as modified) allow operations at BCM to extend for a further 21 years at a rate of 8.6 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. The project approval for BCM provides for operation of existing ancillary equipment; construction and operation of a new coal handling and preparation plant (CHPP); 17 km rail spur line; bridges over the Namoi River and Kamilaroi Highway; a rail load-out facility located at the mine; upgrade of the overburden and coal extraction haulage fleet (with an option for a drag-line); upgrade of electricity transmission lines; and establishment of a water supply borefield and other ancillary infrastructure.

2.2 TARRAWONGA COAL MINE

TCM is an existing open cut coal mine located immediately south of BCM. TCM initially had approval to extract 2 Mtpa of ROM coal until 2017. TCPL submitted an application in July 2011 under Part 3A of the Environment Planning and Assessment Act 1979 (EP&A Act) for an extension of open cut mining operations to 3 Mtpa of ROM coal for a further 17 years. This application was approved by the NSW State Government on 22 January 2013.

TCM have modified Project Approval 11_0047 on a number of occasions since then, with the most recent being in November 2018. Project Approval 11_0047 allow operations at TCM until 2030 at a rate of 3 Mtpa of ROM coal.

2.3 MAULES CREEK COAL MINE

A Project Application for the MCCM was submitted to the NSW Department of Planning (now Department of Planning and Environment) in August 2010 under Part 3A of the EP&A Act. Project approval was granted by the Planning Assessment Commission under delegation of the Minister for Planning and Infrastructure on 23 October 2012. The project approval allows for the construction and operation of an open cut coal mine, with the recovery of up to 13 million tonnes per annum (Mtpa) of ROM coal for a period of 21 years. Key features of the project include transportation of coal by rail to Newcastle, and development of site infrastructure including a CHPP and associated facilities, a train loading facility and rail spur and loop, a mine access road, communications and power reticulation, explosives storage, and a water pipeline from the Namoi River.

Construction of the MCCM commenced in December 2013. Extraction of first coal commenced in the fourth quarter of 2014.

3. WATER RESOURCES AND ADMINISTRATIVE CONTEXT

3.1 SURFACE WATER

3.1.1 Catchments and streams

The slopes and upland areas of the BTM Complex are drained by a series of ephemeral streams rising in the Willowtree Range. The local drainage catchments associated with the area are, from the north, Maules Creek, Back Creek, 'Nagero Creek', Goonbri Creek and Bollol Creek, as shown in Figure 3.1.

BCM is contained within the catchment of an unnamed ephemeral waterway, locally known as 'Nagero Creek'. Nagero Creek drains west towards the Namoi River.

MCCM is largely within the Back Creek catchment with small tributaries flowing north into Back Creek which itself then flows west to meet Maules Creek before flowing into the Namoi River.

TCM is within the catchments of Nagero, Goonbri and Bollol Creeks. These creeks and their unnamed tributaries drain in a westerly and south-westerly direction towards the Namoi River.

Further detail regarding each site-specific mine's surface water systems is provided in the BCM, MCCM and TCM surface water assessments (available on each respective company website).

3.1.2 Relevant surface water sharing plans

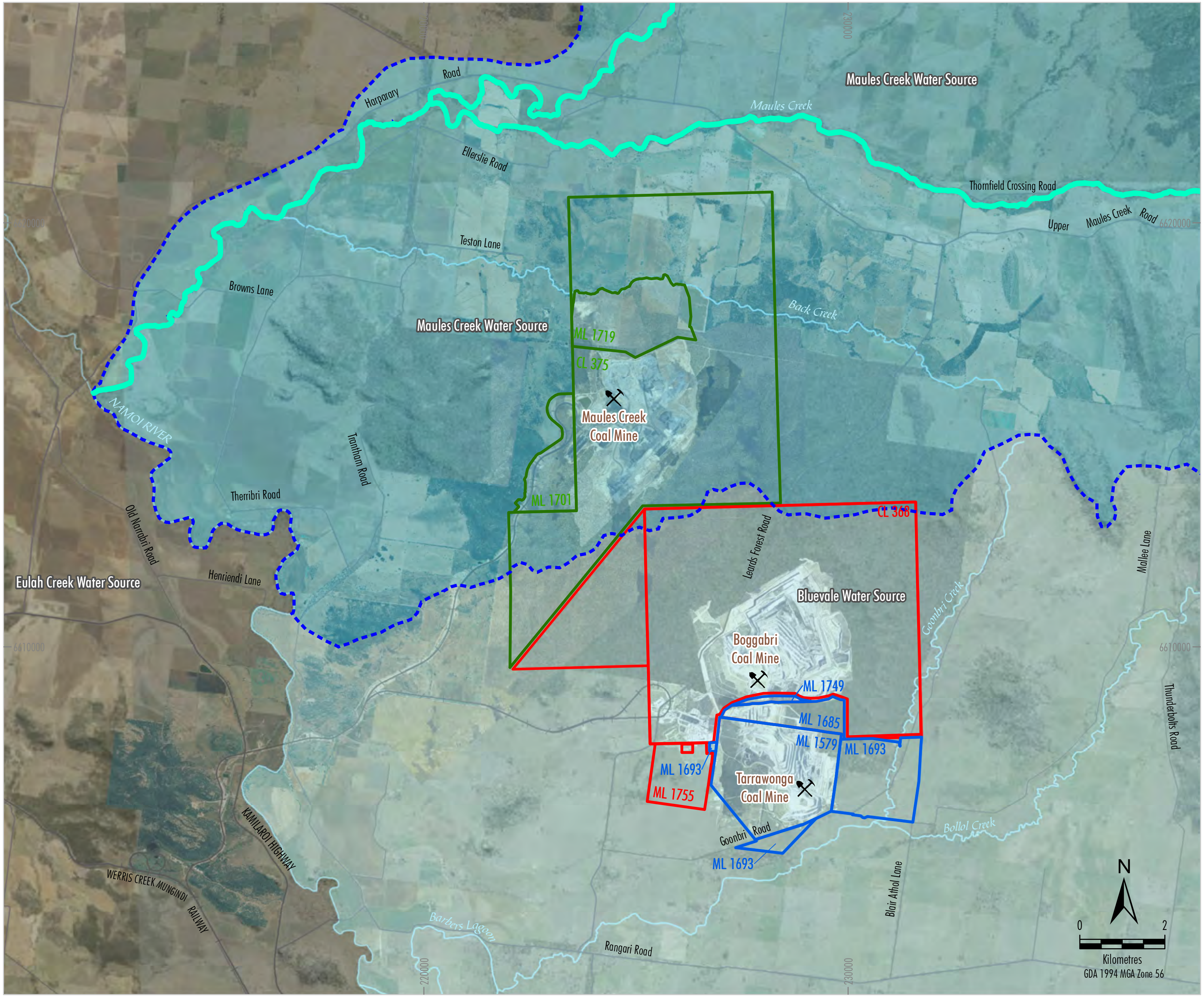
The BTM Complex lies within the Maules Creek Water Source, administered under the Water Sharing Plan (WSP) for the Namoi Unregulated and Alluvial Water Sources. The Maules Creek Water Source is divided into two management zones, the Maules and Horsearm Creeks Management Zone, and the Maules Creek Tributaries Management Zone (Figure 3.1). These local unregulated creeks flow into the Namoi River, which is administered under the WSP for the Upper and Lower Namoi Regulated River Water Sources. Water access licences (WALs) for both these water sources are fully allocated. Each mine site is responsible for holding or obtaining sufficient WALs prior to accessing surface water. WALs currently held by each mine site are listed in Section 3.3.

3.2 GROUNDWATER

3.2.1 Regional geology and hydrogeology

The BTM Complex is located in an area geologically characterised by the Permian Maules Creek Formation, with minor Quaternary alluvium to the south-east and Permian Boggabri Volcanics to the south-west (DMR, 1998). Minor alluvium is also associated with local creeks. Beyond the mining leases, extensive Quaternary alluvium deposits overlie the Boggabri Volcanic deposits to the west and south-west, and the Maules Creek Formation to the south. Coal is extracted from the seams of the Maules Creek Formation. Further south the alluvium directly overlies the Boggabri Volcanics (Figure 3.2).

The thickness of the highly productive Quaternary alluvial deposits along the Namoi River ranges from approximately 30 m to 120 m, decreasing from the thicker palaeochannel in the south-west to a thin cover in the east. The regional groundwater flow direction within this alluvium is generally to the north-northwest. Groundwater in the alluvium associated with Bollol Creek flows south-west towards the Namoi River.



LEGEND

- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine
- Maules Creek Tributaries Management Zone
- Maules and Horsearm Creeks Management Zone
- Bluevale Water Source
- Maules Creek Water Source
- Eulah Creek Water Source

Source: Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)

WHITEHAVEN COAL

IDEMITSU BOGGABRI COAL

BTM WATER MANAGEMENT STRATEGY

Surface Water Features

Figure 3.1

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The Maules Creek alluvial aquifers are located north of BTM and are divided into two distinct zones by a constriction in the flood plain created by the outcropping Permian basement. Upstream of the constriction the Maules Creek alluvium is some 90 square kilometres (km^2) in area and drained by three ephemeral creeks; Horesarm Creek, Middle Creek and Maules Creek (i.e. Upper Namoi Zone 11, Maules Creek Groundwater Source). Downstream of the constriction area, Horsearm Creek and Middle Creek discharge into Maules Creek and a zone of permanent water holes known as Elfin Crossing are present. The Maules Creek alluvial plain widens significantly in this area and Maules Creek eventually discharges into the Namoi River about 11 km west of the MCCM mining lease (AGE, 2011).

Bore yields in the alluvial aquifers are highly variable and dependent on the nature and thickness of the sediment intersected when drilling. The bores in the alluvial aquifers show a very wide range in yields, from less than 1 L/s up to a maximum of 175 L/s (AGE, 2018).

The major groundwater aquifers within the Maules Creek Formation are the coal seams, in particular the Merriown Seam. The Maules Creek Formation aquifers are ‘confined’ to ‘semi-confined’, bounded below by fresh volcanic bedrock and above by low permeability sandstones and conglomerates. Leakage from the Permian strata is restricted, 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 (Parsons Brinckerhoff, 2012a), consistent with the topographic gradient. The groundwater flow within the coal seams of the Maules Creek Formation is controlled primarily by lateral flow within the seams.

Residual volcanic soils associated with the Boggabri Volcanics (weathered profile) to the south-west of the mine lease areas are generally thick enough to retain groundwater volumes of consequence, however their permeability is low. The weathered rock 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 the Namoi River.

Further details regarding the hydrogeology of the BTM Complex area are provided in the site-specific groundwater assessments and in the *Boggabri, Tarrawonga, Maules Creek Complex Numerical Model Update* (AGE, 2018).

3.2.2 Relevant groundwater sharing plans

The three BTM Complex mines target coal seams in the Maules Creek Formation within the Gunnedah-Oxley Basin MDB Groundwater Source defined in the WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011. The surrounding alluvial sediments lie within the following groundwater sources, defined in the WSP for the Upper and Lower Namoi Groundwater Sources 2003 (Figure 3.3):

- Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin’s Leap) Groundwater Source.
- Upper Namoi Zone 5, Namoi Valley (Gin’s Leap to Narrabri) Groundwater Source.
- Upper Namoi Zone 11, Maules Creek Groundwater Source.

The BTM Complex mines are required to obtain access licences for any volumetric groundwater impacts on these water sources. These may be direct impacts such as drainage of the alluvial or porous rock groundwater sources via bores and/or pumps from mine workings, or indirect impacts resulting from drainage, or reduction in inflows to the alluvial groundwater sources. The Upper and Lower Namoi alluvial groundwater sources are fully allocated. As such, licences to account for volumetric impacts would need to be obtained from existing holders. Water entitlements currently held across the BTM Complex are detailed in each mine’s respective surface water and groundwater management plans and are provided in Section 3.3.

3.3 WATER ACCESS LICENCES

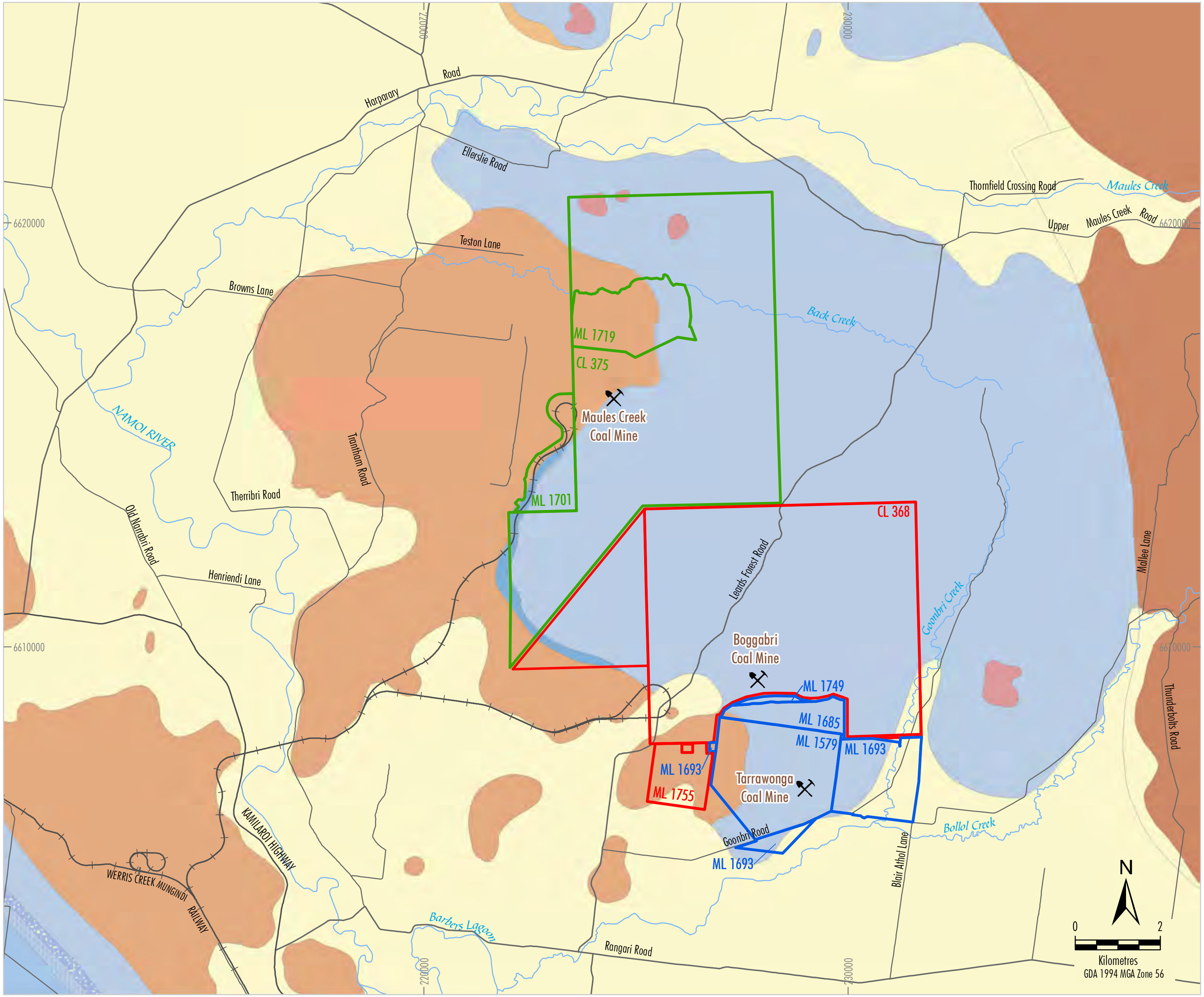
Table 3.1 summarises the surface water and groundwater WALs currently held (at the time of writing) by each mine site. Mine-specific WMPs contain the predicted annual take per mine.

Table 3.1
Water Access Licences for the BTM Complex

Water Source	Predicted Water Take*#	Licence No.	Total Entitlement (units) ^	Type
Maules Creek Coal Mine				
Lower Namoi Regulated River Water Source	As required	WAL13050	3,000.00	Surface water extraction
Maules Creek Water Source (Maules Creek Tributaries Management Zone)	N/A	WAL41585	30.00	Surface water extraction
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	60	WAL27385	38.00	Indirect Aquifer Interception
		WAL12645	35.00	Indirect Aquifer Interception
Upper Namoi Zone 5, Namoi Valley (Gin's Leap to Narrabri) Groundwater Source	0	WAL12811	135.00	Indirect Aquifer Interception
Upper Namoi Zone 11, Maules Creek Groundwater Source	4	WAL12479	78.00	Indirect Aquifer Interception
	-	WAL27383	0.00	Indirect Aquifer Interception
	-	WAL12491	77.00	Indirect Aquifer Interception
	-	WAL12480	215.00	Indirect Aquifer Interception
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	108	WAL36641	800.00	Aquifer interception
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	-	WAL29588	0.00 (subject to conditions)	N/A
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	306	WAL29467	306.00	Aquifer interception
Boggabri Coal Mine				
Lower Namoi Regulated River Water Source	As required	WAL2571	51.00	Surface water extraction
	As required	WAL2572	5.60	Surface water extraction
	As required	WAL2595	243.00	Surface water extraction
	As required	WAL2596	26.50	Surface water extraction
Upper Namoi Regulated River Water Source	-	WAL37067	128.00	Surface water extraction
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	-	WAL12691	457.00	Aquifer Extraction
	-	WAL12767	3.00	Aquifer Extraction
	-	WAL15037	172.00	Aquifer Extraction
	-	WAL24103	275.00	Aquifer Extraction
	-	WAL36547	37.00	Aquifer Extraction
	66	WAL37519	84.00	Aquifer Extraction
Upper Namoi Zone 11, Maules Creek Groundwater Source	4	WAL42234	20.00	Indirect Aquifer Interception
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	-	WAL29473	142.00	Aquifer Extraction
	459	WAL29562	700.00	Aquifer Interception
Tarrawonga Coal Mine				
	145	WAL31084	250.00	Aquifer Interception

Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	-	WAL29548	50.00	Aquifer Interception
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	21	WAL36548	36.00	Indirect Aquifer Interception
Upper Namoi Zone 11, Maules Creek Groundwater Source	1	WAL12480	215.00	Indirect Aquifer Interception

* Value provided via predictive water modelling of the BTM Groundwater Model to be revised periodically. Please refer to section 5.2.
# Predicted modelled water take maximum value to 2020 as per Table 8.10 of BTM Complex Numerical Model Update until a future model review identifies revised predicted values.
^ Licenced entitlement does not include accounting for any licenced carryover permitted under applicable Water Sharing Plan conditions.



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LEGEND

- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine

Regional Geology Legend (relevant formations)

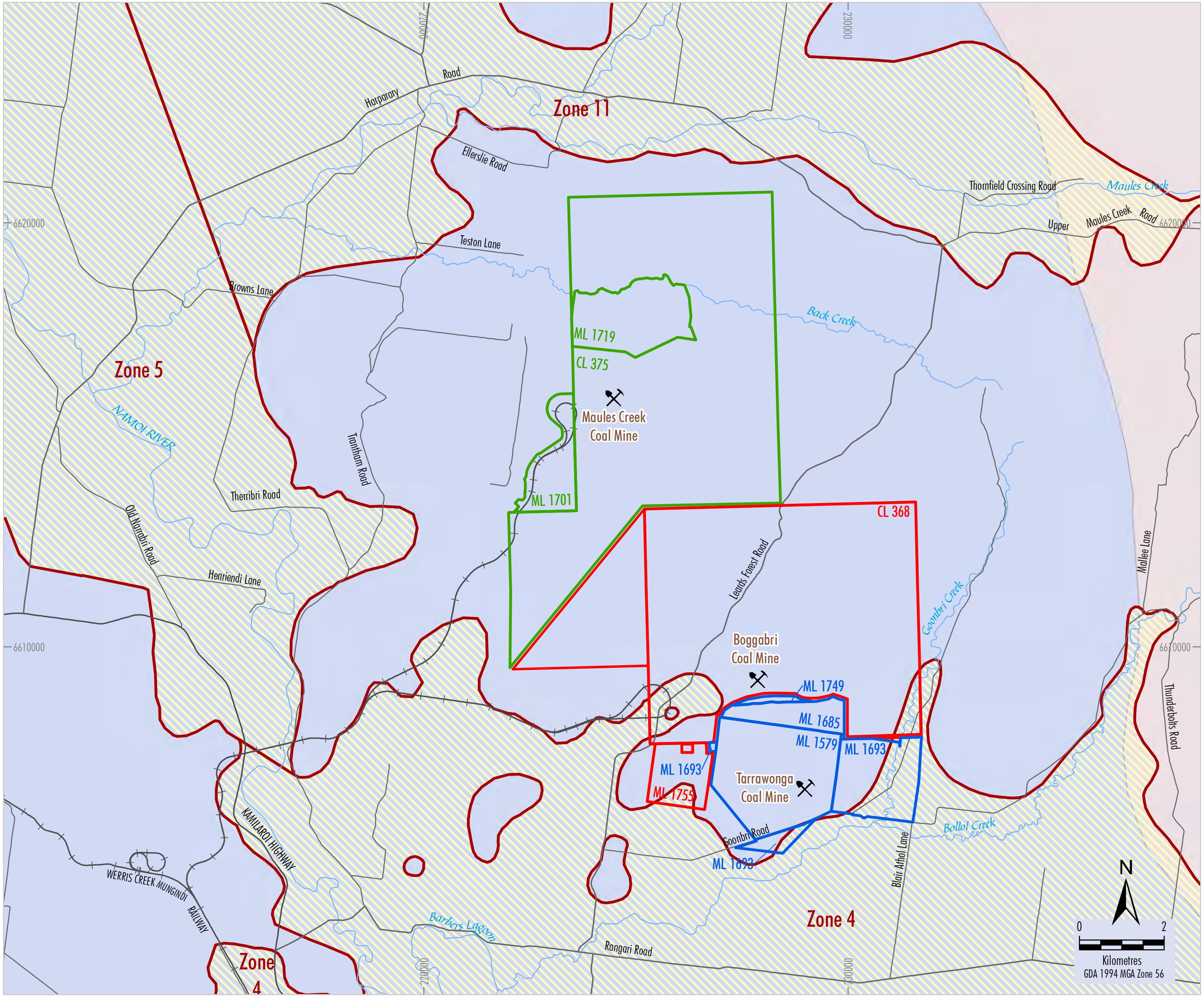
- Undifferentiated Alluvial Deposits
- Maules Creek Formation
- Plf Leard Formation
- Pbr Boggabri Volcanics

Source: *Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)*

BTM WATER MANAGEMENT STRATEGY

Regional Geology

Figure 3.2



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LEGEND

- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine

Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003

- Alluvial Groundwater Source

Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

- Gunnedah-Oxley Basin MDB Groundwater Source

Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011

- New England Fold Belt MDB Groundwater Source

Source: *Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)*

WHITEHAVEN COAL

BTM WATER MANAGEMENT STRATEGY

Relevant Groundwater Sources

Figure 3.3

4. MODELLING

Site-specific surface water and groundwater assessments have previously been prepared for Environmental Assessments and Environmental Impact Statements for the MCCM, TCM and BCM (Table 1.3). The surface water and groundwater models developed to support these assessments are described in Sections 4.1.1 and 4.2.1.

In addition to site-specific assessment, cumulative consideration and modelling of surface water and groundwater has been conducted for the BTM Complex in support of this WMS, which is described in Sections 4.1.2 and 4.2.2.

The overall goal of cumulative consideration/modelling is to demonstrate the conceptual understanding of the cumulative behaviour of surface and groundwater resources in the BTM Complex area, and as such:

1. to estimate quantitatively the cumulative impacts from the BTM Complex on groundwater and surface water resources to inform appropriate management responses (e.g. licence acquisition, compensatory measures for affected landholders, structural measures, additional monitoring, etc.);
2. to estimate the contribution to impacts by individual mines in order to determine appropriate responsibilities for management responses; and
3. to verify the predicted impacts over the course of mining operations through evaluation of design hydraulic behaviour, mine inflows and groundwater drawdown magnitude/extent, with this information feeding back into the above management responses.

4.1 SURFACE WATER

4.1.1 Site-Specific Modelling

Hydrologic and hydraulic models have been developed for BCM (Parsons Brinckerhoff, 2010). The purpose of the modelling was to assess the potential impact of BCM on peak flows in the 'Nagero Creek' catchment, and for the preliminary sizing of diversion drains. The hydrologic and 1D hydraulic models were developed using XPSWMM (version 10.6) software. These models do not include hydraulic structures (such as culverts), but do include sediment basins from the northern spoil dump at the existing TCM.

The Boggabri XPSWMM model provided results for the 5, 20 and 100 year Average Recurrence Interval (ARI) design storm events, for Years 1, 5, 10 and 21 of BCM. The modelling suggests that peak flow rates at the catchment outlet (where 'Nagero Creek' meets the Namoi River floodplain, approximately 1 km downstream of BCM) will reduce over the life of the mine, as a result of water being captured and reused on site (Parsons Brinckerhoff, 2010).

Additionally, a flood study was prepared by WRM (2011) for BCM, using TUFLOW software. The intent of the model was to assess the impact of the proposed rail bridge, haul road upgrade and Therribri Road overpass on the Namoi River floodplain. The model boundary was restricted to the infrastructure area of the Namoi River, and predicted a negligible to minor impact to flood levels, extent and velocities.

Hydrologic and hydraulic modelling has also been carried out for the TCM by Gilbert & Associates (2011). The purpose of the modelling was to design the realignment of Goonbri Creek around the eastern edge of the proposed extended open cut pit. Hydrological modelling was carried out using RORB software, to predict peak design flows for the 2, 20 and 100 ARIs and the Probable Maximum Flood (PMF). 1D hydraulic modelling was carried out using HEC-RAS software to assess the viability of the channel design.

Gilbert & Associates (2011) recommend further hydraulic modelling be carried out using additional survey data, to model the hydraulic characteristics of Goonbri Creek down to Bollol Creek, and downstream to Barbers Lagoon and the Slush Holes. The results of the recommended additional modelling could then be used to provide a more accurate baseline characterisation of existing conditions in Goonbri Creek and Bollol Creek in the final design of the realigned section of Goonbri Creek. Recommendations of the report (among others) include the placement of flow gauging stations on Goonbri Creek to verify and calibrate the completed models, and to assist in performance evaluation during and post construction.

The results of the hydraulic modelling indicate that peak flow velocities in the channel and overbank areas are indicators of stability in the Goonbri Creek realignment.

Hydrological analysis for MCCM was carried out using the Rational Method (WRM, 2011). The method was used to estimate the 100 year ARI design flood discharges in Back Creek along the reach adjacent to the proposed northern overburden area. The estimated flows were then input into a HEC-RAS model to determine the extent of flooding along Back Creek and to quantify potential impacts of TCM on flood levels and behaviour. The results of the modelling indicate that the proposed limit of disturbance is outside of the 100 year ARI flood extent, and therefore no adverse impact to flood levels or behaviour from TCM is expected for flood events up to the 100 year ARI.

4.1.2 Cumulative Considerations

To achieve the cumulative objectives, it is proposed that a detailed review of site-specific surface water models be undertaken to determine if and how cumulative flow behaviour has been incorporated, in terms of flow distribution, timing, depth and velocities throughout the BTM Complex area and downstream. The models should be assessed for their capabilities and limitations with respect to prediction of cumulative surface water impacts as a result of the BTM Complex.

4.2 GROUNDWATER

4.2.1 Site-Specific Modelling

The three existing regional groundwater models are already standardised on common software, namely MODFLOW-SURFACT Version 4 that is distributed commercially by HydroGeoLogic, Inc. (Virginia, USA). This software is able to simulate variably saturated flow and can handle desaturation and re-saturation of multiple aquifers without the “dry cell” problems of Standard-MODFLOW. This is pertinent to the dewatering of water-bearing formations adjacent to open cut mines and to reliable prediction of water level recovery post-mining.

However, there are differences in the user interfaces to each model. The TCM model (Heritage Computing, 2012b) uses the Groundwater Vistas Version 6 graphic user interface (GUI), while the BCM and MCCM models (AGE, 2010 and 2011) rely on proprietary FORTRAN code with some assistance from the PMW in GUI.

More fundamentally, the models differ in the number of model layers and in the way in which target coal seams have been aggregated, reflecting different mining objectives and variable seam geometry for each site.

Each of the BCM, TCM and MCCM models undergo regular maintenance and recalibration as additional data on groundwater responses to progressive mining improves the understanding of the groundwater systems.

4.2.2 Cumulative Modelling

Heritage Computing (2012)

Groundwater modelling of cumulative groundwater impacts was undertaken by Heritage Computing (2012a) as part of the development of the Water Management Strategy. This is in addition to two regional models developed incrementally by AGE for BCM and MCCM, and a separate regional model for TCM developed by Heritage Computing.

The Heritage Computing (2012) groundwater model utilised the geological layers developed during the data sharing process established between the BCM, TCM and MCCM.

The potential cumulative surface water and groundwater impacts and issues are discussed in Section 5.1.

Australasian Groundwater and Environmental Consultants (2018)

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) prepared the report *Boggabri, Tarrawonga, Maules Creek Complex Numerical Model Update* (AGE, 2018) to satisfy the approval conditions for the verification of predicted groundwater impacts against observed datasets every three years. Each of the BTM Complex mines are required to prepare a "*Groundwater Management Plan, which includes… 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*".

As part of the report, the numerical model for the BTM complex was reviewed and verified against monitoring data collected since 2013. Prior to further calibration the model was imported into MODFLOW USG to allow the geological units to be me more accurately represented. Further calibration of the model aimed at reproducing the water level trends observed within the BTM complex monitoring bore network. The calibration resulted in increasing the coal seam hydraulic conductivity (AGE, 2018).

The modelling results and outcomes are described in Sections 5.2 and 5.3.

5. POTENTIAL CUMULATIVE IMPACTS AND ISSUES

Regional numerical modelling conducted as part of the Namoi Catchment Water Study (Schlumberger, 2012) concluded that the area encompassing the BTM Complex (defined as Upper Namoi Zone 4, Namoi Valley [Keepit Dram to Gin's Leap] Groundwater Source) is considered to be at moderate risk from coal and gas developments. In addition, Upper Namoi Zone 5 Namoi Valley (Gin's Leap to Narrabri) Groundwater Source and Upper Namoi Zone 11, Maules Creek Groundwater Source have been located in the vicinity of the BTM Complex and are considered to be at moderate and high risk from mining and coal seam gas developments, respectively. Schlumberger (2012) indicated potential impacts within the Namoi Catchment would likely occur as follows:

- Interception of rainfall and run-off; There is a greater potential for open-cut mines to intercept rainfall and run-off. Where possible operators tend to divert existing surface water drainage around the perimeter of the site to minimise drainage into the open cut. Water intercepted is removed from the surface/groundwater systems and stored on-site for use in operations or treated and discharged.
- Lowering of groundwater levels; Mining below the water table can have an impact on groundwater resources. Dewatering of pits can potentially induce local changes in groundwater gradients and flow directions.
- Pit runoff water and pumped groundwater can be contaminated with suspended solids and/or dissolved minerals and metals, and would need to be treated before discharge into the local drainage system.

Sections 5.1 and 5.2 provide an overview of the detailed assessments of the potential surface water and groundwater impacts associated with BTM Complex operations undertaken as part of the Environmental Assessments (EAs) and technical reports prepared in support of development applications for each project. A summary of previous surface water and groundwater studies is provided in Table 1.4.

5.1 SURFACE WATER

5.1.1 Contaminant export

Mine water, containing suspended solids and soluble salts, will be generated from coal stockpiles and the mining void, as well as groundwater inflows to the mining void. In addition, dirty water containing suspended solids will be generated from runoff from disturbed areas within the mine sites, including from infrastructure areas, unshaped spoil dumps and haul roads. For all mines, mine water will be retained onsite for use (if required), and dirty water will report to settlement ponds for on-site use, or be shared with other mines within the BTM Complex, subject to water sharing agreements being reached on terms acceptable to the mines acting reasonably, or discharged from site in line with approval conditions and licences for each of the mines.

The management of dirty water and mine water at each of the mines is detailed in each site-specific WMP. It will remain the responsibility of each mine to implement the mitigation measures detailed in their WMP's to reduce any cumulative impacts on the surrounding environment during operations and post-mining until relinquishment of the relevant leases.

5.1.2 Catchment areas and flows to local creeks and Namoi River

Mining operations will result in modifications to local surface water catchments. The area of undisturbed (or rehabilitated) catchment draining to the local creeks will reduce over the life of each mine, as the area draining to dirty and mine water management systems increases. Areas draining to local catchments will subsequently increase as rehabilitation is established and runoff is of suitable quality.

Peak flow rates at the catchment outlets are likely to reduce over the life of the mines. This reduction may be attributed to dirty water runoff being captured in sediment dams, thus attenuating peak flow rates. An overall reduction in catchment outflow may also be associated with mine water runoff being stored on-site for reuse, rather than being discharged to the creeks.

Surface water will also, where possible, be diverted around disturbed and mining areas and directed into catchment outlets.

Given the very small contribution of these creeks to the Namoi River catchment, the impacts on the Namoi River flows downstream and the Namoi River water users are likely to be minimal. However, local creek environmental flows may be affected.

The extent to which impacts on streamflows persist beyond the life of BTM Complex will depend on the final landform for each mine (i.e. changes in runoff direction due to the final landforms and permanent catchment excision due to final voids). It will remain the responsibility of each mine to ensure rehabilitation and landform design (including final void catchment areas) is undertaken in accordance with the relevant site-specific approvals.

In locations where the landforms interface, consultation will be conducted between the relevant BTM Complex mines to achieve beneficial cumulative landform objectives (e.g. to minimise long term water impacts).

5.1.3 Flooding

Investigations undertaken as part of the EAs for each mine found that peak flow rates at catchment outlets in the BTM Complex area are likely to reduce as mine areas increase, as described in the section above.

Changes to landforms and hydrology from BTM Complex mining and overburden emplacement have the potential to change flood characteristics for flood prone areas.

For BCM, analysis undertaken by WRM Water and Environment Pty Ltd, and summarised in the EA (WRM, 2009) indicated that mine infrastructure would cause no riverbank erosion upstream or downstream of the project, and predicted a minor impact on flood levels, extent and velocities.

Gilbert & Associates (2011) undertook initial hydrologic and hydraulic modelling for the TCM. The assessment identified the TCM to be predominantly on land with an elevation greater than 275 m AHD, which is above any conceivable flood impact. It determined that the proposed flood bund and embankments of the Goonbri Road realignment would have minimal impact on the Goonbri/Bollol Creek floodplain south of Dripping Rock Road. As part of the proposed Goonbri Creek realignment, further hydraulic modelling will be carried out using additional survey data, to model the hydraulic characteristics of Goonbri Creek down to Bollol Creek, and downstream to Barbers Lagoon and the 'Slush Holes'. The results of this additional modelling can then be used to provide a more accurate baseline characterisation of existing conditions in Goonbri Creek and Bollol Creek in the final design of the realigned section of Goonbri Creek.

Hydrologic and hydraulic analysis for MCCM was carried out by WRM (2011) to determine the extent of flooding along Back Creek and to quantify potential impacts of the MCCM on flood levels and behaviour. Results indicated that the proposed limit of disturbance is outside of the 100 year ARI flood extent, and therefore no adverse impact to flood levels or behaviour from the project is expected for flood events up to the 100 year ARI.

5.2 GROUNDWATER

5.2.1 Groundwater flow

Changes to groundwater flows in areas surrounding each mine are anticipated. Schlumberger (2012) highlighted potential for below water table mining in either open-cut or underground mines to have an impact on quantity and quality of groundwater resources. Dewatering of pits and mines can potentially induce local changes in groundwater gradients and flow directions.

Worst case cumulative groundwater impact assessment undertaken by AGE (2010) determined that cumulative groundwater depressurisation impacts could be expected from the TCM, BCM and MCCM projects. The modelling indicated that depressurisation would reduce the net volume of groundwater flowing from the Permian bedrock into the overlying alluvial aquifers by approximately 30%.

5.2.2 Alluvial aquifer impacts

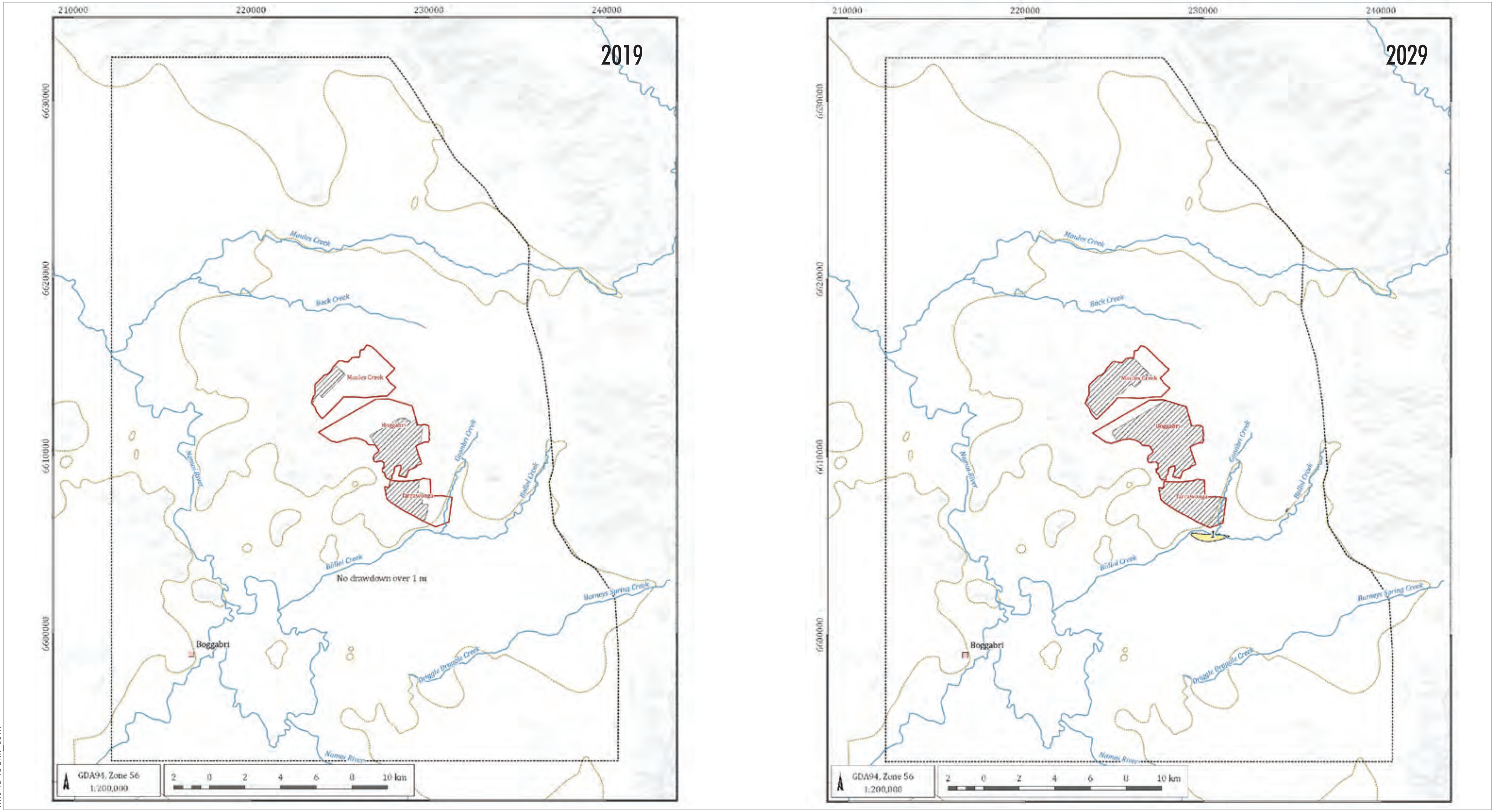
Changes in alluvial groundwater volumes and levels have the potential to occur as a result of mining within the BTM Complex.

The recalibrated model prepared by AGE (2018) predicted limited and localised drawdown within the Narrabri and Gunnedah alluvium, consistent with previous versions of the model. As shown on Figures 5.1 and 5.2, the drawdown is confined to the zones of alluvium that that have infilled valleys immediately adjacent to the active mining areas at Boggabri and Tarrawonga Mine (AGE, 2018).

The drawdown shown in Figures 5.1 and 5.2 represent the cumulative impact on the groundwater regime generated by all three mines operating together. Appendix A contains a series of figures that show how each mine contributes proportionally to the total drawdown and cumulative impact (taken from Appendix D of AGE [2018]. The figures show the proportion of each mine to the cumulative impact is most significant within the active mining area and reduces with distance from the mine. The figures also show that the proportion for each mine changes with time, as mining depth and location progresses.

Modification 5 of the Boggabri Coal Mine involved establishment and operation of a borefield which included two production bores and four contingency production bores. The borefield will contribute to regional cumulative groundwater drawdown associated with the adjacent mining operations. This is estimated to be an additional groundwater drawdown of 1 to 3 m in the alluvium to the east and north-east of the borefield where mine cumulative drawdown is experienced (Parsons Brinckerhoff, 2015).

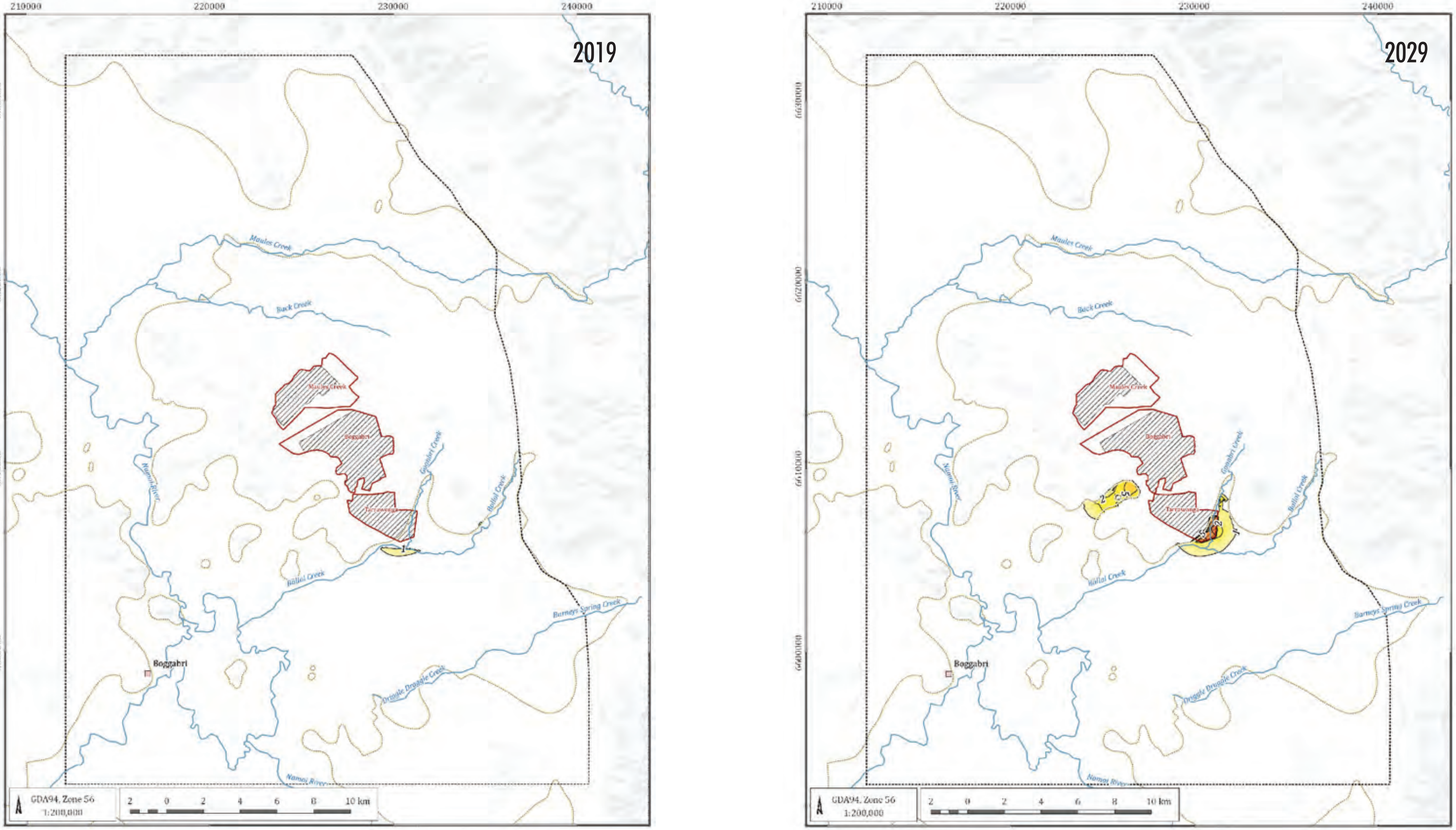
Insert Figure 5.1



BTM WATER MANAGEMENT STRATEGY

Cumlative Groundwater
Drawdown Extent -
Narrabri Alluvim

Figure 5.1



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LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Mine extent
- Model extent
- Alluvium

Drawdown (m)

- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500
- Drawdown contour (m)

WHITEHAVEN COAL

IDEMITSU
BOGGABRI COAL

BTM WATER MANAGEMENT STRATEGY

Cumlative Groundwater
Drawdown Extent -
Gunnedah Alluvim

Figure 5.2

5.2.3 Hard rock aquifer impacts

Impacts to hard rock aquifers are considered to be a potential cumulative issue for the BTM Complex.

Figure 5.3 shows the predicted drawdown extent within the Merriown Seam (refer to AGE [2018] for further details regarding model layers). Compared to previous modelling, the drawdown predicted by the updated model is less extensive to the west and does not extend into the Boggabri Volcanics, but is more extensive towards the east reaching the model boundary. These differences are expected to be a result of:

- changing from MODFLOW SUFACT to MODFLOW USG that allowed pinching out of the coal seams towards the west where they do not exist;
- a simplified approach to representing rainfall recharge (use of the pseudo soil option); and
- the more permeable hydraulic conductivity values determined from the calibration process.

The drawdown shown in Figure 5.3 represents the cumulative impact on the groundwater regime generated by all three mines operating concurrently. Appendix A contains a series of figures that show how each mine contributes proportionally to the total drawdown and cumulative impact.

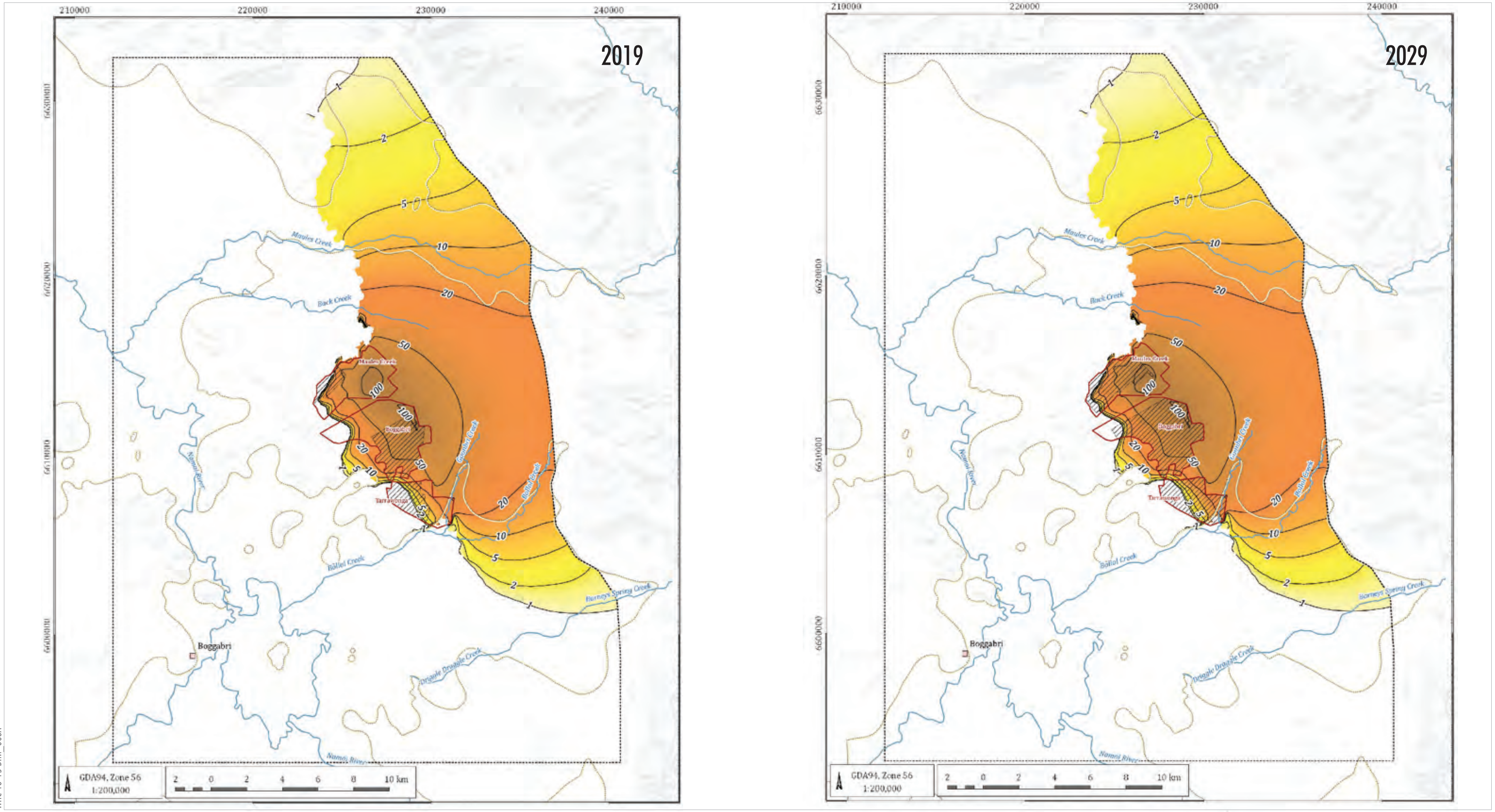
5.2.4 Water quality impacts

The open cuts for each mine in BTM Complex are considered groundwater sinks during operations and post-mining (i.e. final landform) (AGE, 2010; AGE, 2011; Heritage Computing 2012b). The open cuts will draw in groundwater from surrounding aquifers, preventing the release of potentially brackish to saline water back into the surrounding aquifers.

5.3 WATER SUPPLY AND DEMAND

All site WMPs for the BTM Complex mines aim to:

- divert clean water runoff where possible from undisturbed catchment areas around the mine workings into local creeks (‘Nagero Creek’ for BCM, ‘Nagero’, Bollol and Goonbri Creeks for TCM, and Back Creek for MCCM);
- capture dirty water from disturbed areas in sedimentation dams. If the water quality meets licence requirements, and the water is not required for use on-site, it may be discharged into the local catchments or alternatively, if required, shared with other mines within the BTM Complex, subject to water sharing arrangements being agreed between the mines on terms acceptable to the mines acting reasonably;
- use dirty water wherever possible for coal processing and dust suppression;
- use imported water as follows:
    - for BCM, to supplement water from on-site surface water storages and its Zone 4 borefield to meet dust suppression and coal processing demands and as potable water for use in vehicle wash down and construction activities;
    - for TCM, use imported raw water for potable water as well as for other site water deficits and use groundwater from a licensed production bore with an annual entitlement of 50 ML during protracted dry periods; and
    - for MCCM, use imported raw water from an existing high security licence for 3000 ML/yr from the Namoi River for mining operations.



WHC-13-15 BTM_003A

LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Mine extent
- Model extent
- Alluvium

Drawdown (m)

- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500
- Drawdown contour (m)

Source: AGC (2018)

WHITEHAVEN COAL

IDEMITSU BOGGABRI COAL

BTM WATER MANAGEMENT STRATEGY

Cumlative Groundwater Drawdown Extent - Coal Seams

Figure 5.3

Each mine may experience shortfalls during prolonged dry periods. Further details are contained within each mine's respective site water balances.

It is proposed that the mines explore opportunities for water sharing and water transfers between mines within the BTM Complex. This may include sharing excess mine water stored on-site as well as purchasing and/or trading of any excess surface water or groundwater (either allocated or produced) between the mines. The infrastructure to be utilised to share the water between the mines will depend on the terms of the agreement reached between the mines (acting reasonably) as to the volume of water to be transferred and the location of the water source and ultimate destination. The water sharing may involve the use of both permanent and temporary water management infrastructure. Water management plans will be updated where required to reflect any new water sharing arrangements and infrastructure.

Where it is not practicable or feasible to share water, additional water may be purchased on the open market, either temporarily or permanently, by the relevant mine to make up any shortfalls. Furthermore, groundwater may also be traded on a temporary or permanent basis within the greater Gunnedah-Oxley Basin Groundwater Source.

AGE (2018) concluded that the three mines cumulatively have sufficient water licenses to account for groundwater intercepted by mining in the areas managed under the Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources, and sufficient water licenses to account for water indirectly removed from Zone 4 and 11 of the alluvial aquifers managed under the Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources.

6. MONITORING

6.1 EXISTING MONITORING NETWORK

6.1.1 Surface water

Surface water monitoring in the BTM Complex area is carried out by BCM, TCM and MCCM in line with their respective WMPs.

Refer to the approved WMP for each mine's existing surface water monitoring program, including locations, frequency and parameters. The approved site-specific WMPs developed and managed in accordance with the relevant site-specific approvals and licences.

Reporting of surface water monitoring can be found in site-specific Annual Reviews.

6.1.2 Groundwater

Groundwater levels and quality

The current groundwater monitoring network within the BTM Complex comprises a combination of monitoring bores and vibrating wire piezometers (VWPs). Monitoring has been carried out for BCM since mid-2006, TCM since June 2006 and MCCM since June 2010 (AGE, 2018). Installation of the groundwater monitoring network is described in more detail in AGE (2018).

Refer to the approved WMPs for each mine's existing groundwater monitoring locations, frequencies and parameters.

Groundwater seepage

Monitoring of groundwater pit seepage is currently carried out for all mines within the BTM Complex.

The seepage monitoring programs for each of the sites is detailed in their approved site WMPs and includes tracking water pumped from the pit, and calculations of groundwater seepage via water balance calculations.

6.2 BTM COMPLEX CUMULATIVE IMPACT MONITORING NETWORK

6.2.1 Surface water

This section details the cumulative surface water monitoring program to be implemented across the BTM Complex. The program focuses on ambient monitoring in order to identify and manage cumulative impacts on surface water quality, flows and third parties. Monitoring locations have been strategically selected to enable the distribution of surface water quality and quantity impacts from each mine to be understood and appropriately managed.

The cumulative surface water monitoring program does not supersede site WMPs currently in place. Rather the program has been developed to work in parallel. The monitoring locations selected for the cumulative monitoring network are part of the existing networks of each mine (Table 6.1 below). The management of data and reporting for the cumulative network is discussed in Section 8. Table 6.1 sets out the surface water quality and flow monitoring locations, parameters, sampling frequencies and reasoning, with locations shown on Figure 6.1.

Table 6.1
Cumulative Surface Water Monitoring Program

Location	Frequency[e]	Parameters	Rationale
Boggabri Coal Mine			
SW2	Event based[d]	Field parameters - EC & pH, TSS, oil and grease, nutrients[b], metals[c]	Monitors ambient conditions on 'Nagero Creek' upstream of BCM
SW1	Event based	Field parameters - EC & pH, TSS, oil and grease, nutrients[b], metals[c]	Monitors conditions on 'Nagero Creek' downstream of BCM, and downstream of TCM (TCM discharges to 'Nagero Creek' and Goonbri Creek)
Tarrawonga Coal Mine			
GC-U	Event based when the creek is flowing and until a baseline is established, then quarterly + event based only when the creek is flowing.	Field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	Monitors ambient conditions on Goonbri Creek upstream of TCM and proposed Goonbri Creek realignment
BC-U	Event based when the creek is flowing and until a baseline is established, then quarterly + event based only when the creek is flowing.	Field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	Monitors conditions of Bollol Creek just upstream of the confluence of Goonbri and Bollol Creeks, upstream of TCM and proposed Goonbri Creek realignment
BC-D	Quarterly + event based only when the creek is flowing.	Field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	Monitors conditions just downstream of the confluence of Goonbri and Bollol Creeks, downstream of TCM and proposed Goonbri Creek realignment
Maules Creek Coal Mine			
SW4	Monthly + event based until a baseline is established, then quarterly (March, June, September, December) + event based	Field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	Monitors ambient conditions on Back Creek upstream of MCCM
SW9	Quarterly (March, June, September, December) + event based	Flow measurement + field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	Monitors conditions on Back Creek downstream of MCCM
SW5	Monthly + event based until a baseline is established, then quarterly (March, June, September, December) + event based	Flow measurement + field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	On the Namoi River, upstream of the BTM Complex
SW8	Monthly + event based until a baseline is established, then quarterly (March, June, September, December) + event based	Flow measurement + field parameters[a], TSS, oil and grease, nutrients[b], metals[c]	On the Namoi River, downstream of confluence with Maules Creek and downstream of the BTM Complex

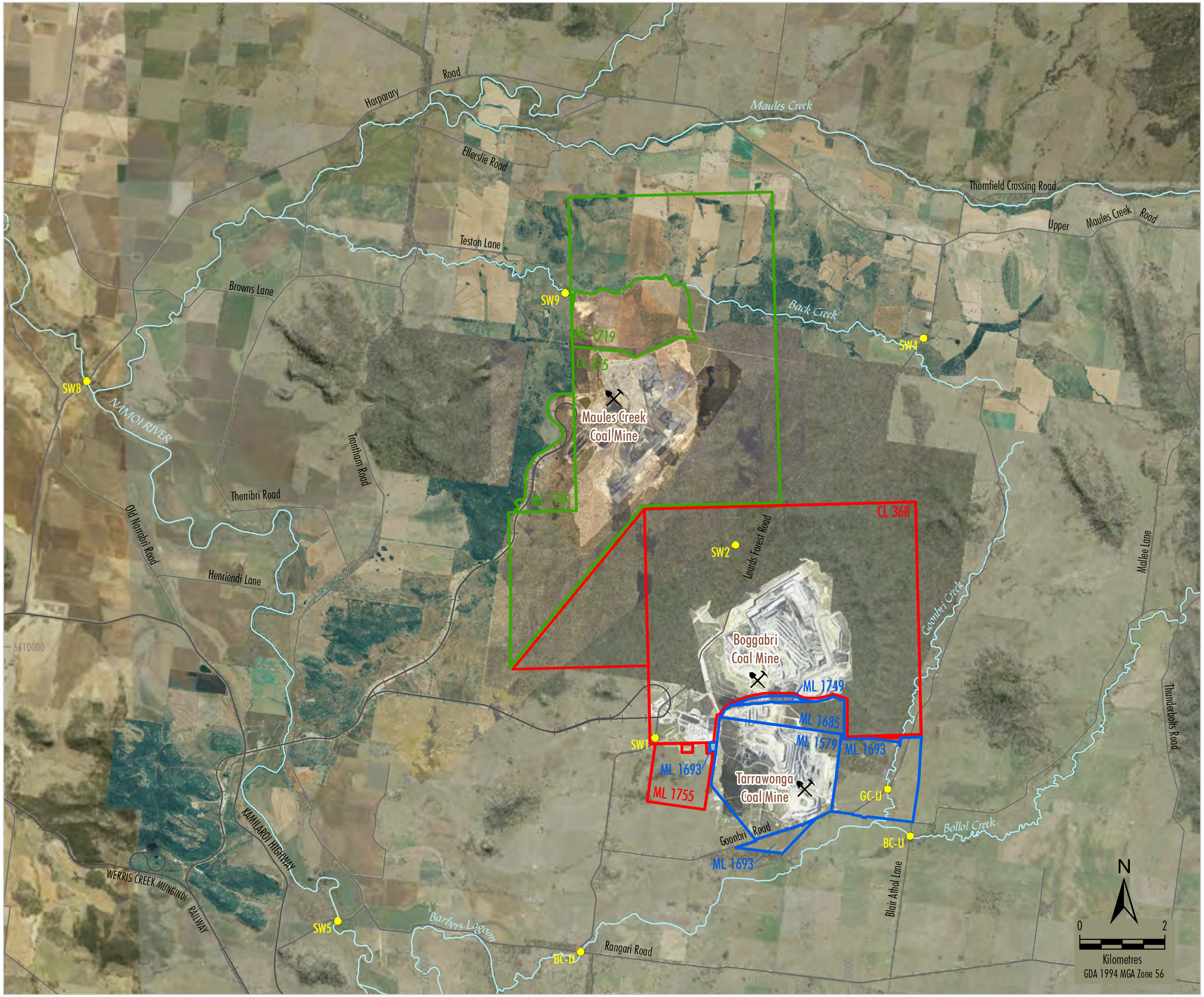
a: pH, EC, temperature, dissolved oxygen, turbidity, ORP

b: Nutrients: phosphorus (total), phosphorus (reactive), nitrogen (total)

c: Aluminium, arsenic, cadmium, chromium, copper, iron, manganese, nickel and zinc.

d: 'Event based' refers to as soon as practicable after a discharge from authorised discharge point has occurred. Please refer to mine specific WMPs for more detailed descriptions of events including post-event monitoring frequency.

e: Quarterly and monthly monitoring within ephemeral creeks (i.e. Nagero Creek, Bollol Creek and Goonbri Creek) will only be undertaken if the creeks are flowing at the time of the scheduled monitoring.



LEGEND

Mining Tenement Boundary - Boggabri Coal Mine

Mining Tenement Boundary - Tarrawonga Coal Mine

Mining Tenement Boundary - Maules Creek Coal Mine

BTM Cumulative Surface Water Network

Source: *Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)*

WHITEHAVEN COAL

IDEMITSU BOGGABRI COAL

BTM WATER MANAGEMENT STRATEGY

Cumulative Surface Water Monitoring Locations

Figure 6.1

WHC-13-15 BTM_204A

Water quality parameters listed in Table 6.1 have been specified based on a combination of existing Environment Protection Licences (EPL) (12407 for the BCM, 20221 for the MCCM and 12365 for the TCM), Namoi catchment uncontrolled streams Water Quality Objectives (WQOs) (DoI – Water, 2006), monitoring carried out for existing surface water operational plans and recommendations made in previous studies (Parsons Brinckerhoff, 2010; Gilbert & Associates, 2011; WRM, 2011).

Flow monitoring involving the installation of water level logger or similar within the main channel of the creeks has been recommended where feasible at the locations listed in Table 6.1 and are considered to be more appropriate than permanent flow gauging stations for the following reasons:

- flow in each creek is ephemeral;
- SW2 will eventually be rendered obsolete due to the progression of mining; and
- water level recording equipment is easier to deploy, does not require extensive calibration and is easier to maintain than flow gauging station equipment.

6.2.2 Groundwater

Groundwater levels and quality

Recommendations were made by Heritage Computing (2012a) to monitor and manage the cumulative impacts on groundwater conditions as a result of mining within the BTM Complex. Those recommendations have been used to guide the development of the BTM Complex groundwater monitoring program.

The program is based on a network of monitoring bores and VWPs to monitor regional groundwater conditions, in addition to existing monitoring bore networks (Section 6.1.2). During October 2013 to January 2014, the proposed bores were constructed. Some sites selected for groundwater quality monitoring have been aligned with existing bores that monitor alluvial aquifers, with the new bores placed to monitor underlying aquifers at the same location. Some sites were selected for water level monitoring only. A number of bores have automatic dataloggers installed to collect continuous water level data, which can be downloaded during sampling rounds.

Some monitoring bores were combined or substituted for those previously recommended in individual mine EAs, provided the targeted lithology and construction was consistent with the rationale defined by Heritage Computing (2012a). Possible rationalisations are included in Table 6.2.

Table 6.2 sets out the cumulative groundwater monitoring network, along with sampling frequencies, parameters and rationale. MCCM installed all individual bores that make up the cumulative groundwater monitoring network. A consultant engaged by MCCM sample these bores for cumulative data for the BTM Complex. Figure 6.2 shows the cumulative groundwater monitoring network for the BTM Complex. Monitoring locations for the cumulative groundwater monitoring network were selected as per recommendations from Heritage Computing (2012a) and in consultation with regulatory agencies.

Groundwater seepage and use

The current groundwater seepage monitoring program being implemented for each mine (Section 6.1.2) will be used to provide a dataset for periodic water balance modelling across the BTM Complex.

Table 6.2
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgbl)	Sampled lithology	Frequency	Parameters	Rationale
Reg1	VWP in interburden and coal seams (4)	N/A	118.7 134.5 193.5 281.5	Alluvium (existing bore GW967138/2), interburden and coal seams	Continuous water level measurement (datalogger).	Water level	Just outside predicted 1 m water table drawdown (Heritage Computing, 2012a). To assess potential impact on middle reaches of Maules Creek. Adjacent DoI – Water bore GW967138/1/2.
Reg2	VWP in interburden and coal seams (4)	N/A	60 120 200 260	Alluvium (existing bore GW041027) and underburden	Continuous water level measurement (datalogger).	Water level	Just outside predicted 1 m water table drawdown (Heritage Computing, 2012a). To assess potential impact on upper reaches of Maules Creek. Adjacent DoI – Water bore GW041027.
Reg3	Bore (1)	57	50.50 – 56.50	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	Just outside predicted 1 m water table drawdown (Heritage Computing, 2012a). To assess potential impact on lower reaches of Maules Creek. Adjacent DoI – Water bore GW030130.
Reg4	Bore (1)	72.5	65.5 – 71.5	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	Outside predicted drawdown impact zones (Heritage Computing, 2012a). 2 km east of Namoi River.

Table 6.2 (Continued)
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgbl)	Sampled lithology	Frequency	Parameters	Rationale
Reg5	Bore (1)	78.7	72.2 – 78.2	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	Within predicted 1 m water table drawdown zone in alluvium (Heritage Computing, 2012a).
Reg5a	Bore (1)	22	18 – 21	Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	Within predicted 1 m water table drawdown zone in alluvium (Heritage Computing, 2012a).
Reg6	Bore (1)	96	88.0 – 94.0	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	Within predicted 1 m water table drawdown zone in 'Nagero Creek' alluvium (Heritage Computing, 2012a). To assess potential impact on 'Nagero Creek'.
Reg7	VMP in interburden and coal seams (3)	N/A	67.5 148.2 242.5	Maules Creek Formation interburden and coal seams	Continuous water level measurement (datalogger).	Water level	On edge of predicted 1 m water table drawdown in Bollol Creek alluvium (Heritage Computing, 2012a). To assess potential impact on Bollol Creek. Adjacent bore BCS6.
Reg7a	Bore (1)	36	24 – 30	Bollol Creek Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	On edge of predicted 1 m water table drawdown in Bollol Creek alluvium (Heritage Computing, 2012a). To assess potential impact on Bollol Creek. Adjacent bore BCS6.

Table 6.2 (Continued)
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgbl)	Sampled lithology	Frequency	Parameters	Rationale
Reg8	VWP in interburden and coal seams (3)	N/A	91.5 221 274	Maules Creek Formation interburden and coal seams	Continuous water level measurement (datalogger).	Water level	In high drawdown zone east of MCCM and north-east of BCM (Heritage Computing, 2012a). In Maules Creek Formation.
Reg9	VWP in interburden and coal seams (3)	N/A	115.8 175.2 268	Maules Creek Formation interburden and coal seams	Continuous water level measurement (datalogger).	Water level	In moderate drawdown zone to north-east of TCM and east of BCM (Heritage Computing, 2012a). In Maules Creek Formation.
Reg10	VWP in interburden and coal seams (4)	N/A	55 144.2 178 185.5	Shallow Maules Creek Formation (and Back Creek water)	Continuous water level measurement (datalogger).	Water level	In moderate drawdown zone on Back Creek north of MCCM (Heritage Computing, 2012a). To assess potential impact on Back Creek. In Maules Creek Formation.
Reg10a	Bore (1)	10	6.75 – 9.75	Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	In moderate drawdown zone on Back Creek north of MCCM (Heritage Computing, 2012a). In Maules Creek Formation.

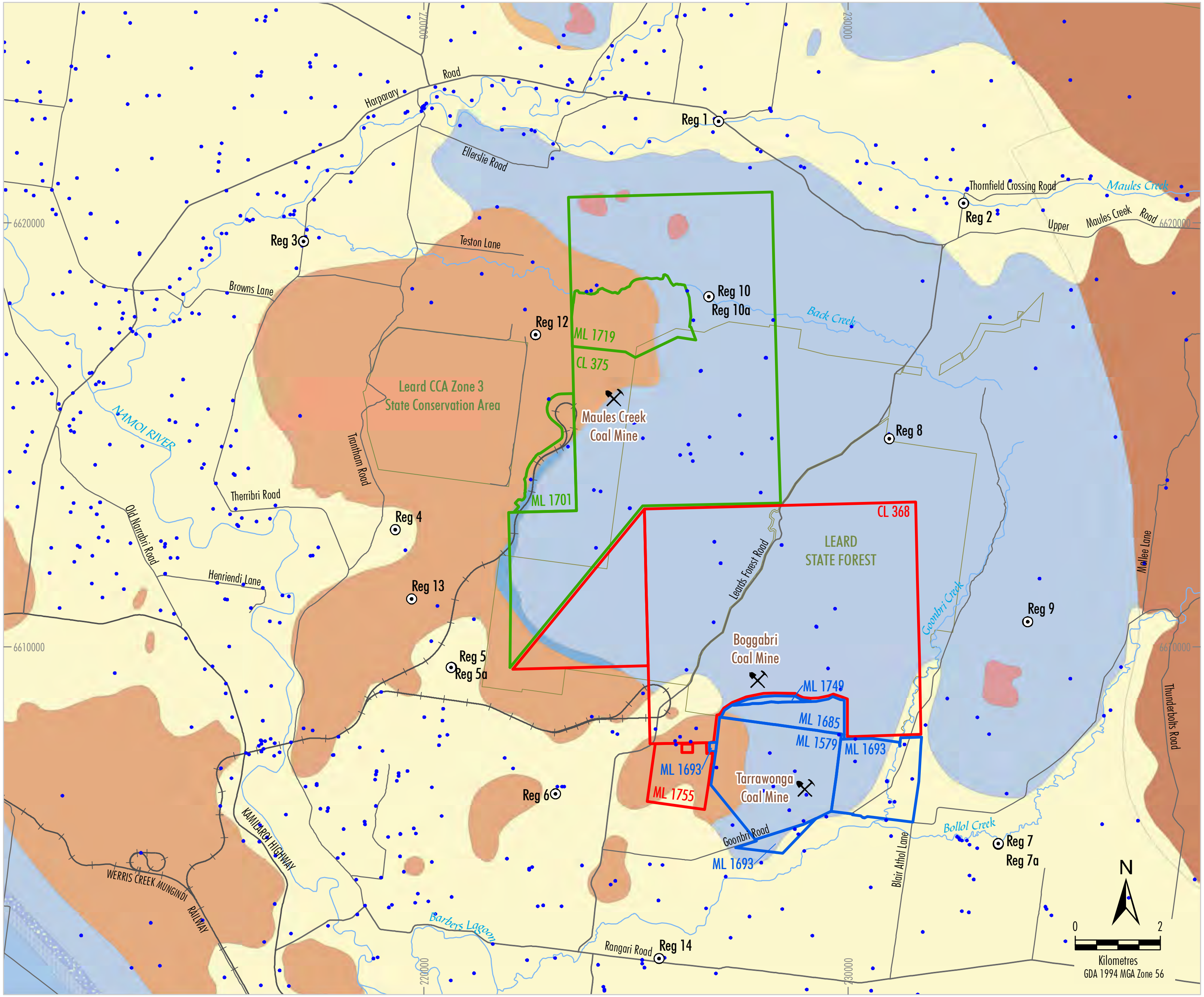
Table 6.2 (Continued)
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgbl)	Sampled lithology	Frequency	Parameters	Rationale
Reg12	Bore (1)	48.3	38.4 – 44.4	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	Within 1 m regolith drawdown zone north-west of MCCM (Heritage Computing, 2012a). In Boggabri Volcanics.
Reg13	Bore (1)	133	128 – 132	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	On edge of 1 m regolith drawdown zone west of BCM (Heritage Computing, 2012a). In Boggabri Volcanics.
Reg14	Bore (1)	102	90 - 96	Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters[a] + major ions + metals[b] + nutrients[c]	In Bollol Creek alluvium well outside any predicted drawdown. Adjacent bore DoI – Water GW030472.

a: pH, EC, temperature, dissolved oxygen, turbidity, ORP.

b: Aluminium, arsenic, cadmium, chromium, copper, iron, manganese, nickel and zinc.

c: Nutrients: phosphorus (total), phosphorus (reactive), nitrogen (total).



BTM WATER MANAGEMENT STRATEGY

Cumulative Groundwater Monitoring Locations for the BTM Complex

Figure 6.2

WHC-13-15 BTM_205B

7. IMPACT MITIGATION

The site-specific WMPs for each of the mines within the BTM Complex contain the following:

- water management and mitigations measures;
- water quality and quantity triggers; and
- event definitions.

Where the monitoring program identifies water quality results above a set trigger level then:

- Each mine in the BTM Complex will be notified as soon as practicable of the monitoring result.
- Monitoring results will be reviewed against previous results to identify a trend or other anomaly.
- An investigation of the potential cause of the impact will be undertaken as well as deliberation between BCM, TCM and MCCM to identify the mine/mines potentially causing the exceedance. The investigator will consider and document:
  - the extent of potential water issue;
  - the receiving environment of the potential water issue; and
  - the timeframe of the potential water issue.
- The mine/mines identified in the previous step as causing the exceedance rectify the issue where possible.
- Report to external agencies will be undertaken, as required by each mine's Project Approval conditions.

8. MANAGEMENT AND IMPLEMENTATION

Each site will maintain the responsibility to comply with the management and monitoring requirements contained in their site management plans, approvals and licences specific to their operation to minimise their impact on water quality and subsequently on the cumulative water quality with the BTM Complex.

The sites will work collectively to coordinate the modelling programs where required.

The Water Management Strategy is one of a number of cumulative environmental management strategies developed in response to mine development approval conditions. As such, the mines will work collectively to:

- Convene BTM Complex meetings quarterly to discuss cumulative monitoring results.
- Communicate changes to any site-specific monitoring locations.
- Provide access to monitoring locations.
- Share data relating to the cumulative monitoring network.
- Respond in a timely manner to requests to enable the Water Management Strategy to be implemented.

Table 8.1 articulates the roles and responsibilities for identifying and managing cumulative impacts where joint mitigation is required.

Table 8.1
Roles and Responsibilities for the BTM Complex

Role	Responsibility	Timing
Roles within the BTM Complex Sites …………………… **Site General Manager or Mine Manager/HSE Manager***	• Each site to comply with the management and monitoring requirements contained in their respective site management plans.	Ongoing
	• Each site to complete surface water and groundwater monitoring required under the BTM Water Strategy.	As required
	• Each mine to maintain responsibility for site-specific licencing requirements.	Ongoing
	• Provide the relevant resources to enable implementation of the BTM Water Management Strategy.	As required
	• BTM Complex sites will ensure the relevant operational personnel are aware of this document.	As required
Site Environmental Representatives (Environmental Superintendent or Environmental Officer*)	• Represent respective operations at regular BTM Complex meetings regarding water management.	As required
	• Regularly convene meetings to discuss cumulative monitoring results.	Quarterly
	• Coordinate updates collectively to the Water Management Strategy.	As required
	• Liaise across BTM sites to address trigger events and review mitigation options.	As required
	• Investigate cumulative complaints with other BTM site representatives.	As required
	• Provide access to monitoring locations.	As required
	• Assist in data and information provision as required by the Water Management Strategy.	Ongoing
	• Share data relating to the BTM Complex cumulative monitoring network.	Ongoing
	• Apply and implement the required monitoring and/or modelling methodologies.	Ongoing and as required
	• Notify sites within the BTM Complex of the monitoring result where the monitoring program identifies water quality results exceed trigger level listed in individual WMPs and identify the mine/mines causing the exceedance.	As required

	• Undertake joint mitigation if required as per any relevant agreed terms.	As required
	• Implement and coordinate reviews of the Water Management Strategy.	Refer to Section 9
	• Implement the site-specific mitigation measures and controls within the applicable site WMP.	Ongoing
Strategy groundwater & surface water monitoring contractors & modelling consultants	• Review and if necessary, update any BTM Complex surface water and groundwater models on an agreed periodic basis.	Refer to Section 9
	• Advise the relevant site of any in-field monitoring related incidents that may have cumulative relevance to the BTM sites.	As required

*or delegate

8.1 COMPLAINT MANAGEMENT

It is recognised that each mine within the BTM Complex has their own complaint handling and incident management protocols, including hotlines, and that these will continue to operate independently. The Water Management Strategy supports the use of the existing mechanisms, with individual mining operations investigating complaints that are raised with them. If the investigating mine considers the complaint to be potentially related to a cumulative impact, it will:

- Advise the other mines of the complaint and potential for cumulative impact as soon as practicable.
- Seek comments from other mines on the complaint/issue.
- Investigate the complaint jointly to determine if the impact was cumulative.
- Develop a response jointly to the complaint.
- Log the complaint on their complaints register where found to be cumulative impact.

9. REVIEW AND REVISION

The BTM Complex WMS has been developed with the input of representatives of BCM, TCM, and MCCM. It is proposed to review, and update if required, the WMS every three years. The review and update of the WMS will be undertaken by BTM, TCM and MCCM collectively. The review would include consideration of new or different monitoring technologies that could be incorporated into the cumulative monitoring program.

Each of the BTM Complex mines are required to prepare a "*Groundwater Management Plan, which includes… 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*". Accordingly, the cumulative groundwater model would be reviewed every three years. Any substantial and relevant changes to the model resulting from the review would be considered in the context of the WMS, and the WMS would be updated to reflect the changes if required. It is noted that this version of the WMS includes consideration of the report *Boggabri, Tarrawonga, Maules Creek Complex Numerical Model Update* prepared by AGE (2018).

The supporting site-specific WMPs and monitoring plans will be reviewed, and if necessary revised in accordance with Schedule 5, Condition 5 of each site-specific Project Approval:

> *Within 3 months of the submission of an:*
>
> *(a) annual review under condition 4 above;*
> *(b) incident report under condition 8 below;*
> *(c) audit under condition 10 below; or*
> *(d) any modification to the conditions of this approval,*
>
> *the Proponent shall review, and if necessary, revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary.*

The site-specific BCM, TCM and MCCM models undergo regular maintenance and recalibration as additional data on groundwater responses to progressive mining improves the understanding of the groundwater systems.

10. REFERENCES

AGE (Australasian Groundwater and Environmental Consultants) 2010, *Report on Continuation of Boggabri Coal Mine: Groundwater Assessment*, Parts 1 and 2, prepared for Boggabri Coal Pty Ltd, October 2010.

AGE (Australasian Groundwater and Environmental Consultants) 2011, *Maules Creek Coal Project Groundwater Impact Assessment*, prepared for Aston Resources Limited, June 2011.

AGE (Australasian Groundwater and Environmental Consultants) 2018, *Boggabri; Tarrawonga Maules Creek Complex Numerical Model Update*, August 2018.

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

BCOPL 2017, *Boggabri Coal Site Water Balance* (Revision 8), by Boggabri Coal Operations Pty Ltd, May 2017.

Canadell, J., Jackson, R.B., Ehleringer, J.B., Mooney, H.A., Sala, O.E. and Schulze, E.D. (1996) Maximum rooting depth of vegetation types at the global scale, Oecologia, 108(4), 583-595.

Cumerland Ecology 2011, *Ecological Assessment: Maules Creek Coal Project*, prepared for Hansen Bailey.

Department of Mineral Resources (DMR) 1998, *The Gunnedah Coalfield, Notes to accompany the 1:100,000 scale Gunnedah coalfield regional geology (north and south) maps*, Geological Survey Report NoGS 1998/505.

D. Young, personal communications, September 2012.

Fensham, R.J. and Fairfax, R.J. (2007) Drought-related tree death of savanna eucalypts: Species susceptibility, soil conditions and root architecture, Journal of Vegetation Science, 18: 71-80

Gilbert & Associates 2011, *Tarrawonga Coal Project Surface Water Assessment*, prepared for Whitehaven Coal, November 2011.

Hansen Bailey, 2010, *Continuation of Boggabri Coal Mine Project Environmental Assessment.* Singleton NSW.

Heritage Computing Pty Ltd 2011, *Peer Review of the Maules Creek Coal Project Groundwater Impact Assessment*, prepared for Aston Resources Ltd, February 2011.

Heritage Computing Pty Ltd, 2012a, *Cumulative Groundwater Management Protocol for Boggabri Coal Mine, Tarrawonga Coal Mine and Maules Creek Coal Project,* Report HC2011/15, draft prepared for Boggabri Coal Pty Ltd, Tarrawonga Coal Pty Ltd, Aston Resources Ltd, September 2012.

Heritage Computing Pty Ltd 2012b, *A Hydrogeological Assessment in Support of the Tarrawonga Coal Project Environmental Assessment*, prepared for Tarrawonga Coal Pty Ltd, January 2012.

NSW Department of Primary Industry Water , Maximum Harvestable Right Dam Calculator, accessed September 2012, available at: http://www.water.nsw.gov.au/Water-licensing/Basic-water-rights/Harvesting-runoff/Calculator/Calculator

NSW Department of Primary Industry Water , Namoi River Water Quality and River Flow Objectives, 1 May 2006, available at: http://www.water.nsw.gov.au/Water-licensing/Basic-water-rights/Harvesting-runoff/Calculator/Calculator

NSW Government, *Water Sharing Plan (WSP) for the Namoi Unregulated and Alluvial and Water Sources 2012, available at:* http://www.legislation.nsw.gov.au/viewtop/inforce/subordleg+493+2012+cd+0+N/

NSW Government, *Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2012,* http://www.legislation.nsw.gov.au/viewtop/inforce/subordleg+616+2011+cd+0+N/

NSW Government, *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003*, http://www.legislation.nsw.gov.au/viewtop/inforce/subordleg+1035+2002+FIRST+0+N/

Parsons Brinckerhoff 2010, *Continuation of Boggabri Coal Mine Project – Surface Water Assessment*, prepared for Hansen Bailey Pty Ltd as part of the Environmental Assessment, October 2010.

Parsons Brinckerhoff 2012, *Boggabri Coal Project – Annual Groundwater Monitoring Review*, March 2012.

Parsons Brinckerhoff 2014a, *Boggabri Coal Project Groundwater Management Plan* (final, version 5), prepared for Boggabri Coal Pty Ltd, February 2014.

Parsons Brinckerhoff 2014b, *Boggabri Coal Project Surface Water Management Plan* (final, version 5), prepared for Boggabri Coal Pty Ltd, February 2014.

Parsons Brinckerhoff 2015, *Boggabri Coal Mine - Project Approval Modification Environmental Assessment (MOD 5)*, for Idemitsu Australia, November 2015

RGS Environmental Pty Ltd 2009, *The Boggabri Continuation of Mining Project - Geochemical Assessment of Overburden and Potential Reject Materials*, November 2009.

Schlumberger Water Services (Australia) Pty Ltd 2012, *Namoi Catchment Water Study Independent Expert Final Study Report*, prepared for Department of Trade and Investment, Regional Infrastructure and Services, July 2012

SLR Consulting Australia Pty Ltd 2014, *Site Water Balance – Tarrawonga Coal Mine,* prepared for Whitehaven Coal, February 2014

Smith S 2009, Mining & the Environment - Briefing Paper No. 6/09, New South Wales Parliamentary Library Research Service July 2009, viewed 18 May 2011, <http://www.parliament.nsw.gov.au/prod/parlment/publications.nsf/0/6C4E3081F6C87AAFCA2575E700010209/$File/Mining%20and%20the%20environment%20BP%206%2009.pdf>

Whitehaven Coal Pty Ltd 2011, *Tarrawonga Water Management Plan*, March 2011 (Includes R.W Corkery & Co Pty Ltd, Groundwater Contingency Plan for the Tarrawonga Coal Mine, prepared for Tarrawonga Coal Pty Ltd, October 2006).

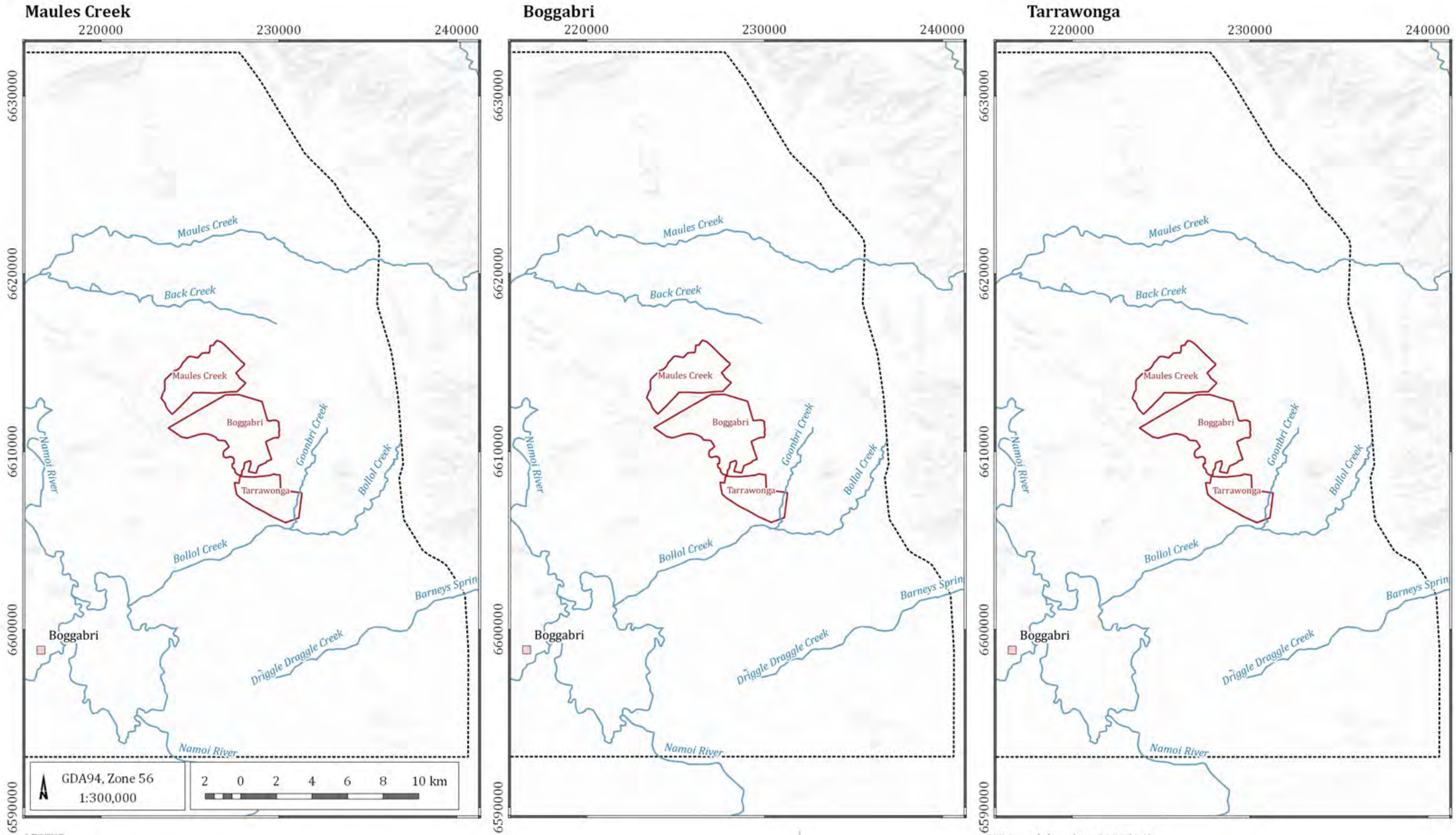
WRM Water and Environment 2009, *Continuation of Boggabri Coal Mine- Namoi River Flood Impact Assessment*, prepared for Hanson Bailey, December 2009.

WRM Water and Environment 2011, *Surface Water Impact Assessment for Maules Creek Project*, prepared for Aston Resources, February 2011.

WRM Water and Environment 2014, *Maules Creek Water Management Plan,* prepared for Whitehaven Coal, March 2014

APPENDIX A

SITE-SPECIFIC CONTRIBUTION TO CUMULATIVE GROUNDWATER DRAWDOWN (FROM AGE [2018])



LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

0	60
10	70
20	80
30	90
40	100
50	Drawdown contribution percentage contour

BTM model update (G1850A)

AGE

Percentage of simulated drawdown attributed to each mine at end 2019 - Layer 1 - Narrabri alluvium

DATE
29/03/2017

FIGURE No:
D.1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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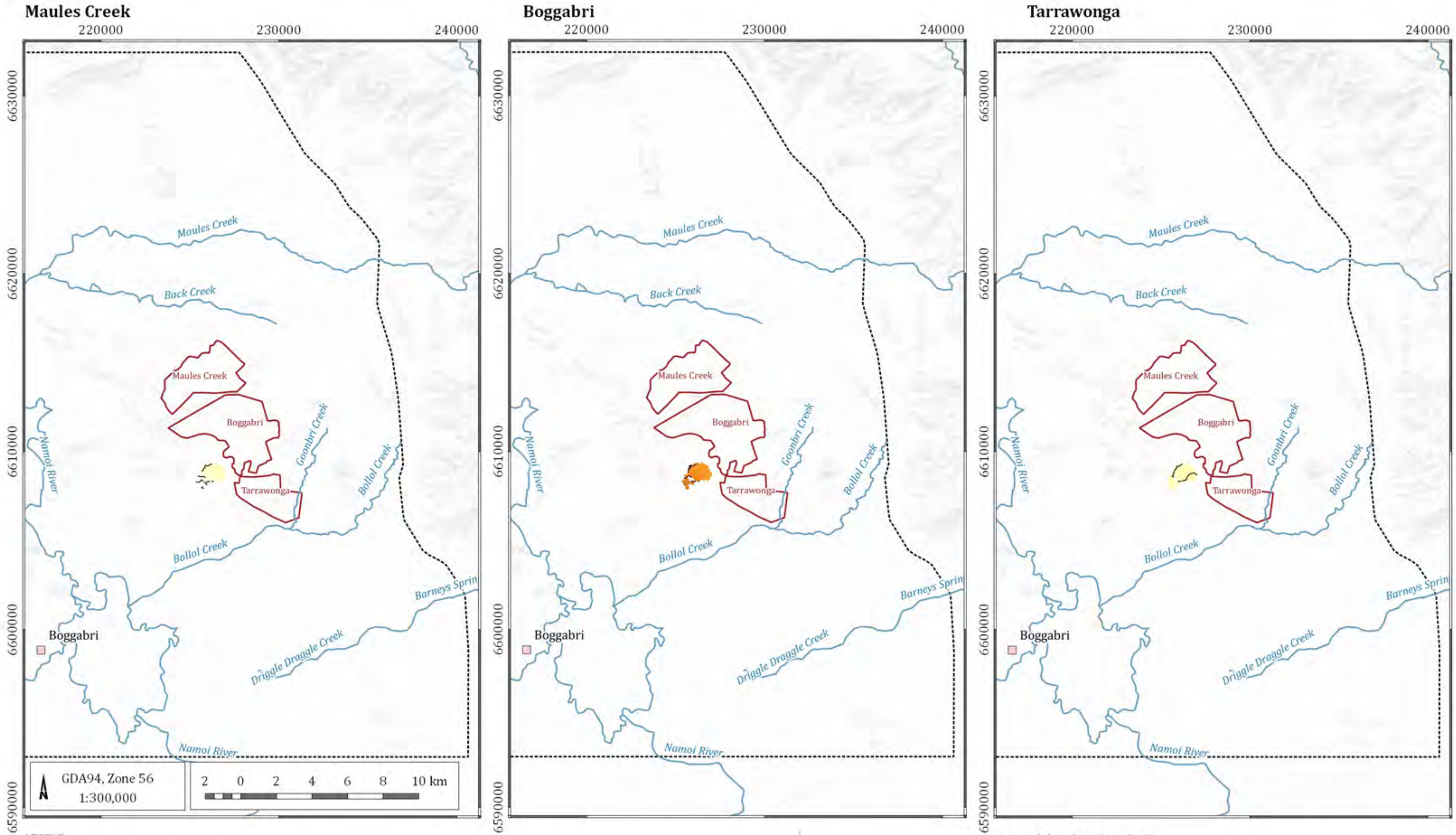

LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

0	60
10	70
20	80
30	90
40	100
50	Drawdown contribution percentage contour

BTM model update (G1850A)

Percentage of simulated drawdown attributed to each mine at end 2019 - Layer 2 - Gunnedah alluvium

DATE
29/03/2017

FIGURE No:
D.2

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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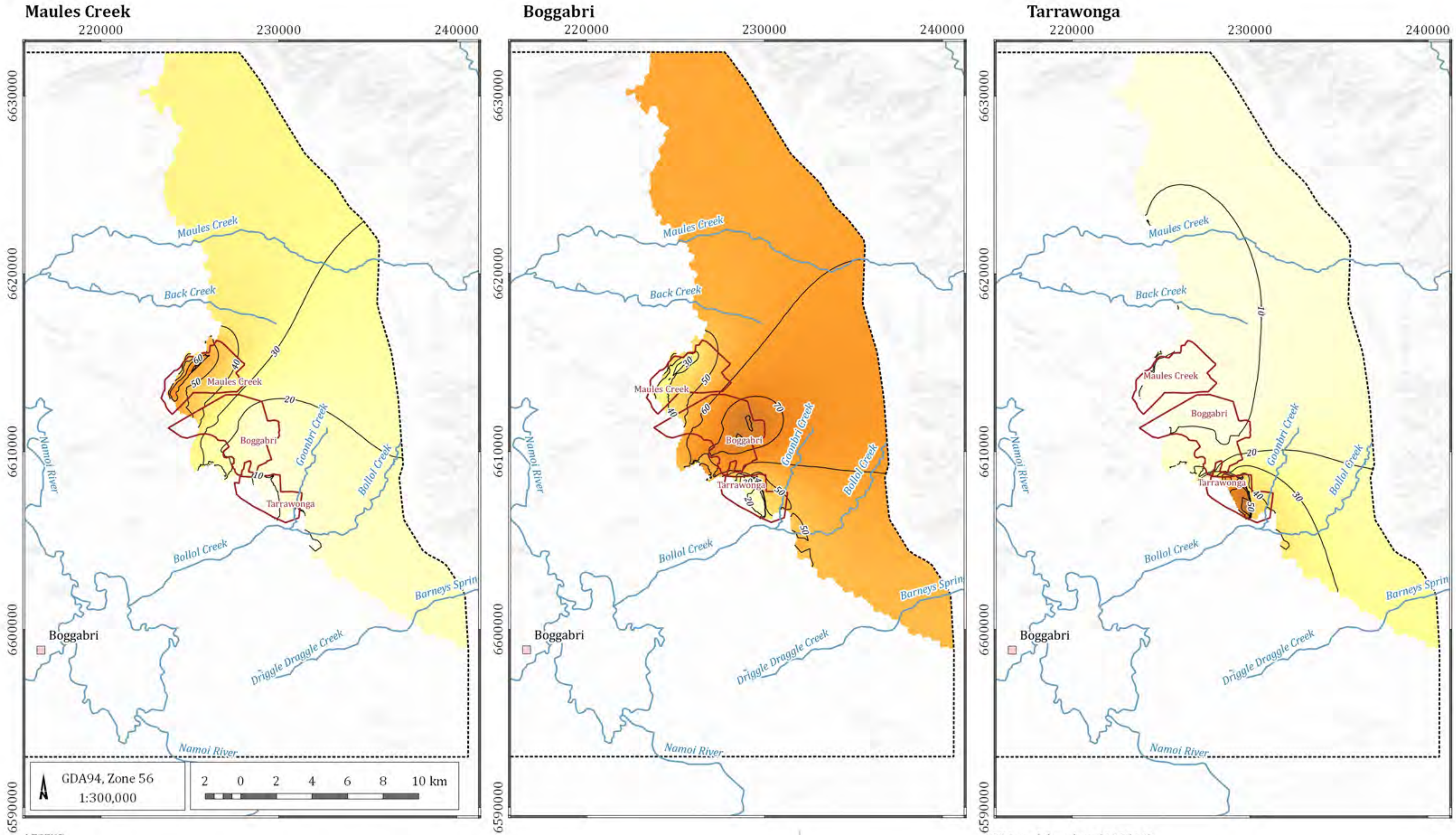

LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Drawdown contribution percentage contour

BTM model update (G1850A)

AGE

Percentage of simulated drawdown attributed to each mine at end 2019 - Layer 8 - Merriown seam

DATE
29/03/2017

FIGURE No:
D.3

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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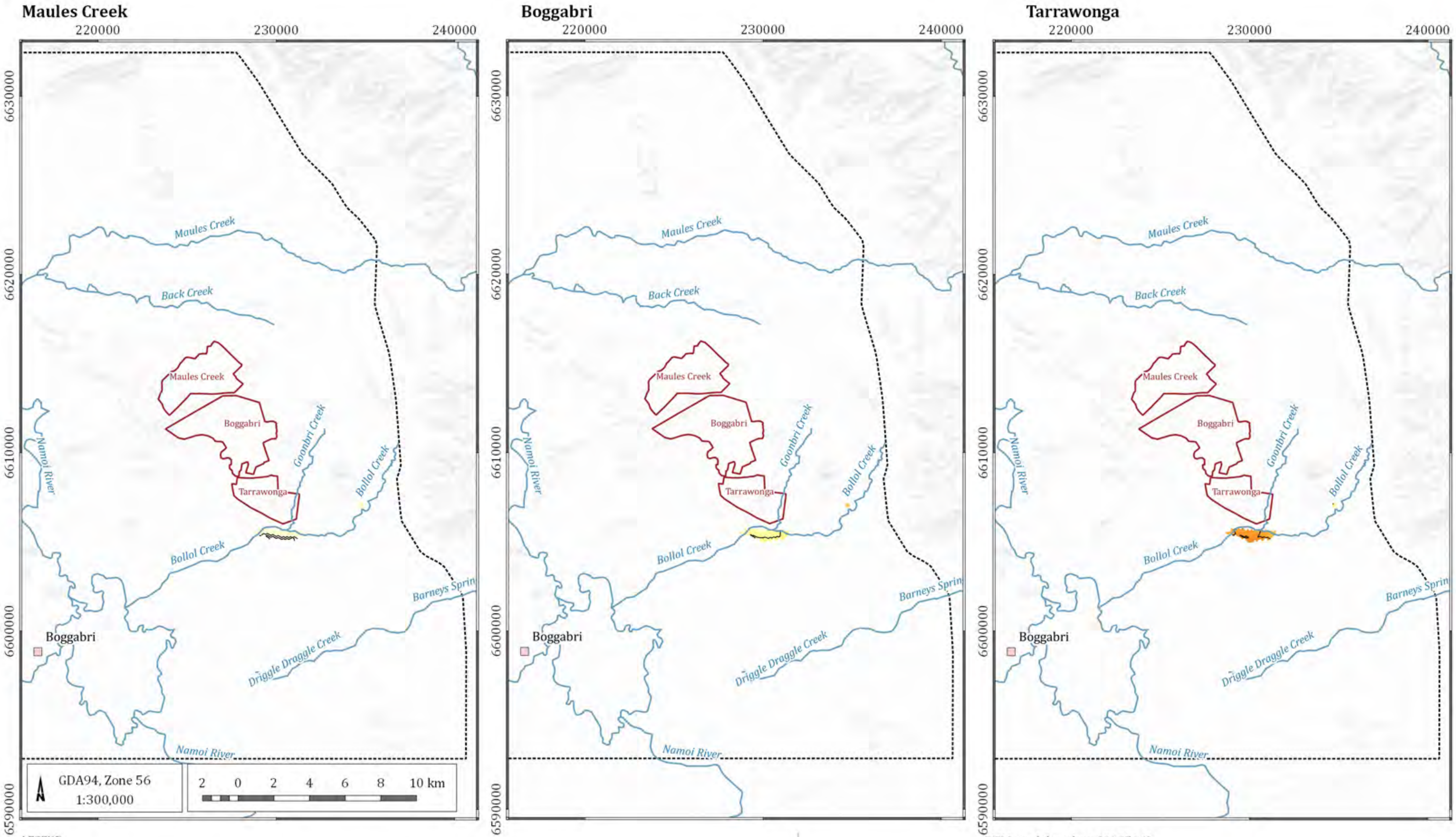

LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Drawdown contribution percentage contour

BTM model update (G1850A)

AGE

Percentage of simulated drawdown attributed to each mine at end 2029 - Layer 1 - Narrabri alluvium

DATE 29/03/2017

FIGURE No: **D.4**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;

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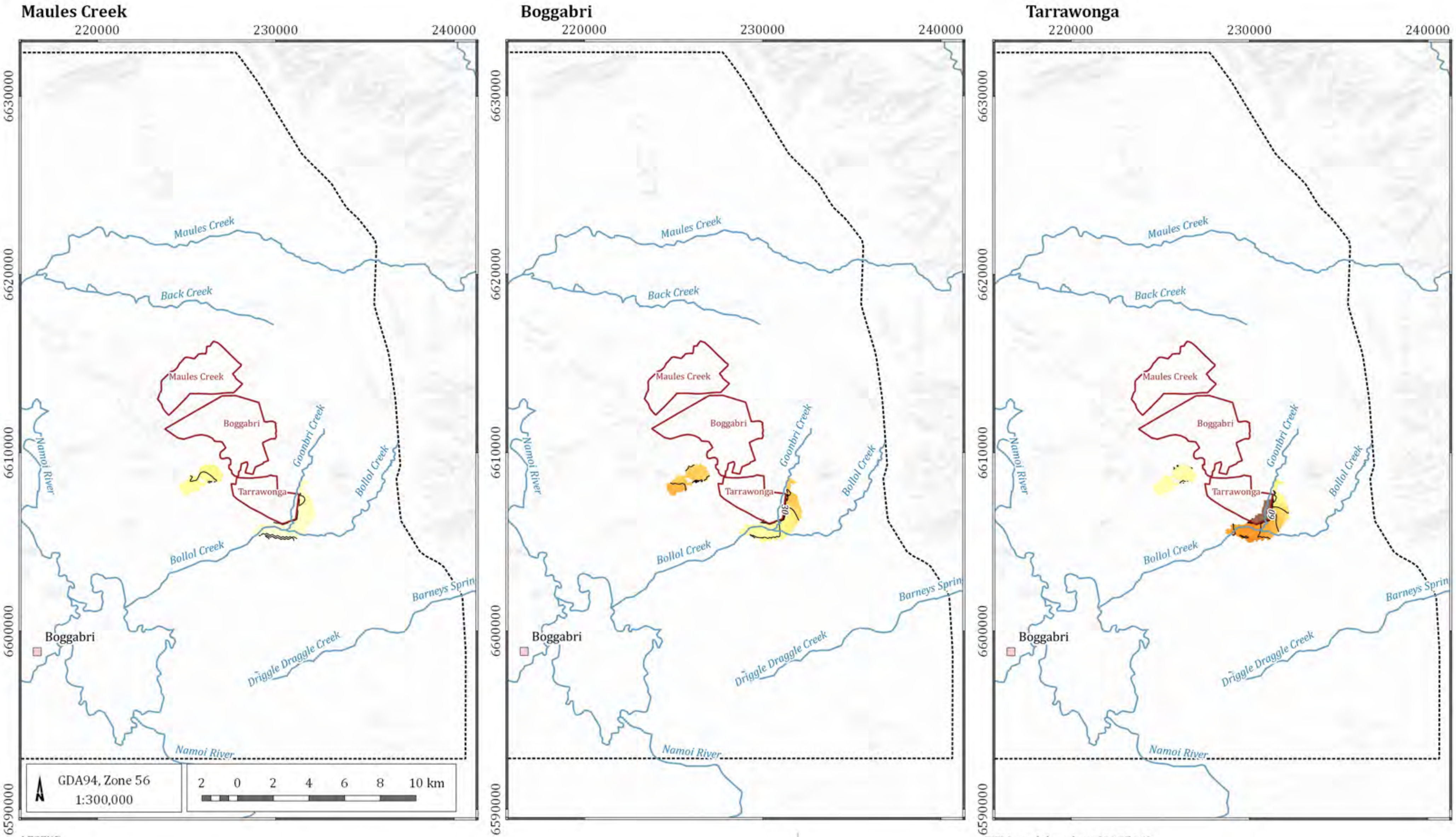

LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Drawdown contribution percentage contour

BTM model update (G1850A)

Percentage of simulated drawdown attributed to each mine at end 2029 - Layer 2 - Gunnedah alluvium

DATE
29/03/2017

FIGURE No:
D.5

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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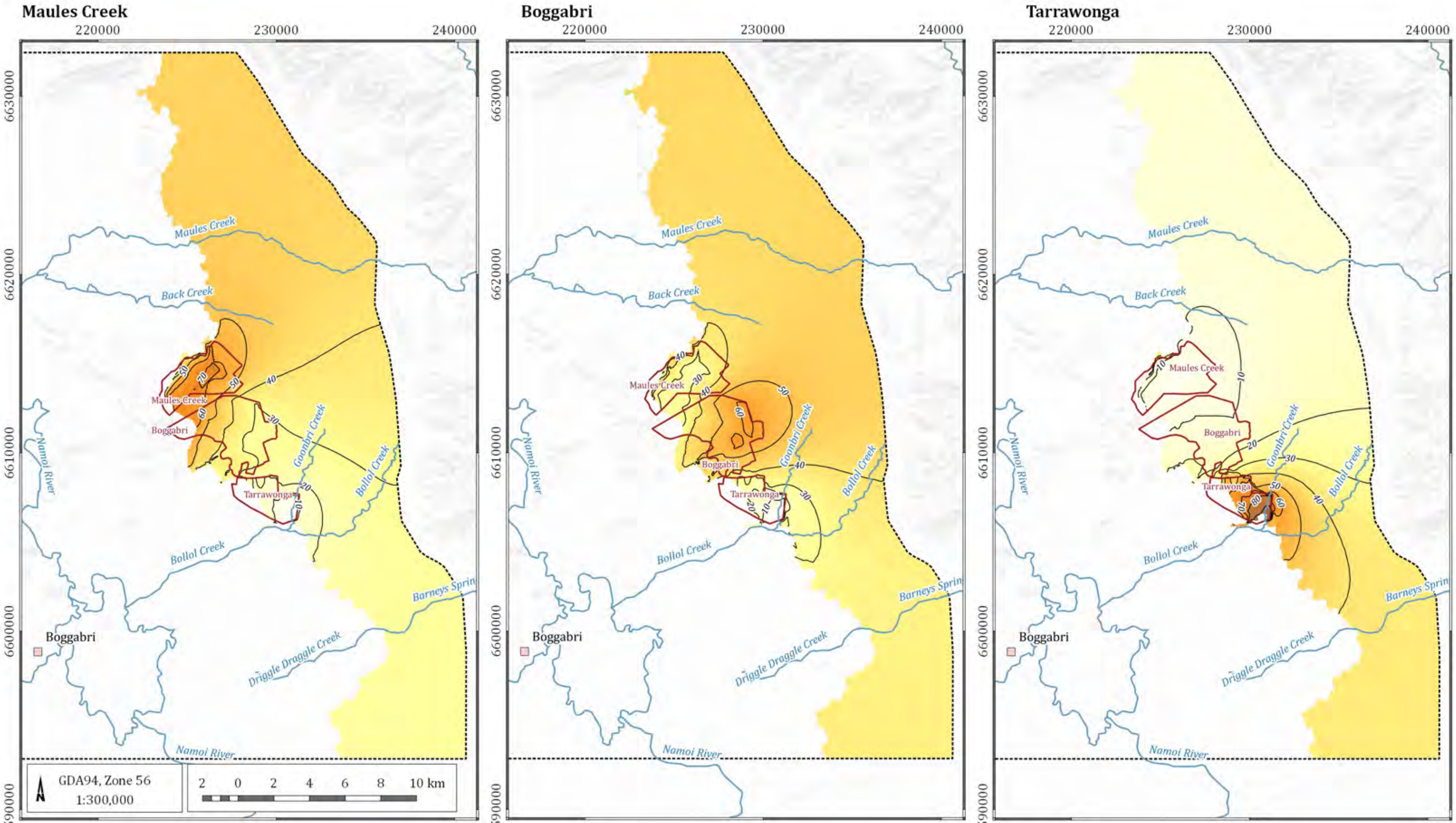

LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Drawdown contribution percentage contour

BTM model update (G1850A)

Percentage of simulated drawdown attributed to each mine at end 2029 - Layer 8 - Merriown seam

DATE
29/03/2017

FIGURE No:
D.6

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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APPENDIX F – WMP Addendum Containing Evaporator Fan Operational Protocol

WATER MANAGEMENT PLAN ADDENDUM

USE OF EVAPORATOR FANS FOR MINE WATER MANAGEMENT

Approval	Name	Position	Signed	Date
Document Owner:	Megan Martin	Env Supt	M.Martin	8/9/22
Authorised by:	Daryl Robinson	Environment and Rehabilitation Mgr	[signature]	8/9/22

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2 MINE WATER MANAGEMENT – USE OF EVAPORATOR FANS 3

3 OPERATIONAL PROTOCOL 8

3.1 IMPACT MITIGATION 8

3.1.1 NOISE 8

3.1.2 SPRAY DRIFT 8

1 PURPOSE

The Tarrawonga Coal Mine (**TCM**) Water Management Plan is required to include details of water management on site and a description of the mine water management systems.

This addendum to the TCM Water Management Plan provides for the use of mobile evaporator fans as a supplementary measure to manage surplus mine water on site. The evaporator fans will be used for the purpose of ensuring that mine water is effectively and safely managed on site (especially after prolonged periods of heavy rainfall).

Once this addendum is approved by the Planning Secretary, it will form part of the TCM Water Management Plan which is required to be implemented under the TCM State significant development consent (PA 11_0047).

2 MINE WATER MANAGEMENT – USE OF EVAPORATOR FANS

Water pumped out of the active mining areas (mine water) is stored in Pit Water Dam (**PWD**) 6 (Figure 1). This water is utilised for dust suppression on roads in the active mining and production areas. Water for dust suppression is pumped into water carts via standpipes.

During periods of higher rainfall, when inflows into the pit exceed the water demand for dust suppression, TCM will accelerate the evaporation of mine water by utilising mobile evaporator fans. Mine water stored in PWD6 will be pumped to the evaporator fans located on the highwall of the pit (Figure 2). These evaporator fans will assist in mine water management by increasing the mine water loss to evaporation (by 'misting' the water pumped through them, increasing the surface area of the water and therefore exposing it to higher rates of evaporation). The use of the evaporator fans will reduce the volume of mine water stored on site. This will assist in ensuring that adequate storage is maintained on site for safely managing mine water.

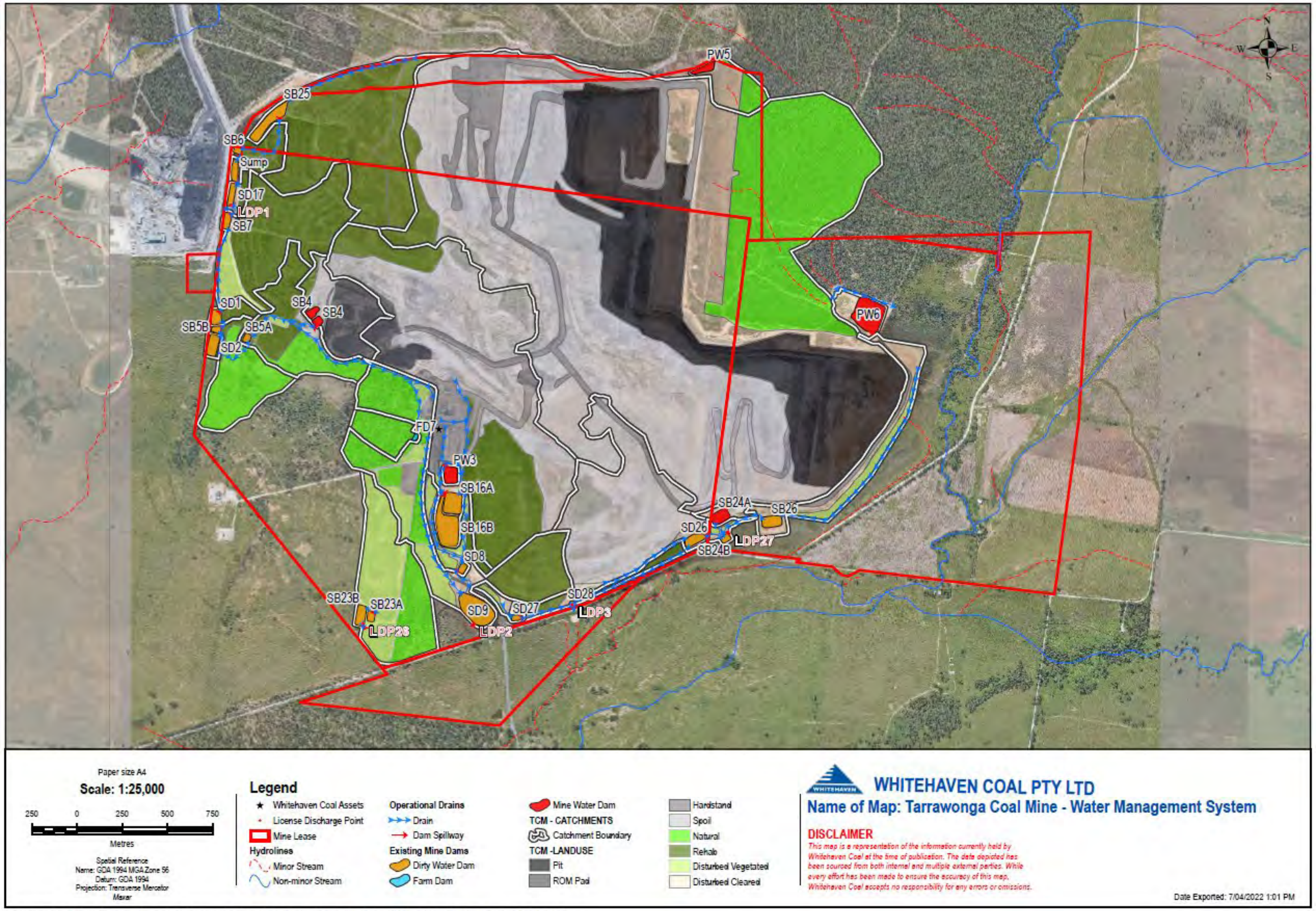
An updated Site Water Balance including the operation of these fans is included in Table 1. The Water Management System (including the evaporator fans) is depicted schematically in Figure 3.

The evaporator fans will be located on the highwall and water 'misted' through them will evaporate over the void/open cut. The evaporator fans will be placed and operated such that the spray does not drift outside of the approved disturbance area.

Evaporator fans will generally be operated in daylight hours. If good evaporation conditions are present beyond daylight hours (for example, on a hot summer evening) the fans may be operated outside of daylight hours. The evaporator fans will each pump up to 2ML of water through them per day. This amount may vary depending on the weather conditions. Wind speed, ambient temperature and humidity also impact the evaporation potential. In highly suitable weather conditions, each evaporator fan may evaporate more than 1.5ML per day. An operational protocol for the fans is outlined in Section 3.

Table 1: Site Water Balance

	Description	Very Dry Year 2019 (ML/year)	Dry Year 2018 (ML/year)	Median Year 2011 (ML/year)	Wet Year 2021 (ML/year)	Very Wet Year 1950 (ML/year)
Water Source (Inputs)	Total runoff	332	510	825	1,840	4,182
	Groundwater inflow	73	73	73	73	73
	Moisture in coal	256	256	256	256	256
	External water	0	0	0	0	0
	Total Input	**661**	**839**	**1,154**	**2,169**	**4,511**
Water Losses and Usage (Outputs)	Evaporation (from water storage)	176	190	204	292	434
	PW6 Fan Evaporation	***134***	***151***	***149***	***156***	***156***
	Moisture loss in coal	256	256	256	256	256
	Crusher dust suppression	35	35	35	35	35
	Haul road and ROM pad dust suppression	622	644	673	555	575
	Vehicle washdown	1	1	1	1	1
	Offsite and licensed discharges	0	0	0	36	624
	Water contained in spoil	112	156	279	525	1,226
	Total Output	**1,336**	**1,433**	**1,597**	**1,856**	**3,307**
Water Surplus/Deficit	**Total Input-Total Output**	**-675**	**-594**	**-443**	**313**	**1,204**



Path: C:\Local_Copy\7. WHC GIS Projects_WHITEHAVEN COAL WATER\1. WHITEHAVEN COAL WATER MANAGEMENT SYSTEM\WHITEHAVENCOAL_WATER_MANAGEMENT_SYSTEM.aprx

Figure 1: Water Management System Layout

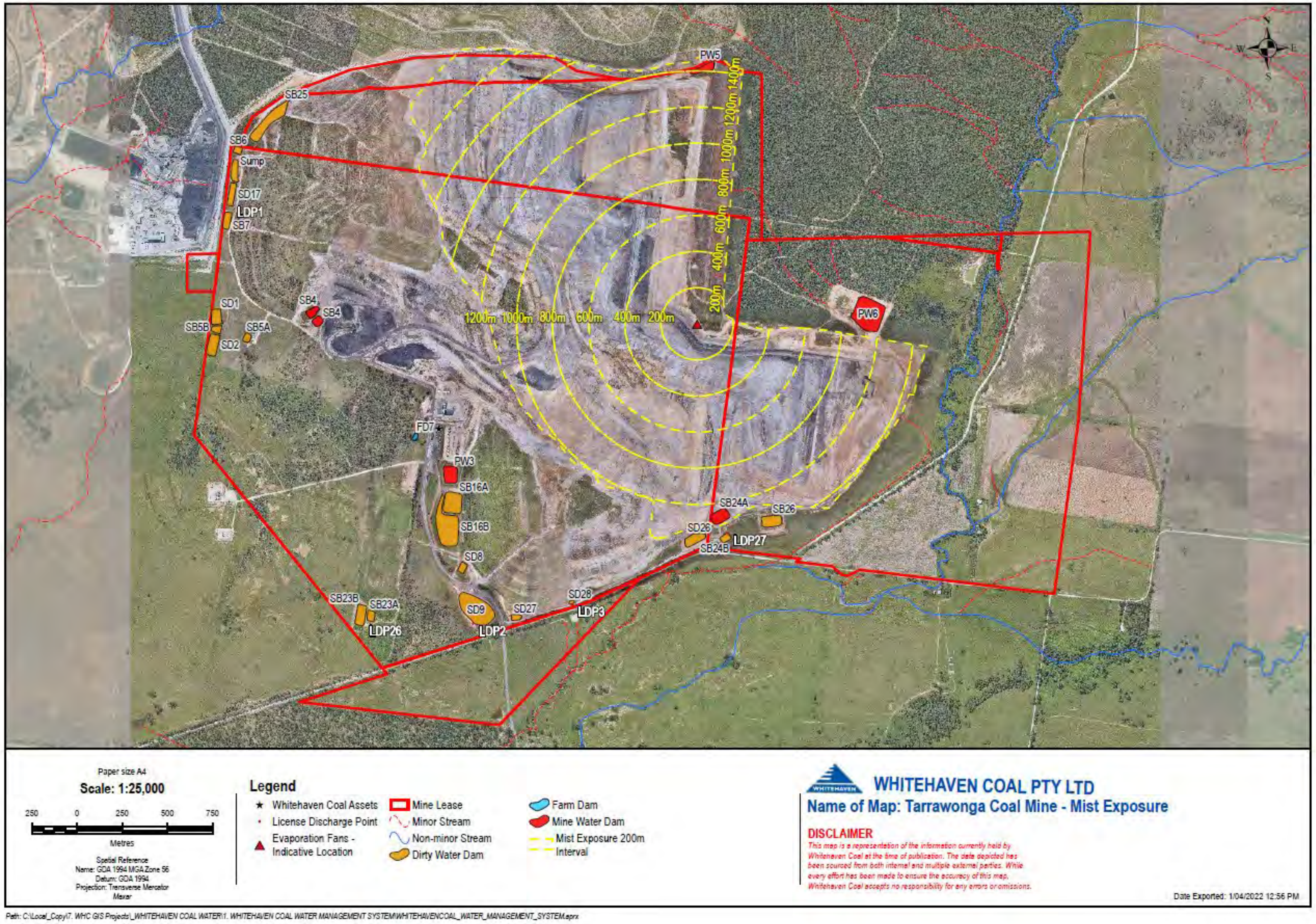


Figure 2: Location of Evaporator Fans and Distance from Boundary

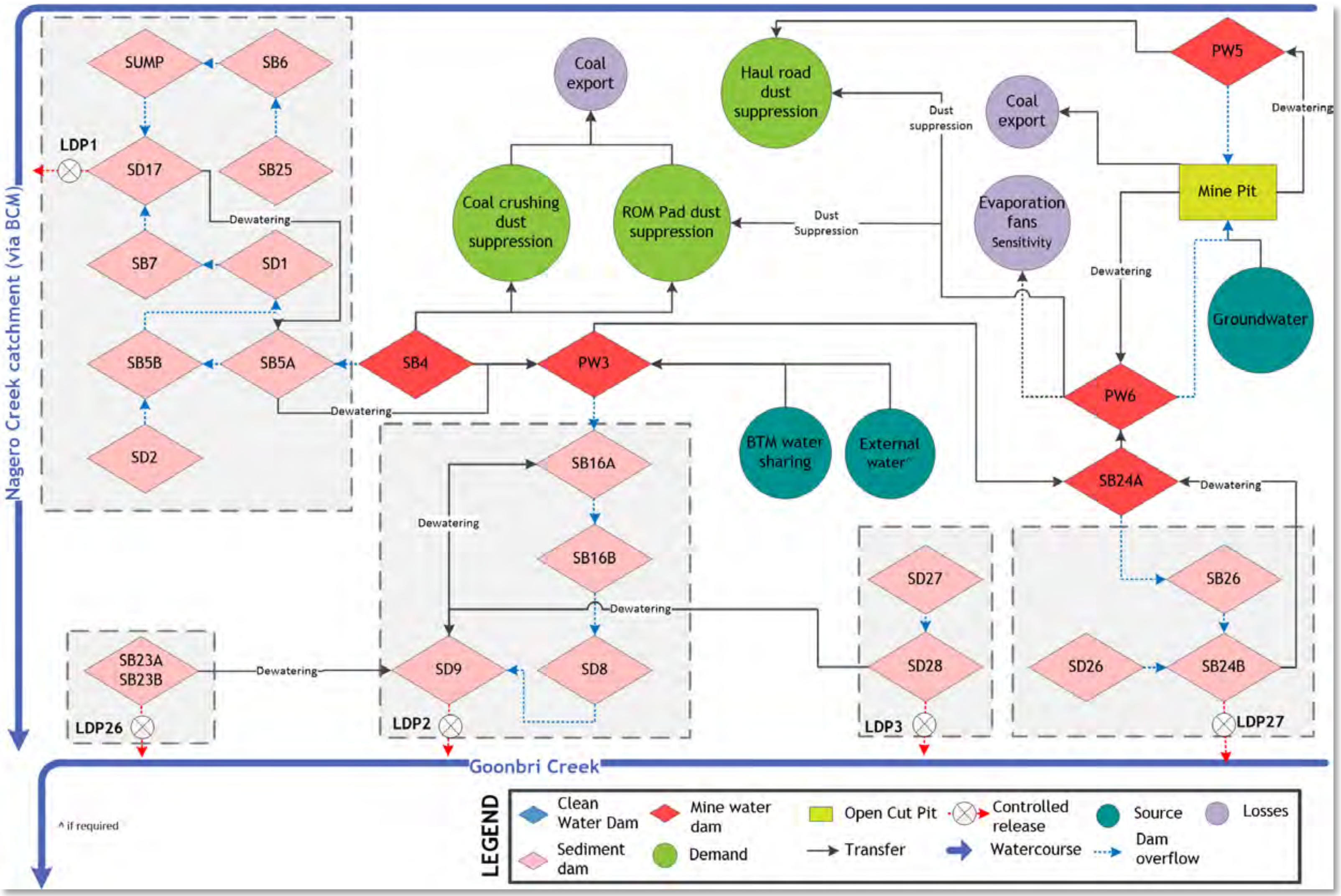


Figure 3: Tarrawonga Water Management System

3 OPERATIONAL PROTOCOL

Mine water stored in PW6 (Figure 1) will be pumped through a surface pipe to the evaporator fans. This pipeline will be positioned so as to ensure that any leaks from the pipe would be securely captured in a bund or the open cut pit/void, and would not spill outside of the approved disturbance boundary. The evaporator fans and associated pipeline will be regularly monitored to ensure that they are properly maintained and operated. As depicted in Figure 2, the indicative location of the evaporator fans is approximately 500m from the project boundary and Mining Lease (ML) extent.

3.1 IMPACT MITIGATION

3.1.1 NOISE

The operation of the evaporator fans is not expected to result in significant noise impacts and the noise impacts of ongoing operations (including the operation of the evaporator fans) would continue to be managed in accordance with the noise conditions of the TCM State significant development consent (PA 11_0047) and environment protection licence (12365).

TCM engaged RWDI to carry out a noise assessment of the evaporator fans. From this assessment, it is predicted that the received noise level from the use of evaporator fans would be negligible in comparison with the noise emissions from the assessed TCM operations (Modification Year 3), with an incremental change of only 0.1 dB at one receiver (RWDI, 2022). Therefore, the evaporator fans are not expected to impact on the acoustic amenity of the surrounding community. Based on this noise assessment, the use of the evaporator fans is not expected to generate maximum noise level events, and compliance with the LA1, 1min noise criterion at night would be achieved at all surrounding privately-owned receivers (as stated above, the evaporator fans will generally be operated in daylight hours).

The evaporator fans will be included in the annual sound power level testing of all noise generating equipment on site at TCM. Attended noise monitoring and continuous noise monitoring will continue at TCM. In the unlikely event that the evaporator fans impact received noise levels on private land above the predicted levels in the Modification 7 Noise Assessment, this routine noise monitoring would identify this and the noise impacts of the evaporator fans. Any impacts would be mitigated by altering the hours of operation. If any exceedance of the applicable noise criteria eventuated during attended monitoring, the evaporator fans would be turned off until it is assessed that the evaporator fans can continue to be operated without causing any exceedance of the applicable noise criteria. Any exceedances would be reviewed and reported if required in accordance with the Tarrawonga Noise Management Plan.

3.1.2 SPRAY DRIFT

As described in Section 2, the fans will be located and operated from the highwall of the pit. They will be located in a central position between the TC and TN pits where the spray mist will be directed over the void. The evaporator fans will be operated to ensure that spray drift is directed over the void and does not leave the approved disturbance boundary of the project.

Information provided by the manufacturer of the fans indicates that the maximum horizontal distance from the fan that spray could drift is ordinarily 30m (Figure 4). The spray would be directed up to a height of 20m above the fan (Figure 4).

As wind would affect the spray, the fans will not be operated when wind speeds are above 3.5m/s and emanating from a southerly or south-westerly direction (to ensure that spray does not drift outside the approved disturbance boundary).

Weather forecasts will be utilised to predict which days will be unsuitable for evaporator fan operation. Evaporator fans will not be operated if the forecast predicts predominantly southerly winds (to ensure that spray does not drift outside the approved disturbance boundary). In addition, wind direction and velocity alerts will be added to the SMS and email alert system linked to the weather station for TCM. Winds adverse to fan operation (i.e. above 3.5m/s and emanating from a S or SW direction) will trigger a SMS and email alert to certain personnel that will include the OCE, Environmental personnel, Operations Manager, Mine Services Superintendent and Production Superintendent. When this alert is received, the evaporator fans will be switched off.

In addition to weather monitoring, visual monitoring will be undertaken on the operating evaporator fans by the OCE during their routine inspections. In the unlikely event of any spray being observed consistently drifting in a north or north-easterly direction (that is away from the void) the evaporator fans will be switched off.

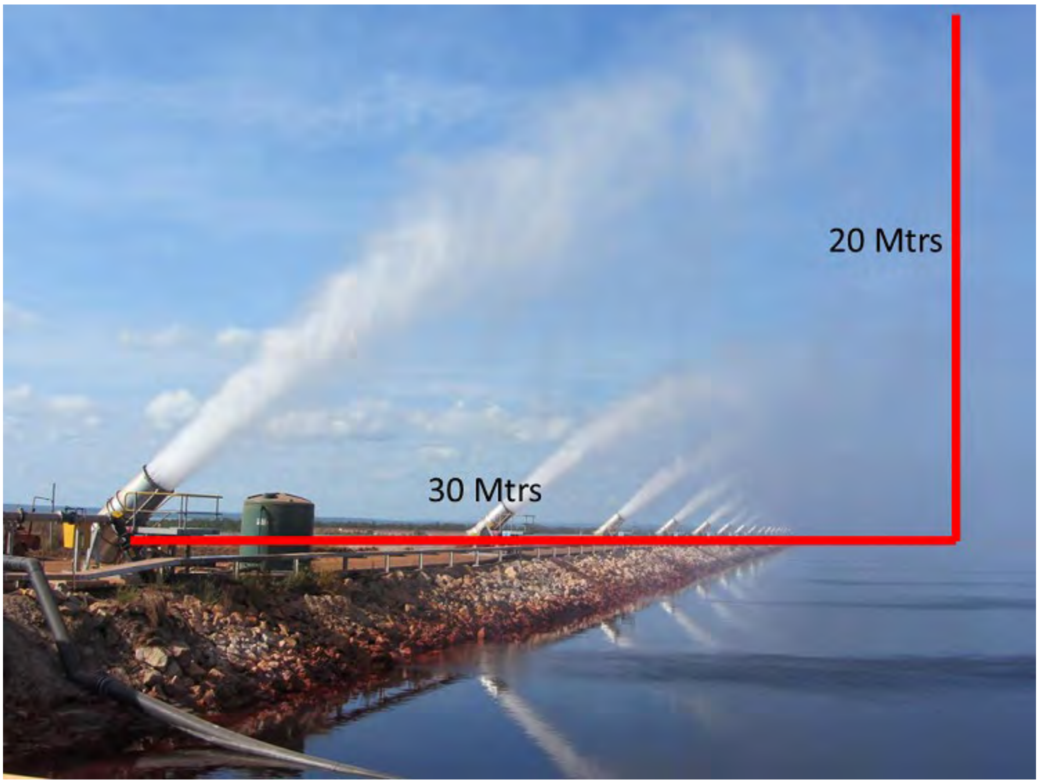


Figure 4: Example Spray from Evaporator Fan Operation (Minetek)

Revisions	Revision Description	Who Consulted	Date
1	Document Developed	WHC Group Water Manager, Tarrawonga Operations Manager, GOC Environment Manager	22/8/22
2	Comments addressed form DPE water	Group Water Manager	8/9/22

Department of Planning and Environment

Our ref: MP11_0047-PA-34

Tony Dwyer
Group Manager – Approvals and Environment
Tarrawonga Coal Pty Ltd
PO Box 600
Gunnedah, NSW, 2380

01/09/2023

Tarrawonga Coal Expansion: Water Management Plan

Dear Mr. Dwyer

Thank you for submitting the Water Management Plan in accordance with Condition 39, Schedule 3 of the consent for the Tarrawonga Coal Expansion (MP11_0047-PA-34). I also acknowledge your response to the Department's review comments and request for additional information.

The Water Management Plan has been prepared in consultation with DPE Water, BCD, and Local Land Services.

I note the following documents will be submitted to the Department as separate tasks:

- a Goonbri Creek Flood Assessment Report, and
- a revised Leard Forest Mining Precinct Water Management Strategy

Accordingly, as nominee of the Planning Secretary, I approve the Water Management Plan (Rev.8, August 2023).

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Charissa Pillay on 02 99955944.

Yours sincerely

Wayne Jones
Team Leader - Post Approval
Resource Assessments

As nominee of the Planning Secretary