WERRIS CREEK COAL

WATER MANAGEMENT PLAN

Edition	Rev.	Comments	Author	Authorised By	Date
1	1	First Draft for WCC Approval	Environ	WCC	26 March 2012
5	H	Annual Review Revision	A Wright	P Easey	31 October 2013
6	I	Annual Review Revision	A Wright	A Wright	27 May 2014
8	K	Final – Removal of Coal Contact Water	A Wright	R Hicks	17 July 2015
9	A	Draft – MOD2 Revision	M Hammond	R Hicks	14 January 2016
9	C	Final – following comments from DP&E	M Hammond, N Archer (SLR)	R Hicks	10 May 2016
9	D	Draft - following further comments from DP&E and DPI-W	L Cini, P Delaney (SLR)	R Hicks	25 January 2017
9	1	Final – incorporating comments from DP&E and DPI-W	L. Cini	R Hicks	10 March 2017
9	2	Updated Irrigation Management Plan	L. Cini	R Hicks	November 2017

CONTENTS

FIGURES

TABLES

ACRONYMS USED THROUGHOUT THIS DOCUMENT

AR	-	Annual Report
ANZECC	-	Australian and New Zealand Environment and Conservation Council, Guidelines for Fresh and Marine Water Quality, 2000.
AS	-	Australian Standard
CCC	-	Community Consultative Committee
DP&E	-	Department of Planning and Environment
DA	-	Development Approval
DGM	-	Means the three-day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples.
DPI-W	-	Department of Primary Industries - Water
EA	-	Environmental Assessment
EC	-	Electrical Conductivity
EL	-	Exploration License
EPA	-	Environment Protection Authority
EPL	-	Environment Protection License
GW	-	Groundwater Works
IMP	-	Irrigation Management Plan
Km	-	Kilometre
I&I NSW	-	Industry & Investment NSW
LOM	-	Life of Mine
m	-	metre
mg/L	-	milligrams per litre
ML	-	Mining Lease
ML	-	Million Litres
MOP	-	Mining Operations Plan for the Werris Creek Coal Mine, December 2015
OEH	-	Office of Environment and Heritage
PA	-	Project Approval
ROM	-	Run-Of-Mine
RLF	-	Rail Load-out Facility
RWC	-	RW Corkery and Associates Pty Limited
VWD	-	Void Water Dam
WAL	-	Water Access License
WCC	-	Werris Creek Coal Pty Ltd
WCC	-	Werris Creek Coal Mine
WMP	-	Water Management Plan (formerly SWMP – Site Water Management Plan)
µS/cm	-	microsiemens per centimetre

1 INTRODUCTION

The Werris Creek Coal Mine (WCC) is operated by Werris Creek Coal Pty Limited (WCC) and is located within the North West Slopes and Plains of New South Wales, approximately 45km south west from Tamworth (**Figure 1-1**). WCC is located approximately 4km south of Werris Creek and 11km north-northwest of Quirindi.

WCC was granted Project Approval (PA) 10_0059 on the 25th October 2011 by the Minister of Planning and Infrastructure for the Life of Mine (LOM) project. The Project involves a northerly extension of the current mine footprint, increasing the projected mine life by approximately 10 to 15 years. PA 10_0059 has subsequently been modified twice under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as follows:

- Modification 1 (10_0059 MOD1) dated 30th August 2012 allowing for the relocation of some surface infrastructure.
- Modification 2 (10_0059 MOD2) dated 3rd November 2015 allowing for minor overburden emplacement changes, agricultural water supply, coal deshaling plant and SB18, and is hereafter referred to as the Modified PA.

To satisfy Condition 23, Schedule 3 of PA 10_0059, WCC is required to prepare and implement a Water Management Plan for the project. The plan has also been prepared to meet the management plan requirements specified in Condition 2, Schedule 5 of the Project Approval, the commitments made in LOM Project and Modification 2 Environmental Assessments (EA), Environment Protection Licence (EPL) 12290 and other water licensing requirements.

This Water Management Plan (WMP) has been developed using a risk management process that follows hazard identification, impact assessment, development of management and mitigation measures and contingency planning. The WMP summarises the results of the surface water and groundwater impact assessments and outlines the control measures to be implemented as a part of the continued operations at WCC to minimise the potential for water impacts on the local community and the environment. The WMP also contains a monitoring program, developed to quantify any water quality impacts of the operation and to assess compliance against the relevant water criteria and also includes the reporting and record keeping requirements to be maintained throughout the mining operations

This WMP has been prepared in consultation with the DP&E, DPI-W, and EPA.

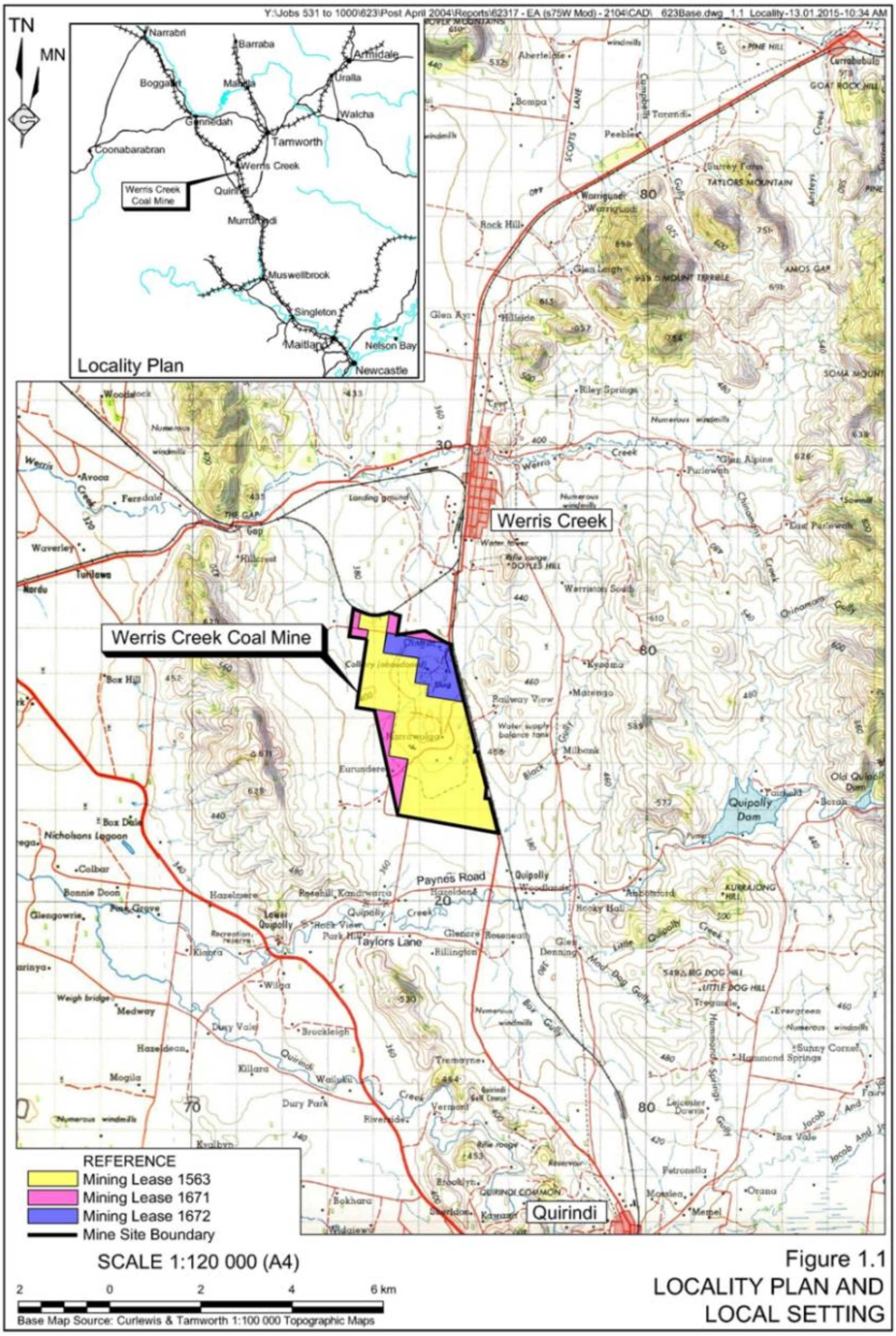

Figure 1-1 Locality Plan and Local Setting (modified from Figure 1.1 R.W. Corkery & Co, 2015)

1.1 Project Description

WCC has approval to mine in full, the Werris Creek coal measures which occur as a synclinal (bowl-shaped) formation to the immediate south of Werris Creek. **Figure 1-2** provides the layout of WCC, as approved by the Modified PA.

Overburden and interburden generated by the progressive exposure of the coal seams is placed within an overburden emplacement which in-fills the mined-out void of the open cut and extends around the south western, southern and western perimeter of the open cut. The overburden emplacement is limited in lateral and vertical extent by the Modified PA (see **Figure 1-2**). The overburden emplacement of WCC is progressively rehabilitated as the RL445 dump is extended northward, in-filling the advancing active void.

Coal mined is placed on a ROM Pad to the west of the open cut where it is crushed, screened and further beneficiated as required before being transferred to a Product Coal stockpile adjacent to the Werris Creek Rail Siding. The majority of product coal is loaded into trains from a Rail Load-out Facility (RLF). The Modified PA permits the incorporation of a new Dry Separation Plant as along with the supply of surplus void water for agricultural activities on and surrounding WCC, amongst other changes.

1.2 Purpose

The purpose of the WMP is to:

- Address and comply with the relevant conditions of the Modified PA, Environment Protection Licence (EPL) 12290 and Water Access Licences (WAL) 32224 and WAL29506;
- Consolidate information relating to baseline conditions and potential impacts from operations associated with the WCC;
- Outline measures to minimise the water related impacts from the WCC on the surrounding community and environment;
- Establish water monitoring programs to assess and report on the level of impact on water as required by statutory approvals; and
- To keep the local community and relevant agencies informed and to provide a mechanism to respond to water issues and complaints effectively.

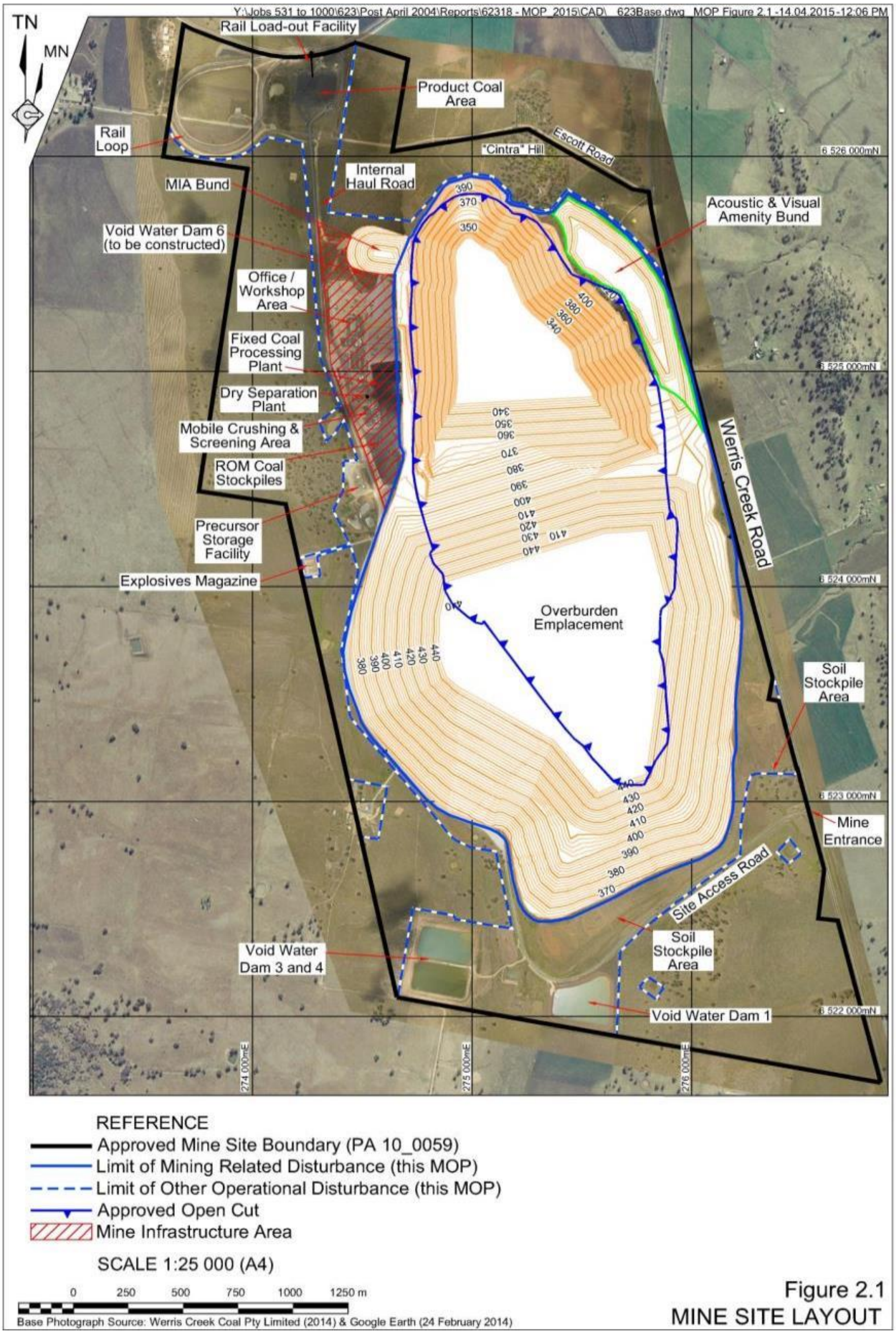

Figure 1-2 WCC MOD2 Layout (from Figure 2.1 RWC 2015b-MOP)

2 STATUTORY REQUIREMENTS

The WMP has been prepared in accordance with the requirements established under various legislative instruments, which are outlined in the following sections.

2.1 Mining Leases ML1563, ML1671, and ML 1672

The WMP has been prepared in accordance with the conditions listed in each of the mining leases ML1563, ML1671, and ML1672, including the *Mining Operations Plan for the Werris Creek Coal Mine, December 2015*, which covers mining operations at WCC. **Table 2-1** summarises the key conditions relating to Water Management required by the mining lease approvals.

Table 2-1 Relevant Conditions from each Mining Lease Approval

Condition	Condition Requirement	Section in this WMP where addressed
16	**Prevention of Soil Erosion and Pollution** Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution (including sedimentation) or soil contamination or erosions, unless otherwise authorized by a relevant approval, and in accordance with an accepted Mining Operations Plan. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwaters. The lease holder must observe and perform any instructions given by the Director-General in this regard.	Section 6 and 7
ML1671 and ML1672		
Condition	**Condition Requirement**	**Section in this WMP where addressed**
2.	**Environmental Harm** (a) The lease holder must implement all practicable measures to prevent and/or minimize any harm to the environment that may result from the construction, operation or rehabilitation of any activities under this lease.	Section 6
12.	**Prevention of soil erosion and pollution** Prospecting operations must be carried out in a manner that does not cause or aggravate air pollution, water (including groundwater) pollution, soil contamination or erosion, unless otherwise authorized by a relevant approval, and in accordance with an accepted Mining Operations Plan.	Section 6 and 7

2.2 Project Approval 10_0059 (MOD2)

The WMP has been prepared in accordance with the requirements of the Modified PA.

Table 2-2 summarises the requirements relating to water management from Schedule 3, Conditions 21 to 23a of the Modified PA, and identifies where these requirements are addressed within this WMP.

Table 2-2 Relevant Conditions from PA 10_0059 (MOD2)

Schedule 3 – Environmental Performance Conditions		
Condition	**Condition Requirement**	**Section in this WMP where addressed**
	SOIL AND WATER	
	Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Proponent is required to obtain the necessary water licenses for the project.	Section 2.5
21	**Water Supply** The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations to match its available water supply, to the satisfaction of the Secretary	Sections 6.1, 6.3.6, 6.3.9 and 7.2
22	**Surface Water Discharges** 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 6.3 and 6.4.2
22A	**Void Water Irrigation** The Proponent shall not provide any water for the purpose of irrigation or stock watering, unless the activity has been approved by the Secretary as part of the Water Management Plan.	Section 6.3.3
23	**Water Management Plan** The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with NOW and EPA by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary by the end of April 2012. In addition to the standard requirements for management plans (see condition 2 of schedule 5), this plan must include:	This document
23(a)	A Site Water Balance that includes details of: • sources of water supply; • water use on-site; • water management on-site; • reporting procedures, which provide for the update of the site water balance in each annual review; and • describes what measures would be implemented to minimise potable water use on-site.	Section 4
23(b)	A Surface Water Management Plan, that includes: • detailed baseline data of the surface water flows and quality in the water bodies that could be affected by the project. A detailed description of the water management system on-site, including the: • clean water diversion systems; • erosion and sediment controls; and • water storages. A plan for identifying, extracting, handling, and the long-term storage of potentially acid forming material on-site; Detailed plans, including design objectives and performance criteria, for:	Section 3.1 Section 6 Section 6.3.12 Section 6.3.12 and 6.4.3

Schedule 3 – Environmental Performance Conditions		
Condition	**Condition Requirement**	**Section in this WMP where addressed**
	• design and management of the final void; • reinstatement of drainage lines on the rehabilitated areas of the site; and • control of any potential water pollution from the rehabilitated areas of the site. • a program to monitor the effectiveness of the water management system; A plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project;	Section 7 and 9 Section 10.1
23(c)	A Groundwater Management Plan, which includes: • detailed baseline data of groundwater levels and quality surrounding the site; • groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts. A program to monitor: • groundwater inflows to the open cut mining operations; • the impacts of the project on any groundwater bores on privately-owned land; • the seepage/leachate from water storages or backfilled voids on-site. A program to validate the groundwater model for the project, and calibrate it to site specific conditions; and A plan to respond to any exceedances of the performance criteria and mitigate and/or offset any adverse groundwater impacts of the project.	Section 3 Section 5 Section 6.8 and 7.1 Section 6.1 Section 10.2
23(d)	An Irrigation Management Plan, which includes: • a detailed methodology for the transfer (including for pipeline and/or road transportation) and application of void water for each irrigation site; • detailed assessment of the irrigation activities guided by the Environmental Guideline *"Use of Effluent by Irrigation, DEC 20014"*, including site specific soil analysis and assessment of the short and long term impacts of salinity and sodicity on soils; • parameters for the sustainable application of void water to maximise water uptake and minimise deep percolation to groundwater and/or run-off for the application site; • identification of the appropriate approvals held under the *Water Management Act 2000*; • a program to monitor void water quality and soil characteristics; and	Section 6.3.3 and APPENDIX A APPENDIX A APPENDIX A Section 6.3.3.1 Sections 7.1.2, 7.5 and APPENDIX A

Schedule 3 – Environmental Performance Conditions		
Condition	**Condition Requirement**	**Section in this WMP where addressed**
	• a description of the procedures to be implemented to measure and report on the quality of water supplied to each individual user and the quantity of void water used against the parameters identified.	Sections 6.3.3, 8 and APPENDIX A, APPENDIX B
23A	**Void Water Dam 1** Within 2 months of the completion of construction works of the expanded Void Water Dam 1, the Proponent shall submit a "works as executed" report to the Secretary and EPA, certified by a practicing engineer, confirming that the expanded dam has been constructed to its design specifications.	Section 6.3.6

2.3 Statement of Commitments

The WMP has been prepared to address the commitments made under Appendix 6 of the Modified PA. **Table 2-3** summarises the Statement of Commitments related to groundwater and surface water, along with where these requirements are addressed within the WMP.

Table 2-3 Statement of Commitments

Objective	Task	Timeframe	Section Ref.
Groundwater			
Effective management of the potential contamination and/or reduction in availability of groundwater resources.	Implement impact mitigation measures in accordance with.an approved Water Management Plan.	As defined by the Water Management Plan	Section 6.3.4
	Undertake groundwater monitoring in accordance with an approved Water Management Plan.	As defined by the Water Management Plan.	Section 7.1
	Implement additional assessment, landowner notification and contingency or compensatory measures in accordance with an approved Water Management Plan	As defined by the Water Management Plan.	Section 10.2
Prevent accumulation of void water within the final landform which may impact on final landform and land use.	Backfill overburden into the final void above the equilibrium water level.	Following cessation of mining.	Section 6.3.12
Surface Water			
	Construct and maintain surface water management infrastructure in accordance with an approved Water Management Plan	Ongoing	Section 6

Objective	Task	Timeframe	Section Ref.
Effective management of the potential contamination and/or reduction in the availability of surface water resources.	Implement impact mitigation measures in accordance with an approved Water Management Plan.	As defined by the Water Management Plan.	Section 6
	Undertake surface water monitoring in accordance with an approved Water Management Plan. Direct sediment-laden runoff into sediment basins for treatment prior to discharge (if required).	As defined by the Water Management Plan.	Section 6.7 and 7.1
Prevention of void water discharge off site.	Operate void water dams with sufficient freeboard to prevent discharge during high rainfall events.	Ongoing	Section 6.3.6 and 6.3.8
	Complete an irrigation assessment for specific irrigation campaigns in accordance with EPA requirements.	Prior to commencement of offsite irrigation.	Section 6.3.3
	Provide each irrigation assessment to the EPA for review and approval.	Prior to commencement of offsite irrigation	Section 6.3.3

2.4 Environment Protection Licence

WCC operates under EPL 12290, issued under Section 55 of the *Protection of the Environment Operations Act 1997*. **Table 2-4** summarises the water management, monitoring and reporting requirements established in EPL12990 for scheduled activities undertaken at the WCC.

Table 2-4 Relevant Requirements from EPL12290

Condition	Condition Requirement	Section in this WMP where addressed
P1.3	Monitoring of discharge water quality, groundwater quality, and water supplied for agricultural use.	Section 7
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Sections 5 to 10
L2	Concentration limits	Section 7
M1	Monitoring Records	Section 8
M2.3	Requirements to monitor concentration of pollutants discharged	Section 7
M3.1	Testing method – concentration limits	Section 7
M7	Requirement to monitor volume of water supplied for agricultural use	Section 7.5
R1	Reporting requirements	Section 8
E2	Water Management Approval prior to providing water for agricultural use	This Plan

2.5 Water Sharing Plans and Water Management Act 2000

The southern portion of WCC is located in the catchment of the Quirindi Creek, which flows into the Mooki and Namoi Rivers. Since July 2016 these catchments are now incorporated into the *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012, which is now the single water sharing plan applying to* WCC. The sharing plan contains water sharing rules which are specific to the Phillips Creek, Mooki Creek, Warrah Creek, Quirindi Creek and Quirindi Alluvial.

The NSW Aquifer Interference Policy (AIP) provides a framework for the identification and assessment of impacts to groundwater resources from mining activities. While it was introduced after the approval of the Life of Mine project and as such does not form the basis of the assessment of WCC impacts on groundwater, it nevertheless provides an information resource to ensure compliance with the Water Management Act 2000. This includes provisions for quantifying groundwater take through mining operations (**Section 4.1**), as well as ensuring minimal harm to any water source as a consequence of the activity (**Sections 6.8 and 10.2**).

Two Water Access Licenses are in operation to allow the take of water for mining purposes. WAL32224 has been allocated 211ML per annum for incidental groundwater in-flow into the void. WCC also holds WAL29506 for 50ML per annum via bore extraction.

2.6 Guidelines

Key guidelines which are relevant to the preparation and implementation of this WMP include:

- ANZECC," Australian and New Zealand Guidelines for Fresh and Marine Water Quality" (the "ANZECC Guidelines"), October 2000;
- Department of Environment and Climate Change, "Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries", June 2008;
- NSW Department of Housing, "Managing Urban Stormwater: Soils and Construction – Volume 1, 4th Edition" (the "Blue Book"), 2004;
- Department of Environment and Conservation, "Approved Methods for the Sampling and Analysis of Water Pollutants in NSW", March 2004; and
- Draft, "Water Reporting Requirements for Mines", Major Projects Assessment Unit, Department of Water and Energy.

3 BASELINE CONDITION

This section summarises the baseline condition of water management at WCC including the hydro-geological context of the site. WCC have been undertaking water monitoring since 2004 and this section presents a summary of previous monitoring results and analysis of that data as it related to background conditions. Monitoring locations are presented in **Section 7**.

3.1 Surface Water

Surface water resources in the local area are defined by two east-west running semi-permanent creeks, fed from the ranges to the east of WCC on the western side of the Great Dividing Range. A catchment divide slicing east-west through the middle of the present day WCC divides the Werris Creek catchment to the north from the Quipolly Creek catchment to the south, with minor drainage lines in the vicinity of WCC feeding these creeks. Water quality in these creeks is highly variable, with flows largely dependent on rainfall in the catchment areas. Two medium-sized dams are located on Quipolly Creek, providing one of a number of drinking water supplies to the local townships. The main Quipolly Dam was enlarged in late 2012, allowing the capture and storage of a significantly larger volume of water. The *Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources 2003* requires releases of water from the dam to be no less than 10L/s or the equivalent to dam inflows, whichever is less.

A summary of water quality within the receiving environment is shown below, with average water quality (**Table 3-1**) and maximum recorded result (**Table 3-2)** for a range of parameters listed from 2007 to 2015.

Table 3-1 Average Receiving Water Quality (2007-2015)

Sample Location	EPL ID	EC (µS/cm)	pH	TSS	NO_3 as N	Total N	Reactive P as P	Total P	Oil & Grease
QCU	25	542	7.64	39.8	0.29	1.04	0.08	0.18	<5
QCD	26	796	7.86	22.0	0.13	0.51	0.10	0.16	<5
WCU	23	799	7.80	79.0	1.84	2.92	0.30	0.40	<5
WCD	24	921	8.08	219.4	3.60	3.76	0.25	0.41	<5
QCU refers to an upstream location within Quipolly Creek and QCD refers to a downstream location within Quipolly Creek. WCU refers to an upstream location within Werris Creek and WCD refers to a downstream location within Werris Creek.									
Source - WCC Surface Water Monitoring Results									

Table 3-2 Maximum Receiving Water Quality (2007-2015)

Sample Location	EPL ID	EC (µS/cm)	pH (min)	pH (max)	TSS	NO_3 as N	Total N	Reactive P as P	Total P	Oil & Grease
QCU	25	1790	6.94	8.36	327	0.88	5.0	0.51	0.90	<5
QCD	26	1180	7.02	8.55	182	0.86	1.8	0.44	0.60	23.0
WCU	23	1500	7.42	8.08	504	4.44	6.0	0.81	1.69	7.0
WCD	24	1400	7.34	8.52	1830	25.20	30.7	0.66	1.66	14.0
QCU refers to an upstream location within Quipolly Creek and QCD refers to a downstream location within Quipolly Creek. WCU refers to an upstream location within Werris Creek and WCD refers to a downstream location within Werris Creek.										
Source - WCC Surface Water Monitoring Results										

3.1 Spoil Characterisation and Acid Forming Potential

Investigations into the acid generating potential of overburden/interburden and coal materials have been undertaken to assess the likelihood of hostile material impacting on background surface and groundwater quality (URS 2004). Analysis of overburden/interburden and coal material has identified:

- Spoil materials are generally slightly alkaline, with pH ranging from 6.6 to 8.4 (mean 7.9).
- EC is very low, ranging from 184 to 248 µS/cm (mean 203 µS/cm).
- Sulphur content of spoil is very low in both spoil and coal material, ranging from <0.01 to 0.03 %S in spoil, and 0.25 to 0.35% in coal seams.
- Acid Neutralising Capacity (ANC) is low to moderate (2.6 to 36kg H_2SO_4/t) for the upper strata (to C seam) and very high (227 to 229kg H_2SO_4/t) for the lower strata.
- Net Acid Producing Potential (NAPP) was negative in all samples. All samples are considered Non-Acid Forming (NAF) and also barren due to the negligible sulphur content.

Based on this characterisation of spoil and coal material, the investigation identified a low potential for both acid formation and soluble salt formation, due to the low concentrations of sulphur in the material, as well as the high ANC, derived from the presence of carbonaceous claystones and carbonaceous mudstones within the coal seams.

3.2 Groundwater

3.2.1 Hydrogeology

The main hydrogeological units identified within and surrounding WCC are shown on **Figure 3-1:**

- Quipolly Alluvium – the Quaternary sediments (sands and gravels) located along Quipolly Creek approximately 2.5km south of the WCC;
- Permian Coal Measures – consisting of nine coal seams and interburden strata of sandstones/siltstone and shales; and
- Werrie Basalt – consisting of basaltic lava flows with a significant weathered profile of clay. Underlying the coal measures, the weathered clays of the upper basalt profile act to form a claystone aquitard providing confinement/semi confinement of the basalt aquifer.

The Permian-aged Coal Measures have low permeability and porosity due to their compacted nature. The main water-bearing zones occur in the coal seams with minor water-bearing zones in the interburden rocks. The Coal Measures strata at WCC forms a closed basin that is surrounded by a low permeability claystone aquitard, limiting the interaction of flows between these two aquifers. Hydraulic testing of the claystone has demonstrated permeability of between 2.5×10^{-9} and 9.9×10^{10} m/s, which provides an effective seal to the Coal Measures. Further evidence to support this aquitard is the discrepancy in water level between the open cut pit and the Werrie Basalt aquifer, with a typical difference in hydraulic head of 110 metres. Similarly, the groundwater levels measured within the Coal Measures aquifer prior to mining varied from that of the Werrie Basalt aquifer at the time, indicating a hydraulic separation between these two groundwater systems. Finally, the water chemistry of the groundwater contained in the Werrie Basalt varies from that of water contained within the open cut pit, signifying different sources and flow paths.

The alluvial aquifer associated with Quipolly Creek contains extensive material of high permeability, with groundwater flows from the east to the west generally following the course of the current creek. The ephemeral Werris Creek does not appear to be supported by a significant alluvial aquifer, with its flow largely derived from rainfall within the catchment. Groundwater flow in the Werrie Basalt is characterised by a predominant east to west flow from the topographical high point to the east of the WCC, with localised flows to the southwest and northwest in the immediate vicinity of WCC.

The permeability of the Quipolly Alluvium is high relative to the underlying basalt/weathered basalt, which would promote horizontal flow through the alluvium. R.W. Corkery & Co. (2010) state that some connectivity between basalt and alluvium may occur in zones where vertical fracturing intersects the alluvium or where alluvium is sufficiently deep to intersect water bearing basalt layers. Groundwater within the Quipolly Alluvium would provide the base flow for Quipolly Creek where surface flows are present. This connectivity can be observed in the lower sections of Quipolly Creek, where the predominantly dry watercourse is recharged by seepage from the aquifer at the point where Quipolly Creek intersects the Quirindi Dome range, as well as in upper sections of Quipolly Creek where releases from Quipolly Dam into Quipolly Creek are quickly absorbed into the alluvial aquifer.

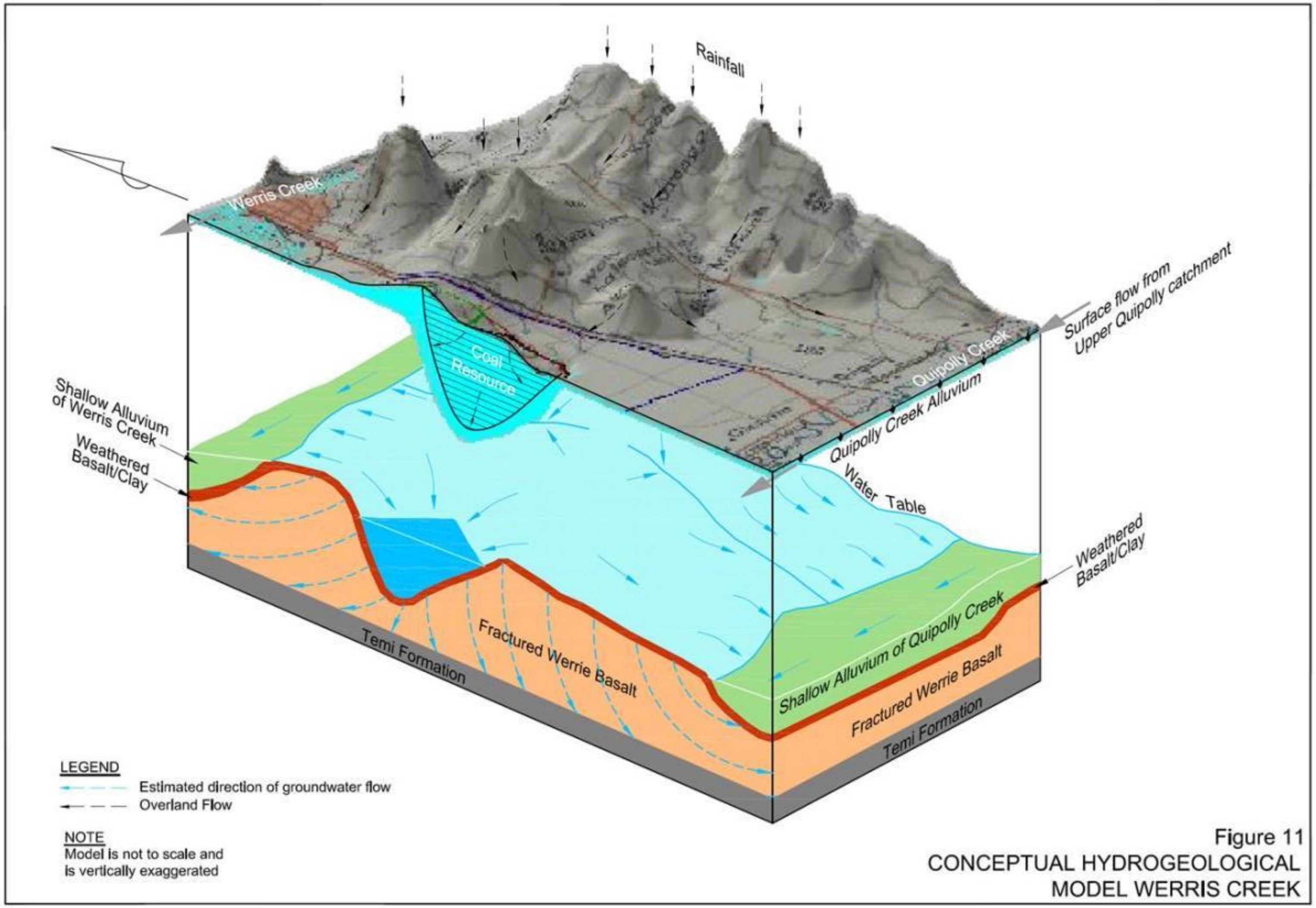

Figure 3-1 Conceptual WCC Groundwater System (modified from Figure 11 RCA, 2010)

3.2.2 Groundwater Quality

Groundwater was sampled at the project site in 2004 prior to the commencement of open cut mining activities (RCA 2004). This sampling program found:

- Groundwater within the existing underground mine workings was slightly acidic with low salinity. The low salinity (brackish water) was considered unusual for coal measures and attributed to the close proximity of the recharge point (i.e. the subcrop).
- Groundwater of the basalt aquifer was found to have a slightly acidic to neutral pH and was brackish. The concentrations of other analytes indicated that the water within the basalt aquifer was generally suitable for irrigation and livestock use.
- Groundwater of the alluvial aquifer was found to be of neutral pH and fresh to slightly brackish. The concentration levels of other analytes indicated that the water within the alluvium was suitable for irrigation and livestock use.

Table 3-3 and **Table 3-4** present a summary of the water quality in the basalt and alluvial aquifers. The analysis includes all data collected between 2004 and 2010.

Table 3-3 Summary of Water Quality in the Werrie Basalt

Region Werrie Basalt	**No of Bores**	**No of Samples**	**Guidelines Agricultural Irrigation and Livestock**		**Concentration Ranges**		
			Irrigation	***Livestock***	***Min***	***Max***	***Mean***
Phosphorous-Reactive (mg/L)	10	202	-	-	0.01	20.5	0.4
Total Phosphorous (mg/L)	10	202	0.8 – 1.2[stv] 0.05[ltv]	-	0.01	26.3	0.72
Total Nitrogen (mg/L)	10	202	25 - 125[stv] 5[ltv]		0.33	546	15.42
Nitrates (mg/L)	10	194	6.77	6.77	0.01	26	6.72
Electrical Conductivity (µS/cm)	10	226	1900 - 4500[stv] 2000 - 5000[ltv]	5000[#]	560	4110	1500
pH-field	10	226	6.5 – 8.5	6.5 – 8.5	6.5	8.4	7.2
ltv – long term value, stv – short-term value, # Poultry – sheep value/long-term trigger value, - No published values							
Source - WCC Groundwater database June 2010							

Table 3-4 Summary of Water Quality in the Alluvium

Region Alluvium	No of Bores	No of Samples	Guidelines Agricultural Irrigation and Livestock		Concentration Ranges		
			Irrigation	*Livestock*	*Min*	*Max*	*Mean*
Phosphorous-Reactive (mg/L)	10	202	-	-	0.02	0.8	0.07
Total Phosphorous (mg/L)	10	202	0.8 – 1.2stv 0.05ltv	-	0.02	2.5	0.11
Total Nitrogen (mg/L)	10	202	25 - 125stv 5ltv		1.1	4.4	1.92
Nitrates (mg/L)	10	194	6.77	6.77	0.96	2.6	1.78
Electrical Conductivity (uS/cm)	10	226	1900 - 4500stv 2000 - 5000ltv	5000#	380	1260	800
pH-field	10	226	6.5 – 8.5	6.5 – 8.5	6.00	8.10	6.73
ltv – long-term value, stv – short-term value, # Poultry – sheep value/long-term trigger value.							
Source - WCC Groundwater database June 2010.							

3.2.3 Groundwater Level

Groundwater levels have been monitored on a bimonthly basis since 2004 as part of the WCC groundwater monitoring programme.

Table 3-5 summarises the groundwater level observations in the Werrie Basalt and Quipolly Alluvium aquifers. For the Quipolly Alluvium, MW12 and MW7 are representative of upstream and downstream aquifer conditions respectively. For the Werrie Basalt, MW5 and MW14 are representative of aquifer conditions either side of the watershed between Quipolly Creek in the south and Werris Creek in the north respectively.

Groundwater levels within the Werrie Basalt and Quipolly Alluvium aquifers exhibit a close correlation with residual rainfall in the area, with relatively steep rises in groundwater level following wetter periods interspersed with longer periods of gradually declining water tables during drier years. This pattern is more pronounced in the shallower Quipolly Alluvium system, and less pronounced in those areas of the Alluvium fed by springs from the Werrie Basalt, immediately upstream from the Kamilaroi Highway crossing.

Table 3-5 Aquifer Long term (2004-2015) Groundwater Levels

Aquifer	Bore	Ownership	Number of Samples	Min	Average	Max
Werrie Basalt Near WCC	MW1	WCC	42	44.11	53	60.82
	MW2	WCC	29	23.4	26.5	31.8
	MW3	WCC	41	7.76	15.4	18.15
	MW4B	WCC	44	7.9	10.5	14.7
	MW5	WCC	47	7.19	8.7	11.46
	MW6	WCC	48	9.8	11.8	14.18

Aquifer	Bore	Ownership	Number of Samples	Min	Average	Max
	MW27*	WCC	17	39.94	44.97	52.36
	MW36A	WCC	7	23.01	23.84	24.45
	MW36B	WCC	7	22.46	23.61	24.2
Werrie Basalt	MW8*	Private	47	11.68	15.4	18.7
	MW10	WCC	47	11.25	17.34	20
	MW14	WCC	48	13.9	16.4	19.4
	MW17B*	Private	32	6	10.6	18.8
	MW19A*	WCC	21	4.5	6.8	9.26
	MW20*	WCC	23	17.35	19.54	21.02
	MW38A	Private	3	14.58	14.84	15.03
	MW38B*	Private	3	10.05	10.12	10.20
	MW38C*	Private	3	21.70	22.65	23.50
	MW38E*	Private	3	10.23	10.39	10.57
#1	MW24A*	WCC	22	12.78	14.27	15.61
	MW29*	Private	23	11.28	14.50	25.93
Quipolly Alluvium	MW7*	Private	42	4	4.45	4.95
	MW12*	Private	52	6.13	8.42	12.24
	MW13*	Private	55	3.81	5.1	6.63
	MW13B*	Private	20	2.93	3.75	5.15
	MW13D*	Private	21	3.56	4.75	5.3
	MW15*	Private	40	3.7	4.72	6.15
	MW16*	Private	30	3.71	5.18	7.27
	MW17A*	Private	29	2.9	4.24	6.32
	MW18A*	Private	26	2.55	4.17	6.28
	MW21A*	Private	28	4.63	7.07	10.35
	MW21B*	Private	3	11.23	11.49	11.67
	MW22A*	Private	25	3.73	5.34	7.41
	MW22B*	Private	24	3.74	5.46	7.68
	MW23A*	Private	20	3.26	3.85	4.32
	MW23B*	Private	20	3.83	4.26	4.75
	MW26B*	Private	3	9.52	9.80	10.26
	MW28A*	Private	22	8.45	12.57	15.65
	MW32*	Private	17	8.45	11.84	14.26
#2	MW34*	Private	14	3.67	4.1	4.62

* - Indicates bore is used for water extraction unrelated to WCC (i.e. stock and domestic or irrigation). #1 – Werrie Basalt in the Black Soil Gully valley to east of Werris Creek Mine. #2 - Werris Creek Alluvium

4 SITE WATER BALANCE

4.1 Water Balance Model

In recent years WCC has operated with the void water dams at or near capacity with misting evaporators used to maximise available storage. Recording of changes in pit water volume following rainfall events has demonstrated that the Water Balance Model (WBM) prepared for WCC by GSSE (2010) for the purposes of the LOM Project Environmental Assessment underestimated the inflows to the open cut void from rainfall (due to an increase in strike length of the pit and increased area of overburden emplacement capturing runoff) and the former underground workings (originally planned to be dewatered but water has been used to manage potential spontaneous combustion).

An updated site WBM has been prepared by Environ (2015) to improve the assessment of the future water management requirements of WCC. The WBM is updated annually as part of the annual review to calibrate the model with observed water volumes and measurements recorded over the previous year as described in **Section 6.1**. A basic summary of the WBM used for this purpose representing flow to the open cut void is shown in **Figure 4-1**.

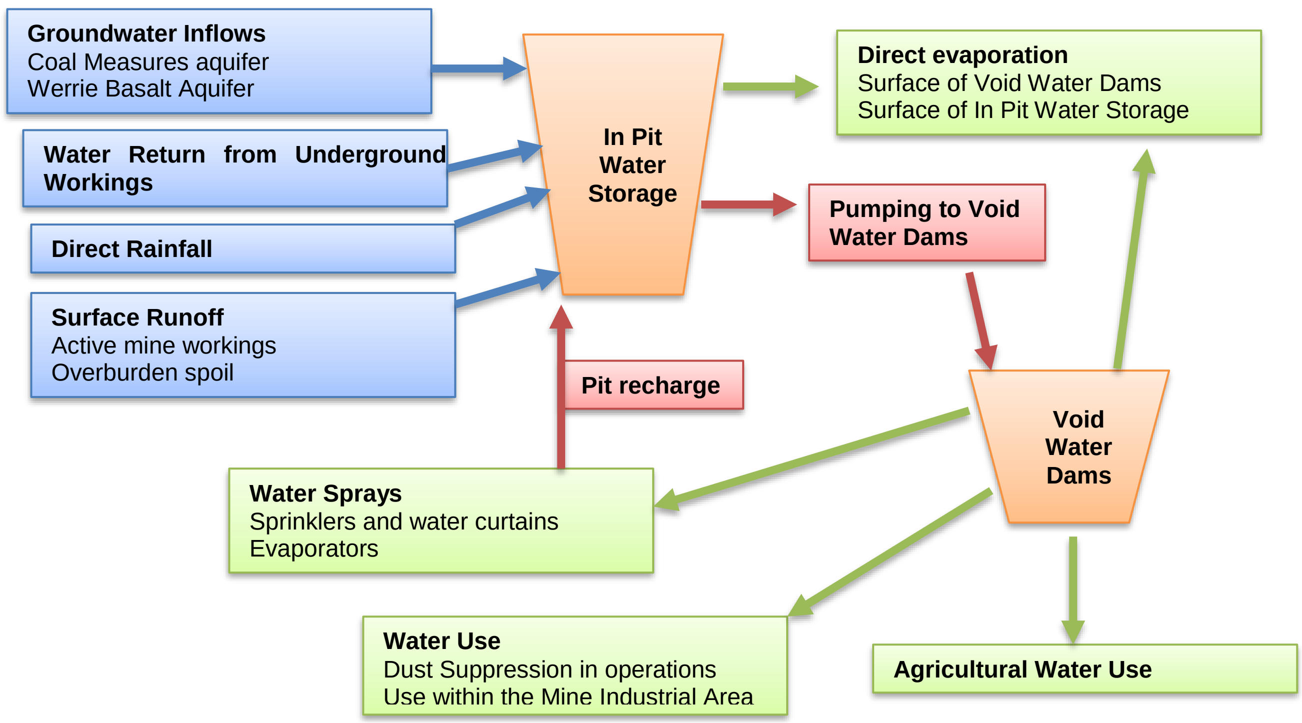

Figure 4-1 Conceptual Site Void Water Balance

Groundwater in-flows were predicted using the calibrated groundwater model for WCC developed by ENVIRON (2014). Groundwater inflows can be broken down into contributions from the aquifers, including the Coal Measures aquifer and Werrie Basalt aquifer, as well as contributions from the former underground workings. The contributions from each groundwater source have been calculated using the hydrogeological model, with a sensitivity analysis undertaken again in 2015 confirming the accuracy of the overall groundwater contribution to the pit.

The 113-year data set of daily rainfall from the Bureau of Meteorology Station (No. 055062) at Werris Creek Post Office was used to provide the direct rainfall in-flow. Inputs for surface runoff were generated by calibrating the original runoff coefficients produced by GSSE (2010), which appear to have been over generalised for assessment of the LOM Project, against observed variation in void water storage.

As depicted in **Figure 4-1**, the key outputs to the Water Balance Model include evaporation from void water dams and water stored in pit, Water Sprays, general on site Water Uses, and the supply of water for agricultural uses. The main on site water use is the utilisation of water carts to control dust across site, however also includes dust suppression of coal conveyors and void water use throughout the workshop areas. Water sprays include the use of evaporators to remove surplus void water, as well as the application of void water to the former underground workings using water curtains and sprinklers to manage spontaneous combustion. Evaporative losses are calculated on the basis of daily average evaporation from the Quirindi Post Office Bureau of Meteorology monitoring site, while all outputs are metered.

In order to best understand the likely surplus / deficit of water over the remaining life of WCC, two mining scenarios were considered in the water balance completed by Ramboll Environ in 2015. These scenarios represent:

- Development of the open cut and rehabilitation at the end of 2017 (which includes the potential decommissioning of Void Water Dam 2 and Void Water Dam 5 (pending operational mining schedules); and
- Development of the open cut and rehabilitation at the end of 2020.

For each mining scenario, a dry (15th percentile), median, and wet (90th percentile) rainfall year was considered (as taken from the 113-year data set from BOM Station No. 055062).

Table 4-1 provides a revised summary of the WBM output for each combination of mining and rainfall scenario. Water losses from the operation of the evaporator units and agricultural water supply have been excluded from **Table 4-1**, as they each form an optional outflow, and are not essential for safe mining at WCC in compliance with legislative requirements. As such, **Table 4-1** provides a base case of void water balance at WCC. As the majority of void water used for the management of spontaneous combustion of the former underground workings is returned to the pit via the underground workings, only that portion which is lost to the system is included in **Table 4-1** (through evaporation and transfer losses).

Table 4-1 Void Water Balance (excluding evaporators and off site agricultural supply)

Inputs / Outputs		Year 2015			Year 2017			Year 2020		
		Median	15th %ile	90th %ile	Median	15th %ile	90th %ile	Median	15th %ile	90th %ile
Inputs	Rainfall/runoff	737	570	1 043	835	643	1 192	792	605	1 130
	Groundwater Inflows – aquifers	54	54	54	47	47	47	22	22	22
	Groundwater inflows - Water return from Underground Workings	67	67	67	-	-	-	-	-	-
	Total	**858**	**691**	**1 164**	**882**	**690**	**1 239**	**814**	**627**	**1 152**
Outputs	Direct Evaporation (from Dam and Pit Surfaces)	408	381	329	428	408	374	409	328	358
	Water use	365	365	365	365	365	365	365	365	365
	Water loss from spon comb management*	36	36	36						
	Total	**809**	**782**	**730**	**793**	**773**	**739**	**774**	**693**	**723**
Balance		**+49**	**-91**	**+434**	**+89**	**-83**	**+500**	**+40**	**-66**	**+429**

Source: Modified after ENVIRON (2015) – Table 1
* Assumes losses of 10% from underground sprinklers; in **Figure 4-1** equates to the difference between (Sprinklers and water curtains) and (pit Recharge)

Variations between years as well as to figures previously reported in the AR are largely attributed to changes in groundwater interception as mining progresses through the syncline of the Coal Measures and back up dip, as well as changes to the size of the pit catchment as mining progresses.

Water on site is used regularly for dust suppression, management of spontaneous combustion, and coal crushing. Water usage is monitored and reconciled with WBM modelling assumptions annually.

The water balance modelling indicates that for a median year, without additional management of water, there is an accumulation of water in the void water dams or open cut void of between 40ML and 89ML. During a wet year the surplus of water is up to 500MLprompting either retention of water within the open cut or additional water management practices. With environmental releases of void water not permitted under current approvals, water reduction solutions including evaporators and the supply of water for agricultural purposes will need to be utilised to balance the predicted surplus of void water during all but dry years. Evaporators can be used to reduce the water surplus by approximately 300ML, counteracting the water surplus in all median rainfall years, and significantly reducing the surplus in wetter years.

Although there is inherent uncertainty in future weather patterns, as the VWD's were operating close to capacity during 2015 and 2016, it is considered that WCC is at greater risk of surplus water. The predicted deficits during low and median rainfall years are not anticipated to impact on water availability for dust suppression for the LOM even with successive dry years. Annual water balance modelling will be used to forecast the upcoming year water usage and trend against LOM requirements.

The proposal to use site-derived water for off-site agricultural irrigation is not considered to represent a significant risk to ensuring water supply needs are met for the LOM. Future commitments to supply water for agricultural use will be factored into water balance modelling in accordance with usage agreements, which may change over time. In addition to this, operational requirements will always take precedence to irrigation requirements.

As part of the Annual Review, a water balance is compiled for the mining configuration over the previous year. Water balance modelling at WCC was completed for the LOM project using a water balance model developed in MS Excel using runoff rates based on the Australian Water Balance Model (AWBM). Data collected throughout the year, including rainfall, metered water use, dam and pit water levels, and ancillary pumping information, is entered into the water balance model, which then allows a calculation of groundwater contribution to the open cut pit. The water balance model is reviewed annually and compared against measured data to review closeness-of-fit.

The WCC groundwater model is simulated annually to predict the groundwater inflow component of the water balance model. A sensitivity analysis is also performed to ensure the accuracy of the groundwater contribution component. The groundwater contribution to the open cut pit calculated from the water balance model is then compared to the predicted contribution from the hydrogeological model, to assess the accuracy of the existing hydrogeological model.

A further calculation of groundwater contribution to the open cut pit is undertaken each year to meet WAL32224 reporting obligations.

4.2 Agricultural Use of Void Water Offsite

On the basis of the water balance model predictions, the volume of void water generated is predicted to exceed the capacity of the void water dams under median and high rainfall scenarios.

In order to alleviate the storage capacity shortfall, the Modified PA permits WCC to make this water available to the owners or users (under lease) of land adjoining or surrounding WCCM for irrigation and/or other agricultural use (i.e. stock watering).

In order to demonstrate that the void water could be utilised for agricultural purposes without adversely impacting on the local environment, SEEC (2015) undertook an assessment to investigate the use of excess void water from WCCM, via irrigation on agricultural land surrounding WCC. SEEC utilised the EPA endorsed *Effluent Reuse Irrigation Model* (ERIM) to demonstrate the feasibility of irrigating the void water to surrounding agricultural lands.

ERIM uses water and nutrient balances to calculate the amount of water and nutrients that should be applied, and at what times, to meet crop requirements whilst ensuring runoff and percolation are minimised.

The SEEC assessment determined that the irrigation of void water to land on and adjacent to WCC could provide a viable means of reducing the volume of water stored within the Void Water Dams and that the void water is a valuable resource to encourage agricultural activities (SEEC 2015). The methods for the use of the void water by agricultural users are discussed in an Irrigation Management Plan (IMP), which has been developed in consultation with the landowner / lease holder (**Section 6.3.3**), and is attached as **APPENDIX A**.

4.3 Short-term Water Strategy

WCC maintains a short term water strategy tool for monitoring current water usage and storage levels and projecting forward three months' future water usage and water make in relation to planning for mining in the lower sections of the open cut pit. The purpose of the short term water strategy is to forecast the site water balance at WCC for the coming 3 months to determine:

- Expected void water dam storage
- How much surplus void water there could be
- Quantify additional options for water use.

4.4 Potable Water Use

Potable water for use at WCC is delivered by truck on an as required basis, and is stored in dedicated tanks in the Mine Industrial Area. To minimise the use of potable water on site, plumbing works have been designed to ensure that potable water is only delivered to those facilities that require water of this quality, including washroom and crib facilities. Potable water use at Werris Creek Mine is anticipated to average approximately 60kL per month.

5 CRITERIA, OBJECTIVES AND TARGETS

5.1 Water Criteria

Table 5-1 outlines the approach to water quality monitoring for each of the monitored elements.

Table 5-1 Water Monitoring Triggers

Parameter	Triggers
Surface Water (Dirty Water Discharge)	
Total Suspended Solids	Licence conditions outlined in **Table 5-2**
Oil & Grease	
pH	
EC	Concentrations are below the maximum background concentrations presented in **Table 3-2**
Nitrate, total nitrogen, total phosphorus and reactive phosphorus	
Coal Contact Water – parameters TBA	TBA
Surface Water Monitoring Quipolly Creek and Werris Creek (downstream monitoring sites)	
pH and EC Oil & Grease Nitrate, total nitrogen, total phosphorus and reactive phosphorus	Concentrations are consistent with upstream values
Groundwater	
Water level	Detection of an increasing trend (depth to water) using Cusum one-sided analysis
Groundwater interception	Determination of groundwater interception as part of Annual Review process identifies annual pit interception exceeds 261ML (WAL32224 & WAL29506)
pH, EC, nitrate, total nitrogen, total phosphorus and reactive phosphorus	Concentrations are within the minimum and maximum background values presented in **Table 3-3** and **Table 3-4**
Water supplied for agricultural use	
pH, EC, and Oil & Grease	Licence conditions as outlined in **Table 5-3**

Should the values identified in **Table 5-1** be triggered, **Section 10** of this WMP outlines the Trigger Action Response Protocol references associated with managing the incident.

Recorded values for pH, Total Suspended Solids (TSS) and Oil & Grease will be compared against the criteria presented in **Table 5-2** adopted from EPL 12290.

Table 5-2 Surface Water Assessment Criteria, EPL 12290

Pollutant	Unit of Measure	50% concentration limit	90% concentration limit	100% concentration limit
Total Suspended Solids	mg/L	20	35	50
Oil & Grease	mg/L	-	-	10
pH	-	-	-	6.5 – 8.5

Recorded water quality values of water supplied for agricultural purposes will be compared against the criteria presented in **Table 5-3**, adopted from EPL 12290.

Table 5-3 Agricultural Water Supply Assessment Criteria , EPL 12290

Pollutant	Unit of Measure	50% concentration limit	90% concentration limit	100% concentration limit
Electrical Conductivity	µS/cm	1100	1200	1600
Oil & Grease	mg/L	-	-	10
pH	pH units	6.5 – 8.5	-	6.5 – 9.0

The methods for evaluating compliance with revised water criteria are presented in **Section 7**.

5.2 Water Objectives and Targets

WCC has established specific objectives and targets for the higher risk water hazards identified in the EA. The objectives and targets (**Table 5-4**) will be reviewed monthly and revised annually based on the overall year's performance. The objectives and targets proposed for the future years are only indicative and will be subject to the results of the Annual Review.

Table 5-4 EMS Water Objectives and Targets

Objective		Performance Indicator	2014-2015 Performance	Target			
Activity	Environmental Hazard			2015-2016	2016-2017	2017-2018	Reason
Discharge	Non-compliance with discharge surface water criteria	Number of Non-compliances with EPL or PA	0	0	0	0	Expectation that there will be no non-compliances
Mining operations dewater aquifer reducing saturated thickness in offsite bores	Landholder's water availability is reduced due to WCC operations	Groundwater investigations identify drawdown in a landholder bore of greater than 10cm due to WCC operations.	0	0	0	0	Nil project related impacts on landholder bores

6 MANAGEMENT STRATEGIES AND MEASURES

For the three distinct environmental aspects of site water management – surface water, erosion and sediment control, and groundwater, the specific management strategies and measures are outlined in **Table 6-1**.

Table 6-1 Site Water Management Controls

Section	Measure	Responsibility	Timing
6.1	Water Modelling	C	Annual
6.2 Surface Water Management			
6.2.1	Segregated Water Streams	Pumper/EO/OCE	As required
6.3 Void Water Management			
6.3.1	Void Water Management System	Pumper/EO	As required
6.3.2	Void Water Pumping	Pumper	As required
6.3.3	Agricultural Use of Void Water	Pumper/EO	As required
6.3.4	Former Underground Workings Water Management	Pumper	As required
6.3.5	Dust Suppression Water Usage	OCE	As required
6.3.6	Void Water Dam Storage Management	Pumper/Mining Superintendent	As required
6.3.7	Pipelines and Valves	Pumper/OCE	As required
6.3.8	High Water Level Alarms	Pumper/EO/OCE	As required
6.3.9	Site Water Usage	EO	As required
6.3.10	Hydrocarbon Management	OCE	As required
6.3.11	Evaporators	Pumper/EO	As required
6.3.12	Final Void Water Level and Quality	Engineer/C	Annual
6.4 Dirty Water Management			
6.4.1	Dirty Water Dams	EO/Pumper	As required
6.4.2	Dirty Water Discharge	EO	As required
6.4.3	Rehabilitation Program	EO	As required
6.5 Clean Water Dams			
6.5.1	Clean Water Dams and Maximum Harvestable Rights	EO	As required
6.5.2	Clean Water Diversion	EO	As required
6.5.3	Water Management at Mine Closure	EO/Engineer	At closure
6.6 Contaminated Water Management			
6.6.1	Oil/Water Treatment	EO/Workshop	As required
6.6.2	Septic Water Treatment	EO	As required
6.7 Erosion and Sediment Controls		Operations/EO	As required
6.8 Groundwater Management			
6.8.1	Groundwater Investigations	EO	As required
6.8.2	Groundwater Licensing	EO	Annual
6.8.3	Groundwater Quality Management	EO	As required
6.8.4	Hydrocarbon Management	Workshop	As required
6.8.5	Saline Water Body Within Mine Void on Cessation of Mining	EO	Year 12
Pumper, OCE – Open Cut Examiner, EO – Environment Officer, C – Consultant			

In order to mitigate any potential water impacts from the WCC LOM Project, a number of surface water and groundwater management controls will be implemented throughout the life of the operation. The management of surface water aims to prevent surface water pollution both within onsite dams and offsite water courses, whilst groundwater management aims to prevent groundwater contamination and minimise groundwater level impacts as a result of mining operations. All water management controls are detailed in **Table 6-1.**

6.1 Water Modelling

Modelling of site water volumes is undertaken for the following purposes:

- To assist with the management of water for site operations;
- To report to DPI-W on groundwater use under the licensing requirements; and
- To calibrate against actual conditions and allow improved predictions of future mining sequences.

To facilitate the above, revisions of the existing surface water balance and groundwater models will be undertaken. The groundwater model will be reviewed annually using the actual mine plan and a rainfall runoff model based on actual rainfall to quantify inflows to the pit over the period as described in **Section 4.1**. Actual standing groundwater levels in bores within the underlying Werrie Basalt will be used to calibrate the model's predicted volume of groundwater intercepted in pit. This prediction will be reported as part of the Annual Review. The site water balance updates will be undertaken by appropriately qualified persons and will be in line with the water balance updates prepared to date.

6.2 Surface Water Management

6.2.1 Segregated Water Streams

Surface water management is based on the separation and segregation of void, dirty and clean water to ensure each stream is appropriately managed based on the potential pollutants in each stream. The definitions of each water stream category are as follows:

- Void Water – the void water catchment area is comprised of the active mining area and overburden emplacement which collects both rainfall runoff and groundwater in the base of the open cut void and needs to be dewatered by pumping to the surface to allow mining of the basal coal seam;
- Dirty Water – the dirty water catchment area comprises those areas previously disturbed by mining such as rehabilitation, infrastructure and soil stockpile areas with the focus on treatment of water quality and subsequent discharge. Runoff of "coal contact" water from the ROM Coal Stockpile/Coal Processing area and TLO/Product Coal Stockpile area has been approved for capture in dirty water dams since the original Werris Creek open cut mine commenced operations in 2005, and with subsequent approvals for the Life of Mine project in 2011. However, Whitehaven Coal is currently working with the NSW EPA to address the key environmental risks associated with coal contact water. Whitehaven Coal has committed to considering and investigating the identified risks and if deemed appropriate explore actions to mitigate any risks identified in consultation with the EPA;

- Clean Water – the clean water catchment area is undisturbed by mining activities and allowed to flow offsite without active management required. Clean water upslope of the mining area and to the east of Werris Creek Road is diverted around the outside of mining operations; and
- Contaminated Water – includes potentially hydrocarbon contaminated water runoff from the workshop and fuel farm areas which is treated through an oil-water separator and water from ablutions is treated through septic systems onsite.

Figure 6-1 displays the current void, dirty and clean water catchments of WCC. The segregation of each water stream is undertaken by diverting clean water away from the active mining (void water) and other disturbed areas (dirty water). Clean and dirty water streams are separated and diverted using a series of contour banks, diversion drains and dams and appropriate erosion and sediment controls. Void water is contained within enclosed pipelines when pumped to the surface and stored within turkeys' nest dams segregated from the dirty water catchment. Management strategies for each of the three main surface water streams and the contaminated water stream are outlined in **Sections 6.3 to 6.6.**

All attempts are made to capture and divert clean water runoff around the site so as to avoid contamination. The volume of 'Dirty' and 'Void' water to be controlled is minimised by both preventing mixing with 'Clean' water, and through maximising the re-use of 'Dirty' and 'Void' water onsite for dust suppression and other process water requirements. The water is used on site based on the following preferential order:

'Void' water (1st) ⇨ 'Dirty' water (2nd) ⇨ 'Clean' water (3rd).

6.3 Void Water Management

The management of void water is critical to business continuity and the protection of the environment at WCC, and for this reason, the void water stream has a higher level of infrastructure and management controls in place. Both scenarios of too much water in pit or not enough water for dust suppression would severely impact production at WCC.

6.3.1 Void Water Management System

A dedicated system of pumps, pipelines and dams has been established to manage void water on site and forms the basis of the Void Water Management System (VWMS) (**Figure 6-2**). The Open Cut Examiners (OCE) or delegate (i.e. an operator acting as the "Pumper") are responsible for the daily void water management with the two most common activities including void water pumping and water cart dust suppression.

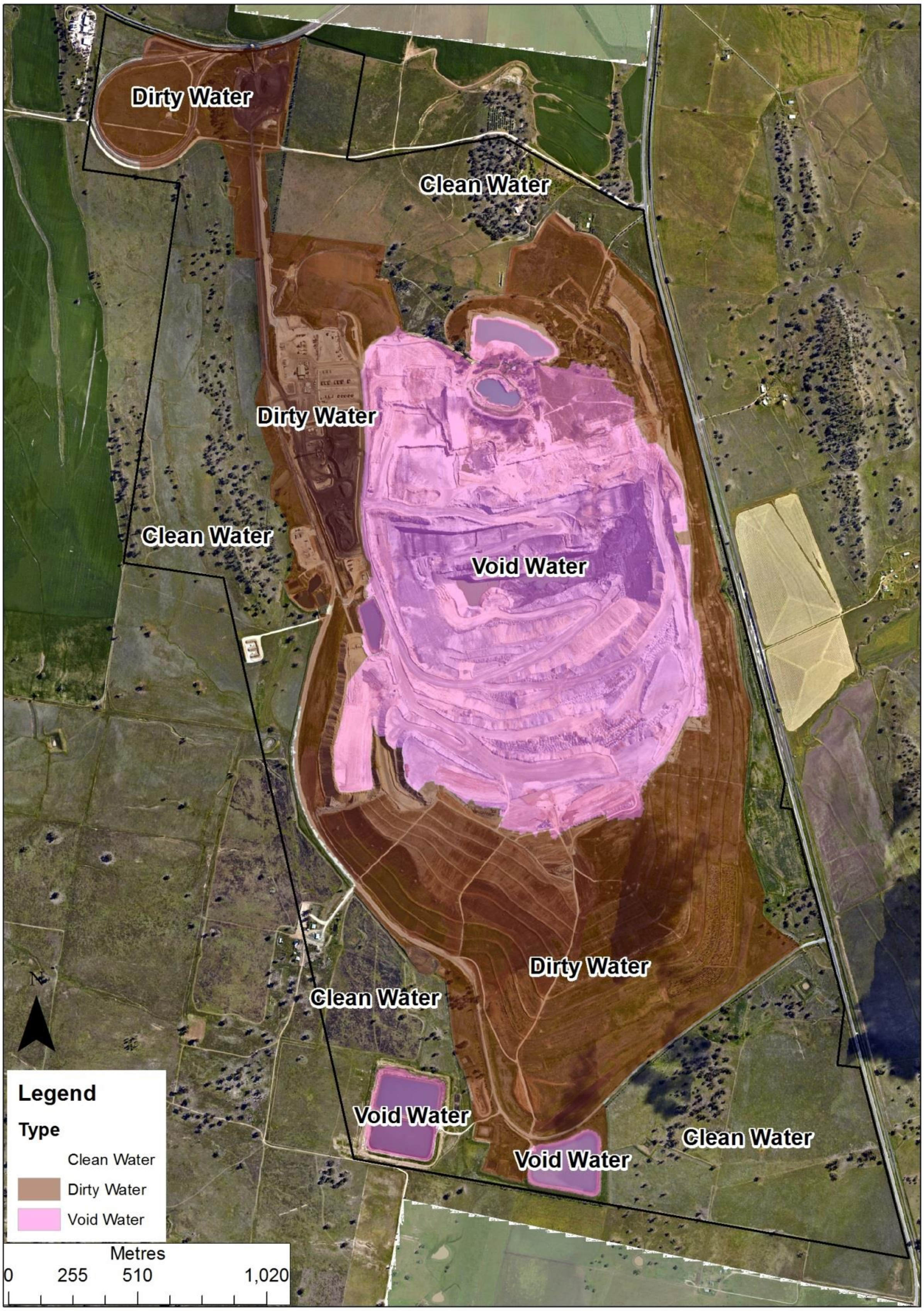

Figure 6-1 WCC Water Management Streams

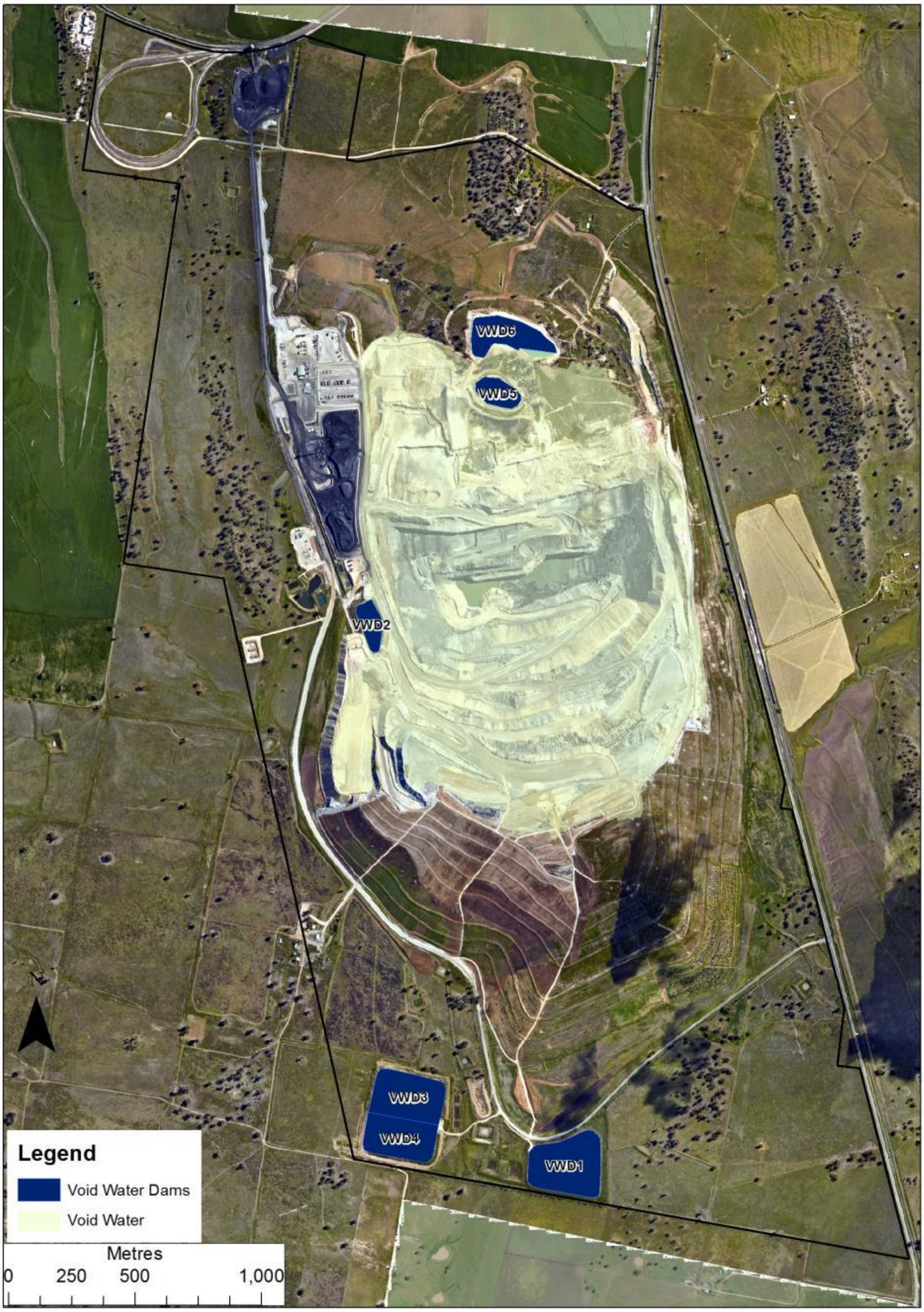

Figure 6-2 WCC Void Water Management System

6.3.2 Void Water Pumping

Void Water Pumping is a key daily water management activity at WCC. Pit water storage, pumping and piping are recognised as environmentally high-risk activities. To manage those activities, procedures are in place to minimise the potential for the discharge of void water offsite while safely dewatering the pit and pumping to void water dams at the surface for dust suppression and other purposes. **Figure 6-3** presents a flow schematic of the general arrangement of the VWMS. The OCE (or delegate/Pumper) is responsible for managing daily void water pumping activities.

WCC maintains a water licence for the interception of groundwater encountered in pit as part of void dewatering (WAL32224 and WAL29506) with a 261ML annual allocation.

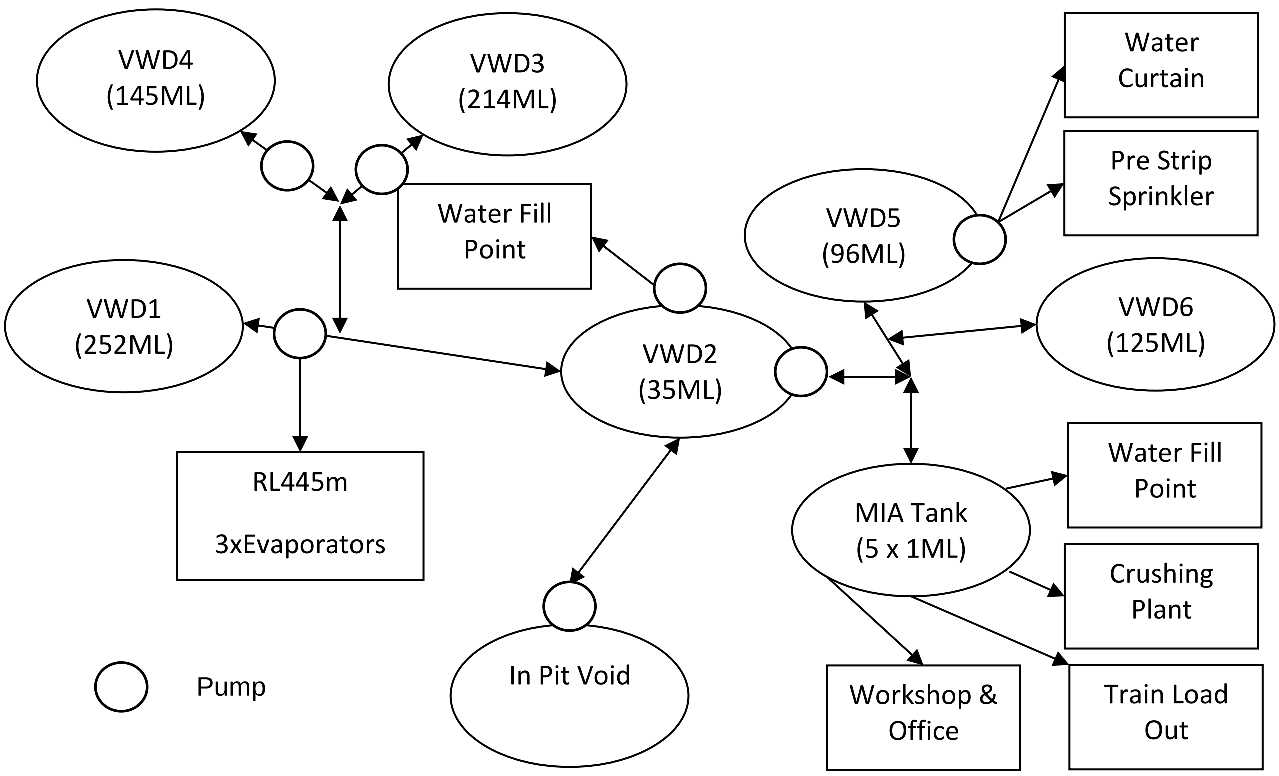

Figure 6-3 Void Water Pumping Flow Schematic for WCC

6.3.3 Management of Void Water for Agricultural Uses

To manage excess void water at WCC, WCM may periodically enter into arrangements for the supply of void water to nearby end users. The provision of void water for agricultural purposes, such as irrigation or stock watering, will be reviewed and managed on a case by case basis as prospective projects are identified by WCC or applications for access to the void water are received from land owners or lease holders ("the User"). Following review of the predicted site water balance, and current storage levels, WCM may enter into agreement to supply water. Pre-requisite for commencing the supply of water are as follows:

- Preparation of an Irrigation Management Plan (within this document)
- Provide each irrigation assessment to the EPA for review and approval
- Execution of an Agreement between the parties – the Supplier and the Irrigator
- Landowners consent
- Approval of the Water Management Plan
- Construction of the necessary water transfer infrastructure

To address the requirements of the Modified PA, WCC have adopted the Irrigation Management Plan as a site-specific assessment,

Each irrigation project will require the preparation of a site specific Irrigation Management Plan, which will be appended to and form part of this Water Management Plan. An Irrigation Management Plan for the 'Plainview Irrigation Project' is included at Appendix A. A template for future Irrigation Management Plans is included at Appendix B.

Unless modified by individual contract, WCC will be responsible for the accumulation and storage of void water on the mine site (within void water dams or the open cut) and initial pumping transfer (to the mine site boundary) of this water. The User will be responsible for the delivery of this water to off-site water storage and use of the water in accordance with the IMP and the POEO Act. Once the void water has been provided to the User under the provisions of this subsection, the water will be considered for all purposes as irrigation water rather than void water. WCC will not and cannot be held liable for the use or misuse of this irrigation water once it has been provided to the User, provided WCC meets the requirements, as far as practicable, of the IMP. Responsibility for the safe use and management of the irrigation water then resides with the User.

Prior to the supply of water to any agricultural Water User, WCC will sample the proposed supply dam for the parameters listed in **Table 7-6** to ascertain the likely suitability for irrigation purposes. During supply monitoring results will be compared to the concentration limits listed in the EPL to ensure any supply of agricultural water will comply with the applicable licence limits.

6.3.3.1 Water Management Act 2000 Approval Requirements

WCC have held discussions with licensing officers of the DPI-W regarding the appropriate approvals required under the *Water Management Act 2000* to ensure the compliant supply and use of void water for irrigation. Under the Act, WCC is required to hold a current Water Access License for the extraction of the water (as part of a Water Supply Works Approval) used for any irrigation program. In addition, an irrigator may be required to hold a Water Use Approval for the specific land under which irrigation is to occur where this land has not previously been identified within an applicable statutory document for WCC.

6.3.3.2 Management of Void Water for Irrigation

Any irrigation program will be managed on a case by case basis, through the application of an Irrigation Management Plan (see **APPENDIX A**) which assesses the specific characteristics unique to each site and irrigation program including:

- An assessment of baseline conditions utilising the EPA guideline "*Use of Effluent by Irrigation",* including site specific soil analysis, consideration of the short and long term impacts of salinity and sodicity on soils, and local groundwater and surface water resources.
- An assessment of the quality of the void water to be used, and desirable parameters for the sustainable application of void water to maximise water uptake and minimise deep percolation to groundwater and/or run-off from the irrigation site.
- Modelling to determine the optimum amount of water and nutrients to be applied.
- A detailed review of the processes and operating methodologies of the proposed irrigation program.
- Monitoring and reporting requirements of the irrigation program.

6.3.3.3 Management of Void Water for Stock Watering

The supply of void water for stock watering will be managed on a case by case basis, through the application of a risk assessment and individual agreement with the Water User which assesses the particulars of the program, including:

- A summary of the baseline conditions, including a comparison of void water quality to the water quality of key sources of stock drinking water in the area.
- An assessment of the suitability of the void water for stock watering against the ANZECC 2000 Guidelines regarding Livestock Drinking Water Quality.
- An overview of the mechanisms for the provision of void water for stock watering, including a summary of responsibilities.
- Monitoring and reporting requirements associated with the provision of void water for stock watering.

Once the void water has been provided to the User under the provisions of this subsection, the water will be considered for all purposes as stock water rather than void water. WCC will not and cannot be held liable for the use or misuse of this stock water once it has been provided to the User, provided WCC meets the requirements, as far as practicable, as detailed in this Water Management Plan. Responsibility for the safe use and management of the stock water then resides with the User.

6.3.4 Former Underground Workings Water Management

Active dewatering of the former underground workings ceased in July 2013 as mining advanced through the former dewatering bore. Dewatering of the former underground workings continues passively as seepage into the open cut pit and is managed as part of pit dewatering activities. WCC must balance dewatering of the underground to minimise the risk of in rush into the pit and boggy working conditions while maintaining water in the underground to prevent spontaneous combustion developing into underground fires. WCC actively uses water curtains and sprinklers to saturate the ground above the former underground workings to exclude oxygen and cool the ground temperature to below that which the coal seam would spontaneously combust.

WCC maintains a water licence for dewatering the former underground workings (WAL29506 and 90AL822531) with a 50ML annual extraction allocation. While the bore is no longer in use, WCC maintains a Water Works Approval (90WA822532) for a bore.

6.3.5 Dust Suppression Water Usage

The primary use of void water at WCC is for dust suppression. Water used for dust suppression is via water carts used to water mainly trafficable areas such as haul roads, excavator loading faces and dumps. The other dust suppression methods are the water sprays on the conveyor transfer points at the coal processing plant and rail load out facility. Approximately 95% of dust suppression water usage is applied by water carts, consuming approximately 350 ML each year. The workshop utilises a small volume of water for equipment and plant wash down prior to maintenance.

6.3.6 Void Water Dam Storage Management

Void dewatering requires surface storage dams to manage void water until it can be used for dust suppression or for agricultural use offsite. WCC currently uses four dedicated void water dams and a former council gravel quarry pit (MIA DAM - VWD5) for surface storage of void water as outlined in

Table 6-2**.**

An additional temporary storage (VWD6) has been constructed in the approved pre-strip area ahead of the open cut pit to assist in storing excess void water whilst mining the G-seam.

Table 6-2 WCC Void Water Dams

Identification	VWD1	VWD2	VWD3	VWD4	VWD5	VWD6
Local Name	**250ML Dam**	**35ML Dam**	**214ML Dam**	**140ML Dam**	**MIA Dam**	**Dam6**
Capacity (ML)	265	35	226	157	94	125
Operating (ML)	250	25	214	145	80	100
Freeboard (m)	0.93	0.87	1.00	1.10	-	1.00
Spillway RL	363.821	388.188	364.30	364.30	-	432.00
Dam Full RL	363.521	387.617	364.00	364.00	430.18	431.00
Wall Crest RL	364.450	389.058	365.30	365.40	-	433.00
Natural RL	358.5	384.732	362.10	361.00	-	431.00
Dam Floor RL	357.0	382.532	357.74	357.74	-	427.00

Other than void water pumping activities, specific management measures related to void water dams are outlined in the "*Operation & Maintenance Manual: Werris Creek Mine Void Water Dams 1, 3 & 4"* and includes the following:

- No construction or excavation within 20m of downstream toe of embankment;
- Maintenance of adequate vegetation cover on downstream slopes including earthworks and sowing if vegetation cover less than adequate or slashing of excessive vegetation growth. No trees or shrubs allowed to grow;
- Spillway inlets and outlets to be maintained free of soil or vegetation build up and spillway channels to be free of blockages;
- Dam embankments and crest to be free of erosion or soft/wet spots with earthworks undertaken as required; and
- Appropriate signage visible and legible.

Void Water Dams 1, 3 & 4 have been prescribed by the NSW Dam Safety Committee (DSC) with Significant Sunny Day and Flood Consequence categories requiring the design, construction and operation to be in accordance with DSC and ANCOLD guidelines. An independent dam engineer will be engaged on an annual basis to undertake a review of dam structure and operation of these void water dams. Any actions identified by the dam engineer will be implemented by WCC and reported in the Annual Review. Void Water Dams 1 and 2 are licenced monitoring points 16 and 27 respectively under EPL 12290.

Piezometers have been installed in the vicinity of the large Void Water Dams 1, 3 & 4 specifically to measure perched water tables that could indicate seepage through embankments and potential instability (**Section 7.3**). All void water dams are inspected regularly to identify any potential areas of weakness or seepage pathways, with a risk management process used to guide corrective actions to respond to any identified problem areas.

6.3.7 Pipelines and Valves

Operational pipelines are located within void or dirty water catchments and this practice will continue as far as practical so that any potential leaks are contained onsite. Pipelines and valves are located in areas outside of heavy vehicle interactions, with major pipe infrastructure protected by bunds / roadway verges. If a potential leak were to occur, water would report to either the void water or dirty water systems. Regular site inspections identify the integrity of the system.

6.3.8 High Water Level Alarms

In addition to regular inspections of void water dam storage levels, WCC has installed high water level alarms in void water dams 1, 3, and 4. Each high water level alarm system will have two float switches, one at the dam full level ("High Water Level") designated as 0.3m below the spillway level and a high water level just below the spillway level ("Spillway Level"). The float switches when triggered will send a prearranged SMS message to the OCE/Pumper and Environmental Officer for the condition "High Water Level" or to the OCE/Pumper, Operations Manager, Planning Engineer/Manager of Mining Engineering and Environmental Officer when the "Spillway Level" has been reached and overflow is imminent.

6.3.9 Site Water Usage

Water on site is used regularly for:

- Dust suppression
- Management of spontaneous combustion
- Coal crushing plant

Surplus water may be reduced by the following uses:

- Evaporators
- Agricultural Water Use

The Environmental Officer will monitor void water usage based on flow meters, void water dam storage levels and water cart load counts. In addition, WCC will engage a hydrogeologist (or similar expertise) to analyse void dewatering records and rainfall levels to update the water model for WCC on an annual basis, and determine the twelve-month total incidental groundwater make for the open cut pit. This will include an assessment of the availability of surplus water for offsite agricultural use over the upcoming year, with particular reference to the security of water supply over the LOM. Further information on these methods is provided in Section 4.1.

6.3.10 Hydrocarbon Management

All hydrocarbon spills will be cleaned up onsite by picking up the contaminated material and either remediating the soil onsite or sending the waste offsite to be disposed of at a licensed waste disposal facility. The Pollution Incident Response Management Plan (PRIMP) will be enacted in response to any major hydrocarbon spill, or a spill that has the potential to impact water quality and ecosystem health downstream of WCC.

The following controls are in place at the site for the management of hydrocarbons:

- Spill kits
- Pre-start inspections;
- Preventative maintenance;
- Informal observations by operators;
- Oil-water Separator

6.3.11 Evaporators

To manage excess void water at WCC, evaporators have been installed to recirculate the water by spraying a mist into the air to increase the surface area of water available to evaporate. All evaporators on average will pump up to 2.7 ML of void water per day, with the proportion evaporated highly dependent on ambient weather conditions, including wind speed, temperature, and humidity. Evaporators will generally be run during daylight hours, however during periods of greater evaporation potential, such as summer evenings, the evaporators may be run overnight.

6.3.12 Final Void Water Level and Quality, and Management of Acid-Forming Materials

The WCC LOM Project Environmental Assessment (R.W. Corkery & Co., 2010) raised the issue of acidity and salinity of final void water quality. Oxidation of pyritic compounds within the coal seams may occur, however the very low concentrations of sulphur measured within the coal seams (0.25-0.35%) combined with a high Acid Neutralising Capacity (ANC) associated with the presence of carbonaceous claystones and mudstones, will sufficiently counteract any acid forming materials. Furthermore, all coal seams will be removed by mining, while the current void water is alkaline due to the alkaline runoff from the overburden emplacement, such that any acidity in the water would be buffered by alkaline spoil water. Notwithstanding the absence of acid-forming materials on site, monitoring of coal quality will continue to assess the concentration of total Sulphur in railed coal, to ensure these assumptions are still valid. In the event that elevated concentrations of total Sulphur are identified in coal samples, further investigations will be undertaken to identify the source of the material, and assess the Net Acid Producing Potential (NAPP) of this material. In the event of high NAPP measurements, additional controls will be undertaken to manage any associated waste material, such as ensuring adequate coverage in the overburden emplacement. However, with the measured very high Acid Neutralising Capacity of the wider spoil material, any localized issues generated from the action of acid forming material (however unlikely), will be quickly neutralized through interaction with the surrounding spoil material.

Final design specifications for the void will be based on a detailed water balance including verified groundwater modelling predictions and a re-assessment of post-mining groundwater equilibration, along with specialist geotechnical investigations to ensure landform stability. RCA (2010) undertook a detailed modelling exercise over 50 years' post mining to determine the groundwater recovery and when equilibrium will be achieved. RCA (2010) determined that groundwater will recover to RL325m after 10 years (**Figure 6-4**), therefore the final void will be backfilled to RL330m, approximately 5m above the long term recovery of groundwater at equilibrium post mining. Water diversion works will be implemented to divert runoff from entering the final void and the background evaporation rate will ensure that the final void will be dry and not retain any sustained water bodies. These measures will prevent the creation of a permanent groundwater sink, as well as avoiding a potential saline water body that could impact on surface water quality post mining.

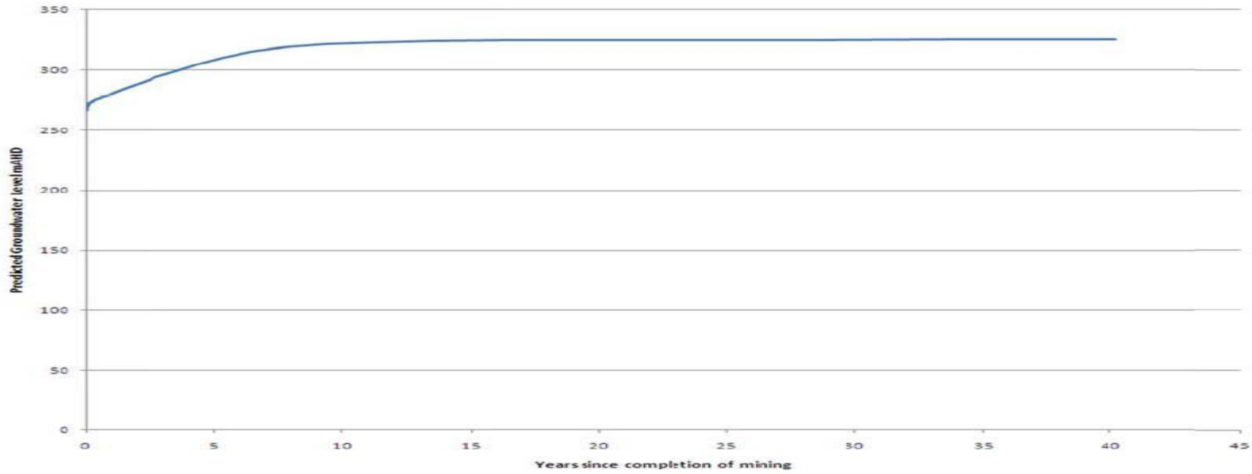

Figure 6-4 Post Mining Predicted Rate of Groundwater Recovery (from Figure 31 RCA, 2010)

Given the final void location is on a topographically high section of the catchment (WCC is the catchment boundary between Quipolly and Werris Creeks) and over 4km from the nearest permanent stream, WCC is unlikely to be flooded. Additionally, the final void water level is predicted to equalise at RL325m, which is below the rehabilitated final void surface level of RL330m. After Year 7 (2018) of the LOM project when WCC mines through the lowest level of the syncline, a groundwater bore will be installed at the base of the deposit to monitor the final void water level. In Year 12 (2023), the groundwater will be re-modelled using the observed data to verify predictions regarding the final void water recovery level. The final landform will be adjusted to achieve a surface elevation that is at least 5.0m above the final standing water level. Groundwater modelling will be undertaken by a suitably qualified hydrogeologist.

6.4 Dirty Water Management

Dirty water management at WCC utilises sediment dams and drains to capture water runoff from disturbed areas (**Figure 6-5** and **Figure 6-6**) and, after treatment of suspended solids (predominant potential pollutant), can be allowed to discharge offsite in accordance EPL 12290.

As approved by the LOM Project Approval in 2011, SB9 and SB10 capture runoff from the ROM and product coal stockpiles respectively. However due to concerns around the potential of contaminants other than sediment to these catchments, further investigations are currently being undertaken to investigate the potential impact of these stockpile areas on water quality in the receiving catchments. Through these investigations, WCC will determine whether Coal Contact Water has the potential to contain contaminants at concentrations above acceptable limits, potentially requiring additional control measures. These actions will ensure that any discharge from these LDPs do not pose a risk of non-trivial harm to human health or the environment and will comply with EPL 12290 discharge conditions and criteria.

6.4.1 Dirty Water Dams

Dams in dirty water catchments are designed to capture the 90th percentile 5-day rainfall depth for the catchment area, which for WCC is 39.2mm. Dirty water containment structures are constructed generally in accordance with the Soils and Construction, Managing Urban Stormwater, Volume 1, 4th Edition (Landcom, March 2004) and Soil and Construction, Managing Urban Stormwater, Volume 2E Mines and Quarries (DECC, June 2008) guidelines as best practice references. Dirty water dams at WCC and there storage volumes are outlined in **Table 6-3**. WCC has begun a survey program of these dams to confirm actual storage capacities, the program will be completed within the term of this document.

The available storage volume in many of the sediment dams has been determined by survey while others are estimates only. Survey will be carried out within the term of this water management plan to confirm the available storage at dams with an estimated capacity.

Sediment load is monitored visually by photographic record of sediment plumes at the entry to dirty water dams during regular inspections. If it is apparent that the sediment deposition rate is higher than desirable the catchment will be inspected to identify any areas requiring either improvement to drainage or erosion control. Sediment will be excavated from these identified dams as required.

Table 6-3 Dirty Water (Sediment Basins) Dams

No.	Description	ML	Comment
SB18	North East – Dirty water capture, treatment and discharge point (EPL TBC)	2.0	Estimated
SB13	Northern Area – Dirty water capture, treatment and use	3.0	Estimated
SB14	Northern Area – Dirty water capture, treatment and use	1.9	Surveyed
SB10	Northern Area – Dirty water capture, treatment and discharge point (EPL 14)	4.6	Surveyed
SB11	Middle Area – Dirty water capture, treatment and use	11.0	Surveyed
SB17	Middle Area – Dirty water capture, treatment and use (BWD)	4.1	Surveyed
SB15	Middle Area – Dirty water capture, treatment and use	0.45	Estimated
SB16	Middle Area – Dirty water capture, treatment and use	4.2	Estimated
SB8	Middle Area – Dirty water capture, treatment and use	3.0	Estimated
SB9	Middle Area – Dirty water capture, treatment and discharge point (EPL 12)	4.0	Partially Surveyed
SB1	Southern Area – Dirty water capture, treatment and use	7.0	Estimated
SB3	Southern Area – Dirty water capture, treatment and use	6.5	Estimated
SB4	Southern Area – Dirty water capture, treatment and use	2.5	Estimated
SB5	Southern Area – Dirty water capture, treatment and use	1.4	Estimated

No.	Description	ML	Comment
SB12	Southern Area – Dirty water capture, treatment and use	9.0	Surveyed
SB2	Southern area – Dirty water capture, treatment and discharge point (EPL 10)	8.5	Surveyed
Total Capacity of All Dirty Water Dams		**67.4**	

Figure 6-5 Middle and Northern Dirty Water Management Systems

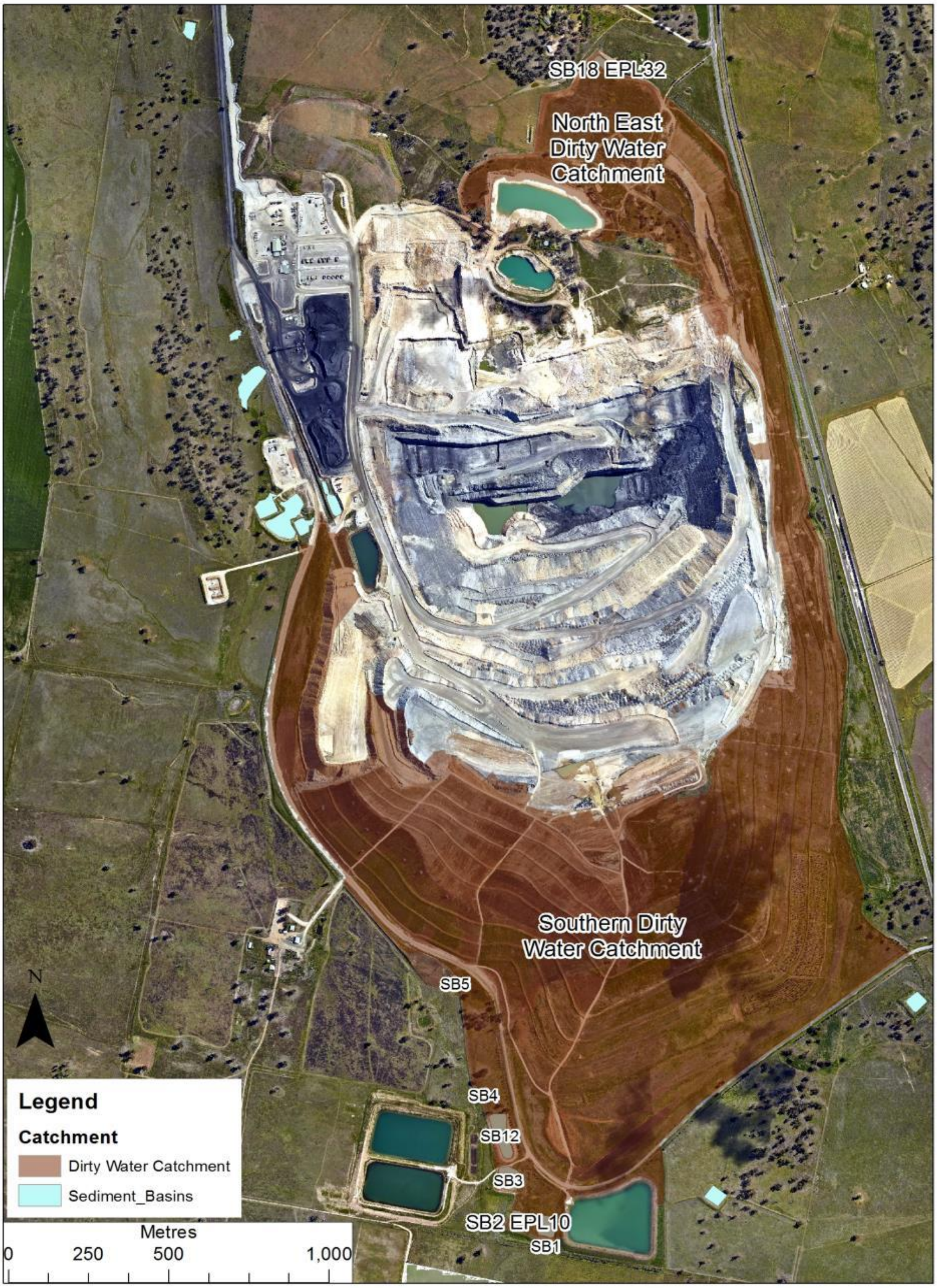

Figure 6-6 Southern and North-Eastern Dirty Water Management Systems

6.4.2 Dirty Water Discharge

EPL 12290 permits WCC to undertake discharges from the licensed discharge points (LDPs) of SB2 (EPL10), SB9 (EPL12), SB10 (EPL14) and SB18 (EPL32). WCC categorises two types of discharges, a discharge due to rainfall runoff and overflowing via the spillway is called a wet weather discharge, while a controlled discharge occurs when the dam water is pumped out. All discharge water quality must meet the limits specified in **Section 7.1.1**. WCC can exceed the Total Suspended Solid limit if over 39.2mm of rainfall is received over a 5-day period, resulting in a wet weather discharge. WCC treats dirty water when required by using polymer based flocculants to lower Total Suspended Solids, reducing turbidity and dosing dams with pool acid to maintain pH within discharge limits. A controlled discharge of settled and (if necessary) treated dirty water would be undertaken in accordance with the EPL 12290 when storage levels within respective LDPs (SB2, SB9 and SB10) are greater than 50%. This would provide the capacity to contain more rainfall events and reduce wet weather discharges. Discharge of dirty water in a controlled manner allows adequate settlement of sediment to be achieved prior to discharge and reduce the potential for sediment-laden water to discharge during wet weather events.

Water sampling laboratory certification requirements are outlined in Section 7.1.3. All laboratory results undertaken prior to a controlled discharge are reviewed against exceedance criteria for compliance.

6.4.3 Rehabilitation Program

WCC progressively rehabilitates areas disturbed by mining activities, including the overburden emplacement area. Over 160 hectares of mining disturbance has been rehabilitated to the *Ecosystem and Land Use Establishment* standard to date. Annual targets have been proposed by WCC in the MOP and Rehabilitation Management Plan equating to roughly 20 hectares per year, which as well as achieving the required final land uses (for WCC is Woodland Ecological Communities and Agriculture), also provide a major control to reduce sediment loads in the dirty water system. A summary of rehabilitation plans and designs as required by the Modified PA is discussed below, however for further details regarding the rehabilitation program and success criteria for WCC, refer to the 2015-2022 MOP.

WCC have adopted a clockwise arrangement of contour banks, spaced at 60 metre slope length intervals, which avoids the need for drop-structures. Hydraulic modelling of this contour bank arrangement has demonstrated that maximum velocities will remain below 2m/s during a 1:50 ARI rainfall event along the length of the 1.2% longitudinal slope, dropping significantly following vegetation cover establishment. Runoff from the central plateau of the final rehabilitation will report to one of five sub-catchments, which form the source of the contour banks, as shown in **Figure 6-7**. Contour banks are inspected to identify areas of potential failure, such that repairs can be made in a timely manner.

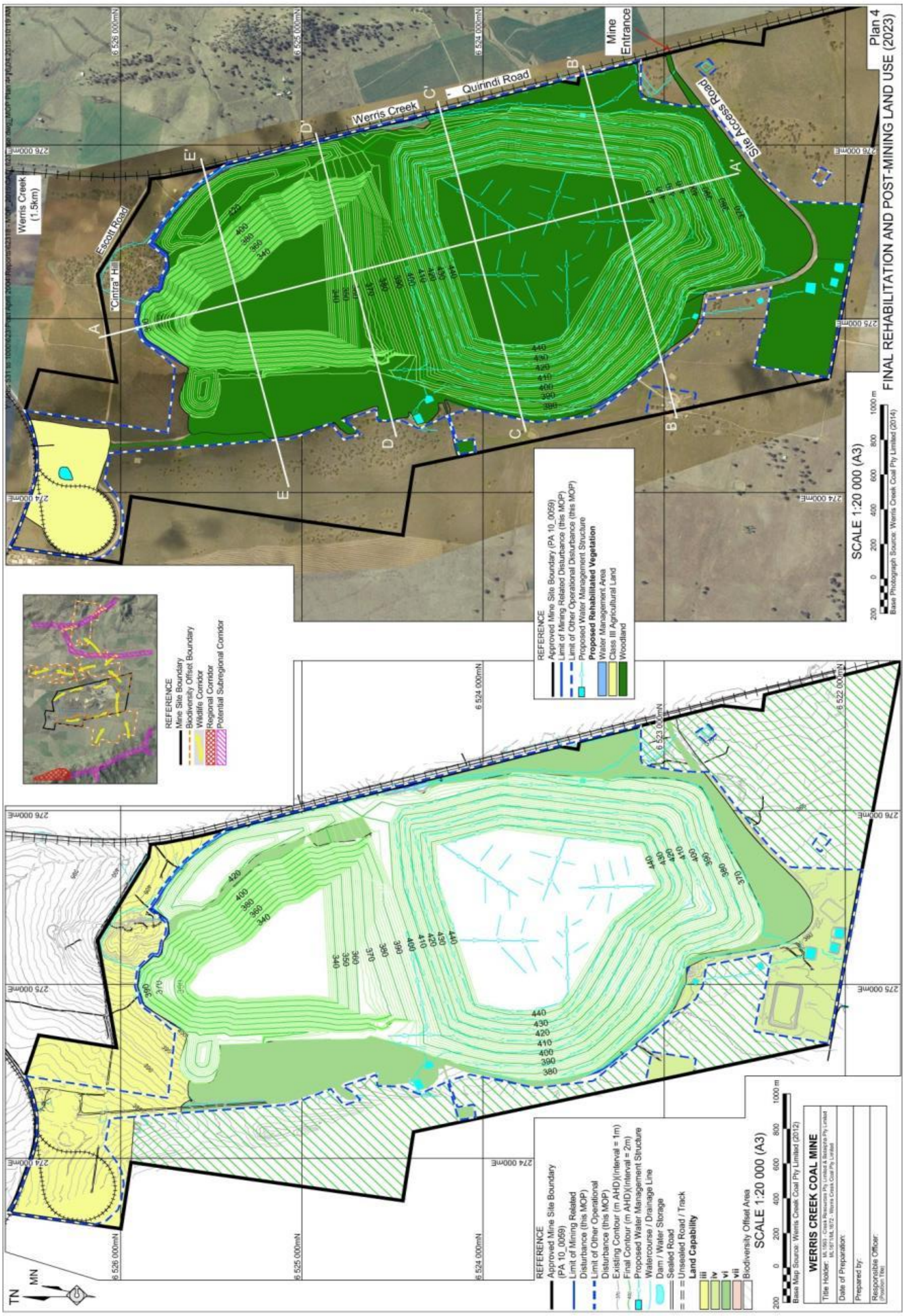

Figure 6-7 Drainage lines on the overburden emplacement rehabilitation area

6.5 Clean Water Management

6.5.1 Clean Water Dams and Maximum Harvestable Rights

The clean water management system is comprised of dams and drains to divert water runoff from undisturbed areas around WCC operations and allow it to continue to drain offsite unimpeded. Clean water dams at WCC are outlined in **Figure 6-8** and **Table 6-4**.

The *Water Act 1912* and *Water Management Act 2000* (WM Act) contain provisions for the licensing of water capture and use, which only apply to clean water dams at WCC. The NSW Farm Dams Policy (1999) outlines the maximum harvestable right dam capacity (MHRDC) for the LOM Project by the following calculation - MHRDC = Project Site Area (ha) x Multiplier Value (0.07).

The MHRDC has been calculated to be approximately 63 ML based on the LOM Project area of 908ha. From **Table 6-4**, the capacity of the existing clean water storage dams that could be used for water supply are within the MHRDC. Hence no licenses are required for these existing dams. No new clean water dams are proposed for the LOM Project.

Table 6-4 Clean Water Dams

No.	Description	ML	Method
SD4	Clean water capture and use Diversion of Clean water around mine	5.1	Surveyed
SD5	Clean water capture and use Diversion of Clean water around mine	4.0	Surveyed
Total Capacity of Existing Clean Water Dams		9.1	Surveyed

6.5.2 Clean Water Diversion

As discussed in **Section 6.1**, WCC will divert clean water away from disturbed areas using contour banks and diversion drains. Existing clean water diversion drains are effective for managing runoff from the adjacent “Railway View” property to the east.

6.5.3 Water Management at Mine Closure

At mine closure, WCC will fill in and rehabilitate all void water dams onsite. Dirty water dams will be retained for a period after mine closure to manage runoff from disturbed areas until fully rehabilitated at which time a decision will be made whether to retain dirty water dams within the final landform. As mine closure is expected to occur around 2023, WCC will prepare a detailed mine closure plan two years prior to mine closure, which will include further details on water management.

Figure 6-8 WCC Clean Water Management System

6.6 Contaminated Water Management

The Contaminated Water stream includes potentially hydrocarbon contaminated water runoff from the workshop and fuel farm and the septic system for treating water from ablutions. Furthermore, runoff from the explosives mixing facility may increase nutrient and hydrocarbon loading to the dirty water management system if not effectively managed. Each of these sub-streams of Contaminated Water are discussed below, with the locations shown in **Figure 6-9**

6.6.1 Oil/Water Treatment

Potentially hydrocarbon contaminated runoff from the workshop concrete hardstand (draining via the workshop sump) and from the separate diesel fuel farm area overflows to a “Ceptor” hydrodynamic separator system which was commissioned in December 2013 following the completion of the relocation and construction of the northern MIA. The Ceptor system is comprised of a dual pre-cast concrete tank system with a combined storage capacity of 6,000L designed to remove free hydrocarbons and suspended solids from stormwater. The primary tank has a lower treatment chamber and a bypass chamber designed as zero-scour for high flows that both sediments (denser than water) and hydrocarbons (lighter of water) are stored separately away from the inflow-overflow water path. The secondary offline tank provides for the storage of treated sediment and oil when the primary tank reaches capacity. To ensure that the Ceptor is maintained in fully function state, a vacuum truck services both tanks regularly. The Workshop sump is also regularly serviced with the silt from both the Workshop sump and Ceptor transported to the onsite bioremediation area for treatment.

As the Ceptor is regularly, the potential for overflow events are significantly reduced. Routine water quality testing within the dirty water catchment of the Ceptor is undertaken to monitor for potential contaminants and compare against site exceedance criteria.

6.6.2 Septic Water Treatment

Ablutions raw water is treated by a septic treatment system approved by the Liverpool Plains Shire Council (Onsite Sewerage Management System 16/13 dated 15th May 2013). Solid effluent is contained within 2x3000L septic tanks and periodically collected by a licensed waste collection and disposal contractor as required while the liquid effluent drains into adsorption trenches. An additional 3000L septic system is located at the Train Load Out Facility, with minimal flow through this system. Solid effluent from this septic system is collected by a licensed waste contractor as required.

6.6.3 Explosives Mixing Facility

Raw products including ammonium nitrate and mineral oil are used in blasting operations at WCC, and are combined at the mixing compound prior to loading. These products if not effectively managed can increase nitrogen loading of receiving waters and potentially contribute to hydrocarbon contamination. To minimise the risk of contamination at the mixing facility, these products are stored in bunded tanks, with a sump catching all runoff from the mixing facility. Furthermore, SB11, which catches any overflow from the sump, is maintained at a low level to minimise the risk of contamination to the discharge site SB9, with water from SB11 pumped back to VWD2 following rainfall runoff events.

Figure 6-9 Contaminated Water Management Infrastructure

6.7 Erosion and Sediment Control

In addition to the controls already discussed in **Section 6.2** to **6.5**, general erosion and sediment controls implemented by WCC are described in the following sections. Erosion and Sediment Control management will follow the guidelines referred to in *Managing Urban Stormwater: Soils and Construction, 4th Edition* (known as the "Blue Book" – Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries* (DECC, 2008), and with the objective of meeting EPL requirements for total suspended solids.

Regular inspections are carried out to ensure that the controls are working as intended, provide early detection of any potential issues requiring rectification, and monitor to ensure sediment controls are adequately maintained. Monitoring will identify areas of potential failure, such that repairs can be made in a timely manner.

6.7.1 Contour banks

Contour banks will be used primarily within the rehabilitation of the overburden emplacement to direct runoff from the upper heights of the rehabilitation to the natural ground level, in a low-moderate energy environment, as described in **Section 6.4.3**. In addition, contour banks will be utilised alongside select boundaries of the dirty water management catchments, where required to separate the clean water catchment from the dirty water catchment.

6.7.2 Diversion drains

Diversion drains will be utilised within the dirty water catchment to conduct runoff away from clean catchments to the dirty water dams (sediment basins) in a low-slope, low-moderate intensity fashion. Diversion drains will also be used to connect successive sediment basins that are operated in series.

6.7.3 Rock lined drains

Rock lined drains will be used to convey dirty water streams for short sections in higher energy environments, where the inherent slope requires stabilisation to prevent excessive head ward erosion of the drain. Rock lining of drains will typically occur along the inflow and outflow channels of sediment basins where there is a risk of erosion, as well as in higher slope drains of the industrial area.

6.7.4 Sediment basins and sumps

Sediment basins are used across WCC as a settling basin for managing sediment loads within the dirty water management system. Their use and distribution across site have previously been described in **Section 6.4.1**. In addition, small scale sumps may be used adjacent to particular areas, such as the Explosives Mixing Facility, as an initial sediment control structure, prior to treatment in the dirty water management system.

6.7.5 Sediment fences

Sediment fences may be utilised on an ad hoc basis to manage sediment loads in freshly disturbed areas, as well as in areas that cannot report to the dirty water management system such as runoff from remote facilities. Sediment fences are not the preferred form of sediment control, and as such will generally only be utilised where the other controls identified above are not practical or effective.

6.7.6 Erosion Control

Generally, erosion rates are reduced by progressive site rehabilitation as discussed in Section 6.4.3 along with contour banks to limit exposed surfaces.

Site specific erosion controls where excessive erosion is evident will be selected as appropriate to the site but may include combinations of measures such as armouring with granular material, placement of jute mesh, hydro seeding, mulching or stabilisation with a binding agent.

6.8 Groundwater Management

6.8.1 Groundwater Level and Inflow Management

Impact to the regional groundwater table from dewatering the former underground workings and from mining below the water table is mitigated by the presence of an existing natural clay aquitard, reducing to minimal the flow of groundwater from the outside Werrie Basalt aquifer into the Coal Measures aquifer and subsequently the WCC open cut pit as described in **Section 3.2.1**. Monitoring of the groundwater regime will be undertaken to provide a routine evaluation of groundwater conditions and to identify groundwater trends. The monitoring program is described in **Section 7**. Monitoring data will be used to revise the existing groundwater model and refine the impact to groundwater evaluations presented in the LOM EA.

Changes in groundwater flow regimes resulting from the operations will be managed through actions to mitigate any impacts determined to be related to the mining operations. Mitigation measures are described in **Section 10.2.1.1**.

6.8.2 Groundwater Licensing

Groundwater interception licences held by WCC under the Water Management Act 2000 are listed in **Table 6-5**.

Table 6-5 WCC Groundwater Licences

Water Access Licence	DPI-W Reference	Water Works Approval	Former Water Act 1912	Allocation
WAL29506	90AL822531	90WA822532	90BL252588	50ML
WAL32224	90AL828344	90WA828345	90BL255087	211ML

6.8.3 Groundwater Quality Management

Impacts to groundwater quality can only be caused by activities on the surface in particular the management of hydrocarbons (**Section 6.8.4**). Annual groundwater quality monitoring will be undertaken to assess the trend in a range of analytes as outlined in **Section 7.4**.

6.8.4 Hydrocarbon Management

Hydrocarbon use and storage on the site can result in contamination of groundwater and surface water. The following principles will be implemented to reduce the risk of a pollution incident:

- An oil/water treatment system (Ceptor – **Section 6.6.1**) manages potentially contaminated water from the workshop and fuel farm areas;
- Waste oil will be disposed offsite by a licensed waste transporter to be recycled; and
- Soils impacted with hydrocarbons around the workshop including silt from the Ceptor and workshop sump will be taken to the onsite bioremediation area for treatment and eventually disposed of onsite when tested to comply with Waste Regulations.

6.8.5 Saline Water Body Within Mine Void on Cessation of Mining

The final mine landform is to achieve an elevation 5.0m above the predicted final standing water level. Re-modelling using observed data is to be undertaken throughout the mine life to ensure accurate predictions of the final standing water level are made. Modelling will be undertaken in Year 12 to assess predicted water levels of the final landform, calibrated with observed water level data. The final landform will be adjusted to achieve a surface elevation that is at least 5.0m above the final standing water level, as per the 2015-2022 MOP.

7 MONITORING

Monitoring is undertaken in accordance with the conditions of EPL12290 and the Modified PA, which specify required methods of sampling, analysis and frequency of monitoring.

7.1 Surface Water Monitoring Program

Surface water monitoring at WCC is structured for discharge monitoring (dirty water controlled or wet weather), and routine (quarterly) monitoring of clean, dirty and void water dams and offsite streams. Non-routine monitoring also occurs on an ad hoc basis to determine immediate water quality of dams onsite. The WCC surface water monitoring locations are presented in **Figure 7-1** and **Figure 7-2**.

7.1.1 Discharge Water Monitoring

WCC is permitted to undertake discharges from the licenced discharge points when the water quality complies within EPL 12290 criteria in Condition L2.4 (or if a rainfall event greater than 39.2mm over five days then the total suspended solids are allowed to be exceed criteria the 50mg/L criteria). The monitoring locations, frequency and analytes tested for discharges are the same regardless of whether it is a wet weather or controlled discharge event into either Quipolly Creek and/or Werris Creek catchments (**Table 7-1**).

Table 7-1 Discharge Monitoring Locations, Frequency & Parameters

Location	Frequency	Parameters
Discharge commences from Licenced Discharge Points SB2 and/or SB9 into the Quipolly Creek catchment:		Electrical Conductivity (µS/cm) Nitrate (mg/L as Nitrogen) Total Nitrogen (mg/L) Oil & Grease (mg/L) pH (no units) Total Phosphorus (mg/L) Reactive Phosphorus (mg/L) Total Suspended Solids (mg/L)
SB2 (EPA10) and/or SB9 (EPA12)	As soon as practicable and not more than 12 hours after discharge	
QC-U (EPA25) QC-D (EPA26)	Within 12 hours of discharge.	
Discharge commences from Licenced Discharge Point SB10 and/or SB18 into the Werris Creek catchment:		
SB18 (EPA 32) and/or SB10 (EPA 14)	As soon as practicable and not more than 12 hours after discharge	
WC-U (EPA23) WC-D (EPA24)	Within 12 hours of discharge.	
Note: Sampling method is by a representative grab sample Note: Sampling will be undertaken in accordance with DEC, 2004		

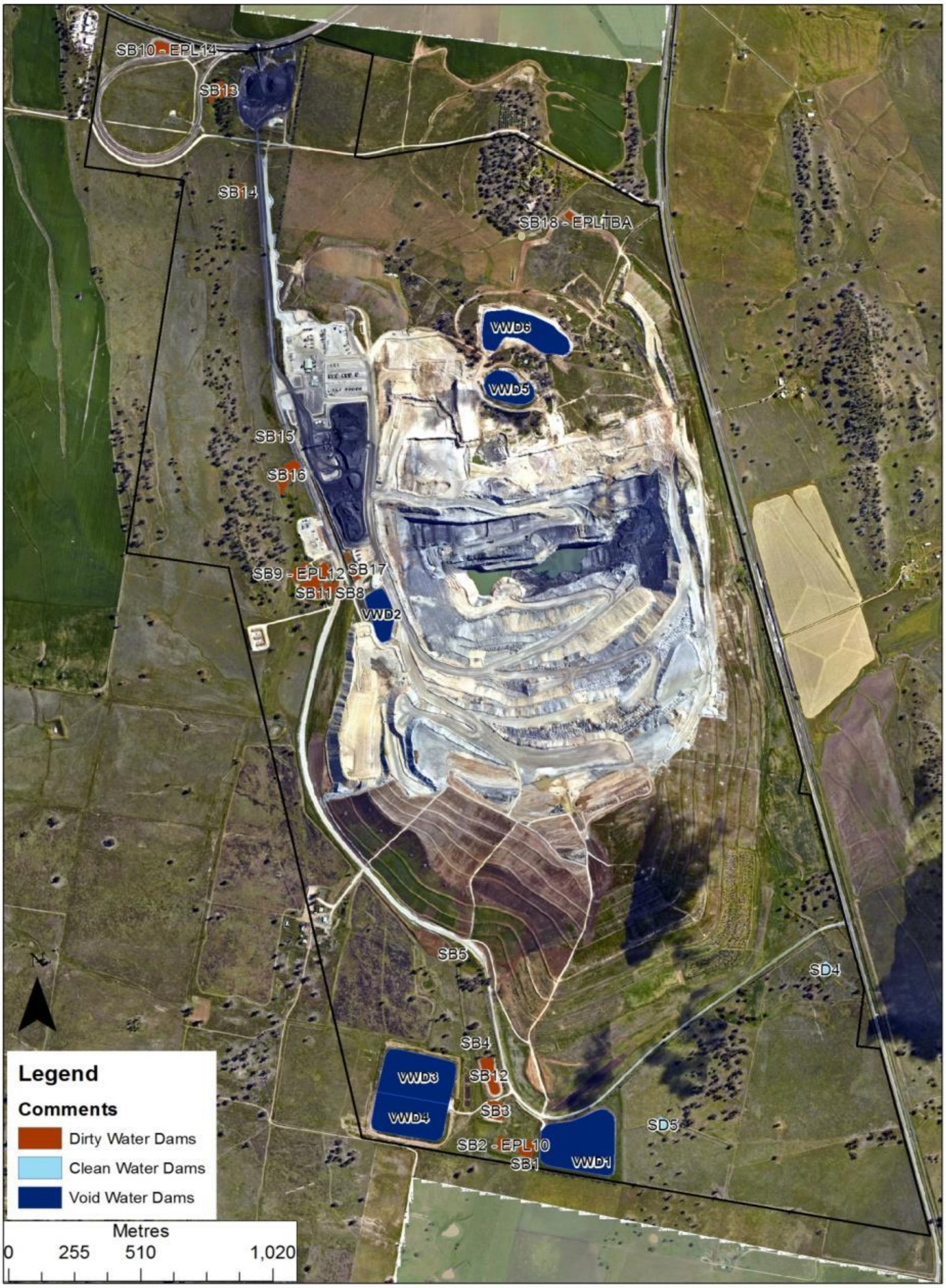

Figure 7-1 Clean, Dirty and Void Water Dams Onsite at WCC

Figure 7-2 EPL12290 Licensed Discharge Points and Offsite Creek Monitoring Locations

7.1.2 Routine Water Monitoring

Routine surface water quality monitoring is undertaken quarterly in accordance with EPL 12290 M2.3 for the void water dams (VWD) 1 & 2 (EPA 16 & 27). Routine water monitoring locations are differentiated by their proximity to WCC, either onsite or offsite. Other onsite monitoring locations from the clean (SD5 and SD6), dirty (SB2, SB9, SB10 and SB18) and void (VWD1, VWD2, VWD3, VWD4) water streams are also sampled on a quarterly basis (**Table 7-2**).

Table 7-2 Quarterly Routine Onsite Surface Water Monitoring

Location	Water Stream	Comment	Parameters
VWD1	Void	EPA16 - 20ML Dam	Biochemical Oxygen Demand (BOD) Electrical Conductivity (µS/cm) Nitrate (mg/L as Nitrogen) Total Nitrogen (mg/L) Oil & Grease (mg/L) pH (no units) Total Phosphorus (mg/L) Reactive Phosphorus (mg/L) Sodium Absorption Ratio (SAR) Total Suspended Solids (mg/L)
VWD2	Void	EPA27 - 35ML Dam	
VWD3	Void	200ML Dam North	
VWD4	Void	200ML Dam South	
SB2	Dirty	EPA10 - Southern catchment	Electrical Conductivity (µS/cm) Nitrate (mg/L as Nitrogen) Total Nitrogen (mg/L) Oil & Grease (mg/L) pH (no units) Total Phosphorus (mg/L) Reactive Phosphorus (mg/L) Total Suspended Solids (mg/L)
SB5	Dirty	Southern catchment	
SB8	Dirty	Middle catchment	
SB9	Dirty	EPA12 – Middle catchment	
SB11	Dirty	Middle catchment	
SB13	Dirty	Northern catchment	
SB10	Dirty	EPA14 – Northern catchment	
SB18	Dirty	EPA TBC – North Eastern catchment	
SD4	Clean	Eastern Clean Diversion	
SD5	Clean	Eastern Clean Diversion	
Note: Sampling method is by a representative grab sample Note: Sampling will be undertaken in accordance with DEC, 2004			

Offsite routine surface water quality monitoring focuses on two catchments, Quipolly Creek and Werris Creek, as the WCC site is situated on the divide between the two catchments. The northern catchment is part of the Werris Creek watershed and the middle and southern catchment are a part of the Quipolly Creek watershed. To quantify any potential impacts from WCC releases into either catchment, an upstream monitoring location has been selected as representative of in-stream water quality before any inflow from WCC and a downstream monitoring point has been selected that represents both upstream and mine water quality. Locations have been selected with easy access from the public road network. During dry periods, the upstream monitoring locations (in particular Quipolly Creek upstream) can run dry and therefore the upstream monitoring point will be taken at the next available location with water in stream, preferably flowing. Any discharge water from WCC into the Quipolly Creek catchment will flow via an unnamed gully into Black Gully before reaching Quipolly Creek. A monitoring location has also been adopted for Black Gully downstream of the confluence with the unnamed gully. **Table 7-3** outlines the quarterly routine offsite surface water quality monitoring program.

Table 7-3 Quarterly Routine Offsite Surface Water Monitoring

Location	Water Stream	Comment	Parameters
QC-U	Quipolly	EPA25 – Quipolly Creek Upstream of mine inflow	Electrical Conductivity (µS/cm) Nitrate (mg/L as Nitrogen) Total Nitrogen (mg/L) Oil & Grease (mg/L) pH (no units) Total Phosphorus (mg/L) Reactive Phosphorus (mg/L) Total Suspended Solids (mg/L)
QC-D	Quipolly	EPA26 – Quipolly Creek Downstream of mine inflow	
BG-D	Quipolly	Black Gully Downstream of mine inflow	
WC-U	Werris	EPA23 - Werris Creek Upstream of mine inflow	
WC-D	Werris	EPA24 - Werris Creek Downstream of mine inflow	
Note: Sampling method is by a representative grab sample Note: Sampling will be undertaken in accordance with DEC, 2004			

7.1.3 Water Sampling Methods

Trained or experienced personnel undertake environmental monitoring using industry accepted monitoring techniques with equipment calibrated to relevant Australian Standards. Analysis of all samples is completed by NATA approved laboratories.

7.2 Water Usage Monitoring

WCC maintains a network of inline flow meters, void water dam storage level boards and water cart fill points to record the void water transfer within the water management system onsite. Each month the Environmental Officer records the flow meters and storage levels of void water dams to determine water usage onsite. These locations are subject to change in response to mining operations and are provided as a guide only. The pit dewatering pipelines are key water inputs and dust suppression are the key output from the water management system.

7.3 Void Water Dam Piezometers

Piezometers have been installed in the vicinity of the large void water dams 1, 3 & 4 specifically to measure perched water tables that could indicate seepage through embankments and potential instability as mentioned in **Section 6.3.6**. Three piezometers at each facility have been installed so that a water table surface can be triangulated and monitored over time, while also providing an indication of any loss of containment from the dam that may contribute to groundwater contamination.

7.4 Groundwater Monitoring Program

To monitor groundwater impacts as a result of mining operations, WCC has established the groundwater monitoring network as shown in **Figure 7-3** and **Table 7-4**. Furthermore, groundwater inflows to the mining void are calculated on an annual basis as part of the update of the Water Balance Model and validation, previously described in **Section 4.1**.

Groundwater monitoring locations will be reviewed, and if necessary, modified in consultation with relevant Departments over the life of the project, in response to monitoring results and changes in the mining operations.

The groundwater monitoring network focuses on the Werrie Basalt and Quipolly Alluvium aquifers adjacent to WCC. The Werrie Basalt groundwater bores can be broken up into mining (adjacent to mining operations and therefore first to show signs of any mining influence), northern (representative of Werrie Basalt aquifer to the north towards Werris Creek) and southern (representative of Werrie Basalt aquifer to the south towards Quipolly Creek and the Alluvium aquifer) bores.

In 2014, a deep nested piezometer (to 99m and 168m) was installed into the Werrie Basalt aquifer adjacent to the coal measures specifically to monitor differences between the shallow and deep (equivalent to the base of the open cut) areas of the Werrie Basalt aquifer. Piezometers have also been installed around the major void water dams at WCC to identify any seepage or other loss of containment, which may contribute to groundwater contamination, as described in **Section 7.3**.

All bores will have the groundwater levels monitored bi-monthly with the levels assessed to the nearest 0.01m. All monitoring bore locations will be surveyed (coordinates and Australian Height Datum elevation) and the stick up (difference between top of bore case and bore collar) known so that the relative levels of the aquifer can be determined. The bore depth will be used to calculate the saturated thickness.

Groundwater sampling is conducted in accordance with the sampling methods specified in EPL12290 and the Approved Methods (DEC, 2004). Furthermore, analysis of groundwater quality is undertaken by a NATA accredited laboratory, with the exception of pH and electrical conductivity, which are measured in the field using calibrated equipment.

Data collected as part of this Groundwater Monitoring Program will be examined as part of the Annual Review process, to assess changes to groundwater quality or quantity within the monitoring network. The Annual Review also includes an assessment of groundwater contribution to the open cut pit as part of the annual update of the water balance model (**Section 4.1**) which will also feed into assessments of mining-related impacts on privately-owned bores. Assessing potential mining-related impacts on privately-owned bores will focus on identifying any changes in groundwater quality or level, taking into consideration the groundwater flow paths and observations from background monitoring bores such as MW8 and MW28A.

Werris Creek Coal Mine	Preferred location zone for new Quipolly Alluvium and Werris Basalt clustered monitoring bore indicated by

Figure 7-3 Groundwater Monitoring Locations

Following recent discussions with the DPI-W regarding opportunities to improve the understanding of groundwater dynamics in the area, WCC have committed to installing additional targeted monitoring bores to drive the continuous improvement of the Groundwater Monitoring Program. WCC plans to install new groundwater monitoring bores as follows:

- a clustered monitoring bore through the Quipolly Alluvium aquifer and into the Werrie Basalt in FY2017. This clustered monitoring bore will enhance the current level of understanding regarding the interactions between the Quipolly Alluvium and Werrie Basalt aquifers.
- a monitoring bore into the syncline of the Coal Measures aquifer to enhance the current understanding around groundwater interactions between the Coal Measures aquifer and the Werrie Basalt aquifer. This monitoring bore will also support the determination of a final groundwater level in the post-mining environment, as described in **Section 6.8.5**. This Coal Measures monitoring bore will be installed following the initial rehabilitation of the overburden emplacement in the vicinity of the proposed bore.

Indicative locations for these proposed new Quipolly Alluvium bores is shown on **Figure 7.3.**

WCC will engage a hydro-geologist to investigate the relationship between groundwater and base flow in Quipolly Creek, to determine if groundwater contributes to base flow.

Table 7-4 Groundwater Monitoring Locations, Frequency and Bore Information

Parameters	Frequency	Bore/Piezometers
Standing Water Level	Bimonthly	WCC owned land: MW1, MW2, MW3, MW4B, MW5, MW6, MW10, MW14, MW20, MW24A, MW27, MW36A, MW36B Privately-owned land: MW8#, MW12, MW13, MW13B, MW13D, MW15, MW16, MW17A, MW17B, MW18A, MW19A, MW21A, MW22A, MW22B, MW23A, MW23B, MW26B, MW28A#, MW29, MW32, MW34, MW38A, MW38B, MW38C, MW38E,
Total Nitrogen Nitrate Nitrogen Total Phosphorus Reactive Phosphorus Electrical Conductivity pH	6 Monthly	WCC owned land: MW1, MW2, MW3, MW4B, MW 5, MW6
Chloride, Sulfate, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Chromium, Copper, Manganese, Nickel, Lead, Vanadium, Zinc, Mercury Ammonium, Nitrite, Nitrite+Nitrate, TKN, Anions, Cations, Ion Balance, TPH	Annually	WCC owned land: MW1, MW2, MW3, MW4B, MW5, MW6, MW10, MW20, MW24A, MW27, MW36A, MW36B Privately-owned land: MW7, MW8#, MW12, MW13, MW13B, MW13D, MW15, MW16, MW17A, MW17B, MW18A, MW19A, MW21A, MW22A, MW22B, MW23A, MW23B, MW26B, MW28A#, MW32
# Regional monitoring bores		

7.5 Monitoring Related to the Agricultural Use of Void Water

As stated in **Section 6.3.3**, WCC will extend the quarterly water monitoring program to include the analytes critical to the assessment of impacts on soil salinity and nutrient levels. The Irrigation Management Plan will determine the appropriate monitoring regime specific to each irrigation program, however generic monitoring requirements will apply to any program. These include monitoring the volume of water delivered each day for agricultural use (**Table 7-5**), and the quality of water supplied (**Table 7-6**), however this monitoring will only occur if and when water is provided to a third party for agricultural use as outlined in **Table 7-6**. Where multiple agricultural users receive water from the same pump, the volume attributable to each user will be individually determined.

Table 7-5 Water Volume Monitoring Requirements for Agricultural Use Supply

Frequency	Unit of Measure	Sampling Method
Daily during any discharge	Kilolitres per day	By calculation (volume flow rate or pump capacity multiplied by operating time) or meter

Table 7-6 Water Quality Monitoring Requirements for Agricultural Use Supply

Pollutant	Units of Measure	Frequency	Sampling Method
pH	pH	Special Frequency 4	Grab sample
Conductivity	Micro-Siemens per centimetre	Special Frequency 4	Grab sample
BOD	Milligrams per litre	Special Frequency 3	Grab sample
Cations (Mg, K, Na)	Milligrams per litre	Special Frequency 3	Grab sample
Dissolved metals (Al, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Va, Zn)	Milligrams per litre	Special Frequency 3	Grab sample
Oil & Grease	Milligrams per litre	Special Frequency 3	Grab sample
Total Dissolved Solids	Milligrams per litre	Special Frequency 3	Grab sample
Special Frequency 3 means every three months. If no water is planned to be provided for agricultural purposes within the three months following scheduled sampling, then sampling is not required. Special Frequency 4 means prior to but not more than 24 hours prior to providing water for agricultural purposes and then weekly thereafter until the provision of water ceases.			

8 REPORTING

8.1 Incident Reporting

In the event of an incident which has caused or threatens to cause material harm to the environment, the WCC PIRMP will be implemented and relevant PIRMP reporting requirements adhered to. Within 7 days of the date of the incident, WCC will provide the DP&E and other relevant agencies with a detailed incident report which will:

- Describe the date, time, duration and nature of the exceedance/incident;
- Identify the type and concentration of every pollutant discharged;
- Identify the cause (or likely cause) of the exceedance/incident;
- Name and contact details of witnesses to the event;
- Describe what action has been taken to date; and
- Describe the proposed measures to address the exceedance/incident.

Any further reports requested by the DP&E will be provided in a timely manner as agreed with the Department.

For any other incidents related to water management, WCC will notify the DP&E and any other relevant agencies (as described in **Section 10**) as soon as practicable after becoming aware of the incident.

8.2 Regular Reporting

WCC will provide regular reporting on the environmental performance of WCC on the Whitehaven Coal website, via EPL reports, CCC reports and Annual Reviews in accordance with the reporting arrangements in any plans or programs approved under the conditions of the Project Approval.

8.3 Reporting for Exceedance of Licence Conditions

In the event that a licence condition is breached or exceeded WCC will advise relevant regulatory agencies that a breach or exceedance has occurred at the earliest opportunity.

9 REVIEW

This document will be reviewed in accordance with the requirements of Condition 4 Schedule 5 of the Modified PA. WCC 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 controls and reporting on outcomes of water quality monitoring and assessment annually in the Annual Review.

10 CONTINGENCY PLAN

WCC is required to implement a contingency plan for the management of any unpredicted impacts and their consequences. In regards to contingency plans for water management, WCC have a number of management strategies that would identify unpredicted water impacts and management measures to mitigate or ameliorate those impacts. The contingency plan and associated Trigger Action Response Protocols will be implemented when water monitoring triggers have been reached as identified in **Table 5-1**.

The following procedures have been developed to manage the above:

- WHC_PRO_OC_WC_Water Monitoring Exceedance TARP
- WHC_PRO_OC_WC_Surface Water TARP
- WHC_PRO_OC_WC_Groundwater TARP

Records and monitoring data are to be maintained and available for review by the appropriate Departments. Details on reporting procedures are contained within **Section 8** of the WMP and the Pollution Incident Response Management Plan may apply.

10.1 Considerations of Potential Surface Water Impacts

10.1.1 Operational Water Use

Surface water contingencies that will be considered in the event of insufficient water use for site operations include:-

- Groundwater extraction from the overburden area under the existing groundwater extraction licence;
- Modify operations to minimise dust suppression requirements;
- Use of clean and dirty water throughout site operations;

Surface water contingencies that will be considered in the event of excess water use for site operations include:-

- Increase in pit storage of void water;
- Use of Evaporators and Sprays to increase evaporation;
- Relocation of evaporators (and use of an additional evaporator) to areas conducive to evaporation;
- Increased dust suppression;
- Increased site storage capacity for void and dirty water;
- Increase offsite irrigation area and agricultural supply; and
- Increased controlled discharge volumes, managed under licence conditions.

10.1.2 Impacts to Geomorphology

In the event that impacts to geomorphology are identified to have resulted from surface water runoff the following steps will be undertaken:-

- Determine if the identified impacts are resulting from mine operations, and the nature of operations that have resulted in the impacts;

- Identify opportunities to remove or reduce the impact and concurrently identify if restoration or rehabilitation works are required in the impacted area;
- If impacts are resulting from water quality, undertake a review of the water treatment procedures for controlled water releases.

10.1.3 Surface Water Quality Contingency

In the event that routine monitoring indicates that a trigger as described in **Section 5.1** has been reached, WCC will review the data, with the outcomes of that review, including any recommendations, being subject to discussion and agreement with the DPI-W hydrologists. Response measures may be implemented to include changes to surface water management practices or changes to the use of site chemicals.

Responses to surface water trigger events are outlined in WHC-PRO-WC-Surface Water Trigger Action Response Plan.

10.2 Consideration of Potential Groundwater Impacts

10.2.1.1 Groundwater Quality Contingency

In the event of a major liquid hydrocarbon/contaminant spill, WCC will enact the PRIMP, which outlines communication and notification protocols, as well as immediate actions to be taken to respond to the pollution incident.

Notwithstanding the measures taken in response to a major incident, WCC recognises that the potential remains for changes in groundwater quality to occur which may or may not be a consequence of potential contaminants from WCC. A trigger of pH, EC, nitrate or phosphate would initially lead to an increase in the analytes monitored and/or frequency of sampling to confirm the magnitude and extent of the change in water chemistry and verify the change is a consequence of mining. Should such a situation be demonstrated by monitoring, appropriate measures to mitigate impacts on groundwater quality will be developed in consultation with DPI-W hydrogeologists, with the nature of the "appropriate solution(s)", e.g. pumping and treatment, isolation or remediation, being dependent on the nature of the issue.

10.2.1.2 Groundwater Quantity Contingency

In the event that routine monitoring indicates that a trigger has been reached as described in Table 5-1 Water Monitoring Triggers**,** with regard to water level being reached the following approach will be taken:

1. WCC will commission a hydrogeologist to undertake a cusum analysis of monitoring bores. The cusum analysis will determine whether the variation is within historical variability or is outside of the range of expected values;

2. Where the cusum analysis demonstrates the water level within the bore is outside of the range of expected values, the hydrogeologist will investigate the cause of the change. The hydrogeologist should review a range of data sources in their determination including:
    - Water level changes in nearby bores;
    - Water level observations from background monitoring bores;
    - Changes in water use of the bore or neighbouring bores;
    - Changes in hydraulic head or flow direction;
    - Climatic influences such as residual rainfall trends;
    - Proximity to other monitoring bores; and
    - Modelled groundwater inflow to the open cut pit.
3. If the hydrogeologist is of the opinion that the reduction is a consequence of mining, WCC will notify the affected landowner(s) and DPI-W, and WCC will enter into negotiations with the affected landowners with the intent of formulating an agreement which provides for one or a combination of:
    - Re-establishment of saturated thickness in the affected bore(s) through bore deepening;
    - Establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;
    - Provision of access to alternative sources of water; and/or
    - Monetary compensation to reflect increased water extraction costs (if any), for example as a consequence of lowering pumps or installation of additional or alternative pumping equipment.

An independent authority may also be used where a dispute arises as to the cause of the change, given that groundwater supply and quality can be affected by non-mining related factors such as bore siltation, aquifer depletion by large scale agricultural users, bacterial infection and fertilizer contamination.

Responses to groundwater trigger events are outlined in WHC-PRO-WC-Groundwater Trigger Action Response Plan.

10.2.1.3 <u>Groundwater Elevation above the Final Landform</u>

The final landform is being developed as part of the mine closure planning process and detailed design objectives and performance criteria will be included in the Mine Closure Plan for Werris Creek.. The Mine Closure Plan will include, but not limited to the following design constraints relating to the final void levels and predicted long term groundwater levels.

In the event that modelling indicates a final standing water level above the final landform, the final landform will be raised to 5.0m above the predicted final level.

In the event that the groundwater table following closure establishes to above the final landform surface the following actions will be taken:

- Monitor established groundwater and soils to determine if salinity concentration is likely in the remaining void and if this salinity would be likely to represent a risk to surrounding groundwater and surface water receptors;
- If a risk is identified, evaluate options for landform reshaping to remove the void.

10.3 Void Water Dam Safety Emergency Plan

The procedures to be followed in the event of an emergency situation occurring which affects the integrity of the WCC Prescribed Void Water Dams (VWD1, 3 and 4) and the safety of people, plant and the environment in the surrounding area are outlined in the *Dam Safety Emergency Plan - Werris Creek Coal Mine: Void Water Dams 1, 3 & 4* (DSEP).

11 REFERENCES

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APPENDIX A – Plainview Irrigation Management Plan

IRRIGATION MANAGEMENT PLAN

PLAINVIEW IRRIGATION PROJECT

IRRIGATION MANAGEMENT PLAN

PLAINVIEW IRRIGATION PROJECT

1. INTRODUCTION

Water balance model predictions for Werris Creek Coal Mine (WCC) demonstrate that the volume of void water generated, primarily through rainfall runoff, is predicted to exceed the capacity of the void water dams under median and high rainfall scenarios. Werris Creek Coal Pty Ltd (WCC) has been approached by multiple landholders in the Quipolly area regarding access to surplus void water for their productive agricultural use. WCC has progressed changes to the Project Approval, Water Management Plan, and Environmental Protection License for WCC, to allow for the offsite supply of excess void water for productive agricultural use. As required under the Environmental Assessment and Project Approval of the Modification (MOD2 Approval), WCC has developed this Irrigation Management Plan (IMP) to assess at an application site level the suitability of the area for irrigation and other controls that will need to be implemented to minimise any impacts on the receiving environment. This IMP, along with the broader Water Management Plan for WCC, addresses the requirements of Schedule 3 Condition 23 (d) of the Modified Project Approval (PA 10_0059 MOD2). This detailed assessment of the proposed irrigation activities has been conducted using the Environmental Guideline “Use of Effluent by Irrigation, DEC 2004”, to assess the specific site characteristics of the Plainview Irrigation Area and the suitability of the use of void water for irrigation in the manner as described by the IMP.

Water Supplier: Werris Creek Coal Pty Ltd (wholly owned by Whitehaven Coal)

Water Irrigator: Peter Hird

Irrigation Area: “Plain View” property (56.4 hectares) is owned by Betalpha Pty Ltd (wholly owned by Whitehaven Coal), leased to Peter Hird (Figure 1) and is to the south of the Werris Creek Coal mining lease.

Figure 1 Werris Creek Mine and Plainview Irrigation Area

2. IRRIGATION METHODOLOGY

The proposed Plain View Irrigation Area is 56.4 hectares

WCC will supply water for irrigation via pump from Void Water Dam 1 (Figure 2) to a pivot irrigation system and additional traveling irrigators as required to effectively apply water to the identified areas.

The Water Irrigator proposes to plant lucerne and irrigate year round (as per requirements for irrigated lucerne production).

2.1 Responsibilities

Water Supplier is responsible for:

- The infrastructure and management of pumping irrigation water from the Werris Creek Coal void water system to the irrigation equipment within the Plain View Irrigation Area;
- Monitoring the quality of the irrigation water to ensure water quality is suitable for irrigation as outlined in this Irrigation Management Plan; and
- Metering the water supplied to the Water Irrigator.

The Water Irrigator is responsible for the management of irrigation water once it has been transferred from the Void Water Dam to the Plain View Irrigation Area, as well as complying with any specific legislative requirements of the irrigation application, including the Protection of the Environment Operations Act (1997) and the Water Management Act (2000).

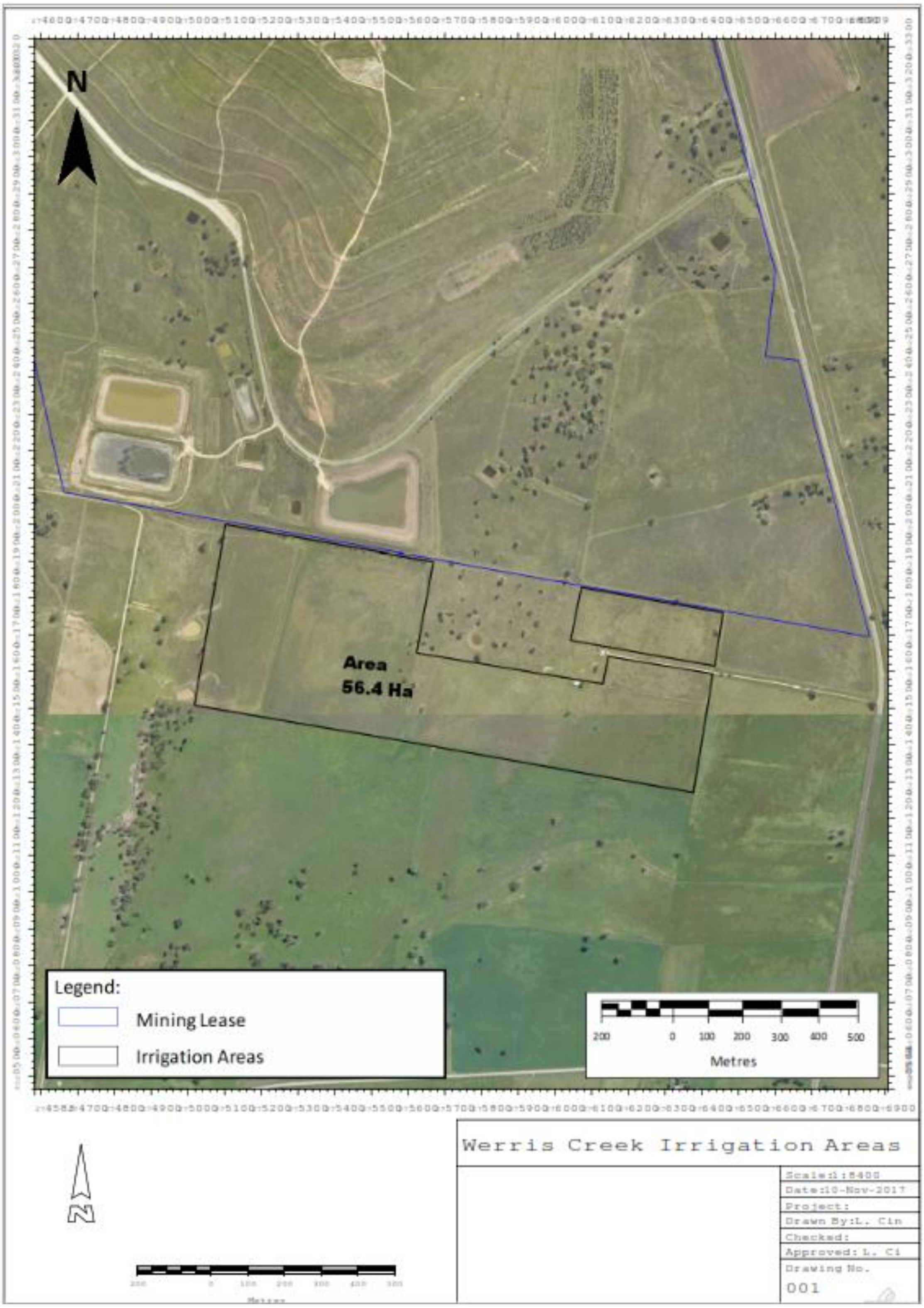

Figure 2 Plainview Irrigation Area

3. ASSESSMENT OF IRRIGATION ACTIVITIES

3.1 IRRIGATION AREA SOILS

Initial desktop review of available information indicated topography, drainage and soil type present would be suitable for an irrigation enterprise.

3.2 Land Use Conflicts

The Plain View Irrigation Area is bounded by land owned by Betalpha Pty Ltd (wholly owned by Whitehaven Coal). Land uses consist of cropping and grazing land to the east, south and west, and the mining lease to the north. Previous land uses for the Plain View Irrigation Area were cropping and grazing. There are no land use conflicts associated with proposed irrigation.

3.3 Soil Landscape

Soil Landscapes Units are described as “areas of land that have recognisable and specific topographies and soils that can be presented on maps and described by concise statements”.

The Duff’s Gully Soil Landscape Unit has been mapped as occurring across the Study Area by the former NSW Department of Land and Water Conservation, incorporating the NSW Soil Conservation Service (now part of NSW Department of Primary Industries (DPI)), on the Soil Landscapes of the Tamworth Sheet 1:100,000 Sheet (Banks, 2001).

Duff’s Gully is derived from geology associated with the Permian-Carboniferous Werrie Basalts and Permian Warrigundi Intrusives, which include basalt, tuffs, tuffaceous sandstones and quartz dolerite. Duff’s Gully is characterised by very long footslopes with broad drainage plains of productive agricultural land. Slopes are generally less than 2% with local relief less than 30 metres and elevation ranging between 340 – 420 metres above sea level.

3.4 Soil Type

The Duff’s Gully Soil Landscape Unit is described by Banks (2001) as being dominated by Vertosols on the lower slopes and drainage plains. Vertosols are clay soils with shrink-swell properties that exhibit strong cracking when dry and have a clay content of 35% or greater.

Soil test results indicate the soil type present within the Study Area is a Black Vertosol. Black Vertosols are characterised as having high inherent soil fertility with widespread gully erosion hazard. They are well suited to intensive cropping (including irrigation) and grazing activities.

Soil test results are shown in Table 1 and Table 2. Both sites A and B were sampled at depths of 15 cm, 60 cm and 120 cm. A summary of the soil test results are as follows:

- Soil texture ranges between a clay loam to silty clay loam.
- pH is strongly alkaline to very strongly alkaline, indicating zinc deficiency could become a production inhibitor when conducting intensive cropping enterprises.
- Exchangeable Sodium Percentage (ESP) indicates soils are non-sodic to marginally sodic throughout the profile.

- Electrical Conductivity according to clay content (EC) indicates soils are non-saline to marginally saline throughout the profile.
- Cation Exchange Capacity (CEC) for all samples is very high
- Phosphorous Sorption Capacity and Phosphorus Sorption Index for all samples are high.
- Organic carbon levels in the topsoil are moderate for both samples.
- Calcium to magnesium (Ca:Mg) ratio is low for all samples which could be corrected with a gypsum application of up to 4 tonnes per hectare prior to planting of lucerne and irrigation. This will greatly increase water use efficiency of any crop and also provide a source of sulfur, reducing fertiliser costs. Gypsum will also aid in reducing sub-soil sodicity.
- Based on their texture, soils have a high water holding capacity of between 240 – 280 millimetres per metre (Williams et al, 1983), making them very suitable for long term irrigation.
- Based on their texture soils have a root zone leaching fraction (LF) of 0.33 (ANZECC, 2000), which when combined with the low soil EC levels is suitable for producing irrigated Lucerne.

Table 1 Soil Chemical Parameters

Plain View	pH		ESP		EC (1:5)		CEC	
	Unit	Rating	%	Rating	dS/m	Rating	cmol/kg	Rating
A1	8.7	Strongly Alkaline	3.9	Non Sodic	0.4	Non-Saline	45.9	Very High
A2	9.4	Very Strongly Alkaline	8.9	Marginally Sodic	1.6	Non-Saline	49.2	Very High
A3	9.6	Very Strongly Alkaline	8.7	Marginally Sodic	2.4	Slightly Saline	54.0	Very High
B1	8.9	Strongly Alkaline	1.0	Non Sodic	1.2	Non-Saline	61.9	Very High
B2	9.3	Very Strongly Alkaline	4.9	Non Sodic	2.4	Slightly Saline	61.5	Very High
B3	9.3	Very Strongly Alkaline	5.5	Non Sodic	2.5	Slightly Saline	62.2	Very High

Table 2 Soil Physical Parameters

Plain View	Soil Texture	Colour	Phosphorus Sorption	Phosphorus Sorption	Ca:Mg	Organic Carbon
	ASC	Munsell	Capacity mg/kg	Index mg/kg	Ratio	%
A1	Silty Clay Loam	Black	1,670	38	1.68	2.5
A2	Silty Clay Loam	Black	1,500	32	1.15	1.7
A3	Silty Clay Loam	Very Dark Grey	1,480	30	1.32	1.4
B1	Clay Loam	Black	2,210	37	2.90	2.8
B2	Clay Loam	Very Dark Grey	2,240	38	0.96	1.5
B3	Clay Loam	Very Dark Grey	2,180	35	0.97	0.9

3.5 Selecting the Site

The Plain View Irrigation Area is located directly to the south and south east of Void Water Dam 1 (VWD1) with landform across the area flat (less than 3% slope), flooding events being rare and nil surface rock outcrop.

Werris Creek is located in a temperate climate zone, with plant water use requirements often deficient during spring, summer and autumn, making the area suited to irrigation.

Soils were mapped as the Duff's Gully Soil Landscape Unit (Banks, 2001) which is described as being dominated by Vertosols on the lower slopes and drainage lines.

Detailed soil testing confirms the soil type as a Black Vertosol which is strongly alkaline, non-sodic, non-saline with a very high cation exchange capacity. This soil type is well suited to irrigation, and detailed in Table 3.

Table 3 Soil Suitability for Irrigation

Soil Property	Limitation			Correction Required
	Nil/Slight	Moderate	Severe	
Exchangeable Sodium (0-40 cm)	0-5	5-10	>10	No
Exchangeable Sodium (40-100 cm)	<10	>10	N/A	No
Salinity as EC (0-70 cm)	<2	2-4	>4	No
Salinity as EC (70-100 cm)	<4	4-8	>8	No
Depth to top of seasonal high water table (m)	>3	0.5-3	<0.5	No
Depth to bedrock or hardpan (m)	>1	0.5-1	<0.5	No
Saturated hydraulic conductivity (mm/h)	20-80	5-20 or >80	<5	No
Available water capacity (mm/m)	>100	<100	N/A	No
Soil pH (surface layer)	>6-7.5	3.5-6.0 or >7.5	<3.5	Yes (2*)
Effective cation exchange capacity (0-40 cm)	>15	3-15	<3	No
Emerson aggregate test	4,5,6,7,8	2,3	1	Yes (1*)
Phosphorus sorption capacity	High	Moderate	Low	No

(1*) Dispersion can be ameliorated using gypsum, which will result in a higher Emerson aggregate score.

(2*) As pH is >7.5 particular attention must be paid to plant available zinc and calcium. Zinc can be applied as granular fertiliser or foliar spray. Gypsum contains calcium, so if dispersion is corrected in (1*) then adequate calcium will also be supplied for optimum plant growth.

3.5.1 Soil Organic Matter

It is recommended that topsoil has >2% organic matter. Soil samples tested have 2.5% and 2.8% organic matter in the top 15 centimetres.

3.5.2 Acid Sulfate Soils

The Plain View Irrigation Area is not located in an acid sulfate soil risk area, therefore there is no risk of acid sulfate soils.

3.6 WATER RESOURCES

3.6.1 Local Groundwater

All monitoring wells/bores (MW) surrounding the Plain View Irrigation Area have a standing water level of greater than 10 metres below ground level. The Evaluation of Groundwater Inflows Werris Creek Coal Mine (Environ, 2014) gives the following standing water levels (below ground level):

- MW1 at 69 metres
- MW2 at 66 metres
- MW5 at 28 metres
- MW6 at 16 metres

3.6.2 Local Surface Water

Surface drainage is to the south towards Quipolly Creek, approximately 2 kilometres away. The Plain View Irrigation Area is not prone to flooding.

Given the location of the Plain View Irrigation Areas distance to surface water sources, along with the soil type and its high moisture holding capacity minimise any risk of irrigation water entering any surface water source. Lucerne is a year round user of water, further reducing any risk from run-off into surface water catchments.

3.6.3 Void Water Quality

Representative samples of void water within the open cut pit and Void Water Dams 1, 2, 3 and 4 are compared to various triggers for short-term agricultural application (irrigation), livestock watering and aquatic ecosystem protection (95%) of ANZECC (2000) summarised in Table 4. These results illustrated each of the analytes tested generally comply with the Short Term Exposure (STE) trigger level for irrigation of ANZECC (2000). In particular, the concentration of metals was generally undetectable or present at very low concentrations (several orders of magnitude below the trigger levels). Some minor exceedances of short-term exposure limits for irrigation of pH, electrical conductivity and sodium were identified as follows:

- Soils within the Plain View Irrigation Area have a naturally high pH with a high pH buffering index (high clay content). Use of void water is highly unlikely to further increase soil pH
- Whilst void water electrical conductivity (EC) has slight exceedances for STE, it is well within NSW Department of Primary Industries tolerances for lucerne and other broadacre crops such as wheat, barley and sorghum (Table 5).
- Whilst zinc and nitrate are above the criteria for Ecosystem Protection for 95% of species, the Plain View Irrigation Area is already a highly modified “farming ecosystem”. Additionally, both zinc and nitrate are beneficial nutrients for the proposed lucerne crop, and as described earlier, soil sampling has indicated available zinc within the soil may be deficient.
- ESP throughout the soil profile is low and along with the soil’s high clay content, it is unlikely the elevated sodium levels in the void water will decrease agricultural production.

Table 4 Void Water Quality

Analyte	Unit	Void Water		Void Water Dams				ANZECC (2000) Criteria		
		(after rain)	(no rain)	1	2	3	4	Irrig (STE)	Stock	Ecos (95%)
pH		8.02	7.92	8.5	8.41	8.74	8.97	6-8.5	-	6.5-7.5
EC	µS/cm	921	929	1,100	1,070	994	1,030	950	-	30-350
SAR		3.03	3.23	4.59	NT	4.82	4.74	-	-	-
TDS	mg/L	512	501	583	NT	546	561	-	4000	-
Hardness as CaCO3	mg/L	244	229	215	NT	173	175	-	-	-
Alkalinity as CaCO3	mg/L	159	160	150	NT	129	121	-	-	-
Sulfate	mg/L	98	118	154	NT	144	145	-	1000	-
Chloride	mg/L	113	117	150	NT	140	147	175	-	-
Calcium	mg/L	78	77	50	NT	43	42	-	1000	-
Magnesium	mg/L	12	9	22	NT	16	17	-	2000	-
Sodium	mg/L	109	113	155	NT	146	144	115	-	-
Potassium	mg/L	9	12	10	NT	10	10	-	-	-
Aluminium	mg/L	<0.01	<0.01	0.02	NT	0.03	0.06	20	5	0.055
Arsenic	mg/L	0.006	0.004	<0.001	NT	0.002	0.001	2	0.5	0.024
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	NT	<0.0001	<0.0001	0.05	0.01	0.0002
Chromium	mg/L	<0.001	<0.001	<0.001	NT	0.012	0.001	1	1	0.001
Copper	mg/L	0.001	0.001	0.001	NT	0.002	0.003	5	1	0.0014
Lead	mg/L	<0.001	<0.001	<0.001	NT	<0.001	<0.001	5	.01	0.0034
Nickel	mg/L	0.006	0.005	<0.001	NT	0.008	<0.001	2	1	0.011
Selenium	mg/L	<0.01	<0.01	<0.01	NT	<0.01	<0.01	0.05	0.02	0.011
Zinc	mg/L	0.024	0.011	0.051	NT	0.006	0.146	5	20	0.008
Iron	mg/L	<0.05	<0.05	<0.05	NT	0.07	<0.05	10	-	-
Mercury	mg/L	<0.0001	<0.0001	<0.0001	NT	<0.0001	<0.0001	0.002	0.002	0.0006
Fluoride	mg/L	0.1	0.2	0.2	NT	0.2	0.1	-	-	-
Ammonia	mg/L	0.15	0.23	<0.01	NT	0.01	<0.01	-	-	0.9
Nitrite	mg/L	0.07	0.08	0.03	0.05	0.05	0.07	-	9.1	-
Nitrate	mg/L	6.23	6.13	2.29	4.86	2.48	4.78	-	90.3	0.7
Kjeldahl N	mg/L	6.3	1.3	0.5	0.7	1.1	1	-	-	0.5
Phosphorus	mg/L	0.01	<0.01	<0.01	<0.01	0.06	<0.01	0.8	-	-
BOD_5	mg/L	<2	<2	<2	<2	<2	<2	-	-	85-110
(orange)	Exceedance of Irrigation (STE) Criteria									
(yellow)	Exceedance of Ecosystem Protection (95%) Criteria									

Table 5 Crop Tolerance to Electrical Conductivity

Water Use	Production Threshold		Water Use	Production Threshold
Enterprise	**EC (µS/cm)**		**Enterprise**	**EC (µS/cm)**
Lucerne	2,000		Canola	4,300
Wheat	4,000		Sheep	5,000
Barley	5,300		Beef Cattle	4,000

3.7 Void Water Quality for Irrigation

According to the Environmental Guideline, the void water proposed to be utilised for irrigation is classed as "Low" strength as shown in Error! Reference source not found.**6**.

Table 6 Void Water Characterisation

Void Water Constituent	Classification mg/L			Correction Required
	Low	**Medium**	**High**	
Total Nitrogen	<50	50-100	>100	No
Total Phosphorus	<10	10-20	>20	No
Biological Oxygen Demand5	<40	40-1,500	>1,500	No
Total Dissolved Solids	<600	600-1,000	>1,000	No
Other Pollutants ANZECC 2000	<5 times	-	>5 times	No
Grease and Oil	<1,500	-	>1,500	No

Error! Reference source not found.**7** summarises the mean and median analytes of the void water quality sampled from the open cut void and void water dams to be used for irrigation modelling. The Sodium Absorption Ratio (SAR) is a measure of the proportion of sodium ions to calcium and magnesium ions, essentially the higher the SAR the more likely soil structural problems will occur.

Table 7 Void Water Quality for Input to Irrigation Model

Sample	EC	pH	SAR	Nitrate	Nitrite	Total N	Total Phosphorus
Type	**µS/cm**	**unit**	**-**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Mean (Median*)	1,023	8.41*	4.3	4.1	0.05	5.0	0.01

Considering the void water quality, SEEC (2015) calculated the root zone salinity and plotted this against sodium absorption ratio (SAR). The root zone salinity (ECse in dS/m) is calculated as ECi (salinity of the water) divided by (2.2 x the root zone leaching fraction [LF]). Based on the texture of the soil, SEEC (2015) applies a LF of 0.3, therefore:

Root Zone Salinity = 1.02 / (2.2 x 0.3) = 1.55

The red circle on Error! Reference source not found.**3** represents the plotted root zone salinity against the SAR of 4.3 (Error! Reference source not found.**7**) over a base graph from ANZECC (2000), which shows the relationship between salinity, sodicity and impact on soil structure. This plot indicates that the void water would be suitable for irrigating lucerne without impacting soil structural stability, especially when consideration is given to the low ESP and high clay content of the Plain View Irrigation Area soil.

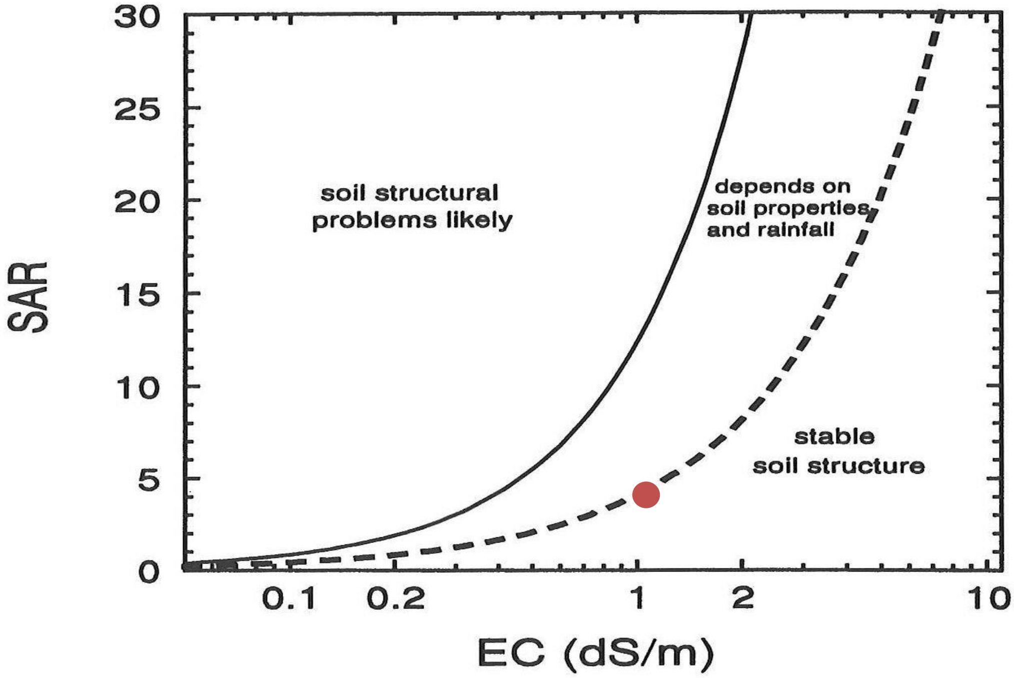

Figure 3 Relationship between SAR and ECi of irrigation water.

3.8 Irrigation Modelling

Water and nutrient balances were modelled using software known as ERIM (Effluent Reuse Irrigation Model) to calculate the amount of water and nutrients that should be applied, and at what times, to meet crop requirements whilst ensuring increases in runoff and percolation are minimised. The ERIM model does not assume water is irrigated every day. Using historical daily rainfall and evaporation data it predicts the deficit of rainfall over evapotranspiration each day and this is used to calculate the irrigation demand. If there is no demand, the water is stored. The model was run for the maximum amount of void water which could be applied in the 90th percentile high rainfall years, as this is likely to cause the greatest impact to soil chemistry.

Inputs to ERIM are as follows:

- Daily Rainfall Data from the Werris Creek Post Office is used and is in-built into ERIM.
- Daily potential evapotranspiration from the Tamworth Airport is used and is in-built into ERIM.
- Vegetation type (in this case it is pasture or moderately sensitive crop).
- Soil water holding capacity estimated from soil texture to be as 164 millimetres (McMullen, 2000). Some percolation is required to ensure salt does not build up in the topsoil. The maximum rate suggested by ERIM is 15 millimetres per month but, in this case, as the site is a re-charge area, and there is a possibility of triggering salinity, 10 millimetres per month has been adopted.
- Nutrient concentrations in void water from Table 4.
- Phosphorous sorption of the soil = 2,065 milligrams per kilogram from Table 2.
- Soil density 1,300 kilograms per cubic metre

- Soil depth available for phosphorous sorption is 1.0 metre.
- Irrigation Water Quantity applied to land is 500 megalitres per annum

Water quantity is assumed as 500 megalitres per annum as this is the amount which would need to be disposed of during a 90th percentile year. The ERIM model (SEEC, 2015) determined the minimum land area required for irrigation in 90th percentile high rainfall years (500 megalitres) would be 80 hectares (assumed for worst case assessment given Plain View Irrigation Area is only 56.4 hectares). SEEC (2015) found that as the nutrient concentrations in void water are very low, they do not match crop demand and so the model predicts they would not increase in the soil over time (Figure 4 and Figure 5). Metals were generally undetectable or present in concentrations much lower than the trigger levels given in ANZECC (2000) and as such these too would not accumulate in the soil to unacceptable levels.

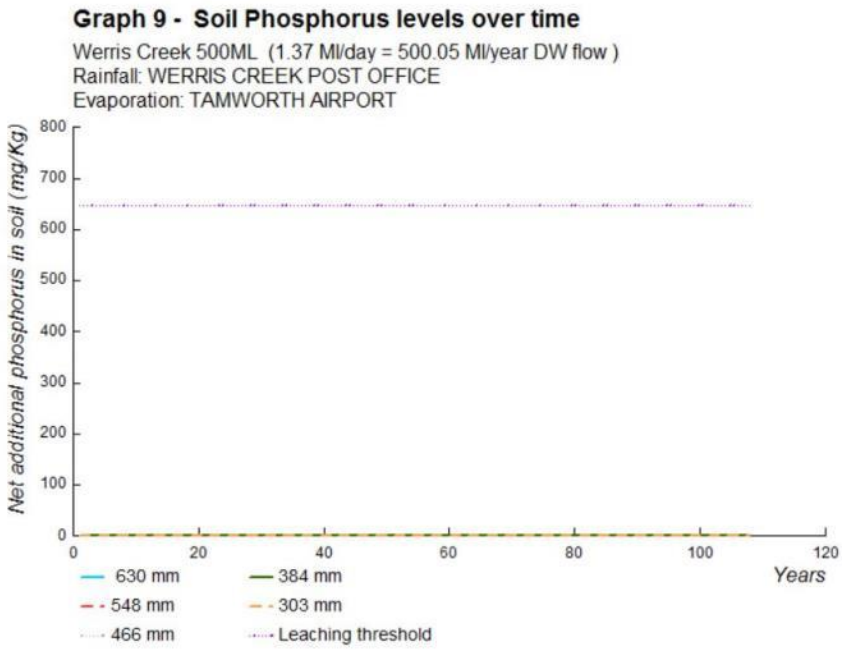

Figure 4 **Projected Soil Phosphorus Levels with Time**

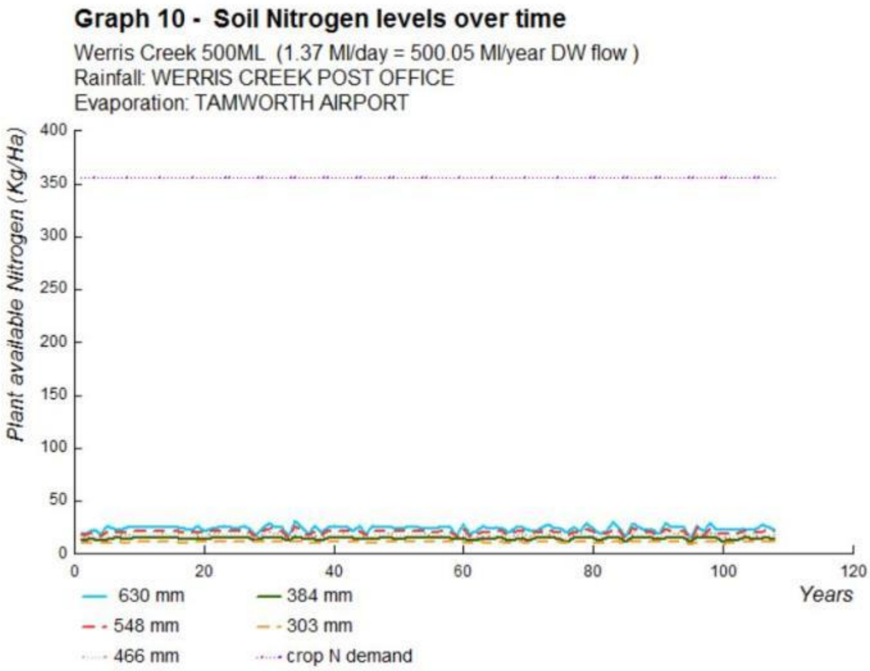

Figure 5 **Projected Soil Nitrogen Levels with Time**

4. APPLICATION OF IRRIGATION WATER

4.1 Irrigation Scheduling

The interval between irrigation and the amount of water to apply when irrigating is dependent on the amount of water held within the crop's root zone and the water requirements of the crop at that particular point in the growing season. Factors influencing this include:

- Soil texture;
- Soil structure and water permeability
- Depth of effective root zone of the soil;
- Evaporation;
- Crop grown; and
- Stage of crop development.

Commercially available programs can be accompanied by agronomic advice to estimate irrigation scheduling for lucerne according to available soil water. The soil textures present, being clay loam and silty clay loam, have some of the highest water holding capacities of all soil types, with an average water storing capacity of 164 millimetres per metre of soil (McMullen, 2000).

WCC suggests that the following guidelines are adhered to in the operation of the irrigation schedule:

- The irrigation schedule is initiated once the soil profile is either saturated following a rainfall event which produces runoff, or after irrigation to bring the soil close to the point of saturation, but prior to any surface runoff. On this date the soil water storage is set to the maximum permissible (164 millimetres per metre for a silty clay loam).
- Evaporation and rainfall are recorded on a daily basis in millimetres.
- To ensure maximum crop production, irrigation should be commenced prior to soil water storage reaching zero.
- The amount of irrigation applied (millimetres per square metre) is recorded.
- The Crop Factor of 0.9 is the average for an established lucerne crop, varying from 0.5 after cutting to 1.2 during peak water demand.
- Crop Water Use is Evaporation multiplied by the Crop Factor.
- Effective Rainfall discounts the first 5 millimetres during any rainfall event in spring, summer and autumn.

Average daily evaporation by month for the Tamworth Agricultural Institute is shown in Table 8. Evaporation generally exceeds plant water demand during spring, summer and part of autumn.

Table 8 Average Daily Evaporation by Month

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	**Ave**
8.6	8.1	6.9	4.6	2.9	2.0	2.1	3.0	4.4	6.0	7.6	8.7	**5.4**

Table 9 shows an example of an indicative irrigation schedule spreadsheet during January 2015 (using Tamworth BOM data) a typically peak water use period for irrigated lucerne.

Table 9 Irrigation Schedule (January Example)

Day	Evaporation	Crop Factor	Crop Water Use	Effective Rainfall	Soil Water Store
0	N/A	N/A	N/A	**Full Irrigation**	164
1	10.6	0.7	7.4	0	157
2	10.0	0.7	7.0	0	150
3	4.0	0.7	2.8	0	147
4	8.0	0.7	5.6	0	141
5	7.4	0.7	5.2	0	136
6	6.0	0.7	4.2	0	132
7	10.6	0.9	9.5	0	122
8	9.4	0.9	8.5	0	114
9	6.8	0.9	6.1	0	108
10	1.8	0.9	1.6	0	106
11	4.4	0.9	4.0	0	102
12	5.4	0.9	4.9	15	112
13	6.2	0.9	5.6	0	106
14	7.6	1.2	9.1	0	97

Day	Evaporation	Crop Factor	Crop Water Use	Effective Rainfall	Soil Water Store
15	9.0	1.2	10.8	0	87
16	9.6	1.2	11.5	0	75
17	9.2	1.2	11.0	0	64
18	10.1	1.2	12.1	0	52
19	7.8	1.2	9.4	0	42
20	7.0	1.2	8.4	0	34
21	10.0	1.2	12.0	0	22
22	3.0	1.2	3.6	**Full Irrigation**	
23	N/A	N/A	N/A	0	164

Soil moisture monitoring may allow the Water Irrigator to calibrate the spreadsheet by adjusting the crop factor and effective rainfall parameters and quantify movement of irrigation water within the soil profile. An important consideration would be for the soil moisture monitoring to concentrate on the wetter areas to minimise waterlogging and accessions to the groundwater.

The Water Irrigator may monitor the irrigation practices and make adjustments to the crop factor and allowable soil water storage as required. If necessary, the Water Irrigator may seek the advice of a professional agronomist.

Given lucerne is a perennial crop with growth 12 months of the year, an effective rooting zone of established lucerne plants of greater than 2 metres, it is unlikely that this enterprise will result in the percolation of irrigation water into the groundwater.

5. APPROVALS REQUIRED UNDER THE WATER MANAGEMENT ACT 2000

Werris Creek Coal currently holds a Water Supply Works approval and Water Access License (WAL32224) under the Water Management Act 2000 (WM Act), for the interception of up to 211ML of water per year through mining activities, and Water Access Licence (WAL29506) for bore extraction of up to 50ML per year. Following discussions with the DPI-W regarding approval and licensing requirements, DPI-W have advised that where the irrigation program is included within a statutory approval document, a Water Use Approval will not be required. The Water Management Plan and this Irrigation Management Plan is a statutory document requiring approval under the Environmental Planning and Assessment Act (1979), and as the Plainview Irrigation Project is included within this statutory plan, no further approvals are required under the Water Management Act (2000). Where the irrigation program is not covered by a statutory plan, the Water Irrigator may require a Water Use Approval prior to irrigation activities.

6. MONITORING AND REPORTING

6.1 Irrigation Water Monitoring

Monitoring of water quality in Void Water Dam 1 by the Water Supplier would occur within the timeframes and parameters shown in Table 10 when applicable within the quarterly surface water monitoring program, and through weekly in situ sampling of pH and electrical conductivity. As the void water has been classified as “Low” strength, the corresponding timeframes for sampling have been adopted.

Table 10 Void Water Quality Monitoring Frequency

Constituent	Low Strength Effluent
pH	Weekly
Electrical Conductivity	
Total Suspended Solids	Quarterly
Biological Oxygen Demand	
Total Dissolved Solids	
Cations (Ca, Mg, K, Na)	
Sodium Absorption Ratio	
Oil and Grease	
Dissolved Metals (Al, As, Ba, Be, Cd, Cr, Co, Cu. Pb, Mn, Ni, Se, Va, Zn, Fe)	
Total Nitrogen	
Total Phosphorus	

6.2 Soil Monitoring

Baseline soil investigations and irrigation modelling have demonstrated that irrigation water can be successfully applied with no long-term degradation in soil quality. Monitoring of the irrigation program will focus on the quality of the void water supplied for irrigation, to ensure that the irrigation water is of an equivalent quality to that of the modelled irrigation water. As such, further monitoring of soil quality will not be undertaken as part of this Irrigation Management Plan.

7. CONCLUSION

The use of Werris Creek Coal void water to irrigate lucerne on the Black Vertosol soils which comprise the Plain View Irrigation Area will result in negligible negative impacts to the current soil status. The supply of excess void water for irrigation will result in significantly improved agricultural productivity on the Plain View Irrigation Area, while reducing the current void water surplus of Werris Creek Mine.

This Irrigation Management Plan has demonstrated that the void water to be supplied for irrigation is of a suitable quality for the long term irrigation of Lucerne and other similar crops on the soils of the proposed Plainview Irrigation Area. As such, irrigation of Lucerne can be achieved using traditional techniques as described above, without any additional controls required. Furthermore, the Water Irrigator is a third party with no prior commercial relationship with WCC, other than as a tenant on a property owned by WCC, and as such, the Water Supplier cannot be held responsible for the actions of the Water Irrigator in the event the Water Irrigator does not follow the requirements within this Irrigation Management Plan, or other legislative requirements.

8. REFERENCES

Australian and New Zealand Environment and Conservation (ANZECC) Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Banks (2001) Soil Landscapes of the Tamworth Sheet 1:100,000 Sheet

Environ (2014) Evaluation of Groundwater Inflows Werris Creek Coal Mine

McMullen (2000) Soilpak for Vegetable Growers NSW Agriculture

NSW Department of Energy and Conservation (2004) Environmental Guidelines Use of Effluent by Irrigation

SEEC (2015) Void Water Irrigation Assessment for Werris Creek Coal Mine (Ref: 14000171-R-02 dated 2 April 2015)

APPENDIX B – Template Irrigation Management Plan

<TEMPLATE> Irrigation Management Plan (IMP)

TEMPLATE

IRRIGATION MANAGEMENT PLAN

<NAME> IRRIGATION PROJECT

1. IRRIGATION AREA DETAILS

Water Supplier: Werris Creek Coal Pty Ltd (wholly owned by Whitehaven Coal)

Water Irrigator: <NAME>

Property Name: <NAME OF PROPERTY>

Property Description: <LOT AND DP>

Location: <INSERT DESCRIPTION OF PROPERTY LOCATION >

Ownership/Leasing: <NAME OF OWNER/NAME OF LESSEE (IF APPLICABLE)>

Proposed area of irrigation: <AREA IN HECTARES>

Proposed crop/landuse: <DECRIBE TYPOE(S) OF CROP/LAND-USE>

Site Plan: <INSERT>

2. PLAN PREPARATION

This Irrigation Management Plan is to be prepared by a suitably qualified professional with qualifications in agronomy or soil science.

Name of person who prepared plan: <NAME>

Organisation: <NAME OF COMPANY>

Qualifications of person: <QUALIFICATIONS>

3. REGULATORY CONTEXT

Werris Creek Coal currently holds a Water Supply Works approval and Water Access License (WAL32224) under the Water Management Act 2000 (WM Act), for the interception of up to 211ML of water per year through mining activities, and Water Access Licence (WAL29506) for bore extraction of up to 50ML per year.

Werris Creek Coal Mine (WCC) has progressed changes to the Project Approval, Water Management Plan, and Environmental Protection License for WCC, to allow for the offsite supply of excess void water for productive agricultural use.

An Irrigation Management Plan (IMP) is required to assess at an application site level the suitability of the area for irrigation and other controls that will need to be implemented to minimize any impacts on the receiving environment. This IMP, along with the broader Water Management Plan for WCC, addresses the requirements of Schedule 3 Condition 23 (d) of the Modified Project Approval (PA 10_0059 MOD2).

DPI-W has advised that where the irrigation program is included within a statutory approval document, a Water Use Approval will not be required. This Irrigation Management Plan will form part of the Water Management Plan, which is a statutory document requiring approval under the Environmental Planning and Assessment Act (1979, and no further approvals are required under the Water Management Act (2000). Where an irrigation program is not covered by a statutory plan, the Water Irrigator may require a Water Use Approval prior to irrigation activities.

4. IRRIGATION METHODOLOGY

<Describe irrigation method, accuracy and controls to prevent waterlogging>

<Describe required flow rate and method of regulating flow>

<Describe frequency of irrigation and anticipated annual water usage per annum>

5. SUPPLY CONNECTION POINT

WCC will supply water for irrigation via pump from Void Water Dam 1 (Figure 2). Irrigation water will be pumped through either PN10 100mm or PN10 150mm polypipe from the pump pad to the Water Irrigator's pipework adjacent to Void Water Dam 1.

The point of connection will be at the property boundary of WCC.

6. RESPONSIBILITIES

Prior to the commencement of supply the Water Supplier (WCM) is responsible for providing information on the typical water quality in accordance with Table 7.5 of the WMP, and the Irrigator is responsible for engaging a suitably qualified professional to complete an Irrigation Management Plan.

During the term of supply the Water Supplier (WCM) is responsible for:

- The infrastructure and management of pumping irrigation water from the Werris Creek Coal void water system to the connection point;
- Monitoring the quality of the irrigation water to ensure compliance with EPL license requirements; and
- Metering or calculating the volume of water supplied to the Water Irrigator.

During the term of supply the Water Irrigator (Applicant) is responsible for:

- the infrastructure and management of irrigation water downstream of the connection point
- complying with any specific legislative requirements of the irrigation application, including the Protection of the Environment Operations Act (1997) and the Water Management Act (2000).

7. TECHNICAL ASSESSMENT

This detailed assessment of the proposed irrigation activities has been conducted using the Environmental Guideline "Use of Effluent by Irrigation, DEC 2004", to assess the specific site characteristics of the proposed irrigation area and the suitability of the use of void water for irrigation in the manner as described by the IMP.

<DESCRIBE ANY DEPARTURES OR QUALIFICATIONS ON THE USE OF THESE METHODS>

<The Applicant is to provide a comprehensive technical assessment of the suitability of the site for the proposed allocation of water. The assessment should include but not necessarily be limited to the following matters:

- *soil landscape and type*
- *soil chemical and physical parameters,*
- *general suitability of the soil for irrigation,*
- *risk of acid sulfate soils,*
- *general crop tolerance to the water quality and specifically crop tolerance to electrical conductivity,*
- *any corrections required to water quality,*
- *the risk of impact on surface waters and groundwater,*
- *proposed methods of irrigation scheduling, and*
- *environmental monitoring requirements>*

8. CONCLUSION

<Provide a concise conclusion as to the suitability of irrigating mine void water, and summary key environmental risks and how they will be mitigated and monitored.>

9. AGREEMENT

The supply of mine void water for irrigation will be subject to application by the Irrigator, consent of the land owner, agreement of Werris Creek Coal, and regulatory approval of the Irrigation Management Plan. These processes will be captured by separate documentation.