Wollongong Coal Limited

Russell Vale Colliery

Underground Expansion Project

Additional Information Response Report

June 2020

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1 INTRODUCTION

The Russell Vale Colliery (**RVC**) is an existing underground coal mine located in Russell Vale, north of Wollongong in NSW that is owned and operated by Wollongong Coal Limited (**WCL**). RVC has been on 'care and maintenance' since 2015 and the current Project Approval applying to mining operations at RVC requires that no mining occur after 31 December 2015.

WCL is seeking Project Approval under the *Environmental Planning and Assessment Act 1979* (**EP&A Act**) to expand the mining operations at RVC. This ongoing application is referred to as the Underground Expansion Project (**UEP**).

The Revised Preferred Project Report and Response to Second PAC Review (**Revised Preferred Project Report**) for the Russell Vale Revised UEP was placed on public exhibition from 1 August to 29 August 2019.

A Submissions Report was prepared to address the key issues raised in the submissions received during the public exhibition period. The Submissions Report was provided in two separate reports, with Part A addressing all key issues raised, apart from groundwater and Part B addressing groundwater issues raised.

During the assessment process, additional information has been provided to DPIE in support of the UEP, which has been consolidated into a separate report (**Additional Information Response Report**).

The Additional Information Response Report includes the following:

- Figure showing mine scheduling over the proposed 5-year mine life, including panel identification numbering;
- Figure showing current and proposed surface facilities, including noise mitigation structures;
- Figure showing identified Aboriginal heritage sites with proposed mining panels underlaid;
- Figure showing identified non-Aboriginal historic heritage sites within the development area;
- Rehabilitation and Post Closure Report by WCL, dated February 2020;
- Reject Geochemical Analysis – ROM Working Section Sample Report by WCL, dated March 2020;
- Catchment Monitoring Program Report by WCL, dated March 2020;
- Letter from Wollongong City Council, dated 2 March 2020, detailing proposed road maintenance contributions for pavement upgrade and maintenance of Bellambi Road resulting from transport of product associated with the project; and
- Flood Analysis and Concept Design Report for Bellambi Gully Creek Diversion by Cardno.

2 ADDITIONAL INFORMATION

2.1 UEP Figures

The following additional Figures have been provided to DPIE in support of the UEP:

- Figure showing mine scheduling over the proposed 5-year mine life, including panel identification numbering (**Appendix 1**);
- Figure showing current and proposed surface facilities, including noise mitigation structures (**Appendix 2**);
- Figure showing identified Aboriginal heritage sites with proposed mining panels underlaid (**Appendix 3**); and
- Figure showing identified non-Aboriginal historic heritage sites within the development area (**Appendix 4**).

2.2 Rehabilitation and Post Closure

WCL reviewed its rehabilitation and post closure commitments for the Russell Vale UEP, within the following report:

> *Russell Vale Colliery. Rehabilitation and Post Closure Commitments. Document No. WCL _RV_EC_RPT_006, dated 20 February 2020.*

The report provides details on the following for the UEP rehabilitation and WCL's post closure commitments:

- Current land use zoning;
- Indicative post mining land use;
- Conceptual rehabilitation objectives;
- Conceptual rehabilitation methods; and
- Conceptual completion criteria.

The report is contained within **Appendix 5**.

2.3 Reject Geochemical Analysis

The EPA within their correspondence dated 23 December 2019 made the following comments related to the environmental assessment of underground reject management:

> *The geochemical testing of the extracted water from coal wash reject be repeated using analytical methods having limits of detection suitable for comparison to 95% default guidelines values for ANZG (2018). It is recommended that individual and composited soil samples be tested.*
>
> *The results compared with ANZECC values and Wongawilli coal seam water quality to determine whether there is likely impact to surface or groundwater.*
>
> *As the principal source of arsenic is from sandstone, analysis be provided of the likely amount of sandstone in the reject. The report notes that the floor of the mine will be Kembla Sandstone but the roof will be coal in order to manage geotechnical and safety constraints.*
>
> *A description of the proposed underground emplacement be given including details of the possible impact of the emplacement on groundwater including:*

- *The underground location and whether the area is dry or will be affected by groundwater in the short or long term;*
- *How the reject will be emplaced: conveyed, trucked or pumped;*
- *The form of the material to be emplaced such as fines, coarse or paste;*
- *Whether the reject will need to be treated for it to be emplaced underground. For example does it need to be stabilised with cementitious material for stability or flocculants for flow if being pumped;*
- *Whether there is enough underground area available that is safely accessible for emplacement;*
- *If applicable, how the emplaced material will interact with groundwater including geochemical interactions and possible groundwater flow;*
- *If there is a groundwater interaction, what is the likely fate of any pollutants leaching from the emplacement.*

As the principal source of arsenic is from sandstone of an unknown origin in the REA, sampling and chemical characterisation of Kembla Sandstone be undertaken to determine the actual level of arsenic likely to come from reject extracted under the project. An analysis should be made of the likely amount of Kembla Sandstone from the floor of the mine.

The EPA agrees with the report's recommendation that if approval is granted, the reject generated on site be tested in accordance with the EPA's Coal Washery Reject Order 2014 before marketing the reject material for beneficial reuse applications.

WaterNSW within their correspondence dated 20 December 2019 made the following comments:

The Submissions Report states that the reject materials are non-acid forming and the concentrations of heavy metals and salts in the material is expected to have a low impact on the quality of surface water and groundwater.

However, when heavy metals concentrations in Table 6 (Appendix 9, page 19) were compared to groundwater investigation levels (NEPC 2013), the concentrations of most heavy metals exceed the groundwater investigation levels. It is also noted that mercury is not included in the analysis.

WaterNSW requests clarification from Wollongong Coal regarding this matter and assessment of whether any proposed underground reject emplacement would satisfy the requirement for a neutral or beneficial effect on water quality.

WCL reviewed the geochemical properties of the projected reject material to be generated and its suitability for emplacement underground within former mine workings or for beneficial use as fill material.

The scope of this review was to provide geochemical characterisation for ROM coal representative of the anticipated reject material and to recommend environmental management measures related to reject emplacement or beneficial reuse. The geochemical review was outlined within the following report:

Russell Vale Colliery. Reject Geochemical Analysis – ROM Working Section Sample. Document No. WCL _RV_EC_RPT_007, dated 05 March 2020.

The report is contained within Appendix 6.

2.4 Catchment Monitoring Program

DPIE requested WCL provide a summary of the swamp related monitoring program completed including baseline, during mining of LWs 4-6, and post mining (2015-present) and including the number of sampling locations and type of monitoring in relevant swamps (including control sites).

The catchment monitoring program was outlined within the following report:

> *Russell Vale Colliery. Catchment Monitoring Program. Document No. WCL _RV_EC_RPT_008, dated 10 March 2020.*

The report is contained within **Appendix 7**.

2.5 Bellambi Lane Road Maintenance Contributions

In response to the proposed UEP with road product transport using Bellambi Lane from the princes Highway to Memorial Avenue, Wollongong City Council conducted an visual assessment into the pavement condition of Bellambi Lane, between the Princes Highway and Memorial Drive, on 3 February 2020. This was to determine the current condition of the pavement and inform future maintenance strategies.

Wollongong City Council (**WCC**) assessment determined that WCC expects to incur an additional $337,877 (in 2019/20 dollars) for the five years of UEP operation, inclusive of contingency.

A copy of the WCC assessment is contained within **Appendix 8**.

WCL propose to provide WCC with progressive payment of contributions during the UEP for road maintenance.

2.6 Bellambi Gully Creek Diversion

Cardno was engaged by WCL to undertake analysis and concept design of flood mitigation works at the Russell Vale Colliery. The works included analysis and design of an open channel to divert clean floodwaters from the operation areas, a detention basin to attenuate flood volumes and peak velocities leaving the site and design of a new dry sediment basin to improve stormwater quality and aid in floodwater detention to minimise flooding downstream of the site.

The design and assessment process were split into two progressive phases, Phase 1 and Phase 2. Phase 1 aimed to establish the flood model for the site and emulate the previously approved BECA (2009) concept design. Phase 2 aimed to further optimise the model for current on-site operational requirements and improve the Phase 1 design.

Primary changes between Phase 1 and Phase 2 are the revision of the creek diversion alignment to better align with toe of the existing slope, a refined channel grade and cross section that would remove the need for a concrete lined channel where possible and a larger OSD basin. Additional survey was also conducted between Phase 1 and Phase 2, resulting in further design changes and refinements in Phase 2.

The results from the Phase 1 flood modelling process confirm the previously approved BECA (2009) stormwater design would provide effective flood mitigation and stormwater management at the site, and have allowed for the further optimisation of that design to better reflect current site operations.

The results from the Phase 2 flood modelling process build upon Phase 1 to provide significant reduction to both flood levels and velocities downstream of the site.

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The Cardno Flood Analysis and Concept Design for Bellambi Gully Creek Diversion is contained within Appendix 9.

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APPENDIX 1

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Legend

- Mt Ousley Road
- RVC East Wongawilli Seam Workings
- RVC East Wongawilli Seam Goaf
- WCL RVC Holdings

Proposed Mining Schedule

- 0-12 Months
- 13-24 Months
- 25-36 Months
- 37-48 Months
- 49-60 Months

Note: Mine Schedule dates start from commencement of mining operation

N

0 240 480
Meters

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WCL RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED

TITLE		
RUSSELL VALE COLLIERY UEP AREA		
PROPOSED MINING SCHEDULE		
	NAME	DATE
DRN	RT	07/02/2020
CKD		
APP		
SCALE	1:12,000	@A3
DRAWING NUMBER		REV
RVC-ENV-066		0

APPENDIX 2

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Image Source: NSW Govt. Imagery

Legend

- Container Noise Wall
- Proposed Noise Wall
- Truck Road to move rejects
- Washery Drawings
- Truck Parking Area
- RVC Lease Boundary

Red Label	Existing Disused Infrastructure
Blue Label	Existing Infrastructure to be used by UEP
Green Label	Infrastructure to be constructed

FIGURE 1

Current and Proposed Plant and Infrastructure with Revised Noise Mitigation Structures

N

0 50 100 m

1:2,000

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WOLLONGONG COAL

WCL RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED

7 Princes Highway, Corrimal, NSW 2518
ABN 28 111 244 896

APPENDIX 3

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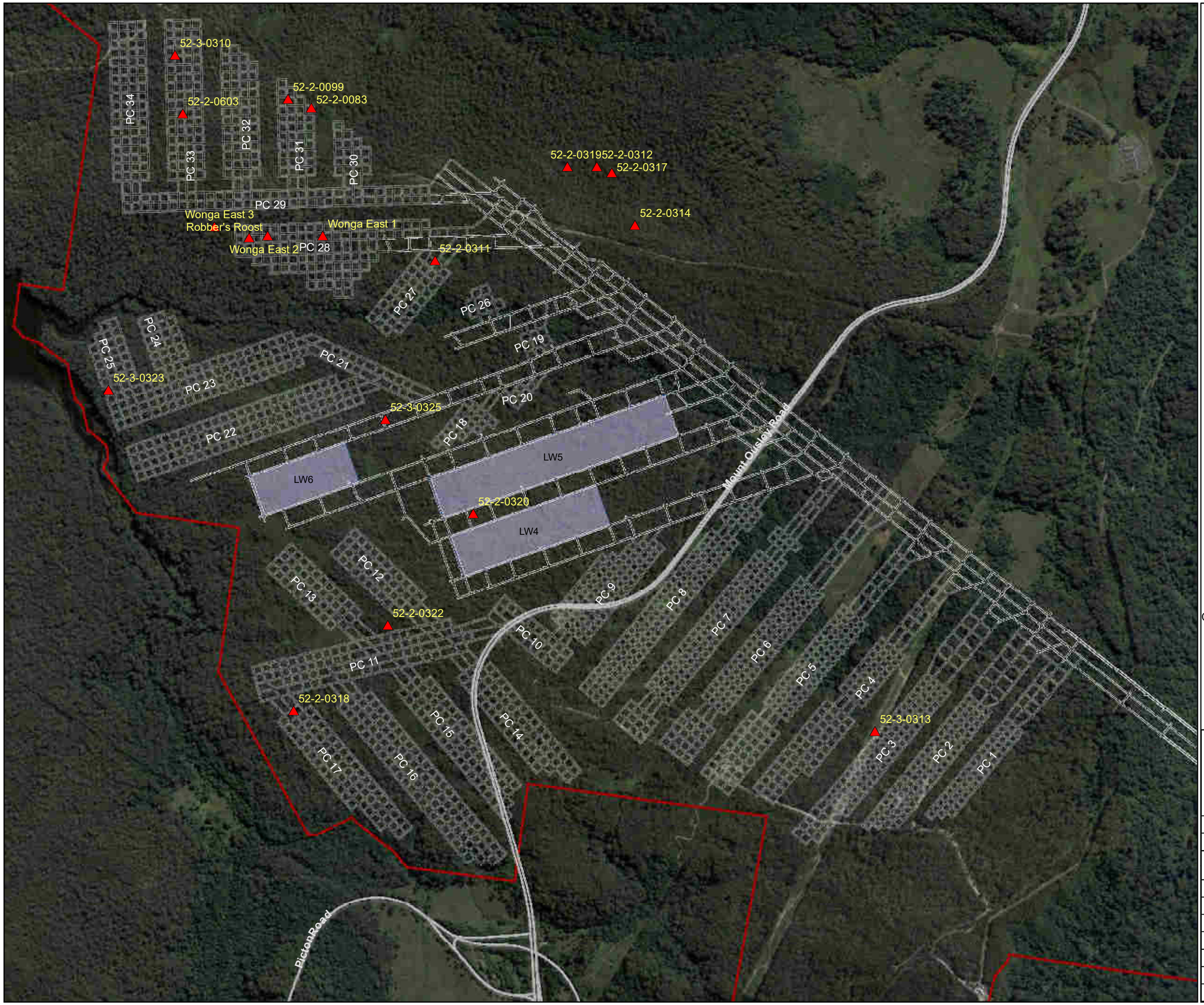

Legend

- Aborginal Heritage Site
- Mt Ousley Road
- Proposed Wongawilli Seam Workings
- RVC East Wongawilli Seam Workings
- RVC East Wongawilli Seam Goaf
- WCL RVC Holdings

Note: Mine Schedule dates start from commencement of mining operation

N

0 240 480
Meters

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WCL RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED

TITLE		
RUSSELL VALE COLLIERY UEP AREA		
PROPOSED MINING SCHEDULE AND ABORIGINAL HERITAGE SITE		
	NAME	DATE
DRN	RT	09/06/2020
CKD		
APP		
SCALE	1:12,000	@A3
DRAWING NUMBER		REV
RVC-ENV-079		0

APPENDIX 4

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Historic Heritage items	
1	Main Portal (S.W.Tunnel 1887)
2	1918 Portal for Ventilation
3	Signal Box
4	old Washery (1960) (now demolished)
5	Concrete base for Ball Mill at Pit Top
7	Former Mines Office (now demolished)
9	Power House Workshops
10	Upper Bench Workshops
11	Workshop Offices
12	Brick Retaining Wall
13	Crib Room and First Aid Station
14	Store Room
15	Closed Adits
16	Gibson's Portal
17	Sandstone Retaining Wall
18	The Preparation Plant
19	Rail Tracks and System
21	The Coal Wagon
22	Remanent Incline Haulage Alignments

Reference: ***NRE No. 1 Colliery, Historical Heritage Assessment. November 2012. ERM***

Legend

- Historic Heritage RVC
- Container Noise Wall
- Proposed Noise Wall
- Truck Road to move rejects
- Washery Drawings
- Truck Parking Area
- RVC Lease Boundary

Red Label — Existing Disused Infrastructure
Blue Label — Existing Infrastructure to be used by UEP
Green Label — Infrastructure to be constructed

Current and Proposed Plant and Infrastructure with Historic Heritage Items

N

0 80 160 m

1:3,500

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

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WCL RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED

7 Princes Highway, Corrimal, NSW 2518
ABN 28 111 244 896

APPENDIX 5

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Wollongong Coal Limited

Russell Vale Colliery

Underground Expansion Project

Rehabilitation and Post Closure Commitments

February 2020

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Document Control	
Site:	Russell Vale Colliery
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1 INTRODUCTION

Wollongong Coal Limited (**WCL**) has reviewed its rehabilitation and post closure commitments for the Russell Vale Underground Expansion Project (**UEP**).

This report provides details on the following for the UEP rehabilitation and WCL's post closure commitments:

- Current land use zoning;
- Indicative post mining land use;
- Conceptual rehabilitation objectives;
- Conceptual rehabilitation methods; and
- Conceptual completion criteria.

WCL's Freehold land holding is outlined on **Figure 1**.

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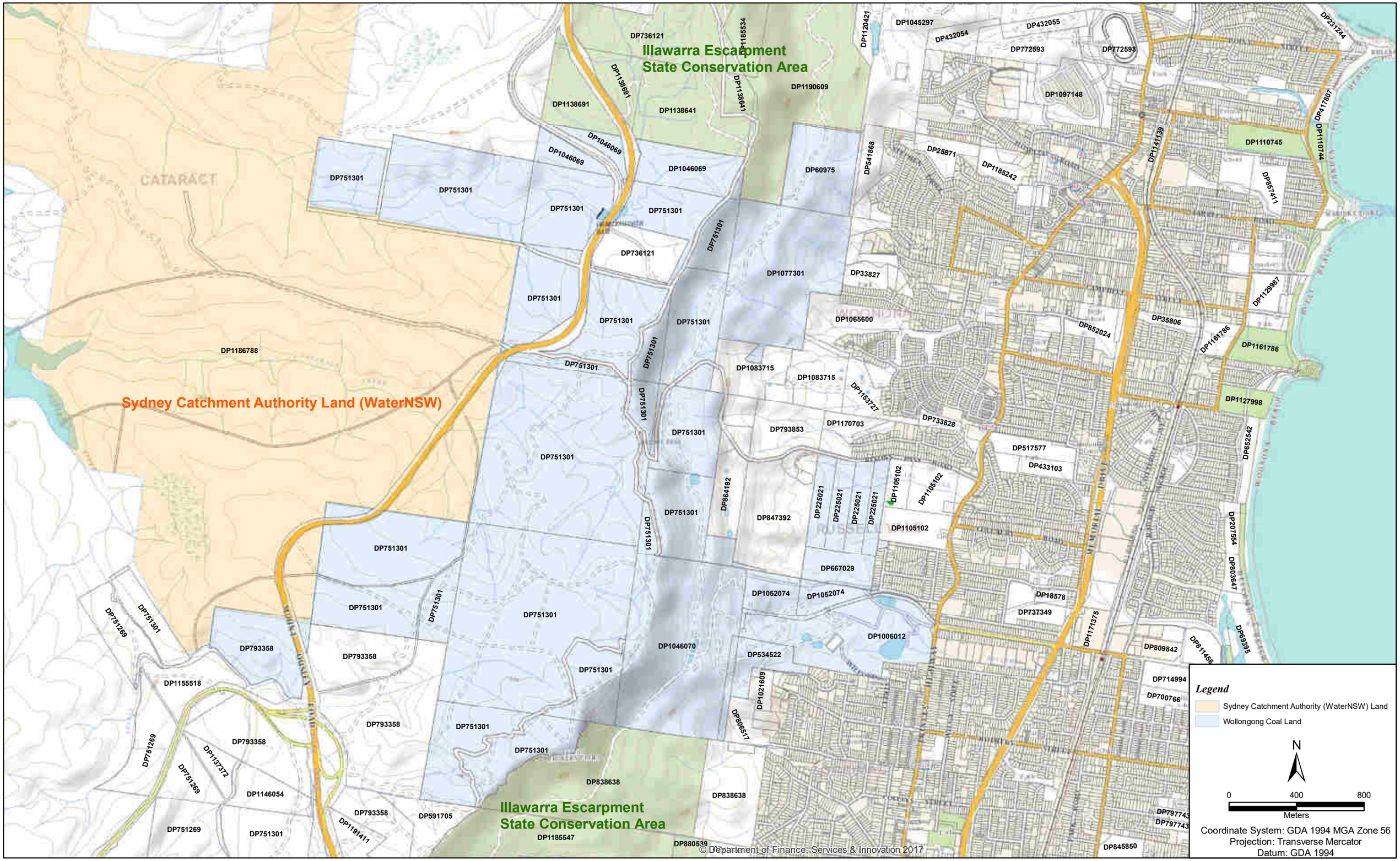

REV	DESCRIPTION	DATE	DRN	CKD

RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED
7 Princes Highway,
Corrimal, NSW 2518
ABN 28 111 244 896

	NAME	DATE	TITLE	
DRN	RT	13/12/2019	RUSSELL VLAE COLLIERY LAND TITLE	
CKD			LAND OWNERSHIP PLAN	
APP				
SCLAE	1:20,000 @A3		DRAWING NUMBER	REV
~~NTS~~			RVC-GEN-050	0

2 CURRENT LAND USE ZONING

The Local Environmental Plan (**LEP**) governing land use planning within the Wollongong Local Government Area (**LGA**) is the *Wollongong Local Environmental Plan, 2009* (**Wollongong LEP, 2009**).

2.1 Aims of Wollongong LEP

The aims of Wollongong LEP 2009 are:

- This Plan aims to make local environmental planning provisions for land in Wollongong in accordance with the relevant standard environmental planning instrument under Section 3.20 of the *Environmental Planning and Assessment Act, 1979* (**EP&A Act**);
- The particular aims of this Plan are as follows:
    - To provide a framework for land use management;
    - To encourage economic and business development to increase employment opportunities;
    - To encourage a range of housing choices consistent with the capacity of the land;
    - To improve the quality of life and the social well-being and amenity of residents, business operators, workers and visitors;
    - To conserve and enhance remnant terrestrial, aquatic and riparian habitats, native vegetation and fauna species;
    - To conserve and enhance heritage;
    - To ensure that development is consistent with the constraints of the land and can be appropriately serviced by infrastructure; and
    - To ensure that significant landscapes are conserved, including the Illawarra Escarpment, Lake Illawarra, the drinking water catchment and the coast line.

The current land use zonings are outlined on **Figure 2**.

2.2 Zone RU1-Primary Production

The objectives of the zone are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base;
- To encourage diversity in primary industry enterprises and systems appropriate for the area;
- To minimise the fragmentation and alienation of resource lands; and
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

1. Permitted without consent:

Building identification signs; Extensive agriculture; Home occupations

2. Permitted with consent:

Agricultural produce industries; Agriculture; Animal boarding or training establishments; Aquaculture; Business identification signs; Dwelling houses; Environmental protection works; Extractive industries; Farm buildings; Forestry; Intensive livestock agriculture; Intensive plant agriculture; Open cut mining; Roads; Roadside stalls

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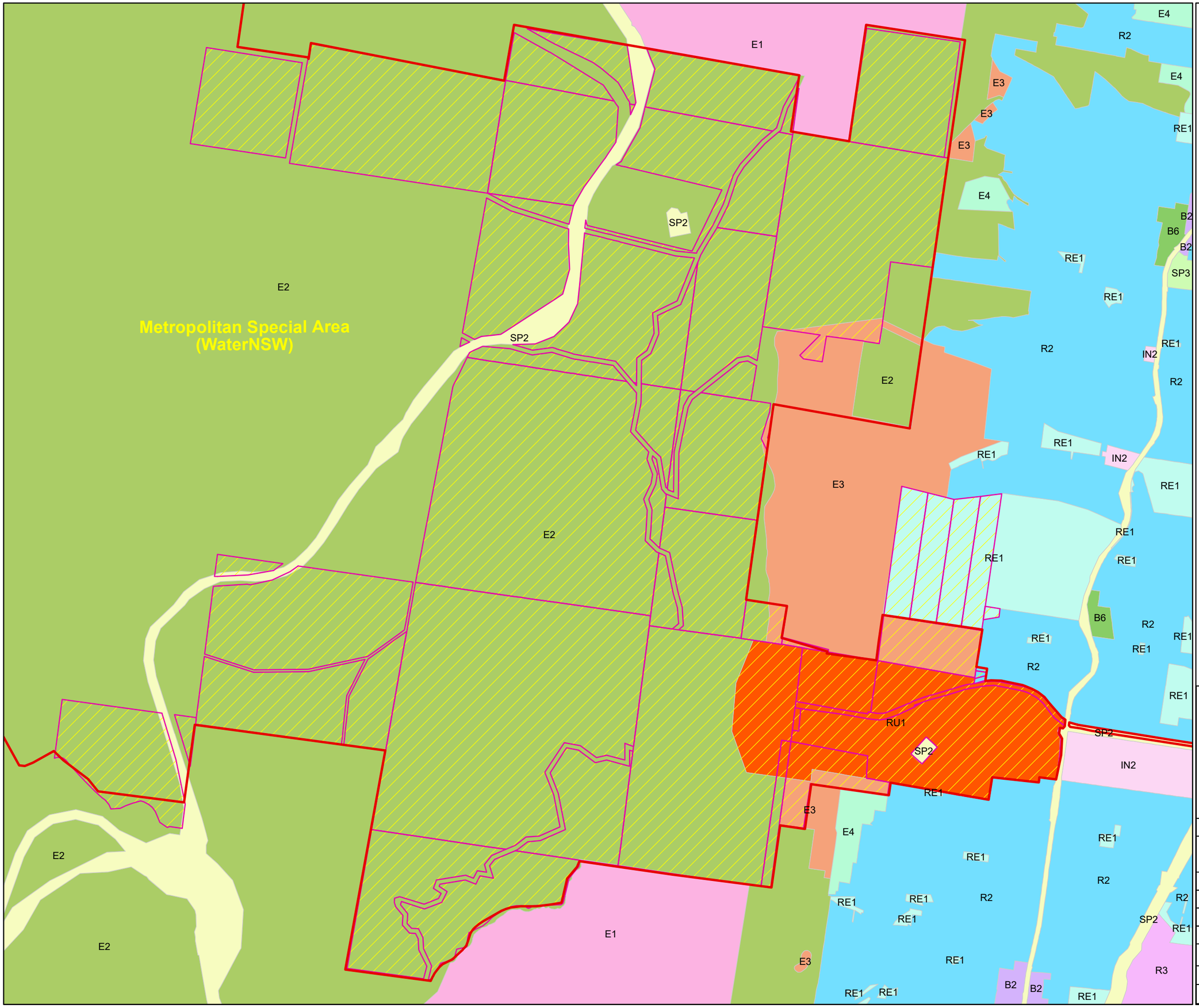


Legend

- Russell Vale Colliery Leases
- Wollongong Coal Freehold Land

LEP 2009 Environmental Zone

- B2, Local Centre
- B6, Enterprise Corridor
- E1, National Parks and Nature Reserves
- E2, Environmental Conservation
- E3, Environmental Management
- E4, Environmental Living
- IN2, Light Industrial
- R2, Low Density Residential
- R3, Medium Density Residential
- RE1, Public Recreation
- RU1, Primary Production
- SP2, Infrastructure
- SP3, Tourist

N

0 0.25 0.5
Kilometers

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WOLLONGONG COAL

RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED
7 Princes Highway
Corrimal, NSW 2518
ABN 28 111 244 896

TITLE-**RUSSELL VALE COLLIERY**

LAND HOLDIING AND LEP ZONING

	NAME	DATE
DRN	RT	24/02/2020
CKD		
APP		
SCALE	1:15,000 @A3	
DRAWING NUMBER		REV
RVC-GEN-052		0

3. Prohibited:

Any development not specified in item 2 or 3

2.3 Zone E2-Environmental Conservation

The objectives of the zone are:

- To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values;
- To prevent development that could destroy, damage or otherwise have an adverse effect on those values;
- To retain and enhance the visual and scenic qualities of the lllawarra Escarpment; and
- To maintain the qual it y of the water supply for Sydney and the lllawarra by protecting land forming part of the Sydney drinking water catchment (within the meaning of *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*) to enable the management and appropriate use of the land by WaterNSW.

1. Permitted without consent

Nil

2. Permitted with consent

Environmental facilities; Environment protection works; Extensive agriculture; Oyster aquaculture; Recreation areas

3. Prohibited

Business premises; Hotel or motel accommodation; Industries; Mu lt i dwelling housing; Pond-based aquaculture; Recreation facilities (major); Residential flat buildings; Restricted premises; Retail premises; Seniors housing; Service stations; Tank-based aquaculture; Warehouse or distribution centres; Any other development not specified in item 2 or 3.

2.4 Zone E3-Environmental Management

The objectives of the zone are:

- To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values; and
- To provide for a limited range of development that does not have an adverse effect on those values.

1. Permitted without consent

Home occupations

2. Permitted with consent

Animal boarding or training establishments; Bed and breakfast accommodation; Building identification signs; Business identification signs; Community facilities; Dwelling houses; Environmental facilities; Environmental protection works; Extensive agriculture; Farm buildings; Farm stay accommodation; Forestry; Home-based child care; Oyster aquaculture; Pond-based aquaculture; Recreation areas; Roads; Secondary dwellings; Tank-based aquaculture

3. Prohibited

Industries; Multi dwelling housing; Residential flat buildings; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3.

3 INDICATIVE POST MINING LAND USE

WCL proposes three post mining land uses on WCL freehold and leasehold land, held under current mining tenure.

The proposed post mining land uses correspond with the following Domains:

- Domain 1 - Escarpment Foothills (Areas zoned RU1 and E3 on the escarpment foot hills including the Russell Vale Pit Top);
- Domain 2 - Escarpment Face (areas zoned E2 from the foothills to the top of the escarpment); and
- Domain 3 - Woronora Plateau (areas west of the escarpment edge).

The post mining Domains are shown on Figure 3.

The indicative post mining uses for each domain are as follows:

- Domain 1 - Urban development - potential mix of dwelling houses, seniors living, retirement living, light industrial and commercial and business uses;
- Domain 2 - WCL Freehold land - private environmental management/recreation or subject to mutually acceptable commercial agreement, potential transfer to NSW Government to form part of the Illawarra Escarpment State Conservation Area (IESCA);
- Domain 3a - WCL Freehold land - subject to mutually acceptable commercial agreement, potential transfer to NSW Government for inclusion into WaterNSW Metropolitan Special Area (MSA); and
- Domain 3b- NSW Government land - part of WaterNSW's MSA.

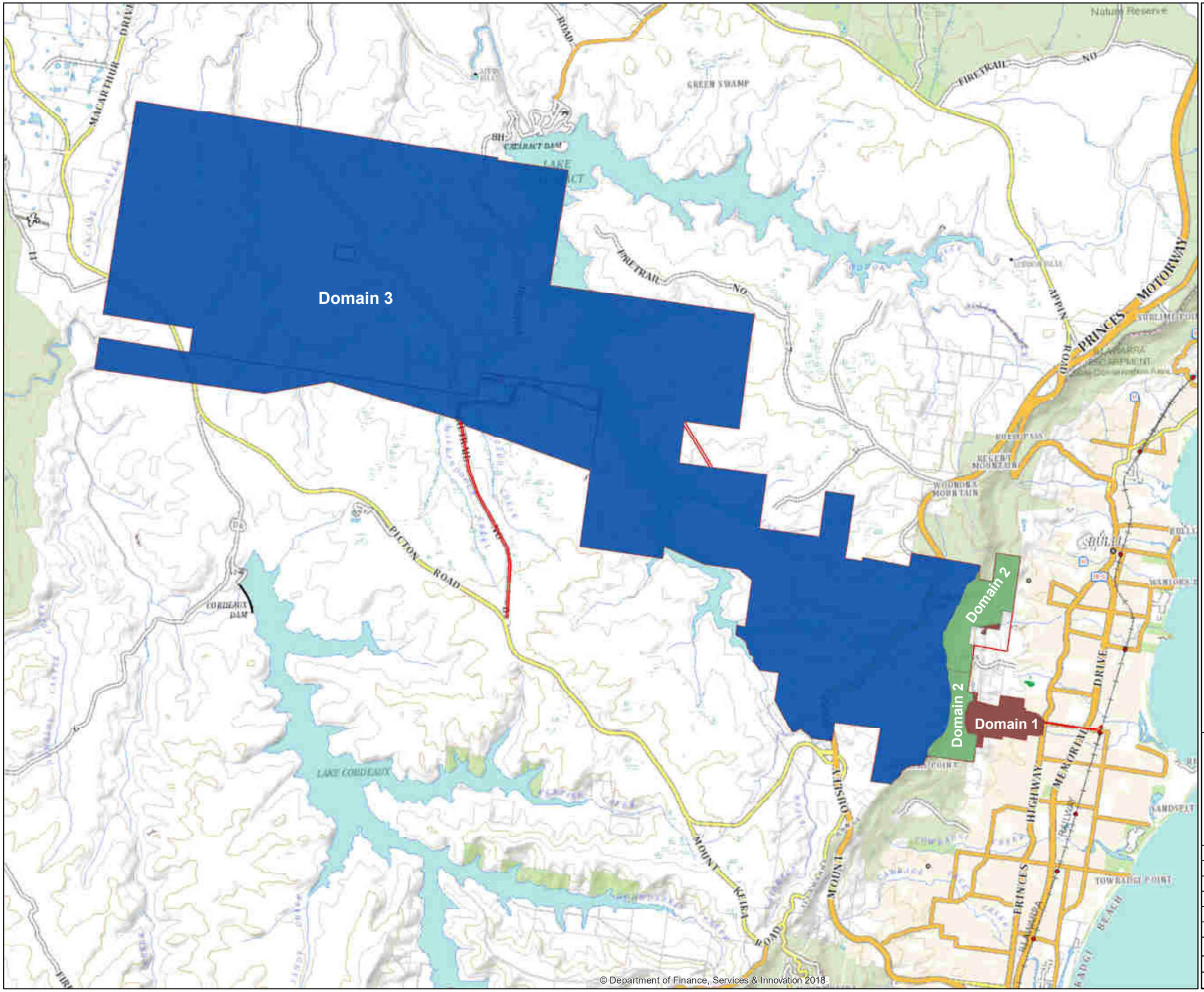
The indicative post mining uses for each domain are outlined on Figure 4.

Mine infrastructure that would be removed from Domain 3 is shown on Figure 5.

The Domain 1 land zoned RU1-Primary Production would be required to be rezoned to another land zone that permits urban development. A rezoning application and Planning Proposal would be required to be submitted to Wollongong City Council.

RUSSELL VALE COLLIERY

Mining Domain



Legend

Domain

- Domain 1
- Domain 2
- Domain 3
- Russell Vale Colliery Leases

N

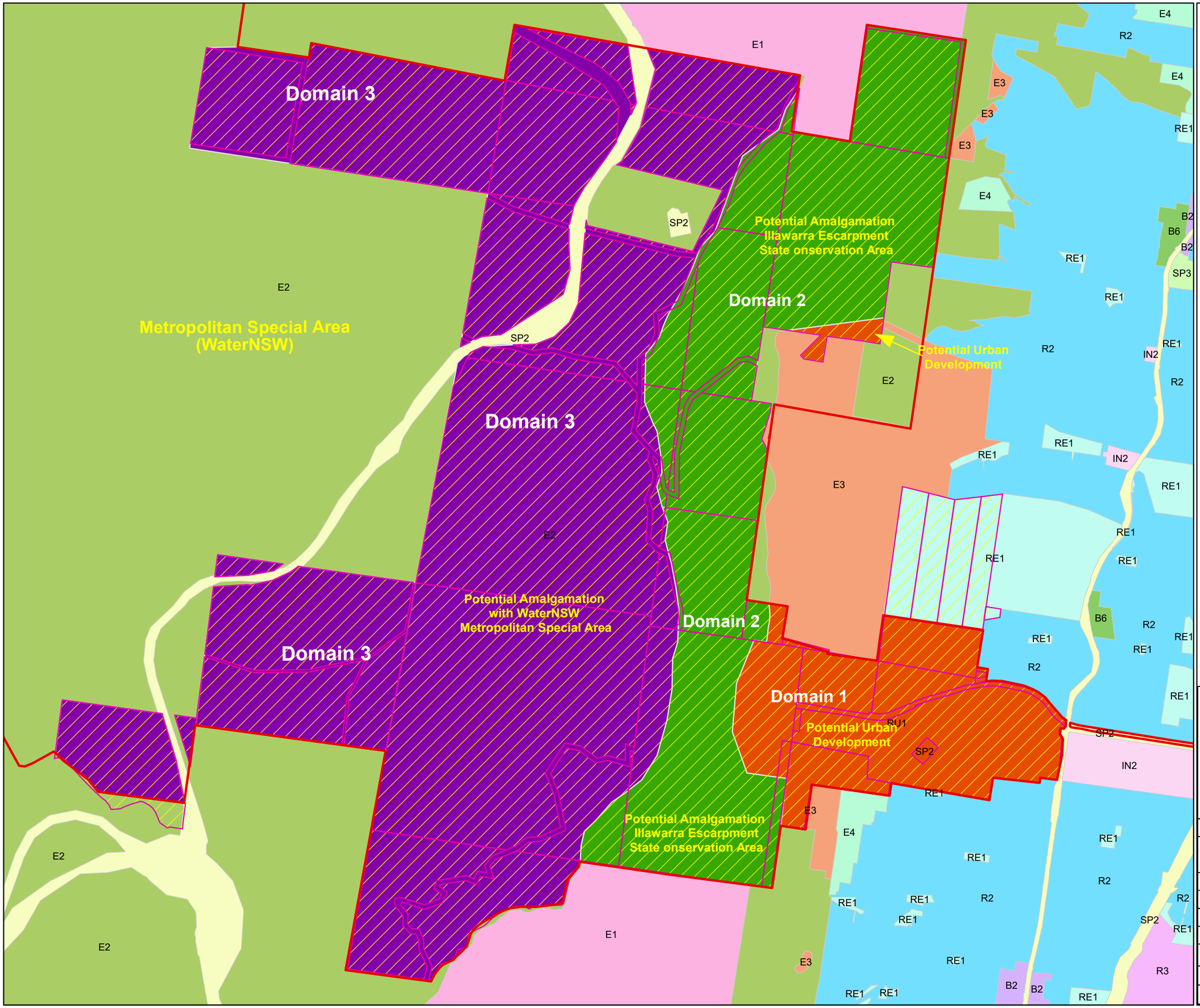
0 1 2
Kilometers

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WOLLONGONG COAL

RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED
7 Princes Highway
Corrimal, NSW 2518
ABN 28 111 244 896

TITLE-**RUSSELL VALE COLLIERY**		
MINING DOMAIN		
	NAME	DATE
DRN	RT	20/02/2020
CKD		
APP		
SCALE	1:60,000 @A3	
DRAWING NUMBER		REV
RVC-GEN-120		1



Legend

- Russell Vale Colliery Leases
- Wollongong Coal Freehold Land

Indicative Post Mining Landuse

- Potential Urban Development
- Potential Amalgamation with Illawarra Escarpment State Coservation Area
- Potential Amalgamation with WaterNSW Metropolitan Special Area

LEP 2009 Environmental Zone

- B2, Local Centre
- B6, Enterprise Corridor
- E1, National Parks and Nature Reserves
- E2, Environmental Conservation
- E3, Environmental Management
- E4, Environmental Living
- IN2, Light Industrial
- R2, Low Density Residential
- R3, Medium Density Residential
- RE1, Public Recreation
- RU1, Primary Production
- SP2, Infrastructure
- SP3, Tourist

N

0 0.25 0.5
Kilometers

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WOLLONGONG COAL

RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED
7 Princes Highway
Corrimal, NSW 2518
ABN 28 111 244 896

TITLE-**RUSSELL VALE COLLIERY**

MINING DOMAIN AND POST MINING LANDUSE

	NAME	DATE
DRN	RT	20/02/2020
CKD		
APP		
SCALE	1:15,000 @A3	
DRAWING NUMBER		REV
RVC-GEN-121		0

RUSSELL VALE COLLIERY

Metropolitan Special Area
Surface Lease
Indicative Post Mining Landuse

Domain 3

No. 5 Shaft

Electrical Transmission Line Easement

Access Road

No. 4 Shaft

No. 3 Shaft

All mine infrastructure and associated services will be removed from surface lease area (green areas) and returned to WaterNSW.

Access roads to be rehabilitated or left for WaterNSW as required

Electrical Transmission Line Easement

No. 2 Shaft

No. 1 Shaft

Electrical Transmission Line Easement

© Department of Finance, Services & Innovation 2018

Legend

- Shaft_Locations
- Infrustructure Area/Serviceable Area
- RVC Domain 3
- Project Application Area
- Russell Vale Colliery Leases

N

0 1 2
Kilometers

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WOLLONGONG COAL

RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED
7 Princes Highway
Corrimal, NSW 2518
ABN 28 111 244 896

TITLE-**RUSSELL VALE COLLIERY**

MINING DOMAIN AND POST MINING LANDUSE

	NAME	DATE
DRN	RT	20/02/2020
CKD		
APP		
SCALE	1:40,000 @A3	

DRAWING NUMBER	REV
RVC-GEN-121	1

4 CONCEPTUAL REHABILITATION OBJECTIVES

4.1 General Lease Area Rehabilitation Objectives

The rehabilitation objectives for the general lease areas are:

- Sites shall remain in a safe, stable, non-polluting and sustainable state;
- The socio-economic benefits of the rehabilitated sites will be maximised;
- Long term maintenance of the sites will not be greater than the surrounding environment;
- The agreed post-mining land use will be compatible with the surround in g land use fabric and land use requirements; and
- The rehabilitated landforms will have no greater management requirements than the surrounding landforms and land uses.

4.2 Domain 1 Rehabilitation Objectives

The rehabilitation objectives for the RU1 zoned Russell Vale Pit Top and E3 zone are based on preparing the land for urban development.

The Unplanned Closure rehabilitation objectives are:

- Seal all mine entries to NSW Resources Regulator's satisfaction; and
- Immediate implementation of works to achieve Long Term rehabilitation objectives.

The Short Term rehabilitation objectives (1 to 5 years) are:

- Progressive removal of redundant, non-heritage mine infrastructure; and
- Progressive revegetation of unused disturbed areas with grasses and shrubs.

The Long Term rehabilitation objectives (end of mine life) are:

- Preservation of all sit e heritage items as required by legislation or in liaison with regulator y authorities;
- Removal of all non-heritage mine infrastructure and services;
- Sealing of all mine entries to NSW Resources Regulator's satisfaction;
- Geotechnical stabilisation of all site benches and slopes as necessary;
- Removal of site water quality control ponds unless required for future use in urban development;
- Removal of identified noxious weeds; and
- Revegetation of all disturbed areas of site with grasses and shrubs.

4.3 Domain 2 Rehabilitation Objectives

The rehabilitation objectives for the Freehold E2 zones on the escarpment face are based on preparing the land for potential integration into the IESCA or private environmental management/recreation.

The Unplanned Closure rehabilitation objectives are:

- Removal of identified noxious weeds in disturbed areas;

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- Revegetation of unused disturbed areas with appropriate local species;
- Maintain roads in serviceable condition; and
- Immediate implementation of works to achieve Long Term rehabilitation objectives.

The Short Term rehabilitation objectives (1 to 5 years) are:

- Removal of identified noxious weeds in disturbed areas;
- Revegetation of unused disturbed areas with appropriate local species; and
- Maintain roads in serviceable condition.

The Long Term rehabilitation objectives (end of mine life) are:

- Preservation of all site heritage items as required by legislation or in liaison with regulatory authorities;
- Removal of all non-heritage mine infrastructure and services;
- Maintain roads in a serviceable condition for National Parks & Wildlife Service (NPWS) and Rural Fire Service (RFS) use;
- Geotechnical stabilisation of all site benches and slopes as necessary;
- Removal of dams;
- Removal of identified noxious weeds in disturbed areas
- Revegetation of all disturbed areas appropriate local species

4.4 Domain 3 Rehabilitation Objectives

The rehabilitation objectives for the Freehold and leasehold E2 zones on the Woronora Plateau are based on preparing the land for either potential integration or integration into the WaterNSW's Metropolitan Special Area.

The Unplanned Closure rehabilitation objectives are:

- Remove identified noxious weeds in disturbed areas;
- Revegetation of unused disturbed areas with appropriate local species;
- Maintain roads in a serviceable condition; and
- Immediate implementation of works to achieve Long Term rehabilitation objectives

The Short Term rehabilitation objectives (1 to 5 years) are:

- Removal of identified noxious weeds in disturbed areas;
- Revegetation of unused disturbed areas with appropriate local species;
- Rehabilitation of mine subsidence imp acts to agency and infrastructure stakeholder satisfaction; and
- Maintain roads in serviceable condition.

The Long Term rehabilitation objectives (end of mine life) are:

- Preservation of all heritage items as required by legislation or in liaison with regulatory authorities;
- Removal of all non-heritage mine infrastructure and services;
- Sealing of all shafts to regulatory standards;
- Removal of environmental monitoring infrastructure;

- Sealing of all boreholes to regulatory standards and revegetation of all exploration and monitoring boreholes;
- Maintain roads in a serviceable condition for WaterNSW and RFS use;
- Removal of water treatment dams;
- Removal of identified noxious weeds in disturbed areas;
- Rehabilitation of mine subsidence impacts to agency and infrastructure stakeholder satisfaction; and
- Revegetation of all disturbed areas to WaterNSW's satisfaction.

5 CONCEPTUAL REHABILITATION METHODS

5.1 Heritage Items

Preservation of heritage items will be undertaken in accordance with the Heritage Management Plan (HMP) at the time of the mine closure.

The implementation of the plan will involve a sit e inspection by a heritage expert to assess the listed heritage items and make recommendations as to what heritage preservation actions may be required. These recommendations could range from full restoration and display of items of mobile heritage, interpretive signage or full restoration of heritage structures.

5.2 Surface Infrastructure

All surface infrastructure will be removed in accordance with current planning and building regulatory requirements for this type of activity.

Structures will be removed first, followed by services and finally the ground will be broadly re- profiled, where possible, to match the surrounding ground contours. During this stage soil and water will be managed via the site's dirty water management system. All waste materials will be recycled, reused or disposed of at an appropriate licensed waste disposal facility. These details will be outlined within a CEMP or project plan.

5.3 Mine Entrances

5.3.1 Adit Filling and Capping

All adits will be sealed to NSW Resources Regulator's standards.

All bulkheads and bulkhead seals will be designed by an engineer who has visited the site and will take into account any possible fretting of the adit perimeter. A bulkhead will be constructed not less than 20 metres from the surface entry point with a minimum depth of cover of 15 metres of solid strata.

Any man-made structures or fittings in the adit will be removed if it is safe to do so. The void from the bulkhead to the adit entrance will be filled with high integrity fill materials in a manner that ensures there are no voids in the adit. The surrounding strata at the entrance to the adit will be secured and protected against weathering and spalling weakening the adit beyond the lip of the solid rock.

A bulkhead seal will be erected at the entrance to the adit and the adit bulkhead and surrounds will be completely covered by mounding earth over the area if possible. A plaque will be placed on the portal bulkhead or in a visible position with the name of the colliery, adit name and date of sealing inscribed on it.

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The design engineer will certify that the bulkheads were completed in compliance with the original design or indicate alterations to the original design. The 'as constructed' drawings will be supplied to the NSW Resources Regulator.

5.3.2 Drift Filling and Capping

All drifts will be sealed to NSW Resources Regulator's standards.

All bulkheads and bulkhead seals will be designed by an engineer who has visited the site and will take into account any possible fretting of the drift perimeter. A bulkhead will be constructed at a point with a minimum depth of cover of 15 metres of solid strata. Where there is a possibility of fretting of the strata surrounding the bulkhead, the bulkhead design will include provision for strata reinforcement to prevent any reduction of the strength of the bulkhead.

The inbye bulkhead may be designed to permit the passage of water but will prevent the flow of any gas from the workings. If the bulkhead is designed with allowance for water passage, the fill material used outbye of the bulkhead will be resistant to water causing it to become flu id or capable of flowing when wet. Any man- made structures or fittings in the drift will be removed if it is safe to do so. The void from the inbye bulkhead to the drift entrance will be filled with high integrity fill materials in a manner that ensures there are no voids in the adit.

The surrounding strata at the entrance to the adit will be secured and protected against weathering and spalling weakening the adit beyond the lip of the solid rock. A bulkhead seal will be erected at the portal mouth to prevent the ingress of water and escape of gas. The final void behind the portal bulkhead will be stowed completely to the roof. The portal may be covered by mounded earth. A plaque will be placed on the portal bulkhead or in a visible position with the name of the colliery, adit name and date of sealing inscribed on it.

5.3.3 Shaft Filling and Capping

All shafts will be sealed to NSW Resources Regulator's standards.

The area around the shaft will be fully enclosed by a man -proof security fence prior to the commencement of shaft filling. All bulkheads and shaft caps will be designed by an engineer. Where seam inserts are still accessible, substantial bulkheads will be constructed to prevent fill material from flowing into the mine workings.

Where insert bulkheads are installed they will permit the passage of water from one side of barrier to the other to reduce the requirement for design against substantial hydraulic head. The engineer will certify that the bulkheads were constructed to the specified design.

Where seam inserts are inaccessible, material will be used to fill the shaft to a level above the seam insert so if the material below the insert moves, the insert will remain completely sealed to prevent any material flowing into the insert. The level of hard rock fill above inserts will be confirmed by plumbing of the shaft.

Suitable fill material should be used to fill the remainder of the shaft. All fill material to be used in the filling of the shaft will be approved by the NSW Resources Regulator.

If surface demolition material is used for shaft fill, it will be crushed and broken to a suitable size to avoid wedging in the shaft. Where the shaft contain s water or maybe subject to water inflow, the filling will ensure that the material will remain in place in the event of the workings being holed, dewatered, or affected by a seismic event.

The use of a concrete plug at each insert will be considered. A full -time competent super visor will be appointed to oversee filling operations as they are taking place. Where possible, fill material will be introduced centrally into the shaft and a water spray will be used at all times when fill is being placed into the shaft. The surface capping of the shaft will be founded on bedrock.

Excavation of surface soil down to bedrock to allow the surface capping to be installed will be done after the shaft is filled to this point. The shaft collar will be removed down to bedrock. The engineer will inspect the site prior to designing of the surface capping and the shaft capping will be designed using a design loading and uniformly distributed load of at least 7kPa. The design of the shaft capping structure will not include support given by the shaft fill material. The design of the surface capping will take into account any possible fretting of material at the shaft perimeter.

All steel reinforcement used in the surface capping structure will have a minimum of 100mm of concrete cover and provision will be made in the surface capping to allow for topping up of fill with additional fill if necessary. The shaft capping will either be left uncovered or be covered to natural ground level. If still exposed the shaft collar will be engraved with the mine and shaft name and date sealed but if covered then a plaque will be fixed to a suitable concrete footing to display the sealing details.

The engineer will certify that the completion of the capping was in accordance with the approved design and *'as constructed'* drawings of shaft capping and shaft fill details will be supplied to the NSW Resources Regulator.

All non-natural materials will be removed from the site. The surface casing will be removed to a depth below ground and the vegetation will be rehabilitated.

5.3.4 Boreholes

5.3.4.1 Sealing

All borehole sealing activities will comply with the latest NSW Resources Regulator's design guidelines or other best practice guidelines relevant to the activity.

All boreholes will be filled in from the total depth to the surface with approved cement mixtures. To avoid excess being deposited on the surface, which may interfere with any land use activities, approved cement mixtures will support the maximum allowable length of grout and provide an effective seal within the hole. The cement mixtures won't be deposited in more than 200m of vertical depth in any borehole at any one time. Setting and weight testing will be completed and recorded before any further cement mixtures can be deposited in the borehole. Samples of the concrete mixture will be kept for strength determinations if the NSW Resources Regulator's requires.

Records will be kept to demonstrate the method used to seal the hole, volumes and types of materials used and information on the drill hole such as depth, diameter and casing string(s) left in the hole. Any loss of cement mixture due to high flow aquifers or permeable strata will be recorded as well as the method used to overcome these problems.

All records relating to the sealing of boreholes will be provided to the NSW Resources Regulator together with a declaration by WCL confirming that the work was carried out according to current guidelines and documenting any variations with supporting explanation.

All boreholes will be sea led by pumping the cement mixture from either the base of the hole or the bottom of the previously cemented section of the hole. Depending on requirements, the cement may be preceded and/ or followed by plugs. The position of the plugs in the borehole will be determined before further grouting. In the event that a number of plugs are used within a borehole, the plugs must be placed so as not to leave a significant unfilled section between the plug and the underlying previously cemented section.

When grouting the surface casing the cement mixture won't extrude from the annulus between the casing and the borehole wall or another larger diameter casing string. All boreholes will be depth tested between all grouting and plug operations to determine if the level of the grout in the borehole is higher than shown in the calculations. All depth testing for this purpose will be recorded. No cement mixture excess will be deposited on the surface.

All casing strings that are not cemented into place will be removed prior to or during the sealing of the hole. Where non-grouted casing cannot be removed, the casing will be perforated and grout will be pumped under pressure to fill the annulus behind the unsealed casing. If necessary a suitable bridge or plug will be placed near the base of the affected casing in order to facilitate the injection of grout behind the casing.

5.3.4.2 Surface Rehabilitation

All non-natural materials will be removed from the sit e. The surface casing will be removed to a depth below ground that meets the requirements of the WaterNSW. The vegetation will be rehabilitated in accordance with the WaterNSW's guidelines or preferred method.

5.3.4.3 Survey

All rehabilitated boreholes will be surveyed to determine their horizontal and vertical positions and survey details will be provided to the NSW Resources Regulator.

A permanent steel identification plate or reference mark will be placed at the location of each borehole for relocation purposes. All boreholes will be surveyed with a vertical position accuracy of +/- 0.3 metres and a horizontal position accuracy of +/ - 1.0 metres.

The vertical position will be referenced to the Australian Height Datum (AHD) level values and the horizontal position will be referenced to the Integrated Survey Grid (ISG) co-ordinate values.

WCL will ensure compliance with any conditions set by relevant regulatory agencies.

The NSW Resources Regulator will be notified when the borehole is abandoned via a modification of the Mining Operations Plan (MOP).

5.3.5 Mine Subsidence

Impacts of a minor nature will not be remediated or rehabilitated if agreed by relevant regulators.

More significant mine subsidence impacts such as creek bed cracking will be rehabilitated using methods approved by NSW Resources Regulator and/or WaterNSW.

If rehabilitation is not possible then WCL will discuss options for offsets with the appropriate regulatory agencies.

6 CONCEPTUAL COMPLETION CRITERIA

The completion criteria in **Table 1**, **Table 2**, and **Table 3**, are general long term criteria based on the relevant rehabilitation objectives for each of the Domains at WCL.

When detailed Closure Plans are completed the general criteria will be refined to become specific and measurable.

Table 1: Domain 1 - Long Term Rehabilitation Indicators

Rehabilitation Phase	Completion Criteria
Decommissioning	○ Heritage structures and locations preserved; ○ Infrastructure removed; ○ Mine entries sealed to Resource Regulator standards and DSC satisfaction with regard to water egress; ○ Services decommissioned (electricity, water, etc.); ○ Mine dams removed unless required for future residential development; ○ Contamination remediated.
Landform Establishment	○ Slopes geotechnically stable; ○ Substrate characterised across Pit Top; and ○ Drainage system established.
Growth Medium Development	○ Growth medium types and depths suitable for grass cover establishment.
Ecosystem Establishment	○ Rapid growth grasses; ○ Sterile grasses used to establish ground cover; and ○ Non-invasive residential grasses for permanent ground cover.
Ecosystem Development	○ Non invasive ground covers maintained in healthy state.

Table 2: Domain 2 - Long Term Rehabilitation Indicators

Rehabilitation Phase	Completion Criteria
Decommissioning	○ Heritage structures and locations preserved; ○ Infrastructure removed; ○ Services decommissioned (electricity, water, etc.); ○ Mine dams removed unless required for future residential development Contamination remediated; and ○ Roads remain serviceable
Landform Establishment	○ Slopes geotechnically stable; ○ Substrate characterised in disturbed areas; and ○ Drainage system established.
Growth Medium Development	○ Growth medium types and depths suitable for local native species regeneration.
Ecosystem Establishment	○ Rapid growing sterile native grasses used to establish initial ground cover; ○ Local native groundcover for substrate stabilisation; ○ Rapid growing local native colonisers for initial native community structure establishment; and ○ Local native species used for mature canopy development.
Ecosystem Development	○ Groundcovers established; ○ Colonisers established; ○ Mature canopy species established; ○ Recruitment of local native flora species evident; ○ Out-competition of noxious weeds by native flora species evident; and ○ Utilisation of site by local native fauna species evident.

Table 3: Domain 3 - Long Term Rehabilitation Indicators

Rehabilitation Phase	Completion Criteria
Decommissioning	○ Heritage structures and locations preserved; ○ Infrastructure removed; ○ Dams and reticulation systems removed; ○ Services decommissioned (electricity, water, etc.); ○ Shafts sealed to regulatory standards; ○ Boreholes sealed to regulatory standards; ○ Environmental monitoring equipment removed; ○ Contamination remediated; and ○ Roads serviceable.
Landform Establishment	○ Slopes geotechnically stable; ○ Substrate characterised in disturbed areas; ○ Drainage system established; ○ Subsidence impacted waterways remediated where possible or offset to Regulator satisfaction; and ○ Subsidence impacted swamps offset to regulator satisfaction.
Growth Medium Development	○ Growth medium types and depths suitable for local native species regeneration.
Ecosystem Establishment	○ WaterNSW approved revegetation methods used in rehabilitation of all catchment disturbance areas.
Ecosystem Development	○ Native species naturally re-established; ○ Out-competition of noxious weeds by native flora species evident; ○ Utilisation of site by local native fauna species evident; and ○ WaterNSW satisfied with rehabilitation.

APPENDIX 6

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Wollongong Coal Limited

Russell Vale Colliery

Reject Geochemical Analysis

ROM Working Section Sample

March 2020

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EXECUTIVE SUMMARY

Reject material produced from the proposed mining of the Wongawilli Coal Seam at Russell Vale Colliery is expected to total up to 200,000 tonnes per annum and is proposed to be either marketed for beneficial reuse or emplaced underground in disused workings.

Reject material from the historical Russell Vale Colliery reject emplacement area was the subject of a report dated November 2019 and further reject analysis has been requested by both the EPA and WaterNSW.

An approximate 3 tonne sample of coal from the Wongawilli Coal Seam was sampled on 23 January 2020 from the proposed Wongawilli mine working section to approximate ROM coal. An approximate 50 kilogram sample was sub-sampled with non-coal reject material further sub-sampled and subjected to geochemical analysis.

The reject material has negligible total sulphur and is regarded as either Non Acid Forming (NAF) or NAF Barren. The reject material has excess Acid Neutralising Capacity (ANC) and a high factor of safety with respect to potential acid generation.

The metal concentrations in the reject material is unlikely to present any environmental issues from heavy metals or the generation of saline run-off.

The reject material impact on the quality of surface water and groundwater is expected to be negligible.

The underground emplacement of reject is not expected to cause impacts on groundwater quality and would meet the requirements for a neutral or beneficial effect on water quality.

The reject material can meet the EPA requirements for beneficial use.

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1 INTRODUCTION

1.1 Background

Wollongong Coal Limited (**WCL**) owns the Russell Vale Colliery, which is an underground metallurgical coal mine located in the Illawarra region of the Southern Coalfield. Currently, the Russell Vale Colliery is on care and maintenance.

Russell Vale Colliery has extracted coal from the Bulli, Balgownie and Wongawilli seams. Russell Vale Colliery is planning to resume mining in the East Domain within the Wongawilli Coal Seam via bord and pillar mining using the Place Change Mining Method. The Place Change Mining Method was selected to improve operational efficiency, reduce costs, minimise surface subsidence and maximise production rates.

It is planned that the working section will be limited to the basal 2.4m section of the Wongawilli Coal Seam to minimise ash content of the ROM coal. The ROM coal, with expected ash to range from about 28 - 32%, will be crushed, screened and then subject to a simple beneficiation process to screen off coarse reject material. The beneficiation process will reduce the ROM coal ash by about 8% to provide a ROM coal product yield of about 80% (i.e. the ROM coal product would have an ash of about 20%).

It is anticipated that approximately up to 200,000 tonnes per annum (**tpa**) of rejects will be generated that will either be beneficially used as fill material, under the EPA's Coal Washery Rejects Order/Exemption 2014 oremplaced underground within former mine workings.

1.2 Government Agencies Comments

Reject material from the historical Russell Vale Colliery reject emplacement area was the subject of a report dated November 2019 and further reject analysis has been requested by both the EPA and WaterNSW.

The EPA within their correspondence dated 23 December 2019 made the following comments related to the environmental assessment of underground reject management:

> *The geochemical testing of the extracted water from coal wash reject be repeated using analytical methods having limits of detection suitable for comparison to 95% default guidelines values for ANZG (2018). It is recommended that individual and composited soil samples be tested.*
>
> *The results compared with ANZECC values and Wongawilli coal seam water quality to determine whether there is likely impact to surface or groundwater.*
>
> *As the principal source of arsenic is from sandstone, analysis be provided of the likely amount of sandstone in the reject. The report notes that the floor of the mine will be Kembla Sandstone but the roof will be coal in order to manage geotechnical and safety constraints.*
>
> *A description of the proposed underground emplacement be given including details of the possible impact of the emplacement on groundwater including:*
>
> - *The underground location and whether the area is dry or will be affected by groundwater in the short or long term;*
> - *How the reject will be emplaced: conveyed, trucked or pumped;*
> - *The form of the material to be emplaced such as fines, coarse or paste;*

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- *Whether the reject will need to be treated for it to be emplaced underground. For example does it need to be stabilised with cementitious material for stability or flocculants for flow if being pumped;*
- *Whether there is enough underground area available that is safely accessible for emplacement;*
- *If applicable, how the emplaced material will interact with groundwater including geochemical interactions and possible groundwater flow;*
- *If there is a groundwater interaction, what is the likely fate of any pollutants leaching from the emplacement.*

As the principal source of arsenic is from sandstone of an unknown origin in the REA, sampling and chemical characterisation of Kembla Sandstone be undertaken to determine the actual level of arsenic likely to come from reject extracted under the project. An analysis should be made of the likely amount of Kembla Sandstone from the floor of the mine.

The EPA agrees with the report's recommendation that if approval is granted, the reject generated on site be tested in accordance with the EPA's Coal Washery Reject Order 2014 before marketing the reject material for beneficial reuse applications.

WaterNSW within their correspondence dated 20 December 2019 made the following comments:

The Submissions Report states that the reject materials are non-acid forming and the concentrations of heavy metals and salts in the material is expected to have a low impact on the quality of surface water and groundwater.

However, when heavy metals concentrations in Table 6 (Appendix 9, page 19) were compared to groundwater investigation levels (NEPC 2013), the concentrations of most heavy metals exceed the groundwater investigation levels. It is also noted that mercury is not included in the analysis.

WaterNSW requests clarification from Wollongong Coal regarding this matter and assessment of whether any proposed underground reject emplacement would satisfy the requirement for a neutral or beneficial effect on water quality.

1.3 Report Scope

This report reviews geochemical properties of the projected reject material to be generated and its suitability for emplacement underground within former mine workings or for beneficial use as fill material.

The scope of this report is to provide geochemical characterisation for ROM coal representative of the anticipated reject material and to recommend environmental management measures related to reject emplacement or beneficial reuse.

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2 REJECT PRODUCTION

2.1 Reject Production

The Russell Vale Colliery Project proposes to mine at a rate of up to 1.2 Mtpa ROM coal that will result in production of up to 1 Mtpa of product coal.

The proposed Coal Processing Plant will comprise a coal sizing plant that will remove oversized rock material using crushing and a simple beneficiation process that includes screening of the plus 80 mm reject material and density beneficiation using air.

The reject material produced will be a nominal +80 mm product with an anticipated size range from -200 mm to + 80 mm. The produced reject material will predominately consist of grey to black shale with minor sandstone and tuff.

No washing of coal will occur on site.

The reject material will be collected at the Coal Processing Plant within a ground stockpile.

There will be approximately 200,000 tpa of rejects produced, which will be managed by the following methods in descending order of preference:

- Beneficial reuse with the reject material transported off site as fill if it meets the EPA requirements for beneficial reuse;
- Use on site for rehabilitation of the site; and
- Emplacement underground within former mine workings and voids.

2.2 Beneficial Reuse

Beneficial reuse of the generated reject material as fill material supplied in accordance with the EPA's Coal Washery Rejects Order/Exemption 2014 will be the preferred disposal method for the reject material generated.

The reject material will consist predominately of shale material with minor sandstone and tuff with a coarse size grading ranging from +80 mm to -200 mm with minimal fines, which is anticipated to find market acceptance as a subbase material in road construction, industrial pad construction and flood mitigation construction works and as a general coarse fill material.

2.3 Reuse Onsite

A small quantity (generally less than 10,000 tonnes) per annum of generated reject material will be reused on site within site rehabilitation works, such as use in former portal sealing and bund wall maintenance.

Additional a small quantity (generally less than 5,000 tonnes) per annum of generated reject material may be reused on site for yard levelling and within site road maintenance.

2.4 Underground Reject Emplacement

The reject material produced from the Coal Processing Plant will be collected within a ground stockpile.

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Reject material that cannot be beneficially reused as fill material due to lack of available market is proposed to be emplaced underground within former mine workings. Initially the underground emplacement areas will be the roadways for the former Wongawilli Longwalls and then within the roadways generated by the Place Change Mining Method.

The former Wongawilli Longwall roadways are mostly dry and the roadways generated by the Place Change Mining Method are anticipated to be mostly dry. Therefore, in the short term, groundwater interaction with the emplaced reject material is expected to be limited. Over time, in the longer term, once the various former working areas of the mine are sealed, groundwater will drain into the former roadways and these will fill with groundwater as the former working re-pressurise.

The reject material is proposed to be carted by truck from the Coal Processing Plant stockpile to the mine portal where it will be initially emplaced within the former roadways by underground loaders and eventually via conveyor and a rock slinger into the underground roadways. In the longer term as the mine development progresses further to the west and transport distances become longer, the reject material may be pumped into the former roadways.

The reject material emplaced will be coarse material within a size range from -200 mm to + 80 mm with minimal fines. The reject material is not proposed to be treated prior to emplacement underground.

There are sufficient roadways for reject emplacement underground with safe working access, given that ROM production is anticipated to produce 17% total reject material (about 200,000 tpa) and this material will only be emplaced underground if markets cannot be found for beneficial reuse off site as fill material under the EPA's Coal Washery Rejects Order/Exemption 2014. Initially sufficient emplacement area existing within the roadways for the former Wongawilli Longwalls.

In the short term, groundwater interaction with the emplaced reject material is expected to be limited as most roadways are generally dry. In the longer term, once the various former working areas of the mine are sealed, the roadways with emplaced rejects will re-pressurise and fill with groundwater. As outlined within further sections of this report, the emplacement reject material is not expected to have any environment impact with groundwater.

3 GEOLOGY

3.1 Southern Coalfield

The Russell Vale Colliery is located in the NSW Southern Coalfield within the southern portion of the Permo-Triassic Sydney Basin. The Late Permian Illawarra Coal Measures contain a number of workable seams in the Southern Coalfield.

Above the Illawarra Coal Measures, the stratigraphy consists of a sequence of sandstone, shale and claystone units within the Narrabeen Group which are, in turn, overlain by the Hawkesbury Sandstone. Overburden consists of approximately 156m off Hawkesbury Sandstone, 280m of Narrabeen Group (consisting of thick bedded Sandstone, and Claystone units), and 42m of Illawarra Coal Measures (to the base of the Wongawilli Seam).

A typical stratigraphic section is shown on **Figure 1.**

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3.2 Wongawilli Coal Seam

Mineable areas of the Wongawilli Coal Seam have been identified within the underground mining areas. The Wongawilli Coal Seam ranges up to about 10 metres thick across the Southern Coalfield and contains numerous bands of non-coal partings.

The Wongawilli Coal Seam dips gently between 1:25 and 1:30 to the WNW from the outcrop on the Illawarra Escarpment. Occasional normal faulting trends in a NW-NNW direction, and roof joints trend NNE.

The economic working section of the Wongawilli Coal Seam targeted by coal operations is the basal 2.8-3.6m section due to numerous stone bands and high ash coal in the remaining seam section. The Farmborough Tuff which is approximately 1m thick and located 5-5.5m above the working floor separates the Wongawilli Coal Seam into upper and lower sections. The basal 2.8-3.6m section is the lowest ash content portion of the Wongawilli Coal Seam.

Wollongong Coal proposes a working section or mining height of about 2.4 metres in the basal section of the Wongawilli Coal Seam.

Coal resources will be left in the immediate mining roof in order to manage the geotechnical and safety constraints associated with the place change mining method. The immediate roof of the Wongawilli Coal Seam consists of 6m of interbedded coal seams (Hargraves and Cape Horn) and mudstones. The floor consists of grey to white sandstone of the Kembla Sandstone.

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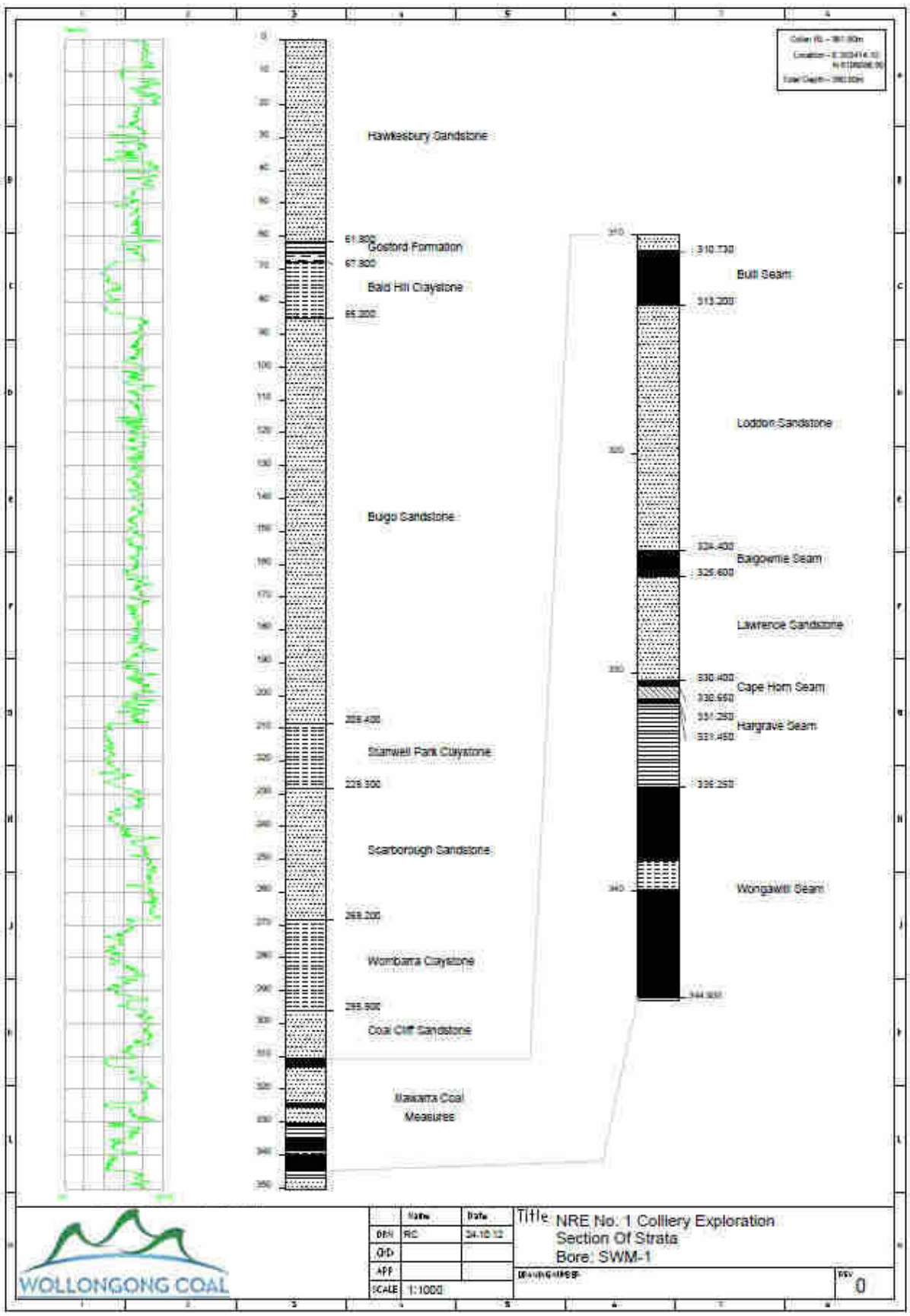

Figure 1: Typical Stratigraphic Section

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4 GEOCHEMICAL CHARACTERISATION

4.1 Overview

The key aims of reject material characterisation are to determine:

- The potential extent or magnitude of acid generation;
- The suitability for reject emplacement underground; and
- The suitability for beneficial reuse as an engineering and general fill material.

4.2 Acid Base Account

The Acid Base Account (**ABA**) estimates the balance between the potential for a material to generate acid and to neutralise acid. The output from an ABA is a value known as the Net Acid Producing Potential (**NAPP**), expressed in units of kilograms of sulphuric acid per tonne (kg H_2SO_4/t).

The NAPP test determines the Maximum Potential Acidity (**MPA**) and the maximum inherent Acid-Neutralising Capacity (**ANC**) of a sample. NAPP calculates a theoretical net acid producing (or consuming) value of a sample by subtracting the theoretical acid neutralising capacity, or ANC of a sample (CaO + MgO for example), from the maximum potential acidity of a sample (total Sulphur).

The total sulphur content is commonly used as a conservative estimate of pyritic sulphur (that is, all S is assumed to be present in the form of pyrite) to calculate the MPA (MPA = weight% S x 30.6). The use of total sulphur is a conservative approach because some sulphur may be present in forms other than pyrite.

The ANC is typically determined by the addition of a known quantity of concentrated hydrochloric acid to a sample, followed by back-titration with sodium hydroxide to quantify the maximum amount of acid consumed by the inherent neutralising capacity of the material.

Two measures of the ABA are calculated from the MPA and ANC:

- NAPP; and
- ANC/MPA ratio.

The NAPP is a qualitative measure of the difference between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP, MPA and ANC are expressed in units of kg H_2SO_4/t and the NAPP is calculated as follows:

- NAPP = MPA – ANC

If the MPA is less than the ANC, then the NAPP is negative, indicating that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC, then the NAPP is positive, indicating that the material may be acid-generating.

The ANC/MPA ratio provides an indication of the relative margin or factor of safety (or lack thereof) for a given material. Various ANC/MPA values are referenced in the literature for indicating safe values for the prevention of acid generation. Those values typically range from 1.5 to 3. As a general rule, an ANC/MPA ratio of 2 or more signifies that there is a high probability that the material will remain near-neutral in pH and should not be problematic in terms of acidity generation and resultant acidic drainage.

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4.3 Geochemical Classification Criteria

The geochemical criteria used to classify the acid forming nature of the reject samples is outlined within **Table 1**. The geochemical analysis reviews if a sample is Non Acid Forming (**NAF**) or Potentially Acid Forming (**PAF**).

Table 1: Geochemical Classification Criteria

Geochemical Classification	Total Sulfur (%)	NAPP (kg H_2SO_4/t)	ANC/MPA Ratio
NAF - Barren	≤ 0.1	-	-
NAF	> 0.1	≤ - 10	> 2
Uncertain (NAF)	> 0.1	> - 10 and ≤ 0	-
Uncertain (PAF)	> 0.1	> 0 and ≤ 10	< 2
PAF	> 0.1	> 10	< 2

5 METHODOLOGY

5.1 Sampling

A three (3) tonne sample of coal from the Wongawilli Coal Seam was sampled on 23 January 2020 from the proposed working section to approximate the expected ROM coal produced. The sampling location was from Main Gate 9 within the B Heading.

The purpose of this sample was to conduct ROM coal and reject properties analysis and to assess the performance of the material through the small scale laboratory beneficiation plant located at ALS Newcastle facility.

An approximate 50 kilogram sub-sample was sampled from the three (3) tonne sample for the purposes of reject geochemical analysis, as outlined on **Photograph 1**.

Photograph 1: ROM Coal Sample

The coarse reject material from the 50 kilogram sample was further sub-sampled by hand picking out the visually obvious and higher density shale, tuff and sandstone material, as shown on Photograph 2. This resulted in an approximate five (5) kilogram reject sample that was then subdivided into 10 further sub-samples, which were then subjected to geochemical analysis.

The majority (95%) of the reject sample consisted of shale material with sandstone and tuff making up approximately (5%), as indicated as the light coloured material in Photograph 2.

Photograph 3 outlines the separated reject sample from the balance of the ROM coal.

It was observed that approximately 60% of the reject material in the reject sample is -80 mm, so is finer that the reject anticipated during proposed ROM production. Additionally 100% of the sandstone and tuff within the reject sample was less than -80 mm size so inclusion of this material within the reject sample represents a conservative case as in anticipated production mode this material would be of a too fine size to be screened out as reject and will continue to be contained within the ROM coal product.

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Photograph 2: ROM Coal Reject Sample

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Photograph 3: Reject Sample and Balance of ROM Coal Sample

5.2 Geochemical Testing

The reject sample were subjected to Acid-Base Account (**ABA**) geochemical testing. The reject samples where sent ALS Brisbane and were crushed and pulverised and subjected to a series of geochemical tests. The geochemical test program was designed to assess the degree of risk from oxidation of pyrite, acid generation, and leaching of soluble metals and salts.

The static geochemical assessment test program also included characterisation of standard soil parameters including salinity and major metal compositions.

Specifically, each sample was tested for:

- pH and Electrical Conductivity (**EC**) (1:5);
- Total sulphur;
- Acid neutralising capacity (**ANC**); and
- Net acid producing potential (**NAPP**).

The reject samples were further subjected to multi-element testing on solid and soluble fractions. The samples were tested for:

- pH and EC (1:5 solid:water);
- Total sulpur;

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- Alkalinity or acidity (pH dependent) (1:5);
- Total metals (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, N, Ni, Sb, Se, Zn) in solids;
- Total cations (Ca, Mg, Na, K); and
- Soluble metals (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Sb, Se, Zn) in 1:5 (solid:water) extracts for both rock sample and pulverised sample.

For comparison purposes, groundwater quality was also tested within the Wongawilli mine workings at various locations within the mine over a period of several days.

The ALS laboratory reports are contained within **Appendix 1**.

6 GEOCHEMICAL TEST RESULTS

6.1 Acid Base Account Results

The test results for the 10 reject samples are outlined in **Table 2**.

All reject samples are classified as being NAF Barren or NAF. All rejects samples are show to be Non Acid Forming and have a high factor of safety in relation to acid generation.

Table 2: Acid Base Results for Reject Samples

Sample	pH	EC	Sulphur	MPA	ANC	ANC/MPA Ratio	NAPP	Classification
ROM - Composite - 01	8.3	22	0.08	2.448	11.7	2.7	-4.1	NAF Barren
ROM - Composite - 02	8.8	60	0.03	0.918	24.5	9.9	-8.2	NAF Barren
ROM - Composite - 03	9.2	67	0.27	8.262	9.4	1.1	-2.3	NAF
ROM - Composite - 04	8.4	64	0.03	0.918	55.2	8.4	-6.8	NAF Barren
ROM - Composite - 05	8.8	73	0.02	0.612	11.2	14.7	-8.4	NAF Barren
ROM - Composite - 06	8.7	53	0.01	0.306	11.3	22.5	-8.6	NAF Barren
ROM - Composite - 07	9.3	92	0.31	9.488	11.5	1.5	-5.1	NAF
ROM - Composite - 08	8.5	62	0.3	9.18	6.2	1.2	-1.7	NAF
ROM - Composite - 09	7.3	7	0.11	3.366	8.3	1.5	-1.0	NAF
ROM - Composite - 10	9.6	181	0.17	5.202	12.4	20.2	-99.8	NAF
Minimum	7.3	7	0.01	0.306	6.2	1.2	-99.8	
Mean	8.7	68.1	0.133	4.070	16.0	6.4	-14.5	NAF Barren
Maximum	9.6	181	0.310	9.488	55.2	22.5	-1.7	

The Queensland DME Technical Guidelines provide some advice in relation to pH and Electrical Conductivity, and this criterion is outlined on **Table 3**.

Table 3: pH and EC Criteria

	Very Low	Low	Medium	High	Very High
pH	< 4.5	4.5 – 5.5	5.5 – 7.0	7.0 – 9.0	> 9.0
EC	< 150	150 - 450	450 - 900	900 – 2,000	> 2,000

The pH of the reject samples are outlined on **Figure 5**. The pH of the REA reject samples are all alkaline and range from 7.3 to 9.6, which, from **Table 3**, can be considered as high to very high.

The Electrical Conductivity of the reject samples are also outlined on **Figure 5**. The EC of the REA reject samples are low and range from 7 uS/cm to 181 uS/cm, which, from **Table 3**, is within the very low to low salinity range.

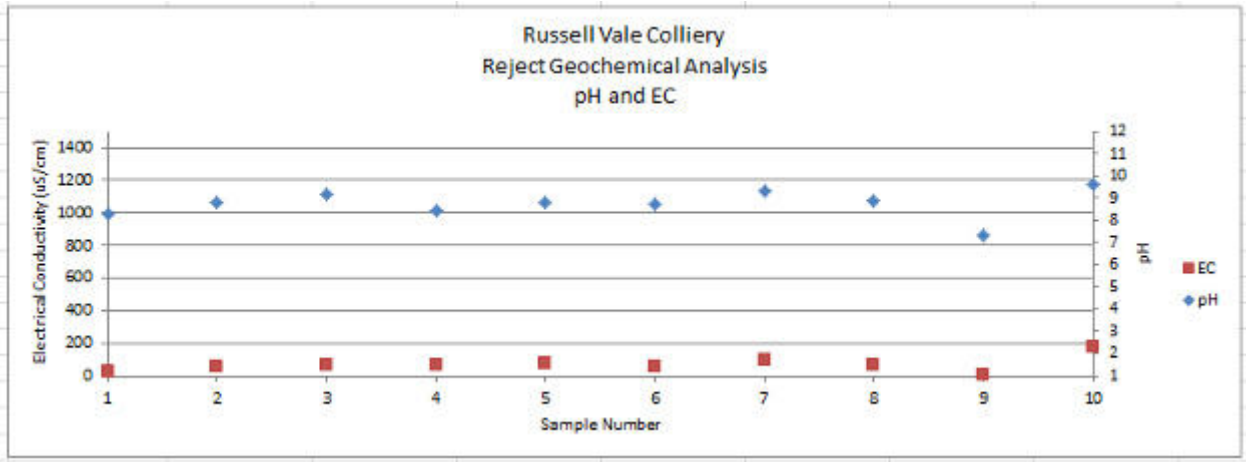

Figure 5: Reject Samples pH and EC

The Total Sulpur of the REA reject samples are outlined on **Figure 6**. The Total Sulpur of the REA reject samples are low and range from 0.01 to 0.31.

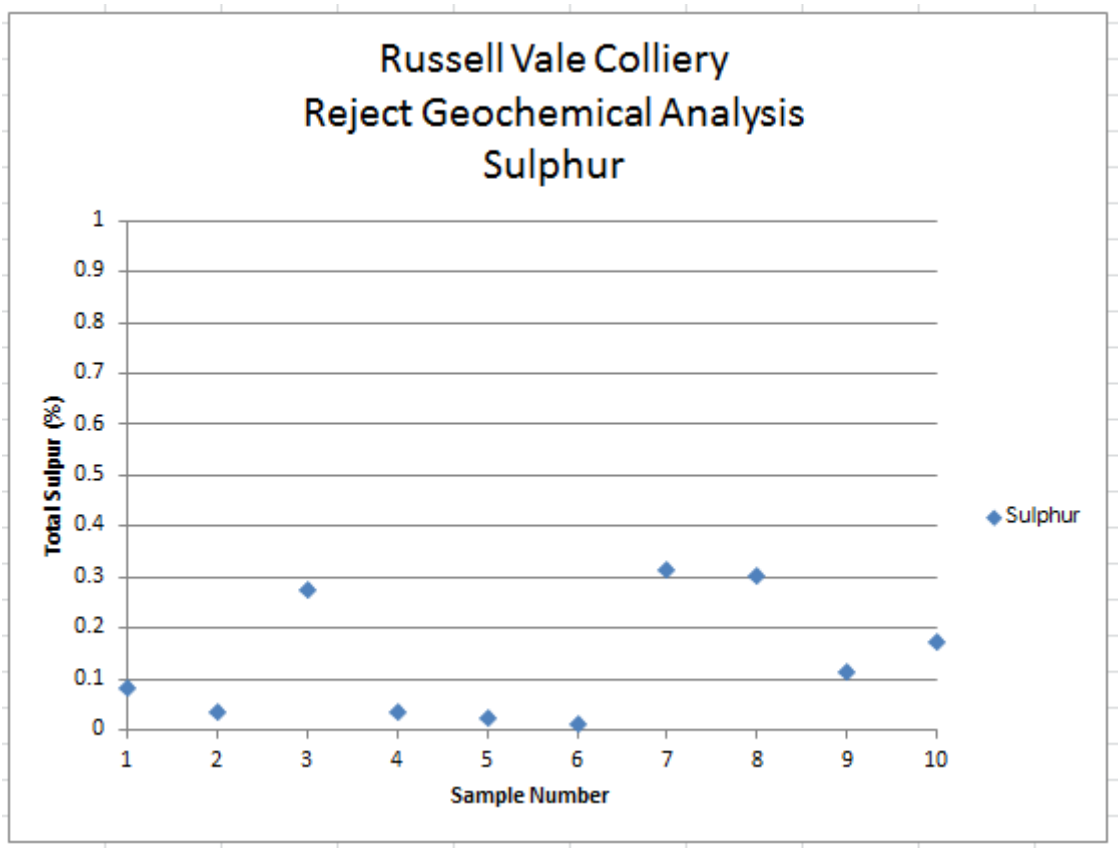

Figure 6: REA Reject Samples Total Sulphur

The MPA of the reject samples are outlined on **Figure 7**. The MPA of the reject samples are low and range from 0.306 kg H_2SO_4/t to 9.486 kg H_2SO_4/t.

The ANC of the REA reject samples are also outlined on **Figure 7**. The ANC of the REA reject samples are moderate and range from 5.2 kg H_2SO_4/t to 105 kg H_2SO_4/t.

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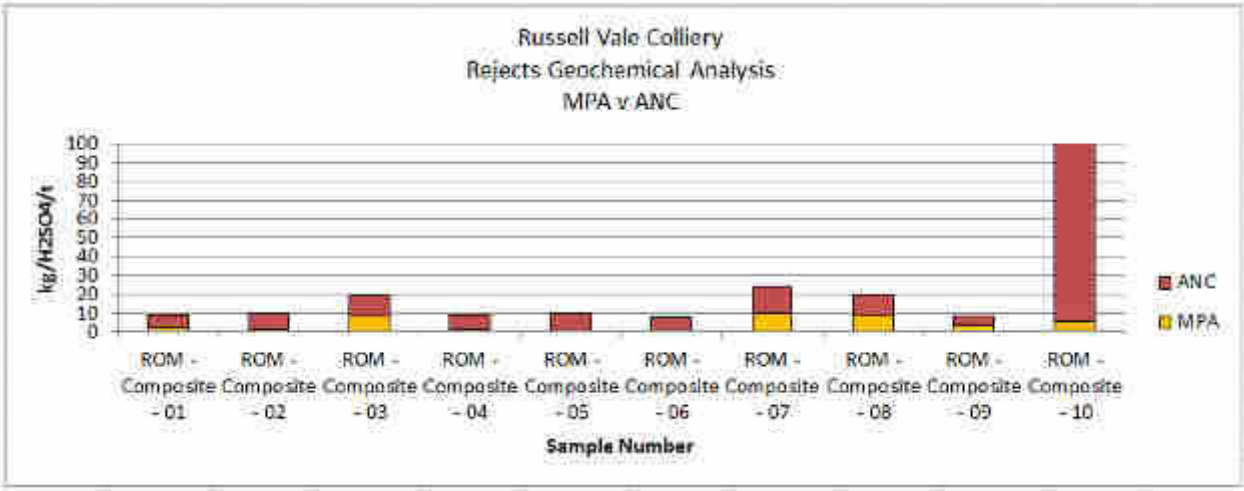

Figure 7: REA Reject Samples MPA and ANC

A plot of ANC versus MPA for the reject samples is shown on **Figure 8**. ANC/MPA ratio lines have been plotted to illustrate the factor of safety associated with the samples. All reject sample ANC/MPA ratio results were greater than 1, showing that there is negligible to low risk of acid generation.

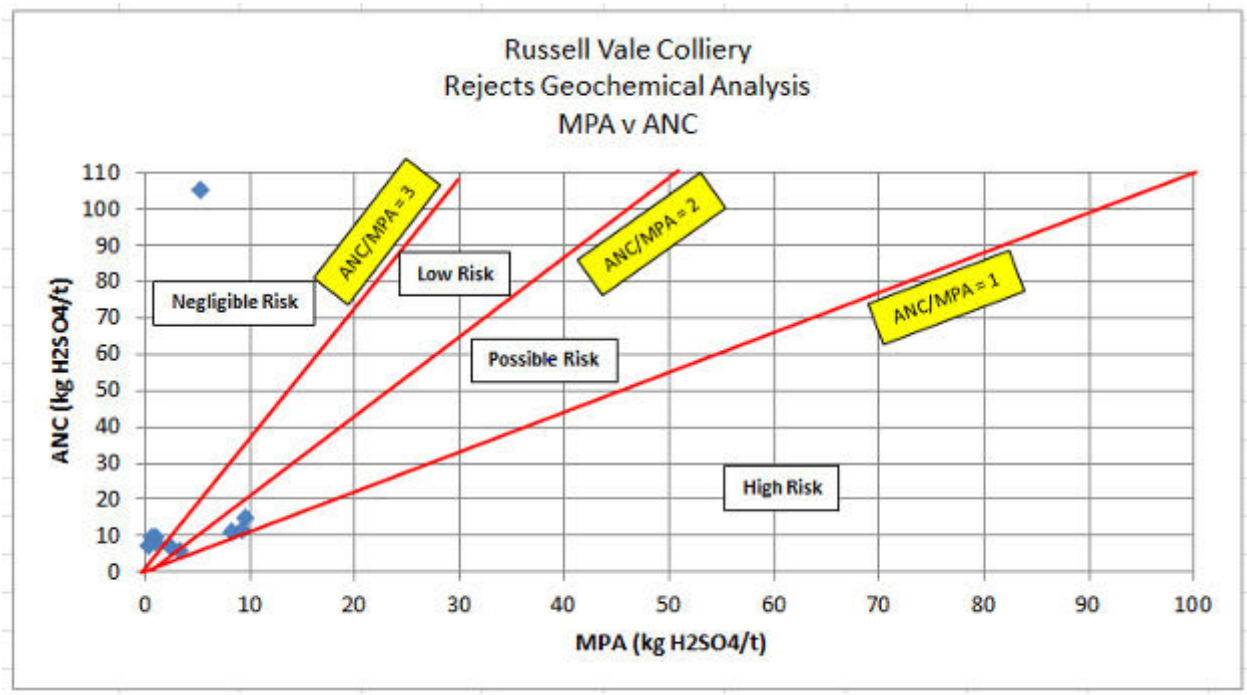

Figure 8: ROM Composite Reject Samples ANC v MPA

6.2 Multi-Element Concentrations in Solids

The analytical geochemical results were compared to the relevant guideline criteria to determine any concerns related to mine operation and final rehabilitation.

The relevant guideline criteria is the NEPC (2013) *Guideline on Investigation Levels for Soil and Groundwater, HIL (C) – recreation open spaces*.

The results from multi-element testing (metals) of the REA reject samples are presented in **Table 5**.

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The results indicates that the total metal concentrations in the reject material are all relatively low and are within the criteria for HIL (C).

6.3 Multi-Element Concentration in Water Extracts

The results from multi-element testing of soluble metals concentrations in water extracts (1:5 solid:water) from the reject samples are presented in **Table 6** for the pulverised samples and **Table 7** for the rock samples. The pulverised sample results within **Table 6** are considered to represent a worst case extreme because as noted within the report the reject material is proposed to be emplaced as a coarse material.

The results are compared to the relevant guideline criteria for both freshwater (ANZECC, 2000 – Trigger Value for Freshwater (95% and 80%), Irrigation and groundwater (NEPC, 2013 – Groundwater Investigation Level – Fresh Water) to determine any water quality concerns related to fresh water and groundwater exposure.

The concentrations of trace metals tested in the water extracts are all very low to low, and predominantly below the analytical detection limit. Some individual samples presented slightly higher results for Aluminium and Arsenic compared to the water quality guidelines for both fresh water and groundwater but the mean for the 10 samples where below these guidelines for Arsenic. The mean result for Aluminium was marginally over the guideline levels but well within the range found within the current groundwater within the Wongawilli mine area.

Overall, the results from multi-element testing of soluble metals concentrations in water extracts indicate that most elements are sparingly soluble and are unlikely to become mobile, are typically below the range of typical water quality conditions expected from within the Wongawilli Coal Seam and are unlikely to impact on surface water or groundwater water quality.

6.4 Groundwater Quality

The groundwater quality results from samples collected within the Wongawilli mine workings are presented within **Table 8**. The results from **Table 8** indicate that the groundwater found within the Wongawilli mine workings generally exceeds the NPEC Groundwater criteria.

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Table 5: Reject Multi-Element Test Results

Parameters	LOR	Unit	NEPC HIL (C)	ROM Composite 01	ROM Composite 02	ROM Composite 03	ROM Composite 04	ROM Composite 05	ROM Composite 06	ROM-Composite 07	ROM Composite 08	ROM Composite 09	ROM Composite 10
Aluminium (Al)	50	mg/kg	-	70	2060	990	3210	2680	2630	660	740	60	550
Antimony (Sb)	5	mg/kg	-	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	5	mg/kg	300	0	0	0	0	0	0	0	0	0	0
Boron (B)	50	mg/kg	20,000	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	1	mg/kg	100	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	10	mg/kg	-	110	690	680	490	550	430	500	490	100	330
Chromium (Cr) total	2	mg/kg	240	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	2	mg/kg	300	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	5	mg/kg	20,000	0	16	7	28	14	14	6	0	0	0
Iron (Fe)	50	mg/kg	-	640	370	5900	260	390	410	6040	4350	750	32200
Lead (Pb)	5	mg/kg	600	0	16	8	31	11	9	9	0	0	8
Magnesium (Mg)	10	mg/kg	-	0	250	590	300	260	250	930	450	0	0
Manganese (Mn)	5	mg/kg	9,000	13	0	183	0	0	0	188	136	12	725
Molybdenum (Mo)	2	mg/kg	-	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	mg/kg	-	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	2	mg/kg	800	0	3	0	3	3	3	0	0	0	0
Potassium (K)	10	mg/kg	-	0	730	240	880	890	830	130	140	0	140
Selenium (Se)	5	mg/kg	700	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	10	mg/kg	-	110	690	680	490	550	430	500	490	100	330
Zinc (Zn)	5	mg/kg	30,000	0	19	36	29	9	8	43	22	0	5

Table 6: Reject Multi-Element in Water Extracts Test Results – Pulverised Sample

Parameters	LOR	Units	ANZEC Freshwater (95%)	ANZEC Freshwater (80%)	ANZEC Irrigation	NEPC Groundwater Freshwater	**Mean**	ROM - Composite - 01	ROM - Composite - 02	ROM - Composite - 03	ROM - Composite - 04	ROM - Composite - 05	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
Aluminium (Al)	0.1	mg/L	**0.055**	**0.15**	**20**	**0.055**	**0.073**	0	0.16	0.19	0	0.17	0.1	0.11	0	0	0
Antimony (Sb)	0.01	mg/L	**-**	**-**	**-**	**-**	**0**	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.01	mg/L	**0.013**	**0.14**	**2**	**0.013**	**0.008**	0	0.03	0	0	0.02	0.02	0	0	0	0.01
Boron (B)	0.1	mg/L	**0.37**	**1.3**	**5**	**0.37**	**0**	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.005	mg/L	**0.0002**	**0.0008**	**0.05**	**0.0002**	**0**	0	0	0	0	0	0	0	0	0	0
Chromium (Cr) total	0.01	mg/L	**0.001**	**0.04**	**1**	**0.001**	**0**	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.01	mg/L	**-**	**-**	**0.1**	**-**	**0**	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.01	mg/L	**0.0014**	**0.0025**	**5**	**0.0014**	**0**	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.05	mg/L	**-**	**-**	**10**	**-**	**0**	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.01	mg/L	**0.0034**	**0.0094**	**5**	**0.0034**	**0**	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	0.01	mg/L	**1.9**	**36**	**10**	**1.9**	**0**	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.01	mg/L	**-**	**-**	**-**	**-**	**0.003**	0	0	0.02	0	0	0	0	0	0	0.01
Nickel (Ni)	0.01	mg/L	**0.011**	**0.017**	**-**	**0.011**	**0**	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	0.01	mg/L	**0.011**	**0.034**	**0.05**	**0.011**	**0**	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	0.01	mg/L	**0.008**	**0.031**	**5**	**0.008**	**0**	0	0	0	0	0	0	0	0	0	0

Table 7: Reject Multi-Element in Water Extracts Test Results – Rock Sample

Parameters	LOR	Units	ANZEC Freshwater (95%)	ANZEC Freshwater (80%)	ANZEC Irrigation	NEPC Groundwater Freshwater	Mean	ROM - Composite - 01	ROM - Composite - 02	ROM - Composite - 03	ROM - Composite - 04	ROM - Composite - 05	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
Aluminium (Al)	0.1	mg/L	0.055	0.15	20	0.055	0.063	0	0.160	0.190	0	0.170	0	0.110	0	0	0
Antimony (Sb)	0.01	mg/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.01	mg/L	0.013	0.14	2	0.013	0.008	0	0.030	0	0	0.020	0.020	0	0	0	0
Boron (B)	0.1	mg/L	0.37	1.3	5	0.37	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.005	mg/L	0.0002	0.0008	0.05	0.0002	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr) total	0.01	mg/L	0.001	0.04	1	0.001	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.01	mg/L	-	-	0.1	-	0	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.01	mg/L	0.0014	0.0025	5	0.0014	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.05	mg/L	-	-	10	-	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.01	mg/L	0.0034	0.0094	5	0.0034	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	0.01	mg/L	1.9	36	10	1.9	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.01	mg/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.01	mg/L	0.011	0.017	-	0.011	0	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	0.01	mg/L	0.011	0.034	0.05	0.011	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	0.01	mg/L	0.008	0.031	5	0.008	0	0	0	0	0	0	0	0	0	0	0

Table 8: Groundwater Quality within Wongawilli Mine Workings

Element	Unit	LOR	NEPC Groundwater - Freshwater	Minimum	Mean	Maximum
Aluminium (Dissolved)	mg/L	0.01	0.055	0.000	0.043	0.120
Aluminium (Total)	mg/L	0.01	0.055	0.000	0.813	6.200
Arsenic (Total)	mg/L	0.001	0.013	0.004	0.022	0.400
Barium (Dissolved)	mg/L	0.001		0.177	0.545	1.120
Barium (Total)	mg/L	0.001		0.216	0.668	1.850
Boron (Dissolved)	mg/L	0.05	0.37	0.060	0.098	0.160
Bromine (Dissolved)	mg/L	0.1		0.000	0.063	0.300
Calcium	mg/L	1		2.00	8.66	49.00
Chloride	mg/L	1		32	86	367
Copper (Dissolved)	mg/L	0.001	0.0014	0.000	0.013	0.088
Copper (Total)	mg/L	0.001	0.0014	0.000	0.032	0.170
Iron (Dissolved)	mg/L	0.05		0.000	0.020	0.210
Iron (Total)	mg/L	0.05		0.000	1.791	32.900
Lead (Dissolved)	mg/L	0.001	0.0034	0.000	0.000	0.004
Lithium (Dissolved)	mg/L	0.001		0.224	0.502	0.959
Magnesium	mg/L	1	1.9	1.00	3.13	9.00
Manganese (Dissolved)	mg/L	0.001		0.000	0.003	0.015
Manganese (Total)	mg/L	0.001		0.000	0.075	0.477
Mercury	mg/L	0.0001		0.000	0.000	0.000
Nickel (Dissolved)	mg/L	0.001	0.011	0.000	0.007	0.036
Strontium (Dissolved)	mg/L	0.001		0.246	0.441	1.130
Strontium (Total)	mg/L	0.001		0.311	0.503	1.270
Zinc (Dissolved)	mg/L	0.005	0.008	0.000	0.039	0.121

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7 BENEFICIAL USE

The NSW has a Resource Recovery Order and Exemption under the *Protection of the Environment Operations (Waste) Regulation 2014* that govern coal washery reject management and beneficial reuse, which is:

- Coal Washery Rejects Order 2014 and Coal Washery Rejects Exemption 2014; and

The Order applies to the supplier of the material and the Exemption applies to the user of the material that intends to apply the material to land.

Copies of the Coal Washery Rejects Order and Exemption are contained within Appendix 2.

7.1 Coal Washery Rejects Order and Exemption

The Coal Washery Rejects Order applies in the circumstances where rejects are proposed to be marketed for sale to an off site user for beneficial use as an engineering material or general fill material. The Order has requirements for sampling and chemical and other testing that needs to be conducted before the material can be used for beneficial use. The chemical and other testing criteria are outlined on Table 9, as is the test results from the reject samples.

The testing regime permits sampling on a continuous process (ie while in production mode) with both characterisation testing, generally from a batch with a composite of 20 samples and routine testing, requiring 5 samples from every 10,000 tonnes or 5 composite samples every 6 months. Alternatively, if there is not a continuous process, the testing regime also can be on a batch basis, with 10 composite samples for every 4,000 tonnes.

Additionally the Order requires that the generator must provide a written statement of compliance certifying that the requirements set out in the Order have been met, plus provide a copy of both the Order and Exemption to the end user.

The Exemption has the effect of exempting the user of the rejects from the provisions of the *POEO Act* for the purposes of using the reject material for application to land in earthworks for civil engineering applications at a premises, provided that the reject material meets the chemical and other requirements of the Order. The Exemption has some restrictions to where the reject material can be applied to land.

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Table 9: Coal Washery Reject Order - Reject Test Results

	Mercury	Cadmium	Lead	Arsenic	Chromium (total)	Copper	Nickel	Selenium	Zinc	EC	pH	Combustible Content	Sulphur
Absolute Maximum Conc.	1	1	100	20	150	100	80	5	200	2 dS/m	7-12	40%	1
ROM - Composite - 01	0	0	0	0	0	0	0	0	0	0.022	8.3	7	0.08
ROM - Composite – 02	0	0	16	0	0	16	3	0	19	0.06	8.8	7.1	0.03
ROM - Composite – 03	0	0	8	0	0	7	0	0	36	0.67	9.2	17.3	0.27
ROM - Composite – 04	0	0	31	0	0	28	3	0	29	0.64	8.4	6.8	0.03
ROM - Composite – 05	0	0	11	0	0	14	3	0	9	0.73	8.8	4.5	0.02
ROM - Composite – 06	0	0	9	0	0	14	3	0	8	0.53	8.7	4.2	0.01
ROM - Composite – 07	0	0	9	0	0	6	0	0	43	0.92	9.3	18.5	0.31
ROM - Composite – 08	0	0	0	0	0	0	0	0	22	0.62	8.9	16.7	0.3
ROM - Composite – 09	0	0	0	0	0	0	0	0	0	0.007	7.3	8.8	0.11
ROM - Composite - 10	0	0	8	0	0	0	0	0	5	0.181	9.6	11.7	0.17
Characterisation Max. Average Conc.	0.5	0.5	50	10	75	50	40	2	100	1 dS/m	8 - 11	30%	0.5
Routine Maximum Average Conc.	NR	NR	50	NR	75	50	40	NR	100	1 dS/m	NR	30%	0.5
Average	0	0	13.1	0	0	14.2	3	0	21.4	0.068	8.7	10.26	0.13

The reject material sample results indicate that the reject samples meet the chemical criteria of the Order.

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8 DISCUSSION

8.1 Acid Base Account

The results of the ABA tests, indicate that all REA reject samples tested are likely to be NAF and have a high factor of safety with respect to potential acid generation.

All reject samples have negligible total sulphur content and a moderate ANC.

In general, the reject samples can be regarded as a NAF Barren or NAF and contain excess ANC.

8.2 Multi-Element Composition

The results indicate that metal concentrations in reject material samples are unlikely to present any environmental concern.

8.3 Water Quality

Water extract results indicate that initial surface run-off and seepage from reject material is likely to be pH neutral to slightly alkaline.

Run-off and seepage from reject material is likely to have low salinity (EC) values. The risk of saline run-off and seepage from reject material significantly impacting the quality of surface and groundwater is expected to be low.

The results from multi-element testing of soluble metals concentrations indicate that the reject emplaced underground is unlikely to impact on surface water or groundwater water quality. The water quality from the emplaced reject material is shown to be well within the existing range of the current groundwater quality at the Wongawilli mine workings.

The underground emplacement of reject is not expected to cause impacts on groundwater quality and would meet the requirements for a neutral or beneficial effect on water quality.

8.4 Beneficial Reuse

The results of the chemical testing indicate that the reject material is capable of meeting the Coal Washery Rejects Order 2014 and will be suitable for beneficial use as an engineering material or general fill material.

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9 CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The reject material produced from the proposed mining of the Wongawilli Coal Seam at Russell Vale Colliery is expected to total up to 200,000 tonnes per annum and is proposed to be either emplaced underground in disused workings or marketed for beneficial use.

The reject material is has negligible total sulphur and can be regarded as a NAF Barren or NAF. The reject material has excess ANC and a high factor of safety with respect to potential acid generation.

The metal concentrations in the reject material is unlikely to present any environmental issues from heavy metals and generation of saline run-off. The reject material impact on the quality of surface water and groundwater is expected to be low.

The underground emplacement of reject material would meet the requirements for a neutral or beneficial effect on water quality.

The reject material is capable of meeting the EPA standards for beneficial use.

9.2 Recommendations

It is recommended that once the mine moves into production mode, reject material be further tested for Acid Base Account parameters on a 6 monthly basis.

It is also recommended that once production commences the rejects generated be tested in accordance with the EPA's Coal Washery Reject Order 2014 in order to be able to market the reject material for beneficial reuse applications.

10 REFERENCES

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ANZECC (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT (2000).

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DME 1995, *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques*. Queensland Department of Minerals and Energy

Hazelton, P.A. and Murphy, B.W (Eds). (2016). *Interpreting Soil Test Results: What do all the numbers mean?* [3rd edn.] CSIRO Publishing, Collingwood, Victoria.

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NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM). *Guideline on investigation levels for soil and groundwater.*

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APPENDIX 1

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CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd, Smithfield NSW 2164 Ph:02 8784 8555 E:samples.sydney@alsenviro.com
Newcastle: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4958 7070 E:samples.newcastle@alsenviro.com
Brisbane: 32 Shand St, Stafford Q 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
Townsville: 14-15 Desma Ct, Bohle Q 4818 Ph:07 4796 0600 E:townsville.environmental@alsenviro.com
Melbourne: 2-4 Westall Rd, Springvale Ph:03 8549 9600 E:samples.melbourne@alsenviro.com
Adelaide: 2-4 Burma Rd, Pooraka SA Ph:08 8359 0890 E:samples.adelaide@alsenviro.com

Environmental Division Brisbane
Work Order Reference
EB2002551

Telephone : + 61-7-3243 7222

14/2

CLIENT:	Wollongong Coal	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☐ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE:	RUSSELL VALE		
PROJECT:		ALS QUOTE NO.: EN/222	COC SEQUENCE NO: COC: 1 2 3 SOF: 1 2 3
ORDER NUMBER:			
PROJECT MANAGER: Sasa Cugalj		CONTACT PH: 0449 675 084	
SAMPLER:		SAMPLER MOBILE:	
COC emailed to ALS? (YES / NO)	NO	EDD FORMAT (or default):	
Email Reports to : rvcmonitoring@wcl.net.au			
Email Invoice to : rvcmonitoring@wcl.net.au, wclap@wcl.net.au			

RELINQUISHED BY: Vishal
DATE/TIME: 29/01/2020 1700

RECEIVED BY:
DATE/TIME:

(Circle)

RECEIVED BY: J. Ulrich
DATE/TIME: 10:00 30/1/20

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	pH & EC (1:5)	Total sulfur	ANC, NAPP	Alkalinity (1:5)	Total metals: Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Sb, Se, Zn	Total cations: Ca, Mg, Na, K (+ exchangable)	Soluble metals: Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Sb, Se, Zn	Soluble cations: Ca, Mg, Na, K Soluble Anions: Cl, SO4	Cation exchange capacity (+ CEC)	Exchangeable sodium potential (ESP)	Combustible content, Mercury	Additional Information
1	ROM Composite - 01	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	Can we get the following tests in both units mg/kg and mg/L: Soluble Sulfate, Chloride, Soluble Major Cations: Total Major Cations, Soluble Metals, Total Metals and Mercury
2	ROM Composite - 02	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
3	ROM Composite - 03	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
4	ROM Composite - 04	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
5	ROM Composite - 05	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
6	ROM Composite - 06	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
7	ROM Composite - 07	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
8	ROM Composite - 08	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
9	ROM Composite - 09	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
10	ROM Composite - 10	28/01/2020	S	B	1	√	√	√	√	√	√	√	√	√	√	√	
				TOTAL	10												

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2002551**	Page	: 1 of 9
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS Russell Vale	Contact	: Customer Services EB
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 4223 6800	Telephone	: +61-7-3243 7222
Project	: ----	Date Samples Received	: 30-Jan-2020 10:00
Order number	: ----	Date Analysis Commenced	: 03-Feb-2020
C-O-C number	: ----	Issue Date	: 13-Feb-2020 17:21
Sampler	: Sasa Cugalj		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

ilac-MRA NATA Accreditation No. 825 Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- NATA accreditation does not apply for reporting of 1:5 soil results in mg/L. 1:5 results represented as mg/L represent concentration in solution, are approximate and assume that 1kg of sample has a volume of 1L.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Calcium/Magnesium Ratio for some samples as the required results for Calcium/Magnesium are below LOR.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio for some samples as the required results for Magnesium/Potassium are below LOR.
- ED007 (Exchangeable Cations by ICP-AES): Unable to calculate Magnesium/Potassium Ratio for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED007 (Exchangeable Cations by ICP-AES): Unable to calculate Calcium/Magnesium Ratio for some samples result as required Calcium & Magnesium results are less than the limit of reporting.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 01	ROM - Composite - 02	ROM - Composite - 03	ROM - Composite - 04	ROM - Composite - 05
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-001	EB2002551-002	EB2002551-003	EB2002551-004	EB2002551-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.3	8.8	9.2	8.4	8.8
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.0	-8.2	-2.3	-6.8	-8.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	22	60	67	64	73
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.5	9.1	10.6	7.7	9.0
ANC as CaCO3	----	0.1	% CaCO3	0.7	0.9	1.1	0.8	0.9
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
EA101: Loss on Ignition								
Loss on Ignition @ 550°C	----	0.1	%	7.0	7.1	17.3	6.8	4.5
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	<0.2	0.8	0.3	2.0	1.8
ø Exchangeable Magnesium	----	0.2	meq/100g	<0.2	0.6	<0.2	0.4	0.5
ø Exchangeable Potassium	----	0.2	meq/100g	<0.2	0.3	<0.2	0.3	0.3
ø Exchangeable Sodium	----	0.2	meq/100g	<0.2	2.6	3.2	1.7	2.0
ø Cation Exchange Capacity	----	0.2	meq/100g	<0.2	4.3	3.5	4.4	4.6
ø Exchangeable Sodium Percent	----	0.2	%	----	61.6	91.9	37.8	43.4
ø Calcium/Magnesium Ratio	----	0.2	-	----	1.3	----	4.6	3.8
ø Magnesium/Potassium Ratio	----	0.2	-	----	1.8	----	1.3	1.6
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	1	12	4	9	15
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	60	20	40	70
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.08	0.03	0.27	0.03	0.02
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	<10
Chloride	16887-00-6	1	mg/L	<1	<1	<1	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	7	16	22	16	20

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 01	ROM - Composite - 02	ROM - Composite - 03	ROM - Composite - 04	ROM - Composite - 05
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-001	EB2002551-002	EB2002551-003	EB2002551-004	EB2002551-005
				Result	Result	Result	Result	Result
ED093F: Dissolved Major Cations - Continued								
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	<10	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**30**	**80**	**110**	**80**	**100**
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	<10
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	**100**	**240**	**890**	**660**	**560**
Magnesium	7439-95-4	50	mg/kg	<50	**250**	**590**	**300**	**260**
Sodium	7440-23-5	50	mg/kg	**110**	**690**	**680**	**490**	**550**
Potassium	7440-09-7	50	mg/kg	<50	**730**	**240**	**880**	**890**
EG005(ED093)F: Dissolved Metals by ICP-AES								
Aluminium	7429-90-5	0.10	mg/L	<0.10	**0.16**	**0.19**	<0.10	**0.17**
Antimony	7440-36-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.01	mg/L	<0.01	**0.03**	<0.01	<0.01	**0.02**
Boron	7440-42-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/L	<0.01	<0.01	**0.02**	<0.01	<0.01
Nickel	7440-02-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG005(ED093)S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	**0.2**	<0.1	<0.1	**0.1**
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 01	ROM - Composite - 02	ROM - Composite - 03	ROM - Composite - 04	ROM - Composite - 05
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-001	EB2002551-002	EB2002551-003	EB2002551-004	EB2002551-005
				Result	Result	Result	Result	Result
EG005(ED093)S : Soluble Metals by ICPAES - Continued								
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**70**	**2060**	**990**	**3210**	**2680**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	<2	<2	<2	<2	<2
Iron	7439-89-6	50	mg/kg	**640**	**370**	**5900**	**260**	**390**
Manganese	7439-96-5	5	mg/kg	**13**	<5	**183**	<5	<5
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg	<5	**16**	**7**	**28**	**14**
Lead	7439-92-1	5	mg/kg	<5	**16**	**8**	**31**	**11**
Nickel	7440-02-0	2	mg/kg	<2	**3**	<2	**3**	**3**
Zinc	7440-66-6	5	mg/kg	<5	**19**	**36**	**29**	**9**
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	**0.1**	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-006	EB2002551-007	EB2002551-008	EB2002551-009	EB2002551-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	9.3	8.9	7.3	9.6
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-6.6	-5.1	-1.7	-1.8	-99.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	53	92	62	7	181
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.9	14.6	10.9	5.2	105
ANC as CaCO3	----	0.1	% CaCO3	0.7	1.5	1.1	0.5	10.7
Fizz Rating	----	0	Fizz Unit	1	1	1	1	2
EA101: Loss on Ignition								
Loss on Ignition @ 550°C	----	0.1	%	4.2	18.5	16.7	8.8	11.7
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	2.5	0.4	0.3	----	1.4
ø Exchangeable Magnesium	----	0.2	meq/100g	0.6	<0.2	<0.2	----	0.9
ø Exchangeable Potassium	----	0.2	meq/100g	0.3	<0.2	<0.2	----	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	1.6	1.6	2.0	----	1.2
ø Cation Exchange Capacity	----	0.2	meq/100g	5.0	2.0	2.3	----	3.6
ø Exchangeable Sodium Percent	----	0.2	%	31.2	80.8	87.4	----	32.7
ø Calcium/Magnesium Ratio	----	0.2	-	4.0	----	----	----	1.5
ø Magnesium/Potassium Ratio	----	0.2	-	1.8	----	----	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	<0.1	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	<0.1	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	<0.1	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	0.1	----
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	0.2	----
Exchangeable Sodium Percent	----	0.1	%	----	----	----	63.4	----
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	11	5	8	<1	5
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	60	30	40	<10	20
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.31	0.30	0.11	0.17

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-006	EB2002551-007	EB2002551-008	EB2002551-009	EB2002551-010
				Result	Result	Result	Result	Result
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	<10
Chloride	16887-00-6	1	mg/L	<1	<1	<1	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	<1	<1	**4**
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	**2**
Sodium	7440-23-5	1	mg/L	**14**	**30**	**21**	**3**	**39**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	**1**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	<10	**20**
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**70**	**150**	**100**	**10**	**200**
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	<10
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	**600**	**1620**	**620**	<50	**23100**
Magnesium	7439-95-4	50	mg/kg	**250**	**930**	**450**	<50	**10500**
Sodium	7440-23-5	50	mg/kg	**430**	**500**	**490**	**100**	**330**
Potassium	7440-09-7	50	mg/kg	**830**	**130**	**140**	<50	**140**
EG005(ED093)F: Dissolved Metals by ICP-AES								
Aluminium	7429-90-5	0.10	mg/L	**0.10**	**0.11**	<0.10	<0.10	<0.10
Antimony	7440-36-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.01	mg/L	**0.02**	<0.01	<0.01	<0.01	**0.01**
Boron	7440-42-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.01**
Nickel	7440-02-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG005(ED093)S : Soluble Metals by ICPAES								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-006	EB2002551-007	EB2002551-008	EB2002551-009	EB2002551-010
				Result	Result	Result	Result	Result
EG005(ED093)S : Soluble Metals by ICPAES - Continued								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**2630**	**660**	**740**	**60**	**550**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	<2	<2	<2	<2	<2
Iron	7439-89-6	50	mg/kg	**410**	**6040**	**4350**	**750**	**32200**
Manganese	7439-96-5	5	mg/kg	<5	**188**	**136**	**12**	**725**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg	**14**	**6**	<5	<5	<5
Lead	7439-92-1	5	mg/kg	**9**	**9**	<5	<5	**8**
Nickel	7440-02-0	2	mg/kg	**3**	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	**8**	**43**	**22**	<5	**5**
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2002551-006	EB2002551-007	EB2002551-008	EB2002551-009	EB2002551-010
				Result	Result	Result	Result	Result
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB2002551**	Page	: 1 of 9
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS Russell Vale	Contact	: Customer Services EB
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 4223 6800	Telephone	: +61-7-3243 7222
Project	: ----	Date Samples Received	: 30-Jan-2020
Order number	: ----	Date Analysis Commenced	: 03-Feb-2020
C-O-C number	: ----	Issue Date	: 13-Feb-2020
Sampler	: Sasa Cugalj		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005(ED093)S : Soluble Metals by ICPAES (QC Lot: 2840017)									
EB2002551-010	ROM - Composite - 10	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit
EB2002551-001	ROM - Composite - 01	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG005(ED093)S : Soluble Metals by ICPAES (QC Lot: 2840017) - continued									
EB2002551-001	ROM - Composite - 01	EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 2840022)									
EB2002552-001	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Molybdenum	7439-98-7	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	14	13	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	19	18	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	307	294	4.41	0% - 20%
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	19	19	0.00	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	2370	2190	7.91	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	14600	14000	4.69	0% - 20%
EB2002551-001	ROM - Composite - 01	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Molybdenum	7439-98-7	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	13	14	7.82	No Limit
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	70	70	0.00	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	640	640	0.00	0% - 50%
EA002: pH 1:5 (Soils) (QC Lot: 2840014)									
EB2002551-010	ROM - Composite - 10	EA002: pH Value	----	0.1	pH Unit	9.6	9.6	0.00	0% - 20%
EB2002551-001	ROM - Composite - 01	EA002: pH Value	----	0.1	pH Unit	8.3	8.5	2.14	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2840013)									

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EA010: Conductivity (1:5) (QC Lot: 2840013) - continued									
EB2002551-010	ROM - Composite - 10	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	181	176	3.03	0% - 20%
EB2002551-001	ROM - Composite - 01	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	22	21	0.00	0% - 20%
EA013: Acid Neutralising Capacity (QC Lot: 2853018)									
EB2002551-001	ROM - Composite - 01	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.5	7.7	16.1	0% - 50%
EB2002552-001	Anonymous	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	27.3	26.9	1.42	0% - 20%
EA101: Loss on Ignition (QC Lot: 2852919)									
EB2002551-001	ROM - Composite - 01	EA101: Loss on Ignition @ 550°C	----	0.1	%	7.0	6.2	12.3	0% - 20%
EB2002551-010	ROM - Composite - 10	EA101: Loss on Ignition @ 550°C	----	0.1	%	11.7	12.1	3.10	0% - 20%
ED006: Exchangeable Cations on Alkaline Soils (QC Lot: 2846167)									
EB2002551-001	ROM - Composite - 01	ED006: Exchangeable Calcium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Magnesium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Sodium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Cation Exchange Capacity	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
EB2002552-002	Anonymous	ED006: Exchangeable Calcium	----	0.2	meq/100g	0.6	0.9	44.8	No Limit
		ED006: Exchangeable Magnesium	----	0.2	meq/100g	<0.2	0.5	82.0	No Limit
		ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Sodium	----	0.2	meq/100g	3.3	3.4	0.00	0% - 50%
		ED006: Cation Exchange Capacity	----	0.2	meq/100g	3.9	4.7	19.7	0% - 20%
ED007: Exchangeable Cations (QC Lot: 2846173)									
EB2002551-009	ROM - Composite - 09	ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
		ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.1	0.1	0.00	No Limit
ED040S: Soluble Major Anions (QC Lot: 2840016)									
EB2002551-010	ROM - Composite - 10	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	20	0.00	No Limit
EB2002551-001	ROM - Composite - 01	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	0.00	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 2855285)									
EB2002551-001	ROM - Composite - 01	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.08	0.09	13.0	No Limit
EB2002552-001	Anonymous	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.08	0.08	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 2840018)									
EB2002551-010	ROM - Composite - 10	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.00	No Limit
EB2002551-001	ROM - Composite - 01	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.00	No Limit
ED093S: Soluble Major Cations (QC Lot: 2840015)									
EB2002551-010	ROM - Composite - 10	ED093S: Calcium	7440-70-2	10	mg/kg	20	20	0.00	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.00	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	200	190	0.00	0% - 50%

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093S: Soluble Major Cations (QC Lot: 2840015) - continued									
EB2002551-010	ROM - Composite - 10	ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.00	No Limit
EB2002551-001	ROM - Composite - 01	ED093S: Calcium	7440-70-2	10	mg/kg	<10	<10	0.00	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.00	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	30	30	0.00	No Limit
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.00	No Limit
ED093T: Total Major Cations (QC Lot: 2840021)									
EB2002551-009	ROM - Composite - 09	ED093T: Sodium	7440-23-5	50	mg/kg	100	100	0.00	No Limit
		ED093T: Potassium	7440-09-7	50	mg/kg	<50	<50	0.00	No Limit
		ED093T: Calcium	7440-70-2	50	mg/kg	<50	<50	0.00	No Limit
		ED093T: Magnesium	7439-95-4	50	mg/kg	<50	<50	0.00	No Limit
EB2002551-001	ROM - Composite - 01	ED093T: Sodium	7440-23-5	50	mg/kg	110	120	0.00	No Limit
		ED093T: Potassium	7440-09-7	50	mg/kg	<50	<50	0.00	No Limit
		ED093T: Calcium	7440-70-2	50	mg/kg	100	110	11.5	No Limit
		ED093T: Magnesium	7439-95-4	50	mg/kg	<50	<50	0.00	No Limit
EG035S: Soluble Mercury by FIMS (QC Lot: 2840019)									
EB2002551-001	ROM - Composite - 01	EG035S: Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2840023)									
EB2002552-001	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EB2002551-001	ROM - Composite - 01	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)S : Soluble Metals by ICPAES (QCLot: 2840017)								
EG005S: Aluminium	7429-90-5	1	mg/kg	<1	2.5 mg/kg	100	78.0	112
EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	0.5 mg/kg	104	70.0	130
EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	0.5 mg/kg	108	83.0	111
EG005S: Boron	7440-42-8	1	mg/kg	<1	2.5 mg/kg	103	70.0	130
EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	0.5 mg/kg	101	87.0	112
EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	0.5 mg/kg	102	91.0	110
EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	0.5 mg/kg	99.6	70.0	130
EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	0.5 mg/kg	104	84.0	111
EG005S: Iron	7439-89-6	1	mg/kg	<1	2.5 mg/kg	101	70.0	130
EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	0.5 mg/kg	96.3	90.0	112
EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	0.5 mg/kg	94.6	70.0	130
EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	0.5 mg/kg	103	70.0	130
EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	0.5 mg/kg	102	82.0	112
EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	0.5 mg/kg	94.9	70.0	130
EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	0.5 mg/kg	103	94.0	110
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 2840022)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	13267 mg/kg	102	70.0	130
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	98 mg/kg	104	84.0	123
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
EG005T: Chromium	7440-47-3	2	mg/kg	<2	15.4 mg/kg	102	83.0	125
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	9.8 mg/kg	93.7	82.0	118
EG005T: Copper	7440-50-8	5	mg/kg	<5	48 mg/kg	98.8	86.0	122
EG005T: Iron	7439-89-6	50	mg/kg	<50	27922 mg/kg	104	70.0	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	50 mg/kg	102	84.0	119
EG005T: Manganese	7439-96-5	5	mg/kg	<5	482 mg/kg	98.6	84.0	113
EG005T: Molybdenum	7439-98-7	2	mg/kg	<2	----	----	----	----
EG005T: Nickel	7440-02-0	2	mg/kg	<2	12.4 mg/kg	104	81.5	118
EG005T: Selenium	7782-49-2	5	mg/kg	<5	----	----	----	----
EG005T: Zinc	7440-66-6	5	mg/kg	<5	115 mg/kg	95.2	80.0	120
EA002: pH 1:5 (Soils) (QCLot: 2840014)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	100	98.0	102

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EA010: Conductivity (1:5) (QCLot: 2840013)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	101	97.0	103
EA013: Acid Neutralising Capacity (QCLot: 2853018)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	9.9 kg H2SO4 equiv./t	107	82.0	120
ED006: Exchangeable Cations on Alkaline Soils (QCLot: 2846167)								
ED006: Exchangeable Calcium	----	0.2	meq/100g	<0.2	8.19 meq/100g	108	70.0	130
ED006: Exchangeable Magnesium	----	0.2	meq/100g	<0.2	6.1 meq/100g	96.4	70.0	130
ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	1.44 meq/100g	85.7	70.0	130
ED006: Exchangeable Sodium	----	0.2	meq/100g	<0.2	2.28 meq/100g	97.1	70.0	130
ED006: Cation Exchange Capacity	----	0.2	meq/100g	<0.2	18 meq/100g	101	70.0	130
ED007: Exchangeable Cations (QCLot: 2846173)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	18.1 meq/100g	94.5	79.0	113
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	9.08 meq/100g	93.2	85.0	115
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.918 meq/100g	93.6	70.0	122
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	3.15 meq/100g	101	76.0	112
ED007: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	31.3 meq/100g	94.6	82.0	112
ED040S: Soluble Major Anions (QCLot: 2840016)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	750 mg/kg	99.3	90.0	114
ED042T: Total Sulfur by LECO (QCLot: 2855285)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.16 %	99.8	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 2840018)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	50 mg/kg	99.4	83.0	119
				<10	5000 mg/kg	98.6	83.0	119
ED093S: Soluble Major Cations (QCLot: 2840015)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	250 mg/kg	101	80.0	120
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	250 mg/kg	102	80.0	120
ED093S: Sodium	7440-23-5	10	mg/kg	<10	250 mg/kg	103	80.0	120
ED093S: Potassium	7440-09-7	10	mg/kg	<10	250 mg/kg	98.9	80.0	120
ED093T: Total Major Cations (QCLot: 2840021)								
ED093T: Sodium	7440-23-5	50	mg/kg	<50	----	----	----	----
ED093T: Potassium	7440-09-7	50	mg/kg	<50	----	----	----	----
ED093T: Calcium	7440-70-2	50	mg/kg	<50	----	----	----	----
ED093T: Magnesium	7439-95-4	50	mg/kg	<50	----	----	----	----
EG035S: Soluble Mercury by FIMS (QCLot: 2840019)								
EG035S: Mercury	7439-97-6	0.0005	mg/kg	<0.0005	0.05 mg/kg	100	83.0	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2840023)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.0847 mg/kg	95.9	70.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EG005(ED093)F: Dissolved Metals by ICP-AES (QCLot: 2839294)								
EG005F: Aluminium	7429-90-5	0.1	mg/L	<0.10	0.5 mg/L	100	77.0	109
EG005F: Antimony	7440-36-0	0.01	mg/L	<0.01	0.1 mg/L	104	70.0	130
EG005F: Arsenic	7440-38-2	0.01	mg/L	<0.01	0.1 mg/L	108	88.0	110
EG005F: Boron	7440-42-8	0.1	mg/L	<0.1	0.5 mg/L	103	70.0	130
EG005F: Cadmium	7440-43-9	0.005	mg/L	<0.005	0.1 mg/L	101	94.0	111
EG005F: Chromium	7440-47-3	0.01	mg/L	<0.01	0.1 mg/L	102	95.0	109
EG005F: Cobalt	7440-48-4	0.01	mg/L	<0.01	0.1 mg/L	99.6	70.0	130
EG005F: Copper	7440-50-8	0.01	mg/L	<0.01	0.1 mg/L	104	94.0	107
EG005F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	70.0	130
EG005F: Lead	7439-92-1	0.01	mg/L	<0.01	0.1 mg/L	96.3	93.0	110
EG005F: Manganese	7439-96-5	0.01	mg/L	<0.01	0.1 mg/L	94.6	70.0	130
EG005F: Molybdenum	7439-98-7	0.01	mg/L	<0.01	0.1 mg/L	103	70.0	130
EG005F: Nickel	7440-02-0	0.01	mg/L	<0.01	0.1 mg/L	102	92.0	112
EG005F: Selenium	7782-49-2	----	mg/L	----	0.1 mg/L	94.9	70.0	130
EG005F: Zinc	7440-66-6	0.01	mg/L	<0.01	0.1 mg/L	103	79.5	120
ED040F: Dissolved Major Anions (QCLot: 2852277)								
ED040F: Sulfate as SO4 2-	14808-79-8	1	mg/L	<1	150 mg/L	99.3	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 2852276)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	99.4	90.0	115
				<1	1000 mg/L	98.6	90.0	115
ED093F: Dissolved Major Cations (QCLot: 2839293)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	101	70.0	130
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	102	70.0	130
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	103	70.0	130
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.9	70.0	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 2840022)							
EB2002551-002	ROM - Composite - 02	EG005T: Arsenic	7440-38-2	100 mg/kg	90.5	70.0	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	94.7	70.0	130
		EG005T: Chromium	7440-47-3	100 mg/kg	94.3	70.0	130
		EG005T: Cobalt	7440-48-4	100 mg/kg	94.9	70.0	130

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 2840022) - continued							
EB2002551-002	ROM - Composite - 02	EG005T: Copper	7440-50-8	100 mg/kg	92.1	70.0	130
		EG005T: Lead	7439-92-1	100 mg/kg	91.9	70.0	130
		EG005T: Manganese	7439-96-5	100 mg/kg	95.3	70.0	130
		EG005T: Nickel	7440-02-0	100 mg/kg	93.4	70.0	130
		EG005T: Zinc	7440-66-6	100 mg/kg	93.0	70.0	130
EG035S: Soluble Mercury by FIMS (QCLot: 2840019)							
EB2002551-002	ROM - Composite - 02	EG035S: Mercury	7439-97-6	0.05 mg/kg	93.9	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2840023)							
EB2002551-002	ROM - Composite - 02	EG035T: Mercury	7439-97-6	0.5 mg/kg	76.0	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2002551**	Page	: 1 of 11
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS Russell Vale	Telephone	: +61-7-3243 7222
Project	: ----	Date Samples Received	: 30-Jan-2020
Site	: ----	Issue Date	: 13-Feb-2020
Sampler	: Sasa Cugalj	No. of samples received	: 10
Order number	: ----	No. of samples analysed	: 10

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Days overdue	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Days overdue
EA002: pH 1:5 (Soils)						
Snap Lock Bag						
ROM - Composite - 01, ROM - Composite - 02, ROM - Composite - 03, ROM - Composite - 04, ROM - Composite - 05, ROM - Composite - 06, ROM - Composite - 07, ROM - Composite - 08, ROM - Composite - 09, ROM - Composite - 10	06-Feb-2020	04-Feb-2020	**2**	----	----	----
EA010: Conductivity (1:5)						
Snap Lock Bag						
ROM - Composite - 01, ROM - Composite - 02, ROM - Composite - 03, ROM - Composite - 04, ROM - Composite - 05, ROM - Composite - 06, ROM - Composite - 07, ROM - Composite - 08, ROM - Composite - 09, ROM - Composite - 10	06-Feb-2020	04-Feb-2020	**2**	----	----	----

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Days overdue	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Days overdue
ED093F: Dissolved Major Cations						
Clear Plastic Bottle - Natural						
ROM - Composite - 01, ROM - Composite - 02, ROM - Composite - 03, ROM - Composite - 04, ROM - Composite - 05, ROM - Composite - 06, ROM - Composite - 07, ROM - Composite - 08, ROM - Composite - 09, ROM - Composite - 10	----	----	----	13-Feb-2020	04-Feb-2020	**9**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
Chloride by Discrete Analyser	0	20	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-AES	0	20	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	0	20	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	0	20	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Chloride by Discrete Analyser	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-AES	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002: pH 1:5 (Soils)								
Snap Lock Bag (EA002)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	04-Feb-2020	×	**06-Feb-2020**	06-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EA010: Conductivity (1:5)								
Snap Lock Bag (EA010)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	04-Feb-2020	×	**06-Feb-2020**	05-Mar-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EA013: Acid Neutralising Capacity								
Pulp Bag (EA013)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**12-Feb-2020**	27-Jan-2021	✓	**12-Feb-2020**	10-Aug-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EA101: Loss on Ignition								
Snap Lock Bag (EA101)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**----**	----	----	**11-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED005: Exchange Acidity								
Snap Lock Bag (ED005)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**07-Feb-2020**	25-Feb-2020	✓	**11-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED006: Exchangeable Cations on Alkaline Soils								
Snap Lock Bag (ED006)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**07-Feb-2020**	25-Feb-2020	✓	**11-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED007: Exchangeable Cations								
Snap Lock Bag (ED007)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**07-Feb-2020**	25-Feb-2020	✓	**11-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED008: Exchangeable Cations								
Snap Lock Bag (ED008)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**07-Feb-2020**	25-Feb-2020	✓	**11-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED040S : Soluble Sulfate by ICPAES								
Snap Lock Bag (ED040S)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	25-Feb-2020	✓	**06-Feb-2020**	05-Mar-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED042T: Total Sulfur by LECO								
Pulp Bag (ED042T)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**12-Feb-2020**	25-Feb-2020	✓	**12-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser								
Snap Lock Bag (ED045G)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	25-Feb-2020	✓	**06-Feb-2020**	05-Mar-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED093S: Soluble Major Cations								
Snap Lock Bag (ED093S)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	26-Jul-2020	✓	**06-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED093T: Total Major Cations								
Snap Lock Bag (ED093T)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**05-Feb-2020**	26-Jul-2020	✓	**06-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EG005(ED093)S : Soluble Metals by ICPAES								
Snap Lock Bag (EG005S)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	26-Jul-2020	✓	**06-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EG005(ED093)T: Total Metals by ICP-AES								
Snap Lock Bag (EG005T)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**05-Feb-2020**	26-Jul-2020	✓	**06-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EG035S: Soluble Mercury by FIMS								
Snap Lock Bag (EG035S)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**06-Feb-2020**	25-Feb-2020	✓	**06-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS								
Snap Lock Bag (EG035T)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**05-Feb-2020**	25-Feb-2020	✓	**06-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED040F: Dissolved Major Anions								
Clear Plastic Bottle - Natural (ED040F)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**----**	----	----	**13-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**----**	----	----	**13-Feb-2020**	25-Feb-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Natural (ED093F)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**----**	----	----	**13-Feb-2020**	04-Feb-2020	×
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							
EG005(ED093)F: Dissolved Metals by ICP-AES								
Clear Plastic Bottle - Natural (EG005F)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**----**	----	----	**13-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Acid Neutralising Capacity (ANC)	EA013	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Cations - soluble by ICP-AES	ED093S	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride Soluble By Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations	ED007	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations on Alkaline Soils	ED006	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Loss on Ignition	EA101	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Soluble	ED040S	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations by ICPAES - Total	ED093T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Soluble Mercury by FIMS	EG035S	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Soluble Metals by ICPAES	EG005S	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acid Neutralising Capacity (ANC)	EA013	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Cations - soluble by ICP-AES	ED093S	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride Soluble By Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations	ED007	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations on Alkaline Soils	ED006	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Soluble	ED040S	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Soluble Mercury by FIMS	EG035S	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Soluble Metals by ICPAES	EG005S	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Cations - soluble by ICP-AES	ED093S	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride Soluble By Discrete Analyser	ED045G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations	ED007	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations on Alkaline Soils	ED006	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Soluble	ED040S	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Method Blanks (MB) - Continued							
Major Cations by ICPAES - Total	ED093T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Soluble Mercury by FIMS	EG035S	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Soluble Metals by ICPAES	EG005S	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Soluble Mercury by FIMS	EG035S	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Chloride by Discrete Analyser	ED045G	0	20	0.00	10.00	×	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-AES	EG005F	0	20	0.00	10.00	×	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	0	20	0.00	10.00	×	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	0	20	0.00	10.00	×	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chloride by Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-AES	EG005F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-AES	EG005F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	0	20	0.00	5.00	×	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-AES	EG005F	0	20	0.00	5.00	×	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Net Acid Production Potential	EA009	SOIL	In house: Referenced to Coastech Research (Canada)(Mod.). NAPP = Acid Production Potential (APP or MAP-Maximum Acid Potential) minus Neutralising Capacity (ANC). NAPP may be +ve, zero or -ve.
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to Rayment and Lyons 3A1 and APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Acid Neutralising Capacity (ANC)	EA013	SOIL	In house: Referenced to USEPA 600/2-78-054, I. Miller (2000). A fizz test is done to semiquanititatively estimate the likely reactivity. The soil is then reacted with an known excess quanitity of an appropriate acid. Titration determines the acid remaining, and the ANC can be calculated from comparison with a blank titration.
Loss on Ignition	EA101	SOIL	In house: Gravimetric procedure based on weight loss at a nominated temperature.
Exchange Acidity by 1M Potassium Chloride	* ED005	SOIL	In house: referenced to Rayment and Lyons, (2011), method 15G1. This method is unsuitable for near neutral and alkaline soils. NATA accreditation does not cover performance of this service.
Exchangeable Cations on Alkaline Soils	* ED006	SOIL	In house: Referenced to Soil Survey Test Method C5. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with alcoholic ammonium chloride at pH 8.5. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil.
Exchangeable Cations	ED007	SOIL	In house: Referenced to Rayment & Lyons (2011) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)
Exchangeable Cations with pre-treatment	ED008	SOIL	In house: Referenced to Rayment & Higginson (2011) Method 15A2. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)
Major Anions - Dissolved	ED040F	SOIL	In house: Referenced to APHA 3120. The 0.45µm filtered samples are determined by ICP/AES for Sulfur and/or Silcon content and reported as Sulfate and/or Silica after conversion by gravimetric factor.
Major Anions - Soluble	ED040S	SOIL	In house: Soluble Anions are determined off a 1:5 soil / water extract by ICPAES.
Sulfur - Total as S (LECO)	ED042T	SOIL	In house: Dried and pulverised sample is combusted in a high temperature furnace in the presence of strong oxidants / catalysts. The evolved S (as SO2) is measured by infra-red detector
Chloride by Discrete Analyser	ED045G	SOIL	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003

Analytical Methods	Method	Matrix	Method Descriptions
Major Cations - Dissolved	ED093F	SOIL	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Cations - soluble by ICP-AES	ED093S	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010 (ICPAES) Water extracts of the soil are analyzed for major cations by ICPAES. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Major Cations by ICPAES - Total	ED093T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010 (ICPAES) Major cations are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-AES	EG005F	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. The ICPAES technique ionises the 0.45µm filtered samples, emitting a characteristic spectrum which is compared against matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Soluble Metals by ICPAES	EG005S	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Soluble metals are determined following an appropriate soil / water extraction of the soil. The ICPAES technique ionises samples in a plasma, emitting characteristic spectrums based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards.
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Soluble Mercury by FIMS	EG035S	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the extract. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method (Alkaline Soils)	ED006PR	SOIL	In house: Referenced to Rayment and Lyons 2011 method 15C1.

Preparation Methods	Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method	ED007PR	SOIL	In house: Referenced to Rayment & Higginson (1992) method 15A1. A 1M NH4Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)
Dry and Crush	EN84	SOIL	In house
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

CHAIN OF CUSTODY

ALS Environmental

Environmental Division
Brisbane
Work Order Reference
EB2004378

CLIENT:	Wollongong Coal	TURNAROUND REQUIREMENTS	☐ Standard TAT (List due date):
OFFICE:	RUSSELL VALE	[illegible]	☐ Non-standard or urgent TAT (List due date):
PROJECT:		ALS QUOTE NO.:	COC SEQUENCE NUMBER (Client use)
ORDER NUMBER:			
PROJECT MANAGER:	Sasa Dugic	CONTACT PH: 0449 675 084	
SAMPLER:		SAMPLER MOBILE:	RELINQUISHED BY: / RECEIVED BY: / RELINQUISHED
COC emailed to ALS? (YES / NO)		EDD FORMAT (or default):	
Email Reports to (will default to PM if no other addresses are added):			DATE/TIME:
Email Invoices to (will default to PM if no other addresses are added):			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	E200G/ED093F: Dissolved Metals by ICP-AES				Additional Information
	1 ROM Composite - 01	28/01/2020	S		1	✓				Analyse crushed portion
	2 ROM Composite - 02	28/01/2020	S		1	✓				Analyse crushed portion
	3 ROM Composite - 03	28/01/2020	S		1	✓				Analyse crushed portion
	4 ROM Composite - 04	28/01/2020	S		1	✓				Analyse crushed portion
	5 ROM Composite - 05	28/01/2020	S		1	✓				Analyse crushed portion
	6 ROM Composite - 06	28/01/2020	S		1	✓				Analyse crushed portion
	7 ROM Composite - 07	28/01/2020	S		1	✓				Analyse crushed portion
	8 ROM Composite - 08	28/01/2020	S		1	✓				Analyse crushed portion
	9 ROM Composite - 09	28/01/2020	S		1	✓				Analyse crushed portion
	10 ROM Composite - 10	28/01/2020	S		1	✓				Analyse crushed portion
										Analyse crushed portion
					10					

Matrix Codes: W = Water, S = Soil, SD = Sediment, SL = Sludge, A = Air, B = Biota, O = Other

Preservation Codes: N = None, A = Acid Preserved, B = Boric Acid Preserved, C = Chemical Preserved, E = Ice Preserved, F = Frozen, H = HCl preserved, L = Lime Preserved, M = Methanol Preserved, N = HNO3 preserved, O = NaOH preserved, P = Phosphoric Preserved, S = H2SO4 preserved, U = Ultrasonic Preserved, V = Vitamin C Preserved, Z = ZnAc + NaOH Preserved, Z2 = ZnAc Preserved, Z3 = Zn Acetate Preserved, Z4 = Acetic Acid Preserved, Z5 = NaOH Preserved, Z6 = Other Preservative

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2004378**	Page	: 1 of 4
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS Russell Vale	Contact	: Customer Services EB
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 4223 6800	Telephone	: +61-7-3243 7222
Project	: ----	Date Samples Received	: 17-Feb-2020 14:36
Order number	: ----	Date Analysis Commenced	: 18-Feb-2020
C-O-C number	: ----	Issue Date	: 02-Mar-2020 16:49
Sampler	: Sasa Cugalj		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- NATA accreditation does not apply for reporting of 1:5 soil results in mg/L. 1:5 results represented as mg/L represent concentration in solution, are approximate and assume that 1kg of sample has a volume of 1L.
- EG005S (Soluble Metals by ICP-AES): The high Laboratory Control Standard recovery for Antimony is deemed acceptable as all sample results are less than the limit of reporting.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 01	ROM - Composite - 02	ROM - Composite - 03	ROM - Composite - 04	ROM - Composite - 05
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2004378-001	EB2004378-002	EB2004378-003	EB2004378-004	EB2004378-005
				Result	Result	Result	Result	Result
EG005(ED093)F: Dissolved Metals by ICP-AES								
Aluminium	7429-90-5	0.10	mg/L	<0.10	**0.16**	**0.19**	<0.10	**0.17**
Antimony	7440-36-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.01	mg/L	<0.01	**0.03**	<0.01	<0.01	**0.02**
Boron	7440-42-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/L	<0.01	<0.01	**0.02**	<0.01	<0.01
Nickel	7440-02-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG005(ED093)S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	**0.2**	<0.1	<0.1	**0.1**
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ROM - Composite - 06	ROM - Composite - 07	ROM - Composite - 08	ROM - Composite - 09	ROM - Composite - 10
			Client sampling date / time	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00	28-Jan-2020 00:00
Compound	CAS Number	LOR	Unit	EB2004378-006	EB2004378-007	EB2004378-008	EB2004378-009	EB2004378-010
				Result	Result	Result	Result	Result
EG005(ED093)F: Dissolved Metals by ICP-AES								
Aluminium	7429-90-5	0.10	mg/L	**0.10**	**0.11**	<0.10	<0.10	<0.10
Antimony	7440-36-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.01	mg/L	**0.02**	<0.01	<0.01	<0.01	**0.01**
Boron	7440-42-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.01**
Nickel	7440-02-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG005(ED093)S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB2004378**	Page	: 1 of 5
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS Russell Vale	Contact	: Customer Services EB
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 4223 6800	Telephone	: +61-7-3243 7222
Project	: ----	Date Samples Received	: 17-Feb-2020
Order number	: ----	Date Analysis Commenced	: 18-Feb-2020
C-O-C number	: ----	Issue Date	: 02-Mar-2020
Sampler	: Sasa Cugalj		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005(ED093)S : Soluble Metals by ICPAES (QC Lot: 2866970)									
EB2004378-001	ROM - Composite - 01	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit
EB2004378-010	ROM - Composite - 10	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005(ED093)S : Soluble Metals by ICPAES (QC Lot: 2866970) - continued									
EB2004378-010	ROM - Composite - 10	EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)S : Soluble Metals by ICPAES (QCLot: 2866970)								
EG005S: Aluminium	7429-90-5	1	mg/kg	<1	2.5 mg/kg	100	78.0	112
EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	0.5 mg/kg	104	70.0	130
EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	0.5 mg/kg	108	83.0	111
EG005S: Boron	7440-42-8	1	mg/kg	<1	2.5 mg/kg	103	70.0	130
EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	0.5 mg/kg	101	87.0	112
EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	0.5 mg/kg	102	91.0	110
EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	0.5 mg/kg	99.6	70.0	130
EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	0.5 mg/kg	104	84.0	111
EG005S: Iron	7439-89-6	1	mg/kg	<1	2.5 mg/kg	101	70.0	130
EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	0.5 mg/kg	96.3	90.0	112
EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	0.5 mg/kg	94.6	70.0	130
EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	0.5 mg/kg	103	70.0	130
EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	0.5 mg/kg	102	82.0	112
EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	0.5 mg/kg	94.9	70.0	130
EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	0.5 mg/kg	103	94.0	110

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)F: Dissolved Metals by ICP-AES (QCLot: 2867614)								
EG005F: Aluminium	7429-90-5	0.1	mg/L	<0.10	0.5 mg/L	100	77.0	109
EG005F: Antimony	7440-36-0	0.01	mg/L	<0.01	0.1 mg/L	104	70.0	130
EG005F: Arsenic	7440-38-2	0.01	mg/L	<0.01	0.1 mg/L	108	88.0	110
EG005F: Boron	7440-42-8	0.1	mg/L	<0.1	0.5 mg/L	103	70.0	130
EG005F: Cadmium	7440-43-9	0.005	mg/L	<0.005	0.1 mg/L	101	94.0	111
EG005F: Chromium	7440-47-3	0.01	mg/L	<0.01	0.1 mg/L	102	95.0	109
EG005F: Cobalt	7440-48-4	0.01	mg/L	<0.01	0.1 mg/L	99.6	70.0	130
EG005F: Copper	7440-50-8	0.01	mg/L	<0.01	0.1 mg/L	104	94.0	107
EG005F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	70.0	130
EG005F: Lead	7439-92-1	0.01	mg/L	<0.01	0.1 mg/L	96.3	93.0	110
EG005F: Manganese	7439-96-5	0.01	mg/L	<0.01	0.1 mg/L	94.6	70.0	130
EG005F: Molybdenum	7439-98-7	0.01	mg/L	<0.01	0.1 mg/L	103	70.0	130
EG005F: Nickel	7440-02-0	0.01	mg/L	<0.01	0.1 mg/L	102	92.0	112
EG005F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	94.9	70.0	130
EG005F: Zinc	7440-66-6	0.01	mg/L	<0.01	0.1 mg/L	103	79.5	120

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2004378**	Page	: 1 of 4
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS Russell Vale	Telephone	: +61-7-3243 7222
Project	: ----	Date Samples Received	: 17-Feb-2020
Site	: ----	Issue Date	: 02-Mar-2020
Sampler	: Sasa Cugalj	No. of samples received	: 10
Order number	: ----	No. of samples analysed	: 10

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Dissolved Metals by ICP-AES	0	20	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Dissolved Metals by ICP-AES	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*		*Sample Date*	*Extraction / Preparation*			*Analysis*		
			Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EG005(ED093)S : Soluble Metals by ICPAES								
Snap Lock Bag (EG005S)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**20-Feb-2020**	26-Jul-2020	✓	**21-Feb-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*		*Sample Date*	*Extraction / Preparation*			*Analysis*		
			Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EG005(ED093)F: Dissolved Metals by ICP-AES								
Clear Plastic Bottle - Natural (EG005F)								
ROM - Composite - 01,	ROM - Composite - 02,	**28-Jan-2020**	**----**	----	----	**02-Mar-2020**	26-Jul-2020	✓
ROM - Composite - 03,	ROM - Composite - 04,							
ROM - Composite - 05,	ROM - Composite - 06,							
ROM - Composite - 07,	ROM - Composite - 08,							
ROM - Composite - 09,	ROM - Composite - 10							

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Soluble Metals by ICPAES	EG005S	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Soluble Metals by ICPAES	EG005S	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Soluble Metals by ICPAES	EG005S	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Dissolved Metals by ICP-AES	EG005F	0	20	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Dissolved Metals by ICP-AES	EG005F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Dissolved Metals by ICP-AES	EG005F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Dissolved Metals by ICP-AES	EG005F	0	20	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-AES	EG005F	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. The ICPAES technique ionises the 0.45µm filtered samples, emitting a characteristic spectrum which is compared against matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Soluble Metals by ICPAES	EG005S	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Soluble metals are determined following an appropriate soil / water extraction of the soil. The ICPAES technique ionises samples in a plasma, emitting characteristic spectrums based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards.

Preparation Methods	Method	Matrix	Method Descriptions
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ Sydney: 277 Woodpark Rd., Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsenviro.com
☐ Newcastle: 5 Rosemount Rd, Westgarth NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsenviro.com
☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Stanley St, Townsville QLD 4810 Ph: 07 4796 0600 E: townsville.enviro@alsglobal.com
☐ Melbourne: 2-4 Walsh St, Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com
☐ Adelaide: 2-4 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsenviro.com
☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT:	Wollongong Coal	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☐ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE:	RUSSELL VALE		
PROJECT:	RV Underground	ALS QUOTE NO.:	COC SEQUENCE NUMBER (Circle)
ORDER NUMBER:			COC: 1 2 3 4 5 6 7
PROJECT MANAGER:	Sasa Cugelj	CONTACT PH: 449 675 084	OF: 1 2 3 4 5 6 7
SAMPLER:	Xingpeng Fan	SAMPLER MOBILE: 0402194675	
COC emailed to ALS? (YES / NO)	NO	EDD FORMAT (or default):	
Email Reports to: rvcmonitoring@wcl.net.au			
Email Invoice to: rvcmonitoring@wcl.net.au, wclap@wcl.net.au			

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:		°C	
Other comment:			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Xingpeng Fan	[signature]		
DATE/TIME: 5/02/2020 14:15	DATE/TIME: 5/2/20 14:45	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	pH + EC	TSS + Turbidity	Oil & Grease	Total Metals - Hg, As, Fe, Mn, Al, Sr, Ba, Cl, Ca, Mg, Cu	Dissolved Metals - Fe, Sr, Mn, Cu, Pb, Zn, Ni, Al, Li, Ba, B, Br, Fe^{2+}	COD + BOD + TOC	Hardness	TKN, TP	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	Iron Tank (Bulli/Balgownie)	4/02/2020 11:00	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
2	B Portal (Wongawilli)	4/02/2020 11:25	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
				TOTAL	14									

Environmental Division
Wollongong
Work Order Reference
EW2000589

Telephone : 02 4225 3125

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW2000534**	Page	: 1 of 6
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: Sasa Cugalj	Contact	: Glenn Davies
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: ----	Telephone	: 02 42253125
Project	: EPA RV Rain Event Site Monitoring	Date Samples Received	: 04-Feb-2020 15:31
Order number	: ----	Date Analysis Commenced	: 04-Feb-2020
C-O-C number	: ----	Issue Date	: 13-Feb-2020 09:40
Sampler	: PS		
Site	: RUSSELL VALE		
Quote number	: WO/001/20 Dust & Water Monitoring		
No. of samples received	: 8		
No. of samples analysed	: 8		

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This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **Analytical work for this work order will be conducted at ALS Sydney.**
- EP005 : NPOC analysis was carried out due to high inoeganic carbon content.
- EG020 : It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- pH and conductivity data supplied by ALS Wollongong.
- pH and conductivity tests completed on day of receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MG7 sump	MG6 9 c/t ft	Bleeder	MG5 B11	MG5 4 c/t
			Client sampling date / time	04-Feb-2020 08:50	04-Feb-2020 08:30	04-Feb-2020 08:05	04-Feb-2020 07:50	04-Feb-2020 07:22
Compound	CAS Number	LOR	Unit	EW2000534-001	EW2000534-002	EW2000534-003	EW2000534-004	EW2000534-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	9.4	9.2	8.8	8.2	8.9
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	4860	3630	3320	3160	3360
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	180	108	7	174	15
EA045: Turbidity								
Turbidity	----	0.1	NTU	424	379	1.0	11.9	6.3
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	323	73	41	33	34
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	33	18	9	5	9
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	16	18	3	15	4
Magnesium	7439-95-4	1	mg/L	6	5	1	1	2
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.08	0.08	<0.01	0.02	0.02
Boron	7440-42-8	0.05	mg/L	0.15	0.11	0.09	0.08	0.09
Strontium	7440-24-6	0.001	mg/L	0.803	0.246	0.348	0.294	0.347
Barium	7440-39-3	0.001	mg/L	0.471	0.293	0.585	0.509	0.544
Copper	7440-50-8	0.001	mg/L	0.022	0.006	0.002	<0.001	0.003
Lithium	7439-93-2	0.001	mg/L	0.777	0.511	0.508	0.452	0.518
Manganese	7439-96-5	0.001	mg/L	0.001	0.011	<0.001	0.006	0.003
Nickel	7440-02-0	0.001	mg/L	0.009	0.008	0.003	0.002	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.074	0.015	<0.005	0.007	0.035
Iron	7439-89-6	0.05	mg/L	<0.05	0.08	<0.05	<0.05	<0.05
Bromine	7726-95-6	0.1	mg/L	0.2	<0.1	<0.1	<0.1	<0.1
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	1.46	2.36	<0.01	0.24	0.13
Arsenic	7440-38-2	0.001	mg/L	0.014	0.010	0.006	0.004	0.004
Strontium	7440-24-6	0.001	mg/L	0.964	0.384	0.380	0.358	0.387
Barium	7440-39-3	0.001	mg/L	0.633	0.536	0.614	0.557	0.590
Copper	7440-50-8	0.001	mg/L	0.054	0.025	<0.001	<0.001	0.003

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MG7 sump	MG6 9 c/t ft	Bleeder	MG5 B11	MG5 4 c/t
			Client sampling date / time	04-Feb-2020 08:50	04-Feb-2020 08:30	04-Feb-2020 08:05	04-Feb-2020 07:50	04-Feb-2020 07:22
Compound	CAS Number	LOR	Unit	EW2000534-001	EW2000534-002	EW2000534-003	EW2000534-004	EW2000534-005
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.086**	**0.477**	<0.001	**0.027**	**0.008**
Iron	7439-89-6	0.05	mg/L	**0.96**	**2.60**	<0.05	**0.36**	**0.10**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	**0.09**	<0.05	<0.05	<0.05
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.9**	**1.8**	**0.3**	**1.0**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.27**	**0.70**	**0.03**	**0.04**	**0.04**
EP005: Total Organic Carbon (TOC)								
Nonpurgeable Organic Carbon	----	1	mg/L	**43**	**37**	**3**	**1**	**1**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**206**	**190**	<10	**11**	<10
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**3**	**7**	**2**	<2	<2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	18.3 sump	12 c/t ft	MG5 A11.30	----	----
			Client sampling date / time	04-Feb-2020 07:12	04-Feb-2020 07:00	04-Feb-2020 07:40	----	----
Compound	CAS Number	LOR	Unit	EW2000534-006	EW2000534-007	EW2000534-008	--------	--------
				Result	Result	Result	----	----
EA005FD: Field pH								
pH	----	0.1	pH Unit	9.0	9.0	7.8	----	----
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3370	3360	2500	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	12	31	124	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	10.9	34.1	120	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	38	42	54	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	13	16	18	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	5	4	5	----	----
Magnesium	7439-95-4	1	mg/L	2	2	2	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	0.03	<0.01	----	----
Boron	7440-42-8	0.05	mg/L	0.10	0.09	0.07	----	----
Strontium	7440-24-6	0.001	mg/L	0.354	0.345	0.289	----	----
Barium	7440-39-3	0.001	mg/L	0.530	0.490	0.609	----	----
Copper	7440-50-8	0.001	mg/L	0.004	0.006	0.005	----	----
Lithium	7439-93-2	0.001	mg/L	0.520	0.494	0.298	----	----
Manganese	7439-96-5	0.001	mg/L	0.002	0.002	0.015	----	----
Nickel	7440-02-0	0.001	mg/L	0.002	0.003	0.004	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	0.046	0.056	0.010	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.21	----	----
Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.21	0.33	0.21	----	----
Arsenic	7440-38-2	0.001	mg/L	0.004	0.005	0.400	----	----
Strontium	7440-24-6	0.001	mg/L	0.376	0.363	0.388	----	----
Barium	7440-39-3	0.001	mg/L	0.550	0.524	1.85	----	----
Copper	7440-50-8	0.001	mg/L	0.004	0.007	0.170	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	18.3 sump	12 c/t ft	MG5 A11.30	----	----
			Client sampling date / time	04-Feb-2020 07:12	04-Feb-2020 07:00	04-Feb-2020 07:40	----	----
Compound	CAS Number	LOR	Unit	EW2000534-006	EW2000534-007	EW2000534-008	--------	--------
				Result	Result	Result	----	----
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.015**	**0.019**	**0.211**	----	----
Iron	7439-89-6	0.05	mg/L	**0.20**	**0.24**	**32.9**	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	**0.05**	**0.14**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**0.3**	**3.9**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.05**	**0.10**	**1.24**	----	----
EP005: Total Organic Carbon (TOC)								
Nonpurgeable Organic Carbon	----	1	mg/L	**90**	**2**	**5**	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	**26**	**96**	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	**9**	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EW2000534**	Page	: 1 of 7
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: Sasa Cugalj	Contact	: Glenn Davies
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: ----	Telephone	: 02 42253125
Project	: EPA RV Rain Event Site Monitoring	Date Samples Received	: 04-Feb-2020
Order number	: ----	Date Analysis Commenced	: 04-Feb-2020
C-O-C number	: ----	Issue Date	: 13-Feb-2020
Sampler	: PS		
Site	: RUSSELL VALE		
Quote number	: WO/001/20 Dust & Water Monitoring		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 2849313)									
ES2004108-003	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	50	50	0.00	0% - 50%
EW2000532-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	51	51	0.00	0% - 50%
EA045: Turbidity (QC Lot: 2844588)									
ES2003843-001	Anonymous	EA045: Turbidity	----	0.1	NTU	5.5	5.8	4.95	0% - 20%
EW2000530-002	Anonymous	EA045: Turbidity	----	0.1	NTU	34.2	32.5	5.10	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 2841271)									
EW2000538-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	38	38	0.00	0% - 20%
ES2003475-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	91	101	9.71	0% - 20%
ED093T: Total Major Cations (QC Lot: 2848888)									
EW2000530-001	Anonymous	ED093T: Calcium	7440-70-2	1	mg/L	33	32	0.00	0% - 20%
		ED093T: Magnesium	7439-95-4	1	mg/L	15	15	0.00	0% - 50%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2848998)									
ES2004212-001	Anonymous	EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.068	0.067	1.86	0% - 20%
EW2000534-008	MG5 A11.30	EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.289	0.288	0.516	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2848999)									
ES2004212-001	Anonymous	EG020A-F: Barium	7440-39-3	0.001	mg/L	0.026	0.025	0.00	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.007	0.006	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.01	0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.01	0.01	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2848999) - continued									
ES2004212-001	Anonymous	EG020A-F: Iron	7439-89-6	0.05	mg/L	0.05	0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EW2000534-008	MG5 A11.30	EG020A-F: Barium	7440-39-3	0.001	mg/L	0.609	0.607	0.368	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.005	0.004	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.298	0.288	3.35	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.015	0.014	0.00	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.010	0.006	53.8	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.07	0.07	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.21	0.20	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2848885)									
EW2000534-006	18.3 sump	EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.550	0.548	0.486	0% - 20%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.015	0.016	0.00	0% - 50%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.21	0.22	0.00	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.20	0.20	0.00	No Limit
EW2000530-001	Anonymous	EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.383	0.392	2.27	0% - 20%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.069	0.068	0.00	0% - 20%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.11	0.11	0.00	0% - 50%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.30	0.30	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2848889)									
ME2000157-002	Anonymous	EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.654	0.655	0.00	0% - 20%
EW2000530-001	Anonymous	EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.624	0.638	2.19	0% - 20%
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2848892)									
EW2000530-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ME2000157-002	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG051G: Ferrous Iron by Discrete Analyser (QC Lot: 2843216)									
ES2002857-001	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
ES2003318-002	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	266000 µg/L	242	9.60	0% - 20%
EG051G: Ferrous Iron by Discrete Analyser (QC Lot: 2843217)									
EW2000534-005	MG5 4 c/t	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2843385)									
ES2003635-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.9	0.8	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2843385) - continued									
ES2003644-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.2	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2843388)									
EW2000534-007	12 c/t ft	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.3	0.00	No Limit
EW2000538-009	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	0.2	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2843386)									
ES2003635-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.18	0.18	0.00	0% - 50%
ES2003644-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.04	80.1	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2843387)									
EW2000534-007	12 c/t ft	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.10	0.09	0.00	No Limit
EW2000538-009	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QC Lot: 2851945)									
ES2003746-015	Anonymous	EP026SP: Chemical Oxygen Demand	----	10	mg/L	1280	1280	0.00	0% - 20%
EW2000534-006	18.3 sump	EP026SP: Chemical Oxygen Demand	----	10	mg/L	<10	<10	0.00	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 2843074)									
ES2002907-001	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	579	554	4.41	0% - 20%
EW2000534-004	MG5 B11	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	0.00	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 2843370)									
ES2002859-001	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	0.00	No Limit
ES2003441-001	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	0.00	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 2845328)									
ES2002546-001	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	133	146	9.32	0% - 20%
EW2000534-001	MG7 sump	EP030: Biochemical Oxygen Demand	----	2	mg/L	3	3	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 2849313)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	101	83.0	129
				<5	1000 mg/L	99.6	82.0	110
EA045: Turbidity (QCLot: 2844588)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	99.2	91.0	105
ED045G: Chloride by Discrete Analyser (QCLot: 2841271)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	104	80.9	127
				<1	1000 mg/L	99.4	80.9	127
ED093T: Total Major Cations (QCLot: 2848888)								
ED093T: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	105	83.0	117
ED093T: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	105	82.0	120
EG020F: Dissolved Metals by ICP-MS (QCLot: 2848998)								
EG020B-F: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	97.6	81.0	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 2848999)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	96.3	80.0	116
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	99.1	82.0	110
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	95.3	81.0	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	93.5	83.0	111
EG020A-F: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	89.0	79.0	117
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	95.8	82.0	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.4	82.0	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	98.5	81.0	117
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	91.6	85.0	115
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	95.5	82.0	112
EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 2848885)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	95.8	82.0	120
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	102	82.0	114
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	103	84.0	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	92.9	83.0	118
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	94.2	85.0	113
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	94.6	85.0	117
EG020T: Total Metals by ICP-MS (QCLot: 2848889)								
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	101	84.0	118

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2848892)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	103	77.0	111
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 2843216)								
EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	2 mg/L	106	89.0	117
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 2843217)								
EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	2 mg/L	105	89.0	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2843385)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.5	69.0	101
				<0.1	1 mg/L	87.4	70.0	118
				<0.1	5 mg/L	96.9	74.0	118
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2843388)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	88.0	69.0	101
				<0.1	1 mg/L	89.9	70.0	118
				<0.1	5 mg/L	93.8	74.0	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2843386)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	92.1	71.0	101
				<0.01	0.442 mg/L	107	72.0	108
				<0.01	1 mg/L	103	78.0	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2843387)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	92.9	71.0	101
				<0.01	0.442 mg/L	94.3	72.0	108
				<0.01	1 mg/L	101	78.0	118
EP020: Oil and Grease (O&G) (QCLot: 2849520)								
EP020: Oil & Grease	----	5	mg/L	<5	5000 mg/L	93.3	81.0	121
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QCLot: 2851945)								
EP026SP: Chemical Oxygen Demand	----	10	mg/L	<10	50 mg/L	105	82.0	112
				<10	500 mg/L	99.6	83.0	113
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 2843074)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	200 mg/L	94.0	74.0	112
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 2843370)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	200 mg/L	90.0	74.0	112
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 2845328)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	200 mg/L	96.0	74.0	112

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Matrix Spike (MS) Report

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 2841271)							
ES2003475-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	114	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 2848999)							
EW2000530-001	Anonymous	EG020A-F: Barium	7440-39-3	1 mg/L	114	70.0	130
		EG020A-F: Copper	7440-50-8	1 mg/L	108	70.0	130
		EG020A-F: Lead	7439-92-1	1 mg/L	110	70.0	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	111	70.0	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	108	70.0	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	111	70.0	130
EG020T: Total Metals by ICP-MS (QCLot: 2848885)							
ES2004220-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	98.1	70.0	130
		EG020A-T: Barium	7440-39-3	1 mg/L	101	70.0	130
		EG020A-T: Copper	7440-50-8	1 mg/L	93.8	70.0	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	93.0	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2848892)							
EW2000530-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	80.1	70.0	130
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 2843216)							
ES2002857-001	Anonymous	EG051G: Ferrous Iron	----	1 mg/L	114	70.0	130
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 2843217)							
EW2000534-005	MG5 4 c/t	EG051G: Ferrous Iron	----	1 mg/L	118	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2843385)							
ES2003635-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	94.4	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2843388)							
EW2000534-008	MG5 A11.30	EK061G: Total Kjeldahl Nitrogen as N	----	10 mg/L	96.4	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2843386)							
ES2003635-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	105	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2843387)							
EW2000534-008	MG5 A11.30	EK067G: Total Phosphorus as P	----	2 mg/L	99.7	70.0	130
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QCLot: 2851945)							
ES2003746-015	Anonymous	EP026SP: Chemical Oxygen Demand	----	582 mg/L	99.6	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EW2000534**	Page	: 1 of 8
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: Sasa Cugalj	Telephone	: 02 42253125
Project	: EPA RV Rain Event Site Monitoring	Date Samples Received	: 04-Feb-2020
Site	: RUSSELL VALE	Issue Date	: 13-Feb-2020
Sampler	: PS	No. of samples received	: 8
Order number	: ----	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005FD: Field pH							
Clear Plastic Bottle - Natural (REGIONAL LAB) (EN67 PK)							
MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**04-Feb-2020**	----	----
EA010FD: Field Conductivity							
Clear Plastic Bottle - Natural (REGIONAL LAB) (EN67 PK)							
MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**04-Feb-2020**	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H)							
MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**10-Feb-2020**	11-Feb-2020	✓
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**06-Feb-2020**	06-Feb-2020	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**04-Feb-2020**	03-Mar-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**08-Feb-2020**	03-Mar-2020	✓
ED093T: Total Major Cations							
Clear Plastic Bottle - Nitric Acid; Unfiltered (ED093T) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**08-Feb-2020**	03-Mar-2020	✓	**08-Feb-2020**	03-Mar-2020	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**08-Feb-2020**	02-Aug-2020	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**08-Feb-2020**	02-Aug-2020	✓	**08-Feb-2020**	02-Aug-2020	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**09-Feb-2020**	03-Mar-2020	✓
EG051G: Ferrous Iron by Discrete Analyser							
Clear Plastic Bottle - HCl - Filtered (EG051G) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**----**	----	----	**05-Feb-2020**	11-Feb-2020	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) MG7 sump, MG6 9 c/t ft, Bleeder, MG5 B11, MG5 4 c/t, 18.3 sump, 12 c/t ft, MG5 A11.30	**04-Feb-2020**	**05-Feb-2020**	03-Mar-2020	✓	**05-Feb-2020**	03-Mar-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G)								
MG7 sump,	MG6 9 c/t ft,	**04-Feb-2020**	**05-Feb-2020**	03-Mar-2020	✓	**05-Feb-2020**	03-Mar-2020	✓
Bleeder,	MG5 B11,							
MG5 4 c/t,	18.3 sump,							
12 c/t ft,	MG5 A11.30							
EP005: Total Organic Carbon (TOC)								
Amber TOC Vial - Sulfuric Acid (EP005)								
MG7 sump,	MG6 9 c/t ft,	**04-Feb-2020**	**----**	----	----	**06-Feb-2020**	03-Mar-2020	✓
Bleeder,	MG5 B11,							
MG5 4 c/t,	18.3 sump,							
12 c/t ft,	MG5 A11.30							
EP020: Oil and Grease (O&G)								
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)								
MG7 sump,	MG6 9 c/t ft,	**04-Feb-2020**	**----**	----	----	**10-Feb-2020**	03-Mar-2020	✓
Bleeder,	MG5 B11,							
MG5 4 c/t,	18.3 sump,							
12 c/t ft,	MG5 A11.30							
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Clear Plastic Bottle - Sulfuric Acid (EP026SP)								
MG7 sump,	MG6 9 c/t ft,	**04-Feb-2020**	**----**	----	----	**11-Feb-2020**	03-Mar-2020	✓
Bleeder,	MG5 B11,							
MG5 4 c/t,	18.3 sump,							
12 c/t ft,	MG5 A11.30							
EP030: Biochemical Oxygen Demand (BOD)								
Clear Plastic Bottle - Natural (EP030)								
MG6 9 c/t ft,	Bleeder,	**04-Feb-2020**	**----**	----	----	**05-Feb-2020**	06-Feb-2020	✓
MG5 B11,	MG5 4 c/t,							
18.3 sump,	12 c/t ft,							
MG5 A11.30								
Clear Plastic Bottle - Natural (EP030)								
MG7 sump		**04-Feb-2020**	**----**	----	----	**06-Feb-2020**	06-Feb-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Biochemical Oxygen Demand (BOD)	EP030	6	60	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	2	12	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ferrous Iron by Discrete Analyser	EG051G	3	24	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Total	ED093T	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	4	25	16.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	10	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	4	39	10.26	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Biochemical Oxygen Demand (BOD)	EP030	3	60	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	2	12	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ferrous Iron by Discrete Analyser	EG051G	2	24	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Total	ED093T	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	6	25	24.00	15.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	6	39	15.38	15.00	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Biochemical Oxygen Demand (BOD)	EP030	3	60	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Ferrous Iron by Discrete Analyser	EG051G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Total	ED093T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ferrous Iron by Discrete Analyser	EG051G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Total	ED093T	WATER	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Samples are digested by USEPA 3005 prior to analysis. The ICPAES technique ionises the sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ferrous Iron by Discrete Analyser	EG051G	WATER	In house: Referenced to APHA 3500 Fe-B. A colorimetric determination based on the reaction between phenanthroline and ferrous iron at pH 3.2-3.3 to form an orange-red complex that is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Field Tests - Port Kembla	EN67 PK	WATER	Field determinations as per methods described in APHA. The analysis is performed in the field by ALS samplers. ALS NATA accreditation apply for this service.
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	WATER	In house: Referenced to APHA 5220 D. Samples are digested with a known excess of an acidic potassium dichromate solution using silver sulfate as a catalyst. The chromium is reduced from the Cr (VI) oxidation state to the Cr (III) state by the oxygen present in the organic material. Both of these chromium species are coloued and absorb in the visible region of (400nm & 600nm) the spectrum. The oxidisable organic matter can be calculated in terms of oxygen equivalents.
Biochemical Oxygen Demand (BOD)	EP030	WATER	In house: Referenced to APHA 5210 B. The 5-Day BOD test provides an empirical measure of the oxygen consumption capacity of a given water. A portion of the sample is diluted into oxygenated, nutrient rich water, and a seed added to begin biological decay. The initial dissolved oxygen content is measured, then the bottle is sealed and incubated for five days. The remaining dissolved oxygen is measured, and from the difference, the demand for oxygen, by biological decay, is determined. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ Sydney 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E: samples.sydney@alsenviro.com
☐ Newcastle: 5 Rosegum Rd, Warabrook NSW 2304 Ph: 02 4958 5439 E: samples.newcastle@alsenviro.com
☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsenviro.com
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E: samples.adelaide@alsenviro.com
☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9250 7555 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: samples.launceston@alsenviro.com

CLIENT:	Wollongong Coal	TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☑ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE:	RUSSELL VALE		
PROJECT:	RV Rain Event Site Monitoring	ALS QUOTE NO.:	
ORDER NUMBER:			
PROJECT MANAGER:	Sasa Cugalj	CONTACT PH: 449 675 084	
SAMPLER:	PS	SAMPLER MOBILE:	
COC emailed to ALS? (YES / NO)	NO	EDD FORMAT (or default):	
Email Reports to: rvcmonitoring@wcl.net.au			
Email Invoice to: rvcmonitoring@wcl.net.au, wclap@wcl.net.au			

COC SEQUENCE NUMBER (Circle): COC: 1 2 3 4 5 6 7; OF: 1 2 3 4 5 6 7

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:
DATE/TIME: 4/2/2020	DATE/TIME: 4/2/20	DATE/TIME:

FOR LABORA
Custody Seal Int
Free Ice / frozen receipt?
Random Sampl
Other comment

Environmental Division Wollongong
Work Order Reference
EW2000534

Telephone : +61 42282126

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	pH + EC	TSS + Turbidity	Oil & Grease	Total Metals - Hg, As, Fe, Mn, Al, Sr, Ba, Cl, Ca, Mg, Cu	Dissolved Metals - Fe, Sr, Mn, Cu, Pb, Zn, Ni, Al, Li, Ba, B, Br, Fe^{2+}	COD + BOD + TOC	Hardness	TKN, TP	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	MG7 sump	4/02/2020 8:50	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	pH / EC
2	MG6 9 c/t ft	4/02/2020 8:30	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
3	Bleeder	4/02/2020 8:05	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
4	MG5 B11	4/02/2020 7:50	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
5	MG5 4 c/t	4/02/2020 7:22	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
6	18.3 sump	4/02/2020 7:12	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
7	12 c/t ft	4/02/2020 7:00	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
8	MG5 A11.30	4/02/2020 7:40	W	P, Nx2, VB, SG, H, SP	7	✓	✓	✓	✓	✓	✓	✓	✓	
				TOTAL	56									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles, ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW2000589**	Page	: 1 of 4
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: Sasa Cugalj	Contact	: Glenn Davies
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: ----	Telephone	: 02 42253125
Project	: RV Underground	Date Samples Received	: 05-Feb-2020 15:10
Order number	: ----	Date Analysis Commenced	: 05-Feb-2020
C-O-C number	: ----	Issue Date	: 13-Feb-2020 10:42
Sampler	: Xingpeng Fan		
Site	: RUSSELL VALE		
Quote number	: WO/001/20 Dust & Water Monitoring		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **Analytical work for this work order will be conducted at ALS Sydney.**
- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG020 : It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EG020: Poor matrix spike recovery was obtained for some elements on sample ES2003932-021 due to matrix interference. Confirmed by reanalysis.
- pH and conductivity data supplied by ALS Wollongong.
- pH and conductivity tests completed on day of receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Iron Tank (Bulli/Balgownie)	B Portal (Wongawilli)	----	----	----
			Client sampling date / time	04-Feb-2020 11:00	04-Feb-2020 11:25	----	----	----
Compound	CAS Number	LOR	Unit	EW2000589-001	EW2000589-002	--------	--------	--------
				Result	Result	----	----	----
EA005FD: Field pH								
pH	----	0.1	pH Unit	8.8	8.9	----	----	----
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3580	3460	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	64	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	1.1	185	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	77	52	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	50	16	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	10	10	----	----	----
Magnesium	7439-95-4	1	mg/L	6	3	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.11	----	----	----
Boron	7440-42-8	0.05	mg/L	0.06	0.09	----	----	----
Strontium	7440-24-6	0.001	mg/L	0.462	0.333	----	----	----
Barium	7440-39-3	0.001	mg/L	1.10	0.447	----	----	----
Copper	7440-50-8	0.001	mg/L	0.086	0.019	----	----	----
Lithium	7439-93-2	0.001	mg/L	0.586	0.443	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	0.007	----	----	----
Nickel	7440-02-0	0.001	mg/L	0.030	0.005	----	----	----
Lead	7439-92-1	0.001	mg/L	0.004	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	0.114	0.057	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	0.08	----	----	----
Bromine	7726-95-6	0.1	mg/L	0.2	<0.1	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	1.93	----	----	----
Arsenic	7440-38-2	0.001	mg/L	0.019	0.007	----	----	----
Strontium	7440-24-6	0.001	mg/L	0.439	0.394	----	----	----
Barium	7440-39-3	0.001	mg/L	1.04	0.583	----	----	----
Copper	7440-50-8	0.001	mg/L	0.122	0.064	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Iron Tank (Bulli/Balgownie)	B Portal (Wongawilli)	----	----	----
			Client sampling date / time	04-Feb-2020 11:00	04-Feb-2020 11:25	----	----	----
Compound	CAS Number	LOR	Unit	EW2000589-001	EW2000589-002	--------	--------	--------
				Result	Result	----	----	----
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.001**	**0.238**	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.06**	**1.72**	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	**0.09**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.5**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.03**	**0.26**	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**7**	**10**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	**42**	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**5**	**2**	----	----	----

CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd, Smithfield NSW 2164 Ph: 02 8784 8555 E: sample.sydney@alsenviro.com
Newcastle: 5 Kingston Pl, Mayfield NSW 2304 Ph: 02 4968 9433 E: sample.newcastle@alsenviro.com
Brisbane: 32 Shand St, Stafford QLD 4053 Ph: 07 3243 7222 E: sample.brisbane@alsenviro.com
Townsville: 14-15 Desma Cl, Bohle QLD 4818 Ph: 07 4796 0600 E: sample.townsville@alsenviro.com
Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph: 03 8549 9600 E: sample.melbourne@alsenviro.com
Adelaide: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E: sample.adelaide@alsenviro.com
Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: sample.perth@alsenviro.com
Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2548 E: launceston@alsenviro.com

CLIENT:	Wollongong Coal	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☐ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE:	RUSSELL VALE		
PROJECT:	RV Underground	ALS QUOTE NO.:	
ORDER NUMBER:			
PROJECT MANAGER:	Sasa Cugalj	CONTACT PH: 449 675 084	
SAMPLER:	PS+XF+CC	SAMPLER MOBILE: 0402194675	
COC emailed to ALS? (YES / NO)	NO	EDD FORMAT (or default):	
Email Reports to: rvcmonitoring@wcl.net.au			
Email Invoice to: rvcmonitoring@wcl.net.au, wclap@wcl.net.au			

COC SEQUENCE NUMBER (Circle)

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED
Xingpeng Fan		
DATE/TIME: 5/02/2020 14:15	DATE/TIME: 5/2/20 14:45	DATE/TIME:

FOR LABO
Custody Seal N/A
Free ice / froz N/A
receipt?
Rercom Sam
Other com me

Environmental Division Wollongong
Work Order Reference
EW2000586

telephone : 02 4225 3125

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED Including SUITES (NB: Suite Codes must be listed to ensure correct analysis) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	pH + EC	TSS + Turbidity	Oil & Grease	Total Metals - Hg, As, Fe, Mn, Al, Sr, Ba, Cl, Ca, Mg, Cu	Dissolved Metals - Fe, Sr, Mn, Cu, Pb, Zn, Ni, Al, Li, Ba, B, Br, Fe^{2+}	COD + BOD + TOC	Hardness	TKN, TP	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	12 c/t - Fish Tank	5/02/2020 7:45	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
2	18.3 c/t - Sump	5/02/2020 7:55	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
3	4 c/t MG5	5/02/2020 8:05	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
4	A11.3 MG5 - Uphole (Balgownie Seam)	5/02/2020 8:15	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
5	B11 MG5 - Floor	5/02/2020 8:40	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
6	Bleeder	5/02/2020 8:30	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
7	9 c/t MG6 - Fish Tank	5/02/2020 9:00	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
8	MG7 - Sump	5/02/2020 9:17	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
9	B27 - Wonga Mains	5/02/2020 9:30	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
10	Iron Tank (Bulli/Balgownie)	5/02/2020 10:00	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
11	B Portal (Wongawilli)	5/02/2020 10:25	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
				TOTAL	70									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV - Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW2000586**	Page	: 1 of 8
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: Sasa Cugalj	Contact	: Glenn Davies
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: ----	Telephone	: 02 42253125
Project	: RV Underground	Date Samples Received	: 05-Feb-2020 15:06
Order number	: ----	Date Analysis Commenced	: 05-Feb-2020
C-O-C number	: ----	Issue Date	: 13-Feb-2020 11:31
Sampler	: Xingpeng Fan		
Site	: RUSSELL VALE		
Quote number	: WO/001/20 Dust & Water Monitoring		
No. of samples received	: 11		
No. of samples analysed	: 11		

ilac-MRA NATA Accreditation No. 825 Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **Analytical work for this work order will be conducted at ALS Sydney.**
- EG020/ED093: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- pH and conductivity data supplied by ALS Wollongong.
- pH and conductivity tests completed on day of receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	12 c/t - Fish Tank	18.3 c/t - Sump	4 c/t MG5	A11.3 MG5 - Uphole (Balgownie Seam)	B11 MG5 - Floor
			Client sampling date / time	05-Feb-2020 07:45	05-Feb-2020 07:55	05-Feb-2020 08:05	05-Feb-2020 08:15	05-Feb-2020 08:40
Compound	CAS Number	LOR	Unit	EW2000586-001	EW2000586-002	EW2000586-003	EW2000586-004	EW2000586-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	8.9	8.8	8.8	7.7	8.3
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3460	3370	3790	2530	3210
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	52	12	12	<5	7
EA045: Turbidity								
Turbidity	----	0.1	NTU	172	34.5	9.4	0.6	2.3
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	47	41	34	54	32
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	16	16	16	18	9
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	10	4	3	4	3
Magnesium	7439-95-4	1	mg/L	3	2	1	2	1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.08	0.04	0.02	<0.01	0.01
Boron	7440-42-8	0.05	mg/L	0.09	0.09	0.10	0.07	0.08
Strontium	7440-24-6	0.001	mg/L	0.326	0.366	0.381	0.328	0.314
Barium	7440-39-3	0.001	mg/L	0.441	0.522	0.571	0.666	0.514
Copper	7440-50-8	0.001	mg/L	0.005	0.002	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	0.369	0.385	0.413	0.224	0.358
Manganese	7439-96-5	0.001	mg/L	0.006	0.002	0.002	0.006	0.001
Nickel	7440-02-0	0.001	mg/L	0.004	0.002	0.002	0.004	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.038	0.043	0.036	0.007	0.018
Iron	7439-89-6	0.05	mg/L	0.06	<0.05	<0.05	<0.05	<0.05
Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	<0.1	0.1	<0.1
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	1.26	0.37	0.07	0.01	0.07
Arsenic	7440-38-2	0.001	mg/L	0.006	0.005	0.004	0.022	0.004
Strontium	7440-24-6	0.001	mg/L	0.401	0.380	0.376	0.313	0.311
Barium	7440-39-3	0.001	mg/L	0.599	0.552	0.573	0.647	0.519

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	12 c/t - Fish Tank	18.3 c/t - Sump	4 c/t MG5	A11.3 MG5 - Uphole (Balgownie Seam)	B11 MG5 - Floor
			Client sampling date / time	05-Feb-2020 07:45	05-Feb-2020 07:55	05-Feb-2020 08:05	05-Feb-2020 08:15	05-Feb-2020 08:40
Compound	CAS Number	LOR	Unit	EW2000586-001	EW2000586-002	EW2000586-003	EW2000586-004	EW2000586-005
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	**0.014**	**0.004**	**0.001**	**0.008**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.200**	**0.035**	**0.005**	**0.007**	**0.006**
Iron	7439-89-6	0.05	mg/L	**1.29**	**0.33**	**0.08**	**0.09**	**0.20**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	**0.05**	<0.05	<0.05	<0.05
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**0.3**	**0.2**	**0.7**	**0.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.26**	**0.08**	**0.04**	<0.01	**0.04**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**19**	**6**	**3**	<1	<1
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**53**	<10	<10	<10	<10
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**2**	<2	<2	<2	**5**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Bleeder	9 c/t MG6 - Fish Tank	MG7 - Sump	B27 - Wonga Mains	Iron Tank (Bulli/Balgownie)
			Client sampling date / time	05-Feb-2020 08:30	05-Feb-2020 09:00	05-Feb-2020 09:17	05-Feb-2020 09:30	05-Feb-2020 10:00
Compound	CAS Number	LOR	Unit	EW2000586-006	EW2000586-007	EW2000586-008	EW2000586-009	EW2000586-010
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	8.6	8.7	9.2	9.3	8.8
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3320	3240	5000	5220	3570
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	5	8	178	25	<5
EA045: Turbidity								
Turbidity	----	0.1	NTU	0.4	25.6	907	129	1.0
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	41	36	347	220	81
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	16	18	36	63	59
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	2	5	49	8	10
Magnesium	7439-95-4	1	mg/L	1	2	6	9	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.06	0.08	0.10	<0.01
Boron	7440-42-8	0.05	mg/L	0.09	0.09	0.15	0.15	0.07
Strontium	7440-24-6	0.001	mg/L	0.373	0.331	0.896	1.13	0.484
Barium	7440-39-3	0.001	mg/L	0.591	0.511	0.515	0.192	1.12
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.023	0.023	0.088
Lithium	7439-93-2	0.001	mg/L	0.392	0.358	0.627	0.777	0.526
Manganese	7439-96-5	0.001	mg/L	<0.001	0.005	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.008	<0.001	0.032
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.004
Zinc	7440-66-6	0.005	mg/L	<0.005	0.028	0.082	0.007	0.121
Iron	7439-89-6	0.05	mg/L	<0.05	0.07	<0.05	<0.05	<0.05
Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	0.3	0.2	0.2
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.31	6.20	1.52	0.02
Arsenic	7440-38-2	0.001	mg/L	0.005	0.006	0.015	0.009	0.021
Strontium	7440-24-6	0.001	mg/L	0.368	0.339	1.27	1.14	0.477
Barium	7440-39-3	0.001	mg/L	0.594	0.518	0.915	0.216	1.10
Copper	7440-50-8	0.001	mg/L	<0.001	0.006	0.087	0.034	0.130

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Bleeder	9 c/t MG6 - Fish Tank	MG7 - Sump	B27 - Wonga Mains	Iron Tank (Bulli/Balgownie)
			Client sampling date / time	05-Feb-2020 08:30	05-Feb-2020 09:00	05-Feb-2020 09:17	05-Feb-2020 09:30	05-Feb-2020 10:00
Compound	CAS Number	LOR	Unit	EW2000586-006	EW2000586-007	EW2000586-008	EW2000586-009	EW2000586-010
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.037**	**0.300**	**0.034**	<0.001
Iron	7439-89-6	0.05	mg/L	<0.05	**0.31**	**3.74**	**0.59**	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	**0.07**	**0.06**	<0.05	<0.05
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**0.3**	**0.7**	**0.2**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.11**	**0.34**	**0.20**	**0.03**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	**4**	**5**	**6**	**3**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	<10	**232**	**11**	<10
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	**4**	**3**	<2	<2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	B Portal (Wongawilli)	----	----	----	----
			Client sampling date / time	05-Feb-2020 10:25	----	----	----	----
Compound	CAS Number	LOR	Unit	EW2000586-011	--------	--------	--------	--------
				Result	----	----	----	----
EA005FD: Field pH								
pH	----	0.1	pH Unit	**8.9**	----	----	----	----
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	**3480**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**60**	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**220**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**50**	----	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**22**	----	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**10**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.11**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.10**	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.355**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.454**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.015**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.407**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.006**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.004**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.062**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.06**	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**1.84**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.007**	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.424**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.612**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.066**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	B Portal (Wongawilli)	----	----	----	----
			Client sampling date / time	05-Feb-2020 10:25	----	----	----	----
Compound	CAS Number	LOR	Unit	EW2000586-011	--------	--------	--------	--------
				Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.242**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**1.63**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.36**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	----	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	----	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**32**	----	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	----	----	----	----

CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT:	Wollongong Coal
OFFICE:	RUSSELL VALE
PROJECT:	RV Underground
ORDER NUMBER:	
PROJECT MANAGER:	Sasa Cugalj
SAMPLER:	Xingpeng Fan
COC emailed to ALS? (YES / NO)	NO
Email Reports to: rvcmonitoring@wcl.net.au	
Email Invoice to: rvcmonitoring@wcl.net.au, wclap@wcl.net.au	

TURNAROUND REQUIREMENTS : ☑ Standard TAT (List due date):
(Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.:

CONTACT PH: 449 675 084

SAMPLER MOBILE: 0402194675

EDD FORMAT (or default):

COC SEQUENCE NUMBER (Circle)

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

RELINQUISHED BY: 4. Chen
DATE/TIME: 6/2/2020 2:10 pm

RECEIVED BY: [illegible]
DATE/TIME: 6/2/20 14:25

RELINQUISHED
DATE/TIME:

FOR LAB
Custody Se
Free ice / fr receipt?
Random Sc
Other con

N/A
N/A

Environmental Division
Wollongong
Work Order Reference
EW2000609

Telephone : 02 42253125

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY — SAMPLE DETAILS MATRIX: Solid(S) Water(W) — CONTAINER INFORMATION — ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to

Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	pH + EC	TSS + Turbidity	Oil & Grease	Total Metals - Hg, As, Fe, Mn, Al, Sr, Ba, Cl, Ca, Mg, Cu	Dissolved Metals - Fe, Sr, Mn, Cu, Pb, Zn, Ni, Al, Li, Ba, B, Br, Fe^{2+}	COD + BOD + TOC	Hardness	TKN, TP	Additional Information: Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	12 c/t - Fish Tank	6/02/2020 7:45	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
2	18.3 c/t - Sump	6/02/2020 7:58	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
3	4 c/t MG5	6/02/2020 8:07	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
4	A11.3 MG5 - Uphole (Balgownie Seam)	6/02/2020 8:16	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
5	B11 MG5 - Floor	6/02/2020 8:26	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
6	Bleeder	6/02/2020 8:28	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
7	9 c/t MG6 - Fish Tank	6/02/2020 9:32	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
8	MG7 - Sump	6/02/2020 9:10	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
9	B27 - Wonga Mains	6/02/2020 9:03	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
10	Iron Tank (Bulli/Balgownie)	6/02/2020 10:40	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
11	B Portal (Wongawilli)	6/02/2020 10:55	W	P, Nx2, VB, SG, H, SP	7	√	√	√	√	√	√	√	√	
				TOTAL	77									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB – VOA Vial Sodium Bisulphate Preserved. VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle, ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW2000609**	Page	: 1 of 8
Client	: **WOLLONGONG COAL LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: Sasa Cugalj	Contact	: Glenn Davies
Address	: CORNER BELLAMBI LANE AND PRINCES HIGHWAY RUSSELL VALE NSW, AUSTRALIA 2517	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: ----	Telephone	: 02 42253125
Project	: RV Underground	Date Samples Received	: 06-Feb-2020 14:50
Order number	: ----	Date Analysis Commenced	: 06-Feb-2020
C-O-C number	: ----	Issue Date	: 14-Feb-2020 12:09
Sampler	: Xingpeng Fan		
Site	: RUSSELL VALE		
Quote number	: WO/001/20 Dust & Water Monitoring		
No. of samples received	: 11		
No. of samples analysed	: 11		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **Analytical work for this work order will be conducted at ALS Sydney.**
- EG020 : It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- pH and conductivity data supplied by ALS Wollongong.
- pH and conductivity tests completed on day of receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	12 c/t - Fish Tank	18.3 c/t - Sump	4 c/t MG5	A11.3 MG5 - Uphole (Balgownie Seam)	B11 MG5 - Floor
			Client sampling date / time	06-Feb-2020 07:45	06-Feb-2020 07:58	06-Feb-2020 08:07	06-Feb-2020 08:16	06-Feb-2020 08:26
Compound	CAS Number	LOR	Unit	EW2000609-001	EW2000609-002	EW2000609-003	EW2000609-004	EW2000609-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	8.8	8.8	8.7	7.7	8.3
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3370	3350	3360	2520	3200
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	34	14	10	130	5
EA045: Turbidity								
Turbidity	----	0.1	NTU	99.4	25.4	16.2	78.7	4.1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	42	39	35	56	33
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	16	16	9	16	9
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	5	4	4	4	2
Magnesium	7439-95-4	1	mg/L	2	2	1	2	1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.06	0.04	0.03	<0.01	0.02
Boron	7440-42-8	0.05	mg/L	0.10	0.10	0.09	0.07	0.09
Strontium	7440-24-6	0.001	mg/L	0.332	0.339	0.372	0.303	0.308
Barium	7440-39-3	0.001	mg/L	0.460	0.481	0.553	0.605	0.505
Copper	7440-50-8	0.001	mg/L	0.004	0.002	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	0.502	0.494	0.505	0.282	0.482
Manganese	7439-96-5	0.001	mg/L	0.003	0.003	0.003	0.006	0.004
Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.004	0.005	0.004
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.052	0.043	0.032	<0.005	0.019
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	<0.1	0.1	<0.1
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.63	0.27	0.15	0.04	0.04
Arsenic	7440-38-2	0.001	mg/L	0.005	0.004	0.004	0.062	0.004
Strontium	7440-24-6	0.001	mg/L	0.373	0.381	0.399	0.344	0.323
Barium	7440-39-3	0.001	mg/L	0.560	0.561	0.606	0.830	0.545

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	12 c/t - Fish Tank	18.3 c/t - Sump	4 c/t MG5	A11.3 MG5 - Uphole (Balgownie Seam)	B11 MG5 - Floor
			Client sampling date / time	06-Feb-2020 07:45	06-Feb-2020 07:58	06-Feb-2020 08:07	06-Feb-2020 08:16	06-Feb-2020 08:26
Compound	CAS Number	LOR	Unit	EW2000609-001	EW2000609-002	EW2000609-003	EW2000609-004	EW2000609-005
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	**0.009**	**0.003**	**0.002**	**0.028**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.056**	**0.019**	**0.012**	**0.038**	**0.002**
Iron	7439-89-6	0.05	mg/L	**0.59**	**0.25**	**0.18**	**4.70**	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	**0.06**	<0.05	<0.05	<0.05	<0.05
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	<0.1	**0.6**	**2.1**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.10**	**0.06**	**0.03**	**0.09**	<0.01
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**12**	**6**	**4**	**4**	**5**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**72**	**34**	**28**	**52**	**23**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**2**	<2	<2	**11**	**2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Bleeder	9 c/t MG6 - Fish Tank	MG7 - Sump	B27 - Wonga Mains	Iron Tank (Bulli/Balgownie)
			Client sampling date / time	06-Feb-2020 08:28	06-Feb-2020 09:32	06-Feb-2020 09:10	06-Feb-2020 09:03	06-Feb-2020 10:40
Compound	CAS Number	LOR	Unit	EW2000609-006	EW2000609-007	EW2000609-008	EW2000609-009	EW2000609-010
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	8.7	8.8	9.3	9.4	8.9
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3320	3210	4970	5230	3560
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	10	274	25	<5
EA045: Turbidity								
Turbidity	----	0.1	NTU	0.5	22.2	969	119	0.7
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	43	38	367	233	80
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	12	18	29	52	50
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	3	5	28	7	10
Magnesium	7439-95-4	1	mg/L	1	2	6	9	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.04	0.11	0.12	0.02
Boron	7440-42-8	0.05	mg/L	0.10	0.10	0.16	0.15	0.07
Strontium	7440-24-6	0.001	mg/L	0.370	0.330	0.778	1.08	0.469
Barium	7440-39-3	0.001	mg/L	0.575	0.522	0.401	0.177	1.06
Copper	7440-50-8	0.001	mg/L	<0.001	0.002	0.003	0.022	0.065
Lithium	7439-93-2	0.001	mg/L	0.525	0.458	0.764	0.959	0.668
Manganese	7439-96-5	0.001	mg/L	<0.001	0.011	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.004	0.007	0.011	0.004	0.036
Lead	7439-92-1	0.001	mg/L	<0.001	0.001	<0.001	<0.001	0.003
Zinc	7440-66-6	0.005	mg/L	<0.005	0.024	0.027	0.005	0.118
Iron	7439-89-6	0.05	mg/L	<0.05	0.08	<0.05	<0.05	<0.05
Bromine	7726-95-6	0.1	mg/L	<0.1	<0.1	0.3	0.2	0.2
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	0.22	3.85	1.11	0.02
Arsenic	7440-38-2	0.001	mg/L	0.006	0.006	0.015	0.009	0.020
Strontium	7440-24-6	0.001	mg/L	0.392	0.367	1.15	1.23	0.496
Barium	7440-39-3	0.001	mg/L	0.636	0.597	0.772	0.220	1.15
Copper	7440-50-8	0.001	mg/L	<0.001	0.003	0.067	0.031	0.062

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Bleeder	9 c/t MG6 - Fish Tank	MG7 - Sump	B27 - Wonga Mains	Iron Tank (Bulli/Balgownie)
			Client sampling date / time	06-Feb-2020 08:28	06-Feb-2020 09:32	06-Feb-2020 09:10	06-Feb-2020 09:03	06-Feb-2020 10:40
Compound	CAS Number	LOR	Unit	EW2000609-006	EW2000609-007	EW2000609-008	EW2000609-009	EW2000609-010
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.002**	**0.022**	**0.190**	**0.030**	<0.001
Iron	7439-89-6	0.05	mg/L	**0.05**	**0.18**	**2.60**	**0.52**	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	**0.11**	<0.05	<0.05	<0.05
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**0.3**	**0.4**	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.06**	**0.40**	**0.18**	**0.02**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**5**	**3**	**22**	**2**	**4**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	**10**	**6**	**7**
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**25**	**46**	**328**	<10	<10
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	**2**	**2**	<2	<2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	B Portal (Wongawilli)	----	----	----	----
			Client sampling date / time	06-Feb-2020 10:55	----	----	----	----
Compound	CAS Number	LOR	Unit	EW2000609-011	--------	--------	--------	--------
				Result	----	----	----	----
EA005FD: Field pH								
pH	----	0.1	pH Unit	**8.8**	----	----	----	----
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	**3380**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**35**	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**143**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**43**	----	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**16**	----	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**7**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**2**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.07**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.10**	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.330**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.438**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.013**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.470**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.003**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.006**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.062**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**1.08**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.006**	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.399**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.581**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.014**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	B Portal (Wongawilli)	----	----	----	----
			Client sampling date / time	06-Feb-2020 10:55	----	----	----	----
Compound	CAS Number	LOR	Unit	EW2000609-011	--------	--------	--------	--------
				Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	**0.086**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.83**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	**0.07**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.10**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**3**	----	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	----	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**60**	----	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	----	----	----	----

APPENDIX 2

Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014

The coal washery rejects exemption 2014

Introduction

This exemption:

- is issued by the Environment Protection Authority (EPA) under clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 (Waste Regulation); and
- exempts a consumer of coal washery rejects from certain requirements under the *Protection of the Environment Operations Act 1997* (POEO Act) and the Waste Regulation in relation to the application of that waste to land, provided the consumer complies with the conditions of this exemption.

This exemption should be read in conjunction with 'the coal washery rejects order 2014'.

1. Waste to which this exemption applies

1.1. This exemption applies to coal washery rejects that are, or are intended to be, applied to land in earthworks for civil engineering applications.

1.2. Coal washery rejects is the waste resulting from washing coal (including substances such as coal fines, soil, sand and rock resulting from that process).

2. Persons to whom this exemption applies

2.1. This exemption applies to the any person who applies, or intends to apply, coal washery rejects to land as set out in 1.1.

3. Duration

3.1. This exemption commences on 24 November 2014 and is valid until revoked by the EPA by notice published in the Government Gazette.

4. Premises to which this exemption applies

4.1. This exemption applies to the premises at which the consumer's actual or intended application of coal washery rejects is carried out.

5. Revocation

5.1. 'The coal washery rejects general exemption 2009' which commenced on 1 November 2009, is revoked from 24 November 2014.

6. Exemption

6.1. Subject to the conditions of this exemption, the EPA exempts each consumer from the following provisions of the POEO Act and the Waste Regulation in relation to the consumer's actual or intended application of coal washery rejects to land in earthworks for civil engineering applications at the premises:

- section 48 of the POEO Act in respect of the scheduled activities described in clauses 39 and 42 of Schedule 1 of the POEO Act;
- Part 4 of the Waste Regulation;
- section 88 of the POEO Act; and
- clause 109 and 110 of the Waste Regulation.

6.2. The exemption does not apply in circumstances where coal washery rejects are received at the premises for which the consumer holds a licence under the POEO Act that authorises the carrying out of the scheduled activities on the premises under clause 39 'waste disposal (application to land)' or clause 40 'waste disposal (thermal treatment)' of Schedule 1 of the POEO Act.

7. Conditions of exemption

The exemption is subject to the following conditions:

7.1. At the time the coal washery rejects are received at the premises, the material must meet all chemical and other material requirements for coal washery rejects which are required on or before the supply of coal washery rejects under 'the coal washery rejects order 2014'.

7.2. The coal washery rejects can only be applied to land in earthworks for civil engineering applications. Approval does not apply to any of the following applications:

7.2.1. Construction of dams or related water storage infrastructure,

7.2.2. Mine site rehabilitation,

7.2.3. Quarry rehabilitation,

7.2.4. Sand dredge pond rehabilitation,

7.2.5. Back-filling of quarry voids,

7.2.6. Raising or reshaping of land used for agricultural purposes, and

7.2.7. Construction of roads on private land unless:

(a) the coal washery rejects are applied to land to the minimum extent necessary for the construction of a road, and
(b) a development consent for the development has been granted under the relevant Environmental Planning Instrument (EPI), or
(c) it is to provide access (temporary or permanent) to a development approved by a Council, or
(d) the works undertaken are either exempt or complying development.

7.3. The consumer can only apply coal washery rejects to land where it is not applied in or beneath water, including groundwater.

7.4. The consumer must keep a written record of the following for a period of six years:

- the quantity of any coal washery rejects received; and
- the name and address of the supplier of the coal washery rejects received.

7.5. The consumer must make any records required to be kept under this exemption available to authorised officers of the EPA on request.

7.6. The consumer must ensure that any application of coal washery rejects to land must occur within a reasonable period of time after its receipt.

8. Definitions

In this exemption:

application or apply to land means applying to land by:

- spraying, spreading or depositing on the land; or
- ploughing, injecting or mixing into the land; or
- filling, raising, reclaiming or contouring the land.

consumer means a person who applies, or intends to apply, coal washery rejects to land.

Manager Waste Strategy and Innovation

Environment Protection Authority

(by delegation)

Notes

The EPA may amend or revoke this exemption at any time. It is the responsibility of the consumer to ensure they comply with all relevant requirements of the most current exemption. The current version of this exemption will be available on www.epa.nsw.gov.au

In gazetting or otherwise issuing this exemption, the EPA is not in any way endorsing the use of this substance or guaranteeing that the substance will confer benefit.

The conditions set out in this exemption are designed to minimise the risk of potential harm to the environment, human health or agriculture, although neither this exemption nor the accompanying order guarantee that the environment, human health or agriculture will not be harmed.

The consumer should assess whether or not the coal washery rejects is fit for the purpose the material is proposed to be used for, and whether this use will cause harm. The consumer may need to seek expert engineering or technical advice.

Regardless of any exemption provided by the EPA, the person who causes or permits the application of the substance to land must ensure that the action is lawful and consistent with any other legislative requirements including, if applicable, any development consent(s) for managing operations on the site(s).

The receipt of coal washery rejects remains subject to other relevant environmental regulations in the POEO Act and the Waste Regulation. For example, a person who pollutes land (s. 142A) or water (s. 120), or causes air pollution through the emission of odours (s. 126), or does not meet the special requirements for asbestos waste (Part 7 of the Waste Regulation), regardless of having an exemption, is guilty of an offence and subject to prosecution.

This exemption does not alter the requirements of any other relevant legislation that must be met in utilising this material, including for example, the need to prepare a Safety Data Sheet (SDS).

Failure to comply with the conditions of this exemption constitutes an offence under clause 91 of the Waste Regulation.

Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014

The coal washery rejects order 2014

Introduction

This order, issued by the Environment Protection Authority (EPA) under clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 (Waste Regulation), imposes the requirements that must be met by suppliers of coal washery rejects to which 'the coal washery rejects exemption 2014' applies. The requirements in this order apply in relation to the supply of coal washery rejects for application to land in earthworks for civil engineering applications.

1. Waste to which this order applies

1.1 This order applies to coal washery rejects. In this order, coal washery rejects means the waste resulting from washing coal (including substances such as coal fines, soil, sand and rock resulting from that process).

2. Persons to whom this order applies

2.1 The requirements in this order apply, as relevant, to any person who supplies coal washery rejects that have been generated, processed or recovered by the person.

2.2 This order does not apply to the supply of coal washery rejects to a consumer for land application purposes at a premises for which the consumer holds a licence under the POEO Act that authorises the carrying out of the scheduled activities on the premises under clause 39 'waste disposal (application to land)' or clause 40 'waste disposal (thermal treatment)' of Schedule 1 of the POEO Act.

3. Duration

3.1 This order commences on 24 November 2014 and is valid until revoked by the EPA by notice published in the Government Gazette.

4. Generator requirements

The EPA imposes the following requirements on any generator who supplies coal washery rejects.

Sampling requirements

4.1 On or before supplying coal washery rejects, the generator must:

4.1.1 Prepare a written sampling plan which includes a description of sample preparation and storage procedures for the coal washery rejects.

4.1.2 Undertake sampling and testing of the coal washery rejects as required under clauses 4.2 and 4.3 below. The sampling must be carried out in accordance with the written sampling plan and Australian Standard 1141.3.1-2012 Methods for sampling and testing aggregates – Sampling – Aggregates (or equivalent).

4.2 Where the coal washery rejects are generated as part of a continuous process, the processor must undertake the following sampling:

4.2.1. Characterisation of the coal washery rejects by collecting 20 composite samples of the waste and testing each sample for the chemicals and other attributes listed in Column 1 of Table 1. Each composite sample must be taken from a batch, truckload or stockpile that has not been previously sampled for the purposes of characterisation. Characterisation must be conducted for coal washery rejects generated and processed during each 2-year period following the commencement of the continuous process; and

4.2.2. Routine sampling of the coal washery rejects by collecting either 5 composite samples from every 10,000 tonnes (or part thereof) processed or 5 composite samples every 6 months (whichever is the lesser); and testing each sample for the chemicals and other attributes listed in Column 1 of Table 1 other than those listed as 'not required' in Column 3. Each composite sample must be taken from a batch, truckload or stockpile that has not been previously sampled for the purposes of routine sampling. However, if characterisation sampling occurs at the same frequency as routine sampling, any sample collected and tested for the purposes of characterisation under clause 4.2.1 may be treated as a sample collected and tested for the purposes of routine sampling under clause 4.2.2.

4.3. Where the coal washery rejects are not generated as part of a continuous process, the generator must undertake one-off sampling of discrete batches, truckloads or stockpiles, by collecting 10 composite samples from every 4,000 tonnes (or part thereof) generated and testing each sample for the chemicals and other attributes listed in Column 1 of Table 1. The test results for each composite sample must be validated as compliant with the maximum average concentration or other value listed in Column 2 of Table 1 and the absolute maximum concentration or other value listed in Column 4 of Table 1 prior to the supply of the coal washery rejects.

Chemical and other material requirements

4.4. The processor must not supply coal washery rejects to any person if, in relation to any of the chemical and other attributes of the coal washery rejects:

4.4.1. The concentration or other value of that attribute of any sample collected and tested as part of the characterisation or the routine or one-off sampling of the coal washery rejects exceeds the absolute maximum concentration or other value listed in Column 4 of Table 1, or

4.4.2. The average concentration or other value of that attribute from the characterisation or one-off sampling of coal washery rejects (based on the arithmetic mean) exceeds the maximum average concentration or other value listed in Column 2 of Table 1, or

4.4.3. The average concentration or other value of that attribute from the routine sampling of coal washery rejects (based on the arithmetic mean) exceeds the maximum average concentration or other value listed in Column 3 of Table 1.

4.5. The absolute maximum concentration or other value of that attribute in any coal washery rejects supplied under this order must not exceed the absolute maximum concentration or other value listed in Column 4 of Table 1.

Table 1

Column 1	Column 2	Column 3	Column 4
Chemicals and other attributes	**Maximum average concentration for characterisation** (mg/kg 'dry weight' unless otherwise specified)	**Maximum average concentration for routine testing** (mg/kg 'dry weight' unless otherwise specified)	**Absolute maximum concentration** (mg/kg 'dry weight' unless otherwise specified)
1. Mercury	0.5	Not required	1
2. Cadmium	0.5	Not required	1
3. Lead	50	50	100
4. Arsenic	10	Not required	20
5. Chromium (total)	75	75	150
6. Copper	50	50	100
7. Nickel	40	40	80
8. Selenium	2	Not required	5
9. Zinc	100	100	200
10. Electrical Conductivity	1 dS/m	1dS/m	2 dS/m
11. pH*	8 to 11	Not required	7 to 12
12. Combustible content	30%	30%	40%
13. Sulphur %	0.5%	0.5%	1%

*Note: The ranges given for pH are for the minimum and maximum acceptable pH values in the coal washery rejects.

Test methods

4.6. The generator must ensure that any testing of samples required by this order is undertaken by analytical laboratories accredited by the National Association of Testing Authorities (NATA), or equivalent.

4.7. The generator must ensure that the chemicals and other attributes (listed in Column 1 of Table 1) in the coal washery rejects it supplies are tested in accordance with the test methods specified below or other equivalent analytical methods. Where an equivalent analytical method is used the detection limit must be equal to or less than that nominated for the given method below.

4.7.1. Test method for measuring the mercury concentration:

4.7.1.1. Analysis using USEPA SW-846 Method 7471B Mercury in solid or semisolid waste (manual cold-vapor technique), or an equivalent analytical method with a detection limit < 20% of the stated absolute maximum concentration in Table 1, Column 4 (i.e. < 0.2 mg/kg dry weight).

4.7.1.2. Report as mg/kg dry weight.

4.7.2. Test methods for measuring chemicals 2 - 9:

4.7.2.1. Sample preparation by digestion using USEPA SW-846 Method 3051A Microwave assisted acid digestion of sediments, sludges, soils, and oils.

4.7.2.2. Analysis using USEPA SW-846 Method 6010C Inductively coupled plasma - atomic emission spectrometry, or an equivalent analytical method with an appropriate detection limit.

4.7.2.3. Report as mg/kg dry weight.

4.7.3. Test methods for measuring the electrical conductivity and pH:

4.7.3.1. Sample preparation by mixing 1 part coal washery rejects with 5 parts distilled water.

4.7.3.2. Analysis using Method 103 (pH) and 104 (Electrical Conductivity) in Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or an equivalent analytical method).

4.7.3.3. Report electrical conductivity in deciSiemens per metre (dS/m).

4.7.4. Test methods for measuring the combustible content and sulphur content:

4.7.4.1. Australian Standard 1038 Coal and coke (or an equivalent analytical method).

4.7.4.2. Report combustible content and sulphur content as %.

Notification

4.8. On or before each transaction, the generator must provide the following to each person to whom the generator supplies the coal washery rejects:

- a written statement of compliance certifying that all the requirements set out in this order have been met;
- a copy of the coal washery rejects exemption, or a link to the EPA website where the coal washery rejects exemption can be found; and
- a copy of the coal washery rejects order, or a link to the EPA website where the coal washery rejects order can be found.

Record keeping and reporting

4.9. The generator must keep a written record of the following for a period of six years:

- the sampling plan required to be prepared under clause 4.1.1;
- all characterisation, routine and/or one-off sampling results in relation to the coal washery rejects supplied;
- the quantity of the coal washery rejects supplied; and

- the name and address of each person to whom the generator supplied the coal washery rejects.

4.10. The generator must provide, on request, the most recent characterisation and sampling (whether routine or one-off or both) results for coal wash rejects supplied to any consumer of the coal washery rejects.

4.11. The generator must notify the EPA within seven days of becoming aware that it has not complied with any requirement in clause 4.1 to 4.7.

5. Definitions

In this order:

application or apply to land means applying to land by:

- spraying, spreading or depositing on the land; or
- ploughing, injecting or mixing into the land; or
- filling, raising, reclaiming or contouring the land.

composite sample means a sample that combines five discrete sub-samples of equal size into a single sample for the purpose of analysis.

consumer means a person who applies, or intends to apply, coal washery rejects to land.

continuous process means a process that produces coal washery rejects on an ongoing basis.

generator means a person who generates coal washery rejects.

transaction means:

- in the case of a one-off supply, the supply of a batch, truckload or stockpile of coal washery rejects that is not repeated.
- in the case where the supplier has an arrangement with the recipient for more than one supply of coal washery rejects, the first supply of coal washery rejects as required under the arrangement.

Manager Waste Strategy and Innovation

Environment Protection Authority

(by delegation)

Notes

The EPA may amend or revoke this order at any time. It is the responsibility of each of the generator and processor to ensure it complies with all relevant requirements of the most current order. The current version of this order will be available on www.epa.nsw.gov.au

In gazetting or otherwise issuing this order, the EPA is not in any way endorsing the supply or use of this substance or guaranteeing that the substance will confer benefit.

The conditions set out in this order are designed to minimise the risk of potential harm to the environment, human health or agriculture, although neither this order nor the accompanying exemption guarantee that the environment, human health or agriculture will not be harmed.

Any person or entity which supplies coal washery rejects should assess whether the material is fit for the purpose the material is proposed to be used for, and whether this use may cause harm. The supplier may need to seek expert engineering or technical advice.

Regardless of any exemption or order provided by the EPA, the person who causes or permits the application of the substance to land must ensure that the action is lawful and consistent with any other legislative requirements including, if applicable, any development consent(s) for managing operations on the site(s).

The supply of coal washery rejects remains subject to other relevant environmental regulations in the POEO Act and Waste Regulation. For example, a person who pollutes land (s. 142A) or water (s. 120), or causes air pollution through the emission of odours (s. 126), or does not meet the special requirements for asbestos waste (Part 7 of the Waste Regulation), regardless of this order, is guilty of an offence and subject to prosecution.

This order does not alter the requirements of any other relevant legislation that must be met in supplying this material, including for example, the need to prepare a Safety Data Sheet. Failure to comply with the conditions of this order constitutes an offence under clause 93 of the Waste Regulation.

APPENDIX 7

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Wollongong Coal Limited

Russell Vale Colliery

Underground Expansion Project

Catchment Monitoring Program

March 2020

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1 INTRODUCTION

The Department of Planning, Industry and Environment (DPIE) requested that Wollongong Coal Limited (WCL) provide the following information for the Russell Vale Underground Expansion project (UEP):

- A summary of the swamp related monitoring program completed including baseline, during mining of LWs 4-6, and post mining (2015-present). Information should include the number of sampling locations and type of monitoring in relevant swamps (including control sites).

The information required by DPIE is outlined within this report.

The location of the existing and proposed monitoring locations is outlined within the Figure contained within Appendix 1.

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2 PRE-MINING AND ACTIVE MINING PERIODS CATCHMENT MONITORING

2.1 Surface Water

Control and impact catchment surface water level and water quality monitoring along Cataract Creek and Cataract River before mining (Baseline) and during active mining are outlined in **Table 1**.

The monitoring frequency is also outlined within **Table 1**.

All sites were monitored for water level continuously using a logger that was downloaded monthly.

Table 1: Historical Monitoring Before and During Mining Surface Water Monitoring

Control or Impact	Swamp Reference	Surface Water Site	Water Level Monitoring Frequency	Pre-Mining Period Field (^)	Active Mining Period Field (^)
Control – Cataract Creek	-	CC3	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC4	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC5	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC6	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC7	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC8	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC9	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CC10	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract Creek	-	CT3	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract River	-	CR3	Continuous (Monthly Download)	Monthly	Weekly
Control – Cataract River	-	CR4	Continuous (Monthly Download)	Monthly	Weekly
Impact (Longwall 5)	-	SP1c	Continuous (Monthly Download)	Monthly	Weekly
Impact (Longwall 5)	CCUS3	CCUS3	Continuous (Monthly Download)	Monthly	Weekly
Impact (Longwall 6)	CCUS4	CT3a	Continuous (Monthly Download)	Monthly	Weekly
Impact (Longwall 6)	CCUS4	CCus4c	Continuous (Monthly Download)	Monthly	Weekly
Impact (Longwall 6)	CRUS1	Crus1c	Continuous (Monthly Download)	Monthly	Weekly

^ Field Samples = EC, pH, DO, ORP, temp and turbidity

2.2 Swamp Piezometers

Swamp piezometer monitoring before mining (as Baseline) and during active mining are outlined in **Table 2**.

The water quality monitoring frequency is also outlined within **Table 2**.

All sites were monitored for water level continuously using a logger that was downloaded monthly.

Table 2: Historical Monitoring Before and During Mining for Swamp Piezometers

Control or Impact	Swamp Reference	Piezometer	Installed	Pre-Mining Period			Active Mining Period		
				Data Collection	Water Quality Field (^)	Water Quality Lab (#)	Data Collection	Water Quality Field (^)	Water Quality Lab (#)
Control (Proposed LW7)	CCU55	**PcC5A**	May 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Control (Proposed LW7)	CCU55	**PcC5B**	May 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Control (Proposed LW7)	CCU55	**PcC5C**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Control (Proposed LW7)	CCU55	**PcC5D**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Control (Near LW6)	CRUS1	**PCr1A**	March 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Control (Near LW6)	CRUS1	**PCr1B**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW4	CCUS21	**PCc6**	March 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW5	-	**SP1**	March 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW5	-	**SP2**	March 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW5	CCUs3	**PCc3**	March 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW6	CCUS4	**PCc4A**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW6	CCUS4	**PCc4B**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW6	CCUS4	**PCc4C**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW6	CCUS4	**PCc4D**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW6	CRUS1	**PCr1C**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly
Impact - LW6	CRUS1	**PCr1D**	October 2014	Continuous (Monthly Download)	Bi-monthly	Quarterly	Continuous (Monthly Download)	Bi-weekly	Monthly

2.3 Swamp Soil Moisture

Swamp soil moisture monitoring before mining (Baseline) and during active mining is outlined in **Table 3**.

All sites were monitored continuously using a data logger that was downloaded monthly.

Table 3: Historical Monitoring Before and During Mining for Swamp Soil Moisture

Control or Impact	Swamp Reference	Piezometer	Installed	Data Collection
Control (Proposed LW7)	CCU55	**PcC5A**	May 2012	Continuous (Monthly Download)
Control (Proposed LW7)	CCU55	**PcC5B**	May 2012	Continuous (Monthly Download)
Control (Proposed LW7)	CCU55	**PcC5C**	October 2014	Continuous (Monthly Download)
Control (Proposed LW7)	CCU55	**PcC5D**	October 2014	Continuous (Monthly Download)
Control (Near LW6)	CRUS1	**PCr1A**	March 2012	Continuous (Monthly Download)
Control (Near LW6)	CRUS1	**PCr1B**	October 2014	Continuous (Monthly Download)
Impact - LW4	CCUS21	**PCc6**	March 2012	Continuous (Monthly Download)
Impact - LW5	-	**SP1**	March 2012	Continuous (Monthly Download)
Impact - LW5	-	**SP2**	March 2012	Continuous (Monthly Download)
Impact - LW5	CCUs3	**PCc3**	March 2012	Continuous (Monthly Download)
Impact - LW6	CCUS4	**PCc4A**	October 2014	Continuous (Monthly Download)
Impact - LW6	CCUS4	**PCc4B**	October 2014	Continuous (Monthly Download)
Impact - LW6	CCUS4	**PCc4C**	October 2014	Continuous (Monthly Download)
Impact - LW6	CCUS4	**PCc4D**	October 2014	Continuous (Monthly Download)
Impact - LW6	CRUS1	**PCr1C**	October 2014	Continuous (Monthly Download)
Impact - LW6	CRUS1	**PCr1D**	October 2014	Continuous (Monthly Download)

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2.4 Ecology Monitoring

Ecology monitoring before mining (Baseline) and during active mining is outlined in Table 4.

Table 4: Historical Monitoring Before and During Mining for Ecology

Swamp Reference	Ecology Monitoring	Commenced	Frequency	Monitoring Status / Date Ceased
BCUS2	Frogs	Summer 2013	Spring & Autumn	Spring 2017
BCUS2	Frogs	Summer 2013	Spring & Autumn	Spring 2017
BCUS4	Vegetation, Dragonfly	Spring 2013	Spring & Autumn	Spring 2017
BCUS11	Vegetation	Spring 2013	Spring & Autumn	Spring 2017
CCUS1	Vegetation, Dragonfly	Autumn 2012	Spring & Autumn	Ongoing
CCUS1	Frogs	Winter 2012	Spring & Autumn	Spring 2017
CCUS2	Vegetation, Frogs	Autumn 2012	Spring & Autumn	Spring 2017
CCUS3	Vegetation	Autumn 2012	Spring & Autumn	Ongoing
CCUS4	Vegetation, Dragonfly, Frogs	Autumn 2012	Spring & Autumn	Ongoing
CCUS5	Vegetation, Dragonfly	Autumn 2013	Spring & Autumn	Ongoing
CCUS10	Vegetation, Dragonfly	Autumn 2013	Spring & Autumn	Spring 2017
CCUS12	Vegetation	Autumn 2013	Spring & Autumn	Spring 2017
CRUS1	Vegetation	Autumn 2011	Spring & Autumn	Ongoing
CRUS1	Frogs	Winter 2012	Spring & Autumn	Spring 2017
CRUS2	Vegetation, Frogs	Spring 2012	Spring & Autumn	Spring 2017
CRUS3	Vegetation	Autumn 2012	Spring & Autumn	Spring 2017

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3 CURRENT CATCHMENT MONITORING

3.1 Surface Water

Surface water monitoring is undertaken in accordance with the *Russell Vale East Water Management Plan*. The surface water monitoring program includes monitoring of water levels, water quality and stream flows.

Current control and impact catchment surface water level and water quality monitoring along Cataract Creek and Cataract River is outlined in **Table 5**.

The monitoring frequency is also outlined within **Table 5**.

All sites are monitored for water level continuously using a logger that is downloaded monthly.

Table 5: Current Surface Water Monitoring

Control or Impact	Swamp Reference	Surface Water Site	Water Level Monitoring Frequency	Water Quality Monitoring Frequency Field (^)
Control – Cataract Creek	-	CC3	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC4	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC5	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC6	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC7	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC8	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC9	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CC10	Continuous (Monthly Download)	Bi-monthly
Control – Cataract Creek	-	CT3	Continuous (Monthly Download)	Bi-monthly
Control – Cataract River	-	CR3	Continuous (Monthly Download)	Bi-monthly
Control – Cataract River	-	CR4	Continuous (Monthly Download)	Bi-monthly
Impact (Longwall 5)	-	SP1c	Continuous (Monthly Download)	Bi-monthly
Impact (Longwall 5)	CCUS3	CCUS3	Continuous (Monthly Download)	Bi-monthly
Impact (Longwall 6)	CCUS4	CT3a	Continuous (Monthly Download)	Bi-monthly
Impact (Longwall 6)	CCUS4	CCus4c	Continuous (Monthly Download)	Bi-monthly
Impact (Longwall 6)	CRUS1	Crus1c	Continuous (Monthly Download)	Bi-monthly

^ Field Samples = EC, pH, DO, ORP, temp and turbidity

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3.2 Swamp Piezometers

Swamp monitoring is undertaken in accordance with the both the *Biodiversity Management Plan* and *Upland Swamp Management P*lan.

Current control and impact catchment swamp piezometer water level and water quality monitoring is outlined in Table 6.

The monitoring frequency is also outlined within Table 6.

All sites are monitored for water level continuously using a logger that is downloaded monthly.

Table 6: Current Monitoring for Swamp Piezometers

Control or Impact	Swamp Reference	Piezometer	Installed	Monitoring Frequency		
				Monitoring Frequency	Field (^)	Lab (#)
Control (Proposed LW7)	CCU55	PcC5A	May 2012	Continuous (Monthly Download)	Bi-monthly	Quarterly
Control (Proposed LW7)	CCU55	PcC5B	May 2012	Continuous	Bi-monthly	Quarterly
Control (Proposed LW7)	CCU55	PcC5C	October 2014	(Monthly Download)	Bi-monthly	Quarterly
Control (Proposed LW7)	CCU55	PcC5D	October 2014	Continuous	Bi-monthly	Quarterly
Control (Near LW6)	CRUS1	PCr1A	March 2012	(Monthly Download)	Bi-monthly	Quarterly
Control (Near LW6)	CRUS1	PCr1B	October 2014	Continuous	Bi-monthly	Quarterly
Impact - LW4	CCUS21	PCc6	March 2012	(Monthly Download)	Bi-monthly	Quarterly
Impact - LW5	-	SP1	March 2012	Continuous	Bi-monthly	Quarterly
Impact - LW5	-	SP2	March 2012	(Monthly Download)	Bi-monthly	Quarterly
Impact - LW5	CCUs3	PCc3	March 2012	Continuous	Bi-monthly	Quarterly
Impact - LW6	CCUS4	PCc4A	October 2014	(Monthly Download)	Bi-monthly	Quarterly
Impact - LW6	CCUS4	PCc4B	October 2014	Continuous	Bi-monthly	Quarterly
Impact - LW6	CCUS4	PCc4C	October 2014	(Monthly Download)	Bi-monthly	Quarterly
Impact - LW6	CCUS4	PCc4D	October 2014	Continuous	Bi-monthly	Quarterly
Impact - LW6	CRUS1	PCr1C	October 2014	(Monthly Download)	Bi-monthly	Quarterly
Impact - LW6	CRUS1	PCr1D	October 2014	Continuous	Bi-monthly	Quarterly

^ Field Samples = EC, pH, DO, ORP, temp and turbidity
# Laboratory Samples - TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered).

3.3 Swamp Soil Moisture

Swamp monitoring is undertaken in accordance with the both the *Biodiversity Management Plan* and *Upland Swamp Management P*lan.

Current control and impact catchment swamp soil moisture monitoring is outlined in Table 7.

The monitoring frequency is also outlined within Table 7.

All sites are monitored for soil moisture continuously using a logger that is downloaded monthly.

Table 7: Current Monitoring for Swamp Soil Moisture

Control or Impact	Swamp Reference	Piezometer	Installed	Data Collection
Control (Proposed LW7)	CCU55	PcC5A	May 2012	Continuous (Monthly Download)
Control (Proposed LW7)	CCU55	PcC5B	May 2012	Continuous (Monthly Download)
Control (Proposed LW7)	CCU55	PcC5C	October 2014	Continuous (Monthly Download)
Control (Proposed LW7)	CCU55	PcC5D	October 2014	Continuous (Monthly Download)
Control (Near LW6)	CRUS1	PCr1A	March 2012	Continuous (Monthly Download)
Control (Near LW6)	CRUS1	PCr1B	October 2014	Continuous (Monthly Download)
Impact - LW4	CCUS21	PCc6	March 2012	Continuous (Monthly Download)
Impact - LW5	-	SP1	March 2012	Continuous (Monthly Download)
Impact - LW5	-	SP2	March 2012	Continuous (Monthly Download)
Impact - LW5	CCUs3	PCc3	March 2012	Continuous (Monthly Download)
Impact - LW6	CCUS4	PCc4A	October 2014	Continuous (Monthly Download)
Impact - LW6	CCUS4	PCc4B	October 2014	Continuous (Monthly Download)
Impact - LW6	CCUS4	PCc4C	October 2014	Continuous (Monthly Download)
Impact - LW6	CCUS4	PCc4D	October 2014	Continuous (Monthly Download)
Impact - LW6	CRUS1	PCr1C	October 2014	Continuous (Monthly Download)
Impact - LW6	CRUS1	PCr1D	October 2014	Continuous (Monthly Download)

3.4 Ecology Monitoring

Ecology monitoring is undertaken in accordance with the both the *Biodiversity Management Plan* and *Upland Swamp Management P*lan.

Current ecology monitoring is outlined in **Table 8**.

The current monitoring frequency is also outlined within **Table 8**.

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Table 8: Current Monitoring for Ecology

Swamp Reference	Ecology Monitoring	Commenced	Frequency
CCUS1	Vegetation, Dragonfly	Autumn 2012	Spring & Autumn
CCUS3	Vegetation	Autumn 2012	Spring & Autumn
CCUS4	Vegetation, Dragonfly, Frogs	Autumn 2012	Spring & Autumn
CCUS5	Vegetation, Dragonfly	Autumn 2013	Spring & Autumn
CRUS1	Vegetation	Autumn 2011	Spring & Autumn

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4 PROPOSED CATCHMENT MONITORING

4.1 Surface Water Monitoring

The current stream level, flow and water quality monitoring, as outlined in **Table 5**, for sites along Cataract River and Cataract Creek will continue.

The surface water sites outlined within **Table 5** are currently well located to provide wide coverage along both watercourses and tributaries. Therefore, no additional stream level, flow and water quality monitoring sites are proposed to be established within these watercourses.

4.2 Swamp Piezometers

Swamp piezometers outlined within **Table 6** will continue to be monitored at the frequency outlined within **Table 6** except during the active mining period where the frequency will be increased to weekly.

Additional swamp piezometers will be installed within swamps, as outlined within **Table 9**.

Table 9: Additional Swamp Piezometers

Swamps	Swamp Number	Borehole Location	Approximate Depth	Groundwater Level Monitoring	Water Quality Monitoring
Shallow Open Standpipe Piezometers (OSPs)					
UEP-SWP-OSP18	CCUS14	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP19	CRUS4	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP20	CCUS1	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP21	CCUS1	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP22	CCUS2	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP23	CRUS2	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP24	CRUS1	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-SWP-OSP25	CRUS6	Swamp	Max. 5 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period

4.3 Swamp Soil Moisture

Swamp soil moisture outlined within **Table 7** will continue to be monitored at the frequency outlined within **Table 7** except during the active mining period where the frequency will be increased to weekly.

Additional swamp soil moisture monitoring will be conducted at sites within swamps outlined within **Table 9**.

4.4 Ecology Monitoring

Monitoring of ecology will be undertaken in accordance with the revised and updated *Biodiversity Management Plan* and *Upland Swamp Management Plan*.

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The existing *Biodiversity Management Plan* and *Upland Swamp Management Pla*n will be reviewed and updated to reflect the Revised Preferred Project and associated management and monitoring measures.

Given that no perceptible subsidence impacts are predicted to occur as a result of the Revised Preferred Project, monitoring of potential biodiversity impacts will be focussed on subsidence impacts as well as primary impacts to groundwater systems associated with upland swamps, and surface water flow and quality in creeks. This will include:

- Continued subsidence monitoring along existing subsidence monitoring lines, and extension of the program to include relevant monitoring for areas within the Revised Preferred Project first workings mine plan;
- Visual inspection of the rock formation that forms the base of upland swamps CCUS4, CCUS5, CCUS10, BCUS4 and BCUS6 during routine monitoring;
- Monitoring of groundwater levels and water quality in upland swamps using the existing network of shallow groundwater piezometers;
- Continued monitoring of surface outflow monitoring in upland swamp CCUS4 using the existing box weir (site CT3a); and
- Monitoring of surface water levels and water quality in Cataract Creek and tributaries using the network of existing sites.

The current Spring and Autumn ecology monitoring as outlined within Table 7 will continue.

4.5 Groundwater Monitoring

The existing *Russell Vale East Water Management Plan* will be reviewed and updated in consultation with DPE-Planning and DPIE-Water and the updated plan will be implemented for the Project.

The existing groundwater monitoring network will continue to be utilised to monitor impacts associated with the Project. The existing groundwater monitoring program will be reviewed and updated to reflect the Project as part of an update to the existing *Russell Vale East Water Management Plan*. The proposed updated groundwater monitoring is outlined within Section 4.5.1 for Panel 2 and Section 4.5.2 for Panel 18.

The groundwater monitoring program will include monitoring of groundwater levels, water quality, pumping volumes and stream flows. The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model as required.

Existing monitoring and management measures associated with the historical mining of longwalls 4 to 6 will remain in place with triggers updated to reflect the reduced groundwater and subsidence impacts for the Revised Preferred Project.

No changes to current groundwater management practices are considered to be warranted, however all monitoring results and management practices will be reviewed regularly to ensure they remain appropriate given the scale of observed impacts.

4.5.1 Panel 2

The groundwater monitoring proposed for Panel 2 is outlined within Table 10.

The proposed groundwater bores are outlined within the Figure contained within Appendix 1.

It is proposed that this monitoring would be established before first mining commences at Panel 1, which will enable monitoring results and observations from commencement of mining.

Table 10: Proposed Groundwater Monitoring – Panel 2

Panel 2	Orientation Relation to Panel	Borehole Location	Approximate Depth	Groundwater Level Monitoring	Water Quality Monitoring
Shallow Open Standpipe Piezometers (OSPs)					
UEP-P2-OSP1	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP2	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP3	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP4	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP5	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP6	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP7	Cross Panel Axis	Roadway	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P2-OSP8	Cross Panel Axis	Roadway	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP- CP1/2-OSP9	Cross Panel Axis	Chain Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-CP2/3-OSP10	Cross Panel Axis	Chain Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
Deep Vibrating Wire Piezometers (VWP)					
UEP-P2-VWP1	Long Panel Axis	Centre Pillar	Max. 200 m	Continuous	Nil
UEP-P2-VWP2	Long Panel Axis	Centre Pillar	Max. 200 m	Continuous	Nil
UEP- CP1/2-VWP3	Cross Panel Axis	Centre Pillar	Max. 200 m	Continuous	Nil
UEP- CP1/2-VWP4	Cross Panel Axis	Centre Pillar	Max. 200 m	Continuous	Nil
Distant Drawdown Effects Piezometers					
UEP-CP3/4-OSP11	Cross Panel Axis	Chain Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-CP3/4-VWP5	Cross Panel Axis	Chain Pillar	Max. 200 m	Continuous	Nil
UEP- CP5/6-OSP12	Cross Panel Axis	Chain Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP- CP5/6-VWP6	Cross Panel Axis	Chain Pillar	Max. 200 m	Continuous	Nil

The groundwater monitoring program designed for Panel 2 is extensive and has been designed to provide monitoring information from both the shallow groundwater system and deeper groundwater as the first workings develop within the panel.

Panel 2 monitoring consists of a number of shallow open standpipe piezometers (OSP) along the longitudinal axis of the panel that will be installed approximately 120 metres apart within the centre pillar. This will enable review of the subsidence wave (if any is noticeable) as the development of the roadways progresses along the long axis of the panel. A row of cross shallow OSPs will also be installed with some bores located over the roadway. These piezometers will enable review of response in the shallow groundwater as the roadway development passes under the panel.

The shallow OSPs will be installed at a depth that is 10 metres below first groundwater make during drilling with the basal 10 metres screened. These OSPs are anticipated to range in depth from 20 metres to a maximum depth of 50 metres, which is dependant of the locations of piezometric surface. Each shallow OSP will have a data logger installed within the screened section to enable continuous groundwater level to be recorded. Additionally as the OSPs are open stand pipe piezometers, a regular manual dip can be conducted to record groundwater level as a calibration of the data logger readings. A water quality sample can also be taken at the time of the manual groundwater level dip reading.

Two long axis deep vibrating wire piezometers (VWP) will also be installed at either end of the panel within the centre pillar, which will be adjacent and coupled with one on the long axis shallow OSPs. Two additional deep VWPs will be located in the chain pillar adjacent either side of the panel in a cross axis orientation and coupled with one of the shallow OSP. The VWP will be drilled the Upper Bulgo Sandstone, with the end of the hole being 50 metres from the base of the Bald Hill Claystone. These VWPs will have about 7 strings installed within the upper, mid and lower Hawkesbury Sandstone, 5 metres above the Bald Hill Claystone, mid Bald Hill Claystone, 5 metres below the Bald Hill Claystone and Upper Bulgo Sandstone. The upper Hawkesbury Sandstone VWP string will be located at a similar position below ground level as the coupled OSP screened interval, which will enable data correlation between the OSP and VWP. The VWPs strings will be grouted in the hole and the monitoring data will be recorded continuously and downloaded monthly.

To record the distant effects from Panel 2 mining, a coupled pair of OSPs and VWPs will also be installed within chain pillar 3/4 and chain pillar 5/6 in approximate line with the cross axis Panel 2 OSPs and VWPs.

It is intended that the monitoring data will be review during and after the mining of Panels 1 and 2 to review if there are any noticeable groundwater drawdown or changes associated with the first working mining. If, as expected, there are minimal observable groundwater impacts, the groundwater monitoring network proposed for future panel will consist of minimal additional piezometers, other than the network that currently exists and that installed for Panel 2 and 18 mining. If on the other hand, groundwater impacts are observed, the groundwater monitoring program outlined above for Panel 2 can be expanded to other panels or a simplified network developed, consisting of one shallow OSP at each end of each panel.

The subsidence monitoring program will be linked to the groundwater program, with a subsidence GNSS unit co-located with each OSP. This will enable direct correlation of any groundwater impact with subsidence. Subsidence monitoring for future panels, is proposed to consist of a GNSS unit located at either end of the long axis of the panel. This will result in low impact on vegetation as each GNSS unit is mounted on a steel pole and data electronically transferred to a central receptor via satellite. This will minimise vegetation clearing required for the GNSS unit install and minimise visits to the GNSS unit during active subsidence period.

4.5.2 Panel 18

The groundwater monitoring proposed for Panel 18 is outlined within Table 11.

The proposed groundwater bores are outlined within the Figure contained within Appendix 1.

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Panel 18 will commence mining concurrently with Panel 2.

A simplified monitoring program is proposed, noting that Panel 18 location has more difficult site access and mindful of locating OSP in locations to minimise vegetation disturbance.

This would consist of three shallow OSPs in the long panel axis and 2 shallow OSPs in the cross panel axis.

Table 11: Proposed Groundwater Monitoring – Panel 2

Panel 18	Orientation Relation to Panel	Borehole Location	Approximate Depth	Groundwater Level Monitoring	Water Quality Monitoring
Shallow Open Standpipe Piezometers (OSPs)					
UEP-P18-OSP13	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P18-OSP14	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P18-OSP15	Long Panel Axis	Centre Pillar	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P18-OSP16	Cross Panel Axis	Roadway	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period
UEP-P18-OSP17	Cross Panel Axis	Roadway	Max. 50 m	Continuous & monthly manual dip	Monthly Weekly During Active Mining Period

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5 APPENDIX 1

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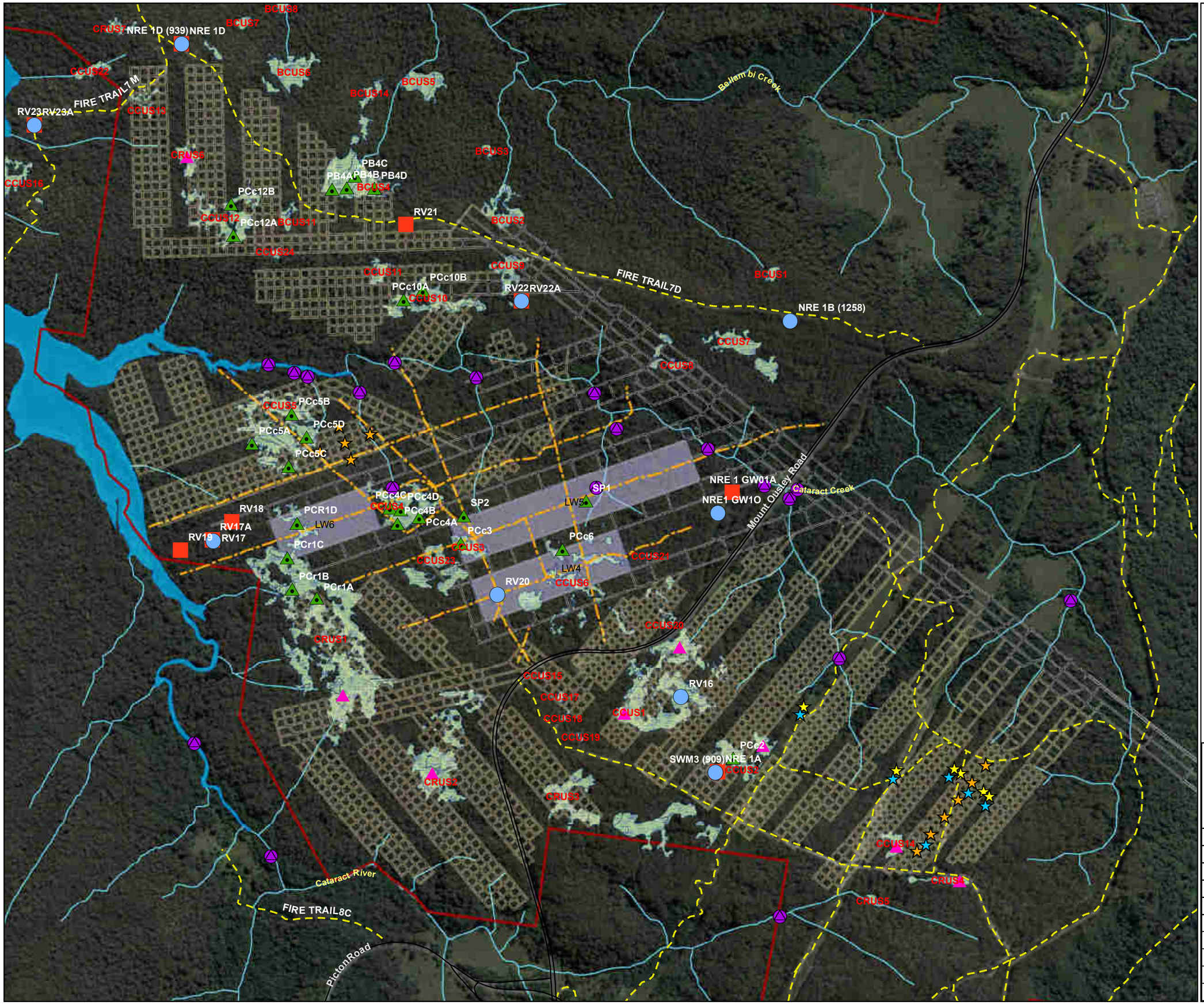

Legend

Proposed Groundwater Monitoring Location

- Shallow Cross Panel OSP
- Shallow Long Panel OSP
- VWP
- Swamp OSP

Existing Groundwater Monitoring Location

- Open Stand Pipe Piezo
- Vibrating Wire Piezo
- Swamp Piezo
- Surface Water Monitoring
- Mt Ousley Road
- Fire Trails (SCA)
- RVC East Wongawilli Seam Workings
- Subsidence Monitoring Line
- Creek
- Swamp Boundaries
- RVC East Wongawilli Seam Goaf
- Catract Reservoir
- WCL RVC Holdings

N

0 240 480
Meters

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WCL RUSSELL VALE COLLIERY
WOLLONGONG COAL LIMITED

TITLE		
RUSSELL VALE COLLIERY UEP AREA		
GROUNDWATER MONITORING		
	NAME	DATE
DRN	RT	18/02/2020
CKD		
APP		
SCALE	1:12,000	@A3
DRAWING NUMBER		REV
RVC-ENV-001		4

APPENDIX 8

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Memo

TRIM Container No: CF-05.01929-Z20/39505
Author's Title/Extension: Senior Civil Assets Engineer - x8893
Date: 2 March 2020

TO:	**STEVEN HORVATH**	**(STRATEGIC PROJECT OFFICER)**
CC:	**NUR JOY**	**(CIVIL ASSET MANAGEMENT UNIT LEADER)**
	JON BRIDGE	**(SENIOR STRATEGIC PROJECT OFFICER)**
	PETER TOBIN	**(SENIOR GEOTECHNICAL OFFICER)**
	KEVIN BOGIE	**(GEOTECHNICAL OFFICER)**
SUBJECT:	**MAINTENANCE IMPLICATIONS AND REQUIRED CONTRIBUTIONS FOR BELLAMBI LN MINIMNG HAULAGE PROPOSAL**	

Introduction
Following the meeting held between City Strategy, Civil Assets and Geotechnical Services on Monday 3 February 2020, an inspection and assessment of into the pavement condition of Bellambi Ln, between Princes Highway and Memorial Dr has been completed. This was undertaken within the context of Wollongong Coal's proposal to reopen the existing colliery at Lot 31 DP1006012, Corrimal.

The proposal, as stated, involves:
- The Colliery operating for a period of five (5) years
- An approximate tonnage of 1,000,000 tons per annum
- Approximately 12,800 laden truck movement per annum totalling 64,000 truck movements over the five-year duration of the proposal
- Semi-Trailers and Rigid-Body Trucks with Dog trailers are proposed; however, B-Double vehicles may be utilised throughout the period of operation.

It is anticipated there will be approximately 12 months of approvals prior to operations commencing on site.

In additional to the above, it is noted that 12,800 truck movements equate to approximately 420,000 tons per annum for a Rigid-Body Truck with Dog Trailer (based on 33t capacity per load) and only approximately 260,000 tons is Semi-Trailers are used (based on 20t capacity per load).

Current Asset Condition
A visual inspection of the road surface and an analysis of the available geotechnical information and testing results was undertaken. This was to determine the current condition of the pavement and inform future maintenance strategies.

Visual inspection of the road surface indicated:
- Areas of aged pavement with visible defects on the eastern and western intersection approaches of Bellambi Ln.
- Multiple areas of pavement along the length of the eastbound carriageway, and extending in some areas into the westbound carriageway, where deep lift asphalt patching maintenance had been undertaken in the past. This work was undertaken in September 2018 to remove localised uplifts in the pavement caused by expensive slag materials in the road base and subbase layers. These local uplifts were generating significant noise
- Pattern cracking was present in the asphalt surface of the eastbound carriageway generally
- Some areas of localised crocodile cracking were present within both carriageways across the length of the road segment.
- The east bound and westbound carriageways appeared to be of disparate construction types.

Analysis of available testing and geotechnical data:

- Borehole data from 1987 shows Bellambi lane to be of roadbase construction over sand drainage to 390mm depth, on the native clayey silt. This construction is still evident in the west bound lanes of the new widened formation.
- The eastbound lanes were built in 1992 using a 60/40 lime to steel furnace slag blend over coalwash. The lime-slag layer was variable in Unconfined Compressive Strength, with results between 3 to 10MPa, classed as heavy bound.
- Beam results in the westbound lanes were measured in 1987. Both the existing westbound and the new eastbound lanes underwent Deflectograph testing in 1996. Results from the 1996 Deflectograph testing are provided below.

	Eastbound Lanes (mm)	Westbound Lanes (mm)	Current Tolerable Deflection (mm)
Memorial Dr to Bowling Alley Driveway	0.607	0.868	1.00
Bowling Alley Driveway to Princes Highway	0.607	0.860	1.00

- Current tolerable deflections for the road segment are 1.0mm. The additional heavy traffic loads will reduce the tolerable deflections to approximately 0.8mm. Further engineering analysis is required to confirm the new tolerable deflection limits.
- Information available indicates that, although there is not “high confidence” in the Deflectograph results, the pavement layers have suitable structural capacity to accommodate current traffic levels.
- With the application of additional heavy vehicle traffic, the westbound lanes are anticipated to be understrength.
- The variable construction of the lime-slag pavement in the eastbound carriageway may present multiple local failures across the length of the road.

Current Remaining Useful Life and Associated Maintenance Strategy

Council holds remaining useful life forecasts for Bellambi Ln in our Asset Management System. These remaining useful life forecasts are provided for each components of the roads structure; the Road Surface, Base Course and Subbase layers. Current remaining useful life forecasts are as follows.

Asset Component	Forecast Reconstruction Year	Remaining Useful Life (in Years – as of Feb 2020)
Road Surface	2030	10.41
Road Base	2040	20.41
Road Subbase	2040	20.41

Based on this information, the current maintenance and renewal strategy for the segment is to extend the life of the road surface by 10 years. This would be done by deep lift asphalt patching, crack sealing maintenance, and the application of a sprayed seal. Additionally, it is anticipated that another establishment for noise mitigation patching will be required in approximately 3-5 years based on the current traffic numbers and mix.

Remaining Useful Life and Associated Maintenance Strategy with the Proposed Additional Traffic

The additional heavy traffic proposed by Wollongong Coal prevents the application of an effective sprayed seal to extend the remaining useful life of the Road Surface. Moreover, the additional heavy vehicle traffic loads are anticipated to have an adverse effect on the areas that currently present pattern cracking and croc cracking. It is our estimation that the combination of additional heavy vehicle traffic loads and a limited ability to complete preventative maintenance will result in the road segment requiring capital renewal works at the end of the five-year operational period. Accordingly, revised remaining useful life estimates for each component are below.

Asset Component	Forecast Reconstruction Year	Remaining Useful Life (in Years – as of Feb 2020)
Road Surface	2026	6.41*
Road Base	2026	6.41*
Road Subbase	2026	6.41*

*Assumes 12 months of approvals and 5 years of operational activity.

While deep lift asphalt patching and crack sealing will need to be completed initially in the areas identified under the *"Current Remaining Useful Life and Associated Maintenance Strategy"*, noise mitigation patching is expected after 1-2 years, and again in 3-5 years time. Additionally, the heavy vehicle traffic will require deep lift asphalt patching, over and above that required by the original strategy, to ensure serviceability over the operational period. This has been estimated at a total of 10% of the total area of the road.

Cost Comparison

The costs associated with the consumption of the remaining useful life of the asset are estimated at $218,847 (in 2019/20 dollars). The table below demonstrates how the calculation was prepared.

Asset	Current Replacement Costs	Expected Useful Life	Annualised Cost	Remaining Useful Life (Current Traffic)	WDV	Remaining Useful Life (Add. Traffic)*+	WDV	Asset Life Consumed	Asset Value Consumed
Surface	$ 256,697	20	$ 12,835	10.41	$ 133,611	6	$ 77,009	4.41	$ 56,602
Base	$ 274,390	80	$ 3,430	20.41	$ 70,004	6	$ 20,579	14.41	$ 49,425
Subbase	$ 626,349	80	$ 7,829	20.41	$ 159,797	6	$ 46,976	14.41	$ 112,821
TOTAL =	**$ 1,157,436.84**							**TOTAL =**	**$ 218,847**

* Assumed 1 year approvals and 5 years of operations

\+ Renewal of the road expected at the end of the operational period (no sprayed seal PM and additional heavy traffic effects)

The costs associated with each scenario (current strategy and strategy with additional heavy vehicle traffic loads) is provided below. Maintenance costs with the additional heavy vehicle traffic are calculated to be (in 2019/20 dollars) higher than the scenario where haulage from the mine does not occur.

Maintenance Costs

	Current Traffic				With Additional Heavy Traffic				
Item	Qty	Unit	Rate	Cost	Qty	Unit	Rate	Cost	Comments
100mm AC Patching									
Location 1	410	m2	$ 93.14	$ 38,186	410	m2	$ 93.14	$ 38,186	
Location 2	310	m2	$ 93.14	$ 28,872	310	m2	$ 93.14	$ 28,872	
Location 3	50	m2	$ 93.14	$ 4,657	50	m2	$ 93.14	$ 4,657	
Add Patching (due to Heavy Traffic)	0	m2	$ 93.14	$ -	992	m2	$ 93.14	$ 92,345	Allow 10% of road surface area only (used Noise Mit patching rate)
Crack Sealing	1	Item	$ 2,000	$ 2,000	1	Item	$ 2,000	$ 2,000	
Sprayed Seal	9915	m2	$ 5.00	$ 49,575	0	m2	$ 5.00	$ -	
Noise Mit Patching									
Patch at 1-2 years	0	LS	$ 45,544	$ -	1	LS	$ 45,544	$ 45,544	Cost of the noise mit works from Sept 2018 ref WO#1474541
Patch at 3-5 years	1	LS	$ 45,544	$ 45,544	1	LS	$ 45,544	$ 45,544	Cost of the noise mit works from Sept 2018 ref WO#1474541
			TOTAL =	**$ 168,834**			**TOTAL =**	**$ 257,148**	

Add Maintenance Costs = $ 88,314

In combination, Wollongong City Council is expected to incur an additional $307,161 of the five years of operation. Trend and Timeseries analyses of the Producers Price Index Number 3101 - Road and Bridge Construction New South Wales a was undertaken to estimate an appropriate rate to index these costs from 2019/20 dollars to 2025/26 dollars. An average annual rate of 2.81% has been adopted.

Total Costs		
Asset Value Consumed	$	218,847
Additional Maintenance Costs	$	88,314
Total Add. Cost to Council	$	307,161
PLUS: Contingency at 10%		$ 30,716
GRAND TOTAL (in 2019/20 dollars)		$ 337,877
GRAND TOTAL (Indexed to 2025/26 Dollars)		**$ 399,091**
Period		**5 years**
Annualised Costs	**$**	**79,818 per annum**

If you require further information, please don't hesitate to contact me on 4227 8893.

Regards,

Stephen Pemberton
Senior Civil Assets Engineer

Attachments
- Route Map as provided by Wollongong Coal (Z20/39510)
- Additional haulage information as provided by Wollongong Coal (Z20/39513)
- Maintenance and Capital Costs Worksheet (Z20/39502)
- Identified Maintenance Areas (Z20/39540)

APPENDIX 9

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Flood Analysis and Concept Design

Bellambi Creek Diversion

8202012401

Prepared for
Wollongong Coal Ltd

16 June 2020

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Approved By:

Shaza Raina
Water Team Lead

Date Approved 16/06/2020

Document History

Version	Effective Date	Description of Revision	Prepared by	Reviewed by
0	22/05/2020	Draft for Client Review	HSM	SBR
1	26/05/2020	Final Report	HSM	SBR
2	04/06/2020	Revised Appendices	HSM	SBR
3	16/06/2020	Revised Final Report	HSM	SBR

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Our report is based on information made available by the client. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Cardno is both complete and accurate. Whilst, to the best of our knowledge, the information contained in this report is accurate at the date of issue, changes may occur to the site conditions, the site context or the applicable planning framework. This report should not be used after any such changes without consulting the provider of the report or a suitably qualified person.

Executive Summary

Cardno was engaged by Wollongong Coal Pty Ltd for the analysis and concept design of flood mitigation works at the Russell Vale Colliery. The works included analysis and design of an open channel to divert clean floodwaters from the operation areas, a detention basin to attenuate flood volumes and peak velocities leaving the site and design of a new dry sediment basin to improve stormwater quality and aid in floodwater detention to minimise flooding downstream of the site

A hydrological assessment of the site and subsequent design was previously carried out in 2009 by BECA Pty Ltd. The concept design produced from this review was approved as part of the MP10_0046- Russell Vale Colliery Preliminary Works Approval and forms the basis for the design work undertaken as part of the study presented in this report.

The design and assessment process were split into two progressive phases, Phase 1 and Phase 2. Phase 1 aimed to establish the flood model for the site and emulate the previously approved BECA (2009) concept design. Phase 2 aimed to further optimise the model for current on-site operational requirements and improve the Phase 1 design.

Primary changes between Phase 1 and Phase 2 are the revision of the creek diversion alignment to better align with toe of the existing slope, a refined channel grade and cross section that would remove the need for a concrete lined channel where possible and a larger OSD basin. Additional survey was also conducted between Phase 1 and Phase 2, resulting in further design changes and refinements in Phase 2.

The results from the Phase 1 flood modelling process confirm the previously approved BECA (2009) stormwater design would provide effective flood mitigation and stormwater management at the site, and have allowed for the further optimisation of that design to better reflect current site operations.

The results from the Phase 2 flood modelling process build upon Phase 1 to provide significant reduction to both flood levels and velocities downstream of the site.

As such, the proposed concept design provided in **Appendix B** of this report is an effective solution for the mitigation of flooding downstream from the site, as well as improved stormwater quality outcomes, as confirmed by the flood assessment results presented in **Appendix D** and **Section 6** below.

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Our report is based on information made available by the client. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Cardno is both complete and accurate. Whilst, to the best of our knowledge, the information contained in this report is accurate at the date of issue, changes may occur to the site conditions, the site context or the applicable planning framework. This report should not be used after any such changes without consulting the provider of the report or a suitably qualified person.

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1 Introduction

Cardno was engaged by Wollongong Coal Pty Ltd for the analysis and concept design of flood mitigation works at the Russell Vale Colliery. The works included analysis and design of an open channel to divert clean floodwaters from the operation areas, a detention basin to attenuate flood volumes and peak velocities leaving the site and design of a new dry sediment basin to improve stormwater quality and aid in floodwater detention to minimise flooding downstream of the site.

A hydrological assessment of the site was previously carried out in 2009 by BECA Pty Ltd. The main outcome of the study suggests that stormwater conveyance through the site may be improved through diversion of flows from Bellambi Gully around coal stockpile areas. Maintenance measures were also recommended as methods to improve the conveyance of the existing channel and minimise the likelihood of failure.

This study aims to provide modelling outcomes of the elements conceptually designed by Beca in 2009 with adjustments to meet the current site requirements. The primary changes are revision of the creek diversion alignment to better align with toe of the existing slope and ideally, a channel grade and cross section that would remove the need for a concrete lined channel.

1.1 Background

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (formerly the NRE No.1 Colliery) in the Southern Coalfield of New South Wales (NSW). The Russell Vale Colliery operates under Project Approval (MP 10_0046) granted by the Planning Assessment Commission (PAC) on 13 October 2011.

During 1998, a major storm event caused considerable flooding throughout the Illawarra region. Review of the rainfall data taken from the Russell Vale catchment confirms that this storm was a statistical 100 year average recurrence interval (ARI) event when compared to BoM statistical models.

Although the mine operators at the time had in place a number of diversion drains, settlement and piped stormwater systems, these structures proved inadequate due to infrequent maintenance, inadequate drainage management system, and insufficient factors of safety in the existing drainage structures. This resulted in large quantities of runoff originating from the escarpment diverting through the existing coal stockpile area immediately located upstream of Prince Highway (refer **Appendix B**, C1001 – C1002). As this coal stockpile area drained to the dirty water treatment and collection system, flows arriving at the inlet exceeded the capacity of the system. This resulted in black water and coal washing entering Bellambi Creek and overtopped the creek banks causing damage to a number of private properties in the surrounding area.

The aftermath of the 1998 flood event prompted the initial study to investigate the stormwater management at the Russell Vale Colliery (the Site). This resulted in a concept stormwater management design being produced by BECA Pty Ltd as part of the Gujarat NRE Stormwater Hydrology Review (November 2009). This approved design achieved the required water quality and flooding improvements through the diversion of the Sites existing clean stormwater network through a new open concrete lined channel that would bypass the majority of the Sites operational areas and discharge directly into Bellambi Gully via an outlet controlled on site detention basin (OSD).

This concept design was subsequently approved by the department and was to be implemented as part the current 3A project approval. (MP10_0046- Russell Vale Colliery Preliminary Works Approval). Some of the recommended measures suggested as part of the 2009 BECA study have since been undertaken on site. Further investigations were subsequently undertaken by WCL to optimise the design of the Sites stormwater controls based on improvements to the existing piped channel. However, changes in the sites operations resulted in the delay of the channel diversion works has also lead to the current decision to construct the diversion channel as an open channel generally in accordance with the proposed BECA design.

1.2 Study Area

In this report the ‘Site’ refers to The Russell Vale Colliery mine, which is located north of Wollongong within the local government area (LGA) of Wollongong in the Illawarra region of NSW. The Site is located in the foothills of the Illawarra escarpment, with elevations of up to 400m AHD and slopes steeply down to the foothills at approximately 30m AHD. The steep slopes of the escarpment are heavily vegetated. The majority of the site and its surface structures are located in the lower reaches and foothills between approximately

30m AHD and 140m AHD. The majority of the site and its surface structures are located in the lower reaches and foothills between approximately 30m AHD and 140m AHD.

The Site is bounded by the Princes Highway to the east, the Woronora Plateau to the west with residential areas of Russell Vale and Corrimal to the north as well as the south respectively.

1.3 Purpose of this Report

This report details the analysis undertaken in developing the most recent concept design for stormwater management at the site with consideration of the recommended measures presented in the 2009 BECA assessment. This report documents the hydrological and hydraulic modelling methodology, the input and processes used, the modelling results as well as a discussion of these outcomes. Final design and mitigation recommendations based on the outcome of the modelling assessments are also provided as part of this report.

2 Available Data

2.1 Topographic Data

2.1.1 Ground Survey

2.1.1.1 Existing Ground Site Survey (2010)

A detailed ground survey of the Site was provided by Wollongong Coal, consistent with the survey provided for use in the Cardno 2015 study. This survey includes detailed elevation levels in the form of 1m contours, location and elevation of structures within the site and s a number of existing culverts, which includes indicative culvert structures based on several surveyed headwalls. This survey data was considered appropriate as it was the data originally used in the previously approved Gujarat NRE Stormwater Hydrology Review by BECA Pty Ltd (Nov 2009).

2.1.1.2 Updated Existing Ground Site Survey (2020)

Following the modelling outcomes of Phase 1 of this Flood Assessment (see **Section 5.1** for Phase 1 details), it was identified that several structures were influencing the flow behaviour across the site. As such, the need for additional survey of these structures and other key areas that are critical in the development of the proposed design measures were identified. As a result of this preliminary assessment, additional survey of the site was undertaken by Cardno in April 2020. This additional survey provided further detail for a number of key stormwater infrastructure identified at the Site, as well as up to date elevation data of the stockpile area.

Due to the operational nature of the site, the stockpile area had changed significantly from what was previously presented in the BECA (2009) design report. Other key features that were further delineated in this survey included the existing Dirty Water Basin system, existing stormwater culverts throughout the stockpile area, and the existing clean water diversion system.

2.1.2 Aerial Laser Survey

Aerial Laser Survey (ALS) data was obtained for the site from NSW Government Spatial Services in the form of a 1 metre Digital Elevation Model (DEM). Four DEM's were obtained for full coverage of the site including:

- Wollongong201304-LID1-AHD_3046194_56_0002_0002_1m
- Wollongong201304-LID1-AHD_3066194_56_0002_0002_1m
- Wollongong201304-LID1-AHD_3066196_56_0002_0002_1m
- Wollongong201405-LID1-AHD_3046196_56_0002_0002_1m

This ALS data was used to define catchment boundaries and to represent the existing surface in the hydraulic model where detailed survey was not available.

2.2 Previous Studies

2.2.1 Gujarat NRE Stormwater Hydrology Review (November 2009).

Undertaken by BECA Pty Ltd in 2009, this report details the methodology in the hydrologic and hydraulic assessment undertaken by BECA to inform the original concept design for a clean stormwater bypass channel and OSD basin. The report provides comprehensive catchment descriptions and delineations as well as a thorough breakdown of the current stormwater management at the Site. Both one-dimensional (1d) and two-dimensional (2d) flood modelling were not undertaken as part of the assessment and design process during this study. The concept design produced from this review was approved as part of the MP10_0046- Russell Vale Colliery Preliminary Works Approval and forms the basis for the design work undertaken as part of the study presented in this report.

2.2.2 Combined Catchments of Whartons, Collins and Farrahars Creeks, Bellambi Gully and Bellambi Lake - Flood Study (March 2011)

The 'Combined Catchment of Whartons, Collins and Farrahars Creeks, Bellambi Gully and Bellambi Lake Flood Study' was prepared by Lyall & Associates for Wollongong City Council (WCC) in 2011. The study area included the catchments of Bellambi Gully, the focus of this flood study.

This study defines flood behaviour in Bellambi Creek under existing conditions in terms of flows, levels and velocities for floods ranging between 5 and 500 years average recurrence interval, as well as for the Probable Maximum Flood (PMF). The study is used in the development of Floodplain Risk Management Plans for the catchment and has recently been replaced by the new Collins Creek Flood Study (2019).

Whilst the hydraulic modelling undertaken in this study only extends from the ocean to the eastern boundary of the site, it provides a valuable calibration reference for any associated flood modelling within this catchment area and was utilised as part of the modelling inputs for our current study.

The study also provides detailed observations of the wider catchment area and historic flood events, as well as key flood model inputs including suitable roughness coefficients and impervious fractions for different land uses within the catchment area. These inputs were utilised for the development of this flood model in conjunction with the more recent Collins Creek Flood Study (September 2019).

2.2.3 Bellambi Gully Flood Study (2015)

The Bellambi Gully Flood Study was prepared by Cardno (2015) to support the augmentation and maintenance of the existing water management system to manage flows down Bellambi Gully as part of the Underground Expansion Project. This study featured a HECRAS flood model and focused on flows between Bellambi Creek and the sites access road and weighbridge areas. The work undertaken by Cardno in this model was aimed to provide alternative mitigation measures for WCL to undertake in order to reduce flooding impacts downstream of the site, particularly those associated with coal stockpile washouts as a result of flooding.

The HECRAS model produced in this assessment is not directly comparable to the comprehensive 2d TUFLOW model utilised in this current study.

2.2.4 Bellambi Gully Flood Assessment (December 2018)

This flood assessment completed by Engeny Pty Ltd in 2018 established the first 2d TUFLOW model for the Site. The assessment developed a comprehensive concept design to manage the stormwater effectively at the site following a series of prior investigations by WCL. However, the introduction of more recent design constraints such as changes to site operations required the proposed concept design to be re-evaluated before its development.

The report provides additional site details and assessment outcomes as well as a comprehensive set of 2d flood maps demonstrating the existing flood behaviour for the Site as well as the predicted flood behaviour as a result of the proposed mitigation measures, which were used to significantly aid in this report's development. Comparison of flood results between the Engeny (2018) flood maps and the flood maps produced in this assessment reaffirms the modelling process undertaken for this current study and acts as a calibration point for further work.

2.2.5 Collins Creek Flood Study (September 2019)

The Collins Creek Flood Study (CCFS, 2019) was prepared by Catchment Simulation Solutions for WCC in 2019 to provide an updated catchment wide flood model to replace the previous model by Lyall & Associates (2011). Building upon the previous catchment wide study the report and associated model results provide a

comprehensive modelling methodology for the wider catchment area and the Bellambi Gully catchment. The study utilises a 2d TUFLOW model, providing direct input into the model developed for the proposed stormwater management system as part of this flood study.

3 Hydrology

3.1 Hydrological Model Selection

The computer model Watershed Bounded Network Model (WBNM; 2012) was used for hydrological modelling of the study area. WBNM is an advanced storage-routing model that allows simulation of catchment behaviour and key structures within a catchment and is a recognised network model in Australian Rainfall and Runoff (ARR, 1987). This particular model was considered appropriate for the task of modelling the study area, given its ability to model a wide range of catchment characteristics and its local development. The model allowed peak flows to be established at various locations throughout the subject site.

3.2 Model Inputs

3.2.1 Sub-Catchment Topology

Details of the sub-catchment delineation used in the hydrologic model is presented **Figure 3-1**. Further delineation of clean and dirty water catchments can be seen in **Appendix E**.

The sub-catchment topology for the constructed model reflects input from:

- Aerial Laser Survey (ALS) elevation data,
- Site survey elevation data provided by WCL,
- Identification of key flow paths by site operational staff and historical reporting,
- Site inspection undertaken by Cardno on 29 May 2020, and
- Aerial photography from NearMap

Catchment delineation undertaken under this assessment identified comparable catchment areas and flow routing at the site with the assessments from BECA (2009) and Engeny (2018), reaffirming the methodology undertaken in this study. Some sub catchments were further delineated to suit the modelling requirements of WBNM.

The figures within **Appendix E** provide a breakdown of ‘clean’ and ‘dirty’ catchment areas within the sub-catchments as well as general flow routing of existing and proposed stormwater structures within the Site. As can be seen in these figures, some ‘clean’ catchment areas flow into ‘dirty’ catchment areas, contributing towards the total dirty water system. Detailed catchment routing used in the modelling process can also be seen in the WBNM model data included within **Appendix A**. It is assumed that any low-flow stormwater networks and first-flush systems utilised on the site are at or beyond its capacity during a large storm event.

3.2.2 Impervious Fraction

Impervious fractions were calculated for the catchment based on aerial photography as well as photos obtained from previous site inspections. Impervious fractions of 100% for buildings, water and concrete/roads and 0% for dirt/gravel, trees and vegetation were applied to the site in line with the values used in the CCFS (2019).

General impervious factors of 60% for light residential, 95% for roads and paved surfaces, and 100% for industrial areas were used downstream of the site, in accordance with WCC Development Control Plan (DCP, 2009) Chapter E14 – Stormwater Management.

3.2.3 Hydrological Parameters

Hydrological parameters adopted for the WBNM model are provided in **Table 3-1**. These values are primarily based on parameters used in the CCFS (2019).

Table 3-1 WBNM Hydrological Parameters

Parameter	Value(s)	Comment
Initial loss (pervious surface)	0 mm	This is value was chosen as a conservative approach
Initial loss (impervious surface)	0 mm	This is value was chosen as a conservative approach

Continuing loss (pervious surface)	2.5 mm/hr	Adopted in accordance with CCFS (2019)
C (Lag parameter)	1.6	Accepted Value for WBNM models within the Illawarra
Stream routing factor	1.00	Accepted value for natural streams

3.2.4 Rainfall Data

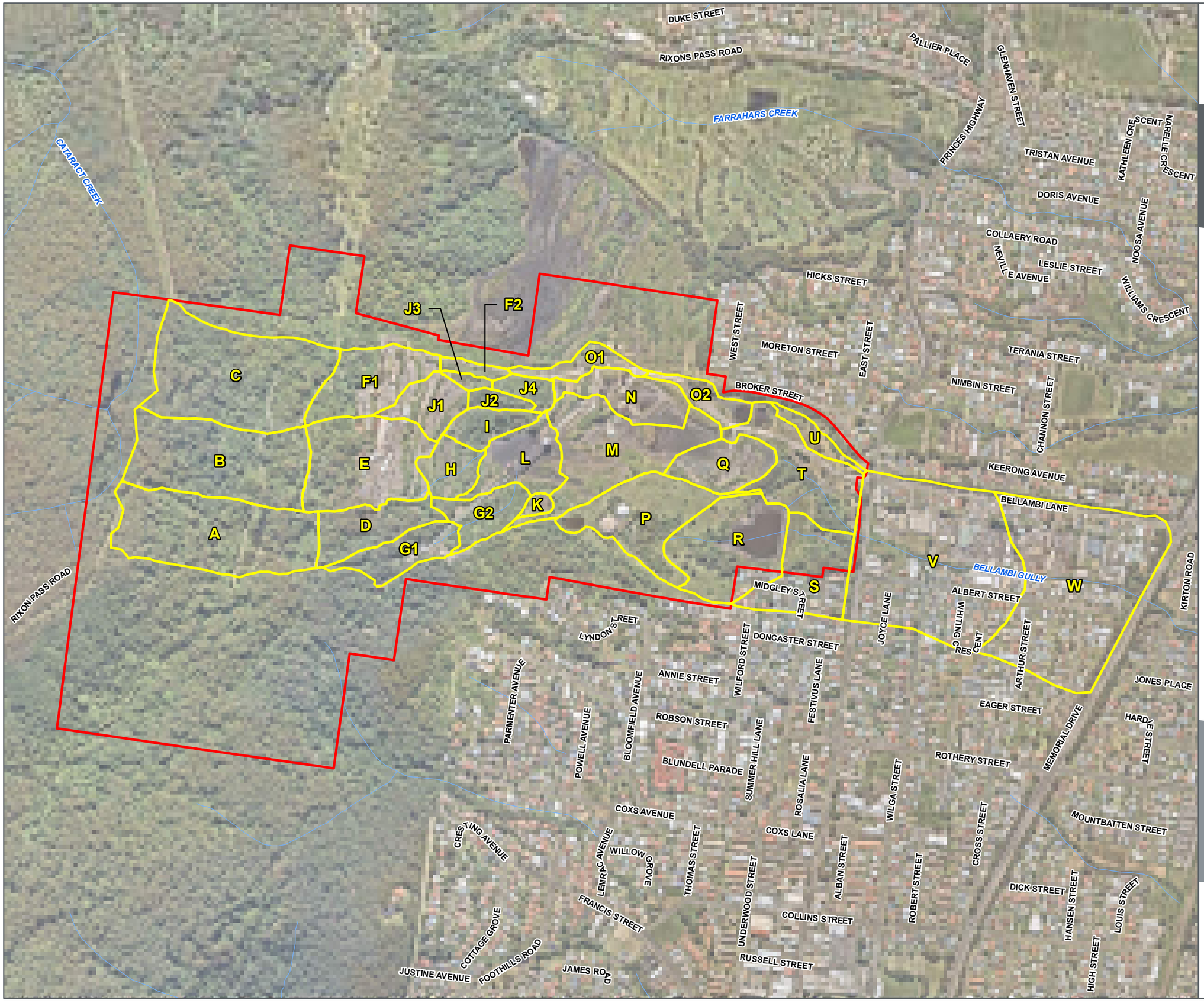
Rainfall data for the site was sourced from the Bureau of Meteorology (BOM). The data used to generate the design storm bursts in the WBNM model is presented in **Table 3-22**. ARR1987 rainfall data has been utilised in this study as ARR2019 has not yet been adopted by WCC.

Table 3-2 Rainfall data

Parameter	Value
2 Year 1 Hour Intensity	46.2 mm/hr
2 Year 12 Hour Intensity	11.2 mm/hr
2 Year 72 Hour Intensity	4.0 mm/hr
50 Year 1 Hour Intensity	103.9 mm/hr
50 Year 12 Hour Intensity	27.0 mm/hr
50 Year 72 Hour Intensity	8.6 mm/hr
F2 Geographic Factor	4.28
F50 Geographic Factor	15.81
Location Skew Coefficient	0.0
% Roughness	100
Moisture Adjustment Factor	0.68

3.3 Results

The WBNM hydrological model was run with a spectrum of storm durations to allow determination of the critical design storm duration for the catchment and the derivation of hydrographs at key locations for use in the hydraulic model. It was established that for events up to and including the PMF the critical duration is 120 minutes. This is in line with results from the CCFS (2019) Refer to **Appendix A** for detailed modelling results.



Hydrological Catchments

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Catchment Boundaries

FIGURE 3-1

1:8,500 Scale at A3

m
0 50 100 150 200

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-05-22 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-026-HydrologicalCatchments.mxd 01
Aerial Imagery supplied by Nearmap (March, 2020)

4 Flood Hydraulics

4.1 Selection of Hydraulic Model

The TUFLOW 2D model was used in the hydraulic assessment of the study area. A 2D model was selected to ensure accurate representation of the steep geography present at the site and to ensure that all 'break out' flows are included in the analysis.

The assessment was undertaken for the 5-year ARI, 10-year ARI, 100-year ARI and PMF storm events. The 100-year ARI event was also modelled with consideration of a design blockage in the order of 20% and a worst-case blockage of 100% to better assess the risk associated with sedimentation and debris movement at the site during a storm event.

4.2 Model Set Up

4.2.1 Model Geometry and Boundary Conditions

4.2.1.1 Phase 1 Model

The TUFLOW model extent stretches from the Bellambi Gully culvert at Memorial Drive, to approximately 1km upstream from the Bellambi Gully culvert underneath Princes Highway. Inflow locations built within the model simulate all flows generated within and upstream of the operational areas of the site. The TUFLOW engine then solves free-surface flow equations to predict flow paths and identify the potential impacts of flooding to neighbouring properties. Three outflow locations were identified within the model. The outflows are located as follows:

- Thenorthernmost outflow is located at Channon Street where floodwaters overtop the road before entering the existing watercourse;
- The second outflow at Bellambi Lane, where flood waters flows onto Bellambi Lane before crossing Memorial Drive at the intersection; and
- The third outflow is at Bellambi Gully where flood waters flows through the Memorial Drive culvert or overtop Memorial Drive in extreme storm events.

Due to the Site's placement relative to the escarpment and the steep slopes present in some areas of the site, a 1m grid size was considered the most appropriate to ensure the intricacies of the Sites flow paths were captured. The model was created using TUFLOW's Graphics Processing Unit (GPU) architecture, enabling unprecedented resolution and intricacy within the model for this site. Elevations within the grid were sourced primarily from survey data provided by WCL (where available) and from ALS in areas downstream of the site.

Hydrographs were extracted from the hydrological model (refer **Section 3**) at key locations for the critical duration and applied to the hydraulic model to simulate design events. Key culverts and stormwater pipes were modelled as 1d networks with connections to the 2d Mesh.

4.2.1.2 Phase 2 Model

The Phase 2 TUFLOW model built upon the same model created in Phase 1 and utilised the same methodology to simulate the required storm events at the site as described above. Key additions to the Phase 2 TUFLOW model that differ from Phase 1 included:

- Updated 2d surface elevation with new ground elevation inputs from the Cardno 2020 survey; and
- Additional and revised 1d network features as identified in the Cardno 2020 survey. These features included, but not limited to:
    - Additional culvert crossings within the stockpile and operational area,
    - Additional connection pipelines between the existing dirty water treatment systems, and

4.2.2 Detailed elevation and location of key culverts downstream of the operational area, including the Princes highway culvert crossing.Materials Mapping and Roughness

Existing roughness conditions were mapped from a combination of aerial photography and observations from previous site visits. Material coverage mapping is presented in **Figure 4-1**. Manning's values adopted

for each material coverage are presented in **Table 4-1**. The values adopted in this study are consistent with the CCFS (2010), where possible. The default material coverage adopted in the model was Pasture.

Table 4-1 Manning's 'n' Roughness Values

Land Use Type	Manning's 'n' Values	
	CCFS (2019)	Cardno
Grass, Lawn or Pasture	0.045	0.045
Concrete and Asphalt	0.020	0.020
Trees and Light Scrub	0.09	0.09
Mildly Dense Vegetation	0.120	0.120
Fenced Properties and Residential	1.00	1.00
Riparian and Wetland areas	0.035	0.035
Macrophyte and Banks	0.06	0.06

4.2.3 Structures and Blockage

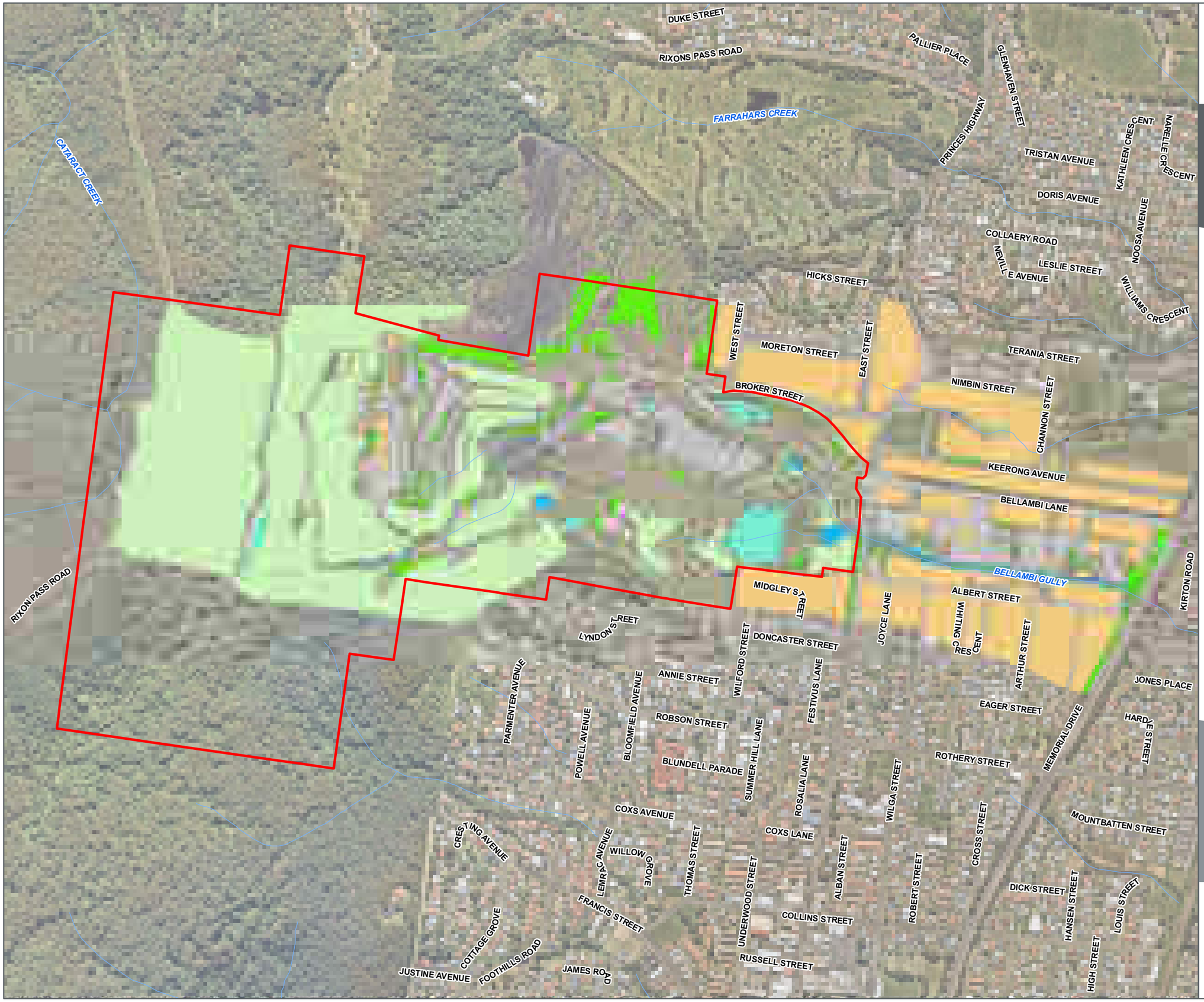
Hydraulic structures including the culverts underneath the Princes Highway, culverts and pipelines within the Site boundary, as well as the outlet control structures of the existing dams were included in the model using details captured from the detailed surveys. As identified above, Phase 2 included additional culverts and structures recently surveyed by Cardno in April 2020 following the Phase 1 assessment.

For the 100-year ARI design storm event, two additional scenarios were modelled where blockage values of 20% and 100% were applied to all culverts and pipelines at the site. These blockage values were chosen in line with previous modelling undertaken at the Site, as representation of a theoretical partial and full blockage scenarios, as occurred in the 1998 flood event. Results presented in this report for the 100-year ARI event include additional flood extents to display the effect of these blockages on flooding in the area. The 100-year ARI impact map is developed from establishing the maximum envelope of all 100-year ARI blockage scenarios presented (refer to **Appendix C** for the flood maps).

4.2.4 Model Calibration

Comparison between the existing 100-year ARI flood level from both the Phase 1 and Phase 2 models shows a general parity in flood levels between the Cardno and CCFS models within Bellambi Creek.

The CCFS flood model coverage only extends to the area immediately downstream of the Bellambi Gully Culvert underneath Princes Highway. Flood levels within Bellambi Gully and flows overtopping onto the residential properties downstream of the culvert are primarily controlled by this culvert structure, resulting in only minor changes between Phase 1 and Phase 2. Minor differences in flood levels between both the Cardno Phase 1 and Phase 2 models with the CCFS model is anticipated due to the greater model detail specifically to the west of Princes Highway developed in the current Cardno model.



Material Coverage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)

Material Type

- Concrete and Asphalt
- Trees and Light scrub
- Riparian and Wetland Areas
- Macrophyte and Banks
- Mildly Dense Vegetation
- Fenced Properties and Residential

Note:
Areas not represented by "Material Type" are classified as a Default Material of Grass, Lawn or Pasture

FIGURE 4-1

1:8,500 Scale at A3

m
0 50 100 150 200

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-05-22 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-027-MaterialCoverage.mxd 01
Aerial Imagery supplied by Nearmap (March, 2020)

5 Proposed Flood Mitigation

The stormwater concept design for the Site aims to mitigate potential flooding at the site in all designed storm events and improve stormwater quality from the site in minor events. The concept design is based primarily on the previous design undertaken by BECA (Gujarat NRE Stormwater Hydrology Review 2009). Changes in the Sites operational requirements and needs since 2009 have led to the opportunity to revisit the BECA design and further refine the concept to achieve a more efficient stormwater management for the Site.

This new stormwater design, as presented in the design set within **Appendix B**, aims to provide an effective "clean" and "dirty" stormwater network that would be resilient to large storm events, easy to maintain and minimise the likelihood of failure under unforeseen circumstances such as excessive blockages storm events including the PMF event.

The key consideration in achieving effective stormwater management at the Site is the separation of the clean and dirty stormwater networks, where "clean" stormwater is identified as any runoff generated from the upstream escarpment areas as well as other vegetated areas and the parts of the site not used in the industrial process, whilst the "dirty" stormwater is identified as stormwater generated from active industrial areas such as high traffic access roads, stockpile areas and processing areas.

5.1 Design Approach

5.1.1 Clean Stormwater

The proposed clean stormwater design consists of the upgrade of the existing clean stormwater bypass pipe network to a larger capacity open channel design. Whilst the existing clean water pipe is effective in diverting most storm events, the 670m long (approximately) underground pipe is prone to blockages as demonstrated in the 1998 major storm event, where the pipeline failed. This failure diverted large quantities of clean stormwater into the stockpile area and eventually into Bellambi Gully, resulting in a considerable amount of residue and coal washing downstream. By utilising a larger open channel design, the capacity of the clean stormwater bypass is increased and the likelihood of any blockage occurring is significantly reduced. The nature of the open channel would also allow for easy access of maintenance and visual inspection of the channel. In order to ensure this channel can operate effectively, the culverts upstream of the channel would need to be maintained and upsized accordingly. Minor bunding and channel reestablishment should also be constructed around the remaining clean water culverts and pipelines upstream of the proposed channel to further ensure mixing of clean and dirty catchments does not occur.

The proposed open channel would discharge into an OSD basin at the east of the site, where flows would be attenuated before discharging into Bellambi Gully to reduce the effects of flooding downstream of the site. This OSD basin has been sized to provide a regulated low flow outlet up to, and including, the 100-year ARI storm event. Should a larger storm event occur (i.e. above the 100-year ARI and up to the PMF event) or an excessive blockage in the OSD outlet eventuate, an overflow weir that discharges directly into Bellambi Gully at the low flow outlet would be activated to ensure no water is directed into the stockpile or operational areas within the Site. The OSD will also provide some sediment removal whilst stormwater is detained in the basin. The overflow arm of the OSD basin that extends uphill in a westerly direction has also been designed to allow easy access for maintenance equipment into the basin and visual inspection.

Both the channel and OSD have been designed with sufficient capacity to capture and convey upstream catchment runoff that is routed to the structures, in accordance with the original BECA (2009) design.

As can be seen in the figures within **Appendix E**, the proposed channel, in combination with the reinstated bunding, will ensure greater separation of the clean catchment reducing strain on the dirty water network. Land south of the channel will require suitable revegetation and rehabilitation following the completion of the channel as it will form part of the clean water network and will no longer be part of the operational stockpile areas.

5.1.2 Dirty Water

Proposed changes to the dirty water system include the construction of a new dry sediment basin and the reconfiguration of the existing wet sediment basins. The dry sediment basin will capture all dirty water surface flows routed from the existing stockpile areas as well as overland flows from upstream operation areas during larger storm events. This basin will reduce flow velocities of the runoff and provide coarse sediment removal prior to discharging into the existing wet sediment basins. The basin will also provide

significant attenuation to the sites dirty water flows, further reducing the load on the existing dirty water system as provides a failsafe during storm events.

This basin is designed with sufficient capacity to contain and treat all surface inflows up to and including the 10-year ARI storm event. In larger storm events, excess stormwater will overflow into the proposed clean water OSD basin. In this scenario the proposed sediment basin will still provide significant sediment removal from the first flush of the storm and the proposed OSD will provide additional sediment detention for any excess flows.

The reconfiguration of the existing wet sediment basins will allow for additional storage capacity, reducing the likelihood of failure during large storm events and improving the sediment removal efficiencies of the basin. Both the wet and dry basins would be built to allow adequate access for machinery and personnel to carry out maintenance as required during dry periods.

5.2 Design Development

The design and assessment process were split into two progressive phases, Phase 1 and Phase 2. Phase 1 aimed to establish the flood model for the site and emulate the previously approved BECA (2009) concept design. Phase 2 aimed to further optimise the model for current on-site operational requirements and improve the proposed Phase 1 design.

5.2.1 Phase 1

Phase 1 of the assessment involved the modelling of an existing case and proposed case for the site, where the proposed model included the new stormwater and flood mitigation features planned for the site. The proposed scenario model also assumed effective stormwater routing of the upstream catchment in accordance with the previous BECA (2009) design. This phase aimed to establish site conditions, existing flow characteristics and further establish the size requirements of the proposed stormwater features.

The preliminary design surface of the proposed stormwater channel was modelled using 12D software and included into the proposed scenario TUFLOW model. The channel was sized in accordance with the BECA (2009) design with minor changes to the proposed channel route to better align with current operational requirements at the site. The proposed OSD basin and dry sediment basin were included in the TUFLOW model by modifying the elevation in the TUFLOW model grid elevation. These basins were modelled to achieve similar results to the basins proposed in the BECA (2010) design.

Under Phase 1, the proposed dry sediment basin detained a maximum of 4550 m^3 of stormwater before routing excess stormwater to the OSD basin. The proposed OSD detained an approximately 13300 m^3 (maximum volume) in the 100-year ARI event. Flood maps from the Phase 1 assessment are presented in **Appendix C**.

This phase confirmed the viability of the BECA (2009) design and successfully identified where potential improvements and optimisations of the proposed design could made in order to better align with the current Site operational requirements, as well as providing additional flood mitigation for the site.

Results from this phase brought light to the need for additional up to date survey within the stockpile area as well as further identification of key stormwater and flooding assets at the site. As recent survey data was not available for some key areas including the stockpile area and several identified stormwater assets, additional site survey was undertaken by Cardo prior to the Phase 2 assessment to better inform the proposed stormwater management designs.

5.2.2 Phase 2

Phase 2 was established consistent with the Phase 1 approach with the incorporation of additional client feedback as well as the new survey acquired by Cardno following the outcome of the Phase 1 assessment. The new survey provided an up to date surface of the existing stockpile areas as well as the area within the vicinity of the proposed clean water channel, OSD basin and dry sediment basin in addition to the dimensions and locations of key stormwater features pertaining to the flood model. This survey also enabled a more detailed and accurate flood modelling and surface design approach.

As new survey data was to be incorporated into the flood model, it was considered pertinent to remodel both the existing and proposed scenarios for Phase 2, to ensure an accurate assessment of the proposed stormwater features. This resulted in some minor changes in the existing case flood model results between Phase 1 and Phase 2.

The updated designs of the proposed stormwater features included a more optimised channel alignment and design capacity, as well as a more detailed OSD basin and dry sediment basin, all of which were modelled

as a 3d surface in 12D ensuring realistic constructability and interface with the existing surface. These updated features were also upsized to utilise the maximum practical basin footprints available at the site, maximising the flood mitigation potential of the proposed works.

Under Phase 2 the proposed dry sediment basin detained a maximum of 11,352 m^3 of stormwater before routing excess stormwater to the OSD basin. The proposed OSD detained a maximum of approximately 27,300 m^3 in the 100-year ARI event. These results were obtained from the maximum flood depth envelope of the two modelled blockage scenarios as discussed in **Section 4.2**.

The Phase 2 design proved to be generally more effective at reducing downstream flood impacts from the Site when compared to Phase 1, primarily due to changes in site operations and the additional flood storage made available for the site since the BECA (2009) design. The Phase 2 concept design set is included in **Appendix B**. The final results from the Phase 2 flood assessment are presented in **Appendix D** and discussed in **Section 6** below.

6 Simulation Results

6.1 Existing Scenario

6.1.1 Phase 1

The model was simulated for the 5, 10 and 100 year ARI events as well as the PMF storm event. Maps of the existing flood depths, extents and velocities for the 10 year ARI event and higher for Phase 1 are presented in **Appendix C**.

In the Phase 1 existing scenario, it was observed that the existing clean water pipeline failed, with clean water overtopping the pipeline and entering the stockpile and operational areas. The stockpile area and dirty water system overtops and spills into Bellambi Lane and Bellambi Creek downstream of the site in this scenario. This is consistent for all flood events modelled at the site. Flow constrained by the existing culvert upstream of the diversion pipeline also divert additional clean water into the stockpile area.

Flood waters overtops the Princes Highway east of the site in multiple locations in this scenario for all modelled storm events. The Princess Highway remains mostly trafficable in all flood events, however some localised areas of deeper flooding of up to 0.5m can be seen causing greater risk on the highway in the 100 year and PMF events in this scenario.

Flooding can be seen to occur downstream of the site through all properties along the banks of Bellambi Creek. Flood water elevations and flowrates for key locations are presented in the **Table 6.1** and **6.2** below.

6.1.2 Phase 2

Due to the increased in survey details incorporated into the Phase 2 model, it was critical to re-establish the existing scenario results to ensure the analysis of the Phase 2 concept design is accurate and as it represents the most up to date conditions on Site. The model was simulated for the 5, 10 and 100 year ARI events as well as the PMF storm event. Maps of the existing flood depths, extents and velocities for the final scenario (Phase 2) are presented in **Appendix D**.

In the existing Phase 2 scenario, the majority of clean floodwater is effectively diverted by the existing pipeline, whilst the stockpile area and dirty water system can be seen to overtop and spill into Bellambi Lane and Bellambi Creek downstream of the site. This is consistent for all flood events modelled at the site. The clean water diversion pipeline failed when using a design blockage of 100% at the existing structures, and this significantly contributed to the additional flows to the stockpile area. Flow constrained by the existing culvert upstream of the diversion pipeline also resulted in the diversion of additional clean water flows into the stockpile area.

Flood waters overtops the Princes Highway east of the site in multiple locations, primarily at the Bellambi Lane intersection and at the sag point of the highway just north of the Bellambi Gully culvert. The Princess Highway remains mostly trafficable in all flood events, with some localised areas of deeper flooding (>0.25m) in the 100 year and PMF events, which has significantly reduced from the previous Phase 1 modelling outcomes. The flood waters that overtop onto the road can be observed to spread out across the road surface, producing a shallow, low velocity inundation, which is safe in terms of hazard and trafficability. Whilst the footprint of flooding appears large, the quantity of flood water overtopping onto the road is minimal, particularly in the smaller storm events.

Flooding can be seen to occur downstream of the site through all properties along the banks of Bellambi Creek. The flood levels here appear consistent with previous Council flood modelling.

Flood water elevations and flowrates for key locations are presented in the **Table 6.3** and **6.4** below.

6.2 Proposed Scenario

6.2.1 Phase 1

The model was run for the 5, 10 and 100 year ARI design events and the PMF event. Maps of the Phase 1 design flood depths, extents and velocities for the modelled storm events are presented in **Appendix C**. Impact maps for all storm events are also provided which display a direct comparison between proposed and existing flood levels for Phase 1 assessment. The 100 year ARI impact map is developed from an envelope of all the blockage scenarios at the site, whilst the other impacts of the modelled storm events represents a 0% blockage of the conduits.

As can be seen in the provided flood maps, a reduction to flood levels would occur downstream of the site in all flood events with the exception of the PMF event. No measurable reduction of flooding can be seen downstream in the PMF event and some minor impacts downstream of the site can now be observed in this event, however these impacts are minimal. Despite this apparent worsening of flood impacts, stormwater quality should likely improve in the PMF event under the Phase 1 design as result of the controlled discharge from the proposed sediment and OSD basins.

As demonstrated in the flood maps, the flood velocity is improved when compared with the existing modelling results in all flood events with the exception of the PMF, where velocities have undergone minimal changes. A blockage envelope was not provided for flood velocities as the 0% blockage produces the most critical flow rate and is considered the critical event in this case. The proposed clean water diversion channel can be seen to convey water at velocities of approximately 2-4m/s during the 100 year ARI event, with localised areas of higher velocities at the reinforced sections of the channel such as drop structures, scour protected interfaces and the deeper concrete/gabion lined portions.

Flood water elevations and flowrates for key locations are presented in **Table 6.1** and **6.2** below.

Table 6-1 Phase 1 Peak Flow Comparison

	Princess Highway Culvert (m^3/s)		Princess Highway Overflow (m^3/s)	
Event	**Cardno Existing**	**Cardno Proposed**	**Cardno Existing**	**Cardno Proposed**
5 year ARI	5.10	4.83	0.56	0.36
10 year ARI	6.30	5.82	0.79	0.70
100 year ARI (0% Blockage)	9.68	9.50	5.47	4.00
100 year ARI (20% Blockage)	7.97	7.84	7.68	5.62
100 year ARI (100% Blockage)	0.00	0.00	17.64	16.77
PMF	11.75	11.77	41.75	41.70

Table 6-2 Phase 1 Flood Level Comparison

	Princess Highway at Bellambi Gully Lane (mAHD)		Princess Highway at Bellambi Gully Culvert (mAHD)	
Event	**Cardno Existing**	**Cardno Proposed**	**Cardno Existing**	**Cardno Proposed**
5 year ARI	27.124	27.124	26.130	26.124
10 year ARI	27.124	27.124	26.141	26.137
100 year ARI (0% Blockage)	27.126	27.124	26.160	26.146
100 year ARI (20% Blockage)	27.126	27.124	26.161	26.144
100 year ARI (100% Blockage)	27.132	27.128	26.161	26.156
PMF	27.140	27.140	26.182	26.181

These results for Phase 1 can be considered a representation of what the BECA 2009 design would achieve in a 2d flood model and provided an important step in the development of the Phase 2 design. The flow behaviour identified by this modelling process highlighted the key structures that required further attention to achieve the greatest outcome for the site and properties downstream. This was deemed critical in the future design development stages for the Site.

6.2.2 Phase 2

The model was run for the 5, 10 and 100 year ARI design events and the PMF event. Maps of the proposed final flood depths, extents and velocities are presented in **Appendix D**. Impact maps for all storm events are also provided which display a direct comparison between proposed and existing flood levels. The 100 year ARI impact map is developed from an envelope of all the blockage scenarios at the site, whilst the other impacts of the modelled storm events represents a 0% blockage of the conduits.

As can be seen in the provided flood impacts maps, a significant reduction to flood levels would occur downstream of the site in all designed flood events with the exception of the PMF event. The areas represented with a yellow colour would no longer experience any flooding in the relevant storm events should the proposed design be adopted, whilst green areas would experience a reduction in flood levels. Pink and Red areas within the site represent new or deeper flood levels, however these locations are limited to where the channel and basins are proposed, as these were mostly dry areas in the existing scenario. It should be noted that these impacts remain within the colliery Site boundary.

Some minor improvements downstream of the site can be observed in the PMF event, however these improvements are minimal and for the most part remain unchanged. Despite this, the proposed design should provide improved sediment removal and minimise damage to the site during the PMF event.

As demonstrated in the flood maps, the flood depths and flood velocity is significantly improved when compared with the existing modelling results in all flood events with the exception of the PMF, where velocities have undergone minimal changes. A blockage envelope was not provided for flood velocities as a 0% blockage produces the most critical flow rate and is considered the critical event in this case. The proposed clean water diversion channel can be seen to convey water at velocities of approximately 2-3m/s during the 100 year ARI event, with localised areas of higher velocities at the reinforced sections of the channel such as drop structures, scour protected interfaces and the deeper concrete/gabion lined portions. This occurs due to the changes in surface elevation at the design interface and/or surface treatment.

Flood water elevations and flowrates for key locations are presented in **Table 6.3** and **6.4** below.

Table 6-3 Final (Phase 2) Peak Flow Comparison

	Princess Highway Culvert (m^3/s)		Princess Highway Overflow (m^3/s)		Bellambi Lane Overflow (m^3/s)	
Event	**Cardno Existing**	**Cardno Proposed**	**Cardno Existing**	**Cardno Proposed**	**Cardno Existing**	**Cardno Proposed**
5 year ARI	7.408	6.424	0.4575	0.0657	0.2754	0.0555
10 year ARI	9.032	6.668	0.6802	0.0771	0.3784	0.0699
100 year ARI (0% Blockage)	15.998	6.862	1.888	0.2148	1.1305	0.1307
100 year ARI (20% Blockage)	14.869	6.516	2.0446	0.1675	1.2422	0.1306
100 year ARI (100% Blockage)	0.0	0.0	18.8392	7.9619	2.3652	0.7261
PMF	21.218	21.229	33.2487	33.3448	3.8249	3.4383

Table 6-4 Final (Phase 2) Flood Level Comparison

	Princess Highway at Bellambi Lane (mAHD)		Princess Highway near Bellambi Gully Culvert (mAHD)	
Event	**Cardno Existing**	**Cardno Proposed**	**Cardno Existing**	**Cardno Proposed**
5 year ARI	27.124	27.124	26.135	26.117
10 year ARI	27.124	27.124	26.141	26.117
100 year ARI (0% Blockage)	27.132	27.125	26.162	26.119
100 year ARI (20% Blockage)	27.132	27.125	26.163	26.117
100 year ARI (100% Blockage)	27.136	27.128	26.173	26.154
PMF	27.145	27.144	26.185	26.181

As demonstrated in the above results, the proposed concept design for both Phases above provides significant reductions in flow rate and flood level from the existing case scenario for all events with the exception of the PMF event, with Phase 2 providing further reductions in all scenarios. The proposed design still achieves greater separation of dirty and clean water catchments during the PMF event when compared to the existing scenario, offering significant water quality benefits to downstream areas.

Figure 6.1 below identifies the locations of key measurements points for flood levels and velocities presented in **Table 6.1** - **6.4** above.

Figure 6-1 Flood Assessment Measurement Locations

7 Conclusion and Recommendations

A detailed hydrological WBNM model and hydraulic 2d TUFLOW model have been established at the site. The models have utilised a combination of ALS data, recent detailed ground survey data and site inspections to inform the modelling process and ensure the most representative outcomes for the site.

The results from the flood modelling process confirm the previously approved BECA (2009) stormwater design would provide effective flood mitigation and stormwater management at the site, and have allowed for the further optimisation of that design to better reflect current site operations.

The proposed concept design provided in **Appendix B** of this report is an effective solution for the mitigation of flooding downstream from the site, as well as improved stormwater quality outcomes, as confirmed by the flood assessment results presented in **Appendix D** and **Section 6** above.

As such it is recommended that:

- The proposed concept design of the clean water diversion channel, clean water OSD basin, and dirty water detention basin be approved and further detailed design be undertaken prior to construction,
- Improvements to the existing stormwater system upstream of the proposed clean water diversion channel be carried out generally in accordance with the approved BECA (2009) design and report,
- Bunding at the inlet of the existing clean and dirty water systems be constructed to improve efficiency in the stormwater system at the Site,
- A stormwater management plan be established for the site to ensure the continued maintenance and effectiveness of the proposed concept design.

APPENDIX

A

WBNM MODEL RESULTS

2. Catchment Details

Steps 2.1 to 2.4: Enter Data for each Subarea in the Model, including Topology, Surface and Flowpath Blocks and Loss Details

Catchment Statistics

Total Area [ha]	98.8
Total Impervious Percent [%]	#REF!
No. of Subareas	28
No. of Subareas with WC Factor	28

2.1 **Catchment Details** | 2.2 **Lag Parameters** | 2.3 **Flowpaths** | 2.4 **Rainfall Losses**

Routing Options | Sort Subareas | Import Mid/Mif | Populate | Populate | Continuing Loss Rate | Populate

								1.6	0.1	R	1	0	2.5	0	0
Subarea Name	D/S Subarea	Area	CG Coords (MGA)		Outlet Coords (MGA)		Imp Fraction	C	Imp Lag	Type	Value	IL	CLR	Imp IL	
		ha	E	N	E	N	%					mm	mm/hr	mm	
U	V	0.766838	306690.8	6195921	0	0	0	1.6	0.1	R	1	0	2.5	0	
R	T	5.336816	306493.7	6195663	0	0	29.9543	1.6	0.1	R	1	0	2.5	0	
N	M	2.561594	306261.4	6196017	0	0	40.3312	1.6	0.1	R	1	0	2.5	0	
J3	J4	0.305023	305880.8	6196053	0	0	3.2059	1.6	0.1	R	1	0	2.5	0	
J4	L	0.787419	306020.7	6196030	0	0	7.1955	1.6	0.1	R	1	0	2.5	0	
E	J1	5.651201	305636.3	6195860	0	0	38.9033	1.6	0.1	R	1	0	2.5	0	
J1	J2	1.822781	305790.3	6195997	0	0	68.5716	1.6	0.1	R	1	0	2.5	0	
J2	I	0.580977	305948.5	6196006	0	0	13.8958	1.6	0.1	R	1	0	2.5	0	
I	L	1.321946	305924.1	6195948	0	0	4.2784	1.6	0.1	R	1	0	2.5	0	
H	L	1.548362	305838.2	6195847	0	0	1.6236	1.6	0.1	R	1	0	2.5	0	
G1	G2	2.085793	305728.7	6195652	0	0	11.7779	1.6	0.1	R	1	0	2.5	0	
B	D	7.218403	305298.5	6195865	0	0	0	1.6	0.1	R	1	0	2.5	0	
A	D	7.688294	305286	6195697	0	0	3.0389	1.6	0.1	R	1	0	2.5	0	
D	G2	2.658514	305650.1	6195711	0	0	0.6473	1.6	0.1	R	1	0	2.5	0	
G2	L	1.864574	305915.7	6195743	0	0	5.9909	1.6	0.1	R	1	0	2.5	0	
L	M	2.737668	306005.1	6195864	0	0	16.1575	1.6	0.1	R	1	0	2.5	0	
K	M	0.295205	306041.8	6195761	0	0	0	1.6	0.1	R	1	0	2.5	0	
M	Q	6.030627	306217.7	6195893	0	0	19.0665	1.6	0.1	R	1	0	2.5	0	
Q	T	2.324824	306479	6195857	0	0	17.415	1.6	0.1	R	1	0	2.5	0	
P	T	4.608401	306293.3	6195732	0	0	10.28	1.6	0.1	R	1	0	2.5	0	
F1	F2	3.448623	305649.7	6196051	0	0	36.5942	1.6	0.1	R	1	0	2.5	0	
F2	O1	0.482274	305890.9	6196081	0	0	27.9216	1.6	0.1	R	1	0	2.5	0	
O1	O2	1.146957	306147.4	6196090	0	0	31.542	1.6	0.1	R	1	0	2.5	0	
O2	T	1.184887	306444.4	6196007	0	0	61.3188	1.6	0.1	R	1	0	2.5	0	
T	V	4.537059	306660.1	6195836	0	0	16.653	1.6	0.1	R	1	0	2.5	0	
S	V	3.833731	306673.6	6195603	0	0	31.6852	1.6	0.1	R	1	0	2.5	0	
V	W	13.30547	306966.9	6195631	0	0	37.4172	1.6	0.1	R	1	0	2.5	0	
W	SINK	12.62381	307298.7	6195572	0	0	70.218	1.6	0.1	R	1	0	2.5	0	

4. Rainfall & Storm Data

Steps 4.1 to 4.4: Enter Data for each Storm in the Model (recorded, design and embedded design) and recorded/imported hydrographs

Rainfall & Storm Statistics

No. of Gauges	1
No. Design Storms	8
No. Recorded Storms	0
No. of Imported Hydrographs	0

Populate

4.1 Rainfall Data

Select Location of IFD Data

External IFD File — Browse...

Location:

Internal Database (see IFD Sheet) — Refresh

Go C601

Select Rainfall Gauges — HINT

Gauge	Gauge Name
1	Russel Vale
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Set Areal Reduction Factor for Design Storms

AUTO Generate based on Storm Duration and Catchment Area

Default 1.00 for Small Catchments (less than 1 km2)

User Defined

4.2 Storm Data - Design

	Design Burst		Design Envelope		Calc. Step	Out Step
DES Storm No.	ARI	Duration	ARI	Duration	mins	mins
1	5	120			1	1
2	10	120			1	1
3	100	120			1	1
4	PMF	120			1	1
5	5	90			1	1
6	10	90			1	1
7	100	90			1	1
8	PMF	90			1	1
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

4.3 Storm Data - Recorded

Event Data	Date	Time	Time Step	Type	Calc. Step	Out Step
REC Event No.			mins		mins	mins
1						
2						
3						
4						
5						
6						

Gauge Data

Event No.						
Gauge Name						
Gauge E						
Gauge N						
Raintotal [mm]						
Rain Data	Rain 1	Rain 2	Rain 3	Rain 4	Rain 5	Rain 6

Show 10 Lines

Show 50 Lines

Show 2500 Lines

GOTO Hydrographs

6. Results-Tables

View Results in Tabular Format

Results for Runfile: U:\FY20\124_Bellambi Creek Diversion\Des-An\Water\Flooding\Hydrology\WBNM\Pr\Pr_PostSurvey\Bellambi Creek_Meta.out

6.1 Results

View Results at Location: Stream Top | Flowrates | Volumes | Time to Peaks | Structures

Storm No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ARI	**5**	**10**	**100**	**PMF**	**5**	**10**	**100**	**PMF**							
Duration	120	120	120	120	90	90	90	90							
Catchment Area	98.76	98.76	98.76	98.76	98.76	98.76	98.76	98.76							
Impervious percent (%)	28.03	28.03	28.03	28.03	28.03	28.03	28.03	28.03							
Rainfall Depth (mm)	85.99	100.41	162.89	525.2	75.67	88.21	142.52	447.46							
Excess Rainfall (mm)	82.39	96.81	159.29	521.6	72.97	85.51	139.82	444.76							
Runoff Depth (mm)	76.18	90.06	150.28	505.39	69.37	81.7	135.2	437.79							
Time to Rain Peak (mins)	35	35	35	20	30	30	30	15							
VOLUMES at Outlet [m3]															
U	619	730	1209	3988	551	647	1064	3403							
R	4366	5132	8456	27756	3883	4551	7447	23709							
N	2119	2488	4087	13366	1879	2200	3592	11404							
J3	244	289	480	1587	217	256	422	1353							
J4	882	1040	1723	5681	784	920	1515	4846							
E	4655	5467	8988	29432	4133	4841	7908	25129							
J1	6174	7248	11902	38934	5482	6418	10473	33251							
J2	6636	7793	12806	41934	5896	6905	11275	35825							
I	7679	9024	14853	48751	6837	8011	13096	41676							
H	1247	1470	2435	8041	1111	1305	2147	6867							
G1	1692	1992	3292	10844	1506	1767	2900	9260							
B	5723	6754	11219	37220	5125	6027	9932	31885							
A	6107	7205	11962	39656	5467	6428	10587	33972							
D	13865	16368	27214	90422	12443	14638	24134	77542							
G2	16961	20023	33295	110704	15236	17922	29552	94975							
L	28798	33964	56355	186955	25847	30377	49994	160340							
K	238	281	465	1534	211	248	409	1308							
M	35605	42009	69781	232103	32058	37689	62083	199379							
Q	37192	43904	73018	243454	33575	39489	65106	209404							
P	3712	4372	7238	23886	3312	3889	6388	20423							
F1	2843	3339	5490	17976	2523	2955	4828	15343							
F2	3235	3800	6251	20482	2872	3364	5499	17484							
O1	4170	4900	8064	26445	3706	4342	7099	22582							
O2	5150	6050	9950	32616	4579	5364	8763	27860							
T	53507	63146	104961	349809	48300	56794	93595	300934							
S	3147	3699	6088	19964	2796	3276	5357	17044							
V	66591	78666	131034	438695	60389	71070	117362	378636							
W	75233	88942	148419	499116	68507	80690	133521	432356							
PEAK FLOWRATES [m3/s]															
PEAK Stream Top															
U	0	0	0	0	0	0	0	0							
R	0	0	0	0	0	0	0	0							
N	0	0	0	0	0	0	0	0							
J3	0	0	0	0	0	0	0	0							
J4	0.12	0.143	0.224	0.325	0.132	0.156	0.242	0.36							
E	0	0	0	0	0	0	0	0							
J1	1.852	2.19	3.456	5.693	2.076	2.449	3.831	6.354							
J2	2.339	2.771	4.436	7.52	2.385	2.825	4.495	8.359							
I	2.435	2.891	4.656	8.092	2.405	2.854	4.573	8.971							
H	0	0	0	0	0	0	0	0							
G1	0	0	0	0	0	0	0	0							
B	0	0	0	0	0	0	0	0							
A	0	0	0	0	0	0	0	0							
D	3.88	4.639	7.63	14.447	3.985	4.77	7.818	15.936							
G2	4.749	5.707	9.508	18.967	4.616	5.548	9.232	20.923							
L	8.292	9.935	16.427	32.653	8.017	9.604	15.874	35.947							
K	0	0	0	0	0	0	0	0							
M	9.079	10.916	18.126	37.931	8.743	10.479	17.444	41.855							
Q	9.351	11.259	19.025	43.37	9.137	10.975	18.497	47.497							
P	0	0	0	0	0	0	0	0							
F1	0	0	0	0	0	0	0	0							
F2	1.192	1.409	2.218	3.492	1.329	1.567	2.443	3.926							
O1	1.319	1.558	2.467	3.978	1.36	1.611	2.555	4.465							
O2	1.591	1.891	3.047	5.134	1.545	1.835	2.951	5.743							
T	12.467	15.076	25.812	60.963	12.206	14.688	24.919	67.05							
S	0	0	0	0	0	0	0	0							
V	13.524	16.335	28.025	69.613	13.282	15.978	27.241	75.343							
W	14.502	17.415	29.645	81.204	13.952	16.763	28.916	86.507							
PEAK Stream Bottom															
U	0	0	0	0	0	0	0	0							
R	0	0	0	0	0	0	0	0							
N	0	0	0	0	0	0	0	0							
J3	0	0	0	0	0	0	0	0							
J4	0.101	0.12	0.192	0.311	0.101	0.12	0.192	0.351							
E	0	0	0	0	0	0	0	0							
J1	1.69	2.008	3.236	5.662	1.675	1.991	3.199	6.265							
J2	2.253	2.677	4.312	7.502	2.224	2.643	4.248	8.317							
I	2.291	2.726	4.426	8.063	2.236	2.659	4.302	8.91							
H	0	0	0	0	0	0	0	0							
G1	0	0	0	0	0	0	0	0							
B	0	0	0	0	0	0	0	0							
A	0	0	0	0	0	0	0	0							
D	3.471	4.168	6.953	14.284	3.357	4.031	6.735	15.722							
G2	4.542	5.457	9.101	18.884	4.379	5.257	8.787	20.758							
L	7.909	9.49	15.764	32.519	7.641	9.156	15.219	35.727							
K	0	0	0	0	0	0	0	0							
M	8.339	10.041	16.906	37.64	8.111	9.74	16.365	41.216							
Q	9.176	11.053	18.689	43.304	8.964	10.772	18.176	47.226							
P	0	0	0	0	0	0	0	0							

F1	0	0	0	0	0	0	0	0
F2	1.144	1.353	2.148	3.488	1.185	1.403	2.222	3.908
O1	1.222	1.452	2.335	3.968	1.205	1.432	2.294	4.432
O2	1.478	1.761	2.856	5.121	1.442	1.714	2.776	5.697
T	12.157	14.672	25.041	60.903	11.891	14.317	24.344	66.051
S	0	0	0	0	0	0	0	0
V	12.703	15.295	26.123	68.746	12.299	14.81	25.443	73.57
W	13.869	16.726	28.602	79.635	13.317	16.039	27.666	84.918
PEAK Local Perv								
U	0.266	0.314	0.501	0.778	0.298	0.353	0.555	0.882
R	1.088	1.295	2.103	3.722	1.137	1.357	2.197	4.097
N	0.499	0.591	0.943	1.547	0.542	0.644	1.024	1.74
J3	0.115	0.137	0.216	0.314	0.127	0.15	0.233	0.347
J4	0.254	0.301	0.48	0.743	0.286	0.338	0.532	0.84
E	1.018	1.211	1.963	3.448	1.067	1.272	2.057	3.803
J1	0.206	0.244	0.388	0.591	0.23	0.272	0.427	0.659
J2	0.183	0.217	0.345	0.521	0.204	0.241	0.377	0.576
I	0.421	0.498	0.791	1.281	0.461	0.547	0.867	1.445
H	0.498	0.589	0.939	1.541	0.54	0.641	1.02	1.733
G1	0.589	0.698	1.117	1.858	0.634	0.753	1.202	2.082
B	1.873	2.24	3.687	6.996	1.91	2.288	3.757	7.717
A	1.922	2.3	3.789	7.215	1.959	2.346	3.856	7.961
D	0.809	0.962	1.549	2.655	0.858	1.021	1.641	2.951
G2	0.564	0.669	1.069	1.771	0.609	0.723	1.153	1.987
L	0.716	0.85	1.364	2.31	0.763	0.908	1.455	2.577
K	0.115	0.137	0.215	0.314	0.127	0.15	0.233	0.347
M	1.36	1.622	2.648	4.818	1.407	1.681	2.738	5.293
Q	0.612	0.725	1.161	1.938	0.657	0.781	1.248	2.17
P	1.184	1.411	2.296	4.105	1.233	1.472	2.389	4.504
F1	0.686	0.814	1.306	2.203	0.733	0.872	1.396	2.461
F2	0.133	0.158	0.249	0.368	0.147	0.174	0.271	0.404
O1	0.272	0.321	0.512	0.797	0.305	0.361	0.568	0.903
O2	0.17	0.201	0.319	0.479	0.189	0.223	0.349	0.529
T	1.098	1.308	2.124	3.764	1.148	1.369	2.218	4.141
S	0.803	0.954	1.536	2.631	0.851	1.013	1.629	2.925
V	2.1	2.514	4.153	8.004	2.131	2.555	4.209	8.843
W	1.094	1.303	2.115	3.747	1.143	1.364	2.209	4.124
PEAK Local Imp								
U	0	0	0	0	0	0	0	0
R	0.699	0.817	1.236	1.727	0.748	0.871	1.313	1.92
N	0.464	0.541	0.819	1.122	0.493	0.574	0.865	1.256
J3	0.005	0.006	0.009	0.011	0.005	0.006	0.009	0.012
J4	0.029	0.033	0.05	0.063	0.03	0.034	0.052	0.072
E	0.94	1.098	1.663	2.356	1.009	1.177	1.775	2.605
J1	0.555	0.648	0.98	1.355	0.591	0.689	1.038	1.512
J2	0.04	0.047	0.071	0.089	0.042	0.049	0.073	0.102
I	0.029	0.034	0.05	0.063	0.03	0.035	0.052	0.072
H	0.013	0.015	0.022	0.027	0.013	0.015	0.023	0.032
G1	0.119	0.139	0.209	0.271	0.124	0.145	0.218	0.308
B	0	0	0	0	0	0	0	0
A	0.112	0.13	0.197	0.254	0.117	0.136	0.204	0.289
D	0.008	0.01	0.014	0.018	0.008	0.01	0.015	0.02
G2	0.056	0.065	0.098	0.124	0.058	0.067	0.101	0.141
L	0.209	0.244	0.368	0.486	0.219	0.256	0.385	0.55
K	0	0	0	0	0	0	0	0
M	0.514	0.6	0.907	1.249	0.547	0.637	0.96	1.396
Q	0.191	0.223	0.337	0.444	0.201	0.234	0.352	0.503
P	0.222	0.26	0.392	0.52	0.234	0.273	0.41	0.588
F1	0.56	0.654	0.989	1.367	0.596	0.695	1.047	1.526
F2	0.066	0.078	0.117	0.148	0.069	0.08	0.121	0.17
O1	0.172	0.2	0.302	0.397	0.18	0.21	0.316	0.45
O2	0.333	0.389	0.587	0.793	0.352	0.41	0.618	0.892
T	0.346	0.404	0.611	0.826	0.367	0.427	0.643	0.929
S	0.54	0.631	0.954	1.317	0.575	0.671	1.01	1.471
V	2.006	2.342	3.555	5.218	2.18	2.541	3.84	5.769
W	3.413	3.985	6.059	9.093	3.744	4.364	6.605	10.251
PEAK Directed to Btm								
U	0	0	0	0	0	0	0	0
R	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0
J3	0	0	0	0	0	0	0	0
J4	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0
J1	0	0	0	0	0	0	0	0
J2	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0
G1	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0
G2	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0	0
F1	0	0	0	0	0	0	0	0
F2	0	0	0	0	0	0	0	0
O1	0	0	0	0	0	0	0	0
O2	0	0	0	0	0	0	0	0
T	0	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0	0
PEAK OUTLET Inflow								
U	0.266	0.314	0.501	0.778	0.298	0.353	0.555	0.882
R	1.687	1.995	3.183	5.358	1.885	2.228	3.51	5.955
N	0.935	1.104	1.727	2.601	1.035	1.218	1.889	2.938
J3	0.12	0.143	0.224	0.325	0.132	0.156	0.242	0.36
J4	0.375	0.443	0.702	1.11	0.411	0.486	0.767	1.257

E	1.852	2.19	3.456	5.693	2.076	2.449	3.831	6.354
J1	2.339	2.771	4.436	7.52	2.385	2.825	4.495	8.359
J2	2.435	2.891	4.656	8.092	2.405	2.854	4.573	8.971
I	2.638	3.141	5.098	9.391	2.567	3.055	4.939	10.365
H	0.506	0.599	0.955	1.566	0.553	0.657	1.043	1.761
G1	0.68	0.804	1.28	2.109	0.758	0.898	1.42	2.368
B	1.873	2.24	3.687	6.996	1.91	2.288	3.757	7.717
A	2.007	2.399	3.943	7.45	2.075	2.482	4.061	8.219
D	4.167	5.004	8.334	16.897	4.038	4.853	8.086	18.62
G2	4.99	5.99	9.977	20.696	4.802	5.764	9.628	22.769
L	8.473	10.178	16.944	35.169	8.195	9.816	16.319	38.69
K	0.115	0.137	0.215	0.314	0.127	0.15	0.233	0.347
M	9.351	11.259	19.025	43.37	9.137	10.975	18.497	47.497
Q	9.505	11.448	19.386	45.511	9.303	11.188	18.886	49.548
P	1.36	1.617	2.614	4.59	1.467	1.745	2.799	5.055
F1	1.192	1.409	2.218	3.492	1.329	1.567	2.443	3.926
F2	1.319	1.558	2.467	3.978	1.36	1.611	2.555	4.465
O1	1.591	1.891	3.047	5.134	1.545	1.835	2.951	5.743
O2	1.803	2.153	3.519	6.327	1.776	2.114	3.422	7.041
T	12.853	15.517	26.53	65.228	12.589	15.165	25.801	70.628
S	1.272	1.506	2.382	3.872	1.426	1.684	2.639	4.336
V	14.502	17.415	29.645	81.204	13.952	16.763	28.916	86.507
W	15.297	18.494	31.606	90.543	14.56	17.534	30.425	96.261
PEAK OUTLET Outflow								
U	0.266	0.314	0.501	0.778	0.298	0.353	0.555	0.882
R	1.687	1.995	3.183	5.358	1.885	2.228	3.51	5.955
N	0.935	1.104	1.727	2.601	1.035	1.218	1.889	2.938
J3	0.12	0.143	0.224	0.325	0.132	0.156	0.242	0.36
J4	0.375	0.443	0.702	1.11	0.411	0.486	0.767	1.257
E	1.852	2.19	3.456	5.693	2.076	2.449	3.831	6.354
J1	2.339	2.771	4.436	7.52	2.385	2.825	4.495	8.359
J2	2.435	2.891	4.656	8.092	2.405	2.854	4.573	8.971
I	2.638	3.141	5.098	9.391	2.567	3.055	4.939	10.365
H	0.506	0.599	0.955	1.566	0.553	0.657	1.043	1.761
G1	0.68	0.804	1.28	2.109	0.758	0.898	1.42	2.368
B	1.873	2.24	3.687	6.996	1.91	2.288	3.757	7.717
A	2.007	2.399	3.943	7.45	2.075	2.482	4.061	8.219
D	4.167	5.004	8.334	16.897	4.038	4.853	8.086	18.62
G2	4.99	5.99	9.977	20.696	4.802	5.764	9.628	22.769
L	8.473	10.178	16.944	35.169	8.195	9.816	16.319	38.69
K	0.115	0.137	0.215	0.314	0.127	0.15	0.233	0.347
M	9.351	11.259	19.025	43.37	9.137	10.975	18.497	47.497
Q	9.505	11.448	19.386	45.511	9.303	11.188	18.886	49.548
P	1.36	1.617	2.614	4.59	1.467	1.745	2.799	5.055
F1	1.192	1.409	2.218	3.492	1.329	1.567	2.443	3.926
F2	1.319	1.558	2.467	3.978	1.36	1.611	2.555	4.465
O1	1.591	1.891	3.047	5.134	1.545	1.835	2.951	5.743
O2	1.803	2.153	3.519	6.327	1.776	2.114	3.422	7.041
T	12.853	15.517	26.53	65.228	12.589	15.165	25.801	70.628
S	1.272	1.506	2.382	3.872	1.426	1.684	2.639	4.336
V	14.502	17.415	29.645	81.204	13.952	16.763	28.916	86.507
W	15.297	18.494	31.606	90.543	14.56	17.534	30.425	96.261
TIME to Peaks [mins]								
TIME Stream Top								
U	0	0	0	0	0	0	0	0
R	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0
J3	0	0	0	0	0	0	0	0
J4	35	35	35	20	30	30	30	15
E	0	0	0	0	0	0	0	0
J1	35	35	35	40	30	30	30	30
J2	40	40	40	40	30	30	30	30
I	41	41	40	40	32	32	32	31
H	0	0	0	0	0	0	0	0
G1	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0
D	40	40	40	40	30	30	30	40
G2	41	41	40	41	32	32	31	40
L	44	43	42	42	35	34	33	40
K	0	0	0	0	0	0	0	0
M	45	45	44	43	38	37	36	40
Q	50	50	48	48	43	42	40	40
P	0	0	0	0	0	0	0	0
F1	0	0	0	0	0	0	0	0
F2	35	35	35	40	30	30	30	30
O1	40	40	40	40	30	30	30	30
O2	40	40	40	40	31	31	30	30
T	48	47	45	48	42	41	40	40
S	0	0	0	0	0	0	0	0
V	52	51	48	55	45	44	41	41
W	62	60	56	55	54	52	47	50
TIME Stream Bottom								
U	0	0	0	0	0	0	0	0
R	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0
J3	0	0	0	0	0	0	0	0
J4	41	41	40	29	32	32	31	30
E	0	0	0	0	0	0	0	0
J1	41	41	41	40	32	32	32	31
J2	41	41	41	40	32	32	32	31
I	44	44	43	41	35	35	34	33
H	0	0	0	0	0	0	0	0
G1	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0
D	44	44	43	43	35	34	34	41
G2	46	45	44	44	37	36	35	41
L	47	47	46	45	39	38	37	41
K	0	0	0	0	0	0	0	0

M	52	51	49	49	44	43	41	43
Q	54	53	51	51	46	45	43	43
P	0	0	0	0	0	0	0	0
F1	0	0	0	0	0	0	0	0
F2	40	40	40	40	31	31	31	30
O1	42	42	41	40	33	33	33	31
O2	44	43	43	41	35	35	34	32
T	54	53	50	55	46	46	43	43
S	0	0	0	0	0	0	0	0
V	63	61	57	57	54	53	49	51
W	69	67	63	60	61	59	55	55
TIME Local Perv								
U	40	35	35	40	30	30	30	30
R	40	40	40	40	30	30	30	30
N	40	40	40	40	30	30	30	30
J3	35	35	35	20	30	30	30	15
J4	40	35	35	20	30	30	30	30
E	40	40	40	40	30	30	30	30
J1	35	35	35	20	30	30	30	30
J2	35	35	35	20	30	30	30	30
I	40	40	40	40	30	30	30	30
H	40	40	40	40	30	30	30	30
G1	40	40	40	40	30	30	30	30
B	40	40	40	40	30	30	30	40
A	40	40	40	40	30	30	30	40
D	40	40	40	40	30	30	30	30
G2	40	40	40	40	30	30	30	30
L	40	40	40	40	30	30	30	30
K	35	35	35	20	30	30	30	15
M	40	40	40	40	30	30	30	40
Q	40	40	40	40	30	30	30	30
P	40	40	40	40	30	30	30	40
F1	40	40	40	40	30	30	30	30
F2	35	35	35	20	30	30	30	15
O1	40	35	35	40	30	30	30	30
O2	35	35	35	20	30	30	30	30
T	40	40	40	40	30	30	30	30
S	40	40	40	40	30	30	30	30
V	40	40	40	40	30	30	30	40
W	40	40	40	40	30	30	30	30
TIME Local Imp								
U	0	0	0	0	0	0	0	0
R	35	35	35	20	30	30	30	15
N	35	35	35	20	30	30	30	15
J3	35	35	35	20	30	30	30	15
J4	35	35	35	20	30	30	30	15
E	35	35	35	20	30	30	30	15
J1	35	35	35	20	30	30	30	15
J2	35	35	35	20	30	30	30	15
I	35	35	35	20	30	30	30	15
H	35	35	35	20	30	30	30	15
G1	35	35	35	20	30	30	30	15
B	0	0	0	0	0	0	0	0
A	35	35	35	20	30	30	30	15
D	35	35	35	20	30	30	30	15
G2	35	35	35	20	30	30	30	15
L	35	35	35	20	30	30	30	15
K	0	0	0	0	0	0	0	0
M	35	35	35	20	30	30	30	15
Q	35	35	35	20	30	30	30	15
P	35	35	35	20	30	30	30	15
F1	35	35	35	20	30	30	30	15
F2	35	35	35	20	30	30	30	15
O1	35	35	35	20	30	30	30	15
O2	35	35	35	20	30	30	30	15
T	35	35	35	20	30	30	30	15
S	35	35	35	20	30	30	30	15
V	35	35	35	20	30	30	30	30
W	35	35	35	20	30	30	30	30
TIME Directed to Btm								
U	0	0	0	0	0	0	0	0
R	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0
J3	0	0	0	0	0	0	0	0
J4	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0
J1	0	0	0	0	0	0	0	0
J2	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0
G1	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0
G2	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0	0
F1	0	0	0	0	0	0	0	0
F2	0	0	0	0	0	0	0	0
O1	0	0	0	0	0	0	0	0
O2	0	0	0	0	0	0	0	0
T	0	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0	0
TIME OUTLET Inflow								
U	40	35	35	40	30	30	30	30
R	40	40	40	40	30	30	30	30

N	35	35	35	40	30	30	30	30
J3	35	35	35	20	30	30	30	15
J4	40	40	40	28	30	30	30	30
E	35	35	35	40	30	30	30	30
J1	40	40	40	40	30	30	30	30
J2	41	41	40	40	32	32	32	31
I	43	43	42	40	34	34	33	32
H	40	40	40	40	30	30	30	30
G1	40	40	40	40	30	30	30	30
B	40	40	40	40	30	30	30	40
A	40	40	40	40	30	30	30	40
D	43	42	42	42	34	33	33	40
G2	45	45	43	43	36	36	35	40
L	46	46	45	44	38	38	36	40
K	35	35	35	20	30	30	30	15
M	50	50	48	48	43	42	40	40
Q	53	53	50	52	45	45	42	43
P	40	40	40	40	30	30	30	30
F1	35	35	35	40	30	30	30	30
F2	40	40	40	40	30	30	30	30
O1	40	40	40	40	31	31	30	30
O2	40	40	40	40	30	30	30	30
T	53	52	49	55	45	45	42	43
S	35	35	35	40	30	30	30	30
V	62	60	56	55	54	52	47	50
W	65	65	63	56	60	58	55	53
TIME OUTLET Outflow								
U	40	35	35	40	30	30	30	30
R	40	40	40	40	30	30	30	30
N	35	35	35	40	30	30	30	30
J3	35	35	35	20	30	30	30	15
J4	40	40	40	28	30	30	30	30
E	35	35	35	40	30	30	30	30
J1	40	40	40	40	30	30	30	30
J2	41	41	40	40	32	32	32	31
I	43	43	42	40	34	34	33	32
H	40	40	40	40	30	30	30	30
G1	40	40	40	40	30	30	30	30
B	40	40	40	40	30	30	30	40
A	40	40	40	40	30	30	30	40
D	43	42	42	42	34	33	33	40
G2	45	45	43	43	36	36	35	40
L	46	46	45	44	38	38	36	40
K	35	35	35	20	30	30	30	15
M	50	50	48	48	43	42	40	40
Q	53	53	50	52	45	45	42	43
P	40	40	40	40	30	30	30	30
F1	35	35	35	40	30	30	30	30
F2	40	40	40	40	30	30	30	30
O1	40	40	40	40	31	31	30	30
O2	40	40	40	40	30	30	30	30
T	53	52	49	55	45	45	42	43
S	35	35	35	40	30	30	30	30
V	62	60	56	55	54	52	47	50
W	65	65	63	56	60	58	55	53

APPENDIX

B

PROPOSED CONCEPT DESIGN

Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Ground Floor, 16 Burelli Street
Wollongong NSW 2500
Tel: 02 4231 9600 Fax: 02 4228 6811
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WOLLONGONG COAL

BELLAMBI CREEK DIVERSION CONCEPT DESIGN

COVER SHEET

82020124-01 C1000
Drawing Number

2
Revision

DATE PLOTTED: 24 April 2020 6:00 PM BY : HAMISH MOSES
CAD File: \\AUWOLCFS03\Projects\FY20\124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1000.dwg

DATE PLOTTED: 24 April 2020 6:00 PM BY : HAMISH MOSES

NORTH

SCHEDULE OF DRAWINGS

DRAWING No.	DESCRIPTION
82020124-01 C1000	COVER SHEET
82020124-01 C1001	SITE LOCALITY PLAN
82020124-01 C1002	GENERAL ARANGEMENT LAYOUT PLAN
82020124-01 C1003	STORMWATER LAYOUT PLAN SHEET 1 OF 3
82020124-01 C1004	STORMWATER LAYOUT PLAN SHEET 2 OF 3
82020124-01 C1005	STORMWATER LAYOUT PLAN SHEET 3 OF 3
82020124-01 C1006	DETAIL SECTIONS

SITE LOCALITY

SCALE 1:5000

NOTE

1. IMAGE SOURCED FROM NEARMAP (MARCH, 2020)

LEGEND

SITE BOUNDARY

0 100 200 300 400 500m

SCALE 1:5000 (A1), 1:10000 (A3)

Rev.	Date	Description	Des.	Verif.	Appd.
2	24/04/2020	CONCEPT DESIGN	HSM	SR	SR
1	22/03/2020	DRAFT CONCEPT DESIGN	HSM	SR	RH

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		Date
Drawn	HSM	22/03/2020
Checked	MPR	24/03/2020
Designed	HSM	22/03/2020
Verified	SR	24/03/2020
Approved	RH	24/03/2020

Client: WOLLONGONG COAL

Project: BELLAMBI CREEK DIVERSION
CONCEPT DESIGN

Title: SITE LOCALITY PLAN AND DRAWING SCHEDULE

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

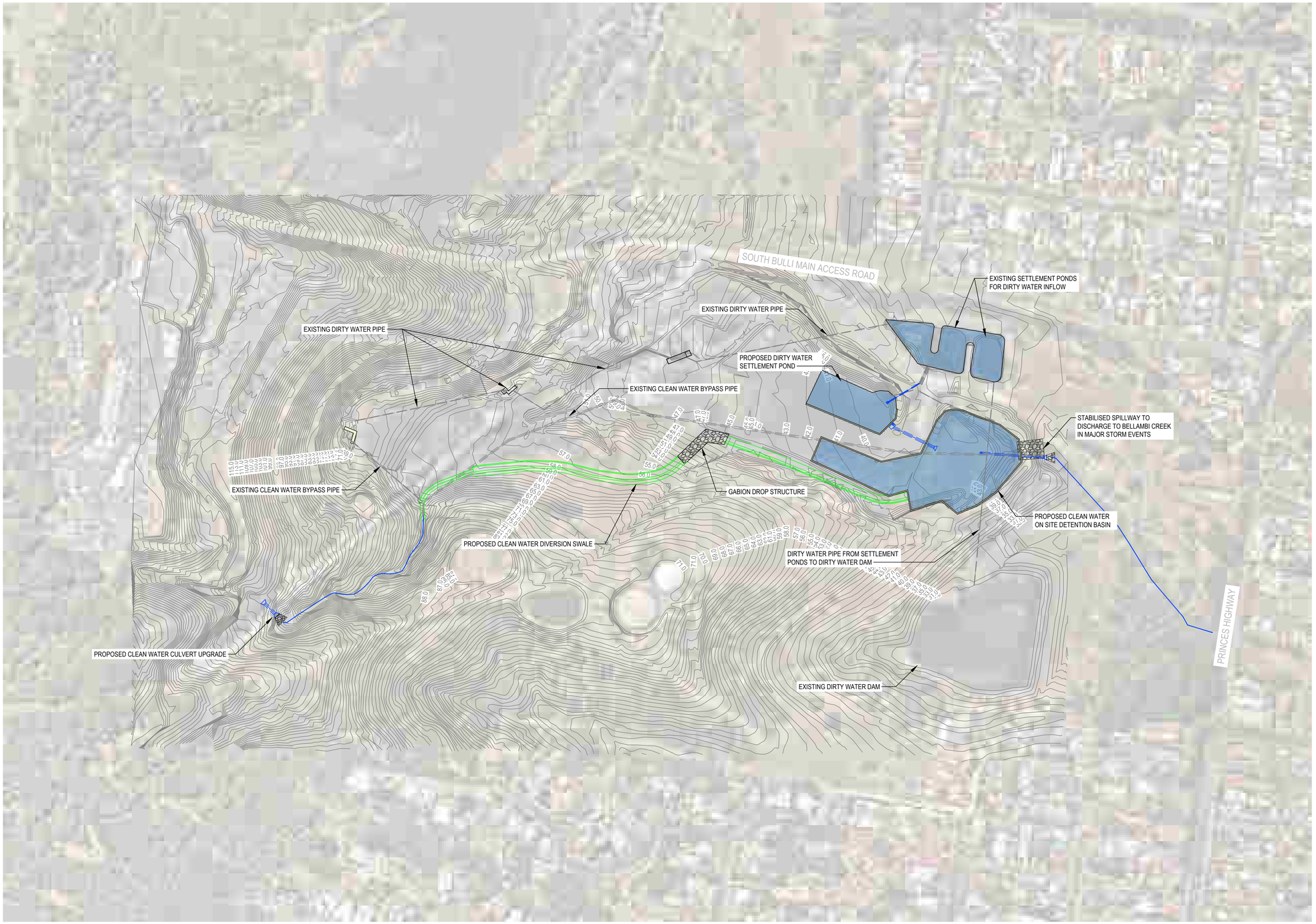
DATUM	Scale	Size
AHD	1:5000	A1

Drawing Number: 82020124-01 C1001

Revision: 2

XREF's: XR-82020124-01-G1-TITLE; XR-82020124-01-E1-SURFACE; XR-82020124-01-B1-BASE; XR-82020124-01-E1-CADASTRE; XR-82020124-01-G1-LEGEND
CAD File: \\AUWOLCFS03\Projects\FY20\124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1001.dwg

DATE PLOTTED: 5 May 2020 2:54 PM BY : HAMISH MOSES



NORTH

NOTE

1. IMAGE SOURCED FROM NEARMAP (MARCH, 2020)

LEGEND

- PROPOSED STORMWATER PIPE/CULVERT
- EXISTING STORMWATER PIPE/CULVERT
- PROPOSED TOP/BOTTOM OF SWALE
- 10.0 EXISTING CONTOURS
- EXISTING WATERCOURSE
- PROPOSED BASIN LOCATIONS
- PROPOSED STABILISATION LOCATIONS
- PROPOSED TOP OF BUND/EMBANKMENT

GENERAL ARRANGEMENT LAYOUT

SCALE 1:2000

0 50 100 150 200m

SCALE 1:2000 (A1), 1:4000 (A3)

Rev.	Date	Description	Des.	Verif.	Appd.
2	24/04/2020	CONCEPT DESIGN	HSM	SR	SR
1	22/03/2020	DRAFT CONCEPT DESIGN	HSM	SR	RH

WOLLONGONG COAL

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Drawn	HSM	22/03/2020
Checked	MPR	24/03/2020
Designed	HSM	22/03/2020
Verified	SR	24/03/2020
Approved	RH	24/03/2020

Client: WOLLONGONG COAL

Project: BELLAMBI CREEK DIVERSION CONCEPT DESIGN

Title: GENERAL ARANGEMENT LAYOUT PLAN

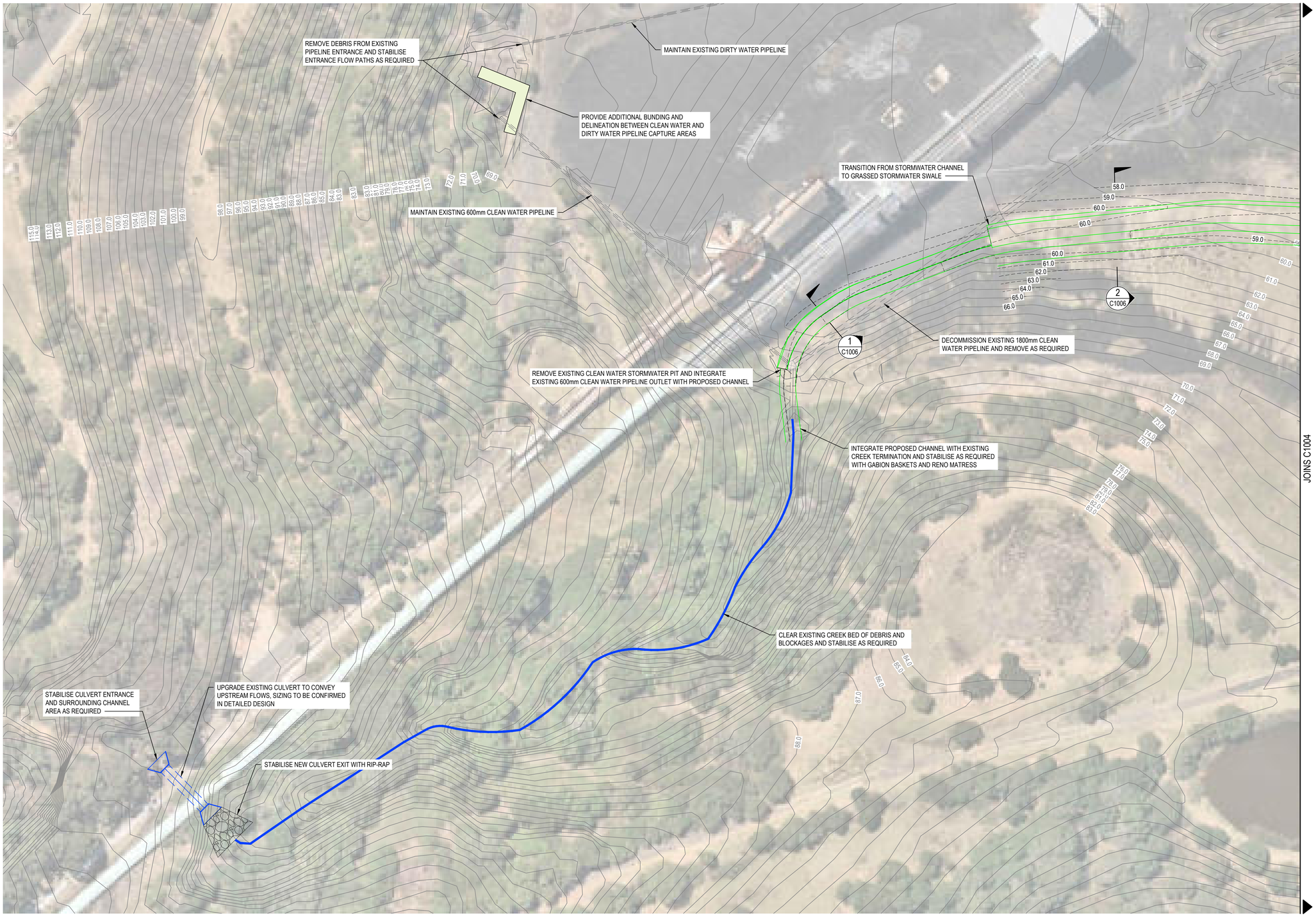
Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DATUM	Scale	Size
AHD	1:2000	A1

Drawing Number: 82020124-01 C1002

Revision: 2

XREFs: XR-82020124-01-G1-TITLE; XR-82020124-01-E1-SURFACE; XR-82020124-01-D1-BASE; XR-82020124-01-E1-CADASTRE; XR-82020124-01-G1-LEGEND
CAD File: \\AUWOLCFS03\Projects\FY20\124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1002.dwg



NORTH

NOTE

1. IMAGE SOURCED FROM NEARMAP (MARCH, 2020)

LEGEND

- PROPOSED STORMWATER PIPE/CULVERT
- PROPOSED STORMWATER STRUCTURE
- EXISTING STORMWATER PIPE/CULVERT
- PROPOSED TOP/BOTTOM OF SWALE
- 10.0 DESIGN SURFACE CONTOURS
- 10.0 EXISTING CONTOURS
- EXISTING WATERCOURSE
- PROPOSED BASIN LOCATIONS
- PROPOSED STABILISATION LOCATIONS
- PROPOSED TOP OF BUND/EMBANKMENT

STORMWATER LAYOUT PLAN

SCALE 1:500

0 10 20 30 40 50m

SCALE 1:500 (A1), 1:1000 (A3)

Rev.	Date	Description	Des.	Verif.	Appd.
2	24/04/2020	CONCEPT DESIGN	HSM	SR	SR
1	22/03/2020	DRAFT CONCEPT DESIGN	HSM	SR	RH

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		Date
Drawn	HSM	22/03/2020
Checked	MPR	24/03/2020
Designed	HSM	22/03/2020
Verified	SR	24/03/2020
Approved	RH	24/03/2020

Client: WOLLONGONG COAL

Project: BELLAMBI CREEK DIVERSION CONCEPT DESIGN

Title: STORMWATER LAYOUT PLAN SHEET 1 OF 3

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DATUM	Scale	Size
AHD	1:500	A1

Drawing Number: 82020124-01 C1003

Revision: 2

DATE PLOTTED: 5 May 2020 2:57 PM BY : HAMISH MOSES

XREFs: XR-82020124-01-G1-TITLE; XR-82020124-01-E1-SURFACE; XR-82020124-01-D1-BASE; XR-82020124-01-G1-LEGEND; XR-82020124-01-D1-SURFACE
CAD File: \\AUWOLCFS03\Projects\PY20124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1003.dwg

DATE PLOTTED: 5 May 2020 2:56 PM BY : HAMISH MOSES

NORTH

NOTE

1. IMAGE SOURCED FROM NEARMAP (MARCH, 2020)

LEGEND

- PROPOSED STORMWATER PIPE/CULVERT
- PROPOSED STORMWATER STRUCTURE
- EXISTING STORMWATER PIPE/CULVERT
- PROPOSED TOP/BOTTOM OF SWALE
- 10.0 DESIGN SURFACE CONTOURS
- 10.0 EXISTING CONTOURS
- EXISTING WATERCOURSE
- PROPOSED BASIN LOCATIONS
- PROPOSED STABILISATION LOCATIONS
- PROPOSED TOP OF BUND/EMBANKMENT

STORMWATER LAYOUT PLAN

SCALE 1:500

0 10 20 30 40 50m

SCALE 1:500 (A1), 1:1000 (A3)

Rev.	Date	Description	Des.	Verif.	Appd.
2	24/04/2020	CONCEPT DESIGN	HSM	SR	SR
1	22/03/2020	DRAFT CONCEPT DESIGN	HSM	SR	RH

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		Date
Drawn	HSM	22/03/2020
Checked	MPR	24/03/2020
Designed	HSM	22/03/2020
Verified	SR	24/03/2020
Approved	RH	24/03/2020

Client: WOLLONGONG COAL

Project: BELLAMBI CREEK DIVERSION
CONCEPT DESIGN

Title: STORMWATER LAYOUT PLAN
SHEET 2 OF 3

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DATUM	Scale	Size
AHD	1:500	A1

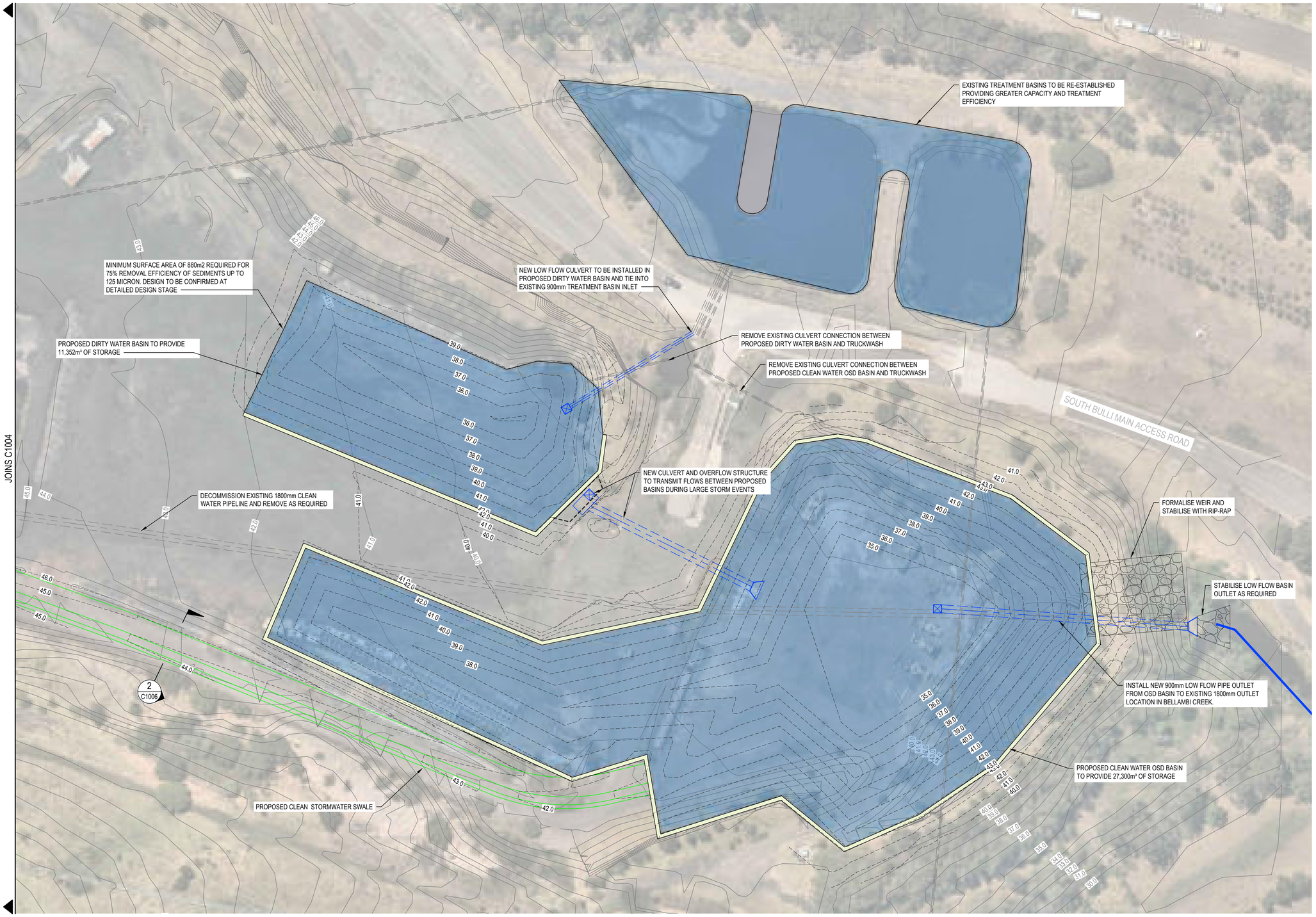
Drawing Number: 82020124-01 C1004

Revision: 2

XREF's: XR-82020124-01-G1-TITLE; XR-82020124-01-E1-SURFACE; XR-82020124-01-D1-BASE; XR-82020124-01-G1-LEGEND; XR-82020124-01-D1-SURFACE
CAD File: \\AUWOLCFS03\Projects\FY20\124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1004.dwg

DATE PLOTTED: 5 May 2020 2:56 PM BY : HAMISH MOSES

JOINS C1004



STORMWATER LAYOUT

SCALE 1:500

NORTH

NOTE

1. IMAGE SOURCED FROM NEARMAP (MARCH, 2020)

LEGEND

- PROPOSED STORMWATER PIPE/CULVERT
- PROPOSED STORMWATER STRUCTURE
- EXISTING STORMWATER PIPE/CULVERT
- PROPOSED TOP/BOTTOM OF SWALE
- 10.0 DESIGN SURFACE CONTOURS
- 10.0 EXISTING CONTOURS
- EXISTING WATERCOURSE
- PROPOSED BASIN LOCATIONS
- PROPOSED STABILISATION LOCATIONS
- PROPOSED TOP OF BUND/EMBANKMENT

0 10 20 30 40 50m

SCALE 1:500 (A1), 1:1000 (A3)

Rev.	Date	Description	Des.	Verif.	Appd.
2	24/04/2020	CONCEPT DESIGN	HSM	SR	SR
1	22/03/2020	DRAFT CONCEPT DESIGN	HSM	SR	RH

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		Date
Drawn	HSM	22/03/2020
Checked	MPR	24/03/2020
Designed	HSM	22/03/2020
Verified	SR	24/03/2020
Approved	RH	24/03/2020

Client: WOLLONGONG COAL

Project: BELLAMBI CREEK DIVERSION CONCEPT DESIGN

Title: STORMWATER LAYOUT PLAN SHEET 3 OF 3

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

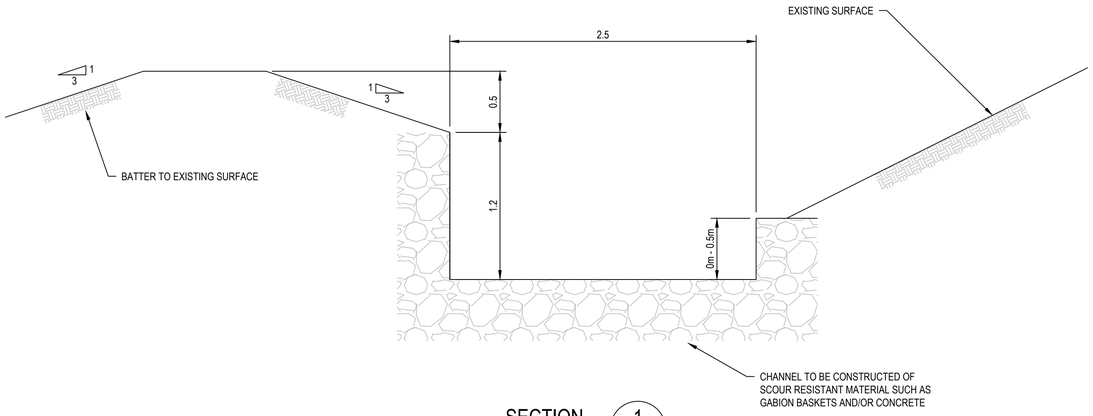
DATUM	Scale	Size
AHD	1:500	A1

Drawing Number: 82020124-01 C1005

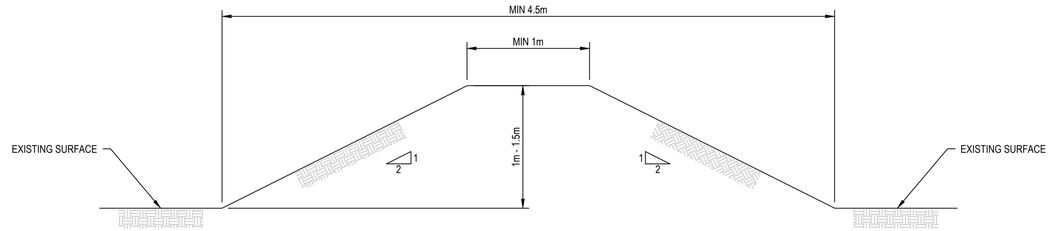
Revision: 2

XREF's: XR-82020124-01-G1-TITLE; XR-82020124-01-E1-SURFACE; XR-82020124-01-D1-BASE; XR-82020124-01-G1-LEGEND; XR-82020124-01-D1-SURFACE
CAD File: \\AUWOLCFS03\Projects\FY20\124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1005.dwg

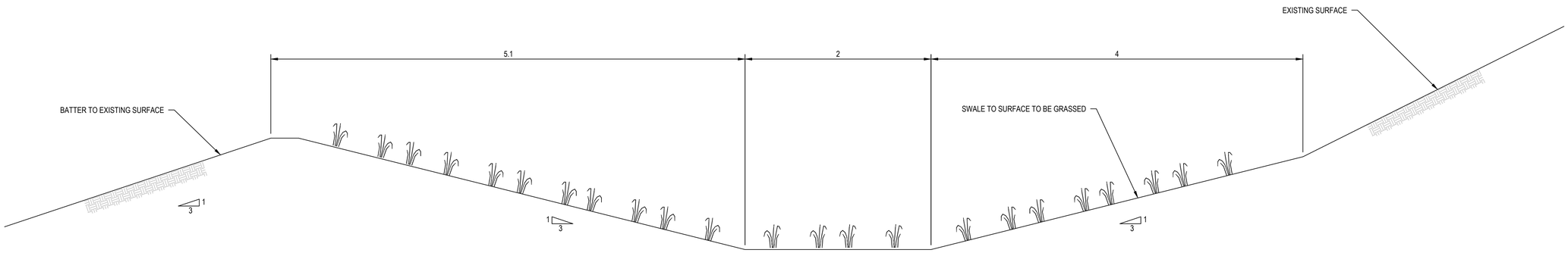
DATE PLOTTED: 24 April 2020 6:02 PM BY : HAMISH MOSES



SECTION 1 / C1003
SCALE 1:25



TYPICAL EARTH BUND SECTION
SCALE 1:25



SECTION 2 / C1003 C1004 C1005
SCALE 1:25

0 0.5 1 1.5 2 2.5m
SCALE 1:25 (A1), 1:50 (A3)

Rev.	Date	Description	Des.	Verif.	Appd.
2	24/04/2020	CONCEPT DESIGN	HSM	SR	SR
1	22/03/2020	DRAFT CONCEPT DESIGN	HSM	SR	RH

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		Date
Drawn	HSM	22/03/2020
Checked	MPR	24/03/2020
Designed	HSM	22/03/2020
Verified	SR	24/03/2020
Approved	RH	24/03/2020

Client: WOLLONGONG COAL
Project: BELLAMBI CREEK DIVERSION
CONCEPT DESIGN
Title: DETAIL SECTIONS

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DATUM	Scale	Size
AHD	1:25	A1

Drawing Number: 82020124-01 C1006
Revision: 2

XREF's: XR-82020124-01-G1-TITLE; XR-82020124-01-D1-DETAILS
CAD File: \\AUWOLCFS03\Projects\FY20\124_Bellambi Creek Diversion\Drawings\Build\C1000\82020124-01 C1006.dwg

APPENDIX

C

PHASE 1 FLOOD MAPS

Phase 1 - Existing 10 Year ARI Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-001-Ex_FloodExtent_10ARI.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Existing 100 Year ARI Flood Extents - 0% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-002-Ex_FloodExtent_100ARI_0pc.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Existing 100 Year ARI Flood Extents - 20% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-003-Ex_FloodExtent_10ARI_20pc.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Existing 100 Year ARI Flood Extents - 100% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

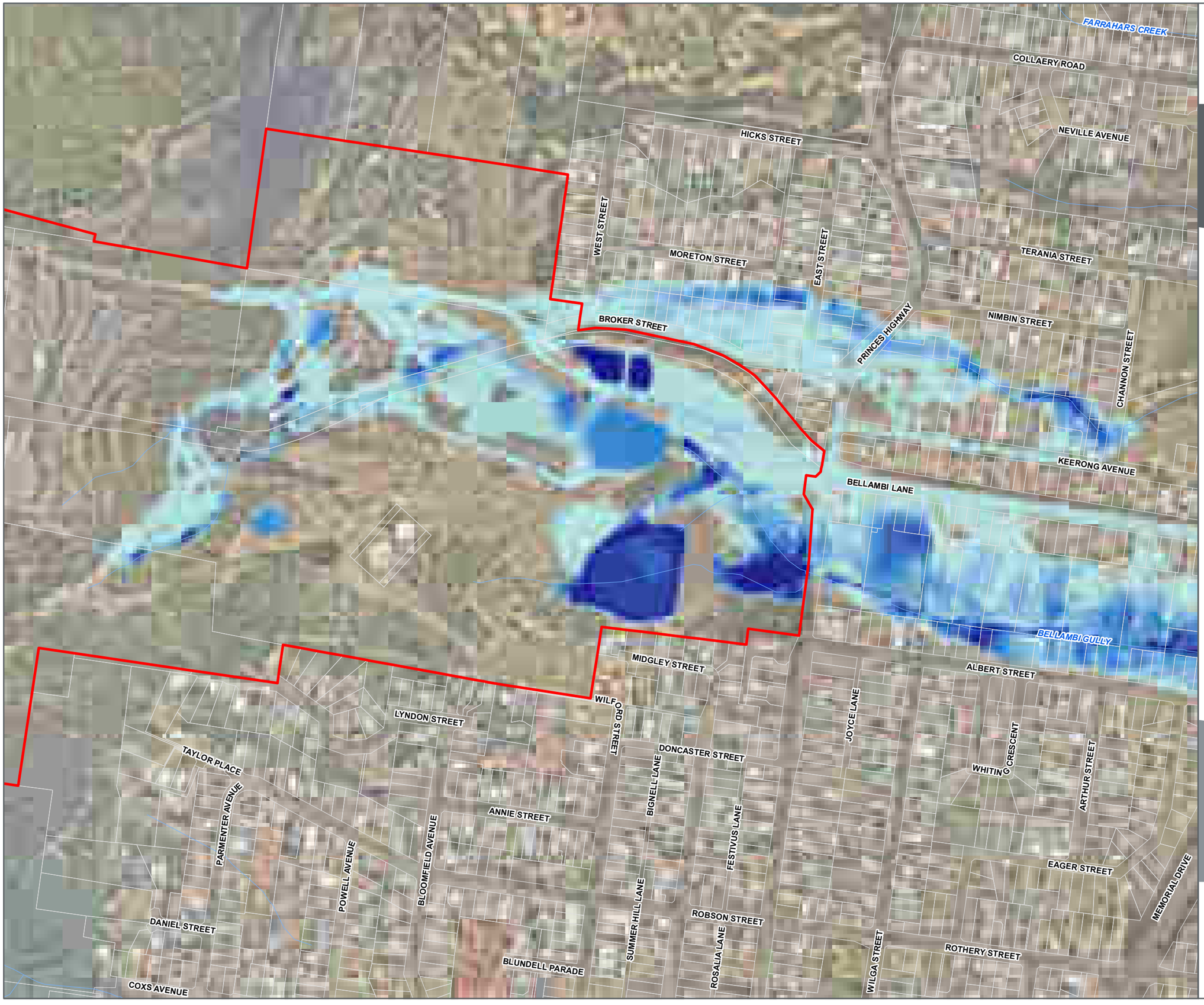
- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-004-Ex_FloodExtent_10ARI_100pc.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)



Phase 1 - Existing PMF Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-005-Ex_FloodExtent_PMF.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Post-Development 10 Year ARI Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

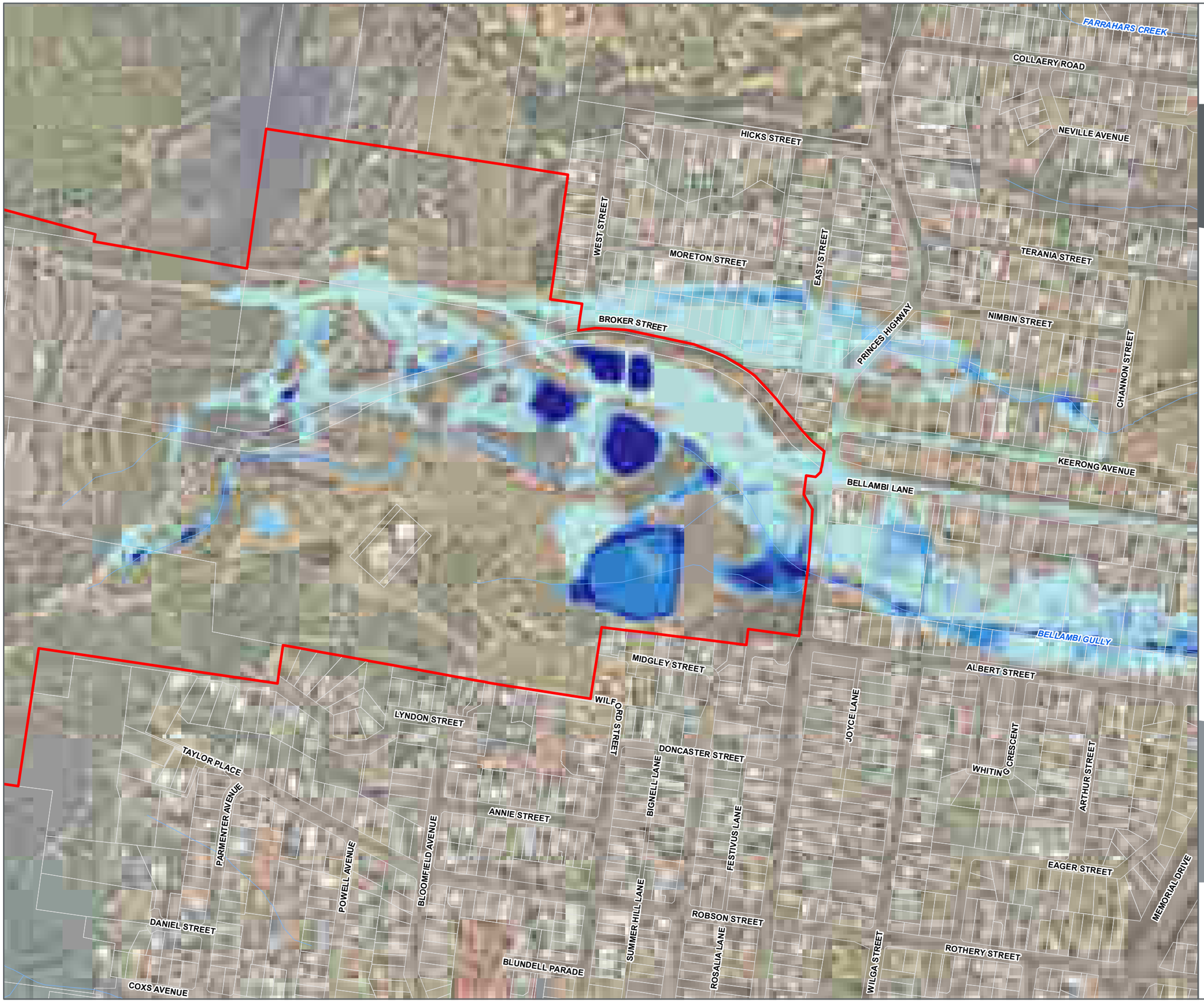
- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-006-PostDev_FloodExtent_10ARI.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)



Phase 1 - Post-Development 100 Year ARI Flood Extents - 0% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

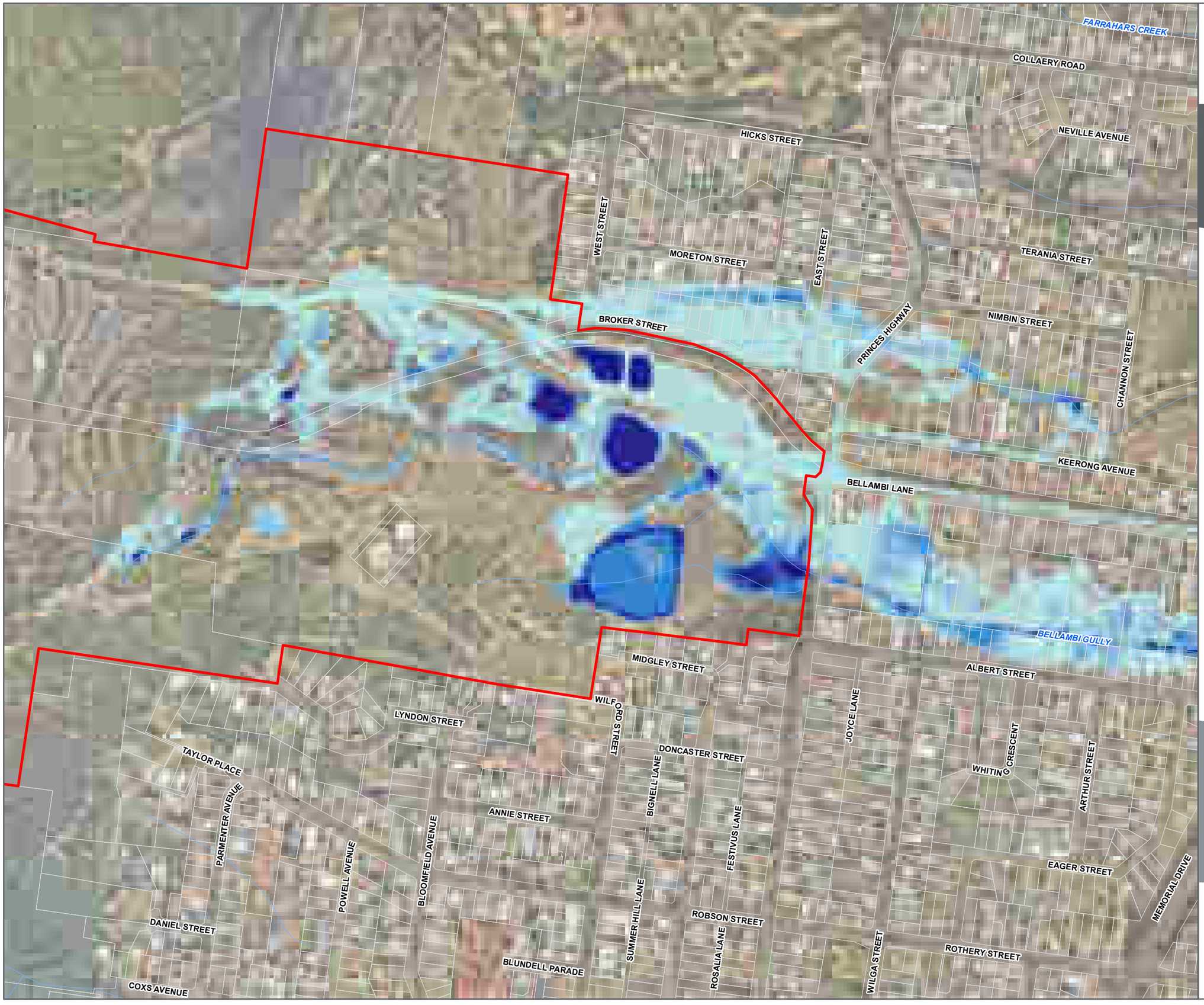
- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-007-PostDev_FloodExtent_100ARI_0pc.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)



Phase 1 - Post-Development 100 Year ARI Flood Extents - 20% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

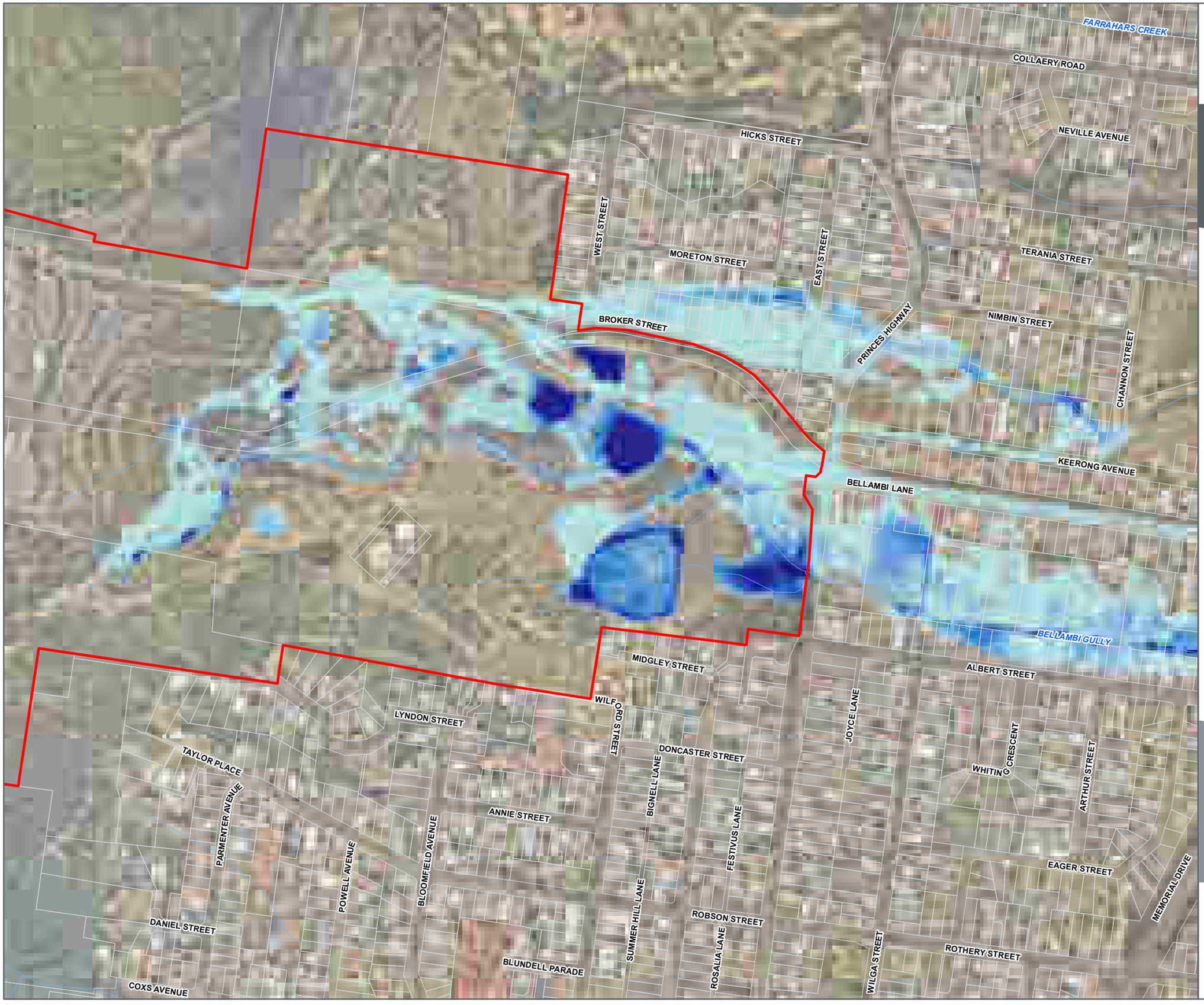
- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-008-PostDev_Extent_100ARI_20pc.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)



Phase 1 - Post-Development 100 Year ARI Flood Extents - 100% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

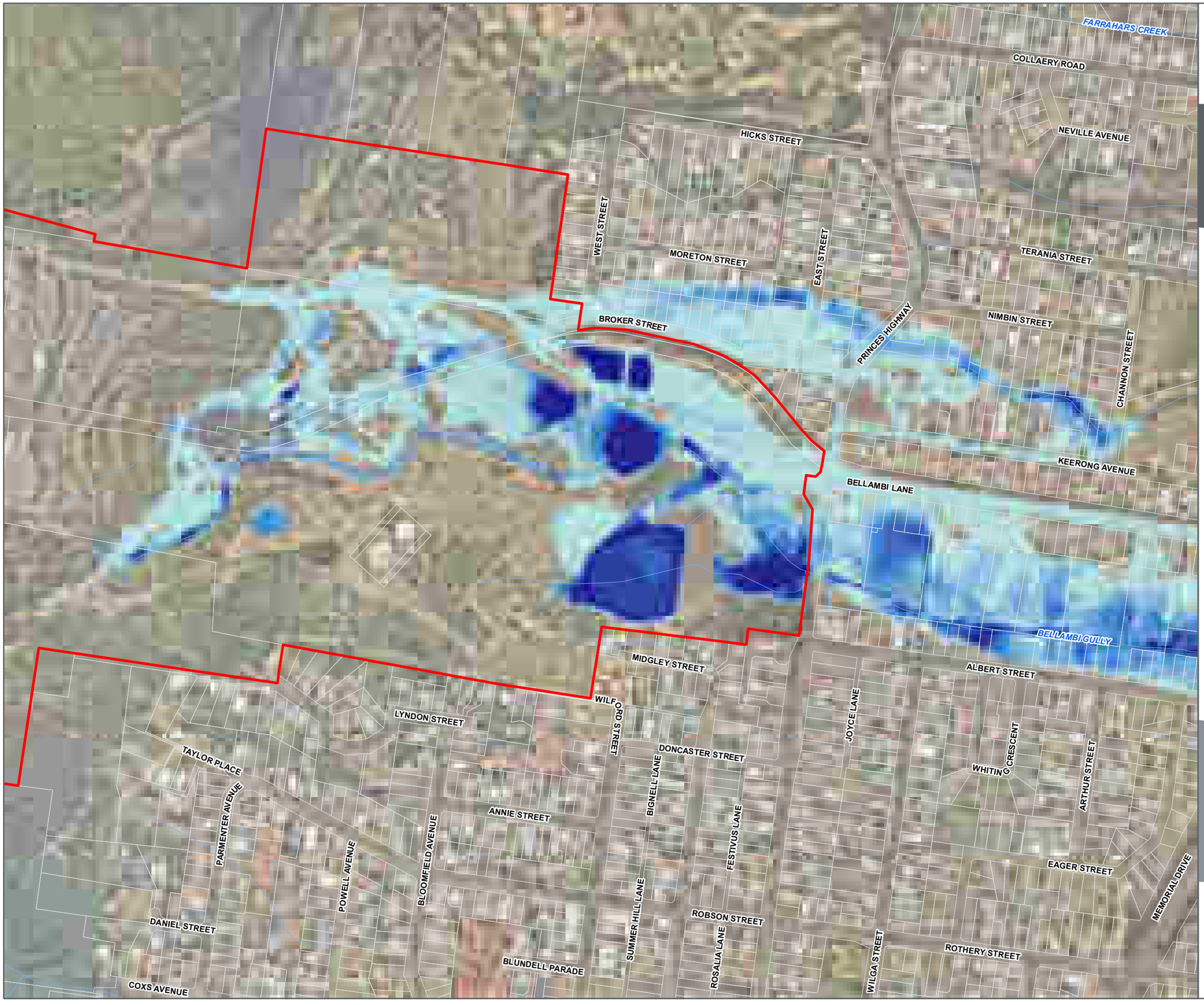
- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-009-PostDev_Extent_100ARI_100pc.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)



Phase 1 - Post-Development PMF Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-010-PostDev_FloodExtent_PMF.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Existing 10 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m

0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-011-Ex_FloodVelocity_10ARI.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Existing 100 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-012-Ex_FloodVelocity_100ARI.mxd 02
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Existing PMF Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-013-Ex_FloodVelocity_PMF.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Post-Development 10 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-014-PostDev_FloodVelocity_10ARI.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Post Development 100 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-015-PostDev_FloodVelocity_100ARI.mxd 02
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - Post Development PMF Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-016-PostDev_FloodVelocity_PMF.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - 10 Year ARI Flood Impacts

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-017-FloodImpact_10ARI.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - 100 Year ARI Flood Impacts (Envelope)

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-018-FloodImpact_100ARI.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

Phase 1 - PMF Flood Impacts

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-03-23 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-019-FloodImpact_PMF.mxd 01
Aerial Imagery supplied by Nearmap (November, 2019)

APPENDIX

D

FINAL FLOOD MAPS

Phase 2 - Existing 5 Year ARI Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-021-Ex_FloodExtent_5ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 10 Year ARI Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-001-Ex_FloodExtent_10ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 100 Year ARI Flood Extents - 0% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-002-Ex_FloodExtent_100ARI_0pc.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 100 Year ARI Flood Extents - 20% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-003-Ex_FloodExtent_10ARI_20pc.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 100 Year ARI Flood Extents - 100% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-004-Ex_FloodExtent_10ARI_100pc.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing PMF Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-005-Ex_FloodExtent_PMF.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 5 Year ARI Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-022-PostDev_FloodExtent_5ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 10 Year ARI Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-006-PostDev_FloodExtent_10ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 100 Year ARI Flood Extents - 0% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-007-PostDev_FloodExtent_100ARI_0pc.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 100 Year ARI Flood Extents - 20% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-008-PostDev_Extent_100ARI_20pc.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 100 Year ARI Flood Extents - 100% Blockage

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-009-PostDev_Extent_100ARI_100pc.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development PMF Flood Extents

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- > 1.50

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-010-PostDev_FloodExtent_PMF.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 5 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-023-Ex_FloodVelocity_5ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 10 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-011-Ex_FloodVelocity_10ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing 100 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-012-Ex_FloodVelocity_100ARI.mxd 03
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Existing PMF Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-013-Ex_FloodVelocity_PMF.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 5 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-024-PostDev_FloodVelocity_5ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 10 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-014-PostDev_FloodVelocity_10ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development 100 Year ARI Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-015-PostDev_FloodVelocity_100ARI.mxd 03
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - Post Development PMF Flood Velocity

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-016-PostDev_FloodVelocity_PMF.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - 5 Year ARI Flood Impacts

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-025-FloodImpact_5ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - 10 Year ARI Flood Impacts

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-017-FloodImpact_10ARI.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - 100 Year ARI Flood Impacts (Envelope)

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m: 0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-018-FloodImpact_100ARI_BO1.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

Phase 2 - PMF Flood Impacts

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Cadastre (NSW SS, 2019)

Change In Flood Levels (m)

- Was Wet Now Dry
- > -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Was Dry Now Wet

1:5,000 Scale at A3

m
0 50 100 150 200

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-04-24 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-019-FloodImpact_PMF.mxd 02
Aerial Imagery supplied by Nearmap (March, 2020)

APPENDIX

E

CLEAN/DIRTY WATER CATCHMENTS

Existing Clean/Dirty Catchment Plan

BELLAMBI, NSW

Legend

- Site Boundary
- Watercourses (NSW SS)
- Catchment Boundary

Existing Stormwater Pipe

- Clean
- Dirty

Catchment Type

- Clean
- Dirty

1:6,000 Scale at A3

m
0 50 100 150 200

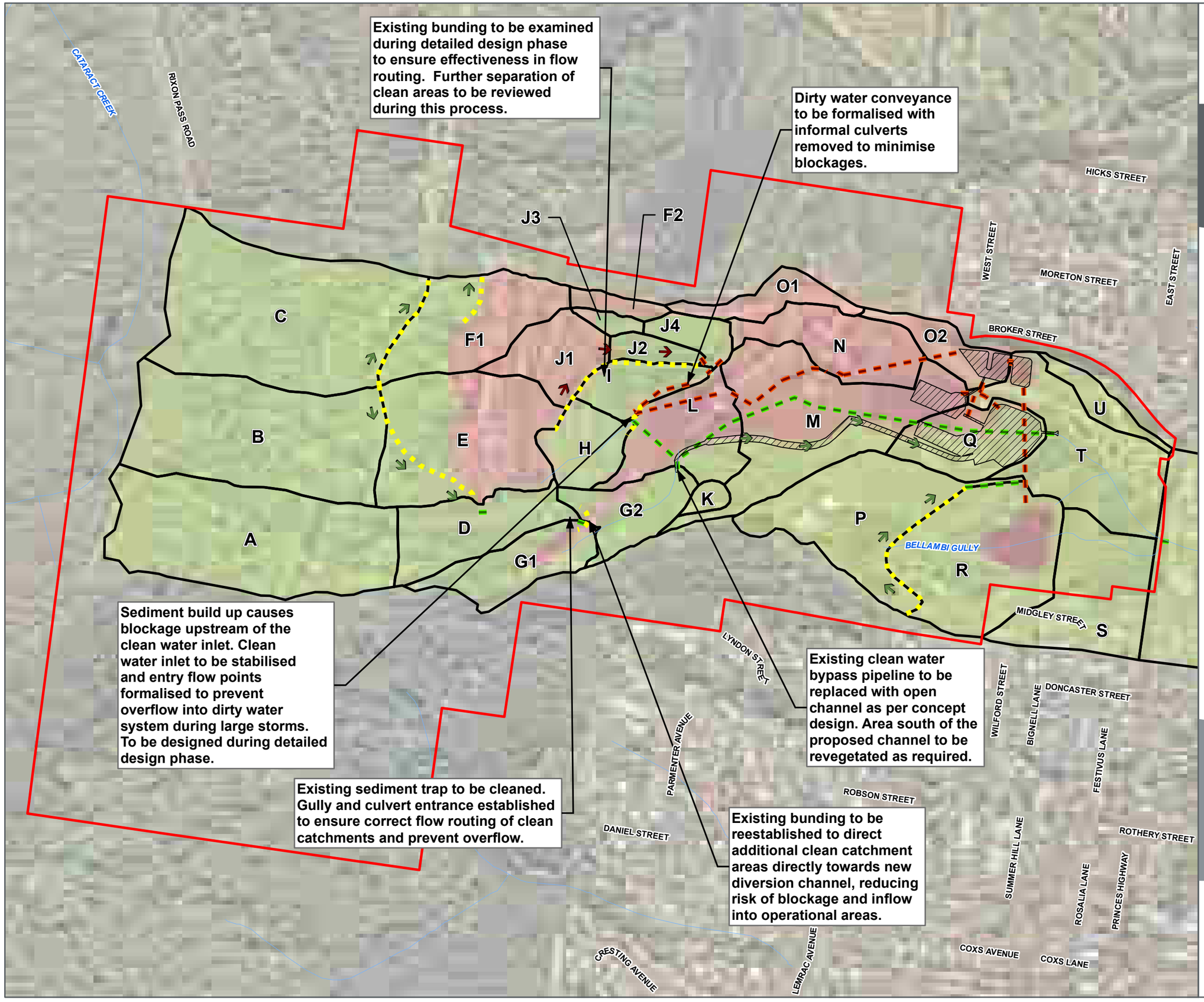
N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-16 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-028-ExCleanDirtyCatchments.mxd 03
Aerial Imagery supplied by Nearmap (March, 2020)

Proposed Clean/Dirty Catchment Plan

BELLAMBI, NSW



Legend

- Site Boundary
- Watercourses (NSW SS)
- Bunds (indicative)
- Catchment Boundary
- Proposed Works*

Flow Direction

- Clean
- Dirty

Existing Stormwater Pipe

- Clean
- Dirty

Catchment Type

- Clean
- Dirty

*Refer to Provided Cardno 82020124-01 C1000-C1006 Civil Set

1:6,000 Scale at A3

m
0 50 100 150 200

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-16 | Project: 82020124-01
Coordinate System: GDA 1994 MGA Zone 56
Map: 82020124-GS-029-PrCleanDirtyCatchments.mxd 03
Aerial Imagery supplied by Nearmap (March, 2020)