RAVENSWORTH
OPEN CUT

GLENCORE

Ravensworth Complex

Annual Review 2021

Name of Operation	Ravensworth Complex
Name of Operator	Ravensworth Operations Pty Limited
Development Consent/ Project Approval #	PA 09_0176 and DA 104/96
Holder of Development Consent/ Project Approval	Ravensworth Operations Pty Limited
ROC Titles/ Mining Leases	ML1325, ML 1357, ML1393, ML1502, ML 1576, ML 1669, ML 1683, CL 380, CL 378, CL 580, CCL 723, CCL 739, A385
RUM Titles/ Mining Leases	ML 1348, ML 1349, ML 1398, ML 1416, ML 1477, ML 1484, ML 1485, ML 1495, ML 1506, ML 1564, ML 1580, ML 1581, ML 1591, ML 1595, ML 1625, ML 1667, ML 1668
Name of holder of Mining Lease	Ravensworth Operations Pty Ltd (primary authorisation holder), Cumnock No.1 Colliery Pty Limited, ICRA Cumnock Pty Limited, Resource Pacific Pty Limited, AGL Macquarie Pty Limited, Glencore Newpac Pty Limited.
Water Licence #	WAL41529, WAL1046, WAL13102, WAL1325, WAL8964
Name of holder of Water Licence #	Ravensworth Operations Pty Limited/ Cumnock
MOP/ RMP start date	1 January 2021
MOP/ RMP end date	31 December 2023
Annual Review start date	1 January 2021
Annual Review end date	31 December 2021

I, Klay Marchant, certify that this audit report is a true and accurate record of the compliance status of Ravensworth Complex for the period 1 January 2021 to 31 December 2021 and that I am authorised to make this statement on behalf of Ravensworth Complex.

Note.

a) *The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.*

b) *The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (Intention to defraud by false or misleading statement—maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents—maximum penalty 2 years imprisonment or $22,000, or both).*

Name of authorise reporting officer	Klay Marchant
Title of authorise reporting officer	Environment and Community Manager
Signature of authorised reporting officer	
Date	31 March 2022

Table of Contents

1. Statement of Compliance

A summary of compliance at Ravensworth Complex is provided in **Table 1-1**.

Document	Compliant
Approvals	
PA 09_0176	NO
DA 104/96	YES
EPBC 2010_5839	YES
Licences	
EPL 2652	NO
Water Licences	YES
Leases	
ML# 1325	YES
ML# 1348	YES
ML# 1349	YES
ML# 1357	YES
ML# 1393	YES
ML# 1398	YES
ML# 1416	YES
ML# 1477	YES
ML# 1484	YES
ML# 1485	YES
ML# 1495	YES
ML# 1502	YES
ML# 1506	YES
ML# 1564	YES
ML# 1576	YES
ML# 1580	YES
ML# 1581	YES

Document	Compliant
ML# 1591	YES
ML# 1595	YES
ML# 1625	YES
ML# 1667	YES
ML# 1668	YES
ML# 1669	YES
ML# 1683	YES
CL# 380	YES
CL# 378	YES
CL# 580	YES
CCL# 723	YES
CCL# 739	YES

Table 1-1 – Statement of Compliance

The non-compliances during the 2021 reporting period are discussed further in ***Section 11***. The non-compliances categories are described in ***Table 1-2***. A summary of the non-compliances with Project Approval 09_0176, EPL 2652 and relevant Mining Leases during the reporting period have been summarised in **Table 1-3**.

Risk Level	Colour code	Description
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless for the likelihood of occurrence
Medium	Non-compliant	Non-compliance with: Potential for serious environmental consequences, but it is unlikely to occur; or Potential for moderate environmental consequences, but is likely to occur
Low	Non-compliant	Non-compliance with: Potential for moderate environmental consequences, but it is unlikely to occur; or Potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

Table 1-2 – Statement of Compliance Key

Relevant approval	Condition #	Condition description	Compliance Status	Comment	Where addressed in the Annual Review
PA09_0176	Schedule 3, Condition 20	All reasonable and feasible avoidance and mitigation measures are undertaken so that particulate matter emissions generated by the Ravensworth mine complex do not exceed the criteria listed in Table 10 (short term PM10 criterion) at any residence on privately-owned land or on more than 25 percent of any privately-owned land.	Non-compliant	Five exceedances of the PM10 short term criteria occurred in 2021.	Section 6.3.2.2 and Section 11
EPL 2652	M2.2	Continuously monitor PM10 at Point 9 and 10 (TEOM G1 and G2)	Non-compliant	Continuous PM10 data was not acquired.	Section 6.34.2.2 and Section 11

Table 1-3 – Summary of Non-Compliances

2. Introduction

The Ravensworth Complex comprises the following operations:

- Ravensworth Open Cut (ROC);
- Ravensworth Underground Mine (RUM); and
- Ravensworth Coal Handling and Preparation Plant (RCHPP).

Figure 2.1 shows the layout of the Ravensworth Complex and **Figure 2.2** shows the regional context.

This Annual Review is for the reporting period 1 January 2021 to 31 December 2021. It includes PA 09_0176 (ROC), DA104/96 (RUM), various mining leases, and associated environmental management plans for the Ravensworth Complex. The project approval and mining lease boundaries are shown on **Figure 2.3**.

2.1 The Ravensworth Complex

2.1.1 The Ravensworth Open Cut (ROC)

ROC is owned and operated by Ravensworth Operations Pty Limited, which is managed by Glencore. An Environmental Assessment (EA) was submitted for the Ravensworth Operations Project in February 2010. The EA was approved by the former Department of Planning, Infrastructure and Environment (DPIE) on 11 February 2011 (PA 09_0176). The approval granted the expansion of existing approved mining operations at ROC and enabled the consolidation of existing approvals for open cut mining and infrastructure within the Ravensworth area. The single project approval has enabled the amalgamation of operational aspects of the mining operations, which has facilitated a consistent and integrated approach to environmental management and mine planning. Details of modifications to PA 09_0176 are included in ***Section 3.1***.

2.1.2 Ravensworth Underground Mine (RUM)

Ravensworth Underground Mine (RUM) is owned by Resource Pacific Pty Limited and Glencore Coal Assets Australia (GCAA) oversees the management.

The area of land within the approved RUM development consent boundaries is owned by RUM, AGL Macquarie, Daracon, Ravensworth Operations Pty Limited, Glendell, and I. Bowman Pty Ltd. Where necessary, RUM undertakes consultation with the relevant parties, including consultation during the preparation of EA modifications and Subsidence Management Plan (SMP) applications.

RUM operates under development consent DA 104/96 dated 20 November 1996. A ninth modification (MOD 9) was submitted during 2012, primarily relating to changes in the longwall (LW) layout of the Liddell Seam (Liddell Seam Project). MOD 9 was approved by the DPIE on 20 June 2013.

The original 1996 development application was supported by an EA for the construction and operation of an underground coal mine. Through subsequent EA modifications, RUM has an approved maximum production of 7 Mtpa of ROM coal.

RUM was placed in Care and Maintenance in October 2014.

The RUM and Ashton Underground Mine share a common mining lease boundary and are approved to extract coal from similar coal seams. In 2021 a tenth modification to DA 104/96 was submitted to the DPIE to allow Ashton Coal Operations Limited (ACOL - who operate Ashton Underground Mine) to access and extract approved but unmined coal resources at RUM and integrate part of the approved RUM with the Ashton Coal Project. Further details are included in **Section 3.1**.

2.1.3 Ravensworth Coal Handing and Preparation Plant (RCHPP)

The RCHPP is located adjacent to the RUM pit top. Once the coal from ROC or RUM reaches the ROM stockpile it is required to be managed by RCHPP. The RCHPP is managed under PA 09_0176.

The RCHPP also receives product coal from Muswellbrook Coal Company. Coal is either fed directly into one of the three modules (20 Mt/year) at a rate of up to 3,600 tph prior to being loaded onto trains, or bypassed directly to domestic customers.

2.2 Mine Contacts

The relevant contact details for ROC, RUM and the RCHPP are shown in **Table 2-1**.

Name	Title	Contact Details
ROC	General Enquiries	Phone: 1800 620 553 Phone: (02) 6570 0700 Fax: (02) 6570 0747 Address: Lemington Road, Off New England Highway Ravensworth, via Singleton, NSW 2330 Postal: PO Box 294, Muswellbrook, NSW 2333 *https://www.glencore.com.au/operations-and-projects/coal/current-operations/ravensworth-operations*
RUM / RCHPP	General Enquiries	Phone: 1800 620 553 Fax: (02) 65700 747 Address: Liddell Station Rd, Ravensworth NSW 2330 Postal: P.O Box 528 Singleton 2330 *https://www.glencore.com.au/operations-and-projects/coal/past-operations/ravensworth-underground*
Tony Israel	Operations Manager	Phone: (02) 6570 0700 Fax: (02) 6570 0747 E-mail: *Tony.Israel@glencore.com.au*
Klay Marchant	Environment & Community Manager	Phone: (02) 6570 0700 Fax: (02) 6570 0747 Email: *Klay.Marchant@glencore.com.au*

Table 2-1 - Mine Contacts

309000 310000 311000 312000 313000 314000 315000 316000 317000 318000 319000 320000

6416000 6415000 6414000 6413000 6412000 6411000 6410000 6409000 6408000 6407000 6406000 6405000 6404000 6403000 6402000 6401000 6400000

Lake Liddell

Liddell

RCCP

RUM

FOY BROOK

Mt Owen Complex

Raw Coal Stockpile

NEW ENGLAND HIGHWAY

Rejects Conveyor

Hunter Valley Operations

MIA

Ravensworth

Glendell

Ashton Mine

FAL BROOK

HUNTER RIVER

Hunter Valley Operations

LEGEND

- DA 104_96
- PA 09_0176
- Ravensworth North Pit
- Out Of Pit Overburden Dumps
- Major Road
- Railway
- 330kV Power Line
- Major Waterway
- Residences - Mine Owned
- Residences - Private

0 350 700 1,050 1,400 m

Scale: 1:45,000

Imagery: Glencore, February 2022

Source: GDA 1994 MGA Zone 56

29/03/2022

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Ravensworth Complex Annual Review 2021

Ravensworth Complex Layout

Figure 2-1

INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA

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290000 300000 310000 320000 330000 340000

6450000 6440000 6430000 6420000 6410000 6400000 6390000 6380000

Upper Hunter Local Government Area

Barrington Tops National Park

Mount Royal National Park

Muswellbrook Local Government Area

MUSWELLBROOK

Lake Liddell

Ravensworth State Forest

FAL BROOK

FOY BROOK

HUNTER RIVER

NEW ENGLAND HIGHWAY

Singleton Local Government Area

GOLDEN HIGHWAY

SINGLETON

PUTTY ROAD

Wollemi National Park

PARSONS CREEK

LEGEND

- PA 09_0176
- LocalGovernmentArea
- Major Road
- Railway
- Major Waterway
- National Park
- StateForest
- Clifton Offset Area
- Hillcrest Offset Area
- RavNorthOffsetArea
- Stewart Offset Area

0 1,500 3,000 4,500 6,000 m

Scale: 1:200,000

Imagery: ESRI, not dated

Source: GDA 1994 MGA Zone 56

29/03/2022

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Ravensworth Complex Annual Review 2021

Regional Context

Figure 2-2

INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA
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Ravensworth Complex Annual Review 2021

Mining Lease Boundaries

Figure 2-3

INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA
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3. Approvals

Operations at Ravensworth Complex are regulated by a range of leases, licences and approvals which are summarised below.

3.1 Project Approval

Ravensworth Operations operate under Project Approval PA 09_0176 (granted on 11 February 2011), in accordance with the Ravensworth Operations Project Environmental Assessment dated February 2010 (2010 EA) and subsequent EA modifications. PA 09_0176 allows for an annual production of up to 16 Mtpa until 2039. This project approval has been modified three times.

A separate approval applies to RUM; Development Consent (DA 104/96).

This Annual Review has been completed to fulfil the requirements of Schedule 5, Condition 3 of PA 09_0176 and Schedule 4, Condition 2 of DA 104/96.

Approval	Title	Date Granted
Ravensworth Operations		
09_0176	Original Approval	11 February 2011
09_0176 Mod 1	Extraction of approximately 2.7 million tonnes of coal in the Narama West mining area.	16 August 2013
09_0176 Mod 2	Allow for an increase in final landform heights to accommodate a more stable free flowing natural landform.	19 December 2014
09_0176 Mod 3	Construction and operation of a tailings pipeline from the RCHPP at Ravensworth Operations to the Mount Owen West Pit Void.	16 February 2016
Ravensworth Underground Operations		
104/96	Original Approval	20 November 1999
104/96 Mod 1	Modification to road haulage conditions	6 January 1998
104/96 Mod 2	Reject emplacement and water management system changes	5 March 2001
104/96 Mod 3	Installation of Substation	11 February 2007
104/96 Mod 4	Solcenic Borehole and Storage Tanks	11 February 2007
104/96 Mod 5	Ventilation Shaft, electricity supply and underground workings	4 July 2007
104/96 Mod 6	Tailings Water Recovery Dam	21 May 2008
104/96 Mod 7	Mining method, water and waste management	3 July 2009
104/96 Mod 8	Extension to LWs 6 to 10 and additional gas management infrastructure	5 January 2011
104/96 Mod 9	Liddell Seam Project	20 June 2013

Table 3-1 – Ravensworth Complex Approvals and Modifications

In 2021 a tenth modification to DA 104/96 was submitted to the DPIE to allow ACOL to access and extract approved but unmined coal resources at RUM and integrate part of the approved RUM with the Ashton Coal Project.

The proposed modification application involves:

- Allowing access for ACOL to extract a portion of the Ravensworth Underground Mine (RUM) coal reserves;
- Connection of the existing Ashton and Ravensworth underground workings;
- Transfer of ROM coal from RUM to the Ashton CHPP;
- Minor changes to the configuration of the Pikes Gully and Middle Liddell Seam Longwalls;
- Extension of mining operations until 31 December 2032; and
- Other administrative changes to facilitate ACOL management and responsibility for a portion of the RUM consent area.

The Mod 10 application finished its exhibition period on 8 December 2021 and the DPIE are currently assessing the application.

3.2 Licences

3.2.1 Environment Protection Licence

Ravensworth operate under Environment Protection Licence (EPL) 2652, with an anniversary date of 12 January. Monitoring results are reported to the EPA as part of the Ravensworth Operations Pty Ltd Annual Return and monitoring data is available on the Ravensworth website.

During the reporting period Ravensworth Complex EPL was varied once on 13 April 2021. The s.58 Licence Variation 1607379 made the following variations to EPL 2652:

Monitoring and Discharge Conditions

- P1.4 – amendment of meteorological station (EPA identification no.13) and NMG3 (EPA identification no.16)

The environmental reporting and monitoring activities undertaken at the Ravensworth Complex as required under EPL 2652, are discussed in **Section 6**.

3.2.2 Surface and Groundwater Licences

Ravensworth holds several surface and groundwater licences, which allow for surface and groundwater extraction and monitoring. Further details regarding these licences are provided in ***Section 7.4*** and ***7.5.***

3.2.3 Radiation Licences

Radiation licences held by the site include Licence 5078362 with an expiry of 5 February 2023. This licence is held for fixed radiation gauges installed at the coal handling and preparation plants. There are 11 gauges in total which are inspected every two years to ensure they comply with EPA compliance requirements. The 11 gauges were inspected on 24 January 2022.

3.3 Other Approvals

3.3.1 Management Plans

The status of site Management Plans as of 31 December 2021 are summarised in *Error! Reference source not found.* In accordance with Schedule 5, Condition 4 of PA 09_0176, Ravensworth will review, and if necessary, revise, the strategies, plans and programs required under the consent within three months of this Annual Review, to the satisfaction of the Secretary of the DPIE.

Document	Reference	Revision Date
RAVENSWORTH COMPLEX		
Ravensworth Complex Environmental Management Strategy (EMS)	PA 09_0176 Schedule 5, Condition 1	10 September 2018
Pollution Incident Response Management Plan (PIRMP)	Pollution Incident Response Management Plan	1 December 2021
Ravensworth Complex Noise Management Plan (NMP)	PA 09_0176 Schedule 3 Condition 9	10 September 2018
Ravensworth Complex Blast Management Plan (BMP)	PA 09_0176 Schedule 3 Condition 17	5 February 2020
Ravensworth Complex Air Quality and Greenhouse Gas Management Plan (AQGGMP)	PA 09_0176 Schedule 3 Condition 24	10 September 2018
Ravensworth Complex Water Management Plan (WMP)	PA 09_0176 Schedule 3 Condition 31	30 March 2020
Ravensworth Complex Biodiversity Management Plan (BioMP)	PA 09_0176 Schedule 3 Condition 31	13 July 2021
Ravensworth Complex Rehabilitation Management Plan (MOP/RMP)	PA 09_0176 Schedule 3 Condition 41	19 November 2021
Ravensworth Complex Heritage Management Plan (HMP)	PA 09_0176 Schedule 3 Condition 42	10 September 2018
Aboriginal Cultural Heritage Management Plan (ACHMP)	PA 09_0176 Schedule 3 Condition 42	19 February 2021
RUM		
Ravensworth Underground Air Quality and Greenhouse Gas Management Plan	DA 104/96, Schedule 2, Condition 14	Covered under the Complex Plans.
Biodiversity, Rehabilitation and Land Management Plan	DA 104/96, Schedule 2, Conditions 4, 7. Mining leases	Covered under the Complex Plans.
Lighting Management Plan	DA 104/96, Schedule 2, Condition 5.	Covered under the Complex Plans.
Bushfire Risk Hazard Reduction Management Plan	DA 104/96, Schedule 2, Condition 6.	Covered under the Complex Plans.
RUM Mining Operations Plan – Care and Maintenance	DA 104/96	1 January 2021 – 31 December 2022

Table 3-2 – Management Plan Status

3.3.2 Mining Operations Plan/Rehabilitation Management Plan

The Ravensworth Operations MOP relates to proposed mining operations and associated activities at Ravensworth Operations for the period 1 January 2021 to 31 December 2023. It was prepared in accordance with the ESG3: Mining Operations Plan (MOP) Guidelines (DRE, 2013) and was approved on 8 October 2021 by the Resources Regulator.

The RUM MOP outlines the operational and environmental management activities proposed for the period 1 January 2021 – 31 December 2022 during care and maintenance at RUM. This MOP was prepared in accordance with the ESG3: Mining Operations Plan (MOP) Guidelines (DRE, 2013) and was approved on 15 December 2020 by the Resources Regulator.

4. Operations During the Reporting Period

4.1 Mining Operations

During the reporting period, mining and coal preparation occurred at the Complex at Ravensworth North and RCHPP. RUM has remained in care and maintenance from October 2014.

During the reporting period, a total of 61.2 million bank cubic metres (Mbcm) of overburden was mined in Ravensworth North Pit to allow the extraction of 12.9 million tonnes (Mt) of Run of Mine (ROM) coal. No mining was undertaken at Narama, Narama West pit and RUM during the reporting period.

A summary for the Ravensworth Complex is outlined in **Table 4-1**. Schedule 2, Condition 6 of PA 09_0176 stipulates that no more than 16 Mt of ROM coal will be produced through open cut mining in a calendar year and no more than 21 Mt of ROM coal will be produced by the combined Ravensworth Complex per calendar year. Ravensworth Operations produced 12.9 Mt of ROM coal during 2021 which is within the annual limits.

Material	Cumulative Production and Waste Start of Reporting Period (Cumulative)	End of Reporting Period (Cumulative)	Next Reporting Period 2022 (Forecast)	2021 Total (Actual)
Ravensworth North				
Prime Overburden (kbcm)	477,290	538,490	63,200	61,200
ROM mined (kt)	90,930	103,793	13,524	12,863
Saleable Product (kt)	59,319	68,021	8,840	8,702
RUM				
ROM Coal (kt)	0	0	0	0
Product Coal (kt)	0	0	0	0
RCHPP				
Coarse Waste Reject (t)	22,904,560	25,415,817	2,887,255	2,511,257
Fine Waste Reject (t)	14,114,925	15,678,787	1,798,011	1,563,862

Table 4-1 – Complex Production and Waste Summary

4.2 Exploration

No exploration was carried out in 2021.

4.3 Construction

The Orica explosives compound was relocated in 2021 due to progression of mining.

4.4 Land Preperation

Land clearing is undertaken in accordance with the Ravensworth Complex Environmental Management System (EMS). Areas are assessed prior to clearing to minimise potential ecological, water management, sediment and erosion and cultural heritage impacts in accordance with the pre-clearing requirements.

During 2021, 14.2 ha at the Ravensworth Complex was disturbed due to progression of mining.

Land disturbed in preparation for rehabilitation is discussed in **Section 8**.

4.5 Mineral Processing

4.5.1 Rejects Emplacement and Tailings

4.5.1.1 Coarse Rejects

Rejects are conveyed from the RCHPP to a reject bin, where they are collected by haul trucks. The haul trucks transport rejects via internal haul roads for co-disposing in the overburden emplacement areas in accordance with regulatory approvals.

4.5.1.2 Tailings

During 2021, tailings were emplaced in the Mount Owen West Pit Void through the Greater Ravensworth Area Water and Tailings Strategy (GRAWTS).

At Ravensworth, the coarse and fine rejects are disposed together. The sub 120 µm reject material is disposed of as tailings through the thickeners.

A total of 2,511,257 tonnes of coarse rejects and 1,563,826 tonnes of fine tailings reject produced by the RCHPP were disposed of into approved storage areas in 2021.

4.5.2 Train and Conveyor Movements

Product coal is transported to the port of Newcastle by rail only. RCHPP train movements are summarised in **Table 4-2**. All levels are compliant with the conditions set out in Schedule 2, Condition 7 of PA 09_0176, which specify that no more than 18 train movements (average) will occur each day, and no more than 20 million tonnes of product coal will be transported to/ from the RCHPP/RCT. Records of all train movements are provided in **Appendix A**.

Train Movements	Total
Annual Average Daily Train Movements	2.6 movements per day
Max Daily Train Movements	7 max movements per day
Total Train Movements	969 total train movements
Average Train Tonnage	9137.7 tonnes
Total product coal loaded from RCHPP	8,836,115.4 tonnes
Average train loading time	115 minutes
Total loading time	1,848.9 hours

Train Movements	Total
Average Load Rate	4,840 tonnes per hour

Table 4-2 - RCHPP Train Movements 2021

Note that in the 2020 Annual Review report it was incorrectly reported in Table 4-2 that there were 616 total train movements in 2020. There were 934 total train movements in 2020.

4.6 Waste Management

Waste is managed in accordance with the Ravensworth Complex EMS and EPL 2652. The EMS has been developed in accordance with the requirements of the Protection of the Environment Operations Act 1997 (POEO Act).

4.6.1 Waste Management and Reporting

The disposal of waste generated on the site is undertaken in accordance with existing regulatory guidelines and established site procedures. ***Note** the 2019 volumes in this table have been updated to reflect actual volumes removed from site in 2019. Previous Annual Reviews reported the 2019 waste disposed offsite incorrectly as it included the amount of waste recycled, which elevated the total waste produced.

Table 4-3 provides waste generation for the Ravensworth Complex since 2017. The total amount of waste that was disposed of and recycled at the Ravensworth Complex in 2021 was 527 tonnes and 3,093 tonnes respectively. The amount of waste produced at ROC and RUM in 2021 was lower than in previous years, however the amount of waste at RCHPP increased due to a greater amount of waste recycled.

Ravensworth Operations reviews its waste minimisation strategies on an as needs basis.

Site	Waste Disposed offsite (t)	Waste recycled (t)	Total waste produced (t)	Waste Recycled (%)
ROC 2021	397	2,659	3,055	87
ROC 2020	559	2,983	3,542	84
ROC 2019*	549	2,932	3,481	84
RUM 2021	4	10	13	73
RUM 2020	5	39	44	89
RUM 2019*	4	146	151	97
RCHPP 2021	126	424	549	77
RCHPP 2020	157	263	420	63
RCHPP 2019*	132	265	397	67

*Note the 2019 volumes in this table have been updated to reflect actual volumes removed from site in 2019. Previous Annual Reviews reported the 2019 waste disposed offsite incorrectly as it included the amount of waste recycled, which elevated the total waste produced.

Table 4-3 – Waste Disposal and Recycling at the Ravensworth Complex

4.7 Product Coal

A total of 8.7 Mt of product coal was transported to the Port of Newcastle from the RCHPP in 2021.

4.8 Decomissioning

There was no decommissioning undertaken at Ravensworth Complex in 2021.

4.9 Next Reporting Period

4.9.1 Mining

During 2022, coal extraction will continue in the Ravensworth North Pit. Forecast production for 2022 in accordance with the MOP is 14 Mt of ROM coal and 9.4 Mt of product coal. Mining in 2022 will remain the same as in 2021 with the equivalent mining equipment, personnel and mining techniques to be utilised in-pit. Ravensworth North will continue progressing in line with the mine plan (and MOP) with rehabilitation expected to reach MOP predictions.

4.9.2 Exploration

The five exploration holes proposed at ROC in 2021 were not undertaken and are now proposed for 2022. All proposed exploration holes are within the current mining footprint and are planned primarily for coal quality, water pressure and geotechnical monitoring.

4.9.3 Construction

The mine access road realignment and Emu Creek Levee bank construction will be undertaken in 2022.

4.9.4 Coarse Rejects and Tailings Disposal

During 2022 coarse rejects will continue to be co-disposed of in overburden emplacement waste areas in accordance with current statutory approval.

5. Actions Required from Previous Annual Review

A letter was received from the DPIE dated 5 August 2021 stating the Annual Review for the period 1 January 2020 to 31 December 2020 satisfied the reporting requirements of PA09_0176 and DA 104/96. No further action or information was requested.

6. Environmental Management and Performance

6.1 Operational Noise

6.1.1 Environmental Management

Noise monitoring and management is outlined in the Ravensworth Complex *Noise Management Plan* which is available on the Ravensworth website.

Noise monitoring consists of both attended and unattended monitoring to meet the requirements of the PA 09_1076, DA 104/96 and EPL 2652. Noise monitoring locations, as discussed in the *Noise Management Plan* are shown on ***Figure 6.1***.

In addition to conducting noise monitoring, Ravensworth continues to implement a number of mitigation strategies with regard to the management of noise to minimise potential noise impact on nearby receivers, and to comply with the relevant conditions of the Project Approvals.

6.1.2 Environmental Monitoring Results

6.1.2.1 Results from the Reporting Period

Noise monitoring results for the reporting period are provided in ***Appendix B***. Relevant noise criteria, as outlined in PA 09_0176 Schedule 3 Conditions 2, 3 and 4, DA 104/96 Condition 12 and EPL 2652 Condition L5 are combined in ***1 Property*** *purchased by Ravensworth Complex*

Table 6-1 and ***Table 6-2***. The 2021 attended noise monitoring program was conducted by Spectrum Acoustics on a monthly basis; there were no exceedances (non-compliances) of noise approval criteria at any location during the reporting period. Site 7/R7 is monitored on a quarterly basis for RUM and there were no exceedances during 2021 monitoring.

Monitoring Location	Receiver Location	Receiver	*Day (LAeq (15min))*	*Evening (LAeq (15min))*	*Night (LAeq (15min))*	*Night (LA1 (1 min))*	Performance during Reporting Period (Appendix B)
-	R1	34 – Stapleton[1]	48	48	48	49	Not applicable as owned by Ravensworth
Site 2	R2	3 – A Bowman	35	35	35	45	Compliant
		13 – A Bowman	38	38	38	45	Compliant
Site 3	R3	Camberwell Village Central 12 – Yates, 21 – Miller, 27 Chisholm	37	37	37	45	Compliant
Site 5		38 - Ninness	36	36	36	45	Compliant
Site 6	R4	Camberwell Village North	35	35	35	45	Compliant

Monitoring Location	Receiver Location	Receiver	*Day (LAeq (15min))*	*Evening (LAeq (15min))*	*Night (LAeq (15min))*	*Night (LA1 (1 min))*	Performance during Reporting Period (Appendix B)
Site 7	R7	Spiteri	35	35	35	45	Compliant
-	-	All other privately-owned land	35	35	35	45	Compliant

[1] *Property purchased by Ravensworth Complex*

Table 6-1 - Noise Criteria dB(A) and performance for 2021 reporting period

In relation to cumulative noise impacts, the Ravensworth Complex implement all reasonable and feasible measures to ensure that the noise generated by the Ravensworth Complex combined with the noise generated by other mines does not exceed the criteria shown in ***Table 6-2***, at any residence on privately-owned land or on more than 25 per cent of any privately-owned land.

Receiver Location	Day	Evening	Night	Performance during Reporting Period. (Appendix D)
R3 and R4 – Camberwell Village	55	45	40	Compliant
All other privately owned land	50	45	40	Compliant

Table 6-2 - Cumulative noise criteria dB(A) LAeq (period) from PA 09_0176 and performance for 2021 reporting period

The noise monitoring location NMG3 (EPA identification no.16) in EPL 2652 was modified as part of the EPL variation in April 2021 (as discussed in ***Section 3.2.1***).

6.1.2.2 Comparison with Predictions

As indicated by the results in ***Appendix B***, all noise monitoring results were within predicted levels for the reporting period.

6.1.2.3 Long Term Trend Analysis

The results are generally consistent with prior years (going back to three years). All results over the last five years have been within approved noise criteria.

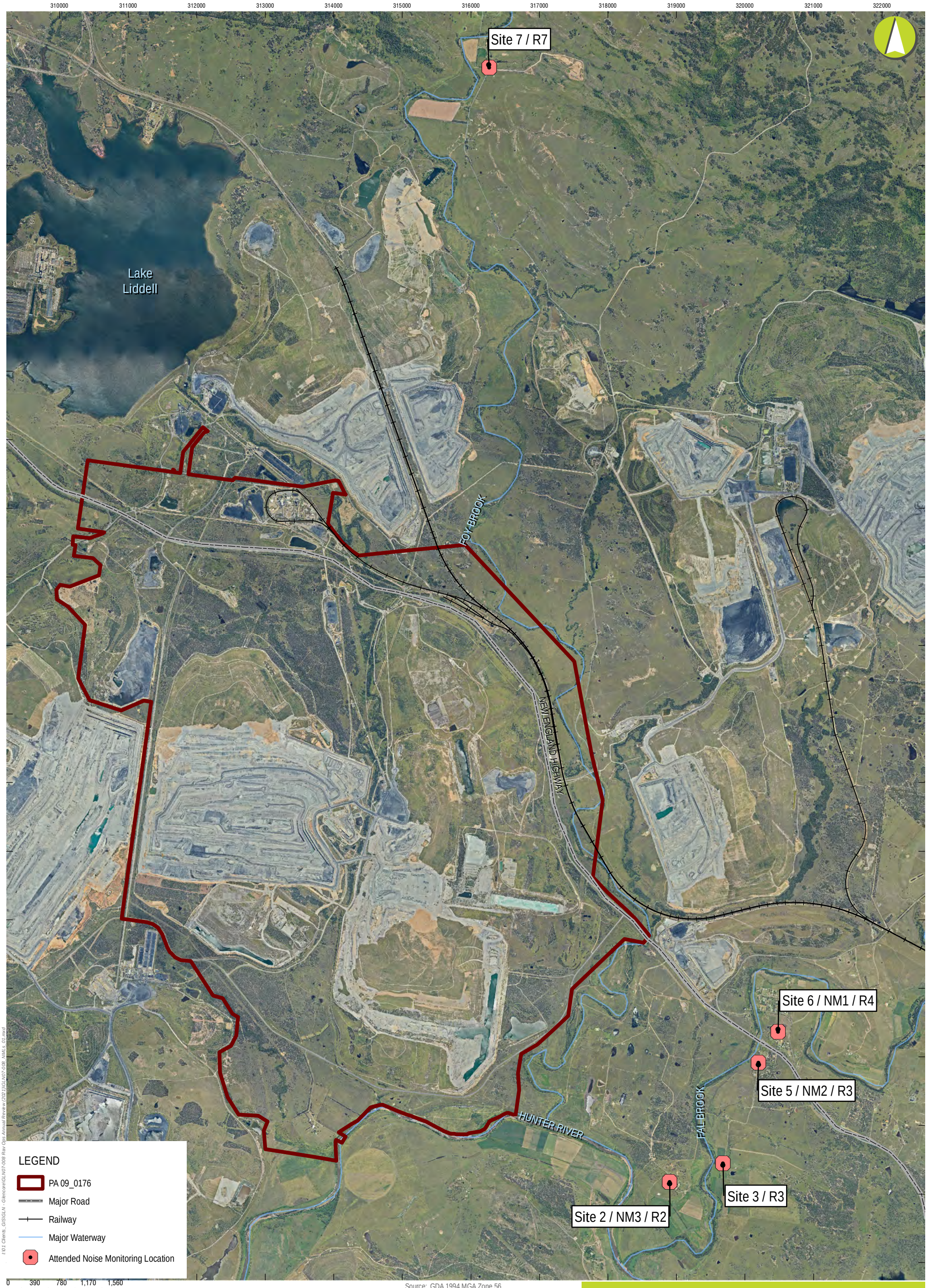
6.1.3 Key Performance and Management Issues

There were no performance or management issues in relation to noise during the reporting period. This included no noise complaints.

6.1.4 Proposed Improvements

Ravensworth will continue to use site procedures, processes and systems to manage noise. Noise monitoring will also continue to be undertaken.

The *Noise Management Plan* will be updated in 2022 to reflect the changes to EPL 2652 noise monitoring conditions.



Ravensworth Complex Annual Review 2021

Noise Monitoring Locations

Figure 6-1

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6.2 Blasting and Vibration

6.2.1 Environmental Management

Blasting at Ravensworth is undertaken in accordance with the Ravensworth Complex *Blast Management Plan*, which was developed in accordance with Schedule 3, Condition 17 of PA 09_0176 and is available on the website. ROC has a number of procedures in place to manage the impacts of blasting including overpressure, vibration, fume and dust.

6.2.2 Environmental Monitoring Results

6.2.2.1 Results from the Reporting Period

A record of all blasting compliance during the reporting period can be found in ***Appendix C***. ***Table 6-3*** indicates performance of Ravensworth with regards to Schedule 3, Condition 10 of PA 09_0176.

During the reporting period there were 204 blasts. No blasts exceeded the overpressure limit of 115dBL or vibration criteria of 5mm/s at non-mined owned residences.

Location	**Approval Criteria** Airblast overpressure (dB(Lin Peak))	Ground vibration (mm/s)	Allowable exceedance	**Environmental Performance in this Reporting Period. See Appendix C for 2021 summary results**
Residence on privately owned land and Camberwell church	120	10	0%	Compliant
	115	5	5% of the total number of blasts over a period of 12 months	Compliant
Ravensworth Public School and Chain of Ponds Hotel	133	10	0%	Compliant
Ravensworth Homestead	126	10	0%	Compliant
Aboriginal axe grinding groove site (REA86)	-	[c] 175	0%	Compliant
1,000ML dam wall and proposed dam wall	-	[b] 25	0%	Compliant
Conveyors, including the Hunter Valley Operations conveyor	-	[b] 100	0%	Compliant
Main Northern Railway culverts and bridges	-	[b] 25	0%	Compliant
Transmission lines	-	[b] 50	0%	Compliant
Ashton underground mine	-	[b] 6	0%	Compliant

a Unless otherwise agreed with the relevant owner/s of the residence, and the Proponent has advised the Department in writing of the terms of this agreement.

b Unless otherwise agreed with relevant infrastructure provider, owner or the regulator (in relation to the dams), and the Proponent has advised the Department in writing of the terms of this agreement.

c Subject to meeting incremental limits under condition 10A (PA_0176).

Table 6-3 - Blasting Criteria and Performance for 2021 Reporting Period

6.2.2.2 Comparison with Predictions

The Ravensworth Operations Project Environmental Assessment (Umwelt, 2010) assessed the impacts of blasting. The assessment determined vibration and airblast (overpressure) criteria that applied to infrastructure and heritage sites that may be affected by the operations. These criteria are provided in the blast result tables, included in **Appendix C**.

During the reporting period both blast vibration and overpressure were generally consistent with EA predictions.

6.2.2.3 Long Term Trend Analysis

Since 2014, there have been no blast exceedances.

6.2.3 Key Performance and Management Issues

Two blasting complaints were received during the reporting period. Further details of these complaints are included in ***Section 9.2***.

6.2.4 Proposed Improvements

Ravensworth will continue to use site procedures, processes and systems to manage blast impacts. Blast monitoring will continue to be undertaken.

Blast monitoring locations will continue to be reviewed and updated as mining progresses.

6.3 Air Quality

6.3.1 Environmental Management

Ravensworth operates in accordance with the approved *Air Quality and Greenhouse Gas Management Plan* (AQGGMP), which is available on the Ravensworth website, and describes air quality management and monitoring requirements associated with the mine.

310000 311000 312000 313000 314000 315000 316000 317000 318000 319000 320000 321000

6416000 6415000 6414000 6413000 6412000 6411000 6410000 6409000 6408000 6407000 6406000 6405000 6404000 6403000 6402000 6401000

Lake Liddell

D33

D30

D17

FOY BROOK

NEW ENGLAND HIGHWAY

SX46 M2 Weather Station

SX45 D4

HVAS 19

HVAS 2

D9

D27

D25

HVAS 4

HUNTER RIVER

D13

FAL BROOK

D12 HVAS 5

LEGEND

- PA 09_0176
- Major Road
- Railway
- Major Waterway
- Weather Station
- High Volume Air Sampler
- Real Time - Dust E-Sampler
- Dust Depositional Gauge

0 350 700 1,050 1,400 m

Scale: 1:45,000

Imagery: Glencore, February 2022

Source: GDA 1994 MGA Zone 56

29/03/2022

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Ravensworth Complex Annual Review 2021

Air Quality Monitoring Locations

Figure 6-2

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6.3.2 Environmental Monitoring Results

6.3.2.1 Results from the Reporting Period

An overview of environmental performance for air quality based on TSP and PM_{10} data (from the site's two TEOMs) and depositional dust is provided in ***Tables 6.4 - 6.6***. See ***Appendix D*** for further detail on exceedance dates and results. The air quality criteria and notes can be found in Schedule 3, Condition 20 of PA 09_0176. Note that no dates within 2021 were declared as extraordinary events.

Pollutant	Averaging period	Approval Criteria Criterion	Environmental Performance this Reporting Period
Total suspended particulate (TSP) matter	Annual	90 µg/m^3	Compliant
Particulate matter < 10 µm (PM_{10})	Annual	30 µg/m^3	Compliant

Note: TSP and PM_{10} performance based on TEOM data

Table 6-4 - Long term criteria for particulate matter

Pollutant	Averaging period	Approval Criteria *Criterion	Environmental Performance this Reporting Period
Particulate matter < 10 µm (PM_{10})	24 hour	50 µg/m^3	Non-Compliant

Note: PM_{10} performance based on TEOM data

Table 6-5 - Short term criterion for particulate matter

The TEOM G1 PM_{10} rolling annual average was below the 30 µg/m^3 PA09_0176 criteria throughout 2021, with an annual average of 17.88 µg/m^3.

The TEOM G2 PM_{10} annual average was below the 30 µg/m^3 PA09_0176 criteria throughout 2021 with an annual average of 15.76 µg/m^3.

The PM_{10} 24 hour criterion of 50 µg/m^3 was exceeded 3 times at TEOM G1 and twice at TEOM G2 during 2021. Relevant authorities were notified of these exceedances throughout the year. The G1 and G2 24 hour average PM_{10} data for 2021 is provided in ***Appendix D***.

Pollutant	Approval Criteria Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level	Environmental Performance this reporting period
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month	Compliant

Note: Deposited dust results are used for internal management purposes only.

Table 6-6 - Long term criteria for deposited dust

Annual average depositional dust results were below 4 g/m^2/month in at every offsite monitoring location during 2021. The annual average at D9 (2.4 g/m^2/month) was lower than the 2020 annual average (3.5 g/m^2/month) as was annual average at D12 (2.0 g/m^2/month in 2021 compared to 2.5

g/m^2/month in 2020). The annual average at D13 (2.3 g/m^2/month) and D27 (2.1 g/m^2/month) were both below 2021 levels (3.1 g/m^2/month).

6.3.2.2 Comparison with Predictions

Air quality predictions against the 2010 EA are outlined in ***Table 6.7 - 6.9***. Cumulative predictions consider the contribution of other mines in the area as well as other local sources of dust.

Dust Deposition

Comparisons of dust deposition levels (Year 10) predicted in the 2010 EA and 2021 measured averages are shown for privately owned and mine owned offsite residences in ***Table 6-7***. All 2021 annual results are greater than the EA predicted values for dust depositional gauges, but are within the 4 g/m^2/month criteria.

Monitor	EA Residence ID	Year 10 Prediction		2021 Results
		Ravensworth Contribution	Cumulative	
D9	40B	0.3	0.7	2.4
D12*	34	0.3	0.9	2.0
D13	3	0.4	0.8	2.3
D27	5Z / 12	0.2	0.7	2.1

* Mine owned residence.

Table 6-7 - ROC Dust Deposition EA Prediction Comparison - Privately Owned & Mine Owned Residences

HVAS TSP and PM_{10}

Comparisons of HVAS TSP and PM_{10} levels (Year 10) predicted in the 2010 EA and 2021 measured averages are shown for privately owned and mine owned residences in ***Table 6.8*** and ***Table 6.9***, respectively.

All 2021 annual results are greater than the predicted values for both PM_{10} and TSP at privately owned residences.

Monitor	EA ID	Year 10 Prediction				2021 Results	
		Ravensworth Contribution (PM_{10})	Cumulative (PM_{10})	Ravensworth Contribution (TSP)	Cumulative (TSP)	PM_{10}	TSP
HVAS 2 / HVAS 19	45	6	14	5	41	18.2	54.3

Table 6-8 - ROC HVAS TSP and PM_{10} EA Prediction Comparison - Privately Owned Residences

Monitor	EA ID	Year 10 Prediction		2021 Results
		Ravensworth Contribution (TSP)	Cumulative (TSP)	
HVAS 4	29P	27	63	52.7
HVAS 5	34	22	56	48.8

Table 6-9 - ROC HVAS TSP EA Prediction Comparison - Mine Owned Residence

6.3.2.3 Long Term Trend Analysis

2021 experienced significantly higher rainfall than in previous years resulting in a reduction in dust levels across the region.

There were five reportable exceedances of PM_{10} 24 hour criterion of 50 µg/m^3 in 2021, compared with 22 exceedances in 2020 and 31 exceedances in 2019. The TEOM G1 PM_{10} annual average of 17.88 µg/m^3 was lower than the 2020 average results of 19.14 µg/m^3. The TEOM G2 PM_{10} annual average of 15.76 µg/m^3 was lower than the 2020 average results of 17.40 µg/m^3.

6.3.3 Key Performance and Management Issues

There were 26 occasions of lost data during the reporting period which were a result of power supply issues with mains supplied by neighbouring mine (Ashton Underground Mine). During a rain event in March 2021 power supply was lost and localised flooding to the area meant access was not possible until water subsided. A generator was installed once access was possible, which allowed monitoring to continue until a permanent repair was possible. Intermittent generator issues were experienced resulting in insufficient daily capture to calculate a daily average. Mains power has since been restored. Another four occasions of lost data were a result of unexplained power outages, and software faults, which were rectified as soon as possible.

There were no complaints related to air quality in the 2021 reporting period.

The AQGGMP was reviewed by ROC in 2021 and submitted to DPIE for approval.

6.3.4 Proposed Improvements

Ravensworth will continue to use site procedures, processes and systems to manage dust. Air quality monitoring will continue to be undertaken during the next reporting period.

6.4 Biodiversity

6.4.1 Environmental Management

Biodiversity is managed in accordance with the *Ravensworth Complex Biodiversity Offset Management Plan* which has been developed and approved in accordance with Schedule 3, Condition 24 of PA09_0176. The *Biodiversity Offset Management Plan* covers the management of biodiversity at the Ravensworth Complex and biodiversity offset areas (BOAs), and is available on the website.

The Ravensworth Complex aims to mitigate effects of mining activities on native vegetation communities, fauna habitat and fauna species by planning and implementing programmes to maintain and improve the biological value of land. The programs are not only for rehabilitation areas but include other potentially degraded sites across the Ravensworth Complex holdings.

A large area has been offset as part of the establishment of Ravensworth North. This has involved the establishment, protection and enhancement of Offset Areas by an Implementation Program, which was approved in 2013. This will provide for the long term conservation of a range of significant ecological features.

6.4.2 Biodiversity Offset Areas – Overview

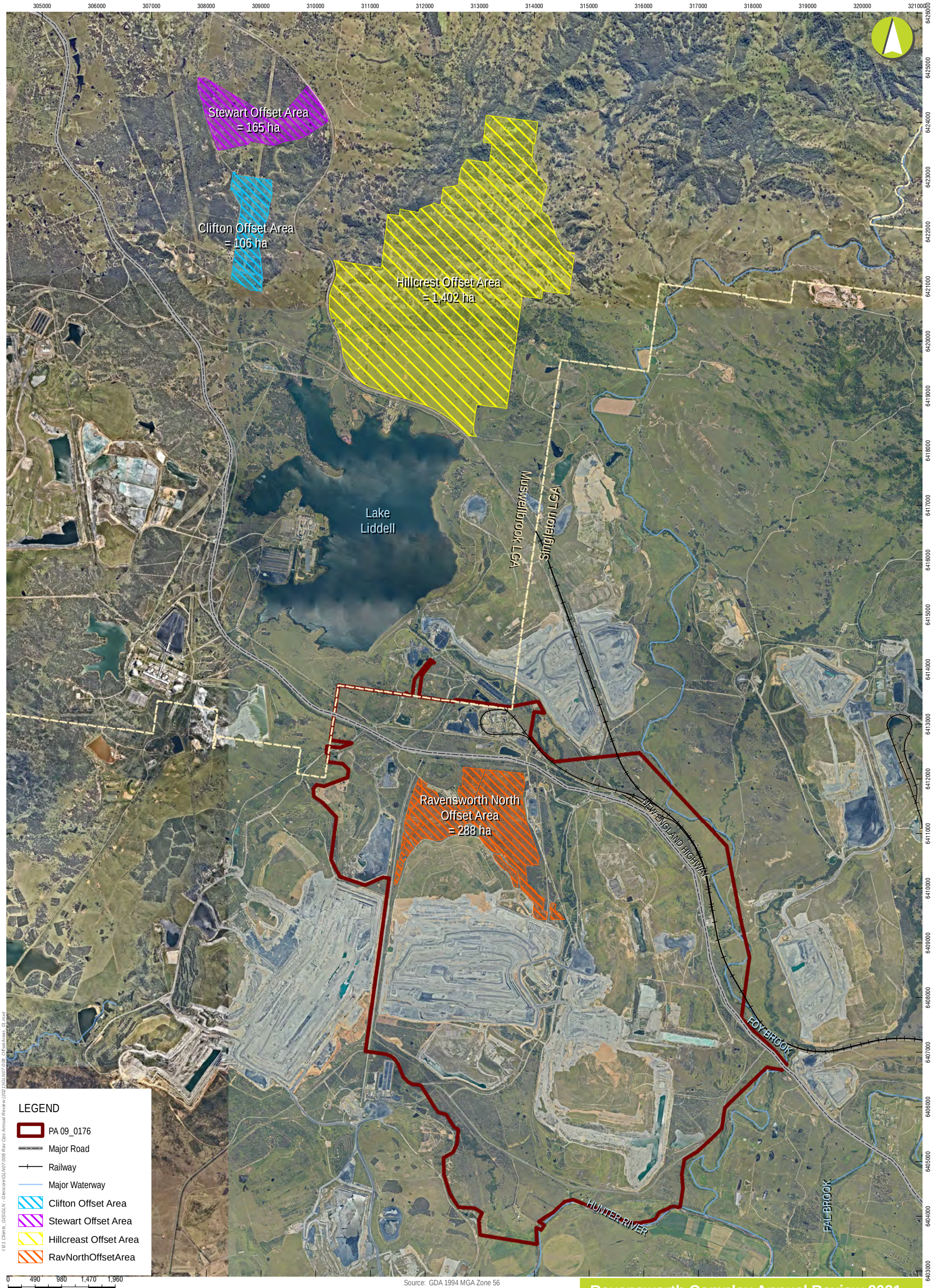
Ravensworth Operations owns and manages four BOAs required under NSW Project Approval (PA 09_0176) and the Federal EPBC Approval (2010/5389). The offset areas are managed in accordance with the Ravensworth Complex Offset Area Management Programme (OAMP). A spatial summary of these offset areas is described in ***Table 6-10*** and shown in **Figure 6-3**.

Name	Size (ha)	Location Description
Ravensworth North Offset Area (RNOA)	288	Immediately North of Ravensworth North Open Cut Disturbance Area
Hillcrest Offset Area (HOA)	1402	Approx. 6km North of Ravensworth Complex
Clifton Offset Area (COA)	106	Approx. 7.5km North of Ravensworth Complex
Stewart Offset Area	165	Approx. 10km North of Ravensworth Complex

Table 6-10 - Location and size of Ravensworth Operations Offset Areas

In accordance with the BOMP (Ravensworth Open Cut, 2021), and the OAMP (Ravensworth Open Cut, 2019) Ravensworth Operations utilises suitably qualified and accredited ecologists to undertake an annual biodiversity monitoring program across all BOAs.

Biodiversity monitoring is undertaken at the BOAs on an annual basis. Monitoring involves vegetation condition assessments and fauna monitoring at twenty eight permanent monitoring locations across all Biodiversity Offset Areas (BOAs). The results of the 2021 monitoring program are discussed in the following section.



LEGEND

- PA 09_0176
- Major Road
- Railway
- Major Waterway
- Clifton Offset Area
- Stewart Offset Area
- Hillcreast Offset Area
- RavNorthOffsetArea

0 490 980 1,470 1,960 m

Scale: 1:62,500

Imagery: Glencore, February 2022

Source: GDA 1994 MGA Zone 56

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Ravensworth Complex Annual Review 2021

Biodiversity Offset Areas

Figure 6-3

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6.4.2.1 BOA Monitoring Results

The survey and assessment by Biodiversity Australia Pty Ltd (2022) was undertaken across winter, spring and summer and involved the continuation of annual vegetation condition assessments and fauna monitoring at 28 permanent monitoring locations across all BOAs.

Fauna

Bird census monitoring in 2021 yielded lower results across three of the four BOAs than in 2020, with the exception of RNOA. As in previous years, woodland sites supported a higher diversity of bird species than grasslands. This is expected as the extent of foraging habitat and shelter is significantly greater within the woodland sites. As vegetation cover increases in grasslands, it is anticipated a greater diversity of birds will be recorded over time. Only one threatened bird was observed in 2021, the grey-crowned babbler. This bird was heard calling in Clifton and RNOA. There were fewer species recorded in 2021 compared with 2020. The regent honeyeater and swift parrot (target species) were not observed. Suitable habitat for these species remains present in all BOAs.

No threatened mammals were detected during the survey period in 2021, in comparison with 2020 which saw three threatened fauna species recorded.

There was an increase in the number of dams with suitable habitat for the Green and Golden Bell Frog across the BOAs in 2021, however no individuals were encountered during the monitoring period.

Flora

Vegetation condition assessments conducted in 2021 indicate a general increase in species diversity across the BOAs, with the exception of Clifton. For the most part, the diversity of exotic species declined or remained very similar to 2020 records. At SOA however, exotic species richness increased marginally within woodland sites. Species richness for all BOAs still remains substantially lower than the peak records of 2016. However, the BOAs appear to be demonstrating a general upward trend in species richness, particularly since the drought conditions of 2017-19. Increased rainfall in 2021 allowed the regeneration of native species in select areas across the BOAs, however grassland sites continue to show low regeneration across some BOAs. Grasslands also contain higher exotic plant densities than woodland sites. This trend has been consistently observed in all BOAs since the commencement of monitoring in 2012.

6.4.3 Key Performance and Management Issues

Appendix E outlines the compliance of the 2021 monitoring results with the biodiversity objectives and target criteria outlined within the OAMP.

Ravensworth finalised its Conservation Agreements (CA) with the NSW Office of Environment and Heritage (OEH) on 31 January 2019 for four biodiversity offset areas associated with the Ravensworth Operations Project in the upper Hunter Valley NSW, being the Ravensworth North, Hillcrest, Clifton and Stewart offset areas.

Weeds and pests continue to be a focus of management within the BOA areas. **Section 6.10** discusses the weed and pest management undertaken during 2021 both within the mining lease boundaries and in the BOAs.

No incidents occurred in the BOAs during the reporting period.

6.4.4 Proposed Improvements

The site's biodiversity and offset areas will continue to be managed consistent with Ravensworth Complex Biodiversity Management Plan. Pest and weed management will continue to be undertaken at the BOAs during 2022, as discussed in ***Section 6.10***.

The continued use of amelioration methods such as direct seeding, brush-matting, planting of fast-growing pioneer species and soil amelioration will be undertaken (where possible) to speed up the recovery of vegetation communities within the BOAs and enhance regeneration success of grassland areas.

6.5 Erosion Management

6.5.1 Environmental Management

Ravensworth Complex manages erosion and sediment control on site in accordance with the approved Erosion and Sediment Control Plan (ESCP), which is included in the Water Management Plan (WMP). The Water Management Plan was updated and approved in 2020 and is available on the Ravensworth Complex website.

6.5.2 Environmental Monitoring Results and Works Undertaken

During the reporting period there were minor upgrades to erosion and sediment controls at site and maintenance of existing erosion and sediment control measures (e.g. desilting of dams).

6.5.3 Key Performance and Management Issues

Erosion and sediment is actively managed with erosion and sediment controls in place, erosion monitoring undertaken and maintenance works undertaken on an annual basis.

6.5.4 Proposed Improvements

Erosion monitoring will continue to be undertaken during 2022, along with maintenance and upgrades to erosion and sediment controls, as required.

6.6 Aboriginal Heritage

6.6.1 Environmental Management

Aboriginal heritage at the Ravensworth Complex is managed in accordance with the *Aboriginal Cultural Heritage Management Plan* (ACHMP). Remaining archaeological (Aboriginal heritage) sites within the Ravensworth Complex Approval boundary (PA 09_0176) are shown on ***Figure 6-4***.

A monitoring program is undertaken for Aboriginal heritage sites that are not directly impacted by approved mining activities, in accordance with the Ravensworth Complex ACHMP. Monitoring is conducted annually. Results from the monitoring program are discussed below.

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6415000 6414000 6413000 6412000 6411000 6410000 6409000 6408000 6407000 6406000 6405000 6404000 6403000

NEW ENGLAND HIGHWAY

FOY BROOK

HUNTER RIVER

LEGEND

PA 09_0176

Major Road

Railway

Major Waterway

Remaining Archaelogical Sites (January 2021)

Monitored in 2021

Not monitored in 2021

0 275 550 825 1,100 m

Scale: 1:35,000

Imagery: Glencore, February 2022

Source: GDA 1994 MGA Zone 56

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Ravensworth Complex Annual Review 2021

Archaeological Sites

Figure 6-4

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6.6.2 Environmental Monitoring Results

The Aboriginal monitoring program for 2021 was undertaken by OzArk Environment and Heritage (OzArk) in November/December 2021. The 2021 monitoring program was attended by Registered Aboriginal Parties (RAPs) David Horton and Christine Paul.

In total 20 sites were monitored for site condition, as well as the grinding groove site REA86 (where photographic monitoring is undertaken annually). The 2021 program managed to visually inspect all site condition monitoring sites, except for the engraving site Bowmans Ck 16 that was under water due to high flows within Bowmans Creek at the time of the monitoring program. Inspections at the 10 photographic monitoring sites did not occur in 2021 as this occurs every three years and is next due to occur in 2023.

The 2021 monitoring program demonstrated that:

- Most sites have been impacted by erosion: most commonly sheet wash erosion. A minority of sites have on-going impacts from extensive gully erosion;
- No sites have been impacted by non-natural activities;
- Revegetation is occurring at many sites and this will slow or halt erosion, particularly sheet wash erosion. However, due to the lack of topsoil at many areas of erosion, this revegetation will take time to establish itself naturally across eroded areas;
- At sites where hay bales have been installed there is clear evidence of a build-up of sediment on the upslope side that encourages vegetation growth. This demonstrates that hay bales are an effective, non-invasive method to control worsening erosion. However, the hay bales require replacement periodically; and
- A number of sites have been identified for replacement as the past monitoring program has demonstrated that they are in stable landforms and not at threat from on-going erosion.

Aboriginal sites at ROC are fenced and sign posted. No impacts other than natural deterioration were noted at any of the monitored sites and it is noted that the fencing program has aided the lack of inadvertent impacts to sites.

6.6.3 Key Performance and Management Issues

During the reporting period there was no salvage of Aboriginal heritage items. There were no complaints or incidents involving Aboriginal heritage sites.

The Ravensworth Complex will continue to replace hay bales periodically as required where there is evidence of disintegration. OzArk recommend that a number of sites be replaced in the 2022 monitoring program. The primary reason is that these sites have displayed very stable environmental conditions over a number of years and there is confidence that these conditions will not markedly change in the near future. Conversely, there are a number of sites at the ROC that have never been subject to monitoring and changing the monitoring sites will allow a broader range of sites to be appropriately managed. All photographic monitoring sites will remain in the program and substitution of sites will only be among the site condition monitoring group of sites.

6.6.4 Proposed Improvements

Ravensworth Complex will continue to hold the monitoring program site inspections annually in accordance with the project ACHMP.

6.7 European Heritage

The Ravensworth Complex has committed to the following heritage management measures in the *Heritage Management Plan,* which is available on the website:

- Manage blasting practices to meet relevant blast impact assessment criteria at listed heritage sites / items within the vicinity of the Project Area; and
- Structural assessment of the Oakland's complex buildings at key stages of the mining process, this complex is to be removed from further monitoring.

6.7.1 Environmental Monitoring Results

A structural assessment inspection of the Oaklands homestead site was undertaken on the 27 November 2019. The site is included in monthly inspections. Weed spraying has been completed and rabbit control at the site is ongoing (see ***Section 6.10***).

6.7.2 Key Performance and Management Issues

There were no management issues related to European heritage at the Ravensworth Complex during 2021.

6.7.3 Proposed Improvements

European heritage will continue to be managed in accordance with the *Heritage Management Plan* in 2022.

6.8 Meteorological Monitoring

The Ravensworth Complex has a weather station onsite to measure atmospheric conditions, including wind speed, wind direction, sigma-theta, humidity, rainfall and temperature in accordance with EPL 2652. This allows up to date predictions to be made on the impact of weather conditions on mining operations.

EPL 2652 was varied in 2021 to move the location of the weather station (EPA identification no.13). The meteorological station was moved due to the progression of mining.

A summary of results is provided in ***Appendix F***.

6.8.1 Average Temperature and Wind Speed

Throughout the reporting period the average mean wind speed was 2.18 m/s.

The average mean air temperature (at 10m) was 17.6 degrees Celsius. The hottest temperature recorded was 30.2 degrees Celsius, and this was experienced in January 2021.

6.8.2 Rainfall

During the reporting period a total rainfall of 1042.4 mm was received. This was more than the previous year when 848.6 mm of rain was received. November 2021 was the wettest month with 262.6 mm, followed by March 2021 with 207.4 mm.

6.9 Weed and Pest Management

6.9.1 Environmental Management Activities and Monitoring Results

6.9.1.1 Weed Management Activities

Monthly environmental inspections at the Ravensworth Complex are used to identify areas of weed infestations as well as review the success of previous weed control programs.

A summary of weed control activities undertaken by HCB Rural and Land Management (HCBRLM) at the Ravensworth Complex and in BOAs in 2021 is presented in ***Table 6-11***. Weed control was predominantly conducted in rehabilitation pasture areas, buffer lands and BOA's. Weed infestations were recorded in the GIS database.

Location	Weed Management	Days Completed
Cumnock	Spraying of Pampas Grass and Bitou Bush	4
	Spraying of Acacia saligna	4
	Spraying of Coolatai Grass, other invasive grasses and general weeds.	36
Rehabilitation Areas	Collecting Pampas Grass seed heads and spraying plants	1
	Spraying of Coolatai Grass	10
	Checking and spraying of Bitou Bush	2
	Spraying of Acacia saligna	19
	Spraying of Galenia, mustard weed and other broad leafs	58.5
	Spraying of African Boxthorn and African Olive	1.5
	Spraying of St John's Wort	2.5
Buffer lands	Checking and spraying Bitou Bush	0.5
	Spraying of African Boxthorn and African Olive	2

Table 6-11 - Weed Control at the Ravensworth Complex and in BOAs during the Reporting Period

6.9.1.2 Feral and Pest Animal Management

Wild Dogs and Foxes

The management strategy for feral animals continued with baiting program conducted during the reporting period. The program was carried out by an experienced consultant and adhered to all best practice guidelines set by NSW Environment, Energy and Science and the Local Land Service.

A 1080 ground baiting program was conducted during May and June 2021 within the Mining Lease boundaries and within the Clifton, Stewart and Hillcrest Offset Areas. This timing aligned with other baiting programs occurring in the Hunter area, including the aerial baiting conducted by Hunter Local Land Services in the Hillcrest Offset Area in May and June 2021.

During the four week program 48 bait stations were set within the mining lease boundary, including the Ravensworth North Offset Area. A total of 72 baits were taken by wild dogs foxes, and unknown

takes. Baiting efficiency for the program was 24%, relating to the target species only (wild dogs and foxes).

There were 25 bait stations established offsite, including 16 bait stations in Hillcrest, 6 in Stewart and 3 in the Clifton Offset Areas. A total of 31 baits were taken by wild dogs, foxes and one unknown take. Baiting efficiency for the program was 30%, relating to the target species only (wild dogs and foxes).

Other Animals

Rabbits and hares were observed on all field cameras during the 1080 ground baiting program, although it was difficult to determine numbers of animals.

Feral cats were observed on various field cameras during the 1080 ground baiting program, and a feral cat control program will be considered in 2022. A pig poison program will also be considered to address a building mob of feral pigs observed on field cameras around the Bayswater Creek area.

A deer was also observed in the Ravensworth North Biodiversity Offset Area. The area will continue to be monitored to determine if a control program is required,

6.9.2 Key Performance and Management Issues

No reportable incidents, performance or management issues regarding weeds and feral animal management occurred during the reporting period.

6.9.3 Proposed Improvements

Throughout 2022 weed monitoring will continue to be undertaken, as well as weed and pest management as required.

6.10 Visual and Lighting

6.10.1 Environmental Management

The Ravensworth Complex employs various management strategies for mitigating and minimising its impacts on the visual amenity from community locations and public roads.

The Ravensworth Complex undertakes regular community inspections. A photographic record is maintained at strategic monitoring locations around the Ravensworth Complex as evidence, and if there are issues identified during the inspection the Open Cut Examiner (OCE) is informed and actions to address any amenity issues from mining operations are completed.

6.10.2 Environmental Monitoring Results

No lighting surveys were undertaken during the reporting period as there was no change to visual impacts at the site.

6.10.3 Key Performance and Management Issues

There were no performance or management issues regarding visual mitigation or lighting during the reporting period.

6.10.4 Proposed Improvements

There are no proposed visual and lighting improvements for 2022.

6.11 Spontaneous Combustion, Methane Drainage and Ventilation

6.11.1 Environmental Management

6.11.1.1 ROC/RCHPP

ROC and the RCHPP a *Spontaneous Combustion Principal Hazard Management* Plan in place that addresses the placement of carbonaceous materials to ensure the potential for spontaneous combustion is minimised. The document identifies potential sources of carbonaceous material at the mine and details methods to be used when handling and disposing. A specific training module has been developed to communicate the requirements of this procedure to appropriate personnel.

6.11.1.2 RUM

Methane drainage and ventilation is undertaken by RUM in accordance with the approved Monitoring Arrangements Management Plan (RAVUG-1057118485-4445). The plan documents and the management strategies associated with mine ventilation.

6.11.2 Environmental Monitoring Results

Monitoring is conducted as per the requirements of the *Spontaneous Combustion Principal Hazard Management Plan*. No significant spontaneous combustion events occurred during the reporting period.

6.11.3 Key Performance and Management Issues

No significant spontaneous combustion events occurred during the reporting period.

6.11.4 Proposed Improvements

Improvements to spontaneous combustion, methane drainage and ventilation are not proposed for the 2022 period. Current management activities are deemed sufficient.

6.12 Bushfire Management

6.12.1 Environmental Management

Slashing of grasses is conducted on a regular basis, such as road verges, infrastructure areas, and sensitive and high risk growth areas to reduce excessive fuels.

The Ravensworth Complex Bushfire Management Plan outlines the key mitigation measures for managing bushfire risk at ROC and the RCHPP.

6.12.2 Environmental Monitoring Results

There were no bushfire events onsite or in BOAs during 2021. The annual bushfire inspection of bushfire management in the offset areas was undertaken in 2021. As a result the Bushfire Management Map was updated.

6.12.3 Key Performance and Management Issues

The Ravensworth Complex Bushfire Management Plan is currently being reviewed and will be finalised in 2022.

6.12.4 Proposed Improvements

No improvements are proposed for the 2022 reporting period.

6.13 Mine Subsidence

6.13.1 Environmental Management

RUM have a *Subsidence Management Plan* to ensure adequate management of any subsidence impacts associated with surface cracking, erosion, slope instability, land degradation and spontaneous combustion due to longwall mining.

Visual subsidence monitoring is undertaken and subsidence repairs are completed in accordance with the SMP.

6.13.2 Environmental Monitoring Results

RUM was in care and maintenance during the reporting period and no underground mining activities occurred. Visual subsidence inspections were undertaken as part of the ongoing Environmental Monitoring Inspections in 2021. Monitoring did not identify any subsidence related issues.

6.13.3 Key Performance and Management Issues

No remedial repair works were required during the reporting period.

6.13.4 Proposed Improvements

There are no proposed improvements in 2022.

6.14 Hydrocarbon and Chemical Management

6.14.1 Environmental Management

Bulk fuel facilities are managed in accordance with *AS1940-2017 The Storage and Handling of Flammable and Combustible liquids.* All permanent fuel facilities are bunded, with measures in place to manage spills.

All hydrocarbon contaminated waste material within pit, hardstand and truck wash areas is bio remediated and disposed onsite in a bioremediation area. The site has been designed to prevent contamination and the storage and handling of chemicals is undertaken in accordance with Australian Standards and relevant guidelines.

Hydrocarbon contaminated water is contained and separated in the site's industrial oily water separators where treated water is recycled for reuse and separated oil is disposed of offsite by the licensed waste contractor. In the event of accidental contamination of onsite dams, contaminated water is contained and transported offsite for treatment by a licensed waste contractor.

6.14.2 Environmental Monitoring Results

The bioremediation area is tested once cells are full and dry or inspection deems testing necessary. Cells 1 – 20 were tested in both May and October 2021.

The bioremediation area remains in good condition with ongoing maintenance to access and lay-down areas throughout the reporting period as required.

6.14.3 Key Performance and Management Issues

Minor spills (Category 1 and below) occurred during the reporting period. There were no Category 2 spills. Contaminated material was taken to the onsite bioremediation area.

There were no significant issues regarding the storage of chemicals throughout the reporting period.

6.14.4 Proposed Improvements

Hydrocarbon spills will continue to be managed appropriately, with any spills cleaned up and contaminated material sent to the bioremediation area.

It is proposed to relocate the bioremediation area as mining advances to the south.

6.15 Greenhouse Gas and Energy

6.15.1 Environmental Management

The Ravensworth Complex is committed to reducing GHG emissions from its operation. The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Cth) provides methods and criteria for calculating GHG emissions and energy data under the NGER Act. Each reporting year technical guidelines based on the Determination are developed, reflecting improvements in estimation methods and in response to industry feedback. On the 14 May 2021 the Commonwealth Clean Energy Regulator issued new Transitional Safeguard Baselines for the Ravensworth Open Cut and the Ravensworth Underground.

6.15.2 Environmental Monitoring Results

6.15.2.1 Results from the Reporting Period

Scope 1 and Scope 2 emissions during the FY21 reporting period are presented in ***Table 6-12***.

Emission Source	T CO_2-e
Ravensworth Open Cut	
Scope 1 Emissions	324,204
Scope 2 Emissions	10,690
Ravensworth UG	
Scope 1 Emissions	155,993
Scope 2 Emissions	4,911
TOTAL	495,798

Table 6-12 - GHG Emissions Summary 2021

6.15.2.2 Comparison with Predictions

The combined Ravensworth Open Cut and Ravensworth Underground Safeguard Baselines is 519,058 T CO2 -e. Actual GHG emissions for 2021 were 495,798T C02-e.

6.15.3 Key Performance and Management Issues

There were no significant issues regarding GHG throughout the reporting period.

6.15.4 Proposed Improvements

There are no proposed improvements for greenhouse gas management in 2022.

7. Water Management

7.1 Water Balance

The overall water balance for the Ravensworth Complex in 2021 was a surplus of 4,644 ML which was well above the forecasted deficit included in the Ravensworth Operations Project (ROP) water balance (Umwelt, 2010) in a 90th percentile rainfall year in 2021. At the time the ROP water balance was prepared, the current GRAWTS scheme was not anticipated and therefore not incorporated into the water balance model calculations. Water imports from other mining operations under the GRAWTS are significant and are likely to account for a significant portion of the discrepancy between the ROP water balance predictions and the observed 2021 site water balance.

Item	Volume (ML)
Inflows	
Rainfall Runoff	6,300
Groundwater Inflow	2,143
ROM Coal Moisture	830
From Mount Owen Complex (MOC)	1,913
From Liddell Coal Operations (LOC)	2,540
Potable Supply	11
From Hunter River	100
Total Inflows	**13,837**
Outflows	
Evaporation	745
Dust Suppression / Washbay	491
CHPP Supply	3,891
Product Coal Moisture	748
Coarse Rejects Moisture	303
Tailings Water	1,495
To MOC	0
To LOC	0
Other Third-party supply (to HVO, Oaklands Property)	8
HRSTS Discharges to the Hunter River	1,511
Uncontrolled Release	2
Total Outflows	**9,195**
Inflow – Outflow	4,642
Recorded Stored on Site at Start of Annual Review Period	6,953
Recorded Stored on Site and End of Annual Review Period	9,539
Change in Storage	2586
Error	9%

Table 7-1 – Ravensworth Complex 2021 Water Balance

7.2 Water Take

Ravensworth Complex holds water access licences WAL 9050, WAL 10771 and WAL 18317 that allow for extraction of water from the Hunter River and Bayswater Creek. The RCHPP also holds WAL 1046, WAL 8964 and WAL 1325 which also allows extraction from the Hunter River.

Ravensworth 2021 water take is outlined in ***Table 7-2***. The extraction of surface water was undertaken in compliance with the conditions of the relevant licences.

Water Licence #	Water Source / Management Zone	Category	Entitlement	Extracted Volume (ML)
WAL 18317 (20AL21098)	Hunter Unregulated and Alluvial Water Source/Jerry Water Source/Jerrys Management Zone (extraction from Bayswater Ck)	General Security	20	0
WAL 9050 (20AL200462)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	500	99.7
WAL10771 (20A200744)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	25	0
WAL 8964 (20AL203224)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	1,590	0
WAL 1046 (20AL201444)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	3	0
WAL 1325 (20AL203042)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	Supplementary	13	0
WAL 13102 (20AL203412)	Hunter River Regulated/Zone 1a (Hunter River from Glenbawn Dam to Goulburn River Junction)	High Security	15	0

Table 7-2 - Surface Water Extractions 2021

ROC holds seven water licences that allow the extraction of groundwater. A total of 2,143 ML of groundwater was extracted in 2021 in accordance with the conditions of all relevant licences.

7.3 Water Supply, Use and Discharges

7.3.1 ROC

The ROC water management system comprises a range of infrastructure including water storages, pipes and pumps for water transfers (within the mine complex and between external water sources and sinks) and instrumentation for flow and level measurement.

Surplus surface water at ROC is transferred to the RCHPP or discharged from the Narama In-pit Storage Dam to the Hunter River via Bowmans Creek under the conditions of ROC EPL No. 2652 and the Hunter River Salinity Trading Scheme (HRSTS) or transferred to other Glencore mine sites under the Greater Ravensworth Water and Tailings Scheme (GRAWTS). The GRAWTS between other Glencore sites transfers water to the Narama In pit Storage Dam and is the primary discharge point for the Complex.

In 2021, ROC discharged 1,511 ML from the Narama In-pit Storage Dam under the conditions of the HRSTS and EPL 2652, with a total of 2.4 ML of unregulated discharges from ROC occurred during 2021.

At 3:30 AM on 12 November 2021 after significant rainfall (115.4 mm in 72 hours - above design capacity), water discharged from a dam into an ephemeral creek, known as Bayswater Creek. The dam, known as the MIA Facilities Dam, is a surface water catchment dam for water runoff from the Ravensworth Mining Infrastructure Facility. A pump on the dam was operational during the event and discharge ceased at approximately 5:30 AM. Due to the small duration of the event (approximately 2 hours), the volume discharged is estimated to be between 2.4 – 4ML. Water sampling was undertaken as soon as possible at key accessible locations (upstream, mid stream and downstream of that location) with samples sent to a NATA accredited laboratory for analysis. Based on water quality analysis it is evident that the water discharged from the MIA Facilities Dam would not have had any detrimental effect on the water in Bayswater Creek.

Surface water management across the Ravensworth Complex is undertaken in accordance with the Ravensworth Complex *Water Management Plan*. This plan was developed in consultation with relevant agencies and approved by the DPIE in accordance with Schedule 3, Condition 31 of PA 09_0176.

7.4 Surface Water Monitoring

7.4.1 Environmental Management

Surface water management across the Ravensworth Complex is undertaken in accordance with the Ravensworth Complex *Water Management Plan*. This plan has been developed and approved by the DPIE in accordance with Schedule 3, Condition 31 of PA 09_0176.

The Ravensworth Complex *Water Management Plan* outlines the interactions of the water management system across the sites that form part of the Ravensworth Complex.

Water quality sampling is undertaken monthly in Bowmans Creek, Bayswater Creek and Emu Creek. Water quality monitoring is undertaken in Davis Creek and Pikes Creek every second month.

Ravensworth Complex undertakes stream health and channel stability monitoring in Bayswater, Emu, Bowmans, Davis and Pikes Creeks. This monitoring involves site inspections and stability assessments, macro invertebrate sampling and water quality monitoring at seven sites across the Complex. The results are compared to reference sites located in the Stewart and Clifton Offset Areas.

7.4.2 Environmental Monitoring Results

7.4.2.1 Surface Water Quality Monitoring Results

Water quality results (pH, EC, TDS and TSS) for the Ravensworth Complex sampling program reported by Engeny Water Management in 2021 are presented in ***Appendix G,*** along with analysis (minimum, maximum and average) and time-series charts. Monitoring locations are shown on ***Figure 7-1***.

Impact assessment criteria (IAC), also referred to as 'trigger values', for pH, EC, TSS and TDS have been determined for specific receiving water monitoring locations as part of the *Ravensworth Complex Water Management Plan*. All surface water quality data collected as part of the monitoring program were assessed against the IAC to identify deviations from the baseline water quality conditions. The results are discussed in Section 2.3 of ***Appendix G***. There were some exceedances of IAC values, which were investigated in accordance with the *Water Management Plan.* The majority were related to samples being taken from pooled water which are unrepresentative of typical water quality. No further mitigation measures were required.

7.4.2.2 Channel Stability

An annual report on stream flow events occurring in Emu, Davis and Bayswater Creeks was prepared by AECOM (2022) for the 2021 reporting period. Flow events were recorded by each of the three flow stations in the flow monitoring network during 2021. The volume and frequency of rainfall during the monitoring period is reflected in the size, number and when the recorded flow events occurred along each creek.

The flow events along Emu Creek have again been reduced due to the installation of the Emu Creek Dam and planned mine activities currently taking place in the upper and middle sections of Emu Creek. The majority and magnitude of recorded flow events along Davis Creek were mostly dependent on rainfall and could have contributed to the related flows in Bayswater Creek. The number of flow events recorded along Davis Creek were almost five times that of the flow events recorded in Bayswater Creek.

With regard to stream stability, the photographic record suggests that the streams have remained relatively stable over the monitored period from the significant rainfall in the first and fourth quarters. Subsequent flow events along Bayswater Creek have not caused any damage to the drop structure.

310000 311000 312000 313000 314000 315000 316000 317000 318000 319000

6415000 6414000 6413000 6412000 6411000 6410000 6409000 6408000 6407000 6406000 6405000 6404000 6403000

W10 W9 W8 W12 W1 W137 W16 W14 W150 W136 W144 W2 CHPP STP W3 W135 W4 W148 W5 W11 W17 W159 W147 W19 W131 W18 W130 W152 W132 NEW ENGLAND HIGHWAY W13 W164 W162 W114 W163 W166 / ROC STP W111 W128 W168 W109 W102 W110 W165 FOY BROOK W169 W122 W161 W129 EPL2 W103 W167 EPL3 EPL4 HUNTER RIVER

LEGEND

- PA 09_0176
- Major Road
- Railway
- Major Waterway
- Surface Water Monitoring Location

0 275 550 825 1,100 m

Scale: 1:35,000

Imagery: Glencore, February 2022

Source: GDA 1994 MGA Zone 56

29/03/2022

I:\01 Clients_GIS\AUR - Aurelia Metals\AUR04_001 Mineral Hill RMP 2022\GLN07-008_Surfacewater-Monitoring_01.mxd

Ravensworth Complex Annual Review 2021

Surface Water Monitoring Locations

Figure 7-1

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7.4.2.3 Stream Health Monitoring

Stream health monitoring is undertaken at Bayswater Creek, Bowmans Creek, Pikes Creek, Davis Creek and Emu Creek on a biannual basis. Monitoring is also undertaken at control sites. The results of the monitoring program; Habscores, Signal2 and erosion and stability observations are provided in ***Table 7-4***. The Habscore provides a relative indicator of stream health at dry and wet sites. The AusRivAs (Signal2) provides an indication of the macroinvertebrate community's overall tolerance to pollution or disturbance.

Biosis (2022) state that Habscores were clustered within the marginal and poor categories which is consistent with previous results and is to be expected considering the highly modified and heavily managed nature of the landscape. These are unlikely to be attributable to mining activities but reflects the agricultural history of the region. SIGNAL 2 scores, an indication of the pollution sensitivity of macroinvertebrate assemblages at a site, remained relatively consistent when monitoring and control sites are considered together.

7.4.2.4 Comparison to Predictions

Stream Health Monitoring

Water quality parameters recorded at the monitoring sites during autumn and spring 2021 sampling were compared against the Ravensworth Complex adopted impact assessment criteria (Umwelt, 2014) listed in ***Table 7-3***.

Site	pH	Oxygen % saturation	Maximum conductivity (µs/cm)
Bayswater Creek (BWC) sites	6.5 – 8.0 (all conditions)	85 – 110 (all conditions)	2100 (all conditions)
Other monitoring sites	6.5 – 8.0 (flow) 6.5 – 8.4 (no flow)	85 – 110 (all conditions)	2100 (flow) 6100 (no flow)

Table 7-3 - Adopted Impact Assessment Criteria

Dissolved oxygen levels below accepted thresholds were recorded at four of the six monitoring sites in autumn 2021 and this is likely to be a result of relatively low flows despite elevated water levels. Three of these four monitoring sites also had conductivity levels above maximum adopted criteria, which again can be attributed to low flow conditions. The remaining two Ravensworth sites did not contain water in Autumn 2021.

All monitoring sites were dry with no flow during the spring monitoring period and as such comparisons of surface water quality between the two seasons at these sites cannot be made.

Overall, these results were consistent with those of previous monitoring.

7.4.2.5 Long Term Trend Analysis

Despite environmental fluctuations in water availability, monitoring sites and control sites overall have remained in a relatively stable but poor condition since the stream health monitoring program incorporated control sites in autumn 2013, and no significant difference has been observed between monitoring sites and the control sites.

Site		2021 Erosion / Stability Observations	HABSCORE		Signal2		HABSCORE		Signal2	
			Autumn 2020	Spring 2020	Autumn 2020	Spring 2020	Autumn 2021	Spring 2021	Autumn 2021	Spring 2021
BWC-AQ2	Bayswater Creek Mid 1	Minor bank erosion upstream. Recovering with groundcover vegetation cover improving.	36* (P)	36* (P)	Dry	Dry	47 (M)	29 (M)	3.06	Dry
BWC-AQ3	Bayswater Creek Mid 2	Significant erosion at points where ephemeral tributaries join with Bayswater Creek.	66 (M)	50* (M)	4.00	Dry	36 (M)	26 (M)	3.55	Dry
BWC-AQ4	Bayswater Creek D/S	Minor erosion of channel edges around the gabion and rip-rap erosion prevention structures.	43* (S)	40* (S)	Dry	Dry	46 (M)	20 (P)	3.47	Dry
DAC-AQ1	Davis Creek U/S	Moderate undercutting and general erosion of banks, somewhat stablised with vegetation.	43* (M)	36* (M)	Dry	Dry	23 (P)	34 (M)	3.59	Dry
DAC-AQ2	Davis Creek D/S	Significant erosion where ephemeral tributaries meet Davis Creek.	31* (P)	31* (P)	Dry	Dry	26 (M)	25 (P)	Dry	Dry
EMC-AQ2	Emu Creek D/S	Significant erosion and undercutting of the left bank.	38 (S)	35* (M)	3.75	Dry	26 (M)	30 (M)	Dry	Dry

O=optimal; S=suboptimal; M=marginal; P=poor. * denotes the site did not contain water

Table 7-4 - Stream Health at Ravensworth Complex for 2020 and 2021

7.4.3 Key Performance and Management Issues

Biosis (2022) concluded that the 2021 monitoring results are considered normal for the locality and no impacts to stream health as a result of mine operation have been detected.

AECOM (2022) concluded that the size, number and when the recorded flow events occurred along each creek in 2021 reflected the volume and frequency of rainfall experienced. Stream stability at monitoring locations remained relatively stable during 2021.

7.4.4 Proposed Improvements

Stream health and stream flow/channel stability will continue to be monitored during the 2022 reporting period.

7.5 Groundwater Management

7.5.1 Environmental Management

The Ravensworth Complex *Water Management Plan* was prepared to satisfy the requirements of the Project Approval PA 09_0176 Schedule 3, Condition 31.

During 2021 a formal review of the depressurisation of coal measures and comparison of responses with the aquifer model predictions was undertaken by AGE (2022) as required by Condition 6.8.4 of PA 09_0176 Statement of Commitments. It was concluded that the model continues to provide a relatively conservative prediction of impact for the Ravensworth operations. Therefore, further calibration of the groundwater model is not considered to be necessary at this stage to establish the level of impact due to Ravensworth Operations.

7.5.2 Environmental Monitoring Results

7.5.2.1 Results from the Reporting Period

During the 2021 monitoring period, the groundwater management monitoring report undertaken by Engeny Water Management (2022) included review of monthly monitoring of water levels, quarterly monitoring of pH and EC, and annual monitoring of inorganic species (speciation data). The results are provided in ***Appendix G*** *and monitoring locations shown on* ***Figure 7-2***.

All monitoring data collected as part of this program is assessed against established IAC in order to:

- Determine whether groundwater extraction volumes are within WAL limits and are comparable with modelled predictions;
- Identify deviations from the baseline water quality conditions; and
- Identify deviations from the baseline groundwater level trends.

Groundwater Quality

A summary of groundwater quality data for pH, EC and trace elements (speciation) is provided in ***Appendix G***, along with individual results. Historical pH and EC results for all current and

decommissioned monitoring bores are also presented in Charts in ***Appendix G*** with the mean and standard deviation for each bore shown on each chart.

A detailed discussion of groundwater quality results for 2021, along with comparison to historical data and IAC values from the Ravensworth Complex *Water Management Plan* can be found in Section 3.3 of ***Appendix G***.

Most groundwater quality results in 2021 were within historical ranges and the adopted IAC, with the observed exceedances being minor in nature and consistent with historical trends. It is recommended that IAC trigger values be reviewed, and that bores be cleared of any sediment that may be impacting water quality results.

Groundwater Levels

In 2021, groundwater levels were measured at eight locations, with monitoring results shown in ***Appendix G***.

Following a period of declining groundwater levels from early 2018, believed to be a consequence of an extended period low rainfall, recorded levels at NPZ7 Small (Hunter River Alluvium) continued to show an increase over the 2021 monitoring period (as observed in the 2020 results), rising from 32.52 mAHD in December 2020 to 41.28 mAHD in December 2021. It is considered that increased rainfall over 2020 and 2021 has resulted in increased surface water recharge to the alluvial aquifer.

NPZ7 Tall (Bayswater seam) and NPZ1 Tall (Lemington seam) both exhibited continued rising water levels over the 2021 period with increases of 6.05 m and 3.71 m respectively. This may reflect an increase in surface water recharge to the aquifers as a result of higher rainfall in 2021.

Recorded water levels at CS4641C (Pikes Gully seam) were relatively stable of the 2021 period This is consistent with the 2020 data trends, following a steady decline in level since 2015, which followed the sharp decline observed from 2013 to 2015 as a result of and dewatering of the former Cumnock underground workings to allow mining in the Ravensworth North Pit.

NPZ6 Tall (Broonies Seam) exhibited a steady decline in water level over the 2021 period with a decrease of less than 2 m, however, NPZ5B P1 which also targets the Broonies seam was stable over 2021. The decrease in NPZ6 Tall water level may be a consequence of the progression of mining in the North Pit, however, it is unclear why a corresponding decrease in NPZ5B P2 did not accompany these results.

Groundwater Depressurisation

In addition to the above, groundwater level is recorded in 8 locations (RNW1, RNW2, RNW3, RNW4, RNW5, RNW6, RNW7 and RNW8) at 12-hour intervals using vibrating wire piezometers in order to identify the groundwater pressure response to mining operations. Historical water level results are presented and discussed in detail in ***Appendix G***. All monitoring bores indicate depressurisation at some depths, however, are typically to a lesser degree than predicted in the Ravensworth Project groundwater model results presented in Ravensworth Operations – Review of Groundwater Model Predictions (AGE, 2020).

Results for bore RNVW1 show depressurisation at depths of 48 mbgl, 68 mbgl, 150 mbgl, 190 mbgl and 240 mbgl (refer to Appendix G) but to a lesser degree than predicted impacts. Depressurisation at a depth of 109 mbgl was, however, observed with the degree of depressurisation exceeding that predicted by the groundwater model and this is consistent with observations in previous years. The groundwater model for the Ravensworth Project also predicted depressurisation at a depth of 326 mbgl for RNVW1, however, results over recent years indicate pressure recovery at this depth.

Results for bore RNVW2 show depressurisation at depths of 239 mbgl and 305 mbgl but to a lesser degree than predicted The groundwater model for the Ravensworth Project also predicted depressurisation at a depth of 140 mbgl for RNVW2, however, results over recent years indicate pressure recovery at this depth.

Results for RNVW3 indicate depressurisation from 2015 onward at all depths, to a lesser degree than predicted in the Ravensworth Project groundwater model results.

Results for RNVW4 show ongoing depressurisation at 102 mbgl, 114 mbgl, 163 mbgl, 201 mbgl and 225 mbgl, typically to a lesser degree than predicted in the Ravensworth Project groundwater model results.

Results for RNVW5 indicate minimal or no depressurisation for the 2021 monitoring period.

Results for RNVW6 have previously indicated depressurisation at depths of 19 mbgl and 66 mbgl in excess of those predicted in the Ravensworth Project groundwater model results as reported in Ravensworth Operations – Review of Groundwater Model Predictions (AGE, 2020). However, pressures have stabilised at a depth of 19 mbgl, with slight recovery in 2021, and recovered at a depth of 66 mbgl in recent years. Depressurisation at a depth of 265 mbgl was previously observed to a lesser degree than predicted by the groundwater model, however, has stabilised over 2020 and 2021. It should be noted that results have not been observed at piezometer RNVW6 since June 2021.

Results for RNVW7 show ongoing depressurisation at depths from 121 mbgl to 335 mbgl which is consistent with groundwater model predictions for the Ravensworth Project.

Vibrating wire piezometer for RNVW8 was removed in June 2020, however, historical results indicate depressurisation at a depth of 252 mbgl but to a lesser degree than predicted in the Ravensworth Project groundwater model results.

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Groundwater Monitoring Locations

Figure 7-2

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8. Rehabilitation

8.1 Rehabilitation Performance

8.1.1 Rehabilitation Status at the End of the Reporting Period

Ravensworth Complex rehabilitation and disturbance areas are summarised in ***Table 8-1*** *and* ***Table 8-2***. A total of 14.2 Ha of new disturbance associated with the progression of the Ravensworth North pit occurred during the reporting period. A total of 30 ha was prepared for rehabilitation in 2021 and 6.7 ha of previously rehabilitated land was redisturbed.

Figure 8-1 includes a map of areas disturbed and rehabilitated during 2021. Photographs of rehabilitation are also provided.

Mine Area Type	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Total Mine Footprint (Ha)	2614.5	2624.9	2639.1
Disturbance (Ha)	1603.0	1617.2	25.7
Land Being Prepared for Rehabilitation (Ha)	70.0	30.0	55.0
Land under Active Rehabilitation (Ha)	932.9	956.2	1017.9
Completed Rehabilitation (Ha)	0	0	0

Table 8-1 - Ravensworth Complex 2021 Rehabilitation and Disturbance

Rehabilitation Site Name	Rehabilitation Type	Rehabilitation Area (Ha)	Rehabilitation Summary
Ravensworth Eastern Emplacement	Central Hunter Grey Box Ironbark Woodland	20.5	Final landform seeded with a native woodland mix and cover crop
Ravensworth Eastern Emplacement	Grazing Pasture	9.5	Final landform seeded with pasture species and cover crop

Table 8-2 - Rehabilitation Performance 2021 - Ravensworth Operations

Photo 1 – Rehabilitation Progress 2021

Photo 2 – Rehabilitation Progress 2021

Photo 3 – Rehabilitation Progress 2021

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2021 Rehabilitation and Disturbance

Figure 8-1

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8.1.2 Summary of Rehabilitation Monitoring

During the reporting period long-term rehabilitation monitoring and a rehabilitation walkover assessment was conducted to compare current conditions of the rehabilitation with closure criteria outlined in the MOP. This information developed management recommendations to guide the rehabilitation towards targeted Ecological Communities and final landform criteria.

8.1.2.1 Rehabilitation Monitoring

Koru Environmental (2022a) undertook rehabilitation monitoring in 2021 at the Ravensworth Complex.

Field surveys were undertaken in October 2021 with a total of 14 rehabilitation blocks and 41 transects/plots assessed across Ravensworth North and Narama emplacements areas. In total 12 rehabilitation blocks were monitored for IEM and two blocks monitored for LTM. Monitoring blocks comprised areas being returned to pasture (approximately 114.5 ha) and native woodland (approximately 255.4 ha).

Appendix H contains tables which summarise the progress of rehabilitation against the MOP completion criteria and the MOP Trigger Action Response Plan.

8.1.2.2 Fauna Monitoring

Fauna monitoring in rehabilitation is required every three years. Biodiversity Australia Pty Ltd were engaged to conduct the 2020 fauna monitoring component of the rehabilitation monitoring program, which was the third fauna monitoring event, following monitoring conducted in 2014 and 2017. No monitoring was required in the 2021 reporting period.

8.1.3 Rehabilitation Maintenance

8.1.3.1 Western Emplacement Area

Ongoing maintenance of the WEA in 2021 focused on weed management and repair of any erosion as required.

8.1.3.2 Cumnock

Rehabilitation works at Cumnock were generally undertaken between 2009 and 2011 using a combination of direct seeding and tubestock planting methods, and including a range of understorey, shrub and tree species (including non-endemic species). This included use of Rhodes grass as the rehabilitation status/landform at time of Ravensworth North Project was pasture.

A Cumnock Rehabilitation/Remediation Plan was prepared by Koru Environmental (2020) to define management strategies aimed at improving the condition of the rehabilitation. This report suggested using cattle grazing in progressive cells to manage areas of exotic grassland. Throughout 2020 the required infrastructure (cattle yards, fencing, pumps, water and tanks) have been installed in preparation for cell grazing to begin in 2021.

The implementation of the Cumnock Rehabilitation Plan was continued in 2021 along with crash grazing in cells. Works undertaken in 2021 include:

- Installation of permanent fencing and repairs to boundary fencing;

- Installation of electric fencing and water troughs for cattle grazing in Cells 1-5;
- Preparation of tree plots; and
- Spraying for invasive grasses and weeds.

The progress and success of completed restoration works is monitored annually by Koru Environmental (2021b).

8.1.3.3 2022 Rehabilitation Maintenance

During the next reporting period, Ravensworth will continue to develop and implement a rehabilitation maintenance strategy to progress rehabilitation to final landform consistent with final land use objectives. In 2022 Ravensworth will complete ongoing maintenance in previously rehabilitated areas. Priority actions for rehabilitation maintenance include:

- Erosion repairs;
- Control of priority weed species as identified during rehabilitation monitoring and inspections;
- Increasing lower-storey species richness in areas where priority weed grasses are absent (or following weed suppression) through hand seeding or tubestock planting;
- Increasing tree densities of rehabilitated areas through supplementary seeding and or tube stock planting; and
- Increasing habitat potential through adding rocks, logs, woody debris and next boxes to rehabilitation areas for fauna.

A Rehabilitation Maintenance Strategy is currently being developed to address priority areas.

8.2 Rehabilitation Trials and Research

8.2.1 Rehabilitation Trial Results

No rehabilitation trials were undertaken at the Ravensworth Complex in 2021.

8.3 Next Reporting Period

Rehabilitation activities proposed in 2022 include:

- Rehabilitation of 55 Ha;
- Maintenance works as outlined in Section 8.3.3;
- Crash grazing using cattle at Cumnock;
- Investigate long term land use options for Cumnock;
- Ongoing inspections and long-term rehabilitation monitoring; and
- Continued pest and weed management across the complex and in offset areas.

9. Community Relations

9.1 Employment Status

At the end of the reporting period, the Ravensworth Complex had approximately 666 full time employees and contractors.

9.2 Compliants

A complaints register is maintained and available on the Ravensworth Complex Website.

There were two complaints received during the 2021 reporting period for the Ravensworth Complex, both of which related to blast events.

9.2.1 Complaint 1

The Environment and Community Manager was contacted by Hunter Valley Operations (HVO) regarding a complaint HVO received from a nearby resident. The compliant was related to a blast undertaken at 1.20 pm on 25 February 2021, which was not undertaken by HVO.

The complainant was called to confirm that Ravensworth had blasted 1.20 pm, with blast overpressure of 111.3 dB and vibration of 0.08 m/s recorded at the nearest monitor to the complainant (Bowman monitor). These recording were within compliance levels.

9.2.2 Complaint 2

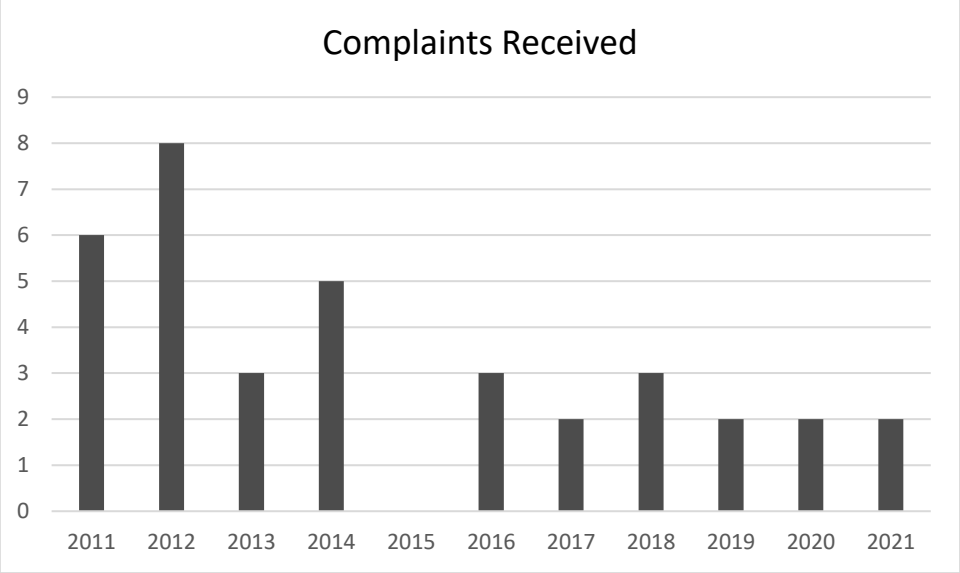
The Environment and Community Manager was contacted by HVO regarding a complaint HVO received from a nearby resident. The complaint was received at 1.26pm on 25 November 2021.

The Environment and Community Manager confirmed that Ravensworth did blast that day at 1.26 pm. A blast overpressure of 97.9 dB and vibration of 0.34 m/s were recorded at the nearest monitor to the complainant (Bowman monitor), which are within compliance levels.

9.2.3 Complaint Trend Analysis

Trend analysis on complaints by year since 2011 in ***Figure 9-1*** shows that annual complaints numbers have been stable since 2016.

Figure 9-1 – Complaints Received



9.3 Community Engagement

The Stakeholder Engagement Plan contains a Community Investment Plan which outlines key projects to be undertaken by the Ravensworth Complex throughout the year.

Community/stakeholder related activities undertaken during the reporting period include:

- Community Consultative Committee Meetings;
- Distribution of community newsletters;
- Mine tour/career talks with local primary schools;
- Active participation in Wild Dog Groups and the LLS; and
- Direct engagement with nearby landholders.

During 2021, the Ravensworth Complex continued to foster positive relationships with the local community through engagement and ongoing financial support provided to a range of community groups and events, including, but not limited to:

- Westpac Rescue Helicopter Service;
- Singleton High School;
- St Catherine's Catholic College;
- St James Primary School;
- Singleton Neighbourhood Centre; and
- Upper Hunter Homelessness Support Service.

9.4 Community Consultative Committee

The Ravensworth Complex maintains a close partnership with the local community. The Community Consultative Committee (CCC) includes Glencore representatives and local community members. This provides a formal forum for interaction between the community, mine management and relevant government departments. The Ravensworth Complex CCC held meetings in February, May, August and November 2021. The community representatives may share information from meetings with the rest of the community and relate any items for discussion at the CCC meetings.

The following key topics were discussed at the CCC meetings:

- Discussion of previous meeting minutes;
- Update on mining and processing activities at the Ravensworth Complex;
- Update on key environment and community aspects, including monitoring results and incidents;
- Update on safety performance; and
- Update on community support programs.

Minutes from the CCC meetings are posted on Ravensworth Complex's website: *https://www.glencore.com.au/operations-and-projects/coal/current-operations/ravensworth-operations/community-documents*.

9.5 Community Newsletter

The Ravensworth Complex circulates a community newsletter every six months to neighbouring residents, its employees, CCC members and other stakeholders and are on the Ravensworth Complex website. The newsletter provides information about the operational progress of the Complex, environmental and safety performance, plus other news of community interest.

10. Independent Audit

An Independent Environmental Audit (IEA) was undertaken in 2021 in accordance with Schedule 5, Condition 8 of PA 09_0176 and Schedule 4, Condition 7 of DA 104/96 by RPS Australia East Pty Ltd (RPS).

The audit included a review of:

- Conditions contained with Project Approval 09_0176 and Development Consent 104/96, including the statement of commitments;
- EPL2652;
- Mining Lease(s);
- Implementation of management plans prepared under Project Approval 09_0176; and
- Water Access Licences.

The IEA was submitted to the DPIE in July 2021. The DPIE requested further information, and an updated Audit report and status update of the IEA recommendation was provided to the DPIE in January 2022. The current status of the IEA recommendations is provided in ***Table 10-1****Error! Reference source not found.*. The IEA Report and Action Plan are available on the Ravensworth website.

Condition	Requirement	Comments and Evidence	Auditor Recommendation	Timing	Status
Non-compliant conditions					
PA 09_0176 S3 C20	**Air Quality Criteria** Except for the air quality-affected land referred to in Table 1, the Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the Ravensworth mine complex do not exceed the criteria listed in Tables 9, 10 or 11 at any residence on privately-owned land or on more than 25 percent of any privately-owned land.	The short term criterion for particulate matter PM10 24 hour criterion of 50 µg/m3 was exceeded numerous times during the audit period. There was one exceedance on 25 May 2021 at SX45-D2 which falls with IEA period and this reporting period.	Undertake the required triennial review and update of the Air Quality and Greenhouse Gas Management Plan. Consideration for review may include the dumping and pushing of overburden in high dumps during adverse weather events and effectiveness of the dust suppression system for the dump hopper. Where changes are made this should be incorporated into training for dispatch, operators and other relevant personnel to ensure awareness.	30 November 2021 31 December 2021	Complete Face to face quarterly training postponed due to COVID-19. To be implemented in 2022.
PA 09_0176 S3 C32	**Biodiversity Offsets** The Proponent shall implement the biodiversity offset strategy as outlined in Table 16 and as generally described in the EA (and shown conceptually in Appendix 7), to the satisfaction of the Secretary	Discrepancies in the overall size of the Ravensworth Biodiversity Offset Areas were identified in 2020 following detailed ground surveys. The surveys identified that three of the four Biodiversity Offset Areas are smaller than the minimum areas required. These include Hillcrest, Clifton, and Stewart. The Department was notified on 6 January 2021 of the discrepancy. Ravensworth Complex are currently investigating options to increase their biodiversity offsets to meet the minimum sizes outlined in the condition.	It is recommended a review of crown roads status in Offset Areas be undertaken and either close roads or seek modification to PA 09_0176. This non-compliance was reported in the 2020 Annual Review.	30 November 2021 (undertake review)	Review commenced. Due to high rainfall in Quarter 4 2021, access to offset areas has been difficult.
PA 09_0176 S3 C51	**Waste** The Proponent shall: (a) minimise and monitor the waste generated by the project;	Review of the on-site sewage treatment and disposal are completed by Singleton Council. Sewage treatment plant quality results for August 2020 were outside of the acceptable limits imposed by Singleton Council.	This non-compliance was reported in the 2020 Annual Review and is not within this reporting period.		

Condition	Requirement	Comments and Evidence	Auditor Recommendation	Timing	Status
	(b) ensure that the waste generated by the project is appropriately stored, handled and disposed of; (c) manage on-site sewage treatment and disposal in accordance with the requirements of Council; and (d) report on waste management and minimisation in the Annual Review, to the satisfaction of the Secretary				
Auditor Opportunities for Improvement					
PA 09_0176 S3 C25	Figure Update		The Air Quality and Greenhouse Gas Management Plan should be revised to include the correct location of the meteorological station.	30 November 2021	Submitted to DPIE on 30 November 2021 for approval
PA 09_0176 S3 C31	Document control		It is recommended that the Water Management Plan cover page be updated with the status of the plan as "Approved" with the document effective date and review date also included.	30 August 2021	Complete
PA 09_0176 S3 C32	Biodiversity Offset Surveys		It is recommended a review of crown roads status in Offset Areas be undertaken and either close roads or seek modification to Project Approval. 09_0176. This non-compliance was reported in the 2020 Annual Review.	30 November 2021 (undertake review)	Review commenced. Due to high rainfall in Quarter 4 2021, access to offset areas has been difficult.
PA 09_0176 S3 C41	Document Control		It is recommended that the Mining Operation Plan (MOP) cover page be updated with the status of the plan as "Approved" and the latest Resource Regulator approval letter included as an Appendix. In addition, consultation as	30 August 2021	Complete. MOP approved 8 October 2021

Condition	Requirement	Comments and Evidence	Auditor Recommendation	Timing	Status
			undertaken with relevant departments to be included in an Appendix.		
PA 09_0176 S3 C42	Document Formatting		The Aboriginal and Cultural Management Plan has cross reference errors throughout the document that should be amended.	30 August 2021	Complete
PA 09_0176 S3 C51	Waste Management		Reinforce correct waste segregation methodology for workshop staff through scheduled training and pre-start meetings. Reduce load on systems by ensuring appropriate additional sewage facilities are available during periods where increased contractors are on site e.g., during maintenance shutdowns.	31 October 2021 Ongoing	Face to face quarterly training postponed due to COVID-19. To be implemented in 2022.
PA 09_0176 6.13.1	Energy Management System - Document review		Document schedule to be reviewed and updated where required.	31 October 2021	Complete
PA 09_0176 S3 C51	Water Management		It was noted that drains and sumps in external apron areas around the workshop, and in the vicinity of the wash down bays were full of accumulated sediment. It is recommended that these areas are regularly inspected and maintained to ensure that the capacity of these systems to capture and manage sediment is maintained. Further to this, the potential for diversion of "clean" water from these areas (such as stormwater from the workshop roof) should be considered to reduce the volume of water that requires management from these systems.	Ongoing 31 December 2021	Ongoing Complete

Table 10-1 – IEA Findings and Status of Actions

11. Environmental Incidents and Non-Compliances

All 2021 incidents, non-compliances and exceedances related to PA 09_0176, DA 104/96 and EPL 2652 are summarised in ***Table 11-1****Error! Reference source not found.*.

Date	Details/Location	Non-Compliance	Action/Response
Non-compliances			
Throughout the reporting period (refer to Appendix D for dates of exceedances).	Five exceedances of the PM_{10} short term criteria occurred in 2021 (refer to **Section 6.4.2.2**)	PA 09_0176	Incident reports were provided to the DPIE on each occasion.
Throughout the reporting period	Continuous PM_{10} data was not acquired.	EPL 2652	TEOMs were inspected and repaired when flooding subsided.
Incidents			
12 November 2021	Discharge of sediment laden water from the MIA Facilities Dam into Bayswater Creek between 3.30am and 5.30 am after significant rainfall. Water sampling was undertaken and the DPIE informed.	PA 09_0176	Ravensworth has committed to implementing remedial actions including – - Review of the Water Management Plan - Review of the catchment areas and sediment dam storage capacity at the site. - Desilting the sediment dam up catchment of the MIA Facilities Dam.

Table 11-1 – Incidents, Non-compliances and Exceedances

12. Activities Proposed in the Next Annual Review Period

12.1 ROC and RCHPP

Key activities proposed for 2022 at ROC / RCHPP include:

- Update of the NMP;
- Prepare Rehabilitation Management Plan;
- Continuation of mining operations at Ravensworth North;
- Undertake exploration activities;
- Continued support for key community projects;
- Continued participation in the CCC;
- Continue progressive rehabilitation of final landform profiles;
- Continuation of rehabilitation monitoring and maintenance;
- Infrastructure relocations within existing disturbance footprint; and
- Consultation with all relevant stakeholders.

12.2 RUM

Key activities proposed for 2022 at RUM include:

- Commence closure activities;
- Undertake underground dewatering activities;
- Undertake flaring and gas management;
- Prepare Rehabilitation Management Plan;
- Continued erosion and sediment control maintenance; and
- Continued spontaneous combustion monitoring.

13. Document Information

Relevant legislation, standards and other reference information must be regularly reviewed and monitored for updates and should be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

13.1 Related Documents

Related documents, listed in ***Table 13-1*** below, are *documents* directly related to or referenced from within this document.

Number	Title
RAVUG-27619932-35	Ravensworth Underground Mining Operations Plan – Care and Maintenance (1 January 2021 – 31 December 2022)
RAVCX-307024981-8541	Ravensworth Open Cut Mining Operations Plan (1 January 2021 – 31 December 2023)

Table 13-1 – Related documents

13.2 Reference Information

Reference information, listed in ***Table 13-2*** below, is *information* that is directly referred to for the development of this document.

Reference	Title
NSW Government (2015)	Post-approval requirements for State significant mining developments – Annual Review Guideline
AECOM (2022)	Annual report on stream flow events occurring in Emu, Davis and Bayswater Creeks for the period inclusive of 1 January to 31 December 2021 plus comments on stream stability in relation to the above creeks with the addition of Bowmans and Pikes Creeks
AGE (2022)	Ravensworth Operations – Review of Groundwater Model Predictions
Biodiversity Australia (2022)	Ravensworth Biodiversity Offset Area Monitoring 2021, Glencore - Ravensworth Coal Mine
Biosis (2022)	Ravensworth Open Cut Stream Health Monitoring Program: Autumn and Spring 2021.
Engeny Water Management (2022)	Ravensworth Complex 2021 Annual Review Surface Water and Groundwater Management and Monitoring Report
HCBRLM (2022a)	Glencore – Ravensworth Complex RCO 522 – Land Management Contract 1 January to 31 December 2021
HCBRLM (2022b)	Ravensworth Open Cut 1080 Wild Dog and Fox Baiting Program Report, Hillcrest, Stewart and Clifton – Autumn 2021

Reference	Title
HCBRLM (2022c)	Ravensworth Open Cut 1080 Wild Dog and Fox Baiting Program Report, Onsite Baiting Program – Autumn 2021
Koru Environmental (2020)	Cumnock Rehabilitation Remediation Plan
Koru Environmental (2022a)	Cumnock Rehabilitation Remediation, Progress Inspection Report 2021
Koru Environmental (2022b)	Rehabilitation Monitoring 2021, Ravensworth Operations
OzArk Environment and Heritage (2022)	2021 Archaeological Monitoring Report, Ravensworth Operations
RPS (2022)	2021 Independent Environmental Audit, Ravensworth Complex
Spectrum Acoustics (2021)	Attended Noise Monitoring (12 separate reports)

Table 13-2 – Reference information

Appendix A - Train Movements

2021 Ravensworth Complex Train Movement Records

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
1	1/01/2021	4:06:48 AM	9112.32
2	1/01/2021	5:06:48 AM	9125.32
3	1/01/2021	6:06:48 AM	8694.67
4	2/01/2021	7:06:48 AM	9089.76
5	2/01/2021	8:06:48 AM	9085.47
6	2/01/2021	9:06:48 AM	9507.28
7	2/01/2021	10:06:48 AM	8828.32
8	3/01/2021	11:06:48 AM	9105.45
9	3/01/2021	12:06:48 PM	9070.8
10	3/01/2021	1:06:48 PM	8638.28
11	3/01/2021	2:06:48 PM	0
12	4/01/2021	3:06:48 PM	9089.4
13	4/01/2021	4:06:48 PM	9014.35
14	4/01/2021	5:06:48 PM	9236.28
15	5/01/2021	6:06:48 PM	9054.48
16	5/01/2021	7:06:48 PM	9231.87
17	6/01/2021	8:06:48 PM	8741.2
18	6/01/2021	9:06:48 PM	8881.61
19	7/01/2021	10:06:48 PM	9035.14
20	7/01/2021	11:06:48 PM	9222
21	7/01/2021	12:06:48 AM	9194.96
22	7/01/2021	1:06:48 AM	8718.88
23	8/01/2021	2:06:48 AM	9132.67
24	8/01/2021	3:06:48 AM	8677.85
25	8/01/2021	4:06:48 AM	8710.99
26	8/01/2021	5:06:48 AM	8649.15
27	9/01/2021	6:06:48 AM	8961.28
28	9/01/2021	7:06:48 AM	8808.59
29	9/01/2021	8:06:48 AM	9133.32
30	9/01/2021	9:06:48 AM	9199.86
31	9/01/2021	10:06:48 AM	8985.25
32	10/01/2021	11:06:48 AM	8938.61
33	10/01/2021	12:06:48 PM	8728.92
34	10/01/2021	1:06:48 PM	8725.67
35	10/01/2021	2:06:48 PM	9020.35

2021 Ravensworth Complex Train Movement Records

36	11/01/2021	3:06:48 PM	8759.45
37	11/01/2021	4:06:48 PM	8989.87
38	11/01/2021	5:06:48 PM	8641.08
39	12/01/2021	6:06:48 PM	8392.1
40	12/01/2021	7:06:48 PM	9120.78
41	12/01/2021	8:06:48 PM	9237.2
42	12/01/2021	9:06:48 PM	8990.94
43	13/01/2021	10:06:48 PM	8524.28
44	13/01/2021	11:06:48 PM	8703.87
45	13/01/2021	12:06:48 AM	8685.39
46	13/01/2021	1:06:48 AM	8550.72
47	13/01/2021	2:06:48 AM	8635.8
48	14/01/2021	3:06:48 AM	9032.08
49	14/01/2021	4:06:48 AM	9135.91
50	14/01/2021	5:06:48 AM	9229.67
51	14/01/2021	6:06:48 AM	9194.06
52	14/01/2021	7:06:48 AM	8998.41
53	15/01/2021	8:06:48 AM	9167.28
54	15/01/2021	9:06:48 AM	8618.39
55	15/01/2021	10:06:48 AM	9158.89
56	15/01/2021	11:06:48 AM	9316.8
57	15/01/2021	12:06:48 PM	9341.04
58	16/01/2021	1:06:48 PM	9067.27
59	16/01/2021	2:06:48 PM	8542.4
60	16/01/2021	3:06:48 PM	8625.71
61	16/01/2021	4:06:48 PM	9342.14
62	16/01/2021	5:06:48 PM	9294.56
63	16/01/2021	6:06:48 PM	9459.16
64	17/01/2021	7:06:48 PM	9091.67
65	18/01/2021	8:06:48 PM	8547.6
66	17/01/2021	9:06:48 PM	8968.48
67	17/01/2021	10:06:48 PM	8692.87
68	17/01/2021	11:06:48 PM	9351.47
69	17/01/2021	12:06:48 AM	8465.3
70	17/01/2021	1:06:48 AM	8593.36
71	18/01/2021	2:06:48 AM	9309.6
72	18/01/2021	3:06:48 AM	8901.51
73	19/01/2021	4:06:48 AM	9122.24

2021 Ravensworth Complex Train Movement Records

74	19/01/2021	5:06:48 AM	9124.16
75	19/01/2021	6:06:48 AM	8785
76	19/01/2021	7:06:48 AM	9095.11
77	20/01/2021	8:06:48 AM	8671.9
78	20/01/2021	9:06:48 AM	9396.47
79	20/01/2021	10:06:48 AM	8617.77
80	20/01/2021	11:06:48 AM	8563.2
81	21/01/2021	12:06:48 PM	9176
82	21/01/2021	1:06:48 PM	9330.6
83	21/01/2021	2:06:48 PM	9019.44
84	21/01/2021	3:06:48 PM	9058.87
85	22/01/2021	4:06:48 PM	9586.31
86	22/01/2021	5:06:48 PM	9112.67
87	23/01/2021	6:06:48 PM	8704.6
88	23/01/2021	7:06:48 PM	8973.85
89	23/01/2021	8:06:48 PM	8866.72
90	23/01/2021	9:06:48 PM	8986.97
91	24/01/2021	10:06:48 PM	8662.76
92	24/01/2021	11:06:48 PM	9228.25
93	24/01/2021	12:06:48 AM	9264.87
94	24/01/2021	1:06:48 AM	8979.5
95	24/01/2021	2:06:48 AM	8579.4
96	25/01/2021	3:06:48 AM	9031.11
97	25/01/2021	4:06:48 AM	8821.19
98	26/01/2021	5:06:48 AM	8958.76
99	26/01/2021	6:06:48 AM	9259.32
100	26/01/2021	7:06:48 AM	8866.48
101	26/01/2021	8:06:48 AM	8761.51
102	27/01/2021	9:06:48 AM	8698
103	27/01/2021	10:06:48 AM	8892.57
104	27/01/2021	11:06:48 AM	8999.6
105	27/01/2021	12:06:48 PM	9037.87
106	28/01/2021	1:06:48 PM	8696.81
107	29/01/2021	2:06:48 PM	8428.7
108	29/01/2021	3:06:48 PM	9238.8
109	30/01/2021	4:06:48 PM	8910.32
110	30/01/2021	5:06:48 PM	8949.77
111	31/01/2021	6:06:48 PM	8938.59

2021 Ravensworth Complex Train Movement Records

112	31/01/2021	7:06:48 PM	8920.47
113	1/02/2021	8:06:48 PM	8689.4
114	1/02/2021	9:06:48 PM	9011
115	1/02/2021	10:06:48 PM	9223.94
116	1/02/2021	11:06:48 PM	8993.36
117	1/02/2021	12:06:48 AM	8831.62
118	2/02/2021	1:06:48 AM	8620
119	2/02/2021	2:06:48 AM	9286.81
120	2/02/2021	3:06:48 AM	8533.04
121	3/02/2021	4:06:48 AM	9229.04
122	3/02/2021	5:06:48 AM	8541.37
123	3/02/2021	6:06:48 AM	8965.21
124	3/02/2021	7:06:48 AM	9003.97
125	4/02/2021	8:06:48 AM	9367.8
126	4/02/2021	9:06:48 AM	8186.6
127	4/02/2021	10:06:48 AM	8905.54
128	4/02/2021	11:06:48 AM	8705.9
129	4/02/2021	12:06:48 PM	9054.16
130	5/02/2021	1:06:48 PM	8855.12
131	5/02/2021	2:06:48 PM	8679.42
132	5/02/2021	3:06:48 PM	8921.42
133	6/02/2021	4:06:48 PM	9186.02
134	6/02/2021	5:06:48 PM	8871.85
135	6/02/2021	6:06:48 PM	9402.02
136	7/02/2021	7:06:48 PM	9626.07
137	7/02/2021	8:06:48 PM	9390.04
138	8/02/2021	9:06:48 PM	8935.9
139	8/02/2021	10:06:48 PM	8898.65
140	8/02/2021	11:06:48 PM	8521.9
141	8/02/2021	12:06:48 AM	8794.76
142	8/02/2021	1:06:48 AM	8822.27
143	8/02/2021	2:06:48 AM	8746.16
144	12/02/2021	3:06:48 AM	7926.5
145	12/02/2021	4:06:48 AM	8856.2
146	12/02/2021	5:06:48 AM	8818.22
147	13/02/2021	6:06:48 AM	8608.47
148	13/02/2021	7:06:48 AM	9288.27
149	12/02/2021	8:06:48 AM	8698.4

2021 Ravensworth Complex Train Movement Records

150	14/02/2021	9:06:48 AM	9335.62
151	15/02/2021	10:06:48 AM	8825.41
152	15/02/2021	11:06:48 AM	8875.17
153	16/02/2021	12:06:48 PM	9091.27
154	16/02/2021	1:06:48 PM	9343.02
155	16/02/2021	2:06:48 PM	8820.22
156	17/02/2021	3:06:48 PM	8886.82
157	17/02/2021	4:06:48 PM	9210.02
158	17/02/2021	5:06:48 PM	8813.01
159	18/02/2021	6:06:48 PM	8790.67
160	18/02/2021	7:06:48 PM	8975.4
161	18/02/2021	8:06:48 PM	8694.22
162	19/02/2021	9:06:48 PM	9027.6
163	18/02/2021	10:06:48 PM	8737.87
164	19/02/2021	11:06:48 PM	8804.02
165	19/02/2021	12:06:48 AM	8962.08
166	19/02/2021	1:06:48 AM	8928.42
167	19/02/2021	2:06:48 AM	8925.02
168	20/02/2021	3:06:48 AM	8718.68
169	20/02/2021	4:06:48 AM	8736
170	20/02/2021	5:06:48 AM	8783.05
171	20/02/2021	6:06:48 AM	9360.45
172	20/02/2021	7:06:48 AM	9270.7
173	20/02/2021	8:06:48 AM	8782.7
174	21/02/2021	9:06:48 AM	9003.41
175	21/02/2021	10:06:48 AM	8746.44
176	21/02/2021	11:06:48 AM	8697.6
177	22/02/2021	12:06:48 PM	8949.2
178	22/02/2021	1:06:48 PM	8905.81
179	22/02/2021	2:06:48 PM	8937.61
180	23/02/2021	3:06:48 PM	9023.15
181	23/02/2021	4:06:48 PM	8898.62
182	24/02/2021	5:06:48 PM	9248.02
183	24/02/2021	6:06:48 PM	9004.82
184	24/02/2021	7:06:48 PM	8664.39
185	25/02/2021	8:06:48 PM	9070.77
186	25/02/2021	9:06:48 PM	9469.82
187	25/02/2021	10:06:48 PM	9391.83

2021 Ravensworth Complex Train Movement Records

188	26/02/2021	11:06:48 PM	8878.68
189	26/02/2021	12:06:48 AM	8909.07
190	27/02/2021	1:06:48 AM	8870.57
191	27/02/2021	2:06:48 AM	9356.84
192	27/02/2021	3:06:48 AM	8905.25
193	28/02/2021	4:06:48 AM	8468.8
194	28/02/2021	5:06:48 AM	8883.77
195	28/02/2021	6:06:48 AM	8739.88
196	1/03/2021	7:06:48 AM	8887.79
197	1/03/2021	8:06:48 AM	9196.28
198	1/03/2021	9:06:48 AM	9517.39
199	1/03/2021	10:06:48 AM	8852.68
200	2/03/2021	11:06:48 AM	8860.79
201	2/03/2021	12:06:48 PM	9367.96
202	2/03/2021	1:06:48 PM	8805.8
203	2/03/2021	2:06:48 PM	9175.04
204	2/03/2021	3:06:48 PM	8950.16
205	3/03/2021	4:06:48 PM	8921.36
206	3/03/2021	5:06:48 PM	8943.4
207	3/03/2021	6:06:48 PM	9528.56
208	3/03/2021	7:06:48 PM	9038.11
209	4/03/2021	8:06:48 PM	9381.22
210	5/03/2021	9:06:48 PM	9554.62
211	6/03/2021	10:06:48 PM	9272.95
212	6/03/2021	11:06:48 PM	9294.28
213	7/03/2021	12:06:48 AM	9255.76
214	9/03/2021	1:06:48 AM	8816.15
215	11/03/2021	2:06:48 AM	8485.76
216	13/03/2021	3:06:48 AM	8858.89
217	13/03/2021	4:06:48 AM	8975.83
218	13/03/2021	5:06:48 AM	9023.05
219	13/03/2021	6:06:48 AM	9436.42
220	13/03/2021	7:06:48 AM	0
221	14/03/2021	8:06:48 AM	9169.76
222	14/03/2021	9:06:48 AM	9152.82
223	14/03/2021	10:06:48 AM	9508.17
224	13/03/2021	11:06:48 AM	8316
225	15/03/2021	12:06:48 PM	0

2021 Ravensworth Complex Train Movement Records

226	15/03/2021	1:06:48 PM	9175.7
227	15/03/2021	2:06:48 PM	9025.95
228	15/03/2021	3:06:48 PM	9198.12
229	15/03/2021	4:06:48 PM	9001.73
230	15/03/2021	5:06:48 PM	8554.9
231	16/03/2021	6:06:48 PM	0
232	16/03/2021	7:06:48 PM	8995
233	16/03/2021	8:06:48 PM	9372.4
234	16/03/2021	9:06:48 PM	9193.5
235	17/03/2021	10:06:48 PM	9062.4
236	18/03/2021	11:06:48 PM	9100.32
237	18/03/2021	12:06:48 AM	9135.22
238	18/03/2021	1:06:48 AM	9313.56
239	24/03/2021	2:06:48 AM	9349.65
240	24/03/2021	3:06:48 AM	0
241	25/03/2021	4:06:48 AM	9269.31
242	25/03/2021	5:06:48 AM	8914.2
243	25/03/2021	6:06:48 AM	9483.85
244	25/03/2021	7:06:48 AM	9331.76
245	25/03/2021	8:06:48 AM	8983.02
246	26/03/2021	9:06:48 AM	8699.52
247	26/03/2021	10:06:48 AM	9022.56
248	26/03/2021	11:06:48 AM	8805.45
249	26/03/2021	12:06:48 PM	9218.63
250	27/03/2021	1:06:48 PM	9402.5
251	27/03/2021	2:06:48 PM	8927
252	27/03/2021	3:06:48 PM	8791.8
253	28/03/2021	4:06:48 PM	9188.42
254	28/03/2021	5:06:48 PM	9134.16
255	28/03/2021	6:06:48 PM	9197.43
256	28/03/2021	7:06:48 PM	8945.8
257	29/03/2021	8:06:48 PM	8863.03
258	29/03/2021	9:06:48 PM	8773
259	29/03/2021	10:06:48 PM	8776.67
260	29/03/2021	11:06:48 PM	9060.76
261	30/03/2021	12:06:48 AM	8961.02
262	30/03/2021	1:06:48 AM	8622.07
263	30/03/2021	2:06:48 AM	8825.79

2021 Ravensworth Complex Train Movement Records

264	30/03/2021	3:06:48 AM	8844.42
265	31/03/2021	4:06:48 AM	8856.05
266	30/03/2021	5:06:48 AM	9249
267	31/03/2021	6:06:48 AM	8983.62
268	31/03/2021	7:06:48 AM	8862.83
269	1/04/2021	8:06:48 AM	8615.42
270	1/04/2021	9:06:48 AM	9112.85
271	1/04/2021	10:06:48 AM	9440.55
272	2/04/2021	11:06:48 AM	8957.73
273	2/04/2021	12:06:48 PM	9376.97
274	2/04/2021	1:06:48 PM	9445.36
275	3/04/2021	2:06:48 PM	9034.05
276	3/04/2021	3:06:48 PM	8797.2
277	4/04/2021	4:06:48 PM	9355.8
278	4/04/2021	5:06:48 PM	9394.56
279	5/04/2021	6:06:48 PM	9248.6
280	5/04/2021	7:06:48 PM	9463.96
281	6/04/2021	8:06:48 PM	9269.42
282	7/04/2021	9:06:48 PM	8834.75
283	12/04/2021	10:06:48 PM	8741.43
284	11/04/2021	11:06:48 PM	9130.6
285	14/04/2021	12:06:48 AM	8519.4
286	15/04/2021	1:06:48 AM	9455.39
287	15/04/2021	2:06:48 AM	9104.64
288	15/04/2021	3:06:48 AM	9423.27
289	16/04/2021	4:06:48 AM	8587
290	16/04/2021	5:06:48 AM	8877.6
291	17/04/2021	6:06:48 AM	8976.85
292	17/04/2021	7:06:48 AM	9297.33
293	18/04/2021	8:06:48 AM	9341.45
294	18/04/2021	9:06:48 AM	8924.23
295	18/04/2021	10:06:48 AM	9281.96
296	19/04/2021	11:06:48 AM	8886.87
297	19/04/2021	12:06:48 PM	8670.96
298	19/04/2021	1:06:48 PM	9142.53
299	19/04/2021	2:06:48 PM	9360.2
300	22/04/2021	3:06:48 PM	8898.35
301	22/04/2021	4:06:48 PM	8895.43

2021 Ravensworth Complex Train Movement Records

302	22/04/2021	5:06:48 PM	8873.65
303	23/04/2021	6:06:48 PM	9253.85
304	23/04/2021	7:06:48 PM	9251.29
305	23/04/2021	8:06:48 PM	8867.43
306	23/04/2021	9:06:48 PM	9280.12
307	24/04/2021	10:06:48 PM	9308.03
308	24/04/2021	11:06:48 PM	8910.62
309	24/04/2021	12:06:48 AM	8843.2
310	24/04/2021	1:06:48 AM	9271.67
311	25/04/2021	2:06:48 AM	9098
312	23/04/2021	3:06:48 AM	8761.1
313	25/04/2021	4:06:48 AM	9528.77
314	25/04/2021	5:06:48 AM	9345.59
315	25/04/2021	6:06:48 AM	8865.43
316	25/04/2021	7:06:48 AM	9161.05
317	26/04/2021	8:06:48 AM	9225.8
318	26/04/2021	9:06:48 AM	9223.29
319	26/04/2021	10:06:48 AM	9150.26
320	29/04/2021	11:06:48 AM	9470.87
321	30/04/2021	12:06:48 PM	8956.41
322	30/04/2021	1:06:48 PM	9171.41
323	30/04/2021	2:06:48 PM	9098.6
324	30/04/2021	3:06:48 PM	8670.2
325	1/05/2021	4:06:48 PM	9157
326	1/05/2021	5:06:48 PM	9037.5
327	1/05/2021	6:06:48 PM	9243.89
328	1/05/2021	7:06:48 PM	9317.85
329	2/05/2021	8:06:48 PM	9298.45
330	2/05/2021	9:06:48 PM	9268
331	3/05/2021	10:06:48 PM	9189.57
332	3/05/2021	11:06:48 PM	9174.61
333	4/05/2021	12:06:48 AM	9283.2
334	4/05/2021	1:06:48 AM	9134.77
335	4/05/2021	2:06:48 AM	9306.05
336	4/05/2021	3:06:48 AM	9205.82
337	5/05/2021	4:06:48 AM	9302
338	4/05/2021	5:06:48 AM	9333
339	5/05/2021	6:06:48 AM	9382.45

2021 Ravensworth Complex Train Movement Records

340	5/05/2021	7:06:48 AM	9421.81
341	5/05/2021	8:06:48 AM	9497.29
342	5/05/2021	9:06:48 AM	9208.05
343	6/05/2021	10:06:48 AM	9364.29
344	6/05/2021	11:06:48 AM	9557.77
345	6/05/2021	12:06:48 PM	9527.86
346	6/05/2021	1:06:48 PM	9322.19
347	7/05/2021	2:06:48 PM	9478.76
348	7/05/2021	3:06:48 PM	8969.6
349	7/05/2021	4:06:48 PM	9211.07
350	7/05/2021	5:06:48 PM	9276.49
351	6/05/2021	6:06:48 PM	9281.4
352	7/05/2021	7:06:48 PM	9415.4
353	8/05/2021	8:06:48 PM	8874.41
354	8/05/2021	9:06:48 PM	9004.46
355	8/05/2021	10:06:48 PM	9419.36
356	8/05/2021	11:06:48 PM	9309.4
357	9/05/2021	12:06:48 AM	8876.56
358	9/05/2021	1:06:48 AM	9230.39
359	9/05/2021	2:06:48 AM	8945.65
360	9/05/2021	3:06:48 AM	9264.05
361	10/05/2021	4:06:48 AM	8940.16
362	8/05/2021	5:06:48 AM	8681.6
363	10/05/2021	6:06:48 AM	9181.2
364	10/05/2021	7:06:48 AM	9406.07
365	11/05/2021	8:06:48 AM	9032.3
366	11/05/2021	9:06:48 AM	9036.22
367	11/05/2021	10:06:48 AM	9272.22
368	11/05/2021	11:06:48 AM	9445.09
369	12/05/2021	12:06:48 PM	9137.6
370	12/05/2021	1:06:48 PM	9409.31
371	12/05/2021	2:06:48 PM	9499.37
372	12/05/2021	3:06:48 PM	9210.4
373	13/05/2021	4:06:48 PM	8911.95
374	13/05/2021	5:06:48 PM	8968.54
375	13/05/2021	6:06:48 PM	8887.56
376	14/05/2021	7:06:48 PM	8838.99
377	13/05/2021	8:06:48 PM	9351.6

2021 Ravensworth Complex Train Movement Records

378	14/05/2021	9:06:48 PM	9359.47
379	14/05/2021	10:06:48 PM	9420
380	15/05/2021	11:06:48 PM	9122.61
381	14/05/2021	12:06:48 AM	9211.2
382	14/05/2021	1:06:48 AM	9211.2
383	15/05/2021	2:06:48 AM	8682.8
384	15/05/2021	3:06:48 AM	8875.2
385	15/05/2021	4:06:48 AM	8868.59
386	15/05/2021	5:06:48 AM	8867.35
387	16/05/2021	6:06:48 AM	8896.27
388	16/05/2021	7:06:48 AM	9204.71
389	16/05/2021	8:06:48 AM	8888.95
390	16/05/2021	9:06:48 AM	9185.54
391	16/05/2021	10:06:48 AM	9244.71
392	16/05/2021	11:06:48 AM	8895.22
393	17/05/2021	12:06:48 PM	9073.67
394	17/05/2021	1:06:48 PM	9183.7
395	18/05/2021	2:06:48 PM	9118.8
396	17/05/2021	3:06:48 PM	9464.65
397	17/05/2021	4:06:48 PM	9259.86
398	17/05/2021	5:06:48 PM	9444.8
399	17/05/2021	6:06:48 PM	9473.47
400	18/05/2021	7:06:48 PM	9490.03
401	18/05/2021	8:06:48 PM	9512.42
402	18/05/2021	9:06:48 PM	9102.16
403	19/05/2021	10:06:48 PM	9488.86
404	19/05/2021	11:06:48 PM	9107.66
405	18/05/2021	12:06:48 AM	9377
406	19/05/2021	1:06:48 AM	9040.26
407	19/05/2021	2:06:48 AM	9275.8
408	31/05/2021	3:06:48 AM	8636.5
409	31/05/2021	4:06:48 AM	9160.08
410	1/06/2021	5:06:48 AM	8635.2
411	1/06/2021	6:06:48 AM	8690.4
412	2/06/2021	7:06:48 AM	9280.86
413	2/06/2021	8:06:48 AM	8604.2
414	2/06/2021	9:06:48 AM	8880
415	3/06/2021	10:06:48 AM	9056.74

2021 Ravensworth Complex Train Movement Records

416	3/06/2021	11:06:48 AM	9175.56
417	3/06/2021	12:06:48 PM	9583.96
418	4/06/2021	1:06:48 PM	9548.2
419	4/06/2021	2:06:48 PM	9465.25
420	5/06/2021	3:06:48 PM	9467.34
421	5/06/2021	4:06:48 PM	8953.81
422	7/06/2021	5:06:48 PM	9021.26
423	9/06/2021	6:06:48 PM	9463.83
424	10/06/2021	7:06:48 PM	9044.12
425	10/06/2021	8:06:48 PM	8971.16
426	10/06/2021	9:06:48 PM	9025.43
427	11/06/2021	10:06:48 PM	9618.81
428	11/06/2021	11:06:48 PM	9367.76
429	11/06/2021	12:06:48 AM	9354.56
430	12/06/2021	1:06:48 AM	9248.9
431	12/06/2021	2:06:48 AM	9096.36
432	12/06/2021	3:06:48 AM	9412.38
433	12/06/2021	4:06:48 AM	9472.15
434	12/06/2021	5:06:48 AM	9595.83
435	13/06/2021	6:06:48 AM	9515.95
436	13/06/2021	7:06:48 AM	9170.15
437	14/06/2021	8:06:48 AM	9114.4
438	15/06/2021	9:06:48 AM	9108.5
439	15/06/2021	10:06:48 AM	9223.9
440	15/06/2021	11:06:48 AM	9455.56
441	16/06/2021	12:06:48 PM	9020
442	16/06/2021	1:06:48 PM	9002.7
443	16/06/2021	2:06:48 PM	8960.8
444	17/06/2021	3:06:48 PM	9183.87
445	17/06/2021	4:06:48 PM	9306.03
446	17/06/2021	5:06:48 PM	9282.16
447	17/06/2021	6:06:48 PM	9327.75
448	17/06/2021	7:06:48 PM	9428.21
449	18/06/2021	8:06:48 PM	9383.23
450	18/06/2021	9:06:48 PM	9355.43
451	18/06/2021	10:06:48 PM	9346.85
452	18/06/2021	11:06:48 PM	9513.6
453	18/06/2021	12:06:48 AM	9363.83

2021 Ravensworth Complex Train Movement Records

454	19/06/2021	1:06:48 AM	8595.4
455	19/06/2021	2:06:48 AM	8726.8
456	19/06/2021	3:06:48 AM	9579.96
457	19/06/2021	4:06:48 AM	9108.72
458	19/06/2021	5:06:48 AM	9586.41
459	19/06/2021	6:06:48 AM	9448.16
460	20/06/2021	7:06:48 AM	9247.8
461	20/06/2021	8:06:48 AM	9318.65
462	20/06/2021	9:06:48 AM	8996.41
463	20/06/2021	10:06:48 AM	9446.2
464	21/06/2021	11:06:48 AM	9041.5
465	21/06/2021	12:06:48 PM	8957.43
466	21/06/2021	1:06:48 PM	8673.8
467	22/06/2021	2:06:48 PM	8771
468	22/06/2021	3:06:48 PM	8730.3
469	24/06/2021	4:06:48 PM	9282.61
470	24/06/2021	5:06:48 PM	9259.36
471	25/06/2021	6:06:48 PM	9271.21
472	26/06/2021	7:06:48 PM	9081.1
473	27/06/2021	8:06:48 PM	9669.32
474	28/06/2021	9:06:48 PM	9344.81
475	28/06/2021	10:06:48 PM	9582.75
476	28/06/2021	11:06:48 PM	9452.2
477	28/06/2021	12:06:48 AM	9254.4
478	29/06/2021	1:06:48 AM	9588.07
479	29/06/2021	2:06:48 AM	9237.23
480	29/06/2021	3:06:48 AM	9159.41
481	30/06/2021	4:06:48 AM	9546.95
482	30/06/2021	5:06:48 AM	9286.61
483	30/06/2021	6:06:48 AM	9258.21
484	30/06/2021	7:06:48 AM	9217.07
485	1/07/2021	8:06:48 AM	9280.52
486	1/07/2021	9:06:48 AM	9283.47
487	2/07/2021	10:06:48 AM	9663.27
488	2/07/2021	11:06:48 AM	9265.01
489	2/07/2021	12:06:48 PM	8790
490	2/07/2021	1:06:48 PM	9342.88
491	2/07/2021	2:06:48 PM	9527.6

2021 Ravensworth Complex Train Movement Records

492	2/07/2021	3:06:48 PM	9387.12
493	3/07/2021	4:06:48 PM	9293.35
494	3/07/2021	5:06:48 PM	8772.4
495	3/07/2021	6:06:48 PM	9798.76
496	3/07/2021	7:06:48 PM	9083.41
497	3/07/2021	8:06:48 PM	9080.35
498	5/07/2021	9:06:48 PM	9191
499	4/07/2021	10:06:48 PM	9257.4
500	4/07/2021	11:06:48 PM	9201.21
501	5/07/2021	12:06:48 AM	9023.67
502	6/07/2021	1:06:48 AM	8864
503	5/07/2021	2:06:48 AM	9006.75
504	5/07/2021	3:06:48 AM	9191.27
505	5/07/2021	4:06:48 AM	9285.46
506	5/07/2021	5:06:48 AM	9283.03
507	6/07/2021	6:06:48 AM	7900.45
508	6/07/2021	7:06:48 AM	8979.72
509	6/07/2021	8:06:48 AM	9011.23
510	6/07/2021	9:06:48 AM	8982.27
511	7/07/2021	10:06:48 AM	8502.8
512	7/07/2021	11:06:48 AM	9587.41
513	7/07/2021	12:06:48 PM	9092.21
514	7/07/2021	1:06:48 PM	9017.8
515	8/07/2021	2:06:48 PM	9322
516	8/07/2021	3:06:48 PM	9285.6
517	8/07/2021	4:06:48 PM	9076.86
518	8/07/2021	5:06:48 PM	9253.27
519	9/07/2021	6:06:48 PM	9060.53
520	9/07/2021	7:06:48 PM	9676.16
521	9/07/2021	8:06:48 PM	9257.21
522	10/07/2021	9:06:48 PM	8887.33
523	10/07/2021	10:06:48 PM	9386.83
524	12/07/2021	11:06:48 PM	8979.56
525	13/07/2021	12:06:48 AM	9413.2
526	14/07/2021	1:06:48 AM	9442.56
527	14/07/2021	2:06:48 AM	9352.74
528	14/07/2021	3:06:48 AM	9374.27
529	15/07/2021	4:06:48 AM	9361.35

2021 Ravensworth Complex Train Movement Records

530	15/07/2021	5:06:48 AM	9406.87
531	15/07/2021	6:06:48 AM	9372.76
532	16/07/2021	7:06:48 AM	9009
533	16/07/2021	8:06:48 AM	8873.1
534	15/07/2021	9:06:48 AM	8874.6
535	16/07/2021	10:06:48 AM	9364.67
536	16/07/2021	11:06:48 AM	9031.52
537	16/07/2021	12:06:48 PM	8990.27
538	16/07/2021	1:06:48 PM	9320.2
539	17/07/2021	2:06:48 PM	8499.4
540	17/07/2021	3:06:48 PM	8441.8
541	18/07/2021	4:06:48 PM	9199.75
542	18/07/2021	5:06:48 PM	9453.67
543	18/07/2021	6:06:48 PM	9122.4
544	19/07/2021	7:06:48 PM	9448.8
545	19/07/2021	8:06:48 PM	9797.52
546	19/07/2021	9:06:48 PM	9156.01
547	20/07/2021	10:06:48 PM	9283.51
548	20/07/2021	11:06:48 PM	9133.6
549	22/07/2021	12:06:48 AM	8830.4
550	21/07/2021	1:06:48 AM	9469.6
551	21/07/2021	2:06:48 AM	9488.02
552	22/07/2021	3:06:48 AM	9158.4
553	22/07/2021	4:06:48 AM	9508.87
554	22/07/2021	5:06:48 AM	9053.43
555	22/07/2021	6:06:48 AM	9366
556	23/07/2021	7:06:48 AM	9213.12
557	24/07/2021	8:06:48 AM	9762.67
558	24/07/2021	9:06:48 AM	9367.07
559	25/07/2021	10:06:48 AM	9245.75
560	25/07/2021	11:06:48 AM	9224.51
561	25/07/2021	12:06:48 PM	8809.6
562	25/07/2021	1:06:48 PM	9384.82
563	26/07/2021	2:06:48 PM	9268
564	26/07/2021	3:06:48 PM	9466.92
565	26/07/2021	4:06:48 PM	9547.42
566	26/07/2021	5:06:48 PM	9394.07
567	27/07/2021	6:06:48 PM	9422.43

2021 Ravensworth Complex Train Movement Records

568	27/07/2021	7:06:48 PM	8926.27
569	27/07/2021	8:06:48 PM	9204.02
570	27/07/2021	9:06:48 PM	9102.2
571	27/07/2021	10:06:48 PM	8788.8
572	28/07/2021	11:06:48 PM	9372.07
573	29/07/2021	12:06:48 AM	9516.82
574	30/07/2021	1:06:48 AM	9564.07
575	31/07/2021	2:06:48 AM	9065.6
576	2/08/2021	3:06:48 AM	8942.95
577	3/08/2021	4:06:48 AM	9383.47
578	3/08/2021	5:06:48 AM	9276.26
579	3/08/2021	6:06:48 AM	8985.62
580	4/08/2021	7:06:48 AM	8934.02
581	4/08/2021	8:06:48 AM	8958.02
582	4/08/2021	9:06:48 AM	8751.8
583	5/08/2021	10:06:48 AM	8927.46
584	5/08/2021	11:06:48 AM	8939.4
585	5/08/2021	12:06:48 PM	9319.2
586	6/08/2021	1:06:48 PM	9092.6
587	6/08/2021	2:06:48 PM	9012.02
588	6/08/2021	3:06:48 PM	8789.6
589	7/08/2021	4:06:48 PM	8931.15
590	7/08/2021	5:06:48 PM	9603.62
591	7/08/2021	6:06:48 PM	9201.07
592	9/08/2021	7:06:48 PM	9317.4
593	8/08/2021	8:06:48 PM	9049.61
594	8/08/2021	9:06:48 PM	8980.35
595	9/08/2021	10:06:48 PM	8999.47
596	9/08/2021	11:06:48 PM	9463.07
597	9/08/2021	12:06:48 AM	9089.22
598	9/08/2021	1:06:48 AM	9293.47
599	9/08/2021	2:06:48 AM	9415
600	12/08/2021	3:06:48 AM	8752.27
601	13/08/2021	4:06:48 AM	8484.1
602	13/08/2021	5:06:48 AM	8754.47
603	13/08/2021	6:06:48 AM	8743.94
604	13/08/2021	7:06:48 AM	8409.9
605	13/08/2021	8:06:48 AM	9148.81

2021 Ravensworth Complex Train Movement Records

606	14/08/2021	9:06:48 AM	8880.47
607	15/08/2021	10:06:48 AM	8696.87
608	17/08/2021	11:06:48 AM	8769.57
609	18/08/2021	12:06:48 PM	8813
610	17/08/2021	1:06:48 PM	9259
611	19/08/2021	2:06:48 PM	8730.8
612	19/08/2021	3:06:48 PM	8936.47
613	20/08/2021	4:06:48 PM	8362.4
614	20/08/2021	5:06:48 PM	9062.07
615	20/08/2021	6:06:48 PM	9064.55
616	20/08/2021	7:06:48 PM	9266.74
617	20/08/2021	8:06:48 PM	9150.2
618	21/08/2021	9:06:48 PM	8901
619	21/08/2021	10:06:48 PM	9388.75
620	21/08/2021	11:06:48 PM	9447.2
621	22/08/2021	12:06:48 AM	9505.3
622	23/08/2021	1:06:48 AM	9202.6
623	22/08/2021	2:06:48 AM	9771.94
624	22/08/2021	3:06:48 AM	9358.95
625	22/08/2021	4:06:48 AM	9575.54
626	23/08/2021	5:06:48 AM	9009.12
627	23/08/2021	6:06:48 AM	8530.8
628	23/08/2021	7:06:48 AM	9603.41
629	24/08/2021	8:06:48 AM	9165.4
630	24/08/2021	9:06:48 AM	9559.56
631	24/08/2021	10:06:48 AM	9416.2
632	25/08/2021	11:06:48 AM	9085.04
633	25/08/2021	12:06:48 PM	8851.7
634	26/08/2021	1:06:48 PM	9195.47
635	25/08/2021	2:06:48 PM	9141.2
636	27/08/2021	3:06:48 PM	9165
637	27/08/2021	4:06:48 PM	9542.87
638	27/08/2021	5:06:48 PM	8963.78
639	28/08/2021	6:06:48 PM	8947.51
640	28/08/2021	7:06:48 PM	8881.47
641	28/08/2021	8:06:48 PM	8877.5
642	29/08/2021	9:06:48 PM	9121.7
643	29/08/2021	10:06:48 PM	9375.8

2021 Ravensworth Complex Train Movement Records

644	29/08/2021	11:06:48 PM	9197.87
645	29/08/2021	12:06:48 AM	8912.79
646	30/08/2021	1:06:48 AM	8908.87
647	30/08/2021	2:06:48 AM	9441.19
648	30/08/2021	3:06:48 AM	8967.81
649	31/08/2021	4:06:48 AM	9676.38
650	31/08/2021	5:06:48 AM	9602.36
651	31/08/2021	6:06:48 AM	9448.95
652	1/09/2021	7:06:48 AM	9610.14
653	1/09/2021	8:06:48 AM	9304.36
654	1/09/2021	9:06:48 AM	9298.2
655	2/09/2021	10:06:48 AM	8661.8
656	2/09/2021	11:06:48 AM	8547
657	2/09/2021	12:06:48 PM	9330.92
658	2/09/2021	1:06:48 PM	9365.64
659	2/09/2021	2:06:48 PM	9045.96
660	3/09/2021	3:06:48 PM	8865.19
661	3/09/2021	4:06:48 PM	8882.59
662	4/09/2021	5:06:48 PM	9086.5
663	4/09/2021	6:06:48 PM	9322.96
664	4/09/2021	7:06:48 PM	8911.45
665	4/09/2021	8:06:48 PM	9664.67
666	5/09/2021	9:06:48 PM	9455.26
667	4/09/2021	10:06:48 PM	9349.58
668	5/09/2021	11:06:48 PM	9444.19
669	5/09/2021	12:06:48 AM	9167.4
670	5/09/2021	1:06:48 AM	9052.39
671	5/09/2021	2:06:48 AM	9397.93
672	5/09/2021	3:06:48 AM	9400.59
673	6/09/2021	4:06:48 AM	9164.6
674	6/09/2021	5:06:48 AM	8675.6
675	6/09/2021	6:06:48 AM	9555.96
676	7/09/2021	7:06:48 AM	8671.79
677	8/09/2021	8:06:48 AM	9316.5
678	7/09/2021	9:06:48 AM	8864.1
679	9/09/2021	10:06:48 AM	8801.64
680	9/09/2021	11:06:48 AM	9263.91
681	9/09/2021	12:06:48 PM	8985.07

2021 Ravensworth Complex Train Movement Records

682	10/09/2021	1:06:48 PM	9184.32
683	10/09/2021	2:06:48 PM	8884.51
684	11/09/2021	3:06:48 PM	9022.03
685	11/09/2021	4:06:48 PM	9159.2
686	11/09/2021	5:06:48 PM	9821.51
687	11/09/2021	6:06:48 PM	9543.79
688	12/09/2021	7:06:48 PM	9188.5
689	12/09/2021	8:06:48 PM	9350.96
690	12/09/2021	9:06:48 PM	9160.22
691	13/09/2021	10:06:48 PM	9255.46
692	13/09/2021	11:06:48 PM	9322.78
693	14/09/2021	12:06:48 AM	9618.39
694	14/09/2021	1:06:48 AM	9273.15
695	14/09/2021	2:06:48 AM	8968.59
696	15/09/2021	3:06:48 AM	9301.11
697	15/09/2021	4:06:48 AM	8992.07
698	15/09/2021	5:06:48 AM	9416.59
699	15/09/2021	6:06:48 AM	9428.76
700	16/09/2021	7:06:48 AM	9730.67
701	16/09/2021	8:06:48 AM	9671.06
702	16/09/2021	9:06:48 AM	9306.7
703	18/09/2021	10:06:48 AM	9099.5
704	18/09/2021	11:06:48 AM	9219.2
705	18/09/2021	12:06:48 PM	9129
706	18/09/2021	1:06:48 PM	9309.15
707	19/09/2021	2:06:48 PM	9217.6
708	19/09/2021	3:06:48 PM	8950.35
709	19/09/2021	4:06:48 PM	9161.79
710	19/09/2021	5:06:48 PM	9255.85
711	20/09/2021	6:06:48 PM	9562.62
712	20/09/2021	7:06:48 PM	8686.86
713	20/09/2021	8:06:48 PM	8783.7
714	20/09/2021	9:06:48 PM	9495.7
715	20/09/2021	10:06:48 PM	9323.4
716	21/09/2021	11:06:48 PM	9191.8
717	21/09/2021	12:06:48 AM	9085.45
718	21/09/2021	1:06:48 AM	9415.59
719	22/09/2021	2:06:48 AM	9031.6

2021 Ravensworth Complex Train Movement Records

720	21/09/2021	3:06:48 AM	9164.16
721	21/09/2021	4:06:48 AM	9164.16
722	22/09/2021	5:06:48 AM	8979.27
723	22/09/2021	6:06:48 AM	8686.86
724	23/09/2021	7:06:48 AM	9063.06
725	23/09/2021	8:06:48 AM	9123.98
726	24/09/2021	9:06:48 AM	8964.79
727	24/09/2021	10:06:48 AM	8948.78
728	24/09/2021	11:06:48 AM	9127.19
729	25/09/2021	12:06:48 PM	9099.3
730	25/09/2021	1:06:48 PM	9112.9
731	25/09/2021	2:06:48 PM	9107.35
732	25/09/2021	3:06:48 PM	9295.82
733	26/09/2021	4:06:48 PM	9141.78
734	26/09/2021	5:06:48 PM	9165.27
735	27/09/2021	6:06:48 PM	9078.39
736	27/09/2021	7:06:48 PM	9494
737	27/09/2021	8:06:48 PM	9161.8
738	28/09/2021	9:06:48 PM	9331.4
739	28/09/2021	10:06:48 PM	9084.27
740	29/09/2021	11:06:48 PM	9154.1
741	29/09/2021	12:06:48 AM	9330.17
742	29/09/2021	1:06:48 AM	9141.66
743	30/09/2021	2:06:48 AM	9400.8
744	30/09/2021	3:06:48 AM	9064.55
745	1/10/2021	4:06:48 AM	9073.2
746	30/09/2021	5:06:48 AM	9048.1
747	1/10/2021	6:06:48 AM	9695.88
748	2/10/2021	7:06:48 AM	9640.98
749	2/10/2021	8:06:48 AM	9136.22
750	2/10/2021	9:06:48 AM	9280.39
751	3/10/2021	10:06:48 AM	9483.82
752	3/10/2021	11:06:48 AM	9466.71
753	3/10/2021	12:06:48 PM	9215.42
754	3/10/2021	1:06:48 PM	9217.7
755	6/10/2021	2:06:48 PM	9428.89
756	3/10/2021	3:06:48 PM	9470.66
757	7/10/2021	4:06:48 PM	9261.12

2021 Ravensworth Complex Train Movement Records

758	9/10/2021	5:06:48 PM	0
759	9/10/2021	6:06:48 PM	9387.09
760	9/10/2021	7:06:48 PM	9025.9
761	10/10/2021	8:06:48 PM	9195.4
762	12/10/2021	9:06:48 PM	9265.47
763	14/10/2021	10:06:48 PM	9614.23
764	14/10/2021	11:06:48 PM	9517.29
765	14/10/2021	12:06:48 AM	9571.88
766	15/10/2021	1:06:48 AM	9140.37
767	15/10/2021	2:06:48 AM	9409.48
768	15/10/2021	3:06:48 AM	9446.35
769	16/10/2021	4:06:48 AM	9013.95
770	16/10/2021	5:06:48 AM	9237.5
771	16/10/2021	6:06:48 AM	9473.1
772	17/10/2021	7:06:48 AM	9350.7
773	17/10/2021	8:06:48 AM	9065.95
774	17/10/2021	9:06:48 AM	9456.58
775	17/10/2021	10:06:48 AM	9134.76
776	17/10/2021	11:06:48 AM	9382.6
777	17/10/2021	12:06:48 PM	9485.89
778	18/10/2021	1:06:48 PM	9090.06
779	18/10/2021	2:06:48 PM	8644.2
780	18/10/2021	3:06:48 PM	9088.69
781	18/10/2021	4:06:48 PM	9450.34
782	19/10/2021	5:06:48 PM	9484.07
783	19/10/2021	6:06:48 PM	8999.79
784	19/10/2021	7:06:48 PM	9388.48
785	19/10/2021	8:06:48 PM	9218.9
786	20/10/2021	9:06:48 PM	9391.28
787	20/10/2021	10:06:48 PM	8755.4
788	20/10/2021	11:06:48 PM	9226.56
789	20/10/2021	12:06:48 AM	9524.47
790	21/10/2021	1:06:48 AM	9123.68
791	21/10/2021	2:06:48 AM	9352.49
792	21/10/2021	3:06:48 AM	9377.5
793	21/10/2021	4:06:48 AM	9456.29
794	21/10/2021	5:06:48 AM	9396.2
795	22/10/2021	6:06:48 AM	9245.2

2021 Ravensworth Complex Train Movement Records

796	22/10/2021	7:06:48 AM	9483.94
797	23/10/2021	8:06:48 AM	9428.14
798	24/10/2021	9:06:48 AM	8579
799	24/10/2021	10:06:48 AM	9114.5
800	25/10/2021	11:06:48 AM	9381
801	25/10/2021	12:06:48 PM	8913.55
802	25/10/2021	1:06:48 PM	9440.34
803	25/10/2021	2:06:48 PM	8963.9
804	26/10/2021	3:06:48 PM	9118.47
805	26/10/2021	4:06:48 PM	9150.2
806	26/10/2021	5:06:48 PM	8950.58
807	26/10/2021	6:06:48 PM	9364.7
808	27/10/2021	7:06:48 PM	9169.43
809	26/10/2021	8:06:48 PM	9300
810	27/10/2021	9:06:48 PM	9193.7
811	27/10/2021	10:06:48 PM	9397.08
812	28/10/2021	11:06:48 PM	9454.3
813	28/10/2021	12:06:48 AM	9609.85
814	28/10/2021	1:06:48 AM	9037.19
815	28/10/2021	2:06:48 AM	9276.17
816	29/10/2021	3:06:48 AM	9497.11
817	29/10/2021	4:06:48 AM	9222.9
818	30/10/2021	5:06:48 AM	9484
819	30/10/2021	6:06:48 AM	9507.81
820	1/11/2021	7:06:48 AM	9183.4
821	2/11/2021	8:06:48 AM	9501.74
822	3/11/2021	9:06:48 AM	9483.68
823	4/11/2021	10:06:48 AM	9308.64
824	4/11/2021	11:06:48 AM	9543.48
825	4/11/2021	12:06:48 PM	9411.04
826	5/11/2021	1:06:48 PM	9403.1
827	5/11/2021	2:06:48 PM	9432.6
828	5/11/2021	3:06:48 PM	9295.83
829	5/11/2021	4:06:48 PM	9411.9
830	6/11/2021	5:06:48 PM	9356.57
831	7/11/2021	6:06:48 PM	9296.17
832	7/11/2021	7:06:48 PM	9133.43
833	7/11/2021	8:06:48 PM	9295.78

2021 Ravensworth Complex Train Movement Records

834	6/11/2021	9:06:48 PM	9323.8
835	8/11/2021	10:06:48 PM	8967.8
836	8/11/2021	11:06:48 PM	8966.4
837	9/11/2021	12:06:48 AM	9248.57
838	10/11/2021	1:06:48 AM	9376.87
839	11/11/2021	2:06:48 AM	9508.57
840	11/11/2021	3:06:48 AM	9693.37
841	12/11/2021	4:06:48 AM	9425.8
842	13/11/2021	5:06:48 AM	9395.14
843	13/11/2021	6:06:48 AM	9372.04
844	14/11/2021	7:06:48 AM	9471.01
845	14/11/2021	8:06:48 AM	9540.8
846	15/11/2021	9:06:48 AM	9468.4
847	15/11/2021	10:06:48 AM	9421.96
848	15/11/2021	11:06:48 AM	9372.7
849	15/11/2021	12:06:48 PM	9568.9
850	17/11/2021	1:06:48 PM	9440.9
851	17/11/2021	2:06:48 PM	9622.19
852	18/11/2021	3:06:48 PM	9723.98
853	18/11/2021	4:06:48 PM	8757.4
854	19/11/2021	5:06:48 PM	9731.87
855	20/11/2021	6:06:48 PM	9266.31
856	20/11/2021	7:06:48 PM	9458.24
857	20/11/2021	8:06:48 PM	9131.5
858	21/11/2021	9:06:48 PM	9126.08
859	21/11/2021	10:06:48 PM	9717.37
860	20/11/2021	11:06:48 PM	8754.2
861	21/11/2021	12:06:48 AM	9325.96
862	21/11/2021	1:06:48 AM	9460
863	21/11/2021	2:06:48 AM	9833.71
864	22/11/2021	3:06:48 AM	9630.56
865	25/11/2021	4:06:48 AM	9370.24
866	25/11/2021	5:06:48 AM	9686.36
867	26/11/2021	6:06:48 AM	9593.57
868	26/11/2021	7:06:48 AM	9505.67
869	25/11/2021	8:06:48 AM	9636
870	26/11/2021	9:06:48 AM	9492.22
871	26/11/2021	10:06:48 AM	9610.37

2021 Ravensworth Complex Train Movement Records

872	26/11/2021	11:06:48 AM	9521.7
873	26/11/2021	12:06:48 PM	9389.4
874	27/11/2021	1:06:48 PM	9370.68
875	28/11/2021	2:06:48 PM	9434.24
876	28/11/2021	3:06:48 PM	9436.38
877	28/11/2021	4:06:48 PM	9265.84
878	28/11/2021	5:06:48 PM	9203.28
879	28/11/2021	6:06:48 PM	7286.29
880	29/11/2021	7:06:48 PM	9328.5
881	29/11/2021	8:06:48 PM	9419.57
882	30/11/2021	9:06:48 PM	9244.4
883	30/11/2021	10:06:48 PM	9290.47
884	30/11/2021	11:06:48 PM	8982.88
885	1/12/2021	12:06:48 AM	8712
886	1/12/2021	1:06:48 AM	9457.23
887	1/12/2021	2:06:48 AM	9414.14
888	1/12/2021	3:06:48 AM	9313.08
889	1/12/2021	4:06:48 AM	9513.74
890	2/12/2021	5:06:48 AM	9324.28
891	2/12/2021	6:06:48 AM	9337.2
892	2/12/2021	7:06:48 AM	9358.48
893	3/12/2021	8:06:48 AM	9295.6
894	3/12/2021	9:06:48 AM	9214.45
895	3/12/2021	10:06:48 AM	9309.44
896	3/12/2021	11:06:48 AM	9361.42
897	4/12/2021	12:06:48 PM	9469.3
898	5/12/2021	1:06:48 PM	8696.8
899	6/12/2021	2:06:48 PM	9245.28
900	8/12/2021	3:06:48 PM	9237.8
901	7/12/2021	4:06:48 PM	9145
902	9/12/2021	5:06:48 PM	9463.37
903	10/12/2021	6:06:48 PM	9313.3
904	10/12/2021	7:06:48 PM	9296.37
905	10/12/2021	8:06:48 PM	9317.57
906	11/12/2021	9:06:48 PM	9409.91
907	11/12/2021	10:06:48 PM	9345.01
908	11/12/2021	11:06:48 PM	9432.76
909	12/12/2021	12:06:48 AM	9235.57

2021 Ravensworth Complex Train Movement Records

910	11/12/2021	1:06:48 AM	9227.2
911	12/12/2021	2:06:48 AM	9196.78
912	12/12/2021	3:06:48 AM	9415.74
913	12/12/2021	4:06:48 AM	9350.76
914	12/12/2021	5:06:48 AM	9364.77
915	13/12/2021	6:06:48 AM	9311.76
916	13/12/2021	7:06:48 AM	9393.88
917	13/12/2021	8:06:48 AM	9189.14
918	13/12/2021	9:06:48 AM	9322.04
919	13/12/2021	10:06:48 AM	9258
920	14/12/2021	11:06:48 AM	9363.2
921	14/12/2021	12:06:48 PM	9376.84
922	14/12/2021	1:06:48 PM	9414.57
923	14/12/2021	2:06:48 PM	9404.45
924	15/12/2021	3:06:48 PM	9435.72
925	15/12/2021	4:06:48 PM	9188.14
926	15/12/2021	5:06:48 PM	9454.3
927	16/12/2021	6:06:48 PM	9377.8
928	16/12/2021	7:06:48 PM	9157.08
929	16/12/2021	8:06:48 PM	9625.05
930	16/12/2021	9:06:48 PM	9303.68
931	17/12/2021	10:06:48 PM	9330.64
932	17/12/2021	11:06:48 PM	9337.82
933	17/12/2021	12:06:48 AM	9401.2
934	18/12/2021	1:06:48 AM	9333.32
935	18/12/2021	2:06:48 AM	9120.28
936	18/12/2021	3:06:48 AM	9384.16
937	19/12/2021	4:06:48 AM	9417.97
938	19/12/2021	5:06:48 AM	9435.82
939	19/12/2021	6:06:48 AM	9563.84
940	19/12/2021	7:06:48 AM	9376.28
941	19/12/2021	8:06:48 AM	9244.77
942	20/12/2021	9:06:48 AM	9140.85
943	20/12/2021	10:06:48 AM	9428.64
944	20/12/2021	11:06:48 AM	9340.5
945	21/12/2021	12:06:48 PM	9306.66
946	21/12/2021	1:06:48 PM	9453.82
947	22/12/2021	2:06:48 PM	9473

2021 Ravensworth Complex Train Movement Records

948	22/12/2021	3:06:48 PM	9578.74
949	22/12/2021	4:06:48 PM	9533.1
950	22/12/2021	5:06:48 PM	9552.8
951	23/12/2021	6:06:48 PM	9445.3
952	23/12/2021	7:06:48 PM	9481.88
953	23/12/2021	8:06:48 PM	9482.74
954	23/12/2021	9:06:48 PM	9416
955	24/12/2021	10:06:48 PM	9349.44
956	26/12/2021	11:06:48 PM	9513.48
957	27/12/2021	12:06:48 AM	8917.56
958	27/12/2021	1:06:48 AM	9373.6
959	27/12/2021	2:06:48 AM	9569.6
960	28/12/2021	3:06:48 AM	8820.63
961	28/12/2021	4:06:48 AM	9364.42
962	28/12/2021	5:06:48 AM	9581.52
963	28/12/2021	6:06:48 AM	9547.77
964	29/12/2021	7:06:48 AM	8902.84
965	29/12/2021	8:06:48 AM	8806.07
966	29/12/2021	9:06:48 AM	9371.28
967	29/12/2021	10:06:48 AM	9455.06
968	30/12/2021	11:06:48 AM	9655.93
969	30/12/2021	12:06:48 PM	7544.9

Appendix B - Noise Monitoring Results (Spectrum Acoustics 2021)

27 January 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.36pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.32pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.53pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.12pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

8 February 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.43pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.32pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.51pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.11pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	9.04pm	<20	-	-	35	Yes	<20	45	Yes	<20	-	-

15 March 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.01pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	9.47pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.10pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10.28pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

12 April 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.23pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.22pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.43pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.07pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

18 May 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.22pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.11pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.32pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10.51pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	11.36pm	<20	-	-	35	Yes	<20	45	Yes	<20	-	-

19 July 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.18pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.08pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.29pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10.48pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

11 August 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.36pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.16pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.37pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.04pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	11.36pm	<20	-	-	35	Yes-	<20	45	Yes	<20	-	-

15 September 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.36pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.16pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.37pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.04pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

8 October 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9.02pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	9.49pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10.09pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10.34pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

25 and 26 November 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	11.05pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	11.54pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	12.14am	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.21pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	10.33pm	<20	-	-	35	Yes	<20	45	Yes	<20	-	-

15 December 2021

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	10.05pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10.57pm	<20	<30-34	Yes	5	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	11.24pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11.44pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

Appendix C - Blast Monitoring Results

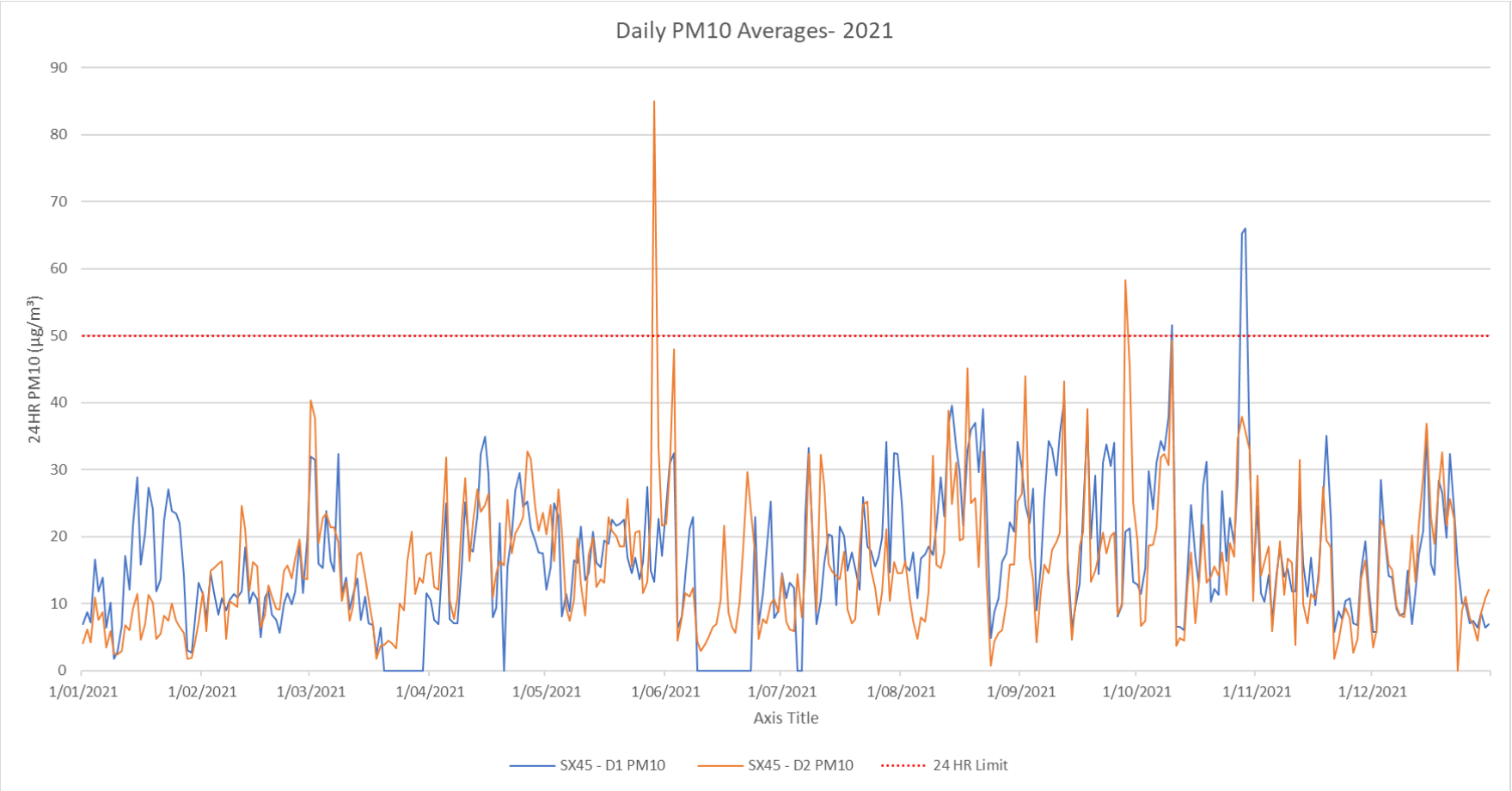
Annual Blast Overpressure Monitoring Results

	Bowmans	Camberwell Village	Camberwell Church	Chain of Ponds Hotel	REA 86 Grinding Grooves	Ravensworth Public School	Ravensworth Homestead
Limit	120	120	120	133	N/A	133	126
Limit 5% up to 120 dBL	115	115	115	N/A	N/A	N/A	N/A
EA Prediction	115	115	N/A	N/A	N/A	N/A	115
Min	69.7	77.7	77.9	84.9	N/A	83.3	82.7
Mean	93.2	92.1	95.4	97.3	N/A	98.3	98.2
Max	114.7	114.5	113.1	114.7	N/A	117.2	114.5
Blast Events Exceeding 120 dBL	0	0	0	N/A	N/A	N/A	N/A
Blast Events Exceeding 115dBL	0	0	0	N/A	N/A	N/A	N/A
% > 115 dBL up to 120 dBL	0	0	0	N/A	N/A	N/A	N/A

Annual Vibration Monitoring Results

	Bowmans	Camberwell Village	Camberwell Church	Chain of Ponds Hotel	REA 86 Grinding Grooves	Ravensworth Public School	Ravensworth Homestead
Limit	10	10	10	10	175	10	10
Limit 5% up to 10mm/s	5	5	5	N/A	N/A	N/A	N/A
EA Prediction	5	5	5	N/A	N/A	N/A	N/A
Min	0	0.01	0.01	0.08	0	0.02	0
Mean	0.12	0.09	0.07	0.25	0.49	0.27	0.09
Max	0.97	0.54	0.75	0.82	3.24	1.34	0.58
Blast events exceeding 10mm/s	0	0	0	0	N/A	0	0
Blast events exceeding 5mm/s	0	0	0	N/A	N/A	N/A	N/A
%> 5mm/s up to 10mm/s	0	0	0	N/A	N/A	N/A	N/A

Appendix D - Air Quality Monitoring Results



PM_{10} 24 hr Exceedances above 50 µg/m^3 during 2021

Date	TEOM Unit	Result (µg/m^3)
29/05/2021	SX45-D2	85.0
28/09/2021	SX45-D2	58.3
10/10/2021	SX45-D1	51.6
28/10/2021	SX45-D1	65.2
29/10/2021	SX45-D1	66.0

Appendix E - Biodiversity Offset Area Compliance

OAMP Reference	Objective	Target Criteria to be Achieved	2021 Monitoring Results	Corrective Actions
Table 6.4	Augment existing vegetation communities in areas zoned natural regeneration.	Evidence of natural regeneration (tree seedlings), decrease in target weeds or target weeds <10% (see weed management plan), no evidence that feral animals are significantly affecting regeneration (visual assessment).	Regeneration recorded across all BOAs. Richness and density of target weed species largely unchanged across BOAs. Several target weed species recorded at both grassland and woodland sites in these BOAs. Some impacts to vegetation from feral animals observed, particularly rabbits, hares and grazing cattle.	Additional assisted regeneration in open grassland areas. Continue to implement management actions outlined in OAMP. Undertake brush-matting (where resources permit) in grassland areas (as per Recommendations). Continue feral animal management within all BOAs.
	Re-establish regionally significant vegetation communities consistent with remnant vegetation in areas zoned assisted regeneration and remediation.	Assisted regeneration and remediation areas within the Offset Areas contain flora species assemblage characteristic of the vegetation communities that are being created.	Data was collected from established monitoring sites to allow for timeline comparisons. Differences in floristics between woodland and grassland sites remain.	Focus assisted regeneration efforts in grassland areas. Continue to undertake scheduled planting works. Undertake brush-matting and soil amelioration measures in grassland areas (as per Recommendations).
	Re-establish or augment fauna habitats for native and threatened fauna (woodland/forest).	Regeneration and remediation areas contain flora species that provide food, shelter and refuge opportunities for native and threatened fauna. Evidence of a range of vegetation structural habitats exists (e.g., canopy species, shrubs, ground cover, developing litter layer etc.) that are commensurate with native and	Data was collected from established monitoring sites to allow for timeline comparisons. Habitat still provided for a range of species. Several threatened fauna species detected historically, although only one detected in 2021. Differences in floristics between woodland and grassland sites remain. Regeneration of	No corrective actions required. Continue to implement management and monitoring actions as per the OAMP.

OAMP Reference	Objective	Target Criteria to be Achieved	2021 Monitoring Results	Corrective Actions
		threatened fauna that occur within the area.	flora species that provide habitat to fauna species is advancing in HOA and SOAs.	
		Native/threatened woodland fauna are utilising offset areas.		
	Re-establish and augment habitat for the Green and Golden Bell Frog (wetland and open grassland areas).	Green and Golden Bell Frog habitat reestablishment and augmentation areas contain flora species that are commensurate with those known to provide habitat for this species.	Structural habitat elements present. Water now present in most dams during the GGBF survey period. Nine dams in RNOA, three in HOA, one in COA and three in SOA had moderately sufficient to suitable habitat features to support the GGBF Evidence of flora plantings near dams at HOA. No GGBFs were recorded during surveys.	Continue to implement management actions as per the OAMP. Implement aquatic vegetation planting with the aim to create densely vegetated areas. Consider alternate monitoring methods (as per Recommendations).
Table 7.3	Targeted weed removal across all offset properties to remove noxious and perennial weed species.	Decrease in abundance of all target weed species in first ten years.	Target weed species recorded across all BOAs. Target weed species recorded at both grassland and woodland sites in these BOAs.	Continue weed mapping and focus on management plan priorities. Continue to implement management actions as per the OAMP with focus on areas described in this report.
		Weed infestations considered negligible across all four offset properties within 15 years.	Data was collected from established monitoring sites to allow for timeline comparisons and future analysis. Exotic species richness/density similar to previous monitoring year.	
	Primary, secondary and maintenance weeding within areas zoned assisted regeneration and remediation, to prepare the sites for planting and maintain them so that weed infestation does not compromise the survival of planted seedlings.	Assisted regeneration and remediation areas within the Offset Areas are dominated by native species in all strata (trees, shrubs, groundcover).	Monitoring did not cover any areas with assisted regeneration. Moderate success of one area of assisted regeneration was noted in Hillcrest.	Continue to implement management actions as per the OAMP.

OAMP Reference	Objective	Target Criteria to be Achieved	2021 Monitoring Results	Corrective Actions
Table 8.1	To minimise browsing/disturbance of regeneration areas.	Minimal level of browsing observed (<10% of plants showing evidence of rabbit browsing in permanent plots).	Rabbits observed within the RNOA and Hillcrest during the 2021 monitoring programme.	Continue feral rabbit management at RNOA and Hillcrest. Continue to implement management actions as per the OAMP.
		Disturbance by feral pigs (i.e. digging) is minimal (visual assessment).	Feral pigs were recorded within RNOA during the 2021 monitoring programme.	Continue to implement management actions as per the OAMP.
	To minimise predation of, or competition with, native species by feral pest species.	Evidence of foxes/feral cats/wild dogs (including scats, dens, signs of predation) is minimal (Visual assessment).	Dog observed crossing through HOA. No evidence of foxes or cats in 2021.	Continue to implement management actions for feral animals as per the OAMP. Ensure monitoring of feral animals is conducted.
		Regular monitoring by PIR cameras show only occasional use of the site by feral predators.	No cameras were deployed in 2021 to monitor feral pests, so unable to comment. Feral pests likely still active in some areas.	
Table 11.1	Increase habitat linkages between Davis and Bayswater Creeks in RNOA through augmenting /creating a series of dams.	A series of 10 dams with habitat specific to the Green and Golden Bell Frog have been created /augmented between Davis and Bayswater Creeks.	N/A	Continue to implement management actions as per the OAMP and OMP.
	Removal of Mosquito Fish from dams on all four properties.	Dams and waterways are free of Mosquito Fish.	No evidence of Mosquito Fish in dams surveyed.	Continue monitoring for Mosquito Fish as per the OAMP.
	Maintain/augment Green and Golden Bell Frog habitat on RNOA and HOA.	All dams to include native emergent and fringing plant species, surrounding shelter sites and unshaded areas within three years.	An increase in augmented GGBF habitat was recorded however a number of dams contain sparse fringing vegetation or no aquatic vegetation.	Focus assisted plantings of suitable aquatic vegetation at dams identified as limited or not suitable habitat for the GGBF. Assisted plantings should aim to create dense patches of vegetation rather than sparse plantings. Continue to implement management actions as per the OAMP.

OAMP Reference	Objective	Target Criteria to be Achieved	2021 Monitoring Results	Corrective Actions
	Conduct ongoing annual Green and Golden Bell Frog surveys on RNOA and HOA to provide a better understanding of the local population.	Increased understanding of the Hunter Catchment Green and Golden Bell Frog population.	No records of the GGBF during the 2021 monitoring programme.	Continue to implement management and monitoring actions as described in the OAMP. Implement other survey methods as discussed in Recommendations.

Appendix F - Meteorological Monitoring Results

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
1/01/2021	93.8	18.4	3.3	124	12.8	8.2
2/01/2021	-	-	2.8	119	13.9	1.8
3/01/2021	86.3	22	1.2	125	22.7	0.2
4/01/2021	90.7	21.8	0.5	300	31.5	40.8
5/01/2021	71.3	24	1.8	260	25.4	0.2
6/01/2021	75.6	22.3	3.6	112	14.7	0
7/01/2021	72.2	19.9	4	125	13.7	0
8/01/2021	67.2	19.4	4.2	121	14.1	0
9/01/2021	84	19.1	3.1	109	14.8	13
10/01/2021	74.5	21.2	2.7	105	18.0	0
11/01/2021	68.6	22.4	2	110	24.6	0
12/01/2021	64.3	24.8	0.7	99	26.9	0
13/01/2021	70.9	24	2.1	99	22.1	0
14/01/2021	61.8	26.9	1.6	282	23.5	0
15/01/2021	55.9	27.5	1	241	24.1	1.6
16/01/2021	27.8	23.4	2.7	232	20.7	0
17/01/2021	46.7	21.9	0.5	108	34.1	0
18/01/2021	54.2	24.3	1.5	284	24.7	0
19/01/2021	59.3	23.1	2.9	112	21.8	0
20/01/2021	72.2	19.6	4	103	13.9	0.4
21/01/2021	60.8	21.6	2.3	117	24.7	0
22/01/2021	57.2	25.8	1.2	288	24.9	0
23/01/2021	42.5	29.9	1.2	286	27.8	0
24/01/2021	42.5	30.1	0.8	65	27.3	0
25/01/2021	48	28.3	1.1	283	24.9	0
26/01/2021	46.4	30.2	2.6	298	20.9	0
27/01/2021	64.7	25.6	4.2	126	14.8	0
28/01/2021	95	20.2	4.7	127	13.5	3.8
29/01/2021	94.8	21.4	4.5	126	11.9	2.2
30/01/2021	79.8	24.1	0.7	179	22.9	0.4
31/01/2021	81.8	23.3	2.5	124	21.2	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
1/02/2021	70	24.8	3.1	119	18.2	0
2/02/2021	77.7	21.6	2.7	106	18.5	38.8
3/02/2021	69.1	21.1	3.1	107	14.9	0
4/02/2021	69	23.4	1.4	97	25.1	0
5/02/2021	65.5	25.5	2.4	103	21.1	0
6/02/2021	83.1	23.2	0.7	282	24.0	4
7/02/2021	73.4	23.8	0.5	143	26.8	28.4
8/02/2021	71.6	21.6	3.4	108	14.2	0
9/02/2021	66.7	21.2	3.5	98	14.3	0
10/02/2021	72.5	19.8	2.8	97	17.5	0
11/02/2021	65.5	21.7	1.1	85	31.0	0
12/02/2021	60.7	24.7	1.6	290	20.5	0
13/02/2021	90.6	22.3	0.6	191	18.7	26.6
14/02/2021	69.5	20.6	3.4	118	14.0	0.2
15/02/2021	70.4	20	4.1	128	14.0	0.4
16/02/2021	84.1	20.9	3.9	114	14.9	12.4
17/02/2021	76.7	20.7	4	106	13.8	1.6
18/02/2021	79.9	20.1	3.4	114	14.5	5.4
19/02/2021	87.1	22.1	3.4	116	13.5	0.2
20/02/2021	85.5	23.1	2.9	109	14.5	0.2
21/02/2021	80.5	23.8	2.7	119	15.0	0.2
22/02/2021	78	24	0.4	111	30.3	3.4
23/02/2021	77.9	20	3.4	122	14.0	0.4
24/02/2021	86.5	18.7	3.4	125	15.5	11.6
25/02/2021	86.2	21.2	0.2	172	28.2	0.2
26/02/2021	67.6	24.4	0.6	195	21.2	0
27/02/2021	89.2	22.1	2.9	124	14.5	0.6
28/02/2021	80.4	24.6	1.4	126	20.6	0
1/03/2021	63.7	26.8	0.3	42	30.7	0
2/03/2021	63.7	22.5	2.4	94	23.5	0
3/03/2021	71.5	19.7	3.6	116	13.6	0
4/03/2021	64.8	21	0.2	44	30.3	0
5/03/2021	51.9	21.8	1.9	102	28.7	0
6/03/2021	66.9	20.2	3.3	99	14.7	0
7/03/2021	68.6	21	2	110	25.8	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
8/03/2021	86.8	20.3	0.9	289	25.6	8.4
9/03/2021	67.5	24.2	1.5	259	19.0	0.2
10/03/2021	74.2	22.8	3.7	105	13.7	0
11/03/2021	74.7	22.8	2.6	107	18.4	2
12/03/2021	82.3	22.7	0.5	125	30.9	0
13/03/2021	71.1	25.2	1.3	302	24.5	0
14/03/2021	94.3	19.6	2.4	130	19.4	53.6
15/03/2021	73.5	17.9	2.5	99	16.1	0
16/03/2021	82	17.9	2.7	110	14.7	0.2
17/03/2021	93.4	18.2	4	118	13.3	3.2
18/03/2021	96.8	18.8	4.2	125	13.0	13.8
19/03/2021	98.6	19.2	4.2	122	12.1	37
20/03/2021	97.9	20.3	5.1	122	11.9	34.6
21/03/2021	98	19.8	4.6	120	11.9	3
22/03/2021	96	18	4.4	118	11.3	39.6
23/03/2021	99	19.5	1.7	126	15.6	11.4
24/03/2021	65.6	22.9	4.7	271	14.0	0.2
25/03/2021	57	21.9	4.6	271	16.7	0
26/03/2021	61.6	20.4	1	246	22.6	0
27/03/2021	60.3	21.1	1.5	264	22.2	0
28/03/2021	57.8	21	0.4	188	27.5	0
29/03/2021	70.3	20.9	2	103	22.4	0
30/03/2021	72.9	18.9	2.5	111	16.8	0.2
31/03/2021	76.1	18	1.8	93	17.1	0
1/04/2021	78.3	18.7	1.5	92	20.2	0
2/04/2021	80.1	19.1	1.9	101	19.4	0
3/04/2021	79.1	19.7	2.1	104	20.3	0
4/04/2021	76.8	20.4	0.8	316	22.3	0
5/04/2021	79.9	21.1	2.1	103	18.1	0
6/04/2021	86.2	21.1	2.9	106	14.9	1.8
7/04/2021	90.2	20.3	2.7	108	15.0	3.6
8/04/2021	83	20.2	1.9	100	20.3	0.2
9/04/2021	63.6	22.3	2.5	277	22.1	0
10/04/2021	58.3	19.7	3.3	273	16.5	0
11/04/2021	42.9	15.8	4	255	16.1	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
12/04/2021	49.9	13.8	1.2	305	29.4	0
13/04/2021	65.6	13.7	0.7	7	29.2	0
14/04/2021	48.4	19.4	3	286	19.4	0
15/04/2021	44.1	21.4	1.6	260	25.4	0
16/04/2021	61.8	17.5	1.7	90	25.9	0
17/04/2021	95.2	14.1	1.5	127	16.3	12
18/04/2021	84.3	14	0.6	260	20.7	0
19/04/2021	72.7	15.2	1.1	290	18.3	0.2
20/04/2021	55.4	17.2	2	272	19.6	0
21/04/2021	54.1	15.3	0.7	245	29.0	0
22/04/2021	50.1	14.2	2.9	263	20.7	0
23/04/2021	50.7	14.9	1.6	281	26.3	0
24/04/2021	65.9	14.2	0.8	302	23.4	0
25/04/2021	69.8	14.7	0.6	81	23.2	0
26/04/2021	78.7	14.8	0.6	56	24.7	0
27/04/2021	78.9	15	1	86	22.4	0
28/04/2021	81.2	15.4	0.6	76	21.8	0
29/04/2021	78	15.5	0.8	87	21.9	0.2
30/04/2021	83	15.8	1.5	84	21.7	0
1/05/2021	82.5	17.2	1.1	102	24.9	0
2/05/2021	81.6	16.7	0.6	100	22.7	0
3/05/2021	75.8	17	1	308	26.3	0
4/05/2021	84.5	15.5	0.7	301	21.9	2
5/05/2021	87	15.7	0.6	118	19.3	0.2
6/05/2021	97.3	17	0.2	287	20.3	7.8
7/05/2021	92	18.4	0.1	79	16.4	3
8/05/2021	81.2	19.2	1.1	317	25.2	0.2
9/05/2021	89.3	16	0.3	11	21.6	0.6
10/05/2021	70.5	18.2	2.2	303	19.6	0
11/05/2021	75.7	16.8	1.5	308	24.8	8.8
12/05/2021	79.8	15.6	0.6	106	24.4	0
13/05/2021	74.2	17.1	2.8	305	20.4	0
14/05/2021	53.3	15.2	3.6	288	20.2	0
15/05/2021	51.4	13.1	4.2	291	21.2	0
16/05/2021	46	11.6	2.9	290	21.4	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
17/05/2021	58.2	11.9	1.7	302	23.4	0
18/05/2021	70.6	12.2	0.8	24	27.4	0
19/05/2021	73.5	11.7	1	323	20.7	0
20/05/2021	69.3	13.2	1.2	315	24.3	0
21/05/2021	89.3	11.8	0.7	93	19.2	1.2
22/05/2021	85.7	12.9	0.9	47	25.8	0.2
23/05/2021	85.3	13	0.6	58	22.0	0.2
24/05/2021	82.3	15.5	1.2	98	22.7	0
25/05/2021	83.7	14.3	0.8	339	26.7	0
26/05/2021	60.2	16.1	2.1	276	24.4	0
27/05/2021	56.2	13.1	2	310	24.9	0
28/05/2021	57.3	11.7	0.5	120	33.3	0
29/05/2021	68.2	9.6	0.6	132	22.4	0
30/05/2021	68.5	12.8	0.9	109	19.3	0
31/05/2021	73.8	12.6	0.5	69	26.9	0
1/06/2021	76.6	12	1	325	24.0	0
2/06/2021	70.4	13.6	0.9	356	25.4	0
3/06/2021	95.5	11.3	0.8	326	27.7	27.8
4/06/2021	69.6	15	3.1	288	21.6	0
5/06/2021	70.3	12.4	2	311	21.7	0
6/06/2021	65.6	10.4	1.8	304	19.5	0
7/06/2021	76.4	9.8	1.2	337	20.0	0
8/06/2021	80.5	12.3	0.6	329	25.9	23
9/06/2021	77.9	9.8	4.2	291	17.1	2.4
10/06/2021	81.2	8.3	2	339	24.0	8.2
11/06/2021	71.8	9.8	4.6	287	15.3	0
12/06/2021	65.7	12.1	4.3	292	14.4	0
13/06/2021	59.5	12.5	4.1	300	17.6	0
14/06/2021	72	10	1.3	315	21.5	0
15/06/2021	77	10	0.9	328	21.1	0
16/06/2021	81.1	11.7	0.3	347	32.9	0.4
17/06/2021	56.3	13.8	5.6	276	14.5	0
18/06/2021	64.3	13.6	5.7	280	14.3	0
19/06/2021	70.5	12.9	1.8	275	26.9	2.8
20/06/2021	70.5	13.7	2.4	156	16.5	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
21/06/2021	80.3	11.8	0.9	99	20.5	0
22/06/2021	85.7	11.5	0.9	109	22.7	0
23/06/2021	89.8	12	0.5	35	27.4	0
24/06/2021	76.1	15.8	3.1	294	17.6	1.6
25/06/2021	71.7	15.3	3.1	278	16.3	1
26/06/2021	65	12.8	3.6	287	16.6	0
27/06/2021	67.6	11.2	2.1	292	19.0	0
28/06/2021	87.5	9.7	1.3	31	19.9	0
29/06/2021	90	13.2	2.3	131	16.2	0.6
30/06/2021	91.6	12.9	1.2	111	23.6	0.2
1/07/2021	95.3	12.8	0.6	105	28.2	8
2/07/2021	88.3	13.8	0.9	284	23.9	0.6
3/07/2021	79.1	12.2	1.1	317	26.6	0.2
4/07/2021	65.2	10.5	1.6	277	26.7	0
5/07/2021	61.2	9.9	2.3	290	26.4	0
6/07/2021	73.6	7.9	1.5	313	22.4	0
7/07/2021	81.2	8	0.6	46	22.5	0
8/07/2021	82	9.3	0.4	24	23.5	0
9/07/2021	98.4	10.2	0.5	316	30.7	8
10/07/2021	74.7	12.4	1	203	29.6	0
11/07/2021	85.6	11.1	0.8	68	23.5	0.2
12/07/2021	87	9.6	0.4	5	27.0	0.2
13/07/2021	72.8	12.7	1.5	297	23.4	0.2
14/07/2021	68.3	14.5	1.7	300	21.2	0
15/07/2021	73.4	17.2	2.3	272	19.5	1
16/07/2021	65.6	14.5	5.3	276	16.6	2
17/07/2021	55.2	12.4	7.1	271	14.7	1.6
18/07/2021	59.1	12.6	4.8	288	15.6	0
19/07/2021	62.7	10.5	3.9	289	15.5	0
20/07/2021	59.5	11.7	5.1	281	14.7	0
21/07/2021	58.9	10.3	1.1	236	19.9	0
22/07/2021	67.3	8.6	0.7	345	29.1	0
23/07/2021	67.1	12.2	2.2	305	24.9	0
24/07/2021	67.1	13	4.6	282	16.7	0.8
25/07/2021	52.7	12.1	6.3	276	15.0	0.2

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
26/07/2021	57.3	13.3	4.5	278	13.7	0
27/07/2021	61.5	13.9	1.7	292	21.7	0
28/07/2021	58.6	15.6	3.3	284	21.7	1.4
29/07/2021	54.4	13.6	2.5	272	26.1	0
30/07/2021	60.2	10.2	1.3	312	21.2	0
31/07/2021	54.7	14.8	1.1	280	28.9	0
1/08/2021	62.2	18.6	2.9	276	20.5	0
2/08/2021	69.7	14.4	2.3	123	18.5	0
3/08/2021	69.1	13.7	4	277	21.1	2.8
4/08/2021	57.1	11.6	5.7	278	14.3	0
5/08/2021	58.2	13.3	4.1	284	16.0	0
6/08/2021	57	13.3	3.3	292	21.1	0
7/08/2021	58.1	12.1	3.6	284	16.8	0
8/08/2021	82.4	10.8	1.4	114	18.3	2.4
9/08/2021	77.6	13.1	1	112	24.9	0.2
10/08/2021	74.9	13.3	1	328	22.9	0
11/08/2021	64.6	15.6	2.3	310	23.7	0
12/08/2021	57.3	17.1	1.6	268	23.9	0
13/08/2021	70	11.3	0.7	328	25.0	0
14/08/2021	72.1	11.9	0.6	105	22.8	0
15/08/2021	57.7	14.1	2	294	21.6	0
16/08/2021	NaN	NaN	4.2	282	17.1	0
17/08/2021	55.2	12.9	0.8	305	32.1	0
18/08/2021	67.2	11.9	1	80	21.3	0
19/08/2021	73.5	12.3	0.9	329	21.9	0
20/08/2021	63.6	15.3	1.3	313	20.7	0
21/08/2021	58.3	15.8	1.4	317	25.2	0
22/08/2021	57	16.5	1	330	25.9	0
23/08/2021	62.5	18.9	1.9	294	22.9	4.4
24/08/2021	86.7	11.4	4.4	279	16.9	22.6
25/08/2021	62.7	12.2	4.5	286	17.5	1.6
26/08/2021	62	12.5	1.5	288	25.5	0
27/08/2021	54.6	13.1	3.1	276	23.9	0
28/08/2021	46	12.6	2.2	290	28.4	0
29/08/2021	55.3	12.3	0.4	353	29.8	0.2

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
30/08/2021	51.5	14.3	1.1	292	26.7	0
31/08/2021	59.7	14.2	0.7	324	24.4	0
1/09/2021	56.6	16.1	1	113	24.3	0
2/09/2021	78.7	16.6	1.2	102	21.1	0
3/09/2021	65.8	17	1.1	331	27.1	0
4/09/2021	70.5	17.3	1.9	292	22.4	1.4
5/09/2021	69.1	14.2	5	276	14.6	5.8
6/09/2021	56.3	13.1	1.3	288	19.0	0
7/09/2021	50.3	14.5	2.7	283	23.1	0
8/09/2021	59.2	15	0.8	342	26.5	0
9/09/2021	44.7	18.6	3.8	285	18.0	0
10/09/2021	42.2	20.3	3.1	274	17.1	0
11/09/2021	54.2	19.8	2.4	295	22.2	0
12/09/2021	32.6	23	3.7	285	22.2	0
13/09/2021	60	16	1.7	145	18.8	5.6
14/09/2021	75.2	12.1	2.7	161	18.4	4.2
15/09/2021	67.4	12.9	1.1	127	25.3	0
16/09/2021	74.1	12.6	1.7	109	19.6	0
17/09/2021	70.3	14.3	0.9	334	26.1	0
18/09/2021	67.4	18.1	3.5	290	20.9	1.8
19/09/2021	51.4	17.2	3.4	280	21.6	0
20/09/2021	41.6	18.1	3.1	263	18.8	0
21/09/2021	46.8	12.3	1.7	230	17.9	0
22/09/2021	58.3	12.7	1	325	28.7	0
23/09/2021	48.4	17.7	3	289	20.3	0
24/09/2021	42.1	20.3	3.8	278	19.4	0
25/09/2021	47.8	18.5	1.2	153	23.0	0
26/09/2021	72.5	13	3.9	116	13.9	0
27/09/2021	63.9	14.5	3.1	126	18.0	0
28/09/2021	62.8	16.4	0.8	67	28.3	0
29/09/2021	82.8	15.7	0.5	304	24.6	9
30/09/2021	76.9	18.2	1.4	300	23.6	0
1/10/2021	73.9	17.7	0.8	281	35.3	9.6
2/10/2021	72	17.1	2.9	284	20.0	0.2
3/10/2021	57.9	19.9	3.6	278	14.9	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
4/10/2021	53.8	19.7	3.8	280	18.8	0
5/10/2021	39.5	17.5	5.1	274	16.0	0
6/10/2021	38.7	17.9	3.2	298	20.8	0
7/10/2021	39	20.3	2.3	296	23.8	0
8/10/2021	61.2	18.7	2.4	116	21.5	0
9/10/2021	58.5	20.8	1	302	22.0	0
10/10/2021	65.6	22	3	295	20.1	5.6
11/10/2021	93.1	14.2	1.9	147	15.9	4.6
12/10/2021	96.3	12.9	3.7	133	13.4	20.4
13/10/2021	88.5	15.9	3.2	128	14.0	4.8
14/10/2021	72.9	19.5	1.1	312	28.4	1.6
15/10/2021	65.7	15.8	3.8	278	19.4	9.8
16/10/2021	56.6	15.7	5.8	274	14.5	0.2
17/10/2021	50.1	17.6	2.2	269	21.9	0
18/10/2021	59.5	18.1	0.9	290	25.6	0
19/10/2021	54	19.5	0.4	164	22.0	0
20/10/2021	64.8	16.3	2.7	104	15.9	0
21/10/2021	73.4	17.4	2.9	113	17.0	0
22/10/2021	74.9	19.5	2.2	113	21.1	0
23/10/2021	73.9	21.8	0.3	207	28.6	9
24/10/2021	65.9	20.1	0.8	232	23.0	0
25/10/2021	39.8	20.8	1.9	231	17.7	0
26/10/2021	61.8	18.1	2.1	124	24.2	0
27/10/2021	59.5	20.6	0.8	289	23.3	0
28/10/2021	48.4	23.2	1.2	307	22.8	0
29/10/2021	47.5	24.5	4.1	281	17.3	0
30/10/2021	52.5	18.6	2.8	117	24.8	0
31/10/2021	61.5	16.7	3.2	114	16.3	0
1/11/2021	61.6	17.4	1.1	107		0
2/11/2021	59.9	20.2	3	121		0
3/11/2021	60	20.1	2	143		0
4/11/2021	75.7	19.1	1.8	111	19.8	0.4
5/11/2021	90.1	17.9	1.8	150	18.1	7.8
6/11/2021	73.2	20.5	0.2	227	29.2	0
7/11/2021	82	20.5	0.4	142	22.3	3.2

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
8/11/2021	83.5	20.7	1.3	112	23.3	13
9/11/2021	70.1	21.8	1.4	144	28.2	0.2
10/11/2021	92.1	19.5	1.1	118	26.7	30
11/11/2021	94.2	19.5	1.7	146	21.4	40.2
12/11/2021	71.6	19.3	3.6	254	19.5	45.2
13/11/2021	56.1	16	8.4	273	13.6	0
14/11/2021	48.1	16.5	5.4	273	14.2	0.4
15/11/2021	42.3	17.4	5.7	271	15.2	0
16/11/2021	49.1	16.9	0.8	218	23.5	0
17/11/2021	62.7	17.5	3	115	17.2	0
18/11/2021	64	20.3	0.7	307	28.9	0
19/11/2021	62.8	23.1	1.9	297	21.2	0
20/11/2021	72.8	22.8	0.5	334	23.9	0.4
21/11/2021	99.5	16.8	3.3	146	15.3	35.2
22/11/2021	87.3	17.1	4.4	133	13.6	5.4
23/11/2021	85.2	19.5	3.5	133	14.9	0.6
24/11/2021	84.8	21.8	1.9	131	20.6	3.4
25/11/2021	93.7	22.2	1	152	27.4	12.8
26/11/2021	94.6	18.8	2.3	147	18.6	52.2
27/11/2021	89.3	15.8	4	144	13.5	4
28/11/2021	77.3	16.3	3.4	133	13.6	0.2
29/11/2021	77	17.8	2	130	18.2	0.4
30/11/2021	97	19.7	0	NaN	16.9	7.6
1/12/2021	84.6	21	3.0	121.0	14.4	0.2
2/12/2021	76.7	22.2	2.9	124.0	16.3	0
3/12/2021	80.6	22.4	0.5	153.0	25.7	26.2
4/12/2021	83.0	21.4	2.5	121.0	21.8	0.8
5/12/2021	71.7	18.1	4.1	124.0	14.1	0
6/12/2021	70.6	19.1	3.4	130.0	15.3	0
7/12/2021	83.2	20.4	0.5	266.0	26.8	14.4
8/12/2021	82.3	20.3	1.4	145.0	22.3	24.6
9/12/2021	83.9	20.1	1.1	112.0	27.1	4.8
10/12/2021	48.3	19.4	4.0	259.0	15.7	0.2
11/12/2021	67.2	18	2.0	126.0	16.4	0
12/12/2021	63.3	19	2.6	115.0	19.9	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
13/12/2021	61.8	20.6	2.0	126.0	28.4	0
14/12/2021	67.6	20.9	2.0	109.0	24.6	0
15/12/2021	55.6	24.3	0.3	98.0	33.3	0
16/12/2021	75.6	22.6	2.4	115.0	20.7	1
17/12/2021	69.2	22.3	3.0	119.0	17.3	0.2
18/12/2021	63.7	26.6	1.9	310.0	24.8	0
19/12/2021	59.6	27.6	3.1	291.0	24.9	2.2
20/12/2021	67.1	26.8	0.5	232.0	31.8	0
21/12/2021	71.9	27.5	0.5	297.0	24.0	0
22/12/2021	70.0	25.6	0.5	350.0	24.7	3
23/12/2021	76.3	24	2.1	128.0	20.0	0.2
24/12/2021	74.2	24.1	2.7	114.0	21.0	0.2
25/12/2021	69.1	25.4	1.8	118.0	26.6	0
26/12/2021	71.7	24	2.7	118.0	20.3	19.4
27/12/2021	86.6	19.1	4.1	142.0	14.5	3
28/12/2021	80.5	18.1	3.6	132.0	15.6	1.4
29/12/2021	70.2	19.3	2.5	118.0	18.2	1
30/12/2021	67.0	20.8	2.5	112.0	19.0	0
31/12/2021	65.2	22.7	2.0	118.0	23.8	0

Appendix G - Surface and Groundwater Management and Monitoring Report (Engeny Water Management 2022)

ENGENY
WATER MANAGEMENT

Ravensworth Complex

2021 Annual Review

Surface Water and Groundwater Management and Monitoring Report

28 March 2022

N1000_119-REP-001-1

Job no. and Project Name: N1000_119 Surface Water and Groundwater Management and Monitoring Report
Doc Path File: \\online.com\files\ManagementNewcastle\Projects\N1000_Glencore\N1000_119 RO 2021 Annual Review\07 Deliv\2. Report\N1000_119-REP-001-1-2021 Surface Water and Groundwater Review.docx

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	17/03/2022	Client Issue	Laura Vincent	Adam Wyatt	Laura Vincent	Adam Wyatt
1	28/03/2022	Client Issue	Laura Vincent	Adam Wyatt	Laura Vincent	Adam Wyatt

Signatures

Contents

Appendices

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1 OVERVIEW

1.1 SCOPE

This 2021 Surface Water and Groundwater Management and Monitoring Report has been prepared in accordance with the requirements of Schedule 5, Condition 3 of PA 09_0176 and the monitoring program detailed in the Ravensworth Complex Water Management Plan (WMP). The scope of this report includes:

- An overview of surface water and groundwater monitoring and impact assessment criteria (IAC).
- Comparison of surface water quality results against adopted trigger values/IAC, including a long-term trend analysis.
- Commentary regarding any impacts on surface water quality as they relate to the Environmental Assessment (EA).
- Comparison of ground water quality and level results against adopted trigger values/ IAC (i.e., 80th and 20th percentile of all available data), including a long-term trend analysis.
- Commentary regarding any impacts on groundwater quality and or depressurisation as they relate to the EA.
- Comparisons of surface water and groundwater extraction volumes with the relevant water access licence entitlement.
- Inclusion of the mine complex water balance results and comparison against the predictions in the EA.
- Commentary regarding any volume error in the water balance results.

The 2021 Surface Water and Groundwater Management and Monitoring Report covers the period from 1 January 2021 to 31 December 2021.

1.2 WATER MANAGEMENT

Water management for RC is detailed in the Ravensworth Complex WMP (Ravensworth Open Cut, 2020). The WMP has been developed in order to satisfy the conditions of development consents and water access licenses (WALs) for the operations managed by RC. The WMP:

- Details the water management strategies required by the development consent conditions in order to manage the quality and quantity of water on site and report on water quality in the area surrounding the mine; and
- Outlines the management commitments and monitoring programs in place to address the specific requirements of the development consents relating to surface water and groundwater at the RC.

2 SURFACE WATER MONITORING

2.1 SURFACE WATER MONITORING PROGRAM

The surface water monitoring program includes observation of the following elements of the RC water management system (WMS) and surrounding creeks:

- Surface water quality and flows in upstream and downstream watercourses.
- Channel stability on upstream and downstream watercourses (addressed separately).
- Stream health conditions in upstream and downstream watercourses (addressed separately).
- On-site water management.
- Discharge to the Hunter River via Bowmans Creek under the Hunter River Salinity Trading Scheme (HRSTS).

Details of the surface water monitoring locations for watercourses are provided in Appendix A. Additional monitoring as detailed in the WMP (Ravensworth Open Cut, 2020) includes:

- Daily rainfall, as recorded from a site weather station.
- Daily water level monitoring of the main water storage dams.
- Water level monitoring of other dams (to be conducted pre, during and post rainfall events of greater than 20 mm in 24 hours).
- Monthly volume of water imported onto the site from offsite in accordance with the relevant WAL requirements.
- Monthly monitoring of dams from which off-site discharge can occur, for the following water quality parameters.
  - pH.
  - Electrical conductivity (EC).
  - Total dissolved solids (TDS).
  - Total suspended solids (TSS).
- Six monthly speciation monitoring of the Narama In-pit Storage Dam for metals, nutrients and hydrocarbons.
- Dams in key locations including the infrastructure area are tested monthly for other analytes including:
  - BOD.
  - Oil and grease.
  - Phosphorus.
- Regular inspections of all sediment and erosion control structures (refer to Ravensworth Complex Erosion and Sediment Control Plan), where possible, during and after storm events (i.e. rainfall events of greater than 20 mm in 24 hours).
- In the event that hydrocarbon contamination of a dam or waterway is suspected (i.e. visible sheen), hydrocarbon monitoring will be undertaken. In the event that contamination is detected, suitable remediation actions will be undertaken.

2.2 IMPACT ASSESSMENT CRITERIA

Impact assessment criteria (IAC), also referred to as 'trigger values', for pH, EC, TSS and TDS have been determined for specific receiving water monitoring locations as part of the WMP (Ravensworth Open Cut, 2020). All surface water quality data collected as part of the monitoring program are assessed against the IAC to identify deviations from the baseline water quality conditions. Surface water quality IAC are presented in Table A.2 in Appendix A.

2.3 SURFACE WATER QUALITY MONITORING RESULTS

Water quality sampling is undertaken monthly at upstream and downstream locations along Bowmans Creek, Bayswater Creek and Emu Creek and every two months in Davis Creek and Pikes Creek. During 2021, samples taken during 'flow' or 'no flow' conditions were documented on the field sheets. While water samples were collected from pooled water in watercourses during no-flow periods, the water quality results from these are not considered to be representative of typical receiving water quality. This understanding aligns with the statement in the WMP (Ravensworth Open Cut, 2020) which acknowledges that the method

to determine IAC "does not allow for water quality variability caused by climatic conditions and the ephemeral nature of the creek systems present at the sites that form the Ravensworth Complex."

Statistical analyses of the 2021 water quality monitoring data for pH, EC, TDS and TSS and time-series figures (including all historical data) are presented in Appendix C. The IAC triggers are shown on the graphs for each watercourse.

2.3.1 Bowmans Creek

Twelve monthly samples were collected from the upstream location for Bowmans Creek (EPL3) and eleven monthly samples collected at the downstream monitoring location for Bowmans Creek (EPL4).

The water quality analysis at the Bowmans Creek monitoring locations identified:

- Three pH results at both EPL3 and EPL4 were outside of the IAC range.
- Two TSS results at both EPL3 and EPL4 were outside of the IAC range, however all results were well below the historically recorded maximum value of 176 mg/L.
- All EC and TDS results were below the IAC criteria.

2.3.2 Bayswater Creek

Eight water quality samples were collected from the Bayswater Creek upstream of ROC (W114) and ten water quality samples were collected from the Bayswater Creek downstream of ROC (W115) in 2021.

Twelve water quality samples were collected from the Bayswater Creek upstream of RUM (W10) and ten water quality samples were collected from the Bayswater Creek downstream of RUM (W11) in 2021.

The water quality analysis at the Bayswater Creek monitoring locations identified:

- Five pH samples at W114 (upstream ROC) and two samples at W115 (downstream ROC) were outside of the IAC limits.
- One pH sample at W11 (downstream RUM) was outside of the IAC limits.
- Eight EC (and TDS) samples at W10 (upstream RUM) were outside of the IAC limits.
- Four TSS samples at W114 (upstream ROC) and five samples at W115 (downstream ROC) were outside of the IAC limits.
- One TSS sample at W10 (upstream RUM) and five samples at W11 (downstream RUM) were outside of the IAC limits.

2.3.3 Emu Creek

Four water quality samples were collected at the Emu Creek downstream monitoring location (W122) 2021, with all but one pH sample falling within the IAC values.

2.3.4 Davis Creek

Five water quality samples were collected at the Davis Creek upstream monitoring location (W152), and one water quality sample collected at the downstream point (W164). EC (and TDS) was within the IAC range for all samples, however three pH samples at W152 (upstream) were outside of the IAC range, and one TSS sample at both W152 (upstream) and W164 (downstream) were outside of the IAC range.

2.3.5 Pikes Gully Creek

Eight water quality samples were collected from the Pikes Creek upstream monitoring location (W135). All pH results were recorded outside of the IAC range. Water samples corresponding to the results with IAC pH exceedances were collected from pooled water may be considered as unrepresentative of typical water quality. All TSS, EC, and TDS results were below the respective IAC values.

Nine water quality sample were collected from the New England Highway (W136) downstream monitoring location, with one exceedance of the IAC value for EC (and TDS), and four exceedances of the IAC range for pH.

Three water quality samples were collected at the downstream monitoring location CHPP Culvert (W137). All pH results, and one EC (and TDS) sample were outside of the IAC range.

3 GROUNDWATER MONITORING

3.1 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program includes assessment of the following elements of the alluvial and hard rock/coal measure aquifers underlying RC:

- Groundwater inflows / seepage into open cut pits and former underground workings.
- Groundwater quality monitoring, including:
  - pH.
  - EC.
  - Various trace elements (i.e., speciation).
- Groundwater levels and aquifer depressurisation.
- Impacts on groundwater dependent ecosystems and riparian vegetation.

Further details on the groundwater monitoring program are included in the WMP (Ravensworth Open Cut, 2020).

Data from the monitoring program is also used to estimate the groundwater seepage into former underground workings and open cut voids.

Details of the groundwater monitoring locations are provided in Appendix B.

During the 2021 monitoring period, the groundwater monitoring program included monthly monitoring of water levels, quarterly (minimum) monitoring of pH and EC, and six-monthly monitoring of inorganic species (speciation data).

3.2 IMPACT ASSESSMENT CRITERIA

All monitoring data collected as part of this program is assessed against established IAC in order to:

- Determine whether groundwater extraction volumes are within WAL limits and are comparable with modelled predictions.
- Identify deviations from the baseline water quality conditions.
- Identify deviations from the baseline groundwater level trends.

3.2.1 pH and EC

Site-specific IAC values for pH and EC have been determined for each monitoring location as part of the WMP (Ravensworth Open Cut, 2020). These values are presented in Appendix B.

3.2.2 Speciation Data

Where site-specific values are not defined at any location, interim and site specific (sodium and chloride) water quality IAC are based on the ANZECC (2000) guidelines as per WMP (Ravensworth, 2020), using values from “Table 5.2.3 - Summary of water quality guidelines for recreational purposes”.

The interim and site-specific IAC values for speciation data are presented in Appendix B.

3.3 GROUNDWATER QUALITY RESULTS

3.3.1 Overview

Groundwater quality data for pH, EC and trace elements (speciation) are provided in **Appendix D**.

A summary of the pH and EC results for each monitoring location is presented in **Appendix D** (**Table D.1**), with individual results presented in **Appendix D** (**Table D.2** to **D.4**).

Historical pH and EC results for all current and decommissioned monitoring bores are presented in **Figures D.1** to **D.6**. Historical pH and EC results for all current monitoring bores are presented in Figures D.7 to D.32 with the mean and standard deviation for each bore shown on each figure. The mean and standard deviation values shown on these figures are based on historical monitoring data from January 2010 to January 2022, as made available through the Glencore Environmental Monitoring Database.

Historically, elevated concentrations of sodium, chloride, sulphate and manganese relative to ANZECC Guidelines (as shown in **Appendix B**, **Table B.3**) have been recorded at numerous monitoring sites. As a result, closer attention is given to these parameters, as in previous annual water reports (Umwelt 2017, Umwelt 2018, Umwelt 2019 and Umwelt 2020).

3.3.2 Alluvium and Underlying Weathered Coal Measures

Quarterly monitoring of groundwater from the alluvium has been undertaken since 2009 at the monitoring location NPZ5B P2 and near Bayswater Creek upstream of the confluence with Emu Creek. Note that NPZ5B P2 was blocked from January 2014 to November 2019 and no water quality data could be collected during this period.

It is noted that NPZ7 Small, located near the Hunter River, is listed as a monitoring bore for the Hunter River alluvium in the site WMP (Ravensworth Operations, 2020), however, an investigation of groundwater trigger exceedances undertaken by Umwelt in 2021 has confirmed that the bore is monitoring weathered Permian coal measures underlying the Hunter River alluvium. This corresponds with the water quality results for the bore that are more saline than what would be expected for the Hunter River alluvium.

The ranges in water quality for NPZ7 Small and NPZ5B P2 is shown in **Appendix D** (**Tables D.2** to **D.4**).

pH results for NPZ7 Small show that pH was consistent with historical data and ranged from pH 7.3 to 7.4 and are all within the adopted IAC range. Four of the six NPZ7 Small EC results were above the IAC limit of 5,259 µS/cm for NPZ7 Small, however the mean EC is below the mean EC for the previous five years. The elevated EC results are therefore considered to be consistent with historical data and the target aquifer in which the bore is screened (i.e. weathered Permian coal measures underlying the Hunter River alluvium).

Analysis of speciation results at NPZ7 (Small) monitoring bore showed consistent or reduced concentrations of sodium and chloride relative to 2018 results:

- Both sodium results were below the recently adopted sodium IAC range.
- Both chloride results were below the recently adopted chloride IAC range.

All other speciation results for NPZ7 (Small) were below interim IAC values.

Six of twelve pH results for NPZ5B P2 (Bayswater Creek alluvium) were outside of the IAC range. An investigation of the trigger exceedances is being undertaken to identify potential trends and inform whether the trigger value for pH should be reviewed.

Water quality results for NPZ5B P2 (Bayswater Creek alluvium) exhibit lower salinity levels than the Hunter River alluvium (NPZ7 (Small)) but elevated levels of manganese above the interim IAC value of 100 µg/L. It is possible that the elevated manganese results are a consequence of the dissolution of manganese bearing alluvial sediments that were wetted following an extended dry period prior to increased rainfall from early 2020. This is partially supported by a slightly elevated manganese level at NP27 (Small) in April.

3.3.3 Bayswater Seam

Monitoring of groundwater quality in the Bayswater Seam occurs at NPZ7 Tall. Water quality results for NPZ7 Tall monitoring bore are shown in **Appendix D** (**Tables D.2** to **D.4**).

Five of the six pH results were slightly below the IAC range, whilst all EC results were within the IAC range.

Analysis of speciation results at NPZ7 Tall monitoring bore showed that both sodium and chloride results were outside the adopted IAC range.

3.3.4 Broonies Seam

Monitoring of groundwater quality in the Broonies Seam is undertaken at NPZ6 (Tall) and NPZ5B P1. Water quality results for NPZ5B P1 and NPZ6 Tall are presented in **Appendix D** (**Tables D.2** to **D.4**).

Two of the twelve pH results recorded at NPZ5B P1 were outside of the IAC range, while all EC results within the IAC range. Analysis of the speciation results for NPZ5B P1 showed:

- Both sodium results were outside of the adopted IAC range.
- The October chloride results were slightly above the adopted IAC range.
- Both sulphate results were above the interim IAC range.
- Both Manganese results were above the interim IAC range.

Eleven of the twelve pH results and six of the twelve EC results for NPZ6 Tall were outside of the IAC range. An investigation of the trigger exceedances (Umwelt 2021) indicates that the pH has been typically above the IAC since 2014 and recommends that the bore be cleared of any sediment that may be impacting water quality results. All NPZ6 Tall sodium and chloride results were above the interim IAC range. However, these results are considered typical of groundwater extracted from a coal seam and the IAC for sodium and chloride which are based on ANZECC 2000 guidelines for recreational water use are not considered applicable. All other speciation results for NPZ6 Tall were below interim IAC values.

3.3.5 Lemington Seam

Monitoring of groundwater quality in the Lemington Seam occurs at NPZ1 Tall, NPZ2 Tall. The ranges in water quality for each monitoring bore are shown in **Appendix D** (**Tables D.2** to **D.4**).

All pH samples at both NPZ1 Tall and NPZ2 Tall, and four of the five EC samples at NPZ2 Tall where outside of the IAC range.

pH levels have frequently been above the trigger level since 2018 and EC has declined with water levels over a corresponding period. The groundwater investigation recommends the bore be cleared of any sediment that may be impacting water quality results.

Analysis of the speciation results for NPZ1 Tall showed:

- Both sodium results were outside of the IAC range.
- Both chloride results were outside of the IAC range; and
- Both manganese results were outside of the IAC range.

Analysis of the speciation results for NPZ2 Tall showed:

- Both sodium results were just outside of the IAC range.
- Both chloride results were outside of the IAC range; and
- Both barium results were outside of the IAC range but are consistent with historical results (from 2014).

3.3.6 Pikes Gully Seams

Monitoring of groundwater quality in the Pikes Gully Seam is undertaken at CS4641C which lies within the Lower Pikes Gully Seam. The range in water quality for CS4641C is presented in **Appendix D** (**Tables D.2** to **D.4**).

Seven pH results and three EC results were outside of the IAC range. An investigation of the trigger exceedances in 2020 (Umwelt 2021) indicated that groundwater levels have declined with the dewatering of the former Cumnock underground workings which has impacted EC and pH levels since 2014. The 2021 results are consistent with the previous years.

Analysis of the speciation results for CS4641C shoed:

- The October sodium results was outside of the IAC range.
- Both chloride results were outside of the IAC range; and
- The October Manganese result was outside of the IAC range.
- The April Barium result was just outside of the IAC range (and the October result just under).

3.3.7 Liddell Seam

Monitoring of groundwater within the Liddell Seam is undertaken at the Coffey Dam Borehole, with both pH and EC values consistently outside of IAC ranges, the later reflected in elevated sodium and chloride levels. Sulphate levels were also observed to be higher than the IAC range.

3.3.8 Other Groundwater Monitoring Locations

Monitoring of groundwater quality in the vicinity of the former Cumnock Wash Plant Pit is undertaken at WPP1 and WPP2. The ranges in water quality within each monitoring bore are shown in Appendix D (Tables D.2 to D.4).

All pH and EC samples at the WPP1 and WPP2 (except one pH sample at WPP2) were within the IAC ranges.

Analysis of speciation results for the WPP1 and WPP2 showed:

- All sodium and chloride results were above the IAC range however these results are considered typical of groundwater extracted from a coal affected aquifer and the IAC for sodium and chloride which are based on ANZECC 2000 guidelines for recreational water use are not considered applicable.
- All sulphate results were well above the IAC range which is consistent with historical monitoring; and
- All manganese results were above the IAC range, which is consistent with previous years when it was noted that manganese concentrations increased as sulphate and chloride concentrations decreased suggesting the possibility of increased surface water recharge due to higher rainfall in 2020 may have mobilised manganese from overlying manganese bearing strata.

3.4 GROUNDWATER LEVEL RESULTS

In 2021, groundwater levels were measured at 14 locations on a monthly basis, with monitoring results shown in **Appendix E** (**Tables E.1 to E.2** and **Figure E.1**) monitoring locations are shown on in **Appendix B** (**Figure B.1**).

3.4.1 Alluvium and Underlying Weathered Coal Measures

Water level monitoring occurs in the Bayswater Creek Alluvium at NPZ5B P2 and the Hunter River Alluvium at NP27 Small.

Following a period of declining groundwater levels from early 2018, believed to be a consequence of an extended period low rainfall, recorded levels at NPZ7 Small (Hunter River Alluvium) showed an increase over the 2020 monitoring period, due to higher rainfall which resulted in increased surface water recharge to the alluvial aquifer. This increase continued through 2021 rising from 32.52 mAHD in December 2020 to 41.28 mAHD in December 2021.

The recorded level in NPZ5B P2 (Bayswater Creek Alluvium) remained relatively constant throughout the 2021 monitoring period.

3.4.2 Bayswater Seam

Groundwater level monitoring in the Bayswater Seam is undertaken at NPZ1 Mid and NPZ7 Tall. NPZ1 Mid is currently blocked and therefore not monitored during 2021. NPZ27 Tall continued to increase during 2021, rising from 35.70 mAHD in January to 41.75 mAHD in December, which is likely a result of the continued rainfall following the extended dry period from 2018 – 2019.

3.4.3 Broonies Seam

Monitoring of groundwater quality in the Broonies Seam is undertaken at NPZ6 Tall and NPZ5B P1. The recorded levels in NPZ6 Tall and NPZ5B P1 remained relatively constant throughout 2021, with the greatest change occurring in NPZ6 Tall which increased by less than 2 m between January and December 2021.

3.4.4 Lemington Seam

Monitoring of groundwater quality in the Lemington Seam occurs at NPZ1 Tall, NPZ2 Tall. The recorded levels in NPZ1 Tall continued to increase during 2021, rising from 33.10 mAHD in January to 36.81 mAHD in December, which is likely a result of the continued rainfall following the extended dry period from 2018 – 2019.

NPZ2 Tall remained relatively constant throughout 2021, which is consistent with historical data.

3.4.5 Pikes Gully Seams

Monitoring of groundwater quality in the Pikes Gully Seam is undertaken at CS4641C which lies within the Lower Pikes Gully Seam. Recorded water levels at CS4641C were relatively stable for the 2021 period. This is consistent with the 2020 data trends, following a steady decline in level since 2015, which followed the sharp decline observed from 2013 to 2015 as a result of and dewatering of the former Cumnock underground workings to allow mining in the Ravensworth North Pit.

3.4.6 Liddell Seam

Monitoring of groundwater within the Liddell Seam is undertaken at the Coffey Dam Borehole. Recorded results at the Coffey Dam Borehole were very stable throughout 2021, with a maximum change of only 0.34 m over the period.

3.4.7 Other Groundwater Monitoring Locations

Monitoring of groundwater quality in the vicinity of the former Cumnock Wash Plant Pit is undertaken at WPP1 and WPP2. Both WPP1 and WPP2 remained very stable throughout 2021, following a subtle increase during 2020.

In addition to the above, groundwater level is recorded in 8 locations (RNW1, RNW2, RNW3, RNW4, RNW5, RNW6, RNW7 and RNW8 as shown on Figure B.1) at 12-hour intervals using vibrating wire piezometers. The purpose of these groundwater level monitoring locations is to identify the groundwater pressure response to mining operations. The water level and depressurisation results from the vibrating wire piezometers is discussed in Section 3.5.

3.5 GROUNDWATER PRESSURE RESPONSE

The groundwater pressure response to mining operations for the 2021 reporting period was measured at 12-hourly intervals using vibrating wire piezometers. The vibrating wire piezometers were installed in 2007 at four locations (CS4655, CS4656, CS4657 and CS4658), in 2008 at four locations (RNVW1, RNVW2, RNVW3, RNVW4), in 2009 in two locations (RVVW5, RNVW6) and in 2010 at two locations (RVVW7, RNVW8).

Piezometers CS4655, CS2656, CS4545, CS4657 and CS4539A have been decommissioned as a result of the progression of the North Pit to the south. The locations of the vibrating wire piezometers are shown in **Appendix B** (**Figure B.1**). Monitoring results are presented graphically in **Appendix E** (**Figures E.2** to **E.10**).

Vibrating wire piezometer CS4658 was removed in June 2020, however, historical results are shown in **Appendix E, Figures E.2**. The results show depressurisation of groundwater at all monitored depths. Depressurisation at a depth of 239 m below ground level (mbgl) was observed to be to a lesser degree than predicted in the Ravensworth Project groundwater model results as reported in Ravensworth Project as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

Results for bore RNVW1 show depressurisation at depths of 48 mbgl, 68 mbgl, 150 mbgl, 190 mbgl and 240 mbgl (refer to **Appendix E**, **Figure E.3**) but to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020). Depressurisation at a depth of 109 mbgl was also observed with the degree of depressurisation exceeding that predicted by the groundwater model and this is consistent with observations in previous years. The groundwater model for the Ravensworth Project also predicted depressurisation at a depth of 326 mbgl for RNVW1, however, results over recent years indicate pressure recovery at this depth.

Results for bore RNVW2 show depressurisation at depths of 239 mbgl and 305 mbgl (refer to **Appendix E**, **Figure E.4**) but to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020). The groundwater model for the Ravensworth Project also predicted depressurisation at a depth of 140 mbgl for RNVW2, however, results over recent years indicate pressure recovery at this depth.

Results for RNVW3 (refer to **Appendix E, Figure E.5**) indicate depressurisation from 2015 onward at all depths. The depressurisation at depths of 103 mbgl, 180 mbgl and 254 mbgl is to a lesser degree than predicted in the Ravensworth Project groundwater model results as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

Results for RNVW4 (refer to **Appendix E, Figure E.6**) show ongoing depressurisation at 102 mbgl, 114 mbgl, 163 mbgl, 201 mbgl and 225 mbgl. The depressurisation at depths of 102 mbgl and 163 mbgl is to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

Results for RNVW5 (refer to **Appendix E, Figure E.7**), indicate minimal or no depressurisation for the 2021 monitoring period. It is noted that the RNVW5 instrument is outputting zero readings on channels 1 (depth of 19 mbgl), 3 (depth of 87 mbgl) and 6 (depth of 279 mbgl) and therefore no observations of depressurisation at these depths can be made. It also began outputting zero reading at channel 7 (depth of 350 mbgl) in March 2021 and therefore the results show in Appendix E, Figure E.7 are for March, while there were still results at CH7.

Results for RNVW6 (refer to **Appendix E, Figure E.7**) have previously indicated depressurisation at depths of 19 mbgl and 66 mbgl in excess of those predicted in the Ravensworth Project groundwater model results as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020). However, pressures have stabilised at a depth of 19 mbgl, with slight recovery in 2021, and recovered at a depth of 66 mbgl in recent years. Depressurisation at a depth of 265 mbgl was previously observed to a lesser degree than predicted by the groundwater model, however, has stabilised over 2020 and 2021. It should be noted that results have not been observed at piezometer RNVW6 since June 2021.

Results for RNVW7 (refer to **Appendix E, Figure E.8**) show ongoing depressurisation at depths from 121 mbgl to 335 mbgl which is consistent with groundwater model predictions for the Ravensworth Project. It is noted that channel 1 (depth of 83 mbgl) appears to be outputting erroneous results and therefore no observations of depressurisation at this depth can be made.

Vibrating wire piezometer for RNVW8 was removed in June 2020, however, historical results are shown in **Appendix E, Figure E.10.** The results indicate depressurisation at a depth of 252 mbgl but to a lesser degree than predicted in the Ravensworth Project groundwater model results as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

3.6 GROUNDWATER MODEL REVIEW

Condition 6.8.4 of the PA 09_0176 requires biennial review of the groundwater model.

A review of the model was completed in 2020 by AGE. The review concluded that the groundwater model continues to predict groundwater impacts with satisfactory accuracy, and that no further calibration of the model is required at this stage. A review of groundwater model predictions will be undertaken again in 2022.

4 WATER BALANCE

4.1 WATER SOURCES AND DEMANDS

The water management system at RC consists of water storages, pumps, pipelines, and instrumentation for flow and level measurement. The existing RC water management system consists of three separate systems, including:

1. Clean (raw) water system.
2. Dirty water system (sediment).
3. Mine water system (saline).

These systems are further described in the Ravensworth Complex WMP.

The WMS infrastructure is monitored and controlled via the RC Citect supervisory control and data acquisition (SCADA) systems (separate systems are used by Ravensworth Open Cut (ROC) and RCHPP/RUM). The Citect SCADA system incorporates a graphical user interface (GUI) that displays the status of WMS infrastructure (e.g. dam levels, pump on/off, flow rates, etc.) and operator access to operate equipment and adjust WMS infrastructure set points. Operational WMS data collected by the Citect SCADA system is utilised in site water accounting models to monitor RC water sources and demands.

Key water sources for the RC include:

- Rainfall/runoff within the ROC and RCHPP WMS.
- Groundwater seepage into operating open cut pits, voids and underground mine pits (and spoils seepage to Narama Pit).
- Moisture in ROM coal.
- Groundwater extracted from the former Cumnock underground workings.
- Water imported from the Mount Owen Complex or Liddell Mine under the Greater Ravensworth Area Water and Tailings Scheme (GRAWTS).
- Water imported from the Hunter River.
- Potable water trucked to site.

Key water demands for the RC include:

- Evaporative losses from water storages.
- Dust suppression (haul roads, stockpiles and handling) and vehicle wash bay losses.
- RCHPP losses: moisture bound with product coal and rejects (coarse and fine).
- Discharges under the Hunter River Salinity Trading Scheme (HRSTS).
- Transfers to the Mount Owen Complex or Liddell Mine under the GRAWTS.

4.2 SURFACE WATER DISCHARGE

Surplus surface water at ROC is transferred to RCHPP or discharged from the Narama In-pit Storage Dam to the Hunter River via Bowmans Creek under the conditions of Ravensworth Operations EPL 2652 and the HRSTS or transferred to other Glencore mine sites under the GRAWTS.

EPL 2652 permits a maximum discharge of 400 ML/day from the Narama In-pit Storage Dam under the HRSTS Regulations. In 2021, RC held a total of 159 salt credits. During some discharge events, additional credits were transferred from other sites. These combined holdings were sufficient for RC to operate under the conditions of the HRSTS and EPL 2652.

In 2021, RC discharged 1,511 ML of water from the Narama In-pit Storage Dam under the conditions of the HRSTS and EPL 2652. A summary of the 2021 discharge events from RC is included in Table 4.1.

During large rainfall events in November 2021, a total of 2.4 ML of unregulated discharges occurred from RC.

Table 4.1: 2021 HRSTS Discharge Events

Discharge Block ID	Total Discharge (ML)	Credits Held
2021-80(2)	11.7	159
2021-80(3)	119.9	159
2021-81(2)	99.8	189
2021-82(4)	129.2	189
2021-84(3)	35.4	194
2021-85(3) (Flood TAD)	42.9	194
2021-87(2)	56.6	159
2021-179(2)	32.3	264
2021-317(1)	18.06	159
2021-320(1)	0.90	159
2021-327(1)	86.39	159
2021-328(1)	101.53	159
2021-329(2)	79.89	177
2021-331(2)	58.18	139
2021-334(2)	170.89	194
2021-336(1)	91.34	184
2021-341(1)	29.64	164
2021-342(1)	25.62	164
2021-343(1)	30.29	234
2021-344(2)	78.30	234
2021-345(3)	170.19	164
2021-346(2)	41.89	164

4.3 SURFACE WATER EXTRACTION

RC holds water access licences WAL 9050, WAL 10771 and WAL 18317 that allow RC to extract water from the Hunter River and Bayswater Creek. In addition, RCHPP holds water access licences WAL 1046, WAL 8964, and WAL 1325 allowing RC to extract water from the Hunter River.

In 2021, RC extracted a total of 99.7 ML from the Hunter River. Table 4.2 presents the surface water extraction for each RC WAL for the 2021 calendar year.

Table 4.2: 2021 Surface Water Extractions

WAL / Reference Number	Water Source / Management Zone	Category	Entitlement	Extracted Volume (ML)
WAL 10771 (20WA200463)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	25	0
WAL 1046 (20AL201444)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	3	0
WAL 13102 (20AL203412)	Hunter River Regulated/Zone 1a (Hunter River from Glenbawn Dam to Goulburn River Junction)	High Security	15	0
WAL 9050 (20AL200744)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	500	99.7
WAL 8964 (20AL203224)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	1,590	0
WAL 1325 (20AL203042)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	Supplementary	13	0
WAL 18317 (20WA210981)	Unregulated River/Jerrys Management Zone	Unregulated	20	0

4.4 GROUNDWATER EXTRACTION

During the 2021 monitoring period, RC extracted a total of 2,143 ML of groundwater. The extraction was undertaken in compliance with the conditions of all relevant licences shown in Table 4.3.

Table 4.3: 2021 Groundwater Extractions

WAL / Reference Number	Water Source	Extraction Limit (ML)
WAL 41496 (20BL170776)	Cumnock South Open Cut	50
WAL 41496 (20BL168240)	Cumnock No 1. Underground Goaf	2,520
WAL 41530 (20BL170462)	Ravensworth West Pit Void Incidental Groundwater Interception	100
WAL 41531 (20BL170749)	Narama Void Incidental Groundwater Interception	150

4.5 2021 WATER BALANCE SUMMARY

4.5.1 Site Recorded Data

The site recorded data in the Ravensworth Complex 2021 Water Accounting Framework (WAF) was used to complete the 2021 water balance assessment.

The site recorded rainfall for 2021 was 1,042 mm which exceeds the long-term 90th percentile rainfall at the Jerry's Plains Bureau of Meteorology station (station number 61086) of 904 mm.

4.5.2 2021 Water Balance

The 2021 water balance summary for RC is provided in Table 4.4.

Table 4.4: Ravensworth Complex 2021 Site Water Balance

Item	Volume (ML)
INFLOWS	
Rainfall Runoff	6,300
Groundwater Inflow	2,143
ROM Coal Moisture	830
From Mount Owen Complex (MOC)	1,913
From Liddell Coal Operations (LOC)	2,540
Potable Supply	11
From Hunter River	100
Total Inflows	**13,837**
OUTFLOWS	
Evaporation	745
Dust Suppression / Washbay	491
CHPP Supply	3,891
Product Coal Moisture	748
Coarse Rejects Moisture	303
Tailings Water	1,495
To MOC	0
To LOC	0
Other Third-party supply (to HVO, Oaklands Property)	8
HRSTS Discharges to the Hunter River	1,511
Uncontrolled Release	2
Total Outflows	**9,195**
Inflow – Outflow	**4,642**
Recorded Stored on Site at Start of Annual Review Period	6,953
Recorded Stored on Site and End of Annual Review Period	9,539

Item	Volume (ML)
Change in Storage	**2586**
Error	**9%**

The RC water balance assessment for 2021 produced a net inventory change over the year of 4,644 ML, compared to the recorded change in inventory of 1,236 ML. This resulted in a water balance error of approximately 9%, which is within the acceptable limit for Glencore WAF reporting. This suggests that all inflow and outflows of the mine water system have been accounted for. The minor balance error is likely a result of estimated / calculated water streams where exact monitoring is not practicable (e.g. groundwater inflow calculations, runoff estimates, etc.).

5 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

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g) This Report does not provide legal advice.

6 REFERENCES

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ENGENY WATER MANAGEMENT

Appendix A:
Surface Water Monitoring Locations and Impact Assessment Criteria

Table A.1: Surface Water Monitoring Locations

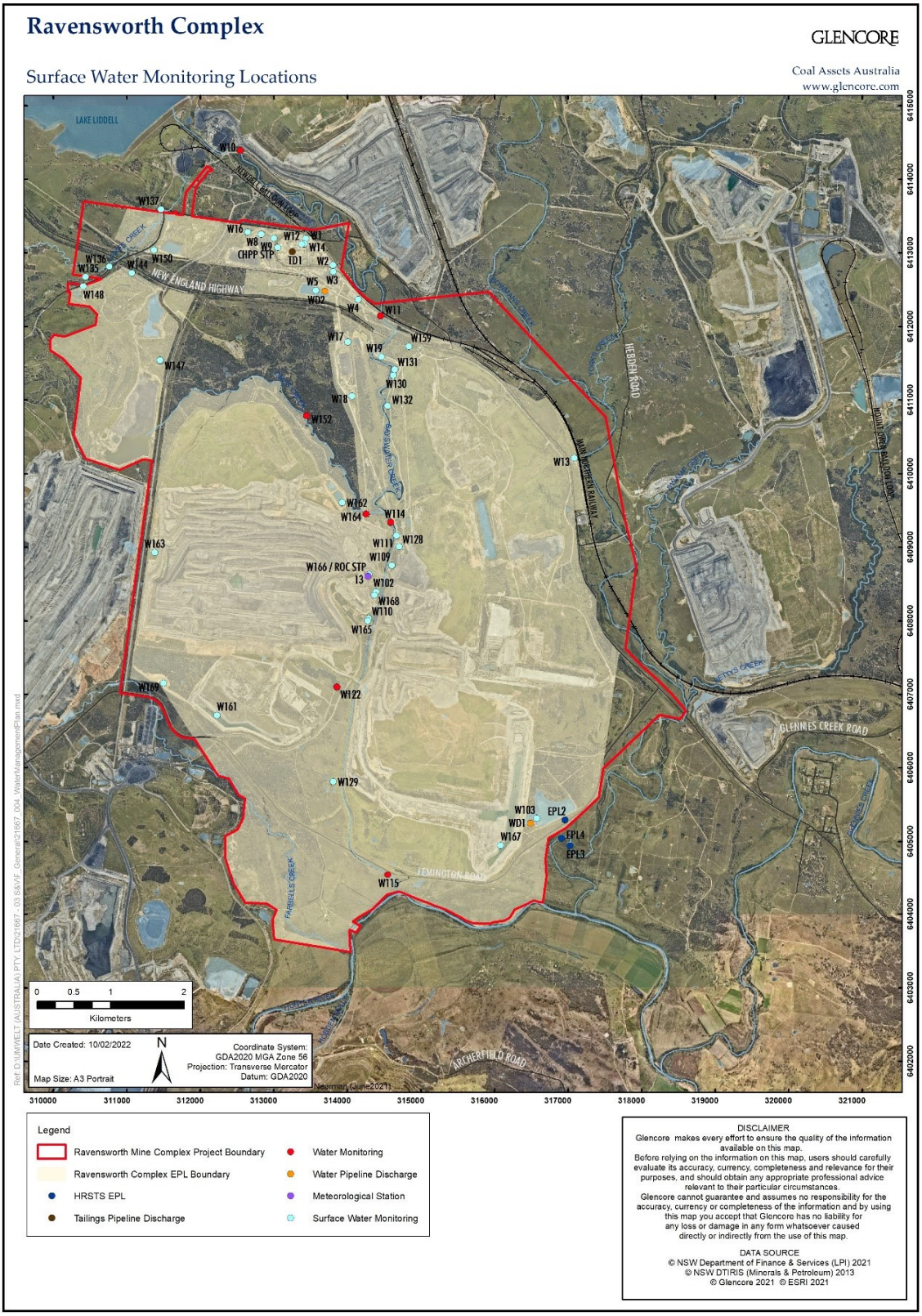
Watercourse	Monitoring Location	Site Description	Monitoring Frequency
Bowmans Creek	EPL 3	Bowmans Creek Upstream[1]	Monthly
	EPL 4	Bowmans Creek Downstream[1]	Monthly
Bayswater Creek (ROP)	W114	Bayswater Creek Upstream	Monthly
	W115	Bayswater Creek Downstream	Monthly
Bayswater Creek (RUM)	W10	Bayswater Creek Upstream	Monthly
	W11	Bayswater Creek Downstream	Monthly
Emu Creek	W122	Emu Creek Downstream	Monthly
Davis Creek	W152	Davis Creek 2	Bi-monthly
	W164	Davis Creek Downstream	Bi-monthly
Pikes Creek	W135	Pikes Gully Creek Upstream	Bi-monthly
	W136	Pikes Gully Creek at New England Highway	Bi-monthly
	W137	Pikes Gully Creek at CHPP Culvert	Bi-monthly

Note 1: During HRSTS discharge events pH, EC and TSS to be monitoring twice per day

Table A.2 Adopted Surface Water IAC Values for Key Water Quality Parameters

Watercourse	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
Bowmans Creek	7.7 – 8.1	1,331	18	817
Bayswater Creek	7.7 – 8.5	4,882	23	3,216
Emu Creek	7.4 – 8.2	3,336	47	1,349
Davis Creek	7.5 – 8.3	7,378	31	4,630
Pikes Gully	7.8 – 8.3	13,832	32	10,818

Figure A.1: Surface Water Monitoring Locations



ENGENY WATER MANAGEMENT

Appendix B:
Groundwater Monitoring Locations and Impact Assessment Criteria

Table B.1: Groundwater Monitoring Locations

Monitoring Location	Target	Monitoring Frequency			
		Water Level	pH	EC	Speciation
Coffey Dam Borehole	Liddell	Monthly	Quarterly	Quarterly	Annually
CS4641C	Pikes Gully	Monthly	Quarterly	Quarterly	Annually
NPZ1 Mid	Bayswater	Monthly	Quarterly	Quarterly	Annually
NPZ1 Tall	Lemington	Monthly	Quarterly	Quarterly	Annually
NPZ2 Tall	Lemington	Monthly	Quarterly	Quarterly	Annually
NPZ5B P1	Broonies	Monthly	Quarterly	Quarterly	Annually
NPZ5B P2	Bayswater Aluvium	Monthly	Quarterly	Quarterly	Annually
NPZ6 Tall	Broonies	Monthly	Quarterly	Quarterly	Annually
NPZ7 Tall	Weathered Permian Coal Measures Underlying Hunter River Alluvium	Monthly	Quarterly	Quarterly	Annually
NPZ7 Small	Bayswater	Monthly	Quarterly	Quarterly	Annually
NPZ7 Mid	Broonies	Monthly	Quarterly	Quarterly	Annually
Borehole P	Liddell	Monthly	Not Sampled	Not Sampled	Not Sampled
WPP1	-	Monthly	Quarterly	Quarterly	Annually
WPP2	-	Monthly	Quarterly	Quarterly	Annually

Table B.2: Adopted Impact Assessment Criteria Values for Key Water Quality Parameters

Monitoring Location	Target	Water Quality Parameter	IAC
Coffey Dam Borehole	Liddell	pH[1]	9.2 - 10
		EC (µS/cm)[1]	3160
CS4641C	Pikes Gully	pH	8.78 - 11.9
		EC (µS/cm)[1]	8900 – 8548
NPZ1 Mid	Bayswater	pH[1]	6.6 - 6.8
		EC (µS/cm)[1]	15015
NPZ1 Tall	Lemington	pH[1]	7 - 7.3
		EC (µS/cm)[1]	9736
NPZ2 Tall	Lemington	pH	8.3-8.4
		EC (µS/cm)[1]	9765
NPZ5B P1	Broonies	pH	7.2 - 7.44

Monitoring Location	Target	Water Quality Parameter	IAC
		EC (µS/cm)[1]	6340
NPZ5B P2	Bayswater Creek Alluvium	pH	7.1 - 7.3
		EC (µS/cm)[1]	2193
NPZ6 Tall	Broonies	pH	7.5 - 7.7
		EC (µS/cm)[1]	7120
NPZ7 Small	Hunter River Alluvium	pH	7.3 - 7.47
		EC (µS/cm)[1]	5259
NPZ7 Tall	Bayswater	pH[1]	7.38 - 7.5
		EC (µS/cm)[1]	8678
NPZ7 Mid	Broonies	pH[1]	7.34 - 7.66
		EC (µS/cm)[1]	8446
WPP1	-	pH[1]	7 - 7.1
		EC (µS/cm)[1]	8604
WPP2	-	pH[1]	7 - 7.32
		EC (µS/cm)[1]	9352

Table B.3 Interim Impact Assessment Criteria Values for Speciation Parameters

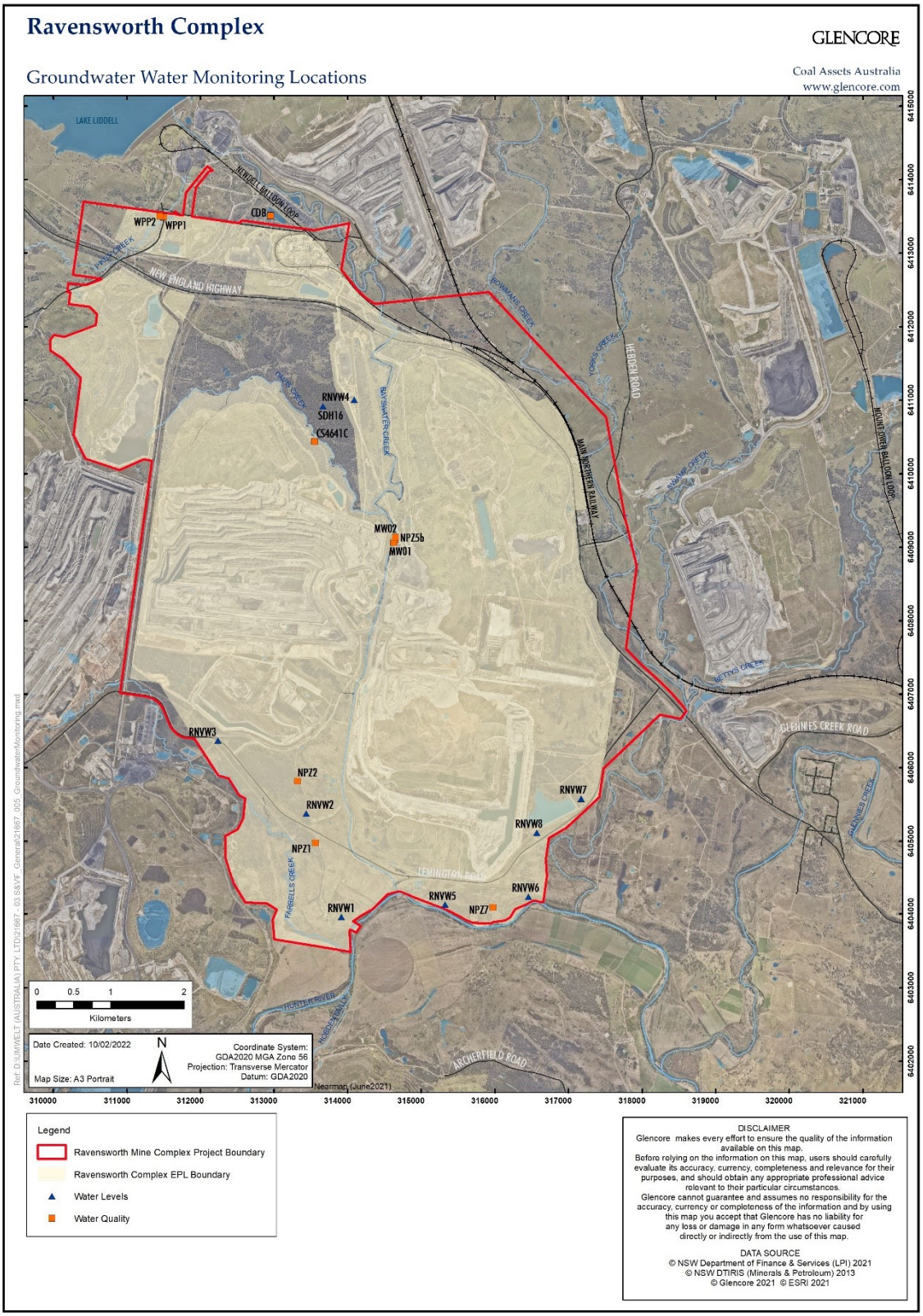
Parameter	Unit of Measurement	IAC Value
Sodium	mg/L	300
Sulphate	mg/L	400
Chloride	mg/L	400
Iron	mg/L	0.3
Silver	mg/L	0.05
Aluminium	mg/L	0.2
Barium	mg/L	1
Cadmium	mg/L	0.005
Copper	mg/L	1
Manganese	mg/L	0.1
Nickel	mg/L	0.1

Parameter	Unit of Measurement	IAC Value
Lead	mg/L	0.05
Selenium	mg/L	0.01
Zinc	mg/L	5
Mercury	mg/L	0.001
Nitrite N	mg/L	1
Nitrate as N	mg/L	10

Table B.4: Site Specific Impact Assessment Criteria Values for Sodium and Chloride

Site	Parameter	Unit of Measurement	IAC Value 80th Percentile	IAC Value 20th Percentile
CS4641C	Sodium	mg/L	1980	1820
	Chloride	mg/L	2482	2310
NPZ1 Tall	Sodium	mg/L	2048	1820
	Chloride	mg/L	2744	2225
NPZ2 Tall	Sodium	mg/L	2178	2100
	Chloride	mg/L	2685	2430
NPZ5B P1	Sodium	mg/L	939	820
	Chloride	mg/L	1020	830
NPZ7 Small	Sodium	mg/L	1496	1300
	Chloride	mg/L	2492	1990
NPZ7 Tall	Sodium	mg/L	1602	1320
	Chloride	mg/L	2542	2099

Figure B.1: Groundwater Monitoring Locations



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WATER MANAGEMENT

Appendix C:
Surface Water Qulity Monitoring Results

Table C.1: 2021 Surface Water Quality Summary (pH and TSS)

Water Course	Monitoring Location	pH			TSS (mg/L)			No. of samples
		Min	Max	Mean	Min	Max	Mean	
Bowmans Creek	EPL3	7.50	7.87	7.74	<5.00	35.00	17.29	12
	EPL4	7.42	7.83	7.71	<5.00	48.00	25.75	11
Bayswater Creek (ROC)	W114	7.41	8.16	7.65	<5.00	341.00	78.50	8
	W115	7.20	8.57	8.07	<5.00	560.00	115.56	10
Bayswater Creek (RUM)	W10	7.80	8.40	8.02	<5.00	27.00	11.75	12
	W11	7.30	8.20	7.88	<5.00	1,220.00	196.88	10
Emu Creek	W122	7.32	7.67	7.49	5.00	23.00	11.25	4
Davis Creek	W152	7.03	7.57	7.29	<5.00	52.00	22.25	5
	W164	7.90	7.90	7.90	86.00	86.00	86.00	1
	W135	7.08	7.66	7.35	<5.00	23.00	12.00	8
Pikes Gully Creek	W136	7.66	8.34	7.92	7.00	19.00	11.33	9
	W137	7.43	7.66	7.53	<5.00	21.00	19.50	3

Table C.2: 2021 Surface Water Quality Summary (Electrical Conductivity and TDS)

Water Course	Monitoring Location	Electrical Conductivity (µS/cm)			TDS (mg/L)			No. of samples
		Min	Max	Mean	Min	Max	Mean	
Bowmans Creek	EPL3	391	1,030	818	309.00	623.00	507.75	12
	EPL4	486	1,160	891	318.00	640.00	516.00	11
Bayswater Creek (ROC)	W114	3,310	4,280	3,779	2,130.00	2,840.00	2,447.50	8
	W115	603	4,570	3,030	459.00	2,840.00	1,892.70	10
Bayswater Creek (RUM)	W10	3,010	6,050	4,939	1,890.00	3,980.00	3,195.00	12
	W11	292	4,110	2,092	188.00	2,600.00	1,364.00	10
Emu Creek	W122	287	1,090	696	286.00	736.00	487.75	4
Davis Creek	W152	168	6,220	1,817	238.00	3,760.00	1,183.00	5
	W164	749	749	749	442.00	442.00	442.00	1
	W135	205	8,450	2,965	174.00	6,580.00	2,216.38	8
Pikes Creek	W136	1,830	19,500	7,121	1,080.00	13,700.00	4,976.67	9
	W137	885	15,100	6,115	571.00	13,600.00	5,287.00	3

The 2021 surface water monthly water quality monitoring results for pH, EC, TSS and TDS for surface water are presented in tables C.3 to C.6 respectively. These tables identify when sampling was not taken due to the monitoring location being dry, or due to two monthly sampling regimes.

Tables C.3-C.6 contain the following formatting:

	Indicates monitoring location was dry
	Indicates non-sampling month
xxxx	Indicates an exceedance of the IAC range

Table C.3: 2021 Watercourse pH Monitoring Results

NOTE: pH field results were used for sites W10 and W11 as no lab results were available.

Site	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
EPL3 - Bowmans Creek Upstream	7.5	7.83	7.75	7.84	7.66	7.76	7.74	7.87	7.79	7.68	7.73	7.74
EPL4 - Bowmans Creek Downstream		7.83	7.73	7.56	7.69	7.75	7.76	7.81	7.75	7.42	7.71	7.75
W114 - Bayswater Creek Upstream				7.76	7.41	7.45	7.50	7.63	7.54	7.73		8.16
W115 - Bayswater Creek Downstream	7.20		7.94	8.41	8.10	8.26	7.91	8.17	8.07	8.09		8.57
W10 - Bayswater Creek Upstream	7.80	7.80	7.90	8.10	7.90	8.10	8.00	8.10	8.00	8.20	7.90	8.40
W11 - Bayswater Creek Downstream	7.80	7.70	7.30	8.20	8.10	8.00	8.00	8.00	8.00	7.70		
W122 - Emu Creek Downstream	7.50		7.46	7.67								7.32
W152 - Davis Creek 2		7.30	7.18			7.14					7.57	7.52
W164 - Davis Creek Down		7.90										
W135 - Pikes Gully Upstream	7.10	7.38	7.08	7.66		7.23		7.46			7.47	7.42
W136 - Pikes Gully @ New England Highway	7.70	7.81	7.66	8.12		8.01		8.34		7.80	8.00	7.78
W137 - Pikes Gully Road @ CHPP Culvert		7.66	7.43									7.50

Table C.4: 2021 Watercourse EC Monitoring Results

Site	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
EPL3 - Bowmans Creek Upstream	391	487	837	754	949	980	931	1020	1030	958	961	518
EPL4 - Bowmans Creek Downstream		486	836	775	965	1020	956	1060	1050	1060	977	516
W114 - Bayswater Creek Upstream				4280	4280	4250	3310	3380	3330	3450		3950
W115 - Bayswater Creek Downstream	603		915	4520	4570	4500	2940	3050	2960	3440		2800
W10 - Bayswater Creek Upstream	4570	5110	3010	5650	5530	5330	5100	5860	4800	5180	6050	3080
W11 - Bayswater Creek Downstream	2290	1252	449	4110	3910	913	2640	2730	2330	292	4110	3910
W122 - Emu Creek Downstream	586		822	1090			1090					287
W152 - Davis Creek 2		168	236			320					2140	6220
W164 - Davis Creek Down		749										
W135 - Pikes Gully Upstream	2320	283	205	1220		7960		8450			1600	1680

Site	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
W136 - Pikes Gully @ New England Highway	3800	6700	4580	6800		10400		19500		1830	3540	6940
W137 - Pikes Gully Road @ CHPP Culvert		885	2360									15100

Table C.5: 2021 Watercourse TSS Monitoring Results

Site	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
EPL3 - Bowmans Creek Upstream	33.0	11.0	<5.0	<5.0	<5.0	<5.0	7.0	<5.0	5.0	13.0	35.0	17.0
EPL4 - Bowmans Creek Downstream		36.0	10.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	9.0	48.0
W114 - Bayswater Creek Upstream				15.0	25.0	341.0	<5.0	5.0	29.0	56.0		<5.0
W115 - Bayswater Creek Downstream	8.0		148.0	560.0	18.0	<5.0	29.0	61.0	8.0	8.0		200.0
W10 - Bayswater Creek Upstream	<5.0	<5.0	8.0	<5.0	<5.0	<5.0	<5.0	<5.0	27.0	<5.0	7.0	5.0
W11 - Bayswater Creek Downstream			1,220.0	85.0	<5.0	5.0	128.0	24.0	<5.0	98.0	8.0	7.0
W122 - Emu Creek Downstream	6.0								11.0	5.0		23.0
W152 - Davis Creek 2		14.0	52.0			16.0					7.0	<5.0
W164 - Davis Creek Down		86.00										
W135 - Pikes Gully Upstream	13.0	15.0	23.0	<5.0		6.0		8.0			7.0	<5.0
W136 - Pikes Gully @ New England Highway	10.0	19.0	12.0	7.0		12.0		10.0		13.0	11.0	8.0
W137 - Pikes Gully Road @ CHPP Culvert		18.0	<5.0									21.0

Table C.6: 2021 Watercourse TDS Monitoring Results

Site	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
EPL3 - Bowmans Creek Upstream	325.0	562.0	623.0	577.0	584.0	542.0	571.0	560.0	492.0	498.0	450.0	309.0
EPL4 - Bowmans Creek Downstream	318.0	562.0	640.0	559.0	609.0	544.0	587.0	555.0	472.0	490.0	340.0	318.0
W114 - Bayswater Creek Upstream			2,460.0		2,160.0	2,130.0	2,240.0	2,220.0	2,770.0	2,760.0	2,840.0	2,460.0
W115 - Bayswater Creek Downstream	8.00		148.0	560.0	18.00	<5.0	29.0	61.0	8.0	8.0		200.0
W10 - Bayswater Creek Upstream	2,130.0	3,880.0	3,290.0	2,890.0	3,980.0	3,670.0	3,430.0	3,620.0	3,440.0	1,890.0	3,320.0	2,800.0
W11 - Bayswater Creek Downstream			188.00	1,530.0	1,780.0	1,740.0	664.00	2,530.0	2,600.0	437.00	771.00	1,400.0
W122 - Emu Creek Downstream	286.0								736.0	529.0		400.0
W152 - Davis Creek 2		238.0	308.0	299.0							1310.0	3760.0
W164 - Davis Creek Down		442.0										
W135 - Pikes Gully Upstream	1730.0	174.0	233.0	731.0		6260.0		6580.0			983.0	1040.0
W136 - Pikes Gully @ New England Highway	2720.0	4430.0	3090.0	4540.0		7970.0		13700.0		1080.0	2280.0	4980.0
W137 - Pikes Gully Road @ CHPP Culvert		571.00	1690.0									13600.0

2021 monthly water quality monitoring results for pH, EC, TSS and TDS are shown below for Bowmans Creek (Figures C.1-C.4), Bayswater Creek (ROP) (Figures C.5-C.8), Bayswater Creek (RUM) (Figures C.9-C.12), Emu Creek (Figures C.13-C.16), Davis Creek (Figures C.17-C.20) and Pikes Gully (Figures C.21-C.24). The mean and standard deviation values shown on the figures are based on historical monitoring data from January 2010 to January 2022, as made available through the Glencore Environmental Monitoring Database.

Figure C.1: Bowmans Creek pH

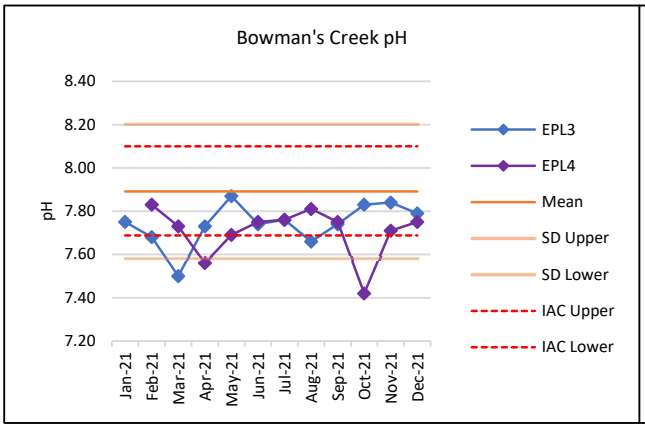


Figure C.2: Bowmans Creek EC

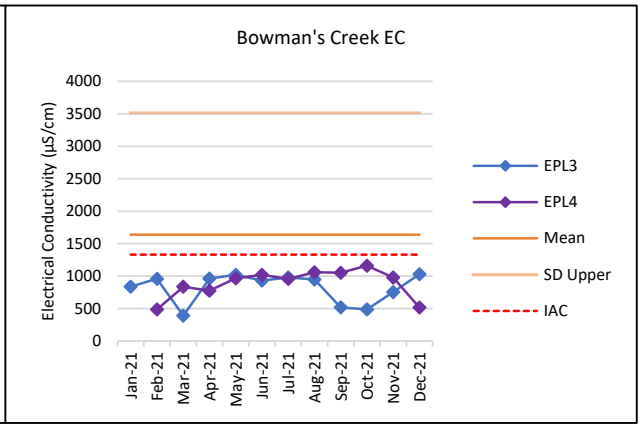


Figure C.3: Bowmans Creek TSS

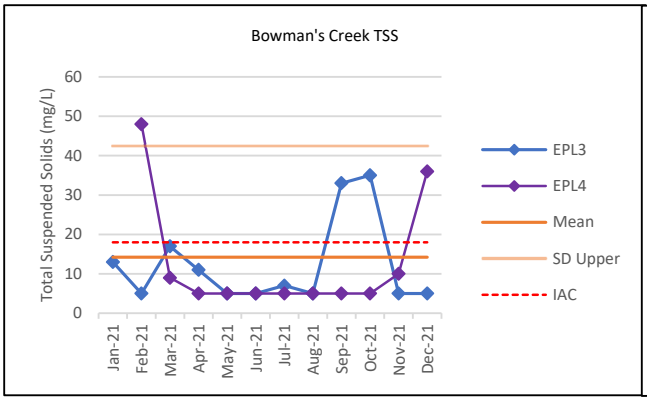


Figure C.4: Bowmans Creek TDS

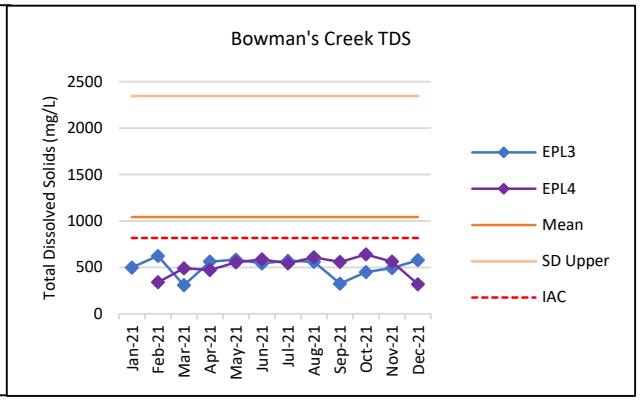


Figure C.5: Bayswater Creek (ROP) pH

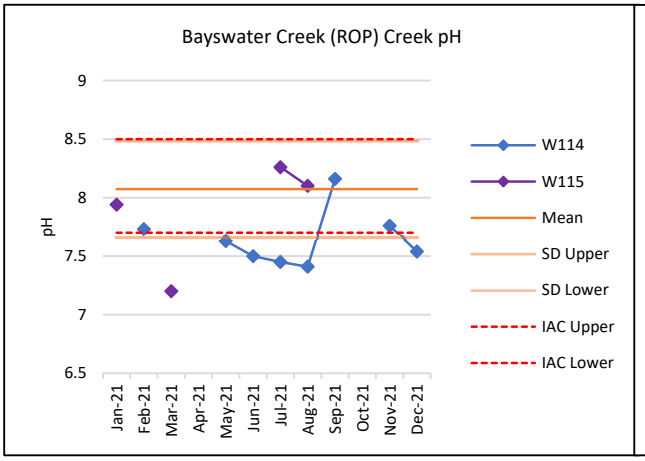


Figure C.6: Bayswater Creek (ROP) EC

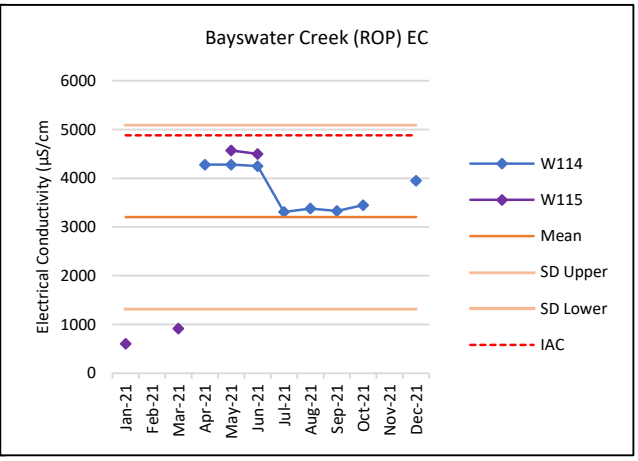


Figure C.7: Bayswater Creek (ROP) TSS

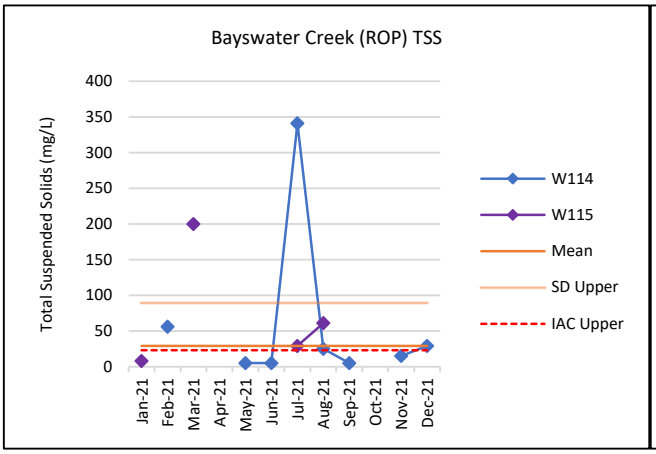


Figure C.8: Bayswater Creek (ROP) TDS

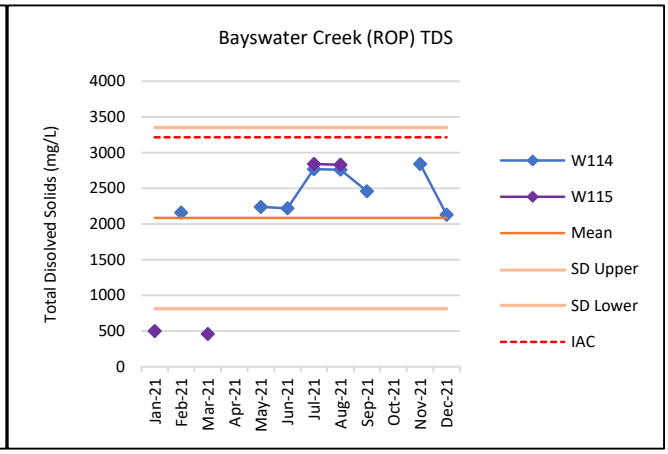


Figure C.9: Bayswater Creek (RUM) pH

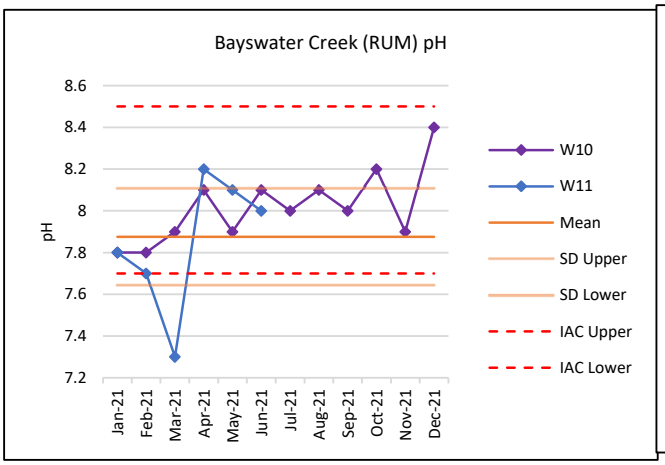


Figure C.10: Bayswater Creek (RUM) EC

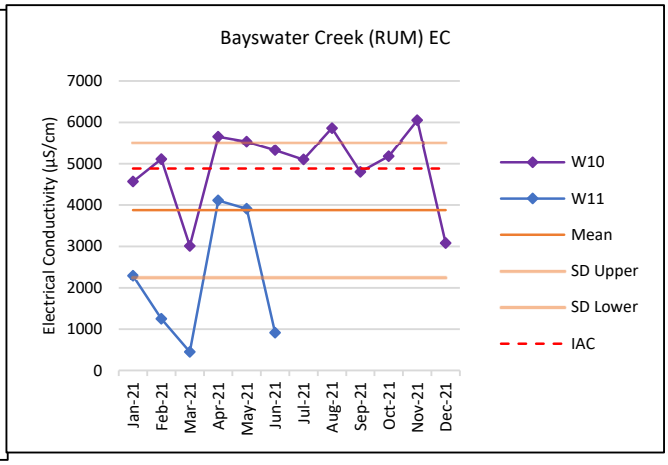


Figure C.11: Bayswater Creek (RUM) TSS

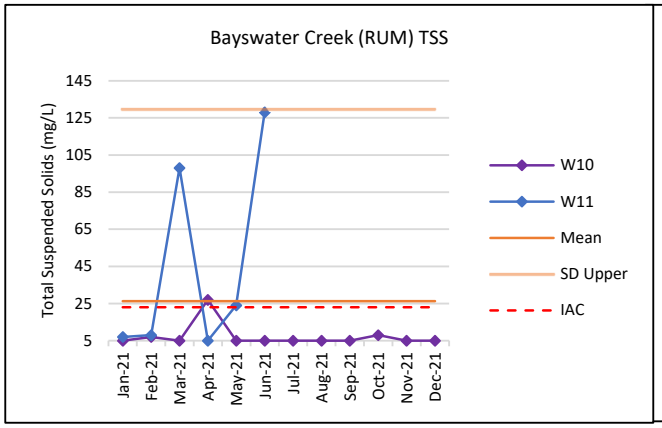


Figure C.12: Bayswater Creek (RUM) TDS

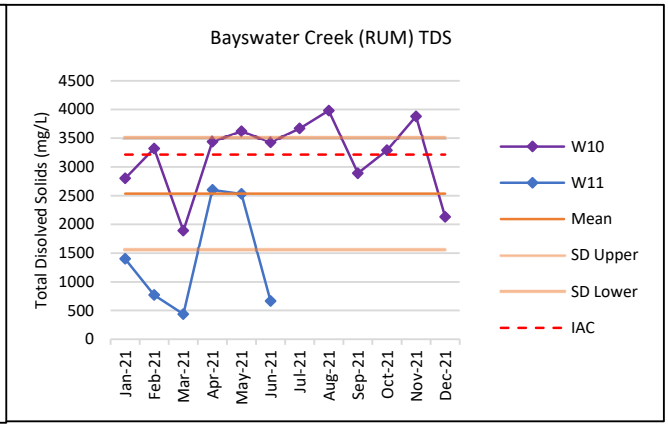


Figure C.13: Emu Creek pH

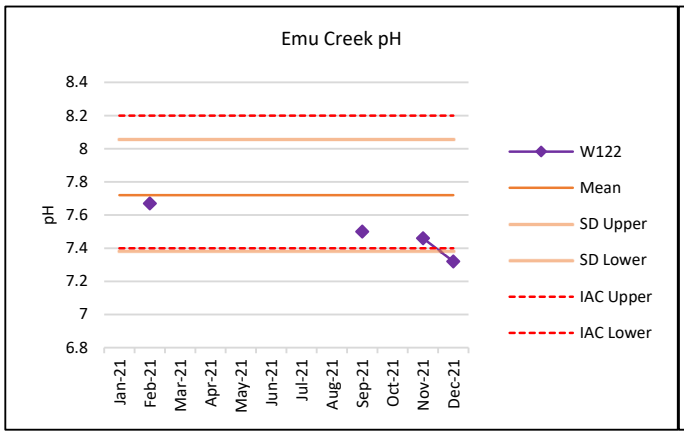


Figure C.14: Emu Creek EC

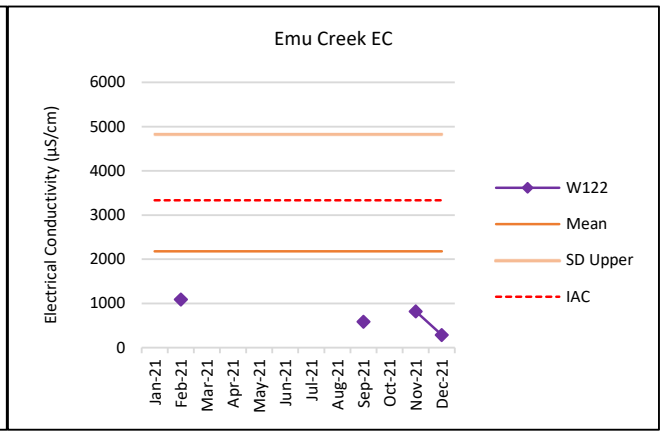


Figure C.15: Emu Creek TSS

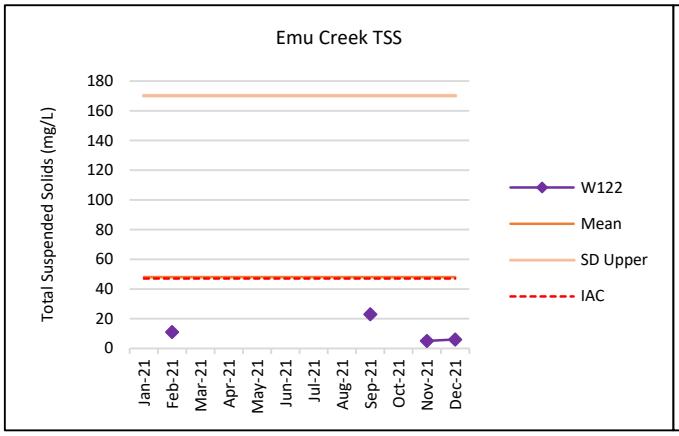


Figure C.16: Emu Creek TDS

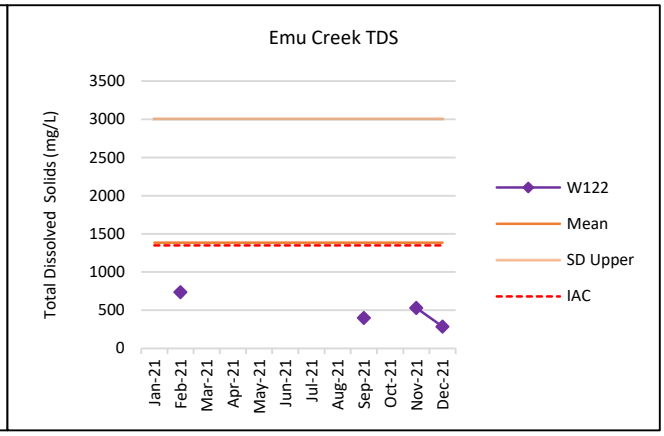


Figure C.17: Davis Creek pH

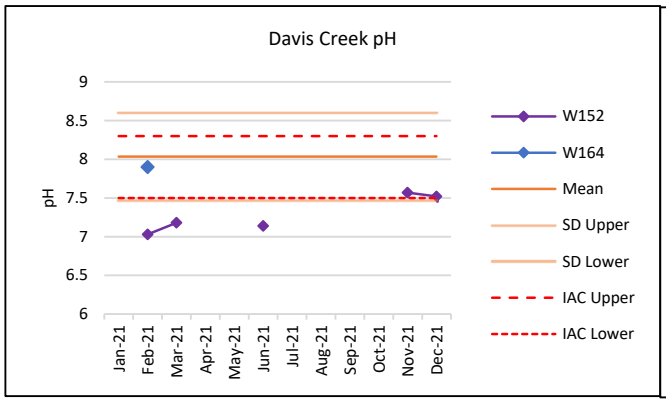


Figure C.18: Davis Creek EC

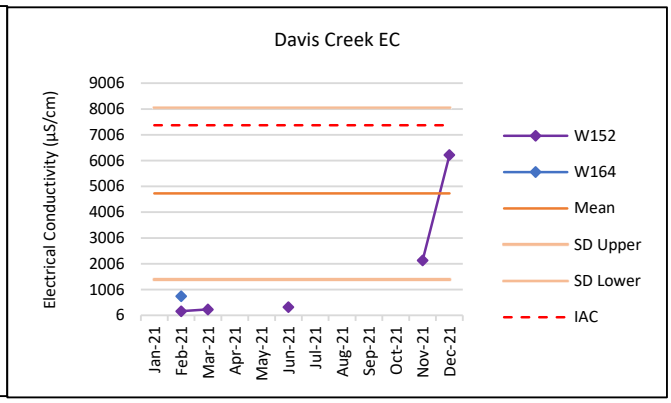


Figure C.19: Davis Creek TSS

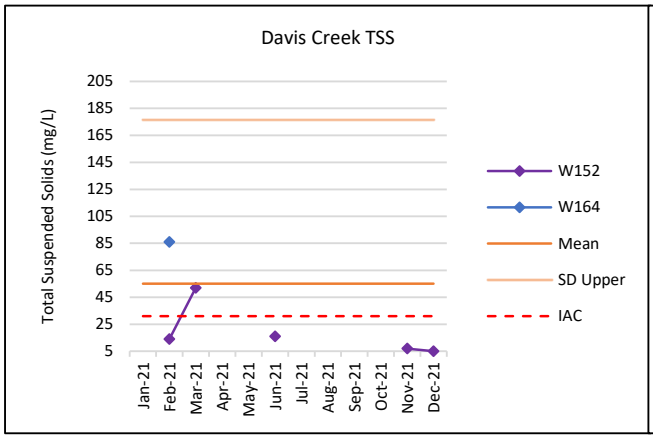


Figure C.20: Davis Creek TDS

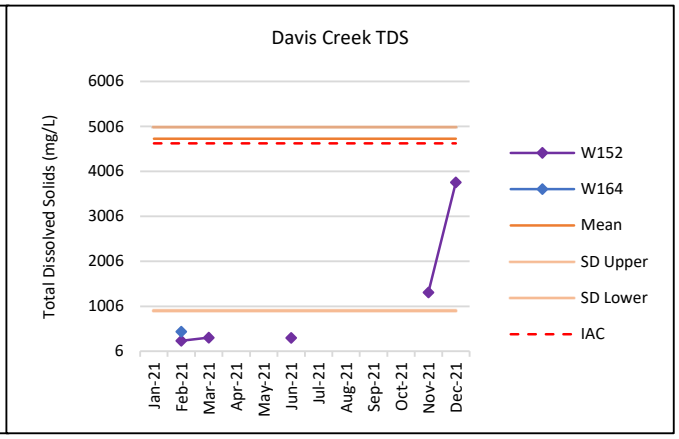


Figure C.21: Pikes Gully pH

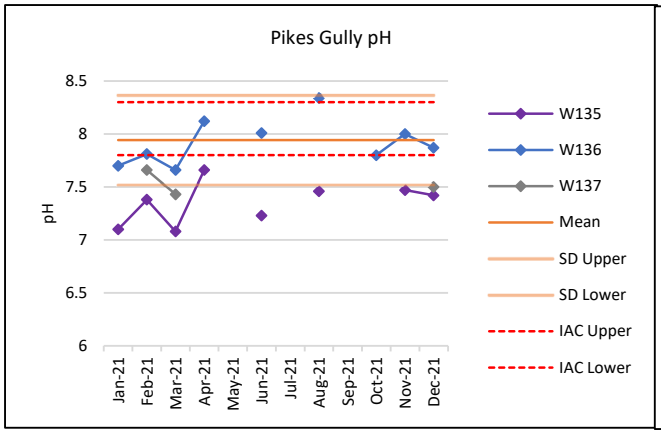


Figure C.22: Pikes Gully EC

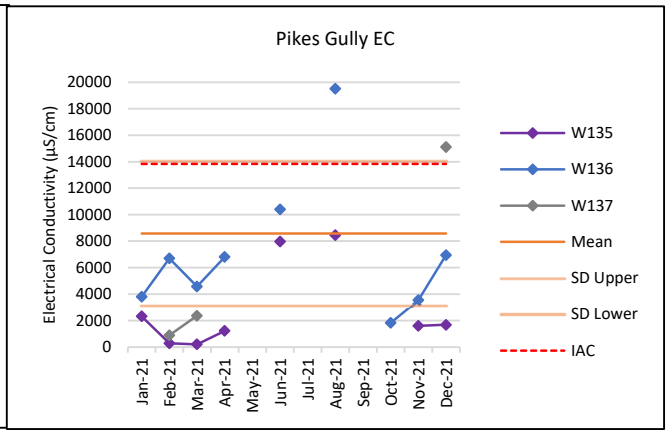


Figure C.23: Pikes Gully TSS

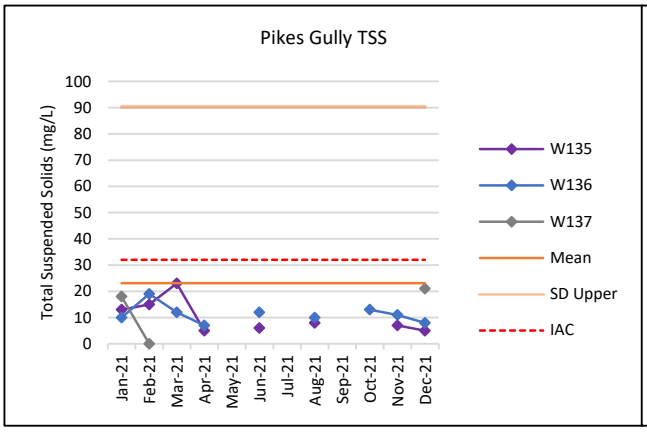
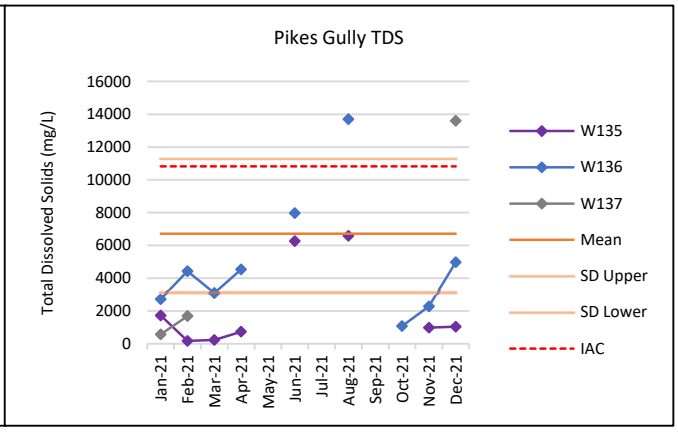


Figure C.24: Pikes Gully TDS



ENGENY WATER MANAGEMENT

Appendix D:
Groundwater Quality Monitoring Results

Table D.1 Groundwater Quality 2021 Summary Statistics

Monitoring Location	Target	pH			Electrical Conductivity			No. of samples
		Min	Max	Mean	Min	Max	Mean	
Coffey Dam Borehole	Liddell	7.4	8.8	8.52	5350	6240	5644	5
CS4641C	Pikes Gully	7.8	7.9	7.8	8450	9220	8888	6
NPZ1 Mid	Bayswater	-	-	-				0
NPZ1 Tall	Lemington	7.4	7.6	7.4	7530	7790	7648	6
NPZ2 Tall	Lemington	7.9	8.2	8.1	9630	9940	9844	5
NPZ5B P1	Broonies	7.2	7.7	7.3	1364	5480	4650	12
NPZ5B P2	Bayswater Creek Alluvium	7.0	7.2	7.1	1503	1809	1622	12
NPZ6 Tall	Broonies	7.7	8.0	7.9	6910	7350	7107	12
NPZ7 Small	Weathered Permian Coal Measures Underlying Hunter River Alluvium	7.3	7.4	7.3	3650	6140	5423	6
NPZ7 Tall	Bayswater	7.2	7.4	7.3	5580	6430	6125	6
NPZ7 Mid	Broonies	-	-	-				0
WPP1	-	7.0	7.1	7.0	6900	8150	7406	5
WPP2	-	6.9	7.1	7.0	8670	9280	9032	5

The 2021 groundwater monthly water quality monitoring results for pH, EC, are presented in Tables D.2 to D.3 respectively. 2021 groundwater speciation results are presented in Table D.4.

Figures D.1 to D.6 present historical pH and EC results for all current and decommissioned monitoring bores. Historical pH and EC results for current monitoring bores are presented in Figures D.7 to D.32 with the mean and standard deviation for each bore shown on each figure. The mean and standard deviation values shown on these figures are based on historical monitoring data from January 2010 to January 2022, as made available through the Glencore Environmental Monitoring Database.

Tables D.2-D.3 contain the following formatting:

	Indicates non-sampling month
xxxx	Indicates an exceedance of the IAC range

Table D.2: Ravensworth Mining Complex Groundwater pH for 2021

Monitoring Results - pH														
Target	Borehole	IAC	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Liddell	Coffey	9.2 - 10	8.8			8.8		8.8		7.4		8.8		
Pikes Gully	CS4641C	8.78 - 11.9	7.8		7.8	7.8		7.8		7.8		7.8		7.8
Bayswater	NPZ1 Mid	6.6 - 6.8	Blocked											
Lemington	NPZ1 Tall	7 - 7.3	7.5				7.4	7.4		7.4		7.4		7.6
Lemington	NPZ2 Tall	7 - 7.3	8.2			8.2			8.0		7.9		8.2	
Broonies	NPZ5B P1	7.2 - 7.44	7.3	7.2	7.5	7.3	7.2	7.3	7.3	7.2	7.2	7.3	7.2	7.7
Bayswater Creek Alluvium	NPZ5B P2	7.1 - 7.3	7.1	7.0	7.0	7.1	7.2	7.1	7.1	7.0	7.2	7.0	7.0	7.0
Broonies	NPZ6 Tall	7.5 - 7.7	7.9	7.8	7.7	7.9	8.0	7.9	8.0	7.9	7.9	7.8	7.8	7.9
Weathered Coal Measures	NPZ7 Small	7.3 - 7.47	7.3			7.4		7.4		7.3		7.3		7.3
Bayswater	NPZ7 Tall	7.38 - 7.5	7.3			7.3		7.4		7.2		7.3		7.3
Broonies	NPZ7 Mid	7.34 - 7.66	Blocked											
-	WPP1	7 - 7.1		7.0			7.0		7.0		7.0		7.1	
-	WPP2	7 - 7.32		7.1			6.9		7.0		7.1		7.1	

Table D.3: Ravensworth Mining Complex Groundwater EC for 2021

Monitoring Results - EC														
Target	Borehole	IAC	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Liddell	Coffey	3,160			5,350		6,240		5,750		5,360			5,520
Pikes Gully	CS4641C	8,900 – 8,548	8,940		8,800		8,900		8,450		9,220			9,020
Bayswater	NPZ1 Mid	15,015	**Blocked**											
Lemington	NPZ1 Tall	9,736	7,620		7,530		7,530		7,630	7,790				7,790
Lemington	NPZ2 Tall	9,765			9,920		9,850		9,630		9,880			9,940
Broonies	NPZ5B P1	6,340	1,364	5,347	5,420	5,480	5,400	5,230	5,010	5,240	4,810	2,100	5,160	5,240
Bayswater Creek Alluvium	NPZ5B P2	2,193	1,809	1,769	1,708	1,655	1,613	1,614	1,530	1,610	1,539	1,535	1,503	1,576
Broonies	NPZ6 Tall	7,120	7,030	7,250	6,970	7,140	7140	7,030	6,910	6,940	7,200	7,320	7,000	7,350
Weathered Coal Measures	NPZ7 Small	5,259	5,190		5,700		5,910		5,950		3,650			6,140
Bayswater	NPZ7 Tall	8,678	5,580		5,900		6,160		6,330		6,350			6,430
Broonies	NPZ7 Mid	8,446	**Blocked**											
-	WPP1	8,604			7,100		7,000		6,900		7,880			8,150
-	WPP2	9,352			9,230		9,090		8,670		9,280			8,890

Table D.4: Ravensworth Mining Complex Groundwater Speciation for 2021

Analysis	Interim IAC (ANZECC)	PIKES GULLY SEAM		BROONIES SEAM				ALLUVIUM & WEATHERED COAL MEASURES			
		CS4641C		ZPZ6 Tall		NPZ5B P1		NPZ7 Small		NPZ5B P2	
		Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20
Field pH	X	7.8	7.8	7.9	7.8	7.3	7.3	7.4	7.3	7.1	7
Field Conductivity (µS/cm)	X	9220	8800	7200	6970	4810	5420	3650	5700	1539	1708
Calcium (mg/L)	X	37	42	11	12	73	84	40	67	48	60
Magnesium (mg/L)	X	14	12	5	5	108	117	72	98	40	45
Sodium (mg/L)	300	1900	1790	1610	1550	954	998	786	1040	235	262
Potassium (mg/L)	X	10	9	8	8	10	14	14	10	4	5
Hydroxide Alkalinity as CaCO3	X		<1.00	<1.00	<1.00	<1.00	<1.00	-	<1.00	<1.00	<1.00
Carbonate Alkalinity as CaCO3	X		52	50	44	<1.00	<1.00	-	<1.00	<1.00	<1.00
Bicarbonate Alkalinity as CaCO3	X		1020	773	971	734	682	-	789	234	264
Alkalinity as CaCO3 (mg/L)	X	1020	1080	823	1010	734	682	550	789	234	264
Sulfate (mg/L)	400	4	<1.00	<1.00	<1.00	547	671	108	78	277	325
Chloride (mg/L)	400	2650	2660	1930	1710	990	1040	970	1640	205	226
Reactive Silica (mg/L)	X	18.6	17.4	17.8	18.8	24.2	23.7	14.4	16.5	36.2	38.3
Ammonia as N (mg/L)	X	2.7	3.05	1.92	1.85	0.9	0.53	4.2	1.5	0.26	0.22
Nitrite as N (mg/L)	1	<0.05	<0.01	<0.01	<0.01	0.02	<0.01	<0.05	<0.01	<0.01	<0.01
Nitrate as N (mg/L)	10	<0.05	0.02	0.07	0.02	0.6	0.18	0.16	0.07	0.18	0.06
Nitrite + Nitrate as N (mg/L)	X	<0.05	0.02	0.07	0.02	0.62	0.18	0.16	0.07	0.18	0.06
TKN as N (mg/L)	X	2.8	4.2	2.7	2.4	2.1	2	5.1	2.3	1.8	1.9
Total Nitrogen as N (mg/L)	X	2.8	4.2	2.8	2.4	2.7	2.2	5.3	2.4	2	2
Total Cations (meq/L)	X		81.2	-	68.6	-	57.6	-	56.9	-	18.2
Total Anions (meq/L)	X		96.6	-	68.4	-	56.9	-	63.6	-	18.4
Zinc (µg/L)	5000	<5.000	5.0	13.0	<5.000	11.0	25.0	<5.000	<5.000	11.0	9.0
Silver (µg/L)	50	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Selenium (µg/L)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
Nickel (µg/L)	100	2.0	2.0	<1.000	<1.000	6.0	6.0	<1.000	<1.000	2.0	2.0
Mercury (µg/L)	1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Manganese (µg/L)	100	98.0	105.0	75.0	78.0	486.0	602.0	146.0	21.0	474.0	566.0
Lead (µg/L)	50	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Iron (µg/L)	300	520.0	180.0	<50.000	360.0	1160.0	880.0	<50.000	<50.000	70.0	140.0
Copper (µg/L)	1000	<1.000	6.0	13.0	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Cadmium (µg/L)	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Barium (µg/L)	1000	1010.0	995.0	222.0	287.0	36.0	44.0	274.0	414.0	42.0	48.0
Antimony (µg/L)	X	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Aluminium (µg/L)	200	<10.000	<10.000	<10.000	10.0	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
Site Specific IAC for pH		8.78-11.9		7.5-7.7		7.2-7.44		7.3-7.47		7.1-7.3	
Site Specific IAC for EC (µS/cm)		8,900 – 8,548		7,120		6,340		5,259		2,193	
Site Specific IAC for Sodium (mg/L)		1.820 – 1,980		N/A		820 – 939		1,300 – 1,496		N/A	
Site Specific IAC for Chloride (mg/L)		2,310 – 2,482		N/A		830 – 1,020		1,990 – 2,492		N/A	

Analysis	Interim IAC (ANZECC)	LIDDELL SEAM		BAYSWATER SEAM				LEMINGTON SEAM		CUMNOCK OPEN CUT			
		COFFEY		NPZ7 Tall		NPZ1 Tall		NPZ2 Tall		WPP1		WPP2	
		Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20
Field pH	X	8.8	8.8	7.3	7.3	7.4	7.4	8.2	8.2	7	7.1	6.9	7.1
Field Conductivity (µS/cm)	X	5360	5350	6350	5900	7790	7530	9880	9920	7880	7100	9280	9230
Calcium (mg/L)	X	22	31	51	72	13	13	19	22	238	197	230	222
Magnesium (mg/L)	X	125	121	100	106	9	7	8	10	377	314	426	431
Sodium (mg/L)	300	1090	1070	1090	1080	1600	1620	2170	2170	1300	1200	1590	1540
Potassium (mg/L)	X	15	15	9	9	8	7	12	15	5	5	12	12
Hydroxide Alkalinity as CaCO3	X	-	<1.00	-	<1.00	-	<1.00	-	<1.00	-	<1.00	-	<1.00
Carbonate Alkalinity as CaCO3	X	-	148	-	<1.00	-	<1.00	-	90	-	<1.00	-	<1.00
Bicarbonate Alkalinity as CaCO3	X	-	1030	-	790	-	1250	-	1450	-	895	-	948
Alkalinity as CaCO3 (mg/L)	X	1200	1180	600	790	1040	1250	1000	1540	820	895	720	948
Sulfate (mg/L)	400	702	730	201	87	6	<1.00	3	<1.00	3340	3000	3770	3910
Chloride (mg/L)	400	680	949	1380	1610	1650	1820	2080	2700	480	458	660	843
Reactive Silica (mg/L)	X	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N (mg/L)	X	5.6	5.3	17.5	17	21	22.3	21.1	21.1	34.4	33	37.6	31.1
Nitrite as N (mg/L)	1	3.13	2.48	2.03	1.38	1.5	2.04	3.2	2.6	<0.05	0.01	<0.05	0.03
Nitrate as N (mg/L)	10	<0.05	<0.01	<0.05	0.01	0.3	<0.01	<0.05	<0.01	<0.05	<0.01	<0.05	<0.01
Nitrite + Nitrate as N (mg/L)	X	0.16	0.02	0.08	0.01	<0.05	0.04	0.09	0.08	<0.05	0.02	<0.05	0.02
TKN as N (mg/L)	X	0.16	0.02	0.08	0.02	0.05	0.04	0.09	0.08	<0.05	0.02	<0.05	0.02
Total Nitrogen as N (mg/L)	X	3.4	2.9	2.5	2.1	2	2.7	3.3	3.7	0.2	<0.10	0.2	2.1
Total Cations (meq/L)	X	3.6	2.9	2.6	2.1	2	2.7	3.4	3.8	0.2	<0.1	0.2	2.1
Total Anions (meq/L)	X	-	58.4	-	59.5	-	71.9	-	96.7	-	88	-	114
Zinc (µg/L)	5000	-	65.5	-	63	-	76.3	-	107	-	93.3	-	124
Silver (µg/L)	50	7.0	<5.000	<5.000	<5.000	<5.000	<5.000	7.0	<5.000	12.0	7.0	6.0	6.0
Selenium (µg/L)	10	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel (µg/L)	100	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
Mercury (µg/L)	1	3.0	3.0	<1.000	<1.000	1.0	1.0	<1.000	1.0	5.0	5.0	6.0	6.0
Manganese (µg/L)	100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Lead (µg/L)	50	72.0	46.0	13.0	17.0	122.0	102.0	85.0	78.0	301.0	341.0	209.0	170.0
Iron (µg/L)	300	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Copper (µg/L)	1000	90.0	290.0	<50.000	<50.000	500.0	400.0	90.0	140.0	120.0	<50.000	<50.000	<50.000
Cadmium (µg/L)	5	8.0	6.0	<1.000	<1.000	<1.000	1.0	8.0	<1.000	17.0	1.0	<1.000	3.0
Barium (µg/L)	1000	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Antimony (µg/L)	X	9.0	10.0	397.0	434.0	436.0	423.0	1210.0	1350.0	24.0	20.0	14.0	16.0
Aluminium (µg/L)	X	<1.000	<1.000	<1.000	<1.000	<1.000	1.0	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Site Specific IAC for pH		9.2 – 10		7.38 – 7.5		7 – 7.3		8.3 – 8.4		7 - 7.1		7 – 7.32	
Site Specific IAC for EC (µS/cm)		3,160		8,678		9,736		9,765		8,604		9,352	
Site Specific IAC for Sodium (mg/L)		N/A		1,320		1,820		2,100		N/A		N/A	
Site Specific IAC for Chloride (mg/L)		N/A		2,099		2,225		2,430		N/A		N/A	

Figure D.1: Ravensworth Mining Complex Groundwater Historical pH (North Western Bores)

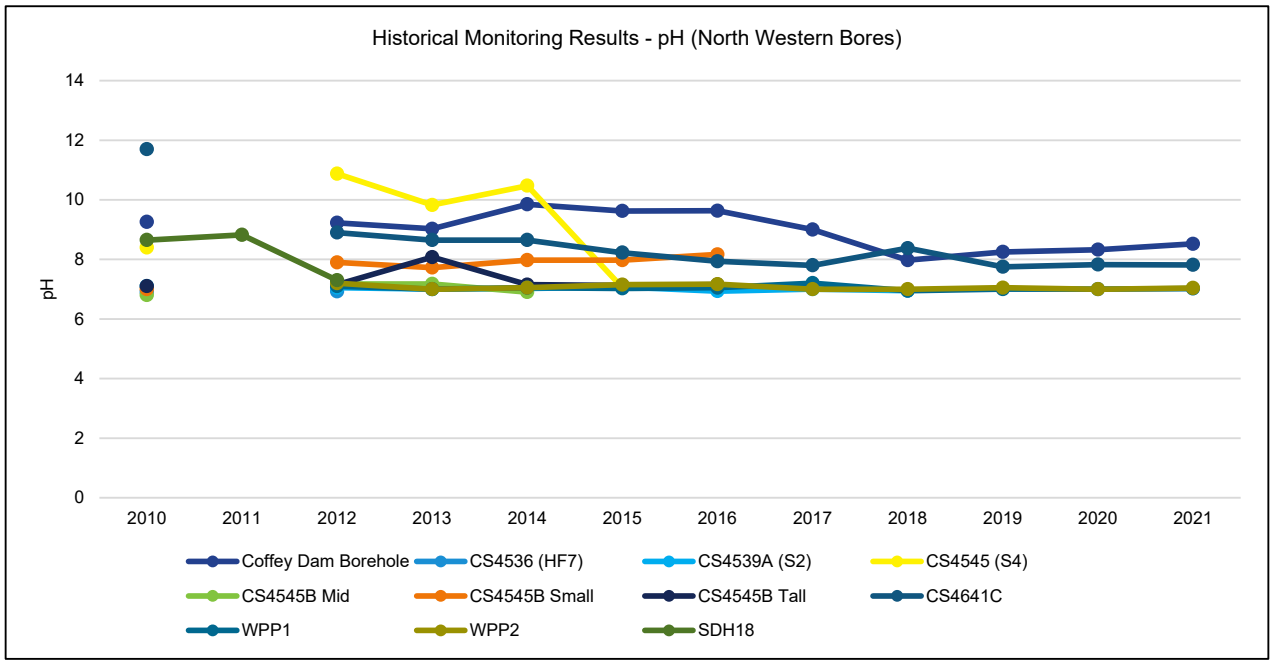


Figure D.2: Ravensworth Mining Complex Groundwater Historical EC (North Western Bores)

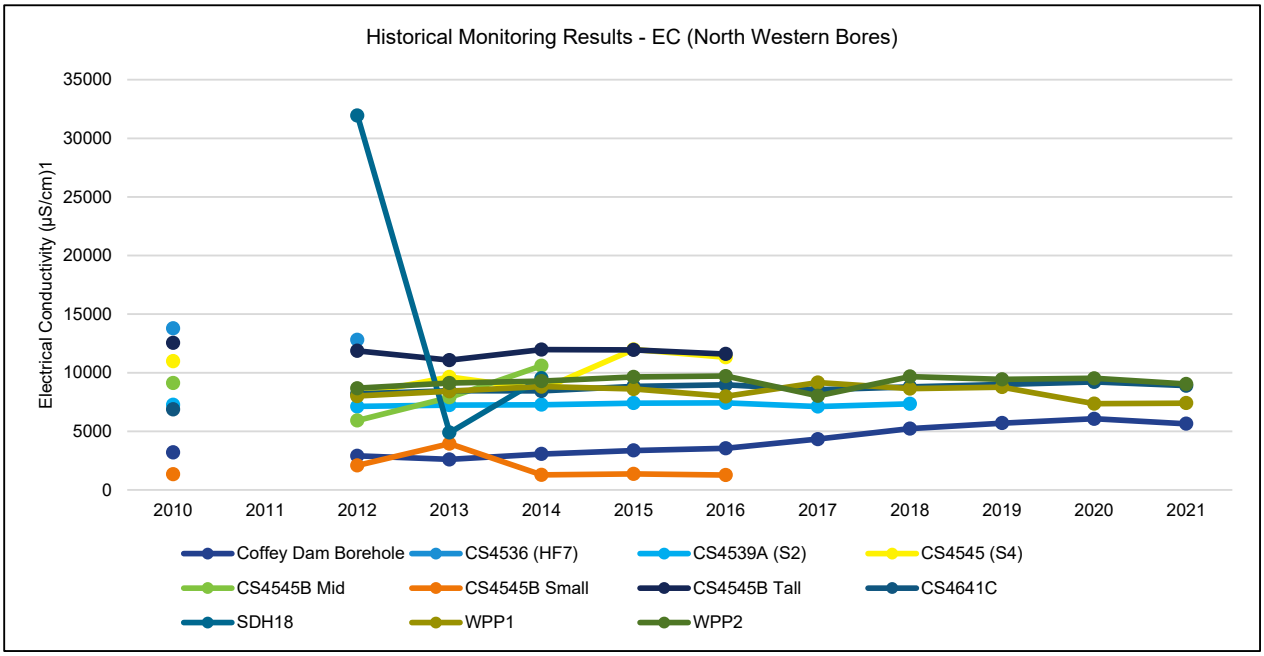


Figure D.3: Ravensworth Mining Complex Groundwater Historical pH (Central Eastern Bores)

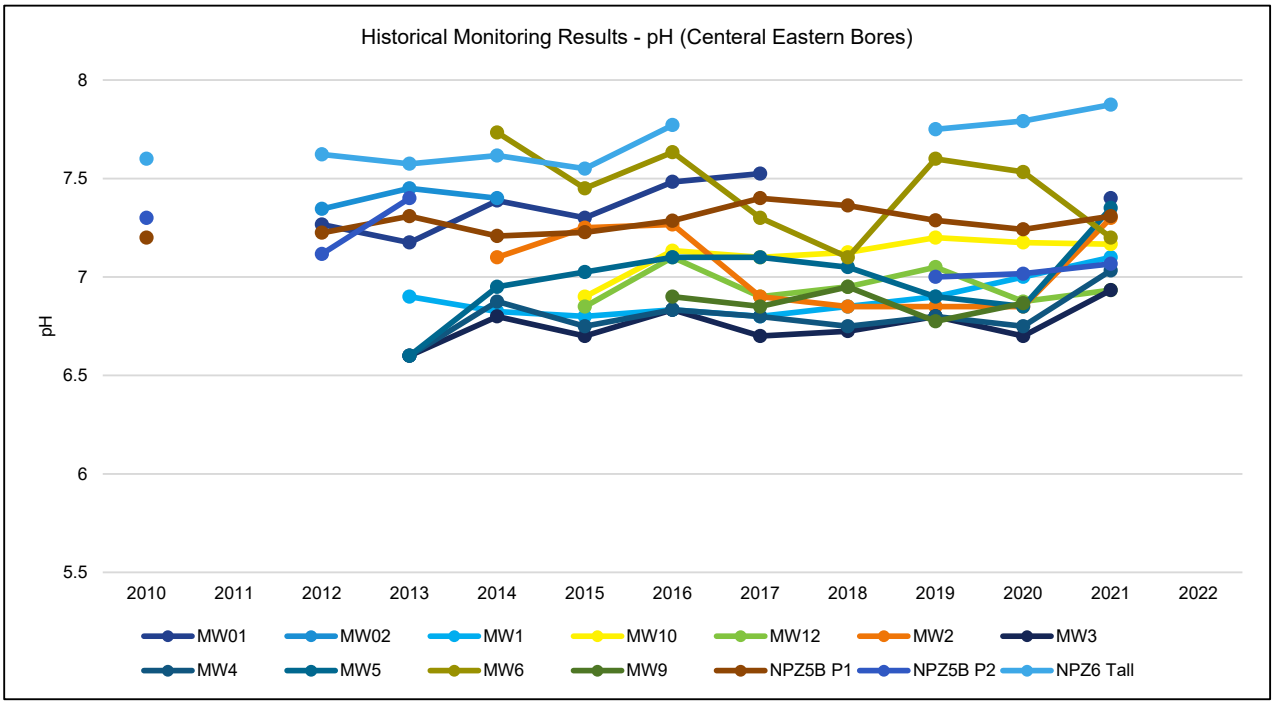


Figure D.4: Ravensworth Mining Complex Groundwater Historical EC (Central Eastern Bores)

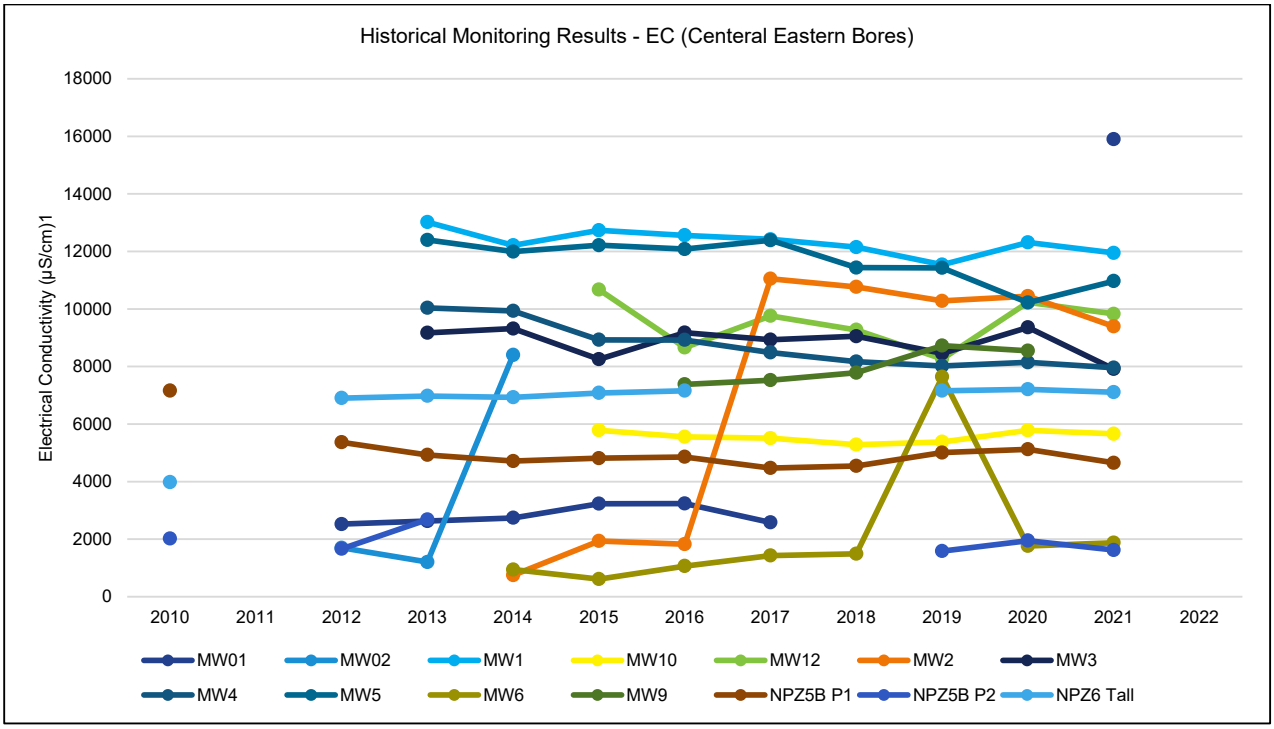


Figure D.5: Ravensworth Mining Complex Groundwater Historical pH (Southern Bores)

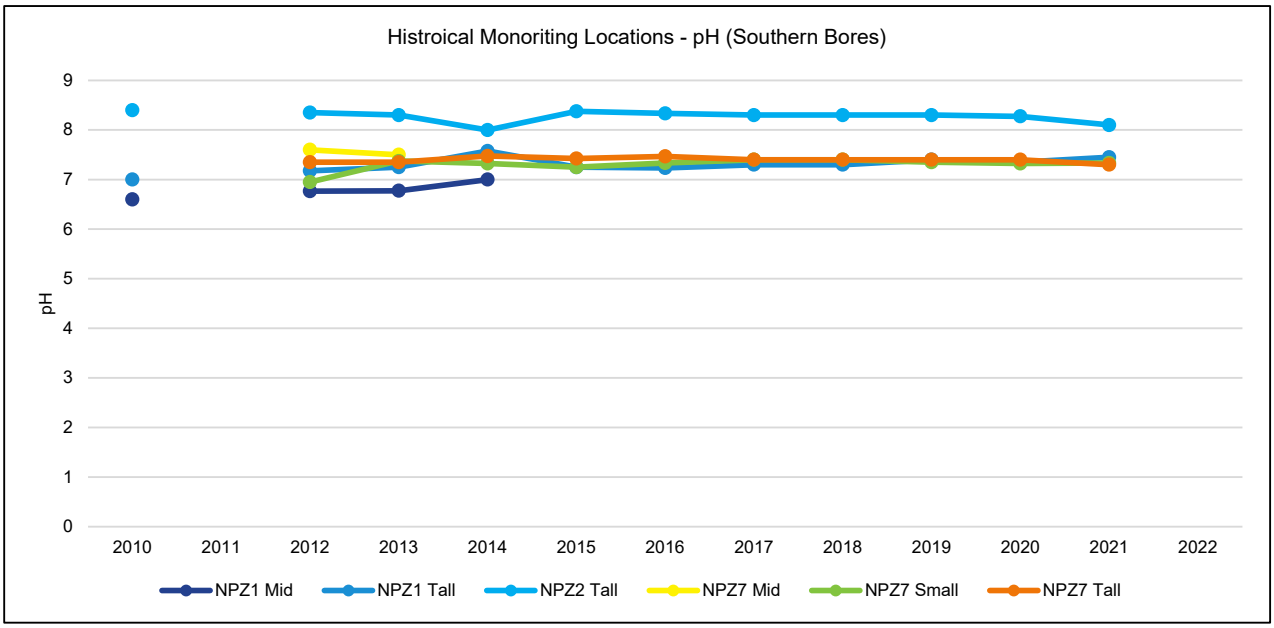
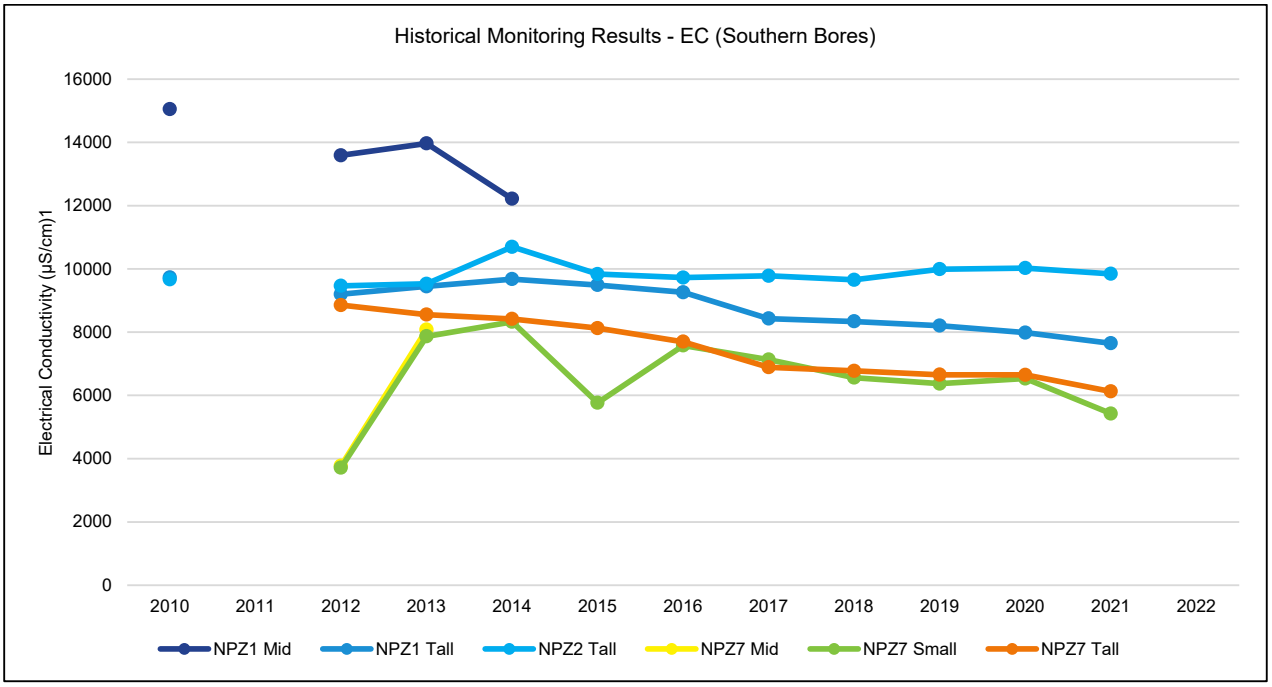


Figure D.6: Ravensworth Mining Complex Groundwater Historical EC (Southern Bores)



Note: available data switched from “lab” results to “field” results in approximately 2017. This change is shown on the below graphs.

Figure D.7: Coffey Dam Borehole Historical pH

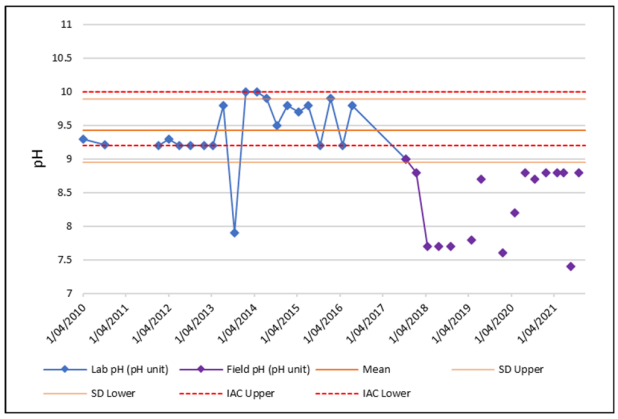


Figure D.8: Coffey Dam Borehole Historical EC

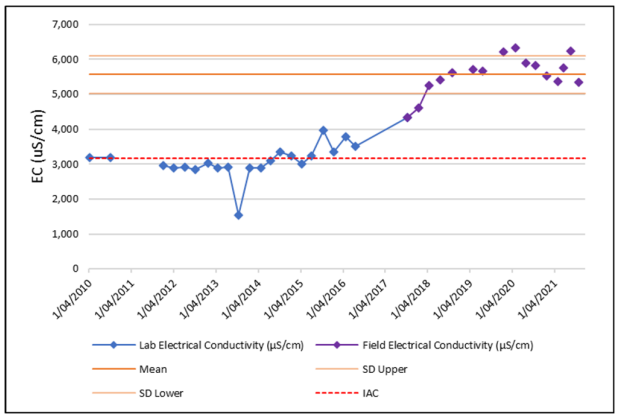


Figure D.9: CS4641C Historical pH

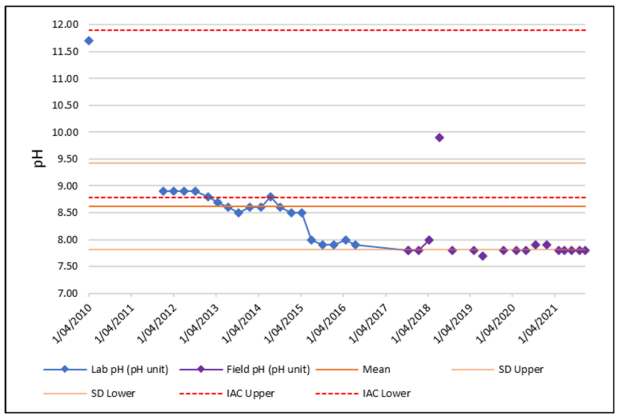


Figure D.9: CS4641C Historical EC

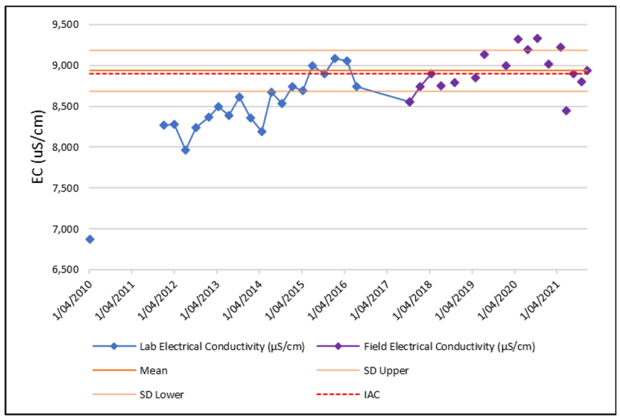


Figure D.11: NPZ1 Mid Historical pH

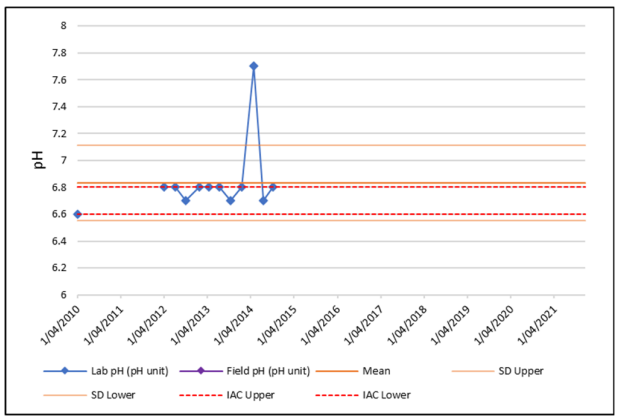


Figure D.12: NPZ1 Mid Historical EC

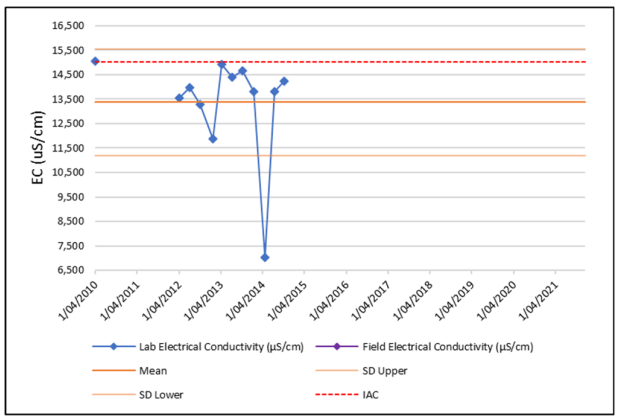


Figure D.13: NPZ1 Tall Historical pH

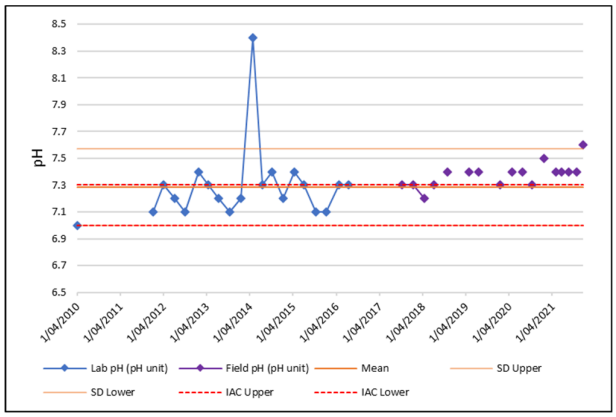


Figure D.14: NPZ1 Tall Historical EC

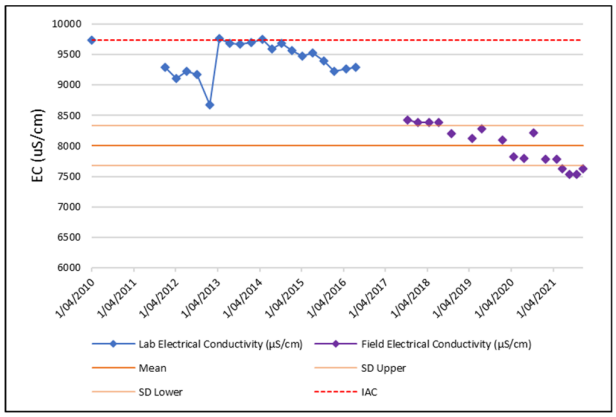


Figure D.15: NPZ2 Tall Historical pH

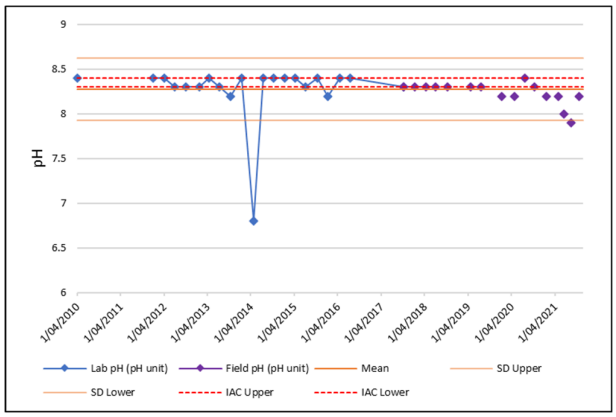


Figure D.16: NPZ2 Tall Historical EC

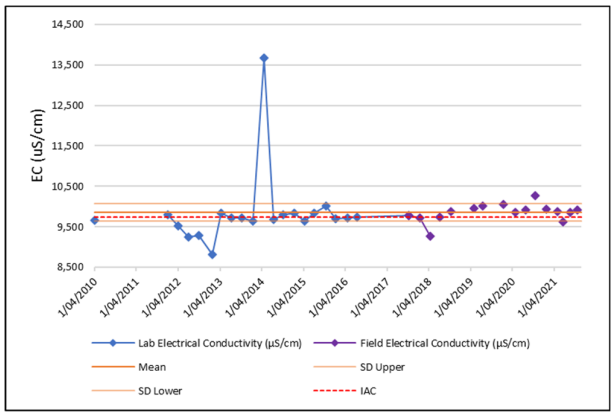


Figure D.17: NPZ5B P1 Historical pH

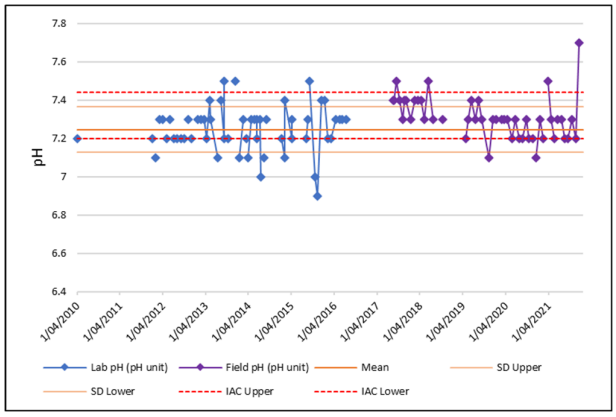


Figure D.18: NPZ5B P1 Historical EC

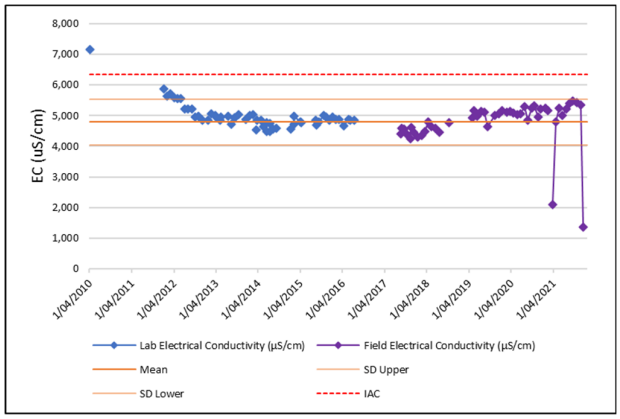


Figure D.19: NPZ5B P2 Historical pH

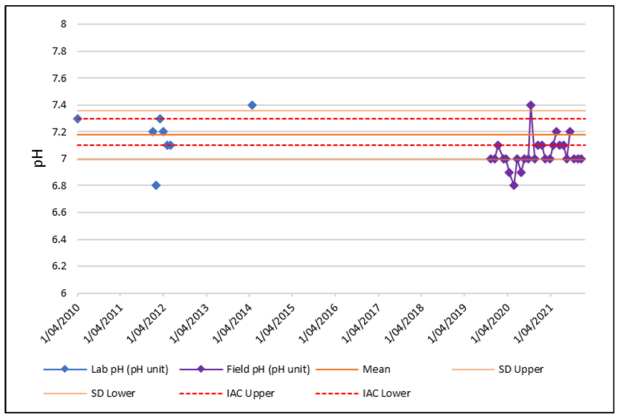


Figure D.20: NPZ5B P2 Historical EC

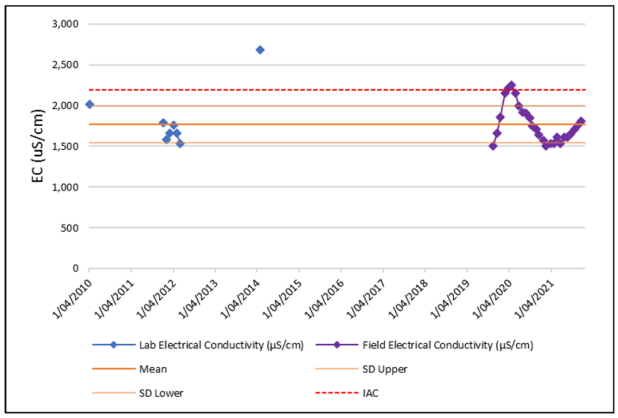


Figure D.21: NPZ6 Tall Historical pH

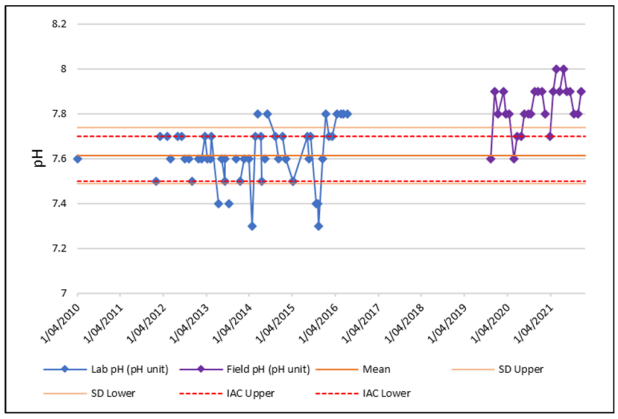


Figure D.22: NPZ6 Tall Historical EC

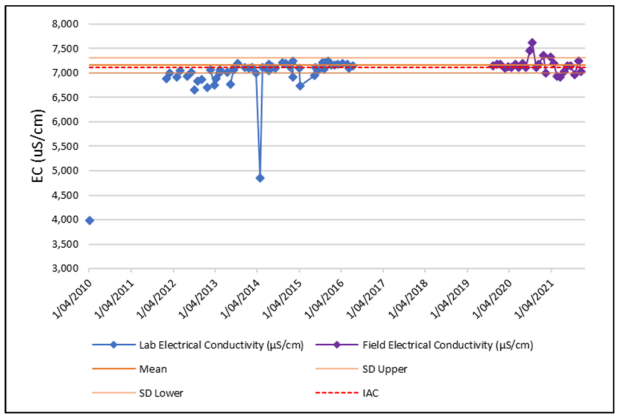


Figure D.23: NPZ7 Small Historical pH

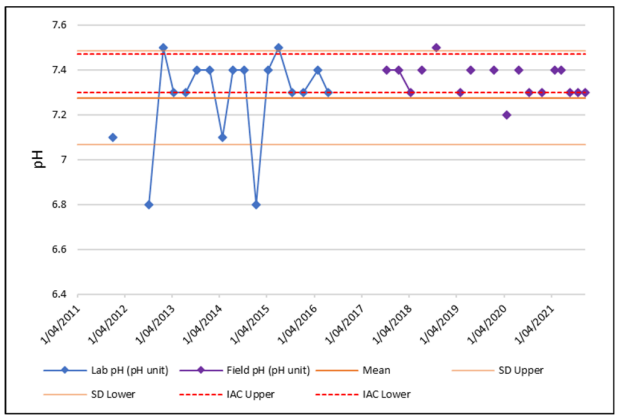


Figure D.24: NPZ7 Small Historical EC

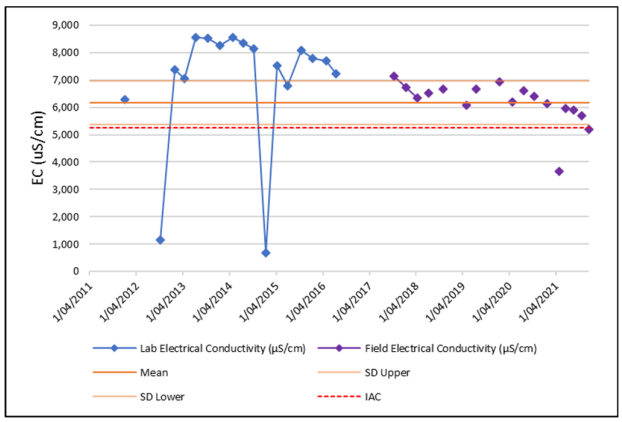


Figure D.25: NPZ7 Tall Historical pH

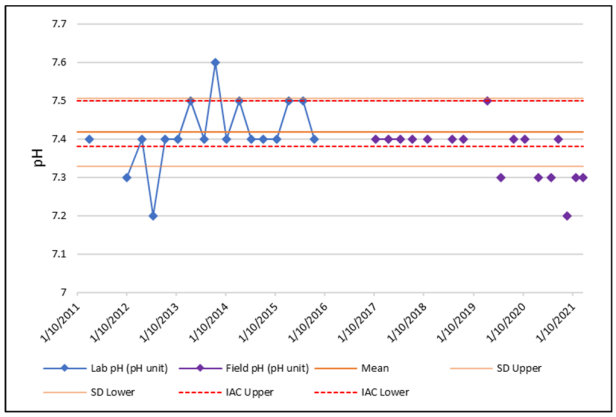


Figure D.26: NPZ7 Tall Historical EC

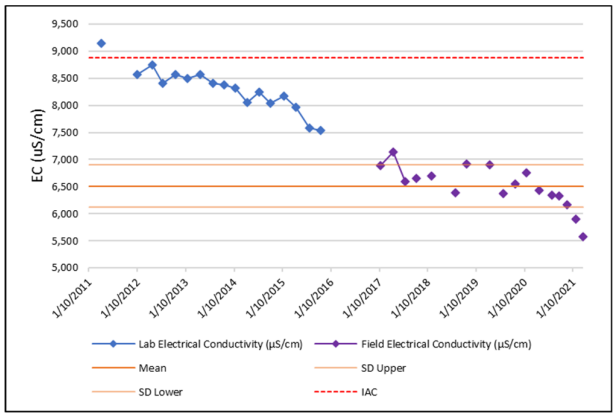


Figure D.27: NPZ7 Mid Historical pH

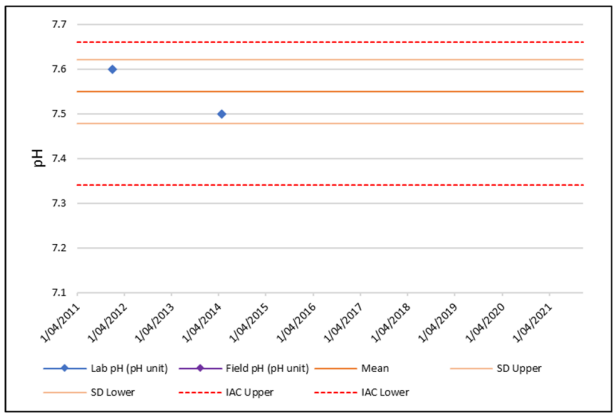


Figure D.28: NPZ7 Mid Historical EC

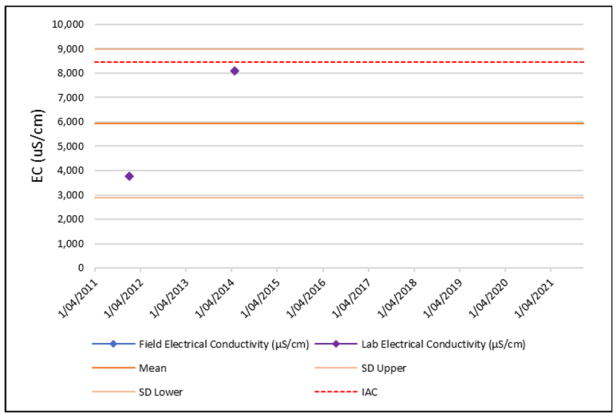


Figure D.29: WPP1 Historical pH

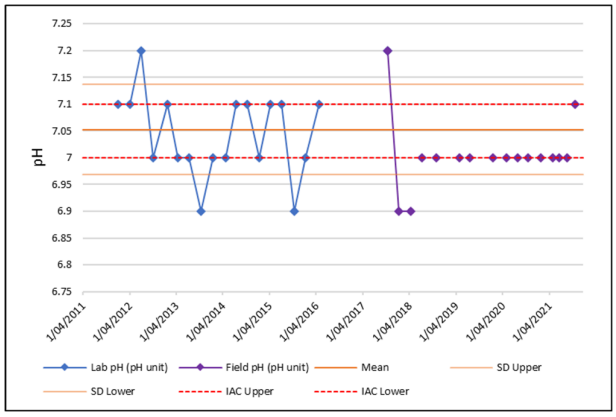


Figure D.30: WPP1 Historical EC

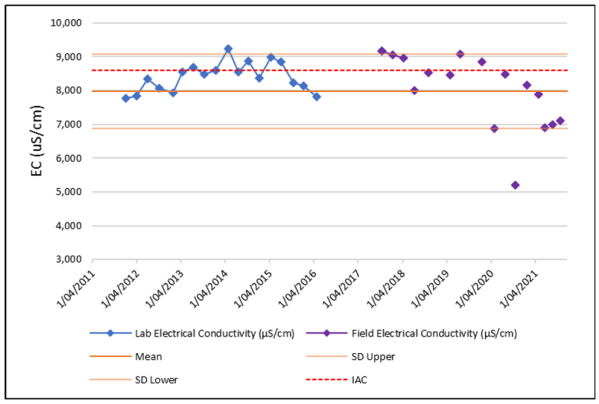


Figure D.31: WPP2 Historical pH

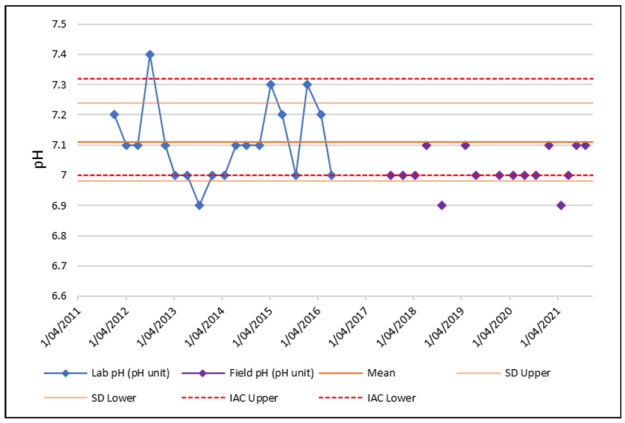
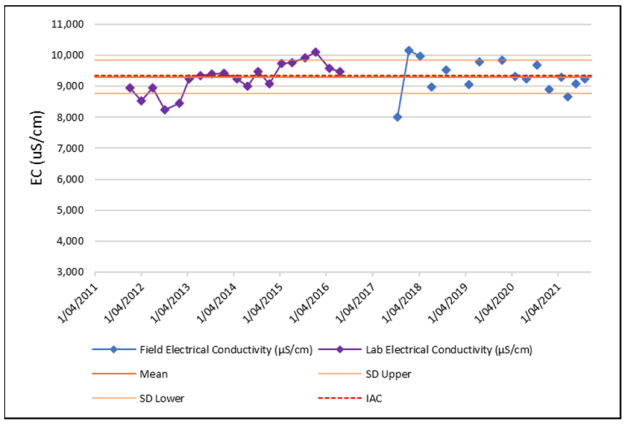


Figure D.32: WPP2 Historical EC



Appendix E:
Groundwater Level Monitoring Results

Table E.1: Ravensworth Mining Complex Groundwater Levels 2021

Borehole	Coffey Dam Borehole		CS4641C		NPZ1 Mid		NPZ1 Tall		NPZ2 Tall		NPZ5B P1		NPZ5B P2	
Collar Level (RL)	100.4		81.6		91.4		91.4		100.9		76		76	
Date	Depth	RL	Depth	RL	Depth	RL	Depth	RL	Depth	RL	Depth	RL	Depth	RL
Jan-2021	45.04	55.31	100.77	-19.13	Blocked		58.33	33.10	67.65	33.21	15.83	60.17	9.77	66.23
Feb-2021	45.02	55.33	100.78	-19.14			57.20	34.23	67.55	33.31	15.76	60.24	9.99	66.01
Mar-2021	45.09	55.26	100.83	-19.19			57.16	34.27	67.05	33.81	15.15	60.85	9.66	66.34
Apr-2021	44.96	55.39	100.01	-18.37			57.71	33.72	67.65	33.21	14.75	61.25	9.68	66.32
May-2021			101.05	-19.41			56.72	34.71	67.63	33.23	14.97	61.03	9.66	66.34
Jun-2021	44.84	55.51	100.98	-19.34			56.03	35.40	67.50	33.36	15.03	60.97	9.64	66.36
Jul-2021	44.79	55.56	101.01	-19.37			57.74	33.69	67.22	33.64	14.82	61.18	9.63	66.37
Aug-2021	44.78	55.57	101.05	-19.41			54.38	37.05	67.70	33.16	15.09	60.91	9.68	66.32
Sep-2021	44.77	55.58	101.12	-19.48			52.63	38.80	67.54	33.32	15.44	60.56	9.74	66.26
Oct-2021	44.75	55.60	101.09	-19.45			52.51	38.92	67.34	33.52	15.88	60.12	9.77	66.23
Nov-2021	44.79	55.56	101.13	-19.49			55.00	36.43	67.26	33.60	15.57	60.43	9.64	66.36
Dec-2021			101.08	-19.44			54.62	36.81			13.97	62.03	9.39	66.61

Table E.2: Ravensworth Mining Complex Groundwater Levels 2021 – continued

Borehole	NPZ6 Tall		NPZ7 Tall		NPZ7 Small		NPZ7 Mid		Borehole P		WPP1		WPP2	
Collar Level (RL)	76.3		61.91		61.91		61.91		82.06		108		110	
Date	Depth	RL	Depth	RL	Depth	RL	Depth	RL	Depth	RL	Depth	RL	Depth	RL
Jan-2021	12.83	63.49	26.21	35.70	31.79	30.12	Blocked		91.96	-9.90	1.74	106.26	3.91	106.09
Feb-2021	13.06	63.26	26.13	35.78	28.58	33.33			92.10	-10.04	1.22	106.78	3.66	106.34
Mar-2021	12.96	63.36									0.80	107.20	2.72	107.28
Apr-2021	13.30	63.02	25.12	36.79	27.33	34.58			91.17	-9.11	1.56	106.44	3.26	106.74
May-2021	13.43	62.89	25.06	36.85	27.15	34.76			91.94	-9.88	1.54	106.46	3.50	106.50
Jun-2021	13.02	63.30	24.53	37.38	26.42	35.49			92.18	-10.12	1.26	106.74	3.27	106.73
Jul-2021	13.03	62.97	24.54	37.37	26.32	35.59			92.85	-10.79	1.52	106.48	3.47	106.53
Aug-2021	13.13	63.19	24.57	37.34	26.26	35.65			93.14	-11.08	1.83	106.17	3.77	106.23
Sep-2021	13.39	62.93	22.10	39.81	22.84	39.07			92.44	-10.38	1.56	106.44	3.54	106.46
Oct-2021	12.83	63.49	22.26	39.65	24.50	37.41			92.08	-10.02	1.90	106.10	3.93	106.07
Nov-2021	12.52	63.80	20.74	41.17	24.18	37.73					0.85	107.15	2.78	107.22
Dec-2021	12.39	63.93	20.16	41.75	20.63	41.28			92.96	-10.90				

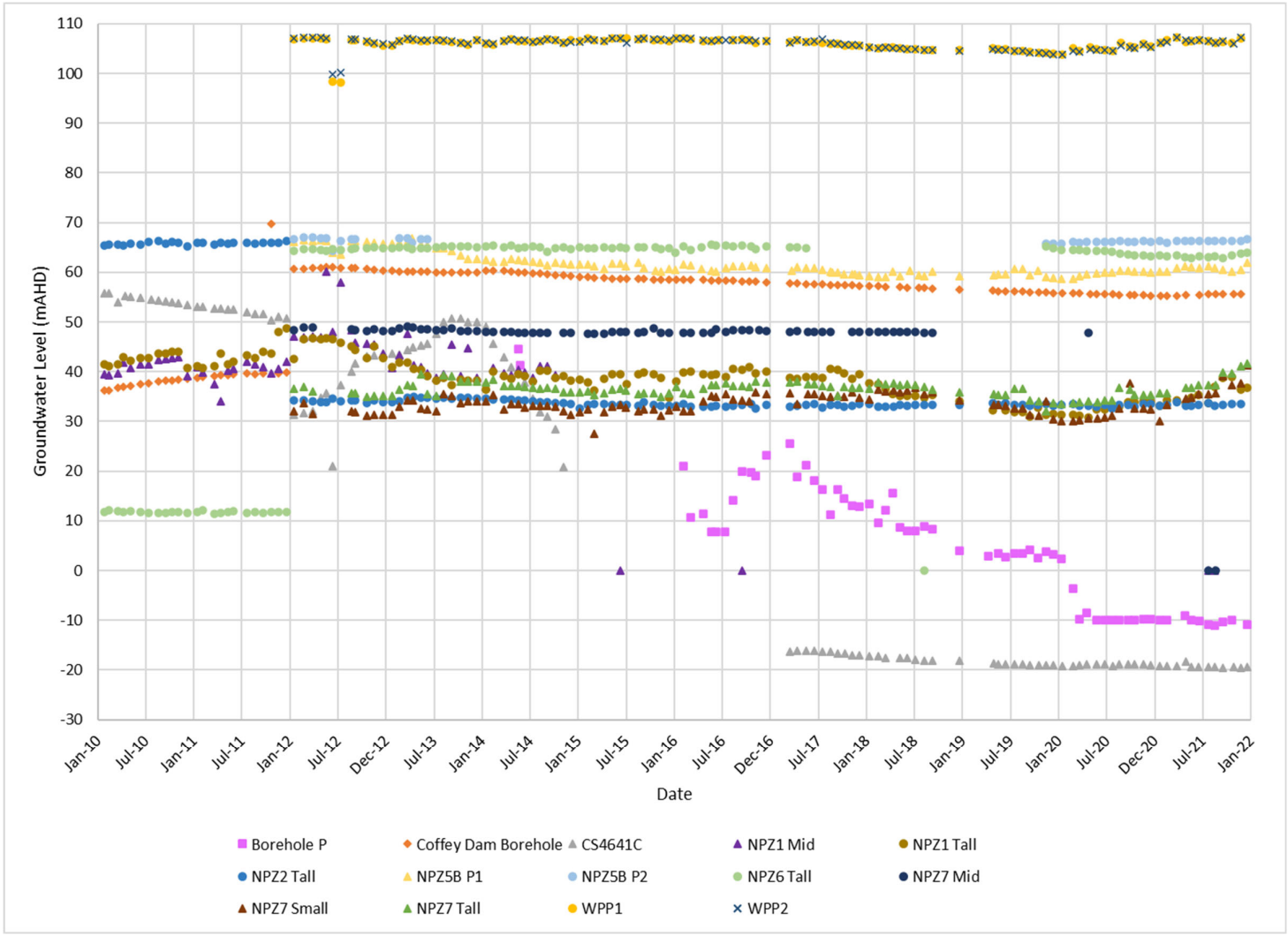


Figure E.1: Ravensworth Mining Complex Historical Groundwater Levels

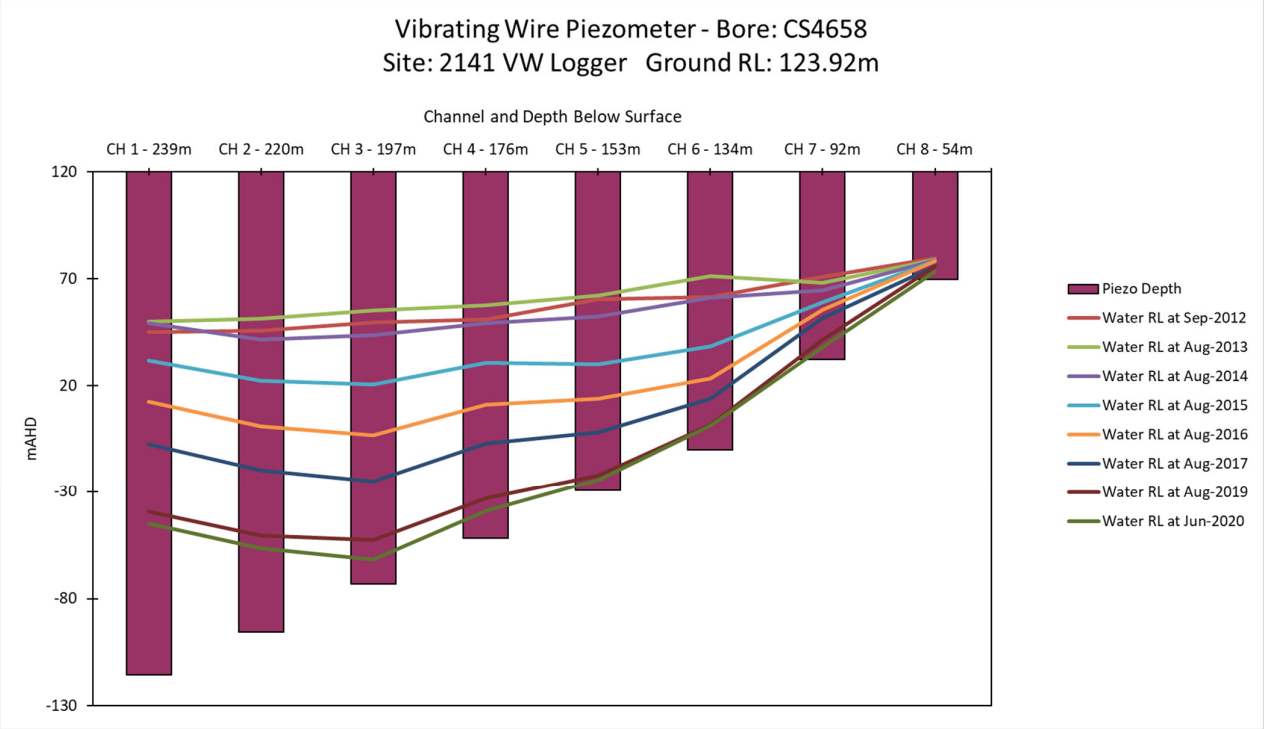


Figure E.2: Vibrating Wire Piezometer - Bore: CS4658 (Site 2141)

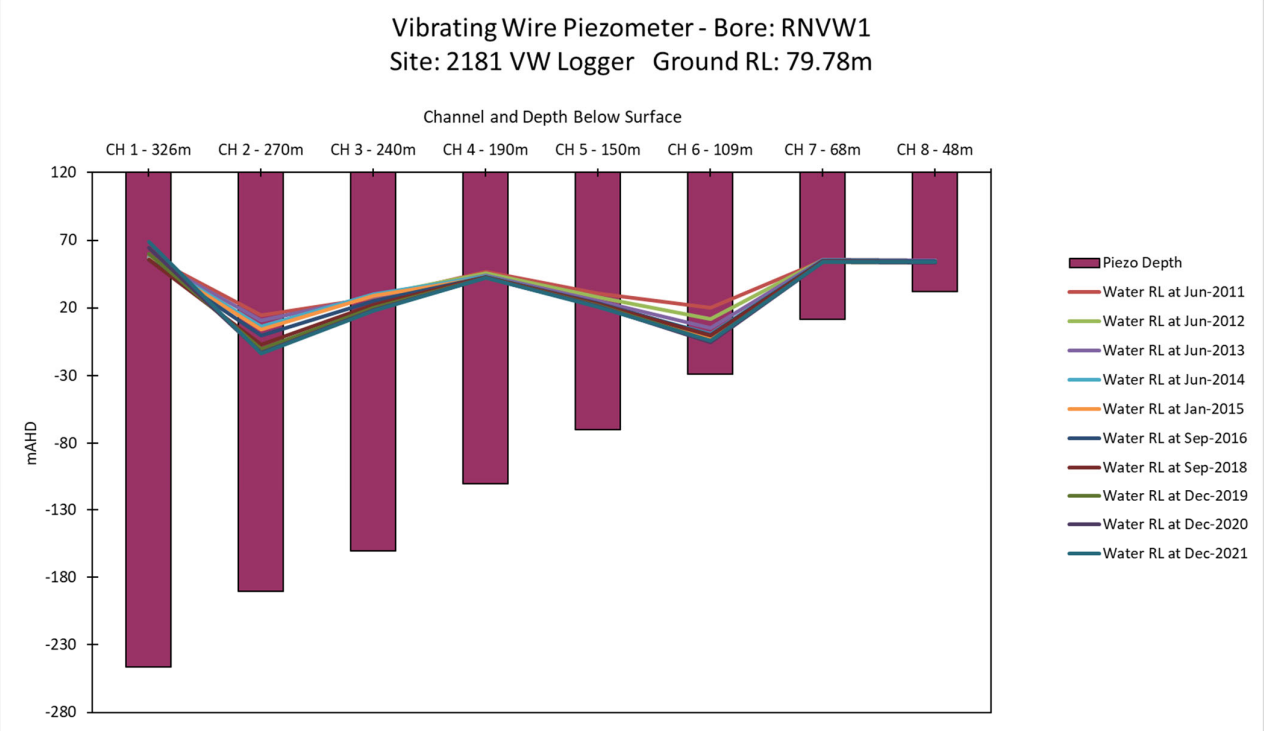


Figure E.3: Vibrating Wire Piezometer - Bore: RNV1 (Site 2181)

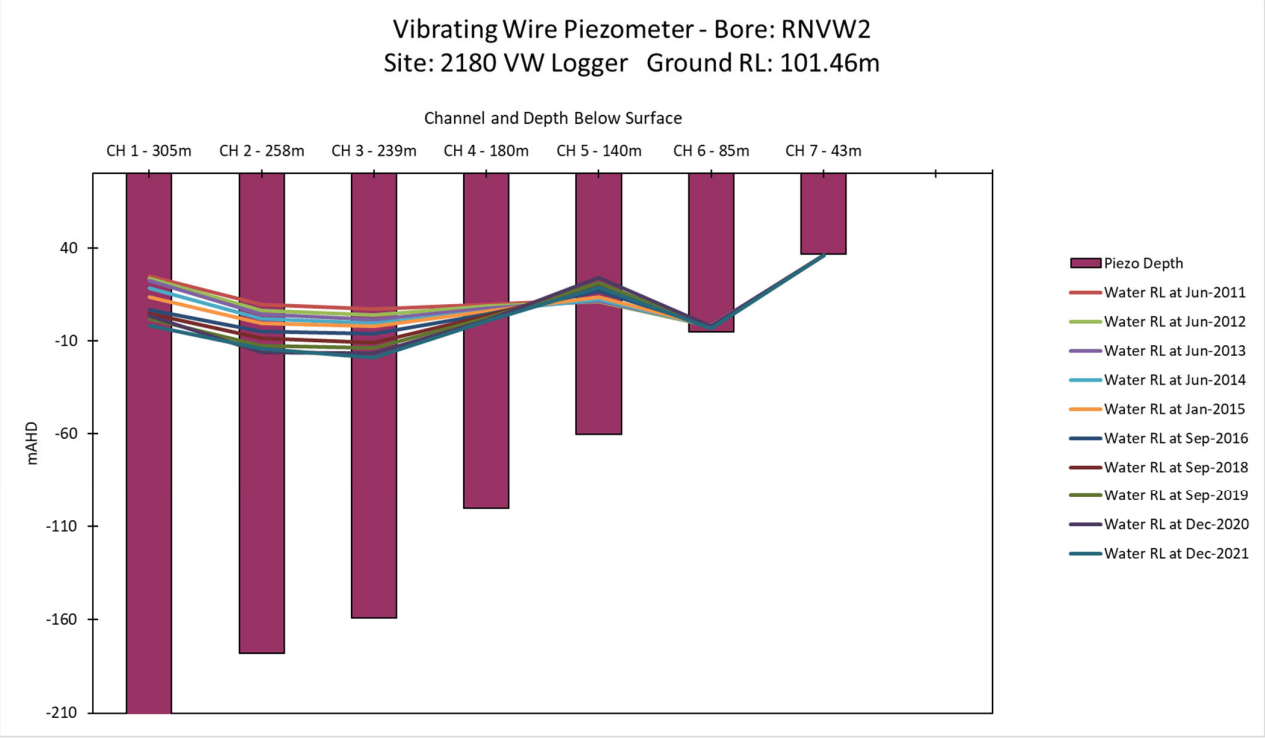


Figure E.4: Vibrating Wire Piezometer - Bore: RNVW2 (Site 2180)

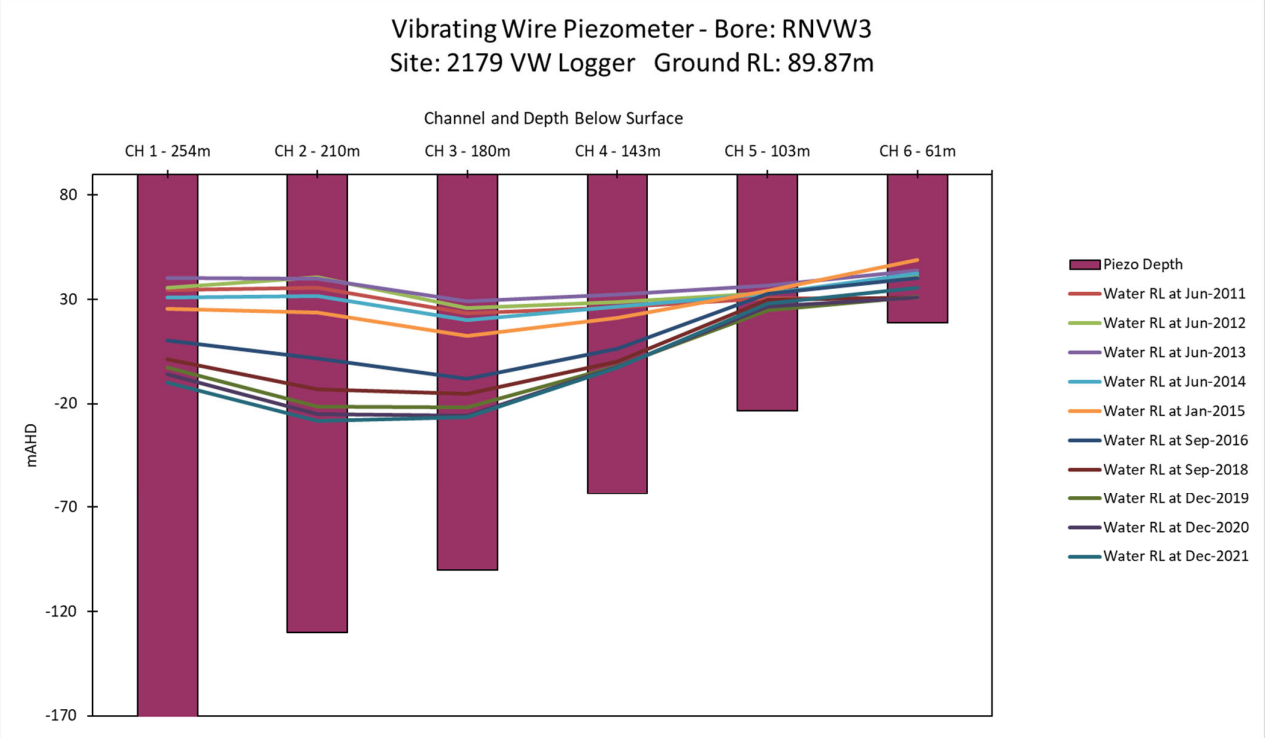


Figure E.5: Vibrating Wire Piezometer - Bore: RNVW3 (Site 2179)

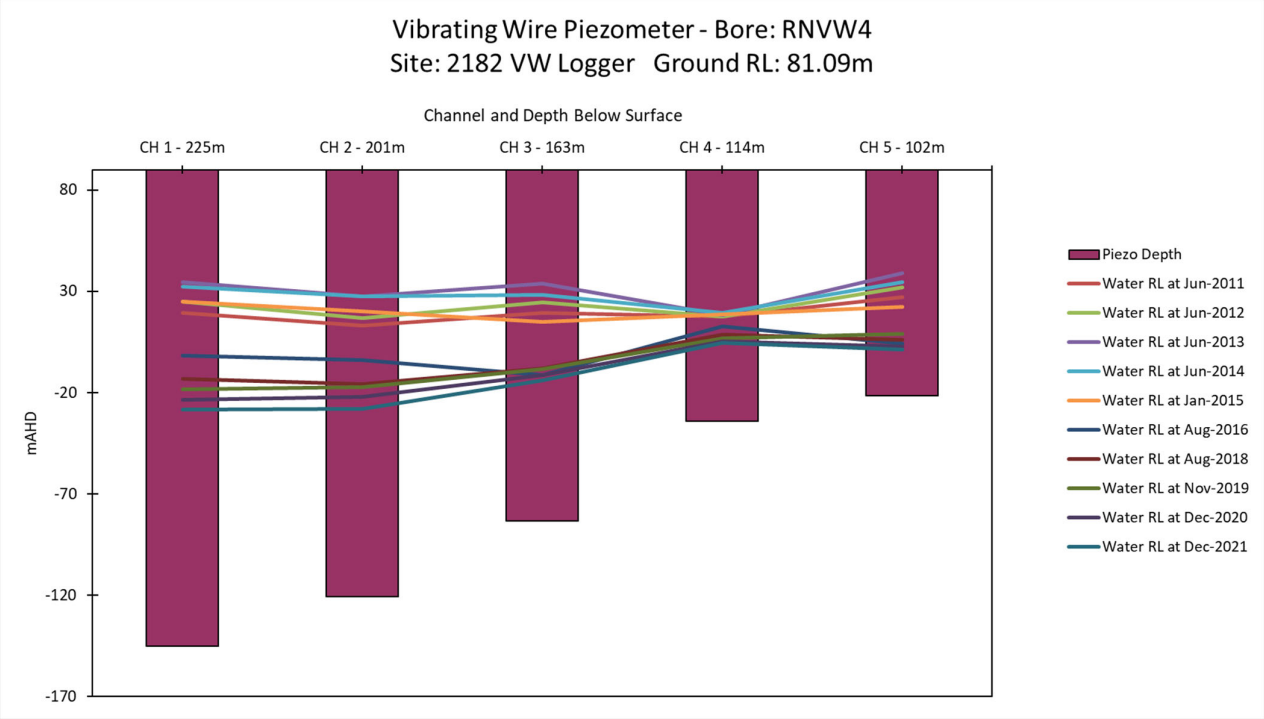


Figure E.6: Vibrating Wire Piezometer - Bore: RNVW4 (Site 2182)

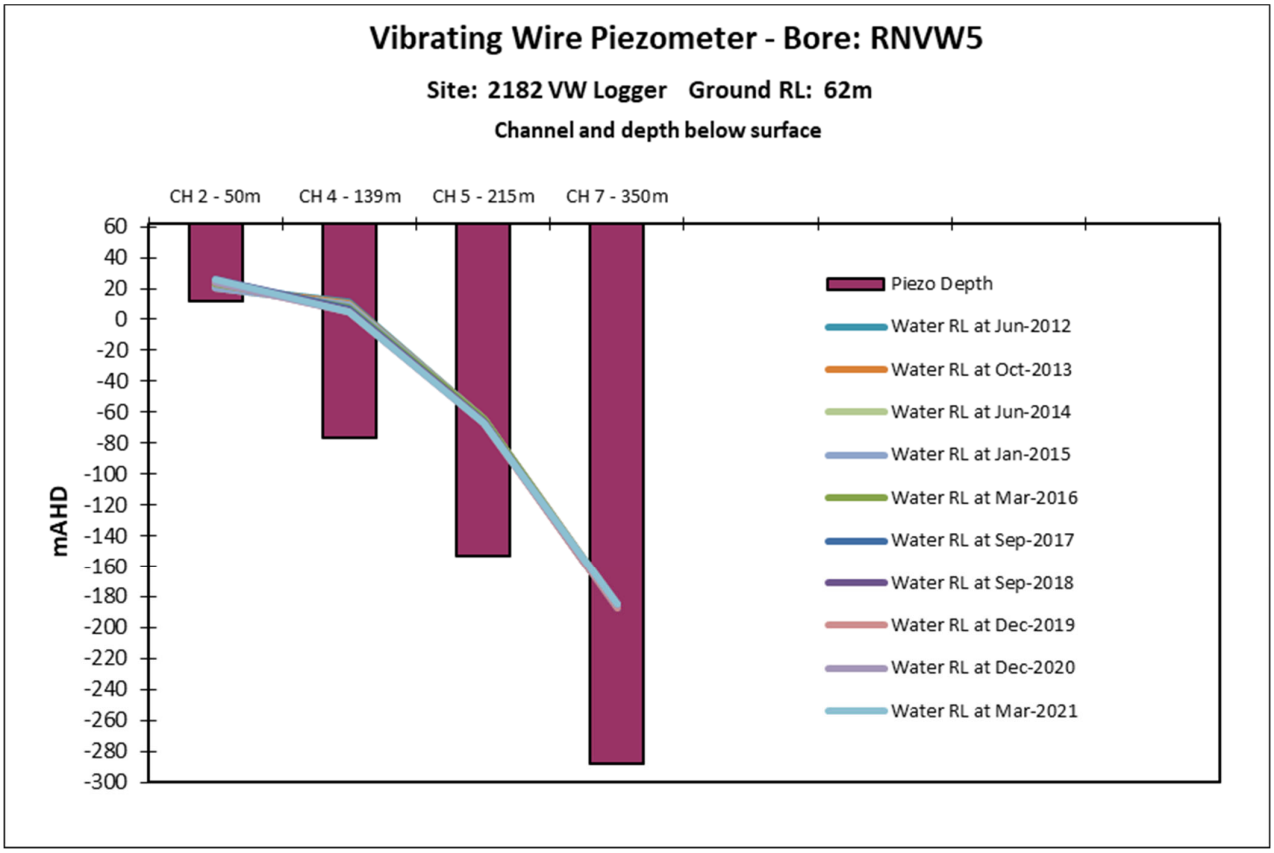


Figure E.7: Vibrating Wire Piezometer - Bore: RNVW5 (Site 2182)

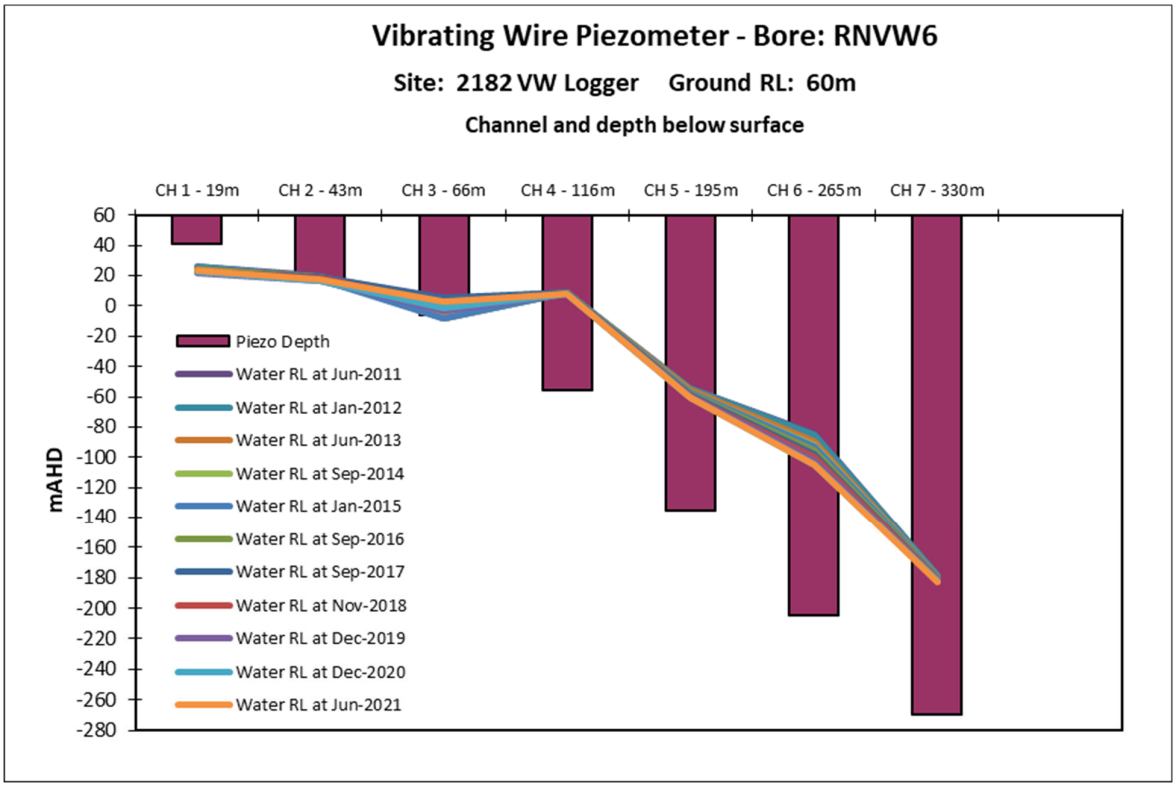


Figure E.8: Vibrating Wire Piezometer - Bore: RNVW6 (Site 2182)

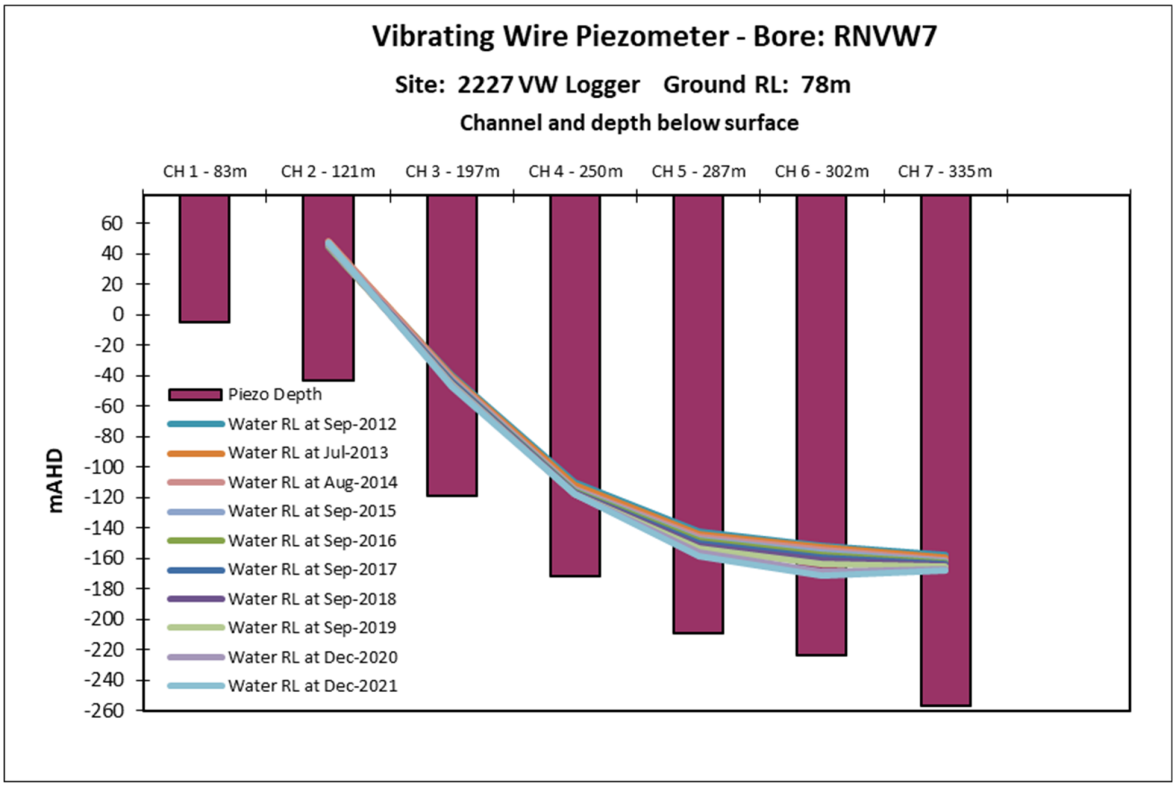


Figure E.9: Vibrating Wire Piezometer - Bore: RNVW7 (Site 2227)

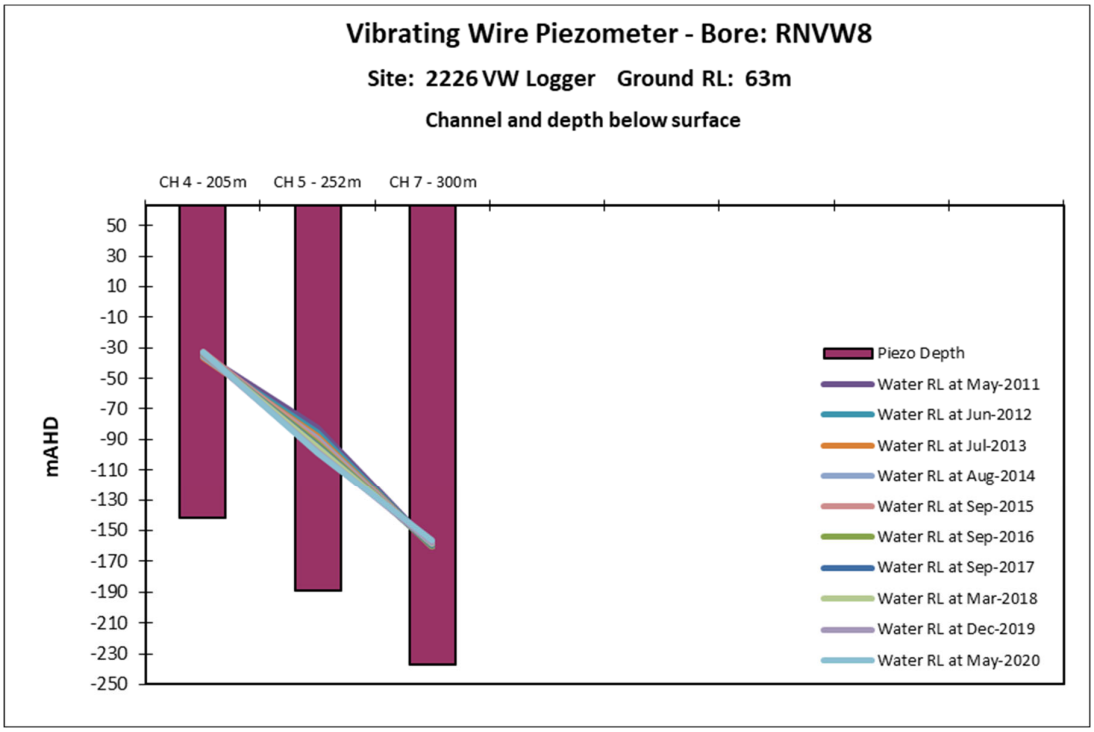


Figure E.10: Vibrating Wire Piezometer - Bore: RNVW8 (Site 2226)

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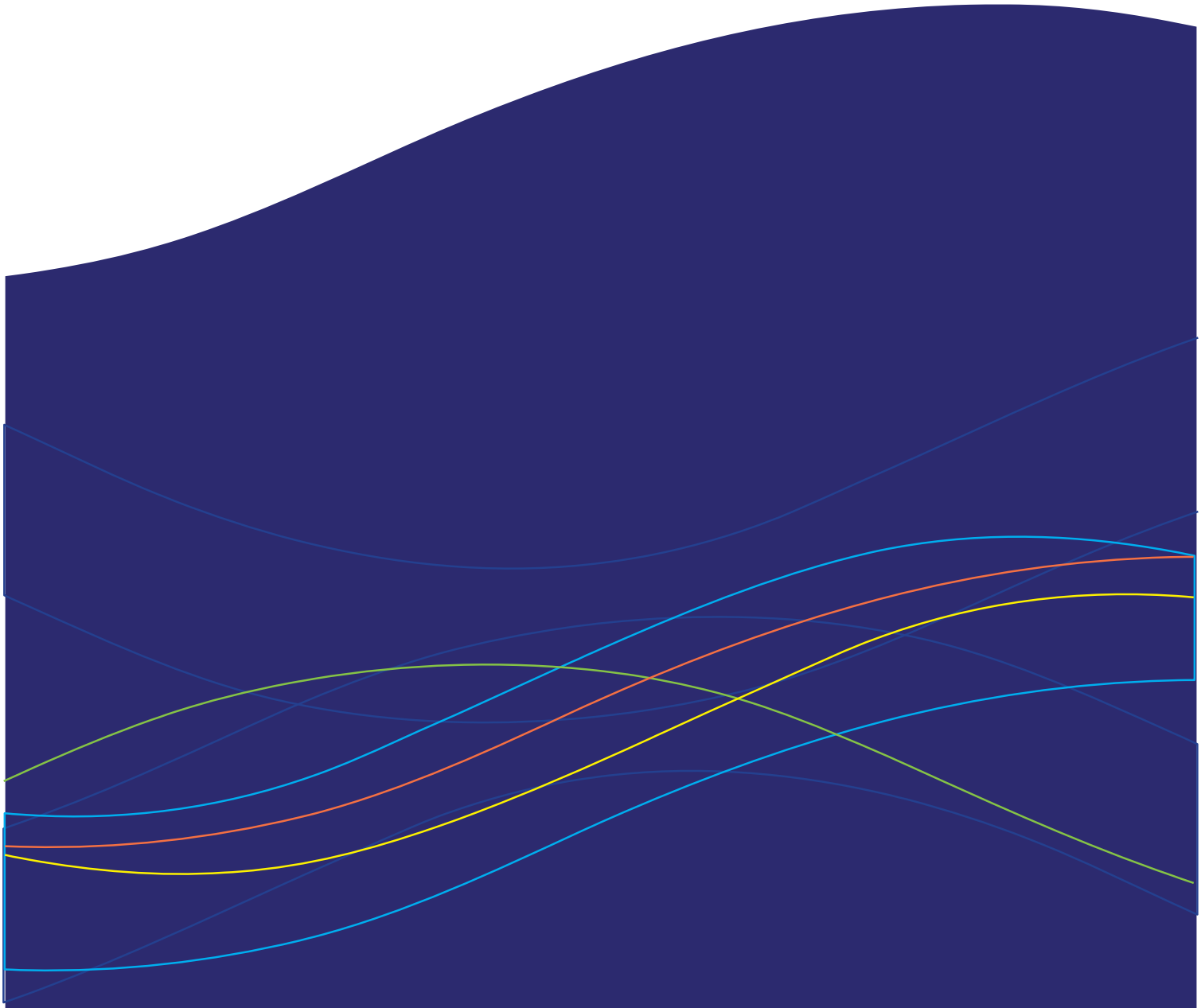

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Appendix H - Rehabilitation Monitoring Summary (Koru Environmental 2022)

Progress against MOP Completion Criteria – Woodland IEM Blocks (Year 1)

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021	
			GBIW-NA-2021	GBIWRM-2021
Landform Establishment Phase				
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Rehabilitation is being undertaken progressively, and land shaping appeared consistent with approved final landform design in all blocks assessed.	Acceptable	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Slopes and natural undulating landforms established as per MOD 2 EA specifications.	Acceptable	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Deep ripping was consistently implemented across the contour in all inspected areas.	Acceptable	Acceptable
Growth Medium Development Phase				
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Soil testing is routinely implemented prior top-dressing to determine ameliorants requirements, and documented in internal 'rehabilitation establishment record' forms or internal GIS database.	Acceptable	Acceptable
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Topsoil depth no longer recorded under the new monitoring methods (revised 2020). However, soil and growth medium cover (visually) appeared adequate throughout.	Acceptable	Acceptable
Woodland seed mix	Performance against benchmark values published by NSW Government or collects at analogue sites.	The seed mix used for woodland rehabilitation was revised by external consultants in 2017, 2018 and 2019 to better align with the targeted CHGBIW; and is regularly reviewed and improved based on the results of the rehabilitation monitoring program.	Acceptable	Acceptable
Ecosystem and Land Use Establishment Phase				
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Not applicable to young rehabilitation at IEM stage where vegetation is considered as still establishing. Ground cover establishment was variable but overall assessed as satisfactory relative to the age of the rehabilitation.	Acceptable	Acceptable

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021	
			GBIW-NA-2021	GBIWRM-2021
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Establishing weed infestations were recorded that posed a risk to the successful establishment of the target woodland community, including: Infestations of exotic pasture grasses in the Narama block. Infestations of Galenia and exotic pasture grasses in the Ravensworth North block.	Maintenance	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	No evidence of damage from vertebrate pests was recorded as impacting the rehabilitation.	Acceptable	Acceptable
Habitat Features	Habitat features, including structures suitable for target species are incorporated into rehabilitation areas at required densities, where appropriate.	Satisfactory densities of artificial habitat features have been established across both blocks including rock piles, log piles and erect stag trees.	Acceptable	Acceptable

Assessment against TARP – Woodland IEM blocks (Year 1)

TARP element	Condition assessment	Status 2021
Monitoring block: GWIW-NA-2020		
Erosion control	Localised superficial rill erosion recorded at two locations (<20cm deep), but overall excellent soil and slope stability observed throughout the block in 2021 – **TARP not activated**.	Monitor
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	Drainage structures (rock-line drains) stable and well performing at the time of inspection and showing no evidence of scouring or erosion – **TARP not activated**.	Acceptable
Ground cover protection	Not measured in Year 1 blocks (walkover only, no plot-based monitoring). Ground cover vegetation establishment was variable across the block as a function of different revegetation timing in various sections of the bock. Vegetation establishment however deemed satisfactory relative to the age of the rehabilitation – **TARP not activated**.	Monitor
Weed presence	Early (and successful) pro-active Galenia control was noted across the block. However, several areas were noted with rapidly establishing infestations of exotic pasture grasses (Guinea Grass and Setaria) posing a risk to successful native woodland establishment – **1st level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings very young at the time of inspection but observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable

TARP element	Condition assessment	Status 2021
Monitoring block: GBIW-RN-2020		
Erosion control	Erosion remediation works have been successful and no key issues of soil/slope erosion were observed across the block at the time of inspection – T**ARP not activated**.	Monitor
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	Drainage structures (contour banks and rock-line drains) stable and well performing at the time of inspection, and showing no evidence of scouring or erosion – **TARP not activated**.	Acceptable
Ground cover protection	Not measured in Year 1 blocks (walkover only, no plot-based monitoring). Ground cover vegetation however appeared as successfully establishing throughout the block – **TARP not activated**.	Monitor
Weed presence	Severe and widespread infestation of Galenia has established across the western half of the block, as well as localised infestations of exotic pasture grasses (Rhodes Grass and Kikuyu) in the eastern section. Significant management inputs will be required - **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable

Progress against MOP Completion Criteria – Pasture IEM Blocks (Years 2 and 3)

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 PAS-NA-2018-1	Monitoring Block Status 2021 PAS-NA-2018-2
Landform Establishment Phase				
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Rehabilitation is being undertaken progressively, and land shaping across all blocks appeared consistent with approved final landform design.	Acceptable	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Established slopes with moderate to steep gradients (10-20 degrees), but consistent with MOD 2 EA specifications in inspected areas.	Acceptable	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Deep ripping was consistently implemented across the contour in inspected areas.	Acceptable	Acceptable
Growth Medium Development Phase				

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 PAS-NA-2018-1	Monitoring Block Status 2021 PAS-NA-2018-2
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Soil testing is routinely implemented prior top-dressing to determine ameliorants requirements, and documented in internal 'rehabilitation establishment record' forms or internal GIS database.	Acceptable	Acceptable
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Excellent topsoil cover recorded across all monitoring locations (measured during the 2019 monitoring event), ranging from 120mm to 400+ mm in depth.	Acceptable	Acceptable
Pasture seed mix	Pasture mix comprises palatable grasses and legumes appropriate to the district and suitable for cattle grazing.	The seed mix used for pasture rehabilitation areas is adequate and comprises a mix of suitable grasses and legume species.	Acceptable	Acceptable
Ecosystem and Land Use Establishment Phase				
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Not applicable to young rehabilitation at IEM stage where vegetation is considered as still establishing. However, good to excellent vegetation establishment was observed throughout the 2018 blocks	Acceptable	Acceptable
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Infestations of Galenia and Acacia saligna remained in both blocks – severe in Block 1 and localised in Block 2 following successful ongoing control works.	Maintenance	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Feral pigs and rabbits/hare were observed in the blocks during previous monitoring years. However, no evidence of damage from vertebrate pests was recorded as impacting the rehabilitation in 2021.	Acceptable	Acceptable
Species composition	Pasture composition comprises palatable grasses and legumes appropriate to the district and suitable for grazing.	Diversity of desirable pasture species relatively low but considered typical of a non-grazed and non-managed rehabilitated pasture, thus satisfactory. Desirable pasture species dominated the pasture composition in Block 2 (representing >90% of total live herbage), however the proportion of desirable species in Block 1 remained unsatisfactory (~50%) due to high weed prevalence.	Maintenance	Acceptable

Assessment against TARP – Pasture IEM blocks (Years 2 and 3)

TARP element	Condition assessment	Status 2021
Monitoring block: PAS-NA-2018-1		
Erosion control	All previously recorded rill/gully erosion processes assessed as stabilised. Some localised residual gully channels to 40cm deep remained defined, but deemed as not warranting repairs considering the limited impacted areas - **2nd level trigger activated**.	Monitor
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	No water management structures present in block – **TARP not activated**.	N/A
Ground cover protection	Average protective ground cover >99% – **TARP not activated**.	Acceptable
Weed presence	Abundance of priority weeds measured at monitoring sites decreased from 2020 levels but remained high at 38.5% average cover. Infestations of Galenia and Acacia saligna remained in block - **2nd level trigger activated**.	Maintenance
Pasture composition	Desirable pasture species on average comprised only ~51% of pasture live herbage - **2nd level trigger activated**.	Maintenance
Pest animals	No significant impacts evidenced **– TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: PAS-NA-2018-2		
Erosion control	Most lower severity rill and gully erosion assessed as stabilised and not warranting remediation. One severe gully channel (80-90cm deep) remains which, although stabilising, requires to be repaired - **2nd level trigger activated**.	Maintenance
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	No water management structures present in block – **TARP not activated**.	N/A
Ground cover protection	Average protective ground cover >92% – **TARP not activated**.	Acceptable
Weed presence	Significant weed control works implemented since last year, resulting in a decrease in recorded average weed cover at monitoring sites from ~24% to ~2%. However, localised infestations of Galenia and Acacia saligna remained in the block - **TARP not activated**.	Maintenance
Pasture composition	Desirable pasture species on average comprised ~92% of pasture live herbage – **1st level trigger activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable

Progress against MOP Completion Criteria – Woodland IEM Blocks (Year 2)

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021		
			GBIW-NA-2018-1	GBIW-NA-2018-2	GBIW-RN-2018
Landform Establishment Phase					
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Rehabilitation is being undertaken progressively, and land shaping appeared consistent with approved final landform design in all blocks assessed.	Acceptable	Acceptable	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Slopes and natural undulating landforms established as per MOD 2 EA specifications.	Acceptable	Acceptable	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Deep ripping was consistently implemented across the contour in inspected areas, where practical. Deep ripping was not consistently implemented in areas of natural relief landforms, where it is impractical to do so as a function of very steep gradients.	Acceptable	Acceptable	Acceptable
Growth Medium Development Phase					
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Soil testing is routinely implemented prior top-dressing to determine ameliorants requirements, and documented in internal 'rehabilitation establishment record' forms or internal GIS database.	Acceptable	Acceptable	Acceptable
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Excellent topsoil cover recorded across all monitoring locations (measured during the 2019 monitoring event), ranging from 100mm to 500+ mm in depth.	Acceptable	Acceptable	Acceptable
Woodland seed mix	Performance against benchmark values published by NSW Government or collects at analogue sites.	The seed mix used for woodland rehabilitation was revised by external consultants in 2017, 2018 and 2019 to better align with the targeted CHGBIW; and is regularly reviewed and improved based on the results of the rehabilitation monitoring program.	Acceptable	Acceptable	Acceptable
Ecosystem and Land Use Establishment Phase					
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Not applicable to young rehabilitation at IEM stage where vegetation is considered as still establishing. Excellent ground cover establishment recorded throughout all blocks in 2021.	Acceptable	Acceptable	Acceptable

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021		
			GBIW-NA-2018-1	GBIW-NA-2018-2	GBIW-RN-2018
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Infestations of priority weeds (of varying extent and severity) occurred in all blocks that posed a risk to the successful establishment of the target woodland community, including Galenia, Acacia saligna and exotic pasture grasses.	Maintenance	Maintenance	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Presence of rabbits/hares was noted throughout most rehabilitation areas. However, associated damage/impacts appeared negligible and not threatening rehabilitation establishment.	Acceptable	Acceptable	Acceptable
Habitat Features	Habitat features, including structures suitable for target species are incorporated into rehabilitation areas at required densities, where appropriate.	Satisfactory densities of artificial habitat features were established in all blocks where feasible in the landform (i.e. excluding areas of natural undulating landforms with very steep gradients). Incorporated features included rock piles, log piles, fallen habitat trees and artificial pond/depressions to provide ephemeral aquatic habitat.	Acceptable	Acceptable	Acceptable

Progress against MOP Completion Criteria – Woodland IEM Blocks (Year 3)

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021			
			GBIW-NA-2019-1	GBIW-NA-2019-2	GBIW-NA-2019-3	GBIW-RN-2019
Landform Establishment Phase						
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Rehabilitation is being undertaken progressively, and land shaping appeared consistent with approved final landform design in all blocks assessed.	Acceptable	Acceptable	Acceptable	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Slopes and natural undulating landforms established as per MOD 2 EA specifications.	Acceptable	Acceptable	Acceptable	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Deep ripping was consistently implemented across the contour in inspected areas, where practical. Deep ripping was not consistently implemented in areas of natural relief	Acceptable	Acceptable	Acceptable	Acceptable

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021			
			GBIW-NA-2019-1	GBIW-NA-2019-2	GBIW-NA-2019-3	GBIW-RN-2019
		landforms, where it is impractical to do so as a function of very steep gradients.				
Growth Medium Development Phase						
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Soil testing is routinely implemented prior top-dressing to determine ameliorants requirements, and documented in internal 'rehabilitation establishment record' forms or internal GIS database.	Acceptable	Acceptable	Acceptable	Acceptable
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Topsoil depth no longer recorded under the new monitoring methods (revised 2020). However soil and growth medium cover (visually) appeared adequate throughout.	Acceptable	Acceptable	Acceptable	Acceptable
Woodland seed mix	Performance against benchmark values published by NSW Government or collects at analogue sites.	The seed mix used for woodland rehabilitation was revised by external consultants in 2017, 2018 and 2019 to better align with the targeted CHGBIW; and is regularly reviewed and improved based on the results of the rehabilitation monitoring program.	Acceptable	Acceptable	Acceptable	Acceptable
Ecosystem and Land Use Establishment Phase						
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Not applicable to young rehabilitation at IEM stage where vegetation is considered as still establishing. Excellent ground cover establishment recorded throughout all blocks in 2021.	Acceptable	Acceptable	Acceptable	Acceptable
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Several weed infestations were recorded in 2021 across the four 2019 rehabilitation blocks that posed a risk to the successful establishment of the target woodland community, including: - Infestations of exotic pasture grasses (of varying severity) in three blocks. - Infestations of Galenia in two blocks. - Infestations of Acacia saligna in one block.	Maintenance	Maintenance	Maintenance	Maintenance

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021			
			GBIW-NA-2019-1	GBIW-NA-2019-2	GBIW-NA-2019-3	GBIW-RN-2019
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Presence of rabbits/hares was noted throughout most rehabilitation areas. However, associated damage/impacts appeared negligible and not threatening rehabilitation establishment.	Acceptable	Acceptable	Acceptable	Acceptable
Habitat Features	Habitat features, including structures suitable for target species are incorporated into rehabilitation areas at required densities, where appropriate.	Satisfactory densities of artificial habitat features were established in all blocks where feasible in the landform (i.e. excluding areas of natural undulating landforms with very steep gradients). Incorporated features included rock piles, log piles, fallen habitat trees and artificial pond/depressions to provide ephemeral aquatic habitat.	Acceptable	Acceptable	Acceptable	Acceptable

Assessment against TARP – Woodland IEM blocks (Years 2 and 3)

TARP element	Condition assessment	Status 2021
Monitoring block: GBIW-NA-2018-1		
Erosion control	One small localised gully channel to 50 cm deep recorded on slope along the eastern boundary. Assessed as not further degraded from last year and not posing a significant risk. However, the feature can be repaired concurrently with the associated/adjoining breached contour bank - **2nd level trigger activated**.	Maintenance
Free draining landforms	No ponding or significant drainage issues recorded (other than erosion in water management structures) – **TARP not activated**.	Acceptable
Water management structures	One location recorded with fully breached contour bank which may need to be repaired - **2nd level trigger activated**.	Maintenance
Ground cover protection	Recorded average protective ground cover >99% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged 30.6%, increased from ~17% in 2020. Widespread and severe infestations of Galenia, Acacia saligna and exotic grasses recorded in the block - **2nd level trigger activated**.	Maintenance
Vegetation Health	Although very sparsely established, shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable

TARP element	Condition assessment	Status 2021
Pest animals	No significant impacts evidenced **– TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: GBIW-NA-2018-2		
Erosion control	Erosion gullies occur in areas of steeper gradients of the natural landform, which materialised early following completion of rehabilitation works. Most channels of lower severity have stabilised following good vegetation establishment (and assessed as not further degraded) and are unlikely to justify remediation. However, localised repair works will be required for those more severe channels (few channels occur to 80-100cm deep) particularly to the north of the block.– **2nd level trigger activated**.	Maintenance
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	Drainage structure well performing with minimal erosion / scouring recorded– **TARP not activated**.	Acceptable
Ground cover protection	Recorded average protective ground cover ~98% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~7.0%, increased from <1.0% in 2020. Galenia successfully suppressed from the block following the 2020 control works. However, a localised infestation of exotic grasses (particularly Setaria and Guinea Grass) has established to the north-east of the block which will need to be treated – **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: GBIW-RN-2018		
Erosion control	All residual slope erosion processes assessed as fully stabilised, demonstrating successful outcomes of the 2018 localised remediation works – **TARP not activated**.	Acceptable
Free draining landforms	No ponding or significant drainage issues recorded (other than erosion in water management structures) – **TARP not activated**.	Acceptable
Water management structures	Localised breaching/tunnelling/overtopping of contour banks recorded in 2019 and 2020 were all confirmed as stabilised and no longer threatening landform stability/integrity – **TARP not activated**.	Acceptable
Ground cover protection	Recorded average protective ground cover >90% – **TARP not activated**.	Acceptable

TARP element	Condition assessment	Status 2021
Weed presence	Priority weed cover measured at monitoring sites averaged ~7.0%, increased from <1.0% in 2020. A widespread and moderately severe infestation of Rhodes Grass has established on the lower contour along the eastern boundary as well as a small area of Kikuyu along the eastern boundary, which will require intervention – **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: GBIW-NA-2019-1		
Erosion control	Good slope stability has been achieved throughout as a function of excellent vegetation establishment. All superficial rill erosion observed last year was fully stabilised and not further degraded (i.e. no remediation works required) – **TARP not activated**.	Acceptable
Free draining landforms	No ponding or significant drainage issues recorded– **TARP not activated**.	Acceptable
Water management structures	Drainage structure well performing with nil erosion / scouring recorded within structures – **TARP not activated**.	Acceptable
Ground cover protection	Recorded average protective ground cover ~99% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~9.4%. However, a widespread and moderately severe infestation of Setaria has established across most of the block which, if left untreated, will likely suppress the germination and/or persistence of native ground covers. Likewise, the localised infestation of Galenia reported last year remained along the southern boundary remained – **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: GBIW-NA-2019-2		
Erosion control	A multitude of erosion gullies occur in areas of steeper gradients of the natural landform, which materialised early following completion of rehabilitation works (as reported in 2020). Most channels of lower severity have stabilised following good vegetation establishment (and assessed as not further degraded) and are unlikely to justify remediation. However, localised repairs may be required for those more severe channels (60-80cm deep) at the northern end of the block.– **2nd level trigger activated**.	Maintenance
Free draining landforms	No ponding or significant drainage issues recorded– **TARP not activated**.	Acceptable

TARP element	Condition assessment	Status 2021
Water management structures	Drainage structure well performing with minimal erosion / scouring recorded within structures – **TARP not activated**.	Acceptable
Ground cover protection	Recorded average protective ground cover >99% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~13.6%. Severity and extent of Galenia infestation mapped in 2020 greatly reduced following successful control. However, moderately severe infestations of exotic grasses (particularly Seteria and Guinea Grass) are establishing throughout most of the block posing a real risk to the persistence of native species if left untreated – **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: GBIW-NA-2019-3		
Erosion control	A multitude of erosion gullies of moderate severity (<50cm deep) occur which materialised early following completion of rehabilitation works. All channels were assessed as stabilised in 2021 following good vegetation establishment, and not further degraded; and none are likely to warrant repairs – **2nd level trigger activated**.	Monitor
Free draining landforms	No ponding or significant drainage issues recorded (other than erosion in water management structures) – **TARP not activated**.	Acceptable
Water management structures	Low severity gullying (to 40cm deep) occurred within the westernmost rock-lined drain as reported in 2020. However the erosion appeared as not further degarded in 2021 and the structure stabilised, thus unlikely to warrant repairs - **2nd level trigger activated**.	Monitor
Ground cover protection	Recorded average protective ground cover ~97.5% – **TARP not activated**.	Acceptable
Weed presence	A severe infestation of exotic grasses (Rhodes Grass, Guinea Grass and Setaria) has established across most of the block (sometimes with Galenia interspersed), which will require significant management inputs. In addition, localised infestations of Acacia saligna were observed as establishing which will also need to be removed - **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: GBIW-RN-2019		

TARP element	Condition assessment	Status 2021
Erosion control	The erosion gullies mapped last year in the eastern slopes remained but did not appear further degraded (all to ~40-50cm deep), and all appeared as stabilising following good ground cover establishment. Repairs are unlikely to be required – **2nd level trigger activated**.	Monitor
Free draining landforms	No ponding or significant drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	Drainage structure well performing with minimal erosion / scouring recorded within structures – **TARP not activated**.	Acceptable
Ground cover protection	Recorded average protective ground cover ~98% – **TARP not activated**.	Monitor
Weed presence	Widespread and severe infestations of Galenia established throughout the central sections of the block – **2nd level trigger activated**.	Maintenance
Vegetation health	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable

Progress against MOP Completion Criteria – Pasture LTM Block

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 PAS-NA-2008
Landform Establishment Phase			
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Criterion no longer applicable to rehabilitation at LTM stage	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Slopes are consistent with MOD 2 EA and generally ≤10 degrees across the block.	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Criterion no longer applicable to rehabilitation at LTM stage	Acceptable
Growth Medium Development Phase			
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Criterion no longer applicable to rehabilitation at LTM stage	Acceptable

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 PAS-NA-2008
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Excellent topsoil cover recorded across all monitoring locations (measured during the 2018 monitoring event), ranging from 120mm to 250 mm in depth.	Acceptable
Pasture seed mix	Pasture mix comprises palatable grasses and legumes appropriate to the district and suitable for cattle grazing.	There is no record of the seed mix used in areas of 2008 rehabilitation, but established pasture is comprised of suitable palatable and productive species.	Acceptable
Ecosystem and land use establishment phase			
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	No large bare patches occur within the block and vegetative cover is excellent throughout	Acceptable
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Areas of localised and minor weed incursion were mapped within the block including Acacia saligna, African boxthorn, Galenia and Sharp Rush; however no severe or widespread infestations occurred that could pose a risk to pasture establishment or productivity. Targeted control is recommended, but requiring management inputs only commensurate with the ongoing routine weed control program.	Acceptable
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	No significant disturbance impacts from vertebrate were noted.	Acceptable
Species composition	Pasture composition comprises palatable grasses and legumes appropriate to the district and suitable for grazing.	A moderate diversity of suitable pasture species occurs, comprising eight palatable grasses and two legumes. The contribution of suitable pasture species to the total live herbage on average exceeded 85%	Acceptable
Ecosystem and land use sustainability phase			
Overall pasture performance	Performance against benchmark values published by NSW Government or collected at analogue sites	Benchmarks used in GCAA monitoring program to assess pasture condition were derived from NSW Government publications and other relevant and reliable literature, studies, trials, etc. All benchmarks we achieved in 2021.	Acceptable

Assessment against TARP – Pasture LTM Block

TARP element	Condition assessment	Status 2021
Monitoring block: PAS-NA-2008		
Erosion control	No active erosion processes recorded in block nor residual erosion features requiring repair **– TARP not activated**.	Acceptable

TARP element	Condition assessment	Status 2021
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	Water management structures in block including contour banks and sediment dam were assessed as stable and well-functioning, with no evident erosion or scouring issues – **TARP not activated**.	Acceptable
Ground cover protection	100% protective ground cover was measured at the monitoring sites, and no large recalcitrant bare patches were identified during the GIS-desktop studies or walkover assessment of the block	Acceptable
Weed presence	Abundance of priority weeds measured at monitoring sites slightly increased from 2018 levels but remained relatively low at ~8.0% average cover. Localised minor weed incursions occur in the block but no severe or widespread infestations requiring management inputs greater than the ongoing routine land management program– **TARP not activated**.	Acceptable
Pasture composition	Suitable pasture species on average comprised >85% of pasture live herbage - **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced **– TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable

Progress against MOP Completion Criteria – CHGBIW LTM Block

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 GBIW-RN-B1
Ecosystem and land use establishment phase			
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Vegetation establishment satisfactory with no large bare patches recorded.	Acceptable
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Moderately severe but widespread infestations of tropical pasture grasses (particularly Rhodes Grass, Guinea Grass and Kikuyu) and Galenia occur in the block requiring management inputs. A high diversity of other priority weed species also occurred, however their prevalence was generally minor.	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Presence of rabbits/hares was noted. However, associated damage/impacts were negligible and not threatening rehabilitation establishment	Acceptable

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 GBIW-RN-B1
Habitat features	Habitat features, including structures suitable for target species are incorporated into rehabilitation areas at required densities, where appropriate.	Adequate densities of habitat features have been incorporated across the lock, including rock piles and log piles.	Acceptable
Ecosystem and land use sustainability phase			
Final rehabilitation	Revegetation areas contain flora species assemblages characteristic of each strata for the desired native vegetation communities.	Native species composition and assemblages were assessed as inadequate in all strata (i.e. <75% of established native species representative of the target community). The tree layer was particularly poorly characteristic of CHGBIW with <50% of species foreign to the target community.	Maintenance
Biometric vegetation attributes	Performance against benchmark values published by NSW government or collects at analogue sites.	Despite inadequate assemblages, total native species richness was high (~33 average native species per site) and within reference sites benchmarks. Vegetation structure (i.e. cumulative FPC in each strata) was overall satisfactory. Cumulative FPC in the mid and lower storeys were on average both within benchmarks. Tree FPC remained slightly below target, but deemed satisfactory relative to the age of the rehabilitation (i.e. expected to naturally improve as rehabilitation matures and further tree growth is achieved). Vegetation function (as captured by average litter cover) was within benchmark.	Monitor
Habitat value	Habitat suitable for target species present.	Current habitat value of the rehabilitation is moderate. The relatively high diversity of native species, the established mid and lower storey layers and the accumulating litter layer provide some food sources and potential refuge/shelter for native fauna to utilise or move across the landscape. In addition, adequate densities of artificial habitat features (rock piles / log piles) have been incorporated that enhance/complement the habitat potential of the rehabilitation. However, vegetation complexity and stratification overall remain limited due to ecologically young age of vegetation. The tree layer is not yet well-established and the low densities of canopy eucalypts may prove a barrier to this successfully occurring in the long term.	Monitor
Fauna species	Monitoring confirms target native fauna species are recorded utilising rehabilitation areas.	Monitoring for fauna presence was not included in the scope of works of this rehabilitation monitoring program.	N/A
Final land use	Where infrastructure has been removed and rehabilitation is completed, woodland rehabilitation will consist of the following vegetation communities:	Based on its current state, it is unlikely that the LTM block of CHGBIW assessed at Ravensworth North WEA will successfully progress towards the target community without significant levels of active management	Maintenance

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2021 GBIW-RN-B1
	• Central Hunter Box-Ironbark Woodland; • Central Hunter Swamp Oak Forest; • Central Hunter Bulloak Forest Regeneration.	and improvement actions. Required actions will include a combination of: successful weed suppression, increase canopy tree stem densities (eucalypts), and increase the representation of species characteristic of the target CHGBIW in all vegetation layers. The latter may occur naturally provided that the former actions (i.e. weed control and eucalypt density increase) are successfully implemented.	

Assessment against TARP – Pasture CHGBIW LTM Block

TARP element	Condition assessment	Status 2021
Monitoring block: GBIW-RN-B1		
Erosion control	Satisfactory slope stability across most of the block, with no active erosion processes or features requiring remediation – **TARP not activated.**	Acceptable
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	A number of residual contour bank breaches occur; however all areas were assessed as fully vegetated and stabilised, with no associated surface drainage issues – **TARP not activated**.	Acceptable
Ground cover protection	Protective ground cover percent not measured at the monitoring site level under revised methods. Good vegetative cover present throughout the block with no identified large bare areas – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites was very low (~5%). However, moderately severe but widespread infestation of Galenia and exotic grasses (particularly Rhodes Grass, Guinea Grass and Kikuyu) occur throughout the block requiring management – **1st level trigger activated**.	Maitenence
Vegetation health	Established vegetation observed as healthy and growing at all location, as exemplified by the distinct increase in FPC cover in all vegetation layers between the last two monitoring events – **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced **– TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable