CENTENNIAL

CENTENNIAL COAL
AIRLY MINE
2024 ANNUAL REVIEW

March 2025

Annual Review Title Block

Name of Operation	Airly Mine
Name of Operator	Centennial Airly Pty Limited
Development Consent/ Project Approval #	SSD_5581 (as modified)
Name of holder of Development Consent/ Project Approval	Centennial Airly Pty Limited
Mining Lease #	ML1331 ML1814
Name of Holder of Mining Lease	Centennial Airly Pty Limited
Water License #	WAL 24386 WAL 36565
Name of Holder of Water License	Centennial Airly Pty Limited
RMP Start Date / End Date	1 August 2022 to perpetuity (RMP Version 1.1 dated 19 December 2023)
Annual Review Start Date	1 January 2024
Annual Review End Date	31 December 2024

I, Graham Healey **certify that this audit report is a true and accurate record of the compliance status of Airly Mine for the period 1 January to 31 December 2024 and that I am authorised to make this statement on behalf of Centennial Airly.**

Note:

a) *The Annual Review is an 'environmental audit' for the purposes of s122B(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 Authorised Reporting Officer	Graham Healey
Title of Authorised Reporting Officer	Mining Engineering Manager
Signature of Authorised Reporting Officer	
Date	31/03/2025

Contents

1 STATEMENT OF COMPLIANCE 1

2 INTRODUCTION 3

2.1 SCOPE 3
2.2 MINE CONTACTS 3
2.3 HISTORY 4

3 APPROVALS 7

3.1 PROJECT APPROVALS, MINING AUTHORISATIONS, AND OTHER LICENCES 7
3.1.1 Changes During the Reporting Period 9
3.2 ANNUAL REPORTING REQUIREMENTS 9

4 OPERATIONS SUMMARY 10

4.1 MINING OPERATIONS 10
4.2 OTHER OPERATIONS 11
4.3 EXPLORATION 12
4.4 LAND DISTURBANCE 12
4.5 CONSTRUCTION 12
4.6 NEXT REPORTING PERIOD 12

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW 13

6 ENVIRONMENTAL PERFORMANCE 16

6.1 METEOROLOGICAL SUMMARY 20
6.2 NOISE 21
6.2.1 Environmental Management 21
6.2.2 Environmental Performance 21
6.2.3 Comparison against Predictions 24
6.2.4 Long Terms Analysis 24
6.2.5 Implemented / Proposed Improvements 25
6.3 BLASTING 25
6.4 AIR QUALITY 25
6.4.1 Environmental Management 25
6.4.2 Environmental Performance 28
6.4.3 Comparisons against Predictions 31
6.4.4 Long Term Analysis 31
6.4.5 Implemented / Proposed Improvements 31
6.5 GREENHOUSE GAS MONITORING 32
6.5.1 Environmental Management 32
6.5.2 Environmental Performance 32
6.5.3 Comparisons against Predictions 32
6.5.4 Long Term Analysis 32
6.5.5 Implemented / Proposed Improvements 33
6.6 BIODIVERSITY 33
6.6.1 Environmental Management 33
6.6.2 Environmental Performance 34
6.6.3 Comparisons against Predictions 36
6.6.4 Long Term Analysis 38
6.6.5 Implemented / Proposed Improvements 38
6.6.6 Biodiversity Offsets 38
6.7 HERITAGE 38
6.7.1 Environmental Management 38
6.7.2 Environmental Performance 39
6.7.3 Comparison against Predictions 41
6.7.4 Long Term Analysis 41
6.7.5 Implemented / Proposed Improvements 41

6.8 MINE SUBSIDENCE 41
6.8.1 Environmental Management 41
6.8.2 Environmental Performance 42
6.8.3 Comparisons against Predictions 52
6.8.4 Long Term Analysis 53
6.8.5 Implemented / Proposed Improvements 54
6.9 OTHER MATTERS 54
6.9.1 Waste 54
6.9.2 National Pollutant Inventory 55

7 WATER MANAGEMENT 56

7.1 WATER LICENCES 57
7.2 WATER BALANCE 57
7.3 SURFACE WATER 58
7.3.1 Environmental Management 58
7.3.2 Environmental Performance 61
7.3.3 Comparison against Predictions 66
7.3.4 Long Term Analysis 67
7.4 GROUNDWATER 67
7.4.1 Environmental Management 67
7.4.2 Environmental Performance 69
7.4.3 Comparisons against Predictions 73
7.4.4 Long Term Analysis 73
7.5 IMPLEMENTED / PROPOSED IMPROVEMENTS 74

8 REHABILITATION 75

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD 75
8.1.1 Summary of Rehabilitation 75
8.1.2 Subsidence Remediation – Mount Airly Panel and Pillar Mining Zone 76

9 COMMUNITY CONSULTATION 78

9.1 COMMUNITY ENGAGEMENT 78
9.2 COMMUNITY COMPLAINTS 78

10 INDEPENDENT ENVIRONMENTAL AUDIT 80

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD 89

12 ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD 90

13 REFERENCES 91

Plans

Plan 1 (AM04125): Airly Mine – Project Application Area & Mining Tenements
Plan 2 (AM04123): Airly Mine - Environmental Monitoring Plan
Plan 3 (AM04124): Airly Mine – Mining Consent Zones & 2024 Workings

Appendices

Appendix 1: Checklist of Annual Review Reporting Requirements
Appendix 2: Noise Monitoring 2024 Annual Report
Appendix 3: 2024 Air Quality Monitoring Results
Appendix 4: Airly Mine Seasonal Ecological (Flora and Fauna) 2024 Monitoring Report
Appendix 5: Review of Monitored Subsidence and Impacts 2024 Annual Report
Appendix 6: Airly Mine Water Monitoring 2024 Annual Report
Appendix 7: Airly Mine Watercourse Stability 2024 Monitoring Report
Appendix 8: Airly Mine Aquatic Ecology 2024 Annual Report
Appendix 9: Airly Mine Stygofauna 2024 Monitoring Report
Appendix 10: Mount Airly Fracture Locations and Descriptions

List of Tables

Table 1-1: Statement of Compliance 1
Table 1-2: 2024 Non-Compliances 2
Table 2-1: Centennial Site Environmental Contact Details 3
Table 3-1: Environmental Approvals held by Centennial Airly 7
Table 4-1: Production Summary & Forecast 10
Table 4-2: Operations Summary 11
Table 5-1: Actions from Previous Annual Review and Regulator Requirements 13
Table 6-1: Summary of Environmental Monitoring Requirements and Environmental Performance 17
Table 6-2: Airly Mine Noise Criteria and Monitoring Summary 23
Table 6-3: 2024 Attended Noise Monitoring Results (17 December 2024) 24
Table 6-4: Airly Mine Air Quality Impact Assessment Criteria 25
Table 6-5: Airly Mine Air Quality Management/Mitigation Measures 26
Table 6-6: Description and Summary of Air Quality Monitoring at Airly Mine 26
Table 6-7: Summary of HVAS Monitoring Results 28
Table 6-8: Adopted Site-Specific Ambient Air Quality Environment 31
Table 6-9: Long Term Air Quality Monitoring Summary (2020 – 2024) 31
Table 6-10: Total GHG Emissions from Airly Mine 33
Table 6-11: Biodiversity related subsidence impact performance measures 37
Table 6-12: Summary of Approved Extraction Plans 41
Table 6-13: Summary of compliance with subsidence impact performance measures 43
Table 6-14: Measured maximum total subsidence over the extracted miniwalls 53
Table 6-15: Waste Summary 55
Table 7-1: Water Licenses and Take 57
Table 7-2: Annual water balance – average existing conditions (2024) 58
Table 7-3: Description of Surface Water Monitoring Locations 59
Table 7-4: Summary of Surface Water Monitoring 62
Table 7-5: Summary of SSGV Assessment and Investigations – 2024 63
Table 7-6: Obligate Stygofauna (and total animal abundance) collected at Airly Mine 72
Table 8-1: Rehabilitation Status 75
Table 9-1: Record of annual community complaints – 2014-2024 79
Table 10-1 Summary Status of Audit Recommendations Identified during the 2024 IEA 81
Table 11-1 Incidents and Non-Compliances during the Reporting Period 89
Table 12-1: Forecast Operations for 2025 90

List of Figures

Figure 2-1: Regional Context 5
Figure 2-2: Site Features 6
Figure 6-1 Summary of Meteorological Conditions 20
Figure 6-2: Airly Mine Noise Monitoring Locations 22
Figure 6-3: Airly Mine Air Quality Monitoring Locations 27
Figure 6-4: Summary of Depositional Dust Monitoring 28
Figure 6-5: Annual HVAS PM10 Monitoring Results 29
Figure 6-6: Annual HVAS TSP Monitoring Results 29
Figure 6-7: Heritage Sites and Mining Activity 2024 and Forecast-2025 40
Figure 6-8: Observed subsidence profiles across MW13-MW16 49
Figure 6-9: Daily subsidence (raw) measurements at GNSS stations over MW13-MW16 49
Figure 6-10: Observed subsidence profiles after extraction of MW17 51
Figure 6-11: Daily subsidence measurements at GNSS stations over MW17 52
Figure 7-1: Surface Water Monitoring Locations (source: GHD, 2025a) 60
Figure 7-2: Observed flow and rainfall – 2024 61
Figure 7-3: Groundwater Monitoring Locations (source: GHD, 2025a) 68
Figure 7-4: Recorded flows at Village Spring 71

Abbreviations

Abbreviation	Description
AHIMS	Aboriginal Heritage Information Management System
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BAM	Biodiversity Assessment Method
BCD	*former* Biodiversity and Conservation Division
BC Act	Biodiversity Conservation Act 2016
CCC	Community Consultative Committee
CEEC	Critically Endangered Ecological Community
CRD	Cumulative Rainfall Departure
DA	Development Approval
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	*former* Department of Planning and Environment
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPL	Environment Protection Licence
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FTE	Full-Time Equivalent
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
GNSS	Global Navigation Satellite System
HB	Herringbone
HVAS	High Volume Air Sampler
IEA	Independent Environmental Audit
IER	Independent Expert Review
IMP REC	Independent Environmental Audit Recommendation
LDP	Licensed Discharge Point
LEP	Local Environmental Plan
ML	Mining Lease
MNES	Matters of National Environmental Significance
MOD	Modification
MPPS	Mount Piper Power Station
MW	Miniwall

Abbreviation	Description
NGER	National Greenhouse and Energy Reporting
NMP	Noise Management Plan
NPWS	National Parks and Wildlife Service
NSW RR	NSW Resources Regulator
PAC	Planning Assessment Commission
PM10	Particulate Matter <10µm
PPMZ	Panel and Pillar Mining Zone
QA/QC	Quality Assurance / Quality Control
RAP	Registered Aboriginal Parties
RMP	Rehabilitation Management Plan
ROM	Run-of-Mine
SMP	Subsidence Management Plan
SSD	State Significant Development
SSGV	Site Specific Guideline Value
TARP	Trigger Action Response Plan
TEC	Threatened Ecological Community
TSP	Total Suspended Particulates
VWPs	Vibrating Wire Piezometers
WAL	Water Access Licence
WMP	Water Management Plan
WRBMP	Western Region Biodiversity Management Plan
WRACHMP	Western Region Aboriginal Cultural Heritage Management Plan
WRHHMP	Western Region Historic Heritage Management Plan
WRAQGMP	Western Region Air Quality and Greenhouse Gas Management Plan

1 STATEMENT OF COMPLIANCE

The compliance status of the Airly Mine for the year 2024 is presented in **Table 1-1**.

During the reporting period there was one non-compliance. **Table 1-2** presents a summary of the non-compliances.

Table 1-1: Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Development Consent SSD_5581	No
Mining Lease 1331	Yes
Mining Lease 1814	Yes
EPL 12374	Yes
WAL24386 (Production Bore)	Yes
WAL36565 (Mine Dewatering)	Yes
EPBC Approval (EPBC 2013/7606)	Yes
Extraction Plan Approvals	Yes
Onsite Sewage Management Approval (Application No: S68182/23)	Yes
Development Approval – DA033/19 (Airly Solar Farm)	Yes

Compliance Status Key for Non-compliances

Risk Level	Colour Code	Description
High	Non-Compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-Compliant	Non-compliance with: • Potential for serious environmental consequences, but 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 is unlikely to occur; or • Potential for low environmental consequences, but is likely to occur
Administrative	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: 2024 Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Where Addressed in Annual Review
SSD_5581	Schedule 4, Condition 7	**Air Quality Management Plan** The Applicant must implement the approved Air Quality Management Plan for the development.	Non-compliant (Administrative)	HVAS malfunctions during the first half of 2024 resulted in missed PM_{10} results, although TSP continued to be recorded. A further missed sample run for both PM_{10} and TSP occurred in October 2024 due to a power outage. As a result the WRAQGMP monitoring program could not be fully implemented during these periods. Although assessment of available data concluded with an extremely high level of certainty that no exceedances of air quality criteria (Schedule 4, Condition 5 of SSD_5581) occurred, the WRAQGMP does not allow for inferred results in place of monitored data when equipment malfunctions or outages occur. Accordingly, this has been recorded as a non-compliance with the implementation of the WRAQGMP, but it does not represent a non-compliance relating to incident reporting or potential impact to sensitive receivers.	**Section 6.4.2** and **Section 11 (Table 11-1)**

2 INTRODUCTION

Airly Mine is an underground coal mine located in the Western Coalfields (refer **Figure 2-1**), within the Sydney Basin, approximately 40 kilometres (km) north-northwest of Lithgow and approximately 171 km northwest of Sydney. Centennial Airly Pty Limited (Centennial Airly) is the operator of Airly Mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited (Centennial Coal).

The Airly Mine Extension Project (SSD_5581) was approved in December 2016 and allows extraction of 1.8 million tonnes of coal per annum for supply to both domestic and international markets by rail for a period of 20 years within the Project Area (**Plan 1**). Airly Mine commenced operations under SSD_5581 on 31 January 2017.

The Mine's disturbance footprint is limited to the pit top and surface infrastructure areas including water management systems, car park, administration building, workshop, conveyors, coal handling plant and mine ventilation infrastructure. The current disturbance footprint of Airly Mine is 54.4 ha, the key surface site features are shown in **Figure 2-2**.

2.1 SCOPE

This Annual Review details the compliance and environmental management performance of Airly Mine over the period 1 January 2024 to 31 December 2024. It has been prepared to demonstrate the sites performance and community engagement activities. The Annual Review has been prepared in accordance with the *Annual Review Guideline* (DPE, 2015) and satisfies:

- the conditions of Project Approval SSD_5581, in particular Schedule 6, Condition 11.[1] and
- Reporting requirements of Environmental Management Plans, Extraction Plans / Subsidence Management Plans.

2.2 MINE CONTACTS

The contact details for the personnel responsible for environmental management and community relations at Airly Mine are provided in **Table 2-1**.

Table 2-1: Centennial Site Environmental Contact Details

Name	Position	Contact Details
Graham Healey	Mine Manager	T: (02) 6359 2101
		E: Graham.C.Healey@centennialcoal.com.au
Sam Price	Environment & Community Superintendent	T: (02) 6359 2108
		E: Sam.Price@centennialcoal.com.au
Community Information and Complaints Line		T: (02) 6359 2108

[1] See **Appendix 1** for a checklist of annual review reporting requirements and where they have been addressed in this Annual Review.

2.3 HISTORY

Prior to the Airly Mine Extension Project (SSD_5581), Airly Mine operated in accordance with the original development consent, DA 162/91, that was granted on 14 April 1993 pursuant to Section 101 of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*). DA 162/91 authorised the extraction of up to 1.8 Mtpa of run-of-mine (ROM) coal within the existing mining lease area, ML1331. DA 162/91 allowed for a limited scale trial mine for a period of 12 months with transport of 300,000 tonnes of ROM coal by road to the Mount Piper Power Station (MPPS).

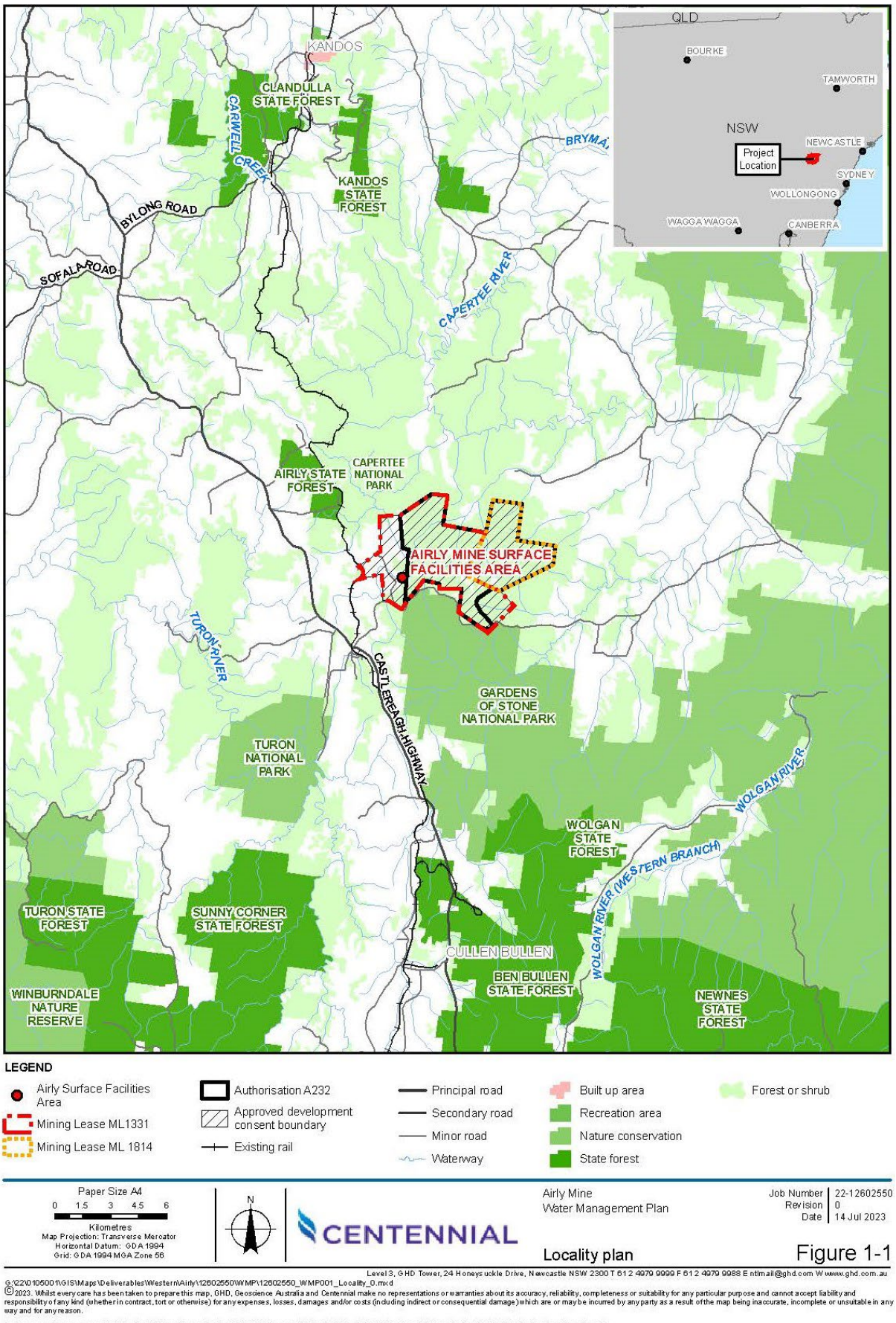
Two subsequent modifications to DA 162/91 were approved and allowed an increased amount of trial mining coal throughput of up to 500,000 tonnes per annum for 2 years to be transported to MPPS by road (MOD 1), and for the construction and operation of a 66 kV power line to the pit top (MOD 2).

Airly Mine moved to a care and maintenance phase in January 2013 and remained in care and maintenance until March 2014. During this phase extraction activities ceased, however environmental management which included environmental monitoring was ongoing. Coal production at Airly Mine resumed in March 2014.

Following re-opening of the mine, another three modifications to DA 162/91 were approved. These modifications were all in relation to extending the expiry date of DA 162/91 while the Airly Mine Extension Project application was being assessed. In October 2014 the development consent for Airly Mine was extended until 31 October 2015 (MOD 3). In August 2015 the development consent for Airly Mine was extended until 30 April 2016 (MOD 4); in March 2016 the consent was extended until 31 October 2016 (MOD 5) and in September 2016 the consent was extended until 31 January 2017 (MOD 6).

On 15 December 2016, SSD_5581 for the Airly Mine Extension Project was approved by the Planning Assessment Commission (PAC) (under delegation from the Minister of Planning) pursuant to Part 4 of the EP&A Act. SSD_5581 allows for the continued underground mining operations at existing production rates until 31 January 2038. SSD_5581 has been modified on three occasions, with an additional two modification applications lodged by Centennial Airly subsequently withdrawn.

In accordance with Condition 10 in Schedule 2 of SSD_5581, Centennial Airly surrendered development consent DA162/91 (as modified) on 31 January 2018 which was accepted by the Department on 10 December 2018.



Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

G:\22\10500\1\GIS\Maps\Deliverables\Western\Airly\12602550\WMP\12602550_WMP001_Locality_0.mxd
© 2023. Whilst every care has been taken to prepare this map, GHD, Geoscience Australia and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3 2006; Centennial: Boundaries, 2013. Created by: fmackay, tmorton

Figure 2-1: Regional Context

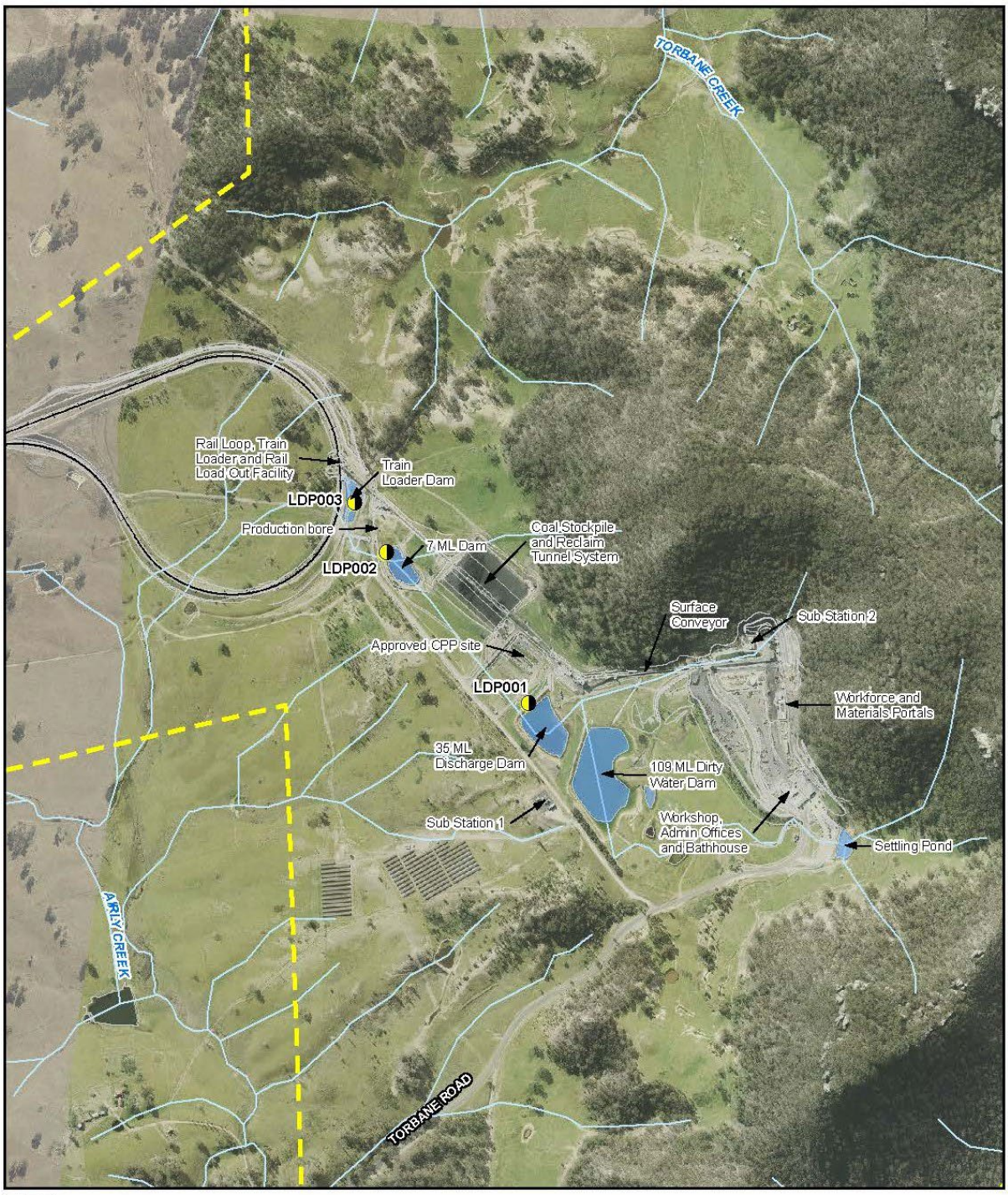


Figure 2-2: Site Features

3 APPROVALS

3.1 PROJECT APPROVALS, MINING AUTHORISATIONS, AND OTHER LICENCES

A summary of Project Approvals, Mining Authorisations, and other Licences relevant to Airly Mine is provided in **Table 3-1**. Current development, mining and environment approvals are available at the Airly Mine website.[2]

Table 3-1: Environmental Approvals held by Centennial Airly

Approval	Description	Expiry Date	Change during Reporting Period (Y/N)
Project Approval – Department of Planning, Housing and Infrastructure			
Development Consent SSD_5581	Project approval for Airly Mine, allowing underground mine development to extract up to 1.8 million tonnes per annum	31 January 2037	N
SSD_5581 (Mod 1)	Mod 1 (additional clarification relating to angle of draw restrictions for secondary workings)		
SSD_5581 (Mod 2)	Mod 2 (permits the importation of water via rail from Charbon Colliery).		
SSD_5581 (Mod 5)	Mod 5 (permits an increase to the workforce and modernised the rehabilitation conditions to align with regulatory reforms).		
Extraction Plans – Department of Planning, Housing and Infrastructure			
Extraction Plan Approval	*MOD 3 Extraction Plan (as Varied)*	N/A	N
Extraction Plan Approval	*Cliff Line Zone of First Workings Extraction Plan (ML1331).*	N/A	N
Extraction Plan Approval	*Splitting & Quartering Extraction Plan.*	N/A	N
Extraction Plan Approval	*Mt Airly Panel & Pillar Mining Zone Extraction Plan (MW02-12).*	N/A	N
Extraction Plan Approval	*Pt Hatteras Panel & Pillar Mining Zone Extraction Plan (MW13-16)*	N/A	N
Extraction Plan Approval	*MW17-18 Panel & Pillar Mining Zone Extraction Plan*	N/A	Y – see **Section 3.1.1**
Extraction Plan Approval	*Cliff Line Zone of First Workings Extraction Plan (ML1814).*	N/A	Y – see **Section 3.1.1**

[2] https://www.centennialcoal.com.au/operations/airly/

Approval	Description	Expiry Date	Change during Reporting Period (Y/N)
Environmental Protection Licence – Environmental Protection Authority			
Environmental Protection Licence 12374 (EPL 12374)	3 licenced discharge points Production of coal >500,000T to 2,000,000T per annum	Renewed Annually (next review due 14 August 2025)	N
Mining Authorisations – Department of Regional NSW (Mining, Exploration and Geoscience)			
Mining Lease 1331 (ML1331)	Mining lease area of approximately 2,745 hectares	20 October 2035	N
Mining Lease 1814 (ML1814)	Mining lease area of approximately 1,258 hectares	22 July 2042	N
Environment Protection and Biodiversity Conservation – Department of Agriculture, Water and the Environment			
EPBC Approval (EPBC 2013/7606)	Permission to carry out mining operations in accordance with SSD_5581 with conditions relating to the protection of Matters of National Environmental Significance (MNES).	31 March 2047	N
Rehabilitation Management Plan – NSW Resources Regulator			
Rehabilitation Management Plan – Airly Mine	Rehabilitation Management Plan (proposed) for Airly Mine with commencement date 1 August 2022	N/A	N
Water Licences – Water NSW			
Water Access Licence (WAL) 24386	Extract up to 158ML per annum (Production Bore)	Perpetuity	N
Water Access Licence (WAL) 36565	Extract up to 120ML per annum (Mine Dewatering)	Perpetuity	N
10BL604518	ARP01	Perpetuity	N
10BL604520	ARP02A & ARP03A	Perpetuity	N
10BL604521	ARP04 & ARP05	Perpetuity	N
10BL605352	ARP06, ARP07, ARP08 & ARP09	Perpetuity	N
10BL605794	ARP11	Perpetuity	N
10BL605793	ARP12, ARP13, ARP13SP, ARP14, ARP15 & ARP15SP	Perpetuity	N

Approval	Description	Expiry Date	Change during Reporting Period (Y/N)
Additional Approvals - Lithgow City Council			
Approval to Operate Onsite Sewage Management System at Airy Mine (Application No: S68182/23)	Approval to Operate Onsite Sewage Management System (Ecomax) at Airly Mine	18/07/2025	N
Development Approval – DA033/19	Airly Solar Farm	-	N
Licence for Minor Works and Occupation – National Parks & Wildlife Service			
NPWS – Licence for Minor Works (dated September 2018)	Licence for minor works for subsidence and groundwater monitoring equipment Mount Airly	30 June 2028	N
NPWS – Licence for Minor Works (dated July 2021)	Licence for minor works for Pt Hatteras subsidence monitoring equipment installations	30 June 2031	N
NPWS – Licence for Minor Works (dated January 2024)	Licence for minor works for south-eastern Genowlan Mountain subsidence monitoring equipment installations	30 November 2033	Y – see **Section 3.1.1**

3.1.1 Changes During the Reporting Period

The following changes to Approvals, Mining Tenements, and other Licences occurred during the reporting period:

- **MW17-18 Panel & Pillar Mining Zone Extraction Plan:** Approval was received 15 January 2024.
- **Cliff Line Zone of First Workings Extraction Plan (ML1814):** Approval was received 27 September 2024.
- **NPWS – Licence for Minor Works – South-eastern Genowlan Mountain:** License was received 12 January 2024. An amendment to the License was received 27 November 2024 to enable installation of two (2) additional GNSS units in the vicinity of the Ultimate Slot Canyon in accordance with approval conditions for the CLZ ML1814 Extraction Plan.

3.2 ANNUAL REPORTING REQUIREMENTS

Appendix 1 provides a checklist of reporting requirements and performance conditions addressed within the Annual Review.

In accordance with the requirements of SSD_5581 (Schedule 6, Condition 11 – Annual Review and Condition 14 – Access to Information), this 2024 Annual Review was provided to the Planning Secretary and is available for access at the Airly Mine website.[3]

[3] https://www.centennialcoal.com.au/operations/airly/

4 OPERATIONS SUMMARY

Underground mining at Airly Mine continued during the reporting period using several extraction methods. Coal is transported via rail to Western Coal Services (WCS) via Lidsdale for further processing prior to being sold or exported. Coal is not processed at Airly Mine. The mine is licensed to operate 24/7 throughout the year and is currently licensed to employ 190 Full Time Equivalent (FTE) employees. General layout of the site can be seen in **Figure 2-2**.

Key operational activities completed in 2024 included:

- 902,370 tonnes ROM production; including:
    - Completed secondary extraction of MW16 in January 2025 and MW15B (southern end);
    - Completed minor drivage in the 402 mains panel towards MW17-18;
    - Completed the development and secondary extraction of MW17;
    - Completed the majority of development of MW18; and
    - Completed production in HB1.
- Continued subsidence remediation works and monitoring on Mount Airly (refer **Section 8.1.2**)
- Received extraction plan approvals for:
    - MW17-18 Panel and Pillar Mining Zone Extraction Plan. Approval was received 15 January 2024.
    - Cliff Line Zone of First Workings Extraction Plan (ML1814). Approval was received 27 September 2024.
- Sought extraction plan approvals for:
    - MW19-22 Panel and Pillar Mining Zone Extraction Plan in the central Genowlan mountain area – draft report submitted in December 2024. Consultation is on-going with plan to submit for approval by Q2 2025.

4.1 MINING OPERATIONS

Details of production and associated waste generated by the site for the report period and next reporting is provided in **Table 4-1**. Since Airly Mine does not process coal on site, no coarse reject and fine rejects were recorded during 2024. There were no inconsistencies between the approved limit and actual production for the reporting period.

Table 4-1: Production Summary & Forecast

Material	Approved Limit	Previous Reporting Period (2023 Actual)	This Reporting Period (2024 Actual)	Next Reporting Period (Forecast)
Waste Rock/ Overburden	N/A	Nil	Nil	Nil
ROM Coal (t)	1,800,000	647,894	902,370	801,693
Coarse reject	N/A	Nil	Nil	Nil
Fine reject (Tailings)	N/A	Nil	Nil	Nil
Saleable product (t)	N/A	647,894	902,370	801,693

4.2 OTHER OPERATIONS

Details of other operational limits relevant to Airly Mine are provided in **Table 4-2**.

Table 4-2: Operations Summary

Limits	Approved Limit (and source)	Previous Reporting Period (2023 Actual)	This Reporting Period (2024 Actual)	Comment
Hours of operation	24/7 (SSD_5581)	24/7	24/7	**Compliant.**
Operating hours restrictions (Construction, Exploration and monitoring borehole drilling)	7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturdays. (SSD_5581)	N/A	N/A	**Compliant.** No construction or exploration and monitoring borehole drilling occurred
Transport (rail)[a]	All coal transported by rail. Average of 2 Trains/day; Max of 5 Trains/day; No more than 1 water train/day. (SSD_5581)	All product coal for the 2023 reporting period was transported from site by rail. Total: 793,335 (t) Average: <2 Trains/day Max: <5 Trains/day Airly Mine did not receive any water trains in 2023.	All product coal for the 2024 reporting period was transported from site by rail. Total: 904,008 (t) Average: <2 Trains/day Max: <5 Trains/day Airly Mine did not receive any water trains in 2024.	**Compliant.** No exceedance of daily or annual limits.
Transport (road)	No transport of coal by road. (SSD_5581)	Nil	Nil	**Compliant.** All coal transported by rail
ROM Stockpile Size	200,000 t (Airly Mine Extension Project EIS, 2014)	Fluctuated throughout the year but always <200,000 (t)	Fluctuated throughout the year but always <200,000 (t)	**Compliant.** The stockpile design does not physically allow the storage of greater than 200,000 t
Employee Numbers	Up to 190 Full time equivalent (FTE) employees (SSD_5581 MOD5)	128 Personnel as of 31 Dec 2023	139 Personnel as of 6 Mar 2025.	**Compliant.** FTE numbers below the maximum approved.

Notes:
[a] Coal transport and rail movement data to provide evidence of compliance for Schedule 2, Condition 8 of SSD_5581 and Schedule 4, Condition 16 of SSD_5581 is available for access at the Airly Mine website – https://www.centennialcoal.com.au/operations/airly/.

4.3 EXPLORATION

No surface exploration activities were undertaken during the reporting period. No surface exploration activities are forecast for the next reporting period.

4.4 LAND DISTURBANCE

No land disturbance activities were undertaken during the reporting period. No land disturbance activities are forecast for the next reporting period.

4.5 CONSTRUCTION

No construction activities were undertaken during the reporting period. Construction of the approved pit top workshop is planned to be completed in the next reporting period.

4.6 NEXT REPORTING PERIOD

The primary objective for Airly Mine is business sustainability achieved through the initiative of a strategic plan and timeline which links the key elements of health and safety, environment, organisational health, community and shareholder value.

Key operational milestones for 2025:

- Forecast 801,693 tonnes ROM production; including:
    - Complete the development and secondary extraction of MW18;
    - Complete production in HB2;
    - Continue 500 Panel mains drivage towards Central Genowlan; and
    - Commence the development of MW19 (subject to receiving Extraction Plan approval).
- Continue subsidence remediation monitoring on Mount Airly (refer **Section 8.1.2**)
- Seek approval for MW19-22 Panel and Pillar Mining Zone Extraction Plan in the central Genowlan mountain area – draft report submitted in December 2024. Consultation is on-going with plans to submit for approval by Q2 2025.
- Seek renewal of approval to Operate Onsite Sewage Management System at Airy Mine (Application No: S68182/23) expires 18 July 2025. Renewal of the approval will be sought prior to expiry.

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

Table 5-1 summarises the outcomes of the 2024 Annual Review, including actions issued by Regulators and actions outlined by Centennial Airly.

A letter was received from DPHI dated 28 May 2024 stating the Annual Review for the period 1 January 2023 to 31 December 2023 satisfied the reporting requirements of SSD_5581. No further action or information was requested.

Table 5-1: Actions from Previous Annual Review and Regulator Requirements

Action Required	Requested By	Action Taken	Annual Review Section
Regulator Requirements			
Nil			
Improvement Actions (Committed in 2023 Annual Review)			
Seek extraction plan approvals for first workings in the ML1814 Cliff Line Zone area and the Panel & Pillar Mining Zone Extraction Plan in the central part of Genowlan mountain.	**Airly Mine**	Cliff Line Zone of First Workings Extraction Plan (ML1814) was approved 27 September 2024. **Complete** MW19-22 Pillar Mining Zone Extraction Plan in the central Genowlan mountain area – draft report submitted in December 2024. Consultation is on-going with plan to submit for approval by Q2 2025. **In progress**	**Section 4**
To help mitigate recurrence of the HVAS loss of power non-sample events a 'loss of power alarm' will be purchased and fitted to the HVAS in early 2025.	**Airly Mine**	A loss of power alarm purchased and fitted to the HVAS during the reporting period. **Complete**	**Section 6.4**
Continue the feral animal control program on mine owned lands to target feral cats and wild dogs. This program has been designed in consultation with Local Land Services, National Parks & Wildlife Service and RPS Consultancy. The program is designed to reduced impacts of feral animal predation to native fauna.	**Airly Mine**	Centennial Airly actively participated in the feral animal control program during the reporting period, targeting feral cats and wild dogs. **Complete (and ongoing)**	**Section 6.6**

Action Required	Requested By	Action Taken	Annual Review Section
Continue the weed control program on the Airly Pit Top and surrounding mine owned lands, including weed spraying works on property at the base of Mt Genowlan and weed control works in the Carinya Offset Area.	**Airly Mine**	The weed control program was continued during the reporting period. **Complete (and ongoing)**	**Section 6.6**
Continued monitoring at surface water monitoring sites in Airly Creek (Airly Creek, Airly Upstream and Airly Tributary) to inform further investigations of the SSGV trigger exceedances.	**Airly Mine**	There were no discharges from Airly Mine in 2024 and the SSGV trigger exceedances are considered unlikely to be due to mining-related activities. **Complete**	**Section 7.3** (Surface Water) **Appendix 6**
Continued monitoring at groundwater monitoring sites ARP09, ARP12 and ARP14 and surface water monitoring sites Genowlan Creek 2 and The Grotto will inform further investigations of the identified trends in pH and some dissolved metals (iron, manganese and zinc) within Genowlan Creek / Genowlan Creek Alluvium and seek to determine whether the hydrogeochemical changes are due to the currently speculated cause related to aeration of previously reduced sediments, that have been exposed to drying and rewetting.	**Airly Mine**	All monitoring was undertaken in accordance with the Airly Mine Water Management Plan. Detailed annual monitoring and assessment reports prepared by GHD for the reporting period found the results continue to suggest the hydrogeochemical changes are naturally occurring and are unlikely to be due to mining-related activities, however the cause remains uncertain. **Investigation ongoing**	**Section 7.4** (Groundwater) **Appendix 6**
Continue to monitor privately owned bores to the east of the Project to improve monitoring transparency and trust with the community.	**Airly Mine**	Groundwater quality monitoring for three private production bores—Nioka, Kingdom, and GW800787—was undertaken during the reporting period. **Complete (and ongoing)**	**Section 7.4** (Groundwater) **Appendix 6**

Action Required	Requested By	Action Taken	Annual Review Section
Continue subsidence remediation works and fracture monitoring on Mount Airly in accordance with the Enforceable Undertaking.	**Airly Mine**	Independent Expert Inspections are completed at six monthly intervals, with assessments completed on 25 January 2024, 1 August 2024 and 20 February 2025. These reports confirmed that remediation works have progressed in accordance with the EU, no further remedial measures are required, and no new or additional impacts were identified during the inspections. **Complete (and ongoing)**	**Section 8.1.2** (Subsidence Remediation – Mount Airly Panel and Pillar Mining Zone)
Management Plan Revisions			
Nil			
Condition Triggers			
In accordance with Condition 3 in Schedule 6 of SSD_5581 strategies, plans, and programs required under the consent will be reviewed within three months of (a) the submission of an incident report; (b) the submission of an annual review; (c) the submission of an audit report; or (d) any modification to the conditions of this consent. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document will be submitted for the approval of the Secretary.	**Airly Mine**	During the reporting period this condition was triggered by: • Submission of the 2023 Annual Review (March) • Submission of the 2024 Independent Environmental Audit (October) The review of strategies, plans, and programs required under the consent were completed as necessary and any revisions submitted for the approval of the Secretary as required.	No further action required

6 ENVIRONMENTAL PERFORMANCE

Centennial Airly implements an Environmental Management Strategy, including management plans, procedures and monitoring programs that provide a framework for managing environment and community risks and impacts. To measure compliance with site approvals and licences, Centennial Airly undertakes a comprehensive monitoring program.

Table 6-1 provides a summary of the monitoring requirements and environmental performance for the reporting period and provides an overview of the relevant approval requirements and management plans. Environmental performance in the reporting period is detailed further in the following sections:

- **Section 6.1** – Meteorological Summary
- **Section 6.2** – Noise
- **Section 6.3** – Blasting
- **Section 6.4** – Air Quality
- **Section 6.5** – Greenhouse Gas Monitoring
- **Section 6.6** – Biodiversity
- **Section 6.7** – Heritage
- **Section 6.8** – Mine Subsidence
- **Section 6.9** – Other Matters
    - Waste (**Section 6.9.1**)
    - National Pollutant Inventory (**Section 6.9.2**)

Note, there are separate sections for reporting the environmental performance for Water (**Section 7**), Rehabilitation (**Section 8**) and Community Consultation (**Section 9**).

Table 6-1: Summary of Environmental Monitoring Requirements and Environmental Performance

Monitoring Type	Overview of Monitoring Requirements	Requirement of Approval / Management Plan	Performance during the reporting period	Annual Review Section
Air quality	4 x DGs – Monthly HVAS – 6-day cycle	Air Quality & Greenhouse Gas Management Plan SSD_5581 EPL 12374	**Non-Compliant** Results are consistent or below EIS predictions and comply with relevant performance criteria, however due to HVAS malfunction and outages the WRAQGMP could not be fully implemented during the reporting period.	Section 6.4, Appendix 3, Section 1, Section 11 (Table 11-1)
Biodiversity	Annual Spring/Summer Monitoring Program in consultation with NPWS	Biodiversity Management Plan EPBC Approval SSD_5581	**Compliant** No impact has been identified. Results are consistent or below EIS predictions.	Section 6.6, Appendix 4
Blasting	*Not Applicable – No Blasting*	*Not Applicable – No Blasting*	***Not Applicable*** *No Blasting*	*Section 6.3*
Heritage	As required. Phased monitoring of heritage sites undermined	Historic Heritage Management Plan Aboriginal Cultural Heritage Management Plan SSD_5581	**Compliant** No impact has been identified. Results are consistent or below EIS predictions. No heritage sites undermined in 2024.	Section 6.7
Meteorological Monitoring	1 weather station – Continuous	SSD_5581 EPL 12374	**Compliant** Meteorological monitoring was undertaken.	Section 6.1
Noise	Annual Attended Noise Monitoring	Noise Management Plan	**Compliant** Results are consistent or below EIS predictions.	Section 6.2, Appendix 2

Monitoring Type	Overview of Monitoring Requirements	Requirement of Approval / Management Plan	Performance during the reporting period	Annual Review Section
Rehabilitation	Subsidence remediation monitoring	Rehabilitation Strategy Rehabilitation Management Plan Enforceable Undertaking to the Planning Secretary SSD_5581 ML1331 ML1814	**Compliant** Rehabilitation works will be conducted in conjunction with mine closure. Subsidence remediation was undertaken in accordance with the Enforceable Undertaking	Section 8, Section 8.1.2, Appendix 10
Subsidence	Cliffs, minor cliffs, pagodas and general land – LiDAR every 6 months – monitor for change. Underground workings – survey of as built pillars. Pillars built as per parameters in Master TARP. GNSS real time monitoring. Surface inspections of tracks. Phased (or triggered) monitoring of heritage sites undermined. Airly Turret Communication Tower (MW13-16 PPMZ EP). Nissen Hut always safe and serviceable (MW13-16 PPMZ EP). Nissen Hut Dam Water level (mAHD) (MW13-16 PPMZ EP). Ground water and surface water monitoring.	Extraction Plans (as detailed in **Table 6-12**) SSD_5581 ML1331 ML1814 Independent Expert Panel (IEP) recommendations	**Compliant** LiDAR surveys conducted in March and August 2024; no mining related changes found in current data. No evidence of pillar instability found in 2024 during statutory inspections. Mining dimensions for extraction of MW17 exceeding the Extraction Plan Mater TARP, but subsidence less than predictions. GNSS data consistent with Extraction Plan predictions and less than EIS predictions. No mining related damage to unsealed tracks observed. No heritage sites undermined in 2024. No impacts to built features, consistent with Extraction Plan and EIS predictions. Ground water and surface water impacts within EIS predictions.	Section 6.8, Appendix 5

Monitoring Type	Overview of Monitoring Requirements	Requirement of Approval / Management Plan	Performance during the reporting period	Annual Review Section
Water	**Surface Water** Surface water Flow (continuous) Surface water quality (monthly) Discharge water monitoring (event based) Nissen Hut Dam monitoring (monthly and continuous) Stream health, including geomorphic condition / watercourse stability (every two years) and aquatic ecology (six-monthly). **Groundwater** Deep Aquifer Water Pressures (continuous) Groundwater levels (monthly) Groundwater quality (monthly) Groundwater seepage (continuous) Stygofauna monitoring (annual)	Water Management Plan SSD_5581 EPL 12374	**Compliant.** Airly Mine was compliant with all conditions of the WMP, EPL12374 and SSD_5581 during the reporting period. Extensive water monitoring program continued during 2024 with the results and analysis being consistent with EIS predictions. Hydrogeochemical changes identified in Genowlan Creek / Genowlan Creek Alluvium but is caused by natural processes. Further monitoring and investigation is being undertaken.	Section 7, Appendix 6, Appendix 7, Appendix 8, Appendix 9

6.1 METEOROLOGICAL SUMMARY

During the reporting period, meteorological monitoring at Airly Mine was undertaken in compliance with:

- SSD_5581 (Schedule 4, Condition 8).
- EPL 12374.

April recorded the highest monthly rainfall during the reporting period, with 117 mm. Overall, the first half of the year was wetter than the long-term monthly averages[4], with January, February, April, May and July exceeding historical norms. In contrast, the second half of the year was generally drier, with March, June, August, September, October, November and December recording below-average rainfall. October recorded the least amount of rainfall in the reporting period, with 21 mm.

The cumulative rainfall for the reporting period of 645.2 mm, which is 83 mm below the long-term annual average of 728.2 mm.

The highest temperature (34.4˚C) was recorded in January, and the lowest temperature (-5.1˚C) was recorded June.

Figure 6-1 presents a summary of the meteorological conditions at Airly Mine during the reporting period.

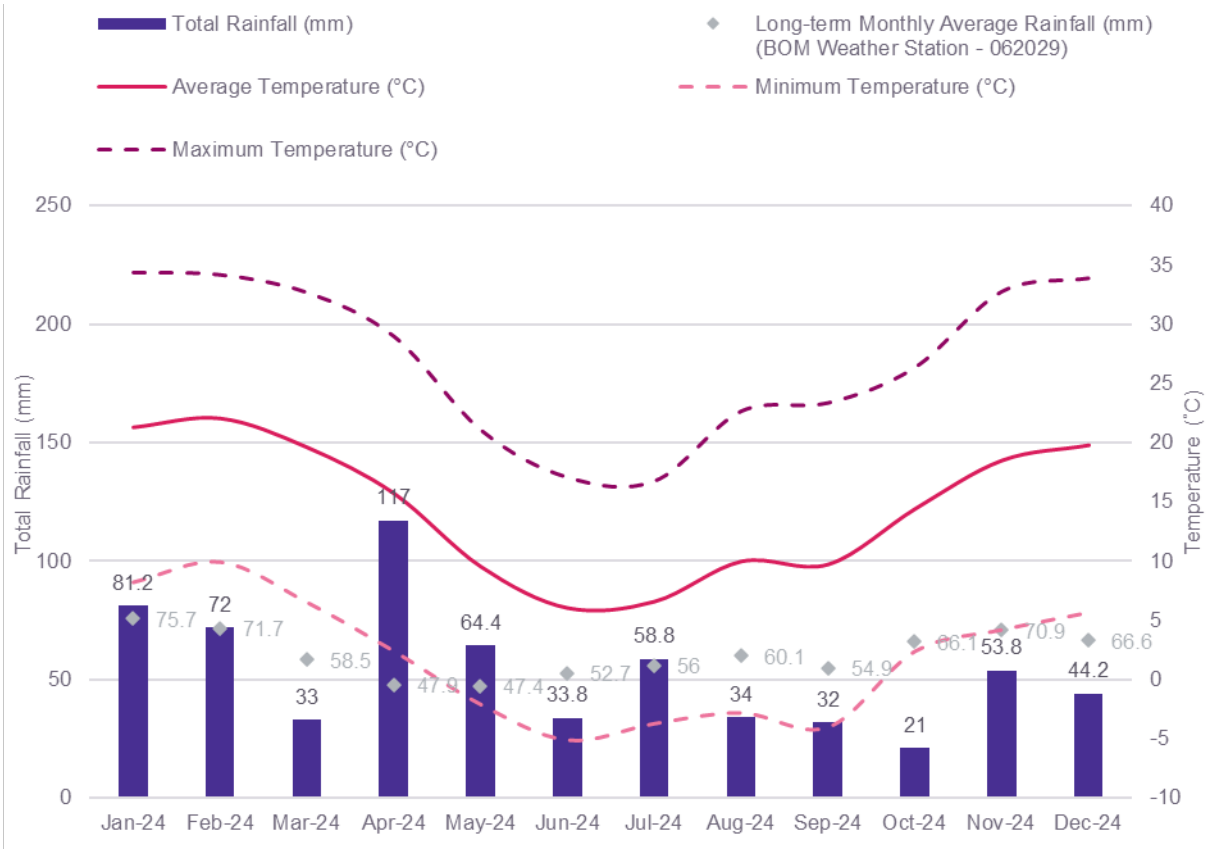


Figure 6-1 Summary of Meteorological Conditions

[4] As determined from a nearby Bureau of Meteorology (BOM) Ilford (Warrangunyah) weather station (062029), which is located approximately 29km north-west of Airly Mine (1928 to 2024)

6.2 NOISE

6.2.1 Environmental Management

Noise at Airly Mine is managed in accordance with the *Western Region Noise Management Plan (November 2021)* (NMP) which has been developed in accordance with Schedule 4, Condition 4 of SSD_5581. The NMP has been developed to ensure that potential noise impacts from Airly Mine on the neighbouring community are minimised. The plan aims to identify suitable measures to manage the noise, as well as to establish a monitoring program that evaluates and reports on compliance against the noise criteria (Schedule 4, Condition 2 of SSD_5581) and the noise operating conditions (Schedule 4, Condition 3 of SSD_5581).

The following sources of noise identified in the NMP are relevant for Airly Mine operations:

- Operation of mobile equipment – e.g. trucks, dozers, loaders.
- Coal handling/processing plant – e.g. conveyors, rotary breaker, screens and hopper filling.
- Rail loading operations.
- Coal transporting activities – e.g. overland conveyors, haul trucks, rail.
- Ventilation fans.

Monitoring at Airly Mine is undertaken to measure the ambient noise levels at the focus receptor locations (potentially worst affected) surrounding the mine. The NMP requires that annual monitoring should be carried out at location ANM1, ANM2 and ANM3 as per the long-term noise monitoring locations outlined in the NMP.

Location ANM1 demonstrates compliance for receptors A2 – A5 (inclusive). Location ANM2 demonstrates compliance for A7 and A8. Location AMN3 directly measures compliance at the Campground (A17) in Mugii Murum-ban State Conservation Area. The noise monitoring locations and relevant receptors are shown in **Figure 6-2**.

6.2.2 Environmental Performance

Airly Mine conducted annual noise compliance assessments (locations ANM1, ANM2 and ANM3) in accordance with SSD_5581 and the NMP. Noise Criteria are specified for day, evening, and night-time period for the amenity of neighbouring residences. Airly Mine complied with the project specific noise criteria at all monitoring sites during attended noise monitoring in the reporting period.

A summary of the noise criteria and noise performance based on attended noise monitoring for 2024, together with management implications and proposed actions is shown in **Table 6-2**. Results from attended noise monitoring undertaken during the period is provided in **Table 6-3**. The annual noise monitoring assessment report is provided in **Appendix 2**.

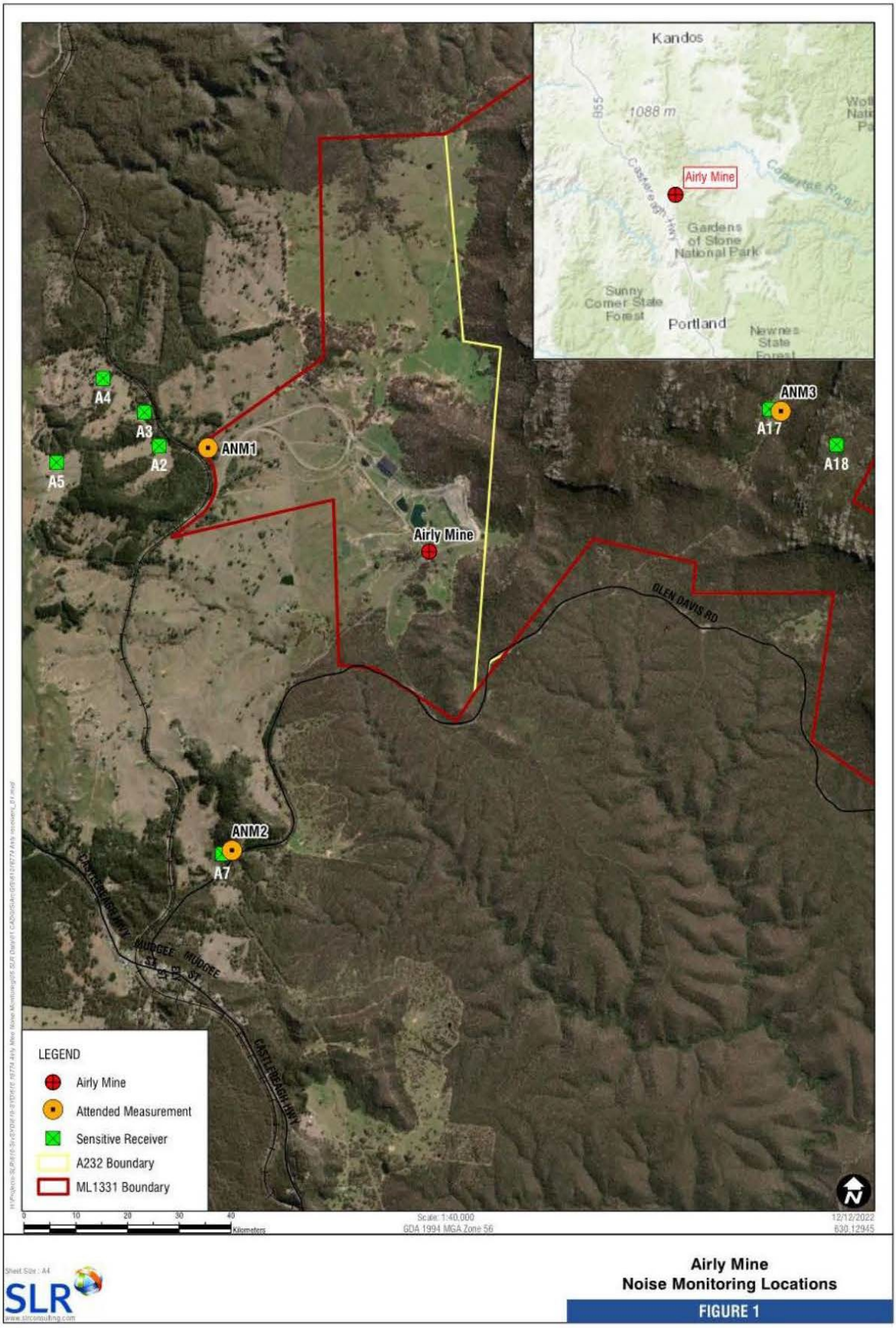


Figure 6-2: Airly Mine Noise Monitoring Locations

Table 6-2: Airly Mine Noise Criteria and Monitoring Summary

<table>
<tr><th colspan="5">Approved Noise Limit (dBA)[5]</th><th>Performance During the Reporting Period</th><th>Key Management Implications</th><th>Implemented / Proposed Management Actions</th></tr>
<tr><td rowspan="2">Receiver (Monitoring Location)</td><td>Day[6]</td><td>Evening[7]</td><td colspan="2">Night[8]</td><td rowspan="5">Annual operated attended noise measurements were conducted during the day, evening and night-time periods at the three noise monitoring locations on Tuesday 17 December 2024.
Airly Mine was inaudible at ANM2 and ANM3 during day, evening and night-time periods. Airly Mine was inaudible at ANM1 during the day period. The estimated noise contributions ($L_{Aeq(15\ min)}$) from Airly Mine at ANM1 was:
• 25 dBA during the evening; and
• 30 dBA during the night-time period (with a 37 dBA $L_{A(max)}$).
All measurements comply with the SSD_5581 noise criteria.</td><td rowspan="5">Noise Management controls at Airly Mine are effective.</td><td rowspan="5">Given the preceding compliance noise monitoring results, additional noise mitigation is not proposed.</td></tr>
<tr><td>$L_{Aeq(15\ min)}$</td><td>$L_{Aeq(15\ min)}$</td><td>$L_{Aeq(15\ min)}$</td><td>$L_{A(max)}$</td></tr>
<tr><td>Any residence on privately-owned land (ANM1 and ANM2)</td><td>35</td><td>35</td><td>35</td><td>52</td></tr>
<tr><td></td><td colspan="3">$L_{Aeq(period)}$ – When in use</td><td></td></tr>
<tr><td>A17 – Campground (ANM3)</td><td colspan="3">50</td><td>N/A</td></tr>
<tr><td>A18 – Nissen Hut (ANM3)</td><td colspan="3">50</td><td>N/A</td><td></td><td></td></tr>
</table>

[5] The noise criteria in **Table 6-2** are to apply to a receiver under all meteorological conditions except under:
a. Wind speeds greater than 3 m/s at 10m above ground level; or
b. Stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level; or
c. Stability category G temperature inversion conditions

[6] Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.

[7] Evening is defined as the period from 6pm to 10pm.

[8] Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

Table 6-3: 2024 Attended Noise Monitoring Results (17 December 2024)

Site	Monitoring Period	Noise level (dBA)			
		Measured	Estimated Site Contribution	Criteria (SSD_5581)	EIS / EA Predictions
ANM1	Day	52 $L_{Aeq(15minute}$	Inaudible	35 $L_{Aeq(15minute)}$	<35 $L_{Aeq(15minute)}$
	Evening	44 $L_{Aeq(15minute}$	25 $L_{Aeq(15minute)}$		
	Night	53 $L_{Aeq(15minute}$	30 $L_{Aeq(15minute)}$		
		65 L_{Amax}	37 L_{Amax}	52 L_{Amax}	<52 $L_{Aeq(15minute)}$
ANM2	Day	63 $L_{Aeq(15minute}$	Inaudible	35 $L_{Aeq(15minute)}$	<35 $L_{Aeq(15minute)}$
	Evening	54 $L_{Aeq(15minute}$	Inaudible		
	Night	39 $L_{Aeq(15minute}$	Inaudible		
		50 L_{Amax}	Inaudible	52 L_{Amax}	<52 $L_{Aeq(15minute)}$
ANM3	Day	54 $L_{Aeq(15minute}$	Inaudible	50 $L_{Aeq(period)}$	<35 $L_{Aeq(15minute)}$
	Evening	52 $L_{Aeq(15minute}$	Inaudible		
	Night	33 $L_{Aeq(15minute}$	Inaudible		

6.2.3 Comparison against Predictions

The noise and vibration impact assessment for the *Airly Mine Extension Project* (SLR, 2014) indicated that noise levels from the modelled operational scenarios are predicted to be below the project specific noise criteria at all privately owned residential assessment locations under all considered meteorological conditions. Operational noise levels are also predicted to comply with the project specific noise criteria at Airly Gap and the Nissen Hut.

SLR *(2019)* prepared a noise impact assessment to support the *Airly Mine Extension Project – Modification 2* and established project trigger noise levels for the receptors assessed with reference to the *Noise Policy for Industry* (EPA, 2017). The proposed modification is not predicted to change existing operational noise emissions and therefore there are no expected exceedances of consented operational noise criteria or the trigger levels in *Rail Infrastructure Noise Guideline* (EPA, 2013) for the day and night periods and passbys for trains on the Wallerawang-Gwabegar Rail Line between Charbon Colliery and Airly Mine.

SLR *(2024)* prepared a noise impact review to support the *Modification Report 5 – Airly Mine SSD 5581*. This review found a minor impact will occur from additional traffic on the Castlereagh Highway resulting in an increase of 0.2 dB which is considered barely perceptible, less than the minor impact 2 dB increase under the NSW Road Noise Policy. There were no changes to established project trigger noise levels associated with MOD 5.

As shown in **Table 6-3** Airly Mine complied with the project specific noise criteria at all monitoring sites during attended noise monitoring in the reporting period and was generally consistent with the EIS.

6.2.4 Long Terms Analysis

Historic monitoring data confirms that Airly Mine is a low-noise generating site, with **no recorded exceedances** in annual noise compliance assessments over the past nine years (2016 to 2024). The 2024 noise levels remained consistent and comparable to previous years.

6.2.5 Implemented / Proposed Improvements

Given the preceding compliance of noise monitoring results, additional noise mitigation is not proposed.

6.3 BLASTING

Airly Mine does not have any need or approval for blasting works. There have been no blasting operations undertaken at Airly Mine to-date and there are no planned blasting operations in future activities.

6.4 AIR QUALITY

6.4.1 Environmental Management

Air quality at Airly Mine is managed and monitored in accordance with the *Western Region Air Quality and Greenhouse Gas Management Plan* (March 2023) (WRAQGMP) which has been developed in accordance with Schedule 4, Condition 7 of SSD_5581 to ensure that potential air quality impacts from Airly Mine on the neighbouring community are minimised.

Table 6-4 shows the air quality impact assessment criteria relevant to the operation as specified Schedule 4, Condition 5 of SSD_5581. **Table 6-5** summarises the emission sources and mitigation measures being implemented at Airly Mine to minimise to the greatest extent practicable emissions to air.

The WRAQGMP outlines the air quality monitoring program designed to demonstrate the compliance with impact assessment criteria and effectiveness of the implemented mitigation measures. The program includes:

- Deposited dust monitoring at four locations, with samples collected monthly.
- One High Volume Air Samplers (HVAS), operated on a six-day cycle, to measure dust deposition rates and concentrations of Total Suspended Particulates (TSP) and Particulate Matter <10µm (PM_{10}).
- One on-site automatic weather station, which collects continuous meteorological data, to support the interpretation of air quality data.

The WRAQGMP monitoring locations are described in **Table 6-6** and shown in **Figure 6-3**. A summary of the monitoring results is provided in **Section 6.4.2**.

Table 6-4: Airly Mine Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Criterion
Particulate Matter < 10µm (PM_{10})	Annual	[a,d] 25 µg/m^3
	24 hours	[a] 50 µg/m^3
Total Suspended Particulate (TSP)	Annual	[a,d] 90 µg/m^3
[c] Deposited Dust	Annual	[a,d] 4 g/m^2/month
		[b] 2 g/m^2/month

Notes:
[a] Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).
[b] Incremental impact (i.e. increase in concentrations due to the development alone, with zero allowable exceedances of the criteria over the life of the development.
[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method.
[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.

Table 6-5: Airly Mine Air Quality Management/Mitigation Measures

Emission Source	Emission Type	Control Measure
Unsealed roads	Dust	Use of water carts to dampen trafficable areas. Vehicle speeds restrictions.
Coal stockpiles	Dust	Use of water cannons/water sprays on coal stockpile, as required.
Train loading	Dust	The use of a train loader which produces a low and even profile of coal on the surface of the wagon and reduces spillages. Transporting coal with a high inherent moisture content.
Mobile Equipment	Exhaust emissions Dust	Regular maintenance of plant and equipment in accordance with the manufacturer's specifications to ensure optimal operating conditions.
Ventilation fans	Exhaust emissions	Use of low sulfur diesel and diesel engines that conform to the standards for exhaust emissions. Implementation of an underground dust suppression system involving the use of water sprays on coal cutting machinery and rubber conveyor belts.
Disturbance areas	Dust	Timely rehabilitation of disturbed areas wherever practical

Table 6-6: Description and Summary of Air Quality Monitoring at Airly Mine

Monitor Point Reference	Description / Location
DM1	Dust gauge DM1 is located south of the operations and nearby a sensitive receiver location designated as A7 (isolated rural residence). This site was predicted to have very low impacts at this location and has not received complaints relating to dust.
DM2	Dust gauge DM2 was located near sensitive receiver A1. This receiver has been proven not to be adversely impacted by dust generation from mining operations. As such, and in accordance with the Long-Term Monitoring Program described within the approved WRAQGMP, DM2 was relocated during the 2020 reporting period to be representative of A2.
DM3	Dust gauge DG3 is not at a sensitive receiver but is close to mine operations along Torbane Rd. If compliance is met at DG3, extrapolated compliance can be inferred for all sites to the west of the operation.
DM4	Dust gauge DG4 is located on mine-owned land to the southwest of the surface facilities. This location is upwind of the prevailing south-westerly winds and is utilised to determine impacts in the south westerly direction.
HVAS	The HVAS was installed and commissioned during 2020. Formal HVAS sampling and reporting of PM_{10} and TSP commenced on 1 January 2021.

Notes:

Monitoring reference points shown as 'DM' (Dust Monitor) are referred to as 'DG' (Dust Guage) within the AQ&GHG Management Plan and below Figure 6-3. The terms are used interchangeably in this document, however this will be revised and aligned during the next revision of the AQ&GHG MP.

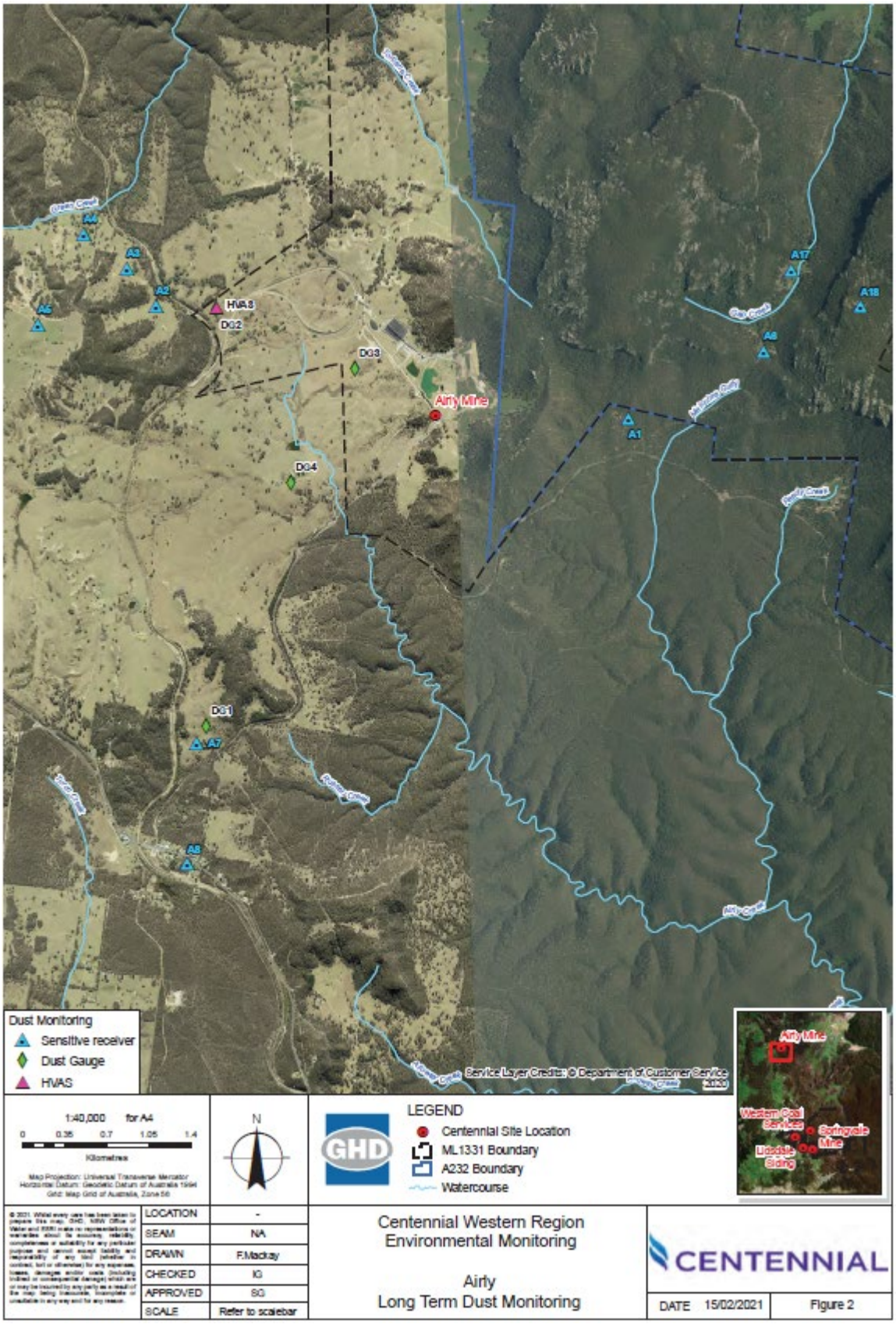


Figure 6-3: Airly Mine Air Quality Monitoring Locations

6.4.2 Environmental Performance

Dust Deposition

Depositional dust (deposited particulate matter) was monitored at four designated sites for Airly Mine. Each gauge was monitored monthly in accordance with AS3580.10.1 (Standards Australia, 2003) *"Methods for Sampling and Analysis of Ambient Air – Determination of Particulates – Deposited Matter – Gravimetric Method"*.

The rolling annual average monitoring results recorded by all depositional dust gauges were found to be below the development consent limit of 4 g/m²/month for the reporting period, as demonstrated in **Figure 6-4.**

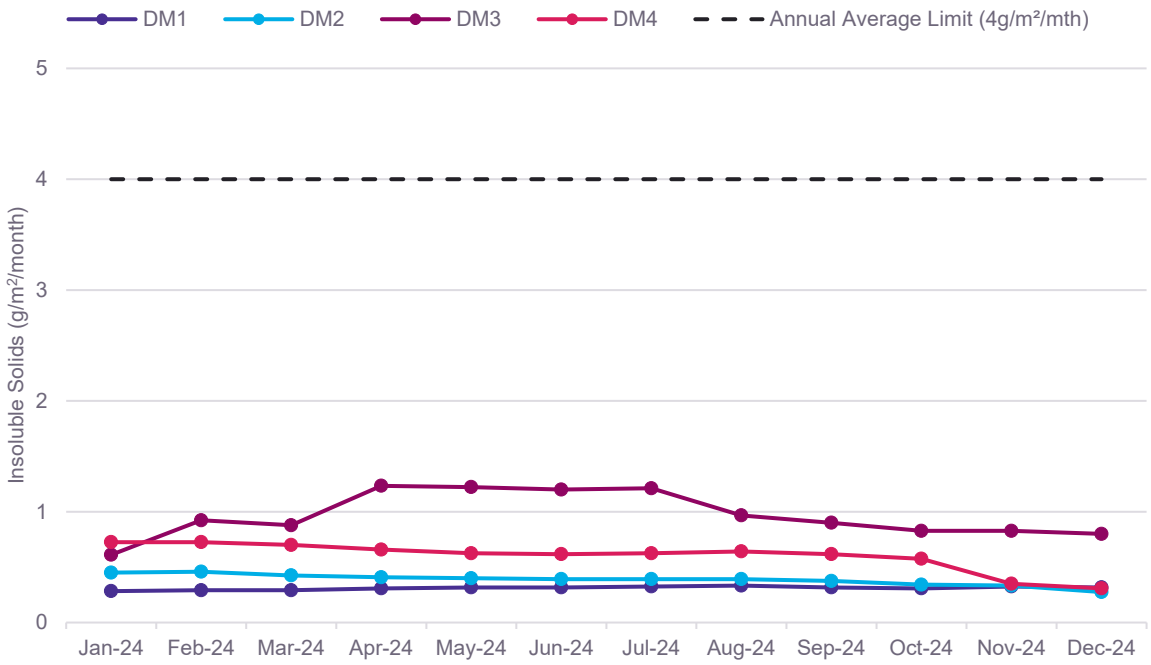


Figure 6-4: Summary of Depositional Dust Monitoring

High Volume Air Samplers

A summary of the recorded results for high volume air sampling is presented in **Table 6-7**, with the 2024 monitoring results provided in **Appendix 3**. The number of days that exceeded the consent criterion is also shown. Rolling annual average and 24-hour results for high volume air sampling at the HVAS location are provided for the following:

- PM_{10} (refer **Figure 6-5**)
- TSP (refer **Figure 6-6**)

The results obtained in the reporting period demonstrates compliance with the air quality impact assessment criteria (24hr and annual averages).

Table 6-7: Summary of HVAS Monitoring Results

Monitoring Location	Averaging Period	Consent Criteria	Maximum (µg/m³)	Mean (µg/m³)	Number of days exceeding criterion
HVAS (PM_{10})	24-hour	50	36.2	N/A	0
	Annual	25	N/A	10.6	0
HVAS (TSP)	Annual	90	N/A	14.5	0

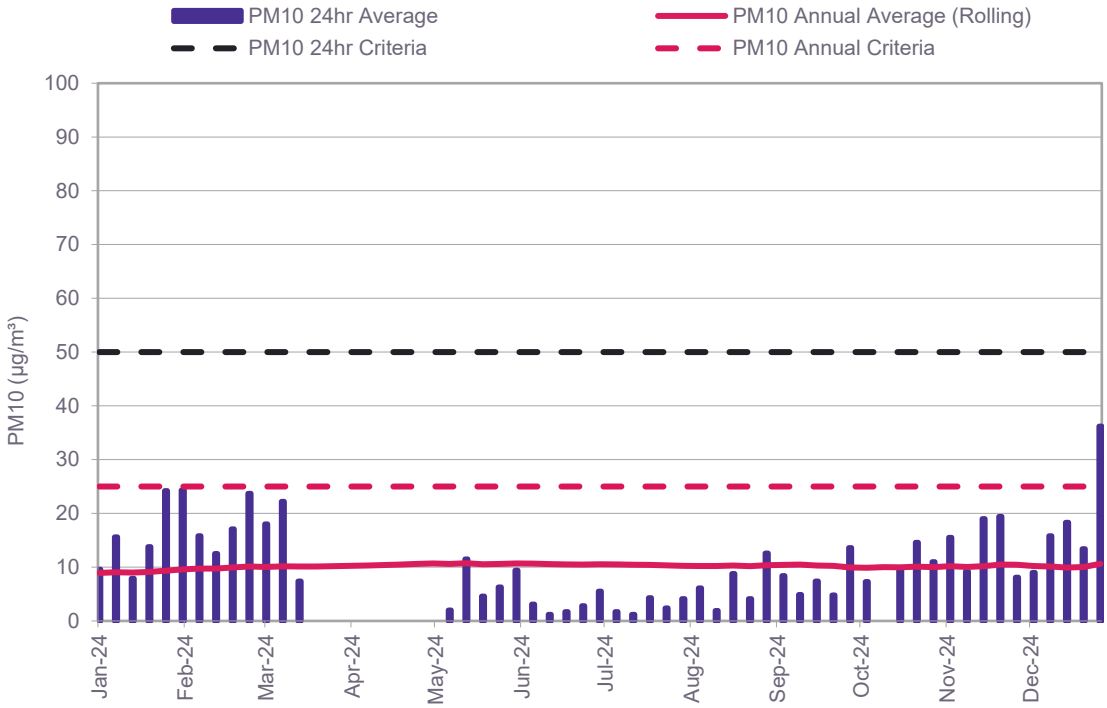


Figure 6-5: Annual HVAS PM_{10} Monitoring Results

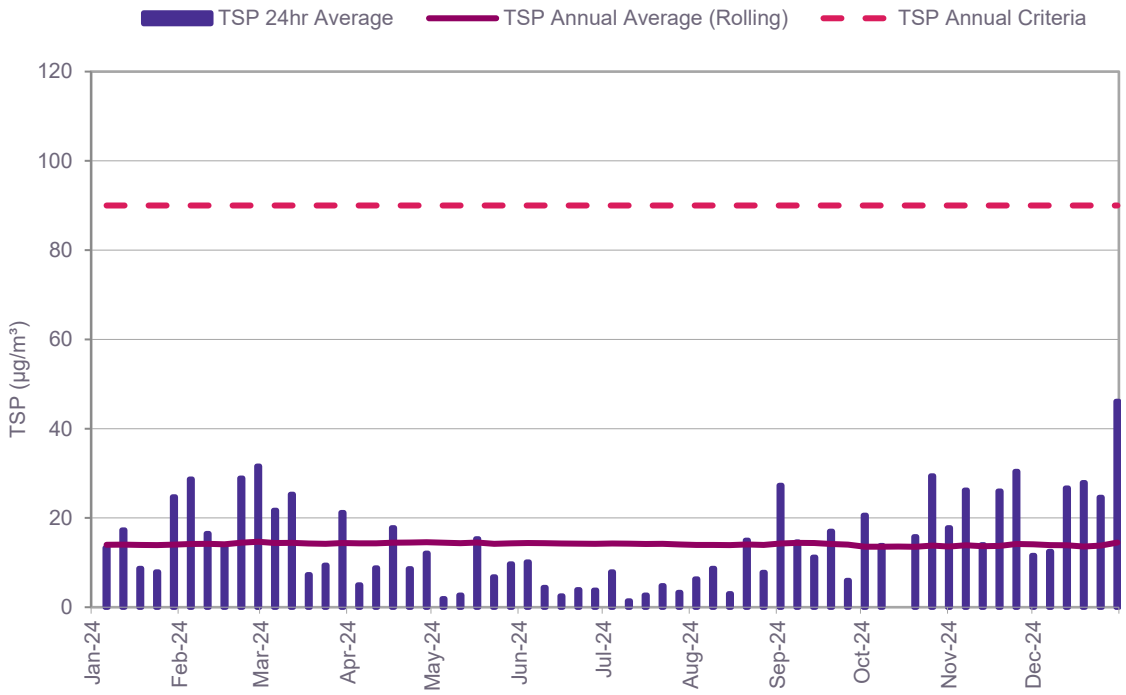


Figure 6-6: Annual HVAS TSP Monitoring Results

Monitoring Issues

Details of all HVAS malfunctions and outages during the reporting period, along with estimation techniques used to assess monitoring compliance, are provided below. Due to these malfunctions and outages, the WRAQGMP monitoring program could not be fully implemented. As a result, a non-compliance with the implementation of the WRAQGMP has been recorded. Further information is provided in **Section 1** and **Section 11** of this report.

PM_{10} Monitoring Equipment Malfunction – 18 January to 18 March 2024

During the reporting period, a malfunction of the PM_{10} unit display screen prevented the reporting of net PM_{10} results. As a precautionary measure, Airly Mine conservatively reported the total mass per filter for PM_{10} samples collected between 18 January and 18 March 2024. Despite this conservative reporting approach, the PM_{10} results, inclusive of the filter paper weight, remained compliant with the air quality limits (ranging from 7.4 to 24.3 µg/m^3). The actual PM_{10} values for this period would be significantly lower than the conservatively reported results.

PM_{10} Monitoring Equipment Failure – 24 March to 5 May 2024

Following the sample run on 18 March 2024, Airly Mine attempted to replace the faulty PM_{10} display unit component. However, during commissioning, the unit shorted out, rendering it unserviceable. As a result, scheduled PM_{10} sampling could not be conducted on the following dates:

- March 24 and 30,
- April 5, 11, 17, 23, and 29, and
- May 5.

TSP samples continued to be measured during this period, with concentrations ranging from 1.9 to 21.2 µg/m^3. As PM_{10} is a subset of TSP, it is reasonable to conclude PM_{10} concentrations remained below the applicable air quality limit of 50 µg/m^3.

This is further supported by a strong positive correlation (Pearson coefficient = 0.84) between TSP and PM_{10} values at Airly Mine. Using the linear regression equation derived from historical data, the **estimated 24-hour average PM_{10} values for this period ranged from 2.7 to 14.3 µg/m^3**, remaining well below the air quality limit.

Based on a historic review of TSP to PM_{10} correlation values, combined with consistently low TSP results, favourable weather conditions, and low DM2 results, Airly Mine concludes with an extremely high level of certainty that no exceedances of PM_{10} limits occurred during March, April and early May 2024.

To restore monitoring capacity, Airly Mine purchased and commissioned a new PM_{10} unit, with monitoring resuming on 11 May 2024.

HVAS Monitoring Disruption – 14 October 2024

A power outage from an unknown event, likely a thunderstorm, prevented the scheduled HVAS sample run on 14 October 2024. In accordance with the WRAQGMP, an internal incident investigation was completed, and the incident has been logged.

Based on an assessment of prevailing weather conditions, low dust deposition results of 0.1 g/m^2/month from DM2, DM3, and DM4, and pre- and post-HVAS monitoring data, Airly Mine concludes with an extremely high level of certainty that there was no exceedance of air quality criteria under Schedule 4, Condition 5 of SSD_5581.

Power was restored to the unit, and the normal 6-day sampling schedule resumed.

6.4.3 Comparisons against Predictions

The predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10} and dust deposition) are provided in **Table 6-8**. All air quality monitoring results remained below annual criteria and consistent with predicted results.

Table 6-8: Adopted Site-Specific Ambient Air Quality Environment

Parameter	Averaging Period	EIS / EA Predictions	Performance during the reporting period
Deposited Dust	Annual	<2 g/m^2/month annual average increase from the previous year.	Annual averages at all monitoring locations were <1 g/m^2/month
		<1.3 g/m^2/month cumulative impact at all Sensitive Receptors.	Annual rolling averages ranged from 0.3 to 1.2 g/m^2/month
TSP	Annual	19.7 µg/m^3 (at the most affected receptor (R2))	Annual rolling average ranged from 13.5 to 14.7 µg/m^3
PM_{10}	24-hour	<43.4 µg/m^3	Maximum 24hr average recorded was 36.2 µg/m^3
	Annual	9.7 µg/m^3 (at the most affected receptor (R2))	Annual rolling average ranged from 8.9 to 10.7 µg/m^3

6.4.4 Long Term Analysis

Table 6-9 provides a summary of air quality monitoring results for the previous five years (2020 to 2024), including annual averages for deposition dust (insoluble solids), PM_{10} and TSP.

Table 6-9: Long Term Air Quality Monitoring Summary (2020 – 2024)

Monitoring Location	Annual Averages					Development Consent Criteria (Annual Average)
	2020[1]	2021	2022	2023	2024	
Insoluble Solids (g/m²/month)						
DM1	0.8	0.8	0.3	0.3	0.3	4 g/m²/month
DM2	0.6	0.4	0.2	0.4	0.3	
DM3	0.6	0.7	0.4	0.6	0.8	
DM4	0.8	0.6	0.3	0.7	0.3	
PM_{10} (µg/m^3)						
HVAS	-	8.4	7.0	8.9	10.6	25 µg/m^3
TSP (µg/m^3)						
HVAS	-	15.3	10.7	13.9	14.5	90 µg/m^3

[1] HVAS sampling and reporting of PM10 and TSP commenced on 1 January 2021.

Airly Mine is considered a low dust emission source, with depositional dust monitoring results largely reflecting background air quality conditions. This conclusion is supported by the fact that monitoring sites located closer to Airly Mine frequently record lower dust levels than the designated background site (DM1). Historical air quality monitoring data indicate that all

measured parameters have remained below the applicable annual criteria and are consistent with predicted results. There is a slight correlation between depositional dust results and seasonal variability, with depositional dust monitoring results for January-March and September-December typically slightly higher than April-August.

6.4.5 Implemented / Proposed Improvements

Dust emission controls are considered effective based upon compliance with the air quality predictions and performance criteria during the Reporting Period. Additional air quality mitigation is not proposed.

6.5 GREENHOUSE GAS MONITORING

6.5.1 Environmental Management

Airly Mine manages, monitors and reports Greenhouse Gas (GHG) Emissions in accordance with the WRAQGMP.

Scope 1 (direct) and Scope 2 (indirect) GHG emissions from Airly continue to be monitored and reported annually in accordance with the Commonwealth Government National Greenhouse and Energy Reporting scheme (NGERS) established by the *National Greenhouse and Energy Reporting Act 2007* (NGER Act).

An Energy and Greenhouse Management System is used to monitor and report energy usage. Key Performance Indicators (KPIs) are tracked, which include energy demand and GHG emissions per tonne of ROM coal produced.

6.5.2 Environmental Performance

Table 6-10 reports the Scope 1 (direct) and Scope 2 (indirect) GHG emissions for the past five reporting periods, including comparison to EIS predictions.[9]

During the reporting period, total greenhouse gas emissions for Airly Mine were 12,693 tonnes CO_2-e, including:

- Scope 1 (direct) emissions: 5,956 tonnes CO_2-e; and
- Scope 2 (indirect) emissions: 6,737 tonnes CO_2-e.

Total GHG emissions decreased by 2,929 tonnes CO_2-e (~19%) in comparison to FY23.

There were no non-compliances relating to GHG emissions or management measures during the reporting period.

6.5.3 Comparisons against Predictions

GHG emissions for the project were predicted in the *Airly Mine Extension Project EIS* (SLR, 2014). In FY24, both Scope 1 (direct) emissions, including fugitive emissions, and Scope 2 (indirect) emissions remained below the EIS predicted levels. **Total actual emissions were 10,196 tonnes CO_2-e (~45%) lower than predictions**.

6.5.4 Long Term Analysis

Table 6-10 presents a summary of GHG emissions reported over the past five financial years, showing:

- GHG emissions remaining consistently below EIS estimates for the project.
- A general downward trend in total GHG emissions.

[9] Note, data is presented for financial year to align with reporting under the National Greenhouse and Energy Reporting scheme ensuring consistency and avoiding discrepancies in public reporting

Table 6-10: Total GHG Emissions from Airly Mine

Emission Source	Estimated Emissions (tonnes CO_2-e)					Predicted Emissions
	FY20	FY21	FY22	FY23	FY24	
Scope 1 Emissions						
Fuel combustion	1,456	1,397	1,451	995	853	1,574.3
Oil/Grease consumption	218	170	90	168	143	3.8
SF_6	5	6	10	10	11	0.4
Fugitives – CH_4	-	127	30	-	-	9,050.7
Fugitives – CO_2	3,627	6,030	7,120	5,788	4,949	
Total Scope 1	**5,306**	**7,730**	**8,701**	**6,958**	**5,956**	**10,629.2**
Scope 2 Emissions						
Electricity consumption	9,447	7,555	8,618	8,663	6,737	12,260
Total Scope 2	**9,447**	**7,555**	**8,618**	**8,663**	**6,737**	**12,260**
Total Greenhouse Gas Emissions						
Scope 1 and 2 Emissions	**14,753**	**15,285**	**17,320**	**15,622**	**12,693**	**22,889.2**

6.5.5 Implemented / Proposed Improvements

Airly Mine has relatively low GHG emission levels and implements several GHG emission reduction measures on site, including engineering mine and infrastructure design to improve energy efficiency, regular maintenance of plant and equipment to minimise fuel consumption and consideration of energy efficiency in plant and equipment selection.

The Airly Mine solar farm was commissioned in April 2020 and has reduced emissions from electricity consumption. Airly will continue to monitor and implement GHG management and reduction measures during the next reporting period.

6.6 BIODIVERSITY

6.6.1 Environmental Management

Biodiversity monitoring throughout the Development Consent Area for SSD_5581 is currently being undertaken in compliance with the Western Region Biodiversity Management Plan (WRBMP) required by Schedule 4, Condition 15 of SSD_5581 and relevant Extraction Plan specific Biodiversity Management Plans (BMPs) required by Schedule 3, Condition 7 of SSD_5581.

Areas of biodiversity significance within the management area include *Biodiversity Conservation Act 2016* (BC Act) and *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened ecological communities (TECs), Groundwater Dependant Ecosystems (GDEs) and BC Act and EPBC Act threatened species and their habitats.

The key biodiversity values include:

- TECs:
    - *Allocasuarina nana* Heathland; and
    - White Box – Yellow Box – Blakely's Red Gum Woodland Critically Endangered Ecological Community (CEEC).
- GDEs
    - MU 13: Tableland Gully Ribbon Gum - Blackwood - Apple Box Forest; and
    - MU 21: Capertee - Wolgan Slopes Red Box - Grey Gum - Stringybark Grassy Open Forest.
- Threatened flora:
    - *Prostanthera stricta* (Mount Vincent Mint-bush);
    - *Eucalyptus cannonii* (Capertee Stringybark); and
    - *Pultenaea sp.* Genowlan Point.
- Threatened fauna:
    - Glossy-black Cockatoos (*Calyptorhynchus lathami*);
    - Forest owls;
    - Woodland birds; and
    - Cave-dwelling Microchiropteran bats (microbat).

Ongoing seasonal ecological monitoring, conducted since 2012, assesses potential impacts of underground mining on threatened species, populations, and communities present within the site. Monitoring methodologies have been refined to target species-specific responses and detect long-term ecological trends resulting from mining activities. All ecological monitoring locations are shown in **Appendix 4**.[10]

The monitoring program is conducted by specialist ecology consultants in accordance with WRBMP and Extraction Plan BMPs, except in areas with restricted access, such as *Pultenaea sp.* Genowlan Point and Genowlan Point *Allocasuarina nana* Heathland, which are being monitored by NSW National Parks and Wildlife Service (NPWS).

6.6.2 Environmental Performance

A summary of the key results and observations obtained from the 2024 monitoring activities is provided below. A detailed report is provided in the *Airly BMP Seasonal Ecological Monitoring Flora and Fauna Monitoring Report 2024* (RPS, 2025) (**Appendix 4**).

The 2024 monitoring results have displayed that threatened species, threatened populations, TECs and groundwater dependent ecosystems are still persisting in the management area, with negligible environmental consequences.

White Box – Yellow Box – Blakely's Red Gum Woodland CEEC

Native plant species richness within the four White Box – Yellow Box – Blakely's Red Gum Woodland Plots has significantly reduced since baseline. However, it is comparable to that of 2017, 2018 and 2023. Vegetation integrity (VI) scores have been calculated for year 2019 to 2024 in line with the Biodiversity Assessment Method (BAM) (DPE, 2020) of which the 2024 composition, function and VI scores are not significantly different in comparison to 2020.

[10] see Figure 2-1: Vegetation community monitoring locations, Figure 2-2: Threatened flora monitoring locations and Figure 2-3: Fauna monitoring locations in the *Airly BMP Seasonal Ecological Monitoring Flora and Fauna Monitoring Report 2024* (RPS, 2025).

Groundwater Dependent Ecosystems

Eleven GDE plots were surveyed in the 2024 monitoring period to establish baseline conditions for future Extraction Plan BMPs. Since undermining commenced in 2023, Pt Hatteras is now classified as an impact area.

Compared to baseline conditions, a significant increase in structural complexity was observed within impact plots at Pt Hatteras in 2024. However, function scores declined significantly, while Vegetation Index (VI) scores remained stable.

Exotic flora species

A total of 26 exotic species were detected in the management area. There has been a slight decrease in exotic species cover in 2024 compared to the 2023 monitoring period. BAM plot 1 has the highest weed cover due to a high grass cover of *Phalaris aquatica* within the riparian area. All weed species have associated management requirements under the *Biosecurity Act 2015*.

Prostanthera stricta

The mean percentage cover of *P. stricta* in 2024 has not significantly changed since 2023, however it has significantly increased in comparison to 2016, 2017, 2019 and 2020. At Genowlan Trig, the percentage cover of *P. stricta* has significantly increased compared to 2016, 2017 and 2018 collectively for the second year in a row.

Eucalyptus cannonii

A total of 26 *E. cannonii* individuals were monitored. Individual *E. cannonii* trees were measured based on tree condition (canopy density and extent %), size (height and diameter) and contextual data. Data was averaged across the population based on the monitoring location of the individuals.

The following significant *E. cannonii* results were identified by the analysis:

- Crown density has significantly increased since 2016/2017 monitoring years at Mt Airly and control populations
- The average crown extent within the Mt Airly population has significantly decreased since 2016/2017
- A significant increase in height was observed in the control population between 2016/2017 and 2024
- No significant variation in diameter at breast height (DBH) has been observed across the populations.

Crown density increases may be correlated with crown extent decreases as changes in tree growth strategies occur (Li et al., 2022). Further to this, crown extent may not be the most reliable indicator of tree health as it varies with tree age. Generally, as a tree ages, crown extent is likely to be proportionally less, when compared to the size of the tree. Therefore, crown density may be a more reliable indicator of tree health.

Glossy-black Cockatoos (Calyptorhynchus lathami)

The presence of Glossy-black Cockatoos was confirmed through a sighting of eight individuals at Genowlan Point (monitoring point ten), and the presence of *Allocasuarina* orts at seven of the ten monitoring locations.

Forest owls

No roost sites displayed evidence of use (i.e., white wash and pellets) and Site 2 remains inaccessible due to landslides. However, a Powerful Owl (*Ninox strenua*; BC Act: Vulnerable) and a Masked Owl (*Tyto novaehollandiae*; BC Act: Vulnerable) were observed during spotlighting suggesting that large forest owls persist within the Airly Mining Lease Area.

Woodland birds

Three of the 68 bird species recorded during diurnal surveys are listed as threatened under the BC Act which include Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable; EPBC Act: Endangered), Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable; EPBC Act: Vulnerable) and Dusky Woodswallow (*Artamus cyanopterus cyanopterus*: BC Act Vulnerable). No significant changes were noted in bird species richness; therefore it is deemed that this is stable across the management area.

Cave-dwelling microbats

Two of the three target microbat species were detected at a definite confidence level during the monitoring period, being the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and the Large-eared Pied-bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable). Whilst not definite, it is likely that given the high number of calls, and location at a known bat roost, the Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*) is also roosting in the management area. The adits continue to support a maternity colony of Eastern Horseshoe Bats.

Other targeted fauna/vertebrate census

Of the 17 native vertebrate species (excluding birds and microbats) detected during the 2024 monitoring period, two are listed as threatened under the BC Act and/or EPBC Act. Spotted-tailed Quoll (*Dasyurus maculatus*; BC Act: Vulnerable; EPBC Act: Endangered) was observed on a camera trap for the first time in the management area since 2012, and two Yellow-bellied Gliders (*Petaurus australis*; BC Act: Vulnerable) were observed during nocturnal spotlighting/call playback surveys. This is the first record of the species in a 15 km radius from Airly Mine.

Feral species

A cat (*Felis catus*) was the only feral fauna species recorded on camera traps during the 2024 monitoring period. This is a notable drop in pest species since 2023, which, in addition to cats, observed the European rabbit (*Oryctolagus cuniculus*), pigs (*Sus scrofa*) and foxes (*Vulpes vulpes*).

Centennial Airly actively participate in feral species management strategies (Airly Cat Trapping Program, Local Land Services District Wild Dog Control, engaging third-party feral species control). This decrease in recorded feral species indicates management strategies employed by Centennial Airly are having success. Pest control is an ongoing recommendation that is upheld by Centennial Airly.

6.6.3 Comparisons against Predictions

The *Airly Mine Extension Project EIS* (RPS, 2014a) predicted the project was unlikely to have a significant impact upon threatened species, EECs or other MNES. Biodiversity-related performance measures are outlined in Schedule 3, Condition 2 (Natural and Heritage Features) of SSD_5581 and shown in **Table 6-11**.

The annual monitoring shows that conditions of SSD_5581 have been adequately addressed and performance criteria have been met.[11]

Table 6-11: Biodiversity related subsidence impact performance measures

Aspect / Features	Performance Measure	Biodiversity Monitoring	Performance During the Reporting Period
Gap and Genowlan Creeks	Negligible environmental consequences to water quality and to bed and bank stability No greater environmental consequences than predicted in the EIS to water flows (including baseflow)	Groundwater Dependant Ecosystems (GDE)	**Compliant** Repeatable and measurable monitoring methods established. Baseline data collected in 2022 and 2023. No significant changes within BAM scores were recorded with the Point Hatteras impact plots. A decrease in compositional scores was recorded in control plots, which is attributed to broader environmental factors, therefore SSD_5581 compliance has been met.
The Grotto	Negligible subsidence impacts or environmental consequence		
Threatened species, threatened populations, EECs and groundwater dependent ecosystems (with the exception of those listed below)	Negligible environmental consequences	White Box – Yellow Box – Blakely's Red Gum Woodland	**Compliant** Decrease in species richness compared to 2015 and 2016, however maintenance of BAM scores, therefore SSD_5581 compliance has been met.
		Prostanthera stricta (Mount Vincent Mint-bush)	**Compliant** No significant change in *P. stricta* cover, therefore SSD_5581 compliance has been met
		Eucalyptus cannonii (Capertee Stringybark)	**Compliant** Whilst crown extent has significantly reduced between monitoring years, crown density is stable or increased since 2017. Therefore, *E. cannonii* tree health is stable across populations, indicating that SSD_5581 compliance has been met.
		Glossy-black Cockatoos *(Calyptorhynchus lathami)*	**Compliant** Continued persistence of threatened bird species, therefore SSD_5581 compliance has been met.
		Large Forest Owls	

[11] Note, performance measure for *Pultenaea sp.* Genowlan Point population and Genowlan Point *Allocasuarina nana* Heathland community are monitored by NPWS.

Aspect / Features	Performance Measure	Biodiversity Monitoring	Performance During the Reporting Period
		Diurnal birds, including threatened and regionally significant woodland bird species	
		Cave-dwelling microbats	**Compliant** Persistence of roosting and breeding microbat species, therefore SSD_5581 compliance has been met.
		Vertebrate census/ other targeted fauna	**Compliant** Persistence of threatened fauna species and relatively low pest species, therefore SSD_5581 compliance has been met.
Pultenaea sp. Genowlan Point population and Genowlan Point *Allocasuarina nana* Heathland community	No environmental consequences	N/A - monitored by NPWS	**Compliant** There was no mining within a 26.5-degree angle of draw of the *Pultenaea* sp. Genowlan Point population and Genowlan Point *Allocasuarina nana* Heathland community. No mining related environmental impacts were detected.

6.6.4 Long Term Analysis

Long-term analysis of biodiversity monitoring is undertaken in the detailed *Airly BMP Seasonal Ecological Monitoring Flora and Fauna Monitoring Report 2024* (RPS, 2025) (**Appendix 4**). Based on the information reported, monitoring in 2024 revealed the overall presence and condition of threatened flora and fauna as comparable to previous monitoring seasons.

6.6.5 Implemented / Proposed Improvements

The results of the biodiversity monitoring remain to be generally in accordance with the predications made in the *Airly Mine Extension Project EIS* (RPS, 2014a) and approved for the project, therefore current management measures are considered adequate.

Airly Mine will continue to conduct feral species management strategies as detailed in **Section 6.6.2**.

6.6.6 Biodiversity Offsets

Airly Mine does not have, and is not required to have, any biodiversity offset areas.

6.7 HERITAGE

6.7.1 Environmental Management

Airly Mine manages Aboriginal heritage in accordance with the Western Region Aboriginal Cultural Heritage Management Plan (WRACHMP) (dated September 2021), which was approved by DPHI in 2021. There are 24 sites registered on the Aboriginal Heritage Information Management System (AHIMS) within the Airly Mine lease boundary.

European heritage is managed in accordance with the Western Region Historic Heritage Management Plan (WRHHMP) (dated June 2018), approved by DPHI in 2018. Within the Airly Mine lease boundary, heritage listings include:

- One general heritage item and 19 archaeological items listed in Schedule 5 – Environmental Heritage of the Lithgow City Council Local Environmental Plan (LEP).
- No heritage items are listed under the Commonwealth Heritage Register, NSW State Heritage Register (SHR), or the s170 registers (state owned items).

The management of heritage items is also included within relevant Extraction Plans, including:

- Historic Heritage Management Plan for Cliff Line Zone of First Workings Extraction Plan within ML1331 (Version Final, dated 14 July 2017);
- Historic Heritage Management Plan for the Airly Splitting and Quartering Extraction Plan (ML1331) (Version 1.4, dated 23 May 2018);
- Aboriginal Cultural Heritage Management Plan for the Airly Splitting and Quartering Extraction Plan (ML1331) (Version 1.3, dated 23 May 2018); and
- Aboriginal Cultural Heritage Management Plan for the Cliff Line Zone of First Workings Extraction Plan (ML1814) (Rev_3, dated 25 July 2024).

The monitoring program for all undermined sites consists of pre and post mining inspections. This is done to ensure that no mining induced impacts to the site have occurred. As such, the monitoring program has been split into two or three phases:

- Phase 1: Baseline recording (prior to site being undermined);
- Phase 2: Post mining initial condition; and
- Phase 3: Post mining secondary inspection (as per WRACHMP).

6.7.2 Environmental Performance

There was no disturbance or undermining of known Aboriginal heritage or European heritage sites during the Reporting Period. The mine schedule and workings for 2024 is shown on **Figure 6-7**.

AHIMS site 45-1-0167, a rock shelter with deposit, is scheduled to be undermined in Q2 2025. Management and monitoring will be undertaken in accordance with the WRACHMP and Aboriginal Cultural Heritage Management Plan for the Cliff Line Zone of First Workings Extraction Plan (ML1814).

A GNSS subsidence monitoring unit has been installed directly above the site 45-1-0167, to continuously track ground movements. A Phase 1 (pre-mining) inspection was completed in November 2024, and baseline photogrammetry will be conducted prior to the site being undermined to enable comparison during and post-mining phases.

During the reporting period, an archaeological survey involving Registered Aboriginal Parties (RAPs) was undertaken to inform the MW19-22 Extraction Plan approval application. The survey was conducted between 25 and 27 November 2024, resulting in the identification and recording of two new Aboriginal sites in the AHIMS database.

Consultation with RAPs regarding the survey findings is ongoing, and upon completion, the Aboriginal Cultural Heritage Management Plan for the MW19-22 Extraction Plan and the WRACHMP will be revised and resubmitted to reflect the updated information.

The Western Region Heritage Committee Meetings were held on 6 March 2024 and 4 September 2024. The presentations included operational updates, compliance reporting, sites undermined and environment and community updates.

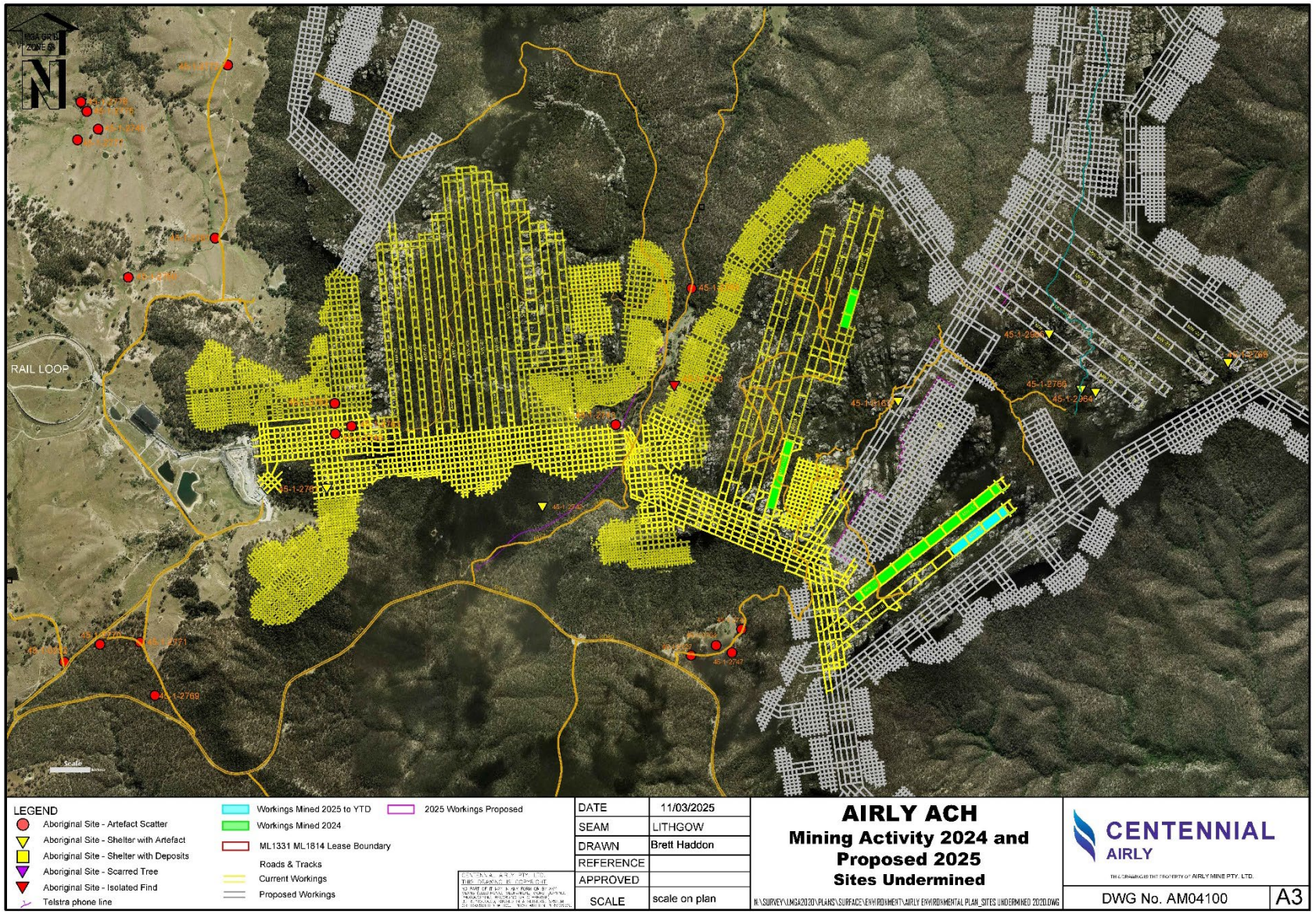


Figure 6-7: Heritage Sites and Mining Activity 2024 and Forecast-2025

6.7.3 Comparison against Predictions

There were no non-compliances relating to heritage matters during the 2024 reporting period.

The results obtained from the heritage monitoring undertaken to date are compliant with the performance measures of Schedule 3, Condition 2 (Natural and Heritage Features) of SSD_5581 and generally in accordance with the predications made in the *Airly Mine Extension Project EIS* (RPS, 2014b), therefore current management measures are considered adequate.

6.7.4 Long Term Analysis

Historically five sites have been undermined, including:

- 45 1 2746 (Artefact Scatter) Dec 2010
- 45 1 2763 (Artefact Scatter) Mar 2011
- 45 1 2761 (Shelter) Jul 2011
- 45 1 2762 (Artefact Scatter) Sep 2015
- 45 1 2748 (Isolated Find) May 2017

The monitoring has confirmed that no registered AHIMS sites have been impacted by the subsidence.

6.7.5 Implemented / Proposed Improvements

Given the preceding compliance of heritage performance measures, additional heritage management and mitigation is not proposed. The pre-clearance permit systems provides the land disturbance due diligence process, implemented by the site and is considered appropriate for the management of heritage sites and items.

The Aboriginal Cultural Heritage Management Plan for the MW19-22 Extraction Plan and the WRACHMP will be revised and resubmitted following the completion of consultation, to incorporate updated information from the 2024 archaeological survey.

6.8 MINE SUBSIDENCE

6.8.1 Environmental Management

In accordance with Schedule 3, Condition 7 of SSD_5581 an Extraction Plan is prepared prior to carrying out any first workings within the Cliff Line Zone and Zone of First Workings or second workings.

The Extraction Plans describe in detail the performance indicators and measures that would be implemented to ensure compliance with the performance measures required by Schedule 3, Condition 2 (Land and Heritage Sites) and Condition 3 (Built Features) of SSD_5581.

Table 6-8 provides a summary of the Extraction Plans approved for the Airly Mine.

Table 6-12: Summary of Approved Extraction Plans

Extraction Plan	Approval	Development / First Workings	Extraction / Second Workings	Mining activities during the reporting period
MOD 3 (as Varied)	6 September 2016[a]	Complete	Complete	N/A[c]

Extraction Plan	Approval	Development / First Workings	Extraction / Second Workings	Mining activities during the reporting period
Cliff Line Zone of First Workings (ML1331)	16 October 2017	Ongoing	N/A	Minor development (first workings) was conducted in this EP Area during the reporting period.
Splitting & Quartering (ML1331)	30 August 2018[b]	Ongoing	Ongoing	No extraction conducted in this EP Area during the reporting period.
Mt Airly Panel & Pillar Mining Zone (MW02-12)	31 May 2019	Complete	Complete	N/A[c]
Pt Hatteras Panel & Pillar Mining Zone (MW13-16)	13 December 2021	Complete	Complete	Extraction in this EP Area was **completed in 2024**, with MW16 and MW15B extracted. Monitoring of the EP Area is ongoing.
MW17-18 Panel & Pillar Mining Zone	15 January 2024	Complete	Ongoing	Extraction in this EP Area commenced in 2024, with MW17 extracted. Extraction of MW18 will be completed in 2025.
Cliff Line Zone of First Workings (ML1814)	27 September 2024	Ongoing	N/A	No development (first workings) conducted in this EP Area during the reporting period.

Notes:
[a] Approval received under development consent DA162/91 (now surrendered). However, in accordance with the notes in SSD_5581, the requirements of Schedule 3, Condition 7 of SSD_5581 do not apply to first or second workings covered by an approved Extraction Plan or Subsidence Management Plan (or one that was under assessment at the time SSD_5581 was granted).
[b] Conditional approval was received for 'Trial Mining Area' in Panels 206 and 207. Additional approvals are required for subsequent splitting and quartering operations. To date Panels 400 and 400A have also received approval (May 2019).
[c] No further monitoring required with cessation of extraction workings for >24 months and negligible ongoing residual subsidence.

6.8.2 Environmental Performance

Overview

During the 2024 reporting period, the following **second workings (miniwall extraction)** was undertaken:

- **MW16**: Extraction occurred between 6 November 2023 and 29 January 2024 in accordance with the *Pt Hatteras PPMZ (MW13-16) Extraction Plan*.
- **MW15B**: Extraction occurred between 26 February and 27 March 2024 in accordance with the *Pt Hatteras PPMZ (MW13-16) Extraction Plan*.
- **MW17**: Extraction occurred between 27 August and 22 November 2024 in accordance with the *MW17-18 Extraction Plan*.

The completion of MW16 and MW15B marks the conclusion of miniwall extraction under the *Pt Hatteras PPMZ (MW13-16) Extraction Plan*. Monitoring of this Extraction Plan Area will continue in accordance with the *MW13-16 Subsidence Monitoring Program* (SMP) until negligible ongoing residual subsidence is observed.

Additionally, **first workings (development and herringbone mining)** were undertaken, including some minor drivage within the Cliff Line Zone of First Workings (ML1331) Extraction Plan area, completion of Herringbone 1 (HB1) and development associated with MW18. The mine schedule and workings for 2024 is shown on **Plan 3** (AM04124).

Table 6-13 provides a summary of compliance with the subsidence performance measures during the reporting period. A detailed analysis available in the *Review of Monitored Subsidence and Impacts 2024 Annual Report* (MSEC, 2025) (**Appendix 5).**

Table 6-13: Summary of compliance with subsidence impact performance measures

Aspect / Features	Performance Measure	Performance During the Current Reporting Period
Water Resources		
Gap and Genowlan Creeks	• Whenever depth of cover is < 40 m, no first or second workings within 20 m of the edge of the creek bed, measured horizontally in the seam • Negligible environmental consequences to water quality and to bed and bank stability • No greater environmental consequences than predicted in the EIS to water flows (including baseflow)	**Compliant** No first or second workings occurred within 20 m of Gap and Genowlan Creek beds where depth of cover is < 40 m. Monitoring confirmed negligible environmental consequences to water quality and to bed / bank stability. Observed flows, including baseflow, were consistent with EIS predictions, with no greater environmental consequences detected.
All other watercourses	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to watercourses detected.
Land		
The Grotto	Negligible subsidence impacts or environmental consequence	**Compliant** Monitoring confirmed negligible subsidence impacts or environmental consequences to The Grotto.

Aspect / Features	Performance Measure	Performance During the Current Reporting Period
Cliffs within a 26.5-degree angle of draw of the Airly underground mine workings	No greater subsidence impacts or environmental consequences than predicted in the EIS *(i.e. occasional rock falls, displacement or dislodgement of boulders or slabs of less then 30 m^3, or fracturing, that do not impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such cliffs	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to cliffs detected.
Pagodas within a 26.5-degree angle of draw of the Airly underground mine workings (other than pagodas affected by the New Hartley interaction zone)	No greater subsidence impacts or environmental consequences than predicted in the EIS *(i.e. occasional rock falls, displacement or dislodgement of boulders or slabs of less then 30 m^3, or fracturing, that do not impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such pagodas	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to pagodas detected.
Pagodas within a 26.5-degree angle of draw of the New Hartley interaction zone	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** There was no mining within a 26.5-degree angle of draw of the New Hartley interaction zone.
Minor cliffs	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to minor cliffs detected.
Steep slopes	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to steep slopes detected.
All other land not covered by a performance measure above	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to other land detected.

Aspect / Features	Performance Measure	Performance During the Current Reporting Period
Biodiversity		
Threatened species, threatened populations, EECs and groundwater dependent ecosystems (with the exception of those listed below)	Negligible environmental consequences	**Compliant** Biodiversity monitoring confirmed negligible environmental consequences. *Refer also to Section 6.6.*
Pultenaea sp. Genowlan Point population and Genowlan Point *Allocasuarina nana* Heathland community	No environmental consequences	**Compliant** There was no mining within a 26.5-degree angle of draw of the *Pultenaea* sp. Genowlan Point population and Genowlan Point *Allocasuarina nana* Heathland community. No mining related environmental impacts were detected.
Heritage sites		
Aboriginal heritage sites identified in Appendix 5	Negligible environmental consequences	**Compliant** No heritage sites undermined in 2024. There has been no mining related impact to any recorded Aboriginal Heritage sites at Airly Mine.
Non-Aboriginal heritage sites identified in Appendix 6	Negligible environmental consequences Wherever depth of cover is < 30 m, no second workings to occur within a setback distance defined by half the depth of cover from site 3 and site 24, measured horizontally in the seam	**Compliant** No heritage sites undermined in 2024. There has been no mining related impacts to any recorded Heritage sites at Airly Mine.
Mine Workings		
First workings beneath any feature where performance measures in this table require no or negligible environmental consequences and to all first workings beneath cliffs	To remain long-term stable and non-subsiding	**Compliant** Development (first workings) was undertaken in accordance with approved Extraction Plans. Pillars were formed at least 1/10th depth from surface. Pillars were >2.11 FOS (i.e., long term stable).

Aspect / Features	Performance Measure	Performance During the Current Reporting Period
Second workings	To be carried out only in accordance with an approved Extraction Plan	**Compliant** Extraction (second workings) occurred in accordance with approved Extraction Plans. *Note: The mining dimensions for extraction of MW17 exceeded the design dimensions of the MW17-18 Extraction Plan. However, this does not constitute a non-compliance of the Extraction Plan. Refer to sub-heading MW17-18 Panel & Pillar Mining Zone Extraction Plan (page 50) for full details.*
Built Features		
Emergency services communication tower and associated sheds and infrastructure	• Always safe and serviceable • Damage must be fully repairable, and must be fully repaired	**Compliant** Airly Turret Communication Tower remained safe and serviceable. No damage was detected.
State survey mark at Genowlan Trig Station, Telstra copper cable and Nissen Hut and outbuilding	• Always safe and serviceable, unless otherwise agreed with the owner • Damage must be fully repairable, and must be fully repaired	**Compliant** State survey mark at Genowlan Trig Station is being affected by subsidence and will be repaired following the completion of subsidence in agreement with the owner. There was no mining within a 26.5-degree angle of draw of the Telstra copper cable. There was no mining related impacts to Telstra's serviceability and no damage was detected or reported. Nissen Hut and outbuilding remained safe and serviceable. No damage was detected.
"Stone Cottage"	• No second workings to occur within a setback distance defined by half the depth of cover from the building, measured horizontally in the seam, unless otherwise agreed with the owner • Always safe and serviceable, unless otherwise agreed with the owner • Damage must be fully repairable, and must be fully repaired, unless otherwise agreed with the owner	**Compliant** There was no mining within a 26.5-degree angle of draw of the "Stone Cottage". No mining related damage was detected.

Aspect / Features	Performance Measure	Performance During the Current Reporting Period
Other built features and improvements including Airly Camp Ground, walking and 4WD tracks, fences and gates	• Use should be maintained wherever practicable in consultation with BCD • Damage must be fully repairable and must be fully repaired	**Compliant** No mining related damage to other built features and improvements was detected.
Public Safety		
Public safety	Negligible additional risk, in consultation with the Resources Regulator and BCD	**Compliant** Negligible additional public safety risk was reported in 2024.

Subsidence Monitoring Activities

Subsidence Monitoring Programs (SMP) are developed for each Extraction Plan, with results presented in this section of the Annual Review.[12]

During the reporting period, subsidence monitoring primarily focussed on the MW13-16 and MW17-18 extraction plan areas and included:[13]

- Remote aerial surface survey monitoring (LiDAR)– all extraction plan areas
- Visual inspection program (opportunistic or targeted (if triggered)) – all extraction plan areas
- Airly Mine Global Navigation Satellite System (GNSS) Monitoring Stations – MW13-16 and MW17-18

Remote aerial photogrammetry

Remote aerial photogrammetry is undertaken at approximately six-monthly intervals, with surveys completed on 13 March and 8 August 2024.

These surveys covered all approved extraction plan areas and did not detect any previously unknown subsidence impacts or natural rockfalls.

Visual inspection program

Opportunistic observations are undertaken by mine personnel or contractors during other routine monitoring visits within the extraction plan areas (i.e., for conventional survey or environmental monitoring). No previously unknown subsidence impacts or natural rockfalls were detected.

There were no trigger-based surface inspections required in 2024.

Annual Review of Monitored Subsidence and Impacts (MSEC, 2025)

Mt Airly Panel & Pillar Mining Zone Extraction Plan (MW02-12)

The 2023 Annual Subsidence Review (MSEC, 2024) concluded that residual subsidence levels had decreased to well below negligible levels and recommended no further resurveys were required over the Mt Airly workings. However, an additional survey of conventional

[12] Monitoring summaries associated with other environmental aspects are presented separately in other relevant sections of this Annual Review, including Water (Section 7), Biodiversity (Section 6.6) and Heritage (Section 6.7).
[13] Monitoring summaries associated with other environmental aspects (including but not limited to water, biodiversity and heritage) are presented separately in other relevant sections of this Annual Review.

subsidence lines over Mt Airly was conducted on 10 December 2024, and GNSS monitoring stations over Mt Airly continued to record daily subsidence data.

Incremental subsidence measurements from December 2024, taken approximately 36 months after the final miniwall (MW12) was fully extracted, confirm that since January 2024, residual movements have remained negligible, ranging from -4 and +15 mm (less than 20 mm). These small values fall within the survey accuracy range and are likely also influenced by natural variation and minor ground movements, further validating the conclusion of negligible ongoing residual subsidence.

Fracture monitoring and independent inspections for potential subsidence impacts and remediation works over the Mt Airly workings are ongoing (for further details refer **Section 8.1.2**).

Pt Hatteras Panel & Pillar Mining Zone Extraction Plan (MW13-16)

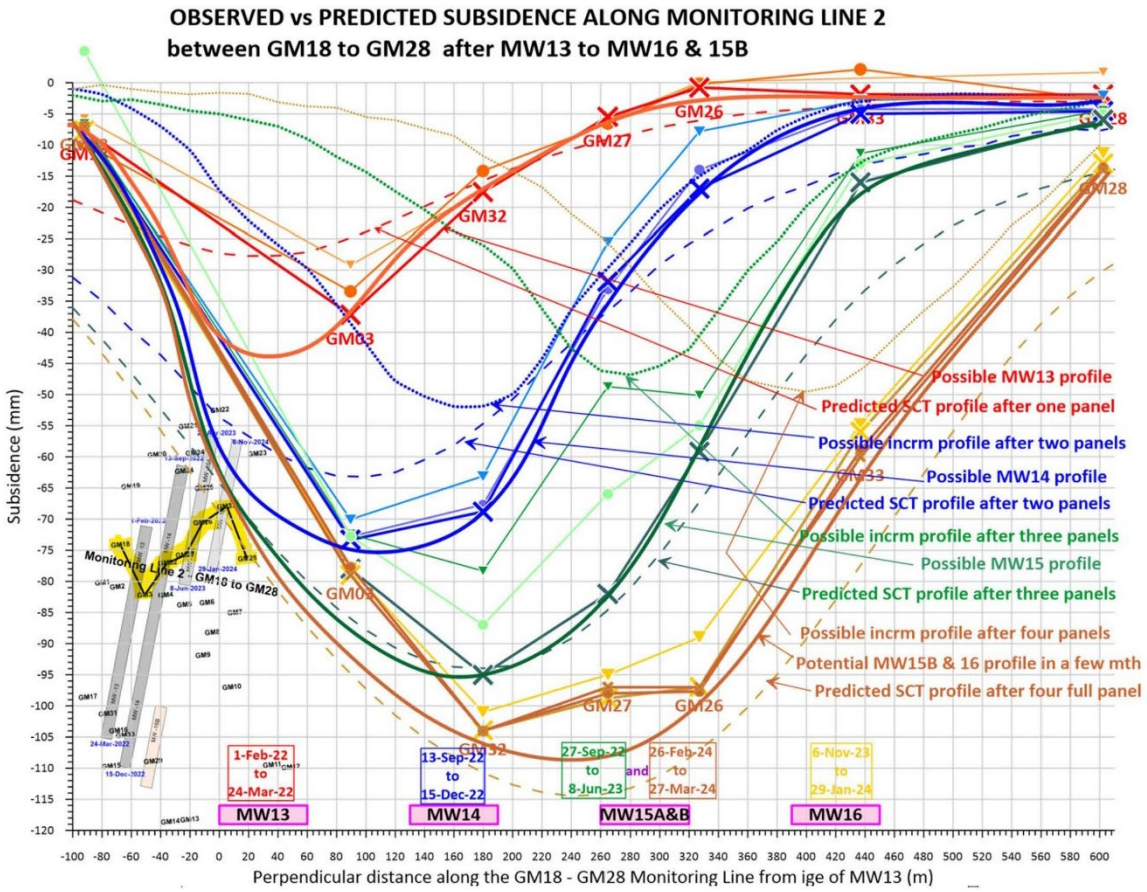
Continuous, near real-time subsidence monitoring is undertaken over the Point Hatteras area of Genowlan Mountain using 34 GNSS monitoring stations, monitored remotely and daily by Centennial Airly.[14]

Key findings MSEC (2025):

- As of December 2024, the maximum measured subsidence over MW13-16 was 104 mm, recorded at GM32.
- MSEC (2025) estimated curved subsidence profiles based on historical monitoring over panels with closely spaced survey pegs. These estimates determined that the maximum “possible” subsidence over MW13-16 is approximately 110 mm.
- The maximum observed subsidence (104 mm) and the maximum possible subsidence (~110 mm) are both below the SCT predicted maximum of 115 mm for four panels. These values are also consistent with the 2014 EIS predictions, which estimated maximum subsidence of less than 125 mm.
- Minor residual movements may still occur; however, they are expected to remain within the SCT modelled threshold of 115 mm and in line with the 2014 EIS prediction of <125 mm.

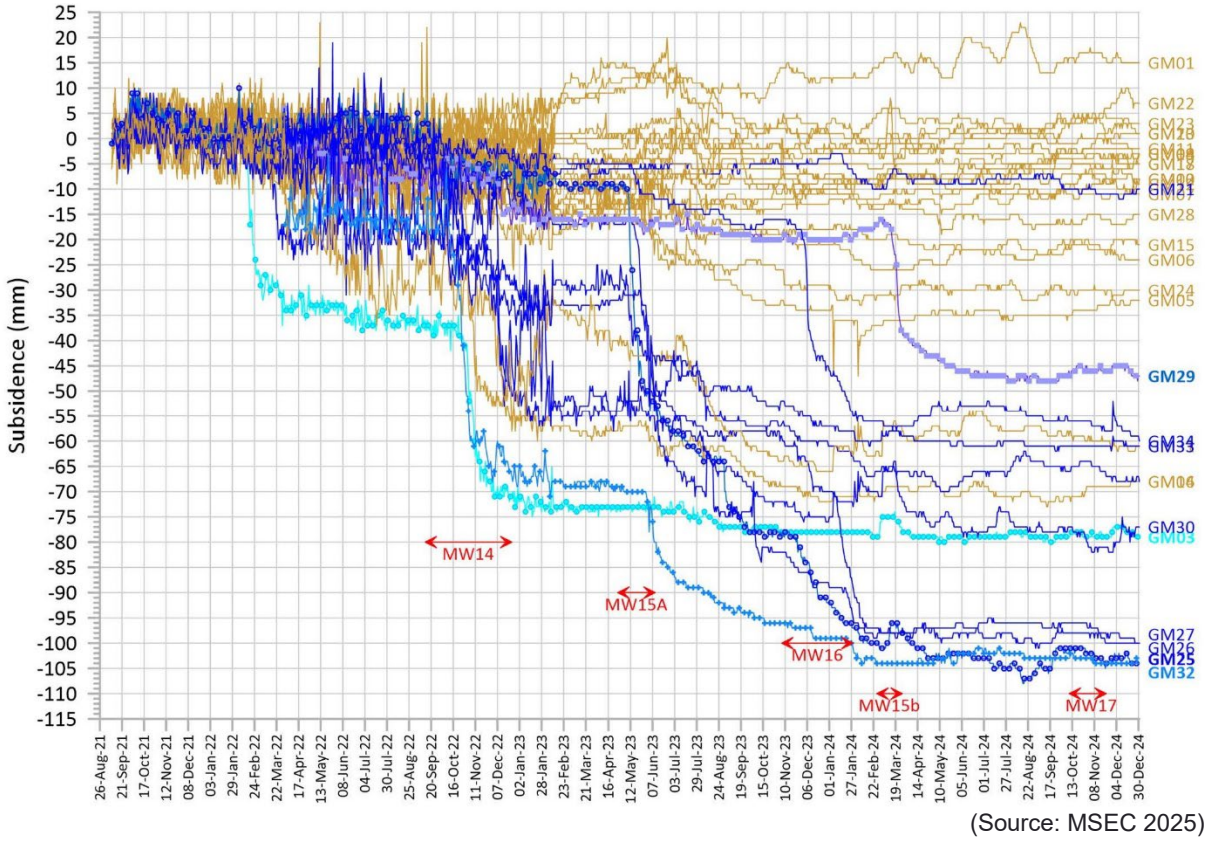
Monitoring data from Monitoring Line 2 (including GM18, GM03, GM32, GM27, GM26, GM33 and GM28) is shown in **Figure 6-8**. Daily vertical subsidence movements measured at GM01 to GM32 is shown on **Figure 6-9**. These time plots of observed subsidence confirm the very low levels of the monitored subsidence over Genowlan Mountain and over MW13-16.

[14] Fig. 3.7 in **Appendix 5** shows the locations of the all the GNSS stations and the location of monitoring lines



(Source: MSEC 2025)

Figure 6-8: Observed subsidence profiles across MW13-MW16



(Source: MSEC 2025)

Figure 6-9: Daily subsidence (raw) measurements at GNSS stations over MW13-MW16

MW17-18 Panel & Pillar Mining Zone Extraction Plan

Continuous, near real-time subsidence monitoring is undertaken over MW17-18 using 22 GNSS survey stations, monitored remotely and daily by Centennial Airly.[15]

Key findings MSEC (2025):

- As of December 2024, the maximum measured subsidence over MW17 was 52 mm, recorded at GM45. Subsidence at GM45 has remained stable since 4 December 2024, indicating negligible residual subsidence from MW17 extraction.
- The measured subsidence of 52 mm at GM45 is slightly higher (+13 mm) than the original SCT predicted base value of 39 (± 20 mm) for the 3.0 m extraction option but remains within the specified tolerance range.
- Inspections identified that the actual extraction height in MW17 exceeded the design parameter outlined in the Extraction Plan. An average extraction height across the MW17 panel was greater than 3.0 m, with a maximum of 3.2 m.
- On 22 January 2025, Centennial Airly notified DPHI that a performance indicator had been triggered, as outlined in the Master Trigger Action Response Plan for MW17-18 (MW17-18 Master TARP) which forms part of the MW17-18 Panel and Pillar Mining Zone Extraction Plan (Extraction Plan).

In response to the triggered indicator, adaptive management measures were implemented, including:

- A compliance review of current subsidence monitoring data against relevant performance criteria in the MW17-18 Master TARP, including for Ground Movement and Subsidence Effects Monitoring and Cliffs and Pagodas;
- Completion of an end-of-panel report for MW17, detailing all observed subsidence effects (individual and cumulative) and comparing them with model predictions; and
- A review of the numerical subsidence model by SCT, assessing the implications of MW17 monitoring results for future panel design and monitoring requirements. SCT recommended a reduced extraction height of 2.8 m for MW18 as the lowest risk option, allowing the MW17-18 panels to maintain a nominal average extraction height of 3.0 m.

In the updated report (SCT AIRLY5865, dated 15 January 2025), SCT revised the predicted maximum subsidence for MW17 to 43 mm (±20 mm) based on the increased extraction height (a 7% increase in seam thickness). The observed 52 mm subsidence at GM45 remains within this updated tolerance range.

The extraction height of MW18 is being reduced to ensure that total subsidence remains below the 2014 EIS prediction of <125 mm, consistent with the Extraction Plan and development consent.

Subsidence monitoring over MW17 has confirmed that the current mine design has successfully limited subsidence, consistent with the limits set out in the SSD_5581 consent and considered satisfactory in the IRP report (2016).

The low levels of subsidence observed following MW17 extraction, and predicted following the extraction of MW18, are consistent with the impacts predicted and approved in the Extraction Plan.

[15] Fig. 4.2 in **Appendix 5** shows the locations of the all the GNSS stations and the location of monitoring lines

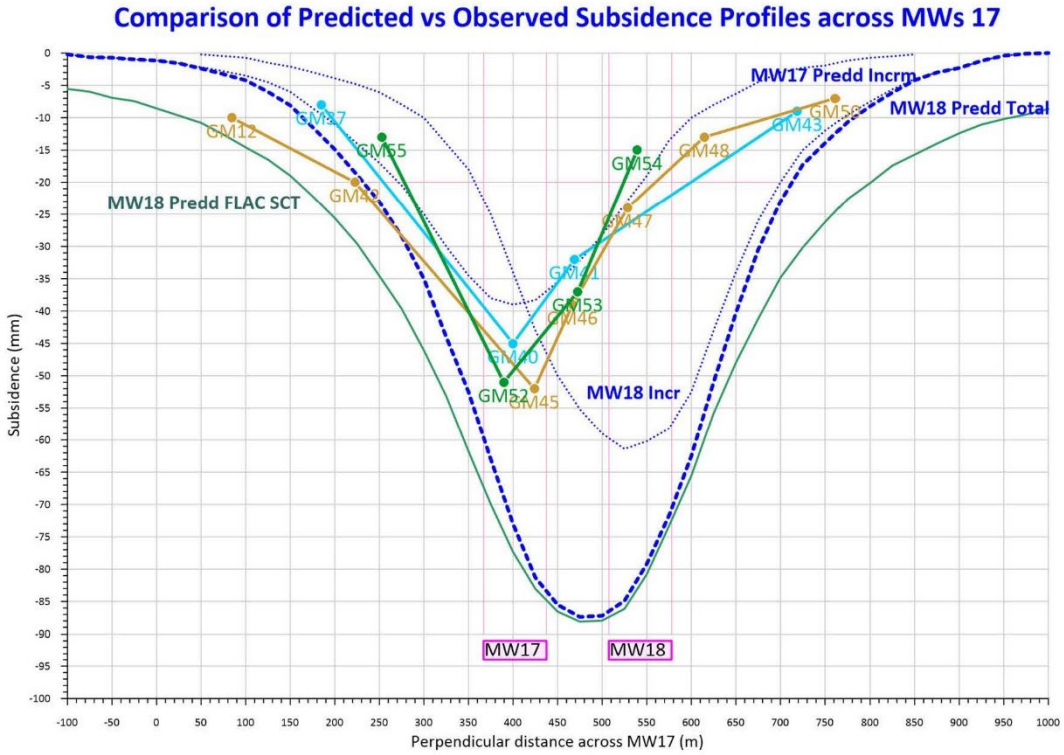
On 28 January 2025, DPHI provided formal approval for the commencement of secondary extraction within MW18, noting that:

- Subsidence resulting from MW 17 was slightly higher than predicted, due to the increased mining height, but remained within the tolerance range;
- The predicted maximum subsidence from MW18 would remain below the target maximum of 125 mm, with a suitable margin of tolerance; and
- Any subsidence impacts are expected to remain at low levels, consistent with the requirements of the development consent.

Figure 6-10 shows a comparison of predicted and observed subsidence profiles from:

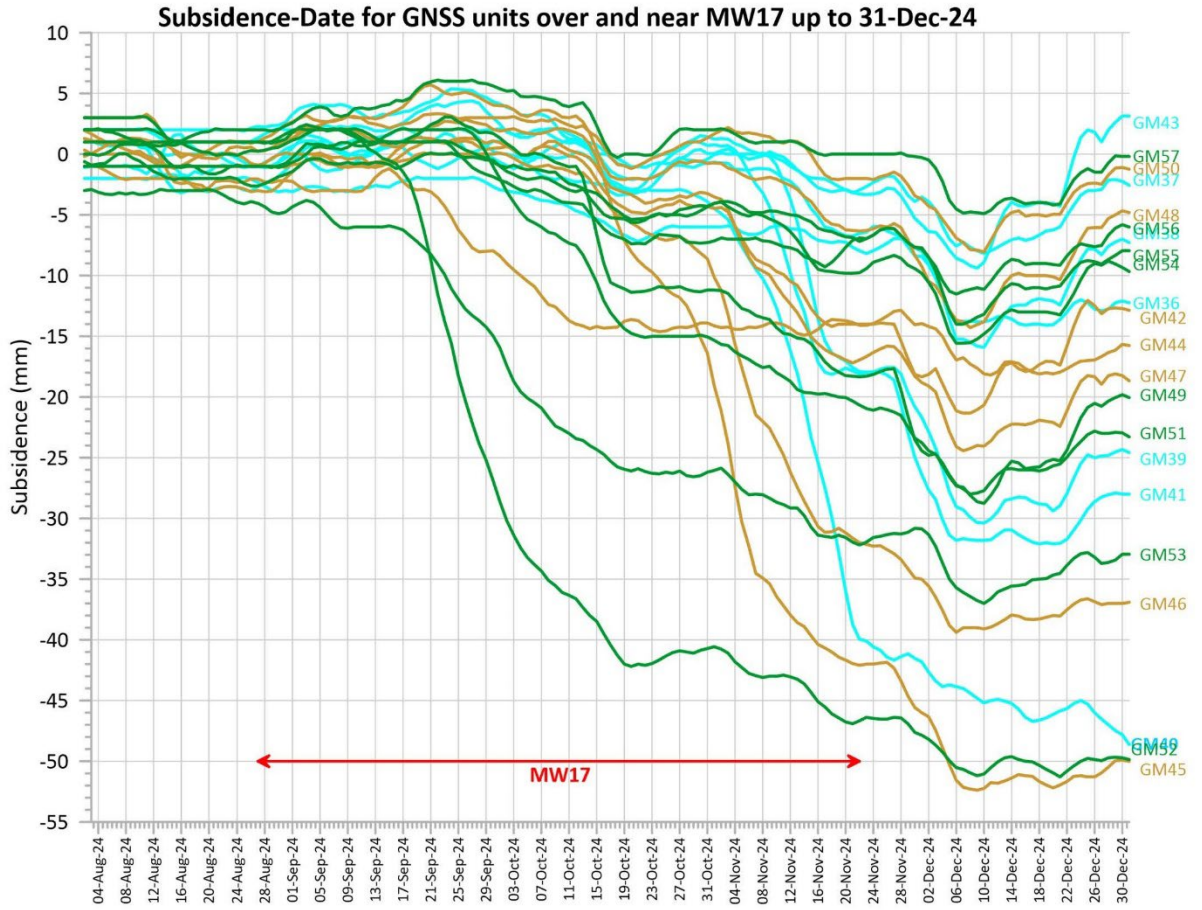
- Monitoring Line 1 (GM52, GM53, GM54, GM55);
- Monitoring Line 2 (GM42, GM45, GM46, GM47, GM48, GM50); and
- Monitoring Line 3 (GM37, GM40, GM41, GM43).

Daily vertical subsidence movements measured at Monitoring Line 1, 2 and 3 is shown on **Figure 6-11**. These time plots of observed subsidence confirm the very low levels of the monitored subsidence over MW17.



(Source: MSEC 2025)

Figure 6-10: Observed subsidence profiles after extraction of MW17



(Source: MSEC 2025)

Figure 6-11: Daily subsidence measurements at GNSS stations over MW17

Observed subsidence impacts

No subsidence impacts or environmental consequences beyond EIS predictions were identified during 2024.

Subsidence impact performance measures continue to be met (refer **Table 6-13**).

6.8.3 Comparisons against Predictions

The *Airly Mine Extension Project EIS* (Golders 2014) report predicted the maximum subsidence over the Panel and Pillar Mining Zone (PPMZ) areas of the mine, after the extraction of a 2.8 m thick seam, 61 m wide mini wall panel widths and 30 m chain pillars, would be less than 125 mm, tilts would be less than 2.5 mm/m and strains would be less than 2 mm/m.

It was assessed that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected. Subsidence reviews are undertaken as part of the Extraction Plan process. The following section compares predictions to the EIS, with reference to Extraction Plans for additional information.

Results discussed in **Section 6.8.2** demonstrate that subsidence within the Pt Hatteras Panel & Pillar Mining Zone (MW13-16) Extraction Plan and MW17-18 Panel & Pillar Mining Zone Extraction Plan areas is within the SCT modelled threshold values. These values are also consistent with the 2014 EIS predictions, which estimated maximum subsidence of less than 125 mm.

6.8.4 Long Term Analysis

Since the higher than predicted subsidence over MW02-12, Centennial Airly have implemented mine design revisions aimed to limit subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125 mm)

The monitored subsidence levels over MW13-MW16 and MW17 has now been shown to match the EIS predicted low levels of subsidence closely, no future surface cracking, rock falls, or cliffs falls are expected over the proposed new extraction panels with the wider chain pillars.

Table 6-14 shows the magnitudes of the maximum observed subsidence over each extraction plan area as each miniwall panel is extracted.

Table 6-14: Measured maximum total subsidence over the extracted miniwalls

Extraction Plan Area	Panel	Survey Date[1]	Panel Extraction End Date	Maximum Subsidence (mm)
Mt Airly (MW02-12)	MW2	7-Aug-2019	19-Aug-2019	38
	MW3	25-Oct-2019	5-Nov-2019	95
	MW4	31-Jan-2020	11-Feb-2020	186
	MW5	23-Apr-2020	8-May-2020	297
	MW6	22-Sep-2020	11-Sep-2020	548
	MW7	26-Nov-2020	1-Dec-2020	612
	MW8	23-Feb-2021	5-Mar-2021	655
	MW9	17-May-2021	12-May-2021	670
	MW10	27-Aug-2021	23-Aug-2021	680
	MW11	12-Oct-2021	12-Oct-2021	690
	MW12	10-Dec-2021	8-Dec-2021	713
	MW12 + 7 mths	27-Jul-2022		707
	MW12 + 13 mths	12-Jan-2023		727
	MW12 + 21 mths	2-Aug-2023		728
	MW12 + 25 mths	12-Jan-2024		744
	MW12 + 36 mths	10-Dec-2024		749
Pt Hatteras (MW13-16)	MW13	24-Mar-2022	24-Mar-2022	Approx. 44
	MW14	16-Dec-2022	16-Dec-2022	Approx. 75
	MW15A	12-Jun-2023	12-Jun-2023	Approx. 95
	MW16	31-Dec-2023	29-Jan-2024	Approx. 98
	MW15B	18-May-2024	27-Mar-2024	Poss. 110*
MW17-18	MW17	8-Jan-2025	22-Nov-2024	52
	MW18	Not commenced	Not commenced	N/A

Notes:
[1] Survey dates for Mt Airly refer to conventional survey of subsidence lines, whilst for Pt Hatteras and MW17-18 survey date reflects date that continuous data from the GNSS monitoring units was accessed.
** the maximum observed subsidence up to 31-Dec-24 was 104 mm, recorded at GM32. MSEC (2025) estimated curved subsidence profiles based on historical monitoring over panels with closely spaced survey pegs. These estimates determined that the maximum "possible" subsidence over MW13-16 is approximately 110 mm.*

6.8.5 Implemented / Proposed Improvements

It can be concluded from the monitoring results, that the FLAC model prepared by SCT accurately analyses the complex relationships between changing material properties, panel & pillar widths, seam thicknesses, number of panels extracted and varying depths of cover over the pillars.

This conclusion indicates Airly Mine have a reliable calibrated model for predictive purposes (within assumptions and limitations).

At these low subsidence values, no surface cracking, rock falls or cliff impacts are expected, and subsidence impact performance measures will continue to be met.

A draft MW19-22 Panel and Pillar Mining Zone Extraction Plan in the central Genowlan mountain area was submitted in December 2024. Consultation is on-going with plan to submit for approval by Q2 2025.

6.9 OTHER MATTERS

6.9.1 Waste

Airly Mine manages waste in accordance with Schedule 4, Condition 23 of SSD_5581, implementing measures to:

- minimise waste generation;
- Ensure appropriate storage, handling and disposal; and
- Monitoring and report on the effectiveness of waste minimisation and management measures in the Annual Review.

The major waste streams generated by the mine include water, packing materials, paper, cardboard, wood, waste oil, oil filters, air filters, oil drums, scrap metal, hoses, sewage effluent, as well as general putrescible rubbish.

Table 6-15 provides a summary of the waste recycled and disposed during the reporting period with a comparison of waste generated over the past 5 years.

During the reporting period, total offsite waste for Airly Mine was 520 tonnes, including:

- 389 tonnes disposed; and
- 131 tonnes recycled.

Waste generation increased by 149 tonnes (~40%) compared to 2023, primarily attributed to a large-scale scrap removal program, which contributed significantly to the overall waste volume. However, the majority of the waste from this project was recycled, resulting in a substantial increase in the recycling rate to 33%, compared to an average of approximately 15% in previous years.

There were no non-compliances at Airly Mine in relation to waste or sewage management during the 2024 reporting period.

Table 6-15: Waste Summary

	2020	2021	2022	2023	2024
Recycling					
Hazardous Recycled (Waste Oil, Oily Water / kL, Batteries, Oil Filters / tonnes)	8.062	9.970	18.455	21.262	17.845
Non-Hazardous Recycled (Paper & Cardboard, Scrap Steel / tonnes)	49.695	32.548	29.658	45.085	113.185
Total Waste Recycled	**57.757**	**42.518**	**48.113**	**66.347**	**131.03**
Disposal					
Hazardous Disposal (Oily Rags / tonnes)	5.744	3.654	-	5.512	9.776
Non-Hazardous Disposal (Mixed Solid Waste / tonnes)	311.084	294.295	290.525	298.680	248.316
Total Waste Disposal	**316.828**	**297.949**	**290.525**	**304.192**	**389.122**
Total Offsite Waste					
Waste recycled and disposed	**374.585**	**340.467**	**338.638**	**370.539**	**520.152**
Percentage Waste Recycled	*15.42*	*13.34*	*14.21*	*17.91*	*33.67*

6.9.2 National Pollutant Inventory

The National Pollutant Inventory (NPI) is a program for tracking and reporting pollution across Australia and ensuring that the community has access to information about the emission and transfer of toxic substances which may affect them locally administered by the Department Climate Change, Energy, the Environment and Water (DCCEEW) in accordance with the National Environment Protection (National Pollutant Inventory) Measure 1998 (as amended).

NPI reporting contains data on 93 substances that have been identified as important due to their possible effect on human health and the environment. Centennial Airly completed the NPI Report for the 23/24 reporting period for the Airly Mine on 30 September 2024. NPI data is available from the DCCEEW website.[16]

[16] https://www.dcceew.gov.au/environment/protection/npi

7 WATER MANAGEMENT

Airly Mine manages and monitors water in accordance with the *Airly Mine Water Management Plan* (GHD, 2024) (WMP). The WMP has been developed in accordance with Schedule 4, Condition 13 of SSD_5581 to address the relevant approvals and licensing requirements[17] through the completion of the following:

- Collation and review of existing information and studies relating to the operation of the water management system at Airly Mine.
- Establish an understanding of the water management system at the site.
- Categorise the existing conditions that are specific to water management requirements.
- Develop catchment plans for the site.
- Identify the clean and dirty water management systems.
- Undertake a review of the capacity of dirty water surface storages in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2* (DECC 2008).
- Determine the suitability of waterway conditions.
- Undertake a water quality assessment and review of existing water quality assessment criteria.
- Determine the future water management requirements.
- Review and develop water monitoring requirements.

During the reporting period, Airly Mine operated the water management system in accordance with the WMP. Monitoring and data review was undertaken in accordance with the WMP, SSD_5581 and EPL 12374 requirements.

A summary of water management and performance in the reporting period is provided in the following sections, including:

- **Section 7.1** – Details of water licensing and associated take
- **Section 7.2**– A summary of the review of the site water balance for the reporting period
- **Section 7.3**– A summary of surface water monitoring results for the reporting period, including:
    - Surface water quality and flow, including routine and discharge monitoring; and
    - Stream health monitoring, including watercourse stability and aquatic ecology.
- **Section 7.4** – A summary of groundwater monitoring results for the reporting period, including:
    - Groundwater levels and quality;
    - Underground mine transfers; and
    - Stygofauna monitoring.

Detailed annual monitoring and assessment reports for the reporting period are provided as appendices.[18]

[17] refer to Section 1.2 of the WMP for relevant approvals and licensing requirements.

[18] **Appendix 6** (annual water monitoring report), **Appendix 7** (biennial watercourse stability monitoring report), **Appendix 8** (annual aquatic ecology monitoring report), and **Appendix 9** (annual stygofauna monitoring report)

7.1 WATER LICENCES

Airly Mine currently holds two water access licences (WALs) under the *Water Management Act 2000* for the extraction of groundwater. A total of 278 ML is licenced for extraction from the Sydney Basin North groundwater source as part of the Water Sharing Plan (WSP) for the Greater Metropolitan Region Groundwater Sources, made up of WAL 24386 (158 ML/year) and WAL 36565 (120 ML/year). WAL 24386 licences the take of water from the production bore (water supply works approval 10WA112537), which is used to supplement water for use in mining activities. WAL 36565 licences the extraction of water from the underground workings to the Dirty Water Dam.

Table 7-1 provides a summary of water take and available water under water access licences for the water year ending during the reporting period (i.e., 1 July 2023 to 30 June 2024), not the calendar year.

Table 7-1: Water Licenses and Take

Licence	Water sharing plan, source and management zone	Entitlement (ML)	Passive Take/Inflow (ML)	Active Pumping (ML)	TOTAL (ML)
WAL24386 (Production Bore)	Greater Metropolitan Region Groundwater Sources Sydney Basin North groundwater source	158	Negligible	24.5	**24.5**
WAL36565 (Mine Inflows)	Greater Metropolitan Region Groundwater Sources Sydney Basin North groundwater source	120	Negligible	0	**0**

7.2 WATER BALANCE

A site water balance model was initially developed for Airly Mine as part of the *Airly Mine Extension Project EIS* (GHD, 2014a) to quantify transfers across the site under future operational conditions, considering various rainfall patterns. This model was updated in 2024 to reflect the current mine plan and operational conditions as part of the *2024 Water Assurance Reporting* (GHD, 2025e).

GHD (2025a) reviewed observed water flows at Airly Mine during 2024 and found:

- Rainfall/runoff is a major water resource at Airly Mine with approximately 113 ha captured by the water management infrastructure on site;
- Modelling suggests rainfall/runoff accounts for 76% of the total water inputs;
- Due to below-average rainfall in 2024, other inflows contributed a higher proportion to overall inflows, including:
    - Production bore extraction (~5%); and
    - In-situ coal moisture (~18%)
- The major outflows at Airly Mine included:
    - ROM coal moisture (entrained) (58.6%);
    - Evaporation (32.9%); and
    - Minor losses from dust suppression and sewage systems (3.7%).

The site water balance for the 2024 calendar year is presented in **Table 7-2**.

Table 7-2: Annual water balance – average existing conditions (2024)

Water Flow	Volume (ML/year)
Inputs	
Direct rainfall onto storages and catchment runoff	98
External potable water supply	2
Groundwater inflows into underground workings	0
Extraction from production bore	6
In situ coal moisture	23
Total Inputs	**129**
Outputs	
Evaporation	45
Dust suppression	5
Sewage to Ecomax effluent treatment system	3
Discharge through LDP001	0
Discharge through LDP002	0
Discharge through LDP003	0
Product coal moisture	80
Clean water diversions	4
Total Outputs	**137**
Change In Storage	
Surface water storages	-8
Underground workings	0
Total Change In Storages	**-8**
Balance	
Change In Water Inventory (Inputs – Outputs – Change In Storage)	**0**

7.3 SURFACE WATER

7.3.1 Environmental Management

Surface water monitoring is undertaken in accordance with the Airly Mine Water Management Plan, SSD_5581 and EPL 12374 requirements.

The site has also developed trigger action response plans (TARP) to identify and manage potentially adverse impacts, as well as assist with managing the site's surface water during storm events.

Surface water monitoring includes:

- Surface water flow (continuous)
- Surface water quality (monthly)

- Discharge water monitoring (event based)
- Nissen Hut Dam monitoring (monthly and continuous)
- Stream health, including:
    - Geomorphic condition and watercourse stability (every two years); and
    - Aquatic ecology (six-monthly).

The surface water monitoring sites are described in **Table 7-3** and shown on **Figure 7-1** and **Plan 2** (AM04123).

Table 7-3: Description of Surface Water Monitoring Locations

Monitoring Point	Description
LDP001	Correlates to EPL Monitoring Location 1, discharge from Discharge Dam into Airly Creek and includes continuous flow monitoring.
LDP002	Correlates to EPL Monitoring Location 7, discharge from 7ML Stockpile Dam into Airly Creek.
LDP003	Correlates to EPL Monitoring Location 8, discharge from Train Loader Dam into Airly Creek. EPL Monitoring Location 8.
Airly Creek	Water quality monitoring location situated on Airly Creek downstream of LDP001.
Airly Creek Upstream	Water quality monitoring location situated on a tributary of Airly Creek, upstream to the west of site Airly Creek site. This location is utilised as a 'background' representation.
Airly Tributary	Water quality monitoring location situated on a tributary of Airly Creek upstream of site Airly Creek site.
Gap Creek	Water quality monitoring location and continuous flow monitoring.
The Grotto	Water quality monitoring location located on Genowlan Creek.
Genowlan Creek	Water quality and continuous flow monitoring location located on Genowlan Creek.
Genowlan Creek 2	Water quality monitoring location and continuous flow monitoring situated on Genowlan Creek.
Various on-site storage dams	Located in pit top. Includes Production Dam, Stockpile Dam, Train Loader Dam, Dirty Water Dam, and Office Tank.
Nissan Hut Dam	Water level and water quality monitoring for the Pt Hatteras Panel & Pillar Mining Zone (MW13-16) Extraction Plan.

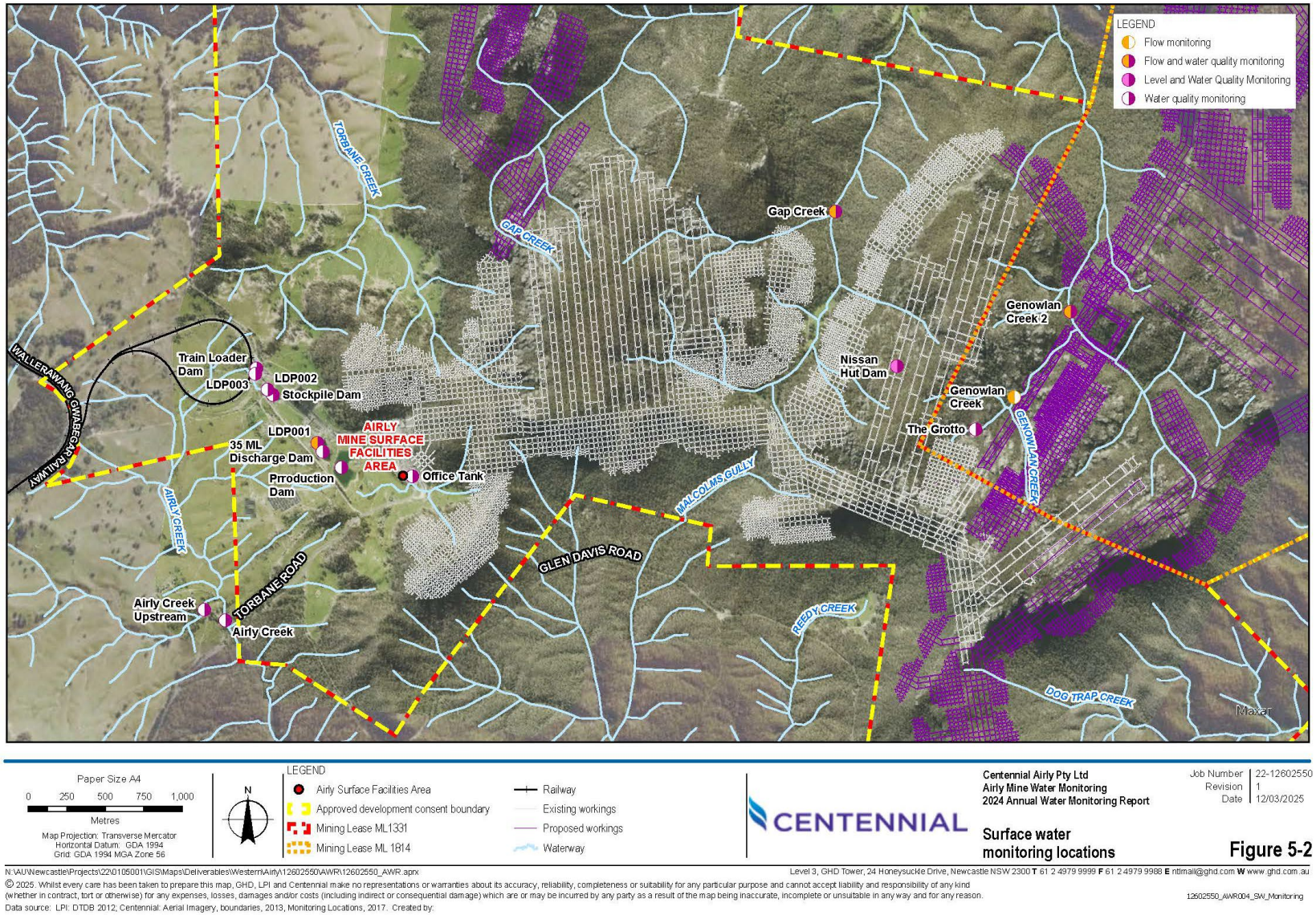


Figure 7-1: Surface Water Monitoring Locations (source: GHD, 2025a)

7.3.2 Environmental Performance

A summary of the key results and observations obtained from the 2024 surface water monitoring activities is provided below. A detailed report is provided in the *Airly Mine Water Monitoring 2024 Annual Report* (GHD, 2025a) (**Appendix 6**).

Surface Water Flow

Continuous flow monitoring is undertaken at Gap Creek and Genowlan Creek (at monitoring locations Gap Creek, Genowlan Creek and Genowlan Creek 2)[19]. A summary of creek flow at these monitoring locations is presented in **Figure 7-2**.

In Q1 2024, a Trigger Action Response Plan F2 (TARP F2) was developed within the WMP to assess potential changes in catchment characteristics and hydrologic runoff patterns that could be linked to site operations. The TARP F2 process was incorporated into the WMP for ongoing monitoring, where the calibrated baseline model is compared to observed streamflow data to detect deviations that could indicate changes in catchment behaviour.

Water flow assessment results from Q2-Q4 2024 confirmed no notable changes in hydrologic regimes at monitored locations, and no changes were attributable to site operations.[20]

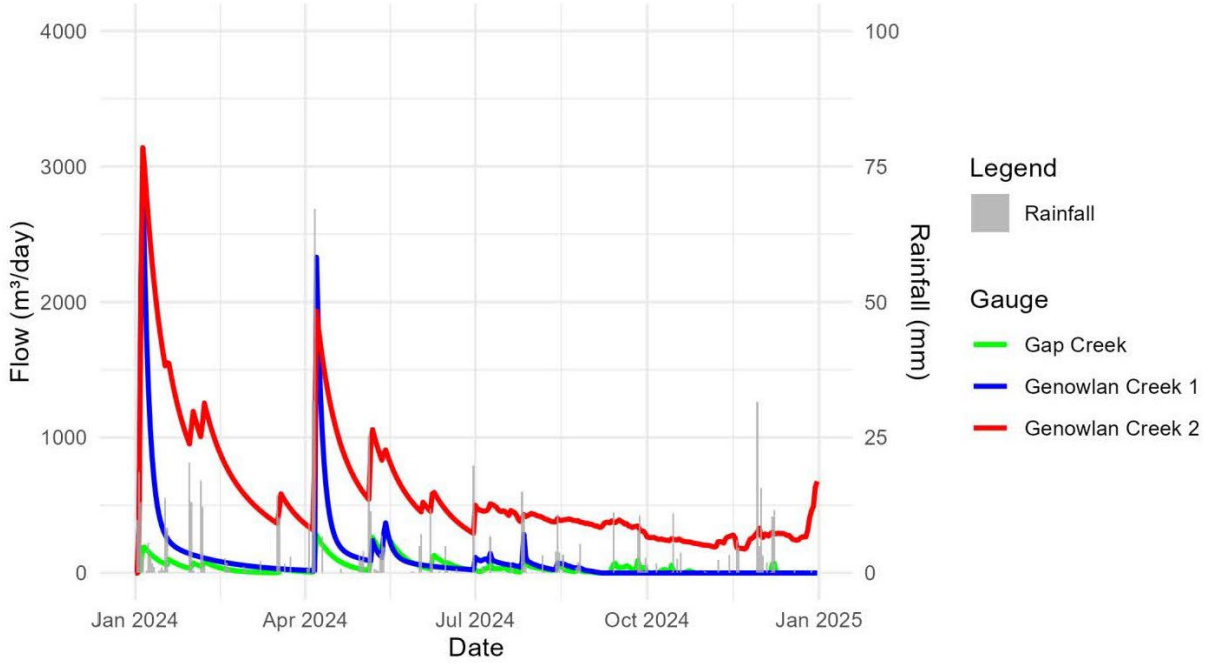


Figure 7-2: Observed flow and rainfall – 2024

Surface Water Quality

Surface water quality monitoring locations are sampled monthly[21]. Water quality data has been compared to site specific guideline values (SSGVs), trigger values reported in the WMP (GHD, 2024) and EPL12374 concentration limits.

A summary of the surface water monitoring locations and monitoring status for the reporting period is presented in **Table 7-4**.

[19] Note, continuous flow monitoring is also undertaken at LDP001 with volumes of water discharged presented in Section 7.3.2 (sub-heading Discharge water monitoring)

[20] see Section 5.1.2 in **Appendix 6**

[21] Exceptions to monthly sampling are noted in Table 7-4

Table 7-4: Summary of Surface Water Monitoring

ID	Sampling Comments	SSGV Exceedance	TARP Trigger
Creeks			
Airly Creek	No flow in June, sampled in all other months	Yes	No
Airly Upstream	No flow in February, March, June and November, sampled in all other months	Yes	Yes – refer **Table 7-5**
Airly Tributary	No flow throughout 2024 (January – December)	No	No
Gap Creek	Sampled monthly January and February, no flow in March, then sampled quarterly	Yes	Yes – refer **Table 7-5**
Genowlan Creek (The Grotto)	Sampled monthly to March, then sampled quarterly	Yes	Yes – refer **Table 7-5**
Genowlan Creek 2	Sampled monthly to March, then sampled quarterly	Yes	Yes – refer **Table 7-5**
Discharge Points			
LDP001	No discharge	No	No
LDP002	No discharge	No	No
LDP003	No discharge	No	No
Storage Dams			
Nissan Hut Dam	Sampled monthly to March, then sampled quarterly	NA	NA
Production Dam	Sampled in all months	NA	NA
Stockpile Dam	Sampled in all months	NA	NA
Train Loader Dam	Sampled in all months	NA	NA
Dirty Water Dam	Sampled in all months	NA	NA

SSGV trigger exceedances were identified at all creek monitoring locations, with exception for Airly Tributary which was not sampled throughout 2024 due to insufficient flow. For Airly Creek these exceedances were not sustained (i.e. not two consecutive monitoring events). Water quality was outside or above the SSGV or trigger values for two consecutive sampling events at Airly Upstream, Gap Creek, Genowlan Creek (The Grotto) and Genowlan Creek 2. As per the WMP (GHD 2024) TARP F2 for water quality, further review and investigations are required.

Table 7-5 provides a summary of the review and investigations required in accordance with the WMP (GHD 2024). A more detailed review of the results from 2024, including time series plots of historical water quality and SSGV trigger level exceedances at each of the surface water monitoring sites is provided in the *Airly Mine Water Monitoring 2024 Annual Report* (GHD 2025a) (refer **Appendix 6**).

Table 7-5: Summary of SSGV Assessment and Investigations – 2024

Location	Investigations
Airly Upstream	Airly Creek, Airly Upstream and Airly tributary are located within the Airly Creek catchment. These sites are monitored for impacts of off-site discharges. No discharges from Airly Mine occurred in 2024. The SSGV exceedances are unlikely to be due to mining-related activities.
Genowlan Creek (The Grotto) Genowlan Creek 2 Gap Creek	The Grotto, Genowlan Creek and Gap Creek are fresh waters of acidic to circumneutral conditions. Fluctuations in metal concentrations have resulted in temporal exceedances, but these appear to be naturally occurring. Water quality trends in the Grotto, Genowlan Creek and Gap Creek are also reflected in proximal alluvial bores. However, mining is not considered the cause of such hydrogeochemical changes, given: • The vertical separation (>100 m) between surface water and underground workings. • The natural recovery response to rainfall. • The chemistry, which is inconsistent with mine storage water and discharge quality. The cause of acidification remains uncertain, though it may result from aeration of reduced sediments exposed to drying and rewetting. However, mineralogical testing found no evidence of reactive sediments, leaving the mechanism unresolved.

Discharge Water Monitoring

Airly Mine has three licenced discharge points for releasing surplus water in accordance with EPL 12374. Condition L2.4 of EPL 12374 contains concentration limits that apply to any discharges from LDP001, LDP002 and LDP003, except when rainfall exceeds 44 mm in a consecutive 5-day period (EPL Condition L2.5).

No discharges from LDP001 (Production Dam), LDP002 (Stockpile Dam) or LDP003 (Train Loader Dam) occurred in 2024.

Nissen Hut Dam

Nissen Hut Dam is a local water source on Genowlan Mountain used for recreation and firefighting activities. There were no non-compliances relating to monitoring at the Nissen Hut Dam in the 2024 reporting period.

Water levels in the dam have been monitored since May 2022 to assess potential groundwater connection and subsidence impact subsequent to undermining in accordance with the requirements of the Subsidence Monitoring Program for the Pt Hatteras Panel and Pillar Mining Zone (MW13-16) Extraction Plan.

Evidence to date from adjacent groundwater standpipe ARP16 indicates no connection between the surface water and groundwater at this location.

Stream Health

There were no non-compliances relating to aquatic ecology or stream health in the 2024 reporting period. A summary of the stream health monitoring undertaken at Airly Mine in 2024, including aquatic ecology monitoring is provided below, for full details refer to **Appendix 7** and **Appendix 8**.

Geomorphic condition and watercourse stability

SSD_5581 requires the development of a Water Management Plan (WMP), including a program to monitor and report on the "geomorphology of the watercourses potentially affected by the development within and immediately outside of the site". The WMP (GHD 2024) states that watercourse stability monitoring is undertaken on third order streams within and immediately outside the site boundary (subject to access requirements) every two years; including Airly Creek, Gap Creek, Genowlan Creek and Dog Trap Creek.

The methods for watercourse stability monitoring undertaken at Airly Mine include:

- Watercourse stability inspections
    - Visual monitoring of the watercourses was carried out by suitably qualified professionals to identify any instabilities that could form as a result of mining operations and general geomorphic condition.
    - The results of this monitoring were compared with the baseline data collected during the *Airly Mine Extension Project* (GHD 2014) and previous biennial monitoring results (which been conducted since 2020).
    - The visual inspection methodology for the assessment does not include quantitative measurements of stream gradient.
- River Styles assessment
    - The River Styles® framework (Brierley and Fryirs 2005) is a river characterisation process that allows interpretation of river form and behaviour from which appropriate management approaches can be formulated.
- Geomorphic condition assessment
    - Categorisation of geomorphic condition following the methods of Outhet and Cook (2004), and Brierley and Fryirs (2005).
    - This categorisation provides an indication of the degree of alteration that reaches within the tributaries have experienced, and the likely response of these reaches to changes in flow rates and durations.

Key findings of the assessment (GHD, 2025b) (**Appendix 7**) were:

- Watercourse stability monitoring was undertaken at Airly Mine between 5 and 8 November 2024.
- River Styles of all assessed creek reaches remain consistent with baseline assessments from the *Airly Mine Extension Project* (GHD, 2014).
- No changes to River Styles were observed in Airly Creek, Gap Creek, Genowlan Creek and Dog Trap Creek
- Airly Creek:
    - Geomorphic condition was mostly moderate, with poor condition reaches identified, associated with active headcuts.
    - Minimal migration of headcuts has been observed since 2020-2022, and instream rock armouring remains intact.
    - In 2024, dense macrophyte coverage (*Typha sp.*) impeded channel visibility, but no additional erosion was observed.
- Gap, Genowlan and Dog Trap Creeks:
    - Geomorphic condition was good, except for an upstream section of Gap Creek (east arm) where land clearing (unrelated to mining) has resulted in the

channelisation of a narrow valley of fine-grained sediments, and historical widening of the channel to create a dam.
    - Minor localised erosion at the dam spillway remains unchanged from previous surveys.
    - These creeks are characterised by confined, bedrock-controlled valley settings, which are geomorphologically stable and subject to only slow rates of change, presenting low risk for impacts related to subsidence.
    - No evidence of bedrock fracturing or subsidence-related impacts was observed.
- Overall, based on the visual assessment undertaken, there is no evidence of exceedances of the stream health performance criteria for geomorphic condition and watercourse stability, as presented in the WMP (GHD, 2024).

The next site inspections to assess geomorphic condition and watercourse stability will be undertaken in 2026.

Aquatic ecology

Aquatic ecology monitoring has been undertaken biannually since spring 2015 within waterways with the potential to be impacted by Airly Mine. GHD conducted autumn 2024 monitoring between 21 and 23 May 2024, and spring 2024 monitoring between 5 and 8 November 2024. The monitoring program involves assessment of seven sites, consisting of:

- Airly Mine Subsidence Sites (5):
    - Baseline Sites (3): Monitor natural conditions unaffected by mining.
    - Potentially Influenced Sites (2): Located where headwaters have been undermined by second workings, assessing changes or potential impacts from mining-induced subsidence.
- Airly Mine Discharge Sites (2):
    - Airly Creek Upstream (AIRUS): Measures natural conditions prior to mine influence.
    - Airly Creek Downstream (AIR): Evaluates potential impacts from licensed discharge points (LDPs).

Macroinvertebrate, water and sediment samples were collected from each site in autumn 2024, however, dry conditions in spring 2024 meant that macroinvertebrate samples were not able to be collected from Gap Creek. Instream habitat surveys were also undertaken in autumn and spring 2024 noting the coverage and condition of riparian and instream vegetation through completion of the RCE inventory (Peterson 1992).

The key findings of the assessment (GHD, 2025c) (**Appendix 8**) were:

- Water Quality and Discharges
    - No discharges from Airly Mine into Airly Creek in 2024, therefore no impacts to water or sediment quality due to discharges.
    - Few elevated toxicant concentrations were observed at impact site AIR, with minimal expected impact on aquatic organisms. Key observations:
        - Dissolved zinc toxicity mitigated by elevated water hardness.
        - Low-level arsenic exceedance (below 95% species protection value) suggests impact only to highly sensitive species.

    - More toxicant exceedances at background site AIRUS than at impact site AIR, indicating greater likelihood of biological impacts at AIRUS.
    - Historical data shows dissolved metals (cobalt, manganese, nickel, zinc) have been consistently elevated at AIR & AIRUS, particularly in dry conditions without mine discharges.
    - Higher salinity and major ion concentrations are observed at low altitude sites (Airly Creek, Torbane Creek and Dog Trap Creek) compared to higher altitude sites (Genowlan and Gap Creeks), likely due to historical land clearing, agricultural landuse, and saline groundwater influence from marine-deposited geology (on Airly Creek).
- Sediment Quality
    - Sediment quality has been consistently good at all sites except background site AIRUS across the historical monitoring period, with very few exceedances of the DGVs observed.
    - Only one exceedance recorded (nickel at AIRUS in autumn 2024).
    - Nickel concentrations at AIRUS show a decreasing trend compared to historical results.
- Macroinvertebrate Community Condition
    - There is no evidence of mine-related impacts to macroinvertebrate communities in 2024.
    - Macroinvertebrate community condition in 2024 reflected local site conditions, including lower water levels, reduced flow, overgrowth of algae, and land use practices.
    - Pristine, higher altitude sites (Gap and Genowlan Creeks) had similar communities, which contrasted to the macroinvertebrate communities at low altitude sites (Airly Creek, Torbane Creek and Dog Trap Creek).
    - Despite drying conditions influencing the water quality and water and habitat availability, the macroinvertebrate community at AIR was in a similar or better condition than AIRUS in 2024.
    - No evidence of impacts to flows in Gap Creek following the undermining of its headwaters, or any evidence of impacts to the macroinvertebrate community of Torbane Creek (TOR) or Gap Creek (GAP) due to undermining.

The next round of aquatic ecology monitoring will be conducted in autumn 2025.

7.3.3 Comparison against Predictions

Surface water related predictions during the operation of the Project were outlined in the *Airly Mine Extension Project EIS* (GHD, 2014a) and summarised within the water management performance measures as required by Schedule 4, Condition 12 of SSD_5581.

It is noted, surface impacts were not predicted in the *Airly Mine Extension Project EIS* (GHD 2014a), however surface subsidence fracturing has been observed at Mt Airly and are potentially associated with mining within the panel and pillar area in 2020 and 2021. These subsidence impacts were assessed in the Surface Water Subsidence Impact Assessment (GHD, 2022) which indicates there is no evidence of subsidence related impacts to surface water flows at the gauged locations, post mining. In addition, there have been no adverse impacts predicted for these hydrological or hydraulic conditions of catchments or waterways.

The results obtained from the surface water monitoring program, inclusive of surface water flow, quality, discharge water quality and volume monitoring, Nissen Hut Dam potential

subsidence effects monitoring and stream health monitoring, during the reporting period are compliant with the performance measures of SSD_5581 and generally in accordance with the predications made in the *Airly Mine Extension Project EIS* (GHD, 2014a), therefore current management measures are considered adequate.

7.3.4 Long Term Analysis

Long-term analysis of surface water monitoring is undertaken in the detailed annual monitoring and assessment reports for the reporting period (provided as appendices). Based on the information reported, the results of the surface water monitoring are generally in accordance with the predications made in the *Airly Mine Extension Project EIS* (GHD, 2014a) and approved for the project.

7.4 GROUNDWATER

7.4.1 Environmental Management

Groundwater monitoring is undertaken in accordance with the Airly Mine WMP and SSD_5581 requirements.

Groundwater related monitoring is comprised of the following:

- **Groundwater levels and quality**, including**:**
    - **Vibrating Wire Piezometers** – Monitoring of deep aquifer water pressures via vibrating wire piezometers (VWPs) at five locations (excluding ARP01, ARP02A, ARP03 and ARP08 which became dysfunctional between 2018 and 2023).
    - **Groundwater aquifer levels and quality** – Monitoring of water levels and quality in alluvial, Narrabeen Sandstone and Permian aquifers from eight standpipe piezometers (excluding ARP07 which has been dry since July 2013, ARP08 which has been mined through, and ARP16, which has been dry since installation in December 2021).
- **Private bore groundwater quality** – Monitoring water quality of three private production bores.
- **Groundwater seepage** – Monitoring of groundwater seepage flows at Village Spring and in mine workings.
- **Stygofauna monitoring** – for stygofauna in six monitoring bores.

The groundwater monitoring sites are shown on **Figure 7-3** and **Plan 2** (AM04123).

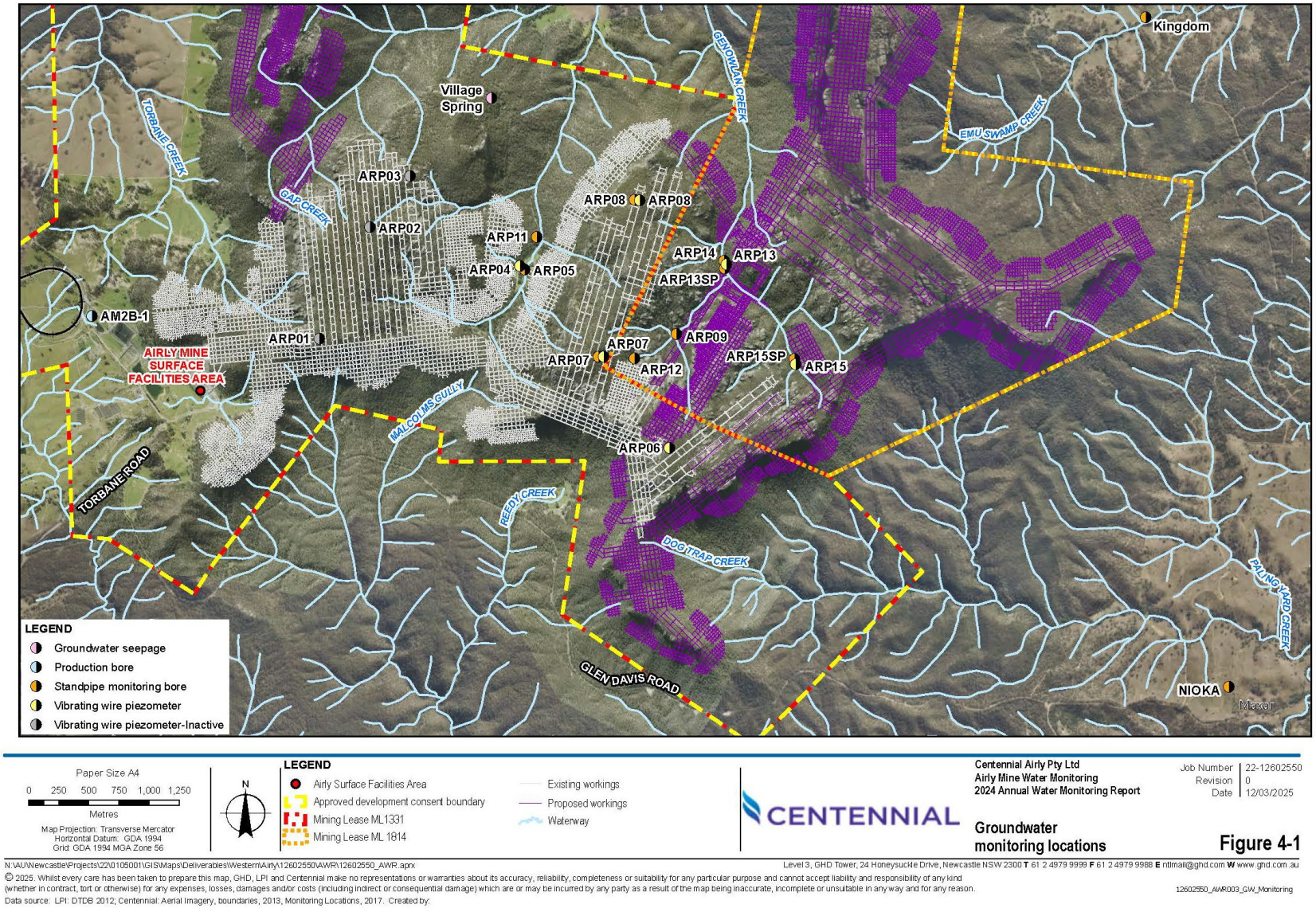


Figure 7-3: Groundwater Monitoring Locations (source: GHD, 2025a)

7.4.2 Environmental Performance

A detailed summary of the 2024 groundwater monitoring activities is provided in the *Airly Mine Water Monitoring 2024 Annual Report* (GHD, 2025a) (**Appendix 6**). Key findings confirm that groundwater trends remain consistent with historical observations, with no unexpected mining-related impacts identified.

Groundwater Levels

Vibrating Wire Piezometers

Overall, groundwater pressure trends in 2024 are similar to those reported between 2013 and 2023 (and reported in the EIS), confirming that changes in groundwater pressures align with expected mining-related dewatering and broader regional trends, with no evidence of unexpected mining-related impacts.

Several monitoring locations within the Permian Coal Measures have become dysfunctional, likely due to matrix shifts from subsidence, particularly beneath Mount Airly (ARP01, ARP02A and ARP03). However, where functioning (ARP06 and ARP07), monitoring records indicate the Middle River Seam has historically been dry or exhibited fluctuating pressures, following an overall decreasing trend. Fluctuations may reflect percolating recharge in localised areas. ARP07 remains dry, indicating that this aquifer is not continuous throughout the strata. All monitoring points in the Irondale Seam have been lost, except ARP06, which has remained dry long-term (since 2013).

The Lithgow Seam and Marrangaroo Formation show overall decreasing groundwater pressure trends, albeit monitoring locations have become largely compromised. Minor decreases in groundwater pressure observed in the Lithgow Seam at ARP13 and ARP15, are consistent with expected dewatering effects from mining.

Regional aquifers in the Shoalhaven and Devonian (ARP04, ARP13 and ARP15) continue to show decreasing groundwater trends. ARP13 has recorded levels below its trigger value since November 2019, a trend that continued through 2024. However, recent monitoring shows stable pressures with no net change. Similarly, ARP15 recorded decreases in 2024. Observed decreases are attributed to regional influences such as groundwater abstraction and drying climate effects rather than mining activity.

Standpipe Groundwater Levels

Hydrographs for alluvial groundwater locations ARP05, ARP09, ARP11, ARP12 and ARP14; and fractured and porous rock groundwater locations ARP07SP, ARP13SP and ARP15SP are shown in **Appendix 6**.

Alluvial monitoring locations demonstrated expected wetting and drying cycles, with upper catchment locations (e.g., ARP09 and ARP12) responding more directly to rainfall, while lower catchment locations (e.g., ARP14) exhibited greater stability, supported by a larger underlying aquifer. ARP05 continued its historical pattern of only recording water levels following above-average rainfall, fluctuating following average rainfall events in Q3 and Q4.

In the upper Permian strata (ARP11 and Village Spring) groundwater levels and flows remain responsive to rainfall. Continued recovery at ARP11 (since 2020) indicates that this stratum has not been adversely impacted by mining activity in the lower seam.

In the Narrabeen Sandstone, ARP07SP has been dry since installation in July 2013 and remained dry throughout 2024, reinforcing that this aquifer is not continuous throughout the strata. ARP15SP remained relatively stable above the trigger value throughout 2024, confirming no adverse mining impacts.

A decrease in groundwater levels was recorded at ARP13SP in the Lithgow Seam, aligning with expected dewatering effects from mining and mirroring the pressure trends observed in the VWPs.

Groundwater Quality

Groundwater quality results for 2024, along with historical records, are presented in **Appendix 6**, with corresponding trigger values as defined in the WMP (GHD 2024). Groundwater quality monitoring in 2024 recorded numerous exceedances of water quality trigger values across the network, with low pH and elevated manganese, nickel, and zinc being the most common. These trends align with historical patterns and broader climatic influences, and do not indicate any unexpected impacts from mining activities.

Alluvial locations generally exhibit fresh and acidic conditions, with pH ranging from 5 to 6, but dropping to approximately 4 at ARP12. Metal signatures varied between locations, suggesting discontinuous water storage within alluvial sediments. The presence of freshwater conditions is attributed to rainfall recharge, which may also be potentially contributing to acidification. Importantly, the historical recovery of alluvial groundwater levels in response to rainfall events supports the conclusion that these systems are not being influenced by mining-induced subsidence.

Monitoring in the Permian Coal Measures, at ARP11 and Village Spring, exhibit brackish water, though pH varies, with ARP11 tending toward acidic conditions (6.3–6.5) and Village Spring historically alkaline (8), now trending toward neutral (7). The distinct characteristics between these sites support the conclusion that they are sourced from disconnected water bodies. Both waters show elevated levels of nickel and zinc. Lead is also elevated in ARP11 and as is manganese in Village Spring.

In the Narrabeen Sandstone (ARP15SP), groundwater is fresh and continuing to freshen, indicative of rainfall recharge. Water remained slightly acidic (pH 6–7), with elevated manganese, nickel, and zinc. The recovery of groundwater levels in response to rainfall supports the conclusion that water quality changes at this location are more likely due to drying climatic conditions and rewetting cycles rather than mining.

Groundwater in the Lithgow Seam (ARP13SP) remains fresh with low pH (4–6). Elevated iron, manganese, nickel, and zinc levels have been recorded over the past two years, correlating with increased occurrences of low pH. However, trends in manganese, nickel, and zinc appear to be declining, while iron concentrations continue to rise.

Private Bore Groundwater Quality

Groundwater quality monitoring for three private production bores—Nioka, Kingdom, and GW800787—was undertaken in accordance with the monitoring commitments in the Statement of Commitments of SSD_5581.

Groundwater quality results for 2024, along with historical records, are presented in **Appendix 6**, with corresponding trigger values as defined in the WMP (GHD 2024).

Groundwater quality in all bores was generally slightly alkaline and slightly brackish, consistent with natural background conditions. While isolated exceedances of some parameters (such as nickel, iron, manganese, and zinc) were recorded, no concerning trends were identified, and these are considered to reflect natural variability rather than any mining influence.

Groundwater Seepage

Village Spring

The rate of seepage of groundwater from the Permian strata at Village Spring has been monitored continuously using a tipping bucket flow gauge and data logger since February 2011. Continuous flow was observed throughout 2024 except September reflective of rainfall.

Figure 7-4 presents the daily groundwater seepage rates. The average seepage rate for 2024 was 11.96 kL/day, with a minimum recorded flow rate of 6.83 kL/day on 28 November 2024 and a maximum flow rate of 20.22 kL/day on 5 April 2024. The observed decrease in flow rates throughout 2024 aligns with the CRD trend.

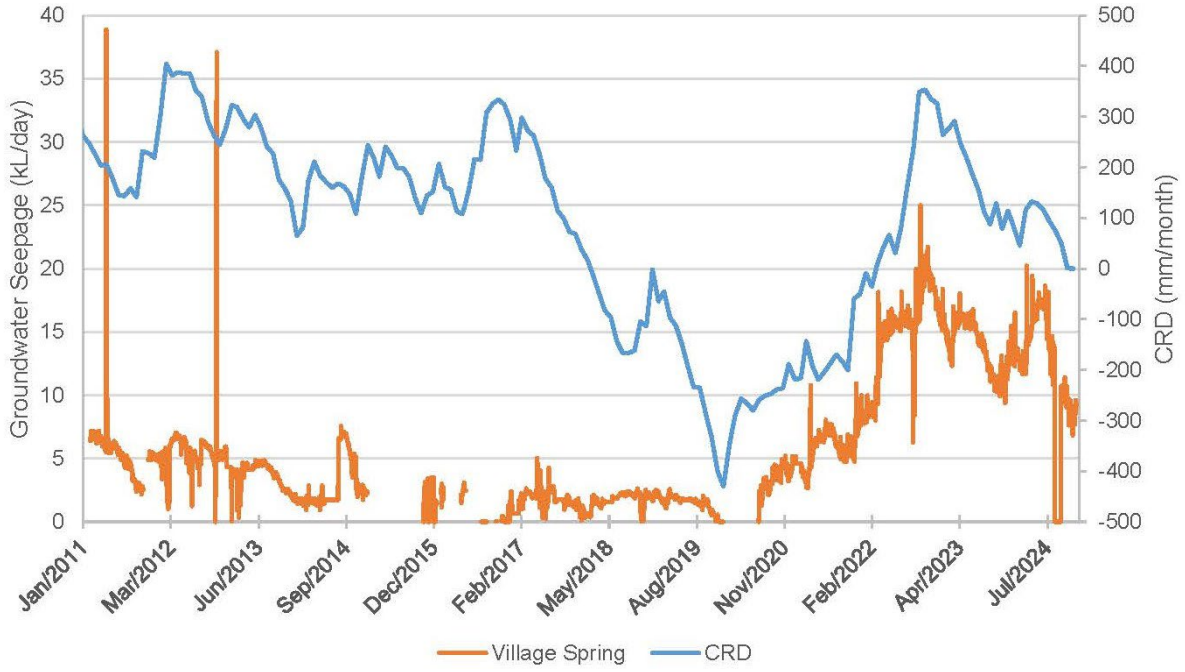


Figure 7-4: Recorded flows at Village Spring

Underground Workings

The hydrogeological model for Airly Mine (GHD, 2025f) predicted <2 m^3/day groundwater inflows to the mine void to date. These inflows would not be measurable, largely occurring in increased coal moisture and would not have required transfer via pumping to the surface facilities area. Consistent with the prediction, no measurable groundwater inflow occurred.

Groundwater inflow is predicted to significantly increase from 2024 as mining progresses to the northeast under Genowlan Mountain where saturated conditions are anticipated. Modelling predicts inflows to peak at approximately 130 m^3/day by 2028.

Stygofauna Monitoring

Stygofauna monitoring was conducted in accordance with Schedule 4, Condition 13 of SSD_5581, which requires a program to monitor and report on stygofauna and hyporheic fauna. The WMP (GHD, 2024) details that sampling is to be conducted annually, using suitable groundwater bores.

Monitoring was completed in May 2024. No non-compliances were recorded in the 2024 reporting period. A summary of the stygofauna monitoring undertaken at Airly Mine in 2024 is provided below, for full details refer to **Appendix 9**.

Since 2016, ten rounds of stygofauna sampling have been undertaken, with a consistent annual program in place since 2018 across six bores (ARP05, ARP09, ARP11, ARP13SP, ARP14, ARP15SP). Monitoring results indicate that stygofauna populations fluctuate in response to groundwater availability, which in turn reflects climatic conditions rather than mining activity. A summary of the stygofauna monitoring since 2018 is presented in **Table 7-6**.

Table 7-6: Obligate Stygofauna (and total animal abundance) collected at Airly Mine

Sample Date	Gap Creek		Genowlan Creek			
	ARP05 *(Alluvial)*	ARP11 *(Sandstone)*	ARP09 *(Alluvial)*	ARP14 *(Alluvial)*	ARP15SP *(Sandstone)*	ARP13SP *(Lithgow Seam)*
Nov-18 (Spring)	-	1 (2)	-	-	-	-
Mar-19 (Autumn)	-	-	-	-	1 (3)	-
Oct-20 (Spring)	-	-	1 (9)	1 (42)	3 (35)	*1 (2)*[a]
Apr-21 (Autumn)	1 (1)	-	1 (6)	2 (7)	3 (29)	-
Aug-22 (Winter)	2 (2)	-	-	2 (24)	1 (2)	-
Oct-23 (Spring)	2 (9)	0 (1)	-	1 (7)	-	-
May-24 (Autumn)	3 (25)	0 (8)	1 (8)	2 (10)	-	-

Notes:
[a] ARP13SP is not prospective for stygofauna as it is deeper than 50 m (approximately 73 m). As ARP13SP is not prospective for stygofauna due to its depth, it was theorised that the individuals may have been transferred to the ARP13SP sample from another bore. The monitoring methods were altered in 2021 to eliminate the possibility of sample contamination. No animals were collected from ARP13SP in April 2021, August 2022, October 2023, or May 2024 despite stygofauna being collected from other bores, which supports the theory of cross-contamination (GHD, 2025d).

In May 2024, stygofauna were collected from ARP05, ARP09, and ARP14—three shallow alluvial bores with low salinity (<150 µS/cm) and strong connectivity to nearby surface waterways. The richness and abundance observed in 2024 were higher than in October 2023 and are more consistent with results from 2020 to 2022, suggesting that the wetter conditions in early 2024 supported increased stygofauna activity.

No stygofauna were collected from ARP15SP in May 2024, consistent with October 2023 sampling. While this bore previously supported stygofauna (2019–2022), a declining trend has been evident since October 2020, which appears to correlate with lower groundwater levels due to dry conditions. Slight recovery of groundwater levels between January and May 2024, was insufficient to restore stygofauna presence, likely reflecting either continuing effects of lower rainfall or natural patchiness in distribution.

ARP11 showed the presence of One family (eight individuals) of edaphobite (i.e. soil dwelling fauna), consistent with findings from 2023. However, true stygofauna have not been recorded at this site since 2018, possibly due to elevated salinity and turbidity following its re-wetting in 2021 after an extended dry period. Water levels at ARP11 have been increasing and may support stygofauna returning to this bore.

No stygofauna were collected from ARP13SP in May 2024. ARP13SP is considered not prospective for stygofauna due to its depth (>70 m) and location within the Lithgow Seam, and this was supported by the absence of stygofauna in this bore.

Overall, monitoring results show that stygofauna are prevalent in shallow alluvial and sandstone aquifers, with presence largely governed by natural hydrological variability. The observed fluctuations in stygofauna richness and abundance align closely with rainfall trends and groundwater level responses, particularly in bores such as ARP05, ARP09, and ARP14. Importantly, no stygofauna have been observed in bores affected by mining (e.g., ARP13SP), and no stygofauna-bearing aquifers have shown evidence of mining-related impacts.

As outlined in the approved Extraction Plans, the risk of surface cracking or groundwater drawdown in shallow aquifers is low, and findings from the 2024 monitoring period support the conclusion that Airly Mine operations are not impacting stygofauna or the aquifers that support them.

7.4.3 Comparisons against Predictions

Groundwater related predictions during the operation of the Project were outlined in the *Airly Mine Extension Project EIS* (GHD, 2014b) and summarised below:

- All predicted groundwater impacts are limited to the Project Application Area.
- No high priority GDEs or other groundwater users (either holders of Water Access Licences or users under basic landholder rights) have been identified within the area of groundwater impact.
- No groundwater impacts are predicted to occur within World Heritage Areas, including the Gardens of Stone National Park.
- Groundwater extraction and interception from the Sydney Basin North groundwater source over the life of the Project (proposed conditions) is predicted to peak at 180 ML/year (50th percentile) or 199 ML/year (90th percentile).
- The Project will be able to operate in accordance with the rules of the Sydney Basin North groundwater source.
- The operation of the production bore is not expected to result in any drawdown in the Shoalhaven Group aquifer.
- Depressurisation throughout most of the Narrabeen Sandstone is expected to be negligible (not measurable), although some minor depressurisation may occur at the interface between the Narrabeen and Permian strata.
- Panel and pillar mining will not be undertaken below the Grotto and Oasis areas, avoiding potential depressurisation and reductions in baseflow in these areas.
- Predicted groundwater drawdown within the Gap Creek and Genowlan Creek alluvium as well as the baseflow reduction was mitigated via a restriction of mining in the Shallow Zone so that there is no mining beneath Gap Creek and Genowlan Creek (and to a distance of 20 m from the creeks) where the depth of cover is less than 40 m.

The results obtained from the groundwater monitoring program during the reporting period are generally in accordance with the predications made in the *Airly Mine Extension Project EIS* (GHD, 2014b), therefore current management measures are considered adequate.

7.4.4 Long Term Analysis

Long-term analysis of surface water monitoring is undertaken in the detailed annual monitoring and assessment reports for the reporting period (provided as appendices). Based on the information reported, the results of the groundwater monitoring are generally in accordance

with the predications made in the *Airly Mine Extension Project EIS* (GHD, 2014b) and approved for the project.

7.5 IMPLEMENTED / PROPOSED IMPROVEMENTS

On 22 March 2024, Airly Mine received DPHI approval for Revision 9 of the WMP (GHD, 2024). Further updates to the regulator-endorsed WMP were undertaken during 2024, with Revision 10 (*draft*), prepared to consider the outcomes of the updated groundwater model (GHD, 2025f) and the proposed MW19-22 Extraction Plan. Revision 10 will be finalised and submitted to DPHI for approval in 2025.

The monitoring program in the WMP will continue to be implemented at Airly Mine.

Continued monitoring at groundwater monitoring sites ARP09, ARP12 and ARP14 and surface water monitoring sites Genowlan Creek 2 and The Grotto will inform further investigations of the identified trends in pH and some dissolved metals (iron, manganese and zinc) within Genowlan Creek / Genowlan Creek Alluvium to support further investigation of the hydrogeochemical changes which are considered naturally occurring and unlikely to be due to mining-related activities, however the cause remains uncertain.

8 REHABILITATION

Airly Mine manages rehabilitation in accordance with the Rehabilitation Management Plan (RMP), which was prepared in accordance with the NSW Resources Regulator (NSW RR) Form and Way-Rehabilitation Management Plan for Large Mines (NSW RR, July 2021). The RMP is a requirement under the Mining Regulation 2016 and was originally submitted via the NSW RR Portal on 29 July 2023, and most recently updated on 19 December 2023.

The RMP was developed to meet the requirements of SSD_5581 (Conditions 25, 26, 27B and 27C in Schedule 4), and satisfies the obligations under ML1331 and ML1814. It describes the management of rehabilitation at Airly Mine and is publicly available on the Airly Mine website[22].

On 6 June 2024, a draft Airly Mine Rehabilitation Strategy, prepared in accordance with Schedule 4, Condition 27 of SSD_5581, was submitted to relevant stakeholders for consultation. Feedback received will be incorporated into the final version of the strategy, which is scheduled for submission in 2025.

This section addresses the annual rehabilitation reporting requirements for the Annual Review as required by Schedule 6, Condition 11 of SSD_5581.[23]

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD

8.1.1 Summary of Rehabilitation

Table 8-1 below provides an overview of the rehabilitation status for Airly Mine, including a summary of the previous, current, and projected reporting periods. Airly Mine did not complete any rehabilitation within the 2024 reporting period. The disturbance footprint of Airly Mine remained at 56.65ha during the reporting period.

Table 8-1: Rehabilitation Status

Mine Area Type	Reporting Period		
	Year 2023 (ha) (Actual)	Year 2024 (ha) (Actual)	Year 2025 (ha) (Forecast)
A. Total mine footprint[1]	57.63	57.63	57.63
B. Total active disturbance[2]	56.65	56.65	56.65
C. Land being prepared for rehabilitation[3]	0	0	0
D. Land under active rehabilitation[4]	0.98	0.98	0.98
E. Completed rehabilitation[5]	0	0	0

Notes:
*[1] **Total Mine Footprint:** includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands. Please note that subsidence remediation areas are excluded.*
*[2] **Total Active Disturbance:** includes all areas requiring rehabilitation.*
*[3] **Land being prepared for rehabilitation:** includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development.*
*[4] **Land under active rehabilitation:** includes areas under rehabilitation and being managed to achieve relinquishment – includes 'ecosystem and land use establishment' and 'ecosystem and land use sustainability.*
*[5] **Completed rehabilitation:** requires formal sign off from DRE that the area has successfully net the rehabilitation land use objectives or completion criteria.*

[22] www.centennialcoal.com.au/operations/airly/
[23] Annual reporting requirements in the RMP, and relevant Mining Leases, is also reported in the Annual Rehabilitation Report (ARR) and Forward Program (FWP) and submitted using the online form accessible via the NSW RR mine rehabilitation portal.

Airly Mine will conduct rehabilitation works in accordance with the approved Rehabilitation Management Plan (RMP) at the completion of life-of-mine operations. Due to the nature of Airly Mine, there is limited opportunity for any progressive rehabilitation to occur prior to the cessation of life-of-mine operations.

There are no areas of land available to be rehabilitated as all areas of the active disturbance footprint are currently being utilised for mining operations. As such, there is no rehabilitation activities planned for the next reporting period; this is unlikely to change until Airly Mine moves into closure preparation.

8.1.2 Subsidence Remediation – Mount Airly Panel and Pillar Mining Zone

During the extraction of miniwall panels under Mount Airly (2019-2021), observed subsidence surpassed the predicted maximum subsidence of 125 mm and some associated surface cracks were identified. **Appendix 10** provides an overview of the subsidence impacts identified to date, which have been subject to remediation.[24]

In accordance with Schedule 6, Condition 7(b) of SSD_5581 options for remediation were assessed in Remediation Risk Assessment Reports prepared by Douglas Partners (11 April 2022 & 22 July 2022)[25]. These reports, submitted to DPHI, outlined potential remediation strategies, preferred remediation measures, and alternative courses of action.

On 26 May 2022, Centennial Airly received an Enforceable Undertaking (the Undertaking) to the Planning Secretary under section 9.5 of the EP&A Act. The Undertaking requires Airly Mine to remediate identified subsidence cracks within the Mugii Murum Ban State Conservation Area, following the methods described in the Remediation Risk Assessment Reports and agreed upon with NPWS.

By 30 June 2022, Centennial Airly had developed and provided a schedule of works detailing the steps required to obtain approvals from the relevant authorities and implement all recommended remediation measures.

As part of the Undertaking, Independent Expert Inspections must be conducted every six months to:

- Identify any previously undetected subsidence-related impacts that may have developed since the last inspection;
- Independently certify the completion of remediation activities, ensuring that all works meet regulatory and environmental commitments; and
- Assess the condition of previously identified subsidence-related impacts and remediation works and confirm whether deterioration or other changes have occurred.

Key Activities and Findings During the Reporting Period

Three Independent Expert Inspections of the Mount Airly Remediation Area were conducted by Mr. Will Wright (Douglas Partners Pty Ltd) on 25 January 2024 and 1 August 2024, and 20 February 2025. Key findings from the inspections include:

- No previously unidentified subsidence-related impacts were detected.

[24] Centennial Airly have implemented adaptive management to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm) - see **Section 6.8.3**

[25] *Risk Assessment of Subsidence Crack Remediation Mugii Murum-ban State Conservation Area* (Douglas Partners. 2022a) and *Geotechnical and Remediation Assessment of MW02 Rock Fall Area* (Douglas Partners, 2022b)

- No perceptible changes to existing fracturing were observed beyond remedial improvements.
- Pin monitoring records indicated changes of less than 5 mm, which remain within the margin of error for these measurements.
- Remedial works are proceeding in accordance with the recommendations of previous Douglas Partners reports.
- No changes to the recommendations of previous inspections were made.

In January 2024, Douglas Partners recommended that no further sand filling be undertaken, concluding that both stabilised and un-stabilised sand infill presented a higher risk of aesthetic damage to exposed rock surfaces than allowing natural weathering to continue. They also recommended extending accelerated weathering treatments to untreated rock faces.

These findings were presented to the Airly Mine Community Consultative Committee (CCC) in February 2024, which was supportive of extending accelerated weathering trials. Application to the previously untreated areas commenced in April 2024.

In May 2024, a comprehensive update on the subsidence remediation program was provided to the CCC by the approved Independent Expert, Mr Will Wright (Principal Geotechnical Engineer, Douglas Partners). The presentation covered remediation recommendations, activities completed to date, findings independent reviews, and the decision to discontinue sand filling trials. It was confirmed that no further sand filling will be undertaken.

Following the August 2024 inspection, Douglas Partners released a report in September 2024 recommending a hold on any further remedial measures, concluding that accelerated weathering treatments have been effective, and further reapplication is considered unnecessary. The report advised that natural weathering should be allowed to continue, with ongoing periodic monitoring to assess stability over time.

Status of Remediation and Ongoing Monitoring

All physical remediation works have now been completed[26] and independently certified. Apart from ongoing six-monthly Independent Expert Inspections and routine monitoring, no further remediation is required. Monthly reports continue to be submitted to DPHI to provide progress updates on subsidence remediation and monitoring activities.

The monitoring program continues to demonstrate the effectiveness of remediation efforts, with no new subsidence-related impacts or concerns identified during the reporting period. It has been determined that periodic monitoring to assess ongoing stability should continue, while further remedial measures remain on hold to allow natural weathering to progress.

[26] refer to the previous Airly Mine Annual Reviews on the Airly Mine website for detailed discussion on the remediation activities completed prior to this reporting period - https://www.centennialcoal.com.au/operations/airly/

9 COMMUNITY CONSULTATION

9.1 COMMUNITY ENGAGEMENT

9.1.1 Community Consultative Committee

Airly Mine has established and operates a Community Consultative Committee (CCC) in accordance with the *Community Consultative Committee Guidelines for State Significant Projects* (Department of Planning & Environment, 2016) as required by Schedule 6, Condition 8 of SSD_5581.

The Airly Mine Community Consultative Committee is chaired by an independent Chairperson, and includes representatives from the community, Capertee Valley Land Care Group, Lithgow City Council, Colo Committee and National Parks and Wildlife Service.

During the reporting period, the Committee held three CCC meetings on:

- 2 February 2024;
- 5 May 2024;
- 9 September 2024; and
- 19 November 2024.

Topics discussed during the year at the CCC Meetings include:

- Airly Operations,
- Environmental Management,
- Subsidence Management,
- Environmental Monitoring, and
- Community Relations.

Minutes of all Community meetings are available on the Airly Mine website.[27]

Airly Mine will continue to maintain and improve an open dialogue with community stakeholders and the CCC during the next reporting period.

9.1.2 Community Sponsorship

In addition to the annual production contribution to Lithgow City Council in accordance with Schedule 2, Condition 15 of SSD_5581, financial and in-kind contributions were made by Airly Mine to the following non-profit organisations and community groups during the 2024 reporting period:

- Capertee Hall / Capertee Progress Association
- Capertee Progress Association (CPA)

In addition, Airly Mine also provides in kind donations as well as volunteering employee time to help organise and run community events and fund raisers. Airly Mine will continue to offer the same community service and contributions in the next reporting period.

9.2 COMMUNITY COMPLAINTS

There were no community complaints received during the reporting period.

Table 9-1 below shows the community complaints record for the period 2014 to 2024. Due to the low number of complaints received there is no evidence of an identifiable trend in the

[27] www.centennialcoal.com.au/operations/airly/

frequency of community complaints being received by Airly Mine. Details of complaints are listed on the Complaints Register on the Airly Mine website.[28]

Table 9-1: Record of annual community complaints – 2014-2024

Aspect	Community Complaints by Reporting Period										
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Noise	-	-	-	-	-	-	-	-	-	-	-
Air	-	-	-	-	-	-	-	-	-	-	-
Subsidence	-	-	-	-	-	-	-	-	8	-	-
Waste	-	-	-	-	-	-	-	-	-	-	-
Water	-	-	-	-	-	-	-	-	-	-	-
Rehab / Closure	-	-	-	-	-	-	-	-	-	-	-
Other	-	1	-	2	-	-	1	-	-	1	-
Total	**-**	**1**	**-**	**2**	**-**	**-**	**1**	**-**	**8**	**1**	**-**

[28] www.centennialcoal.com.au/operations/airly/

10 INDEPENDENT ENVIRONMENTAL AUDIT

In accordance with Schedule 6, Condition 12 of SSD_5581 an Independent Environmental Audit (IEA) is required to be undertaken every 3 years, as part of the IEA process, Airly Mine also conducts an Independent Expert Review (IER) of the Groundwater Management Plan & Groundwater Model in accordance with Schedule 4, Condition 14 of SSD_5581.

The most recent audit was completed by Integrated Environmental Management Australia (IEMA) (Lead Auditor) and Katarina David (Groundwater Expert), consisting of a site inspection, as well as document reviews and interviews with personnel. The IEA covered the period 11 February 2021 to 24 July 2024. The findings of the audit were reported in the Independent Environmental Audit 2024 Airly Mine, dated 16 October 2024.

In accordance with Schedule 6, Condition 13 of SSD_5581, a copy of the audit report, together with responses to the recommendations contained in the audit report were provided to DPHI.[29]

Table 10-1 provides an update on the status of responses to the audit recommendations remaining.

The next Independent Environmental Audit will be undertaken in 2027.

[29] As required by Schedule 6, Condition 14 of SSD_5581 the Audit Report and Responses to the Recommendations are also available on the Airly Mine website (as above)

Table 10-1 Summary Status of Audit Recommendations Identified during the 2024 IEA

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
Air Quality Management Plan SSD 5581 Schedule 4 Condition 7	NC REC 1 Update the Western Region Air Quality and Greenhouse Gas Management Plan to include a method to calculate results when HVAS/monitors malfunction. Specifically, the amendment should describe how inference can be used for PM_{10} results when monitors malfunction.	A1 AIR IEA 2024: Centennial will update the relevant Air Quality and Greenhouse Gas Management Plan to include conservative provisions for extrapolating compliance of PM10 and TSP results during HVAS malfunctions/outages.	On track for completion by June 2025
Documents to be publicly available Mining Amendment (Standard Conditions of Mining Leases—Rehabilitation) Regulation 2021 - 16. (3) Certain documents to be publicly available	NC REC 2 Create a tracking spreadsheet, calendar, or other document to record when regulatory reporting is completed. This will demonstrate compliance with specific timeframes such as the timing to make documents publicly available required under the Standard Conditions for Mining Leases.	A2 AIR IEA 2024: Centennial will create a tracking system to address the specific requirements under the Standard Conditions of Mining Leases – Rehabilitation.	A tracking system has been created. **Complete**

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
Subsidence Performance Measures SSD 5581 Schedule 3 Condition 2	IMP REC 1 Complete an assessment of subsidence results from inspections and monitoring in the Annual Review against the Schedule 3 Condition 2 of the Project Approval requirements (subsidence Impact Performance Measures – Natural and Heritage Features.) and Schedule 3 Condition 3 (Built Features) This would likely be in table format and have columns for compliance status and comment against each aspect. Where further information is required, we recommend this table directs the reader to a more detailed section of the Annual Review.	A3 AIR IEA 2024: Centennial will incorporate a subsidence performance measure compliance table within the 2024 Annual Review.	This recommendation has been addressed in this Annual Review – refer Section 6.8 and Appendix 6. **Complete**
Noise Management Plan SSD 5581 Schedule 4 Condition 4	IMP REC 2 Consult with DPHI to determine if they are supportive of Centennial de-coupling Airly from the Western Regional Noise Management Plan. Based on their response, Centennial to create a stand-alone Airly NMP at a time to be determined by Airly.	A4 AIR IEA 2024: Centennial will submit a letter to DPHI to request de-coupling Airly Mine from the: • Western Region Noise Management Plan; and the • Western Region Air Quality Greenhouse Gas Management Plan.	On track for completion by April 2025
Air Quality SSD 5581 Schedule 4 Condition 5	IMP REC 3 If results are estimated due to outages, this should be clearly noted and identified in the Annual Review.	A5 AIR IEA 2024: Centennial will continue to detail all HVAS outages in the Annual Review and provide detail on any sample estimation techniques utilised to determine the compliance monitoring status.	This recommendation has been addressed in this Annual Review – refer Section 6.4 and Appendix 3 **Complete**

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
Air Quality SSD 5581 Schedule 4 Condition 5	IMP REC 4 Provide raw data of dust monitoring results in Annual Review appendix.	A6 AIR IEA 2024: Centennial will include the raw data of dust monitoring results as an appendix to the 2024 Annual Review.	This recommendation has been addressed in this Annual Review – refer Section 6.4 and Appendix 3 **Complete**
Air Quality and Greenhouse Gas Management Plan SSD 5581 Schedule 4 Condition 7	IMP REC 5 Consult with DPHI to determine if they are supportive of Centennial de-coupling Airly from the Western Regional Air Quality and Greenhouse Gas Management Plan. Based on their response, Centennial to create a stand-alone Airly AQGHGMP at a time to be determined by Airly.	A7 AIR IEA 2024: Centennial will submit a letter to DPHI to request de-coupling Airly Mine from the: • Western Region Noise Management Plan; and the • Western Region Air Quality Greenhouse Gas Management Plan.	On track for completion by April 2025
Water Management Performance Measures SSD 5581 Schedule 4 Condition 12	IMP REC 6 Review procurement processes to avoid over-ordering supplies.	A8 AIR IEA 2024: Centennial will review the ordering/procurement process to avoid over- ordering supplies.	A review of the ordering and procurement processes was completed in December 2024. **Complete**
Water Management Performance Measures SSD 5581 Schedule 4 Condition 12	IMP REC 7 Ensure bunded areas are fit for purpose and used appropriately (Refer to AS 1940).	A9 AIR IEA 2024: Centennial will conduct an internal audit of the Pit Top bunded areas to ensure they are fit for purpose and used appropriately (in accordance with AS 1940).	An internal audit of the Pit Top bunded areas was conducted in October 2024. **Complete**

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
Surface Water Management Plan SSD 5581 Schedule 4 Condition 13	IMP REC 8 Modify the Airly Mine Water Monitoring Annual Reports in the Annual Reviews to clearly outline the surface water monitoring locations and parameters have been monitored in accordance with the WMP.	A10 AIR IEA 2024: Centennial will modify the 2024 Annual Water Monitoring Report to clearly demonstrate that the surface water monitoring locations and parameters have been monitored in accordance with the WMP. The 2024 Annual Water Monitoring Report will be appended to the 2024 Annual Review.	This recommendation has been addressed in this Annual Review – refer Appendix 6. **Complete**
Groundwater Management Plan SSD 5581 Schedule 4 Condition 13	IMP REC 9 Groundwater recommendations: • The monitoring data should be compared to the trigger levels in the already approved WMP and any updated version of the WMP (even if not formally approved) but includes most up to date data and information.	A11 AIR IEA 2024: Centennial will address this action in the 2024 Annual Water Monitoring Report.	This recommendation has been addressed in this Annual Review – refer Appendix 6. **Complete**
	• Trigger levels for piezometric level and water quality should be listed in table or provided as a line on the water quality graphs in the annual report to allow comparison against the observed. This is particularly important as the trigger levels are updated frequently and this would allow quick overview without needing to go to most recent WMP for checking.	A12 AIR IEA 2024: Trigger levels were included in the 2023 Annual Report graphics. This will continue for the 2024 Annual Report.	This recommendation has been addressed in this Annual Review – refer Appendix 6. **Complete**
	• Groundwater supply for potentially affected landowners needs to be discussed in the WMP.	A13 AIR IEA 2024: Centennial will address this action within the next revision of the WMP.	Revision 10 of the WMP has addressed this recommendation. **Complete**

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
	• The groundwater model should be updated to include the changes made in the model and the outcomes of the model. The model needs to provide more accurate predictions to the observed inflow. The model output should include the predictive results for piezometric levels for all bores to allow the comparison with the observed data.	A14 AIR IEA 2024: Centennial will incorporate the revised groundwater model output into the next revision of the WMP.	Revision 10 of the WMP has addressed this recommendation. **Complete**
Independent Expert Review SSD 5581 Schedule 4 Condition 14	IMP REC 10 Groundwater recommendations: • The improvement would include presentation of major ions on a Piper or similar geochemical diagram for different time periods or shown with different colour on a same diagram. Trigger levels for groundwater quality (metals) should be added to the graphs to enable comparison.	A15 AIR IEA 2024: Centennial will improve the graphical presentation of major ions, including trigger levels for groundwater quality, within the 2024 Annual Water Report.	This recommendation has been addressed in this Annual Review – refer Appendix 6. **Complete**
	• To allow comparison of predicted groundwater levels and drawdown over time, the updated model (GHD, 2024) results could be provided as time series data i.e. hydrographs for predicted piezometric levels at each of the calibrated points and predicted drawdown maps with prediction for smaller time increments (5 years). This is in addition to predicted groundwater inflow presented in a table or graph.	A16 AIR IEA 2024: This action will be addressed in the groundwater model report.	The groundwater model report (GHD, 2025f) addresses this recommendation. **Complete**

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
	• Data presentation (water quality graphs) could be improved to allow comparison with previous periods and areas.	A17 AIR IEA 2024: Centennial will include quality graphs, grouped based on areas and show time series for the history of monitoring, in the 2024 Annual Report.	This recommendation has been addressed in this Annual Review – refer Appendix 6. **Complete**
	• It is recommended that any changes made to the groundwater model in the future are documented, explained, and justified along with results presented in the particular annual report. Without this information it is difficult to understand what and why the change was made and what its result is.	A18 AIR IEA 2024: Centennial will provide a chronology of previous model updates within the revised groundwater model report.	The groundwater model report (GHD, 2025f) addresses this recommendation. **Complete**
Biodiversity Management Plan SSD 5581 Schedule 4 Condition 15	IMP REC 11 Centennial to consider decoupling Airly from the Western Region plans and create a separate Biodiversity Management Plan solely for Airly Mine, at a time to be determined by Airly. Centennial should consider combining Pit Top and Extraction Plan biodiversity requirements under the one Airly Biodiversity Management Plan document. Centennial should consult with DPHI to confirm this alternate approach.	A19 AIR IEA 2024 Centennial will submit a letter to DPHI requesting to de-couple Airly form the Western Region Biodiversity Management Plan. Additionally, Centennial will request to combine the Pit Top and Extraction Plan biodiversity requirements into the one wholistic Airly Mine Biodiversity Management Plan.	On track for completion by April 2025
Biodiversity Management Plan SSD 5581 Schedule 4 Condition 15	IMP REC 12 Centennial to clarify the intent of this condition with DPHI, including the interpretation of surface disturbance under the development as defined by SSD_5581.	A20 AIR IEA 2024 Centennial will submit a letter to DPHI requesting clarification on the intent of S.4, C.15 of SSD_5581, including the interpretation of surface disturbance under the development as defined by SSD_5581.	On track for completion by April 2025

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
Bushfire Management SSD 5581 Schedule 4 Condition 22	IMP REC 13 Update the Bushfire Management Plan as per scheduled review date.	A21 AIR IEA 2024: Centennial will review and update the Bushfire Management Plan prior to the schedule review date of June 2025.	On track for completion by June 2025
Management Plan Requirements SSD 5581 Schedule 6 Condition 2	IMP REC 14 On next review of Management Plans update the cross-referencing table to include the requirements of this condition (Schedule 6 Condition 2).	A22 AIR IEA 2024: Noted. On the next review of each relevant management plan, Centennial will update the cross-referencing table to include the requirements of S.6, C2 of SSD_5581.	Ongoing completion – commencing 2025
Revision of Strategies, Plans or Programs SSD 5581 Schedule 6 Condition 3	IMP REC 15 Create a tracking spreadsheet, calendar, or other document to record the review of management plans following the preparation of the Annual Review, as well as for other triggers including Modifications and Incidents. This will provide evidence to verify that the required review has occurred, even where revisions are not required.	A23 AIR IEA 2024: Centennial will create a tracking document to record the review of management plans following all relevant triggers.	On track for completion by June 2025
Incident Reporting SSD 5581 Schedule 6 Condition 9	IMP REC 16 Create a tracking spreadsheet, calendar, or other document to record required incident notifications within specified timeframes for relevant agencies.	A24 AIR IEA 2024: Centennial will create a tracking document to record the required incident notifications within specified timeframes for relevant agencies.	A process and document for tracking incident notifications has been created. **Complete**
Administrative – EPL Labelling of Licensed Discharge Points EPL12374 Condition O4.3	IMP REC 17 Submit a license variation to correct the identified error (LDP 7 and 8) in the EPL.	A25 AIR IEA 2024: Centennial will submit a license variation to correct the identified error related to the incorrect labelling of “LDP 7 and 8” within EPL12374.	On track for completion by June 2025

Aspect & Condition Reference	REC Number & IEA - Recommendation	Airly Mine Response / Action Plan	Status Update
General Environmental Management No Applicable Condition Reference.	IMP REC 18 Review the inert structure being stored at the Pit Top to ensure it can be re-used or it is stored in the most efficient way possible.	A26 AIR IEA 2024: Centennial will review the volume of inert structure located on the Pit Top with a focus on more efficiently storing or scrapping materials/equipment where possible.	A review was undertaken in February 2025. **Complete**

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

Table 11-1 provides a summary of the incidents and non-compliances, including the actions taken in response to the incident/non-compliance.

During the reporting period there was one non-compliance (and zero reportable incidents and community complaints).

Table 11-1 Incidents and Non-Compliances during the Reporting Period

Compliance[30]	Overview of incident/non-compliance	Description of incident/non-compliance	Actions	Status of Actions
Non-Compliance 1 (Administrative)	The WRAQGMP could not be fully implemented during the reporting period.	HVAS malfunctions during the first half of 2024 resulted in missed PM_{10} results, although TSP continued to be recorded. A further missed sample run for both PM_{10} and TSP occurred in October 2024 due to a power outage. Although assessment of available data concluded with an extremely high level of certainty that no exceedances of air quality criteria (Schedule 4, Condition 5 of SSD_5581) occurred, the WRAQGMP does not allow for inferred results in place of monitored data when equipment malfunctions or outages occur. Accordingly, this has been recorded as a non-compliance with the implementation of the WRAQGMP, but it does not represent a non-compliance relating to incident reporting or potential impact to sensitive receivers.	In response to this non-compliance, Centennial will: • Provide details of all HVAS malfunctions and outages, and sample estimation techniques utilised to determine the monitoring compliance status in this Annual Review • Update the WRAQGMP to include conservative provisions for extrapolating compliance of PM_{10} and TSP results during HVAS malfunctions and/or outages.	refer Section 6.4 and Appendix 3 **Complete** On track for completion by June 2025

[30] See Compliance Status Key beneath **Table 1-1** for risk level, colour code and description.

12 ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Table 12-1 presents the key activities that are currently planned for the next reporting period.

Table 12-1: Forecast Operations for 2025

Improvement Actions
Continue the extensive environmental monitoring and reporting program.
Continue subsidence remediation and fracture monitoring on Mount Airly in accordance with the Enforceable Undertaking.
Continued monitoring at groundwater monitoring sites ARP09, ARP12 and ARP14 and surface water monitoring sites Genowlan Creek 2 and The Grotto will inform further investigations of the identified trends in pH and some dissolved metals (iron, manganese and zinc) within Genowlan Creek / Genowlan Creek Alluvium and seek to determine whether the hydrogeochemical changes are due to the currently speculated cause related to aeration of previously reduced sediments, that have been exposed to drying and rewetting.
Continued monitoring at surface water monitoring sites in Airly Creek (Airly Creek, Airly Upstream and Airly Tributary) to inform further investigations of the SSGV trigger exceedances. Note, there were no discharges from Airly Mine in 2024 and the SSGV trigger exceedances are considered unlikely to be due to mining-related activities.
Seek extraction plan approvals for the Panel & Pillar Mining Zone Extraction Plan in the central part of Genowlan mountain.
Management Plan Revisions
The Aboriginal Cultural Heritage Management Plan for the MW19-22 Extraction Plan and the WRACHMP will be revised and resubmitted following the completion of consultation, to incorporate updated information from the 2024 archaeological survey.
The Water Management Plan, Revision 10 (draft), has been prepared to consider the outcomes of the updated groundwater model (GHD, 2025f) and the proposed MW19-22 Extraction Plan. Revision 10 will be finalised and submitted to DPHI for approval in 2025.
Condition Triggers
In accordance with Condition 3(b) in Schedule 6 of SSD_5581 strategies, plans, and programs required under the consent will be reviewed within three months of the submission of this annual review. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document will be submitted for the approval of the Secretary.

13 REFERENCES

Cardno (2014) *Aquatic Ecology and Stygofauna Assessment, Airly Mine Extension Project*, report prepared for Centennial Coal Company Limited.

Douglas Partners (2022a). *Risk Assessment of Subsidence Crack Remediation Mugii Murum-ban State Conservation Area*. Prepared for Centennial Airly Pty Limited.

Douglas Partners (2022b). *Geotechnical and Remediation Assessment of MW02 Rock Fall Area (Rev 1).* Prepared for Centennial Airly Pty Limited.

GHD (2014a) *Airly Mine Extension Project: Surface Water Impact Assessment*, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2014b) *Airly Mine Extension Project: Groundwater Impact Assessment*, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2016) *Western Operations: Regional Water Management Plan*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2018) *Airly Mine: Site specific guideline values*, prepared for Centennial Airly Pty Ltd.

GHD (2021) *Western Region Noise Management Plan*, (Revision No. 5) prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2024) *Airly Mine Water Management Plan*, (Rev 9 dated 22 March 2024, approved) prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025a) *2024 Annual Water Monitoring Report*. Prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2025b) *Airly Watercourse Stability Monitoring Annual Report 2024*. Report in preparation for Centennial Airly Pty Ltd.

GHD (2025c) *Airly Aquatic Ecology Monitoring Annual Report 2024*. Report in preparation for Centennial Airly Pty Ltd.

GHD (2025d) *Airly Stygofauna Monitoring Report 2024*. Prepared for Centennial Airly Pty Ltd.

GHD (2025e) *Airly Mine Water Assurance Reporting*. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025f) *Airly Mine Groundwater Model*. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

Golder Associates (2014) *Subsidence Predictions and Impact Assessment for Airly Mine*. Prepared for Centennial Coal Company Limited.

MSEC (2024). *2023 Annual Review of Monitored Subsidence and Impacts*. Prepared for Centennial Airly Pty Ltd.

MSEC (2025). *2024 Annual Review of Monitored Subsidence and Impacts*. Prepared for Centennial Airly Pty Ltd.

Outhet, D. and Cook, N. (2004). *"Definitions of Geomorphic Condition Categories for Streams"* Unpublished internal draft paper for use throughout NSW by the Department of Infrastructure, Planning and Natural Resources.

Peterson RC (1992) *The RCE: a Riparian, Channel, and Environment Inventory for small streams in the agricultural landscape*, Freshwater Biology, 27(2), 295–306.

RPS (2014a) *Airly Mine Extension Project Flora and Fauna Assessment*, prepared by RPS Australia East Pty Ltd for Centennial Airly Pty Limited.

RPS (2014b) *Airly Mine Extension Project Cultural Heritage Impact Assessment*, prepared by RPS Australia East Pty Ltd for Centennial Airly Pty Limited.

RPS (2025) *Airly BMP Seasonal Ecological Monitoring Flora and Fauna Monitoring Report 2024*. Prepared for Centennial Airly Pty Limited.

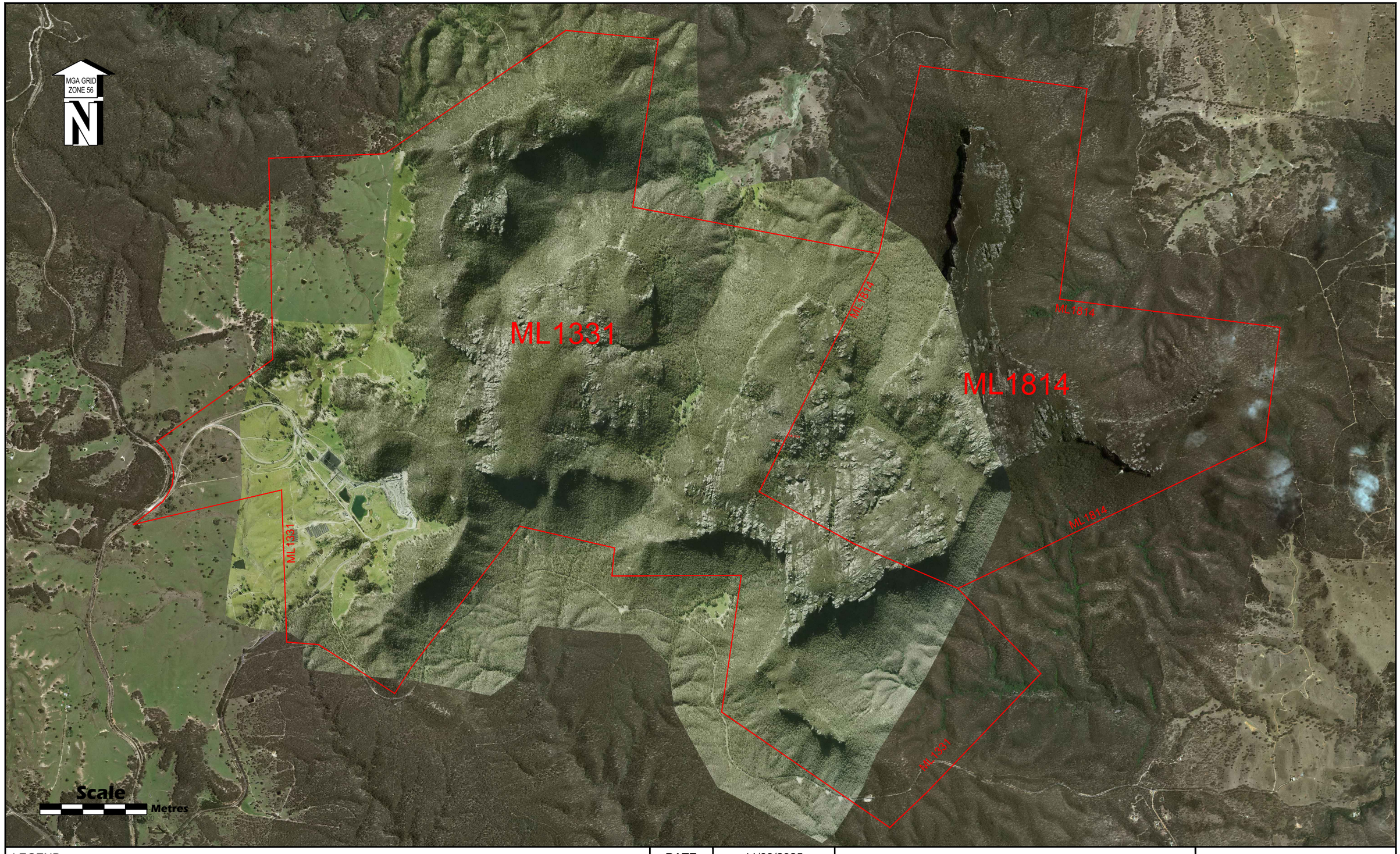
SLR (2014) *Airly Mine Extension Project Air Quality Impact Assessment and Greenhouse Gas Assessment*, prepared by SLR Consulting Australia Pty Ltd for Centennial Coal Company Limited.

SLR (2023) *Modification Report 5 – Airly Mine SSD 5581* (SLR Ref: 630.30611-R01, Version No: 1.1, dated August 2023). Prepared by SLR Consulting Australia Pty Ltd for Centennial Airly Pty Limited.

SLR (2025) *Airly Coal Mine Annual Noise Monitoring December 2024* (SLR Ref No.: 610.18774-R06-v1.0, dated 21 January 2025). Prepared by SLR Consulting Australia Pty Ltd for Centennial Airly Pty Limited.

PLANS

Plan 1 (AM04125): Airly Mine – Project Application Area & Mining Tenements



LEGEND

Mining Lease ML1331 & ML1814

DATE	11/03/2025
REFERENCE	N:\Survey\1.MGA2020\DWG\SURFACE\Cadastral\ML1331__ML1814 Colliery Holdings.dwg
SCALE	As Shown
A3H	

Airly Mine
Project Application Area and Mining Tenements

CENTENNIAL AIRLY

THIS DRAWING IS THE PROPERTY OF AIRLY MINE PTY. LTD.

DRG. No. AM04125

Plan 2 (AM04123): Airly Mine - Environmental Monitoring Plan

MGA GRID ZONE 56

N

Capertee National Park

Springvale Biodiversity Offset Area

TORBANE CREEK

VILLAGE SPRING

KINGDOM BORE

ARP03A
ARP03

GAP CREEK

GAP CREEK

ARP02A
ARP02

ARP11

MOUNT AIRLY

ARP04
ARP05

ARP08

GENOWLAN MOUNTAIN

GEN CRK 2
V notch

ARP14
ARP13SP
ARP13

NISSAN HUT DAM

GEN CRK
ARP09

ARP07

Comms Tower

THE GROTTO

ARP12

GEN CRK
Grotto V-Notch

ARP15SP
ARP15

ARP01

AMN3

AMN1

DM2
HVAS

TLO DAM
LDP 3
LDP 2
Production Bore
7ML DAM

DM3

LDP 1
35ML DAM
109ML DAM

ARP06

TS7138

DM4

AIRLY CREEK UPSTREAM

AIRLY CREEK

AIRLY CREEK

Gardens of Stone National Park

Mungii Murum-Bran State Conservation Area

DOG TRAP CREEK

NIOKA

AMN2
DM1

Scale

NOTE Workings are shown indicative only
Current mine workings - refer to digital mine working plan
Any queries on the workings - refer to the survey department at Airly Mine

Airly Mine EPL License No. 12374 Monitoring Points		
EPA ID No.	NAME	TYPE
MP1	LDP1	WATER
MP3	DM1	DUST
MP4	DM2	DUST
MP5	DM3	DUST
MP6	DM4	DUST
MP7	LDP2	WATER
MP8	LDP3	WATER

LEGEND

- ML1331 ML1814 Lease Boundary
- Water Monitoring
- National Park
- Mungii Murum-Ban SCA
- Groundwater Monitoring Borehole
- Aquatic Monitoring
- Dust Monitoring
- Noise Monitoring
- Licensed Discharge Points
- HVAS

DATE	12/03/2025
REFERENCE	N:\Survey\1.MGA2020\PLANS\SURFACE\Environment\Environmental Constraints\Airly Environmental Monitoring Plan 2023wg.dwg
SCALE	1:15400

Environmental Monitoring Plan

CENTENNIAL AIRLY

THIS DRAWING IS THE PROPERTY OF AIRLY MINE PTY. LTD.

DRG. No. AM04123

Plan 3 (AM04124): Airly Mine – Mining Consent Zones & 2024 Workings

MGA GRID ZONE 56

N

NEW HARTLEY SHALE MINE OLD WORKINGS (approx 25m Above Lithgow Seam)

TORBANE COLLIERY OLD WORKINGS (Lithgow Seam)

Airly MOD3 Extraction Plan Variation (2016)

Airly MOD3 Extraction Plan Approved (2012)

0 0.5 1 KILOMETRES

NOTE: The workings and seals shown on this plan are **indicative only**
Current mine workings - refer to digital mine working plan
Any queries on the workings - refer to the survey department at Airly Mine

LEGEND

- Torbane colliery old workings
- New Hartley shale mine old workings
- New Hartley shale mine potential interaction zone (piz)
- Additional 50m setback / first workings only area
- 50m setback from workings (Inrush control)
- Splitting and Quartering ML1331
- Mod 3 EPA Area
- Mod 3 EPA Area Variation
- Worked roadways
- Proposed roadways
- 2024 Mine Workings
- 2023 Mine Workings
- 2022 Mine Workings
- ML1331 & ML1814
- Mining limit(26.5°Offset from Cliff Base (as defined by RPS,110 DOC or 30m from base of Cliff)
- Panel and pillar mining zone
- Partial pillar zone
- Shallow mining zone
- Cliff line zone (CLZ)

DATE	211/03/2025
REFERENCE	
N:\Survey\1.MGA2020\PLANS\SURFACE\Environment\Environmental Review Plans\2020-2022_Workings_ConsentZones.dwg	
SCALE	AS SHOWN

Airly Consent Mining Zones Workings 2022,2023 & 2024 30/12/2024 Mine Workings

CENTENNIAL AIRLY

THIS DRAWING IS THE PROPERTY OF AIRLY MINE PTY. LTD.

DRG. No. AM04124

APPENDICES

Appendix 1: Checklist of Annual Review Reporting Requirements

This appendix provides a checklist of reporting requirements and performance conditions addressed within the Annual Review.

Approval	Requirement	Annual Review Section
SSD_5581 Schedule 6 Condition 11 (Annual Review)	*By the end of March each year following the commencement of development under this consent, or other timing as may be agreed by the Secretary, the Applicant must submit a report to the Department reviewing the environmental performance of the development to the satisfaction of the Secretary. This review must:*	This Document
	(a) describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;	Section 4 Section 8 & Section 11
	(b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, which includes a comparison of these results against the: • *the relevant statutory requirements, limits or performance measures/criteria;* • *the monitoring results of previous years; and* • *the relevant predictions in the documents listed under condition 2(a) and the IPRP's Report;*	Section 6 & Section 7
	(c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;	Section 1 & Section 11
	(d) identify any trends in the monitoring data over the life of the development;	Section 6 & Section 7
	(e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	Section 6 & Section 7
	(f) describe what measures will be implemented over the next year to improve the environmental performance of the development.	Section 6 & Section 7
SSD_5581 Schedule 4 Condition 23 (Waste)	*The Applicant must:* *(a) implement all reasonable and feasible measures to minimise the waste (including coal reject) generated by the development;* *(b) ensure that the waste generated by the development is appropriately stored, handled and disposed of; and* ***(c) monitor and report on the effectiveness of waste minimisation and management measures in the Annual Review,*** *to the satisfaction of the Secretary.*	Section 6.9.1
SSD_5581 Schedule 6 Condition 14 (Access to Information)	*14. The Applicant must:* *(a) make the following information publicly available on its website:* • *….* • ***the last five annual reviews;*** • *…* *(b) keep this information up to date,* *to the satisfaction of the Secretary.*	Section 3.2

Appendix 2: Noise Monitoring 2024 Annual Report

Airly Coal Mine

Annual Noise Monitoring December 2024

Centennial Airly Pty Ltd

Glen Davis Road
CAPERTEE NSW 2846

Prepared by:

SLR Consulting Australia

Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street, North Sydney NSW 2060, Australia

SLR Project No.: 610.18774.00000

21 January 2025

Revision: V1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V1.0	21 January 2025	Adam Sirianni	Martin Davenport	Martin Davenport

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Centennial Airly Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Basis of Report ..... **i**
1.0 Introduction **1**
2.0 Relevant Noise Criteria **1**
2.1 Conditions of Approval Noise Limits 1
3.0 Operational Noise Monitoring Methodology **2**
3.1 General Requirements 2
3.2 Operator Attended Noise Monitoring 3
3.2.1 Methodology 3
3.2.2 Operator Attended Noise Monitoring Locations 3
4.0 Results and Discussion **5**
4.1 Results of Operator Attended Noise Monitoring 5
4.1.1 Discussion of Results 7
4.1.2 Operational Compliance Assessment 7
4.1.3 Sleep Disturbance 7
5.0 Conclusion **7**

Tables in Text

Table 1 Noise Impact Assessment Criteria 1
Table 2 Noise Monitoring Locations 3
Table 3 Attended Noise Survey Results Location – ANM1 5
Table 4 Attended Noise Survey Results Location – ANM2 6
Table 5 Attended Noise Survey Results Location – ANM3 6
Table 6 Operational Noise Assessment 7
Table 7 Sleep Disturbance Assessment 7

Figures in Text

Figure 1 Attended Noise Monitoring Locations 4

Appendices

Appendix A Acoustic Terminology
Appendix B Calibration Certificates

1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Centennial Airly to conduct the 2024 annual noise compliance monitoring for the Airly Coal Mine (ACM) as guided by the Centennial Coal Noise Management Plan Western Region (NMP) November 2021.

The purpose of this assessment was to determine the noise contribution from Airly Coal Mine operations, in accordance with the Conditions of Approval (CoA) SSD_5581, Schedule 4, Condition 2.

The report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

2.0 Relevant Noise Criteria

2.1 Conditions of Approval Noise Limits

EPL 12374 does not contain any requirements relation to noise, however, Schedule 4, Condition 2 of SSD_5581 provides operational noise limits for sensitive receivers, which are provided in **Table 1**.

Table 1 Noise Impact Assessment Criteria

Land	Day $L_{Aeq(15min)}$	Evening $L_{Aeq(15min)}$	Night $L_{Aeq(15min)}$	Night L_{Amax}
Any residence on privately-owned land	35	35	35	52
	$L_{Aeq(period)}$ – When in Use			
A17 (Camp ground)	50			N/A
A18 (Nissen Hut)	50			N/A

Note: Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am, On Sundays and Public Holidays, Daytime 8.00 am -6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

SSD_5581 goes on to state:

“Noise generated by the development is to be measured in accordance with the relevant requirements of the NSW Industrial Noise Policy. Appendix 8 sets out the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria. However, these criteria do not apply if the Applicant has a negotiated agreement with the owner/s of the relevant residence or land to generate higher noise levels, and the Applicant has advised the Department in writing of the terms of this agreement.”

Appendix 8 of SSD_5581 outlines the conditions under which the noise criteria is applicable.

1. The noise criteria in Table 1 are to apply to a receiver under all meteorological conditions except under:
   a. Wind speeds greater than 3 m/s at 10m above ground level; or
   b. Stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level; or
   c. Stability category G temperature inversion conditions
2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station required under Condition 8 of Schedule 4.

3. Attended monitoring is to be used to evaluate compliance with the relevant conditions of this consent.

4. Unless the Secretary agrees otherwise, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended from time to time), in particular the requirements relating to:

    a. monitoring locations for the collection of representative noise data;

    b. meteorological conditions during which collection of noise data is not appropriate;

    c. equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and

    d. modifications to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.

3.0 Operational Noise Monitoring Methodology

3.1 General Requirements

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of AS IEC 61672.1 – 2019 Electroacoustics - Sound level meters, AS IEC 60942 2017 Electroacoustics – Sound calibrators, and carried current NATA or manufacturer calibration certificates.

Instrument calibration was checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

Noise measurements and assessments in this report have been prepared in accordance with Australian Standard AS 1055-1997 “Description and Measurement of Environmental Noise” Part 1, 2 and 3 and with reference to the Noise Policy for Industry (NPfI) and the NMP.

The objectives of the noise monitoring assessment were as follows:

- Measure the noise contribution from Airly Coal Mine operations at the ANM1, ANM2 and ANM3 locations as per the long-term noise monitoring locations outlined in the NMP.
- Ascertain all sources of noise within each of the noise surveys, including estimated contribution or maximum level of each source.
- Assess the noise emissions of Airly Coal Mine operations, in relation to the PA/EPL/CoA limits for the site and with regard to wind speed and direction during the noise surveys.

3.2 Operator Attended Noise Monitoring

3.2.1 Methodology

Operator attended noise measurements were conducted during the day, evening and night-time periods at the three noise monitoring locations.

The objective of the operator attended noise monitoring was to measure $L_{Aeq(15minute)}$ and L_{Amax} noise levels at the nearest potentially affected receptors to determine the noise contribution of mining activities associated with Airly Coal Mine, and to assist in defining noise sources and the character of noise in the area.

Operator attended noise measurements were conducted using two one-third octave integrating B&K 2270 sound level meters (s/n 3029485 and 3008204). Calibration certificates for all acoustic instrumentation used throughout the monitoring programme is provided in **Appendix B**.

3.2.2 Operator Attended Noise Monitoring Locations

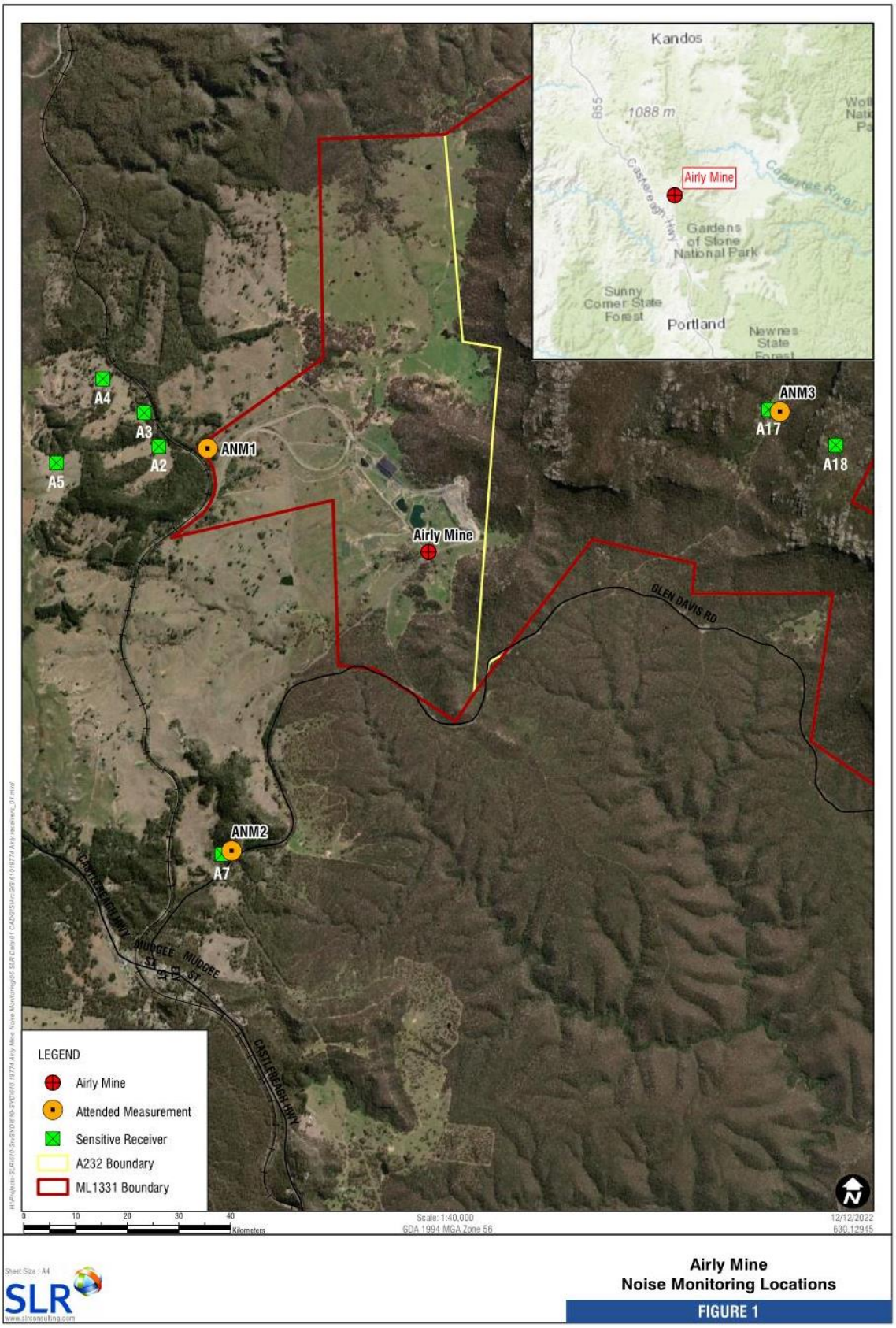
Operator attended noise surveys were conducted at the locations provided in **Table 2** to determine the character and contribution of noise sources, including ACM pit top operations, in relation to the total ambient noise level.

An aerial photograph showing the approximate locations of the noise monitoring locations is provided in **Figure 1**.

Table 2 Noise Monitoring Locations

Location	Description
ANM1	To the west of pit top operations near the Airly Coal Mine rail Loop. ANM1 is on mine owned land at the point most representative of sensitive receivers A2 to A5 as shown in **Figure 1**.
ANM2	To the south of pit top operations and representative of sensitive receivers A7 and A8. ANM2 is close to Glen Davis Rd and the Castlereagh Highway.
ANM3	To the east of pit top operations. ANM3 is located in the Mount Airly Camping Area grounds and is representative of sensitive receivers A17 and A18.

Figure 1 Attended Noise Monitoring Locations



4.0 Results and Discussion

4.1 Results of Operator Attended Noise Monitoring

Operator attended noise measurements were conducted during the daytime, evening and night-time periods on Tuesday 17 December 2024.

Weather conditions during the surveys were relatively warm with temperatures up to 30°C during the day and down to 21°C during the night.

Weather conditions were generally calm with winds up to 3m/s at times.

A summary of the operator attended measurements, including the estimated contribution of noise sources, is contained within **Table 3**, **Table 4** and **Table 5**.

Table 3 Attended Noise Survey Results Location – ANM1

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	17/12/2024 11:23 30°C 1.5m: 2-3m/s SW	61	55	54	51	52	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Insects – 40 to 44 dBA Wind – 52 to 55 dBA Birds – 55 to 61 dBA
Evening	17/12/2024 21:14 25°C 1.5m: 0-1m/s S	50	47	46	42	44	Site related noise events: Conveyor – 23 to 26 dBA **Airly Coal Mine Contribution LAeq(15minute) = 25 dBA** Other noise events: Insects – 43 to 50 dBA Wind – 42 to 45 dBA
Night	17/12/2024 22:03 22°C 1.5m: 0-2m/s E	65	55	54	51	53	Site related noise events: Conveyor – 25 to 37 dBA **Airly Coal Mine Contribution LAeq(15minute) = 30 dBA LAmax = 37 dBA** Other noise events: Insects – 50 to 55 dBA Aircraft – 44 to 46 dBA Impact – 65 dBA

Table 4 Attended Noise Survey Results Location – ANM2

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	17/12/2024 10:39 29°C 1.5m: 2-3m/s W	65	64	64	61	63	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Insects – 60 to 64 dBA Birds – 61 to 65 dBA Traffic – 30 to 37 dBA
Evening	17/12/2024 19:53 28°C 1.5m: 0.5m/s SW	59	58	56	51	54	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Traffic – 30 to 34 dBA Insects – 50 to 58 dBA Birds – 57 to 59 dBA
Night	17/12/2024 22:48 21°C 1.5m: 2-3m/s E	50	45	41	34	39	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Insects – 43 to 49 dBA Wind – 40 to 50 dBA

Table 5 Attended Noise Survey Results Location – ANM3

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	17/12/2024 10:04 29°C 1.5m: 1-2m/s W	71	57	55	53	54	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Wind – 35 to 50 dBA Insects – 50 to 56 dBA Birds – 59 to 71 dBA Aircraft – 55 dBA
Evening	17/12/2024 19:58 27°C 1.5m: Calm	56	54	54	50	52	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Birds – 54 to 56 dBA Insects – 50 to 52 dBA
Night	17/12/2024 22:47 21°C 1.5m: 1-2m/s E	50	39	35	29	33	Site related noise events: **Airly Coal Mine Inaudible** Other noise events: Wind – 32 to 40 dBA Insects – 30 to 36 dBA Impacts –37 dBA

4.1.1 Discussion of Results

No modification factors for low frequency noise or tonal noise is required to be applied for all monitoring locations.

4.1.2 Operational Compliance Assessment

Results of the operator attended noise measurement contributions from Airly Coal Mine operations compared with the relevant noise criteria are summarised in **Table 6**.

Table 6 Operational Noise Assessment

Location SSD/EPL Locations	Estimated $L_{Aeq(15minute)}$ Contribution dBA			Noise Criteria $L_{Aeq(15minute)}$ dBA			Compliance		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
ANM1	I/A	25	30	35	35	35	Yes	Yes	Yes
ANM2	I/A	I/A	I/A	35	35	35	Yes	Yes	Yes
ANM3	I/A	I/A	I/A	50	50	50	Yes	Yes	Yes

Table 6 indicates that compliance with the relevant operational noise criteria was achieved at all of the noise monitoring locations during all periods.

4.1.3 Sleep Disturbance

Results of the sleep disturbance measurements compared with the relevant noise criteria are summarised in **Table 7**.

Table 7 Sleep Disturbance Assessment

Location	Airly L_{Amax} Noise Level Contribution dBA	Noise Criteria L_{Amax} dBA	Compliance
ANM1	37	52	Yes
ANM2	Inaudible	52	Yes
ANM3	Inaudible	NA	NA[1]

Note 1: No sleep disturbance criteria applicable for ANM3.

5.0 Conclusion

An assessment of noise emissions from Airly Coal Mine, has been conducted by SLR for 2024.

Operator attended noise measurements were conducted at noise monitoring locations ANM1, ANM2 and ANM3 during the day, evening and night-time periods on Tuesday 17 December 2024.

The assessment and analysis of the results of the operator attended noise monitoring has shown that Airly Coal Mine noise emission levels were in compliance with the CoA/EPL noise limits at all monitoring locations during the day, evening and night-time noise monitoring periods.

Appendix A Acoustic Terminology

Airly Coal Mine

Annual Noise Monitoring December 2024

Centennial Airly Pty Ltd

SLR Project No.: 610.18774.00000

21 January 2025

Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

Sound Power Level

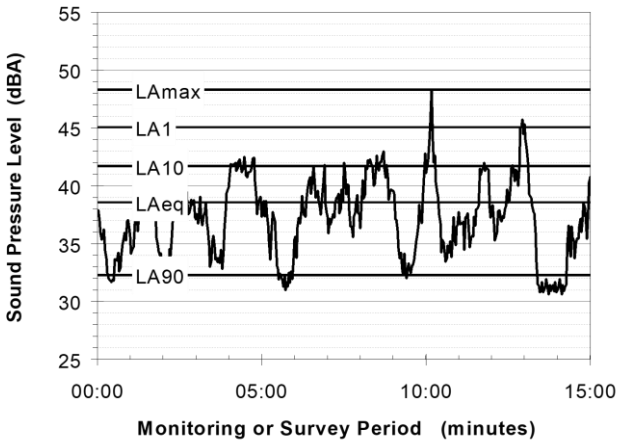
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

Frequency Analysis

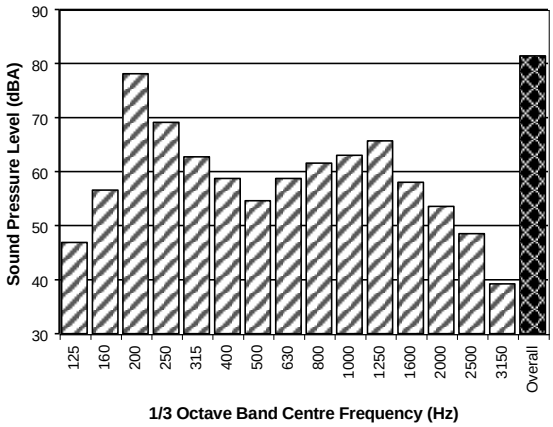
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- Tonality - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- Impulsiveness - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- Intermittency - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- Low Frequency Noise - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

Human Perception of Vibration

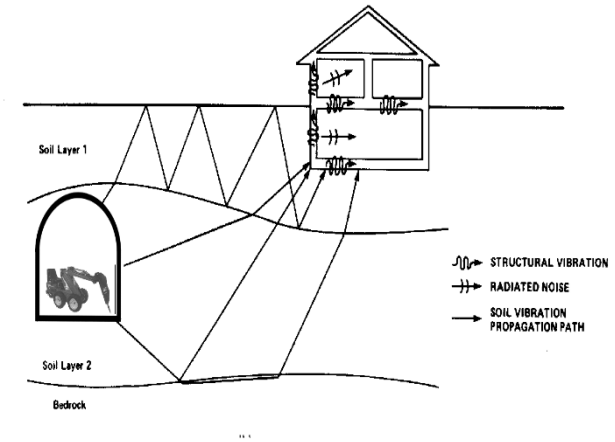
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

Appendix B Calibration Certificates

Airly Coal Mine

Annual Noise Monitoring December 2024

Centennial Airly Pty Ltd

SLR Project No.: 610.18774.00000

21 January 2025

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: SLM36946

EQUIPMENT TESTED: Sound Level Meter

Manufacturer:	B&K		
Type No:	2270	**Serial No:**	3029485
Mic. Type:	4189	**Serial No:**	3260622
Pre-Amp. Type:	ZC0032	**Serial No:**	30123
Filter Type:	1/3 Octave	**Test No:**	F036953

Owner: SLR Consulting Australia Pty Ltd
120 High Street
North Sydney, NSW 2060

Tests Performed: IEC 61672-3:2013 & IEC 61260-3:2016

Comments: All Test passed for Class 1. (See overleaf for details)

CONDITIONS OF TEST:

Ambient Pressure	1013	hPa ±1 hPa	**Date of Receipt :**	27/07/2023
Temperature	23	°C ±1° C	**Date of Calibration :**	01/08/2023
Relative Humidity	29	% ±5%	**Date of Issue :**	01/08/2023

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Hein Soe

Accredited for compliance with ISO/IEC 17025 - Calibration
Results of the tests, calibration and/or measurements included in this document are traceable to SI units through reference equipment that has been calibrated by the Australian National Measurement Institute or other NATA accredited laboratories demonstrating traceability.

This report applies only to the item identified in the report and may not be reproduced in part.

The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab No. 9262
Acoustic and Vibration Measurements

Acu-Vib Electronics
CALIBRATIONS SALES RENTALS REPAIRS

Head Office & Calibration Laboratory
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
(02) 9680 8133
www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: SLM39354

EQUIPMENT TESTED: Sound Level Meter

Manufacturer:	B&K		
Type No:	2270	**Serial No:**	3008204
Mic. Type:	B&K 4189	**Serial No:**	2983643
Pre-Amp. Type:	B&K ZC0032	**Serial No:**	29477
Filter Type:	1/3 Octave	**Test No:**	F039356

Owner: SLR Consulting Australia Pty Ltd
120 High Street
North Sydney, NSW 2060

Tests Performed: IEC 61672-3:2013 & IEC 61260-3:2016

Comments: All Test passed for Class 1. (See overleaf for details)

CONDITIONS OF TEST:

Ambient Pressure	997	hPa ±1 hPa	**Date of Receipt :**	02/04/2024
Temperature	25	°C ±1° C	**Date of Calibration :**	08/04/2024
Relative Humidity	54	% ±5%	**Date of Issue :**	08/04/2024

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: .....

AUTHORISED SIGNATURE: ..... Hein Soe

Accredited for compliance with ISO/IEC 17025 - Calibration

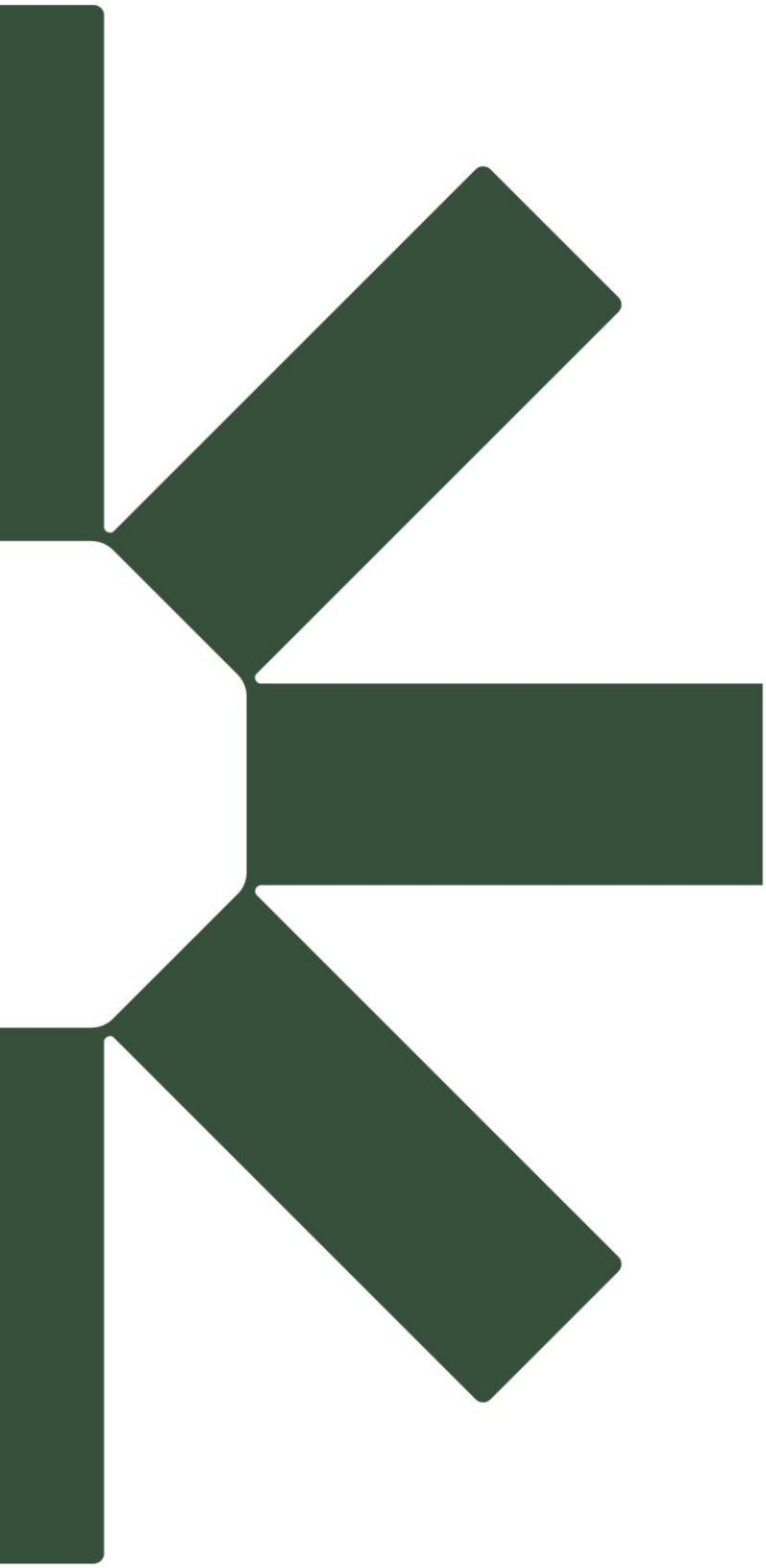
Results of the tests, calibration and/or measurements included in this document are traceable to SI units through reference equipment that has been calibrated by the Australian National Measurement Institute or other NATA accredited laboratories demonstrating traceability.

This report applies only to the item identified in the report and may not be reproduced in part.

The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

Acu-Vib Electronics
ACOUSTICS AND VIBRATIONS
Head Office & Calibration Laboratory
Unit 14, 22 Hudson Avenue, Castle Hill NSW 2154
(02) 9680 8133
www.acu-vib.com.au

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Laboratory No. 9262
Acoustic and Vibration Measurements



Making Sustainability Happen

Appendix 3: 2024 Air Quality Monitoring Results

CERTIFICATE OF ANALYSIS

Report Group	: **RGME2500004**	Page	: 1 of 38
Amendment	: **3**		
Client	: **CENTENNIAL COAL COMPANY**	Laboratory	: Environmental Division Mudgee
Contact	: Sam Price Airly Environmental Officer	Contact	: Customer Service (ALS Mudgee)
Address	: Glen Davis Road CAPERTEE NSW 2846	Address	: 1/29 Sydney Road Mudgee NSW Australia 2850
Telephone	: 6359 2107	Telephone	: 02 6372 6735
Project	:	Date Samples Received	: 09-Jan-2024 10:17
Sampler	: ----		
Quote number	: ----		
No. of samples received	: 170		
No. of samples analysed	: 170		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Descriptive Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Bronwyn Murphy (ALS Mudgee)	Environmental Services Representative	Laboratory - Mudgee, Mudgee, NSW
Erin Sessions (ALS Mudgee)		Laboratory - Mudgee, Mudgee, NSW
Mary Monds (ALS Mudgee)	Environmental Services Representative	Laboratory - Mudgee, Mudgee, NSW
Thomas Regan	Laboratory Technician	Laboratory - Mudgee, Mudgee, NSW
Thomas Regan	Laboratory Technician	Newcastle - Inorganics, Mayfield West, NSW
Zoran Grozdanovski	Team Leader - Chemistry	Newcastle - Inorganics, Mayfield West, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

Work Order Specific Comments

Work Order: **ME2400164**

- HVAS Site PM10: Sample pre-sample and post-sample runs not able to be conducted as per AS/NZS 3580.9.3 and 3580.9.6 specifications of 5 mins due to HVAS machine error. NATA accreditation does not apply for results reported in g/m2.month. Results should be scrutinised accordingly.

Work Order: **ME2400178**

- **HVAS Site PM10: Sample pre-sample and post-sample runs not able to be conducted as per AS/NZS 3580.9.3 and 3580.9.6 specifications of 5 mins due to HVAS machine error. Nata accreditation does not apply for results reported in g/m2.month. Results should be scrutinized accordingly.**

Work Order: **ME2400219**

- Only approved EPA methods for the analysis of air pollutants in New South Wales are used: Insoluble Solids by gravimetric AS3580.10.1 and in-house EA140 and EA141; Ash by gravimetric AS3580.10.1 and in-house EA120; Combustible matter by gravimetric AS3580.10.1 and in-house EA125.
- Dust analysis as per AS3580.10.1-2016. Samples passed through a 1mm sieve prior to analysis. NATA accreditation does not apply for results reported in deposition units e.g., g/m².mth where the sampling procedure is not NATA accredited. ALS Mudgee laboratory is NATA accredited for dust sampling, therefore ALS Mudgee reported deposition units are accredited.
- **Date in: 02/01/2024. Date out: 02/02/2024.**
- Date In: , Date Out: .
- EA119MU: NATA accreditation does not cover the performance of this service
  EA119MU: Ash - Including Dirt/Mineral Matter and Sand
  EA119MU: Fine Dark Particles - Including Coal and Soot
  EA119MU: Organic Matter - Including Insects, Vegeration, Polysaccharide Slime, Copper Sludge and Grain
- For dust analysis, the Limit of Reporting (LOR) referenced in the reports for deposited matter parameters represents the reporting increment rather than reporting limit.

Work Order: **ME2400252**

- **HVAS Site PM10: Sample Pre-sample and post-sample runs not able to be conducted as per AS/NZS 3580.9.3 and 3580.9.6 specifications of 5 mins due to HVAS machine error. NATA accreditation does not apply for results reported in g/m2.month. Results should be scrutinised accordingly.**

Work Order: **ME2400291**

- HVAS Site PM10: Flow rate calibration frequency outside AS/NZS 3580.9.6 specifications of ≤2 months due to unit being unresponsive. Results should be scrutinised accordingly.

Work Order: **ME2400412**

- Date In: 02/02/2024, Date Out: 04/03/2024.

Work Order: **ME2400430**
- **HVAS Site PM10: Flow rate calibration frequency outside AS/NZS 350.9.6 specifications of ≤ 2 months due to unit being unresponsive. Results should be scrutinised accordingly.**

Work Order: **ME2400444**
- **HVAS Site PM10: Flow rate calibration frequency outside AS/NZS 350.9.6 specifications of ≤ 2 months due to unit being unresponsive. Results should be scrutinised accordingly.**

Work Order: **ME2400546**
- Only approved EPA methods for the analysis of air pollutants in New South Wales are used; PM10 - AS 3580.9.6 and TSP by AS3580.9.3 and in-house method EA143; the concentration of TSP and PM10 in air, reported at 0oC and 101.3kPa.
- Only approved EPA methods for the sample collection of air pollutants in New South Wales are used; PM10 - AS 3580.9.6 and in-house method EN66.2 and TSP by AS3580.9.3 and in-house EN66.2.

Work Order: **ME2400580**
- **PM10: No sample - No data. Unit out for repair.**

Work Order: **ME2400593**
- Date In: 04/03/2024, Date Out: 03/04/2024.

Work Order: **ME2400630**
- **PM10: No sample - No. data Unit out for repair.**

Work Order: **ME2400690**
- **PM10: No sample - No data. Unit out for repair.**

Work Order: **ME2400731**
- **PM10: No sampe - Unit out for repairs.**

Work Order: **ME2400751**
- Date In: 03/04/2024, Date Out: 02/05/2024.

Work Order: **ME2400774**
- **PM10: No sample - Unit out for repairs.**

Work Order: **ME2400905**
- Date In: 02/05/2024, Date Out: 31/05/2024.

Work Order: **ME2401078**
- Dust analysis as per AS3580.10.1-2016. Samples passed through a 1mm sieve prior to analysis. NATA accreditation does not apply for results reported in deposition units e.g., g/m².mth where the sampling procedure is not NATA accredited.
- Date In: 31/05/2024, Date Out: 02/07/2024.

Work Order: **ME2401141**
- Unless otherwise stated, analytical work for this work order will be conducted at ALS Mudgee.

Work Order: **ME2401234**
- Unless otherwise stated, analytical work for this work order will be conducted at ALS Mudgee, NATA acceditation no. 825, site no. 15224.

Work Order: **ME2401241**
- **Dust analysis conducted by ALS Newcastle, NATA Accreditation No. 825, Site No. 1656.**

- Date In: 01/07/2024, Date Out: 01/08/2024.

Work Order: **ME2401303**

- **The siting of the HVAS TSP and HVAS PM10 units is compliant for all conditions for background stations as per AS/NZS 3580.1.1 Guide to siting air monitoring equipment and EN66.2. All siting conditions, as per AS/NZS 3580.1.1, are checked in the annual site audit and no new non-compliance was noted during this sampling event.**

Work Order: **ME2401330**

- The siting of the HVAS TSP and PM10 units is compliant for the conditions of background stations as per AS/NZS 3580.1.1 and EN66.2.

Work Order: **ME2401394**

- Date In: 01/08/2024, Date Out: 30/08/2024.

Work Order: **ME2401572**

- Date In: 30/08/2024, Date Out: 01/10/2024.

Work Order: **ME2401655**

- **HVAS Site TSP & PM10: Sample exposure period outside AS/NZS 3580.9.3 and 3580.9.6 specifications of 24 ± 1 hour due to power outage .**

Work Order: **ME2401733**

- Date In: 01/10/2024, Date Out: 31/10/2024.

Work Order: **ME2401898**

- Date In: 31/10/2024, Date Out: 02/12/2024.

Work Order: **ME2401985**

- Monthly Maintenance is conducted for PM10 by AS 3580.9.6 and in-house method EN66.2 and TSP by AS3580.9.3 and in-house EN66.2.

Work Order: **ME2500005**

- Date In: 02/12/2024, Date Out: 02/01/2025.
- Only approved EPA methods for the sample collection of air pollutants in New South Wales are used; Atmospheric dust fall by AS 3580.10.1 and in-house EN66.1.

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	06-Jan-2024 00:00	06-Jan-2024 00:00	12-Jan-2024 00:00	12-Jan-2024 00:00	18-Jan-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400056-001	ME2400056-002	ME2400102-001	ME2400102-002	ME2400164-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**13.3**	**----**	**17.3**	**----**	**8.7**
PM10	----	1.0	µg/m³	**----**	**9.6**	**----**	**15.6**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**18.8**	**----**	**24.1**	**----**	**12.0**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**13.7**	**----**	**21.8**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	18-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	30-Jan-2024 00:00	30-Jan-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400164-002	ME2400178-001	ME2400178-002	ME2400209-001	ME2400209-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**16.0**	**----**	**24.7**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**22.2**	**----**	**34.1**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**7.9**	**----**	**13.8**	**----**	**24.2**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	05-Feb-2024 00:00	05-Feb-2024 00:00	11-Feb-2024 00:00	11-Feb-2024 00:00	17-Feb-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400252-001	ME2400252-002	ME2400291-001	ME2400291-002	ME2400339-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**28.7**	**----**	**16.5**	**----**	**13.5**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**38.3**	**----**	**23.0**	**----**	**18.5**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**24.3**	**----**	**15.8**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	17-Feb-2024 00:00	23-Feb-2024 00:00	23-Feb-2024 00:00	29-Feb-2024 00:00	29-Feb-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400339-002	ME2400363-001	ME2400363-002	ME2400430-001	ME2400430-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**28.9**	**----**	**31.6**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**39.0**	**----**	**42.6**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**12.5**	**----**	**17.1**	**----**	**23.7**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	06-Mar-2024 00:00	06-Mar-2024 00:00	12-Mar-2024 00:00	12-Mar-2024 00:00	18-Mar-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400444-001	ME2400444-002	ME2400493-001	ME2400493-002	ME2400516-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**21.7**	**----**	**25.3**	**----**	**7.3**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**29.8**	**----**	**34.7**	**----**	**10.1**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**18.0**	**----**	**22.2**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	TSP
			Sampling date / time	18-Mar-2024 00:00	24-Mar-2024 00:00	24-Mar-2024 00:00	30-Mar-2024 00:00	05-Apr-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400516-002	ME2400546-001	ME2400546-002	ME2400580-001	ME2400630-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**9.4**	**----**	**21.2**	**5.0**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**13.0**	**----**	**29.5**	**7.1**
PM10 (mass per filter)	----	0.1	mg/filter	**7.4**	**----**	**0.2**	**----**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	TSP	TSP	TSP	TSP
			Sampling date / time	11-Apr-2024 00:00	17-Apr-2024 00:00	23-Apr-2024 00:00	29-Apr-2024 00:00	05-May-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400661-001	ME2400690-001	ME2400716-001	ME2400731-001	ME2400774-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**8.8**	**17.8**	**8.6**	**12.1**	**1.9**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**12.4**	**24.9**	**12.1**	**17.1**	**2.7**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	11-May-2024 00:00	11-May-2024 00:00	17-May-2024 00:00	17-May-2024 00:00	23-May-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400803-001	ME2400803-002	ME2400847-001	ME2400847-002	ME2400869-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**2.7**	**----**	**15.3**	**----**	**6.8**
PM10	----	1.0	µg/m³	**----**	**2.0**	**----**	**11.5**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**3.8**	**----**	**21.7**	**----**	**9.8**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**2.9**	**----**	**16.5**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	23-May-2024 00:00	29-May-2024 00:00	29-May-2024 00:00	04-Jun-2024 00:00	04-Jun-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400869-002	ME2400896-001	ME2400896-002	ME2400939-001	ME2400939-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**9.7**	**----**	**10.1**	**----**
PM10	----	1.0	µg/m³	**4.6**	**----**	**6.3**	**----**	**9.4**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**13.9**	**----**	**14.6**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**6.8**	**----**	**9.1**	**----**	**13.7**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	10-Jun-2024 00:00	10-Jun-2024 00:00	16-Jun-2024 00:00	16-Jun-2024 00:00	22-Jun-2024 00:00
Compound	CAS Number	LOR	Unit	ME2400988-001	ME2400988-002	ME2401002-001	ME2401002-002	ME2401039-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**4.4**	**----**	**2.5**	**----**	**3.9**
PM10	----	1.0	µg/m³	**----**	**3.1**	**----**	**1.2**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**6.4**	**----**	**3.6**	**----**	**5.6**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**4.5**	**----**	**1.8**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	22-Jun-2024 00:00	28-Jun-2024 00:00	28-Jun-2024 00:00	04-Jul-2024 00:00	04-Jul-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401039-002	ME2401065-001	ME2401065-002	ME2401100-001	ME2401100-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**3.8**	**----**	**7.9**	**----**
PM10	----	1.0	µg/m³	**1.7**	**----**	**2.8**	**----**	**5.5**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**5.5**	**----**	**11.5**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**2.5**	**----**	**4.1**	**----**	**8.0**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	10-Jul-2024 00:00	10-Jul-2024 00:00	16-Jul-2024 00:00	16-Jul-2024 00:00	22-Jul-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401141-001	ME2401141-002	ME2401166-001	ME2401166-002	ME2401200-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**1.4**	**----**	**2.7**	**----**	**4.8**
PM10	----	1.0	µg/m³	**----**	**1.7**	**----**	**1.2**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**2.0**	**----**	**3.9**	**----**	**7.1**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**2.4**	**----**	**1.7**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	22-Jul-2024 00:00	28-Jul-2024 00:00	28-Jul-2024 00:00	03-Aug-2024 00:00	03-Aug-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401200-002	ME2401234-001	ME2401234-002	ME2401291-001	ME2401291-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**3.3**	**----**	**6.3**	**----**
PM10	----	1.0	µg/m³	**4.3**	**----**	**2.4**	**----**	**4.1**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**4.8**	**----**	**9.3**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**6.4**	**----**	**3.5**	**----**	**6.1**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	09-Aug-2024 00:00	09-Aug-2024 00:00	15-Aug-2024 00:00	15-Aug-2024 00:00	21-Aug-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401303-001	ME2401303-002	ME2401330-001	ME2401330-002	ME2401360-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**8.7**	**----**	**3.0**	**----**	**15.0**
PM10	----	1.0	µg/m³	**----**	**6.1**	**----**	**1.9**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**12.7**	**----**	**4.3**	**----**	**21.5**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**9.0**	**----**	**2.8**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	21-Aug-2024 00:00	27-Aug-2024 00:00	27-Aug-2024 00:00	02-Sep-2024 00:00	02-Sep-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401360-002	ME2401385-001	ME2401385-002	ME2401416-001	ME2401416-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**7.8**	**----**	**27.3**	**----**
PM10	----	1.0	µg/m³	**8.8**	**----**	**4.1**	**----**	**12.6**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**11.3**	**----**	**36.0**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**12.6**	**----**	**6.0**	**----**	**16.7**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	08-Sep-2024 00:00	08-Sep-2024 00:00	14-Sep-2024 00:00	14-Sep-2024 00:00	20-Sep-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401447-001	ME2401447-002	ME2401495-001	ME2401495-002	ME2401518-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**14.6**	**----**	**11.2**	**----**	**17.0**
PM10	----	1.0	µg/m³	**----**	**8.4**	**----**	**4.9**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**20.7**	**----**	**16.1**	**----**	**23.9**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**12.1**	**----**	**7.1**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	20-Sep-2024 00:00	26-Sep-2024 00:00	26-Sep-2024 00:00	02-Oct-2024 00:00	02-Oct-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401518-002	ME2401561-001	ME2401561-002	ME2401584-001	ME2401584-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**6.0**	**----**	**20.6**	**----**
PM10	----	1.0	µg/m³	**7.4**	**----**	**4.8**	**----**	**13.6**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**8.6**	**----**	**29.3**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**10.5**	**----**	**6.9**	**----**	**19.7**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	08-Oct-2024 00:00	08-Oct-2024 00:00	20-Oct-2024 00:00	20-Oct-2024 00:00	26-Oct-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401621-001	ME2401621-002	ME2401678-001	ME2401678-002	ME2401706-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**13.8**	**----**	**15.8**	**----**	**29.4**
PM10	----	1.0	µg/m³	**----**	**7.3**	**----**	**9.9**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**19.6**	**----**	**22.1**	**----**	**41.6**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**10.5**	**----**	**14.1**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	26-Oct-2024 00:00	01-Nov-2024 00:00	01-Nov-2024 00:00	07-Nov-2024 00:00	07-Nov-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401706-002	ME2401750-001	ME2401750-002	ME2401783-001	ME2401783-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**17.8**	**----**	**26.2**	**----**
PM10	----	1.0	µg/m³	**14.6**	**----**	**11.0**	**----**	**15.5**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**24.8**	**----**	**35.5**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**20.9**	**----**	**15.6**	**----**	**21.5**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	13-Nov-2024 00:00	13-Nov-2024 00:00	19-Nov-2024 00:00	19-Nov-2024 00:00	25-Nov-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401815-001	ME2401815-002	ME2401847-001	ME2401847-002	ME2401880-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**14.0**	**----**	**26.0**	**----**	**30.4**
PM10	----	1.0	µg/m³	**----**	**9.2**	**----**	**19.0**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**19.3**	**----**	**36.1**	**----**	**40.6**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**12.7**	**----**	**26.3**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	TSP	PM10
			Sampling date / time	25-Nov-2024 00:00	01-Dec-2024 00:00	01-Dec-2024 00:00	07-Dec-2024 00:00	07-Dec-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401880-002	ME2401919-001	ME2401919-002	ME2401948-001	ME2401948-002
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**11.6**	**----**	**12.5**	**----**
PM10	----	1.0	µg/m³	**19.4**	**----**	**8.1**	**----**	**9.0**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**15.8**	**----**	**16.8**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**25.9**	**----**	**11.0**	**----**	**12.1**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	TSP	PM10	TSP	PM10	TSP
			Sampling date / time	13-Dec-2024 00:00	13-Dec-2024 00:00	19-Dec-2024 00:00	19-Dec-2024 00:00	25-Dec-2024 00:00
Compound	CAS Number	LOR	Unit	ME2401985-001	ME2401985-002	ME2402029-001	ME2402029-002	ME2402034-001
				Result	Result	Result	Result	Result
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**26.7**	**----**	**27.9**	**----**	**24.6**
PM10	----	1.0	µg/m³	**----**	**15.8**	**----**	**18.3**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**35.8**	**----**	**38.6**	**----**	**33.6**
PM10 (mass per filter)	----	0.1	mg/filter	**----**	**21.2**	**----**	**25.2**	**----**

Analytical Results

Sub-Matrix: AIR (Matrix: AIR)			Sample ID	PM10	TSP	PM10	----	----
			Sampling date / time	25-Dec-2024 00:00	31-Dec-2024 00:00	31-Dec-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	ME2402034-002	ME2500008-001	ME2500008-002	--------	--------
				Result	Result	Result	----	----
EA143: Particulates in Air								
Total Suspended Particulates	----	1.0	µg/m³	**----**	**46.1**	**----**	**----**	**----**
PM10	----	1.0	µg/m³	**13.4**	**----**	**36.2**	**----**	**----**
EA143: Particulates in Air - HVAFs								
Total Suspended Particulates (mass per filter)	----	0.1	mg/filter	**----**	**62.8**	**----**	**----**	**----**
PM10 (mass per filter)	----	0.1	mg/filter	**18.2**	**----**	**49.4**	**----**	**----**

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM1	DM2	DM3	DM4	DM1
				Sampling date / time	02-Feb-2024 12:36	02-Feb-2024 10:44	02-Feb-2024 11:17	02-Feb-2024 11:51	04-Mar-2024 10:50
Compound	CAS Number	LOR	Unit		ME2400219-001	ME2400219-002	ME2400219-003	ME2400219-004	ME2400412-001
					Result	Result	Result	Result	Result
EA119MU: Characterisation of Particulates									
ø Ash	----	5	%		----	----	50	----	----
ø Fine Dark Particles	----	5	%		----	----	<5	----	----
ø Organic Matter	----	5	%		----	----	50	----	----
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		31	31	31	31	31
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		0.2	0.5	2.2	0.2	0.2
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		0.1	0.4	2.5	0.2	0.1
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		104	144	146	131	51
EA130: Volume									
Volume	----	1	mL		1810	2570	2350	2110	1130
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		0.3	0.9	4.7	0.4	0.3

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM2	DM3	DM4	DM1	DM2
				Sampling date / time	04-Mar-2024 09:57	04-Mar-2024 10:20	04-Mar-2024 11:15	03-Apr-2024 10:59	03-Apr-2024 09:53
Compound	CAS Number	LOR	Unit		ME2400412-002	ME2400412-003	ME2400412-004	ME2400593-001	ME2400593-002
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		----	----	----	30	30
Time(days)	----	1	days		31	31	31	----	----
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		----	----	----	0.2	0.1
Ash Content	----	0.1	g/m².month		0.3	1.4	0.2	----	----
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		----	----	----	0.2	<0.1
Combustible Matter	----	0.1	g/m².month		0.1	1.6	0.1	----	----
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		----	----	----	57	53
Calculated Rainfall	----	1	mm		63	52	48	----	----
EA130: Volume									
Volume	----	1	mL		----	----	----	1020	945
Volume	----	1	mL		830	770	770	----	----
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		----	----	----	0.4	0.1
Total Insoluble Matter	----	0.1	g/m².month		0.4	3.0	0.3	----	----

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM3	DM4	DM1	DM2	DM3
				Sampling date / time	03-Apr-2024 10:13	03-Apr-2024 10:34	02-May-2024 10:54	02-May-2024 09:47	02-May-2024 10:07
Compound	CAS Number	LOR	Unit		ME2400593-003	ME2400593-004	ME2400751-001	ME2400751-002	ME2400751-003
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		30	30	29	29	29
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		0.2	0.2	<0.1	0.1	1.6
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		<0.1	<0.1	0.3	<0.1	1.7
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		50	58	123	123	136
EA130: Volume									
Volume	----	1	mL		896	924	2210	2200	2440
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		0.2	0.2	0.3	0.1	3.3

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM4	DM1	DM2	DM3	DM4
				Sampling date / time	02-May-2024 10:30	31-May-2024 13:50	31-May-2024 12:38	31-May-2024 13:02	31-May-2024 13:26
Compound	CAS Number	LOR	Unit		ME2400751-004	ME2400905-001	ME2400905-002	ME2400905-003	ME2400905-004
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		**29**	**29**	**29**	**29**	**29**
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		<0.1	**0.3**	**0.1**	**0.2**	**0.1**
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		**0.5**	**0.1**	<0.1	<0.1	**0.1**
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		**142**	**60**	**70**	**71**	**75**
EA130: Volume									
Volume	----	1	mL		**2290**	**1070**	**1260**	**1270**	**1200**
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		**0.5**	**0.4**	**0.1**	**0.2**	**0.2**

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM1	DM2	DM3	DM4	DM1
				Sampling date / time	02-Jul-2024 10:38	02-Jul-2024 09:54	02-Jul-2024 10:12	02-Jul-2024 10:55	01-Aug-2024 10:55
Compound	CAS Number	LOR	Unit		ME2401078-001	ME2401078-002	ME2401078-003	ME2401078-004	ME2401241-001
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		32	32	32	32	31
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		0.1	0.1	0.1	0.1	0.1
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		<0.1	<0.1	<0.1	<0.1	0.1
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		60	63	56	69	44
EA130: Volume									
Volume	----	1	mL		1080	1130	1010	1100	792
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		0.1	0.1	0.1	0.1	0.2

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM2	DM3	DM4	DM1	DM2
				Sampling date / time	01-Aug-2024 09:47	01-Aug-2024 10:08	01-Aug-2024 10:34	30-Aug-2024 10:30	30-Aug-2024 09:44
Compound	CAS Number	LOR	Unit		ME2401241-002	ME2401241-003	ME2401241-004	ME2401394-001	ME2401394-002
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		31	31	31	29	29
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		0.1	0.1	<0.1	0.1	0.1
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		0.2	0.2	0.4	0.2	0.1
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		47	46	50	37	39
EA130: Volume									
Volume	----	1	mL		841	817	804	670	700
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		0.3	0.3	0.4	0.3	0.2

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM3	DM4	DM1	DM2	DM3
				Sampling date / time	30-Aug-2024 10:06	30-Aug-2024 10:48	01-Oct-2024 11:52	01-Oct-2024 10:41	01-Oct-2024 10:59
Compound	CAS Number	LOR	Unit		ME2401394-003	ME2401394-004	ME2401572-001	ME2401572-002	ME2401572-003
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		29	29	32	32	32
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		0.1	0.1	0.2	0.1	0.1
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		0.3	0.5	0.2	0.1	0.2
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		37	42	36	38	37
EA130: Volume									
Volume	----	1	mL		664	678	655	688	666
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		0.4	0.6	0.3	0.2	0.3

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM4	DM1	DM2	DM3	DM4
				Sampling date / time	01-Oct-2024 11:34	31-Oct-2024 11:32	31-Oct-2024 09:51	31-Oct-2024 10:12	31-Oct-2024 11:15
Compound	CAS Number	LOR	Unit		ME2401572-004	ME2401733-001	ME2401733-002	ME2401733-003	ME2401733-004
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		**32**	**30**	**30**	**30**	**30**
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		**0.1**	**0.2**	**0.1**	**0.1**	**0.1**
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		**0.1**	<0.1	<0.1	<0.1	<0.1
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		**40**	**22**	**24**	**21**	**22**
EA130: Volume									
Volume	----	1	mL		**725**	**389**	**424**	**378**	**397**
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		**0.2**	**0.2**	**0.1**	**0.1**	**0.1**

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM1	DM2	DM3	DM4	DM1
				Sampling date / time	02-Dec-2024 10:38	02-Dec-2024 09:57	02-Dec-2024 10:13	02-Dec-2024 11:01	02-Jan-2025 10:03
Compound	CAS Number	LOR	Unit		ME2401898-001	ME2401898-002	ME2401898-003	ME2401898-004	ME2500005-001
					Result	Result	Result	Result	Result
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		32	32	32	32	31
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		0.4	0.2	0.2	0.2	0.2
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		0.2	0.2	0.2	0.1	0.2
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		96	60	67	92	27
EA130: Volume									
Volume	----	1	mL		1710	1080	1200	1670	480
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		0.6	0.4	0.4	0.3	0.4

Analytical Results

Sub-Matrix: DEPOSITIONAL DUST (Matrix: AIR)				Sample ID	DM2	DM3	DM4	----	----
				Sampling date / time	02-Jan-2025 09:16	02-Jan-2025 09:42	02-Jan-2025 10:26	----	----
Compound	CAS Number	LOR	Unit		ME2500005-002	ME2500005-003	ME2500005-004	--------	--------
					Result	Result	Result	----	----
EA120 - EA142: Days Exposed									
Time(days)	----	1	days		**31**	**31**	**31**	**----**	**----**
EA120: Ash Content									
Ash Content	----	0.1	g/m².month		**0.3**	**0.3**	**0.3**	**----**	**----**
EA125: Combustible Matter									
Combustible Matter	----	0.1	g/m².month		**0.1**	**0.2**	**0.1**	**----**	**----**
EA130: Calculated Rainfall									
Calculated Rainfall	----	1	mm		**52**	**53**	**53**	**----**	**----**
EA130: Volume									
Volume	----	1	mL		**935**	**942**	**971**	**----**	**----**
EA141: Total Insoluble Matter									
Total Insoluble Matter	----	0.1	g/m².month		**0.4**	**0.5**	**0.4**	**----**	**----**

Analytical Results

Descriptive Results

Sub-Matrix: **AIR**

Method: Compound	Sample ID - Sampling date / time	Analytical Results
EN66.2 Sampling, Site Audit & Flow Rate Measurement of HVAS		
EN66.2: Monthly Maintenance	TSP - 17-Feb-2024 00:00	20/02/2024
EN66.2: Monthly Maintenance	PM10 - 17-Feb-2024 00:00	20/02/2024
EN66.2: Monthly Maintenance	TSP - 17-Apr-2024 00:00	18/04/2024
EN66.2: Monthly Maintenance	TSP - 04-Jun-2024 00:00	06/06/2024
EN66.2: Monthly Maintenance	PM10 - 04-Jun-2024 00:00	06/06/2024
EN66.2: Monthly Maintenance	TSP - 15-Aug-2024 00:00	16/08/2024
EN66.2: Monthly Maintenance	PM10 - 15-Aug-2024 00:00	16/08/2024
EN66.2: Monthly Maintenance	TSP - 20-Oct-2024 00:00	21/10/2024
EN66.2: Monthly Maintenance	PM10 - 20-Oct-2024 00:00	21/10/2024
EN66.2: Monthly Maintenance	TSP - 19-Nov-2024 00:00	20/11/2024
EN66.2: Monthly Maintenance	PM10 - 19-Nov-2024 00:00	20/11/2024
EN66.2: Monthly Maintenance	TSP - 13-Dec-2024 00:00	16/12/2024
EN66.2: Monthly Maintenance	PM10 - 13-Dec-2024 00:00	16/12/2024
EN66.2: No Sample	PM10 - 30-Mar-2024 00:00	Unit out for repair
EN66.2: No Sample	PM10 - 05-Apr-2024 00:00	Unit out for repair
EN66.2: No Sample	PM10 - 11-Apr-2024 00:00	Unit out for repair
EN66.2: No Sample	PM10 - 17-Apr-2024 00:00	Unit out for repair
EN66.2: No Sample	PM10 - 23-Apr-2024 00:00	Unit out for repair
EN66.2: No Sample	PM10 - 29-Apr-2024 00:00	Unit out for repairs.
EN66.2: No Sample	PM10 - 05-May-2024 00:00	Unit out for repairs
EN66.2: No Sample	TSP - 14-Oct-2024 00:00	See comments.
EN66.2: No Sample	PM10 - 14-Oct-2024 00:00	See comments.

Inter-Laboratory Testing

Analysis conducted by ALS Newcastle, NATA accreditation no. 825, site no. 1656 (Chemistry / Biology). Only applies to samples ME2400593 (001, 002, 003, 004) ME2400751 (001, 002, 003, 004) ME2400905 (001, 002, 003, 004) ME2401078 (001, 002, 003, 004) ME2401241 (001, 002, 003, 004) ME2401394 (001, 002, 003, 004) ME2401572 (001, 002, 003, 004) ME2401733 (001, 002, 003, 004) ME2401898 (001, 002, 003, 004) ME2500005 (001, 002, 003, 004).

(AIR) EA125: Combustible Matter

(AIR) EA120: Ash Content

(AIR) EA130: Calculated Rainfall

(AIR) EA130: Volume

(AIR) EA141: Total Insoluble Matter

(AIR) EA120 - EA142: Days Exposed

Appendix 4: Airly Mine Seasonal Ecological (Flora and Fauna) 2024 Monitoring Report

AIRLY BMP SEASONAL ECOLOGICAL MONITORING

Flora and Fauna Monitoring Report 2024



17788
F1
24 March 2025

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D1	Draft report for client review – awaiting bat call analysis	Rebecca Cocks and Abbie Ferris	Tara Boreham	Chris Wellington	28/02/2025
F1	Final report following client review	Tara Boreham		Tara Boreham	24/03/2025

Approval for issue

Chris Wellington  28 February 2025

This report was prepared by RPS within the terms of RPS' engagement with its client and in direct response to a scope of services. This report is supplied for the sole and specific purpose for use by RPS' client. The report does not account for any changes relating the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report. RPS does not accept any responsibility or liability for loss whatsoever to any third party caused by, related to or arising out of any use or reliance on the report.

Prepared by:

RPS

Abbie Ferris
Ecologist

Unit 2A, 45 Fitzroy Street
Carrington NSW 2294

T +61 2 4940 4200
E abbie.ferris@rpsconsulting.com

Prepared for:

Centennial – Airly

Sam Price
Environment and Community Coordinator

319 Glen Davis Drive
Capertee, NSW, 2946

T 02 6357 9206
E sam.price@centennialcoal.com.au

EXECUTIVE SUMMMARY

Centennial Airly Pty Ltd (Centennial Airly) operates an approved coal mining lease to extract thermal coal at Airly and Genowlan Mountains, which form part of the Mugii Murum-ban State Conservation Area (SCA). Approval for the Airly Mine is specified under State Significant Development 5581 (SSD-5581).

Biodiversity monitoring throughout the Development Consent Area for SSD-5581 (i.e., the management area) is currently being undertaken in compliance with the Biodiversity Management Plan Western Region (Western Region BMP; Centennial 2019) and relevant Extraction Plan (EP) specific Biodiversity Management Plans (BMPs) required by consent Schedule 4, Condition 15 of SSD-5581.

Areas of biodiversity significance within the management area include *Biodiversity Conservation Act 2016* (BC Act) and *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened ecological communities (TECs), Groundwater Dependant Ecosystems (GDEs) and BC Act and EPBC Act threatened species and their habitats, situated within the management area, including:

- TECs:
  - *Allocasuarina* nana Heathland
  - White Box – Yellow Box – Blakely's Red Gum Woodland Critically Endangered Ecological Community (CEEC).
- GDEs
  - MU 13: Tableland Gully Ribbon Gum - Blackwood - Apple Box Forest
  - MU 21: Capertee - Wolgan Slopes Red Box - Grey Gum - Stringybark Grassy Open Forest.
- Threatened flora:
  - *Prostanthera stricta* (Mount Vincent Mint-bush)
  - *Eucalyptus cannonii* (Capertee Stringybark)
  - *Pultenaea sp*. Genowlan Point.
- Threatened fauna:
  - Glossy-black Cockatoos (*Calyptorhynchus lathami*)
  - Forest owls;
  - Woodland birds
  - Cave-dwelling Microchiropteran bats (microbat).

The monitoring program has been, and will continue to be, conducted in line with SSD-5581 with the exception of the areas which have restricted access and are being monitored by NSW National Parks and Wildlife Service (NPWS), that is *Pultenaea sp*. Genowlan Point and Genowlan Point *Allocasuarina nana* Heathland.

This annual monitoring addresses the biodiversity-related conditions of consent outlined in SSD-5581. Schedule 3, Condition 2 of the SSD-5581 development consent specifies the following performance measures:

1. Gap and Genowlan Creeks: Negligible environmental consequences to water quality and to bed and bank stability; no greater environmental consequences than predicted in the EIS to water flows (including baseflow).
2. The Grotto: Negligible subsidence impacts or environmental consequences.
3. Threatened species, threatened populations, EECs and groundwater dependent ecosystems (with the exception of those listed below): Negligible environmental consequences.
4. *Pultenaea sp.* Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community: No environmental consequences.

This monitoring report comprises information pertaining to performance measure three and provides baseline biodiversity data for the performance measures one and two. Performance measure 4 is addressed in a separate monitoring report prepared by National Parks and Wildlife Services (NPWS).

The 2024 monitoring results have displayed that threatened species, threatened populations, TECs and groundwater dependent ecosystems are still persisting in the management area, with negligible environmental consequences. Further discussion is provided below.

White Box – Yellow Box – Blakely's Red Gum Woodland CEEC

Native plant species richness within the four White Box – Yellow Box – Blakely's Red Gum Woodland Plots has significantly reduced since baseline (2015 – 2016). However, it is comparable to that of 2017, 2018 and 2023. Vegetation integrity (VI) scores have been calculated for year 2019 to 2024 in line with the Biodiversity Assessment Method (BAM; DPE 2020) of which the 2024 composition, function and VI scores are not significantly different in comparison to the 2019 to 2020 baseline.

Groundwater Dependent Ecosystems

Eleven GDE plots were surveyed in the 2024 monitoring period. Two are located within the Point Hatteras Extraction Plan Area; seven are located within the Grotto supporting the Cliff Line Zone Extraction Plan and are in baseline; and two are control plots located away from mining activity. As mining within the Point Hatteras Extraction Plan Area is complete (see **Section 1.1**), Point Hatteras is now considered an impact area. In comparison to the baseline, no significant changes were recorded across the BAM scores. Therefore, SSD compliance has been met. Within corresponding control plots, a significant decrease in composition scores was recorded between baseline and 2024 suggesting that changes in BAM scores are likely due to broader environmental factors.

Exotic flora species

A total of 26 exotic species were detected in the management area. There has been a slight decrease in exotic species cover in 2024 compared to the 2023 monitoring period. BAM plot 1 has the highest weed cover due to a high grass cover of *Phalaris aquatica* within the riparian area. All weed species have associated management requirements under the *Biosecurity Act 2015*.

Prostanthera stricta

The mean percent cover of *P. stricta* in 2024 has not significantly changed since 2023, however it has significantly increased in comparison to 2016, 2017, 2019 and 2020. At Genowlan Trig, the percent cover of *P. stricta* has significantly increased compared to 2016, 2017 and 2018 collectively for the second year in a row.

Eucalyptus cannonii

A total of 26 *E. cannonii* individuals were monitored. Individual *E. cannonii* trees were measured based on tree condition (canopy density and extent %), size (height and diameter) and contextual data. Data was averaged across the population based on the monitoring location of the individuals.

The following significant *E. cannonii* results were identified by the analysis:

- Crown density has significantly increased since 2016/2017 monitoring years at the Mount Airly and control populations
- The average crown extent within the Mount Airly population has significantly decreased since 2016/2017
- A significant increase in height was observed in the control population between 2016/2017 and 2024
- No significant variation in DBH has been observed across the populations.

Crown density increases may be correlated with crown extent decreases as changes in tree growth strategies occur (Li et al., 2022). Further to this, crown extent may not be the most reliable indicator of tree health as it varies with tree age. Generally, as a tree ages, crown extent is likely to be proportionally less, when compared to the size of the tree. Therefore, crown density may be a more reliable indicator of tree health.

Glossy-black Cockatoos (*Calyptorhynchus lathami*)

The presence of Glossy black-cockatoos was confirmed through a sighting of eight individuals at Genowlan Point (monitoring point ten), acoustic recording, and the presence of *Allocasurina* orts at seven of the ten monitoring locations.

Forest owls

No roost sites displayed evidence of use (i.e., whitewash and pellets) and Site 2 remains inaccessible due to landslides. However, a Powerful Owl (*Ninox strenua*; BC Act: Vulnerable) and a Sooty Owl (*Tyto tenebricosa*; BC Act: Vulnerable) were observed during spotlighting and Southern Boobook (*Ninox novaeseelandiae*) were detected across the management area, suggesting that large forest owls persist within the Airly Mining Lease Area.

Woodland birds

Three of the 71 bird species recorded during diurnal surveys are listed as Vulnerable under the BC Act which include Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable; EPBC Act: Endangered), Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable; EPBC Act: Vulnerable), and Dusky Woodswallow (*Artamus cyanopterus cyanopterus*: BC Act Vulnerable). No significant changes were noted in bird species richness, therefore it is deemed that this is stable across the management area.

Cave-dwelling microbats

Two of the three target microbat species were detected at a definite confidence level during the monitoring period, being the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and the Large-eared Pied-bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable). Whilst not definite, it is likely that given the high number of calls, and location at a known bat roost, the Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*) is also roosting in the management area. The adits continue to support a maternity colony of Eastern Horseshoe Bats.

Other targeted fauna/vertebrate census

Of the 18 native vertebrate species (excluding birds and microbats) detected during the 2024 monitoring period, two are listed as threatened under the BC Act and/or EPBC Act. Spotted-tailed Quoll (*Dasyurus maculatus;* BC Act: Vulnerable; EPBC Act: Endangered) was observed on a camera trap for the first time in the management area since 2012, and two Yellow-bellied Gliders (*Petaurus australis*; BC Act: Vulnerable) were observed during nocturnal spotlighting/call playback surveys. This is the first record of the species in a 15 km radius from Airly Mine.

Feral species

A cat (*Felis catus*) was the only feral fauna species recorded on camera traps during the 2024 monitoring period. This is a notable drop in pest species since 2023, which, in addition to cats, recorded the European rabbit (*Oryctolagus cuniculus*), pigs (*Sus scrofa*) and foxes (*Vulpes vulpes*). Centennial Airly actively participate in feral species management strategies (Airly Cat Trapping Program, Local Land Services District Wild Dog Control, engaging third-party feral species control). This decrease in recorded feral species indicates management strategies employed by Centennial Airly are having success. Pest control is an ongoing recommendation that is upheld by Centennial.

Contents

EXECUTIVE SUMMMARY ..... **II**

1 INTRODUCTION **1**
1.1 Management area 1
1.2 Objectives 2
1.3 Compliance 5

2 METHODS **6**
2.1 Overview 6
2.1.1 Monitoring approach 6
2.1.2 Airly monitoring program 6
2.1.3 Limitations 7
2.2 Vegetation community 7
2.2.1 White Box – Yellow Box – Blakely's Red Gum Woodland 8
2.2.2 Groundwater Dependent Ecosystems 9
2.2.3 Exotic species 11
2.3 Flora 13
2.3.1 *Eucalyptus cannonii* (Capertee Stringybark) 13
2.3.2 *Prostanthera stricta* (Mount Vincent Mint-bush) 16
2.4 Fauna 16
2.4.1 Glossy black-cockatoos 16
2.4.2 Forest owls 17
2.4.3 Woodland birds 17
2.4.4 Cave-dwelling microbats 18
2.4.5 Vertebrate census 19
2.5 Survey timing and weather 21

3 RESULTS **23**
3.1 Vegetation community 23
3.1.1 White Box – Yellow Box – Blakely's Red Gum Woodland 23
3.1.2 Groundwater Dependent Ecosystems 25
3.1.3 Exotic species 31
3.2 Flora results 32
3.2.1 *Prostanthera stricta* (Mount Vincent Mint-bush) 32
3.2.2 *Eucalyptus cannonii* (Capertee Stringybark) 33
3.3 Fauna results 35
3.3.1 Glossy black-cockatoos 35
3.3.2 Forest owls 36
3.3.3 Woodland birds 36
3.3.4 Cave-dwelling microbats 38
3.3.5 Vertebrate census 39
3.3.6 Feral species 40

4 COMPLIANCE **42**

5 CONCLUSION **45**
5.1 Vegetation communities 45
5.2 Flora 45
5.3 Fauna 46

6 REFERENCES **47**

Tables

Table 1-1: Centennial Airly BMPs....1
Table 1-2: Biodiversity related subsidence impact performance measures (Schedule 3 - condition 2 SSD-5581)....5
Table 1-3: Biodiversity monitoring requirements....5
Table 2-1: Target species and monitoring methods....6
Table 2-2 Conversion of PCT classifications....7
Table 2-3 Landscape context of the management area....8
Table 2-4: BAM growth form groups and attributes....9
Table 2-5: Location, PCT and monitoring method of GDE plots....9
Table 2-6 *E. cannonnii* monitoring locations....13
Table 2-7: Tree condition data and definition....13
Table 2-8: *P. stricta* monitoring locations. 16
Table 2-9: Woodland bird transect location....17
Table 2-10: Target Bird Species....17
Table 2-11: Target Microbat Species....18
Table 2-12: Additional target fauna species....19
Table 2-13: Temperature, rainfall and day length during the Spring 2024 monitoring period....21
Table 2-14: Temperature, rainfall and day length during the Summer 2024 monitoring period....21
Table 3-1: BAM composition, structure, function and VI scores across 2019 – 2024....23
Table 3-2: GDE plots - mean BAM scores across monitoring locations for the current and previous monitoring period....25
Table 3-3: 2023 and 2024 stream condition....28
Table 3-4: GDE stream type parameters....28
Table 3-5: Occurrences of high exotic species cover in White Box – Yellow Box – Blakely's Red Gum Grassy Woodland plots....31
Table 3-6: Mean percent cover of *P. stricta* across location and years (n = number of transects)....32
Table 3-7: Average *E. cannonii* condition classes across monitoring years. Note that transects at Point Hatteras were established in 2022. 33
Table 3-8: 2024 Glossy black-cockatoo monitoring results....35
Table 3-9: Threatened diurnal bird species recorded within the 2024 monitoring period 38
Table 3-10: Microbat species recorded in the 2024 monitoring period 38
Table 3-11: Threatened fauna species (excluding birds and microbats) recorded during the 2024 survey period....39
Table 4-1: Assessment of biodiversity related subsidence impact performance measures (Schedule 3 – condition 2 SSD-5581)....42

Plates

Plate 2-1: BioMetric plot dimensions....8
Plate 2-2: Crown extent ratio (UVM 2005) 14
Plate 3-1: Chewed orts scattered under *Allocasurina* (L) and a close-up of chewed orts (R) 36
Plate 3-2: Male Superb Lyrebird (*Menura novaehollandiae*) image captured at camera trap location 2 (The Grotto)....37
Plate 3-3: Spotted-tailed Quoll (*Dasyurus maculatus*; BC Act: Vulnerable; EPBC Act: Endangered) recorded at CT9, behind Pit Top....40
Plate 3-4: Unconfirmed New Holland Mouse (*Pseudomys novaehollandiae;* EPBC Act: Vulnerable) recorded on camera trap R29, The Grotto....40

Figures

Figure 1-1: Site Location....3
Figure 1-2: BMP areas....4
Figure 2-1: Vegetation community monitoring locations....12
Figure 2-2: Threatened flora monitoring locations....15
Figure 2-3: Fauna monitoring locations....20

Graphs

Graph 2-1: 2023 and 2024 monthly rainfall (mm) compared to historical average monthly rainfall (1971-2024) for Glen Alice (BOM 2024). 22
Graph 3-1: Histogram displaying mean native plant species richness between monitoring years 23
Graph 3-2 Histogram displaying mean BAM scores (composition, structure, function, VI) between monitoring years....24
Graph 3-3: GDE plots – mean native plant species richness and SE of across monitoring location and PCT for the current and previous monitoring periods 25
Graph 3-4: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Pt. Hatteras – PCT 3295 for 2022 to 2024 monitoring periods. 26
Graph 3-5: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Control – PCT 3295 for 2022 to 2024 monitoring periods. 26
Graph 3-6: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Grotto – PCT 3226 for 2022 to 2024 monitoring periods.....27
Graph 3-7: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Grotto – PCT 3495 for 2022 to 2024 monitoring periods.....27
Graph 3-8: Stream flow type across sampled locations 29
Graph 3-9: Substrate type across sampled locations....30
Graph 3-10: Bank slope type across sampled locations 30
Graph 3-11: Mean exotic species cover within White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and GDE BAM plots....31
Graph 3-12: Histogram displaying mean % cover of *P. stricta* and SE across monitoring locations and years. Note that transects at Genowlan Point were established in 2022 32
Graph 3-13: Histogram displaying average crown density (%) and SE across monitoring locations and years....34
Graph 3-14: Histogram displaying average crown extent % and SE across monitoring locations and years....34
Graph 3-15: Histogram of mean *Allocasuarina* cover (%) and ±SE since 2019 (L) and percentage of monitoring sites with crewed orts present (R). * Indicates no data collected for this metric in 2020....35
Graph 3-16: Mean bird species richness ±SE recorded during diurnal bird transects at impact and control sites across monitoring periods....37

Appendices

Appendix A 2024 *Eucalyptus cannonii* monitoring photos
Appendix B White Box - Yellow Box - Blakely's Red Gum Grassy Woodland Plots – species list and photos
Appendix C GDE Plots – species list and photos
Appendix D Rapid Aquatic Assessment plot photos
Appendix E Fauna species list
Appendix F Bat Call Analysis

1 INTRODUCTION

Centennial Airly Pty Ltd operates an approved coal mining lease to extract thermal coal at Airly and Genowlan Mountains, which form part of the Mugii Murum-ban State Conservation Area (SCA; **Figure 1-1**). Approval for the Airly Mine is specified under State Significant Development 5581 (SSD-5581).

Biodiversity monitoring throughout the Development Consent Area for SSD-5581 (i.e., the management area) is currently being undertaken in compliance with the relevant Biodiversity Management Plans (BMP) required by consent Schedule 4, Condition 15 of SSD-5581. BMPs relevant to Centennial Airly are summarised in **Table 1-1** and as displayed in **Figure 1-2**.

Table 1-1: Centennial Airly BMPs

BMP	Version/date	Baseline years
Biodiversity Management Plan Western Region (Western Region BMP)	Final v3/ August 2019	2015-2016
Biodiversity Management Plan: Mount Airly Panel and Pillar Zone Extraction Plan (Mount Airly BMP)	Final/ March 2019	2016-2017
Biodiversity Management Plan for Cliff Line Zone of First Workings within ML1331 (ML1331 CLZ BMP)	Final/ January 2018	2015-2016
Biodiversity Management Plan: Point Hatteras Panel and Pillar Mining Zone Extraction Plan (Point Hatteras BMP)	Rev 1/ October 2021	2021-2022
Biodiversity Management Plan: MW17-18 Panel & Pillar Mining Zone Extraction Plan (MW17-18 BMP)	Rev 1/ June 2023	2022-2023
Biodiversity Management Plan for Cliff Line Zone within ML1814 (CLZ ML1814 BMP)	Draft/ 10 October 2023	2022-2023
Biodiversity Management Plan: MW19 – 22 Panel & Pillar Mining Zone Extraction Plan (MW19-22 BMP)	Draft/ 23 December 2024	2023-2024

1.1 Management area

The management area is defined as the Airly Mine Consent Boundary, as shown in **Figure 1-1**, and is located on and around the mesas (i.e., isolated escarpments) at Mount Airly and Genowlan Mountain within the Mugii Murum-ban SCA. This area contains a range of habitat types such as dry eucalypt forests, wet forests, gullies and gorges, and heath scrubs on rocky outcrops.

Vegetation communities mapped within the management area include over 365 hectares (ha) of sandstone escarpment and pagoda features (RPS 2014, DEC 2004) identified by the Department of Planning and Environment (DPE) as sensitive to longwall mining subsidence (i.e., potential to destabilise slopes and escarpments, ultimately altering habitat niches). Therefore, monitoring the species that are present, their ecology and natural variation before, during and after mining is integral in assessing any impacts incurred by underground mining.

Areas of biodiversity significance within the management area include *Biodiversity Conservation Act 2016* (BC Act) and *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened ecological communities (TECs), Groundwater Dependant Ecosystems (GDEs) and BC Act and EPBC Act threatened species and their habitats, situated within Centennial owned lands, including:

- Threatened flora:
  - *Prostanthera stricta* (Mount Vincent Mint-bush)
  - *Eucalyptus cannonii* (Capertee Stringybark)
  - *Pultenaea sp*. Genowlan Point.
- Threatened fauna:
  - Glossy-black Cockatoos (*Calyptorhynchus lathami*)
  - Forest owls
  - Woodland birds

  - Cave-dwelling Microchiropteran bats (microbat).
- TECs:
  - *Allocasuarina* nana Heathland Endangered Ecological Community (EEC)
  - White Box – Yellow Box – Blakely's Red Gum Woodland EEC.
- GDEs
  - MU 13: Tableland Gully Ribbon Gum - Blackwood - Apple Box Forest; and
  - MU 21: Capertee - Wolgan Slopes Red Box - Grey Gum - Stringybark Grassy Open Forest.

Monitoring within the management area was developed by the Centre for Mine Land Rehabilitation (CMLR) and was commenced in 2012 by the University of Queensland (UQ), with RPS further refining the program since 2015. The monitoring program has been and will continue to be conducted in line with SSD-5581 with the exception of the areas which have restricted access and are being monitored by NSW National Parks and Wildlife Service (NPWS), that is *Pultenaea sp*. Genowlan Point and Genowlan Point *Allocasuarina nana* Heathland.

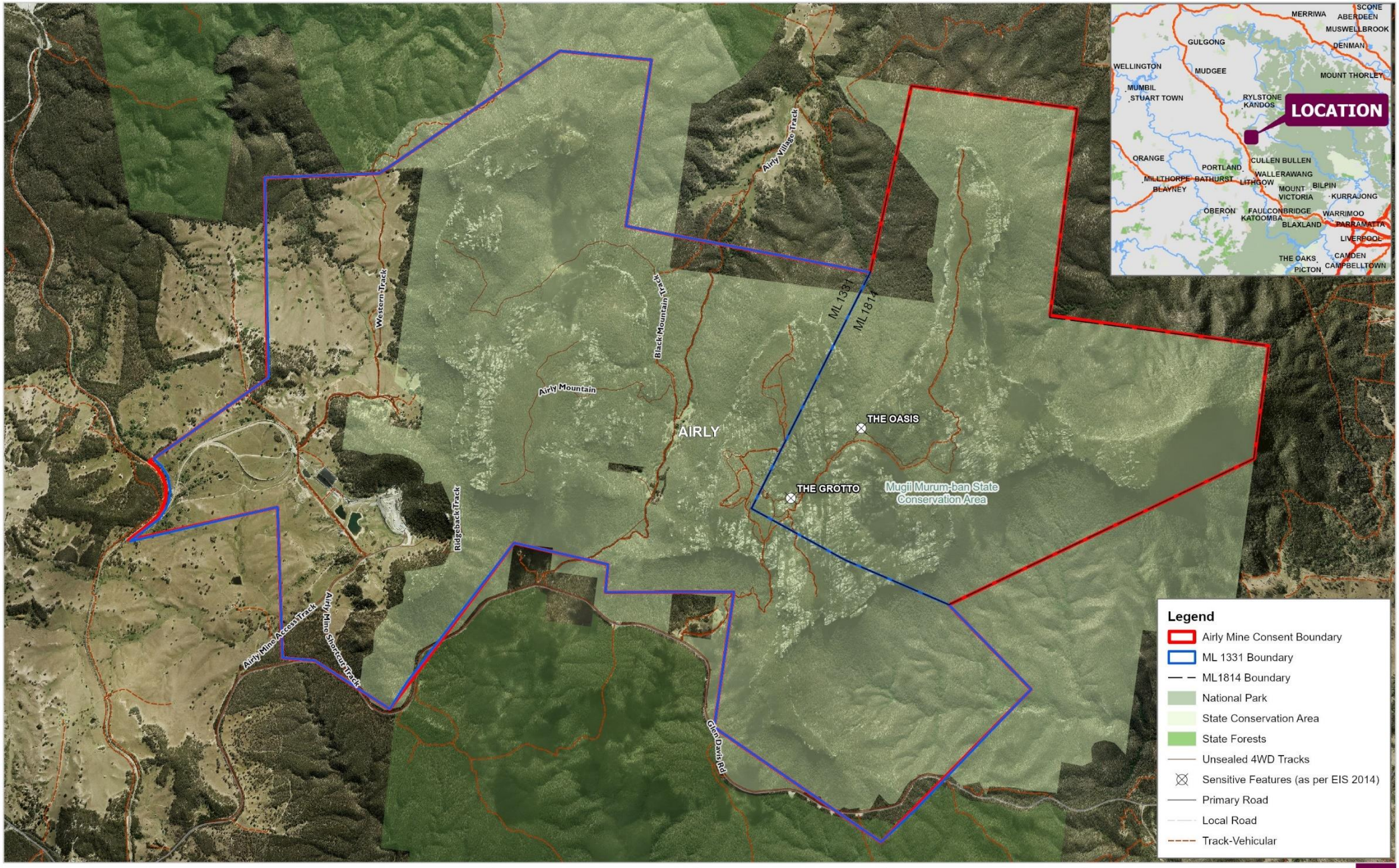
Previous flora and fauna monitoring for the Airly Mine was developed and implemented by the CMLR and was based on a Before-After-Control-Impact (BACI) approach and has been ongoing since 2012. The 2024 monitoring by RPS is based on the prior monitoring program with variation where necessary to reflect operational circumstances.

1.2 Objectives

This report documents the methods and results obtained from the 2024 BMP monitoring works as specified in the relevant BMPs for the management area (see **Table 1-1** and **Figure 1-2**). Discussion and recommendations are provided where relevant to compliance matters.

The objectives of this monitoring program are to:

- Identify any significant changes in the habitat quality and/or species presence as a result of the mining operations
- Make an assessment of the seasonal data to determine if key performance measures (see **Table 1-2**) are being met
- Collect data to inform baseline condition for future BMPs (i.e., BMP for Cliff Line Zone within ML1331 & ML1814).



SITE LOCATION

CLIENT: Centennial
PROJ: 17803
LOCATION: Airly

MAP: Figure 1
VERSION: A
DATE EXPORTED: 20/03/2025
TECHNICIAN: NATALIE.WOOD

DATA SOURCES
Centennial, RPS, NSWSS,

0.5 0 0.5 1 1.5 Km

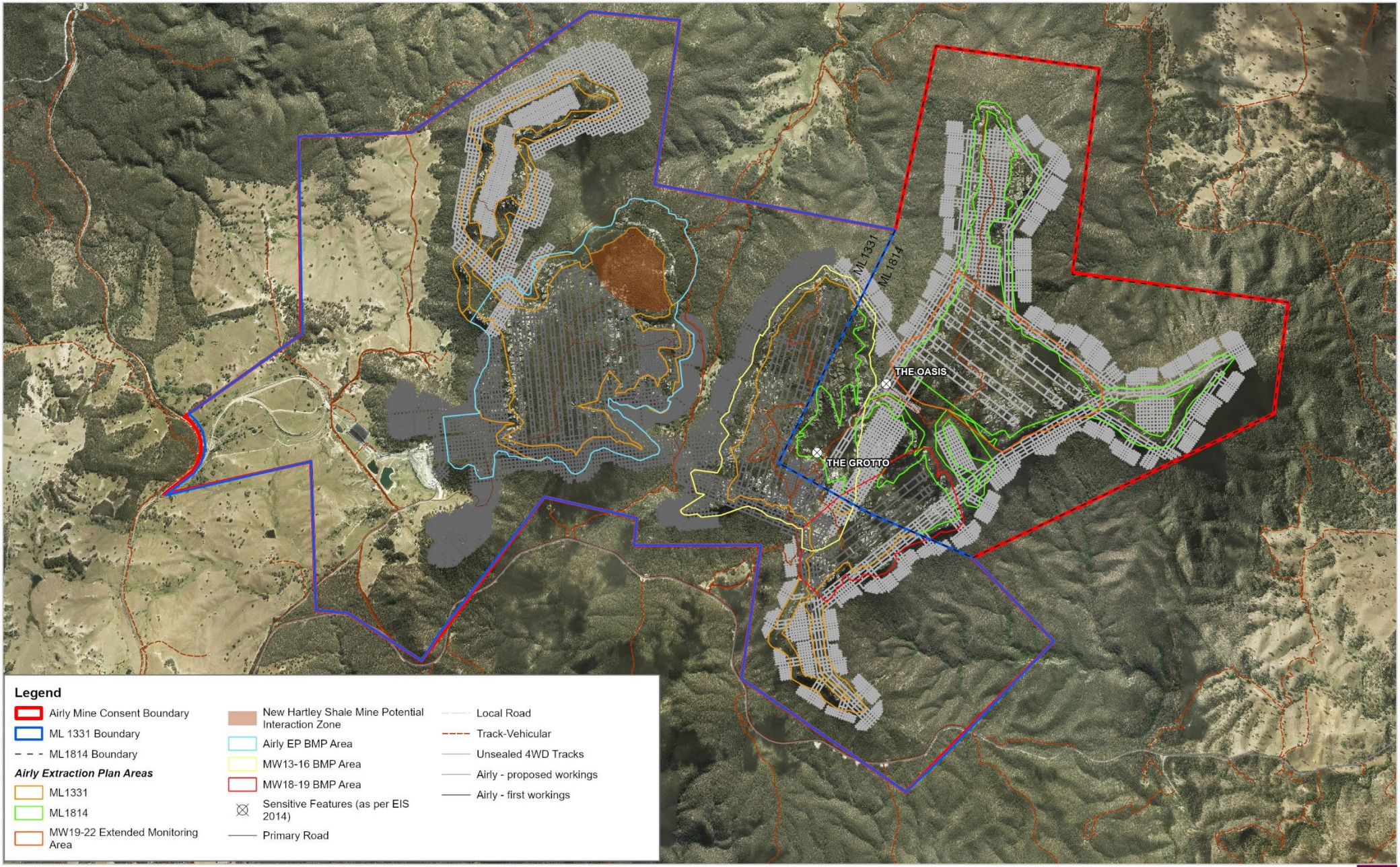
SCALE 1:32,000
A3 SIZE / Projection: GDA2020 MGA Zone 56

N

FIGURE 1.1

IMPORTANT NOTE
1. This plan was prepared for the sole purposes of the client for the specific purpose for which it is provided and dated. This plan is strictly limited to the Purpose and circumstances as at the date of this plan and will not be used for any other applications, purpose, use or matter.
The plan is presented without the assumption of a duty of care to any other person (other than the Client) ("Third Party") and may not be relied on by Third Party.
2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss, damage, liability or claim arising out of any reliance by
a. A third Party viewing, using or relying on the plan;
b. RPS Australia East Pty Ltd relying on information provided to it by the Client or a Third Party where the information is incorrect, incomplete, inaccurate, out-of-date or unreasonable;
c. Any inaccuracies or other faults with information or data sourced from Public Bodies;
d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate;
e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd;
f. any claim or action by any Third Party arising against the reasonable direction of RPS Australia East Pty Ltd;
g. the accuracy, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.
3. Without limiting paragraph 1 or 2 above, this plan may not be copied, distributed, or reproduced by any process unless this note is clearly displayed on the plan.
4. The aerial photography used in this plan has not been rectified. The image has been stretched as a best fit on the boundaries shown and position is approximate only.

PROJECT PATH: C:\Users\natalie.wood\OneDrive - Tetra Tech, Inc\Centennial\Airly\Airly BMP\Airly_BMP_2024.aprx



BMP AREAS

CLIENT: Centennial
PROJ: 17803
LOCATION: Airly

MAP: Figure 2
VERSION: A
DATE EXPORTED: 20/03/2025
TECHNICIAN: NATALIE.WOOD

DATA SOURCES
Centennial, RPS, NSWSS,

0.5 0 0.5 1 1.5 Km
SCALE 1:32,500
A3 SIZE / Projection: GDA2020 MGA Zone 56

N

FIGURE 1.2

IMPORTANT NOTE
1. This plan was prepared for the sole purposes of the client for the specific purpose of producing a photographic overlay plan. This plan is strictly limited to the Purpose and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.
The plan is presented without the assumption of a duty of care to any other person (other than the Client) ("THIRD Party") and may not be relied on by Third Party.
2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss, damage, liability or claim arising out of or incidental to:
a. a Third Party publishing, using or relying on the plan;
b. RPS Australia East Pty Ltd relying on information provided to it by the Client or a Third Party where the information is incorrect, incomplete, inaccurate, out-of-date or unreasonable;
c. any inaccuracies or other faults with information or data sourced from a Third Party;
d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate.
e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd;
f. Lodgment of this plan with any local authority against the recommendation of RPS Australia East Pty Ltd;
g. the accuracy, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.
3. Without limiting paragraph 1 or 2 above, this plan may not be copied, distributed, or reproduced by any process unless this note is clearly displayed on the plan.
4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

PROJECT PATH: C:\Users\natalie.wood\OneDrive - Tetra Tech, Inc\Centennial\Airly\Airly BMP\Airly_BMP_2024.aprx

1.3 Compliance

This annual monitoring addresses the biodiversity-related conditions of consent outlined in SSD-5581. Specific environmental conditions are defined in Schedule 3, Condition 2 as outlined in **Table 1-2**.

Table 1-2: Biodiversity related subsidence impact performance measures (Schedule 3 - condition 2 SSD-5581)

Biodiversity feature	Performance measure
1. Gap and Genowlan Creeks	Negligible environmental consequences to water quality and to bed and bank stability. No greater environmental consequences than predicted in the EIS to water flows (including baseflow).
2. The Grotto	Negligible subsidence impacts or environmental consequences.
3. Threatened species, threatened populations, EECs and groundwater dependent ecosystems (with the exception of those listed below)	Negligible environmental consequences.
4. *Pultenaea* sp. Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community	No environmental consequences.

This monitoring report comprises information pertaining to performance measure three and provides baseline biodiversity data for performance measures one and two (**Table 1-2**). Performance measure four is addressed in a separate monitoring report prepared by National Parks and Wildlife Services (NPWS).

The following BMP priorities and the sections in which they are addressed in this report are provided in **Table 1-3** below.

Table 1-3: Biodiversity monitoring requirements

Biodiversity monitoring	Location addressed in report
Prostanthera stricta (Mount Vincent Mint-bush)	**Section 3.2.1**
Eucalyptus cannonii (Capertee Stringybark)	**Section 3.2.2**
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland (MU20; PCT 703)	**Section 3.1.1**
Groundwater Dependant Ecosystems (GDE)	**Section 3.1.2**
Weeds	**Section 3.1.3**
Glossy-black Cockatoos (*Calyptorhynchus lathami*)	**Section 3.3.1**
Large Forest Owls	**Section 3.3.2**
Diurnal birds, including threatened and regionally significant woodland bird species	**Section 3.3.3**
Cave-dwelling microbats	**Section 3.3.4**
Vertebrate census/other targeted fauna	**Section 3.3.5**
Feral species	**Section 3.3.6**

2 METHODS

2.1 Overview

2.1.1 Monitoring approach

The Sustainable Minerals Institute (SMI CMLR) applied the principles of a Before After Control Impact (BACI) monitoring design in developing the monitoring program in the BMP (SMI CMLR 2013). In a BACI design, data is simultaneously collected at 'Impact' and 'Control' sites, before and after an impact occurs, thus establishing a comparative quantitative dataset suitable for determining causation where significant change is detected within an 'impact site'.

2.1.2 Airly monitoring program

Annual flora and fauna monitoring at Airly Colliery in 2024 was completed from 28th October to the 1st November and 16th December to the 19th December 2024.

The monitoring methods performed in the annual monitoring program are in line with the BMPs outlined in **Table 1-1**. Details on which methods were completed in the October/November monitoring events are provided below in **Table 2-1**. The location of each monitoring site is illustrated in **Figure 2-1**, **Figure 2-2** and **Figure 2-3**.

Table 2-1: Target species and monitoring methods

Biodiversity value	Monitoring methodology	Data analysis	timing
Prostanthera stricta	Permanent 50 m transects incorporating a 5 x 5 m floristic plot.	Comparison of data collected from permanent monitoring sites. Statistical analysis comparing years e.g., T-test.	Annually in Spring/Summer
Eucalyptus cannonii	Sample existing known individual *E. cannonii.* Targeted surveys for additional potential habitat.	Comparison of data collected from permanent monitoring sites. Statistical analysis comparing years e.g., T-test.	Annually in Spring/Summer
White Box – Yellow Box – Blakely's Red Gum Woodland EEC	Permanent 20 m x 50 m floristic plots.	Comparison of data collected from permanent monitoring sites. Statistical analysis comparing years e.g., T-test.	Annually in Spring/Summer
Ground Water Dependant Ecosystems (GDEs)	Permanent 20 m x 50 m floristic plots.	Comparison of data collected from permanent monitoring sites. Statistical analysis comparing years e.g., T-test.	Annually in Spring/Summer
Glossy black-cockatoo	Assessment/count of orts and percent cover within established plots of known stands of *Allocasuarina* trees.	Statistical analysis comparing before and after e.g., T-test.	Annually in Summer
Diurnal birds	30 minute bird transects at permanent plots and opportunistic sightings.	Statistical analysis comparing species richness of woodland bird species and change on a year-to-year basis.	Annually in Spring/Summer
Large forest owl roost and koalas	Assessment of known owl roosts (pellet presence) Call Playback Songmeter or Targeted callplayback/ spotlighting.	Presence/absence.	Annually in Spring/Summer

Biodiversity value	Monitoring methodology	Data analysis	timing
Microbats	Anabats deployed at eight permanent locations.	Presence/absence. Statistical analysis comparing species richness of woodland bird species and change on a year-to-year basis.	Annually in Summer
Vertebrate census	Stationary infrared cameras set at target areas of suitable habitat for Spotted-tailed Quoll and Rosenberg's Goanna.	Presence/absence.	Annually in Spring/Summer
Feral species	Recording the location of any feral species -data to be supplied to NPWS at end of survey each year.	Compare presence/absence.	Annually in Spring/Summer

2.1.3 Limitations

In reviewing the design of the SMI CMLR (2013) monitoring program it is noted that it resembles a more simplistic Before-After monitoring framework. This is apparent in the transition of 'control' sites to 'impact' sites as the mining face progresses. As indicated in a BACI monitoring model, a 'Before-After' model is able to detect change over time; however, is unable to accurately define causation for this change (i.e., is it mining related?). While repeated measures methods have been adopted for most monitoring activities (i.e., sampling the exact same area or transect), a Before-After monitoring framework cannot distinguish between the effects of external unrelated variables such as bushfire, rainfall or drought and those originating from operational activities. These design flaws are irreconcilable unless the program is revised to include control sites that are permanent quarantined from an operational related impact.

2.2 Vegetation community

The following sections detail the monitoring methods utilised in the 2024 surveys for the sensitive vegetation communities:

- White Box - Yellow Box - Blakely's Red Gum Grassy Woodland is listed as Critically Endangered Ecological Community (CEEC) under the BC Act and critically endangered under the EPBC Act; and
- GDEs or 'facultative ecosystems':
  - MU 3: Hillslope Talus Mountain Gum – Brown Stringybark – Grey Gum – Broad-leaved Hickory Moist Forest; and
  - MU 21: Capertee – Wolgan Slopes Red Box – Grey Gum – Stringybark Grassy Open Forest.

Classification of the vegetation communities are detailed in **Table 2-2.**

Table 2-2 Conversion of PCT classifications.

New PCT	Parent MU – PCT	Formation	TEC
3510 – Capertee Slopes Stringybark-Box Forest	MU 20 – 703 – Blakely's Red Gum – Yellow Box – Rough-barked Apple grassy woodland of the Capertee Valley, Sydney Basin Bioregion	Grassy Woodlands	• BC Act Listed CEEC (Part) White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland • EPBC Act Listed CEEC White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
3495 – Western Blue Mountains Monkey Gum Gully Forest	MU 3 – 941 – Hinterland riverflat eucalypt forest	Forested Wetlands	Not a TEC

New PCT	Parent MU – PCT	Formation	TEC
3226 – Western Blue Mountains Montane Wet Fern Forest	MU 21 – 1615 – Monkey Gum – *Eucalyptus blaxlandii* shrubby open forest on basalt of the Sydney Basin	Southern Escarpment Wet Sclerophyll Forests	Not a TEC

2.2.1 White Box – Yellow Box – Blakely's Red Gum Woodland

BWG plots were monitored using plots measuring flora composition, vegetation structure and ecological function as defined by the Biodiversity Assessment Methodology (BAM). Four established BAM plots have been used to gather repeated monitoring data, the location of these plots illustrated in **Figure 2-1**. These plots were originally established to collect data under the previous BioBanking Assessments Method (BBAM), with data collection transitioned to BAM methodology following the commencement of the BC Act and implementation of BAM guidelines.

2.2.1.1 Biodiversity Assessment Method

The BAM method involves estimating the vegetation composition, structure and function to determine the vegetation integrity. Flora species observed within the 20 x 20 m (400 m^2) plot were assigned to a growth form as listed in **Table 2-4** and given a score of abundance and coverage. High threat weed species were identified. The method used to measure these attributes is detailed in the BAM 2020 (State of NSW 2020). Vegetation condition scores comprising of a composition score, structure score, function score and vegetation integrity (VI) score were calculated using the BAM Calculator (BAM-C).

Landscape context necessary for understanding vegetation communities and using the BAM-C are displayed in **Table 2-3**.

Table 2-3 Landscape context of the management area.

Landscape context	
Interim Biogeographic Regionalisation for Australia (IBRA)	South Eastern Highlands
IBRA Sub Region	Capertee Uplands
NSW (Mitchell) Landscape	Newnes Plateau
Percent native vegetation cover	90
Connectivity features	Connectivity through Mugii Murum-ban SCA and Greater Blue Mountains Area
Rivers and streams	Multiple first, second and third order streams including Genowlan Creek

The start and end points of each BAM plot (i.e., 50 m central transect, **Plate 2-1**) were marked with wooden stakes and labelled. Location data for each of these points was recorded using a differential GPS. Photographs were taken of each BAM plot from a standardised point at an approximate height of 1.5 m. A horizontal field of view of approximately 40 degrees was achieved, which is within the central angle of view for human vision (i.e., 40-60 degrees).

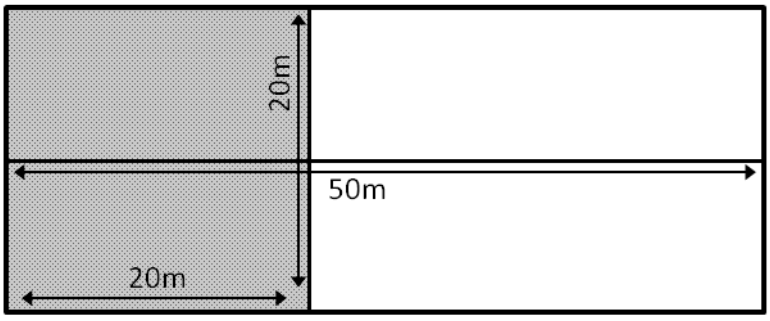


Plate 2-1: BioMetric plot dimensions

Table 2-4: BAM growth form groups and attributes

Composition (20 x 20 m plot)	Structure (20 x 20 m plot)	Function (20 x 50 m plot)
a) Tree Richness (TR)	a) Tree Cover (TC)	a) Number of large trees (No.LT)
b) Shrub Richness (SR)	b) Shrub Cover (SC)	b) Tree regeneration (TR)
c) Grass and grass-like Richness (GGR)	c) Grass and grass-like Cover (GGC)	c) Tree stem size class (TSSC)
d) Forb Richness (FR)	d) Forb Cover (FC)	d) Total length of fallen logs (TLFL)
e) Fern Richness (FeR)	e) Fern (Cover (FeC)	e) Litter cover (1m^2 subplots x 5) (LC)
f) Other Richness (OR)	f) Other Cover (OC)	f) High threat exotic vegetation cover (THE)
		g) Hollow-bearing trees (HBT)

Vegetation structure

The structural complexity and age structure of vegetation was quantified by counting the number of large trees (i.e. > 50 cm diameter at breast height [DBH]), presence of tree canopy species regeneration and tree stem size classes (i.e. presence of trees with a DBH of 5-9 cm, 10-20 cm, 20-30 cm, 30-50 cm, 50-80 cm and >80 cm). This was measured for the 1,000 m^2 plot.

Hollow-bearing Trees

The number of hollow-bearing trees were counted within the 1,000 m^2 plot.

Fallen Log Length

The total linear length of fallen logs exceeding 10 cm in diameter were measured within the 1,000 m^2 plot.

Litter Cover

The per cent cover of dead litter cover was estimated in five, 1 m^2 quadrats within the 1,000 m^2 plot.

2.2.1.2 Data analysis

Data was compared with previous seasons data to determine if any change have occurred. A One-Way ANOVA (Excel V2212 Analysis ToolPak) was used to compare if BAM and VI score differs across years at a 5% significance level (i.e., $p < 0.05$). If change was detected, two-tailed t-tests were conducted to determine if the current monitoring season was the cause for change (both negative and positive effects) at a significance level of 5% (i.e., $p < 0.05$).

2.2.2 Groundwater Dependent Ecosystems

GDE plots were monitored using both BAM plots (i.e., measuring flora composition, vegetation structure and ecological function as defined by the BAM) and a rapid aquatic assessment modified from the Australian River Assessment System (AUSRIVAS) methodology. Ten GDE BAM plots and five rapid aquatic assessments have been established at the base of Point Hatteras and the Grotto for the Point Hatteras BMP and CLZ ML1814 BMP to establish baseline and gather repeated monitoring data. The location and method applied at these plots are summarised in **Table 2-5** and shown in **Figure 2-1**.

Table 2-5: Location, PCT and monitoring method of GDE plots

Plot	BMP location	PCT	Monitoring method
1	Point Hatteras	3495/941	• BAM plot • Rapid aquatic assessment
2	Point Hatteras	3495/941	• BAM plot • Rapid aquatic assessment

Plot	BMP location	PCT	Monitoring method
3	Control	3495/941	• BAM plot
4	Control	3495/941	• BAM plot
5	Grotto (CLZ ML1814 BMP)	3226/1615	• BAM plot • Rapid aquatic assessment
6	Grotto (CLZ ML1814 BMP)	3226/1615	• BAM plot • Rapid aquatic assessment
7	Grotto (CLZ ML1814 BMP)	3226/1615	• BAM plot • Rapid aquatic assessment
8	Grotto (CLZ ML1814 BMP)	3226/1615	• BAM plot • Rapid aquatic assessment
9	Grotto (CLZ ML1814 BMP)	3495/941	• BAM plot • Rapid aquatic assessment
10	Grotto (CLZ ML1814 BMP)	3495/941	• BAM plot • Rapid aquatic assessment
11	Grotto (CLZ ML1814 BMP)	3495/941	• BAM plot • Rapid aquatic assessment

2.2.2.1 Biodiversity Assessment Method

See **Section 2.2.1.1**.

2.2.2.2 Rapid aquatic assessment

A rapid aquatic assessment modified from the AUSRIVAS methodology was completed at each plot where a running creek was present. The start and end points of each 50 m GDE plot were marked with wooden stakes and labelled. Location data for each of these points was recorded using a differential GPS. Photographs were taken of each GDE plot from a standardised point at an approximate height of 1.5 m. A horizontal field of view of approximately 40 degrees was achieved, which was within the central angle of view for human vision (i.e., 40-60 degrees).

The following assessments were conducted during each monitoring period:

a. Stream condition:
    i. Flow width (m) averaged from set distance along the stream (5 m, 15 m, 25 m, 35 m, 45 m);
    ii. Max flow width (m);
    iii. Min flow width (m);
    iv. Soil moisture ±3% VWC averaged from set distance along the stream (5 m, 15 m, 25 m, 35 m, 45 m);
    v. Clarity/sediment load (0 [no clarity] – 5 [clearest]);
    vi. Erosion (0 [no signs of erosion] – 5 [severe]).
b. Stream type:
    i. Stream flow type:
        1. Pooling;
        2. Flowing;
        3. Continuous;
        4. Discontinuous;
        5. Riffles.
    ii. Aquatic vegetation type:

1. Submerged;
2. Floating;
3. Emergent.

iii. Substrate type:

1. Bedrock;
2. Boulder (>256mm);
3. Cobble (64-256mm);
4. Pebble (16-64mm);
5. Gravel (2-16mm);
6. Sand (0.06-2mm);
7. Clay/Silt (<0.06mm).

iv. Bank slope:

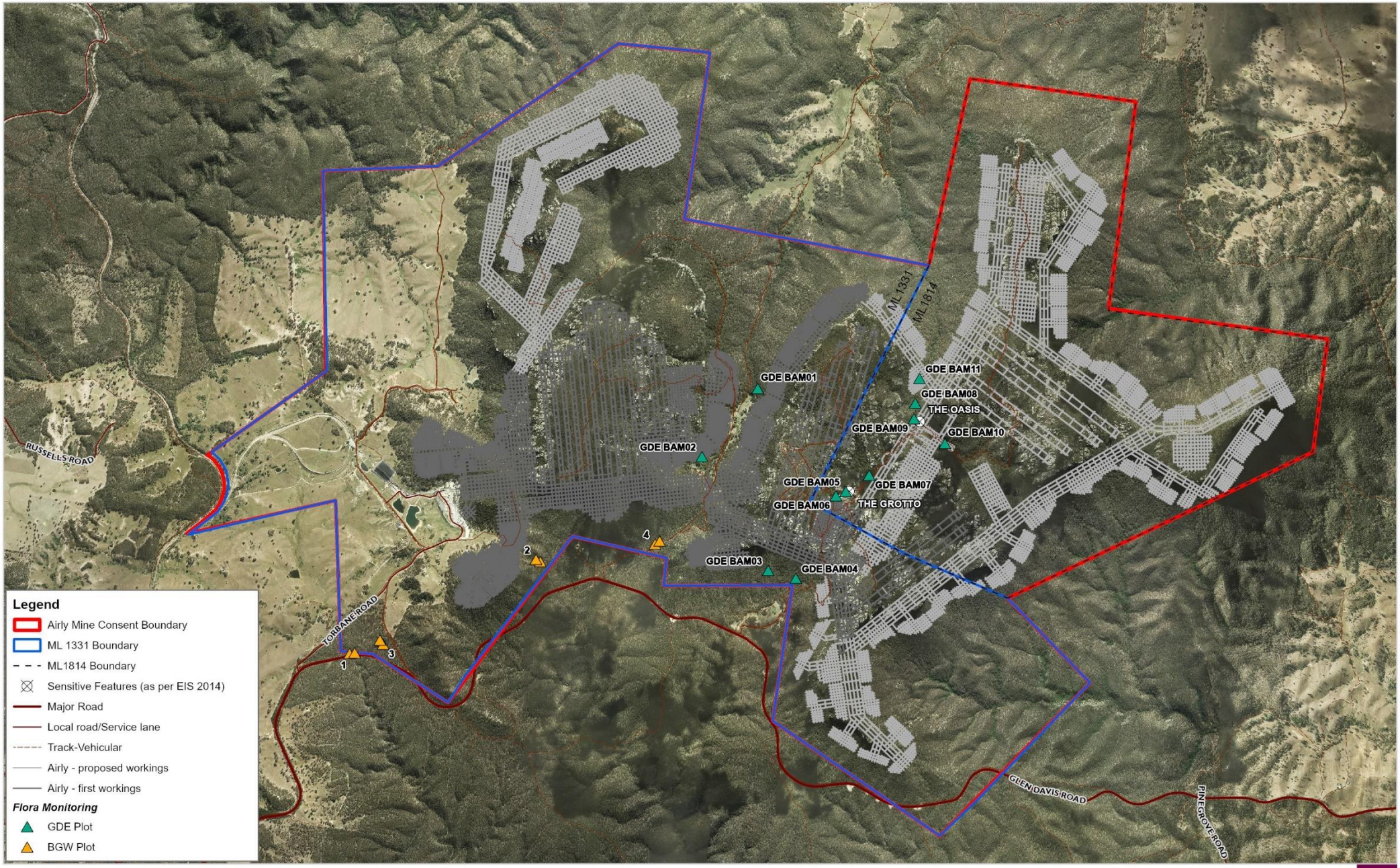
1. Flat <10°;
2. Low 10 – 30°;
3. Moderate 30 – 60°;
4. Steep 60 – 80°;
5. Vertical 80 – 90.

2.2.2.3 Data analysis

Data was compared with previous seasons data to determine if any change had occurred. A One-Way ANOVA (Excel V2212 Analysis ToolPak) was used to compare if native plant species richness and BAM scores differ across years at a 5% significance level (i.e., $p < 0.05$). If change was detected, two-tailed t-tests were conducted to determine if the current monitoring season was the cause for change (both negative and positive effects) at a significance level of 5% (i.e., $p < 0.05$).

2.2.3 Exotic species

Exotic species establishment was estimated in conjunction with the BAM plots. Within the 20 x 20 m quadrant at each site the total cover and abundance of exotic species was recorded. Total exotic species was calculated and exotic species with a cover of 3% or greater were discussed.



VEGETATION COMMUNITY MONITORING LOCATIONS

CLIENT: Centennial
PROJ: 17803
LOCATION: Airly

MAP: Figure 3
VERSION: A
DATE EXPORTED: 20/03/2025
TECHNICIAN: NATALIE.WOOD

DATA SOURCES
Centennial, RPS, NSWSS.

0.5 0 0.5 1 1.5 Km
SCALE 1:32,000
A3 SIZE / Projection: GDA2020 MGA Zone 56

N

FIGURE 2.1

IMPORTANT NOTE
1. This plan was prepared for the sole purposes of the client for the specific purpose of producing a photographic overlay plan. This plan is strictly limited to the purpose and it does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.
The plan is presented without the assumption of a duty of care to any other person (other than the Client) ("THIRD Party") and may not be relied on by Third Party.
2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss, damage, liability or claim arising out of or incidental to:
a. a Third Party publishing, using or relying on the plan;
b. RPS Australia East Pty Ltd relying on information provided to it by the Client or a Third Party where the information is incorrect, incomplete, inaccurate, out-of-date or unreasonable;
c. any inaccuracies or other faults with information or data sourced from a Third Party;
d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate;
e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd;
f. judgment of this plan with any local authority against the recommendation of RPS Australia East Pty Ltd;
g. the accuracy, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.
3. Without limiting paragraph 1 or 2 above, this plan may not be copied, distributed, or reproduced by any process unless this note is clearly displayed on the plan.
4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

PROJECT PATH: C:\Users\natalie.wood\OneDrive - Tetra Tech, Inc\Centennial\Airly\Airly BMP\Airly_BMP_2024.aprx

2.3 Flora

The following sections detail the monitoring methods utilised in the 2024 surveys for the threatened flora species:

- *Prostanthera stricta* (Mount Vincent Mint-bush; BC Act: Vulnerable); and
- *Eucalyptus cannonii* (Capertee Stringybark; BC Act: Vulnerable).

2.3.1 *Eucalyptus cannonii* (Capertee Stringybark)

Individuals of threatened species *E. cannonii* are permanently monitored. A total of 28 *E. cannonii* locations were monitored of which ten were newly installed at Point Hatteras in 2022 to establish the baseline data for MW13-16 BMP. See **Figure 2-2** for monitoring locations.

Table 2-6 *E. cannonnii* monitoring locations

Location within management area	Tree ID			Comment
Control	T5 T6 T7	T10 T11	T12 T14	Adjacent to Airly pit top
Mount Airly (Impact)	T1 T2 T3 T4	T8 T9 T13 T14	T15 T16 T17 T18	Controlled burn across Mount Airly occurred in 2018.
Point Hatteras (Impact)	T22 T23 T24 T25	T26 T27 T28	T29 T30 T31	Established in 2022 monitoring period

The following assessments are conducted during each monitoring period:

a. Supporting data:
   i. Tree species;
   ii. Location;
   iii. Photograph (trunk and canopy); and
   iv. Date and time.
b. Tree condition data
c. Tree size data; and
d. Contextual data:

See **Table 2-7** for further definitions.

Table 2-7: Tree condition data and definition

Parameter	Definition
Condition	
Crown density ratio	The amount of crown branches, foliage and reproductive structures that blocks light visibility through the crown. Each tree species has a normal crown that varies with the site, genetics, tree damage, etc.
Crown extent ratio	Is a percentage determined by dividing the live crown length by the actual tree length;

Parameter	Definition

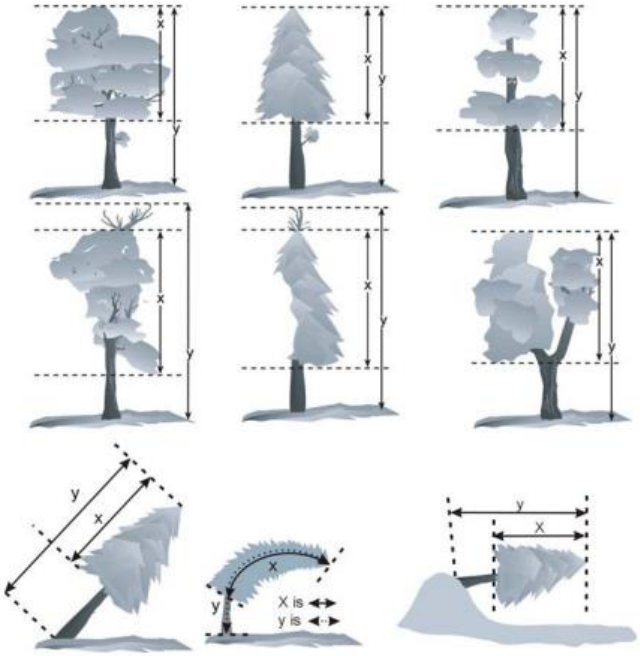
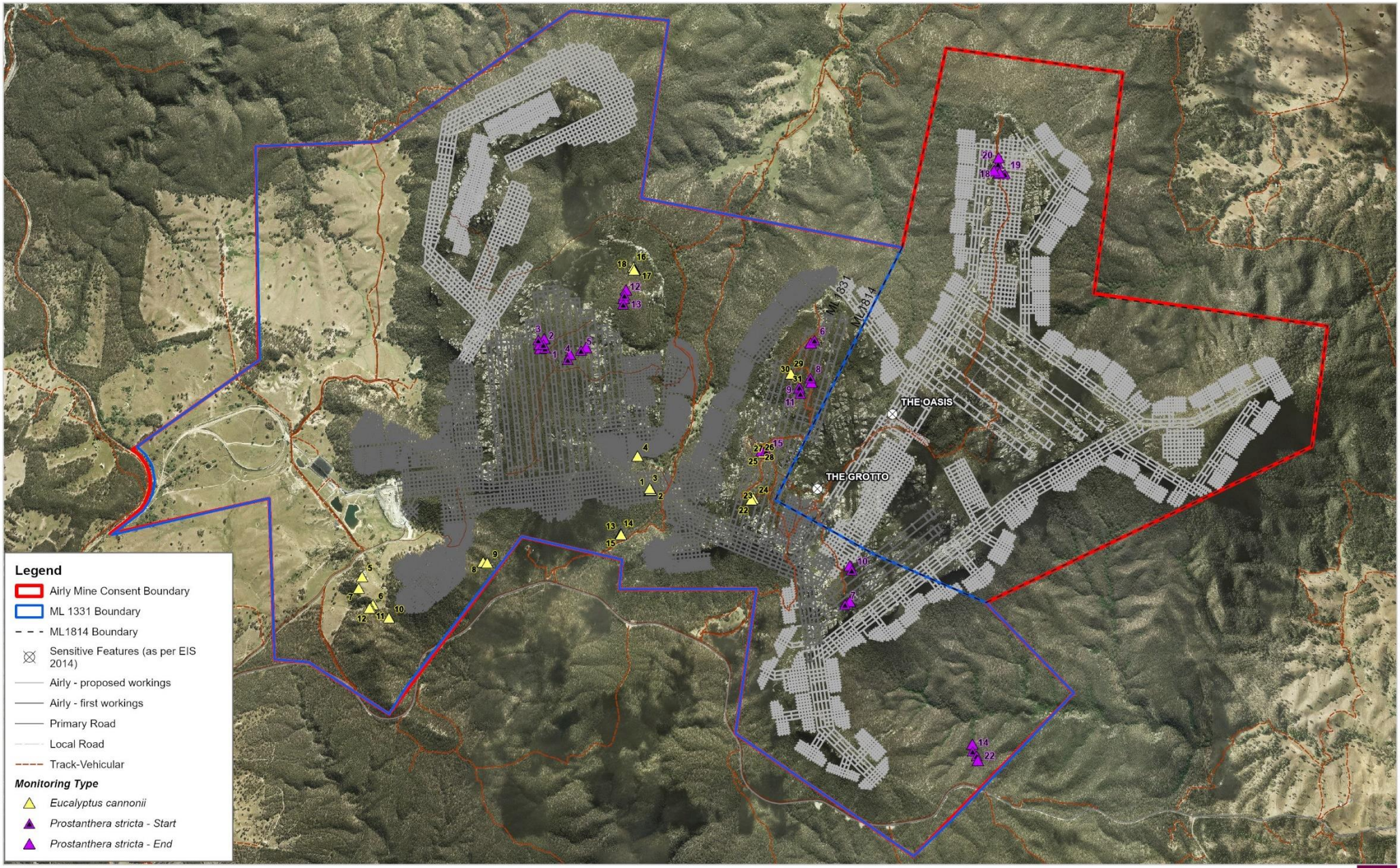


Plate 2-2: Crown extent ratio (UVM 2005)

Tree size	
Height	Height from ground to top of canopy in meters
Diameter at Breast Height (DBH)	Diameter of the tree at breast height (~1.5 m off the ground) recorded in cm
Context	
Subsidence	Potential to destabilise slopes and escarpments, ultimately altering habitat niches
Erosion	The removal of soil or rocks by wind, water, or other natural agents.
Weed presence	Presence of exotic plant species.

2.3.1.1 Data analysis

Tree condition data was compared with previous seasons data to determine if any change had occurred in score across the trees at the monitoring locations (i.e., Mount Airly, Point Hatteras; Control). Two-tailed t-tests were conducted to determine if the current monitoring season differs (both negative and positive effects) from baseline (2015/2016) at each location at a significance level of 5% (i.e., $p < 0.05$).



THREATENED FLORA MONITORING LOCATIONS

CLIENT: Centennial
PROJ: 17803
LOCATION: Airly

MAP: Figure 4
VERSION: A
DATE EXPORTED: 20/03/2025
TECHNICIAN: NATALIE.WOOD

DATA SOURCES
Centennial, RPS, NSWSS.

0.5 0 0.5 1 Km
SCALE 1:30,000
A3 SIZE / Projection: GDA2020 MGA Zone 56

N

FIGURE 2.2

IMPORTANT NOTE
1. This plan was prepared for the sole purposes of the client for the specific purpose of producing a photogrammetric overlay dxm. This plan is strictly limited to the Purposes and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.
The plan is presented without the assumption of a duty of care to any other person (other than the Client) ("The Third Party") and may not be relied on by Third Party.
2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss, damage, liability or claim arising out of or incidental to:
a. a Third Party publishing, using or relying on the plan;
b. RPS Australia East Pty Ltd relying on information provided to it by the Client or a Third Party where the information is incorrect, incomplete, inaccurate, out-of-date or unreasonable;
c. any inaccuracies or other faults with information or data sourced from a Third Party;
d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate;
e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd;
f. Judgment of this plan with any local authority against the recommendation of RPS Australia East Pty Ltd;
g. the ownership, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.
3. Without limiting paragraph 1 or 2 above, this plan may not be copied, distributed, or reproduced by any process unless this note is clearly displayed on the plan.
4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

PROJECT PATH: C:\Users\natalie.wood\OneDrive - Tetra Tech, Inc\Centennial\Airly\Airly BMP\Airly_BMP_2024.aprx

2.3.2 *Prostanthera stricta* (Mount Vincent Mint-bush)

Eighteen *P. stricta* monitoring transects were surveyed in 2024. Their transect ID and location within the management area based on the EP specific BMPs is summarised in **Table 2-8**.

Table 2-8: *P. stricta* monitoring locations.

Location within management area	Transect ID	Comment
Genowlan Point (Control)	T18	Established in 2022 monitoring period
	T19	
	T20	
Genowlan Trig (Control)	T7	T10 re-established in 2022. Currently control plots but will be undermined within MW17-18 EP.
	T10	
Gully (Control)	T22	T22 established in 2022. T10 re-stablished in 2022
	T14	
Mount Airly (Impact)	T1	Controlled burn across Mount Airly occurred in 2018.
	T2	
	T3	
	T4	
	T5	
	T12	
	T13	
Point Hatteras (Impact)	T6	T15 re-stablished in 2015
	T8	
	T9	
	T15	

P. stricta was monitored using 50 m long point intercept transects located across the management area. Start and end points coordinates were staked out and these coordinates were accurately recorded using a differential GPS unit.

The point intercept method was used to determine the density of *P. stricta* populations across eighteen 50 m transects including four plots which were established in 2022, and two that were re-established in 2022. See **Figure 2-2** for monitoring locations. Any section of *P. stricta* that was seen to be overhanging or underneath the transect lines were measured to the nearest 5 mm (Elzinga et al, 2001). Once transect point data was recorded, a percentage cover score was calculated for each transect. Additionally, floristic data within 5 x 5 m plots was collected. These plots were carried out at the start of each transect with the aim to record all vascular flora present at the time of the survey.

2.3.2.1 Data analysis

Data is compared with previous seasons data to determine if any change has occurred. A One-Way ANOVA (Excel V2212 Analysis ToolPak) was used to compare if the cover of *P.stricta* differed across years at a 5% significance level (i.e., $p < 0.05$). If change was detected, two-tailed t-tests were conducted to determine if the current monitoring season was the cause for change (both negative and positive effects) at a significance level of 5% (i.e., $p < 0.05$). This was repeated for each monitoring location (i.e., Mount Airly, Point Hatteras, Control).

2.4 Fauna

2.4.1 Glossy black-cockatoos

Monitoring for evidence of Glossy Black-Cockatoos was undertaken in October and November 2024. Glossy Black-Cockatoos have a particular diet and feed only on the seeds in cones of She-oaks (*Casuarina and*

Allocasuarina sp., but specifically *Allocasuarina littoralis* (Black She-oak) within the Airly mining lease. Those cones, referred to as 'orts' are then discarded, leaving evidence of Glossy Black-Cockatoo activity. The orts can thus be used to detect recent activity of Glossy Black-Cockatoos in the locality.

Monitoring involved surveying for the presence of chewed orts within six 50 x 50 m stands of *Allocasuarina littoralis* in order to determine recent utilisation of the habitat as shown in **Figure 2-3**. Attributes measured within each 50 m^2 search area include:

- Percent canopy cover and percent *Allocasuarina* species cover;
- Presence of orts; and
- Presence of Glossy black-cockatoos.

Additionally, if any Glossy-Black Cockatoo individuals were observed outside of these plots they were recorded by GPS location and photos are taken where practicable.

2.4.1.1 Data analysis

Data is compared with previous seasons data to determine if any change had occurred at the monitoring locations (i.e., Mount Airly, Point Hatteras; Control). Two-tailed t-tests were conducted to determine if the *Allocasuarina* species cover in the current monitoring season differed (both negative and positive effects) from previous monitoring years at each location at a significance level of 5% (i.e., $p < 0.05$).

2.4.2 Forest owls

Monitoring for evidence of large forest owls was undertaken in October and November 2024. This monitoring targeted previously known areas of owl activity (e.g., roost or sighting), looking for any evidence of Powerful Owls, Sooty Owls and Masked Owls presence within these areas through deployment of song meters. Installation and analysis of song meter data occurred across one survey week in spring at 6 locations.

The location of song meter placement completed in 2024 are displayed in **Figure 2-3**.

2.4.3 Woodland birds

Threatened woodland bird species were monitored using permanent transects, diurnal bird surveys and opportunistic surveys throughout the management area. Previously established sites were used to continue monitoring for threatened bird species and allow for comparisons between seasons/years. Sites included four habitat types; grassland, woodland, wet forest and pagoda shrubland, the locations of which are shown in **Figure 2-3**. Target bird species are listed in **Table 2-10**.

Table 2-9: Woodland bird transect location

Transect ID	Type	Habitat type	Location	BMP
1	Impact	Grassland	Airly Pit Top	Site Specific BMP
2	Impact	Woodland	Airly Pit Top	Site Specific BMP
3	Impact	Woodland	Airly Pit Top	Site Specific BMP
4	Impact	Wet Forest	Airly Gap	Site Specific BMP
5	Impact	Pagoda Heath	Airly Mountain	Site Specific BMP
6	Impact	Woodland	Airly Mountain	Site Specific BMP
7	Control	Wet Forest	Carinya Offset Area	Site Specific BMP

Table 2-10: Target Bird Species

Scientific name	Common name	Conversation status
Anthochaera phrygia	Regent Honeyeater	Critically Endangered under EPBC Act Critically Endangered under BC Act
Melithreptus gularis	Black-chinned Honeyeater	Vulnerable under BC Act
Climacteris picumnus	Brown Treecreeper	Vulnerable under BC Act

Scientific name	Common name	Conversation status
Stagonopleura guttata	Diamond Firetail	Vulnerable under BC Act
Petroica phoenicea	Flame Robin	Vulnerable under BC Act
Petroica boodang	Scarlet Robin	Vulnerable under BC Act
Melanodryas 18acropus18 cucullata	Hooded Robin	Vulnerable under BC Act
Callocephalon fimbriatum	Gang-gang Cockatoo	Vulnerable under BC Act Endangered under EPBC Act
Pachycephala inornata	Gilbert's Whistler	Vulnerable under BC Act
Calyptorhynchus lathami	Glossy Black-Cockatoo	Vulnerable under BC Act Vulnerable under EPBC Act
Glossopsitta pusilla	Little Lorikeet	Vulnerable under BC Act
Grantiella picta	Painted Honeyeater	Vulnerable under BC Act Vulnerable under EPBC Act
Ninox strenua	Powerful Owl	Vulnerable under BC Act
Tyto tenebricosa	Sooty Owl	Vulnerable under BC Act
Chthonicola sagittatus	Speckled Warbler	Vulnerable under BC Act
Daphoenositta chrysoptera	Varied sittella	Vulnerable under BC Act
Pomatostomus temporalis	Grey-crowned Babbler	Vulnerable under BC Act
Artamus cyanopterus	Dusky Woodswallow	Vulnerable under BC Act

The methodology included prescribed transects, conducted for approximately 20 minutes by two Ecologists with all birds observed and heard being documented. Variables that may have influenced bird presence include type of habitat disturbance, amount of flowering vegetation, and weather conditions.

2.4.3.1 Data analysis

Bird diversity data is compared to previous seasons and baseline to determine trends across the broader Airly Mine Lease Area.

2.4.4 Cave-dwelling microbats

Anabats (microbat vocalisation recording devices) were used to record ultrasonic bat calls of targeted cave-dwelling bats that are known to occur in specific habitat types within the Management Area. Anabats were deployed at ten sites including two adit roosts (a horizontal passage leading into a mine) in December 2024 to evaluate foraging habitat and roosting habitat. Target microbat species are listed in **Table 2-11**. Anabat locations for 2024 are provided in **Figure 2-3**.

Table 2-11: Target Microbat Species

Scientific Name	Common Name	Conversation Status
Miniopterus orianae oceanensis	Eastern Bentwing-bat	Vulnerable under BC Act Sensitive to geological instability
Rhinolophus megaphyllus	Eastern Horseshoe bat	Protected under BC Act Sensitive to geological instability
Chalinolobus dwyeri	Large-eared Pied bat	Vulnerable under BC Act and EPBC Act Sensitive to geological instability

The identification of bat echolocation calls recorded during surveys was undertaken using Anabat Insight (Titley Electronics, Version 2.0.2) software undertaken by Dr Anna McConville at Echo Ecology. Reference calls were obtained from the NSW database and from the authors personal collection. Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite – Pass identified to species level and could not be confused with another species;
- Probable – Pass identified to species level and there is a low chance of confusion with another species;

- Possible – Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species;
- Species group – Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality; and
- Unknown – Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

2.4.4.1 Data analysis

Data was compared with previous seasons data to determine if any change had occurred between years. Two-tailed t-tests were conducted to determine if the native species diversity in the current monitoring season differs (both negative and positive effects) from previous monitoring years at each location at a significance level of 5% (i.e. $p < 0.05$).

2.4.5 Vertebrate census

During all monitoring events, all vertebrate fauna species observed or heard opportunistically were recorded. The inventory is aimed at the following:

- Recording basic presence/absence of all vertebrates within the management area, regardless of their potential sensitivity to undermining or conservation status;
- Detecting new or rare species that may require future monitoring, but have not been recorded within the management area previously; and
- Detection of feral fauna species.

Stationary infrared cameras were deployed during fauna monitoring periods in areas of suitable habitat as shown in Figure 2-3

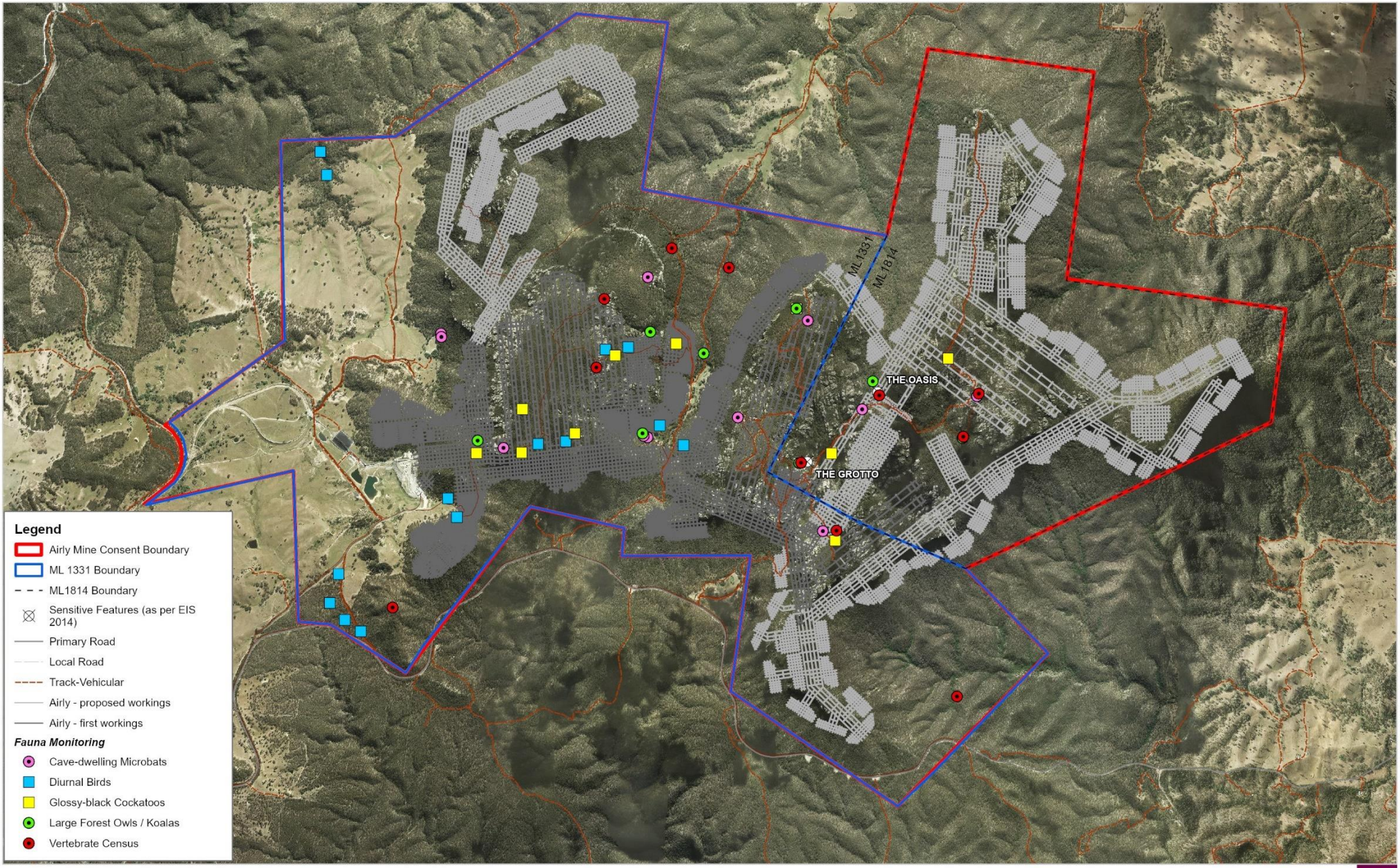
Figure 2-3. Fauna targeted by camera trap placement included the threatened Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) and Rosenberg's Goanna (*Varanus rosenbergi*) which have previously been detected within the Airly mining lease site. Gully habitats were targeted for the Spotted-tailed Quoll, whereas lower lying rocky habitats were targeted for the Rosenberg's Goanna. At each location, a tin of sardines was used to attract the species. **Table 2-12** lists the additional target fauna for the program.

Table 2-12: Additional target fauna species

Scientific name	Common name	Conversation status
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable under BC Act Endangered under EPBC Act Sensitive to habitat alteration
Varanus rosenbergi	Rosenberg's Goanna	Vulnerable under BC Act
Hoplocephalus bungaroides	Broad-headed Snake	Endangered under BC Act Vulnerable under EPBC Act
Phascolarctos cinereus	Koala	Endangere under BC Act Endangered under EPBC Act

2.4.5.1 Data analysis

Data was compared with previous seasons data to determine if any change had occurred between years. Two-tailed t-tests were conducted to determine if the native species diversity in the current monitoring season differs (both negative and positive effects) from previous monitoring years at each location at a significance level of 5% (i.e. $p < 0.05$).



THREATENED FLORA MONITORING LOCATIONS

CLIENT: Centennial
PROJ: 17803
LOCATION: Airly

MAP: Figure 5
VERSION: A
DATE EXPORTED: 20/03/2025
TECHNICIAN: NATALIE.WOOD

DATA SOURCES
Centennial, RPS, NSWSS,

0.5 0 0.5 1 1.5 Km
SCALE 1:32,000
A3 SIZE / Projection: GDA2020 MGA Zone 56

N

FIGURE 2.3

IMPORTANT NOTE:
1. This plan was prepared for the sole purposes of the client for the specific purpose of producing a photographic overlay plan. This plan is strictly limited to the Purpose and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.
The plan is presented without the assumption of a duty of care to any other person (other than the client) ("Third Party") and may not be relied on by Third Party.
2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss, damage, liability or claim arising out of or incidental to:
a. a Third Party publishing, using or relying on the plan;
b. RPS Australia East Pty Ltd relying on information provided to it by the Client or a Third Party where the information is incorrect, incomplete, inaccurate, out-of-date or unreasonable;
c. any inaccuracies or other faults with information or data sourced from a Third Party;
d. RPS Australia East Pty Ltd relying on surface indications that are incorrect or inaccurate;
e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd;
f. Lodgment of this plan with any local authority against the recommendation of RPS Australia East Pty Ltd;
g. the accuracy, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.
3. Without limiting paragraph 1 or 2 above, this plan may not be copied, distributed, or reproduced by any process unless this note is clearly displayed on the plan.
4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

PROJECT PATH: C:\Users\natalie.wood\OneDrive - Tetra Tech, Inc\Centennial\Airly\Airly BMP\Airly_BMP_2024.aprx

2.5 Survey timing and weather

The Bureau of Meteorology (BOM) and Geoscience Australia provides the weather details for all survey periods as outlined in **Table 2-13** to **Table 2-14.** Weather data was collected from Lithgow (Cooerwull; station 063226).

Table 2-13: Temperature, rainfall and day length during the Spring 2024 monitoring period

Date	Min temp (°C)	Max temp (°C)	Rainfall (mm)	Sun rise – Sun set
28/10/2024	3.5	24.0	0	06:03 - 19:23
29/10/2024	7.5	23.7	0	06:02 - 19:24
30/10/2024	11.9	25.0	0	06:01 - 19:25
31/10/2024	4.4	23.7	0	06:00 - 19:26
1/11/2024	6.0	21.8	0.6	05:59 - 19:27

BOM- http://www.bom.gov.au/climate/dwo/202102/html/IDCJDW2075.202102.shtml
Geoscience AUS- http://www.ga.gov.au/geodesy/astro/sunrise.jsp

Table 2-14: Temperature, rainfall and day length during the Summer 2024 monitoring period

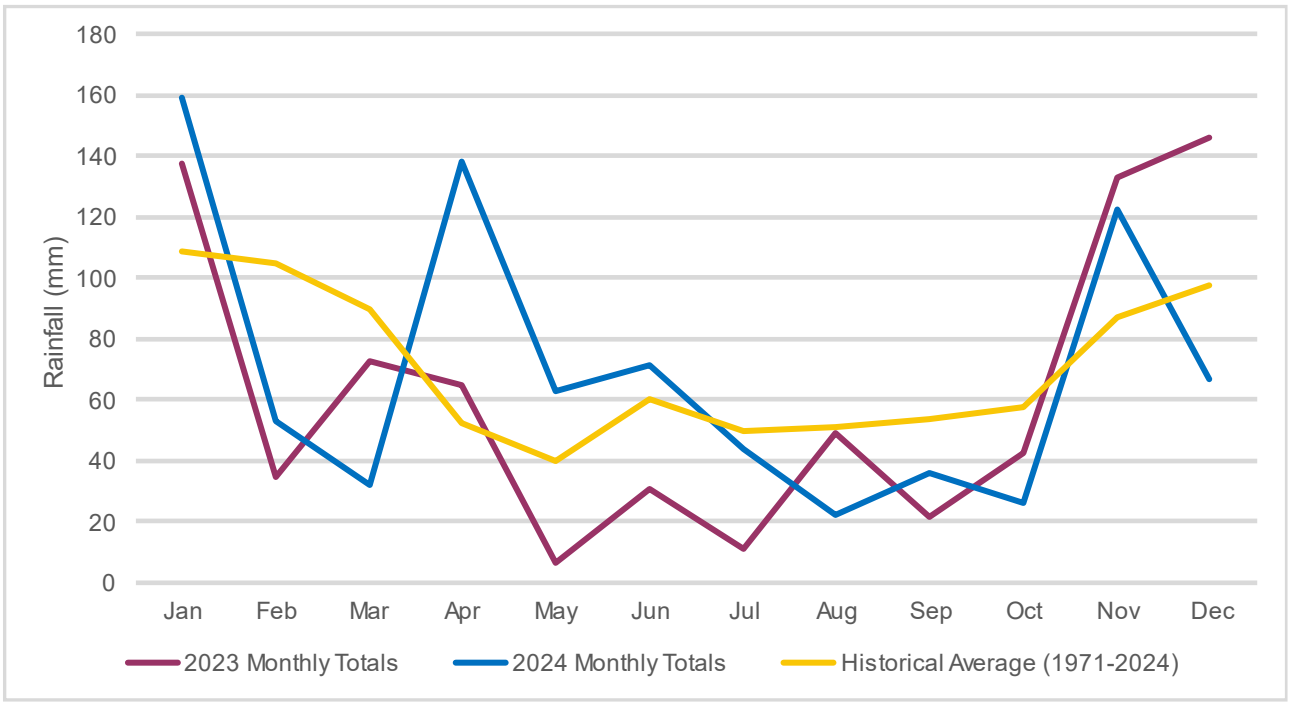
Date	Min temp (°C)	Max temp (°C)	Rainfall (mm)	Sun rise – Sun set
16/12/2024	13.6	31.1	0	05:44 – 20:06
17/12/2024	12.8	31.2	0	05:45 – 20:07
18/12/2024	12.9	17.7	0.4	05:45 – 20:07
19/12/2024	11.1	19.5	0.4	05:45 – 20:08

BOM- http://www.bom.gov.au/climate/dwo/202102/html/IDCJDW2075.202102.shtml
Geoscience AUS- http://www.ga.gov.au/geodesy/astro/sunrise.jsp

Average monthly rainfall data for 2023 and 2024 in comparison to historical average monthly rainfall is displayed in **Graph 2-1** below.

Rainfall in 2023 was below the historical average eight months of the year with substantial rainfall events occurring in January, November and December 2023. April recorded slightly above historic average rainfall and the remainder of the year experienced rainfall below the historic average in 2023. Rainfall in 2024 was more sporadic than the previous year, with January, April and November experiencing rainfall substantially higher than the historic average, as well as May and June with slightly above average rainfall. The other seven months recorded lower than historic average rainfall. February of 2023 and 2024 recorded the biggest difference in rainfall from the historic average across the year, both years experiencing 50mm less rainfall than the historic average.

The mean annual rainfall for 2024 was slightly higher than 2023 by 83.6mm. In comparison to the historic mean annual rainfall, 846.8mm, the rainfall in 2024 was similar, recording an annual mean of 832.0mm, a 14.8mm difference (BOM 2024).



Graph 2-1: 2023 and 2024 monthly rainfall (mm) compared to historical average monthly rainfall (1971-2024) for Glen Alice (BOM 2024).

3 RESULTS

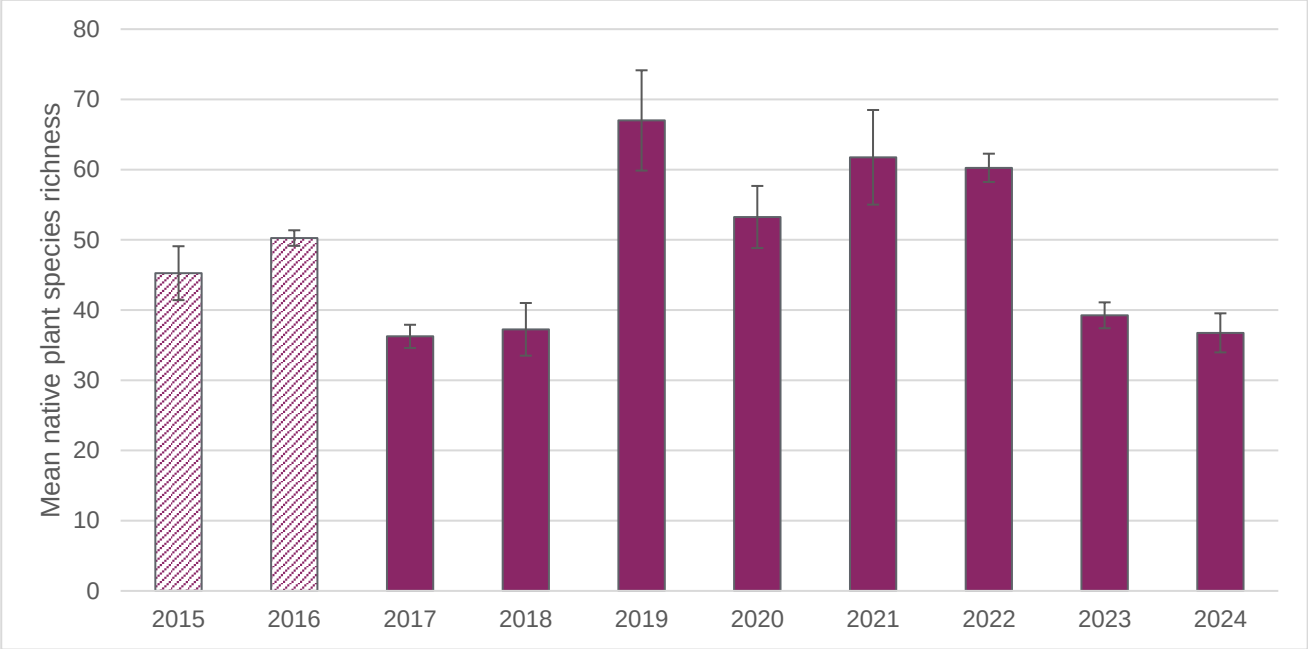
3.1 Vegetation community

3.1.1 White Box – Yellow Box – Blakely's Red Gum Woodland

3.1.1.1 Native plant species richness

Four BAM plots in MU20 (PCT 703/3510) were surveyed in the 2024 monitoring period (see Figure 2-1

Figure 2-1). **Graph 3-1** below shows native plant species richness in BAM plots across the years 2015 to 2024.



Graph 3-1: Histogram displaying mean native plant species richness between monitoring years

Native plant species richness has significantly reduced since baseline. However, it is comparable to that of 2017, 2018 and 2023.

A one-way ANOVA was performed to compare monitoring year and native plant species richness which revealed that there was a statistically significant difference in native plant species richness between at least two years ($F [8, 27] = 7.4378$; $p < 0.0001$). A paired two-tailed t-test was performed to compare the 2024 mean native plant species richness to baseline years. The mean native species richness in 2024 has significantly decreased since both the 2015 ($p = 0.0234$) and 2016 ($p = 0.0187$) monitoring years. Native plant species richness is comparable to years 2023, 2017 and 2018.

See **Appendix B** for full flora inventory and photo monitoring.

3.1.1.2 Vegetation integrity

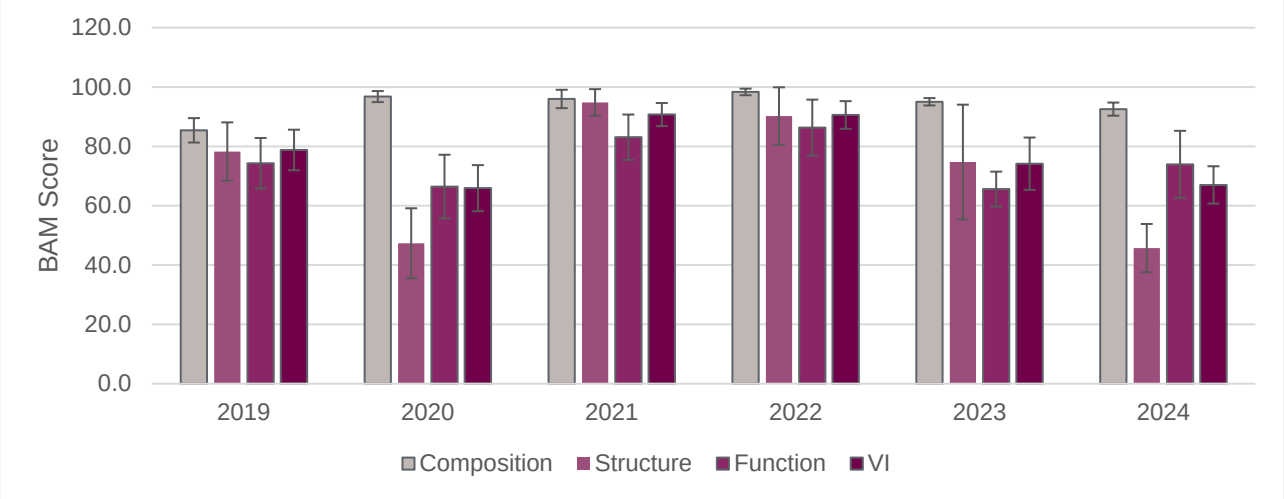
BAM and VI score were calculated for the four White Box - Yellow Box - Blakely's Red Gum Grassy Woodland BAM plots. **Table 3-1** and **Graph 3-2** provides a summary of these scores.

Table 3-1: BAM composition, structure, function and VI scores across 2019 – 2024

Year	Composition	Structure	Function	VI score
2019	85.4	78.3	74.3	78.8
2020	96.8	47.3	66.5	65.9
2021	96.0	94.8	83.1	90.8

Year	Composition	Structure	Function	VI score
2022	98.4	90.2	86.4	90.6
2023	95.1	74.7	65.6	74.2
2024	92.6	45.7	74.0	67.0

Red = statistical decrease since baseline; Green = statistical increase since baseline



Graph 3-2 Histogram displaying mean BAM scores (composition, structure, function, VI) between monitoring years

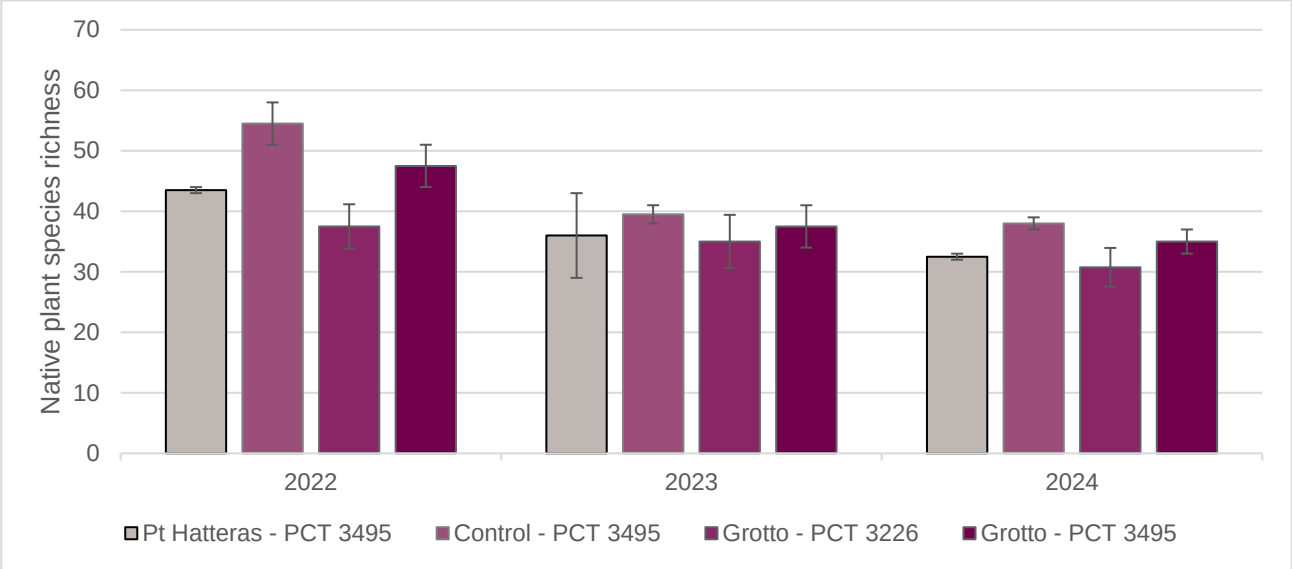
Paired two-tailed t-tests were performed to compare the 2024 BAM scores to baseline years (2019 and 2020). Across all BAM score metrics, no significant changes were recorded between 2024 and baseline.

3.1.2 Groundwater Dependent Ecosystems

Eleven GDE plots were surveyed in the 2024 monitoring period. Plots were located within both the Point Hatteras BMP area, and within the Grotto to establish baseline data for the CLZ ML1814 BMP (see Figure 2-1

Figure 2-1).

3.1.2.1 Native plant species richness



Graph 3-3: GDE plots – mean native plant species richness and SE of across monitoring location and PCT for the current and previous monitoring periods

Graph 3-3 above displays the native plant species richness within the GDE plots across monitoring locations from 2022 to 2024. In 2022 PCT 3495 control plots displayed the highest species richness and generally PCT 3495 had a higher diversity than PCT 3226. This remains the same for 2023 and 2024, however the variation between plots is much lower. In general, native species richness has decreased each year, however not at a level of significant, across all GDE plots. See **Appendix C** for the full flora inventory and photo monitoring.

3.1.2.2 Vegetation integrity

Table 3-2 displays the composition, structure, function and VI scores within the GDE plots across monitoring locations for 2023 and 2024. The histograms below (**Graph 3-4** - **Graph 3-7**) display the composition, structure, function and VI scores across PCT's and GDE locations from 2022 to 2024. Since Point Hatteras was undermined in 2023, this area is now considered an impact area.

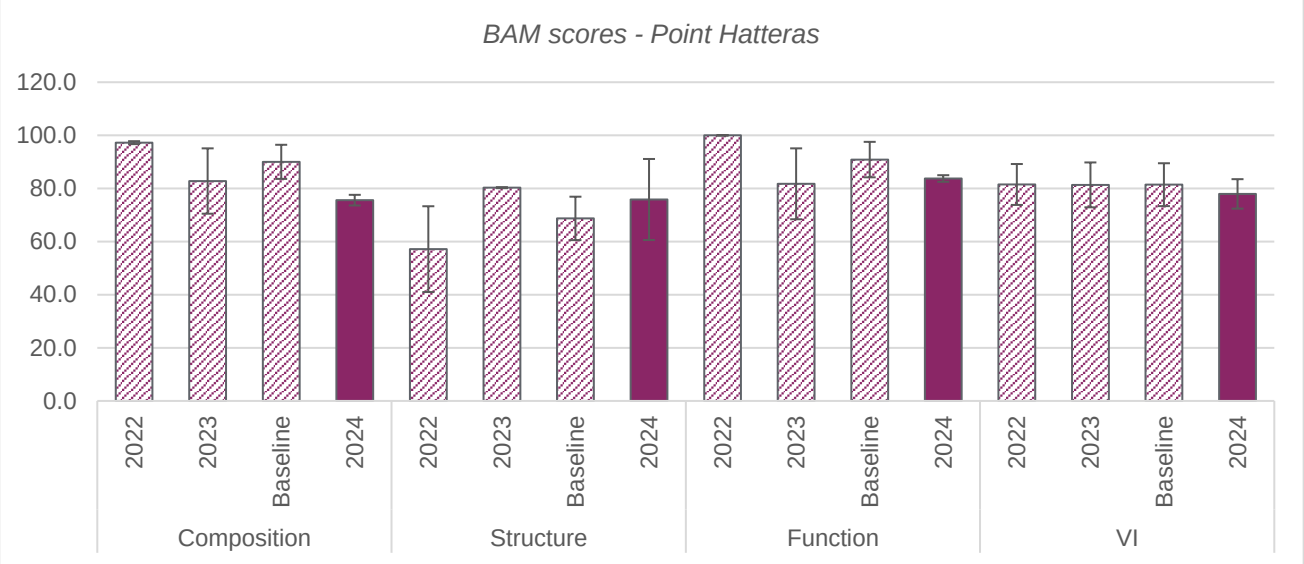
In general composition, structure, function and VI scores have been stable across all PCTs apart from PCT 3495 located in the Point Hatteras EP Area. Further analysis is provided below.

Table 3-2: GDE plots - mean BAM scores across monitoring locations for the current and previous monitoring period

Location – PCT	Composition	Structure	Function	VI
2023				
Impact				
Point Hatteras – PCT 3495	82.8	80.3	81.8	81.4
Control				
Control – PCT 3495	90.7	88.2	79.2	85.7
Grotto – PCT 3226	81.0	52.2	98.1	71.6
Grotto – PCT 3495	81.0	50.4	88.8	71.2

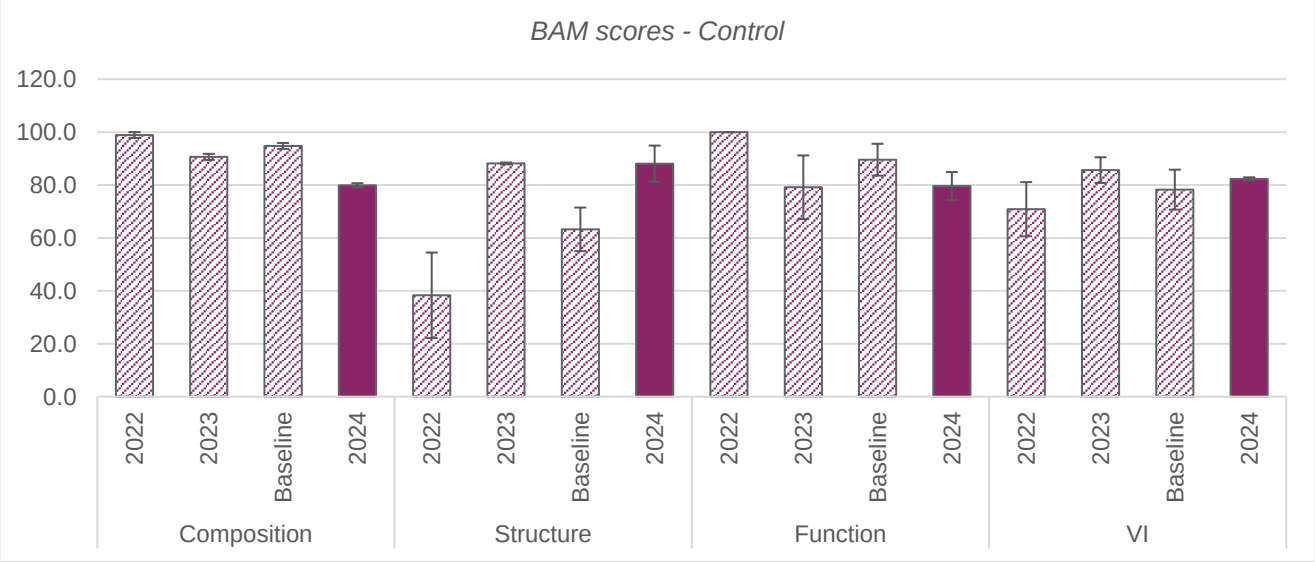
Location – PCT	Composition	Structure	Function	VI
2024				
Impact				
Point Hatteras – PCT 3495	75.6	75.9	83.8	78.0
Control				
Control – PCT 3495	79.9	88.1	79.6	82.3
Grotto – PCT 3226	75.6	51.0	90.1	69.8
Grotto – PCT 3495	69.6	51.7	78.9	65.2

Red = statistical decrease; Green = statistical increase



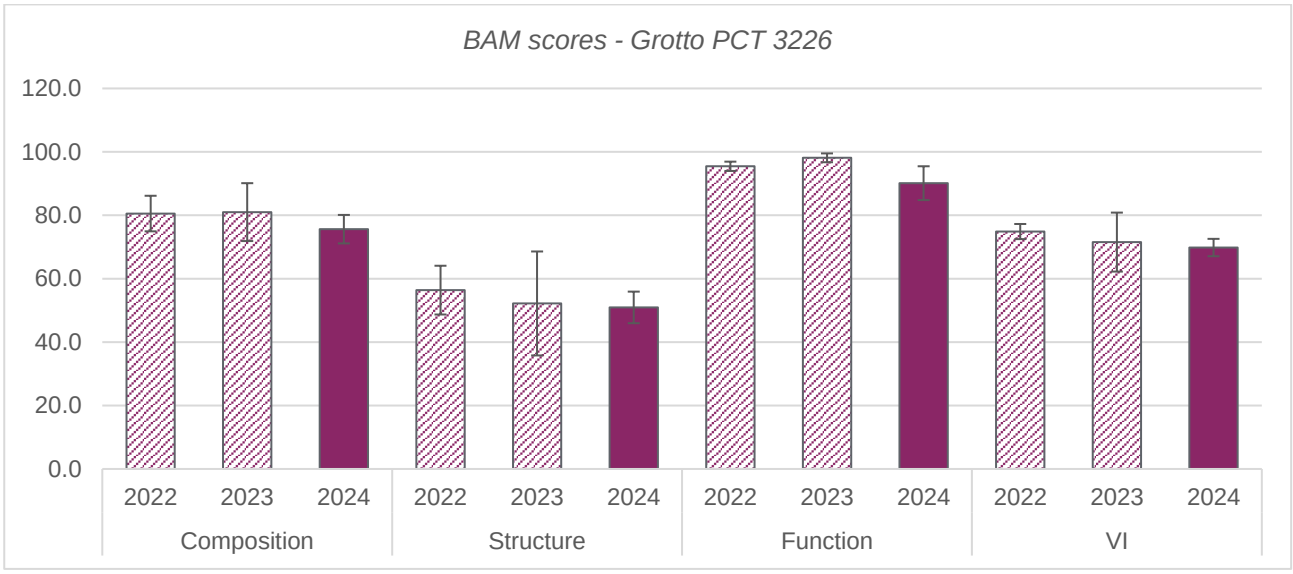
Graph 3-4: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Point Hatteras – PCT 3295 for 2022 to 2024 monitoring periods.

Paired two-tailed t-tests were performed to compare the impact plots (Point Hatteras) 2024 BAM scores to 2022 (see **Graph 3-4**). No significant changes in composition, structure, function and VI scores were detected between 2024 and baseline (2022/2023). A decrease in composition and function between 2024 and 2022 was recorded, however scores are comparable to 2023. VI scores are consistent across all years.



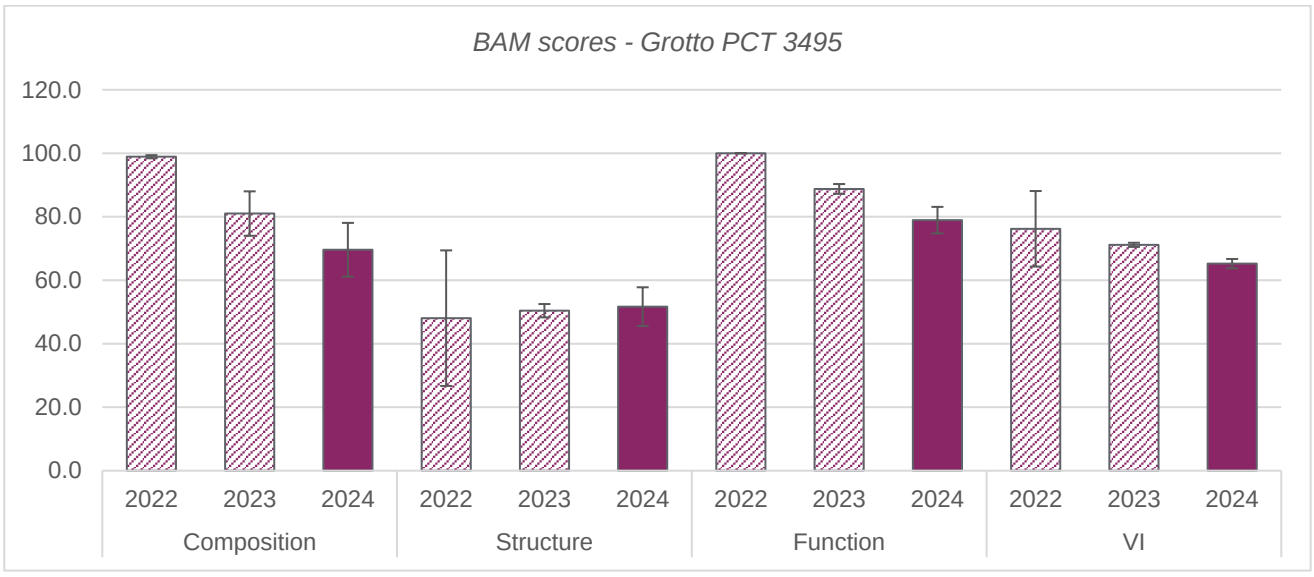
Graph 3-5: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Control – PCT 3495 for 2022 to 2024 monitoring periods.

Paired two-tailed t-tests were performed to compare Control plots for PCT 3495 2024 BAM scores to baseline (2022 and 2023) (see **Graph 3-5**). A significant decrease in composition scores was recorded between baseline and 2024. On the contrary, structure scores have substantially increased since 2022. This suggests that a decrease in composition scores is due to cryptic forb species reducing overall species richness, whilst the increase in structure suggests there has been an increase in cover of dominant species. As these plots are not within an impact area, compositional changes are likely due to broader environmental factors such as reduced rainfall across 2024 and competition. VI scores have been consistent across years with 2022 exhibiting the lowest score.



Graph 3-6: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Grotto – PCT 3226 for 2022 to 2024 monitoring periods.

Paired two-tailed t-tests were performed to compare Grotto plots for PCT 3226 2024 BAM scores to 2022 (see **Graph 3-6**). No statistically significant differences were recorded. All BAM scores have been consistent across years.



Graph 3-7: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE in Grotto – PCT 3495 for 2022 to 2024 monitoring periods.

Paired two-tailed t-tests were performed to compare Grotto plots for PCT 3495 2024 BAM scores to 2022 (see **Graph 3-7**). Function scores have significantly reduced in 2024 since 2022 and 2023. Function scores measure changes in leaf litter and fallen log habitat. Changes in function scores are likely within these plots

due to their location within riparian locations, therefore are exposed to hydrological processes that may deposit or remove leaf litter and logs from year to year. Overall, VI scores are stable.

3.1.2.3 Rapid aquatic assessment

Rapid aquatic assessment occurred along 50 m transects within the Grotto at nine locations adjacent to streams. GDE BAM11 is a newly established plot in 2024.

Table 3-3 provides a summary of the stream condition within the Grotto for 2023 and 2024 whilst **Table 3-4** provides a summary of the stream types. This data forms a part of the baseline condition of these monitoring locations. This assessment was completed at or near each plot where a stream is or may be present. There was no data collected at impact sites GDE BAM01, GDE BAM02 and GDE BAM11 in 2023. GDE BAM11 is a newly established plot in 2024.

Table 3-3: 2023 and 2024 stream condition

Plot name	Average flow width (m)	Max flow width (m)	Min flow width (m)	Average soil moisture ±3% VWC	Clarity/sediment load (0 poor – 5 clear)	Erosion (0 absent – 5 severe)
2023						
GDE BAM05	0	0	0	3.9	0	1
GDE BAM06	0	0	0	0.0	0	1
GDE BAM07	0	0	0	15.0	0	1
GDE BAM08	1.86	2.8	1	39.9	5	1
GDE BAM10	1	5	0	9.3	0	4
2024						
GDE BAM01	1.06	2	0.5	38.6	3	4
GDE BAM02	3.4	7	1.5	4.6	5	0
GDE BAM05	0	0	0	3.4	0	3
GDE BAM06	0	0	0	7.0	0	0
GDE BAM07	1.94	3	0.5	2.3	5	5
GDE BAM08	0.66	1	0.3	26.2	2	2
GDE BAM09	1.54	2	1.2	10.8	5	1
GDE BAM10	2	2.5	1.5	5.4	5	2
GDE BAM11	1.59	4	0.15	11.7	0	1

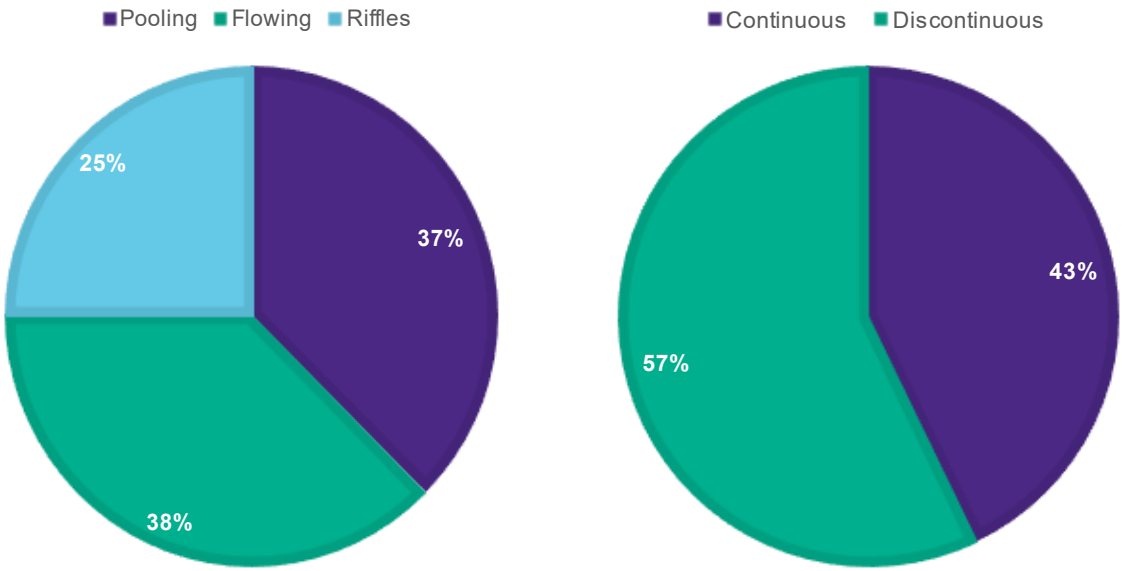
The average, max and min flow width, were all higher in 2024 than in 2023. However, the average soil moisture, and clarity/sediment load was lower in 2024 than in 2023. This difference could be attributed to lower rainfall in 2024 compared to 2023 in Spring/Summer. GDE BAM05, 07 and 08 recorded higher erosion scores in 2024 compared to 2023.

Table 3-4: GDE stream type parameters

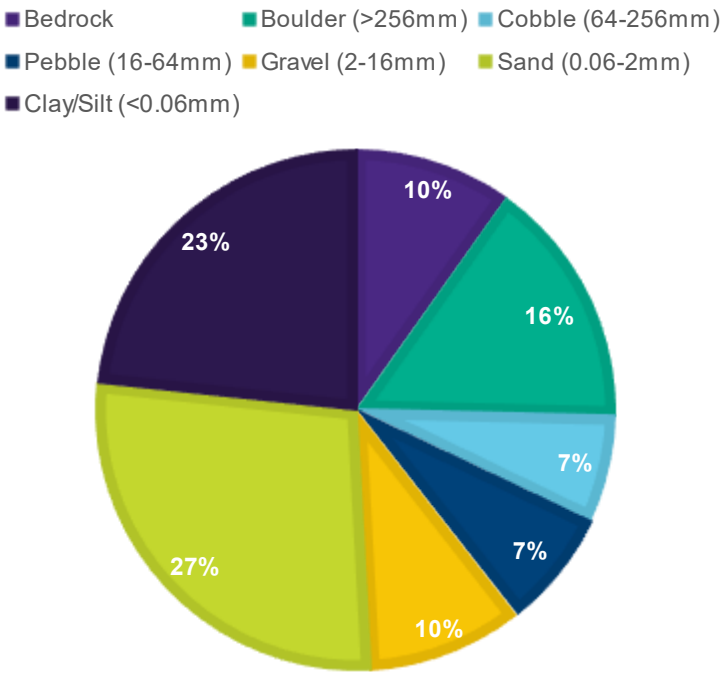
Parameter	Percent of streams sampled
Stream flow type	
Pooling	33%
Flowing	33%
Continuous	33%
Discontinuous	44%
Riffles	22%
Aquatic vegetation type	
Submerged	22%
Floating	11%
Emergent	67%

Parameter	Percent of streams sampled
Substrate type	
Bedrock	10%
Boulder (>256mm)	16%
Cobble (64-256mm)	7%
Pebble (16-64mm)	7%
Gravel (2-16mm)	10%
Sand (0.06-2mm)	27%
Clay/Silt (<0.06mm)	23%
Bank slope	
Flat <10°	69%
Low 10 – 30°	0%
Moderate 30 – 60°	11%
Steep 60 – 80°	10%
Vertical 80 – 90°	10%

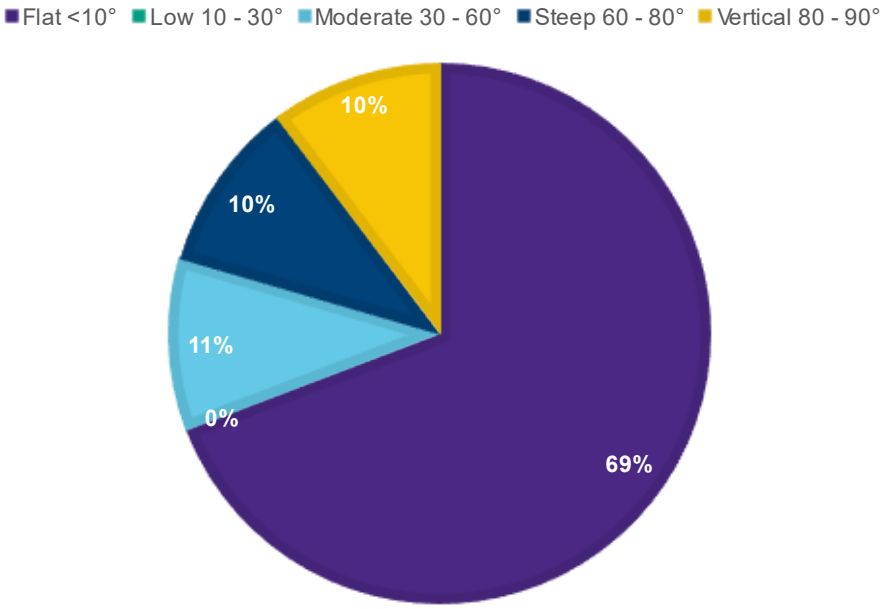
Half of the streams had areas that were pooling or flowing and some had riffles, and more streams presented discontinuous flow (**Graph 3-8**). Aquatic vegetation was present at most of the locations in the form of emergent vegetation, with some submerged and floating vegetation. Substrate varied across all types, with sand and clay/silt the most persistent (**Graph 3-9**Graph 3-9). Bank slopes consisted of flatter slopes with some moderate to vertical, typical of the gully landscape (**Graph 3-10**).



Graph 3-8: Stream flow type across sampled locations



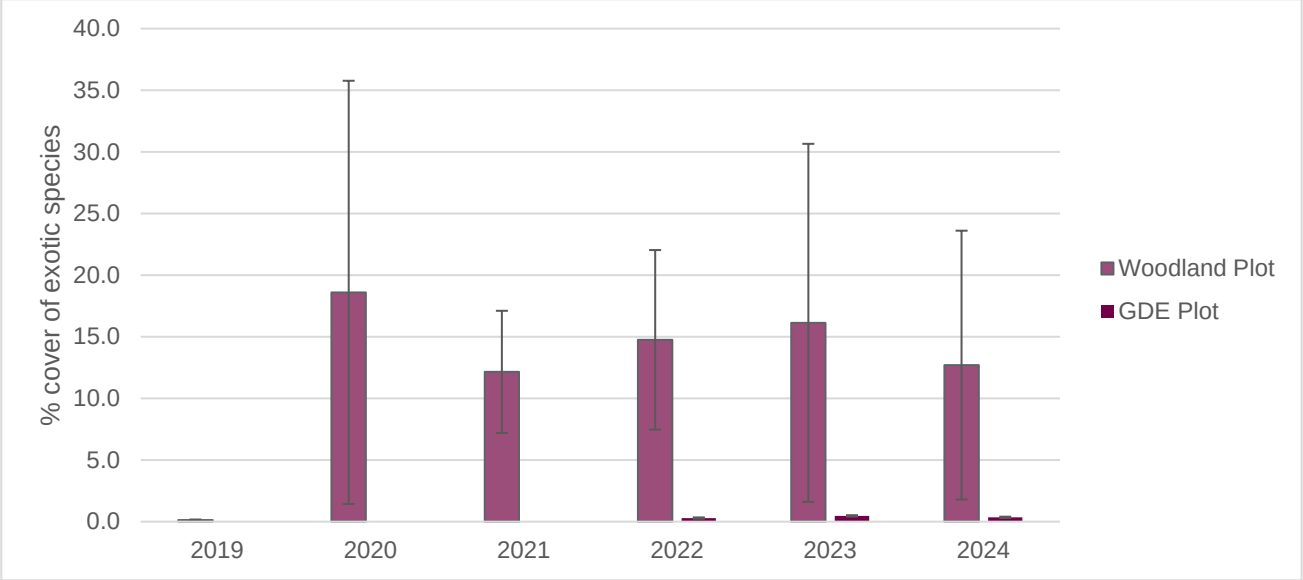
Graph 3-9: Substrate type across sampled locations



Graph 3-10: Bank slope type across sampled locations

3.1.3 Exotic species

Across the 14 BAM plots, a total of 26 exotic species were detected in the management area. This is consistent with those recorded in the 2023 monitoring period.



Graph 3-11: Mean exotic species cover within White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and GDE BAM plots

Graph 3-11 shows that in the 2024 monitoring period there has been a decrease in exotic species cover within the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland BAM plots compared to the previous two years, with an average of 12.7% cover. Within the GDE plots, exotic species cover is low with an average of 0.4% cover.

Exotic species with a cover of 3% or greater are summarised in **Table 3-5**. Woodland plot 1 has the highest exotic species cover due to a high grass cover of *Phalaris aquatica* within the riparian area. All weed species have management requirements under the *Biosecurity Act 2015*.

Table 3-5: Occurrences of high exotic species cover in White Box – Yellow Box – Blakely's Red Gum Grassy Woodland plots

Quadrant	Exotic species with a cover of 3% or greater	Total % cover
BAM 1	*Phalaris aquatica*	40

3.2 Flora results

3.2.1 *Prostanthera stricta* (Mount Vincent Mint-bush)

Eighteen transects were completed across the 2024 monitoring program, including four transects which were established, and two transects that were re-established in 2022 (see **Figure 2-2**). **Table 3-6** summarises the mean percent cover of *P. stricta* across transects at each monitoring location.

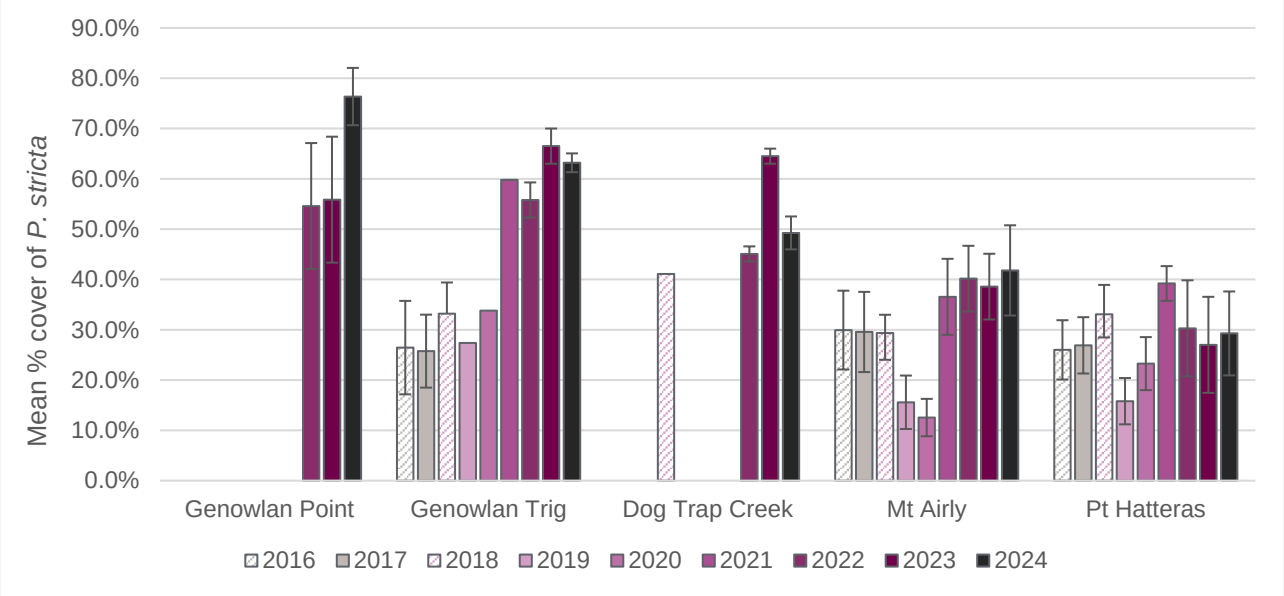
Table 3-6: Mean percent cover of *P. stricta* across location and years (n = number of transects)

Location	Mean percent cover								
	Y2016	Y2017	Y2018	Y2019	Y2020	Y2021	Y2022	Y2023	Y2024
All transects	28.1% (n =10)	28.0% (n =10)	31.8% (n =14)	16.6% (n =12)	17.4% (n =11)	39.4% (n =11)	42.7% (n =15)	44.9% (n = 18)	48.0% (n = 18)
Genowlan Point							54.6%	55.9%	76.4%
Genowlan Trig	26.5%	25.8%	33.2%	27.4%	33.8%	59.8%	55.8%	66.5%	63.2%
Dog Trap Creek			41.1%				45.1%	65%	49.3%
Mount Airly	29.9%	29.6%	29.3%	15.6%	12.5%	36.6%	40.2%	38.6%	41.8%
Point Hatteras	26.0%	26.9%	33.1%	15.8%	23.3%	39.2%	30.3%	27%	29.3%

Red = statistical decrease from the previous year; Green = statistical increase from previous year

A one-way ANOVA was performed to compare monitoring year and mean percent cover of *P. stricta* which revealed that there was a statistically significant difference between at least two years ($F(8, 113) = 6.284$, $p = <0.0001$).

A two-tailed t-test was performed to compare the 2024 mean percent cover of *P. stricta* to previous years. The mean % cover of *P. stricta* in 2024 has not significantly changed since 2023, however it has significantly increased in comparison to 2016, 2017, 2019 and 2020. See **Graph 3-12** for a visual representation of these results.



Graph 3-12: Histogram displaying mean % cover of *P. stricta* and SE across monitoring locations and years. Note that transects at Genowlan Point were established in 2022

Two-tailed t-test was performed to compare the 2024 % cover of *P. stricta* at Mount Airly, Point Hatteras and Genowlan Trig to previous years. The results are as follows:

- The % cover of *P. stricta* at Mount Airly did not significantly change in 2024. Outliers in the 5th and 95th percentile recorded a 5% and 80% cover of *P. stricta*, respectively. Despite this, *P.* stricta on Mount Airly has been consistent with no statistically significant changes since 2021. This pattern correlates with likely population recovery after a controlled burn across Mount Airly in 2018, and then stabilisation of the population in 2024
- The % cover of *P. stricta* at Point Hatteras did not significantly change in 2024 and did not significantly change in any other year
- The % cover of *P. stricta* at Genowlan Trig did not significantly change in 2024 and did not significantly change in any other year. However, there was a statistical increase in 2024, compared to 2016, 2017 and 2018 collectively.

It is to note that three new transects were established at Genowlan Point in 2022 and have been left out of the population analysis between years.

3.2.2 *Eucalyptus cannonii* (Capertee Stringybark)

A total of 28 *E. cannonii* individuals were monitored during the 2024 survey period (see **Figure 2-2**). The condition as well as size class of *E. cannonii* trees were assessed as per the parameters in **Table 2-7** and were averaged depending on the monitoring location of the individuals. **Table 3-7** summarises these results. Photo monitoring is provided in **Appendix A.**

The results in **Table 3-7** indicate that mean crown density % measured in 2024 was significantly higher than baseline at Mount Airly (M = 50, SD = 15; $t(11) = 2.465$), p = 0.024 and Control (M = 72, SD = 14; $t(6) = 4.011$, p= 0.002) when compared to baseline (2016-2017). This has been an ongoing trend for this metric for both Mount Airly and Control.

Mean crown extent % measured in 2024 was significantly lower than baseline at Mount Airly when compared to baseline in 2016-2017 (M = 43, SD = 23; $t(11) = -4.300$, p = <0.001). This has been an ongoing trend for this metric at Mount Airly.

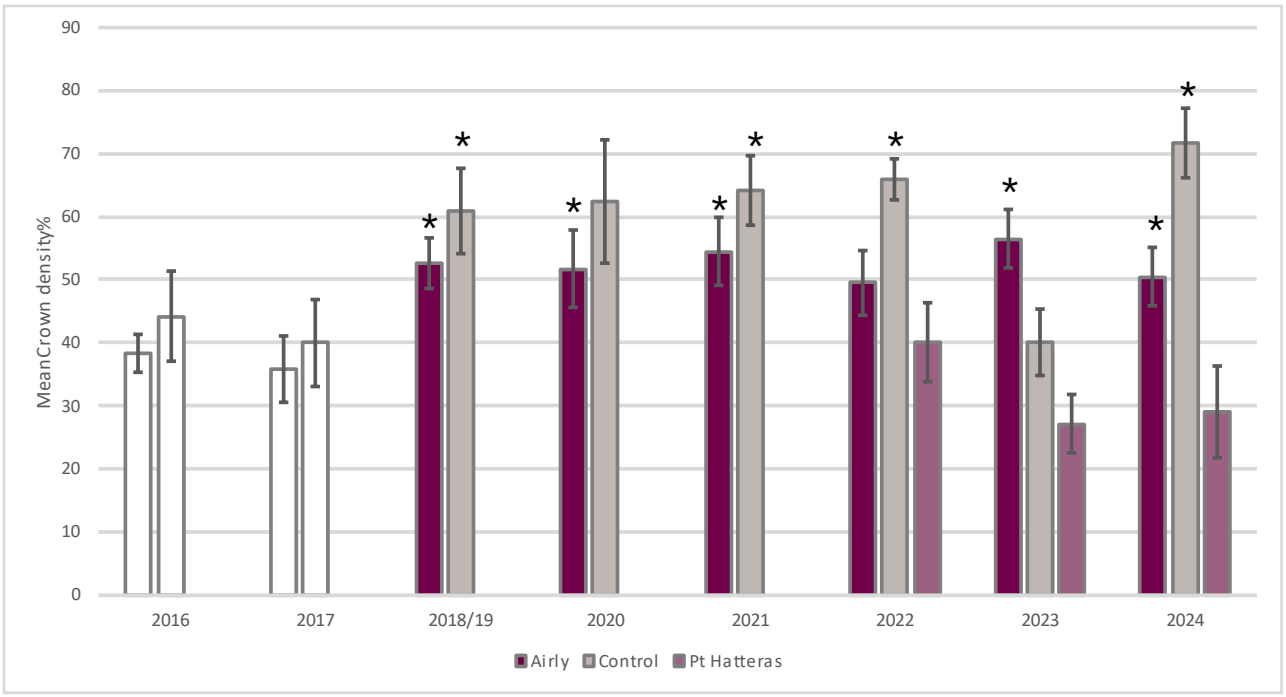
Average height (m) of E*. cannonnii* measured in 2024 was significantly higher than baseline only within Control during 2024 (M = 22, SD = 4; $t(6) = 3.073$, p = 0.015). This metric was also significantly higher during 2023.

Table 3-7: Average *E. cannonii* condition classes across monitoring years. Note that transects at Point Hatteras were established in 2022.

Location	2016	2017	2018/19	2020	2021	2022	2023	2024
Average crown density %								
Mount Airly	38	36	53	52	54	50	57	50
Control	44	40	61	63	64	66	40	72
Point Hatteras[1]	-	-	-	-	-	40	27	29
Average crown extent %								
Mount Airly	75	76	78	58	76	48	36	43
Control	73	73	85	69	69	58	66	60
Point Hatteras[1]	-	-	-	-	-	40	33	24
Average height (m)								
Mount Airly	20	16	16	16	19	17	18	21
Control	17	14	16	16	18	17	22	22
Point Hatteras[1]	-	-	-	-	-	11	12	13
Average DBH (cm)								
Mount Airly	58	56	66	20	53	67	54	56
Control	50	53	57		56	54	56	57
Point Hatteras[1]	-	-	-	-	-	28	28	29

Red = statistical decrease since 2016/2017; Green = statistical increase since 2016/2017;

[1] Monitoring for Point Hatteras established in 2022, no statistical analysis undertaken for Point Hatteras.

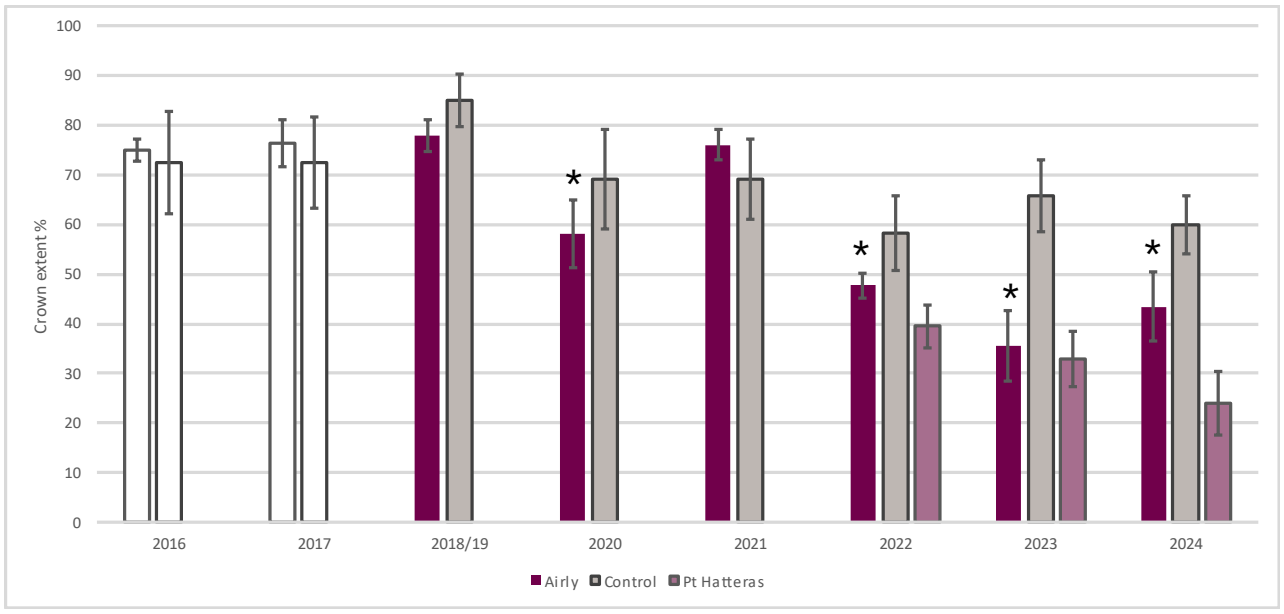


Graph 3-13: Histogram displaying average crown density (%) and SE across monitoring locations and years.

*** indicates statistical difference (p <0.05) detected between monitoring period and mean of baseline (2016-2017).**

The results in **Graph 3-13** shows that mean crown density of *E. cannonii* at Mount Airly in 2024 is slightly lower than 2023, but generally comparable to previous years. Measured mean crown density at Point Hatteras in 2024 was comparable to that measured in 2023 but was approximately 10% lower than 2022. No statistical analysis was undertaken for Point Hatteras.

Mean crown density % within control sites has steadily increased year-on-year since 2018-19, excluding 2023 when density decreased substantially (~ decrease of 25%). Conversely, a year-on-year increase in crown density has not been observed in impact sites (i.e. Mount Airly and Point Hatteras)



Graph 3-14: Histogram displaying average crown extent % and SE across monitoring locations and years.

*** indicates statistical difference (p <0.05) detected between monitoring period and mean of baseline (2016-2017).**

The results in **Graph 3-14** indicate that the mean crown extent of *E. cannonii* at Mount Airly in 2024 (43%) is slightly higher than in 2023 (36%), but significantly lower than mean crown extent % measured during baseline (75% and 76% in 2016 and 2017, respectively). Mean crown extent % measured at Point Hatteras in 2024 (24%) is lower than both 2023 (33%) and 2022 (40%). No statistical analysis is undertaken at Point Hatteras.

Mean crown extent % within control sites has been higher than impact sites in all years, except 2021 when it was slightly lower than Mount Airly (69% at control and 76% at Mount Airly. Although mean crown extent % at control has been lower than baseline between 2020 and 2024, the difference has not been significant.

3.3 Fauna results

3.3.1 Glossy black-cockatoos

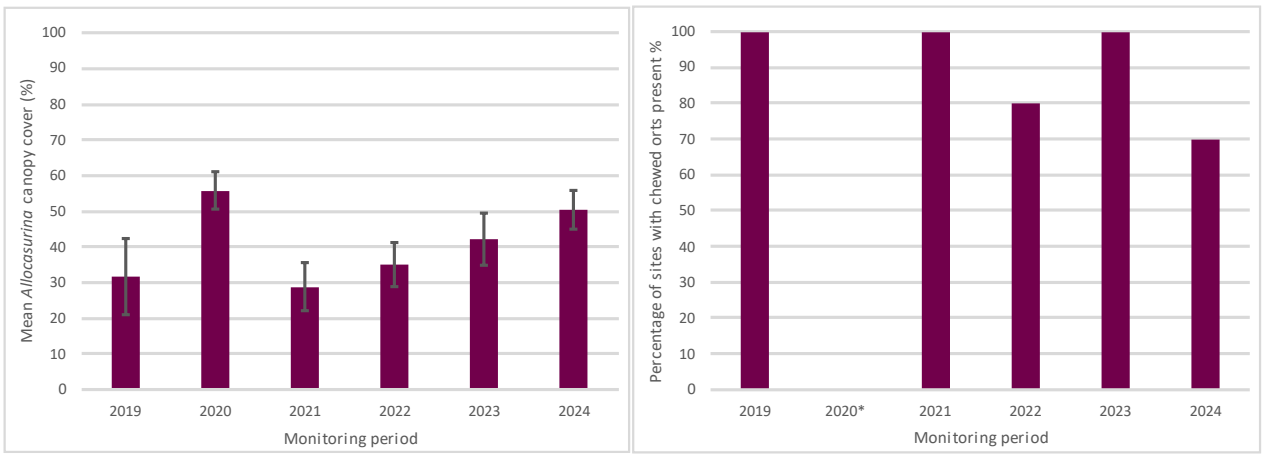
The presence/absence of Glossy black-cockatoos and the condition of *Allocasuarina* trees (primary feed trees) were monitored at ten locations across Mount Airly, Genowlan Trig, Genowlan Point and Mt Hatteras during the 2024 monitoring period. **Table 3-8** provides a summary of the metrics and results recorded during the 2024 field survey. Chewed orts are shown in **Plate 3-1** for reference.

The presence of Glossy black-cockatoos was confirmed through a sighting of eight individuals at monitoring point 10 (Genowlan Point), in addition to the confirmed presence of *Allocasuarina* 'orts' at seven of the ten monitoring locations.

Table 3-8: 2024 Glossy black-cockatoo monitoring results

Location	Site Number	Total Canopy Cover (%)	*Allocasuarina* Canopy Cover (%)	Orts Present (P) or Absent (A)	Chewed Orts Ground Coverage (%)	Glossy black-cockatoo Presence (P) or Absence (A)
Airly	1	65	60	A	0	A
Airly	2	40	40	A	0	A
Airly	3	50	50	P	5	A
Airly	4	35	60	A	0	A
Airly	5	50	85	P	3	A
Airly	6	55	30	P	1	A
Point Hatteras	7	50	60	P	10	A
Point Hatteras	8	60	35	P	10	A
Genowlan Trig	9	50	55	P	3	A
Genowlan Point	10	65	30	P	2	P

Green = Glossy-black cockatoos observed and/or inferred presence (chewed orts present)



Graph 3-15: Histogram of mean *Allocasuarina* cover (%) and ±SE since 2019 (L) and percentage of monitoring sites with crewed orts present (R). * Indicates no data collected for this metric in 2020.

The results in **Graph 3-15(L)** indicate that mean *Allocasurina* canopy cover (%) has continued to increase year-on-year since 2020. **Graph 3-15(R)** indicates that the percentage of sites with chewed orts present remains high. However, during this monitoring period there was a 30% decrease in the percentage of sites recording chewed orts (70% in 2024) compared to 2023 (100%).



Plate 3-1: Chewed orts scattered under *Allocasurina* (L) and a close-up of chewed orts (R)

3.3.2 Forest owls

Three of the four forest owl roost locations were visually surveyed across Mount Airly. Site 2 remains inaccessible due to landslides. Searches were conducted for owl pellets and whitewash however none was identified at the roost locations. Call playback and spotlighting confirmed the presence of a Powerful Owl (*Ninox strenua*; BC Act: Vulnerable) and a Sooty Owl (*Tyto tenebricosa*; BC Act: Vulnerable) near Airly Campground. Song meter analysis also detected Southern Boobook (*Ninox novaeseelandiae*) at every forest owl survey site and the Sooty Owl (*Tyto tenebricosa*; BC Act: Vulnerable) was detected at Airly Campground.

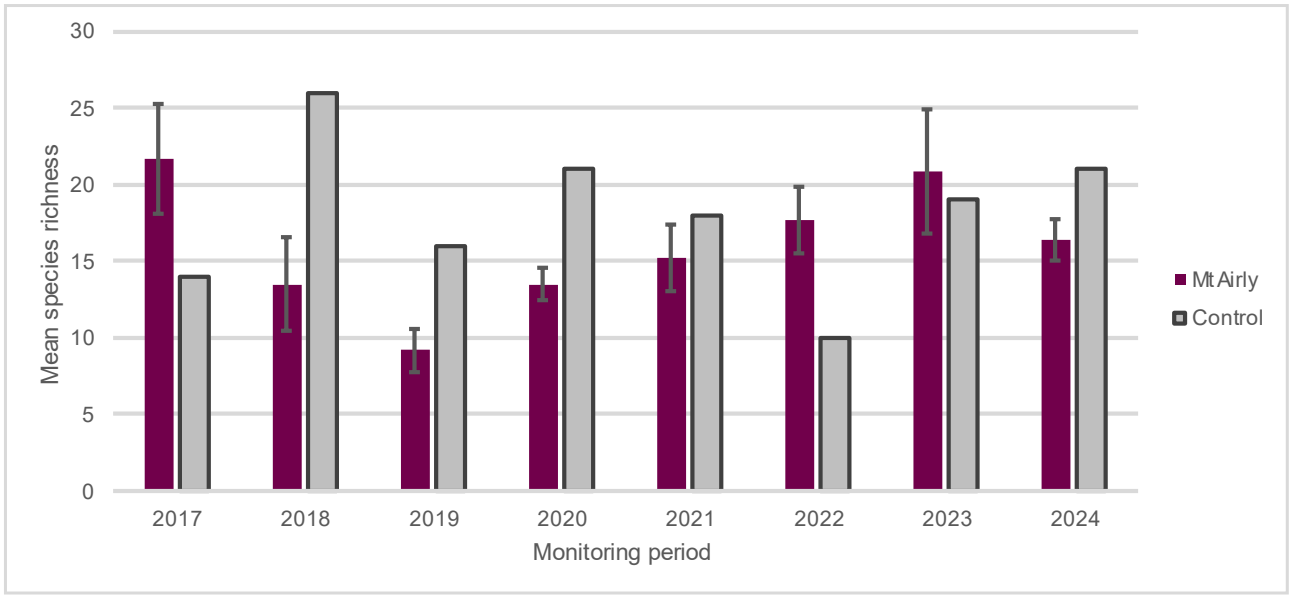
3.3.3 Woodland birds

A total of 71 bird species were detected during the 2024 monitoring period of which 51 were detected during the diurnal bird transects. The additional 20 bird species were detected through opportunistic sightings, camera trap observations and acoustic recording. See **Appendix E** for the full fauna inventory.

The most common bird species was the Superb Lyrebird which was heard calling in six of the seven birding transects and observed in camera trap footage (see **Plate 3-2**). Other common bird species noted across five or more birding transects include the Australian Magpie (*Cracticus tibicen*), Grey Fantail (*Rhipidura albiscapa*), Pied Currawong (*Strepera graculina*), Rufous Whistler (*Pachycephala rufiventris*) and Spotted Pardalote (*Pardalotus punctatus*).



Plate 3-2: Male Superb Lyrebird (*Menura novaehollandiae*) image captured at camera trap location 2 (The Grotto)



Graph 3-16: Mean bird species richness ±SE recorded during diurnal bird transects at impact and control sites across monitoring periods

A two-tailed t-test was performed to compare the 2023 birding species richness across all transects to previous years. Whilst mean species richness increased at control plots and decreased at Mt. Airly from 2023, no statistically significant changes were noted. Therefore, it is deemed that the bird species richness across the management area is stable as shown in **Graph 3-16**.

Three of the recorded bird species are listed as threatened under the BC Act and one is also listed under the EPBC Act. See **Table 3-9** for a summary of the threatened bird species recorded in the 2024 survey period.

Table 3-9: Threatened diurnal bird species recorded within the 2024 monitoring period

Common name	Scientific name	Observation type and method	Count	BC Act	EPBC Act
Gang-gang Cockatoo	*Callocephalon fimbriatum*	OW; Opportunistic	5	Vulnerable	Endangered
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	OW; Opportunistic	4	Vulnerable	Vulnerable
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	OW; Birding	2	Vulnerable	Not Listed

O = Observed, W = Heard

The Little Lorikeet (*Glossopsitta pusilla*; BC Act: Vulnerable), Scarlet Robin (*Petroica boodang*: BC Act: Vulnerable) and Square-tailed Kite (*Lophoictinia isura*; BC Act: Vulnerable) were observed in 2023 but were not observed during this monitoring period.

3.3.4 Cave-dwelling microbats

A total of ten Anabat detectors were installed over four nights in December 2024. A total of 44,260 call sequences were recorded, of which 11,053 call sequences were able to be analysed (i.e. were not 'noise' files or bat calls of short length). Of the bat calls, 4,238 call sequences (38%) were able to be confidently identified (those classified as either definite or probable identifications) to species level. Species recorded in the 2024 monitoring period, confidence level and their BC Act and EPBC Act status are summarised in **Table 3-10**.

Two of the three target microbat species were detected at a definite confidence level, being the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and the Large-eared Pied-bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable). The Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*) was possibly detected at all anabat locations (see **Appendix F**), however calls of the Southern Forest Bat (*Vespadelus regulus*) and the Little Forest Bat (*Vespadelus vulturnus*) overlap in this region and it can't be distinguished reliably from bat calls. However, given the high number of calls, and location at a known bat roost, it is likely that the Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*) is roosting within the Airly Lease Area.

One threatened microbat species, the Large-eared Pied Bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable) was confidently detected at all sites in the 2024 monitoring period.

Due to the high number of calls of the Eastern Horseshoe Bat (*Rhinolophus megaphyllus*) during the survey, the adits (Anabat FS14) are likely to be a maternity colony of this species. The complete bat call analysis is in **Appendix F**.

Table 3-10: Microbat species recorded in the 2024 monitoring period

Species Name	Common Name	Confidence	Anabat	BC Act	EPBC Act
Austronomus australis	White-striped Free-tailed Bat	Definite	2, 3, 4, 7, 11, FS8, FS12, FS13, FS14	Not Listed	Not Listed
Chalinolobus dwyeri	Large-eared Pied Bat	Definite	2, 3, 4, 6, 7, 11, FS8, FS12, FS13, FS14	Vulnerable	Vulnerable
Chalinolobus gouldii	Gould's Wattled Bat	Definite	2, 3, 4, 6, FS12, FS13, FS8	Not Listed	Not Listed
Chalinolobus morio	Chocolate Wattled Bat	Definite	2, 3, 6, 11, FS13, FS14, FS8	Not Listed	Not Listed
Ozimops planiceps	Southern Free-tailed Bat	Definite	2, 4, FS12, FS13, FS14	Not Listed	Not Listed

Species Name	Common Name	Confidence	Anabat	BC Act	EPBC Act
Rhinolophus megaphyllus	Eastern Horseshoe Bat	Definite	2, 3, 4, 6, 7, 11, FS13, FS14, FS8	Not Listed	Not Listed

3.3.5 Vertebrate census

A total of 18 native vertebrate species (excluding birds and microbats) were detected during the 2024 monitoring period. This included:

- Four frog species
- Twelve mammal species
- Two reptile species.

Of the 18 native vertebrate species (excluding birds and microbats), two are listed as Vulnerable under the BC Act and one is also listed as Endangered under the EPBC Act. See **Table 3-11** for threatened fauna species recorded in the 2024 survey period. This is the first year since 2012 that the Spotted-tailed Quoll (*Dasyurus maculatus;* BC Act: Vulnerable; EPBC Act: Endangered) has been observed, see **Plate 3-3**. Two Yellow-bellied Gliders (*Petaurus australis*; BC Act: Vulnerable) were observed during nocturnal spotlighting/call playback surveys. This is the first record of this species in the area, the closest record being on the Newnes Plateau, 15km east of Arily Mine. A potential New Holland Mouse (*Pseudomys novaehollandiae*; EPBC Act: Vulnerable) was recorded on camera trap footage in the Grotto, however ID confirmation is needed by the Australian Museum, see **Plate 3-4**. Once confirmed, this will also be the first record in the area for the New Holland Mouse, with the nearest record also being on the Newnes Plateau. The Rosenberg's Goanna (*Varanus rosenbergi*; BC Act: Vulnerable) was not observed this year, after being recorded at Pt. Hatteras for the previous four years. See **Appendix E** for the full fauna inventory.

Table 3-11: Threatened fauna species (excluding birds and microbats) recorded during the 2024 survey period

Scientific name	Common name	Observation type and method	Count	BC Act	EPBC Act
Dasyurus maculatus	Spotted-tailed Quoll	O, camera trap	1	Vulnerable	Endangered
Petaurus australis	Yellow-bellied Glider	O, nocturnal survey	2	Vulnerable	Not Listed

O = Observed



Plate 3-3: Spotted-tailed Quoll (*Dasyurus maculatus*; BC Act: Vulnerable; EPBC Act: Endangered) recorded at CT9, behind Pit Top



Plate 3-4: Unconfirmed New Holland Mouse (*Pseudomys novaehollandiae;* EPBC Act: Vulnerable) recorded on camera trap R29, The Grotto

3.3.6 Feral species

One feral fauna species was recorded during the 2024 monitoring period, cat (*Felis catus*), captured on camera trap. The cat is the most common feral species consistently recorded in the management area. A further three feral species recorded in 2023, pig (*Sus scrofa*), fox (*Vulpes vulpes*) and European rabbit

(*Oryctolagus cuniculus*), were not observed this monitoring period. See **Appendix E** for the full fauna inventory.

Centennial Airly actively participate in feral species management strategies (Airly Cat Trapping Program, Local Land Services District Wild Dog Control, engaging third-party feral species control) and is an ongoing recommendation that is upheld by Centennial Airly.

4 COMPLIANCE

Table 4-1: Assessment of biodiversity related subsidence impact performance measures (Schedule 3 – condition 2 SSD-5581)

Biodiversity feature – Performance measure	Biodiversity monitoring	Location addressed in report	Relevant BMP	Comment	Compliance status for monitoring period
Gap and Genowlan Creeks The Grotto Threatened species, threatened populations, EECs and groundwater dependent ecosystems. • Negligible environmental consequences to water quality and to bed and bank stability • No greater environmental consequences than predicted in the EIS to water flows (including baseflow) Negligible subsidence impacts or environmental consequences	Groundwater Dependant Ecosystems (GDE)	**Section 3.1.2**	• CLZ ML1814 BMP	• 11 GDE plots were established in the 2022 monitoring period. Plots were located within both the Point Hatteras BMP area, and within the Grotto to establish baseline data to provide baseline condition for the CLZ ML1814 BMP. • GDE plots consist of photo monitoring BAM plots and a 50 m rapid aquatic assessment based on AUSRIVAS where suitable.	• Repeatable and measurable monitoring methods established. • Baseline data collected in 2022 and 2023. • As mining within the Point Hatteras BMP area has commenced, two impact plots are deemed active. No significant changes within BAM scores were recorded with the Point Hatteras impact plots. A decrease in compositional scores was recorded in control plots. Therefore, changes are likely due to broader environmental factors. • As such therefore SSD-5581 compliance has been met. • Plots within the Grotto remain in baseline.
Threatened species, threatened populations, EECs and groundwater dependent ecosystems.	White Box – Yellow Box – Blakely's Red Gum Woodland	**Section 3.1.1**	• Western Region BMP • Mount Airly BMP	• The mean native species richness in 2024 has significantly decreased since the 2015 and 2016 monitoring years. • Vegetation integrity scores have been calculated for year 2019 to 2024 in line with the BAM. • 2024 composition, function and VI scores are not significantly different to baseline years (2019 and 2020).	• Decrease in species richness compared to 2015 and 2016, however maintenance of BAM scores, therefore SSD-5581 compliance has been met.

Biodiversity feature – Performance measure	Biodiversity monitoring	Location addressed in report	Relevant BMP	Comment	Compliance status for monitoring period
• Negligible environmental consequences	*Prostanthera stricta* (Mount Vincent Mint-bush)	**Section 3.2.1**	• Western Region BMP • Mount Airly BMP • ML1331 CLZ BMP • Point Hatteras BMP • MW17-18 BMP	• Plots that were installed or re-established in 2022 to provide supplementary controls, and for Point Hatteras and MW17-18 BMPs were reassessed in 2023 and 2024. • Across all transects, the % cover of *P. stricta* has significantly increased since 2020. • Genowlan Trig mean *P. stricta* cover has significantly increased two consecutive years.	• No significant change in *P. stricta* cover, therefore SSD-5581 compliance has been met
	Eucalyptus cannonii (Capertee Stringybark)	**Section 3.2.2**	• Western Region BMP • Mount Airly BMP • Point Hatteras BMP	• The average *E. cannonii* crown density has significantly increased since baseline at the Mount Airly population. • The average crown extent within the Mount Airly population has significantly decreased since baseline for three consecutive years. • The average height within the Control population has significantly increased since 2022. • No significant variation in DBH has been observed across any of the populations. • Crown extent may not be the most reliable indicator of tree health, as it varies significantly with tree age. Therefore, crown density would be a more reliable indicator of tree health.	• Whilst crown extent has significantly reduced between monitoring years, crown density is stable or increased since 2017. Therefore, *E. cannonii* tree health is stable across populations, indicating that SSD-5581 compliance has been met.
Threatened species, threatened populations, EECs and groundwater dependent ecosystems. • Negligible environmental consequences	Glossy-black Cockatoos (*Calyptorhynchus lathami*)	**Section 3.3.1**	• Western Region BMP • Mount Airly BMP • ML1331 CLZ BMP • Point Hatteras BMP • MW17-18 BMP	• The presence of Glossy black-cockatoos was confirmed through acoustic recording, opportunistic sightings of individuals and chewed 'orts' were noted as present at seven of the ten monitoring locations.	• Continued persistence of threatened bird species, therefore SSD-5581 compliance has been met. •
	Large Forest Owls	**Section 3.3.2**		• No roost sites displayed indirect evidence of use (i.e., white wash and pellets); however, a Powerful Owl (*Ninox strenua*; BC Act: Vulnerable) and a Sooty Owl (*Tyto tenebricosa*; BC Act: Vulnerable) were detected by means of spotlighting and Southern Boobook (*Ninox novaeseelandiae)* were detected on songmeters.	
	Diurnal birds, including threatened and regionally	**Section 3.3.3**		• Statistical analysis confirmed that bird species richness across the management area is stable.	

Biodiversity feature – Performance measure	Biodiversity monitoring	Location addressed in report	Relevant BMP	Comment	Compliance status for monitoring period
	significant woodland bird species		• CLZ ML1814 BMP		
	Cave-dwelling microbats	**Section 3.3.4**		• Similarly to 2023, two of the three target microbat species were detected at a definite confidence level during the summer survey, being the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and the Large-eared Pied-bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable). • The breeding colony of Eastern Horseshoe Bat continues to persist at the adit locations.	• Persistence of roosting and breeding microbat species, therefore SSD-5581 compliance has been met.
	Vertebrate census/ other targeted fauna	**Section 3.3.5**		• Spotted-tailed Quoll (*Dasyurus maculatus;* BC Act: Vulnerable; EPBC Act: Endangered) was observed for the first time since 2012. • Two Yellow-bellied Gliders (*Petaurus australis*; BC Act: Vulnerable) were observed during nocturnal spotlighting. • One feral cat was recorded on camera traps on one occasion. • No feral dogs, pigs, rabbits or foxes were recorded during the 2024 monitoring period.	• Persistence of threatened fauna species and relatively low pest species, therefore SSD-5581 compliance has been met
Pultenaea sp. Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community. • No environmental consequences	*Pultenaea* sp. Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community	N/A	N/A	• Monitored by NPWS	• N/A

5 CONCLUSION

This annual monitoring addresses the biodiversity-related conditions of consent outlined in SSD-5581. Schedule 3, Condition 2 of the SD-5581 development consent specifies the following performance measures:

1. Gap and Genowlan Creeks: Negligible environmental consequences to water quality and to bed and bank stability; no greater environmental consequences than predicted in the EIS to water flows (including baseflow).
2. The Grotto: Negligible subsidence impacts or environmental consequences.
3. Threatened species, threatened populations, EECs and groundwater dependent ecosystems (with the exception of those listed below): Negligible environmental consequences.
4. *Pultenaea sp.* Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community: No environmental consequences.

This monitoring report comprises information pertaining to performance measure three and provides baseline biodiversity data for the performance measures one and two. Performance measure four is addressed in a separate monitoring report prepared by National Parks and Wildlife Services (NPWS).

The 2024 monitoring results have indicated that threatened species, threatened populations, EECs and GDEs are still persisting in the management area, with negligible environmental consequences, therefore SSD-5581 compliance has been met. Further discussion is provided below.

5.1 Vegetation communities

The mean native species richness of the White Box – Yellow Box – Blakely's Red Gum Woodland CEEC plots is slightly lower in 2024 compared to 2023. Whilst the 2024 mean native species richness is only slightly lower than 2023, this metric is now significantly less than the baseline years, 2015-2016. A similar decrease occurred in 2017-2018 before increasing to the highest diversity of native species recorded in 2019. Continued monitoring will determine if this is a trend related to El Nino/La Nina climactic shifts, of if further investigation is needed. No changes in BAM scores has been recorded within the woodland plots since the 2019-2020 baseline.

Eleven GDE plots were surveyed in the 2024 monitoring period. Two are located within the Point Hatteras Extraction Plan Area; seven are located within the Grotto supporting the Cliff Line Zone Extraction Plan and are in baseline; and two are control plots located away from mining activity. BAM scores have been calculated for year 2019 to 2024 in line with the BAM (State of NSW 2020).

As mining within the Point Hatteras Extraction Plan Area is complete (see **Section 1.1**), Point Hatteras is now considered an impact area. In comparison to the baseline, no significant changes were recorded across the BAM scores. Therefore, SSD compliance has been met. Within corresponding control plots, a significant decrease in composition scores was recorded between baseline and 2024 suggesting that changes in BAM scores are likely due to broader environmental factors. Overall vegetation integrity scores and species richness remains stable.

A total of 26 exotic species were detected in the management area. In the 2024 monitoring period, there has been a slight decrease of exotic species cover within the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland BAM plots. BAM plot 1 has the highest weed cover due to a high grass cover of *Phalaris aquatica* within the riparian area. GDE plots display a negligeable weed species cover. All weed species require management under the *Biosecurity Act 2015*.

5.2 Flora

The mean percent cover of *P. stricta* in 2024 has not significantly changed since 2023, however it has significantly increased in comparison to 2016, 2017, 2019 and 2020. At Genowlan Trig, the % cover of *P. stricta* has significantly increased compared to 2016, 2017 and 2018 collectively for the second year in a row. As no reductions in P. stricta cover has been recorded, the species is persisting within the Airly Mining Lease Area and SSD-5581 compliance has been met.

The following significant *E. cannonii* results were identified by the analysis:

- Crown density has significantly increased since 2016/2017 monitoring years at the Mount Airly and control populations
- The average crown extent within the Mount Airly population has significantly decreased since 2016/2017
- A significant increase in height was observed in the control population between 2016/2017 and 2024
- No significant variation in DBH has been observed across the populations.

Crown density increases may be correlated with crown extent decreases as changes in tree growth strategies occur (Li et al., 2022). Further to this, crown extent may not be the most reliable indicator of tree health as it varies with tree age. Generally, as a tree ages, crown extent is likely to be proportionally less, when compared to the size of the tree. Therefore, crown density may be a more reliable indicator of tree health. As crown density has increased and *E. cannonii* is persisting, SSD-5581 compliance has been met.

5.3 Fauna

Threatened fauna species continue to persist within the Airly Mine Lease Area, therefore SSD 5581 compliance has been met. Further evidence is provided below.

Continued monitoring of Glossy black-cockatoos has shown that this species persists on site, with evidence of feeding (chewed orts) and the presence of individuals recorded opportunistically throughout the management area.

No roost sites displayed evidence of use (i.e., white wash and pellets) and Site 2 remains inaccessible due to landslides. However, a Powerful Owl (*Ninox strenua*; BC Act: Vulnerable) and a Sooty Owl (*Tyto tenebricosa*; BC Act: Vulnerable) were observed during spotlighting and acoustic recording detected Southern Boobook (*Ninox novaeseelandiae*) at every forest owl survey site therefore the large forest owl species persist across the ML Area.

Three of the 71 bird species recorded during diurnal surveys are listed as Vulnerable under the BC Act which include Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable; EPBC Act: Endangered), Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable; EPBC Act: Vulnerable), and Dusky Woodswallow (*Artamus cyanopterus cyanopterus*: BC Act Vulnerable). No significant changes were noted in bird species richness, therefore it is deemed that bird diversity it stable across the management area.

Two of three target microbat species were detected this monitoring period, the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and the Large-eared Pied-bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable). Due to the high number of calls, the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) is likely roosting in the adits. The third target species, the Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*), was also possibly detected at all anabat locations. This cannot be confirmed, however, as the calls of this species can't be distinguished reliably from other bat calls. Given the high number of calls, and location at a known bat roost, it is likely that the Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*) is roosting within the Airly Lease Area.

Of the 18 native vertebrate species (excluding birds and microbats) detected during the 2024 monitoring period, two are listed as threatened under the BC Act and/or EPBC Act. Spotted-tailed Quoll (*Dasyurus maculatus;* BC Act: Vulnerable; EPBC Act: Endangered) was observed on a camera trap for the first time in the management area since 2012, and two Yellow-bellied Gliders (*Petaurus australis*; BC Act: Vulnerable) ware observed during nocturnal spotlighting/call playback surveys, which is the first time the species has been recorded in the area. An unconfirmed identification of a New Holland Mouse has also been recorded on a camera trap in the Grotto. Ongoing monitoring will confirm presence and images have been sent to the Australian Museum to assist with identification.

A cat (*Felis catus*) was the only feral fauna species recorded on camera traps during the 2024 monitoring period. This is a notable drop in pest species since 2023, which observed the European rabbit (*Oryctolagus cuniculus*), pigs (*Sus scrofa*) and foxes (*Vulpes vulpes*). No feral dogs (*Canis lupus*) were recorded this year for the third year in a row. Centennial Airly actively participate in feral species management strategies (Airly Cat Trapping Program, Local Land Services District Wild Dog Control, engaging third-party feral species control). The cat is the most commonly observed feral species in the management area, however the drop in feral species in the recent monitoring data suggests the success in these management methods.

6 REFERENCES

BOM (2024). Weather Station Directory - Lithgow (Cooerwull) (station 063226). Accessed December 2024. http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=061334

Churchill (2009). Australian Bats.

Centennial (2018) Airly Mine Splitting and Quartering Extraction Plan (ML1331)- Biodiversity Management Plan (EP-BMP). Prepared by RPS for Centennial.

Centennial (2021). Biodiversity Management Plan: Point Hatteras Panel and Pillar Mining Zone Extraction Plan (Point Hatteras BMP). Prepared by RPS for Centennial.

Centennial (2019a) Western Region Biodiversity Management Plan, Airly Site Specific Biodiversity Management Plan. Prepared by RPS for Centennial.

Centennial (2019b). Biodiversity Management Plan: Mount Airly Panel and Pillar Zone Extraction Plan (Mount Airly BMP). Prepared by RPS for Centennial.

DECC (2008a). Descriptions for NSW (Mitchell) Landscapes Version 2 (2002).

DEC (2006), The Vegetation of the Western Blue Mountains. Unpublished report funded by the Hawkesbury Nepean Catchment Management Authority, Department of Environment and Conservation, Hurstville.

Department of Planning and Environment [DPE] (2020). Biodiversity Assessment Methodology.

Li, Liu and Jin (2022). Impacts of stand density on tree crown structure and biomass: A global meta-analysis. Agricultural and Forest Meteorology, Volume 326, https://doi.org/10.1016/j.agrformet.2022.109181. Web Link: https://www.sciencedirect.com/science/article/pii/S0168192322003689

McCaffrey, N., McKenna, P., Glenn, V., Fletcher, A. and Erskine. P. (2015). Research and monitoring of flora and native vegetation at Airly Mine and Mugii Murum-ban State Conservation Area, NSW. Centre for Mine Land Rehabilitation, QLD.

Menkhorst and Knight (2010). A Field Guide to the Mammals of Australia

NSW DCCEEW (2025). BioNet Atlas. Accessed 26/08/2025. https://atlaseditor.bionet.nsw.gov.au/Default.aspx

RPS (2014), Airly Mine Extension Project Flora and Fauna Assessment, March 2014, RPS Australia East

RPS (2017a) Airly Mine Flora and Fauna Monitoring Report 2016/2017. Report to Centennial Coal.

RPS (2017b) Airly Mine Seasonal Flora and Fauna Monitoring Report 2015/2016. Report to Centennial Coal.

RPS (2019) Airly Mine Flora and Fauna Monitoring Report 2019. Report to Centennial Coal.

RPS (2020) Airly Mine Flora and Fauna Monitoring Report 2020. Report to Centennial Coal.

RPS (2021). Airly Mine Flora and Fauna Monitoring Report 2021. Report prepared for Centennial Airly.

RPS (2022). Airly Mine Flora and Fauna Monitoring Report 2022. Report prepared for Centennial Airly.

RPS (2023). Airly Mine Flora and Fauna Monitoring Report 2023. Report prepared for Centennial Airly.

State of NSW (2020). Biodiversity Assessment Method.

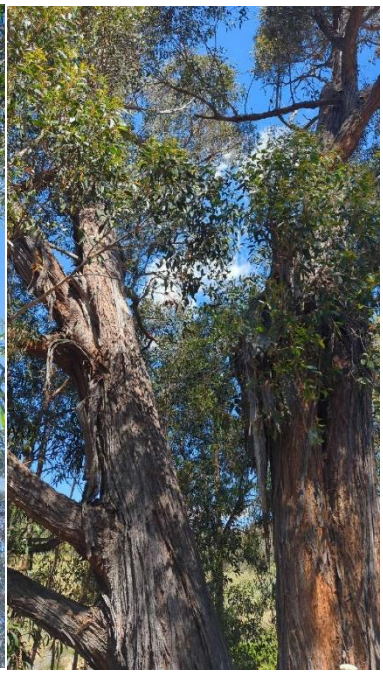
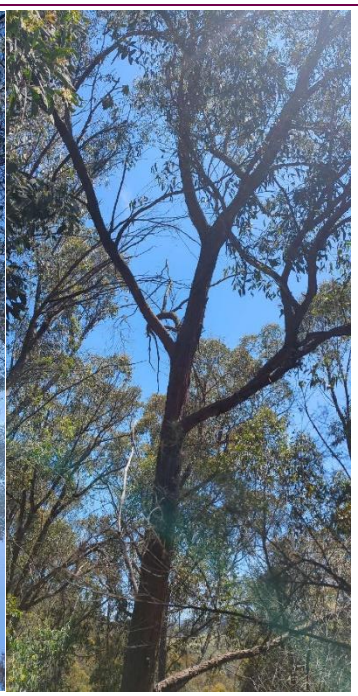
UVM (2005). 3.0 Phase 3 Field Guide - Crowns: Measurements and Sampling October, 2005

Appendix A
2024 *Eucalyptus cannonii* monitoring photos

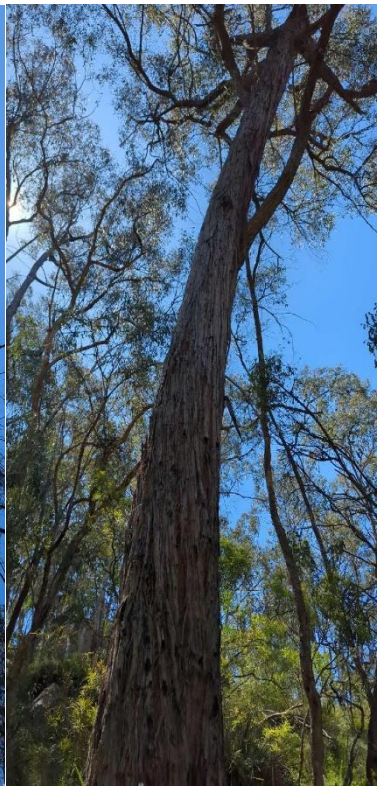
Apx Table 1: Condition Assessment for *Eucalyptus cannonii*

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
1								
2	80	10	10	19	45.5	No	No	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
3	55	35	5	22	52.2	no	no	
4	40	80	45	20	86	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point	
5	90	80	0	25	87	no	yes		
6	75	55	0	25	42.5	no	yes		

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
7	80	40	0	20	55.5	no	no	
8	60	60	2	30	80	no	yes	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point	
9	40	25	2	25	81	no	yes		
10	65	70	0	14	46	no	yes		

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point	
11	50	50	0	20	29	no	no		
12	70	65	0	25	79	no	no		

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
13	50	33	0	30	56	no	no	
14	65	25	0	35	65	no	yes	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
15	30	35	0	25	52.5	no	yes	
16	30	40	5	6	18.3	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
17	55	50	45	8	30	no	no	
18	50	85	80	8	50	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
22	50	30	5	15	33	no	no	
23	60	70	10	15	31	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
24	35	30	5	15	34	no	no	
25	15	5	5	15	27	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
26	5	5	80	12	20	no	no	
27	0	0	0	12	19	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point
28	30	35	70	13	28	no	no	
29	10	10	80	12	26	no	no	

Tree ID	Crown density (%)	Crown extent (%)	Crown Epicormic Growth Extent (%)	Height (m)	DBH (cm)	Signs of Subsidence	Weed presence	Photo Monitoring Point	
30	65	25	60	13	35	no	no		
31	20	30	80	10	34	no	no		

Appendix B
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland Plots – species list and photos

Apx Table 2: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland - Flora species list

Scientific name	Exotic	Common Name	BAM 1 Cover	BAM 1 Abundance	BAM 2 Cover	BAM 2 Abundance	BAM 3 Cover	BAM 3 Abundance	BAM 4 Cover	BAM 4 Abundance
Acacia dawsonii		Poverty Wattle	2	20						
Acacia dealbata		Silver Wattle	4	20						
Acacia elongata		Swamp Wattle			0.1	2				
Acacia falciformis		Broad-leaved Hickory					8	20		
Acacia implexa		Hickory Wattle					2	8		
Acacia longifolia					0.2	5			0.5	10
Acacia melanoxylon		Blackwood			7	25				
Acaena echinata		Sheep's Burr					0.1	20		
Acaena novae-zelandiae		Bidgee-widgee	0.2	20	2	200	0.1	20		
Adiantum aethiopicum		Common Maidenhair	0.2	50						
Amyema spp.		Mistletoe							0.2	3
Arthropodium minus		Small Vanilla Lily	0.1	20						
Billardiera scandens		Hairy Apple Berry			0.2	5				
Brachyloma daphnoides		Daphne Heath	0.8	10						
Bursaria spinosa		Native Blackthorn			3	10			15	20
Calotis cuneata		Mountain Burr-Daisy	0.1	2						
Carex appressa		Tall Sedge	0.5	5						
Carex spp.					0.1	10				
Cassinia sifton			2	50			0.2	5		

Scientific name	Exotic	Common Name	BAM 1 Cover	BAM 1 Abundance	BAM 2 Cover	BAM 2 Abundance	BAM 3 Cover	BAM 3 Abundance	BAM 4 Cover	BAM 4 Abundance
Cassinia uncata		Sticky Cassinia	0.8	20	0.5	2	0.2	5		
Cenchrus clandestinus	*	Kikuyu Grass	2	200						
Cheilanthes sieberi		Rock Fern	0.1	20	0.2	30			0.1	10
Chrysocephalum apiculatum		Common Everlasting							0.1	5
Cirsium vulgare	*	Spear Thistle	0.1	5	0.5	50	0.2	10		20
Clematis aristata		Old Man's Beard			3	50			4	30
Clematis glycinoides		Headache Vine					0.4	20		
Clematis spp.									0.1	5
Conyza spp.	*				0.1	10			0.1	10
Cynoglossum australe					0.2	10				
Daucus spp.					0.1	20				
Desmodium spp.		Tick-trefoil			0.1	20				
Dianella revoluta		Blueberry Lily	2	50	1	10	2	40		
Dichondra repens		Kidney Weed					0.1	20	1	200
Echinopogon caespitosus		Bushy Hedgehog-grass							0.1	10
Echium plantagineum	*	Patterson's Curse					0.1	10		
Ehrharta erecta	*	Panic Veldtgrass	0.2	10						
Eleocharis gracilis			0.2	100						
Entolasia stricta		Wiry Panic			0.1	10			1	20
Epacris spp.									1	2
Erodium crinitum		Blue Crowfoot			0.5	50			0.5	50
Eucalyptus albens		White Box	2	1	10	5				
Eucalyptus blakelyi		Blakely's Red Gum	0.6	1			4	2		
Eucalyptus cannonii		Capertee Stringybark			15	1				
Eucalyptus dalrympleana		Mountain Gum	0.4	2					10	5

Scientific name	Exotic	Common Name	BAM 1 Cover	BAM 1 Abundance	BAM 2 Cover	BAM 2 Abundance	BAM 3 Cover	BAM 3 Abundance	BAM 4 Cover	BAM 4 Abundance
Eucalyptus macrorhyncha		Red Stringybark	8	6			1	0		
Eucalyptus mannifera		Brittle Gum	0.4	1						
Eucalyptus melliodora		Yellow Box			5	2	15	3	10	4
Eucalyptus moluccana		Grey Box					2	1		
Eucalyptus polyanthemos		Red Box							10	4
Eucalyptus punctata		Grey Gum					0.5	0		
Euchiton spp.					0.1	3				
Festuca rubra subsp. rubra	*	Red Fescue	1	20						
Galium gaudichaudii		Rough Bedstraw			1	150			1	250
Galium spp.			0.1	5						
Gamochaeta purpurea	*	Purple Cudweed							0.1	5
Geranium neglectum			0.2	20						
Geranium solanderi		Native Geranium							1	100
Glycine clandestina		Twining glycine			1	50	0.2	20	0.5	100
Glycine microphylla		Small-leaf Glycine							0.1	50
Glycine tabacina		Variable Glycine	0.1	5	0.1	20	0.1	10		
Gonocarpus tetragynus		Poverty Raspwort			0.1	30				
Gonocarpus teucrioides		Germander Raspwort			0.3	50				
Grevillea acanthifolia			0.1	1						
Grona varians							0.2	20		
Heliotropium amplexicaule	*	Blue Heliotrope					0.2	20		
Hibbertia circumdans			0.1	5						
Hydrocotyle laxiflora		Stinking Pennywort					0.1	20		

Scientific name	Exotic	Common Name	BAM 1 Cover	BAM 1 Abundance	BAM 2 Cover	BAM 2 Abundance	BAM 3 Cover	BAM 3 Abundance	BAM 4 Cover	BAM 4 Abundance
Hydrocotyle sibthorpioides					0.5	250			1	200
Hypericum gramineum		Small St John's Wort	0.2	50			0.1	10		
Hypochaeris radicata	*	Catsear	1	500	0.1	20	0.2	20	0.2	10
Indigofera australis		Australian Indigo			3	20			15	30
Juncus planifolius			0.1	5						
Juncus usitatus			0.2	10						
Lagenophora stipitata		Common Lagenophora					0.1	10		
Lepidosperma laterale		Variable Sword-sedge			4	30	0.1	5	1	5
Leptomeria acida		Sour Currant Bush							0.2	5
Lomandra filiformis		Wattle Matt-rush	0.4	20						
Lomandra longifolia		Spiny-headed Mat-rush			30	100	35	100	5	50
Lomandra multiflora subsp. multiflora		Many-flowered Mat-rush	0.3	10			0.4	5	0.2	5
Lomatia myricoides		River Lomatia			3	15				
Lysimachia arvensis	*	Scarlet Pimpernel	0.1	5	0.5	50	0.1	10		
Microlaena stipoides		Weeping Grass			25	1000	35	5000	35	500
Oxalis perennans			0.1	20			0.1	5		
Oxalis spp.					0.1	50			0.1	100
Ozothamnus diosmifolius		White Dogwood	0.8	10			0.8	10		
Pellaea falcata		Sickle Fern	0.1	10						
Persoonia linearis		Narrow-leaved Geebung	0.4	5						
Phalaris aquatica	*	Phalaris	40	10000						
Pittosporum multiflorum		Orange Thorn					0.1	1		
Plantago debilis		Shade Plantain	0.1	15						

Scientific name	Exotic	Common Name	BAM 1 Cover	BAM 1 Abundance	BAM 2 Cover	BAM 2 Abundance	BAM 3 Cover	BAM 3 Abundance	BAM 4 Cover	BAM 4 Abundance
Plantago hispida							0.1	5		
Plantago lanceolata	*	Lamb's Tongues	0.1	5	1	100	0.1	5	0.2	15
Poa labillardierei var. labillardierei		Tussock	1	50	8	75			5	50
Poa sieberiana		Snowgrass	2	50	0.3	10			5	50
Pomaderris spp.									1	5
Prunella vulgaris	*	Self-heal	0.1	5						
Pseudognaphalium luteoalbum		Jersey Cudweed							0.1	10
Ranunculus inundatus		River Buttercup	0.6	200						
Ranunculus lappaceus		Common Buttercup			0.1	3				
Rosa rubiginosa	*	Sweet Briar					0.6	10		
Rubus fruticosus sp. agg.	*	Blackberry complex	0.4	5			0.4	10		
Rubus moluccanus		Molucca Bramble			0.1	5			0.5	10
Rubus parvifolius		Native Raspberry			0.3	15				
Samolus valerandi		Common Brookweed	1	200						
Senecio jacobaea	*	Ragwort	0.1	10	0.1	2				
Senecio linearifolius		Fireweed Groundsel							0.1	10
Senecio madagascariensis	*	Fireweed							0.1	5
Senecio minimus									0.1	5
Senecio quadridentatus		Cotton Fireweed	0.3	15			0.1	5		
Sigesbeckia orientalis subsp. orientalis		Indian Weed								5
Solanum stelligerum		Devil's Needles							0.1	5
Soliva sessilis	*	Bindyi					0.1	5		
Sonchus asper	*	Prickly Sowthistle					0.2	15		

Scientific name	Exotic	Common Name	BAM 1 Cover	BAM 1 Abundance	BAM 2 Cover	BAM 2 Abundance	BAM 3 Cover	BAM 3 Abundance	BAM 4 Cover	BAM 4 Abundance
Sonchus oleraceus	*	Common Sowthistle	0.1	5					0.1	10
Stellaria pungens		Prickly Starwort	0.2	20					1	3
Taraxacum officinale	*	Dandelion							0.1	3
Typha orientalis		Broad-leaved Cumbungi	0.5	20						
Urtica incisa		Stinging Nettle							0.1	2
Verbena bonariensis	*	Purpletop	0.2	5						
Veronica plebeia		Trailing Speedwell	0.1	10			0.2	25		
Viola betonicifolia		Native Violet			0.1	20				
Viola hederacea		Ivy-leaved Violet			1	50				
Wahlenbergia stricta		Tall Bluebell	0.1	5						
Wurmbea dioica subsp. dioica		Early Nancy					0.1	5		

Apx Table 3: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland plot photos

Plot ID	Photo - start
BAM 1	
BAM 2	

Plot ID	Photo - start
BAM 3	
BAM 4	

Appendix C
GDE Plots – species list and photos

Apx Table 4: GDE - Flora species list

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Acacia falcata									0.4	1														
Acacia falciformis		Broad-leaved Hickory	4	5	5	5																		
Acacia obtusifolia			8	20	2	5	15	20	4	6	5	3	5	15	0.3	1			0.2	1				
Acacia spp.		Wattle					0.5	3																
Acaena novae-zelandiae		Bidgee-widgee																			0.1	5		
Adiantum aethiopicum		Common Maidenhair									0.1	2	0.2	30			0.5	50	0.2	20	0.2	20	0.8	100
Ajuga australis		Austral Bugle			0.2	10	0.3	30	0.4	50									1	50	0.1	10		
Allocasuarina littoralis		Black She-Oak					0.5	1																
Ambrosia artemisiifolia	*	Annual Ragweed	0.1	5																				
Amperea xiphoclada											0.5	5												
Amyema spp.		Mistletoe					0.3	2	1	6													1	4
Billardiera scandens		Hairy Apple Berry	0.1	10					0.1	10														
Blechnum cartilagineum		Gristle Fern							0.5	5	7	50			1	10	3	30	30	500	4	20	5	50
Bursaria spinosa		Native Blackthorn			10	100	5	20	3	15													0.5	1
Calochlaena dubia		Rainbow Fern									10	100	2	20	55	200	15	50			0.6	20	25	100
Cassinia aureonitens																					0.1	5		

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Cassinia spp.							0.1	1																
Cassinia uncata		Sticky Cassinia	0.1	5									0.5	5										
Cheilanthes sieberi		Rock Fern	0.1	5	0.2	10																		
Cirsium vulgare	*	Spear Thistle	0.1	1	0.1	5																		
Clematis aristata		Old Man's Beard					0.2	15	0.9	20	0.1	5	2	20	0.1	5	0.5	50					2	20
Clematis glycinoides		Headache Vine	0.3	20	0.4	20	0.2	10	0.1	3									0.3	20	0.4	20		
Conyza bonariensis	*	Flaxleaf Fleabane	0.1	5																				
Conyza spp.	*						0.3	30	0.2	50			0.1	3										
Cordyline stricta		Narrow-leaved Palm Lily																					0.2	3
Coronidium elatum																					0.2	5		
Cyathea australis		Rough Treefern									1	2			10	10	10	10			1	5		
Cyathea cooperi		Straw Treefern																					4	5
Dendrobium speciosum		Rock Lily																					0.4	2
Dendrobium striolatum		Streaked Rock Orchid									0.1	1												
Desmodium spp.		Tick-trefoil					0.2	50	0.1	100							0.2	30					0.3	100
Dianella caerulea		Blue Flax-lily	3	100	0.2	20	4	25											3	100	0.2	5		

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Dianella caerulea var. producta									3	50	1	30	2	50	0.5	20								
Dianella revoluta		Blueberry Lily									0.1	1												
Dichondra repens		Kidney Weed			0.8	500	0.3	100	0.5	100			0.2	100	0.1	50	1	100	0.2	50	0.2	5000		
Doodia aspera													2	75			10	500	1	50	0.3	20	3	100
Echinopogon ovatus		Forest Hedgehog Grass			0.2	10																		
Elaeocarpus obovatus		Hard Quandong									0.2	2												
Elaeocarpus reticulatus		Blueberry Ash									2	2	3	10	10	6			0.2	1	6	2	1	1
Entolasia marginata		Bordered Panic	0.2	10															0.2	10	0.2	20		
Entolasia stricta		Wiry Panic							0.1	15	0.1	10	0.2	35			0.1	10					0.1	10
Epacris muelleri											1	2												
Eucalyptus albens		White Box					0.5	2																
Eucalyptus cannonii <--> macrorhyncha							15	3																
Eucalyptus cypellocarpa		Monkey Gum	20	8	15	5	30	7	30	5	25	4	3	2	20	3	10	1	15	3			19	4
Eucalyptus fastigata		Brown Barrel													15	2								
Eucalyptus macrorhyncha		Red Stringybark							10	3	5	1	10	5										

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Eucalyptus melliodora		Yellow Box			20	4															6	2		
Eucalyptus piperita		Sydney Peppermint																	15	2	5	1		
Eucalyptus polyanthemos		Red Box					0.5	2																
Eucalyptus punctata		Grey Gum	5	3																				
Euchiton involucratus		Star Cudweed	0.1	5																				
Euchiton spp.							0.1	5					0.1	3										
Eustrephus latifolius		Wombat Berry	0.1	5	0.1	5																		
Exocarpos cupressiformis		Cherry Ballart	0.2	2																				
Forb spp.													0.1	1										
Galium binifolium					0.8	100													0.4	50				
Galium gaudichaudii		Rough Bedstraw							0.1	50	0.1	5			0.1	10	0.1	50					0.1	50
Galium leiocarpum													0.2	100					0.8	100	0.2	100		
Gamochaeta spp.	*												0.1	5										
Geitonoplesium cymosum		Scrambling Lily	0.2	20	0.2	20			0.3	25			0.2	25	0.1	10	0.3	50	0.2	10	0.2	20	0.1	20
Geranium neglectum					0.2	50															0.2	50		
Geranium solanderi		Native Geranium					0.1	25	0.1	15					0.1	10	0.4	50					0.4	100
Glycine clandestina		Twining glycine					0.1	30	0.1	20													0.2	30

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Glycine tabacina		Variable Glycine	0.1	5	0.2	20													0.1	5				
Gonocarpus tetragynus		Poverty Raspwort					0.1	1			0.1	5	1	50										
Gonocarpus teucrioides		Germander Raspwort	0.4	50			0.1	10											0.2	20	0.1	10		
Goodenia ovata		Hop Goodenia	20	50																				
Grona varians					1	1000													0.5	100				
Hardenbergia violacea		False Sarsaparilla					0.2	5																
Hedycarya angustifolia		Native Mulberry															2	1					3	3
Hibbertia aspera		Rough Guinea Flower	1	20															0.2	5	0.5	10		
Hibbertia empetrifolia subsp. empetrifolia																							0.2	1
Hibbertia obtusifolia		Hoary Guinea Flower					0.3	2																
Hydrocotyle laxiflora		Stinking Pennywort			3	5000													0.2	100				
Hydrocotyle sibthorpioides									0.8	250			0.1	100							0.4	500	0.5	100
Hypochaeris radicata	*	Catsear	0.1	2	0.1	2	0.1	10					0.1	5	0.1	1	0.1	1						
Indigofera australis		Australian Indigo	2	20	0.2	5	4	25	4	15							0.5	1	0.6	5	1	10	0.4	2
Lagenifera stipitata		Blue Bottle-daisy					0.5	50	0.2	20			0.2	50	0.1	10	0.1	2						

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Lagenophora stipitata		Common Lagenophora			0.2	20													0.1	20	0.1	20		
Lepidosperma laterale		Variable Sword-sedge			0.1	2	1	5			2	5	3	20										
Leptospermum polygalifolium		Tantoon									20	15	25	30	15	15	2	1	0.2	1	35	20		
Leucopogon juniperinus		Prickly Beard-heath			0.2	5	1	10	0.7	2														
Leucopogon lanceolatus							2	10	2	10					0.3	1			0.5	5	0.2	2		
Lindsaea microphylla		Lacy Wedge Fern							0.1	15	0.1	5			0.1	10	0.1	50						
Lomandra longifolia		Spiny-headed Mat-rush	5	50	20	200	15	30	5	25	3	15	4	30	1	10	4	9	5	50	2	15	5	15
Lomandra multiflora subsp. multiflora		Many-flowered Mat-rush			0.2	5																		
Marsdenia rostrata		Milk Vine																					0.2	10
Microlaena stipoides		Weeping Grass	0.2	50	30	1000	7	50	4	100	0.1	10	25	500	0.5	50	10	500	0.4	50	25	5000	2	50
Myosotis australis		Australian Forget-me-not	0.1	2																				
Myrsine variabilis													999	999	0.1	1					0.2	2		
Notelaea venosa		Veined Mock-olive																			0.1	2	1	1

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Oplismenus aemulus																			0.2	20	0.6	200		
Oplismenus imbecillis																	0.5	30					0.1	30
Oxalis perennans			0.1	10	0.1	20															0.1	50		
Oxalis spp.									0.1	10													0.1	20
Pandorea pandorana		Wonga Wonga Vine											0.1	5										
Persoonia linearis		Narrow-leaved Geebung	0.1	5			0.7	3	2	3	0.2	1	1	5	0.1	2								
Persoonia spp.																	0.1	1						
Pimelea curviflora																							0.1	1
Pittosporum multiflorum		Orange Thorn																			2	10	1	3
Plantago hispida					0.1	5																		
Plantago lanceolata	*	Lamb's Tongues					0.4	30	0.2	10														
Poa labillardierei var. labillardierei		Tussock			0.6	20													0.4	20				
Poa sieberiana		Snowgrass					2	50	0.4	10													0.1	2
Poaceae indeterminate	*	Grasses, reeds and bamboos							0.1	20														
Podolobium aciculiferum		Needle Shaggy Pea					0.5	2																

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Polyscias sambucifolia		Elderberry Panax											0.7	3										
Pomaderris spp.							1	3	1	5			3	15										
Pteridium esculentum		Bracken	3	50			0.3	10	20	150	1	2	4	30			4	30	4	50	8	100	2	15
Pyrrosia rupestris		Rock Felt Fern									0.3	100											0.3	20
Rubus parvifolius		Native Raspberry															0.5	5			0.1	5	0.1	10
Rytidosperma pallidum		Redanther Wallaby Grass; Silvertop Wallaby Grass	2	50																				
Schelhammera undulata									0.1	5							0.1	1						
Senecio minimus					0.1	5	0.2	15	0.2	10														
Sigesbeckia orientalis subsp. orientalis		Indian Weed	0.2	5																				
Smilax glyciphylla		Sweet Sarsparilla																					0.1	2
Solanum brownii		Violet Nightshade	0.3	5	0.1	5																		
Solanum prinophyllum		Forest Nightshade	0.4	10	0.2	5			0.2	10							0.1	1	0.1	5	0.2	5		
Stellaria pungens		Prickly Starwort													0.2	30			0.1	10				
Stylidium spp.											0.1	3												

Scientific Name	Exotic	Common Name	1 Cover	1 Abundance	2 Cover	2 Abundance	3 Cover	3 Abundance	4 Cover	4 Abundance	5 Cover	5 Abundance	6 Cover	6 Abundance	7 Cover	7 Abundance	8 Cover	8 Abundance	9 Cover	9 Abundance	10 Cover	10 Abundance	11 Cover	11 Abundance
Urtica incisa		Stinging Nettle			0.1	2																		
Veronica notabilis		Forest Speedwell																	0.6	20				
Veronica plebeia		Trailing Speedwell	0.2	10			0.1	50	0.1	5	0.1	3	0.1	50	0.1	5	0.1	10					0.2	30
Viola hederacea		Ivy-leaved Violet	0.1	5	0.2	20	0.4	150	1	250	0.1	5	2	200	0.1	50	2	100	0.2	50	0.4	1000	0.2	50
Viola sieberiana							0.4	150					0.3	75										
Wahlenbergia gracilis		Sprawling Bluebell	0.1	5																				

Apx Table 5: BAM plot photos

Plot ID	Photo
GDE BAM 1	
GDE BAM 2	

Plot ID	Photo
GDE BAM 3	
GDE BAM 4	
GDE BAM 5	

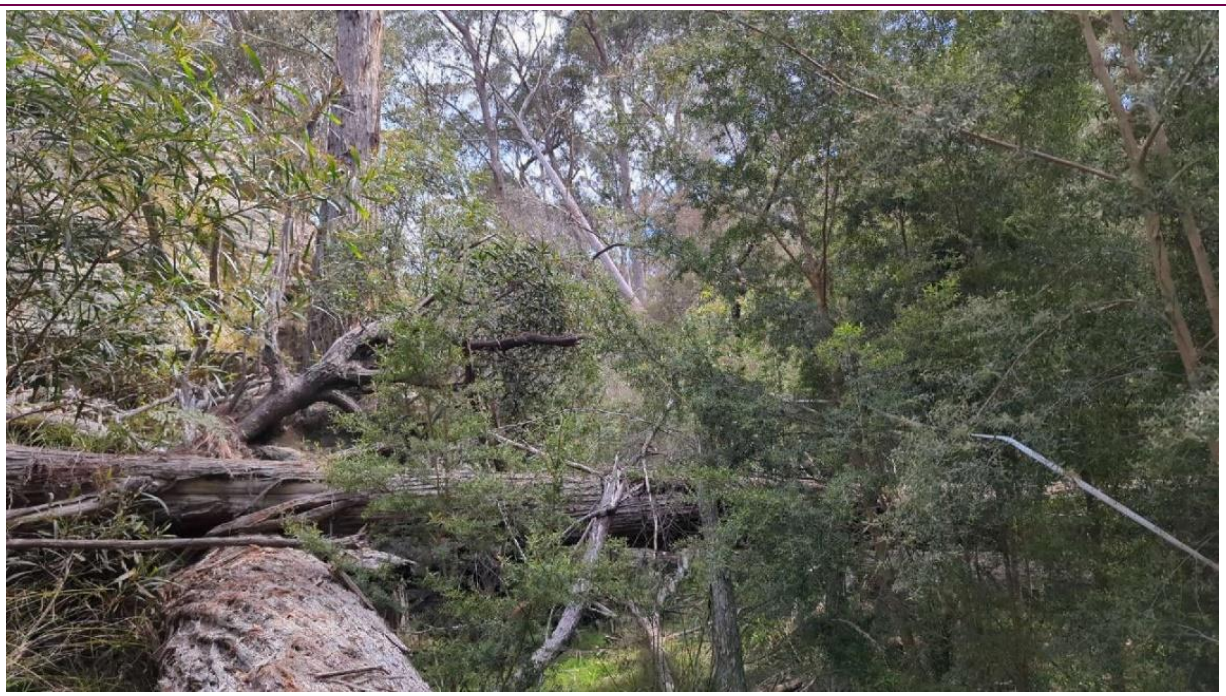
Plot ID	Photo
GDE BAM 6	
GDE BAM 7	
GDE BAM 8	

Plot ID	Photo
GDE BAM 9	
GDE BAM 10	
GDE BAM 11	

Appendix D Rapid Aquatic Assessment plot photos

Apx Table 6: Rapid Aquatic Assessment plot photos

Plot ID	Photo
GDE BAM 1	
GDE BAM 2	

Plot ID	Photo
GDE BAM 5	
GDE BAM 6	

Plot ID	Photo
GDE BAM 7	
GDE BAM 8	

Plot ID	Photo
GDE BAM 9	
GDE BAM 10	N/A
GDE BAM 11	



Appendix E
Fauna species list

Class	Common Name	Scientific name	Exotic	Count	Obs. Type	Method	BC Act	EPBC Act
Amphibian	Common Eastern Froglet	*Crinia signifera*		50	W, AR	Opportunistic, Songmeter	Not Listed	Not Listed
Amphibian	Eastern Banjo Frog	*Limnodynastes dumerilii*		10	AR	Songmeter	Not Listed	Not Listed
Amphibian	Peron's Tree Frog	*Litoria peronii*		5	W, AR	Opportunistic, Songmeter	Not Listed	Not Listed
Amphibian	Red-backed Toadlet	*Pseudophryne coriacea*		2	AR	Songmeter	Not Listed	Not Listed
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*		1	O	Opportunistic	Not Listed	Not Listed
Birds	Australian King-Parrot	*Alisterus scapularis*		15	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Australian Magpie	*Cracticus tibicen*		11	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Australian Raven	*Corvus coronoides*		5	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Australian Wood Duck	*Chenonetta jubata*		1	O	Opportunistic	Not Listed	Not Listed
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		4	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Brown Honeyeater	*Lichmera indistincta*		2	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Brown Thornbill	*Acanthiza pusilla*		2	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Brush Cuckoo	*Cacomantis variolosus*		1	W	Birding	Not Listed	Not Listed
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*		1	W	Birding	Not Listed	Not Listed
Birds	Common Bronzewing	*Phaps chalcoptera*		2	O	Opportunistic	Not Listed	Not Listed
Birds	Crimson Rosella	*Platycercus elegans*		10	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Dusky Woodswallow	*Artamus cyanopterus cyanopterus*		3	OW	Birding, Opportunistic	Vulnerable	Not Listed
Birds	Eastern Rosella	*Platycercus eximius*		3	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Eastern Yellow Robin	*Eopsaltria australis*		8	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Fairy Martin	*Petrochelidon ariel*		1	O	Opportunistic	Not Listed	Not Listed
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*		4	OW, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Forest Raven	*Corvus tasmanicus*		1	W	Birding	Not Listed	Not Listed

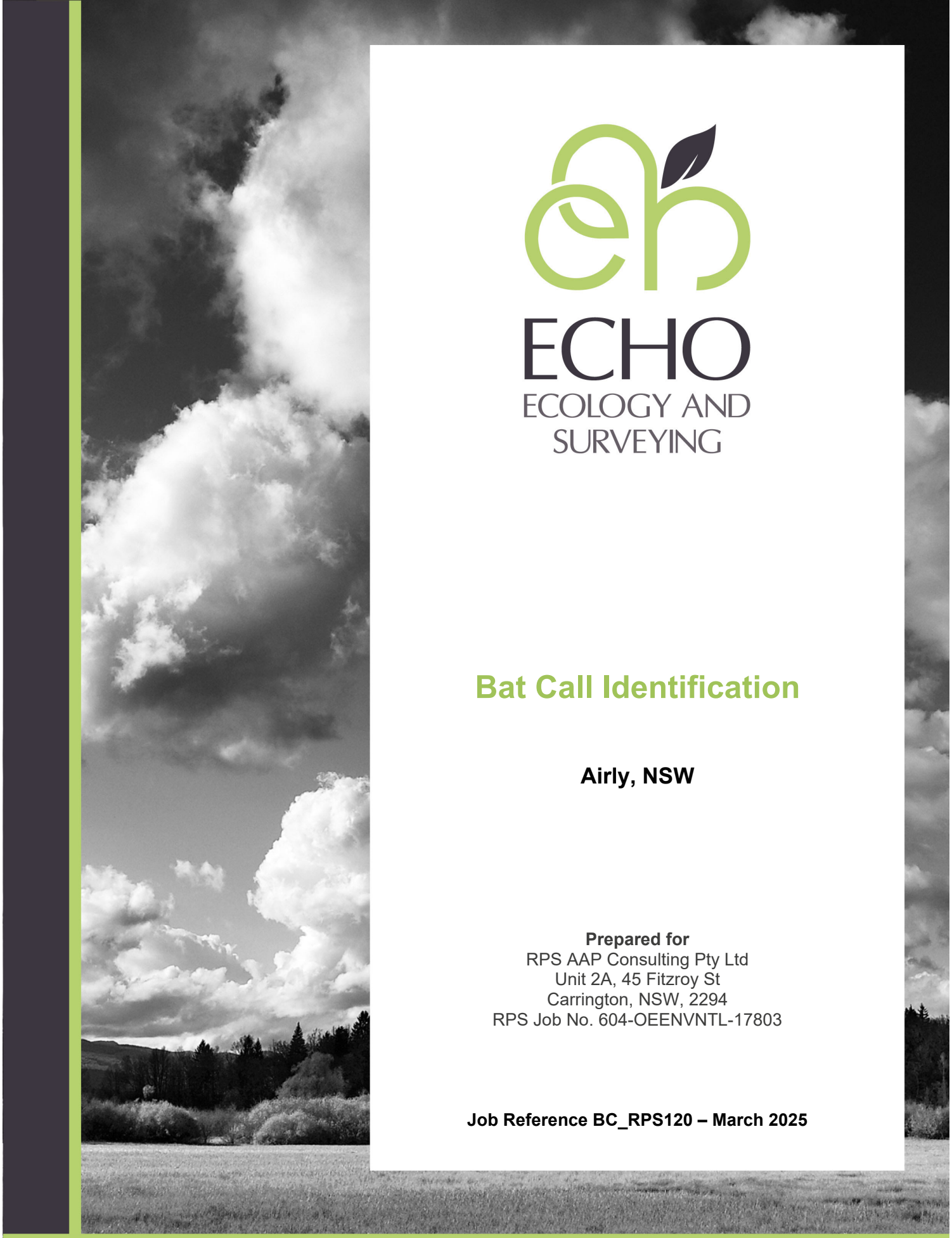
Class	Common Name	Scientific name	Exotic	Count	Obs. Type	Method	BC Act	EPBC Act
Birds	Gang-gang Cockatoo	^^*Callocephalon fimbriatum*		4	W, AR	Birding, Songmeter	Endangered	Endangered
Birds	Glossy Black-Cockatoo	^*Calyptorhynchus lathami*		6	W, AR	Birding, Songmeter	Vulnerable	Vulnerable
Birds	Golden Whistler	*Pachycephala pectoralis*		3	W	Birding, Opportunistic	Not Listed	Not Listed
Birds	Grey Butcherbird	*Cracticus torquatus*		2	W, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Grey Fantail	*Rhipidura albiscapa*		23	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Grey Shrike-thrush	*Colluricincla harmonica*		11	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Jacky Winter	*Microeca fascinans*		1	W	Birding	Not Listed	Not Listed
Birds	King/Superb Parrot	*Parrot Hybrid*		1	O	Opportunistic	Not Listed	Not Listed
Birds	Laughing Kookaburra	*Dacelo novaeguineae*		6	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Magpie-lark	*Grallina cyanoleuca*		1	W	Birding	Not Listed	Not Listed
Birds	Masked Lapwing	*Vanellus miles*		1	O	Opportunistic	Not Listed	Not Listed
Birds	New Holland Honeyeater	*Phylidonyris novaehollandiae*		1	O	Opportunistic	Not Listed	Not Listed
Birds	Noisy Friarbird	*Philemon corniculatus*		8	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Noisy Miner	*Manorina melanocephala*		2	W2, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Olive-backed Oriole	*Oriolus sagittatus*		1	W	Birding	Not Listed	Not Listed
Birds	Pacific Koel	*Eudynamys orientalis*		1	AR	Songmeter	Not Listed	Not Listed
Birds	Pied Currawong	*Strepera graculina*		9	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Powerful Owl	^^*Ninox strenua*		2	OW	Spotlighting	Vulnerable	Not Listed
Birds	Purple Swamphen	*Porphyrio porphyrio*		1	O	Opportunistic	Not Listed	Not Listed
Birds	Rainbow Lorikeet	*Trichoglossus haematodus*		1	OW, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Red Wattlebird	*Anthochaera carunculata*		3	OW, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Red-browed Finch	*Neochmia temporalis*		4	W	Birding, Opportunistic	Not Listed	Not Listed
Birds	Restless Flycatcher	*Myiagra inquieta*		1	W	Birding	Vulnerable	Not Listed
Birds	Rockwarbler	*Origma solitaria*		1	O	Birding	Not Listed	Not Listed
Birds	Rufous Fantail	*Rhipidura rufifrons*		6	OW	Birding, Opportunistic	Not Listed	Not Listed

Class	Common Name	Scientific name	Exotic	Count	Obs. Type	Method	BC Act	EPBC Act
Birds	Rufous Whistler	*Pachycephala rufiventris*		10	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Sacred Kingfisher	*Todiramphus sanctus*		1	W	Birding	Not Listed	Not Listed
Birds	Satin Bowerbird	*Ptilonorhynchus violaceus*		5	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Satin Flycatcher	*Myiagra cyanoleuca*		1	W	Birding	Not Listed	Not Listed
Birds	Sooty Owl	*Tyto tenebricosa*		1	W, AR	Spotlighting, Songmeter	Vulnerable	Not Listed
Birds	Southern Boobook	*Ninox novaeseelandiae*		6	AR	Songmeter	Not Listed	Not Listed
Birds	Spotted Pardalote	*Pardalotus punctatus*		12	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Striated Pardalote	*Acanthiza lineata*		3	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Striated Thornbill	*Cacatua galerita*		1	W	Birding	Not Listed	Not Listed
Birds	Sulphur-crested Cockatoo	*Malurus cyaneus*		3	W, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Superb Fairy-wren	*Malurus cyaneus*		4	OW, AR	Birding, Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Superb Lyrebird	*Menura novaehollandiae*		18	OW, Q, AR	Birding, Opportunistic, Camera trap, Songmeter	Not Listed	Not Listed
Birds	Tawny Frogmouth	*Podargus strigoides*		1	AR	Songmeter	Not Listed	Not Listed
Birds	Welcome Swallow	*Hirundo neoxena*		1	O	Opportunistic	Not Listed	Not Listed
Birds	White-browed Scrubwren	*Sericornis frontalis*		3	OW, Q	Birding, Opportunistic, Camera trap	Not Listed	Not Listed
Birds	White-faced Heron	*Egretta novaehollandiae*		1	O	Opportunistic, Birding	Not Listed	Not Listed
Birds	White-naped Honeyeater	*Melithreptus lunatus*		2	O	Opportunistic, Birding	Not Listed	Not Listed
Birds	White-plumed Honeyeater	*Ptilotula penicillatus*		1	OW	Birding	Vulnerable	Not Listed
Birds	White-throated Gerygone	*Gerygone olivacea*		5	W	Birding	Not Listed	Not Listed
Birds	White-throated Treecreeper	*Cormobates leucophaea*		8	OW, AR	Birding, Songmeter	Vulnerable	Not Listed
Birds	White-winged Chough	*Corcorax melanorhamphos*		2	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Willie Wagtail	*Rhipidura leucophrys*		2	OW, AR	Opportunistic, Songmeter	Not Listed	Not Listed
Birds	Wonga Pigeon	*Leucosarcia melanoleuca*		1	W, AR	Birding, Songmeter	Not Listed	Not Listed

Class	Common Name	Scientific name	Exotic	Count	Obs. Type	Method	BC Act	EPBC Act
Birds	Yellow Thornbill	*Acanthiza nana*		22	OW	Birding	Not Listed	Not Listed
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*		15	OW	Birding, Opportunistic	Not Listed	Not Listed
Birds	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*		4	W, AR	Birding, Songmeter	Not Listed	Not Listed
Birds	Yellow-tufted Honeyeater	*Lichenostomus melanops*		2	O	Birding, Opportunistic	Not Listed	Not Listed
Mammalia	Brown Antechinus	*Antechinus stuartii*		4	Q	Camera trap	Not Listed	Not Listed
Mammalia	Bush Rat	*Rattus fuscipes*		3	Q	Camera trap	Not Listed	Not Listed
Mammalia	Cat	*Felis catus*	*	1	Q	Camera trap	Not Listed	Not Listed
Mammalia	Common Brushtail Possum	*Trichosurus vulpecula*		9	O,Q	Opportunistic, Camera trap	Not Listed	Not Listed
Mammalia	Common Wombat	*Vombatus ursinus*		5	O, Q	Opportunistic, Camera trap	Not Listed	Not Listed
Mammalia	Eastern Grey Kangaroo	*Macropus giganteus*		12	O, Q	Opportunistic, Camera trap	Not Listed	Not Listed
Mammalia	New Holland Mouse (unconfirmed)	*Pseudomys novaehollandiae*		1	Q	Camera trap	Not Listed	Vulnerable
Mammalia	Red-necked Wallaby	*Macropus rufogriseus*		1	Q	Camera trap	Not Listed	Not Listed
Mammalia	Short-beaked Echidna	*Tachyglossus aculeatus*		5	Q	Camera trap	Not Listed	Not Listed
Mammalia	Spotted-tailed Quoll	*Dasyurus maculatus*		1	Q	Camera trap	Vulnerable	Endangered
Mammalia	Sugar Glider	*Petaurus breviceps*		2	OW, AR	Spotlighting, Songmeter	Not Listed	Not Listed
Mammalia	Swamp Wallaby	*Wallabia bicolor*		9	O, Q	Opportunistic, Camera trap	Not Listed	Not Listed
Mammalia	Unidentified Microbat	*Microchiroptera suborder*		10	O, W	Spotlighting	Not Listed	Not Listed
Mammalia	Yellow-bellied Glider	*Petaurus australis*		2	O	Spotlighting	Vulnerable	Not Listed
Reptiles	Bearded Dragon	*Pogona vitticeps*		1	O	Opportunistic	Not Listed	Not Listed
Reptiles	Lace Monitor	*Varanus varius*		9	O, Q	Opportunistic, Camera trap	Not Listed	Not Listed

Note: O = observed, W = heard, AR = songmeter analysis, Q = camera trap analysis

Appendix F Bat Call Analysis



ECHO
ECOLOGY AND
SURVEYING

Bat Call Identification

Airly, NSW

Prepared for
RPS AAP Consulting Pty Ltd
Unit 2A, 45 Fitzroy St
Carrington, NSW, 2294
RPS Job No. 604-OEENVNTL-17803

Job Reference BC_RPS120 – March 2025

Echo Ecology and Surveying • PO Box 4132 Crescent Head
Ecology - 0423 801 779 • **Surveying -** 0418 604 460 • **E:** info@echoecology.com.au • **W:** echoecology.com.au

This report has been prepared to document the analysis of digital ultrasonic bat echolocation calls received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use. Bat calls were identified by Anna McConville.

This report was authored by



Dr Anna McConville
PhD, B.Env.Sc.

Job Reference: BC_RPS116
9 March 2025

Contents

1.0 Introduction 1

2.0 Methods 1

2.1 Call Identification 1

2.2 Log file review 2

2.3 Limitations 2

3.0 Results 3

3.1 Log file review 4

4.0 Sample Calls 9

5.0 References 11

Appendix A Species Identification Confidence and Characteristics – Sydney Basin

Appendix B Log File Review

List of Tables

Table 3-1: Results of bat call analysis (number of passes per site per night) 5

List of Figures

Figure 4-1: *Austronomus australis* definite call 9

Figure 4-2: *Chalinolobus dwyeri* definite call 9

Figure 4-3: *Chalinolobus gouldii* definite call 9

Figure 4-4: *Chalinolobus morio* definite call 10

Figure 4-5: *Ozimops planiceps* definite call 10

Figure 4-6: *Rhinolophus megaphyllus* definite call 10

Figure 4-7: *Vespadelus darlingtoni* probable call..... 11

1.0 INTRODUCTION

This report has been commissioned by RPS Australia East Pty Ltd to analyse bat echolocation call data collected from Airly, NSW. Data was provided electronically to the author. This report documents the methods involved in analysing bat call data and the results obtained only.

2.0 METHODS

2.1 Call Identification

The identification of bat echolocation calls recorded during surveys was undertaken using Anabat Insight (Titley Electronics, Version 2.1.2) software. Files from Anabat Express units (.zca) were first converted to .zc (max 15s duration, Smoothness - None) and a noise filter was applied (EE_Allbats.als, ZC – auto, Smoothness - 4). The identification of calls was undertaken with reference to Pennay et al. (2004) and through the comparison of recorded reference calls from the Sydney Basin. Reference calls were obtained from the NSW database and from the authors personal collection.

A list of potentially occurring echolocating bat species for the region (approximately 50 – 100 km radius) was obtained from the Australasian Bat Society – Bat Map (https://www.ausbats.org.au/batmap.html) and was used to constrain the identification of bat calls.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality

- Unknown - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.
- Not Identified – a bat call identified by the noise filter, but that was not analysed as part of this project. E.g. when extra nights of data are collected than are needed.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

On occasion, call notes are recorded such as whether there was feeding buzzes or social calls recorded. These are recorded only opportunistically while identifying calls and not every call has been thoroughly checked for these features.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

Nomenclature follows the Australian Faunal Directory (https://biodiversity.org.au/afd; downloaded 15 June 2020).

The echolocation call characteristics used to differentiate species for the region and the identification potential for each species are described in Appendix A.

2.2 Log file review

We reviewed the log files for each night of recording and have summarised the detector settings, recording duration and any errors. This may be used to confirm survey effort, the use of correct detector settings and may help diagnose missing data.

2.3 Limitations

The identification of bat species from echolocation calls in many Australian regions is not straightforward. Our reference call libraries tend to be relatively small, some species vary their call frequency with region and bat behaviour may also influence call shapes and frequencies. Additional factors may add to the level of uncertainty of species identification from echolocation calls such as short call sequences, high levels of noise and missing echolocation pulses. Some species share overlapping echolocation call characteristics and some overlap so much that we are unable to differentiate between species with our current knowledge.

To assist with the interpretation of our results within this context of uncertainty, we provide a qualitative indication of the confidence of bat call identification by assigning confidence levels (Definite, Probable, Possible and Species Groups). We have also provided a list of the general identification potential for each species potentially occurring within your sample region (Appendix A). For a more complete species inventory, bat call recording should be combined with other survey methods such as trapping.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Activity levels should not be compared among species as different species have different detectability due to factors such as call loudness, foraging strategy and call identifying features. Activity comparisons among sites are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

The bat call identification results presented in this report should be interpreted with these limitations in mind and in many cases trapping and habitat assessment should also be undertaken in conjunction with bat call recording.

3.0 RESULTS

Calls were recorded in full spectrum and zero crossings format using Anabat Express and Anabat Express FS bat detectors (Titley Scientific).

A total of 44,260 files were provided, from which 11,053 bat call sequences were able to be analysed (ie were not ‘noise’ files or bat calls of short length). Of the bat calls, 4,238 call sequences (38 %) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 3-1). Species recorded confidently within the site include:

- *Austronomus australis* (White-striped Free-tailed Bat)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Chalinolobus gouldii* (Gould’s Wattled Bat)
- *Chalinolobus morio* (Chocolate Wattled Bat)
- *Ozimops planiceps* (Southern Free-tailed Bat)
- *Rhinolophus megaphyllus* (Eastern Horseshoe Bat)
- *Vespadelus darlingtoni* (Large Forest Bat)

Additionally, the following bat species potentially occurred within the site, but could not be confidently identified (those calls classified as possible or as a species group):

- *Falsistrellus tasmaniensis* (Eastern Falsistrelle)
- *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat)
- *Myotis macropus* (Large-footed Myotis)
- *Nyctophilus geoffroyi* (Lesser long-eared bat)
- *Nyctophilus gouldi* (Gould's long-eared bat)
- *Ozimops ridei* (Ride's Free-tailed Bat)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Scotorepens balstoni* (Inland Broad-nosed Bat)
- *Scotorepens orion* (Eastern Broad-nosed Bat)
- *Vespadelus regulus* (Southern Forest Bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturnus* (Little Forest Bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors (or are difficult to identify by bat call) and habitat assessment should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Table 3-1 below summarises the results of the bat call analysis.

3.1 Log file review

The log file review indicated that detectors were set for entire nights and mostly functioning correctly. However, a number of the units had their minimum trigger frequency set to 15 or 16 kHz which may have resulted in missing some lower frequency calling bats such as *Austronomus australis* (White-striped Freetail Bat). Full details are provided in Appendix B.

Table 3-1: Results of bat call analysis (number of passes per site per night)

Key: V – Vulnerable; E – Endangered; X – listed as. For species group identifications where one or more of the species are listed as threatened, the species initials that are listed as threatened have been entered into the EPBC Act, BC Act, Species Credit, Ecosystem Credit and/or SAII columns

CONFIDENCE	IDENTIFICATION	EPBC ACT	BC ACT	SPECIES CREDIT	ECOSYSTEM CREDIT	SAII	Anabat 11			Anabat 2 -			Anabat 3 -			Anabat 4 -			Anabat 6			Anabat 7		
							16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024
DEFINITE	*Austronomus australis*	-	-	-	-	-	13	4	1	5	2	2	4	6	-	14	20	-	-	-	-	-	3	-
	Chalinolobus dwyeri	V	V	X	-	Breeding	-	1	-	5	4	-	78	63	7	17	111	-	25	22	14	-	2	3
	Chalinolobus gouldii	-	-	-	-	-	-	-	-	2	2	-	2	3	-	5	1	-	-	2	-	-	-	-
	Chalinolobus morio	-	-	-	-	-	3	-	-	-	8	-	2	1	-	-	-	-	2	2	-	-	-	-
	Ozimops planiceps	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-
	Rhinolophus megaphyllus	-	-	-	-	-	-	1	-	2	5	-	1	1	-	-	4	-	10	3	40	552	470	673
PROBABLE	*Austronomus australis*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3	6	-	-	-	-	-	-	-
	Chalinolobus dwyeri	V	V	X	-	Breeding	2	2	-	-	2	-	22	26	1	5	49	-	9	9	1	-	-	2
	Chalinolobus gouldii	-	-	-	-	-	-	-	-	4	12	-	3	-	-	1	3	-	-	1	-	-	-	-
	Chalinolobus morio	-	-	-	-	-	4	-	-	-	8	-	3	-	-	-	2	-	3	5	1	-	-	1
	Ozimops planiceps	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rhinolophus megaphyllus	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	1	-	-	3	1	1
	Vespadelus darlingtoni	-	-	-	-	-	13	10	-	4	6	2	13	4	-	16	73	-	147	188	53	1	3	1
POSSIBLE	*Chalinolobus dwyeri*	V	V	X	-	Breeding	1	-	-	-	1	-	8	15	-	3	13	-	8	4	2	1	1	3
	Ozimops ridei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rhinolophus megaphyllus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Vespadelus darlingtoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
SPECIES GROUPS	*Chalinolobus gouldii / Ozimops planiceps*	-	-	-	-	-	3	3	-	2	3	1	9	4	-	1	2	-	-	8	-	2	3	-
	Chalinolobus gouldii / Ozimops ridei / Ozimops planiceps / Scotorepens balstoni	-	-	-	-	-	3	10	1	5	17	-	11	31	-	22	108	-	3	4	1	32	18	-

CONFIDENCE	IDENTIFICATION	EPBC ACT	BC ACT	SPECIES CREDIT	ECOSYSTEM CREDIT	SAII	Anabat 11			Anabat 2 -			Anabat 3 -			Anabat 4 -			Anabat 6			Anabat 7		
							16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024
	Chalinolobus gouldii / Scotorepens balstoni	-	-	-	-	-	2	1	-	6	20	1	5	13	-	6	40	-	4	2	3	1	2	-
	Chalinolobus gouldii / Scotorepens balstoni / Scoteanax rueppellii	-	Sr	-	Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chalinolobus morio / Vespadelus vulturnus / Vespadelus troughtoni	-	Vt	Vt	-	Vt	23	23	-	14	47	2	14	13	1	16	98	-	159	127	27	137	267	198
	Falsistrellus tasmaniensis / Scotorepens orion	-	Ft	-	Ft	-	17	14	-	4	9	-	27	6	1	33	59	-	168	145	32	-	-	-
	Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	-	Ft Sr	-	Ft Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	14	2	-	-	-	-
	Miniopterus orianae oceanensis / Vespadelus regulus	-	Moo	Moo	Moo	Moo	2	-	-	-	1	-	23	1	1	2	3	-	3	1	4	18	15	2
	Miniopterus orianae oceanensis / Vespadelus vulturnus	-	Moo	Moo	Moo	Moo	16	8	-	18	108	-	89	14	1	23	83	-	84	77	33	290	425	715
	Myotis macropus / Nyctophilus geoffroyi / Nyctophilus gouldi	-	Mm	Mm	-	-	1	1	-	2	-	-	1	-	-	1	-	-	25	12	4	-	1	-
	Ozimops ridei / Ozimops planiceps	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-
	Vespadelus darlingtoni / Vespadelus regulus	-	-	-	-	-	-	-	-	1	1	-	4	1	1	-	6	-	3	7	1	-	1	-
	Vespadelus vulturnus / Vespadelus troughtoni	-	Vt	Vt	-	Vt	3	1	-	-	-	-	-	2	-	3	4	-	8	-	-	-	-	-
UNKNOWN	Unknown bat call (short duration or poor quality)	-	-	-	-	-	23	39	-	26	27	2	53	48	4	33	47	-	129	184	65	124	204	172
	'Noise' files	-	-	-	-	-	2105	1669	1355	1134	860	132	1730	640	748	1375	1336	258	1227	1295	1929	852	642	455
TOTAL							**2235**	**1789**	**1357**	**1234**	**1145**	**142**	**2103**	**893**	**765**	**1580**	**2069**	**258**	**2032**	**2101**	**2210**	**2013**	**2058**	**2226**
CALL NOTES	Feeding buzz	-	-	-	-	-	-	-	-	1	12	-	-	-	-	-	13	-	1	-	-	-	-	-
	Social call	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2	9	-	13	23	1	-	-	-

CONFIDENCE	IDENTIFICATION	EPBC ACT	BC ACT	SPECIES CREDIT	ECOSYSTEM CREDIT	SAII	Anabat FS12			Anabat FS13			Anabat FS14			Anabat FS8		
							16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024
DEFINITE	*Austronomus australis*	-	-	-	-	-	3	3	1	-	4	1	-	8	1	-	-	-
	Chalinolobus dwyeri	V	V	X	-	Breeding	16	12	-	-	2	-	-	7	12	3	5	7
	Chalinolobus gouldii	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	1
	Chalinolobus morio	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	17
	Ozimops planiceps	-	-	-	-	-	-	2	-	41	-	-	1	-	-	-	-	-
	Rhinolophus megaphyllus	-	-	-	-	-	-	-	-	10	8	-	70	52	116	-	1	1
PROBABLE	*Austronomus australis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chalinolobus dwyeri	V	V	X	-	Breeding	4	-	-	-	1	-	1	1	5	3	1	4
	Chalinolobus gouldii	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-
	Chalinolobus morio	-	-	-	-	-	1	-	-	-	1	-	-	6	1	1	-	15
	Ozimops planiceps	-	-	-	-	-	-	-	-	12	-	-	-	1	-	-	-	-
	Rhinolophus megaphyllus	-	-	-	-	-	-	-	-	3	-	-	1	2	4	-	-	-
	Vespadelus darlingtoni	-	-	-	-	-	1	-	-	180	88	-	1	4	3	38	53	429
POSSIBLE	*Chalinolobus dwyeri*	V	V	X	-	Breeding	1	1	-	-	1	-	1	1	1	4	3	2
	Ozimops ridei	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
	Rhinolophus megaphyllus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
	Vespadelus darlingtoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPECIES GROUPS	*Chalinolobus gouldii / Ozimops planiceps*	-	-	-	-	-	-	3	-	23	15	1	7	2	1	8	1	-
	Chalinolobus gouldii / Ozimops ridei / Ozimops planiceps / Scotorepens balstoni	-	-	-	-	-	2	2	-	1	29	2	30	31	2	72	63	45
	Chalinolobus gouldii / Scotorepens balstoni	-	-	-	-	-	3	4	-	-	10	-	-	6	-	54	16	3

CONFIDENCE	IDENTIFICATION	EPBC ACT	BC ACT	SPECIES CREDIT	ECOSYSTEM CREDIT	SAII	Anabat FS12			Anabat FS13			Anabat FS14			Anabat FS8		
							16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024	16/12/2024	17/12/2024	18/12/2024
	Chalinolobus gouldii / Scotorepens balstoni / Scoteanax rueppellii	-	Sr	-	Sr	-	-	-	-	1	1	-	-	1	-	-	-	-
	Chalinolobus morio / Vespadelus vulturnus / Vespadelus troughtoni	-	Vt	Vt	-	Vt	5	6	-	9	17	-	186	402	60	32	58	60
	Falsistrellus tasmaniensis / Scotorepens orion	-	Ft	-	Ft	-	-	-	-	196	138	-	-	-	1	9	15	38
	Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	-	Ft Sr	-	Ft Sr	-	-	-	-	-	-	-	-	1	-	1	-	-
	Miniopterus orianae oceanensis / Vespadelus regulus	-	Moo	Moo	Moo	Moo	1	2	-	1	2	-	8	13	26	6	-	30
	Miniopterus orianae oceanensis / Vespadelus vulturnus	-	Moo	Moo	Moo	Moo	8	10	-	56	21	1	84	126	107	90	70	34
	Myotis macropus / Nyctophilus geoffroyi / Nyctophilus gouldi	-	Mm	Mm	-	-	-	-	-	-	-	-	1	1	-	8	10	1
	Ozimops ridei / Ozimops planiceps	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-
	Vespadelus darlingtoni / Vespadelus regulus	-	-	-	-	-	1	1	-	2	4	-	-	2	2	3	8	51
	Vespadelus vulturnus / Vespadelus troughtoni	-	Vt	Vt	-	Vt	-	-	-	-	-	-	1	1	-	-	-	-
UNKNOWN	Unknown bat call (short duration or poor quality)	-	-	-	-	-	21	19	8	137	101	5	76	119	93	89	72	106
	'Noise' files	-	-	-	-	-	1384	418	3485	715	1197	29	1042	1408	546	1088	914	570
TOTAL							**1452**	**483**	**3494**	**1389**	**1647**	**39**	**1511**	**2196**	**982**	**1510**	**1290**	**1414**
CALL NOTES	Feeding buzz	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1
	Social call	-	-	-	-	-	-	-	-	4	2	-	-	1	-	2	-	3

4.0 SAMPLE CALLS

A sample of the calls actually identified from the site for each species is given below.

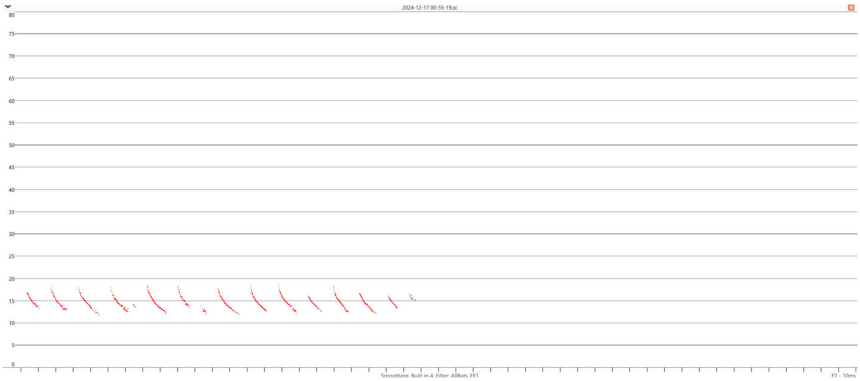


Figure 4-1: *Austronomus australis* definite call

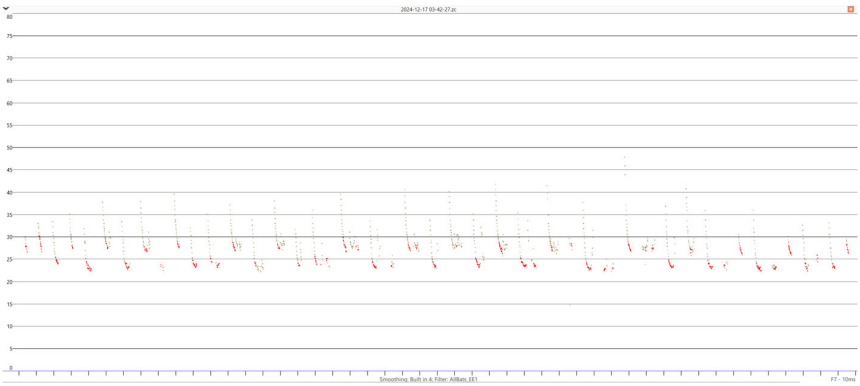


Figure 4-2: *Chalinolobus dwyeri* definite call

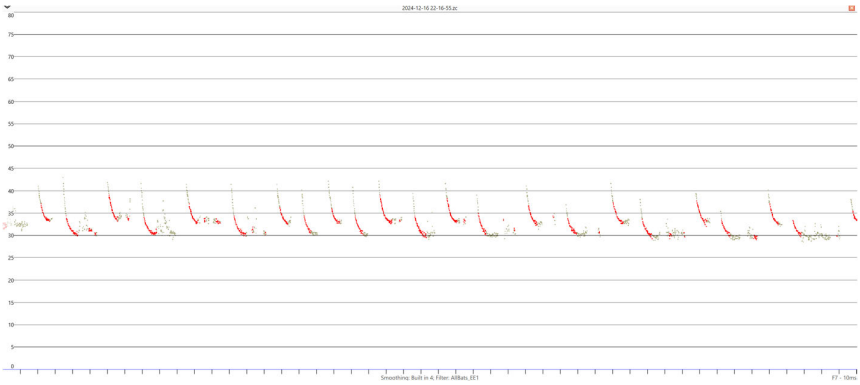


Figure 4-3: *Chalinolobus gouldii* definite call

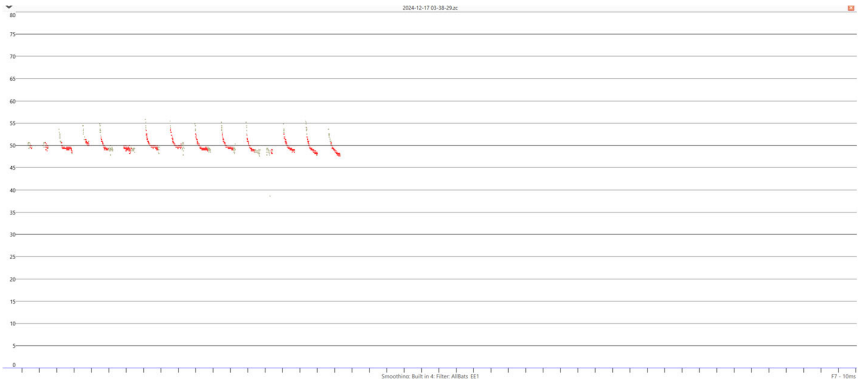


Figure 4-4: *Chalinolobus morio* definite call

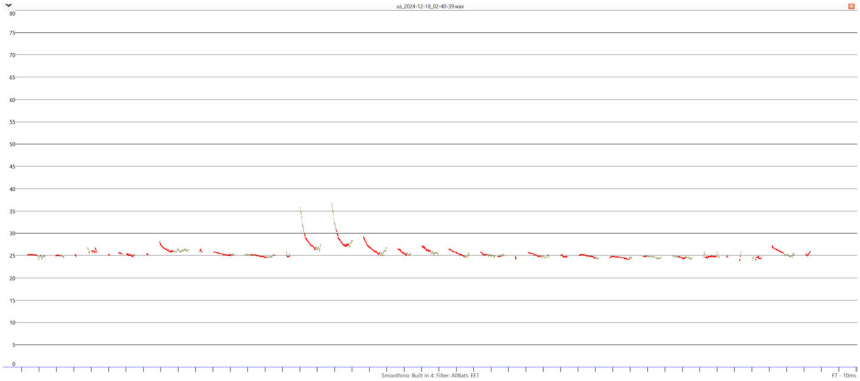


Figure 4-5: *Ozimops planiceps* definite call

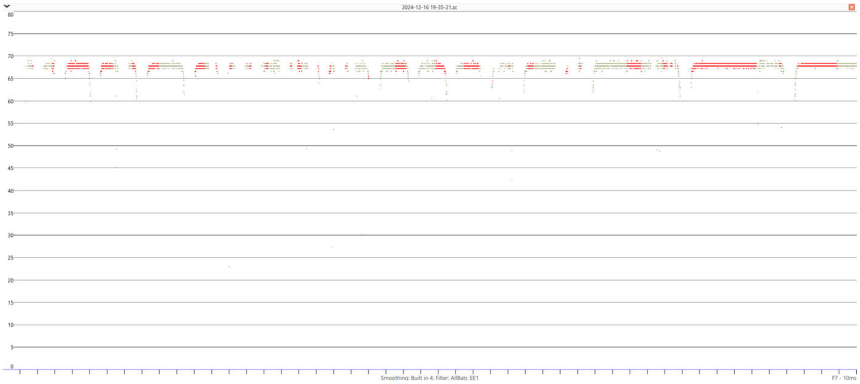


Figure 4-6: *Rhinolophus megaphyllus* definite call

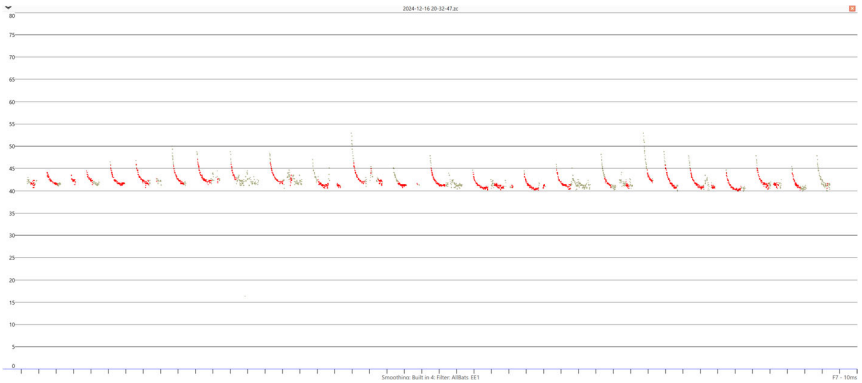


Figure 4-7: *Vespadelus darlingtoni* probable call

5.0 REFERENCES

Adams, M. D., Law, B.S., French, K.O. (2009). "Vegetation structure influences the vertical stratification of open- and edge-space aerial-foraging bats in harvested forests." Forest Ecology and Management 258(9): 2090-2100.

Adams, M. D., Law, B.S., French, K.O. (2010). Reliable automation of bat call identification for eastern New South Wales, Australia, using classification trees and AnaScheme software. *Acta Chiropterologica* 12(1): 231-245.

Australasian Bat Society Incorporated (undated) *Standards for reporting bat detector surveys*, http://batcall.csu.edu.au/abs/issues/ABS_Anabat_survey_standards.pdf

Churchill, S. (2008). *Australian Bats.* Second Edition Allen & Unwin; Crows Nest, NSW.

Corben, C. (2010) Feeding buzzes, *Australasian Bat Society Newsletter*, 35:40-44.

Law, B.S., Reinhold, L. and Pennay, M. (2002). Geographic variation in the echolocation calls of Vespadelus spp. (Vespertilionidae) from New South Wale and Queensland, Australia. *Acta Chiropterologica* 4: 201-215.

Pennay, M., Law, B. and Reinhold, L. (2004). *Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001a). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Queensland Department of Natural Resources and Mines, State Forests of New South Wales, University of Southern Queensland, and New South Wales National Parks and Wildlife Service, Australia.

Reinhold, L., Herr, A., Lumsden, L., Reardon, T., Corben, C., Law, B., Prevett, P., Ford, G., Conole, L., Kutt, A., Milne, D. and Hoye, G. (2001b). Geographic variation in the echolocation calls of Gould's wattled bat *Chalinolobus gouldii*. *Australian Zoologist* 31: 618-624.

Van Dyck, S. and Strahan, R. (Eds.) (2008). *The Mammals of Australia: Third Edition*. New Holland; Sydney.

APPENDIX A SPECIES IDENTIFICATION CONFIDENCE AND CHARACTERISTICS – SYDNEY BASIN

Table A1: Identification confidence and characteristics of bat echolocation calls from the Blue Mountains - Sydney basin region

Scientific Name	Common Name	Identification Potential	Identification characteristics
Austronomus australis	White-striped Free-tailed Bat	High	Good quality calls unlikely to be confused. However, partial calls may be confused with social calls of other bat species and insects.
Chalinolobus dwyeri	Large-eared Pied Bat	High	Calls may overlap with *Saccolaimus flaviventris*. However, good quality call sequences are unlikely to be confused due to small pulse shape and alternating pulses in *Chalinolobus dwyeri*.
Chalinolobus gouldii	Gould's Wattled Bat	Mod - High	Overlaps with *Ozimops ridei* and *Scoteanax rueppellii*. In good quality recordings, differentiated from *Ozimops ridei* by curved pulses and from *Scoteanax rueppellii* by alternating pulse frequencies.
Chalinolobus morio	Chocolate Wattled Bat	Mod - High	Overlaps with *Vespadelus vulturnus, Vespadelus pumilus, Vespadelus troughtoni* and possibly with *Miniopterus orianae oceanensis* in some areas. Differentiated from *Vespadelus* spp. by the presence of down-sweeping tails on pulses and generally little doppler effect that is typically displayed by *Vespadelus* spp. Not differentiated from *Miniopterus orianae oceanensis* where they overlap in characteristic frequency.
Falsistrellus tasmaniensis	Eastern Falsistrelle	Low	Overlaps in characteristic frequency with *Scotorepens orion* and *Scoteanax rueppellii*. *Falsistrellus tasmaniensis* is most frequently recorded from more elevated locations in the region. However, some records exist from coastal lowlands and so included it in our species groups in coastal areas as a precautionary measure. We do not distinguish *Falsistrellus tasmaniensis* from *Scotorepens orion* where they overlap in frequency due to overlapping call characteristics.

Scientific Name	Common Name	Identification Potential	Identification characteristics
Miniopterus orianae oceanensis	Eastern Bent-winged Bat	Low – Mod	Overlaps in characteristic frequency with *Vespadelus darlingtoni, Vespadelus regulus* and possibly with *Chalinolobus morio*. Differentiated from *Vespadelus* spp. by characteristic one-phase 'stepped' feeding buzz (if present) and generally little doppler effect (that is typically displayed by *Vespadelus* spp.). Not differentiated from *Chalinolobus morio* where they overlap in characteristic frequency.
Myotis macropus	Large-footed Myotis	Low - Mod	Overlaps in call features with *Nyctophilus* spp. Differentiated from *Nyctophilus* spp. in good quality call sequences with pulse intervals < 75 ms, initial slope > 400 OPS and often with a central kink and varying slopes among pulses.
Nyctophilus geoffroyi	Lesser long-eared bat	Low	Overlaps in call features with *Nyctophilus gouldi* and *Myotis macropus*. Differentiated from *Myotis macropus* by pulse intervals > 95 ms and an initial slope of < 300 OPS. However, *Nyctophilus geoffroyi* and *Nyctophilus gouldi* are unable to be differentiated from each other.
Nyctophilus gouldi	Gould's long-eared bat	Low	Overlaps in call features with *Nyctophilus geoffroyi* and *Myotis macropus*. Differentiated from *Myotis macropus* by pulse intervals > 95 ms and an initial slope of < 300 OPS. However, *Nyctophilus geoffroyi* and *Nyctophilus gouldi* are unable to be differentiated from each other.
Ozimops ridei	Ride's Free-tailed Bat	Mod	Overlaps in characteristic frequency with *Micronomus norfolkensis* and *Chalinolobus gouldii*. Differentiated from *Chalinolobus gouldii* in long call sequences with mostly flat pulse shapes. Differentiated from *Micronomus norfolkensis* in long call sequences with little pulse alternation.
Phoniscus papuensis	Golden-tipped Bat	Low	Has a very quiet call that is not often recorded by bat detectors.
Rhinolophus megaphyllus	Eastern Horseshoe Bat	High	Long duration, flat calls at characteristic frequency of 66 – 70kHz, unlikely to be confused with any other species.

Scientific Name	Common Name	Identification Potential	Identification characteristics
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	Mod - High	Calls may overlap with *Chalinolobus dwyeri*. However, good quality call sequences are unlikely to be confused due to *Chalinolobus dwyeri* having small pulse shape and alternating pulses. The harmonics of *Saccolaimus flaviventris* assist identification in full spectrum (.WAV) recordings. The characteristic frequency of the fundamental (first harmonic) is 10-12 kHz, the second (loudest harmonic) is 20-25kHz and the third harmonic 30-35kHz.
Scoteanax rueppellii	Greater Broad-nosed Bat	Low – Mod	Overlaps in characteristic frequency with *Chalinolobus gouldii*, *Micronomus norfolkensis*, *Scotorepens orion* and *Falsistrellus tasmaniensis*. Differentiated from *Micronomus norfolkensis* in long call sequences with mostly curved pulse shapes. Differentiated from *Chalinolobus gouldii* only in long call sequences with no alternating pulse frequencies. Differentiated from *Scotorepens orion* and *Falsistrellus tasmaniensis* by long pre-characteristic sections. Usually only identified at a probable confidence level.
Scotorepens orion	Eastern Broad-nosed Bat	Low	Overlaps in characteristic frequency with *Falsistrellus tasmaniensis* and *Scoteanax rueppellii*. *Falsistrellus tasmaniensis* is most frequently recorded from more elevated locations in the region. However, some records exist from coastal lowlands and so included it in our species groups in coastal areas as a precautionary measure. We do not distinguish *Falsistrellus tasmaniensis* from *Scotorepens orion* where they overlap in frequency due to overlapping call characteristics.
Vespadelus darlingtoni	Large Forest Bat	Low - Mod	Overlaps in characteristic frequency with *Miniopterus orianae oceanensis* and *Vespadelus regulus*. Differentiated from *Miniopterus orianae oceanensis* by a two-phase feeding buzz (where present) or by substantial doppler effect (typically displayed by *Vespadelus* spp.). Only differentiated from *Vespadelus regulus* where they do not overlap in characteristic frequency.
Vespadelus regulus	Southern Forest Bat	Low	Overlaps in characteristic frequency with *Vespadelus darlingtoni, Vespadelus vulturnus* and *Miniopterus orianae oceanensis*. Differentiated from *Miniopterus orianae oceanensis* by a two-phase feeding buzz (where present) or by substantial doppler effect (typically displayed by *Vespadelus* spp.). Usually unable to be differentiated from *Vespadelus darlingtoni* and *Vespadelus vulturnus* in this region where they overlap in frequency.

Scientific Name	Common Name	Identification Potential	Identification characteristics
Vespadelus troughtoni	Eastern cave bat	Low	Overlaps in characteristic frequency with *Chalinolobus morio* and *Vespadelus vulturnus*. Differentiated from *Chalinolobus morio* in long call sequences with few down-sweeping tails on pulses and by the doppler effect that is typically displayed by *Vespadelus* spp. However, unable to be differentiated from *Vespadelus vulturnus* in this region.
Vespadelus vulturnus	Little Forest Bat	Low	Overlaps in characteristic frequency with *Chalinolobus morio* and *Vespadelus troughtoni*. Differentiated from *Chalinolobus morio* in long call sequences with few down-sweeping tails on pulses and by the doppler effect that is typically displayed by *Vespadelus* spp. Only differentiated from *Vespadelus troughtoni* in calls with a characteristic frequency 47-48kHz.

APPENDIX B LOG FILE REVIEW

Table B1: Log file review results

Folder	Log file name	Night	Model	Serial	Sample Rate / Div Ratio	Firmware Version	Trigger min freq (kHz)	Trigger max freq (kHz)	Zc Sensitivity	Average of Latitude	Average of Longitude	Max of File Duration (s)	Set to Record?	Entire Night?	Errors?	Comments
Anabat 11	SN584621 2024-12-16	16/12/2024	Express	SN584621	8	V5507J				-33.10567006	150.0716701	15	Yes	Yes		
Anabat 11	SN584621 2024-12-17	17/12/2024	Express	SN584621	8	V5507J				-33.10566003	150.0716999	15	Yes	Yes		
Anabat 11	SN584621 2024-12-18	18/12/2024	Express	SN584621	8	V5507J				-33.10564003	150.0716601	15	Yes	Yes		
Anabat 2 -	SN409322 2024-12-16	16/12/2024	Express	SN409322	8	V5507J				-33.11677	150.05528	15	Yes	Yes		2 Buffer overrun warning messages, possibly some data loss
Anabat 2 -	SN409322 2024-12-17	17/12/2024	Express	SN409322	8	V5507J				-33.11677	150.05528	15	Yes	Yes		Recording ended at 6:30 17/2/23, no warning in log file
Anabat 2 -	SN409322 2024-12-18	18/12/2024	Express	SN409322	8	V5507J				-33.11712	150.05618	15	Yes	Yes		
Anabat 3 -	SN620435 2024-12-16	16/12/2024	Express	SN620435	8	V5507J				-33.10712984	150.0472501	15	Yes	Yes		
Anabat 3 -	SN620435 2024-12-17	17/12/2024	Express	SN620435	8	V5507J				-33.1071	150.04721	15	Yes	Yes		
Anabat 3 -	SN620435 2024-12-18	18/12/2024	Express	SN620435	8	V5507J				-33.10709002	150.04723	15	Yes	Yes		
Anabat 4 -	recordings	16/12/2024	Anabat Express FS	761670	320000Hz	Sonic v3.0.9.24137	15	250	16	-33.09861264	150.055715	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat 4 -	recordings	17/12/2024	Anabat Express FS	761670	320000Hz	Sonic v3.0.9.24137	15	250	16	-33.09878986	150.0546364	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat 4 -	recordings	18/12/2024	Anabat Express FS	761670	320000Hz	Sonic v3.0.9.24137	15	250	16	-33.09882967	150.0548695	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded

Folder	Log file name	Night	Model	Serial	Sample Rate / Div Ratio	Firmware Version	Trigger min freq (kHz)	Trigger max freq (kHz)	Zc Sensitivity	Average of Latitude	Average of Longitude	Max of File Duration (s)	Set to Record?	Entire Night?	Errors?	Comments
Anabat 6	SN507272 2024-12-16	16/12/2024	Express	SN507272	8	V5507J				-33.10394367	150.060577	15	Yes	Yes		
Anabat 6	SN507272 2024-12-17	17/12/2024	Express	SN507272	8	V5507J				-33.10612845	150.0601003	15	Yes	Yes		
Anabat 6	SN507272 2024-12-18	18/12/2024	Express	SN507272	8	V5507J				-33.10615994	150.06008	15	Yes	Yes		
Anabat 7	SN507250 2024-12-16	16/12/2024	Express	SN507250	8	V5507J				-33.09944	150.01776	15	Yes	Yes		
Anabat 7	SN507250 2024-12-17	17/12/2024	Express	SN507250	8	V5507J				-33.09944	150.01776	15	Yes	Yes		
Anabat 7	SN507250 2024-12-18	18/12/2024	Express	SN507250	8	V5507J				-33.09944	150.01776	15	Yes	Yes		
Anabat FS12	16/12/2024	16/12/2024	Anabat Express FS	761653	ZC	Sonic v3.0.9.24137	15	250	16	-33.09700382	150.0343132	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS12	17/12/2024	17/12/2024	Anabat Express FS	761653		Sonic v3.0.9.24137	15	250	16	-33.09720677	150.0344335	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS12	18/12/2024	18/12/2024	Anabat Express FS	761653		Sonic v3.0.9.24137	15	250	16	-33.09710375	150.0344241	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS13	recordings	16/12/2024	Anabat Express FS	761696		Sonic v3.0.9.24137	15	250	16	-33.10884392	150.0235	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS13	recordings	17/12/2024	Anabat Express FS	761696		Sonic v3.0.9.24137	15	250	16	-33.10898984	150.0235402	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS13	recordings	18/12/2024	Anabat Express FS	761696		Sonic v3.0.9.24137	15	250	16	-33.1088	150.02328	15	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded

Folder	Log file name	Night	Model	Serial	Sample Rate / Div Ratio	Firmware Version	Trigger min freq (kHz)	Trigger max freq (kHz)	Zc Sensitivity	Average of Latitude	Average of Longitude	Max of File Duration (s)	Set to Record?	Entire Night?	Errors?	Comments
Anabat FS14	16/12/2024	16/12/2024	Anabat Express FS	761673		Sonic v3.0.9.24137	15	250	16	-33.09924635	150.0178172	10	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS14	17/12/2024	17/12/2024	Anabat Express FS	761673		Sonic v3.0.9.24137	15	250	16	-33.09981	150.01768	10	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS14	18/12/2024	18/12/2024	Anabat Express FS	761673		Sonic v3.0.9.24137	15	250	16	-33.09926	150.01759	10	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS8	recordings	16/12/2024	Anabat Express FS	761681		Sonic v3.0.9.24137	16	240	16	-33.10825	150.03798	12	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS8	recordings	17/12/2024	Anabat Express FS	761681		Sonic v3.0.9.24137	16	240	16	-33.10871	150.03857	12	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded
Anabat FS8	recordings	18/12/2024	Anabat Express FS	761681		Sonic v3.0.9.24137	16	240	16	-33.10818874	150.0383684	12	Yes	Yes	Min trigger high	The minimum trigger frequency is set higher than Austronomus australis calling frequency. It should be set at 8-10 kHz. Some lower frequency calls may have not been recorded

Appendix 5: Review of Monitored Subsidence and Impacts 2024 Annual Report

Centennial Coal: **Airly Mine**

2024 Annual Review of Monitored Subsidence and Impacts

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
A	initial issue	DK		25-Jan-25
B	Updated version	DK	CEM	25-Mar-25

Report produced: For submission to the Department of Planning, Housing and Infrastructure

Background reports available at *www.minesubsidence.com*[1]:

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

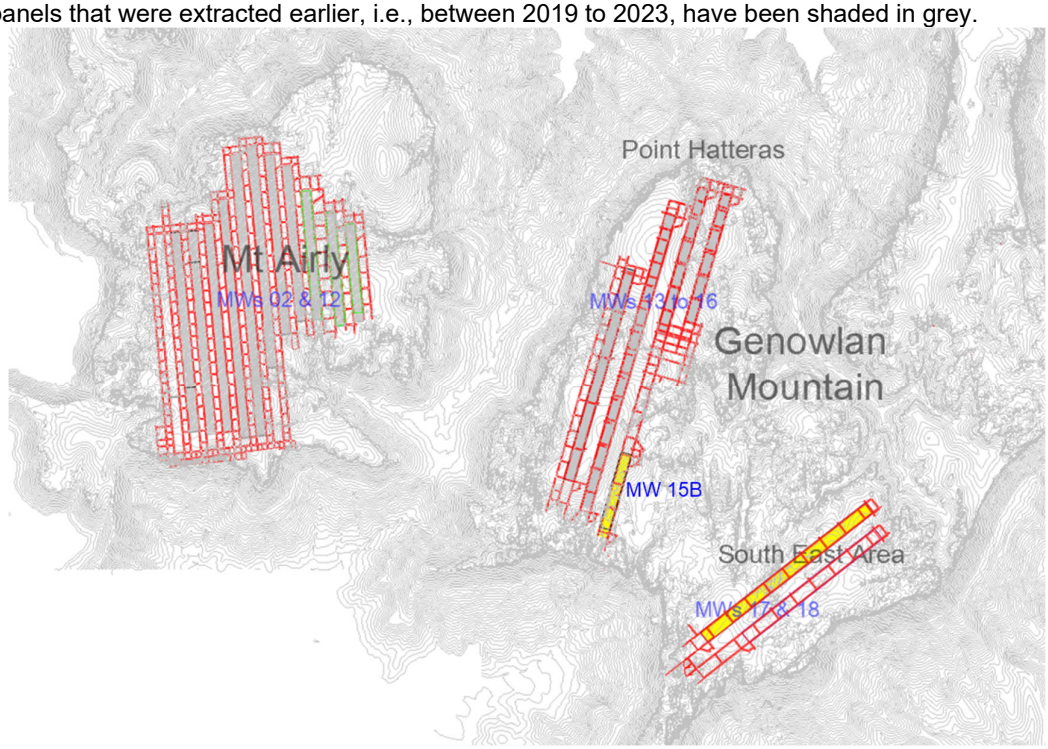
[1] Direct link: http://www.minesubsidence.com/index_files/page0004.htm

Airly Mine (Airly) is an existing underground coal mine that is located 5 kilometres (km) north-east of the village of Capertee, 40 km north-northwest of Lithgow and 171 km north-west of Sydney. Centennial Airly Pty Limited (CA) is the operator of Airly and CA is a wholly owned subsidiary of Centennial Coal Company Limited.

Airly was approved subject to various development consent conditions, including a requirement for an annual review report of the environmental performance to the satisfaction of the Secretary of the Department of Planning and Environment. These conditions suggest that the annual review should include a comprehensive review of:

- the subsidence monitoring results over the previous calendar year.
- a comparison of these results against the relevant statutory requirements, limits or performance measures/criteria;
- a discussion of these results against previous years and the relevant predictions in the EIS, including the identification of any non-compliance over the last year;
- an identification of any trends in the monitoring data over the life of the development;
- an identification of any discrepancies between the predicted and actual impacts of the development, with an analysis of the potential cause of any significant discrepancies; and
- a description of what measures are proposed to be implemented over the next year to improve the environmental performance of the development.

This 2024 Annual Subsidence Review Report provides the required subsidence monitoring and impact reviews for the calendar year 2024, when Mini Wall 15B (MW15B) and MW17 were extracted, as highlighted in **yellow** below. The MW panels that were extracted earlier, i.e., between 2019 to 2023, have been shaded in grey.



CA commenced extracting mini walls under the Mount Airly mesa in June 2019. MW02 to MW04 were extracted in 2019. MW05 to MW07 were extracted during 2020. MW08 to MW12 were extracted in 2021.

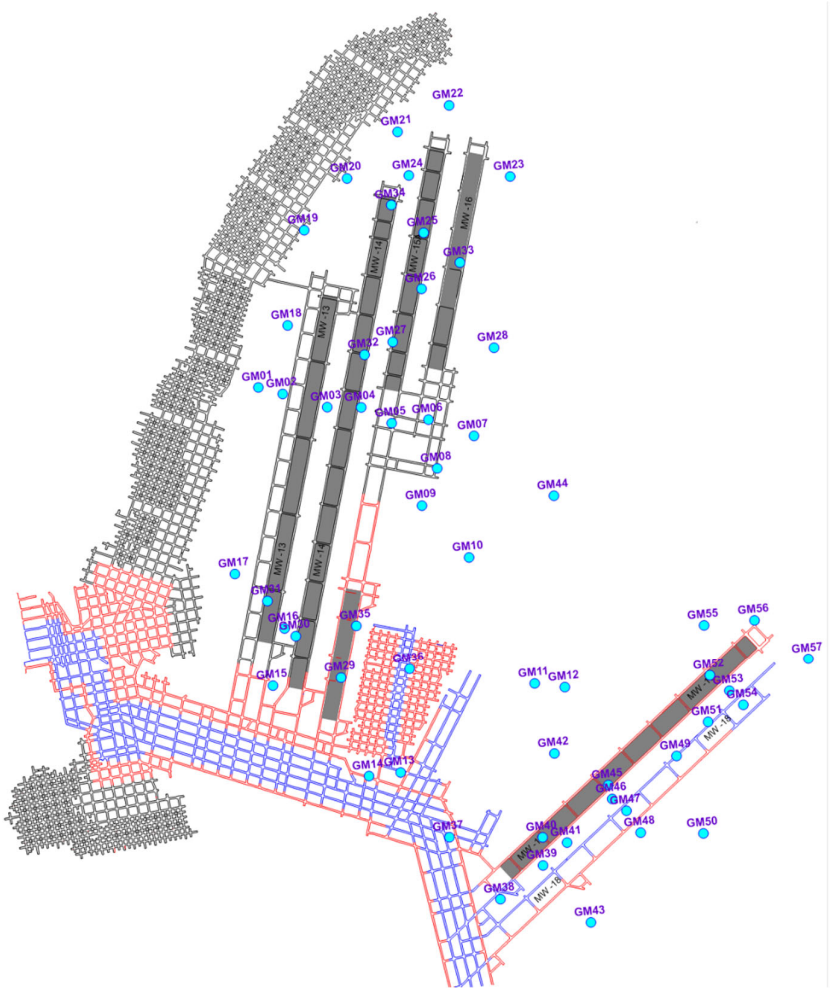
The subsidence monitoring over Mount Airly was undertaken by surveying the exact position of about 250 pegs that were installed about 15 metres apart along 4 survey lines. These surveys were undertaken three times for each of the eleven mini walls from an array of continuously operated Global Navigation Satellite System (GNSS) survey base stations that were positioned around the edges of the Mount Airly mesa.

The monitoring of the GNSS base stations over Mount Airly has continued on a daily basis during 2024 and ongoing residual subsidence monitoring over Mount Airly has also been undertaken in July and December 2024, even though the results of the subsidence surveys in 2023 indicated that residual subsidence levels had reduced to negligible levels. The new residual subsidence monitoring in 2024 also confirms that, since Jan 2023, only negligible residual movements of less than 20 mm have been monitored over Mount Airly.

CA commenced extracting mini wall panels under the Genowlan Mountain mesa in Feb 2022, with MW13 and MW14 being extracted during 2022. CA extracted MW15A and most of MW16 in 2023. Extraction in MW16 was completed in Jan 2024 and MW15B and MW17 were extracted in 2024.

The subsidence monitoring over Genowlan Mountain has been undertaken remotely on a daily basis using continuously operated Global Navigation Satellite System (GNSS) survey stations. Over the Point Hatteras area of Genowlan Mountain (MWs 13 to 16) this monitoring was undertaken using 34 GNSS units. Over the South East area of Genowlan Mountain (MWs 17 & 18) this monitoring was undertaken using 22 GNSS units.

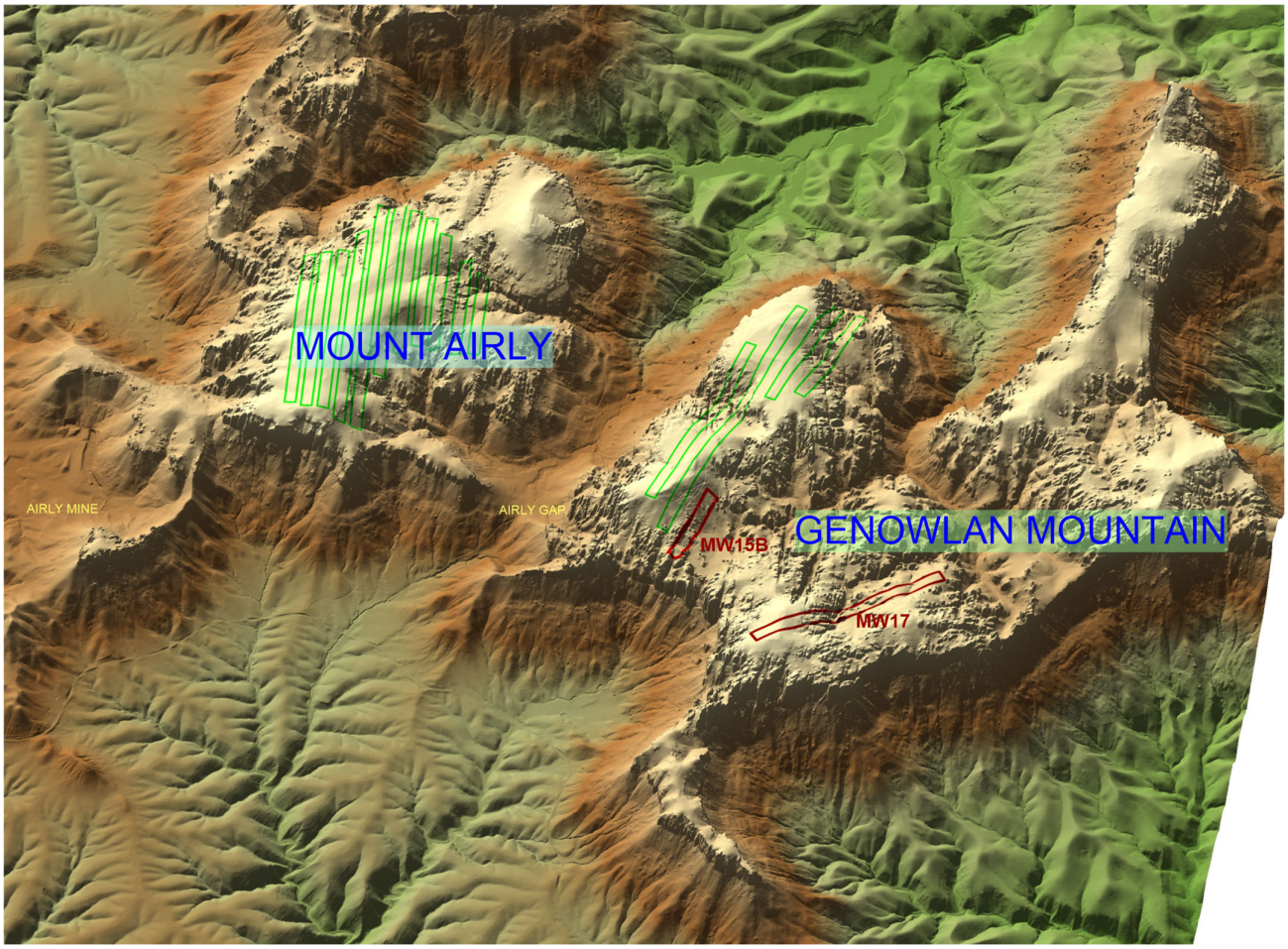
The location of these GNSS units in relation to the extracted panels under the Genowlan Mountain is shown in this sketch.



The extracted panels have been shaded in **grey**. Access into these mined panels and **grey** coloured headings has been removed.

The **blue** coloured headings carry the fresh air into the mine and the **red** coloured headings carry the return air out of the mine.

The extracted MW panels under Mount Airly and Genowlan Mountain are also shown in the sketch below, where the MWs extracted between 2019 to 2023 are coloured in light **green** and the panels extracted in 2024 are coloured **red**, i.e., MW15B and MW17.



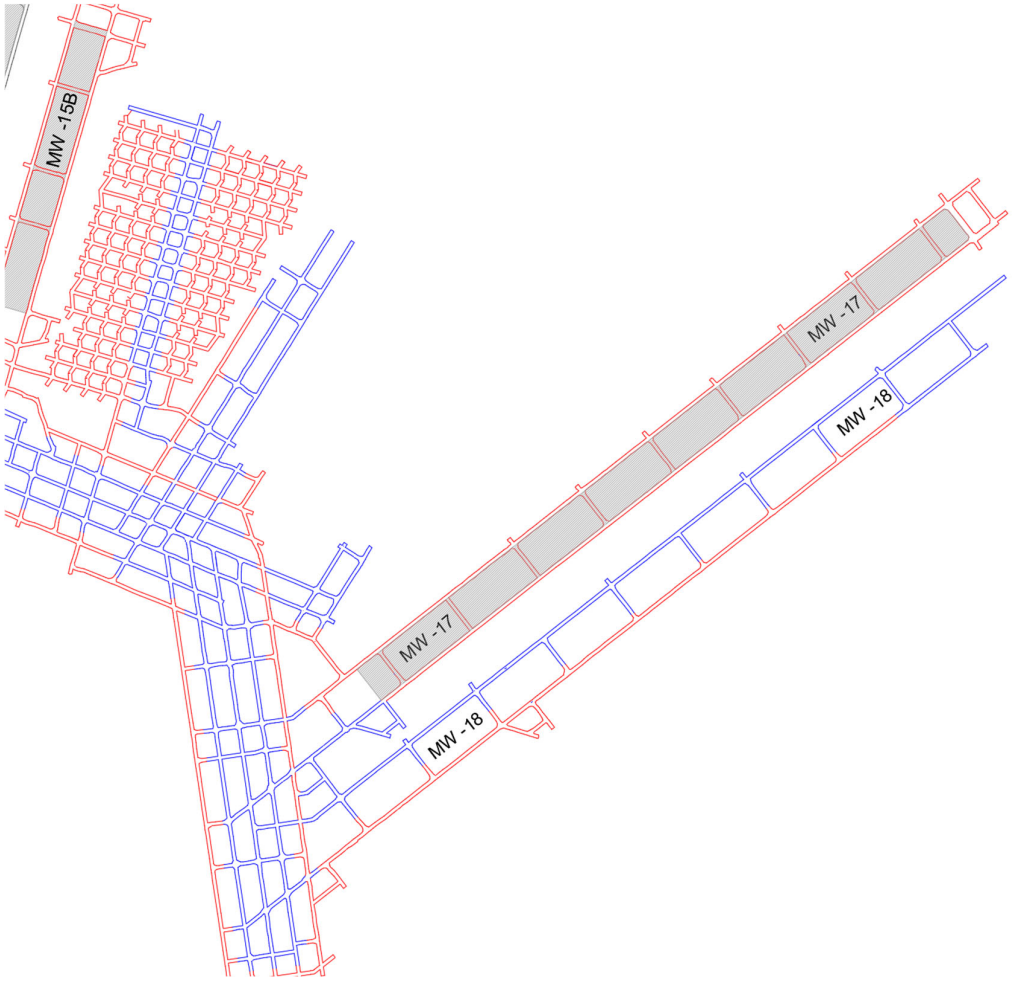
The maximum subsidence that was observed over Mount Airly just after the extraction of MW12, i.e. in Dec-21 was 713 mm at peg B28 that is located over MW05. This location was not only where the greatest depth of cover (DoC) occurred, but it also coincided with where some pillars had several large faults cutting through them with throws of up 0.7m. The maximum observed subsidence measured over Mount Airly in Dec-24, i.e. 36 months after extracting MW12, was 749 mm also at peg B28, an increase of 36 mm or 5% at this location since extraction in MW12 stopped.

The cause of this much higher than expected level of subsidence over Mount Airly was investigated just after MW07 was extracted by Strata Control Technology (SCT) using a FLAC model, (Heritage Y et al 2022) in 2021. SCT advised that the mechanism contributing to most of the extra subsidence was shearing and fracturing of the softer strata layers that lie 10 m to 35 m above the coal pillars, i.e., it was not a weakness of the pillar but the strata layers immediately above the pillar.

Despite the increased subsidence levels that were experienced over MWs 02 to 10 on Mount Airly and, despite some surface cracking occurring around these panels, only one very small rock fall with a volume of less than 2 m^3 was observed. This small rock fall occurred in 2022, and no mining-induced cliff falls were observed over or around the Mount Airly mine workings even though the maximum measured subsidence was 749 mm.

Extraction over the Point Hatteras areas of the Genowlan Mountain mesa commenced in MW13 in 2022 and CA had extracted MW 14 by the end of 2022. CA had extracted MW 15A and almost all of MW16 during 2023. The remainder of MW16 and all of MW15B was extracted in 2024.

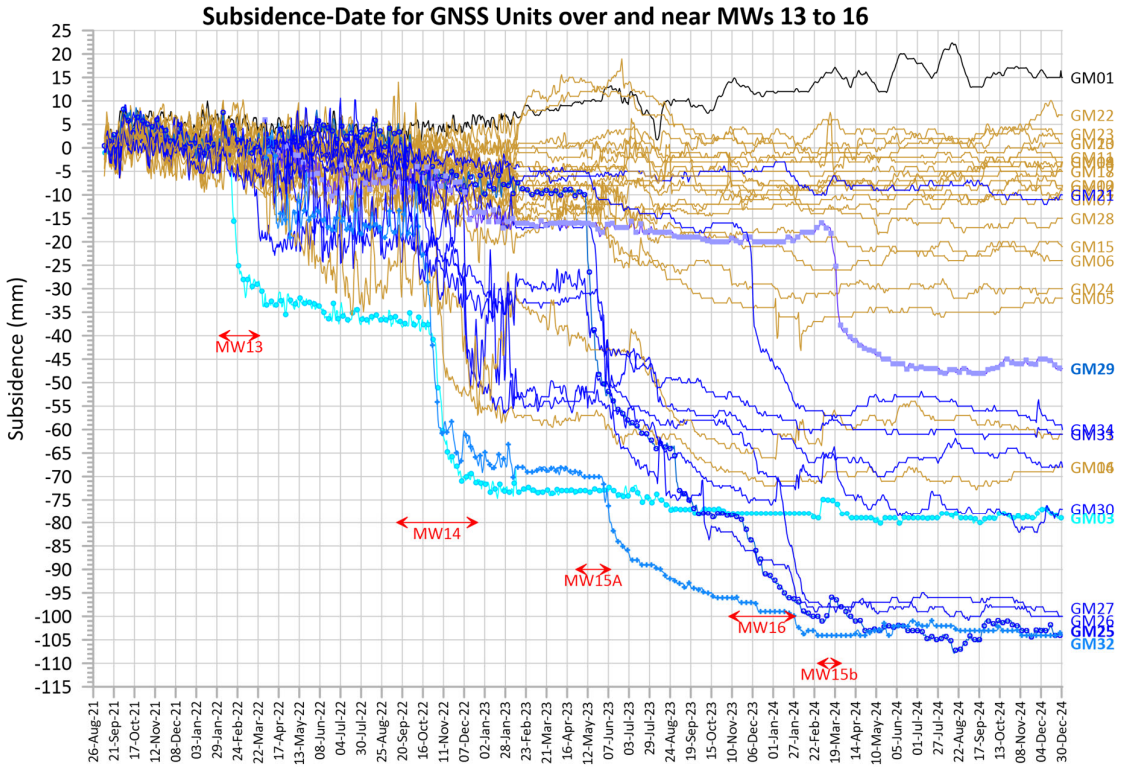
The sketch below shows the extraction completed in the south eastern area of Genowlan Mountain at the end of 2024, i.e., CA completed the extraction of MW17 in Nov-24 and almost completed the extraction of the headings for MW18 in Dec-24. CA planned to complete the development of headings for MW18 in early 2025 and then commence the extraction of MW18 later in early 2025.



The plot below shows the monitored subsidence up to the end of 2024 from the initial 34 GNSS units (GM01 to GM34) that were located over and near MWs13 to 16, i.e. in the Point Hatteras area of Genowlan Mountain, plotted against time. This plot confirms that low levels of subsidence were measured at these GNSS units over MWs 13 to 16.

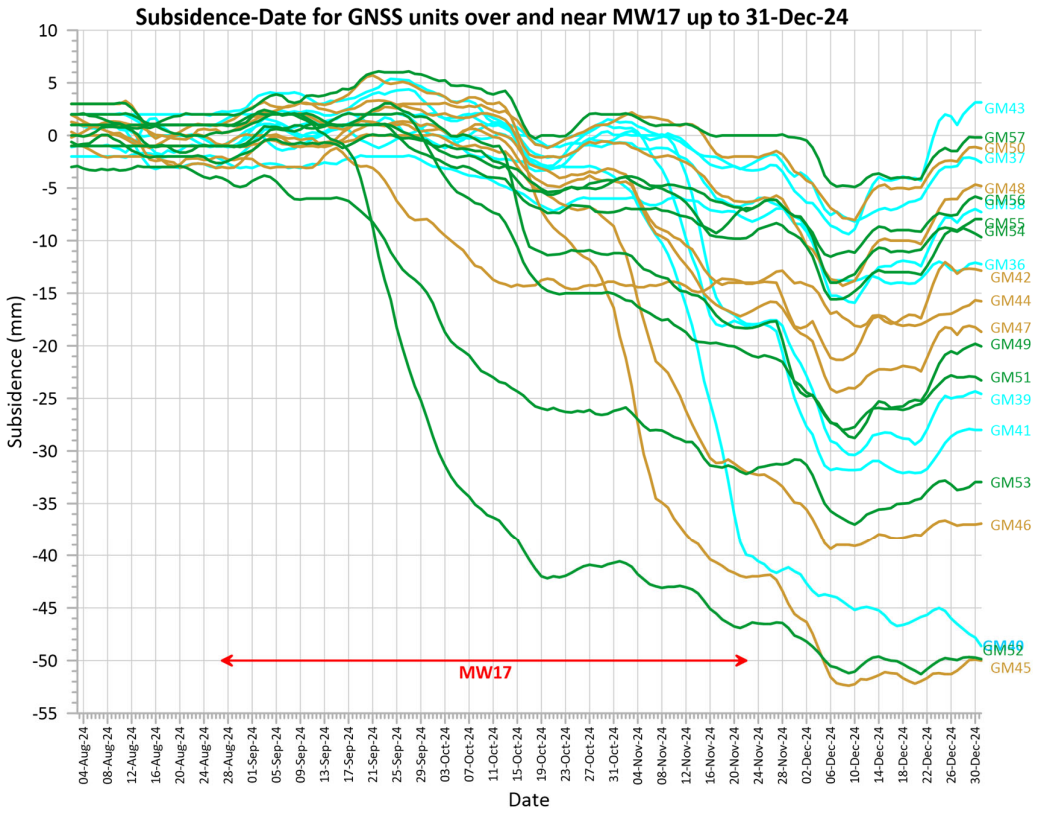
This plot shows the measured subsidence over MWs 13 to 16 has not changed much since Jul-2024, i.e., after the last panel, i.e. MW15B, was extracted in Mar-2024.

The maximum subsidence up to the end of 2024 was 108 mm at peg GM25 in Aug-24, but, at the end of 2024 the maximum measured subsidence was 104 mm at both GNSS units, GM32 and GM25, that were centrally located over MWs13 to 16. Note the reported measurement tolerance of the units is ± 5 mm.



This plot also shows that the newer GNSS units (GM35 to GM57) that were installed in Feb-23 have a better accuracy and show far less scatter than the earlier GNSS units. The reading variations from many of these newer units can be accounted for due to changes in climatic conditions, i.e. weather and ground moisture.

The plot below shows the monitored subsidence from the 22 GNSS units over and near MWs17 plotted against time up to the end of 2024. The maximum observed subsidence up to 31-Dec-24 was 52 mm at GNSS unit GM45, and, at the end of 2024, the maximum measured subsidence had slightly reduced to 50 mm at both peg GM32 and GM45. Note the reported measurement tolerance of the units is ± 5 mm, although as can be seen in the small scatter above, it is better than that.



It can be noted, from the above plots, that, soon after the MW face passed each GNSS unit, mining-induced subsidence was experienced depending on the proximity of each unit to the extracted panel and many other factors, such as the depth of cover, seam thickness and surface topography. Initially each unit experienced rapidly increasing subsidence for about one month and then slower rates of residual subsidence for a further period of about another month.

Additionally, some GNSS units also experienced small variations in observed subsidence due to the changing stresses over and around the panels as other headings were driven near each unit. Plus, on top of the mining induced changes, these GNSS units also experienced additional changes in subsidence level, of ± 4mm due to the changing weather conditions such as from the higher-than-average levels of rain fall that occurred at the end of 2024. But these subsidence numbers are all very small, and it should be remembered that the survey accuracy of these GNSS units is only ± 5 mms.

These observed subsidence results over MWs 13 to 16 and MW17 on Genowlan Mountain supports or confirms that SCT's FLAC model successfully analyses the complex strata relationships between strata properties, panel and pillar sizes, depths of cover, seam thicknesses and number of mined panels reasonably well and indicates that SCT has designed the revised pillar and panel widths appropriately.

The wider chain pillars between MWs 10 to 12 and MWs 13 to 17 have now been shown to limit subsidence to very low to negligible subsidence levels that are less than the EIS predicted low levels of subsidence, and, hence, no future surface cracking, rock falls, or cliffs falls are expected over the proposed new extraction panels with these wider chain pillars. That is, with these very wide chain pillars and very low levels of subsidence, there should be little chance of exceedance of the development approval conditions for cliffs.

However, it is important to also note, as mentioned in both the 2014 EIS and the IRP report (2016), that cliff formations near Airly often experience natural rock falls due to ongoing natural weathering and erosion processes, i.e. rock falls and cliff falls are commonly observed in locations that are remote from mining activity, typically after heavy rainfall events.

The IRP report (2016) advised that, whilst the proposed methods of extraction had the potential to avoid significant impacts on the cliffs, steep slopes and pagodas and the protection zones proposed in the EIS were considered appropriate to provide the required level of protection to cliff formations, this report stated; "*It should be recognised that cliff formations do experience rock falls naturally at a surprisingly relatively rapid rate which is why the cliffs exist in the landform, so, full protection is not possible.*"

Hence, in conclusion the subsidence monitoring in 2024 has confirmed that the current mine design has successfully limited subsidence, in areas with the wider chain pillars, to the very low subsidence levels which are lower than were suggested in the 2014 EIS and considered satisfactory in the IRP report (2016).

Because of these very low levels of subsidence being predicted and observed at the Mount Airly and Genowlan Mountain internal and external cliffs and rock features, there should be little chance of exceedance of the development approval conditions for cliffs.

CONTENTS

1.0 INTRODUCTION AND BACKGROUND TO AIRLY PRIOR TO 2024 **10**
1.1. Background 10
1.1.1. Topography and Environmental Context 10
1.1.2. Independent Expert Review Panel and Assessment 10
1.1.3. Development Consent Approval for Continued Operations 10
1.1.4. Independent Expert Panel (IEP) and Ongoing Oversight 11
1.1.5. Extraction Plans 11
1.2. Purpose of this Report 11
1.3. Subsidence Impact Performance Measures – Summary of Compliance 12
2.0 SUBSIDENCE MONITORING RESULTS OVER MWS 02 TO 12 AND MOUNT AIRLY **15**
2.1. Early Airly subsidence monitoring results over Mount Airly 15
2.2. Chain pillar widening after MW10 for MWs 11 & 12 17
2.3. Airly subsidence monitoring results over Mount Airly and MWs 11 & 12 17
2.4. Review of ongoing subsidence monitoring over Mount Airly 20
3.0 SUBSIDENCE MONITORING RESULTS OVER MWs 13 to 16 - POINT HATTERAS **23**
3.1. Predictions over MWs13 to 16 at Point Hatteras & Genowlan Mountain 23
3.2. Monitoring results over MWs13 to 16 under Point Hatteras & Genowlan Mountain 25
3.2.1. Adjustment to monitoring results over MWs13 to 16 for late installed pegs 26
3.3. Subsidence vs Time plots from GNSS units over MWs13 to 16 27
3.4. Subsidence Cross Section plots over MWs13 to 16 29
3.4.1. Monitoring Line 1 plots over MWs13 to 14 29
3.4.2. Monitoring Line 2 plots over MWs13 to 16 31
3.4.3. Monitoring Line 3 plots over MWs13 to 15 32
3.4.4. Monitoring Line 4 plots over MWs14 to 16 33
3.5. Comparisons of Measured vs Predicted Subsidence after MW13 to MW16 34
3.6. Observed Subsidence Contours over MWs 13 to 16 36
3.7. Observed Horizontal Movement Vectors after MW16 40
3.8. *Conclusions from the vertical subsidence monitoring data* 44
3.9. *Observed Horizontal Movement Vectors after MW15B* 44
3.10. Subsidence Monitoring Conclusions 44
4.0 SUBSIDENCE MONITORING RESULTS OVER MW17 **45**
4.1. Initial Subsidence Predictions over MW17 45
4.2. Subsidence Measurements over MW17 45
4.3. Updated Subsidence Predictions over MW17 45
4.4. Why wasn't the highest subsidence measured at GNSS Unit 40 where the DoC is greatest? 48
4.5. Maximum Subsidence Comparison between Predictions against Measured 49
4.6. Subsidence Summary after MWs 13 to 17 51
5.0 SUBSIDENCE MONITORING RESULTS OVER HB1 FIRST WORKINGS AREA **52**
5.1. Location of HB1 52
5.2. HB1 Subsidence Monitoring and Impacts 53
6.0 OBSERVED SUBSIDENCE IMPACTS & COMPARISONS WITH PREDICTED IMPACTS **54**
6.1. Predicted impacts 54
6.2. Observed subsidence impacts and environmental consequences up to 2024 54
6.3. Conclusion and Likelihood of future cliff impacts 58
APPENDIX A. GLOSSARY OF TERMS, ABBREVIATIONS AND DEFINITIONS **59**
APPENDIX B. REFERENCES **63**

Figure numbers are prefixed by the number of the chapter or the letter of the appendix in which they are presented.

Figure No.	*Description*	*Page*
Fig. 2.1	Mount Airly location of mini wall panels, subsidence monitoring lines and pegs, monitoring survey dates, and dates of commencing and finishing of panels (MSEC)	15
Fig. 2.2	3D image of surface levels over Mount Airly, the location of MWs02 to 12, subsidence monitoring lines and pegs, monitoring survey dates, and dates of commencing and finishing the mini wall panels (MSEC)	16
Fig. 2.3	Observed total subsidence profile after MW10 and predicted profiles after MWs 11 & 12 (SCT, 2021)	17
Fig. 2.4	Location & horizontal movement of the eleven GNSS base station units over Mount Airly (Aeromatix)	18
Fig. 2.5	Observed total subsidence, tilt and strain profiles up to Dec-24 over MWs 02 to 12 (MSEC)	19
Fig. 2.6	Ongoing subsidence being recorded at the eleven GNSS base located over Mount Airly	21
Fig. 2.7	Observed total subsidence contours just after MWs 02 to 12 - Dec 21 (MSEC)	22
Fig. 3.1	Surveyed and modelled vertical subsidence comparison (SCT, 2021)	23
Fig. 3.2	The FLAC modelling results of 61 m wide mini wall panels at 300 m DoC with 70m wide chain pillars and 2.8 m extraction height (SCT, 2021)	23
Fig. 3.3	Airly - Point Hatteras Panel and Pillar Mining Zone (Attachment A of Extraction Plan Approval)	24
Fig. 3.4	Location of GNSS subsidence monitoring stations over MWs 13 to 16 with locations of Monitoring Line 1 to Monitoring Line 4 plotted against a surface terrain model of Genowlan Mountain (MSEC)	25
Fig. 3.5	Location of all 34 GNSS subsidence monitoring stations over MWs 13 to 16 with locations of the monitoring lines and highlighted eight new GNSS stations (MSEC)	26
Fig. 3.6	Raw measured subsidence from all the GNSS units over MWs13 to 16	27
Fig. 3.7	Sav-G Smoothed Measured subsidence from all the GNSS units over MWs13 to 16	27
Fig. 3.8	Measured Horizontal Movements from all the GNSS units over MWs13 to 16	28
Fig. 3.9	Observed Subsidence along Monitoring Line 1 (MSEC)	30
Fig. 3.10	Observed Subsidence along Monitoring Line 2 (MSEC)	31
Fig. 3.11	Observed Subsidence along Monitoring Line 3 (MSEC)	32
Fig. 3.12	Observed Subsidence along Monitoring Line 4 (MSEC)	33
Fig. 3.13	Review of Predicted vs Observed Subsidence from all GNSS units after MW13	34
Fig. 3.14	Review of Predicted vs Observed Subsidence from all GNSS units after MW14	34
Fig. 3.15	Review of Predicted vs Observed Subsidence from all GNSS units after MW15A	35
Fig. 3.16	Review of Predicted vs Observed Subsidence from all GNSS units after MW16 and MW15B	35
Fig. 3.17	Observed Subsidence Contours from all GNSS units after MW14	36
Fig. 3.18	Observed Subsidence Contours from all GNSS units after MW15A	37
Fig. 3.19	Observed Subsidence Contours from all GNSS units after most of MW16	38
Fig. 3.20	Observed Subsidence Contours from all GNSS units after MW15B	39
Fig. 3.21	Observed Horizontal Movements of GNSS units after the extraction of MWs 13 to 15A (MSEC)	41
Fig. 3.22	Observed Horizontal Movements of GNSS units after the extraction of MWs 13 to 16 (MSEC)	42
Fig. 3.23	Observed Horizontal Movements of GNSS units after the extraction of MWs 13 to 15B (MSEC)	43
Fig. 4.1	Locations of GNSS units over MW17 and Observed Horizontal Movements of GNSS units after the extraction of MWs 17 (Aeromatix)	45
Fig. 4.2	Observed subsidence from GNSS units over and near MW17 (MSEC)	46
Fig. 4.3	Updated SCT subsidence predictions over MWs 17 & 18 (SCT)	46
Fig. 4.4	Variation in DoC along MW17	47
Fig. 4.5	Locations of GNSS units over MW17 and location of monitoring lines over MWs 17 (MSEC)	47
Fig. 4.6	Classic SubsidenceOn Seam vs Panel Width on Depth Plot from Holla)	48
Fig. 4.7	Classic Subsidence on Seam vs Panel Width on Depth Plot from Holla (Airly EIS 2014, plus Airly MW02, MW13 and MW17 results added by MSEC)	48
Fig. 4.8	Observed subsidence from GNSS units over and near MW17 (SCT & MSEC)	49
Fig. 4.9	Observed subsidence from GNSS units over and near MW17 compared to initial SCT predictions (SCT & MSEC	50
Fig. 5.1	Location of initial surface crack, i.e., 120 m west of MW02, during MW06 (CA Jul 2020)	54
Fig. 5.2	Locations of surface cracks and small rock fall near Fracture 02 and MW02 (CA, Jan 2023)	55
Fig. 5.3	Location of Fracture 02 and small rock fall, i.e. near the North-West corner of MW02 (Douglas Partners, Jul 2022)	56
Fig. 5.4	Monitored horizontal ground movements (mm) near the small rock fall and Fracture 02	57
Fig. 5.5	Monitored horizontal ground movements (mm) at GNSS Site 03 near the small rock fall	57

1.1. Background

Airly Mine (Airly) is an existing underground coal mine that is located 5 kilometres (km) north-east of the village of Capertee, 40 km north-northwest of Lithgow and 171 km north-west of Sydney. Centennial Airly Pty Limited (CA) is the operator of Airly and CA is a wholly owned subsidiary of Centennial Coal Company Limited.

1.1.1. Topography and Environmental Context

The surface areas over Airly are characterised by a steep and rugged topography with large areas of cliffs, minor cliff lines and escarpments that are clearly visible for tens of kilometres in all directions. The topography over the Airly mine lease area is dominated by Mount Airly and Genowlan Mountain which are two large mesas that sit broadly within the landscape of the Capertee Valley, which extends for over 30 km from north to south and east to west. This valley is surrounded by large sandstone cliffs and steep talus slopes similar to those found on Mount Airly and Genowlan Mountain. The surface topography on top of these two mesas varies from gently undulating plateau areas to steep sided valleys, major cliff lines, pagodas and gorges.

Most of the surface areas over Airly are located within the Mugii Murrum-ban State Conservation Area (MMSCA) that has been recognised to have significant natural and cultural heritage values and significant mineral resources. The MMSCA was gazetted in 2011 to protect environmental and cultural heritage values while permitting mining.

As detailed in the 2014 Airly Mine Extension Project EIS, CA developed a conservative approach to mining throughout the lease by employing different mining methods for different areas, referred to as 'mining zones', and each method was targeted to suit each specific area. This EIS report was predominantly based on the premise that low levels of subsidence within each of the mining zones would avoid surface cracking and minimise risks of impacts to cliff lines, pagodas, and other natural features, as Centennial had successfully been undertaking for twenty years at its Clarence Mine.

A key objective of this conservative approach was to minimise the risk of surface impacts through appropriate mine design to reduce subsidence. Sensitive high cliffs and escarpments located on the external parts of the Mount Airly and Genowlan Mountain mesas were to be protected by a Cliff Line Zone (CLZ) of only First Workings (i.e., no secondary extraction). The Panel and Pillar Mining Zones (PPMZs), located in the centres of the mesas, were designed with mini wall extraction of narrow panels (width around one quarter of conventional longwalls) and large chain pillars that were designed in order to limit subsidence.

This 2014 EIS report, which was prepared by Golder Associates, predicted the maximum subsidence over the PPMZ areas of the mine, after the extraction of 61 m wide mini wall panel widths and 29.5 m chain pillars, would be less than 125 mm, tilts would be less than 2.5 mm/m and strains would be less than 2 mm/m. It was assessed that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected.

1.1.2. Independent Expert Review Panel and Assessment

The Planning and Assessment Commission proposed in 2015 that a panel of suitably qualified experts should be set up to review subsidence advice and comment on the adequacy of the proposed designs and monitoring plans. In September 2016, the former Department of Planning and Environment, (now Department of Planning, Housing and Infrastructure (DPHI)), commissioned an Independent Review Panel (IRP) to review and report on the accuracy and reliability of mine subsidence impacts presented in the EIS. The IRP comprised Dr Ken Mills (Strata Control Technology, SCT), Professor Ismet Canbulat (University of NSW, UNSW) and Don Kay (Mine Subsidence Engineering Consultants, MSEC). The IRP report, titled "*Report of the Independent Review Panel established to review and report on the accuracy and reliability of mine subsidence impacts on sensitive features across the Airly Mine Extension Project Application Area*", dated July 2016, advised that the various proposed partial mining systems were considered conservative by comparisons with industry standards and could be expected to maintain surface subsidence movements at low levels.

The 2014 EIS and this IRP report (2016) both noted that cliff formations often experience rock falls due to natural weathering and erosion and hence providing full protection, even with an ultra-conservative mine design was not possible as natural cliff falls are regularly seen. This IRP report (2016) also advised that, whilst the protection zones proposed were considered appropriate to provide the required level of protection to cliff formations and the proposed methods of extraction had the potential to avoid significant impacts on the cliffs, steep slopes and pagodas, high confidence subsidence monitoring over the initial panel and pillar mining areas should be undertaken to confirm that the levels of ground movement monitored over the early mini walls were as low as those being predicted.

1.1.3. Development Consent Approval for Continued Operations

In December 2016, Airly was granted development consent approval, SSD_5581, to extend its operations for another 20 years and this approval included the extraction of mini walls within a panel and pillar zone beneath the central areas of the Mount Airly and Genowlan Mountain mesas under various small cliffs and pagodas and near

the massive external cliff lines. This 2016 Development Consent also provided the following definitions for rock formations and set the following performance measures for the following rock formation categories.

Cliffs within a 26.5 degree angle of draw of the Airly underground mine workings	No greater subsidence impacts or environmental consequences than predicted in the EIS *(ie occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 m^3, or fracturing, that do not impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such cliffs
Pagodas within a 26.5 degree angle of draw of the Airly underground mine workings (other than pagodas affected by the New Hartley interaction zone)	No greater subsidence impacts or environmental consequences than predicted in the EIS *(ie occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 m^3, or fracturing, that do not impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such pagodas
Pagodas within a 26.5 degree angle of draw of the New Hartley interaction zone	No greater subsidence impacts or environmental consequences than predicted in the EIS
Minor cliffs	No greater subsidence impacts or environmental consequences than predicted in the EIS
Steep slopes	No greater subsidence impacts or environmental consequences than predicted in the EIS

1.1.4. Independent Expert Panel (IEP) and Ongoing Oversight

Because of the various unknowns associated with the unique Airly mine design, the approval Conditions of Consent required the setting up of a further Independent Expert Panel (IEP) to provide ongoing advice to Airly and DPHI on the preparation of Extraction Plans and their implementation in order to meet the performance measures, particularly those relating to cliffs and pagoda formations, to the satisfaction of the DPHI.

This IEP was set up in 2017 and it comprises Dr Ken Mills (Strata Control Technology, SCT) and Professor Ismet Canbulat (University of NSW, UNSW).

1.1.5. Extraction Plans

In accordance with Schedule 3, Condition 7 of SSD_5581 an Extraction Plan is prepared prior to carrying out any first workings within the Cliff Line Zone and the Zone of First Workings or second workings.

CA operates in accordance with several approved Extraction Plans, including:

- MOD 3 (as Varied)
- Cliff Line Zone of First Workings (ML1331)
- Splitting & Quartering (ML1331)
- Mt Airly Panel & Pillar Mining Zone (MW02-12)
- Pt Hatteras Panel & Pillar Mining Zone (MW13-16)
- MW17-18 Panel & Pillar Mining Zone
- Cliff Line Zone of First Workings (ML1814)

Extraction Plans are developed in consultation with the IEP and other relevant stakeholders and describe in detail the performance indicators and measures that would be implemented to ensure compliance with the approval Conditions of Consent.

1.2. Purpose of this Report

Airly was approved subject to a development consent condition requiring an Annual Review Report of the environmental performance to the satisfaction of the Secretary of the DPHI. These conditions suggest that the Annual Review should include a comprehensive review of:

- the subsidence monitoring results over the previous calendar year;
- a comparison of these results against the relevant statutory requirements, limits or performance measures/criteria;
- a discussion of these results against previous years and the relevant predictions in the EIS, including the identification of any non-compliance over the last year;
- an identification of any trends in the monitoring data over the life of the development;
- an identification of any discrepancies between the predicted and actual impacts of the development, with an analysis of the potential cause of any significant discrepancies; and
- a description of what measures are proposed to be implemented over the next year to improve the environmental performance of the development.

This report provides these required subsidence monitoring and impact reviews for the calendar year 2024.

1.3. Subsidence Impact Performance Measures – Summary of Compliance

Table 1.1 provides a summary of compliance during the reporting period with the subsidence impact performance measures as detailed in:

- Schedule 3, Condition 2 (Land and Heritage Sites); and
- Schedule 3, Condition 3 (Built Features) of SSD_5581.

A detailed analysis of the performance is provided in the following sections of this this Annual Review.

Note, monitoring summaries associated with other environmental aspects are presented separately by other relevant specialists, including:

- Water (including performance measures associated with The Grotto);
- Biodiversity; and
- Heritage.

These specialist reports should be read in conjunction with this Annual Review to provide a comprehensive understanding of compliance with subsidence impact performance measures.

Table 1.1 Summary of compliance with subsidence impact performance measures

Aspect / Features	Performance Measure	Performance During 2024
Water Resources		
Gap and Genowlan Creeks	Whenever depth of cover is < 40 m, no first or second workings within 20 m of the edge of the creek bed, measured horizontally in the seam Negligible environmental consequences to water quality and to bed and bank stability No greater environmental consequences than predicted in the EIS to water flows (including baseflow)	**Compliant** No first or second workings occurred within 20 m of Gap and Genowlan Creek beds where depth of cover is < 40 m. Monitoring confirmed negligible environmental consequences to water quality and to bed / bank stability. Observed flows, including baseflow, were consistent with EIS predictions, with no greater environmental consequences detected.
All other watercourses	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to watercourses detected.
Land		
The Grotto	Negligible subsidence impacts or environmental consequence	**Compliant** Monitoring confirmed negligible subsidence impacts or environmental consequences to The Grotto.
Cliffs within a 26.5 degree angle of draw of the Airly underground mine workings	No greater subsidence impacts or environmental consequences than predicted in the EIS (ie occasional rock falls, displacement or dislodgement of boulders or slabs of less then 30 m3, or fracturing, that do not impact Aboriginal heritage, EECs or public safety), that in total do not impact more than 2% of the total area of such cliffs	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to cliffs detected.
Pagodas within a 26.5 degree angle of draw of the Airly underground mine workings (other than pagodas affected by the New Hartley interaction zone)	No greater subsidence impacts or environmental consequences than predicted in the EIS (ie occasional rock falls, displacement or dislodgement of boulders or slabs of less then 30 m3, or fracturing, that do not impact Aboriginal heritage, EECs or public safety), that in total do not impact more than 2% of the total area of such pagodas	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to pagodas detected.

Aspect / Features	Performance Measure	Performance During 2024
Pagodas within a 26.5 degree angle of draw of the New Hartley interaction zone	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** There was no mining within a 26.5 degree angle of draw of the New Hartley interaction zone.
Minor cliffs	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to minor cliffs detected.
Steep slopes	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to steep slopes detected.
All other land not covered by a performance measure above	No greater subsidence impacts or environmental consequences than predicted in the EIS	**Compliant** Monitoring confirmed subsidence impacts were consistent with EIS predictions, with no greater environmental consequences to other land detected.
Biodiversity		
Threatened species, threatened populations, EECs and groundwater dependent ecosystems (with the exception of those listed below)	Negligible environmental consequences	**Compliant** Biodiversity monitoring confirmed negligible environmental consequences.
Pultenaea sp. Genowlan Point population and Genowlan Point Allocasurina nana Heathland community	No environmental consequences	**Compliant** There was no mining within a 26.5 degree angle of draw of the Pultenaea sp. Genowlan Point population and Genowlan Point Allocasurina nana Heathland community. No mining related environmental impacts were detected.
Heritage sites		
Aboriginal heritage sites identified in Appendix 5	Negligible environmental consequences	**Compliant** No heritage sites undermined in 2024. There has been no mining related impact to any recorded Aboriginal Heritage sites at Airly Mine.
Non-Aboriginal heritage sites identified in Appendix 6	Negligible environmental consequences Wherever depth of cover is < 30 m, no second workings to occur within a setback distance defined by half the depth of cover from site 3 and site 24, measured horizontally in the seam	**Compliant** No heritage sites undermined in 2024. There has been no mining related impacts to any recorded Heritage sites at Airly Mine.
Mine Workings		
First workings beneath any feature where performance measures in this table require no or negligible environmental consequences and to all first workings beneath cliffs	To remain long-term stable and non-subsiding	**Compliant** Development (first workings) was undertaken in accordance with approved Extraction Plans. Pillars were formed at least 1/10th depth from surface. Pillars were >2.11 FOS (i.e., long term stable).
Second workings	To be carried out only in accordance with an approved Extraction Plan	**Compliant** Extraction (second workings) occurred in accordance with approved Extraction Plans. Note: The mining dimensions for extraction of MW17 exceeded the design dimensions of the MW17-18 Extraction Plan. However, this does not constitute a non-compliance of the Extraction Plan. ***Refer to the Airly Mine 2024 Annual Review*** for full details.

Aspect / Features	Performance Measure	Performance During 2024
Built Features		
Emergency services communication tower and associated sheds and infrastructure	Always safe and serviceable Damage must be fully repairable, and must be fully repaired	**Compliant** Airly Turret Communication Tower remained safe and serviceable. No damage was detected.
State survey mark at Genowlan Trig Station, Telstra copper cable and Nissen Hut and outbuilding	Always safe and serviceable, unless otherwise agreed with the owner Damage must be fully repairable, and must be fully repaired	**Compliant** State survey mark at Genowlan Trig Station is being affected by subsidence and will be repaired following the completion of subsidence in agreement with the owner. There was no mining within a 26.5 degree angle of draw of the Telstra copper cable. There was no mining related impacts to Telstra's serviceability and no damage was detected or reported. Nissen Hut and outbuilding remained safe and serviceable. No damage was detected.
"Stone Cottage"	No second workings to occur within a setback distance defined by half the depth of cover from the building, measured horizontally in the seam, unless otherwise agreed with the owner Always safe and serviceable, unless otherwise agreed with the owner Damage must be fully repairable, and must be fully repaired, unless otherwise agreed with the owner	**Compliant** There was no mining within a 26.5 degree angle of draw of the "Stone Cottage". No mining related damage was detected.
Other built features and improvements including Airly Camp Ground, walking and 4WD tracks, fences and gates	Use should be maintained wherever practicable in consultation with BCD Damage must be fully repairable and must be fully repaired	**Compliant** No mining related damage to unsealed tracks observed.
Public Safety		
Public safety	Negligible additional risk, in consultation with the Resources Regulator and BCD	**Compliant** Negligible additional public safety risk was reported in 2024.

2.1. Early Airly subsidence monitoring results over Mount Airly

An updated subsidence prediction report was prepared for CA by Strata[2] (March 2019) just before extraction commenced in the PPMZ areas. This report advised that the maximum short-term subsidence over the 2019 Airly Extraction Plan Area was likely to be 60 mm and the long-term maximum subsidence was predicted to be 70 mm. This report also advised that the maximum short-term subsidence over the whole Airly mine was likely to be 70 mm and the long-term maximum subsidence was predicted to be 110 mm. This Strata[2] report confirmed the 2014 EIS advice that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected. This report also advised that:

- the mine design was built on successful experience in other locations, especially Clarence Colliery;
- the mini wall mine design was considered to be unique in a mesa environment; and
- high confidence/accuracy subsidence monitoring would be undertaken over the initial mining areas.

CA commenced extracting mini walls under Mount Airly in June 2019 and completed all the miniwall panel extraction under Mount Airly, i.e., MWs 02 to MW12, during 2021.

Fig. 2.1 and Fig. 2.2 show the Mount Airly mini wall panels and the locations of the subsidence monitoring lines, A, B, C and D.

This plan shows the dates when the various mini walls were extracted (in red at the commencing and finishing ends of each panel, and the location of the mini wall face at the times when the survey lines were monitored (**in blue**).

It can be noticed that the monitored survey dates didn't always coincide with when the face completed extraction within each mini wall and, in these cases, the survey dates chosen for the end of each panel have been highlighted with a **blue** ellipse.

The incremental subsidence per panel has been calculated by subtracting the subsidence at or near the end of the preceding panel from the subsidence measured at or near the end of the current panel.

The incremental subsidence per panel may have been slightly more or less for some panels if all the surveys had been undertaken as each mini wall was completed , but these differences are not significant.

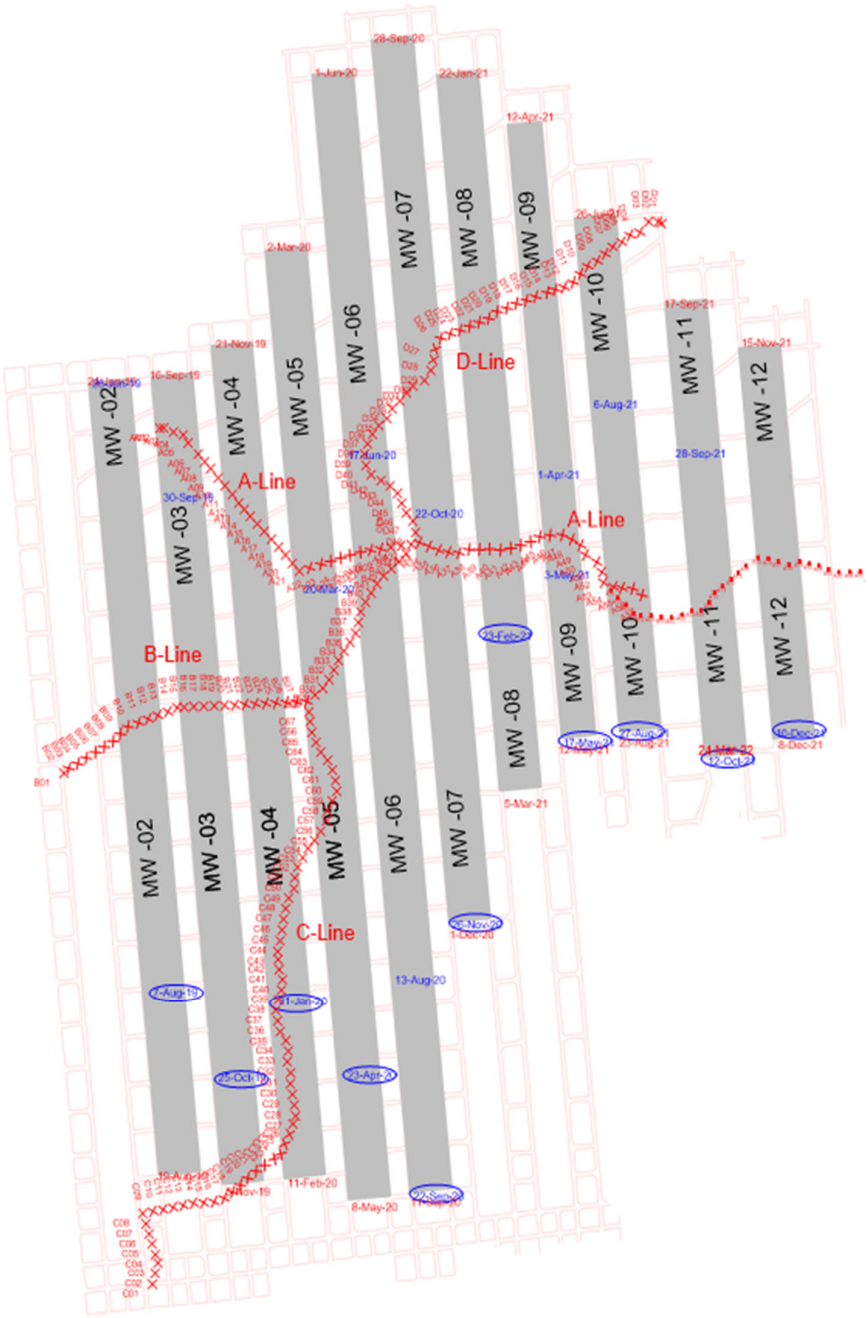


Fig. 2.1 Mount Airly location of mini wall panels, subsidence monitoring lines and pegs, monitoring survey dates, and dates of commencing and finishing of panels (MSEC)

It can be noted from the start and end dates shown in Fig. 2.1, that CA extracted miniwalls MW02 to MW04 during 2019, MWs 05 to MW07 were extracted during 2020 and MWs 08 to MW12 were extracted in 2021.

Fig. 2.2 shows the Mount Airly mini wall panels and the locations of the four subsidence survey lines plotted over a surface RL image. Fig. 2.2 also shows the main monitoring line being used to produce the observed subsidence profiles across Mount Airly, which is called the combined B-A Line.

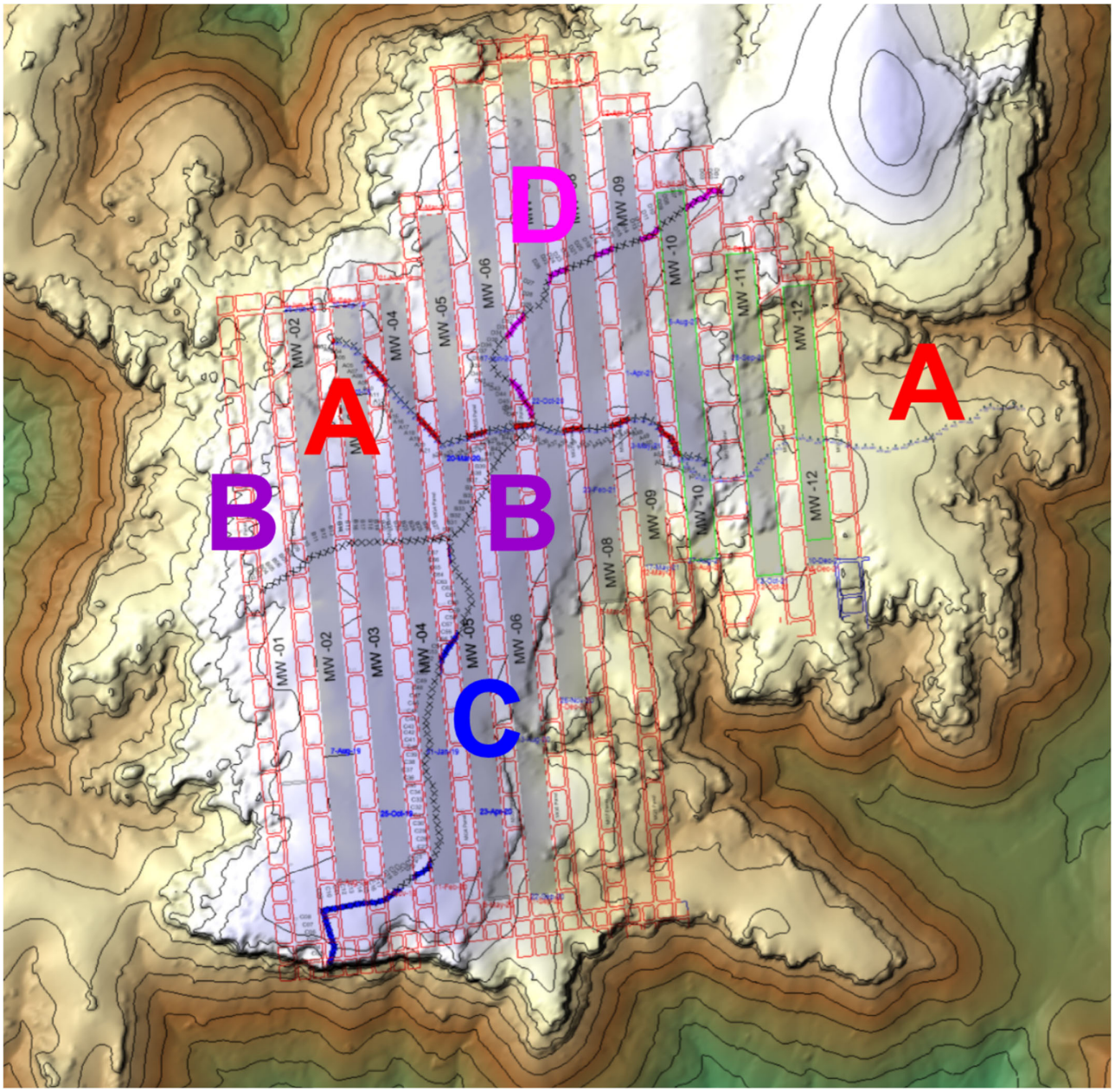


Fig. 2.2 3D image of surface levels over Mount Airly, the location of MWs02 to 12, subsidence monitoring lines and pegs, monitoring survey dates, and dates of commencing and finishing the mini wall panels (MSEC)

However, after extracting most of the first three mini walls on Mount Airly, i.e., MW02, MW03 and most of MW04, CA advised, after reviewing the January 2020 survey, that the measured subsidence of 186 mm had exceeded the maximum subsidence limit of 125 mm. Despite this increased level of subsidence, no surface cracking, rock falls or cliff falls were found over the Mount Airly mesa after the extraction of MW04.

As required by TARP triggers, CA sought advice on why these increased levels of subsidence occurred. A report by Strata[2], (May 2020), titled "*Panel and Pillar Mining Zone: Updated Subsidence Model*", Report No: AIR-015-Rev1, advised that two methods of subsidence estimation had been used for the PPMZ mini walls: an empirical model and a numerical approach (LaMODEL). This report advised that the empirical methods were based on a database of low span (W) to DoC (H) ratio panels in the Western Coalfields and, hence, this report had confirmed that the 2014 Airly mine planning and subsidence predictions had heavily relied on the data measured at the nearby Clarence Mine that operated in the Katoomba Seam, whilst Airly was to work in the Lithgow Seam.

For this report Strata[2] plotted the monitoring results of panels with very low W/H ratios in the Lithgow seam separately to those from the Katoomba seam and this highlighted that significantly higher subsidence occurs over the Lithgow seam. It was then recognised that the near roof strata of the Katoomba Seam was stiffer and more competent than the roof in the Lithgow seam.

When Airly had mostly extracted MW05, in April 2020, the maximum observed subsidence had increased to 297 mm. After MW06 was extracted in September 2020, the maximum observed subsidence had increased to 548 mm and one small surface crack was found on the Mount Airly mesa over MW01 near the edge of MW02. After Airly extracted MW07 in November 2020, the maximum observed subsidence was 612 mm, and, after MW08 was extracted, in February 2021, the maximum observed subsidence was 655 mm. When Airly extracted MW09 in May 2021, the maximum observed subsidence had increased to 670 mm and after Airly extracted MW10 in August 2021, the maximum observed subsidence had increased to 680 mm.

More surface cracks were found around the mined void after MW10 was extracted, but no rock falls or cliff falls were observed.

2.2. Chain pillar widening after MW10 for MWs 11 & 12

To try to reduce the observed subsidence levels back to the predicted maximum subsidence limit of 125 mm, CA engaged SCT to study the observed subsidence behaviour and advise on the necessary modifications to the panel and pillar design so that mining the remaining mini walls would not result in more subsidence than the 125 mm limit.

After calibrating the FLAC model, SCT confirmed that the model also predicted very low levels of sag subsidence after extraction of the narrow, very subcritical, 61 m wide panels. The model also revealed that the higher than predicted observed subsidence was primarily the result of the compression or squashing of the relatively weak strata layers that were located immediately above the 29.5 m wide chain pillars (SCT Report AIRLY5240 2021). That is, it was not a weakness of the pillar but the strata layers above the pillar. This modelling indicated that, where the DoC was low then less compression of the strata overlying the pillars occurred, but higher depths of cover (DoC) resulted in extra weight on these weak strata overlying the chain pillars and this resulted in the higher-than-expected subsidence. Hence, SCT suggested that much wider chain pillars were needed between the future mini wall panels to reduce subsidence levels back to the predicted subsidence limits set in the 2014 EIS. When this SCT review was completed and the redesign was completed, MW09 had been developed, which meant MW11 was the first opportunity to implement any recommended changes in the mine design.

As shown in Fig. 2.3, SCT recommended a 60 m wide chain pillar was required between MW10 and MW11, (where the DoC ranged up to 255 m) to arrest the increased subsidence experienced over MW 02 to 10, (where the DoC ranged up to 274 m). SCT also suggested a 40 m pillar was required between MW11 and MW12, (where the DoC ranged up to 235 m) to restrict subsidence due to MW12 below 125 mm. The panel widths for MW11 and MW12 remained the same at 61 m wide. The predicted extra or additional subsidence over MWs 11 & 12 since MW10 was 80 mm, i.e., the difference between the predicted profile after MW12 and the observed profile after MW10.

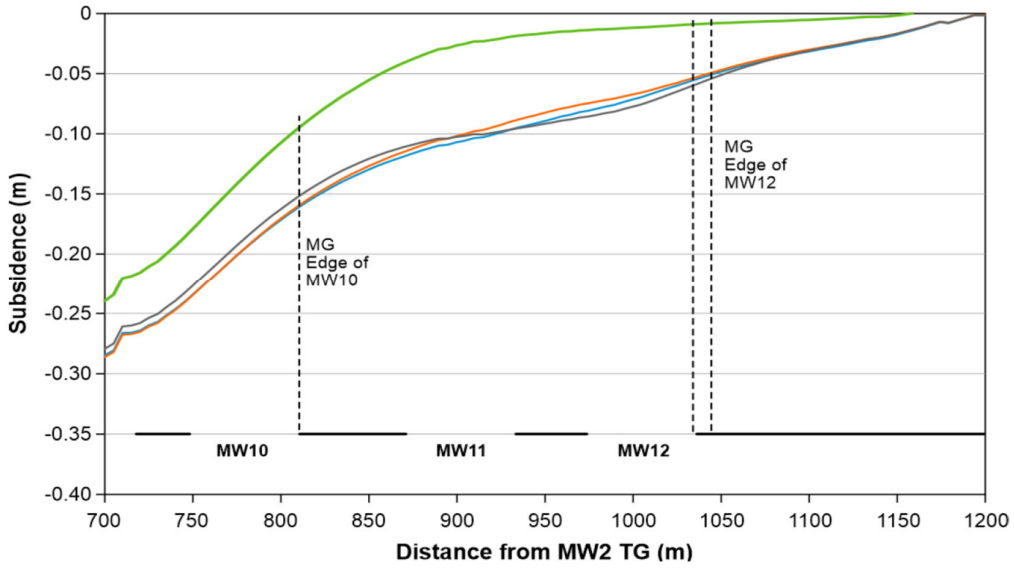


Fig. 2.3 Observed total subsidence profile after MW10 and predicted profiles after MWs 11 & 12 (SCT, 2021)

2.3. Airly subsidence monitoring results over Mount Airly and MWs 11 & 12

Approvals for the redesign were granted and CA commenced extraction of MW11 in September 2021 with the much wider pillars and CA completed the extraction of MW12 in December 2021.

After Airly extracted MW11 in October 2021, the maximum observed subsidence increased slightly to 690 mm, and, after MW12 was extracted, in December 2021, the maximum observed subsidence was 713 mm with most of this extra subsidence being measured over the narrower pillars.

As can be seen in Fig. 2.1 and Fig. 2.2, this combined B-A Line includes all of the B-Line, which is located over MW02 to MW06 and the eastern portion of the A-Line, i.e., which is located over MW06 to beyond MW12.

The subsidence monitoring over Mount Airly was undertaken by surveying the positions of about 250 pegs that were installed about 15 metres apart along 4 survey lines. These surveys were undertaken accurately three times for each of the eleven mini walls from an array of eleven continuously operated Global Navigation Satellite System (GNSS) survey base stations that were positioned around the edges of the Mount Airly mesa, as shown in Fig. 2.4.

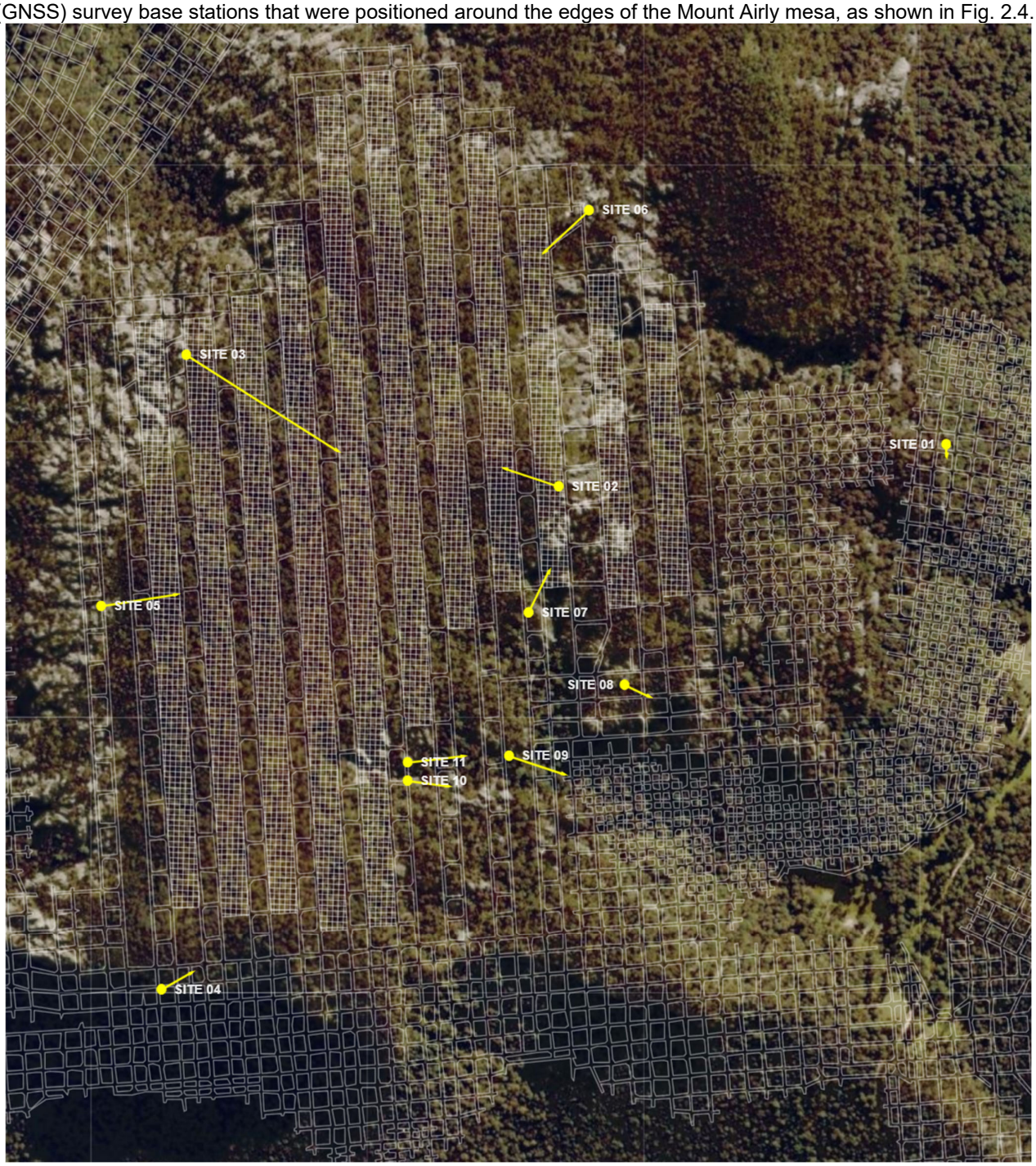


Fig. 2.4 Location & horizontal movement of the eleven GNSS base station units over Mount Airly (Aeromatix)

Fig. 2.4 also shows the vectors of horizontal movement recorded at these GNSS survey base stations.

Fig. 2.5 shows the observed total subsidence, tilt and strain profiles that were measured along the combined B-A Line, plotted as perpendicular distances from the initial goaf edge of MW2, just before or just after each of the mini walls MWs 02 to 12 were extracted. Fig. 2.5 shows both the observed total subsidence profiles after each of the MWs 02 to 12 was extracted and the incremental subsidence profiles per MW along the combined B-A Line, plotted as perpendicular distances from the initial goaf edge of MW2. Fig. 2.5 also shows the incremental profiles plotted from the advancing goaf edges of each panel.

Fig. 2.5 shows that sometimes shows small amounts of uplift are measured around the edges of the part of the subsidence bowl, i.e. near the cliff lines. That is, as the strata over the mined panels subsided downwards, parts of the edges around the subsidence bowl were lifted slightly upwards, i.e., higher than their position before mining. This small amount, i.e., up to 36mm of uplift, complicates the calculations of increments and in some cases, the increment of subsidence can be large than the total subsidence at these pegs.

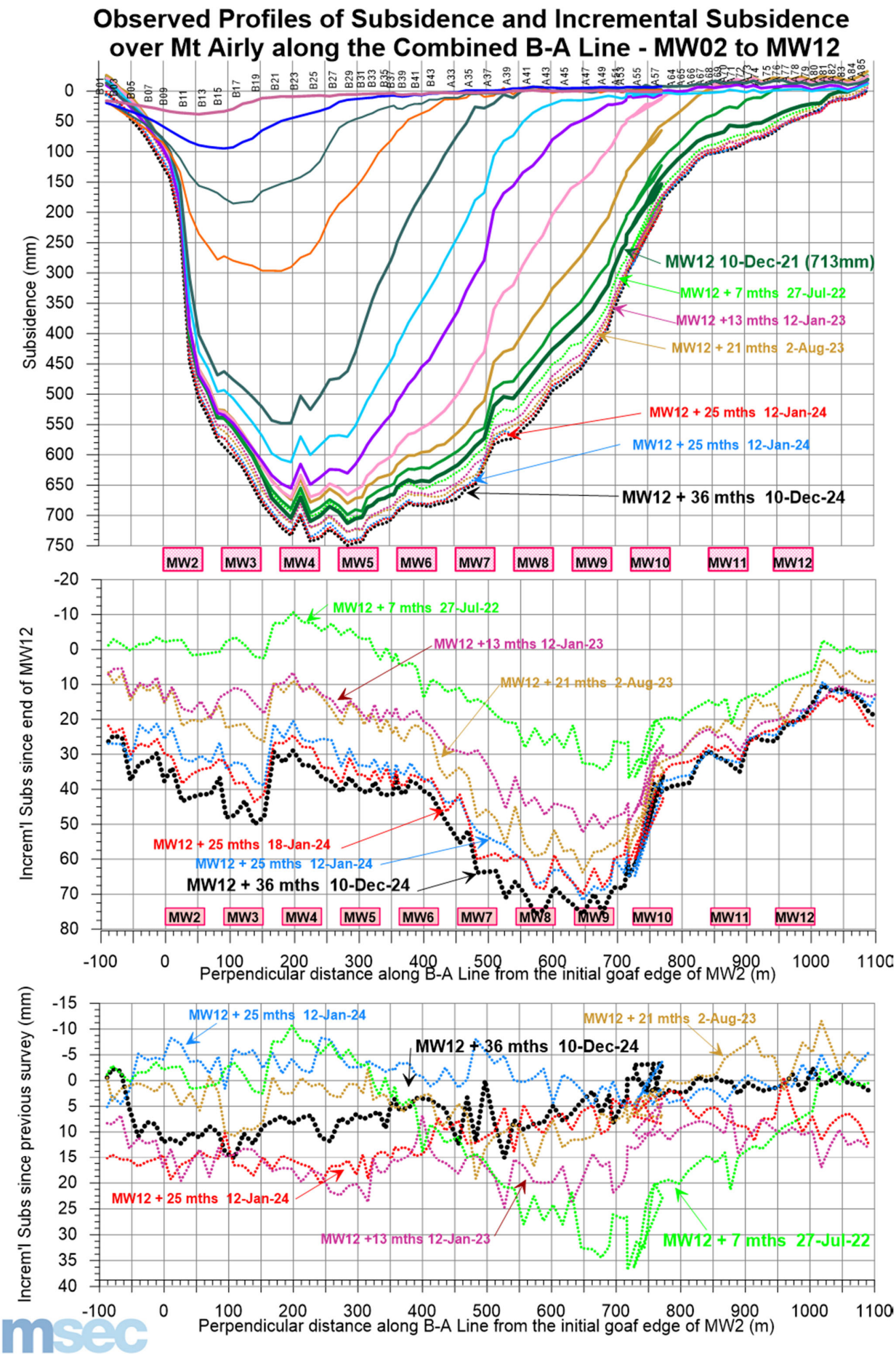


Fig. 2.5 Observed total subsidence, tilt and strain profiles up to Dec-24 over MWs 02 to 12 (MSEC)

2.4. Review of ongoing subsidence monitoring over Mount Airly

The top plot in Fig. 2.5 represents the observed total subsidence profiles for each MW along the BA-Line over MWs 02 to 12, plus it shows as dashed lines five extra subsidence profiles that were surveyed to review the ongoing residual subsidence for a period of up to 36 months after MW12 was extracted.

This top plot in Fig. 2.5 shows the maximum subsidence observed at the end of extraction in MW12 in Dec-21 was 713 mm at peg B28 over MW05, and the additional subsidence at B28 at the end of 2024 was 749 mm, i.e., (749-713 = 36 mm), which is mostly associated with the ongoing or long-term residual subsidence over MWs 02 to 10.

The two lower plots in Fig. 2.5 show the observed incremental subsidence profiles along this BA-Line. The first of these incremental plots shows all the surveyed additional subsidence since MW12 was completed. The bottom plot in Fig. 2.5, shows the observed incremental subsidence profiles since the previous survey to help review the extent of this ongoing subsidence.

The incremental subsidence profiles shown in Fig. 2.5 were calculated by subtracting the subsidence measured at the survey pegs at the end of a panel from the subsidence measured at or near the end of the preceding panel.

Incremental subsidence profiles therefore indicate the strata ground movements resulting from the extraction of a mined panel and the performance of the remaining pillars.

If the chain pillars and the strata overlying these Airly chain pillars had been stable and only experienced elastic compression or squashing, then only low levels of total and incremental subsidence would have been measured.

However, it can be noted from Fig. 2.5 that the incremental subsidence measured after the extraction of each panel is spread out not only over the current panel, but it is spread out over many previous panels, and this highlights that failures continued in the strata overlying the previous chain pillars as each new panel was extracted.

Residual subsidence is usually defined as the additional, time-dependent subsidence that develops after all the mining near that panel is completed or mining has moved sufficiently far enough away from the affected area to not influence the subsidence over the panel. The rate of residual subsidence usually reduces asymptotically to miniscule levels, when survey accuracy and the shrinking and swelling of the soil due to changes in moisture content can form a large proportion of the measured changes.

Usually, residual subsidence of an extra 5 to 10% additional subsidence over the maximum subsidence measured over the panel can be observed over a panel for several months to two years after extraction is completed in a panel with stable pillars, Holla and Barclay (2000), Whittaker and Reddish (1989) and Kay et al (2022). Most of this extra residual long-term subsidence is often measured over the sides of mined longwall panel where the measured subsidence is much smaller than the maximum subsidence over the centre of the panel. In these locations the residual subsidence for each survey peg in these locations can be a much higher percentage of the measured subsidence at those specific peg locations.

However, since the reason provided for the increase in measured subsidence over Airly MWs 02 to 10 is associated the squashing and fracturing of the weaker strata layers that lie over the chain pillars, which is a very different mechanism to the normal longwall panel subsidence, CA has undertaken extended subsidence monitoring over Mount Airly after MW12 was extracted to assess and review the levels of ongoing residual subsidence over MWs 02 to 12. In this Mount Airly case, the measured maximum residual subsidence, since MW12 was completed, of 75 mm was measured over MW09 and this amount represents about 10.5 % of the maximum observed subsidence of 713 mm. Over MW09 the measured residual subsidence after MW12 represented up to 18% of the measured subsidence of pegs in this location. Over MWs 11 and 12, the measured residual subsidence of 22 to 37 mm represented 30% to 50% of the measured subsidence of the pegs located over MWs 11 & 12. Hence, these residual results follow the typical range of observed residual subsidence patterns.

It can be noted from the black dashed line in the bottom plot in Fig. 2.5 that that was surveyed in Dec 24, i.e., 36 months after MW12, that the incremental subsidence measured in Dec 24 since the previous survey in July 24 was only -4 and +15 mm. The previous survey measured in Jul 24 was only -8 mm to +5 mm more than the survey in Jan 24. These small values are within the survey accuracy of monitoring over MWs 02 to 12 and it shows that only negligible ongoing residual subsidence can be expected from now on.

The monitoring of the GNSS base stations over Mount Airly, see Fig. 2.4, has continued on a daily basis even though the surveys in 2023 indicated that residual subsidence levels had reduced to levels well below negligible levels.

As shown in Fig. 2.6, these GNSS base stations over Mount Airly have only moved less than 20 mm in height during 2024. As discussed above, the bottom plot in Fig. 2.5 showed that the observed incremental subsidence profiles along the A and B-Line pegs moved less than 20 mm in 2024, i.e. +7 and -13 mm, and these changes could mainly be due to changes in the level of the GNSS base stations.

No further monitoring has been undertaken on the survey pegs over Mount Airly since December 2024, however, monitoring of the GNSS base stations has continued, and the results show, that, since early 2024, only negligible residual movements have been monitored as these base stations.

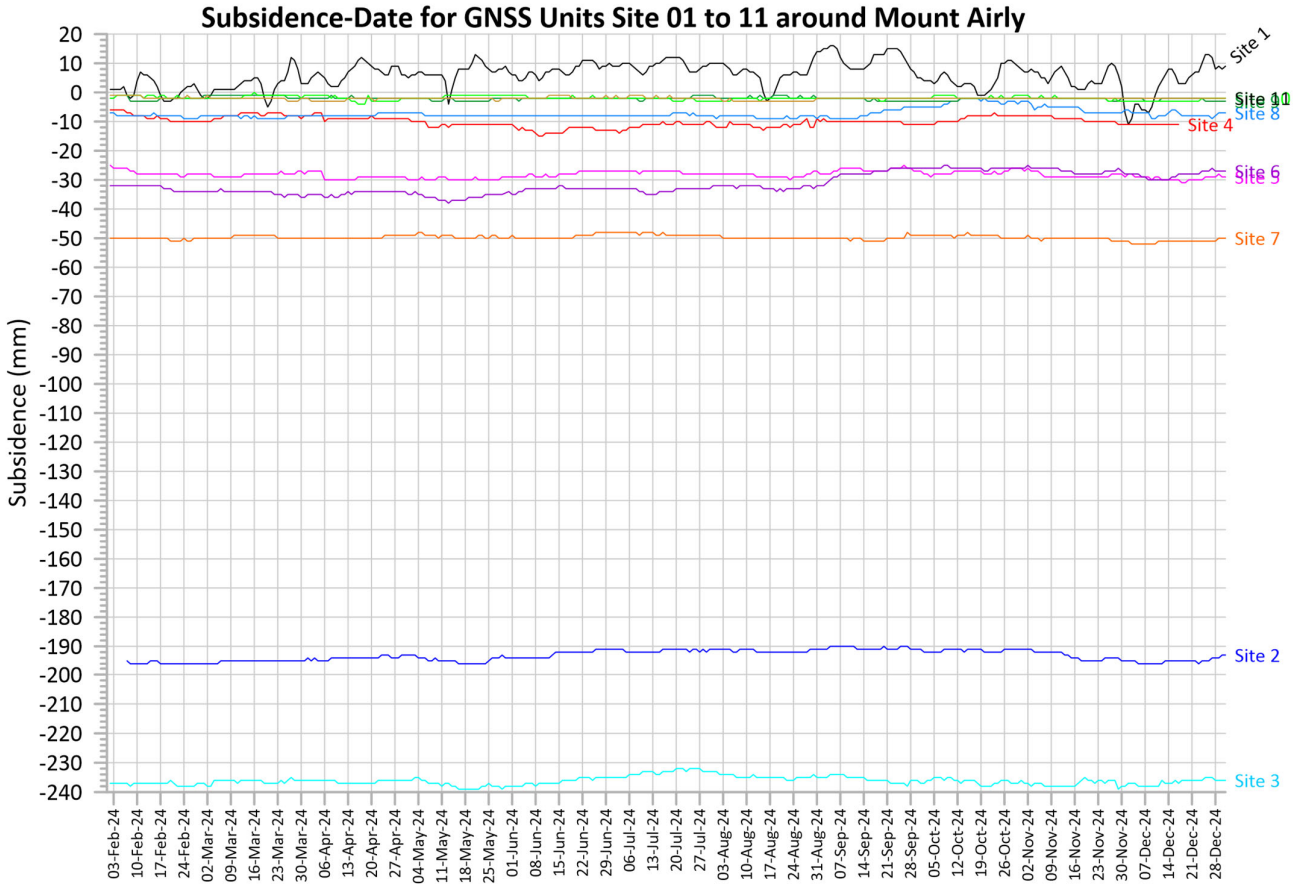


Fig. 2.6 Ongoing subsidence being recorded at the eleven GNSS base located over Mount Airly

The very low subsidence and horizontal movements that were monitored over MWs 11 and 12, confirms that the observed movements closely matched the predicted subsidence movements from the FLAC model developed by SCT. That is, this monitoring over MWs 11 and 12 has confirmed that these wider 60 m and 40 m pillars successfully reduced the spread of the high subsidence values over MWs 02 to 10 to levels over MWs 11 and 12 that are below the 2014 EIS predicted levels of 125 mm.

Because of the higher-than-expected subsidence over MWs 02 to 10, several minor subsidence impacts occurred over and around MWs 02 to 10 that are detailed in Section 4. No further surface cracks or rock falls have been observed over and around MWs 02 to 10 in 2023 or 2024.

While surface cracking and one small rock fall was observed around MWs 02 to 10 and over Mount Airly where the measured subsidence exceeded the approved maximum subsidence limits, no surface cracking, rock falls or cliff falls have been observed over the areas where the wider pillars were formed, i.e., over MWs 11 and 12.

Fig. 2.7 shows the observed total subsidence contours over the Mount Airly mesa after MWs 02 to 12 (2021). The asymmetry of the observed subsidence profiles could have resulted of the influence of the angle of the many faults that were discovered in the workings in Mount Airly.

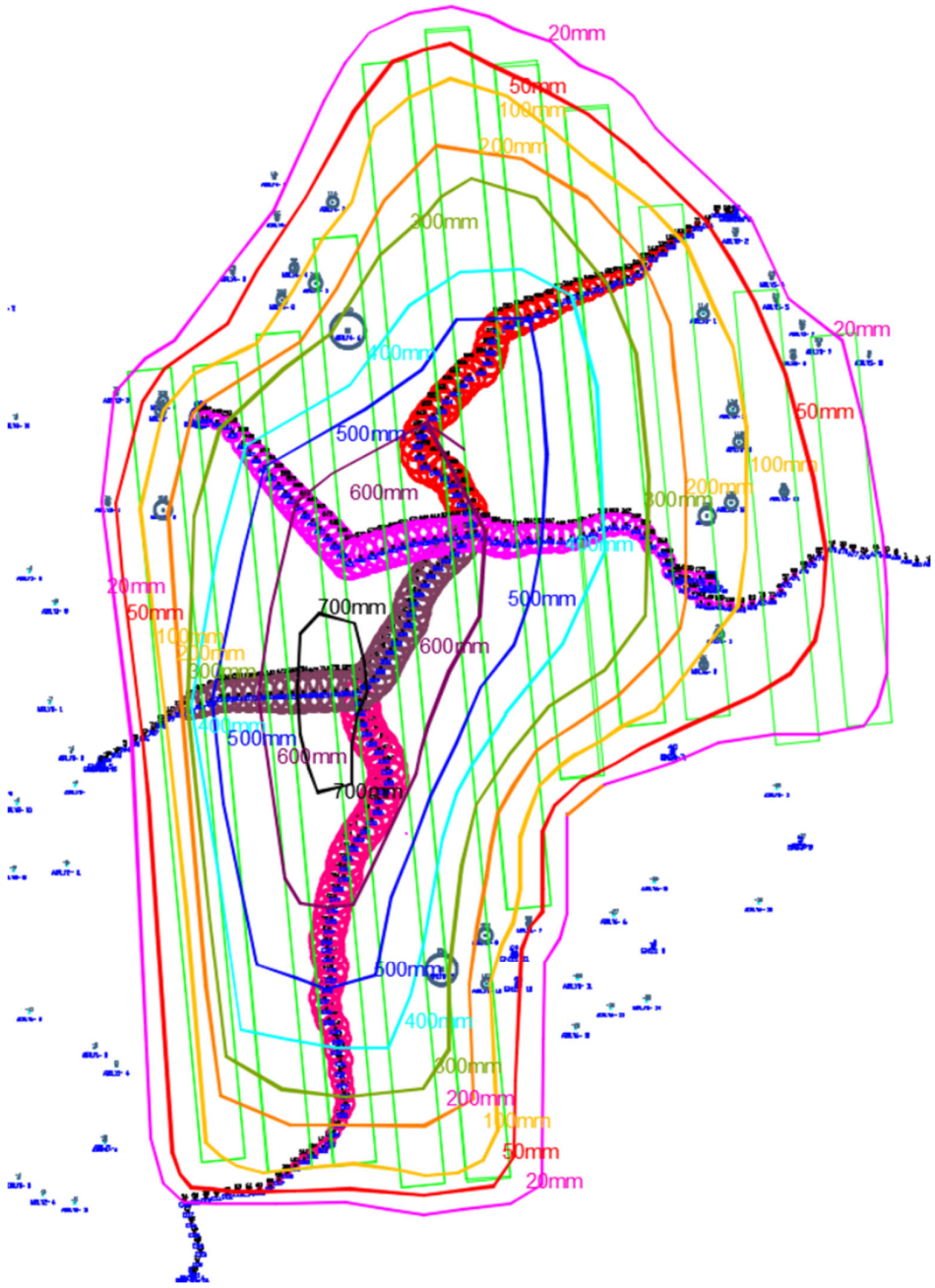


Fig. 2.7 Observed total subsidence contours just after MWs 02 to 12 - Dec 21 (MSEC)

3.1. Predictions over MWs13 to 16 at Point Hatteras & Genowlan Mountain

After successfully designing the barrier pillar between MW10 and MW11 to arrest the high levels of subsidence over MWs 02 to 10, CA engaged SCT to further use their calibrated FLAC model to help advise on the necessary modifications to the mini wall mine design for MWs 13 to MW16, (*where the DoC ranged up to 305 m*).

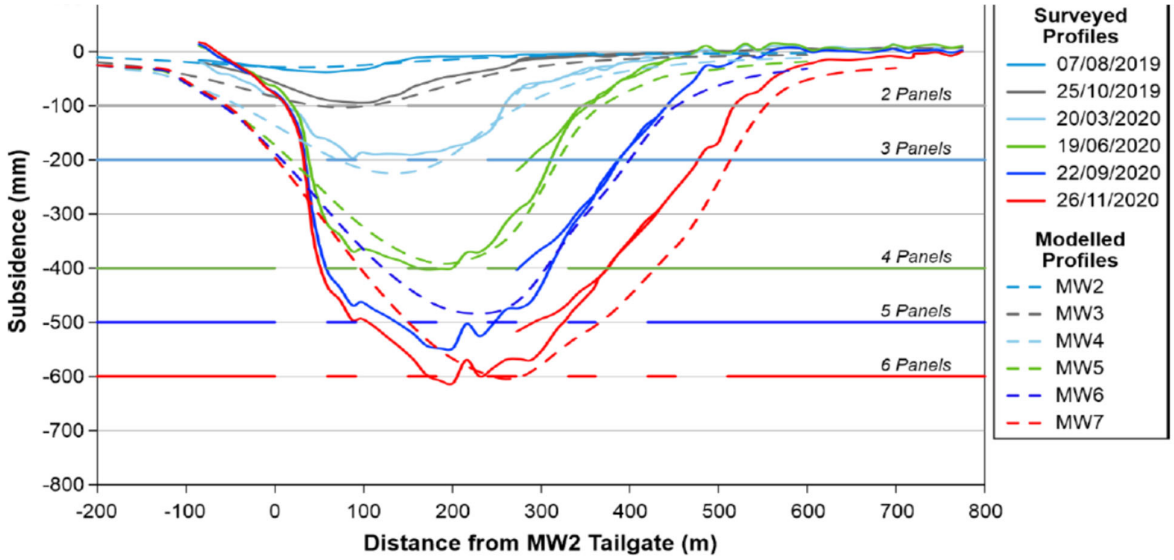


Fig. 3.1 Surveyed and modelled vertical subsidence comparison (SCT, 2021)

Fig. 3.1 shows a comparison of the FLAC modelled and measured subsidence over MWs 2 to 7, which shows the model predicts the maximum values well for the maximum DoC of 270m.

This FLAC modelling study (SCT Report AIRLY5240, dated 20 January 2021 and SCT Report AIRLY5265, Aug 2021) recommended that the chain pillar widths over Point Hatteras, where the DoC ranged up to 305 m and where there could be three or four 61 m wide panels side by side, be substantially increased from the 29.5m pillar that was designed and used under Mount Airly to limit the strata failures in the weaker strata layers that lie above the Lithgow Seam. The mathematical modelling was undertaken by SCT recommended that, with the mini wall panel widths of 61 m (rib to rib) and the much wider proposed chain pillar widths of 70 m (solid) for MWs 13 to 16, the predicted subsidence, after four mini walls at Point Hatteras on Genowlan Mountain, (*where the DoC ranged up to 305 m*), are extracted, i.e., will be 115 mm, which is less than the 2014 EIS total subsidence prediction of 125 mm. Fig. 3.2 shows predicted subsidence profiles over one to five mini wall panels for the maximum DoC of 300 m, based on the SCT modelling (SCT Report AIRLY5265, Aug 2021).

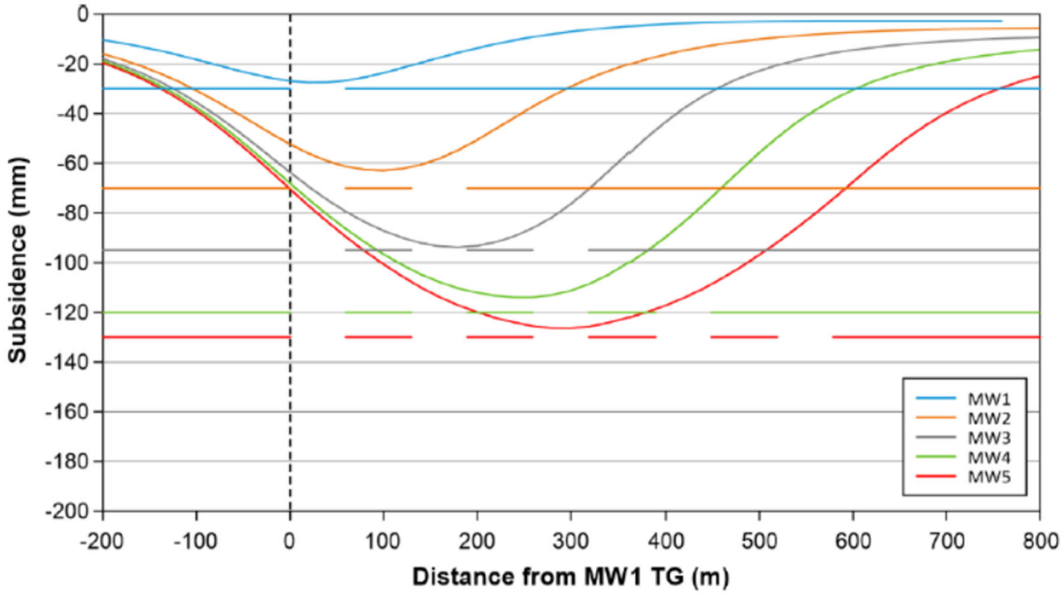


Fig. 3.2 The FLAC modelling results of 61 m wide mini wall panels at 300 m DoC with 70m wide chain pillars and 2.8 m extraction height (SCT, 2021)

In this report, SCT advised that the subsidence profiles shown in Fig. 3.1 predicts the maximum vertical subsidence the mined mini walls quite well but the modelled subsidence profiles outside the panels are overestimated due to boundary effects. That is, the SCT model over-predicts the subsidence outside the mining area and, therefore, over-predicts the predicted limit of vertical subsidence as is shown in Fig. 3.1.

Airly received Extraction Plan Approval in December 2021 from the former Planning, Industry & Environment NSW (DPIE), now the Department of Planning, Housing and Infrastructure (DPHI), for the extraction of Miniwalls MW13 to MW16 within the Point Hatteras Panel and Pillar Mining Zone. The locations of MWs 13 to 16 are shown in Fig. 3.3. DPHI agreed that the proposed mine layout is likely to limit potential subsidence impacts, effects, and environmental consequences to low levels, and provides protection to all cliffs within the Cliff Line Zone from mining induced subsidence impacts. Zone 1 was defined in which additional GNSS subsidence monitoring units were requested.

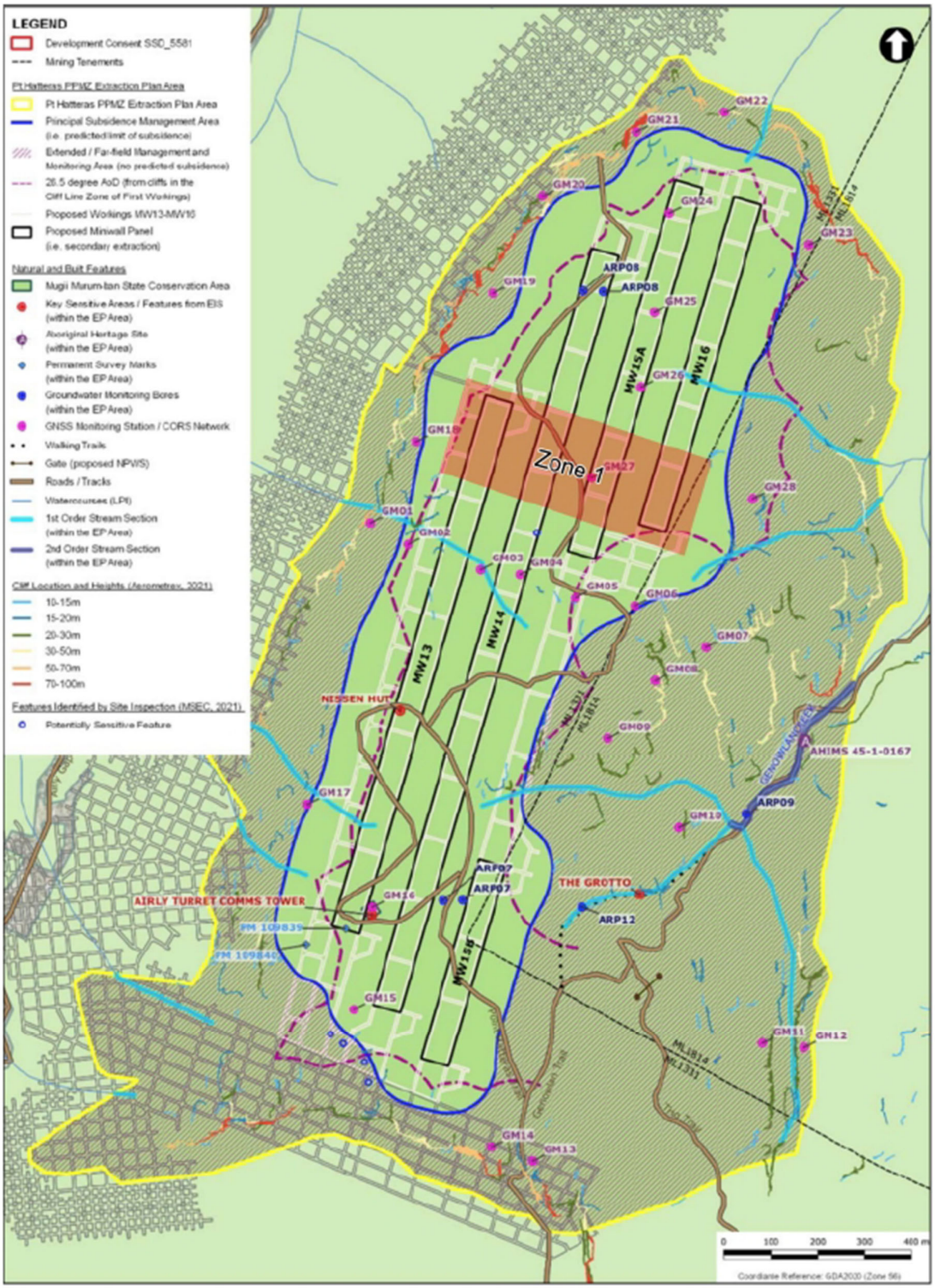


Fig. 3.3 Airly - Point Hatteras Panel and Pillar Mining Zone (Attachment A of Extraction Plan Approval)

3.2. Monitoring results over MWs13 to 16 under Point Hatteras & Genowlan Mountain

CA commenced extracting mini wall panels under the Genowlan Mountain mesa in Feb 2022, with MW13 and MW14 being extracted during 2022.

CA extracted MW15A and most of MW16 in 2023.

Extraction in MW16 was completed in Jan 2024 and MW15B and MW17 were extracted in 2024.

Daily mining-induced movements (subsidence effects) subsidence monitoring are being measured remotely by Michael Nicholson Consulting Pty Ltd (MNC) for CA over the Point Hatteras area of Genowlan Mountain using an array of 34 continuously operating Global Navigation Satellite System (GNSS) survey stations.

Fig. 3.4 shows the location of the 34 GNSS units over Genowlan Mountain with the locations of four monitoring cross lines plotted against a surface terrain model of the Point Hatteras area of Genowlan Mountain.

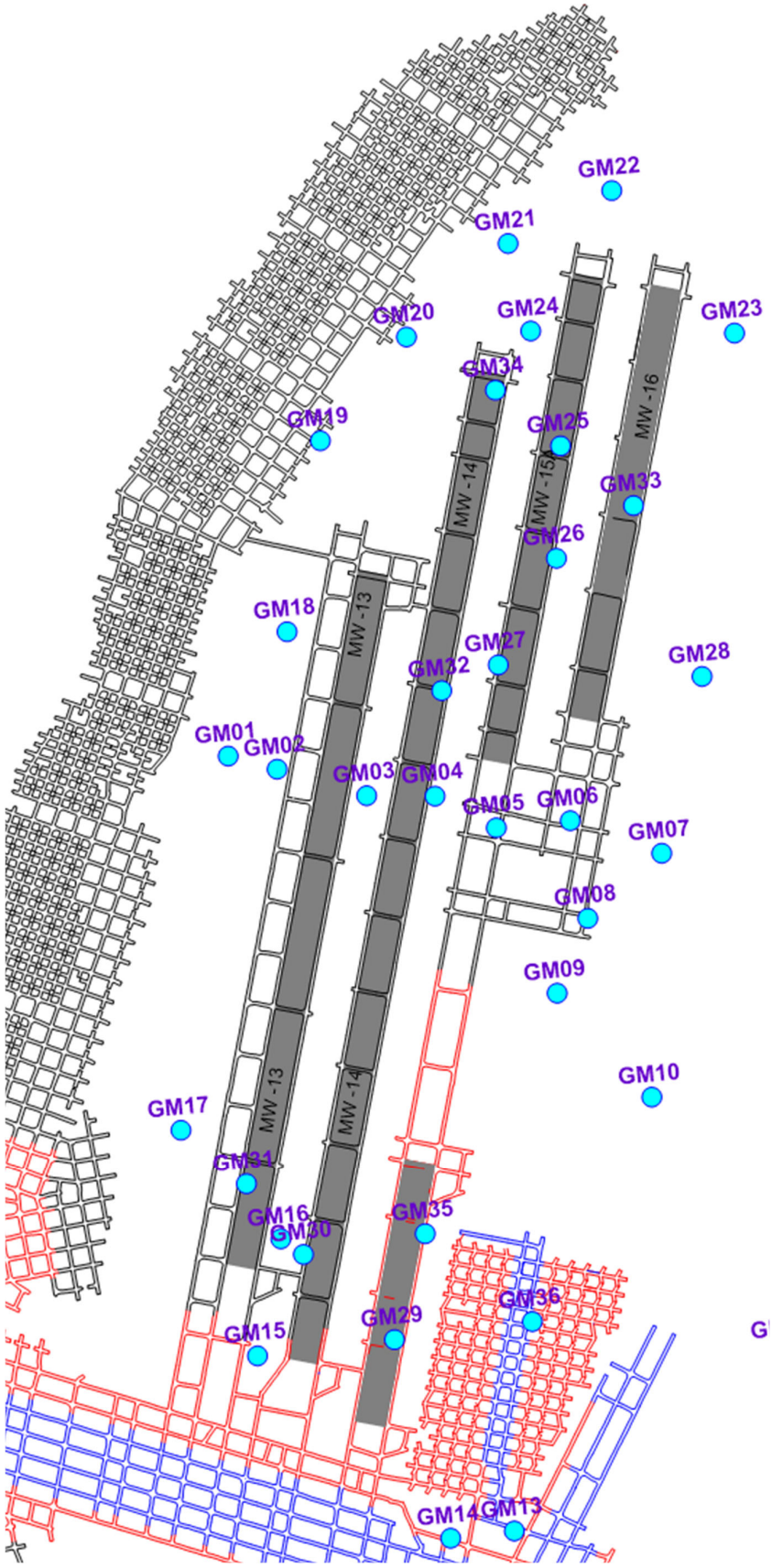


Fig. 3.4 Location of GNSS subsidence monitoring stations over MWs 13 to 16 with locations of Monitoring Line 1 to Monitoring Line 4 plotted against a surface terrain model of the Point Hatteras area of Genowlan Mountain (MSEC)

3.2.1. Adjustment to monitoring results over MWs13 to 16 for late installed pegs

Fig. 3.5 shows the locations of all the GNSS over MWs 13 to 16 including twenty-eight units, i.e., GM01 to GM28, that were installed prior to the start of MW13 in September 2021 and six GNSS units that are highlighted in yellow that were installed in March and April 2022 after the extraction of MW13 and prior to the start of MW14 at the request of the IEP during consultation for approval of the MW13 to MW16 Extraction Plan. The additional locations were identified as likely to provide data on the impact of subsidence and the sites were considered reasonably accessible within the State Conservation Area.

It is common practice for surveyors to have install to new replacement survey pegs after previously installed pegs were lost and the new pegs are usually assigned a new start value based on the monitored movements of the available surrounding pegs. In those cases, and in this situation where new GNSS units are added, reviews are required of the monitored subsidence from the initially available 28 GNSS units to assess the likely "missing" MW13 subsidence value that would have been monitored at the six new units if they had been installed before MW13 was extracted. A review that was detailed in previous MSEC reports, concluded that 3 of these new GNSS units, i.e., GM29, GM33 and GM34, were located remote from the edges of MW13 and, hence, they would have experienced negligible subsidence levels from the extraction of MW13. However, the following three new GNSS units would have experienced the following small amounts of subsidence due to the extraction of MW13 if they had been installed earlier:

- GM30 might have experienced 10 mm more subsidence,
- GM31 might have experienced 12 mm more subsidence and
- GM32 might have experienced 15 mm more subsidence.

These small amounts have therefore been added to the raw subsidence values for these units so that so that the are plotted values match the subsidence for the other units that were installed before MW13 was extracted.

Additionally, a further two new GNSS units were installed on 18-Jan- 2024 at the request of the IEP just before the extraction of MW16 was completed. For these two new GNSS units the likely "missing" subsidence value from MWs 13 to 15A and most of MW16 was assessed to be 21 mm for GM35 and 8 mm for GM36 as highlighted in light **red** in Fig. 3.5. The "missing" horizontal movements for these units was assessed at 15 mm for GM35 and 2 mm for GM36.

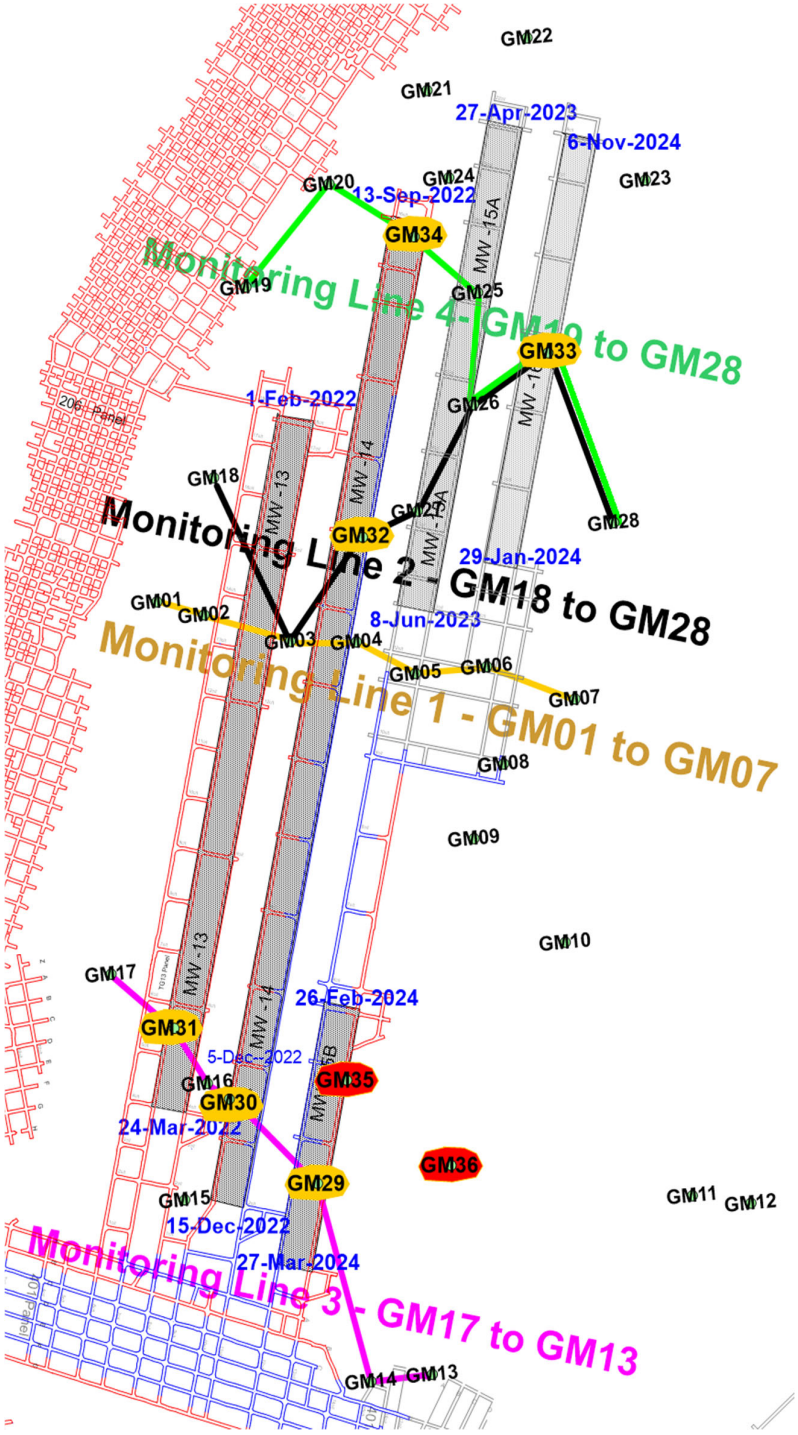


Fig. 3.5 Location of all 34 GNSS subsidence monitoring stations over MWs 13 to 16 with locations of the monitoring lines and highlighted eight new GNSS stations (MSEC)

These "missing" small amounts have therefore been added to the raw subsidence GNSS results for these pegs for all the plots and impact assessments in every MSEC report on subsidence results over MWs 13 to 16.

3.3. Subsidence vs Time plots from GNSS units over MWs13 to 16

Fig. 3.6 shows the raw subsidence measured daily at all the 34 GNSS units in 2021, 2022 2023 and 2024.

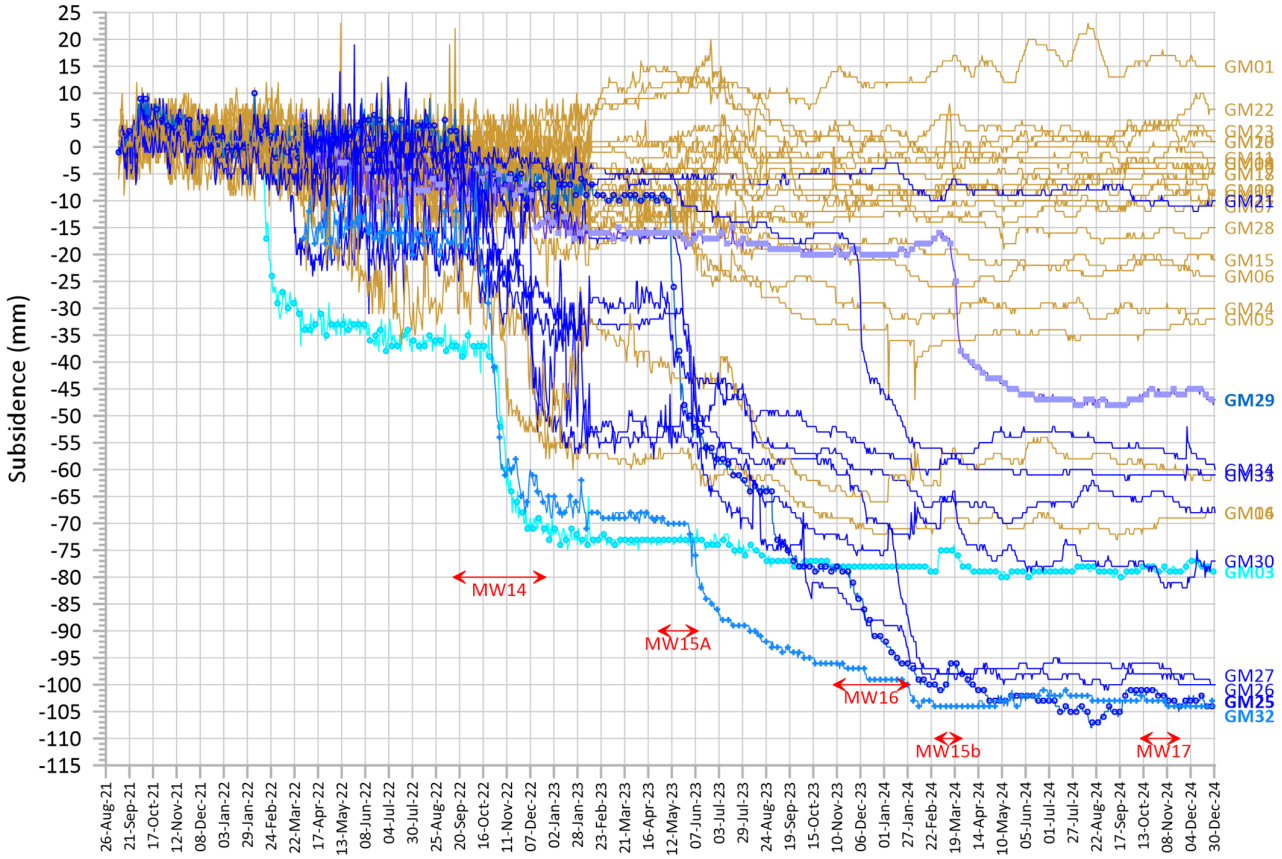


Fig. 3.6 Raw measured subsidence from all the GNSS units over MWs13 to 16

Fig. 3.7 shows the smoothed subsidence measured daily at all the 34 GNSS units in 2021, 2022 2023 and 2024, i.e. peaks slightly reduced. This smoothing was undertaken with a Savitzky-Golay polynomial (*detailed below*).

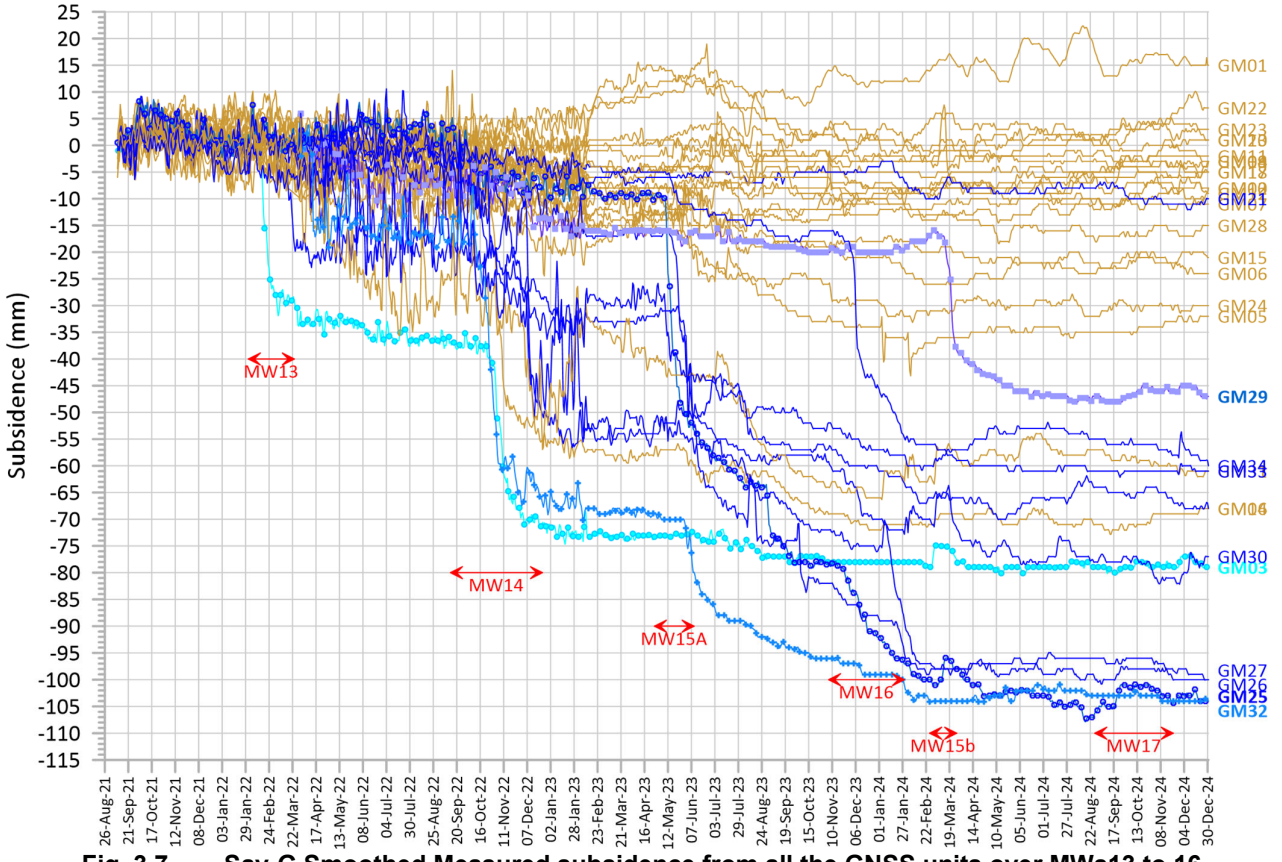


Fig. 3.7 Sav-G Smoothed Measured subsidence from all the GNSS units over MWs13 to 16

It can be noted in Fig. 3.6 that the newer GNSS units that were installed after Feb-23 have a better measuring accuracy and far less scatter than the earlier GNSS units. The earlier GNSS measurements need to be smoothed to reduce the scatter and better reveal the data trends, but the newer units still show small variations that result from changes in mining, climatic conditions, i.e. weather and ground moisture, and satellite measurement influences, i.e. positioning technology, terrain relief, and sensor viewing angles.

Rather than using a moving average filter, which can shift and flatten the peaks too much, a Savitzky-Golay polynomial to the power of 7 (n=7) has been used. The Savitzky-Golay filter is a widely-used smoothing algorithm that is based on the least-squares fitting of polynomials to segments of the data where the data points are equally spaced. Compared to the moving-average smooths of the same width, the Savitzky-Golay smooth is more effective at retaining the shape of the original signal, with only the peaks in the raw data being reduced. After comparing Fig. 3.6 and Fig. 3.7, it can be noted between that the Savitzky-Golay smooth does not modify the results of the newer units much. All the subsidence values reported and the plots shown in this report have been slightly smoothed using this Savitzky-Golay filter.

Fig. 3.7 confirms that only low levels of the subsidence were measured at these GNSS units over MWs 13 to 16, with the maximum measured subsidence up to the end of 2024 being 108 mm at peg GM25 in Aug-24. At the end of 2024 the maximum measured subsidence reduced back to 104 mm at GNSS units, GM32 and GM25, that were centrally located over MWs13 to 16. Fig. 3.7 also shows that the ongoing residual subsidence has stopped over MWs 13 to 16 after Jun-24, i.e., three months after the last panel, i.e. MW15B, was extracted in Mar-2024. This figure also shows that, when MW17 was extracted in the south eastern area of Genowlan Mountain, i.e. Aug to Nov 2024, no extra subsidence was observed at the GNSS units that were located over MWs 13 - 16.

The maximum observed subsidence was first recorded at GNSS unit GM32 at 104 mm in Feb 2024 and this value did not increase after MW15B was extracted. The maximum observed horizontal movement over MWs 13 to 16 was less than 62 mm. These GNSS units provide fluctuating subsidence values that are generally within $\pm$ 3 mm, although in a few cases they varied up to $\pm$ 20 mm. The newer GNSS units installed in early 2023 provide more consistent values with less fluctuations.

As was expected, the GNSS units that were located immediately above the panels, MWs 13 to 16, experienced the most subsidence. The GNSS units that were located away from the mini wall panels experienced little subsidence. Fig. 3.7 also shows that rather than subsiding downwards as most of the units do, some of these GNSS units that were observed to be lifted higher than their initial positions by up to 20 mm higher than their initial positions. Most of these units were located on rock around the edges of the mesa, but some these units were installed over soil which can shrink and swell with changes in ground moisture after prolonged rain. Those units that were installed on the edges of the escarpments appear to be raised up in a see-saw motion rotation as strata beams were subsided downwards over goaf.

Fig. 3.8 shows the smoothed horizontal movements that were measured daily at all the 34 GNSS units up to the end of 2024.

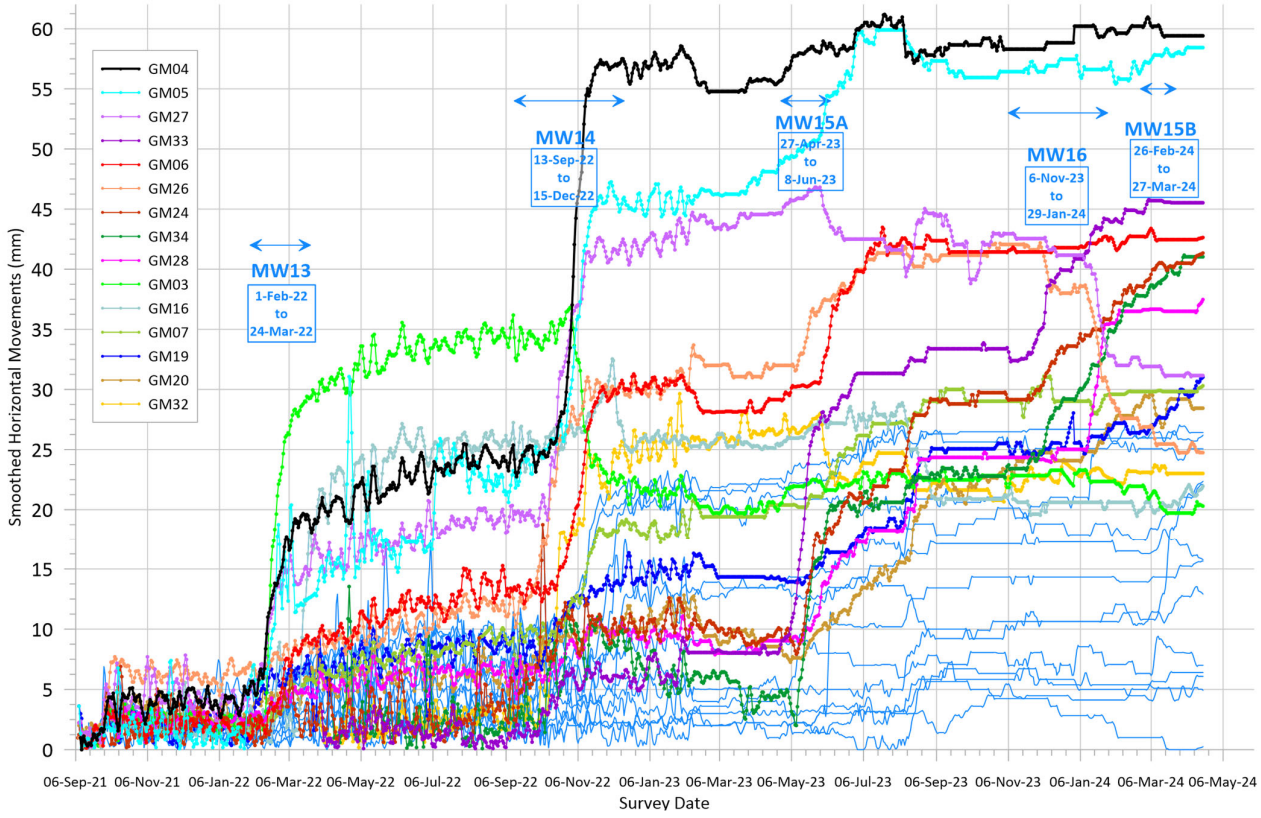


Fig. 3.8 Measured Horizontal Movements from all the GNSS units over MWs13 to 16

3.4. Subsidence Cross Section plots over MWs13 to 16

Fig. 3.5 shows the locations of the all the 36 GNSS stations over MWs 13 to 16, the dates when the face started and finished extraction in each mini wall and the location four cross lines.

It should be noted that MW16 was extracted before MW15B. Fig. 3.5 also shows that all mini walls were stopped short of various cliffs, and hence only a short distance of these panels had four adjacent mini walls, i.e., approximately 170 m of MWs 13, 14, 15A & 16, as also shaded and labelled “Zone 1” in Fig. 3.3.

Fig. 3.5 also shows the locations of these four-monitoring cross lines;

- **Monitoring Line 1** – GM01 to GM07 is highlighted in **yellow**. It only crosses two panels, i.e., MWs 13 and MW14 in the centre of the Point Hatteras panels.
- **Monitoring Line 2** - GM18, GM03, GM32, GM27, GM26, GM33 and GM28 is highlighted in **black**. It crosses four panels side by side, i.e., MWs 13, MW14, MW15A and MW16, in the central to northern part of Point Hatteras.
- **Monitoring Line 3** - GM17, GM31, GM16, GM30, GM29, GM14 and GM13 is highlighted in **magenta**, in the southern part of Point Hatteras where only three panels, MWs13 to MW15B, were extracted.
- **Monitoring Line 4** - GM19, GM20, GM34, GM25, GM26, GM33 and GM28 is highlighted in **green** in the far northern part of Point Hatteras, where there were three panels, MWs14, MW15A and MW16.

Similarly, there are only short distances where three adjacent mini walls occur, i.e., MWs 14, 15A and 16 and MWs 13, 14 and 15B. Hence the subsidence predictions, relating to 4 adjacent mini walls in Fig. 3.2 only applies to limited areas over this series of panels (Zone 1) and, given the necessity for end effects at the goaf commencing ends and goaf finishing ends, the full predicted subsidence levels for 4 adjacent panels of 115 mm for 4 adjacent mini walls may not actually occur.

3.4.1. Monitoring Line 1 plots over MWs13 to 14

That is, as shown in Fig. 3.5, the **Monitoring Line 1** (GM01 to GM07) cross line passes near but not over MWs 15A and 16. Hence, this monitoring line will mainly be used to show the results over MWs 13 and 14. A different monitoring cross line, called **Monitoring Line 2** that shows the subsidence results from six GNSS units, GM18, , GM03, GM32, GM27 and GM28 will be used to show the subsidence results over Zone 1, across MW13, MW14, MW15A and MW16.

Monitoring data from the GM01 to GM07 cross line, i.e. **Monitoring Line 1**, is presented in Fig. 3.9 to show the subsidence trends over a short portion of MWs 13 and MW16 up to 18-May-2024, i.e. 52 days after MW15B finished. Although only two panels are extracted under **Monitoring Line 1,** MW15A and MW16 are located close enough to slightly effect the observed movements of some of these GNSS units.

Generally one survey epoch is shown at the end of mining of each panel and if available a second epoch one month later and last a third survey epoch is shown at the start of mining the next following mini wall.

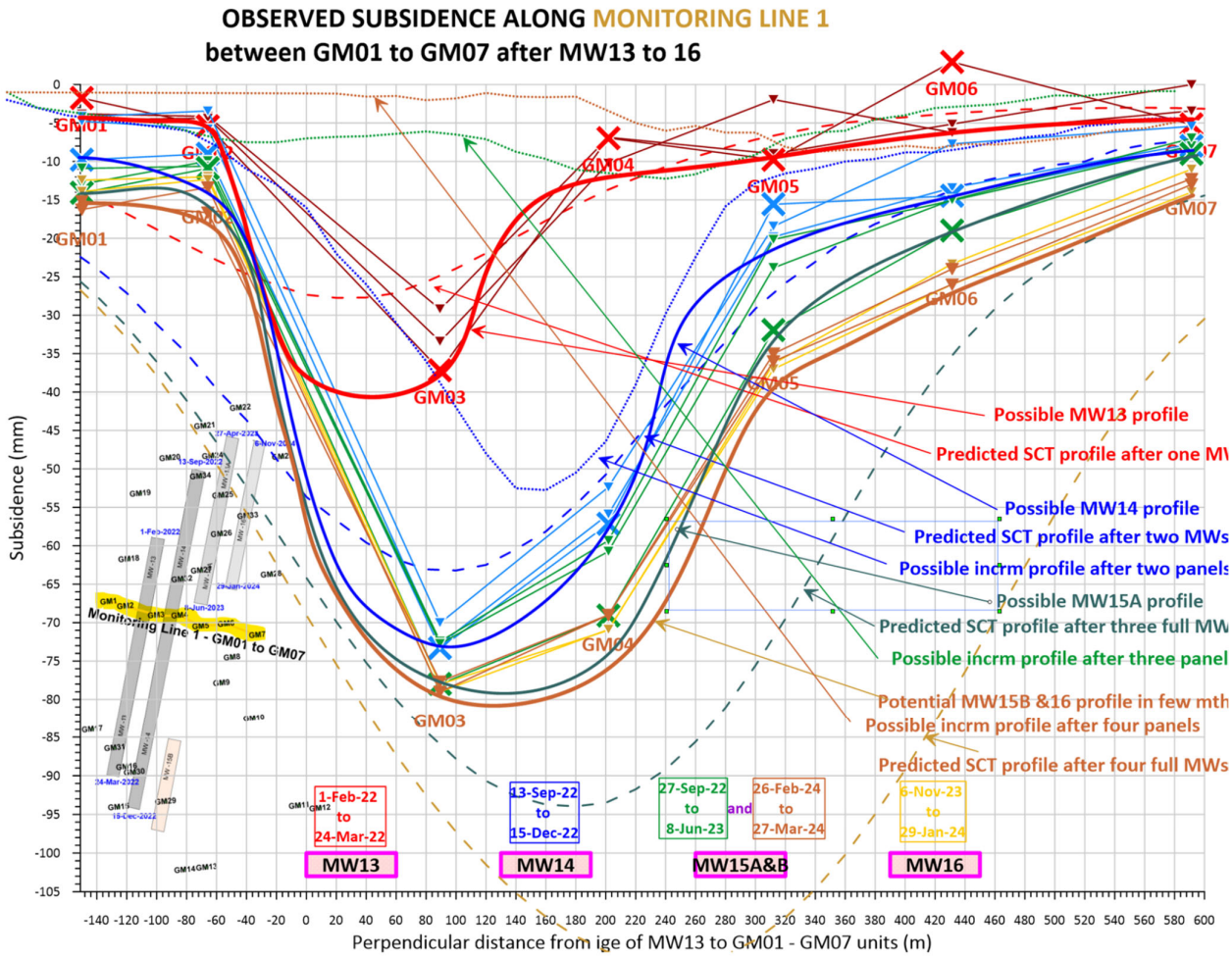


Fig. 3.9 Observed Subsidence along Monitoring Line 1 (MSEC)

Fig. 3.9 also shows the observed subsidence profiles between GNSS stations, GM01 to GM07, for three monitoring dates per mini wall. One profile measured at the end of mining of each panel, the second one month later and then the third at the start of mining the next following mini wall. As only seven GNSS units are available across this monitoring line, a **straight-line** subsidence profile has been drawn between the available subsidence values for each survey date. One "possible" curved subsidence profile has also been drawn between these measured values to show the maximum profile after each mini wall extraction based on our experience of monitoring over panels with monitoring cases with closely spaced survey pegs. Fig. 3.9 also includes **dotted** incremental subsidence profiles for MW14, MW15A and MW16. The maximum incremental subsidence profiles for MW13, MW14, MW15A and MW16 were 41 mm, 53 mm, 12 mm and 9 mm.

Fig. 3.9 also includes **dashed** subsidence profiles along this monitoring line that were predicted by SCT for one, two, three and four panels. It can be noted that the monitored subsidence profiles for MWs 13 and 14 were slightly higher than the predicted profiles, but it should be remembered that the excess is less than 15 mm, i.e. the results were within the accuracy of the SCT prediction method and the accuracy of the survey monitoring method.

When MW13 was extracted, the maximum observed subsidence level was around 40 mm, which is very similar to the subsidence levels that were measured when MW02 was extracted 38 mm. In these cases, no chain pillars were formed.

However, when there two panels separated by different width chain pillars, the maximum observed subsidence level over MWs 13 and 14 was 73 mm, while the maximum observed subsidence level over MWs 02 and 03 was 95 mm, as shown in Table 3.1.

3.4.2. Monitoring Line 2 plots over MWs13 to 16

Monitoring data from **Monitoring Line 2** is presented in Fig. 3.10 to show the subsidence trends over MWs 13 to MW15B up to 18-May-2024, i.e. 52 days after MW15B finished. As shown in Fig. 3.10 four panels are extracted under **Monitoring Line 2**.

Fig. 3.10 also shows the observed subsidence between GNSS stations, GM18, GM03, GM32, GM27, GM26, GM33 and GM28, for three monitoring dates per mini wall. One survey epoch is shown at the end of mining of each panel and if available a second epoch one month later and last a third survey epoch is shown at the start of mining the next following mini wall. As only seven GNSS units are available across this monitoring line, a **straight-line** subsidence profile has been drawn between the available subsidence values for each survey date.

"Possible" curved subsidence profiles have also been drawn between these measured values based on our experience of monitoring over panels with monitoring cases with closely spaced survey pegs. Fig. 3.10 also includes **dotted** incremental subsidence profiles for MW14, MW15A, plus MW16 and MW15B. The maximum incremental subsidence profiles for MW13, MW14, MW15A, MW16 and MW15B were 44 mm, 52 mm, 47 mm and 49 mm.

Fig. 3.10 also includes **dashed** subsidence profiles along this monitoring line that were predicted by SCT for one, two, three and four panels. It can be noted that the monitored subsidence profiles for MWs 13 and 14 were slightly higher than the predicted profiles for some panels, but the excess is less than 18 mm, and the results were within the accuracy of the SCT prediction method and the accuracy of the survey monitoring method. The monitored subsidence profile after MW15B was extracted was less than was predicted for four panels.

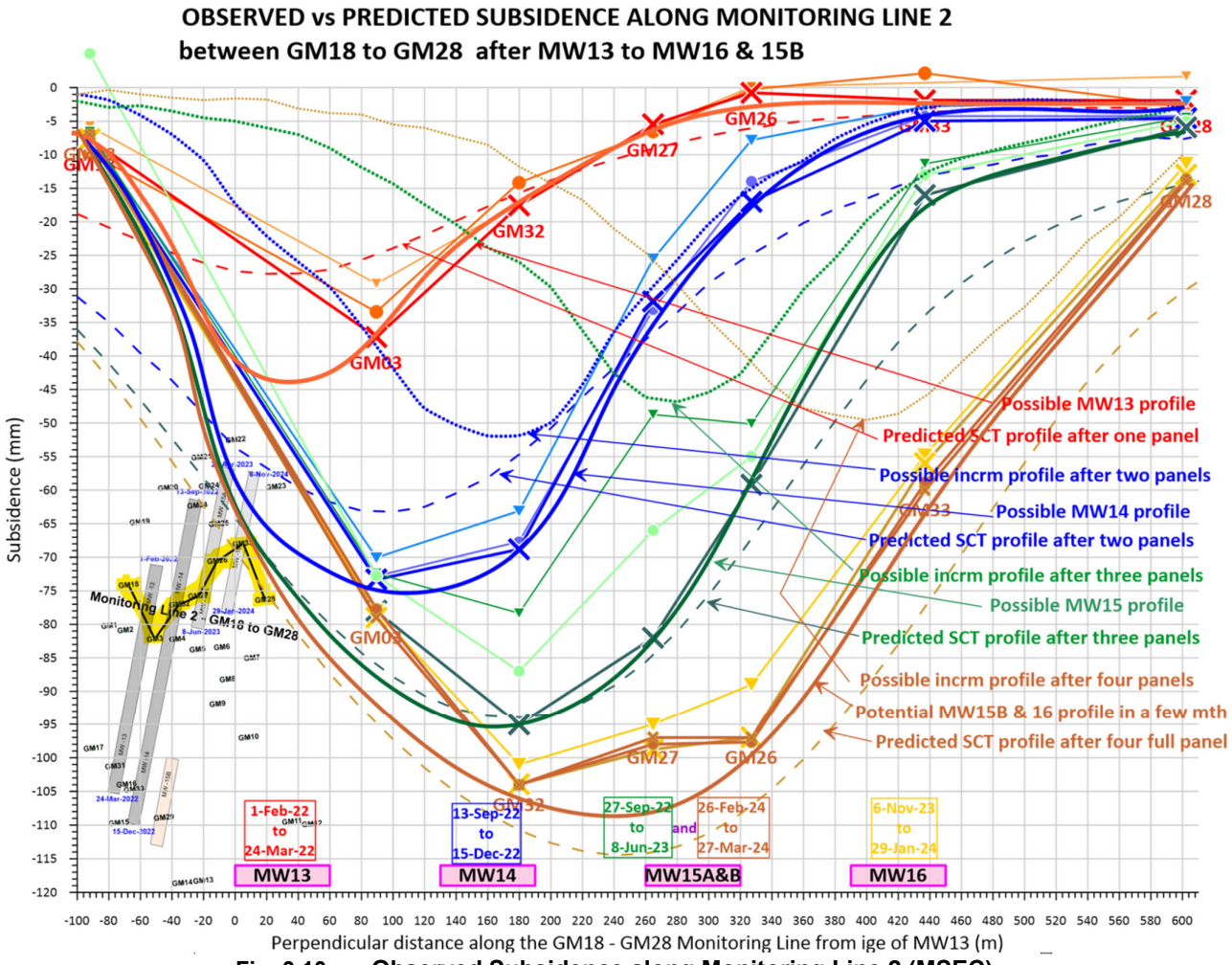


Fig. 3.10 Observed Subsidence along Monitoring Line 2 (MSEC)

3.4.3. Monitoring Line 3 plots over MWs13 to 15

Monitoring data from **Monitoring Line 3** is presented in Fig. 3.11 to show the subsidence trends over MWs 13 to MW16 up to 18-May-2024, i.e. 52 days after MW15B finished. As shown in the Fig. 3.11 only three panels are to be extracted under **Monitoring Line 3,** i.e. MW13, 14 and 15B. This is because MW15A and MW16 are located too remote from this line and did not affect the observed movements of these GNSS units along this monitoring line. The newly installed GNSS units GM35 and GM36, as shown in **red** in Fig. 3.11 are not included as they recorded similar values to GM29 and GM14 and are not impacted by the first workings in the HB2 Panel.

Fig. 3.11 also shows the observed subsidence between GNSS stations, GM17, GM31, GM16, GM30, GM29, GM14 and GM13, for three monitoring dates per mini wall. One survey epoch is shown at the end of mining of each panel and if available a second epoch one month later and last a third survey epoch is shown at the start of mining the next following mini wall. As only seven GNSS units are available across this monitoring line, a **straight-line** subsidence profile has been drawn between the available subsidence values for each survey date. "Possible" curved subsidence profiles have also been drawn between these measured values based on our experience of monitoring over panels with monitoring cases with closely spaced survey pegs.

Fig. 3.11 also includes **dotted** incremental subsidence profiles for MW14, MW15A, plus MW15B and MW16. The maximum incremental subsidence profiles for MW13, MW14, MW15A, MW16 and MW15B were 26 mm, 33 mm, 4 mm and 33 mm.

As shown by the curved "possible" profiles drawn in Fig. 3.11 while the maximum subsidence monitored along this monitoring line, after MW15B was almost fully extracted was 74 mm, however, if more units had been installed it is possible that the maximum subsidence could have been 75 mm, or slightly higher depending on further ongoing residual subsidence.

Fig. 3.11 also includes **dashed** subsidence profiles along this monitoring line that were predicted by SCT for one, two, and three panels. It can be noted that the monitored subsidence profiles over MWs 13 and 14 along this **Monitoring Line 3** were slightly lower than the monitored profiles over **Monitoring Line 1** and **Monitored Line 2** and the predicted profiles for one and two panels.

This is most likely due to the close proximity of these GNSS units to the finishing ends of these panels and the depths of cover over **Monitoring Line 3** are slightly lower than over **Monitoring Line 1** and **Monitored Line 2**.

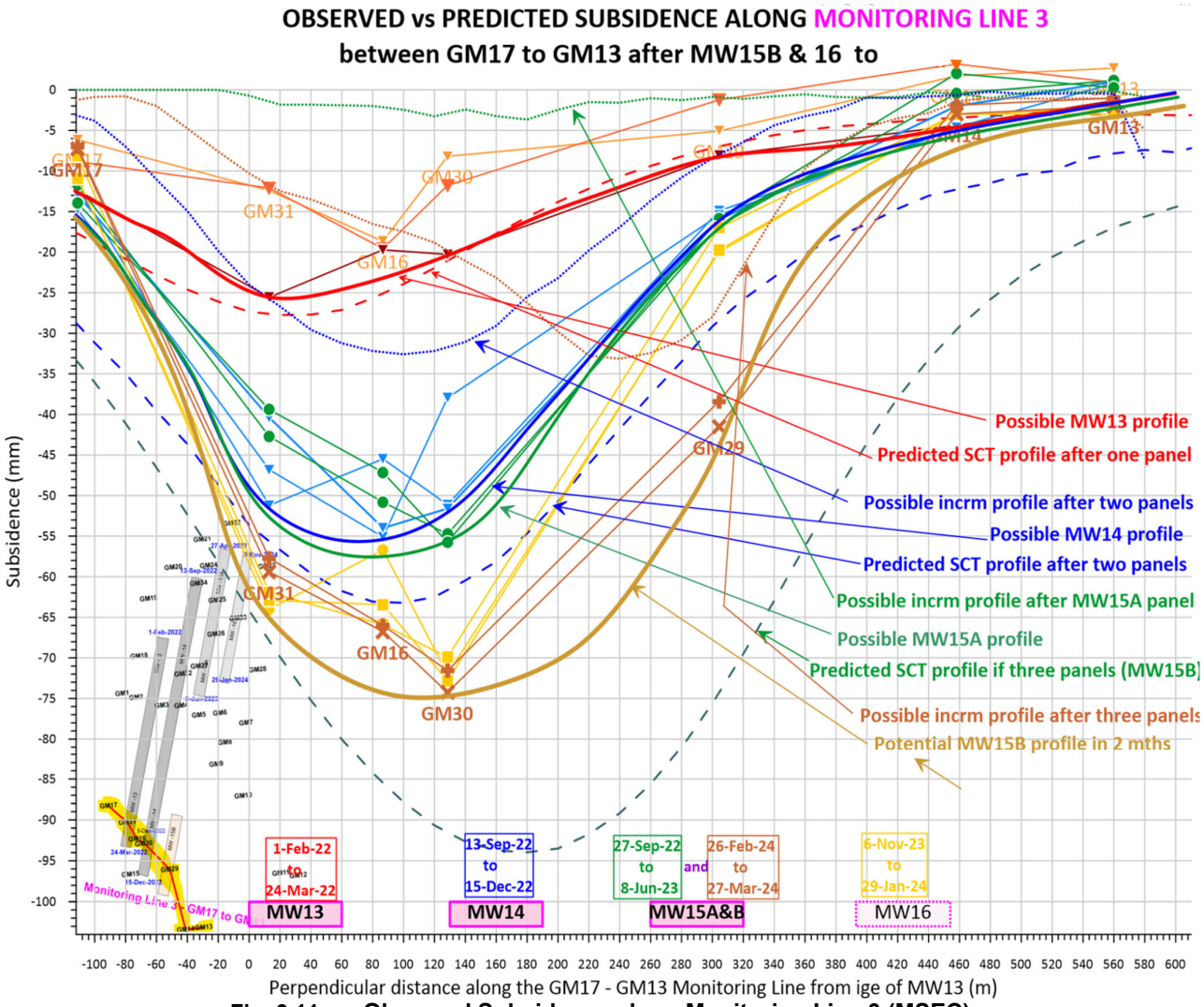


Fig. 3.11 Observed Subsidence along Monitoring Line 3 (MSEC)

3.4.4. Monitoring Line 4 plots over MWs14 to 16

Monitoring data from **Monitoring Line 4** is presented in Fig. 3.12 to show the subsidence trends over MWs 14 to MW16 and MW15B up to 18-May-2024, i.e. 52 days after MW15B finished. As shown in Fig. 3.12, only three panels are to be extracted under **Monitoring Line 4**, i.e. MW14, 15A and 16. MW13 is located remote from this line and did not affect the observed movements of these GNSS units.

Fig. 3.12 also shows the observed subsidence between GNSS stations, GM19, GM20, GM34, GM25, GM26, GM33 and GM28, for three monitoring dates per mini wall. One survey epoch is shown at the end of mining of each panel and if available a second epoch one month later and last a third survey epoch is shown at the start of mining the next following mini wall.

Fig. 3.12 also includes **dotted** incremental subsidence profiles for MW14, MW15B plus MW15A and MW16. The maximum incremental subsidence profiles for MW13, MW14, MW15A, MW16 and MW15B were 26 mm, 33 mm, 3 mm and 33mm.

As only seven GNSS units are available across this monitoring line, a **straight-line** subsidence profile has been drawn between the available subsidence values for each survey date. "Possible" curved subsidence profiles have also been drawn between these measured values based on our experience of monitoring over panels with monitoring cases with closely spaced survey pegs.

Fig. 3.12 also includes **dotted** incremental subsidence profiles for MW15B plus MW15A and MW16. The maximum incremental subsidence profiles for MW14, MW15A, MW16 and MW15B were 34 mm, 58 mm and 49 mm.

As shown by the curved "possible" profiles drawn in Fig. 3.12, while the maximum subsidence monitored along this monitoring line, after MW15B was almost fully extracted was 101 mm, if more units had been installed it is possible that the maximum subsidence could have been slightly higher depending on further ongoing residual subsidence occurring.

Fig. 3.12 also includes **dashed** subsidence profiles along this monitoring line that were predicted by SCT for one, two, three and four panels. It can be noted that the monitored subsidence profiles for MWs 14, 15A and 16 were slightly higher than the predicted profiles for one, two and three panels, but it should be remembered that the excess is less than 20 mm, i.e. the results were within the accuracy of the SCT prediction method and the accuracy of the survey monitoring method.

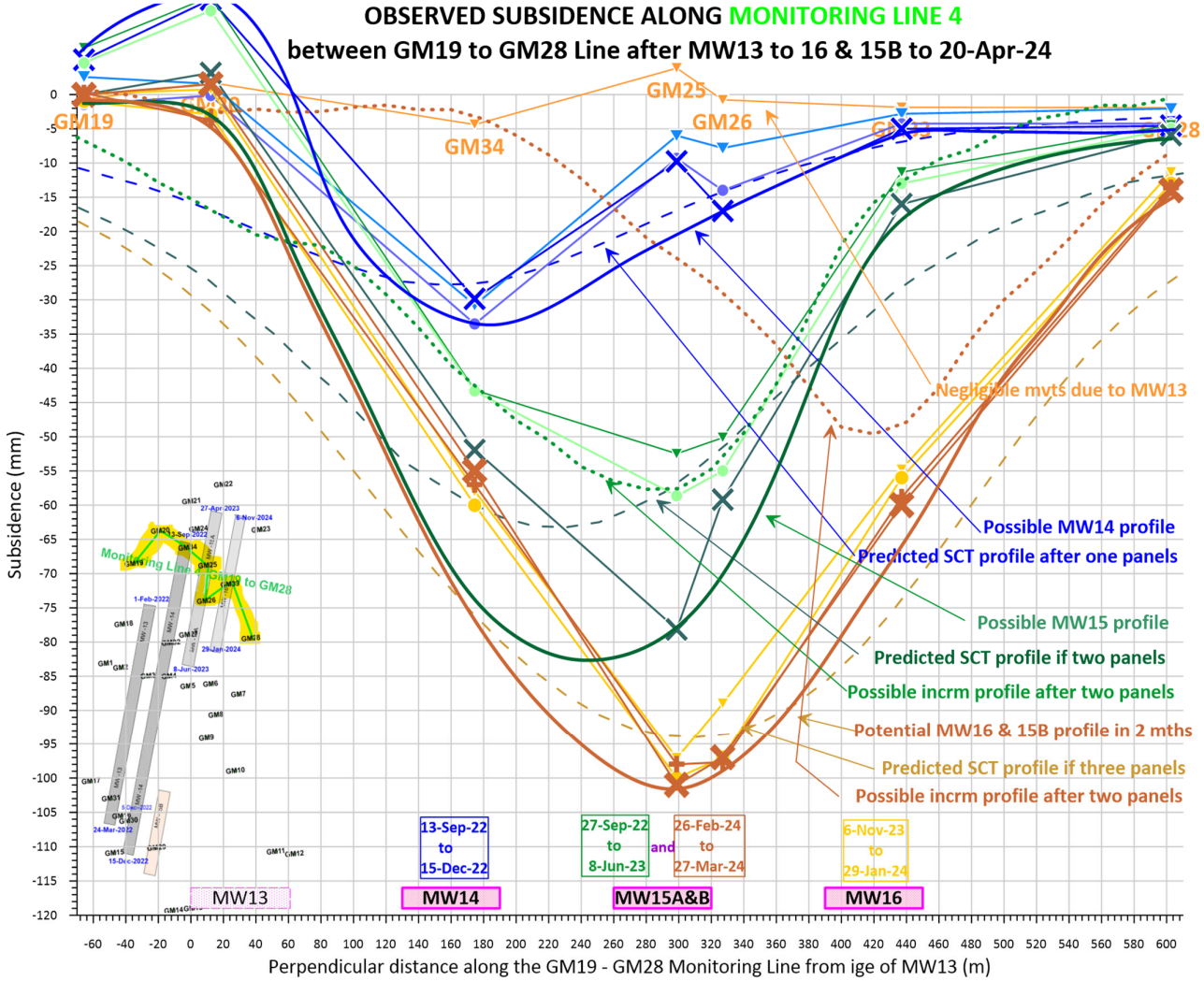


Fig. 3.12 Observed Subsidence along Monitoring Line 4 (MSEC)

3.5. Comparisons of Measured vs Predicted Subsidence after MW13 to MW16

Fig. 3.13 to Fig. 3.16 show plots of the observed raw subsidence after MW13, MW14, MW15A, MW16 and MW15B compared against the SCT predicted subsidence values for all 34 GNSS units during extraction of MWs 13 to 16.

It can be noted that slight exceedances occurred compared to the predictions for one, two and three panels, i.e. by 1 to 14 mm, however, there were no exceedances over the predictions for four side by side panels when MW16 and MW15B were extracted as at the end of 2024.

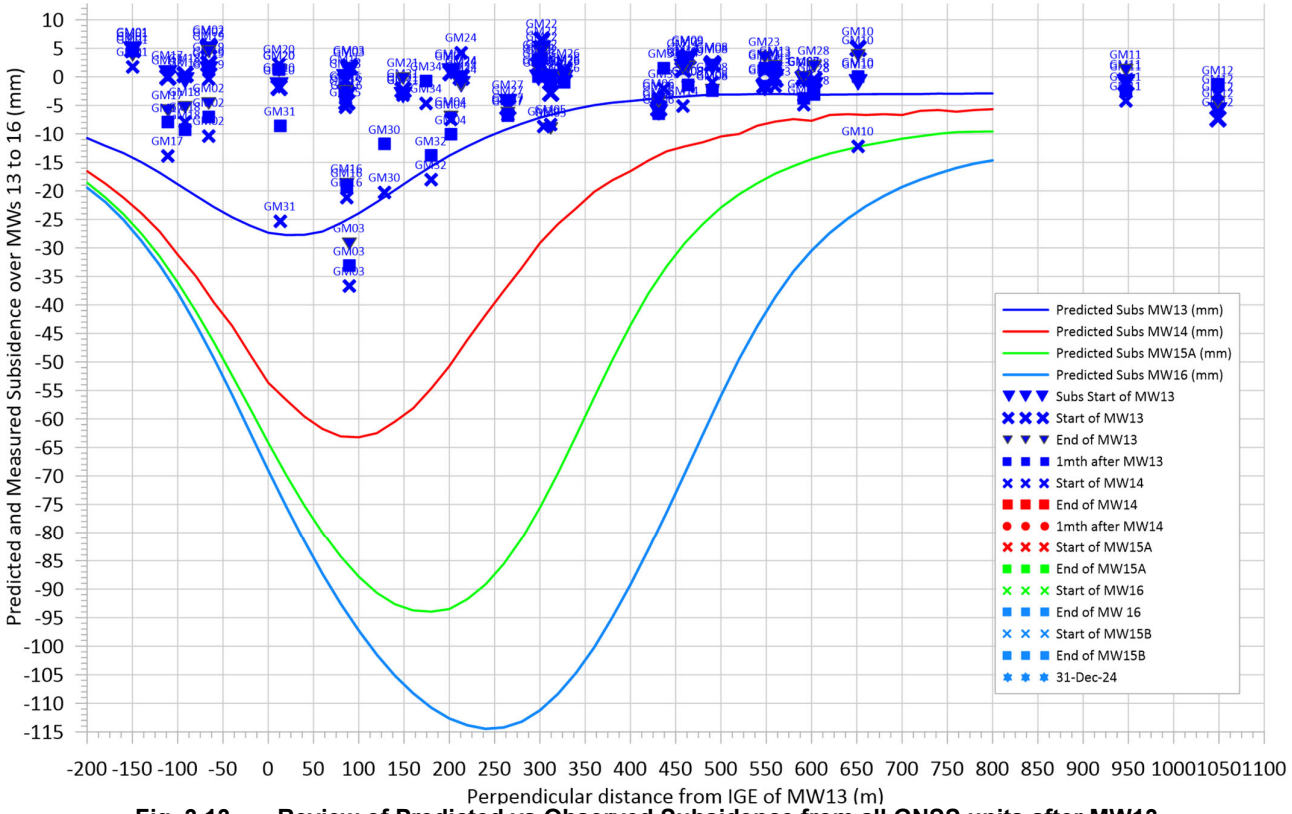


Fig. 3.13 Review of Predicted vs Observed Subsidence from all GNSS units after MW13

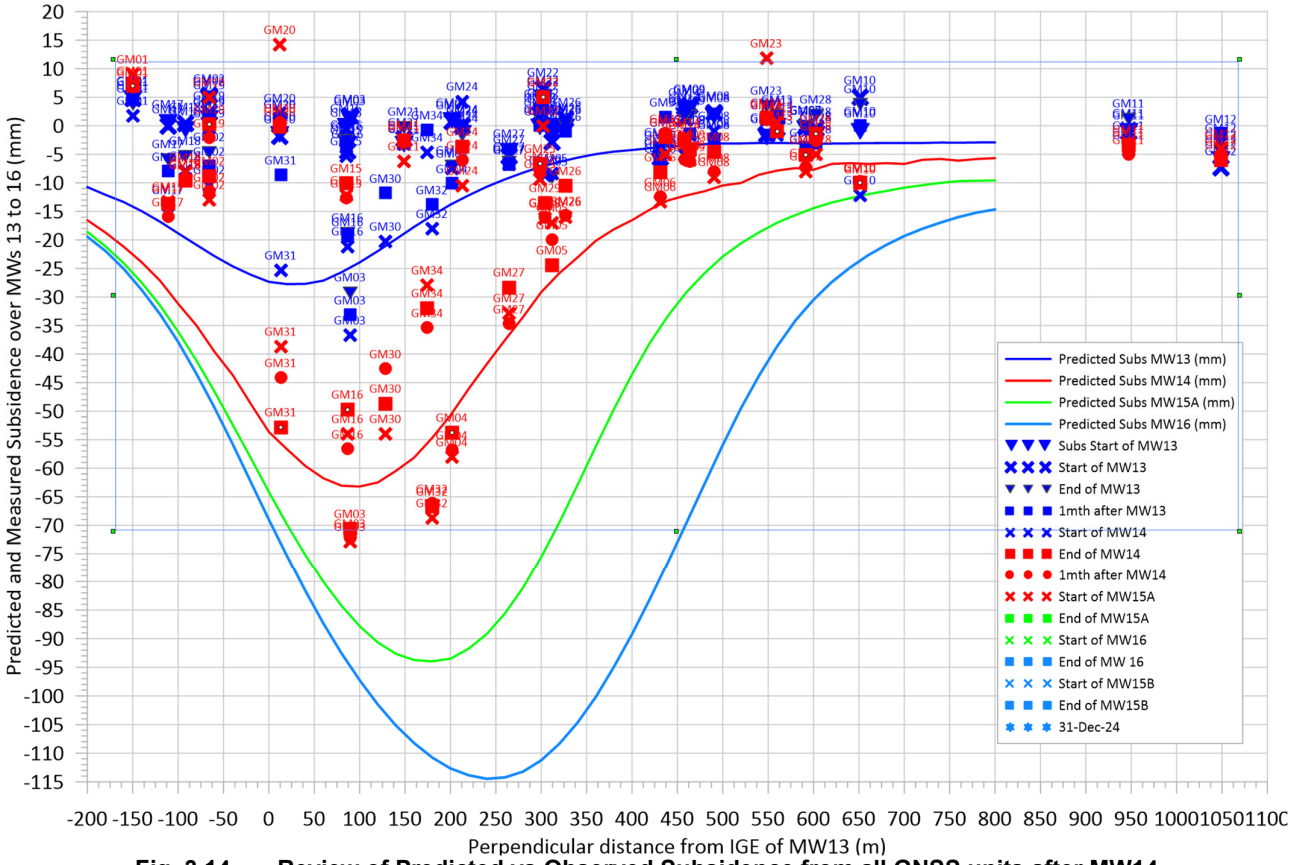


Fig. 3.14 Review of Predicted vs Observed Subsidence from all GNSS units after MW14

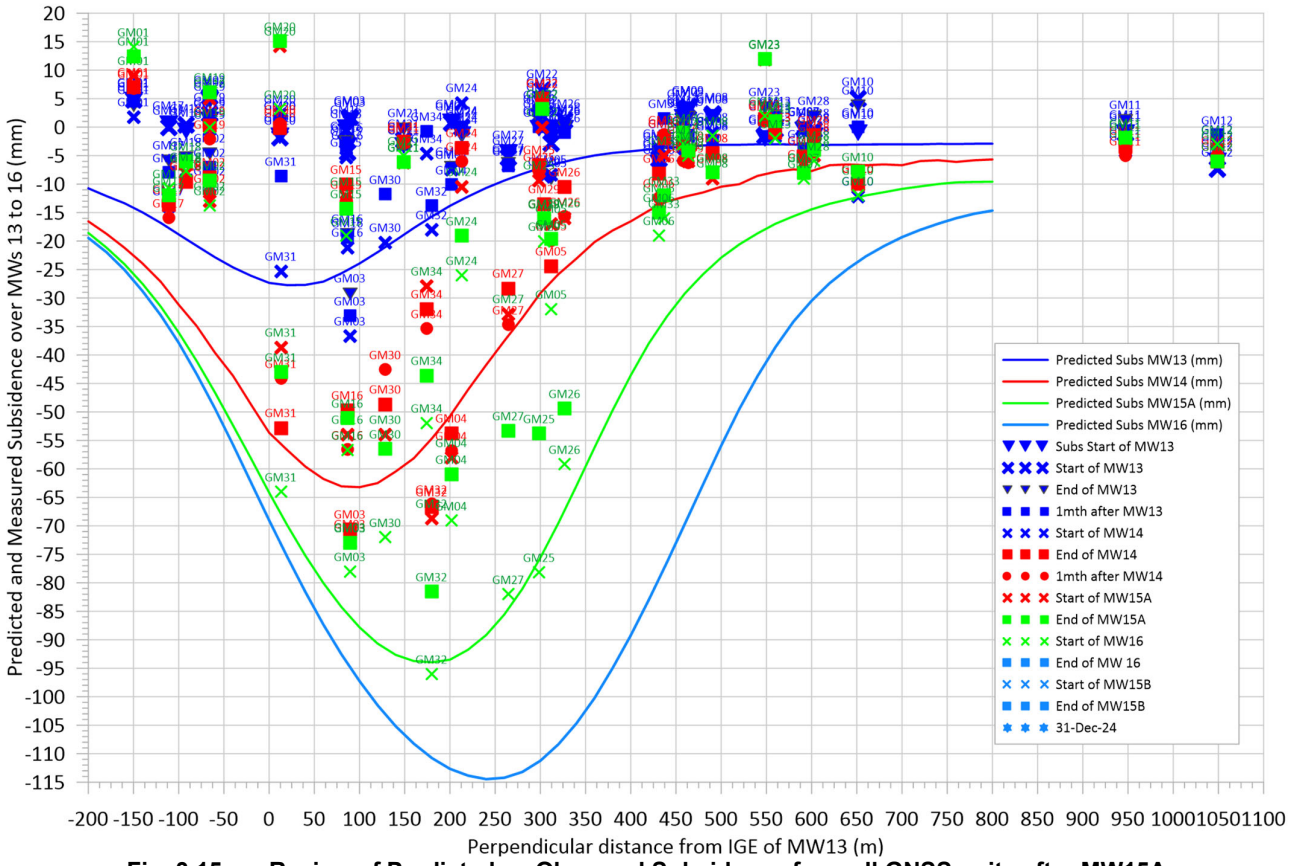


Fig. 3.15 Review of Predicted vs Observed Subsidence from all GNSS units after MW15A

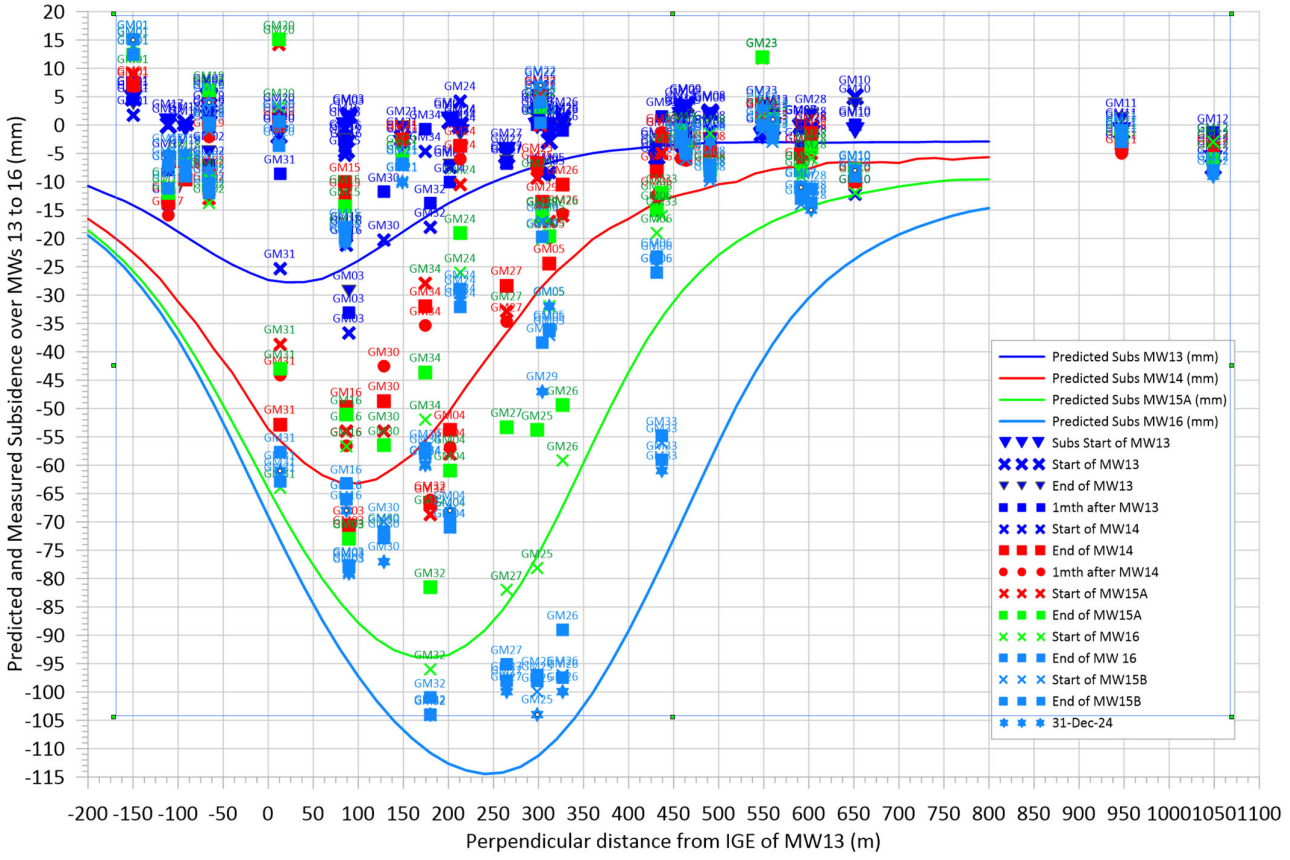


Fig. 3.16 Review of Predicted vs Observed Subsidence from all GNSS units after MW16 and MW15B

3.6. Observed Subsidence Contours over MWs 13 to 16

Fig. 3.17 shows some assumed observed subsidence contours over MW13 to MW14 in April 2023, i.e., just before extraction in MW15A commenced, based on the available GNSS station subsidence results. The positions of these subsidence contours are highly subjective, and other contours may have been drawn if more GNSS units or survey pegs could have been installed over this mesa.

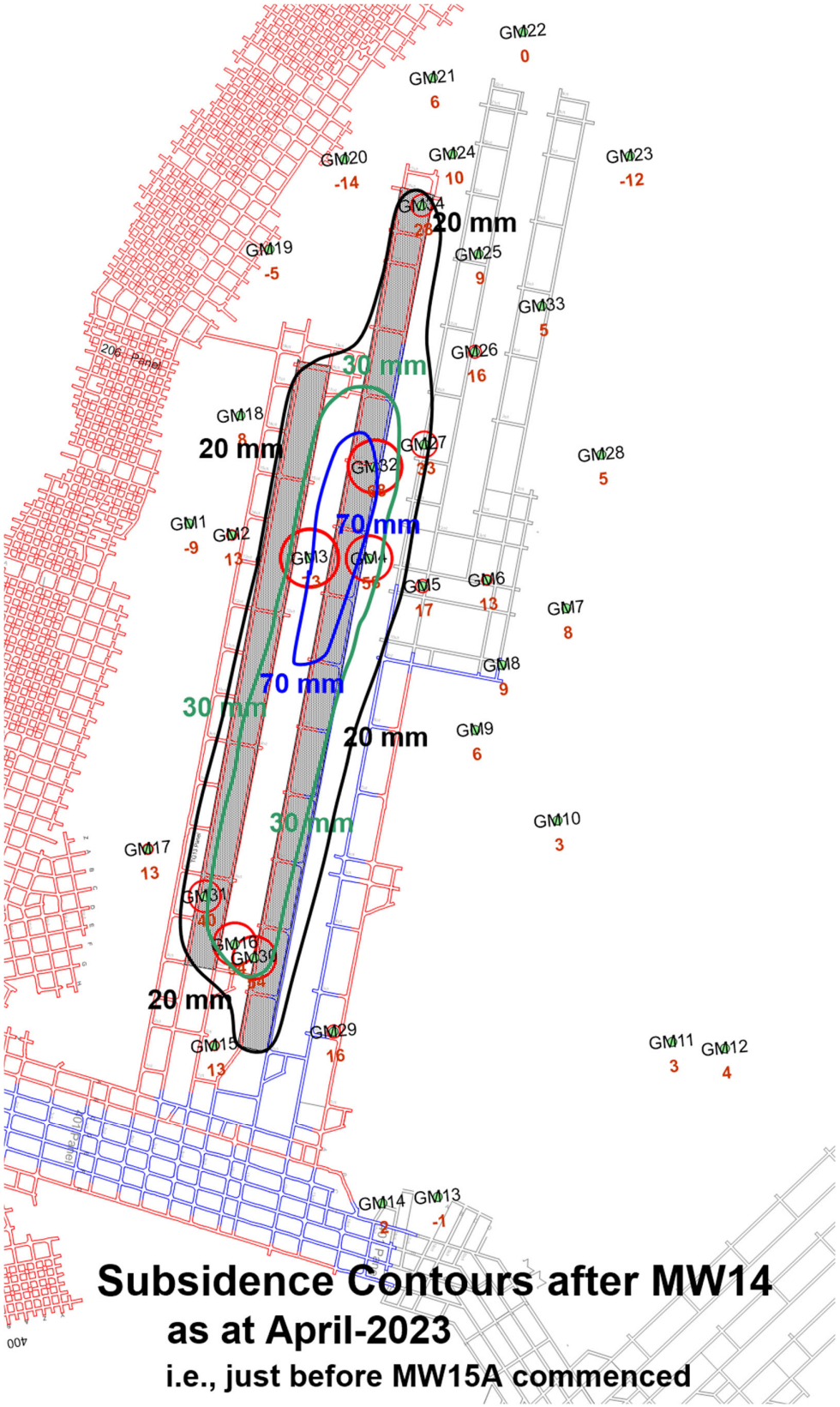


Fig. 3.17 Observed Subsidence Contours from all GNSS units after MW14

Fig. 3.18 shows some assumed observed subsidence contours after MW13 to MW15A were extracted in July 2023 based on the available GNSS station subsidence results. The positions of these subsidence contours are highly subjective, and other contours may have been drawn if more GNSS units or survey pegs could have been installed over this mesa.

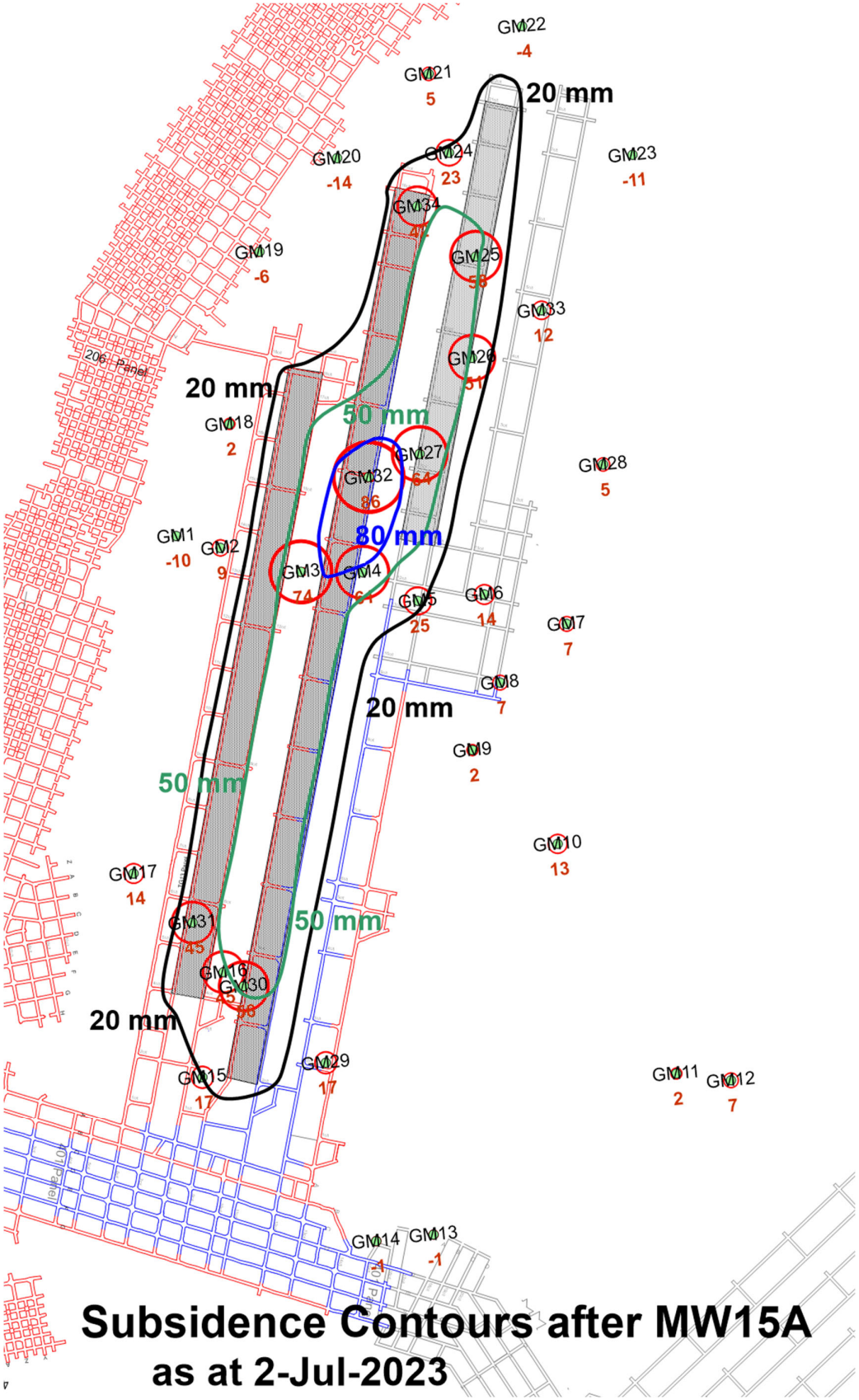


Fig. 3.18 Observed Subsidence Contours from all GNSS units after MW15A

Fig. 3.19 shows some assumed observed subsidence contours after MW13 to MW15A were extracted and most of MW16 was extracted in Dec 2023 based on the available GNSS station subsidence results. The positions of these subsidence contours are highly subjective, and other contours may have been drawn if more GNSS units or survey pegs could have been installed over this mesa.

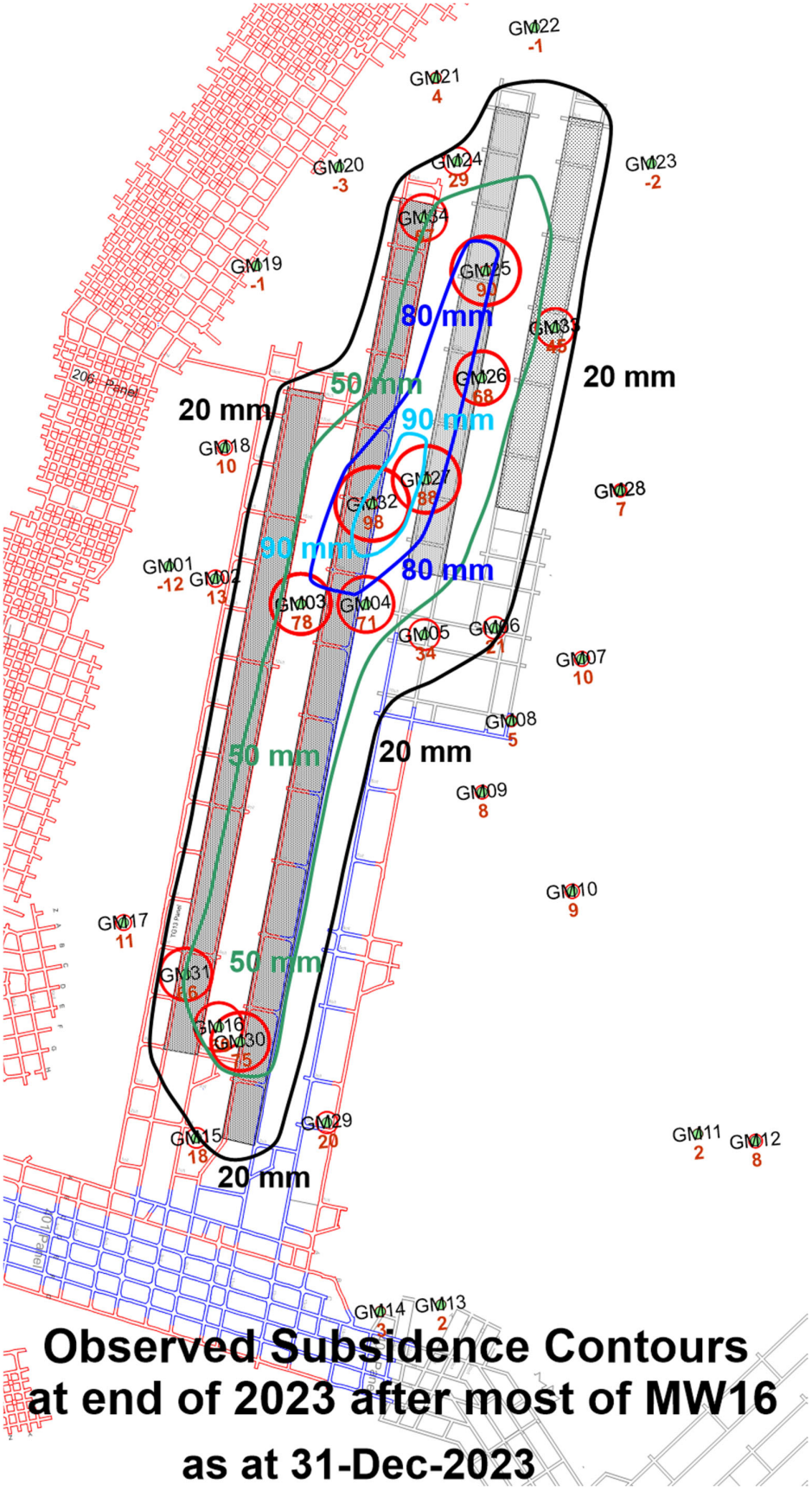


Fig. 3.19 Observed Subsidence Contours from all GNSS units after most of MW16

Fig. 3.20 shows some assumed observed subsidence contours after MW13 to MW15A and MW15B were extracted in May 2024 based on the available GNSS station subsidence results. The positions of these subsidence contours are highly subjective, and other contours may have been drawn if more GNSS units or survey pegs could have been installed over this mesa.

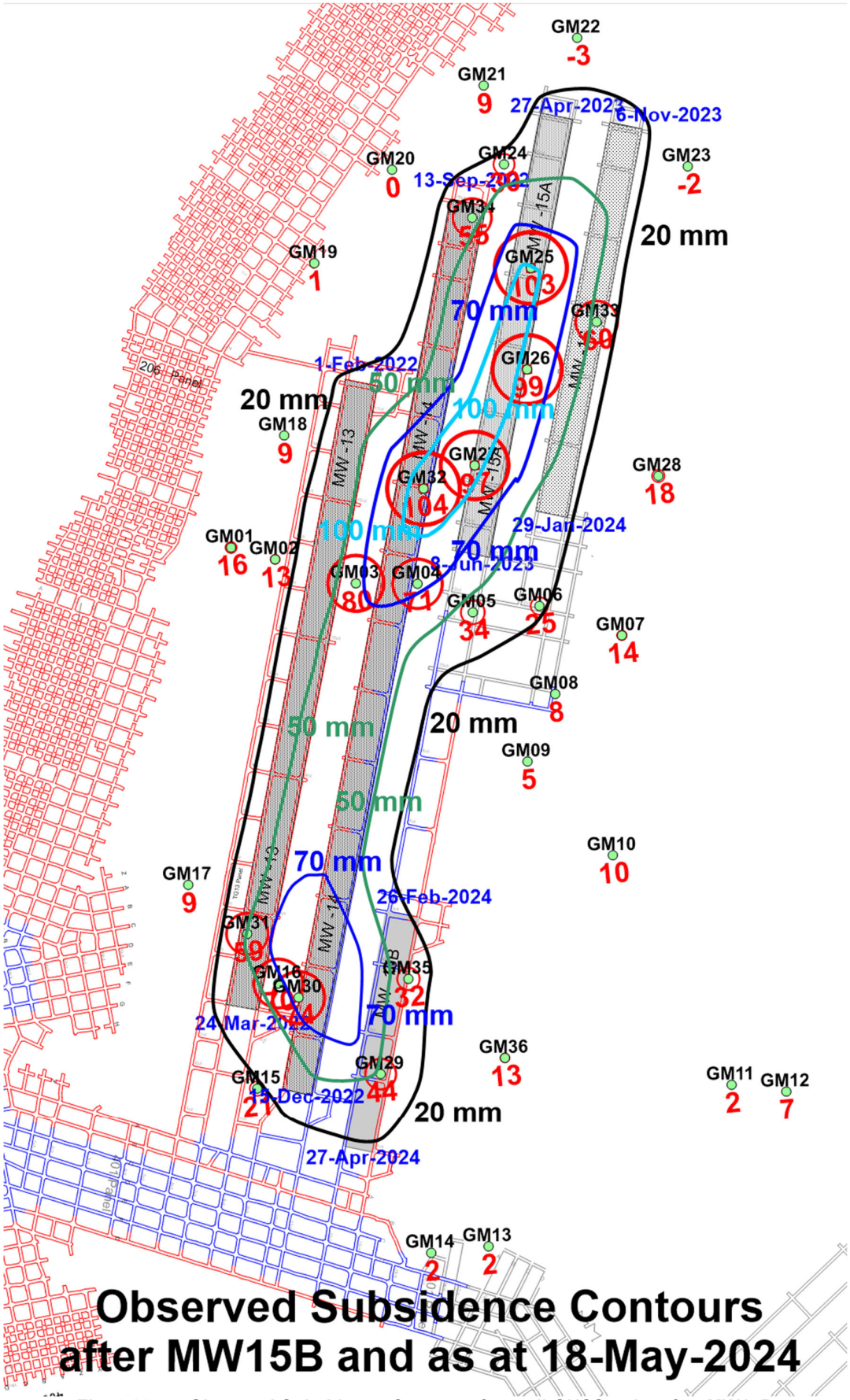


Fig. 3.20 Observed Subsidence Contours from all GNSS units after MW15B

3.7. Observed Horizontal Movement Vectors after MW16

Fig. 3.8 showed the observed horizontal movements measured at the GNSS units on a daily basis up to the end of 2023. Fig. 3.21 shows the horizontal movements measured as vectors at the GNSS units on 2-Jul-2023, i.e., after MW15A was extracted and Fig. 3.22 shows the horizontal movements measured as vectors at the GNSS units on 31-Dec-2023, i.e., when MW16 was almost fully extracted and Fig. 3.23 shows the horizontal movements measured as vectors at the GNSS units on 3-Mar-2024, i.e., after MW15B was extracted. *No adjustment was provided for the missing horizontal movements at the six new GNSS units that were installed after MW13*.

The maximum horizontal movement measured after MW15A was extracted was 60 mm which was recorded at station GM04 and GM05, which are located up on top of the Genowlan Mountain mesa. The maximum horizontal movement measured after MW16 was almost extracted was 59 mm which was recorded at station GM04. Slightly higher measurements of subsidence and horizontal movements would have been recorded if there had been more GNSS units located over the mesa.

As the GNSS units are spaced widely apart from each other, the monitoring system is not designed to measure maximum tilts, strains and curvatures over the panels. Given that maximum observed subsidence is 98 mm, it is expected that actual mining-induced tilts, strains and curvatures would also be relatively minor.

Other subsidence effects such as mining-induced tilts, strains and curvatures were not specifically predicted by SCT (2021), which focussed on predicting maximum subsidence above the miniwall panels.

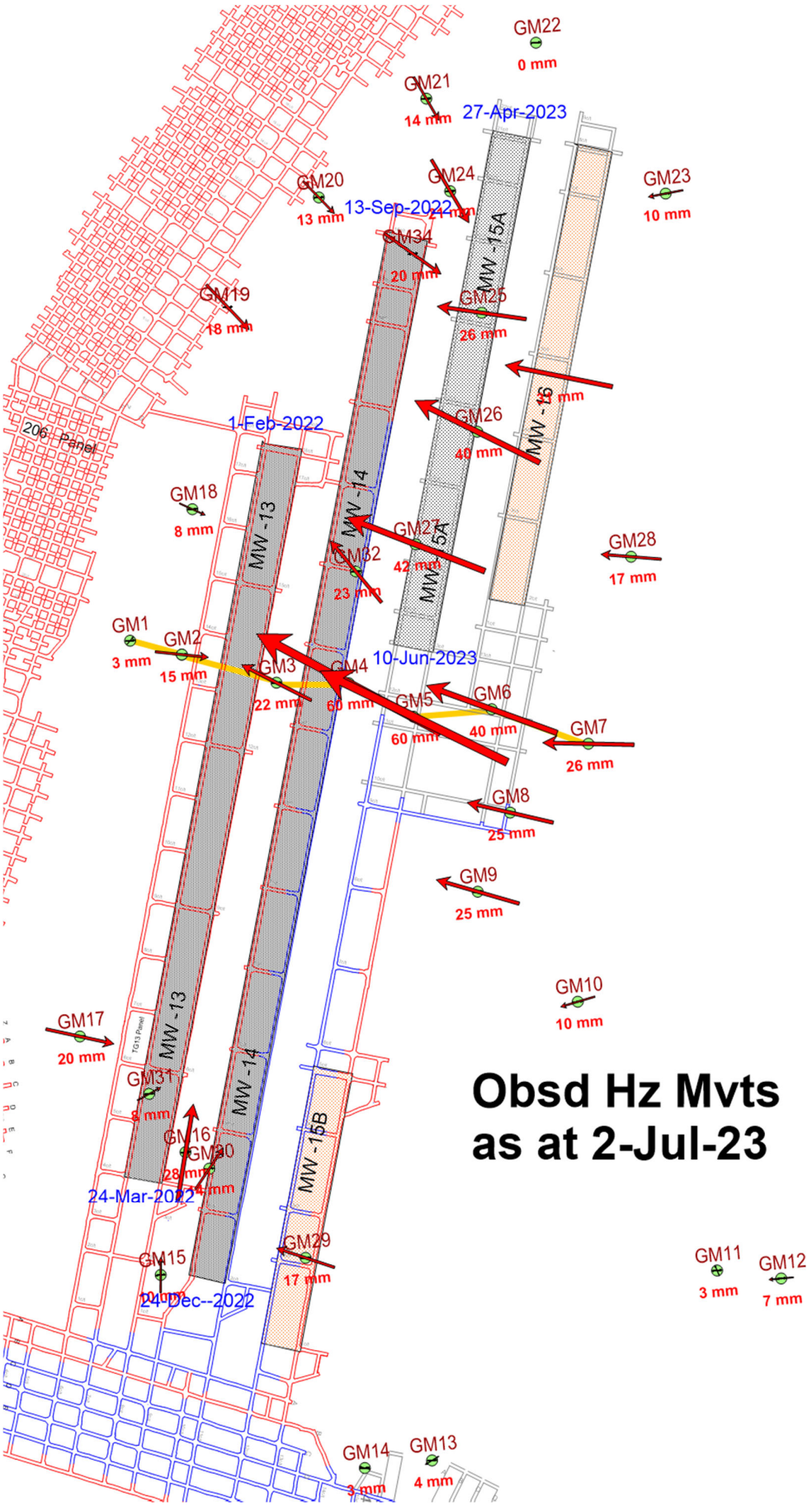


Fig. 3.21 Observed Horizontal Movements of GNSS units after the extraction of MWs 13 to 15A (MSEC)

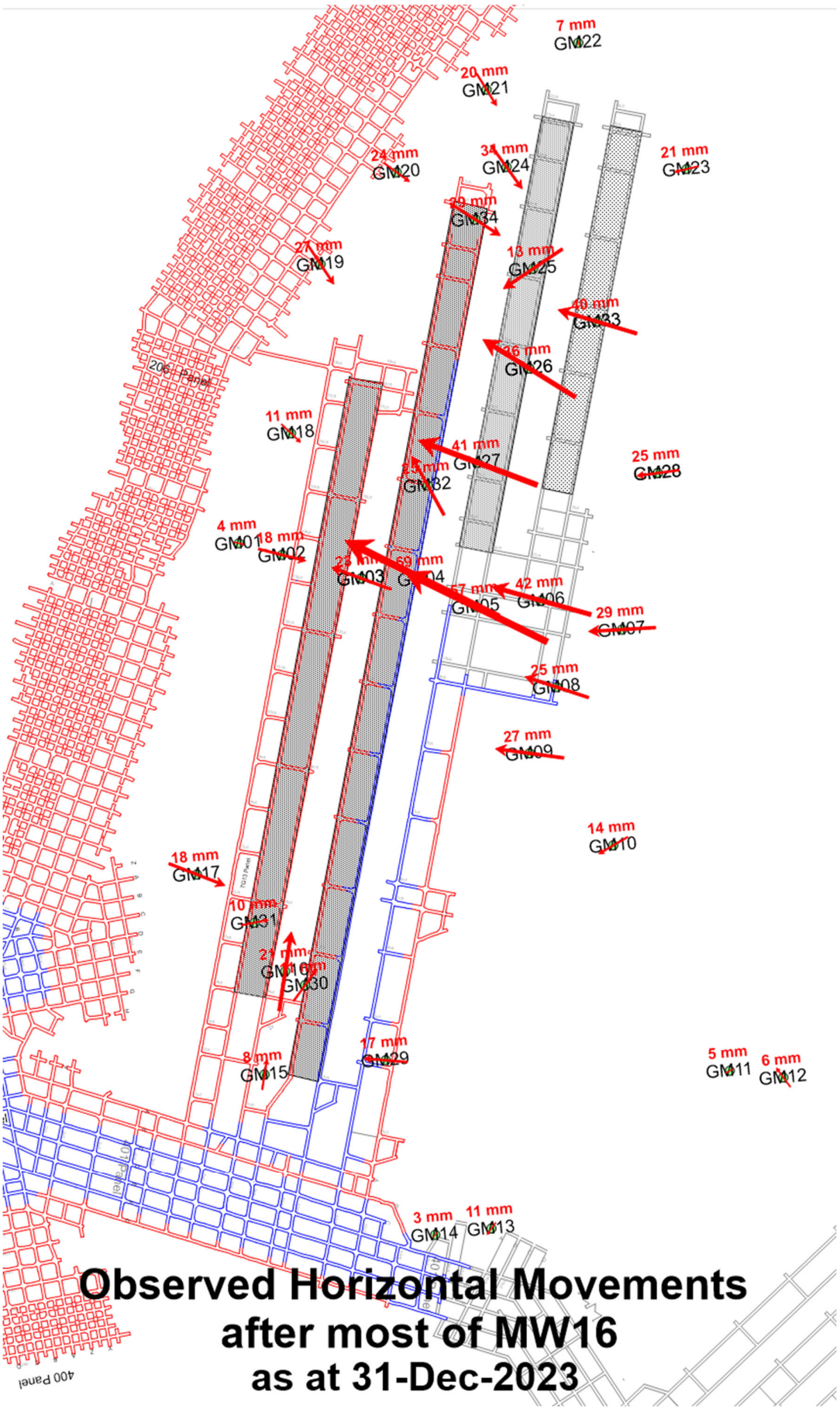


Fig. 3.22 Observed Horizontal Movements of GNSS units after the extraction of MWs 13 to 16 (MSEC)

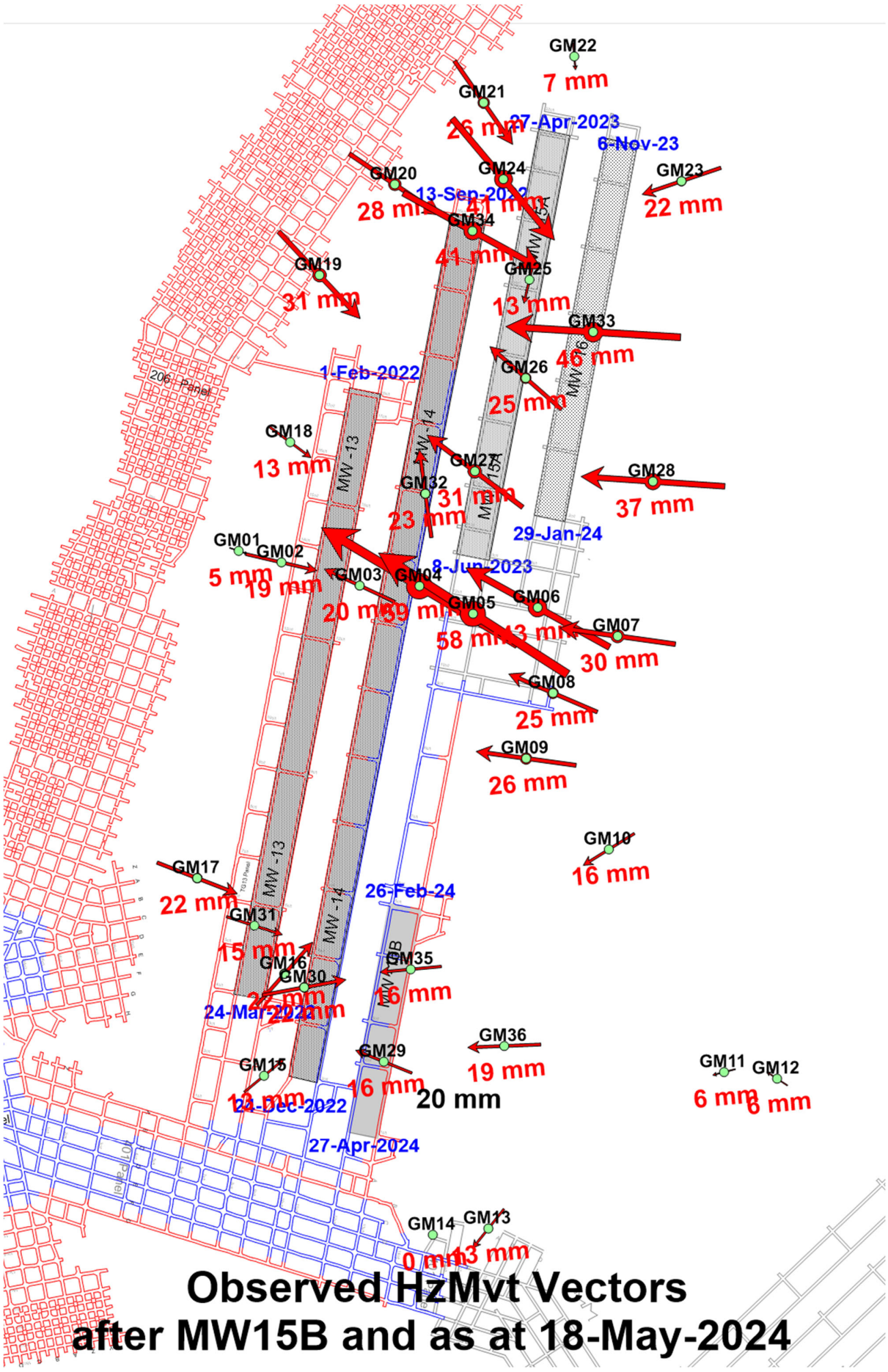


Fig. 3.23 Observed Horizontal Movements of GNSS units after the extraction of MWs 13 to 15B (MSEC)

3.8. *Conclusions from the vertical subsidence monitoring data*

Fig. 3.7 to Fig. 3.23 showed that less subsidence has measured over MW13 to 16 than was predicted for four panels being extracted. That is, based on the available subsidence monitoring, after MWs13 to 16 was extracted under Point Hatteras, the maximum observed subsidence level was 104 mm with the maximum possible or likely subsidence being about 110 mm, which is less than the predicted SCT levels of 115 mm for four panels over MWs 13 to 16, (SCT Report AIRLY5240. Jan 2021 and SCT Report AIRLY5265, Aug 2021), and less than the approved subsidence limit of 125 mm.

It can be noted from Fig. 3.7 that the four GNSS units with greatest observed subsidence values, i.e., GM32 (104 mm), GM27 (100 mm), GM26 (100 mm), and GM25 (104 mm), are all located over the central regions of MWs 13 to 16, where the depths of cover are the greatest. Slightly higher maximum subsidence values would have been recorded if more GNSS units had been installed where the depths of cover were higher.

Miniwall mining in this area is complete and, based on the subsidence monitoring that has been undertaken to date, it can be concluded that the ongoing residual subsidence will remain low and the total subsidence should remain less than the approved subsidence limit of 125 mm.

3.9. *Observed Horizontal Movement Vectors after MW15B*

Fig. 3.8 showed the observed horizontal movements measured at all the GNSS units on a daily basis up to the end of 2024.

The maximum horizontal movements measured after MW15B was extracted of 59 mm and 58 mm were recorded at stations GM04 and GM05, which are located up on top of the Genowlan Mountain mesa, as shown in Fig. 3.22.

It can be noted from that most of the GNSS units were moved towards the centre of the mined panels and the maximum horizontal movements occurred where there would have been also considerable downslope movement.

As the GNSS units are spaced widely apart from each other, the monitoring system is not designed to measure maximum tilts, strains and curvatures over the panels. Given that maximum observed subsidence is only 104 mm, it is expected that actual mining-induced tilts, strains and curvatures would also be relatively minor.

Other subsidence effects such as mining-induced tilts, strains and curvatures were not specifically predicted by SCT (2021), which focussed on predicting maximum subsidence above the miniwall panels.

3.10. Subsidence Monitoring Conclusions

CA has now extracted MW16 and MW15B under the Point Hatteras region of the Genowlan Mountain.

Very low subsidence levels have been monitored over MWs 13 to 16. Slightly higher measurements of subsidence and horizontal movements would have been recorded if there had been more GNSS units located over the mesa and some further small residual movements can be expected over MW16.

However, the maximum expected subsidence levels are lower than the SCT FLAC model predicted subsidence value of 115 mm and less than the maximum predicted values in the 2014 EIS of 125 mm.

Hence, it can be concluded from the monitoring results, that the FLAC model accurately analyses the complex relationships between changing material properties, panel & pillar widths, seam thicknesses, number of panels extracted and varying DoCs over the pillars.

4.1. Initial Subsidence Predictions over MW17

The SCT report, dated June 2023, SCT AIRLY5612, predicted the maximum subsidence over MW17 would be 39 ± 20 mm for an extracted seam thickness of nominally 3.0m.

4.2. Subsidence Measurements over MW17

Daily subsidence movements (subsidence effects) are being measured remotely over MWs17 to 18 from 22 continuously operating Global Navigation Satellite System (GNSS) survey stations, that are located as shown in Fig. 4.1. Fig. 4.1 also shows vectors of the horizontal movements of the GNSS units, (Geomatix).

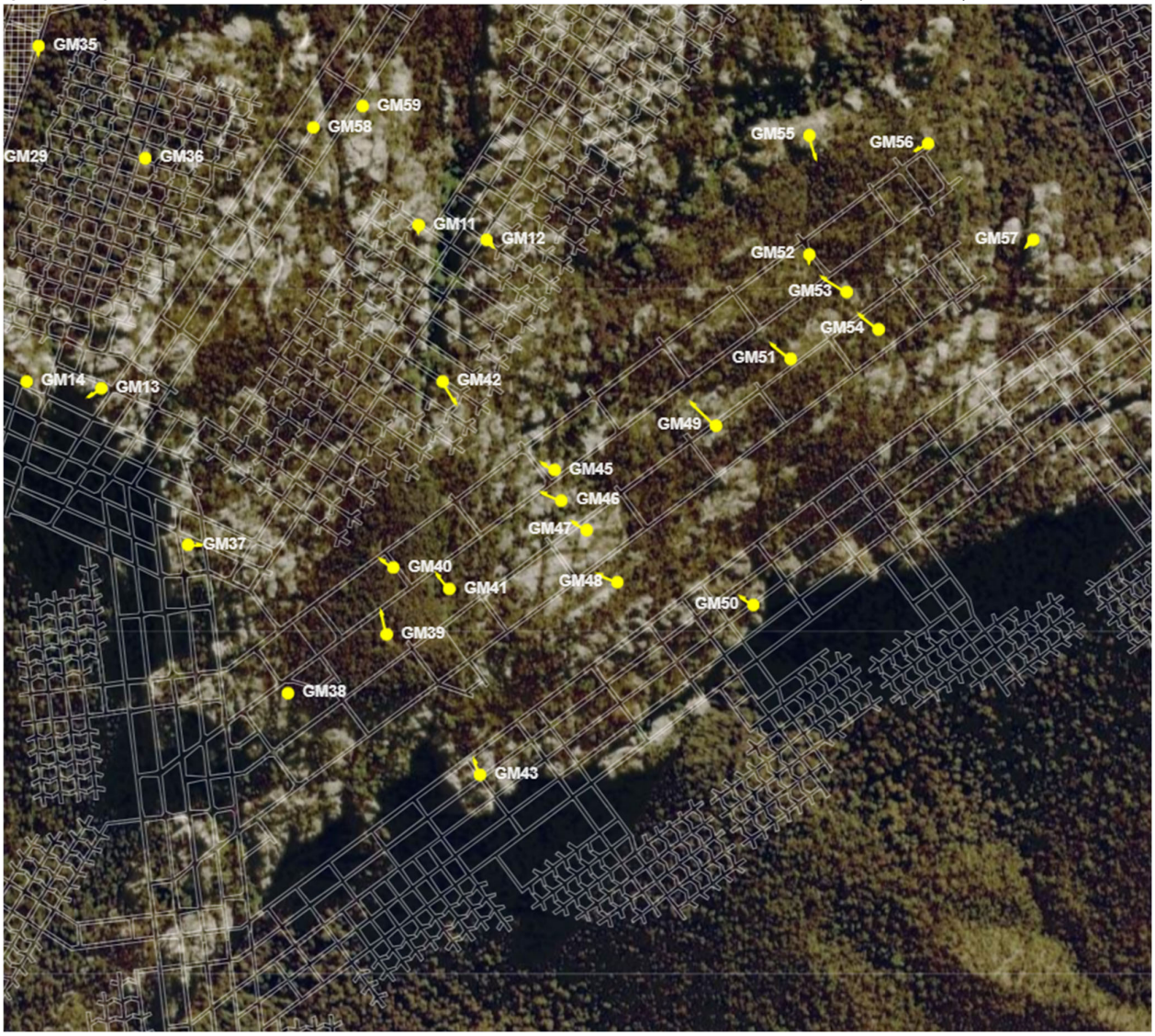


Fig. 4.1 Locations of GNSS units over MW17 and Observed Horizontal Movements of GNSS units after the extraction of MWs 17 (Aeromatix)

Fig. 4.2 shows the measured subsidence at each of the 22 GNSS units over and near MW17 plotted against time. Extraction in MW17 was completed on 22 Nov-2024. The maximum measured subsidence was 52 mm at GNSS unit GM45 in the middle of MW17 on 9-Dec-24 and, then as can be seen in Fig. 4.2, the maximum observed subsidence reduced to 50 mm on 31-Dec-24 at both GM45 and GM52.

4.3. Updated Subsidence Predictions over MW17

In an updated report, SCT AIRLY5865, dated 15th January 2025, (*i.e. after MW17 was extracted*), SCT advised that the actual extracted seam thickness in MW17 had increased slightly to 3.2m, (*an increase of 7%*), and the updated maximum subsidence prediction due to MW17 is 43 mm (*an increase of 10%*), as shown in the Table below in Fig. 4.3. The measured maximum subsidence at unit GM45 of 52 mm is slightly higher (*by 9 mm*) than the base SCT predicted value of 43 ± 20 mm, but it does fit within the tolerance range specified by SCT of 43 ± 20 mm.

As indicated in this Table, CA is now considering varying the seam thickness to be extracted in MW18 to ensure the maximum subsidence over both MWs 17 & 18 remains under 125 mm.

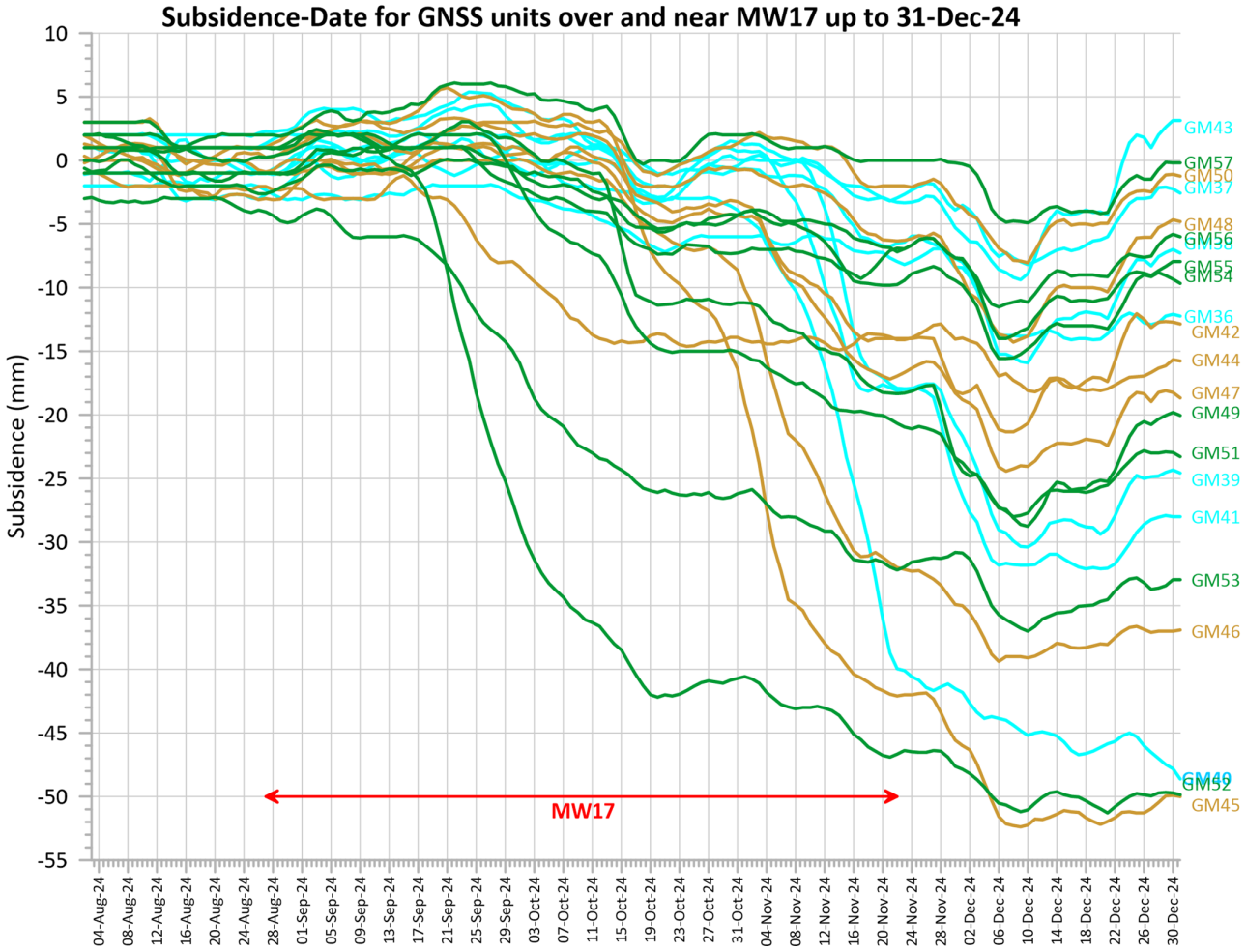


Fig. 4.2 Observed subsidence from GNSS units over and near MW17 (MSEC)

Table 1. Model surface subsidence results from MW17 and MW18 extraction at various cut heights

Depth (m)	Panel Width (m)	Pillar Width (m)	Extraction Height (m)		Subsidence (mm)			
			MW17	MW18	MW17	MW18	+20mm Tolerance	Max. Subsidence (m)
260	70.5	70	3.2	**2.8**	43	88	**108**	**118**
260	70.5	70	3.2	**3**	43	90	**110**	**120**
260	70.5	70	3.2	**3.2**	43	95	**115**	**125**

Fig. 4.3 Updated SCT subsidence predictions over MWs 17 & 18 (SCT)

Three of these GNSS units are located directly over the MW17 panel, i.e. GM40, GM45 and GM52, and it was expected that the maximum observed subsidence would occur at one of these units. Fig. 4.4 shows the variation in DoC over MW17 and it can be noted that the DoC varies along the panel. Near GM52 the average DoC is 220m, near GM45 the average DoC is 250m, and near GM40 the average DoC is 280m as shown in Fig. 4.4.

It can be noted, from this plot, that, each unit experienced rapidly increasing subsidence for about one month and then slower rates of residual subsidence for a further period of some months. It is not clear yet why increased levels of residual subsidence were observed over GM40, but it could be that having the greatest DoC, the claystone layers located just above the seam at GM49 were more affected than the layers over GM45 and GM52.

Additionally, each GNSS unit also experiences small variations in subsidence due to the changing stresses over and around the MW17 panel as the MW18 headings were driven near each unit. Plus, as can be seen in this plot that, on top of the mining induced changes, these GNSS units also experience additional changes in subsidence levels, of ± 4 mm, due to the changing weather conditions, such as from the higher-than-average levels of rain fall that occurred in early December.

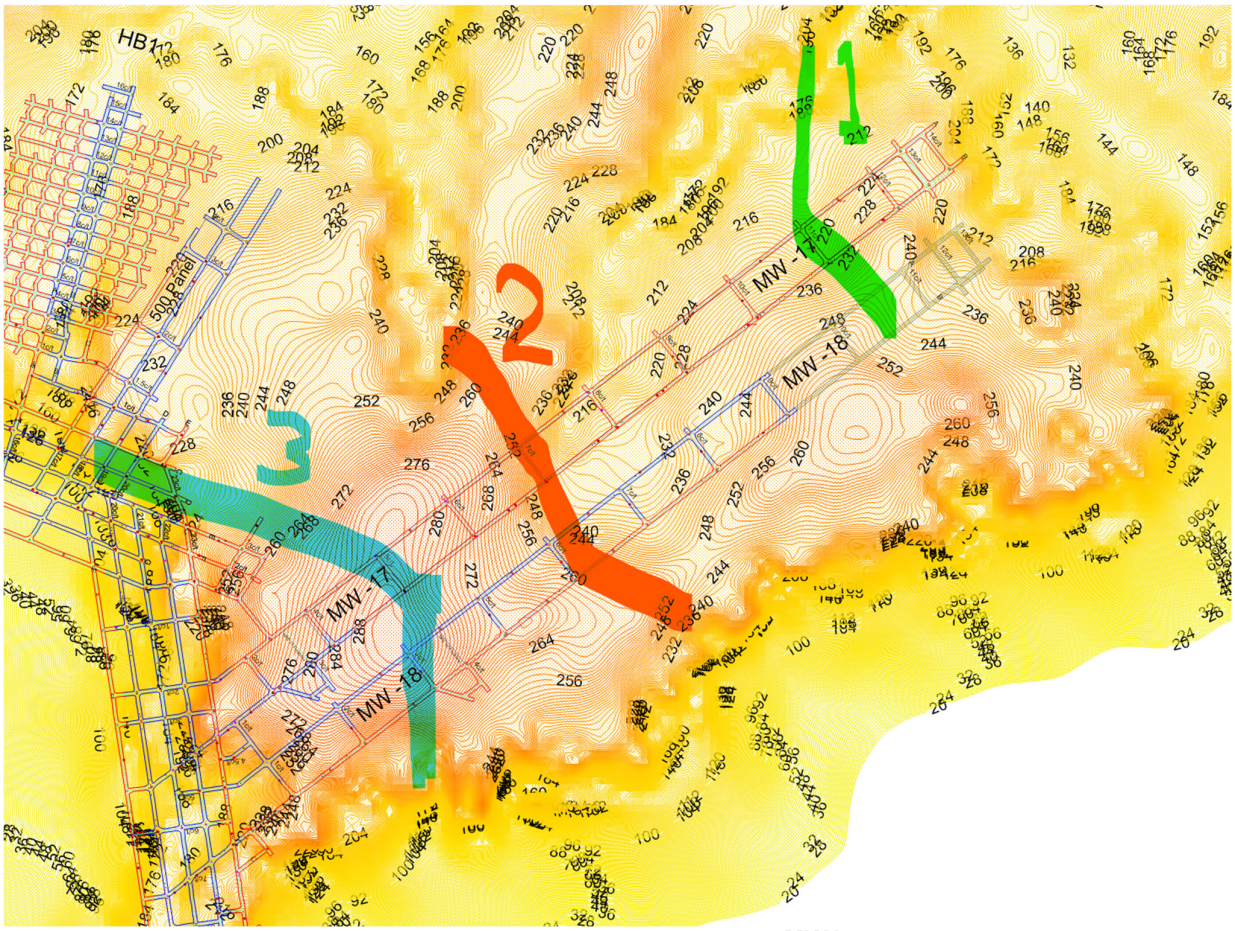


Fig. 4.4 Variation in DoC along MW17

Fig. 4.4 and Fig. 4.5 show the GNSS unit locations plotted over a current mine plan of the MW17 to 18 workings, plus it shows the location of three prediction lines, labelled **PrednLine 1**, **PrednLine 2** and **PrednLine 3, and** the measured subsidence (mm) at each GNSS unit up to the end of December 2024 as labels below each GNSS unit.

The subsidence time curves that are shown in Fig. 4.2 have been coloured **green**, **brown** or **blue** depending on whether the GNSS unit is located near **PrednLine 1**, **PrednLine 2** and **PrednLine 3**.

in Fig. 4.2 it can be seen that GM52 and GM45 have not changed much since 4th Dec 24, whilst ongoing residual subsidence was continuing at GM40 as at the end of December 20124

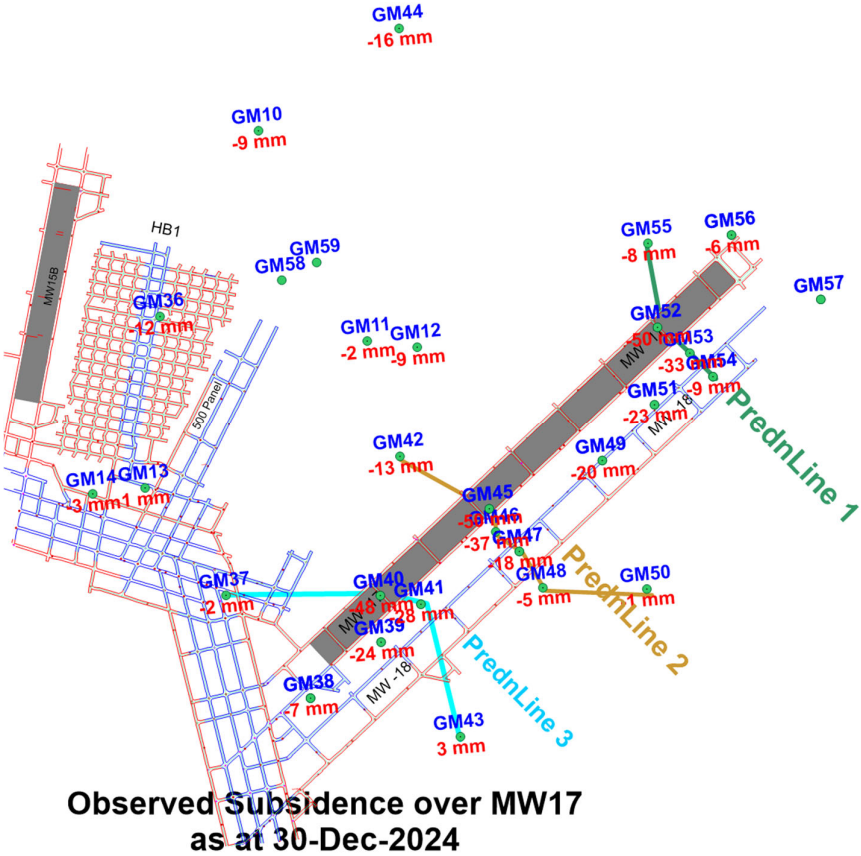


Fig. 4.5 Locations of GNSS units over MW17 and location of monitoring lines over MWs 17 (MSEC)

4.4. Why wasn't the highest subsidence measured at GNSS Unit 40 where the DoC is greatest?

Over the previously extracted panels at Airly, i.e. over MWs 02 to 16, the highest subsidence levels were observed where the DoC was greatest because the main mechanism causing most of the unexpected subsidence was associated with failures over the pillars. That is, highest subsidence occurred where there were pillars and where the DoC and weight on the pillars was greatest.

But since MW17 is at the moment a single or first panel in a series of panels, no pillars have been formed at this stage and, hence, the subsidence over this panel is not controlled by failures over the pillars, but it is controlled by sag subsidence mechanism. To result in very low subsidence, the Airly mine was designed with very narrow panels of low panel width to depth ratios (W/H) so that they would have little sag subsidence.

As was predicted in the Airly EIS and, as has been identified by the later mathematical modelling and as has been the measured over single panels at Airly, the maximum sag subsidence component with very narrow panels has been successfully small and less than 60 mm.

Fig. 4.6, which were prepared in 2014 for the Airly EIS, show the maximum measured subsidence over a range of single first panels from differing coal regions and different seams, and the observed sag subsidence over first panels generally reduces as the panel's width to depth ration reduces.

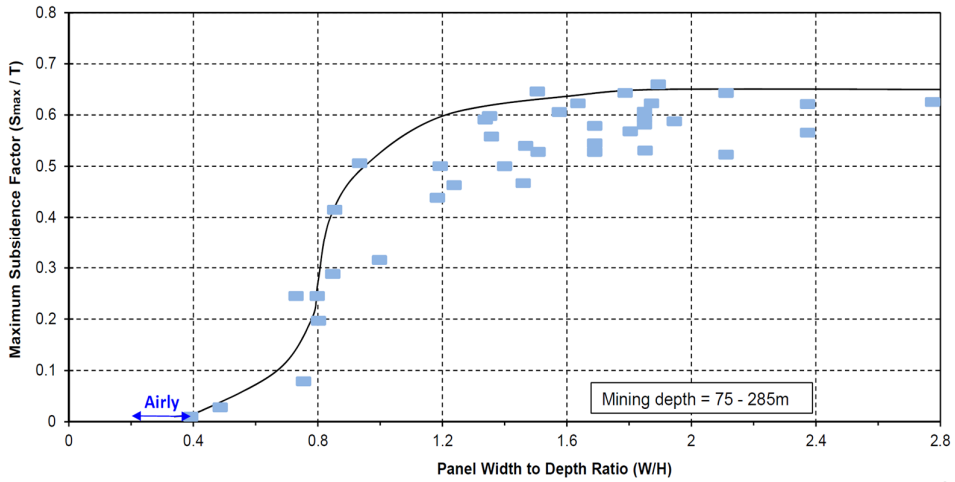


Fig. 4.6 Classic SubsidenceOn Seam vs Panel Width on Depth Plot from Holla)

Fig. 4.7 shows more detail of the available monitored cases with very low Panel Widths on Depth of Cover that were similar to Airly and now, the measured maximum subsidence over the single panels at Airly, i.e. MW 02, MW13 and now MW17, have now been added to the second detailed plot below.

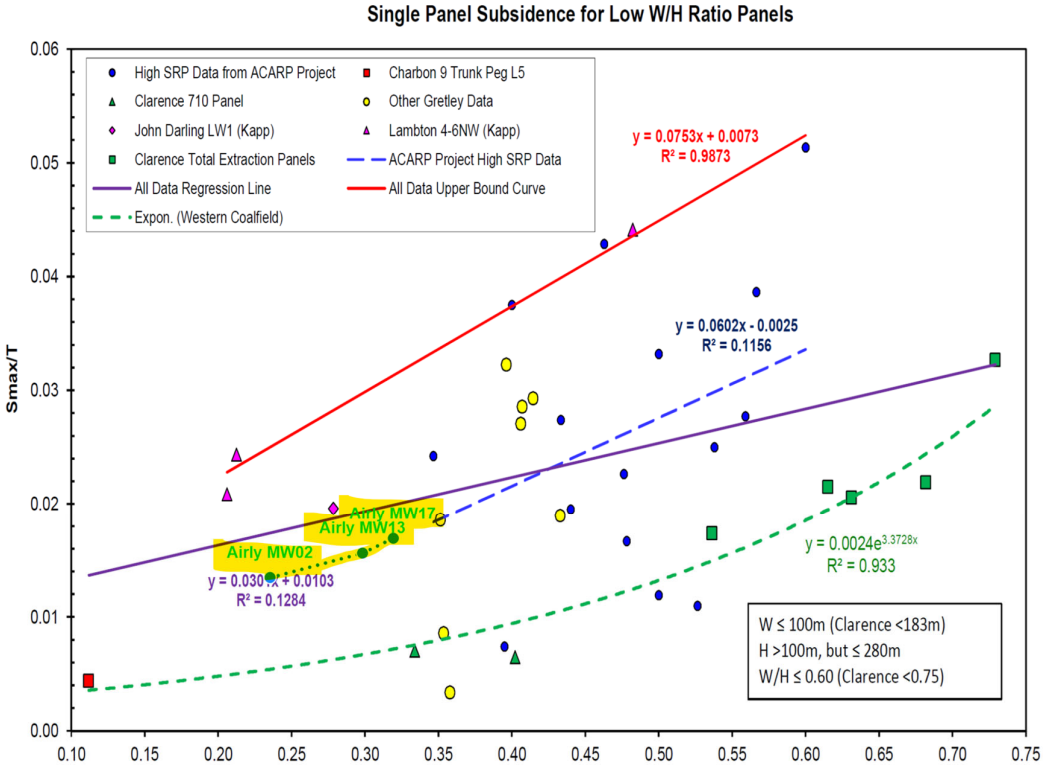


Fig. 4.7 Classic Subsidence on Seam vs Panel Width on Depth Plot from Holla (Airly EIS 2014, plus Airly MW02, MW13 and MW17 results added by MSEC)

As shown in Fig. 4.7, the observed subsidence on seam thickness for the single panels at Airly appear to be all very consistent when plotted to compare sag subsidence, i.e. Smax/Seam thickness against the panel W/H ratio. The new data plotted for the new Airly single or first panel sag subsidence cases is detailed below.

- The maximum measured subsidence over MW02 was 38 mm, or 0.0136 times the extracted seam thickness of 2.8m, at peg B12 where the Depth of Cover (DoC) was 260 m. For this location the panel width was 61 m and, hence, the panel W/H ratio was 0.235.
- The maximum measured subsidence over MW13 was 44 mm, or 0.0157 times the extracted seam thickness of 2.8m, at unit GM03, where the DoC was 205 m. For this location the panel width was 61 m and, hence, the panel W/H ratio was 0.297.
- The maximum measured subsidence over MW17 was 52 mm, or 0.0162 times the extracted seam thickness of 3.2m, at unit GM45, where the DoC was 220 m. For this location the panel width was 70 m and, hence, the panel W/H ratio was 0.318.

4.5. Maximum Subsidence Comparison between Predictions against Measured

Comparison between Predicted Subsidence Profile against Measured Subsidence Profile

The above referenced SCT reports provided a subsidence profile across both MWs 17 & 18 for the predicted **total** subsidence, but it only provided a maximum subsidence prediction for MW17d it didn't provide a single profile over or across MW17.

Fig. 4.8 shows three **predicted** subsidence profiles that were provided by the SCT predictions across MWs17 & 18 after the extraction of both MWs 17 & 18 for three different seam thicknesses, i.e. a **blue curve for 2.8 m seam**, a **green curve for 3.0 m seam** and a **red curve for 3.2 m seam** thickness extraction, (*Figure 7 in the SCT prediction report dated June 2023, SCT AIRLY5612*).

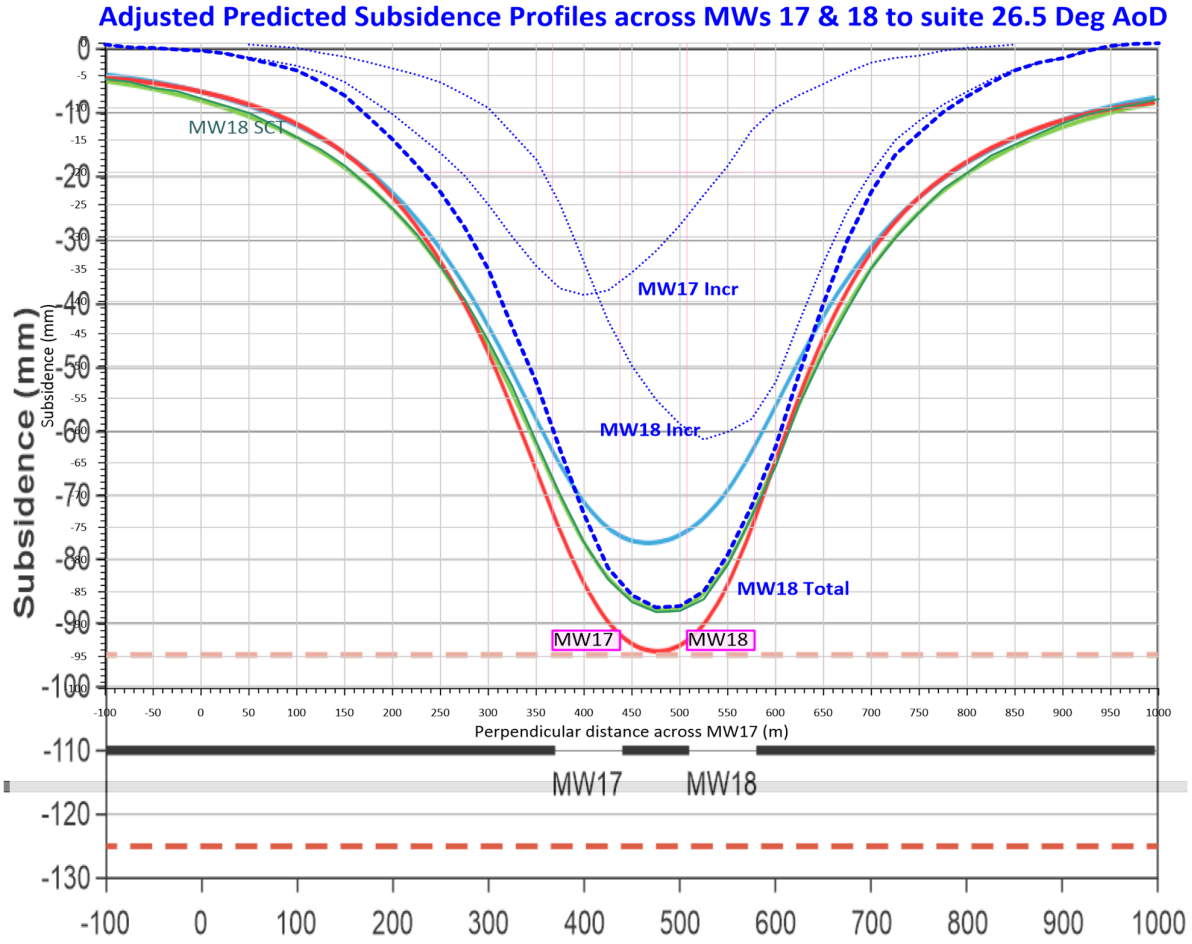


Fig. 4.8 Observed subsidence from GNSS units over and near MW17 (SCT & MSEC)

CA chose the **3.0 m seam** extraction option and the predicted total subsidence after MW17 & 18 is 88 ± 20 mm, as is as shown in Fig. 4.8.

SCT previously advised that the FLAC predicted profiles were generally been too wide and, as suggested by SCT, MSEC prepared the updated **dark blue dashed** predicted subsidence profile that is shown in Fig. 4.8 for the total subsidence profile after MW17 & 18 to match the expected 26.5 degree angles of draw profiles and the maximum predicted subsidence of 88 ± 20 mm.

Then, MSEC prepared the two thinner dotted blue predicted incremental subsidence profiles for MW17 and MW18 that are shown in the plot below to match the expected 26.5 degree angles of draw profiles. The MW17 incremental profile has the SCT maximum predicted subsidence of 39 mm and the MW18 maximum value of 61 mm was deduced to align with the SCT maximum predicted subsidence over both MWs 17 & 18mm of 88 mm.

However following the increased seam extraction thickness of 3.2 m over MW17 and the updated SCT predictions for varying seam thicknesses in MW18, MSEC has revised the analysis of subsidence profiles across MWs 17 & 18 and Fig. 4.9 shows the revised predicted subsidence profiles across the three prediction lines over MW17 against the predicted values for the case where MW17 is extracted with 3.2 m and MW18 is extracted with 2.8 m, i.e. the total predicted subsidence after MW17 & 18 is maintained at 88 mm. It can be seen that MW17 has a maximum predicted subsidence of 43 mm and MW 18 now has a maximum predicted subsidence of 60 mm.

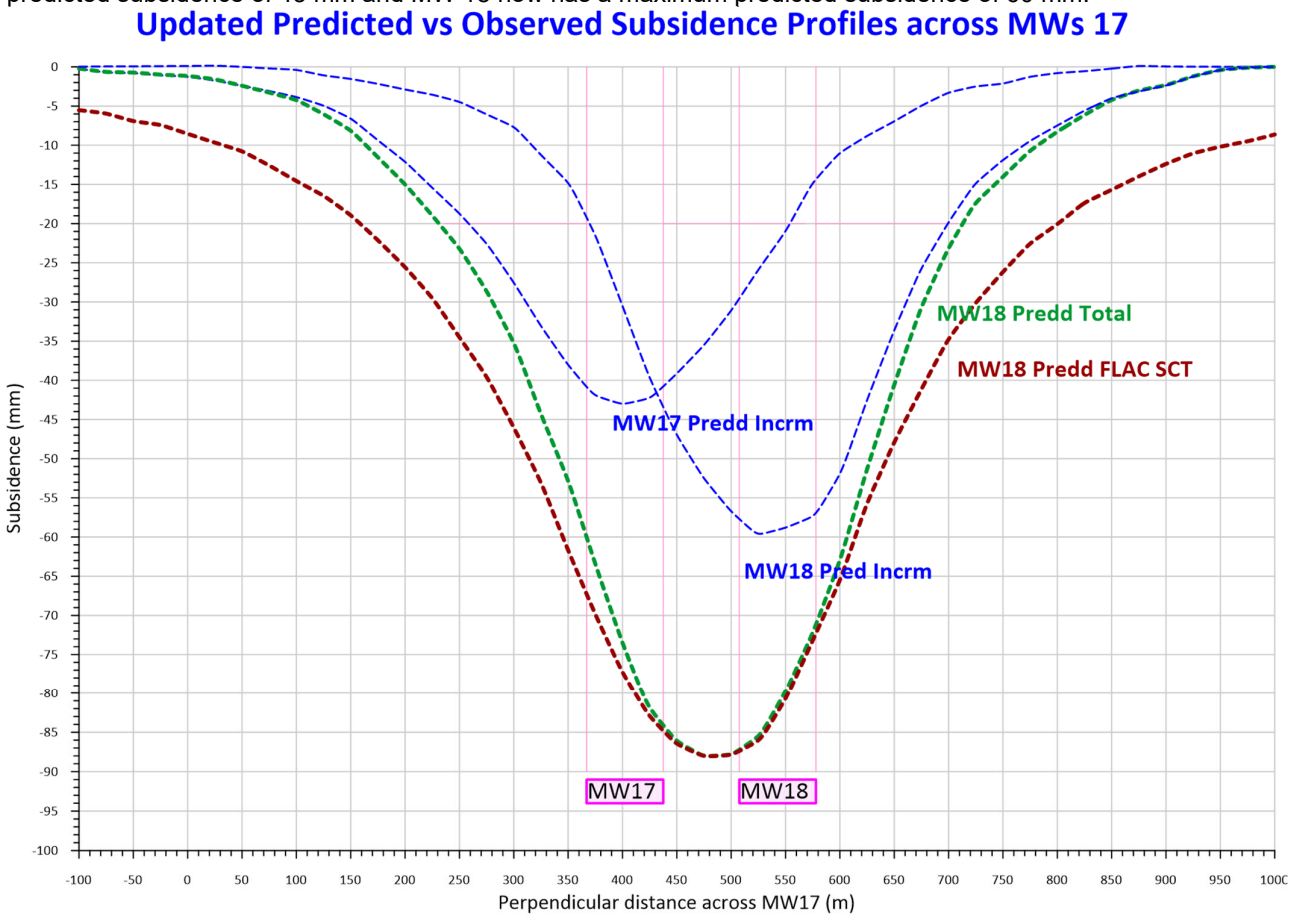


Fig. 4.9 Observed subsidence from GNSS units over and near MW17 compared to initial SCT predictions (SCT & MSEC

The available subsidence monitoring results over Airly such as the results over MWs 13 to 16 and MW17 on Genowlan Mountain have confirmed that SCT's FLAC model successfully analysed the complex strata relationships between strata properties, panel and pillar sizes, depths of cover, seam thicknesses and number of mined panels reasonably well. That is, the subsidence results over MWs 13 to 16 demonstrated reliability in the subsidence predictions from the FLAC modelling and effectiveness of the mine design in selected appropriate panel dimensions to limit subsidence to the required low levels for differing depths of cover, panel widths.

Although the maximum observed subsidence over MW17 is currently 52 mm at unit GM45, which slightly exceeds the lower range of SCT's maximum predicted subsidence for MW17 of 43 mm by 9 mm, it is still expected that the final subsidence over MW17 and MW 18 will remain well below the maximum predicted subsidence value of 90 mm $\pm$ 20 mm.

As these subsidence predictions are below the subsidence limit designed in the 2014 Airly EIS and the 2016 IRP report of 125 mm, then these low levels of subsidence should result in no surface cracking, rock falls or cliffs falls over MWs17 and 18.

4.6. Subsidence Summary after MWs 13 to 17

The maximum observed subsidence over each of the Airly mini walls are shown in Table 3.1 below.

It can be noted that the maximum observed subsidence over MWs 13 to 16 at the end of 2024 was 104 mm at unit GM32. Very similar subsidence levels were also measured at unit GM25, GM26 and GM27.

GM32, GM25, GM26 and GM27 are all centrally located over MWs 13 to 16 as was shown in Fig. 3.4.

Table 3.1. Measured maximum total and incremental subsidence over the extracted mini walls

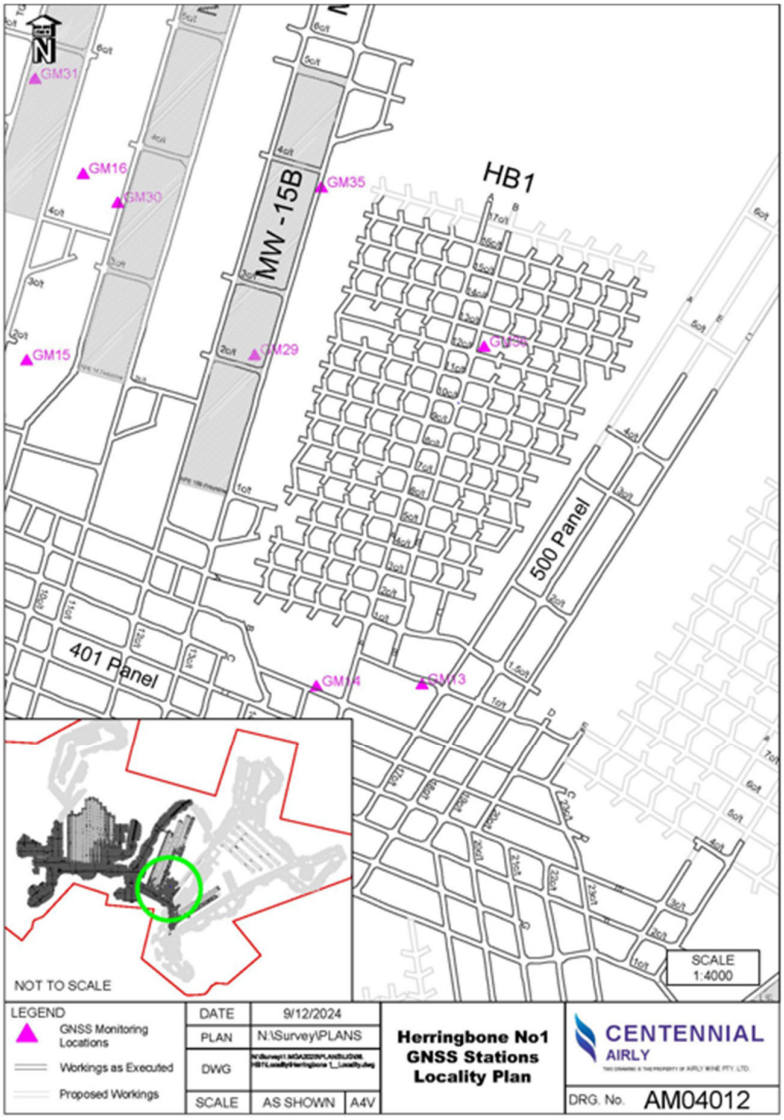
Extraction Plan Area	Panel	Survey Date	Panel Extraction End Date	Maximum Subsidence (mm)	Incremental Subsidence (mm)
	MW2	7-Aug-19	19-Aug-19	38	38
	MW3	25-Oct-19	5-Nov-19	95	63
	MW4	31-Jan-20	11-Feb-20	186	104
	MW5	23-Apr-20	8-May-20	297	144
Mount	MW6	22-Sep-20	11-Sep-20	548	289
Airly	MW7	26-Nov-20	1-Dec-20	612	177
	MW8	23-Feb-21	5-Mar-21	655	123
	MW9	17-May-21	12-May-21	670	164
	MW10	27-Aug-21	23-Aug-21	680	131
	MW11	12-Oct-21	12-Oct-21	690	77
	MW12	10-Dec-21	8-Dec-21	713	44
	MW12 + 7 mths	27-Jul-22	8-Dec-21	707	37
	MW12 + 13 mths	12-Jan-23	8-Dec-21	727	52
	MW12 + 21 mths	2-Aug-23	8-Dec-21	728	64
	MW12 + 25 mths	12-Jan-24	8-Dec-21	744	70
	MW12 + 36 mths	10-Dec-24	8-Dec-21	749	75
	MW13	24-Mar-22	24-Mar-22	Approx. 44	44
Point	MW14	16-Dec-22	15-Dec 22	Approx 75	53
Hatteras *	MW15A	12-Jun-23	8-Jun 23	Approx 95	45
	MW16	10-Dec-23	29-Jan-24	Poss. 108	50
	MW15B	18-May-24	27-Mar-24	Poss. 110*	48
South-Eastern	MW17	31-Dev-24	22-Nov-24	52	52

5.1. Location of HB1

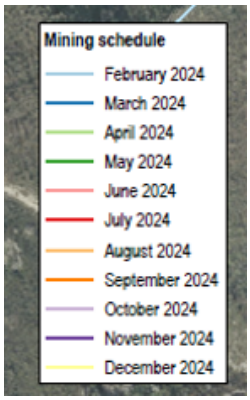
As shown in this sketch, the HB1 First Workings Area was extracted between February 2024 and December 2024 between MW15B and the 500 Panel First Workings.

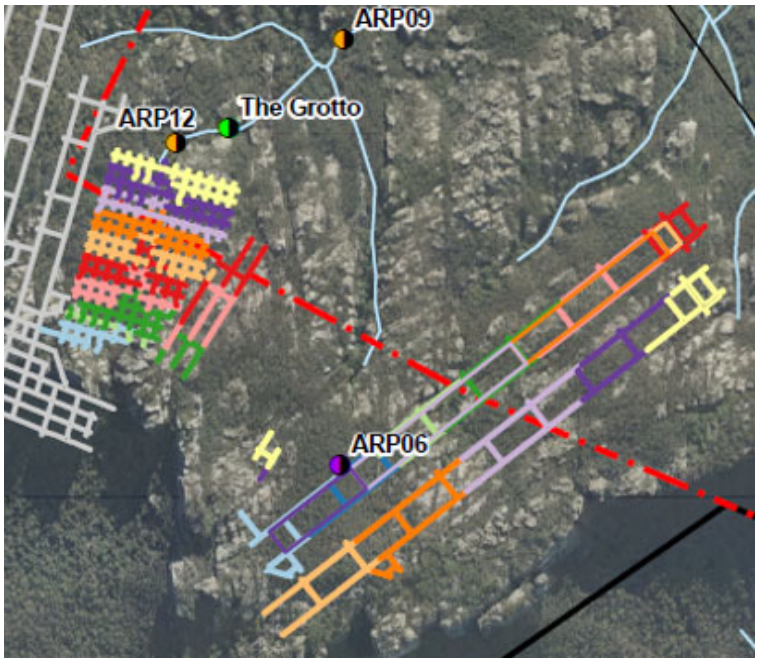
Centennial designed this HB1 Area as a first workings herringbone design with no secondary or panel extraction.

The headings are 5.5 m wide and the remaining pillars were designed to be long term stable to not result in more than 20 mm of subsidence to cause no impacts and no subsidence effect on adjacent panels, i.e., the adjacent MW 13 to 16 area shouldn't experience more subsidence than the EIS maximum prediction of 125 mm.



Mining schedule for development of HB1 is shown in this sketch.



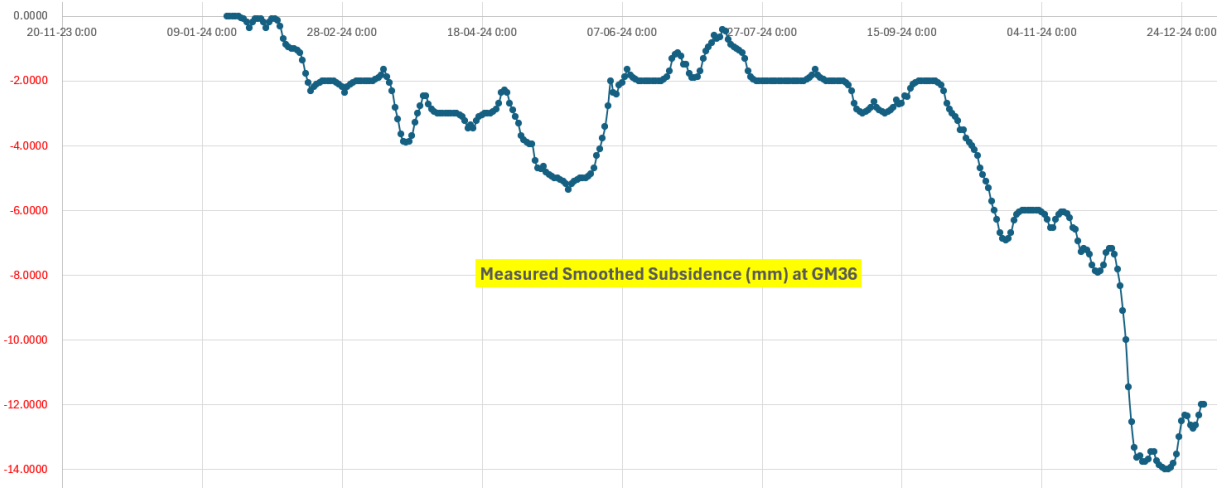


5.2. HB1 Subsidence Monitoring and Impacts

The measured subsidence over the HB1 panel is shown in the sketch below. Subsidence monitoring commenced in January 2024 and this chart shows the smoothed daily monitoring up to the end of 2024.

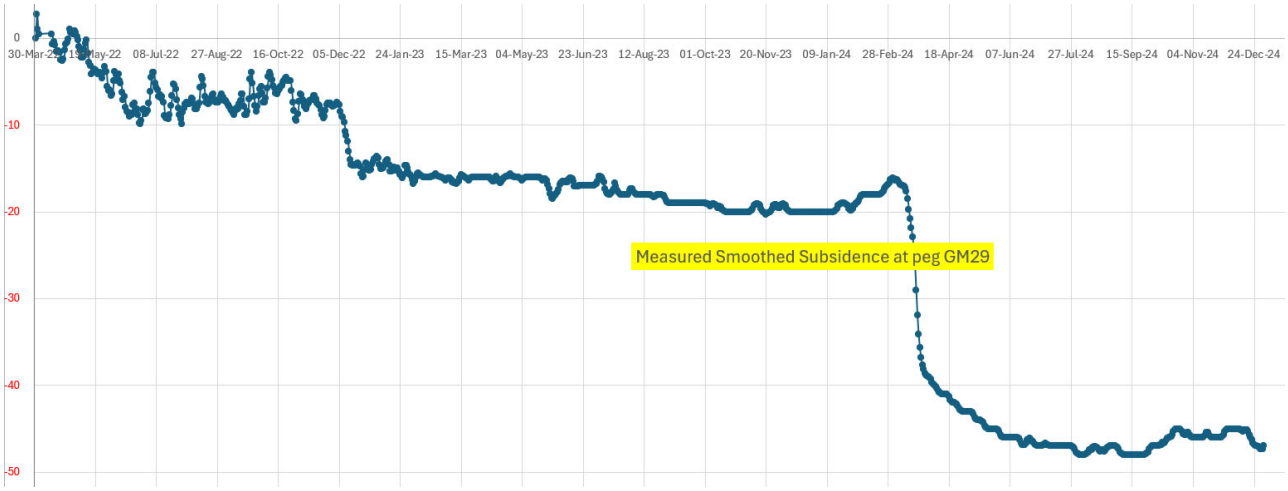
The maximum measured subsidence during 2024 is 14 mm.

These very low levels of subsidence are unlikely to cause any impacts on the surface and as expected no impacts were observed on the surface.



The following subsidence plot shows the measured subsidence at peg GM29 that is located over the centre of MMW15B.

It can be noted that the subsidence from extracting MW15B in February and March 2024 was measured at peg GM29 immediately with the residual subsidence tapering off as usual within two months. It can also be noted the extraction of HB1 did not impact the subsidence measured over MW15B.



6.1. Predicted impacts

The Airly EIS report, which was prepared by Golder Associates in 2014, predicted the maximum subsidence over the PPMZ areas of the mine, after the extraction of a 2.8 m thick seam, 61 m wide mini wall panel widths and 30 m chain pillars, would be less than 125 mm, with tilts less than 2.5 mm/m and strains of less than 2 mm/m.

This 2014 Airly EIS report assessed that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected.

6.2. Observed subsidence impacts and environmental consequences up to 2024

Due to the increased subsidence levels, over MWs 02 to 10 after the extraction of MW12, of up to 744 mm, the occurrence of surface cracking and a small rock fall over and around MWs 02 to 10 was consistent with observations at other mines where similar subsidence levels have been recorded near cliff lines.

The first surface fracture (Fracture 01) was identified during visual surface inspections by CA on 7 July 2020 during the extraction of MW06, as shown in Fig. 6.1.

This surface crack was observed above solid unmined coal areas 120 m west of the initial goaf edge of MW02, i.e., above the tail gate of where MW01 was planned and where much higher-than-expected maximum subsidence levels were being measured during the extraction of MW06.

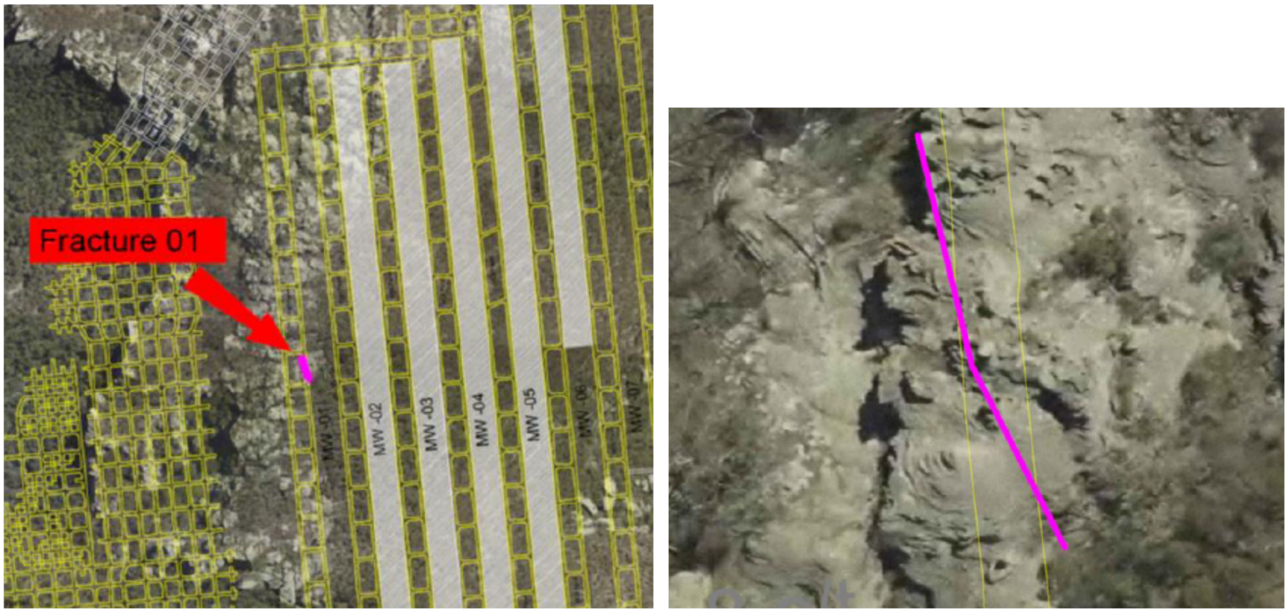


Fig. 6.1 Location of initial surface crack, i.e., 120 m west of MW02, during MW06 (CA Jul 2020)

The commencing pegs along the B Line are located near this crack, and they were surveyed in June 2020 and August 2020. As indicated in Fig. 2.1 Fig. 2.5 monitoring of this B Line shows the maximum subsidence over the four and a half panels of MWs 02 to 06 was between 403 mm in June 2020 and 487 mm in August 2020.

Monitoring of the nearest survey peg to Fracture 01, i.e., peg B01, located 90 m from the goaf edge, indicated that the ground at this peg had subsided down to 18 mm in April 2020 when MW05 was almost completed. However, as MW06 was being extracted this peg was uplifted in June 2020 by 28 mm to be 10 mm higher than its original level, and, in August 2020, this peg was uplifted 15 mm higher than its original level.

The depth of cover at Peg B08 near the edge of MW02, as shown in Fig. 2.5 is 254 m and, hence, this crack is at 0.47 times the depth of cover from the panel edge. This distance further out than most of the observed surface cracks in our data base of mining induced fractures from other mines, but it is just inside the 26.5-degree Angle of Draw (AoD). Of the 300 surface cracks that were closely monitored and surveyed over many longwalls at Baal Bone Colliery most were located over the panel and within 0.4 times the DoC from the panel edge. The furthest out from the panels edge in our data base is an unusual case where Smax was 1.23 m over the panel, with a crack being found at 100 m out at a depth of cover of 170 m.

Fig. 6.2 shows the location of the other fractures that were observed over MWs 02 to 10.

Details of other observed surface cracking were included in the 2020, 2021, 2022 and 2023 Centennial Coal Airly Mine Annual review.

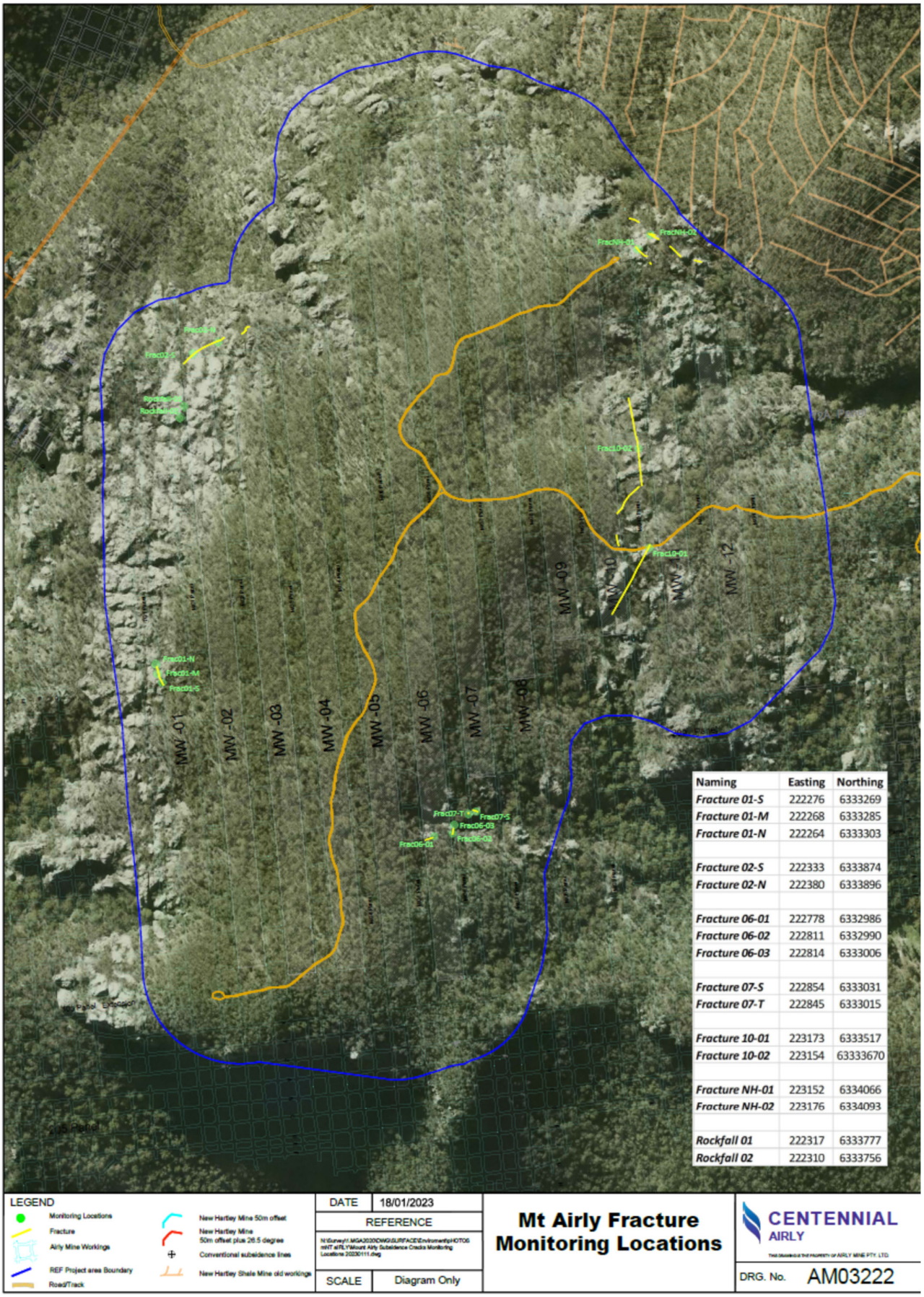


Fig. 6.2 Locations of surface cracks and small rock fall near Fracture 02 and MW02 (CA, Jan 2023)

The onset of a **small rock fall** impact that was observed in May 2022 above MW02, i.e. after all extraction in MW12 was completed in December 2021, occurred when maximum subsidence levels of over 713 mm were measured over MWs 02 to 12.

Details of the observed small rock fall over MWs 02 on the Mount Airly was included in the Airly 2022 Annual Subsidence Report, (MSEC, March 2023).

The plot below, Fig. 6.3, shows the location of this small rock fall and pagoda cracking that was located over the tail gate edge of MW02 near Fracture 02.

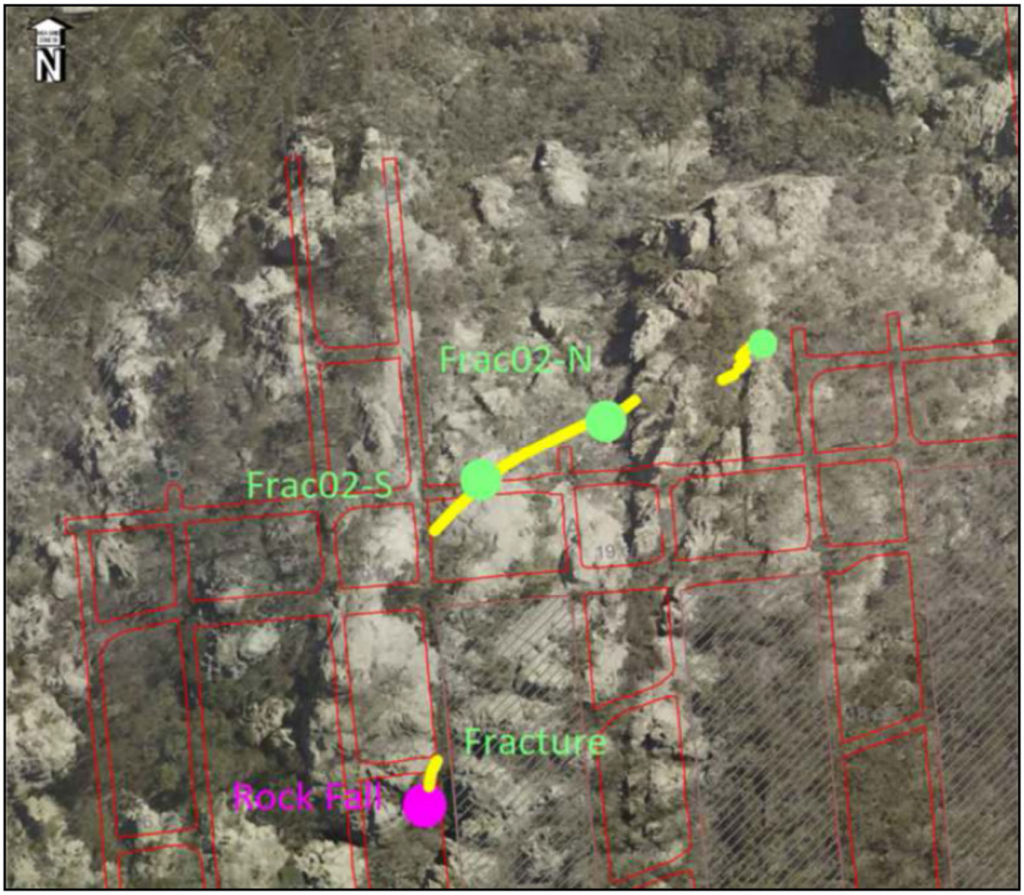


Fig. 6.3 Location of Fracture 02 and small rock fall, i.e. near the North-West corner of MW02 (Douglas Partners, Jul 2022)

It can be noted from Fig. 6.2 that all the surface cracking at Mount Airly was observed around the edges of the greater-than-expected subsidence bowl over MWs 02 to 10, where higher ground tilting, horizontal movements, curvatures and strains were monitored. No surface cracking, rock falls or cliff falls were observed outside 26.5 degrees from the edge of the mined panels.

One of the GNSS units that was established to set up the subsidence monitoring lines over Mount Airly, i.e. GNSS Site 03, is located close to where the small rock fall occurred, (*see yellow highlighted location of GNSS Site 03 in Fig. 6.4*).

The ongoing monitoring data that is still being collected from this GNSS Site 03 indicates that the ground in that vicinity had moved horizontally towards the south-east by up to 300 mm whilst being subsided more than 200 mm around the time of this small rock fall.

Nevertheless, it is now believed that, with the use of the FLAC model, wider chain pillars will be designed to limit future subsidence levels at all future panels at Airly to below the 2014 EIS subsidence limits of 125 mm and, hence, these surface cracking impacts, rock fall and cliff fall impacts that all occurred over Mount Airly at much higher subsidence onset levels are unlikely to occur over Genowlan Mountain.

No further surface cracking and rock falls have been observed over Mount Airly since the wider pillars were left after MWs 10.

Additionally, no surface cracking and rock falls have been observed over Genowlan Mountain where the wider pillars have been left resulting in very low predicted and observed subsidence levels.

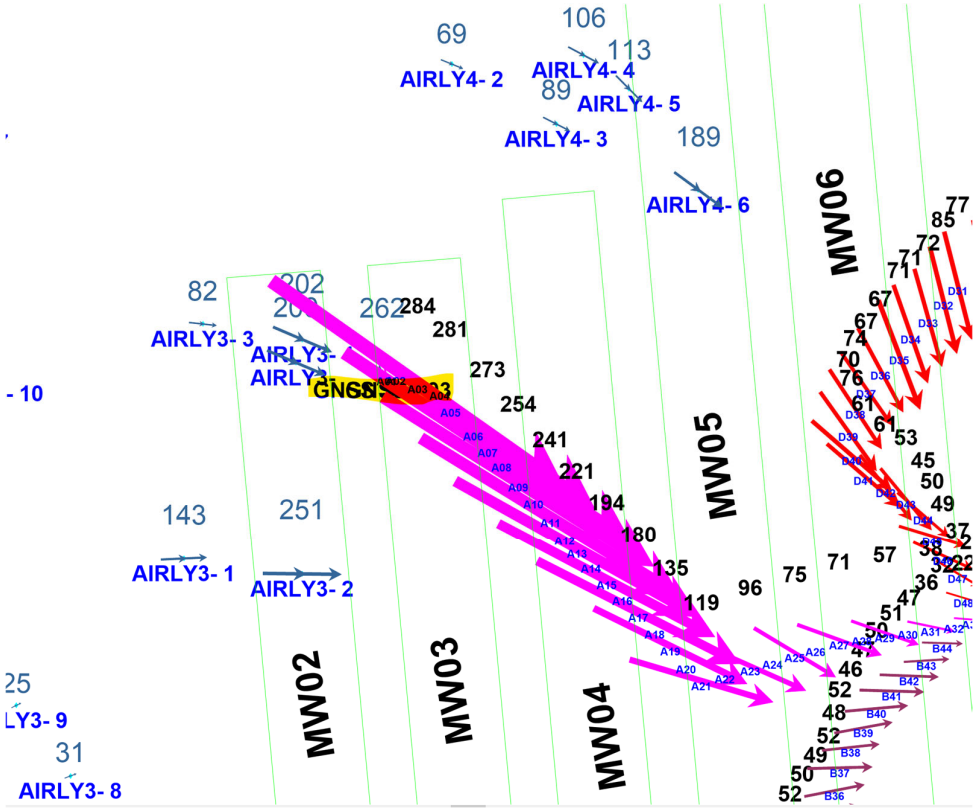


Fig. 6.4 **Monitored horizontal ground movements (mm) near the small rock fall and Fracture 02**

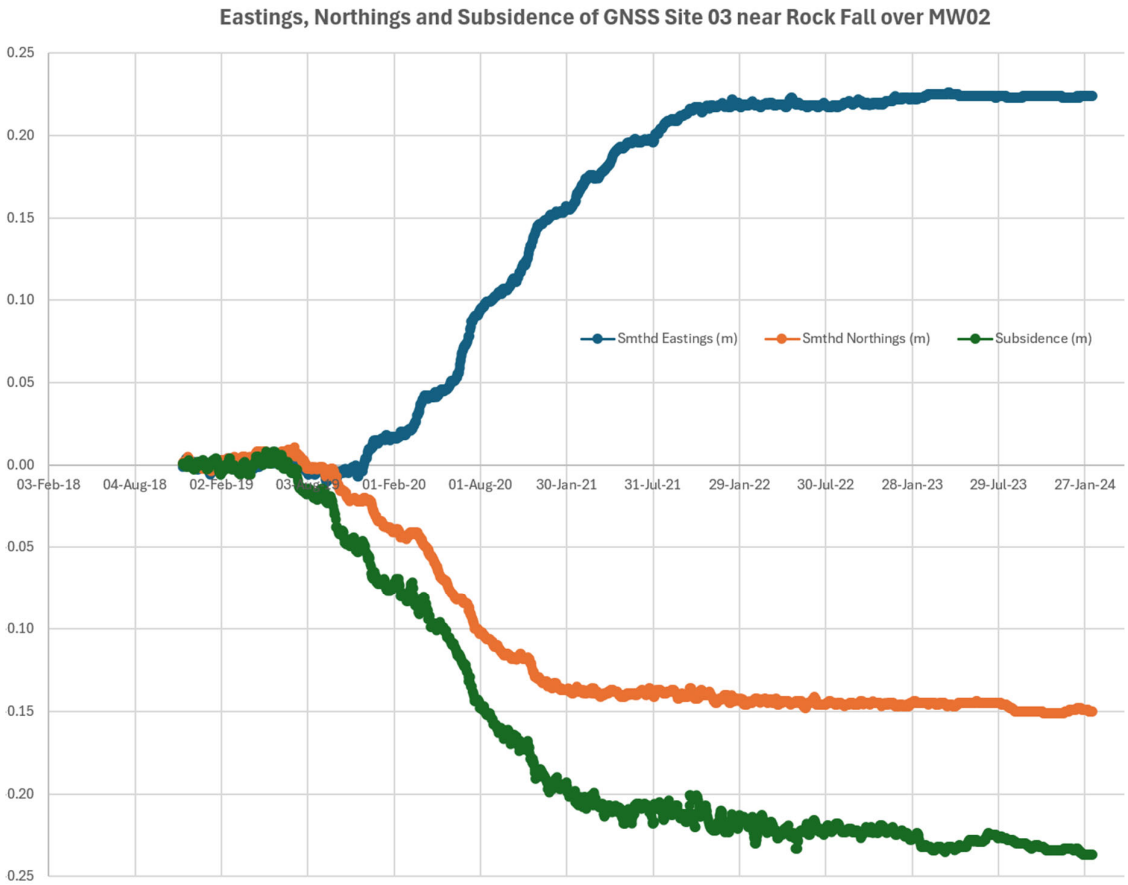


Fig. 6.5 **Monitored horizontal ground movements (mm) at GNSS Site 03 near the small rock fall**

6.3. Conclusion and Likelihood of future cliff impacts

No subsidence impacts or environmental consequences, such as surface cracking, rock falls or cliff falls, have been reported by from visual inspections or environmental monitoring over MWS 11 and 12 on Mount Airly, where subsidence was limited to below 125 mm by much wider chain pillars. This includes regular visual inspections of cliff lines within the area by Airly staff and consultants, LIDAR reviews and none have been reported elsewhere.

Due to these very low mining induced subsidence ground movements being monitored, no subsidence impacts or environmental consequences have been observed over Point Hatteras area of Genowlan Mountain after the mining of MWs 13 to 15A, 15B, 16 and MW17.

This impact observation is consistent with previous records of no cliff instabilities at other mines at similar very low mine subsidence ground movements near other cliffs located over other coal mines in NSW.

Based on the above observations, the subsidence impact performance measures outlined in Table 1 of Schedule 3 of SSD 5581 are expected to be met when extraction of MW18 is completed should it proceed as approved.

However, it is prudent to note, as both the 2014 EIS and the IRP report (2016) reported, that cliff formations near Airly often experience natural rock falls and cliff due to ongoing natural weathering and erosion processes, i.e. rock falls and cliff falls are commonly observed in locations remote from mining activity. Hence it would be impossible to provide full protection from rock falls and cliff falls, even with an ultra-conservative mine design, as it is not possible to predict when natural cliff falls would occur.

The IRP report (2016) advised that, whilst the protection zones proposed in the EIS were considered appropriate to provide the required level of protection to cliff formations and the proposed methods of extraction had the potential to avoid significant impacts on the cliffs, steep slopes and pagodas. The report stated; "*It should be recognised that cliff formations do experience rock falls naturally at a surprisingly relatively rapid rate which is why the cliffs exist in the landform, so, full protection is not possible. A precautionary approach is recommended because the database of experience of appropriate setbacks from mining to protect cliff formations is relatively limited and Trigger, Action, Response Plans are unlikely to be effective to prevent rock falls. close and detailed monitoring should be undertaken before, during and after mining*."

Hence, whilst there could be occasional rock falls of small slabs of rock falling naturally, because of the very low levels of subsidence being predicted at the identified internal cliffs and rock features, there should be little chance of exceedance of the development approval conditions for cliffs.

APPENDIX A. GLOSSARY OF TERMS, ABBREVIATIONS AND DEFINITIONS

Glossary of Terms, Abbreviations and Definitions

Some of the more common mining terms used in the report are defined below:

Adaptive management	Adaptive management includes monitoring subsidence effects and impacts and, based on the results, modifying the mining plan as mining proceeds to ensure that the effects, impacts and/or associated environmental consequences remain within predicted and/or designated ranges and in compliance with the consent conditions
Airly	Airly Mine.
Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence).
AoD	Angle of draw.
AHD	Australian Height Datum.
CA	Centennial Airly Pty Limited.
Chain pillar	A block of coal left unmined between the longwall extraction panels.
Cover depth (H)	The depth of cover measured from the surface to the top of the seam. Cover depth is often provided as an average over the area of the panel.
Cliffs	Continuous rockfaces having minimum heights of 10 metres, minimum lengths of 20 metres and minimum slopes of 2 to 1, i.e., having minimum angles to the horizontal of 63°.
Cliff Fall	Rock falls off rock formations that represent a high proportion of the rock formation.
CLZ	Cliff Line Zone
Closure	The reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of *millimetres (mm)*, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.
Critical area	The area of extraction at which the maximum possible subsidence of one point on the surface occurs.
Curvature	The change in tilt between two adjacent sections of the tilt profile divided by the average horizontal length of those sections, i.e., curvature is the second derivative of subsidence. Curvature is usually expressed as the inverse of the **Radius of Curvature** with the units of *1/kilometres (km-1)*, but the value of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*. Curvature can be either **hogging** (i.e., convex) or **sagging** (i.e., concave).
DoC	Depth of cover or cover depth.
DTIRIS	NSW Dept of Trade & Investment, Regional Infrastructure & Service
EIS	Environmental Impact Study
Environmental consequences	The environmental consequences of subsidence impacts, including damage to built features; loss of surface water flows to the subsurface; loss of standing pools in watercourses; adverse water quality impacts; cliff falls; rock falls; damage to Aboriginal heritage sites; impacts on terrestrial or aquatic ecology; and ponding
Extracted seam	The thickness of coal that is extracted. The extracted seam thickness is thickness normally given as an average over the area of the panel.
Effective extracted seam thickness (T)	The extracted seam thickness modified to account for the percentage of coal left as pillars within the panel.
Face length	The width of the coalface measured across the longwall panel.
Far-field movements	The measured horizontal movements at pegs that are located beyond the longwall panel edges and over solid unmined coal areas. Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.
FLAC	Fast Lagrangian Analysis of Continua, is numerical modelling software for 2D geotechnical analysis of soil, rock, groundwater, and ground support
GNSS	Global Navigation Satellite System.
Goaf	The void created by the extraction of the coal into which the immediate roof layers collapse.
Goaf end factor	A factor applied to reduce the predicted incremental subsidence at points lying close to the commencing or finishing ribs of a panel.
Horizontal displacement	The horizontal movement of a point on the surface of the ground as it settles above an extracted panel.

IEP	Independent Expert Panel
Inflection point	The point on the subsidence profile where the profile changes from a convex curvature to a concave curvature. At this point the strain changes sign and subsidence is approximately one half of S max.
Incremental subsidence	The difference between the subsidence at a point before and after a panel is mined. It is therefore the additional subsidence at a point resulting from the excavation of a panel.
IRP	Independent Review Panel
Kms	Kilometres.
m	metres
MGA56	Map Grid Australia Zone 56
MW	Mini Wall
MWs	Mini Walls
Minor Cliffs	Continuous rockfaces having heights between 5 metres and 10 metres, minimum lengths of 20 metres and a minimum slope of 2 to 1.
MMSCA	Mugii Murrum-ban State Conservation Area.
MSEC	Mine Subsidence Engineering Consultants.
Pagoda	a conical or sub conical rock formation, whether smooth, platy, stepped or terraced, generally between 5 and 20 metres in height that is not a cliff or minor cliff
Panel	The plan area of coal extraction.
PPMZ	Panel and Pillar Mining Zone**.**
PM	Permanent Mark.
Panel length (L)	The longitudinal distance along a panel measured in the direction of (mining from the commencing rib to the finishing rib.
Panel width (Wv)	The transverse distance across a panel, usually equal to the face length plus the widths of the roadways on each side.
Panel centre line	An imaginary line drawn down the middle of the panel.
Pillar	A block of coal left unmined.
Pillar width (Wpi)	The shortest dimension of a pillar measured from the vertical edges of the coal pillar, i.e., from rib to rib.
RFS	NSW Rural Fire Service.
Rock Fall	Rock falls off rock formations that represent a small proportion of the rock formation
SCT	Strata Control Technology.
Shear deformations	The horizontal displacements that are measured across monitoring lines and these can be described by various parameters including; horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index.
steep slope	An area of land having a gradient between 1 in 3 (33% or 18.3^0) and 2 in 1 (200% or 63.4^0)
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points, i.e., strain is the relative differential displacement of the ground along or across a subsidence monitoring line. Strain is dimensionless and can be expressed as a decimal, a percentage or in parts per notation. **Tensile Strains** are measured where the distance between two points or survey pegs increases and **Compressive Strains** where the distance between two points decreases. Whilst mining induced **strains** are measured **along** monitoring lines, ground **shearing** can occur both vertically, and horizontally **across** the directions of the monitoring lines.
Sub-critical area	An area of panel smaller than the critical area.
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of *millimetres (mm)*. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured.
Subsidence Effects	The deformations of the ground mass surrounding a mine, sometimes referred to as 'components' or 'parameters' of mine subsidence induced ground movements, including vertical and horizontal displacements, tilts, curvatures, strains, upsidence and closure.

Subsidence Impacts	The physical changes or damage to the fabric or structure of the ground, its surface and natural features, or built structures that are caused by the subsidence effects. These impacts considerations can include tensile and shear cracking of the rock mass, localised buckling of strata, bed separation, rock falls, collapse of overhangs, failure of pillars, failure of pillar floors, dilation, slumping and also include subsidence depressions or troughs.
Subsidence Consequences	The knock-on results of subsidence impacts, i.e., any change in the amenity or function of a natural feature or built structure that arises from subsidence impacts. Consequence considerations include public safety, loss of flows, reduction in water quality, damage to artwork, flooding, draining of aquifers, the environment, community, land use, loss of profits, surface improvements and infrastructure. Consequences related to natural features are referred to as environmental consequences.
Super-critical area	An area of panel greater than the critical area.
Tilt	The change in the slope of the ground as a result of differential subsidence and is calculated as the change in subsidence between two points divided by the horizontal distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.
UCS	Uniaxial Compressive Strength
UDEC	Universal Distinct Element Code - a two-dimensional numerical program that simulates the quasi-static or dynamic response to loading of media containing multiple intersecting joint structures. – for 2D modelling of Jointed and Blocky material
UNSW	University of New South Wales
Uplift	An increase in the level of a point relative to its original position.
Upsidence	Upsidence results from the dilation or buckling of near surface strata at or near the base of the valley. The term uplift is used for the cases where the ground level is raised above the pre-mining level, i.e., when the upsidence is greater than the subsidence. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.

APPENDIX B. REFERENCES

References

Aerometrex, (2020), "*Initial Cliff Identification Airly Report* "

Aerometrex, (2021), "*Major Cliff Identification Genowlan Mountain "Phase 1*".

Aerometrex, (2021), "*Major Cliff Identification Genowlan Mountain "Phase 2*".

Ahola, MP, 1990, "*Geomechanical Evaluation Of Escarpments Subjected To Mining Induced Subsidence*", Denver Research Centre, Denver, Colorado, USA, Balkema

Bell, PG, 1977, "*The Mount Mulligan Coal Mine Disaster*, 1921", Thesis, James Cook University of North Queensland.

Centennial Coal, April 2019, "*Airly Mine Subsidence Monitoring Program - Airly Panel and Pillar Extraction Plan (ML1331)",* AIR-MP-0151, EP-SMP_Rev1

Centennial Coal, March 2021, "Centennial Coal *Airly 2020 Mine Annual Review",* Final Signed

Centennial Coal, March 2022, "Centennial Coal *Airly 2021 Mine Annual Review",* Final Signed

Centennial Coal, March 2023, "Centennial Coal *Airly 2022 Mine Annual Review",* Final Signed

Creech, M, 1998, "*The effects of conglomerate channels on longwall mining and surface subsidence*", Proc MSTS 1998

Cunningham, D.M. 1986, "*The Nattai North Escarpment Failure*". B Sc (Hons), Thesis, University of Wollongong.

Donnelly, L.J, (2000), "*Reactivation of geological faults during mining subsidence*", Journal of mining technology, Vol. 109, Issue 3, pp 179-190.

Douglas Partners, April 2022, "Report on *Assessment of Subsidence Crack Remediation Mugii Murum-ban State Conservation Area*", 204170.00 R002.Rev2

Douglas Partners, July 2022, "*Assessment of Subsidence Crack Remediation Mugii Murum-ban State Conservation Area*", 204170.00 R003.Rev1

Douglas Partners, Feb 2023, "Assessment of Subsidence Crack Remediation - Mugii Murum-ban State Conservation Area - Six Monthly Walkover and Works Inspection 18 January 2023", 204170.00 R004.Rev1

Eade, P & Wood, J, (2001) "*Longwalling and its impact in the Southern coalfield – recent BHP experiences*"

Esterhuizen, G S, (1997) "*Investigations into the effect of discontinuities on the strength of coal pillars*" The Journal of The South African Institute of Mining and Metallurgy, pp 57-62.

Evans, RS 1981, "*An Analysis of Secondary Toppling Rock Failures - The Stress Redistribution Method*". Q.J. Eng. Geol. London, 1981, Vol. 14. pp 77-86.

Evans, RS, 1978, "*Time Dependent Factors Influencing the Rock Slope Stability of the Illawarra Escarpment, N.S.W*". University of N.S.W., PhD Thesis

Franks, CAM, and Geddes, JD, 1985, "*A Comparative Study by Numerical Modelling of Movements on Sloping Ground due to Longwall Mining*", Proceedings of the 3rd Conference on Ground Movements and Structures, Pentech Press, London, pp. 377-96.

Franks, CAM, and Geddes, JD, 1986, "*Subsidence On Steep Slopes Due To Longwall Mining*", International Journal Of Mining And Geological Engineering, Chapman and Hall A, 291-301

Franks, CAM, 1983, "*An Analysis of the Effects of Hillside Topography on Mining Subsidence in the South Wales Coalfield*". PhD Thesis, University of Wales.

Gentry, DW, & Abet, JF, 1978, "*Surface Response to Longwall Coal-mining in Mountainous Terrain*." Bulletin 0 the Association of Engineering Geologists 15, 191-220.

Gentry, DW, Stewart, CL and King, RP, 1981, "*Rock mechanics instrumentation program - York Canyon Mine, Raton New Mexico. Final report, Vol 1*", US Dept of Energy, Contract No. DE AC01-74ET 12530, 93-170

Golder Associates, July 2014, "*Subsidence Predictions and impact Assessment for Airly Mine*", Rep No 127621105-003-R-Rev2.

Golder Associates, September 2014, "*Centennial Coal Airly Mine Extension Project Environmental Impact Statement*", Rep No 137623024_061_R_Rev2.

Harvey CR, 1989. "*Evaluation of Rock Formations in the Lithgow Region with respect to Coal Mining*" Unpublished research project, University of New South Wales; pp 73

Heritage, Y, 2021, "*Airly Mine Subsidence and Pillar Width Modelling Assessment – Point Hatteras Area Mt. Genowlan*", SCT Report AIRLY5265. 18 August 2021

Heritage, Y, Boyling, A, Corbett, P, 2022, "*Determination of the Subsidence Mechanism for Subcritical Miniwall Panels, Airly Coal Mine*", SCT Report AIRLY5240. 20 January 2021

Hill, D, & White, E, 2017. "*Progress in Partial Extraction Layout Design for Productivity, Safety and Subsidence Management at Clarence Colliery*". Proc. of 10th Triennial Conference on Mine Subsidence, MSTS, Pokolbin.

Hill, D, 2005 “*Coal Pillar Design Criteria for Surface Protection”* Coal Operators' Conference (Coal 2005) University of Wollongong & the Australasian Institute of Mining and Metallurgy, 2005, 31-38.

Hill, D, July 2014, “*Centennial Coal Subsidence Predictions and Impact Assessment for Airly Mine*”, Golder Associates, Rep No 127621105-003-R-Rev0.

Hill, D, March 2019, “*Panel and Pillar Mining Zone: Revised Subsidence Estimates and Impacts*”, Strata^2, Rep No AIR-006-Rev2

Hill, D, May 2020, “*Centennial Coal Airly Mine - Panel and Pillar Zone: Updated Subsidence Model*”, Strata^2, Rep No AIR-015-Rev1.

Hill, D, Golder Associates, July 2014, *Centennial Coal Subsidence Predictions and Impact Assessment for Airly Mine*, Rep No 127621105-003-R-Rev0.

Holla, L, (1998). "*Geological factors affecting mine subsidence assessment*". Proceedings of the Australian Geomechanics Society Conference on Geotechnical and Geological Engineering in the Hunter Valley, University of Newcastle, NSW, 11-13 July 1998.

Holla, L, Barclay, E. (2000). "*Mine Subsidence in the Southern Coalfield - Chapter 5 Major factors modifying the theoretical subsidence behaviour*". Department of Mineral Resources, NSW. pp 35-48.

Holt, G, June 1993, “*Assessment of Impact of Subsidence from proposed underground mining at Airly, NSW*”.

Independent Review Panel, Airly, July 2016, (Mills K, Canbulat, I and Kay DR), “*Accuracy and Reliability of Mine Subsidence Impacts on Sensitive Features Across the Airly Mine Extension Project Application Area*”

Jeran, PW, & Adamek, V, 1988, "*Subsidence due to undermining of sloping terrain: a case study*", US Department of Interior Bureau of Mines, Report of Investigations/1988, RI 9205

Jones, RE, and Pariseau, WG, Payme, V, & Takenaka, G, 1990, "*Sandstone Escarpment Stability in the Vicinity of Longwall Mining Operations*". 31st U.S. Symposium on Rock Mechanics, Colorado School of Mines, Golden, CO, June 18*-20,1990.

Kapp, WA, & Clough A, 1986 “*Subsidence due to longwall mining & its effects on topographic features at Angus Place*”

Kapp, WA, & Clough, AJ, 1986. "*Subsidence due to Longwall Mining and its Effects on Topographic Features at Angus Place Colliery*" - BHP Steel Collieries Divn. Report (Unpublished).

Kapp, WA, 1973, "*Mine subsidence*", Proceedings of the 4th Symposium of the Australian Institute of Mineralogists and Metallurgists, Illawarra, 1-1.9

Kapp, WA, 1982, "*A Review of Subsidence Experiences in the Southern Coalfield, New South Wales, Australia*", in Symposium Proceedings, State of the Art of Ground Control in Longwall Mining Subsidence, Honolulu, Hawaii, ASME, pp. 167-82.

Kay, DR, 1990. et al. "*Angus Place Subsidence Modelling Joint Study*". Department of Minerals and Energy. Sydney.

Kay, DR, 1991, “*Effects of Subsidence on Steep Topography and Cliff Lines”. NSW Department of Mineral Resources Report for ERDC Project No. 124*”, 624 pages. NERDDP Report No 1446, NSW.

Kay, DR, 2014, “ACARP. C18015: “*Effects of Mine Subsidence, Geology & Surface Topography on Observed Valley Closure Movements and development of an Updated Valley Closure Prediction Method*” - (An update on ACARP Research Project Reports C8005 & C9067)

Kay, DR, 2015 March, Letter Report, “*MSEC Peer Review of EIS Report on Subsidence Predictions and Impact Assessments for Airly Mine by Golder Associates”*.

Kay, DR, 2020 May, “*MSEC Site Inspection Report over Mount Airly (March 2020) and Peer Review of Report on Subsidence Predictions and Impact Assessments for Airly Mine*”

Kay, DR, 2020 Sep, “*Airly Mine – Review of Observed Subsidence over Mini Walls 2 to 6 and Preliminary UDEC Subsidence Modelling*”, MSEC1110

Kay, DR, 2020 Sep, “Airly Mine – Cliff Impact Assessment Report due to proposed extraction of MWs 7 to 9”, MSEC Report Number MSEC1121

Kay, DR, 2020 Sep, “*Airly Mine – Updated Cliff Impact Assessment Report due to proposed extraction of Miniwalls 11 and 12.*”, Report Number MSEC1185

Kay, DR, 2021 Jul, “*Airly Mine – Cliff Impact Assessment Report due to proposed extraction of Miniwall 7 to 9.*” MSEC Report Number MSEC1121

Kay, DR, 2021 Feb, “*Supplementary Cliff Impact Assessment MWS 8 & 9”* - MSEC Report Number MSEC1169

Kay, DR, 2021 Jul, “*Airly Mine – Updated Cliff Impact Assessment Report - Due to proposed extraction of Miniwalls 11 and 12*” - MSEC Report Number MSEC1185

Kay, DR, 2021 Oct, “*Airly Colliery – MW13 to MW16 - Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 13 to 16 in support of the Extraction Plan Application*” - MSEC Report Number MSEC1195

Kratzsch, H, 1983. “*Mining Subsidence Engineering*”, Springer-Verlag, Berlin

Malgot J, Baliak & Mahor T, 1986. "*Prediction Of The Influence Of Underground Coal Mining On Slope Stability In The Vtacnik Mountains*". Bulletin of the Int Assoc of Engineering Geology No 33

McGill MC, (2002), "*Geotechnical Studies of Retreat Pillar Mining at Shallow Depth"* PhD thesis, Univ British Columbia

Metropolitan Water Sewerage & Drainage Board 1974, "*Mining Subsidence. Surface Subsidence Cracking and Rock Falls .... Report for Mining under Stored Waters Enquiry*.

Mills K, (SCT), Canbulat I, (UNSW) & Kay DR, (MSEC), July 2016, "*Report of the Independent Review Panel Established to Review and Report on Accuracy and Reliability of Mine Subsidence Impacts on Sensitive Features Across the Airly Mine Extension Project*"

Mills, K & Canbulat, I, June 2020, "*Airly Mine Mini Wall Panels*: IEP Subsidence Observations"

Mills, K, SCT 1995 "*Photogrammetric Monitoring of Mining Induced Subsidence Movements in Rock Formations at Baal Bone Colliery*" Report No. BBO0567,

Molinda, GM, & Ingram DK, (1989), "*Effects of structural faults on ground control in selected coal mines in southwestern Virginia*" US Bureau of Mines Investigations 9289

Mong. J. 1986. "*Angus Place Colliery Geotechnical report on the surface effects of mining longwall No.9 Panel*". Electricity Commission of NSW Technical Memorandum No. DE291. Unpublished

Nelson, WJ, 1981, "*Faults and their effect on coal mining in Illinois*" - Illinois State Geological Survey Division

Newcom Collieries Pty. Ltd. 1988. "*Report on Angus Place Colliery Longwall11 – Proposed Extension by 150m*"

Nicholson, M, MNC, Aug 2022, Site Inspection and Ground Truthing of Cliffs over and Near proposed MW17-19,

Novacoal, October 1991, "*Airly Coal Project Environmental Impact Statement*."

Office of Environment and Heritage, NSW National Parks & Wildlife Service, Sept 2015, "*Draft Plan of Management Mugii Murum-ban, State Conservation Area*"

Patton, F.D. and A.J. Hendren. 1972. "*General report on mass movements*", in Proceedings of the 2nd Int. Congress of International Association of Engineering Geology,

Pells PJN, Braybrooke JC, Mong J & Kotze GP, 1987, "*Cliff Line Collapse Associated with Mining Activities*". Slope Stability and Stabilisation. Balkema. ISBN 90 61730 1

Pitchers, R, 2022, "*South East Genowlan (MW17-19) Pillar and Panel Width Numerical Modelling Assessment*", SCT Report AIRLY5521-Rev1. 19 December 2022

Pitchers, R, 2022, "*Assessment of subsidence for Point Hatteras pillar width redesign in relation to cliff standoff requirements*", SCT Report AIRLY5865. 15 January 2025

Pitchers, R, 2025, "*Numerical Modelling Subsidence Assessment for MW17 & MW18 Extracted at Varied Cut Heights*", SCT Report AIRLY5368. 18 August 2021

Pells, PJN.,1991."*A Note on Escarpment Instability Associated with Mining Subsidence*". pp66-73. Second Triennial Conference on Buildings and Structures Subject to Mine Subsidence. Maitland N.S.W.

Radloff BJ, & Mills KW, 2001 "*Management of Mine Subsidence Impacts on Cliffs at Baal Bone Colliery (Western Coalfield NSW*)" Coal Mine Subsidence 2001, Current Practice and Issues – Proceedings of the 5th Triennial Conference of the Mine Subsidence Technological Society, Maitland, Aus. pp63-75

Rippon, A, 2023, "MW17-18 *Pillar and Panel Optimisation Assessment: Increasing from 56m panels and 50 m pillars to 70.5 panels and 70 m pillars*", (SCT Report AIRLY5612)

RPS Australia East, 2018, "*Airly Panel and Pillar Zone: Identification of Cliffs, Minor Cliffs and Pagodas including Cliff Top and Toes Determinations" PR 136374,*

RPS Australia East, 2018, "*Identification of Cliffs, Minor Cliffs and Pagodas with the Cliff Line Zone (CLZ)" PR135156,*

RPS, Sept 2021, "*Baseline Ecology Assessment Report – Pt Hatteras PPMZ EP",* PR149502

RPS, Sept 2021, "*Point Hatteras, Airly, Heritage* B*aseline Ecology Assessment",* PR149502 3

Sahu, P, et al, 2017, "*Impact of Geological Discontinuities on Underground Coal Mining*", Conference: International Conference on Underground Space Technology

Shadbolt, CH, 1977. "*Mining subsidence — historical review and state-of-the art*". Proceedings Conference on Large Ground Movements, UWIST, Cardiff, 705-748.

Smith P, 1991 "*Landscape Implications of Underground Mining in the Western Coalfields, NSW*" Master of Environmental Studies Thesis, UNSW

Soole, P., Mills, K. and Radloff, B.J., 2001 "*Displacement Monitoring and Visualisation Using Terrestrial Photogrammetry*" Proceedings of the 5th Triennial MSTS Conference

Strata Engineering, (2010). "*Design of Partial Extraction Layout for Airly Mines*". Report No. 09-001-AIR-4 to Airly Mine.

Strata Engineering, (2012). "*Preliminary Assessment of Subsidence Associated with Four Mining Concepts*".

Report Strata Engineering, (2012). "*Geotechnical Assessment for Proposed Partial Extraction Layout Options",* SEA Report No. 09-001-AIR-12. to Airly Mine.

Strata Engineering, (2012). "*Pillar Stability in 101 and 200 Areas",* SEA Report No. 09-001-AIR-10. to Airly Mine.

Strata Engineering, (2012). "*Subsidence Impact Assessment on the Cliff Lines above the Proposed 700W and 800 Areas"",* SEA Report. to Airly Mine.

Waddington Kay & Associates (2001). "*Research into the Impacts of Mine Subsidence on the Strata and Hydrology of River Valleys and Development of Management Guidelines for Undermining Cliffs, Gorges and River Systems*". ACARP Project No. C8005; Illawarra Coal BHP Minerals, WKA74

Waddington Kay & Associates, (2002), "*Management Information Handbook on the undermining of Cliffs, Gorges and River Systems*"; ACARP Projects C8005 and C9067.

Waddington Kay & Associates, (2002), ACARP Project No. C9067, "*Subsidence Impacts on River Valleys, Cliffs, Gorges and River Systems*", Report WKA110.

Wang, H, et al, (2016) "*Influence of fault slip on mining-induced pressure and optimization of roadway support design in fault-influenced zone*" Journal of Rock Mechanics and Geotechnical Engineering

White E, 2014, "*Clarence Colliery – Partial Extraction to Protect Surface Features*", Proc. of 9th Triennial Conference on Mine Subsidence, MSTS, Pokolbin.

Wood, J, 1998, "*Rock Falls over Tower Colliery Longwalls 10 to 15*", Cataract River"

Wood, J, 1998, "*Rock Falls over Tower Colliery Longwalls 14 & 15"*, Cataract River"

Wood, J, 2000, "*Report on Rock Falls over Tower Colliery Longwall 17*", Nepean River"

Wood, J, 2004, "*Appin Area 7 Cataract River Cliff Study*"

Appendix 6: Airly Mine Water Monitoring 2024 Annual Report

Airly Mine Water Monitoring

2024 Annual Report

Centennial Airly Pty Ltd

26 March 2025

→ **The Power of Commitment**



GHD Pty Ltd | ABN 39 008 488 373
GHD Tower, Level 3, 24 Honeysuckle Drive
Newcastle, New South Wales 2300, Australia
T +61 2 4979 9999 | **F** +61 2 9475 0725 | **E** ntlmail@ghd.com | **ghd.com**

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	A. Cribb	A. Barron		S. Gray		03/03/25
S4	1	A. Barron	S. Gray		S. Gray		13/03/25
S4	2	A. Harvey	S. Gray		S. Gray		26/03/25

© GHD 2025

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Executive summary

Centennial Airly Ltd engaged GHD Pty Ltd to compile a groundwater and surface water report for the 2024 monitoring period. The purpose of this report is to satisfy the consent conditions of the Airly Mine Extension Project (EPBC 2013/7076, SSD - 5581), environment protection licence (EPL) 12374 and the Airly Mine Water Management Plan Revision 9 (WMP) (Centennial Coal, 2024). The information presented herein demonstrates compliance with these conditions has been met throughout 2024.

Groundwater Monitoring SSGVs

Groundwater monitoring was undertaken in accordance with the groundwater monitoring program set out in the WMP and includes vibrating wire piezometers (VWPs), sampling of groundwater bores (levels and quality) and flow monitoring of groundwater seepage from a natural spring (Village Spring). Groundwater pressures and levels are assessed to triggers developed for functional VWPs ARP04, ARP06 and ARP13 and standpipes ARP14 and ARP15SP. Extended dry periods have historically characterised standpipes ARP05, ARP07, ARP09, ARP11 and ARP12 and water level trigger values have therefore not previously been defined at these locations. Such conditions are considered to reflect low rainfall periods as opposed to any mining induced affect. Groundwater quality is assessed to Site Specific Guideline Values (SSGVs) for ARP09, ARP12, Kingdom, Nioka and GW800787.

Groundwater Pressures and Levels

Groundwater pressure trends in 2024 are similar to those reported between 2013 and 2023. Overall, piezometric pressure is generally low and decreasing at the existing VWP monitoring locations, ranging from 0 m to 10 m above the measuring point elevation, with little observable response to rainfall. The low piezometric pressure is considered to reflect horizontal flow and seepage discharge occurring to mesa faces. There is a downward hydraulic gradient from the Narrabeen Sandstone to the Illawarra Coal Measures.

Pressure data are not available at VWPs ARP01, ARP02A, ARP03 and ARP08. All levels recorded at VWPs ARP04 and ARP06 during 2024 were within the respective trigger values. Pressure at ARP13 in the Devonian is 15.4 m below the trigger, assumedly reflecting regional drying and not considered mining related.

No trigger exceedances occurred in standpipe monitoring locations. Most standpipes are installed in alluvial sediments and show water levels are responsive to rainfall.

Groundwater Quality

Numerous water quality exceedances were recorded across the monitoring network with low pH and elevated manganese, nickel and zinc being the most common.

Alluvium monitoring points in the upper catchment (ARP09 and ARP12) are more responsive to rainfall and demonstrate cycling through wetting and drying cycles while water levels are more stable lower in the catchment supported by a larger aquifer (ARP14). All alluvial locations show fresh and acidic conditions generally in the pH range of 5 to 6 but approximating 4 at ARP12. ARP14 demonstrates a wide range of elevated metals. Zinc is commonly elevated at all locations except at ARP12. Metal signatures support discontinuation of water stored in alluvial sediments. Fresh conditions reflect rainfall as source of recharge and may be the cause of acidification. Alluvial monitoring points have historically shown recovery in water level in response to rainfall events disputing mining associated subsidence influence. Declining water quality is not considered to be associated with mining activities and, instead, is speculated to be the result of drying-wetting cycles.

Monitoring in the Narrabeen Sandstone (ARP15SP) shows water is fresh and increasingly freshening indicative of rainfall recharge. The water is also acidic ranging pH 6 to 7 with elevated levels of manganese, nickel and zinc. Water recovery at ARP15SP in response to rain disputes deleterious mining impact, hence, changes in water quality are speculated to be the result of drying climate conditions and rewetting cycles.

Monitoring points in the upper Permian include standpipe ARP11 and Village Spring. At these locations, groundwater level / flow is responsive to rainfall. Recovery in ARP11 from circa 2020 indicates this stratum has not been adversely impacted by mining activity in the lower seam. Both waters present as brackish however pH differs towards acidic in ARP11 (6.3-6.5) and historically alkaline (8) at Village Spring although recent gauging shows trending towards neutral (7). This distinction supports disconnected sources, and that water held in this stratum is discontinuous. Both waters show elevated levels of nickel and zinc. Lead is also elevated in ARP11 and as is manganese in Village Spring.

Water quality in the Lithgow Seam (ARP13SP) is fresh and of low pH (4-6) with elevated levels of iron, manganese, nickel and zinc in the last two-years correlating to the increased incidence of pH around 4. Trends in manganese, nickel and zinc appear to be in decline while iron concentrations continue to rise.

Seepage Flow

Groundwater seepage from the Permian strata is monitored continuously at Village Spring. Continuous flow was observed throughout 2024 except September reflective of rainfall. Groundwater inflow to the underground workings was reportedly negligible (not measureable) throughout 2024.

Surface Water Monitoring

The flow gauge for Genowlan Creek showed largely dry conditions throughout 2024. Flow rates at Gap Creek and Genowlan Creek 2 gauges show generally decreasing trends over the year due to reduced rainfall compared to previous years.

Surface water quality at Airly Creek is circumneutral to alkaline and brackish. Dissolved metal exceedances (e.g., antimony, barium, cobalt, iron, nickel, manganese and zinc) occurred at Airly Creek and Airly Upstream inconsistently through 2024. Airly Tributary was not sampled throughout 2024 due to insufficient flow.

Genowlan Creek was characterised by low pH (~4 at the Grotto and ~5 at Genowlan Creek 2), similar to that recorded in the Genowlan Creek Alluvium (ARP12 and ARP14). Water is fresh with isolated occurrences of metal exceedances. Increasing iron was recorded at The Grotto (as well as in ARP12) concurrent with high levels of iron bacterial flocculant and was gauged to be anoxic.

Conclusions

Overall, groundwater pressure trends in 2024 are similar to those reported between 2013 and 2023 (and reported in the EIS). Monitoring locations in regional aquifers in the Shoalhaven and Devonian, tens to hundreds of metres, respectively, below the mine show decreasing groundwater trends.

Water pressure loss evident in the Shoalhaven Group and in the Devonian Strata at ARP13 is not reflected in the standpipe ARP13SP installed in the Lithgow Seam. The inconsistency produces doubt that such declines reflect mining impact and instead may point to climatic effects resulting in lower recharge of the regional aquifers.

Numerous monitoring locations within the Permian Coal Measures have become dysfunctional and are assumed to have been compromised due to matrix shifts resulting from subsidence, particularly beneath Mount Airly. Where functioning, monitoring records show the seams to be historically dry or with fluctuating pressure changes, overall decreasing pressure trends. Monitoring in the Narrabeen Sandstone generally shows decreasing water levels or otherwise dry conditions. The decreasing water levels are considered to reflect reduction in rainfall recharge.

Alluvium monitoring points indicate dry or drying conditions reflecting lower rainfall. Additionally, groundwater quality indicates acidification and mobilisation of metals.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1 and the assumptions and qualifications contained throughout the report.

Abbreviations

Abbreviation	Description
µS	micro Siemens
µS/cm	micro Siemens per centimetre
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
BoM	Bureau of Meteorology
Centennial	Centennial Airly Pty Ltd
cm	centimetre
CRD	Cumulative Rainfall Departure
DGV	Default Guideline Values
DoE	Department of Environment
DPI	Department of Primary Industries
DSITI	Department of Science, Information Technology and Innovation
EC	Electrical conductivity
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
GHD	GHD Pty Ltd
ha	hectare
kL	kilolitre
kL/day	kilolitres per day
Km	kilometre
L	litre
LDP	licensed discharge points
m	metre
m bgl	metres below ground level
m bTOC	metres below top of casing
mg	milligram
mg/L	milligrams per litre
ML	megalitres
mm	millimetre
NSW	New South Wales
NTU	Nephelometric Turbidity unit
RPS	RPS Pty Ltd
SILO	Scientific Information for Land Owners
SSD	State Significant Development
SSGV	Site Specific Guideline Values
TSS	Total suspended solids

Abbreviation	Description
VWP	Vibrating Wire Piezometers
WAL	Water Access Licence
WMP	Water Management Plan
WSP	Water Sharing Plan

Contents

1. Introduction **1**
1.1 Background 1
1.2 Objectives of this report 1
1.3 Limitations 2
2. Approvals and licence requirements **4**
2.1 Development consent 4
2.1.1 Airly Mine extension project statement of commitments 8
2.2 Environment protection licence 9
2.3 Water licences 10
3. Site environment **11**
3.1 Water management infrastructure 11
3.1.1 Production bore 11
3.2 Climate 13
3.2.1 Rainfall 13
3.2.2 Cumulative rainfall departure 14
3.2.3 Evaporation 15
4. Groundwater monitoring **17**
4.1 Monitoring network 17
4.2 Monitoring program 19
4.2.1 Water levels 19
4.2.2 Water quality 20
4.2.3 Seepage flow 20
4.2.4 Access 20
4.3 Groundwater levels 22
4.3.1 Vibrating wire piezometers 23
4.3.2 Standpipes 24
4.4 Groundwater quality 24
4.4.1 Standpipe monitoring bores 26
4.4.2 Shoalhaven Group groundwater – Production Bore (AM2B-1) 27
4.4.3 Devonian groundwater – Nioka and Kingdom 27
4.4.4 GW800787 27
4.4.5 Permian groundwater – Village Spring seepage 27
4.5 Groundwater flow 27
4.5.1 Village Spring 27
4.5.2 Underground workings 28
4.6 Trigger Action Response Plan review – Groundwater 28
5. Surface water monitoring program **31**
5.1 Surface water flow 31
5.1.1 Creek flow statistics 31
5.1.2 Surface water flow assessment 32
5.2 Surface water quality 35
5.2.1 Airly Creek 35
5.2.2 Genowlan Creek 36

5.2.3 Licensed discharge points 36
5.2.4 Nissan Hut Dam 37
5.2.5 Trigger Action Response Plan review – surface water quality 38
6. Impact assessment 39
6.1 2024 operations 39
6.1.1 Groundwater inflow 39
6.1.2 Groundwater levels and quality 39
6.1.3 Surface water 40
6.1.4 Production bore AM2B-1 42
6.1.5 Old production bore 42
6.1.6 Site water balance 42
6.2 2025 operations 43
6.2.1 Groundwater 43
6.2.2 Surface water 43
7. Summary 44
8. References 47

Table index

Table 2.1 Development consent SSD-5581 conditions 4
Table 2.2 Independent Environmental Actions 7
Table 2.3 Statement of commitments 8
Table 2.4 LDP001 water quality concentration limits 9
Table 2.5 LDP002 and LDP003 water quality concentration limits 10
Table 3.1 Rainfall dataset statistics 13
Table 4.1 Groundwater monitoring network details 17
Table 4.2 Minimum observed water levels 22
Table 4.3 Groundwater quality trigger values (WMP Rev 9) 25
Table 4.4 Trigger Action Response Plan – Stage 1 trigger investigations 28
Table 5.1 Flow statistics for recorded gauges in 2024 31
Table 5.2 Summary of surface water flow assessment against TARP F2 for Q2-Q4, 2024 32
Table 5.3 Current Genowlan Creek 2 model parameters 33
Table 5.4 Current Gap Creek model parameters 33
Table 5.5 Sampling locations exceptions 2024 35
Table 5.6 Trigger Action Response Plan Surface Water quality investigation 38
Table 6.1 Annual water balance – average existing conditions (2024) 42
Table 7.1 Summary of monitoring 44

Figure index

Figure 1.1 Locality Plan 3
Figure 3.1 Surface area features 12
Figure 3.2 Annual rainfall recorded at Illford (Warrangunyah) Station, 1901 to 2024 13
Figure 3.3 Cumulative rainfall departure curve, 1901 to 2024 14
Figure 3.4 Cumulative rainfall departure, 2023 / 2024 15

Figure 3.5 Monthly evaporation and rainfall recorded at BoM Illford (Warrangunyah) Station (station 62031), 2024 16
Figure 4.1 Groundwater monitoring network 21
Figure 4.2 Recorded flows at Village Spring 28
Figure 5.1 Observed flow and rainfall at recorded surface water gauges 31
Figure 5.2 Surface water monitoring locations 34
Figure 5.3 Nissan Hut Dam water levels 37
Figure 6.1 Genowlan Creek catchments monitoring sites 41

Appendices

Appendix A Groundwater hydrographs
Appendix B Water quality timeseries
Appendix C SSGV and DGV summary
Appendix D Piper Charts

1. Introduction

Airly Mine (the site) is an underground coal mine owned and operated by Centennial Airly Pty Ltd (Centennial Airly). It is located near Capertee Village, approximately 40 km north-west of Lithgow on the Castlereagh Highway in the Western Coalfield of NSW (refer Figure 1.1).

Centennial Airly commissioned GHD to compile surface water and groundwater data pertaining the site and its monitoring network into a consolidated annual report for the purpose of demonstrating compliance with their monitoring requirements. This report presents an assessment of surface water and groundwater at Airly Mine for 2024 in relation to trigger values specified in the Airly Mine Water Management Plan Revision 9 (WMP) (Centennial Coal, 2024) and historical trends. The information provided herein will be relied upon for inclusion in overarching reports for the Airly Mine Annual Review.

1.1 Background

Airly Mine was granted Development Consent DA162/91 for the development of an underground coal mine on 14 April 1993 by the then Minister for Planning following a Commission of Inquiry held in 1993. The development consent allows Airly Mine to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal within the mining lease ML1331. Mining is undertaken by bord and pillar and narrow pillar extraction methods within the Lithgow Seam.

The mine underwent a period of care and maintenance from January 2013 to March 2014. The Airly Mine Extension Project (SSD-5581) was approved in December 2016 and allowed mining for a period of 20 years within the boundaries of ML1331 and ML1814. Five modifications to SSD-5581 have been approved.

The current regulator approved version of the Airly Mine Water Management Plan is Revision 9 (Centennial Coal, 2024). Version 10 of the WMP is currently being prepared by GHD (GHD, 2025a) to update in accordance with the outcomes of the updated groundwater model (GHD, 2025c).

1.2 Objectives of this report

The objective of this report is to present the status of surface water and groundwater in the vicinity of the Airly underground mine with respect to:

– Mining related activity, identifying any potential impact/s, if occurring.
– Consent conditions for the Airly Mine Extension Project (EPBC 2013/7076, SSD - 5581).
– Environment protection licence (EPL) 12374.
– The Airly Mine Water Management Plan, Revision 9 (Centennial Coal, 2024).

1.3 Limitations

This report: has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and Centennial Airly Pty Ltd as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

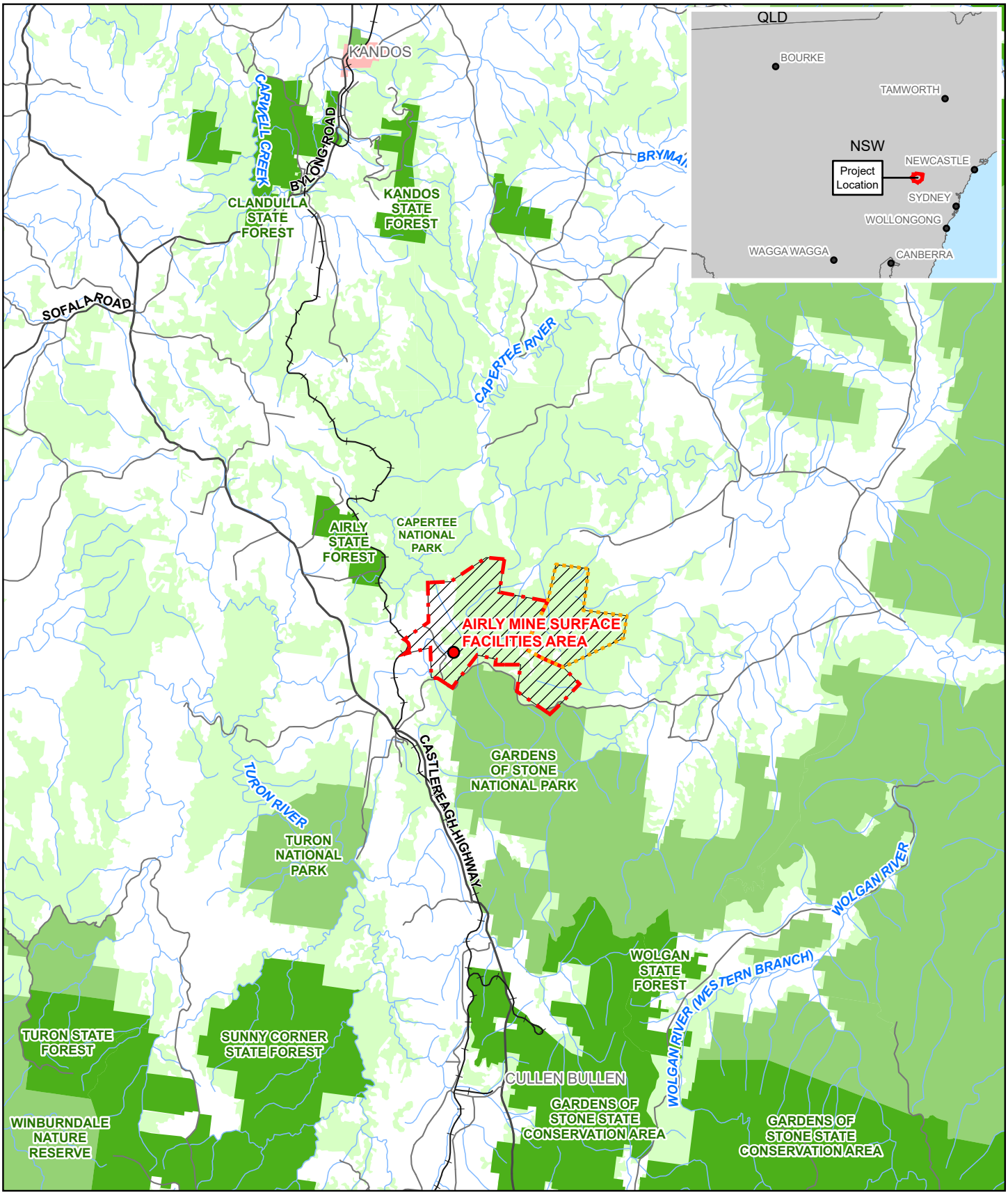
The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Centennial Airly Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.



LEGEND

- Airly Surface Facilities Area
- Mining Lease ML1331
- Mining Lease ML 1814
- Approved development consent boundary
- Existing rail
- Principal road
- Secondary road
- Minor road
- Waterway
- Built up area
- Recreation area
- Nature conservation
- State forest
- Forest or shrub

Paper Size A4

0 1.5 3 4.5 6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

CENTENNIAL

Centennial Airly Pty Ltd
Airly Mine Water Monitoring
2024 Annual Water Monitoring Report

Job Number 22-12602550
Revision 0
Date 12/03/2025

Locality plan

Figure 1-1

12602550_AWR001_Locality
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12602550\AWR\12602550_AWR.aprx

© 2025. Whilst every care has been taken to prepare this map, GHD, Geoscience Australia and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3 2006; Centennial: Boundaries, 2013. Created by: tmorton

2. Approvals and licence requirements

2.1 Development consent

The WMP addresses specific water components of the conditions of development consent SSD-5581, which was granted in December 2016 and last modified in December 2023 (Mod 5). The relevant requirements of the consent are outlined in Table 2.1. This is noted to be a comprehensive list, and not all conditions are relevant to this annual report. For the full table of development consent requirements, please see the WMP. Where relevant conditions have been addressed in this document, the sections are also listed in Table 2.1, otherwise direction to another source has been made.

Table 2.1 Development consent SSD-5581 conditions

Condition		Compliant	Relevant section of this document
Schedule 4 13.	Prior to carrying out any development under this consent, unless the Secretary agrees otherwise, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Secretary. This plan must:	Yes	NA (refer to WMP)
Schedule 4 13. (a)	Be prepared in consultation with the DoE, EPA and the Water division, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary.	Yes	NA (refer to Appendix A and Appendix B in the WMP).
Schedule 4 13. (b)	Include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 6).	Yes	NA (refer to Table 1.3 in the WMP).
Site water balance			
Schedule 4 13. (c) (i)	Details of sources and security of water supply, including contingency supply for future reporting periods.	Yes	NA (refer to Sections 3.2 to and 3.5 of the WMP).
	Details of water use and management on site.	Yes	Section 3.1 Also refer to Section 3.2 to 3.4 of the WMP.
	Details of any off-site water discharges.	Yes	Section 5.2.3 Also refer to Section 1.2.4, 3.2.2 and 3.5.2 of the WMP.
	Reporting procedures, including the preparation of a site water balance for each calendar year.	Yes	Section 6.1.6 Also refer to Section 7.4 of the WMP .
	Investigates and implements all reasonable and feasible measures to minimise water use on site.	Yes	NA (refer to Section 3.5.1 of the WMP).
Surface water management plan			
Schedule 4 13. (c) (ii)	Detailed baseline data on water flows and quality in the watercourses that could potentially be affected by the development, including, but not limited to Gap, Genowlan and Airly Creeks.	Yes	Section 5 Also refer to Section 5.1 of the WMP.
	Continuous flow monitoring at Airly Village Spring and the Grotto.	Yes	Section 4.5.1 and Section 5.

Condition		Compliant	Relevant section of this document
			Also refer to Section 4.2.2 and 4.4.1 of the WMP.
	Provisions for the recalculation of site-specific trigger values in relation to water discharges to Airly Creek once a minimum of two years data is obtained from the Airly Creek 'U/S' monitoring location in accordance with ANZECC guidelines.	Yes	NA (refer GHD 2018a and Section 6.1.1 of the WMP).
	The provision and implementation of adaptive management measures to ensure that subsequent water discharges to Airly Creek comply with the recalculated site-specific trigger values derived from the Airly Creek 'U/S' monitoring location.	Yes	NA (refer to TARPS in Appendix F of the WMP).
	A detailed description of the water management system, including the: – Clean water diversion systems. – Erosion and sediment controls (mine water system). – Mine water management systems.	Yes	NA (refer to Section 3.2 and 3.3 of the WMP).
	Detailed objectives and performance criteria, including trigger levels for investigating any potentially adverse impacts associated with the development for:	Yes	-
	Downstream surface water quality.		Section 5.2 Also refer to Section 6 of the WMP.
	Downstream water users, including with respect to any subsidence-related flow reductions in Gap and Genowlan Creeks.		NA (refer GHD 2018a and Section 6 of the WMP).
	Stream and riparian vegetation health in Gap, Genowlan and Airly Creeks within and immediately outside of the site.		NA Refer to Section 6.2 of the WMP. Riparian vegetation assessment outlined in Airly Site Specific Biodiversity Management Plan (BMP).
	A program to monitor and report on: – Effectiveness of the mine water management system. – Surface water flows, quality and geomorphology of the watercourses potentially affected by the development within and immediately outside of the site.	Yes	Section 5 Also refer to Section 4 and 7 of the WMP and Section 1.3.2 of GHD 2018b. Also refer to Section 3 of GHD (2025d) and Section 3 of GHD (2025e).

Condition		Compliant	Relevant section of this document
	– The performance measures listed in Table 6 including, but not limited to event-based monitoring of the hydrology, quality, ecotoxicology and chemical composition of water in Airly Creek under discharge conditions at points 5 and 6, or as otherwise determined in consultation with the EPA, to ensure that protection is provided to 99% of all species in the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area in accordance with ANZECC guidelines.		
	Reporting procedures for the results of the monitoring program.	Yes	NA (refer to Section 7.1 of the WMP).
	A plan to respond to any exceedances of performance measures, and repair, mitigate and/or offset any adverse surface water impacts of the development, including measures to provide compensatory water supply to any affected downstream water user.	Yes	NA (refer to Section 6.3 and Appendix F of the WMP).
Groundwater Management Plan			
Schedule 4 13. (c) (iii)	Detailed baseline data of groundwater levels, yield and quality in the region that could be affected by the development, including licensed privately-owned groundwater bores and a detailed survey/schedule of groundwater dependent ecosystems (including springs and their discharge quantity and quality).	Yes	Section 4 Also refer to Section 5.3 in the WMP.
	Consultation with the Water Division on the installation of all new monitoring bores, the scheduled sampling and quality determination of parameters for monitoring bores.	Yes	NA (refer to Section 4.4 of the WMP).
	Groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts.	Yes	Section 4.3 and 4.4. Also refer to Section 6.1.4 and 6.2.4 in the WMP .
	A program to monitor and report on: – Springs and their discharge quantity and quality. – Groundwater inflows transferred to the surface water management system. – The seepage/leachate from water storages and emplacements. Impacts of the development on: – Regional and local (including alluvial) aquifers.	Yes	Section 4.1 Also refer to Sections 4.4 and 4.5 of the WMP .

Condition		Compliant	Relevant section of this document
	– Groundwater supply of potentially affected landowners. – Groundwater dependent ecosystems (including rules for the management of groundwater level impacts to protect groundwater dependent ecosystems), and riparian vegetation.		
	A program to monitor and report on stygofauna and hyporheic fauna.	Yes	NA (refer to Section 4.4.3 of the WMP and the Western Region Stygofauna Monitoring Assessment Plan).
	A program to review and validate the groundwater model for the development, including independent expert review.	Yes	NA (refer to Section 7.6 and Appendix G of the WMP).
	A plan to respond to any exceedances of the performance measures.	Yes	NA (refer to Section 6.3 and Appendix F of the WMP).
Independent Environmental Audit			
Schedule 6 13.	Within 12 weeks of commissioning this audit, or as otherwise agreed by the Planning Secretary, the applicant must submit a copy of the audit report to the Planning Secretary, together with its response to any recommendations contained in the audit report a timetable for the implementation of these recommendations as required. The Applicant must implement these recommendations, to the satisfaction of the Planning Secretary.	Yes	Table 2.2

NA – not applicable to this report.

Table 2.2 Independent Environmental Actions

Aspect & Condition Reference	REC Number & IEA – Recommendation	Airly Mine Response / Action Plan	Where Addressed
Surface Water Management Plan SSD 5581 Schedule 4 Condition 13	IMP REC 8 Modify the Airly Mine Water Monitoring Annual Reports in the Annual Reviews to clearly outline the surface water monitoring locations and parameters have been monitored in accordance with the WMP.	A10 AIR IEA 2024: Centennial will modify the 2024 Annual Water Monitoring Report to clearly demonstrate that the surface water monitoring locations and parameters have been monitored in accordance with the WMP. The 2024 Annual Water Monitoring Report will be appended to the 2024 Annual Review.	Fig 5.2 & Appendix C.
Groundwater Management Plan SSD 5581 Schedule 4 Condition 13	IMP REC 9 Groundwater recommendations: – The monitoring data should be compared to the trigger levels in the already approved WMP and any updated version of the WMP (even if not formally approved) but includes most up to date data and information.	A11 AIR IEA 2024: Centennial will address this action in the 2024 Annual Water Monitoring Report.	Tables 4.2 and 4.3.

Aspect & Condition Reference	REC Number & IEA – Recommendation	Airly Mine Response / Action Plan	Where Addressed
	– Trigger levels for piezometric level and water quality should be listed in table or provided as a line on the water quality graphs in the annual report to allow comparison against the observed. This is particularly important as the trigger levels are updated frequently and this would allow quick overview without needing to go to most recent WMP for checking.	A12 AIR IEA 2024: Trigger levels were included in the 2023 Annual Report graphics. This will continue for the 2024 Annual Report.	Tables 4.2 and 4.3
	IMP REC 10 Groundwater recommendations: – The improvement would include presentation of major ions on a Piper or similar geochemical diagram for different time periods or shown with different colour on a same diagram. Trigger levels for groundwater quality (metals) should be added to the graphs to enable comparison.	A15 AIR IEA 2024: Centennial will improve the graphical presentation of major ions, including trigger levels for groundwater quality, within the 2024 Annual Water Report.	Appendix B and Appendix D.
Independent Expert Review SSD 5581 Schedule 4 Condition 14	IMP REC 11 – Data presentation (water quality graphs) could be improved to allow comparison with previous periods and areas.	A17 AIR IEA 2024: Centennial will include quality graphs, grouped based on areas and show time series for the history of monitoring, in the 2024 Annual Report.	Appendix B

2.1.1 Airly Mine extension project statement of commitments

In addition to the conditions of development consent, Centennial Airly also committed to the management strategies and monitoring activities outlined in Table 2.3 as part of the Airly Mine Extension Project.

Table 2.3 Statement of commitments

Commitment	Compliant	Where addressed
Additional groundwater monitoring bores will be installed during the pre-mining phase within Gap Creek and Genowlan Creek alluvium in the areas of predicted groundwater drawdown and monitored for groundwater levels and quality (where accessible).	Yes	NA (refer GHD 2017)
Daily groundwater volumes transferred to the surface facilities area will be monitored.	Yes	Section 4.5.2
The WMP will establish critical threshold levels for groundwater levels and groundwater quality to trigger additional assessment and management and will define the mechanism for identifying and reporting exceedances. Action will be taken if the Level 1 minimal impact considerations (or other critical threshold levels) are found to be exceeded.	Yes	NA (refer to Section 6.1.4 of the WMP)
Groundwater monitoring data will be audited on an annual basis and compared to hydrogeological modelling predictions. The WMP will define the mechanism for identifying and reporting variations from predictions.	Yes	Section 4.3
Should more than 278 ML/year of groundwater flow into the underground workings (i.e. more than the existing water access licences) due to greater than predicted storage within the Permian strata (particularly within the old shale workings), it will be necessary for Centennial Airly to purchase an additional water access licence to cover the excess groundwater volume.	Yes	NA (refer to Sections 1.2.5, 3.3.2 and 6.1.3 of the WMP).

Commitment	Compliant	Where addressed
Additional groundwater monitoring points to be installed during the pre-mining phase within Gap Creek and Genowlan Creek alluvium in the areas of predicted groundwater drawdown. The groundwater monitoring points will monitor the following parameters: – Piezometric height – Groundwater quality – Groundwater flow – Geomorphic conditions of third order streams The monitoring of the above noted parameters will be undertaken on a quarterly basis except for the monitoring of geomorphic condition of third order streams which will be undertaken every two years.	Yes	NA (refer WMP)
Monitoring groundwater bores on adjacent private properties will be undertaken to provide understanding of regional groundwater systems. Parameters to be monitored will be: – Piezometric height – Groundwater quality	Yes	Sections 4.4.3 and 4.4.4. Monitoring program outlined in Section 4.4.1 of the WMP.
Monitor macroinvertebrate ecology in Airly Creek at appropriate upstream and downstream locations biannually (spring and autumn).	Yes	NA (refer to Sections 2 and 3 of GHD 2025e).

NA – not applicable to this report

2.2 Environment protection licence

Airly Mine currently holds environment protection licence (EPL) 12374, with water currently licensed to be discharged from the site through the following licensed discharge points (LDPs):

– LDP001 – Discharge to Airly Creek via the Production Dam
– LDP002 – Discharge to Airly Creek via the Stockpile Dam
– LDP003 – Discharge to Airly Creek via the Train Loader Dam

EPL 12374 specifies water sampling of LPDs and the receiving water course during discharge events and comparison to specific water quality concentration limits as summarised in Table 2.4 and Table 2.5.

The water quality limits presented in Table 2.4 and Table 2.5 do not apply when the discharge occurs solely as a result of significant rainfall, measured as that which exceeds 44 mm over any consecutive five-day period at the site.

Table 2.4 LDP001 water quality concentration limits

Parameter	Units	Concentration limit	
		90 percentile concentration limit	100 percentile concentration limit
Ammonia	mg/L	-	0.32
Arsenic (dissolved)	mg/L	-	0.024
Electrical conductivity (EC)	µS/cm	2244	-
Copper (dissolved)	mg/L	-	0.013
Nickel (dissolved)	mg/L	-	0.1
Nitrogen (total)	mg/L	2	-
Oil and grease	mg/L	-	10
pH	pH units	-	6.5-9.0

Parameter	Units	Concentration limit	
		90 percentile concentration limit	100 percentile concentration limit
Phosphorus (total)	mg/L	0.5	-
Total suspended solids (TSS)	mg/L	-	50
Turbidity	NTU	-	40
Zinc (dissolved)	mg/L	-	0.072

Table 2.5 LDP002 and LDP003 water quality concentration limits

Parameter	Units	100 percentile concentration limit
Oil and grease	mg/L	10
pH	pH units	6.5–9.0
Total suspended solids (TSS)	mg/L	50
Turbidity	NTU	40

2.3 Water licences

Airly Mine currently holds two water access licences (WALs) under the *Water Management Act 2000* for the extraction of groundwater. A total of 278 ML is licensed for extraction from the Sydney Basin North groundwater source as part of the Water Sharing Plan (WSP) for the Greater Metropolitan Region Groundwater Sources, made up of WAL 24386 (158 ML/year) and WAL 36565 (120 ML/year). WAL 24386 licenses the take of water from the onsite production bore (water supply works approval 10WA112537), which is used to supplement water for use in mining activities. WAL 36565 licenses the extraction of water from the underground workings to the 109 ML Dirty Water Dam.

A number of licences are held by Airly Mine under the *Water Act 1912* for groundwater monitoring bores.

3. Site environment

The site environment, including descriptions of the topography, hydrology, geology and hydrogeology, is provided in the WMP. A review of current water management infrastructure for 2024 is summarised below.

3.1 Water management infrastructure

Water management infrastructure for surface catchment and management of clean and dirty water at Airly Mine comprise:

- A discharge dam (Production Dam) for the storage of clean water for use or discharge via licensed discharge point 1 (LDP001) into a drainage channel which flows through the site and ultimately discharges to Airly Creek.
- A system of small primary settling dams for trapping coarse sediment, including the Train Loader Dam and Filter Ponds upstream of the 109 ML Dirty Water Dam.
- Overflows from the Train Loader Dam are discharged to Airly Creek via licensed discharge point 3 (LDP003).
- A large secondary dam (109 ML Dirty Water Dam) and a smaller dam (Stockpile Dam) into which overflow from the small settling dams and the coal stockpile discharge, respectively, and allow settlement of fine sediments.
- Overflows from the Stockpile Dam are discharged to Airly Creek via licensed discharge point 2 (LDP002).
- A Production bore (AM2B-1).

Water management infrastructure are shown in Figure 3.1.

3.1.1 Production bore

Centennial Airly has a licensed production bore (AM2B-1, bore licence no. 10WA112537; Water Access Licence (WAL) 24386), located adjacent to the existing rail loop. AM2B-1 was installed in 2009 within sandstone and siltstone of the Shoalhaven Group and was licensed to extract up to 158 ML/year of groundwater at a maximum rate of 5 L/s. AM2B-1 is a potential water supply for mining operations at Airly Mine. Approximately 5.7 ML was extracted from the production bore in 2024 for the use in coal production[1].

AM2B-1 is sampled for water quality via the installed pump. Water levels are gauged in the adjacent ‘old production bore’.

[1] Note water access reported against WALs is calculated for the financial year. Water access in the Annual Report is calculated for the calendar year.



LEGEND

- Licensed discharge point
- Infrastructure
- Approved development consent boundary
- Pollution control structure
- Rail loop
- Waterway

Paper Size A4

0 50 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

CENTENNIAL

Centennial Airly Pty Ltd
Airly Mine Water Monitoring
2024 Annual Water Monitoring Report

Job Number	22-12602550
Revision	0
Date	12/03/2025

Site features

Figure 3-1

12602550_AWR002_SiteFeatures
N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12602550\AWR\12602550_AWR.aprx

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

© 2025. Whilst every care has been taken to prepare this map, GHD, LPI and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: LPI: DTDB 2012; Centennial: Aerial Imagery, Infrastructure 2013. Created by:

3.2 Climate

3.2.1 Rainfall

Daily rainfall data were obtained from the Scientific Information for Land Owners (SILO) database operated by the Queensland Government - Department of Science, Information Technology, and Innovation (DSITI, 2020). SILO Patched Point Data is based on historical data from a particular Bureau of Meteorology (BoM) station with missing data 'patched in' by interpolating with data from nearby stations.

For this assessment, SILO data were obtained from the BoM Ilford (Warrangunyah) station (number 62031), which is located approximately 29 km north-west of Airly Mine. This station was chosen based on the length and quality of the data record and proximity to the site. The period of rainfall data used for this assessment dates from January 1901 to December 2024 and is summarised as annual totals in Figure 3.2. The SILO data have been compared to the onsite weather station rainfall site AWS01, which is located on Genowlan Mountain. Data from AWS01 are used in this review. The statistics for these rainfall datasets are displayed in Table 3.1.

Table 3.1 Rainfall dataset statistics

Statistic	SILO Ilford gauge (62031)	AWS01
Minimum average rainfall	305.6 mm in 1982	398.4 mm in 2019
Average annual rainfall	686.5 mm	672.6 mm
Median annual rainfall	665.3 mm	645.2 mm
Maximum annual rainfall	1622.6 mm in 1950	1019.4 mm in 2022
Total rainfall for 2024	818.8 mm (80th percentile)	645.2 (50th percentile)

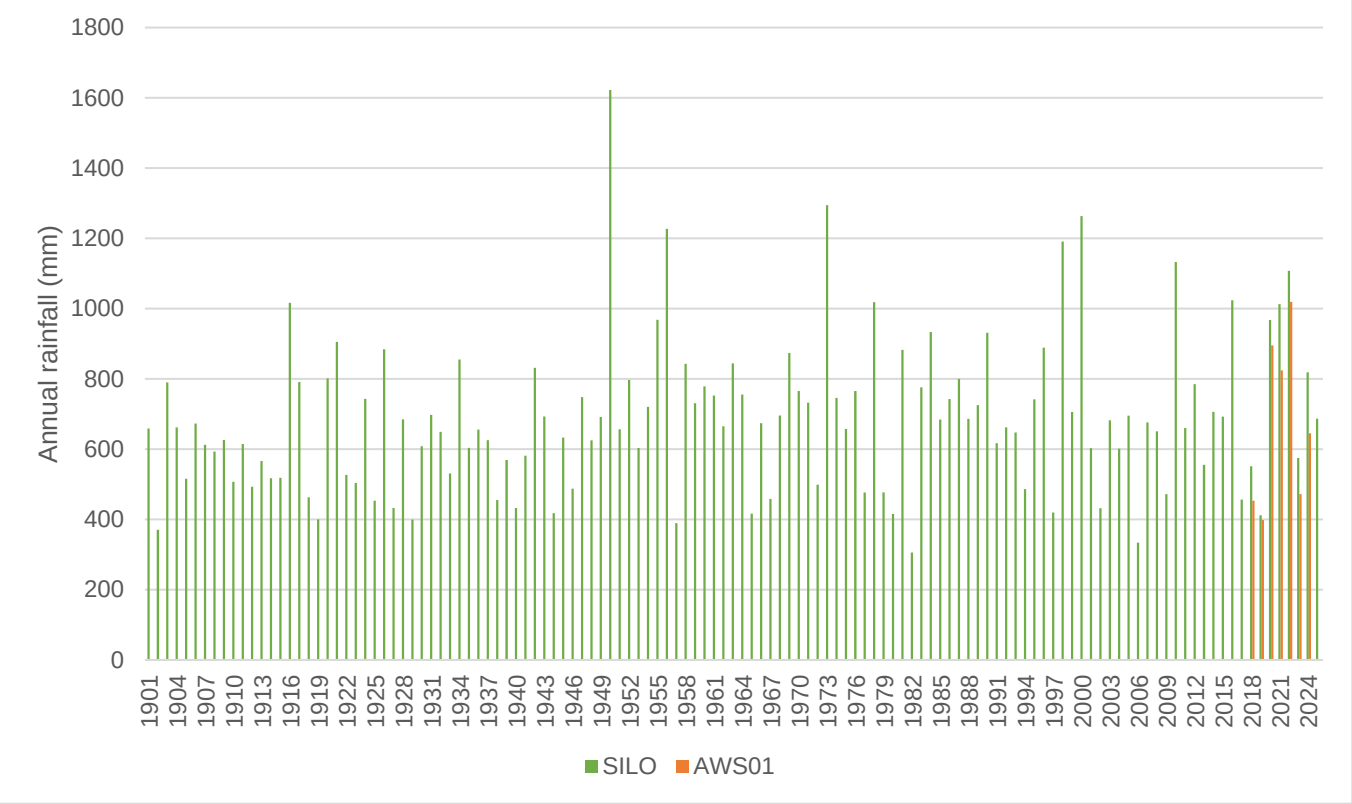


Figure 3.2 Annual rainfall recorded at Illford (Warrangunyah) Station, 1901 to 2024

For the SILO gauge, total rainfall in 2024 was above the historical average (818.8 mm vs 686.5 mm). Monthly rainfall varied from 121.8 mm in Jan to 32.8 mm in October. The monthly rainfall in January, February, April, June, July, August and December 2024 were only slightly higher than the long-term monthly averages.

3.2.2 Cumulative rainfall departure

A cumulative rainfall departure (CRD) curve presents the cumulative difference between the observed monthly rainfall and long-term average monthly rainfall. The CRD curve only deviates from zero due to atypical (above and below average) rainfall. Increase in the CRD reflects above average rainfall while a decrease reflects below average rainfall. Historical CRD inclusive of results from 2024 is shown in Figure 3.3. In 2024, no significant deviation from the average was recorded, with the CRD fluctuating only marginally from zero between March and December (Figure 3.4).

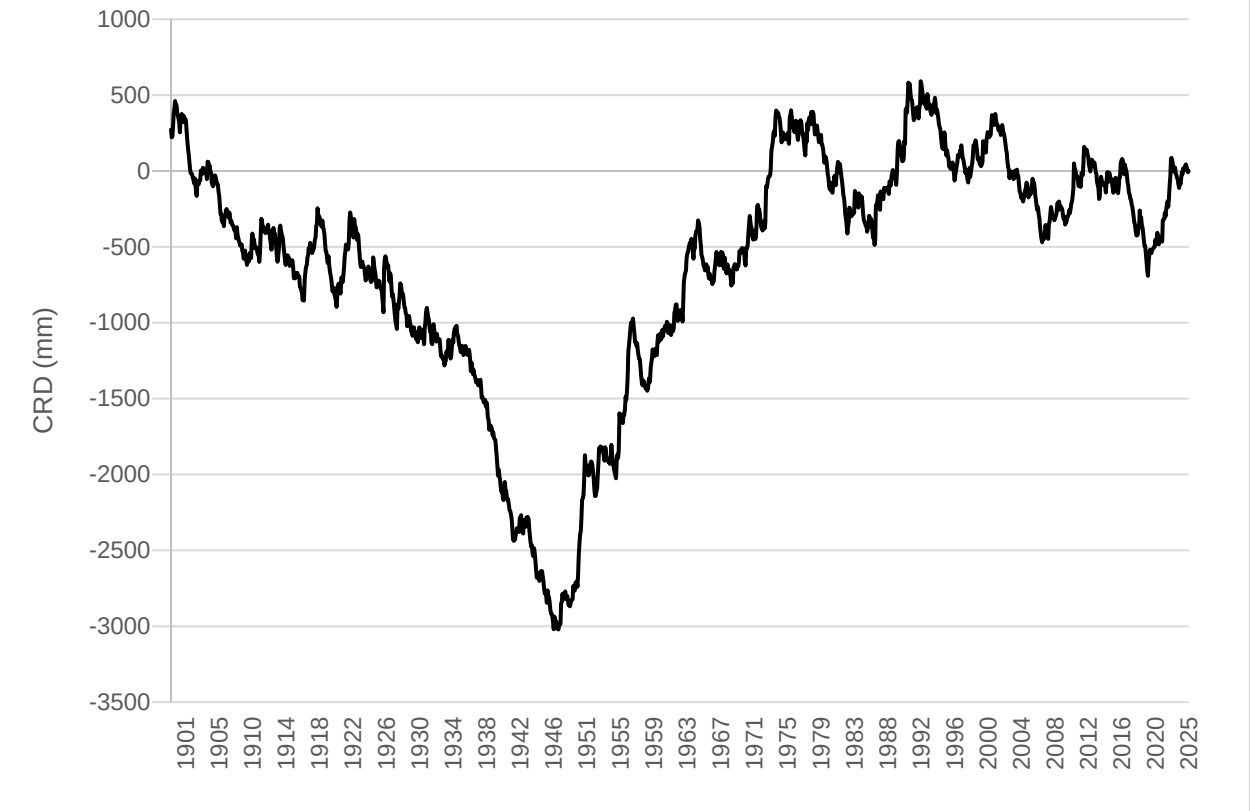


Figure 3.3 Cumulative rainfall departure curve, 1901 to 2024

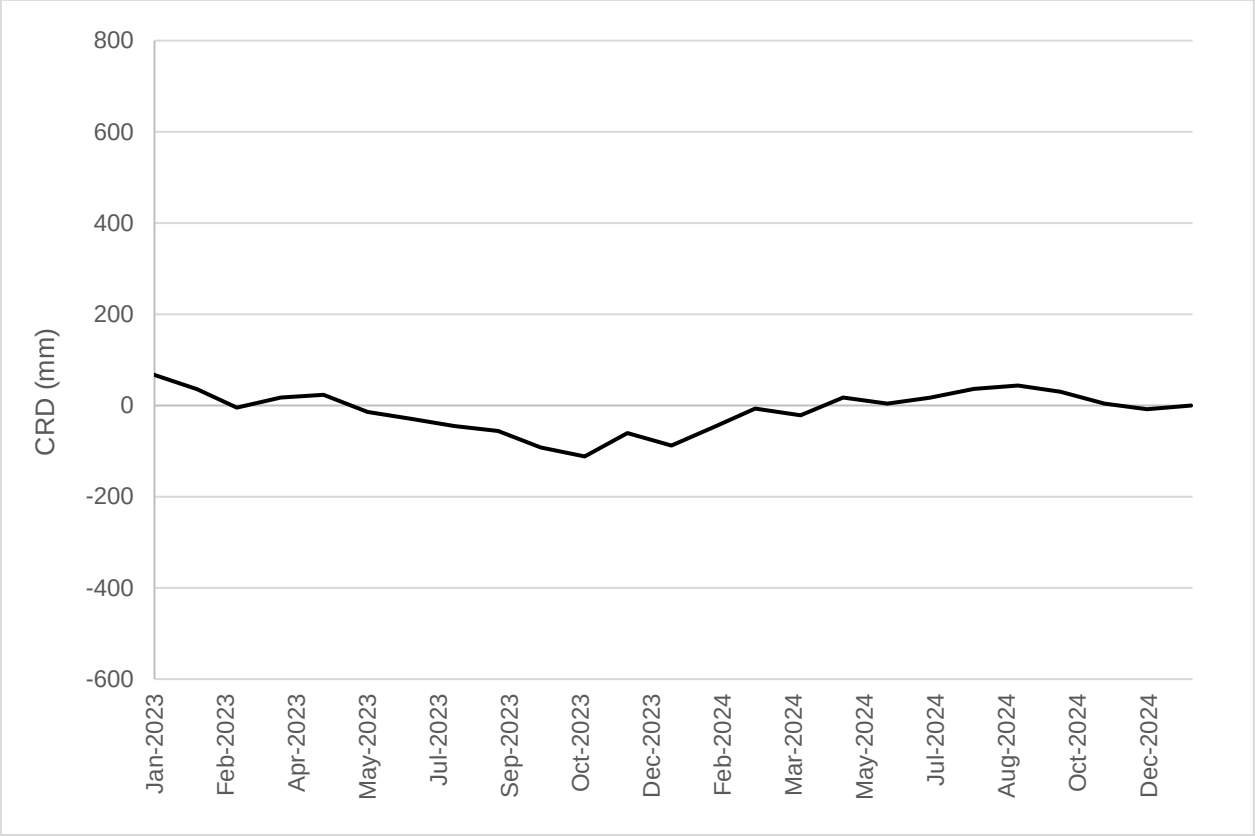


Figure 3.4 Cumulative rainfall departure, 2023 / 2024

3.2.3 Evaporation

Evaporation data were also obtained from the BoM Ilford (Warrangunyah) station (number 62031), as the nearest station with historical evaporation records. The long-term average annual evaporation total is 1345.9 mm, compared to the long-term annual average rainfall of 686.5 mm. This gives an annual deficit of approximately 659.4 mm. Monthly evaporation in 2024 varied between 30.8 mm in June and 194 mm in December. In 2024, the evaporation totals for all months were below the historical average, except for March, July, August and September (Figure 3.5). Annual total evaporation for 2024 was 1,249.8 mm, and annual total rainfall for 2024 was 818.8 mm, giving a deficit of approximately 431 mm for 2024.

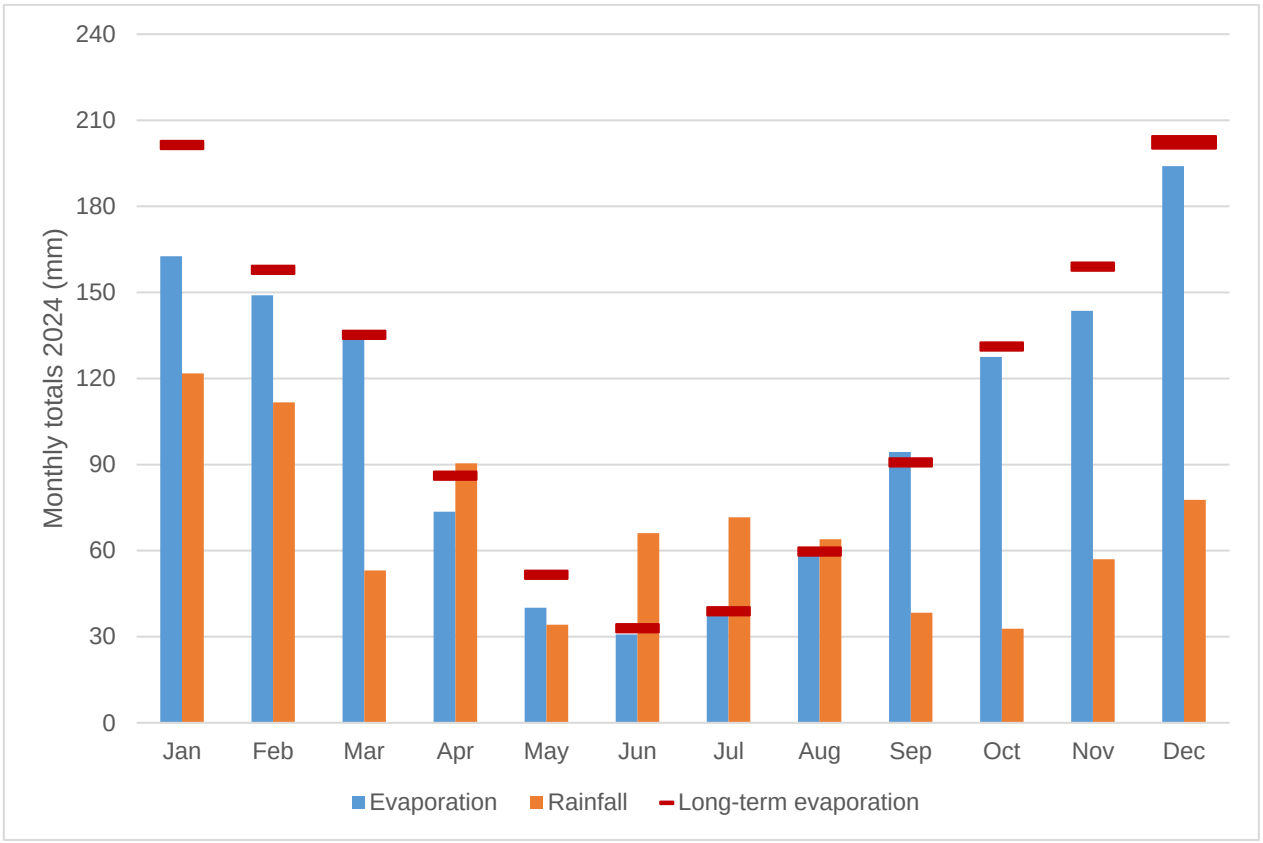


Figure 3.5 ***Monthly evaporation and rainfall recorded at BoM Illford (Warrangunyah) Station (station 62031), 2024***

4. Groundwater monitoring

4.1 Monitoring network

The monitoring program for 2024 comprised:

– Monitoring of deep aquifer water pressures via vibrating wire piezometers (VWPs) at five locations (excluding ARP01, ARP02A, ARP03 and ARP08 which became dysfunctional between 2018 and 2023).
– Monitoring of water levels and quality in alluvial, Narrabeen Sandstone and Permian aquifers from eight standpipe piezometers (excluding ARP07 which has been dry since July 2013, ARP08 which has been mined through, and ARP16, which has been dry since installation in December 2021). Note that AM2B-1 and Old Production Bore are adjacent to each other and considered to be the one site (one monitors quality and the other levels of the Shoalhaven Group).
– Monitoring water quality of three private production bores.
– Monitoring of groundwater seepage flows at Village Spring and in mine workings.

Details of the monitoring network are presented in Table 4.1 and shown in Figure 4.1. Note that ARP16 and GW800787 have not yet been surveyed and are not shown in Figure 4.1.

Table 4.1 Groundwater monitoring network details

Type	Location	Monitoring Period	Lithology	Status
VWPs	ARP01	June 2012–2018 All loggers dysfunctional since 2018.	Narrabeen Sandstone (74 m bgl)	VWP dry since installation. Dysfunctional (2015)
			Irondale Seam (238.5 m bgl)	Dysfunctional (2018)
			Lithgow Seam (260 m bgl)	Dysfunctional (2018)
			Marrangaroo Formation (263 m bgl)	Dysfunctional (2018)
	ARP02A	May 2012–2023 Marrangaroo Formation, Irondale and Lithgow Seam dysfunctional since 2020. Narrabeen Sandstone dysfunctional since 2023.	Narrabeen Sandstone (65 m bgl)	Dysfunctional (WMP 2024)
			Irondale Seam (243 m bgl)	VWP dry since 2012 – Dysfunctional (2020)
			Lithgow Seam (266 m bgl)	VWP dry since installation – Dysfunctional (2020)
			Marrangaroo Formation (270 m bgl)	Dysfunctional (2020)
	ARP03	July 2012–2023	Narrabeen Sandstone (136 m bgl)	Dysfunctional (2020)
			Middle River Seam (165 m bgl)	VWP logger dysfunctional (2023)
			Lithgow Seam (252 m bgl)	VWP dry since installation – Dysfunctional (2021)
			Marrangaroo Formation (257 m bgl)	VWP dry since February 2022. Dysfunctional
	ARP04	April 2012–present	Lithgow Seam (25 m bgl)	Working – VWP dry since June 2016
			Marrangaroo Formation	Working

Type	Location	Monitoring Period	Lithology	Status
			(28.5 m bgl)	
			Shoalhaven Siltstone (210.3 m bgl)	Working
	ARP06	June 2013–present	Narrabeen Sandstone (230 m bgl)	Working
			Irondale Seam (252 m bgl)	VWP dry since December 2013. Erroneous since November 2024.
			Lithgow Seam (288 m bgl)	VWP dry since installation. Erroneous since November 2024
			Marrangaroo Formation (295 m bgl)	VWP dry since January 2016. Erroneous since November 2024
	ARP07	July 2013–present (dry)	Middle River Seam (168 m bgl)	Working – VWP dry since installation
			Lithgow Seam (252 m bgl)	Working – VWP dry since installation
	ARP08	September 2013– present (Dry) The VWP is obsolete	Narrabeen Sandstone (183 m bgl)	Working – VWP dry since January 2016
			Irondale Seam (282.5 m bgl)	Dysfunctional since September 2022
	ARP13	December 2016– present	Shoalhaven Group (120 m bgl)	Working
			Devonian strata (280 m bgl)	Working
	ARP15[2]	January 2017– present	Lithgow Seam (125 m bgl)	Working
			Shoalhaven Group (200 m bgl)	Working – VWP dry since June 2017
			Devonian strata (365 m bgl)	Working
Standpipes	AM2B-1	2009–present	Shoalhaven Group (38–87 m bgl)	Working (quality only)
	Old Production Bore	May 2017- present	Shoalhaven group (37-69 m bgl)	Working (Levels only)
	ARP05	August 2012–present	Gap Creek alluvium (8–11 m bgl)	Working - generally dry between September 2017 and March 2021. Water level response since April 2021 following rainfall.
	ARP07	July 2013–present	Narrabeen Sandstone (110–119 m bgl)	Working – dry since install in July 2013
	ARP08	September 2013– 2022	Lithgow Seam (301–305 m bgl)	No longer monitored / mined through
	ARP09	June 2013–present	Genowlan Creek alluvium (3–4 m bgl)	Working – Mostly dry, responds after rainfall

[2] Logger box damaged by tree fall January 2021.

Type	Location	Monitoring Period	Lithology	Status
	ARP11	January 2017– present	Permian strata (1.25–15.3 m bgl)	Working – Rainfall driven water level recovery since September 2021
	ARP12	January 2017– present	Genowlan Creek alluvium (0.5–2.6 m bgl)	Working - Responds after rainfall
	ARP13SP	January 2017– present	Lithgow Seam (67.5–70.5 m bgl)	Working
	ARP14	January 2017– present	Genowlan Creek alluvium (0.5–2.3 m bgl)	Working
	ARP15SP	January 2017– present	Narrabeen sandstone (10–16 m bgl)	Working
	ARP16 (Nissan Hut)	December 2021 – present	Unknown	Working (Dry since install)
Landholder bores	Nioka	January 2017 – present	Devonian strata	Working (quality only)
	Kingdom	November 2019– present	Devonian strata	Working (quality only)
	GW800787	December 2021 - present	Unknown	Working – dry (quality only)
Seepage	Village Spring	February 2011–present	Permian Siltstone	Regular flow – accessed by foot
	Mine workings	December 2009–present	Lithgow Seam	Negligible (unmeasurable) volumes reported to date

4.2 Monitoring program

4.2.1 Water levels

Water pressure is gauged automatically via VWPs or downhole pressure transducers within standpipes and recorded by data loggers every one to twelve hours. Continuous data loggers were downloaded monthly throughout the first quarter of 2024 and then quarterly for the remainder of the 2024 monitoring period consistent with the updated monitoring program in the WMP (2024). Manual water level gauging of each standpipe occurred during each sampling event.

Numerous VWPs have become dysfunctional since installation, as presented in Table 4.1.

Downhole pressure transducers in the standpipes occasionally become dysfunctional due to age and are replaced as soon as practicable. The transducer located at ARP05 became dysfunctional in 2019 and was removed in 2020. It was not replaced until December 2021 (following water level recovery after the drought). The logger at ARP11 became dysfunctional in April 2023 and was replaced in July 2023. The data logger at ARP15SP became dysfunctional in September 2023 and was replaced in January 2024. The data logger at ARP12 became dysfunctional in December 2024 and should be replaced in 2025.

Groundwater levels are not measured at production bores AM2B-1, Nioka, Kingdom and GW800787 due to installed head works. Groundwater levels at the old production bore (adjacent to AM2B-1) have been monitored via pressure transducer and manual gauging since May 2017.

4.2.2 Water quality

Water quality is assessed quarterly at standpipes, the production bore (AM2B-1), Village Spring, and from private bores GW103410 (Nioka), Kingdom and GW800787. No samples were collected from ARP07 or ARP16 during 2024 due to persistent dry conditions. Samples were collected at ARP09 from January to May, however, due to dry conditions no samples were collected in Q3 and Q4 2024.

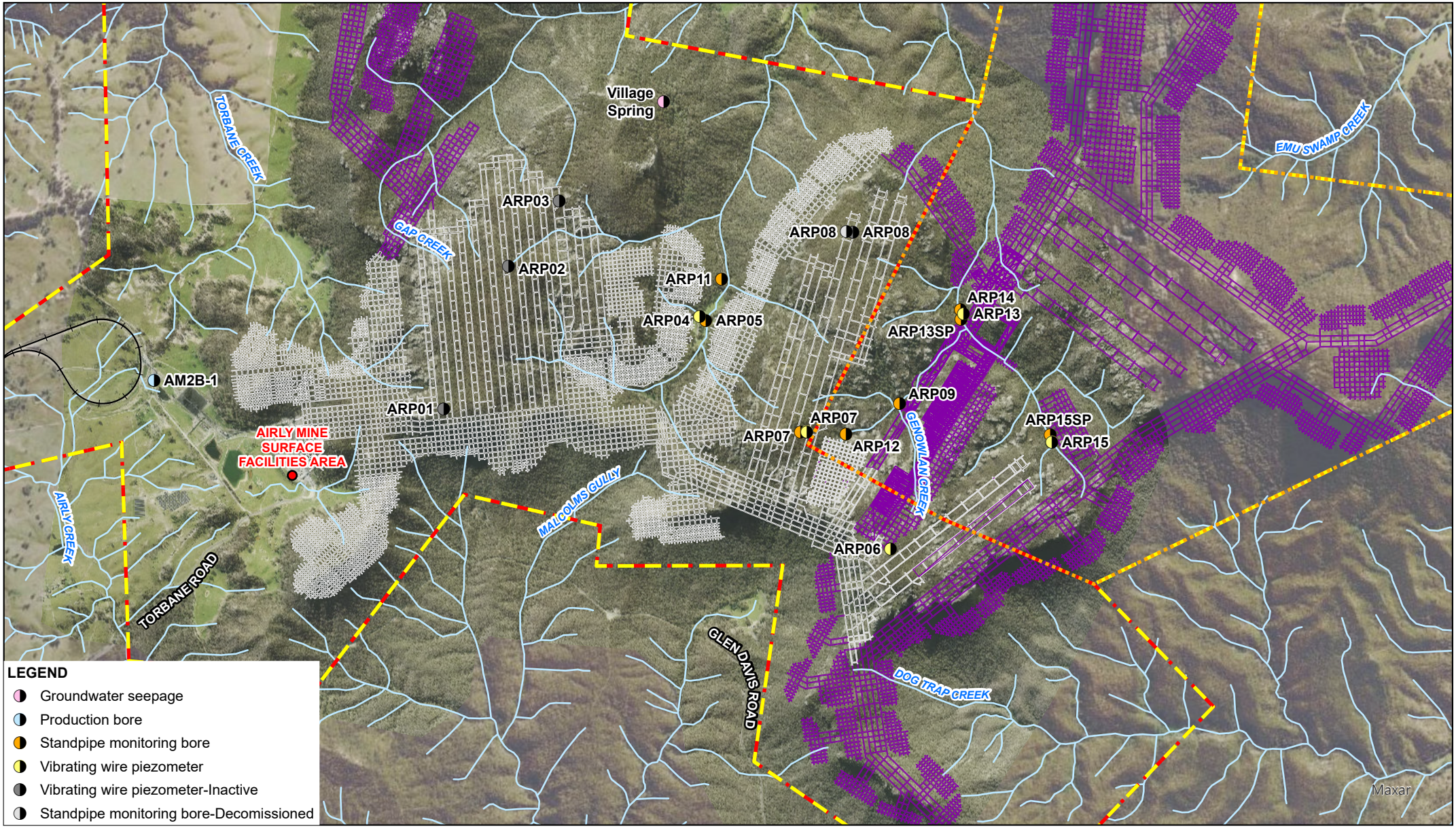
4.2.3 Seepage flow

The flow rate at Village Spring is monitored continuously using a tipping bucket flow gauge and data logger. Data is uploaded to an online database via remote telemetry.

In accordance with licence stipulations, Centennial reported the transfer of approximately 5.7 ML from underground to surface for the 2024 calendar year.

4.2.4 Access

Access to most monitoring locations is considered adequate during dry weather and low fire risk conditions. During wet or windy conditions, access restrictions occur due to park closure, untraversable tracks and fallen trees. The track to ARP06 and Village Spring has degraded and become impassable requiring access by foot, though the track to ARP06 was graded in Q3, allowing for easier access. Access to ARP13, ARP14 and ARP15 is also limited to foot given site rehabilitation activities. Continued access to these locations may be impeded by vegetation growth.



Paper Size A4

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Airly Surface Facilities Area
- Approved development consent boundary
- Mining Lease ML1331
- Mining Lease ML 1814
- Existing workings
- Proposed workings
- Waterway

CENTENNIAL

Centennial Airly Pty Ltd
Airly Mine Water Monitoring
2024 Annual Water Monitoring Report

Job Number 22-12602550
Revision 0
Date 26/03/2025

Groundwater monitoring locations

Figure 4-1

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12602550\AWR\12602550_AWR.aprx

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

© 2025. Whilst every care has been taken to prepare this map, GHD, LPI and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: LPI: DTDB 2012; Centennial: Aerial Imagery, boundaries, 2013, Monitoring Locations, 2017. Created by:

12602550_AWR003_GW_Monitoring

4.3 Groundwater levels

Quarterly minimum groundwater levels reported throughout 2024, with accompanying trigger elevations are presented in Table 4.2. For clarity, the applicable trigger elevations are those specified in the WMP – Revision 9, however the revised groundwater trigger elevations developed for the WMP (Revision 10, *in draft* (GHD 2025a)) are presented for comparison. Time series plots for all VWPs and standpipes are presented in Appendix A. Analysis of VWP and standpipe elevations and levels are described in Section 4.3.1 and Section 4.3.2 respectively.

Table 4.2 Minimum observed water levels

Location	Strata	Trigger Value (WMP – Rev. 9) (m AHD)	Triger Value (WMP - Rev. 10 (*in draft*) (m AHD)	Jan - Mar (m AHD)	Apr - Jun (m AHD)	Jul - Sept (m AHD)	Oct - Dec (m AHD)
Vibrating Wire Piezometers							
ARP01	Narrabeen Sandstone	–	–	ND	ND	ND	ND
	Irondale Seam	–	–	ND	ND	ND	ND
	Lithgow Seam	–	–	ND	ND	ND	ND
	Marrangaroo Formation	–	–	ND	ND	ND	ND
ARP02A	Narrabeen Sandstone	–	–	ND	ND	ND	ND
	Irondale Seam	–	–	ND	ND	ND	ND
	Lithgow Seam	–	–	ND	ND	ND	ND
	Marrangaroo Formation	–	–	ND	ND	ND	ND
ARP03	Upper Sandstone	–	–	ND	ND	ND	ND
	Middle River Seam	–	–	ND	ND	ND	ND
	Lithgow Seam	–	–	ND	ND	ND	ND
	Marrangaroo Formation	–	–	ND	ND	ND	ND
ARP04	Lithgow Seam	–	–	Dry (737.2)	Dry (737.2)	Dry (737.2)	Dry (737.2)
	Marrangaroo Formation	734	734	735.5	735.6	735.5	735.6
	Shoalhaven Siltstone (lower)	666.8	666.6	671.6	671.5	671.5	671.3
ARP06	Narrabeen Sandstone	865	867.2	867.6	867.5	867.3	867.2
	Irondale Seam	–	–	Dry (769.1)	Dry (769.1)	Dry (768.9)	Dry (768.7)*
	Lithgow Seam	–	–	Dry (737.9)	Dry (737.9)	Dry (737.9)	Dry (737.8)*
	Marrangaroo Formation	–	–	Dry (728.1)	Dry (727.8)	Dry (729.7)	Dry (730.6)*
ARP07	Middle River Seam	–	–	Dry (812.4)	Dry (813.1)	Dry (813.2)	Dry (813.0)
	Lithgow Seam	–	–	Dry (733.7)	Dry (733.3)	Dry (733.2)	Dry (732.1)
ARP08	Narrabeen Sandstone	–	–	ND	Blocked	Blocked	Blocked
	Irondale Seam	–	–	ND	Blocked	Blocked	Blocked
ARP13	Shoalhaven	–	–	686.3	686.3	686.3	686.3

Location	Strata	Trigger Value (WMP – Rev. 9) (m AHD)	Triger Value (WMP - Rev. 10 (*in draft*) (m AHD)	Jan - Mar (m AHD)	Apr - Jun (m AHD)	Jul - Sept (m AHD)	Oct - Dec (m AHD)
	Devonian	570	570	**558.7**	**557.1**	**555.6**	**554.6**
ARP15	Lithgow Coal Seam	–	–	727.2	726.9	726.0	725.5
	Shoalhaven Siltstone	–	–	639.1	639.0	638.8	638.5
	Devonian	–	–	571.2	570.4	569.8	567.9
Standpipes							
ARP05	Gap Creek alluvium	–	–	751.2	751.2	751.8	753.3
ARP07	Narrabeen Sandstone	–	–	Dry	Dry	Dry	Dry
ARP08	Lithgow Seam	–	–	Blocked	Blocked	Blocked	Blocked
ARP09	Genowlan Creek Alluvium	–	–	854.1	854.0	853.9	Dry (853.6)
ARP11	Permian strata	–	–	740.5	741.1	741.7	741.5
ARP12	Genowlan Creek Alluvium	–	–	891.5	893.1	893.1	ND
ARP13SP	Lithgow Seam	–	–	718.7	718.4	718.2	718.2
ARP14	Genowlan Creek Alluvium	781.0 (well dry)	782.1	782.6	782.6	782.6	782.4
ARP15SP	Narrabeen Sandstone	828.4	830.8	833.9	834.0	834.3	833.6
ARP16	Unknown	–	–	ND	ND	ND	ND

Notes:

ND – No available data

Bold – trigger value exceedance

4.3.1 Vibrating wire piezometers

All levels recorded for ARP04 and ARP06 during 2024 were within their respective trigger values. ARP13 has recorded levels below the trigger value since November 2019. This continued throughout 2024.

As detailed in Table 4.1, pressure data are not available for VWPs within ARP01, ARP02 or ARP03 assumedly due to mining induced subsidence damaging the infrastructure. The transducer in the Irondale Seam at ARP08 has been dysfunctional since September 2022, while the Narrabeen Sandstone has been dry since installation in September 2013.

Overall, piezometric pressure is generally low and decreasing at the existing VWP monitoring locations, ranging from 0 m to 10 m above the measuring point elevation, with little observable response to rainfall. The low piezometric pressure is considered to reflect horizontal flow and seepage discharge occurring to mesa faces. There is a downward hydraulic gradient from the Narrabeen Sandstone to the Illawarra Coal Measures.

Decreasing pressures have been reported in 2024 at ARP04 within the Shoalhaven Siltstone (lower). Levels within the Marrangaroo Formation were stable while consistently dry conditions within the Lithgow Seam were recorded throughout 2024. The location has been undermined, and the decreases are reflective of dewatering that has occurred because of mining.

Groundwater pressures at ARP06 during 2024 showed dry conditions within the Lithgow Seam, the Marrangaroo Formation, and the Irondale Seam. A net decrease of 0.4 m within the Narrabeen Sandstone in APR06 was observed between January and November 2024, thereafter, pressure readings have been unreliable.

Decreasing pressures were observed between December 2017 and July 2022 within the Shoalhaven Siltstone at ARP13. During 2024 pressures stabilised and showing no net change. A decreasing trend has also been observed in the Devonian Strata, since 2017. Current groundwater pressures are approximately 15.4 m below the trigger value, at 554.6 m AHD, with a decrease of 4.1 m in 2024. While the 0.5 m decrease reported for 2024 in the Lithgow Seam at the same location (the standpipe ARP13SP) is due to mining, decreases in the lower formations (particularly the Devonian) is expected to reflect regional trends.

Pressure trends in ARP15 in 2024 mirrored those of 2023 where water levels continued to decrease, with a net decrease of 1.9 m in the Lithgow Seam, and 0.6 m in the Shoalhaven strata observed throughout 2024. Pressures also decreased by 3.3 m between January and December 2024 in the Devonian strata, a departure from relatively stable levels observed throughout 2023. Similarly to ARP13, decreases in the Lithgow Seam are expected because of mining. The decreasing pressures in lower strata are more likely reflective of regional drying.

4.3.2 Standpipes

Hydrographs for alluvial groundwater locations ARP05, ARP09, ARP11, ARP12 and ARP14; and fractured and porous rock groundwater locations ARP07, ARP13SP and ARP15SP are shown in Appendix A. Groundwater level trigger values are in affect for bores ARP14 and ARP15SP. A summary of groundwater levels during 2024 is presented below:

- Historically, ARP05 has only recorded water levels following above average rainfall. Groundwater level was between 751.2 m AHD (6.87 m bgl) and 763.02 m AHD (4.95 m bgl) throughout 2024, following average rainfall events in Q3 and Q4 (refer to Section 3.2).
- ARP07 has been dry since installation in July 2013 and remained dry throughout 2024.
- Groundwater levels at ARP09 fluctuated in response to rainfall events throughout 2024, becoming predominantly dry from October 2024. This historically has been the result of reduced rainfall. Groundwater fluctuated between 854.10 m AHD (3.5 m bgl) in March 2024 and 853.6 m AHD (4.0 m bgl) (dry).
- ARP11 was dry from January to September 2021. Water level recovery was observed thereafter and has continued throughout 2024, stabilising in the latter part of the year at 741.1 m AHD (9.8 m bgl). The water level response has previously been attributed to cumulative above average rainfall received throughout 2021 and 2022, recharging the Permian strata in which the bore is installed.
- ARP12 groundwater elevations were relatively stable throughout 2024 (891.5 m AHD, 3.19 m bTOC) to 893.1 m AHD, 1.89 m bTOC). It is noted that the data logger malfunctioned in Q4 hence no continuous pressure data is available for October to December 2024. The manually gauged level has been used for this period.
- Groundwater levels remained stable at ARP13SP throughout 2024, though water levels were below the 2023 average at 718.2 m AHD (66.69 m bgl).
- Groundwater levels remained consistent throughout 2024 at ARP14, above the trigger at approximately 782.5 m AHD (0.8 m b TOC).
- Levels at ARP15SP remained relatively stable above the trigger value throughout 2024 ranging 834.3 m AHD to 833.6 m AHD.
- ARP16 has remained dry since installation in December 2021.

4.4 Groundwater quality

Groundwater quality results for 2024 are plotted with historical records in Appendix B. The data have been presented with corresponding trigger values defined in the WMP (Revision 9) for ARP05, ARP09, ARP11, ARP12, ARP13SP, ARP14, ARP15SP, landholder bores (Nioka, Kingdom, GW800787) and Village Spring. These trigger values are presented in Table 4.3. Groundwater quality trigger values are unchanged in Revision 10 of the WMP. Piper plots have been updated for each quarter (Appendix D).

Table 4.3 Groundwater quality trigger values (WMP Rev 9)

Parameter	Units	Trigger value										
		ARP05	ARP09	Village Spring	ARP11	ARP12	ARP13SP	ARP14	ARP15SP	Nioka	Kingdom	GW800787
Physicochemical parameters												
EC	µS/cm	146	56	487	1760	79	760	82	109	1669	1346	744
pH	pH units	5.8–6.0	4.79 - 5.33	7.8–8.3	6.6–7.2	5.21 - 6.4	6.7–7.2	5.7–7.2	5.9–7.5	7.04 - 7.57	6.72 - 7.24	6.79 - 7.37
TDS	mg/L	176	35	300	1170	48	463	74	71	1160	735	461
TSS	mg/L	–	-	16	–	-	–	–	–	–	–	–
Dissolved metals												
Arsenic	mg/L	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/L	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/L	0.003	0.002	0.001	0.002	0.001	0.002	0.001	0.009	0.004	0.02	0.002
Iron	mg/L	0.08	0.74	0.05	1.14	1.19	1.28	0.9	1.54	0.21	0.13	0.18
Lead	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001
Manganese	mg/L	0.009	0.017	0.004	0.343	0.025	0.31	0.081	0.282	0.018	0.007	0.039
Mercury	mg/L	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Nickel	mg/L	0.003	0.002	0.004	0.006	0.001	0.003	0.002	0.011	0.001	0.004	0.005
Zinc	mg/L	0.081	0.032	0.026	0.016	0.182	0.033	0.033	0.067	0.08	0.024	0.024

4.4.1 Standpipe monitoring bores

Groundwater pH at ARP05 (Gap Creek Alluvium) fluctuated in the slightly acidic range from below the lower SSGV to circumneutral, 5.57 to 6.0 (see Appendix C). Field EC remained low throughout 2024 (May-December) indicating fresh conditions (138 µS/cm to 175.4 µS/cm), however, exceeded the SSGV in Q4. Major ion concentrations remained Na-Cl/HCO_3 type / throughout the year. Only dissolved zinc exceeded the SSGVs in 2024, by a factor of two in Q1, but falling below the trigger in subsequent GMEs.

Groundwater at APR09 (Genowlan Creek Alluvium) was sampled in Q1 and Q2. The water volume was otherwise insufficient to facilitate sample collection. Major ion concentrations show Na-Cl dominance. Water was acidic, falling below the lower SSGV limit in Q1. pH has historically been low in ARP09 (see Appendix B), though trends show a decrease since mid-2020. EC was low, below the SSGV, in Q1 and Q2 ranging between 35 µS/cm and 43 µS/cm, indicating extremely fresh conditions. Zinc exceeded the SSGVs in Q1 and Q2 at 0.189 mg/L and 0.083 mg/L, respectively.

Groundwater at ARP11 (Permian strata) is Na-HCO_3 dominant (Appendix D). Since water level recovery in late 2021, groundwater has been slightly acidic. pH was below the lower SSGV threshold in Q1, Q2 and Q3 (6.3– 6.5). EC indicated brackish conditions and remained within the SSGV threshold throughout 2024 ranging between 920 µS/cm and 1,079 µS/cm. Other exceedances of SSGVs occurred for lead and nickel with no concerning trend development. Zinc concentrations exceeded the SSGV throughout 2024 and, exceeded the historical average with a peak concentration of 0.127 mg/L in Q1.

Groundwater at ARP12 (Genowlan Creek Alluvium) is of Na-Cl type, historically fresh and acidic. pH exceeded the lower SSGV throughout 2024, with new historical lows for pH recorded in Q1, the lowest being 3.96. Water is generally fresh at ARP12, however, EC far exceeded the SSGV in Q2 with results seven times the SSGV. EC returned to fresh in the Q3 and Q4 period, ranging more within the historical average. There were no recorded metal exceedances.

Groundwater at ARP13SP (Lithgow Seam) is Ca-HCO_3 type, slightly brackish and slightly acidic. Groundwater was slightly less acidic than 2023 recordings, and generally fell below the lower SSGV. The lowest pH recording occurred in Q1 (6.6). Metal concentrations were generally below the SSGV, except for nickel, and zinc. Dissolved zinc concentrations continued to decrease in 2024, though remained above respective SSGV. Nickel exceeded the respective SSGV in all quarters except Q4, also showing a general decreasing trend.

Groundwater at ARP14 (Genowlan Creek alluvium) is Na-HCO_3 . Historically, the water at ARP14 has been fresh and slightly acidic. pH fluctuated throughout 2024, occasionally below the lower SSGV threshold, falling below historical records in Q1 and Q3, and continuing the overall decreasing trend observed in 2023. EC fluctuated above and below the SSGV, with three exceedances recorded (90 µS/cm, 98.4 µS/cm and 90.1 in Q1, Q2 and Q4, respectively). Numerous dissolved metal exceedances occurred including:

– Arsenic at 0.002 mg/L in Q4.
– Cadmium (0.0002 mg/L), chromium (0.04 mg/L) and nickel (0.006 mg/L) in Q1.
– Copper at 0.037 mg/L (exceedance of concern) in Q1, at 0.012 mg/L (exceedance of concern) in Q3 and at 0.006 mg/L in Q4.
– Iron at 5.01 mg/L (exceedance of concern) in Q1, at 1.31 mg/L in Q2, at 6.39 mg/L (exceedance of concern) in Q3 and 3.92 mg/L (exceedance of concern) in Q4.
– Lead at 0.014 mg/L (exceedance of concern) in Q1, at 0.002 mg/L in Q3 and at 0.002 mg/L in Q4.
– Manganese at 0.28 mg/L in Q1, at 0.21 mg/L in Q2, at 0.20 mg/L in Q3 and at 0.35 mg/L (exceedance of concern) in Q4.
– Zinc at 0.268 mg/L (exceedance of concern) in Q1 and at 0.036 mg/L in Q3.

Groundwater at ARP15SP (Narrabeen Sandstone) is Na-Cl type, generally fresh and slightly acidic. pH remained consistent within 2023 records, remaining below the lower trigger value in all quarters. EC remained below the SSGV limit throughout 2024. Most metal concentrations were below trigger values except for some isolated exceedances in manganese and zinc; and continued exceedances in nickel throughout 2024 ranging between 0.038 mg/L in Q1 and 0.012 mg/L in Q4.

4.4.2 Shoalhaven Group groundwater – Production Bore (AM2B-1)

The production bore is installed within the Shoalhaven Group and sampled for water quality via the installed pump. In 2022 there was significant variation in groundwater quality due to incorrect sampling methods from the sampling contractor (ALS). These variations included a change from the expected Mg-SO_4 signature to Ca-HCO_3. Review of 2024 water quality results show correct sampling methods were used throughout 2024, with water quality observations within expected concentrations. Results remained within expected levels throughout 2024, with ionic composition remaining as Mg-SO_4 type.

EC was saline, peaking at 4,620 µS/cm in March 2024. Compared to Airly Mine monitoring bores installed in the alluvial strata and the Permian Coal Measures, the Shoalhaven Group groundwater at AM2B-1 has elevated concentrations of cadmium, cobalt, iron, manganese, magnesium, nickel and zinc. Concentrations of these analytes have fluctuated without trend since monitoring began in 2012. There was a slight increase in manganese and a significant increase in cobalt concentrations in 2024 (0.136 mg/L).

4.4.3 Devonian groundwater – Nioka and Kingdom

Groundwater from the landholder bores is generally slightly alkaline and slightly brackish.

At Nioka, pH was generally circumneutral, with only Q3 observations below the lower SSGV value. EC was stable excepting in Q4 where it increased to 1,607 µS/cm, though remained below the SSGV limit throughout 2024. The water type is Ca-HCO_3 type (Appendix D). Metal concentrations are generally low and there are no trends of concern, while nickel did exceed the SSGV in Q1 and Q3.

EC concentrations at Kingdom continued to decrease, consistent with the trend observed since 2020. pH fluctuated in 2024, with one result falling below the lower SSGV (6.6 in Q3) . The water type is Ca-HCO_3. Dissolved metals were generally low with no trends of concern except for an isolated exceedance of iron in Q1 (0.15 mg/L). Dissolved zinc also exceeded in Q1 and Q4 (0.04 mg/L and 0.027 mg/L, respectively).

4.4.4 GW800787

Groundwater at landholder bore GW800787 is circumneutral and slightly brackish. The EC was gauged above the SSGV in Q1 (755 µS/cm) and Q4 (737 µS/cm)). Water was of Ca-HCO_3 type with no trends of concern. Manganese exceeded the SSGV in Q1 and Q2 (0.042 mg/L in Q1 and Q2).

4.4.5 Permian groundwater – Village Spring seepage

There was a departure from historical trends at Village Spring in 2024. Water chemistry was more Mg-HCO_3 type, a shift from the historically Ca-HCO_3 type. Water was more brackish in 2024, though did not exceed the SSGV, however pH was consistently more acidic with results falling below the lower SSGV in every quarter contrasting an alkaline history. Dissolved metals were generally within the SSGVs, except for fluctuations in manganese, nickel and zinc. Concentrations of all analytes are within historical ranges.

4.5 Groundwater flow

4.5.1 Village Spring

The rate of seepage of groundwater from the Permian strata at Village Spring has been monitored since February 2011. A plot of daily groundwater seepage rates is shown in Figure 4.2. Continuous flow was recorded for all months, except September, in which data was of low quality (quality code 255 QC). The average seepage rate was 11.96 kL/day, with a minimum flow rate of 6.83 kL/day on 28 November 2024 and a maximum flow rate of 20.22 kL on 5 April 2024. As shown in Figure 4.2, the decreased flowrate throughout 2024 reflects the trend in CRD.

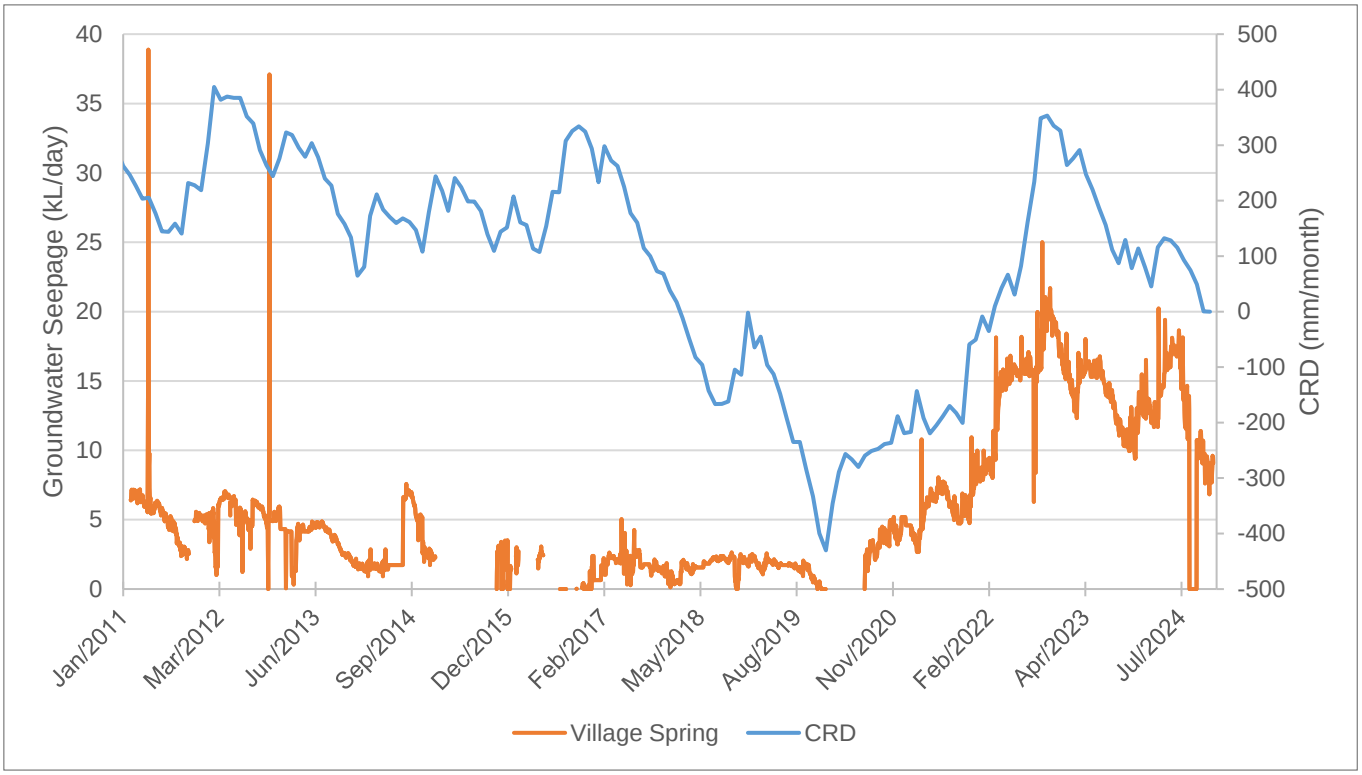


Figure 4.2 *Recorded flows at Village Spring*

4.5.2 Underground workings

Groundwater inflow to mine workings has historically been reported as low and of negligible volume. To this end, water from Production Dam (abstracted from the production bore) has been relied on for use in underground mining activities. This was consistent in 2024 with no measurable groundwater inflow being transferred from the underground workings to the surface[3].

4.6 Trigger Action Response Plan review – Groundwater

Groundwater data were reviewed against the Trigger Action Response Plan to identify if any stage 1 triggers have occurred. Trigger Action Response Plans and the stage 1 triggers are defined within the WMP, Revision 9. Identified stage 1 triggers are presented in Table 4.4, with stage 1 trigger value exceedances shown in red.

Table 4.4 *Trigger Action Response Plan – Stage 1 trigger investigations*

Monitoring location	Parameter/trigger value	Recorded exceedances and month	Investigation
Groundwater elevation			
ARP13 (Devonian)	Level (570 m AHD)	Jan-Mar 558.7 m AHD Apr-Jun 557.1 m AHD Jul-Sept 555.6 m AHD Oct-Dec 554.6 m AHD	Groundwater level consistently below trigger. As described in Section 4.3, this is attributable to a regional trend and not considered to be attributable to mining.
Groundwater quality			
Alluvial			
ARP09	Dissolved zinc (0.032 mg/L)	January 0.189 February 0.063 March 0.116 May 0.083	

[3] Note reported underground to surface transfer in Section 4.2.3 is largely reclaimed surface water.

Monitoring location	Parameter/trigger value	Recorded exceedances and month	Investigation
ARP12	pH (5.21 pH units)	January 3.96 February 4.46 March 5.04 May 5.13 October 4.48 December 5.06	Numerous consecutive exceedances were reported within the alluvium monitoring locations, with ARO09, ARP12 and ARP14 recording stage 1 trigger exceedances. As described in Section 6.1.2, alluvium monitoring points in the upper catchment (ARP09 and ARP12) are more responsive to rainfall and demonstrate cycling through wetting and drying cycles while water levels are more stable lower in the catchment supported by a larger aquifer (ARP14). Metal signatures support discontinuation of water stored in alluvial sediments. Fresh conditions reflect rainfall as source of recharge and may be the cause of acidification. Alluvial monitoring points have historically shown recovery in water level in response to rainfall events disputing mining associated subsidence influence. Declining water quality is not considered associated to mining activities and, instead, is speculated to be the result of drying-wetting cycles.
ARP14	EC (82 µS/cm)	January 89.6 February 85.4 March 61.9 May 98.4 October 71 December 90.1	
	Copper (0.001 mg/L)	January <0.001 February 0.037 March <0.001 May <0.001 October 0.012 December 0.006	
	Iron (0.9 mg/L)	January 0.87 February 5.01 March 1.64 May 1.31 October 6.39 December 3.92	
	Lead (0.001 mg/L)	January <0.001 February 0.014 March <0.001 May <0.001 October 0.002 December 0.002	
	Manganese (0.081 mg/L)	January 0.149 February 0.28 March 0.177 May 0.213 October 0.2 December 0.347	
Fractured rock			
ARP13SP	pH (6.7–7.2)	January 6.59 February 6.67 March 6.82 May 6.74 October 6.6 December 6.93	Consecutive exceedances of pH, nickel and zinc were reported in the fractured rock. These were generally minor, and exhibit a decreasing trend throughout the year, although zinc at ARP13SP was more elevated earlier in the year (however within the range reported in previous years).
	Nickel (0.003 mg/L)	January 0.002 February 0.003 March 0.008 May 0.004 October 0.004 December 0.003	

Monitoring location	Parameter/trigger value	Recorded exceedances and month	Investigation
	Zinc (0.033 mg/L)	January 0.036 February 0.239 March 0.227 May 0.114 October 0.068 December 0.062	
ARP15SP	Zinc (0.067 mg/L)	January 0.077 February 0.137 March 0.056 May 0.061 October 0.05 December 0.065	
Landholder			
GW800787	Manganese (0.039 mg/L)	March 0.042 May 0.042 October 0.025 December 0.032	Consecutive exceedances of manganese were reported in groundwater at landholder bore GW800787. No further exceedances were reported in 2024. No further action.
Upper Permian			
Village Spring	pH (7.8–8.3 pH units)	January 6.97 February 7.81 March 7.4 May 7.43 October 6.95 December 8.08	Consecutive exceedances were reported within the Upper Permian strata during 2024 at Village Spring and ARP11. As described in Section 6.1.2, groundwater is suspected to be discontinuously held within the strata. Recovery in ARP11 from circa 2020 following the prior drought period indicates this stratum has not been adversely impacted by mining activity in the lower seam.
ARP11	pH (Lower trigger of 6.6 pH units)	January 6.29 February 6.38 May 6.5 October 6.31	
	Zinc (0.016 mg/L)	January 0.058 February 0.044 March 0.127 May 0.042 October 0.025 December 0.03	

5. Surface water monitoring program

The surface water monitoring program undertaken throughout 2024 included flow, level and quality monitoring. All existing surface water monitoring locations are shown in Figure 5.2.

5.1 Surface water flow

Continuous flow monitoring is undertaken at Gap Creek, Genowlan Creek 1 and Genowlan Creek 2. Continuous water level monitoring is also conducted at the Dirty Water Dam, Production Dam, Stockpile Dam and Train Loader Dam. Recorded flows from Gap Creek and Genowlan Creek 2 are utilised to identify whether changes to creek flow have been anticipated based upon deviation from historical flow and catchment conditions as described in the Trigger Action Response Plan F2 (TARP F2) outlined in the WMP prepared during Q1 of 2024.

5.1.1 Creek flow statistics

A summary of creek flow at Gap Creek, Genowlan Creek 1 and Genowlan Creek 2 is presented below in Figure 5.1. Discharges via LDP001 did not occur during 2024. Key statistics of recorded flow gauges are summarised in Table 5.1.

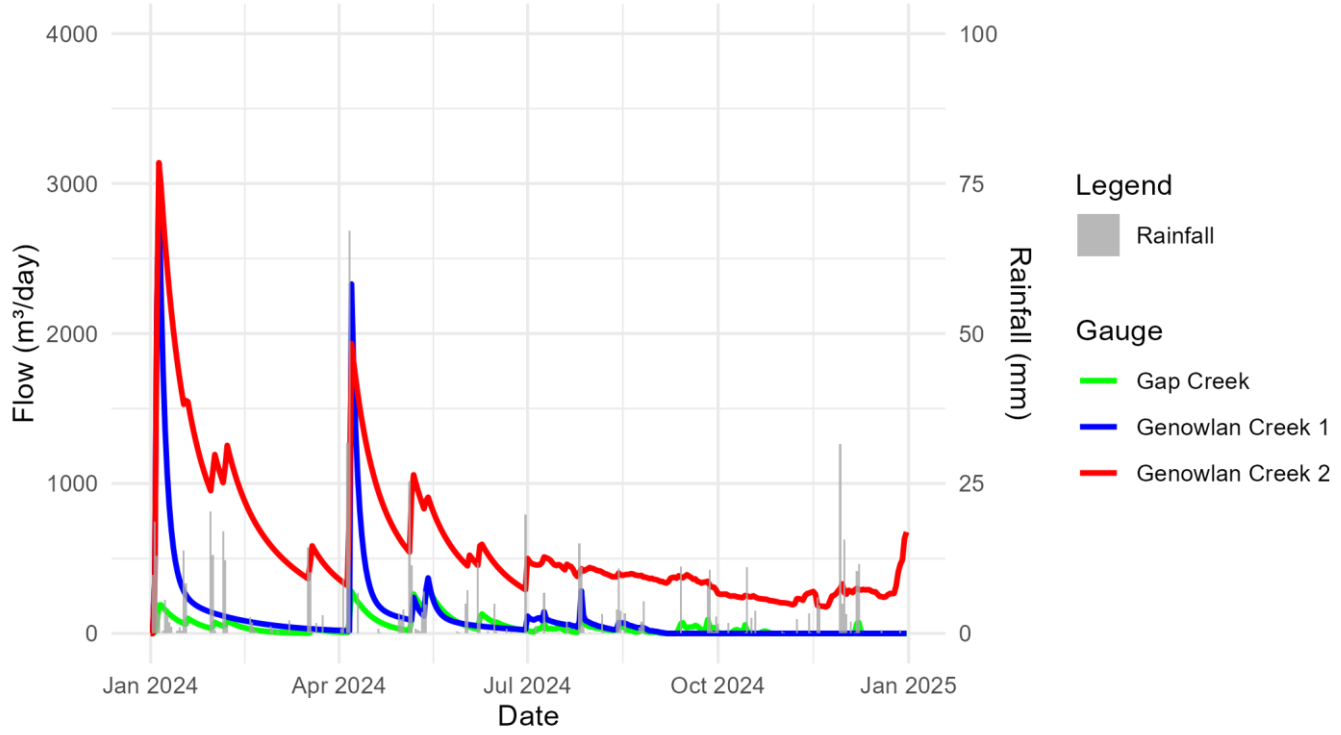


Figure 5.1 Observed flow and rainfall at recorded surface water gauges

Table 5.1 Flow statistics for recorded gauges in 2024

Gauge	Gap Creek	Genowlan Creek 1	Genowlan Creek 2
Mean	44.3 m^3/day	119.6 m^3/day	584.9 m^3/day
Median	24.3 m^3/day	40.5 m^3/day	424.0 m^3/day
Max	302.1 m^3/day	2911.0 m^3/day	3139.0 m^3/day
Standard Deviation (SD)	57.7 m^3/day	320.2 m^3/day	464.2 m^3/day
Coefficient of variation (CV)	1.3	2.7	0.8
q5 (5^{th} percentile)	0.0 m^3/day	0.0 m^3/day	215.4 m^3/day

Gauge	Gap Creek	Genowlan Creek 1	Genowlan Creek 2
q10 (10th percentile)	0.0 m^3/day	0.0 m^3/day	243.1 m^3/day
q90 (90th percentile)	116.5 m^3/day	207.4 m^3/day	1128.5 m^3/day
q95 (95th percentile)	177.9 m^3/day	400.5 m^3/day	1541.5 m^3/day

5.1.2 Surface water flow assessment

As identified above, during Q1 2024 a Trigger Action Response Plan (TARP) was developed within the Water Management Plan (WMP) to identify whether changes to the catchment characteristics and hydrologic runoff patterns may have occurred, and if so, whether they may have been attributed to site operations. This involved the following:

– Establishing a water balance model to estimate streamflow at the Airly Mine. The model was developed and calibrated to conditions occurring at the time of this report using historical observations.
– The calibrated model established a baseline set of model parameters for the Australian Water Balance Model (AWBM) which reflects the current catchment properties and the current rainfall-runoff response. Statistics associated with the AWBM calibration had good outcomes, which indicated that the model was able to recreate observations at three stream gauges within the expected parameter bounds.
– For future monitoring (Q2, Q3, and Q4) the baseline model could be run with recent meteorological data using the calibrated baseline model parameters; and the outputs from this model could be compared to observed streamflow to determine the level of similarity between the two datasets. Datasets which are in good agreement would suggest no notable changes to catchment characteristics or the rainfall-runoff response, whereas deviation between the two datasets may warrant further investigation of the catchment behaviour.
– A proposed process for TARP F2 was established and was reflected in the Water Management Plan.

This process of identifying potential changes in surface water flow was undertaken in Q2-Q4, which identified no notable changes to hydrologic regimes at the monitored locations. A summary by quarter is included below in Table 5.2 and identified no changes attributable to the site from Q2-Q4 in 2024.

Table 5.2 Summary of surface water flow assessment against TARP F2 for Q2-Q4, 2024

Quarter	Gap Creek	Genowlan Creek
Q2	The calibration model was run using measured flow rates and meteorological data from 01/01/2024 to 30/06/2024. The NSE for Gap Creek was low (0.124), requiring further investigation. The model was reassessed using the full dataset (March 2018 onwards), yielding an NSE of 0.750, consistent with baseline values. A site walkover confirmed soil and vegetation blocked the gauge, affecting calibration quality. Data from May–June 2024 was deemed unreliable and excluded. Gauges were maintained by clearing debris.	The calibration model for 01/01/2024 to 30/06/2024 produced an NSE of 0.956 for Genowlan Creek 2, which was satisfactory. No changes in catchment characteristics were detected, and the model successfully predicted flows.
Q3	The calibration model (01/03/2024 to 30/09/2024) indicated an NSE decline for Gap Creek, likely due to gauge clearing in Q2. The full dataset reassessment confirmed an acceptable NSE (>0.6). The model remained within baseline parameters, and no catchment changes were identified.	The Q3 calibration (01/03/2024 to 30/09/2024) yielded an unsatisfactory NSE for Genowlan Creek 2, likely due to Q2 gauge clearing. A full dataset reassessment showed good NSE values (>0.7). The model remained within acceptable limits, and no catchment changes were observed.
Q4	The Q4 calibration (01/10/2024 to 31/12/2024) again showed an unsatisfactory NSE for Gap Creek, likely due to previous gauge clearing. The full dataset reassessment returned a satisfactory NSE (0.598). The model remained valid, with no evidence of catchment changes.	The Q4 calibration (01/10/2024 to 31/12/2024) produced an unsatisfactory NSE for Genowlan Creek 2, again attributed to Q2 gauge clearing. The full dataset reassessment indicated good NSE values (0.760). The model remained within baseline parameters, and no catchment changes were noted.

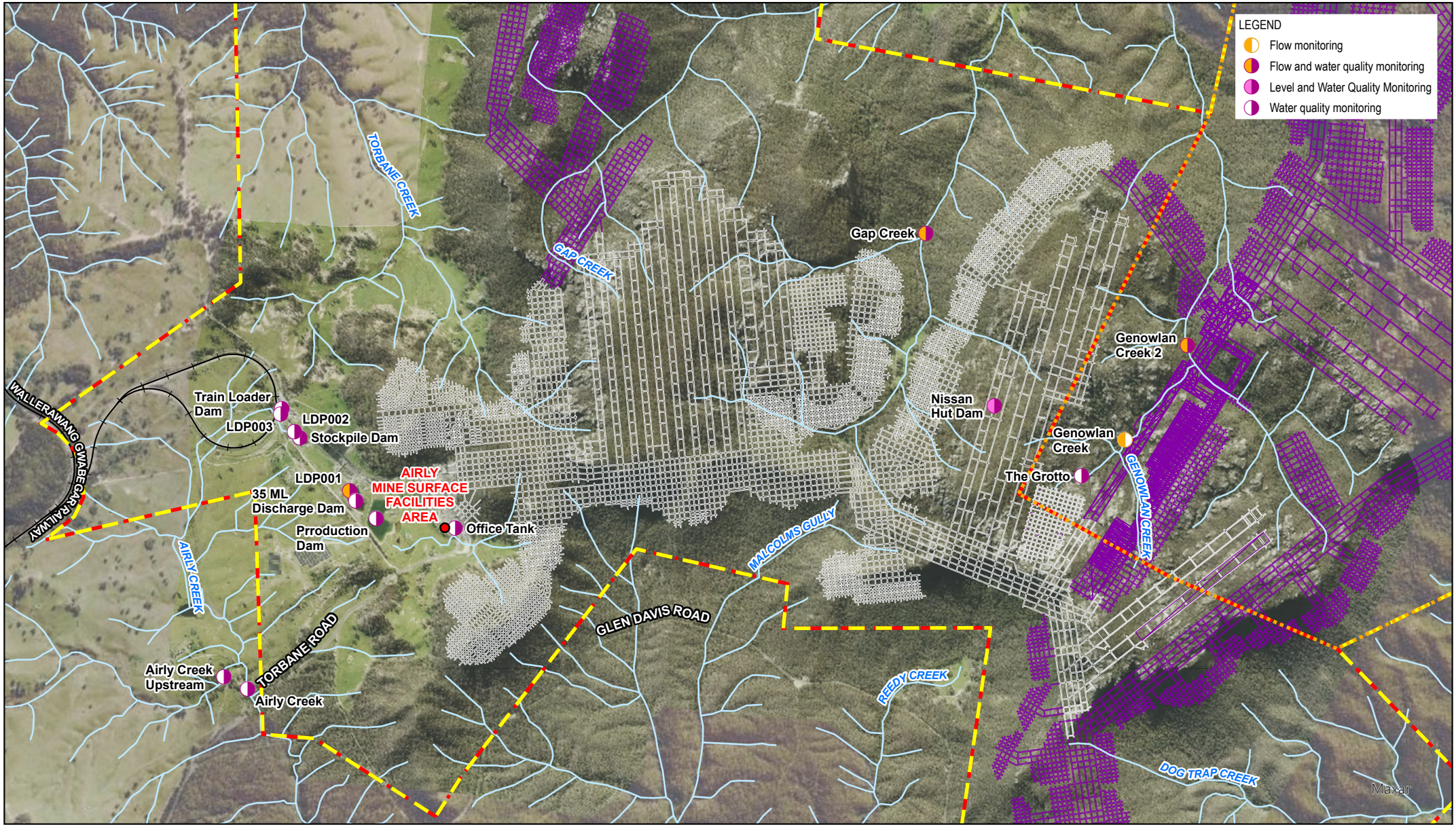
Current model parameters for Gap Creek and Genowlan Creek 2 are summarised below in Table 5.3 and Table 5.4 based on most recent model calibration with all model parameters within the acceptable to good range. No parameters are within the unacceptable range.

Table 5.3 Current Genowlan Creek 2 model parameters

Parameter	Calibration result	Unacceptable NSE	Satisfactory NSE	Acceptable NSE	Good NSE
Kb	**0.999**	Kb ≠ 1	Kb ≠ 1	Kb ≠ 1	Kb ≠ 1
Ks	**0.940**	< 0.81 or > 0.97	0.81 – 0.97	0.83 – 0.96	0.89 – 0.94
BFI	**0.741**	< 0.60 or > 0.87	0.60 – 0.87	0.62 – 0.84	0.68 – 0.79
A1	**16.0%**	> 33%	0% - 33%	0% - 27%	0% - 16%
A2	**52.0%**	No Limit	0% - 100%	0% - 81%	0% - 53%
C1	**0.278 mm**	No Limit	No Limit	No Limit	No Limit
C2	**164 mm**	No Limit	No Limit	No Limit	18.5 mm – 200 mm
C3	**385 mm**	< 130 mm	130 mm – 500 mm	268.6 mm – 500 mm	363.9 mm – 480 mm
PET Factor	**50.0%**	< 46.0% or > 54.3%	46.0% to 54.3%	47.1% to 54.3%	50.2% to 53.3%

Table 5.4 Current Gap Creek model parameters

Parameter	Calibration result	Unacceptable NSE	Satisfactory NSE	Acceptable NSE	Good NSE
Kb	**1.00**	< 0.94	0.94 – 1.00	0.96 – 1.00	0.98 – 0.99
Ks	**0.90**	< 0.57	0.57 – 1.00	0.66 – 1.00	0.79 – 0.98
BFI	**0.60**	< 0.14	0.14 – 1.00	0.27 – 1.00	0.47 – 0.97
A1	**16%**	< 5% or > 23%	5% - 23%	7% - 21%	16% - 18%
A2	**48%**	< 1% or > 54%	1% - 54%	7% - 48%	16% - 39%
C1	**16.9 mm**	No Limit	No Limit	0 mm – 36.6 mm	0 mm – 17 mm
C2	**195 mm**	< 61.2 mm	61.2 mm – 200 mm	78.7 mm – 200 mm	105.0 mm – 200 mm
C3	**500 mm**	< 385.4 mm	385.4 mm – 500 mm	405.7 mm – 500 mm	426 mm – 500 mm
PET Factor	**62.0%**	< 62%	62% - 100%	62% - 88.1%	63.4% - 76.1%



Paper Size A4

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Airly Surface Facilities Area
- Approved development consent boundary
- Mining Lease ML1331
- Mining Lease ML 1814
- Railway
- Existing workings
- Proposed workings
- Waterway

CENTENNIAL

Centennial Airly Pty Ltd
Airly Mine Water Monitoring
2024 Annual Water Monitoring Report

Job Number 22-12602550
Revision 1
Date 12/03/2025

Surface water monitoring locations

Figure 5-2

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12602550\AWR\12602550_AWR.aprx

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

© 2025. Whilst every care has been taken to prepare this map, GHD, LPI and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: LPI: DTDB 2012; Centennial: Aerial Imagery, boundaries, 2013, Monitoring Locations, 2017. Created by:

12602550_AWR004_SW_Monitoring

5.2 Surface water quality

Surface water quality monitoring locations were inspected monthly. Exceptions to the monthly sampling regime are listed in Table 5.5.

Table 5.5 Sampling locations exceptions 2024

Location	Sampling comments
Airly Creek	No flow in June
Airly Creek Upstream	No flow in February, March, June and November
Airly Tributary	No flow throughout 2024
Gap Creek	No flow in March – Sampled quarterly following Q1
Genowlan Creek (The Grotto)	Sampled quarterly after monthly to March
Genowlan Creek 2	Sampled quarterly after monthly to March
LDP001	No discharge
LDP002	No discharge
LDP003	No discharge
Nissan Hut Dam	Sampled quarterly after monthly to March
Production Dam	Sampled in all months
Stockpile Dam	Sampled in all months
Train Loader Dam	Sampled in all months
Dirty Water Dam	Sampled in all months

Time series plots of surface water quality are presented in Appendix B. Water quality data have been compared to site specific guideline values (SSGVs) or trigger values reported in the WMP.

5.2.1 Airly Creek

Airly Creek, Airly Upstream and Airly tributary are located within the Airly Creek catchment. These sites are monitored for impacts of off-site discharges. Airly tributary were dry throughout 2024. Airly Creek was sampled in in all months of Q1, Q2, Q3 (except June), and Q4. Airly Creek US was also sampled for each quarter, though not all months were sampleable due to low flow conditions. In Airly Creek US samples were not collected in February, March, June and November (see Table 5.5).

Airly Creek, Airly US and Airly tributary water quality results are tabulated in Appendix C (Table C.1). Results from laboratory and *in situ* physico-chemical analysis of samples collected during Q1, Q2, Q3 and Q4 are discussed below.

In Airly Creek, pH was generally circumneutral throughout 2024 remaining within the SSGVs (7.1 pH units to 7.8 pH units). EC was gauged above the SSGV in Q1 of 2024 (2,970 µS/cm), remained below the SSGV throughout Q2 and Q3 (1,890 µS/cm to 2,520 µS/cm) before increasing in Q4 to above the SSGV (2,930 µS/cm). Water type is magnesium/calcium type (Appendix B). Metal SSGV exceedances occurred predominantly in Q1 and Q4 and included:

– Antimony at 0.01 mg/L in Q1
– Barium at 0.018 mg/L in Q1 and at 0.019 mg/L in Q4
– Cobalt at 0.002 mg/L in Q1 and at 0.003 in Q4
– Manganese at 1.34 mg/L in Q1 and 2.10 mg/L in Q4
– Zinc at 0.01 mg/L in Q1 and at 0.013 mg/L in Q4

In Airly Creek Upstream, pH remained within the SSGVs and within historical ranges, excepting Q3 results (8.1 pH units). EC remained within the SSGV for Q1 to Q3 sampling events, however exceeded the SSGV in Q4 (2,770 µS/cm). Total nitrogen exceeded the SSGV at Airly Creek US in all sampling events except Q3 (0.9, 0.9, 0.5 and 1.0 mg/L in Q1, Q2, Q3 and Q4, respectively. Dissolved barium exceeded the relevant SSGV in Q1 and Q4 (0.02 mg/L) and no other metal exceedances were recorded at Airly Creek US between Q1 and Q3. There were three exceedances in the Q4 sampling including:

– Cobalt at 0.002 mg/L.
– Manganese at 1.95 mg/L.
– Nickel at 1.95 mg/L, far exceeding the SSGV of 0.008 and making this an exceedance of concern.

Airly Tributary was not sampled throughout 2024 due to insufficient flow.

5.2.2 Genowlan Creek

The Grotto, Gap Creek and Genowlan Creek 2 are located within the Genowlan Creek catchment. These sites are monitored for potential changes to surface water features as a result of subsidence impacts.

Surface water at the Grotto is of sodium-chloride type reflecting rainfall. The pH at The Grotto remained acidic, fluctuating between 4.32 pH units (below the lower SSGV threshold) to 6.59 pH units (above the upper pH threshold). Water was fresh at The Grotto remaining below the SSGV for all quarters, EC ranging between 59.6 µS/cm and 41.3 µS/cm. Dissolved metal exceedances included:

– Iron at 1.52 mg/L (SSGV limit of 0.51) in Q1, 1.24 mg/L in Q3 and 1.0 mg/L in Q4.
– Chromium at 0.004 in Q2, recorded below the LOR for all other sampling events.
– Manganese at 0.019 mg/L in Q4.

Gap Creek was monitored throughout all quarters of 2024. pH ranged slightly acidic to basic in Q1, exceeding the upper and lower SSGVs. All other sampling events recorded circumneutral pH (6.7 pH units). EC exceeded the SSG in all sampling events except Q3, ranging from 243 µS/cm to 189 µS/cm. All dissolved metals were below SSGVs except manganese in Q1.

Surface water quality at Genowlan Creek 2 was slightly acidic throughout 2024, consistent with historical data. Water was generally more acidic with pH ranging between 5.2 pH (below the lower SSGV threshold units and 6.0 pH units. Genowlan Creek 2 is of sodium-chloride type. Only one exceedance of the SSGVs for dissolved metals was recorded during 2024. Dissolved zinc exceeded the trigger value in Q1.

5.2.3 Licensed discharge points

Surface water storages were monitored for water quality and discharge volumes throughout 2024. Dam storage water quality time series are presented in Appendix B. Dam storages show a major ion signature of calcium-sulphate type.

According to the Environmental Protection Licence (no. 12374), 100 percentile concentration limits apply to discharges from LDP001 and LDP002, except when rainfall exceeds 44 mm in a consecutive 5-day period.

No discharges from LDP001 (Production Dam), LDP002 (Stockpile Dam) or LDP003 (Train Loader Dam) occurred in 2024.

5.2.4 Nissan Hut Dam

Nissan Hut Dam is a local water source on Genowlan Mountain used for recreation and firefighting activities. Water levels in the dam have been monitored since May 2022 to assess potential groundwater connection and subsidence impact subsequent to undermining. However, evidence to date from adjacent groundwater standpipe ARP16 indicates no connection between the surface water and groundwater at this location.

ARP16 was installed adjacent the dam in December 2021. The bore was drilled to 13.92 m BGL and installed with a 6 m screen. No water was intercepted during drilling, and the location was dry at the time of well installation. ARP16 remained dry throughout the year.

Surface water level in Nissan Hut Dam is monitored with a water level gauge and continuous logger installed in May 2022. Levels in 2024 generally fluctuated with rainfall, with lowest levels recorded in January (1.13 m). There was a general increase in level from January to May, where the highest level was recorded (1.62 m) before a decline from May to December (Figure 5.3).

Nissan Hut Dam was sampled quarterly throughout 2024. No SSGVs are in affect due to the limited baseline data set. pH ranged slightly acidic, though within ANZG guidelines (6.5 to 7.3). No concurrent notable trends in EC or metals were recorded. The dam is turbid and contains brown algae and throughout 2024 recorded between 20 and 30 mg/L of total dissolved solids and in October 2024, 14 mg/L totals suspended solids. The water was fresh throughout 2024, with EC ranging 33.0 to 50 µS/cm. No piper plot is developed for Nissan Hut Dam, however ionic composition was chloride dominant throughout the year. Metal concentrations are low with concentrations above laboratory LORs limited to the following:

– Aluminium at 0.28 mg/L in Q3.
– Iron at 0.58 mg/L in Q1, 0.81 mg/L in Q2, 0.47 mg/L in Q3 and 1.25 mg/L in Q4.
– Manganese at 0.116 mg/L in Q1, 0.106 mg/L in Q2, 0.027 mg/L in Q3 and 0.202 mg/L in Q4.
– Zinc at 0.032 mg/L in Q1 and 0.007 mg/L in Q4.

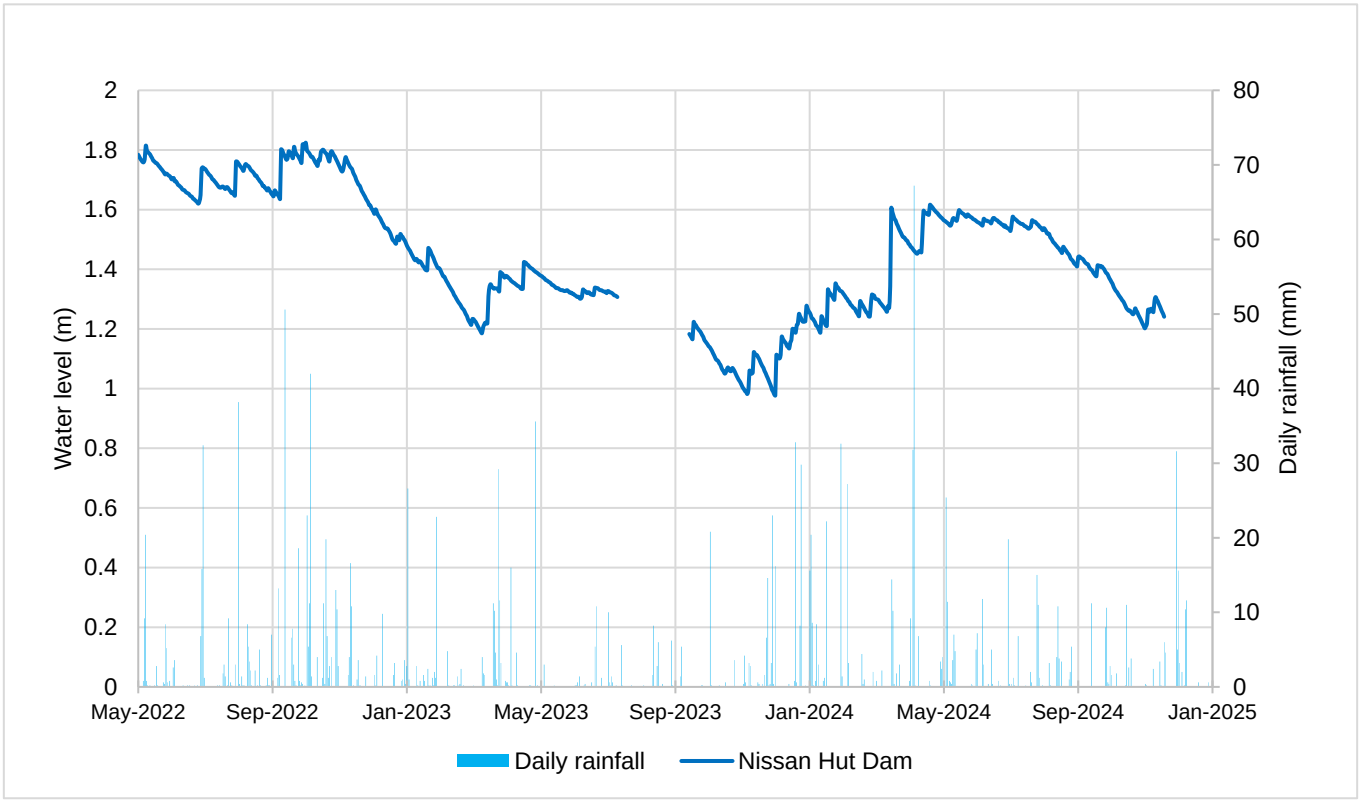


Figure 5.3 Nissan Hut Dam water levels

5.2.5 Trigger Action Response Plan review – surface water quality

Surface water quality data were reviewed against the Trigger Action Response Plan F2 to identify if any stage 1 triggers for surface water quality have occurred. Trigger Action Response Plans and the stage 1 triggers are defined within the WMP, Revision 9. Identified stage 1 triggers are presented in Table 5.6.

Table 5.6 Trigger Action Response Plan Surface Water quality investigation

Monitoring location	Parameter/trigger value	Recorded exceedances and month	Investigation
Surface water quality			
Genowlan Creek 2	pH (5.6 pH units lower trigger, 6.2 pH units upper trigger)	January 5.56 February 5.22 March 7.1 May 5.8 October 6.01 December 6.05	Two consecutive exceedances of lower pH trigger values were recorded during January and February, constituting a stage 1 trigger event. Variability of pH at Genowlan Creek 2 has been historically observed. The results recorded below the lower pH trigger value are within historical values observed during 2022/2023. Sediment sampling was conducted in 2024 to identify source of low pH in Genowlan Creek, however not found to be attributable to reduced sediments (such as sulfides). As described in Section 6.1.3, investigation is ongoing as the source is still unknown. One upper trigger value exceedance was recorded, however no further investigation was undertaken as no consecutive exceedance of the upper trigger value was recorded.
Gap Creek	EC (178 µS/cm)	January 243.4 February 207.5 May 138.8 October 189.6 December 242.5	Two consecutive exceedances of the EC trigger value within Gap Creek were reported in January and February 2024, and again in October and December 2024, each constituting a stage 1 trigger event. All exceedances, except the January result, are within the historical range of results, and likely attributable to below average rainfall received throughout 2024 (refer to Section 3.2.2). Gap Creek is periodically dry and these results may be the result of sampling from remnant pools (subject to evaporation and salinisation).

6. Impact assessment

6.1 2024 operations

6.1.1 Groundwater inflow

Since 2015 mining of the Lithgow Seam has generally extended east from the surface facilities area. Mining was by bord and pillar prior to 2019 with panel and pillar mining commencing in 2019 and occurring to the east of ARP01 and the south-west of ARP03A. Bord and pillar operations occurred south and south-west of ARP06 during 2020. In 2023, operations included continuation of first workings to the east of the existing workings; south of ARP12 and ARP06 and including panel and pillar extraction northeast of ARP14.

The updated groundwater model for Airly Mine (GHD, 2025c) predicted <2 m^3/day groundwater inflows to the mine void to date. These inflows would not be measurable, largely occurring in increased coal moisture and would not have required transfer via pumping to the surface facilities area. Consistent with the prediction, no measurable groundwater inflow occurred.

Groundwater inflow is predicted to significantly increase from 2024 as mining progresses to the northeast under Genowlan Mountain where saturated conditions are anticipated. Modelling predicts inflows to peak at approximately 130 m^3/day by 2028.

6.1.2 Groundwater levels and quality

Overall, groundwater pressure trends in 2024 are similar to those reported between 2013 and 2023 (and reported in the EIS). Monitoring locations in regional aquifers in the Shoalhaven and Devonian, tens to hundreds of metres, respectively, below the mine show decreasing groundwater trends. These trends are considered to reflect regional impacts to groundwater resulting from either, or a combination of, abstraction and climate effects. No water quality monitoring occurs in these strata.

Numerous monitoring locations within the Permian Coal Measures have become dysfunctional and are assumed to have been compromised due to matrix shifts resulting from subsidence, particularly beneath Mount Airly. Where functioning, monitoring records show the Middle River Seam to be historically dry or with fluctuating pressure changes, overall decreasing. Fluctuations may reflect percolating recharge in localised areas. Otherwise, dry conditions (i.e., at ARP07) indicate the aquifer is not continuous throughout the strata. All monitoring points in the Irondale have been lost, or as is the case at ARP06, have been dry long-term (since 2013). The Lithgow and Marrangaroo show overall decreasing groundwater pressure trends, albeit monitoring locations have become largely compromised. Water quality in the Lithgow Seam (ARP13SP) is fresh and of low pH (4-6) with elevated levels of iron, manganese, nickel and zinc in the last two year correlating to the increased incidence of pH around 4. Trends in manganese, nickel and zinc appear to be in decline while iron concentrations continue to rise.

Monitoring points in the upper Permian include standpipe ARP11 and Village Spring. At these locations, groundwater level/flow is responsive to rainfall. Recovery in ARP11 from circa 2020 indicates this stratum has not been adversely impacted by mining activity in the lower seam. Both waters present as brackish however pH differs towards acidic in ARP11 (6.3-6.5) and historically alkaline (8) at Village Spring although recent gauging shows trending towards neutral (7). This distinction supports disconnected sources, and that water held in this stratum is discontinuous. Both waters show elevated levels of nickel and zinc. Manganese is also elevated at Village Spring.

Monitoring in the Narrabeen Sandstone generally shows decreasing water levels or otherwise dry conditions. The decreasing water levels are considered to reflect reduction in rainfall recharge. ARP06 has shown slow, continuous decline while ARP15SP has historically shown high responsiveness to rainfall events. Water quality at ARP15SP is fresh and increasingly freshening indicating rainfall recharge. The water is also acidic ranging pH 6 to 7 with elevated levels of manganese, nickel and zinc. Water recovery at ARP15SP in response to rain disputes deleterious mining impact, hence, changes in water quality are speculated to be the result of drying climate conditions and rewetting cycles.

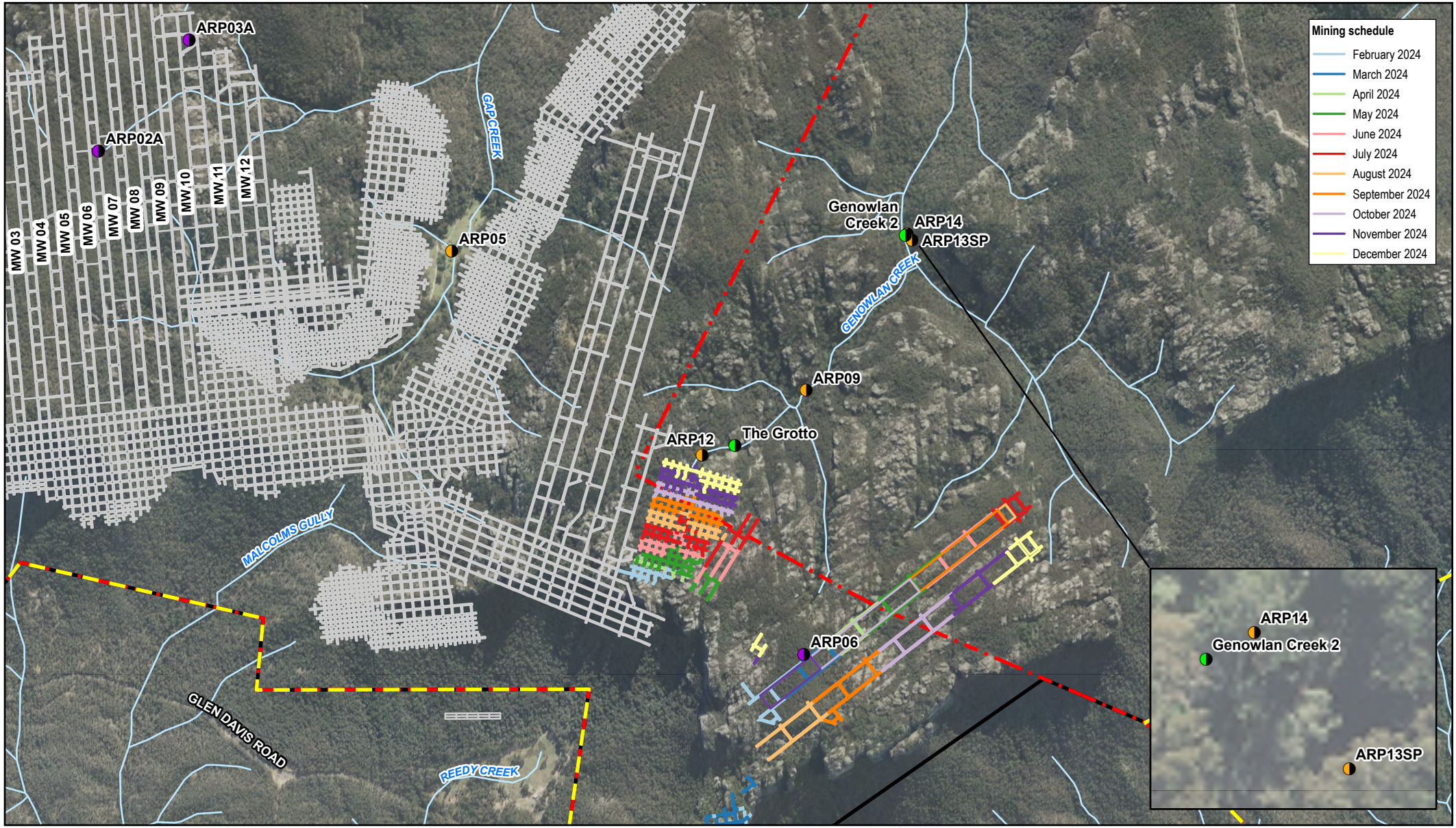
Alluvium monitoring points in the upper catchment (ARP09 and ARP12) are more responsive to rainfall and demonstrate cycling through wetting and drying cycles while water levels are more stable lower in the catchment supported by a larger aquifer (ARP14). All alluvial locations show fresh and acidic conditions generally in the pH range of 5 to 6 but approximating 4 at ARP12. ARP14 demonstrates a wide range of elevated metals. Zinc is commonly elevated at all locations except at ARP12. Metal signatures support discontinuation of water stored in alluvial sediments. Fresh conditions reflect rainfall as source of recharge and may be the cause of acidification. Alluvial monitoring points have historically shown recovery in water level in response to rainfall events disputing mining associated subsidence influence. Declining water quality is not considered associated to mining activities and, instead, is speculated to be the result of drying-wetting cycles.

6.1.3 Surface water

Flows in Gap Creek and Genowlan Creek were responsive to the rainfall events throughout 2024. Observed flows during 2024 were decreased compared to historical data (2022-2023), corresponding to below average rainfall received throughout the year (refer to Figure 3.3, Section 3.2.2). Surface water quality throughout 2024 was similar to 2023.

Airly surface waters (creek and upstream) are distinctly different to Genowlan and Gap creeks. Airly waters are circumneutral tending alkaline, brackish and with some isolated metal concentrations. Conversely, the Grotto, Genowlan Creek and Gap Creek are fresh waters of acidic to circumneutral conditions. Similarly, fluctuation in metal concentrations results in temporal exceedances.

Water quality in the Grotto, Genowlan Creek and Gap Creek are reflected in proximal alluvial bores. However, mining is not considered the cause of such hydrogeochemical changes considering the vertical separation (>100 m) and the recovery response to rainfall. The chemistry is also inconsistent with mine storage water and discharge quality. The cause of acidifying conditions remains unknown. It has been speculated to occur due to aeration of previously reduced sediments, that have been exposed to drying and rewetting however mineralogical testing failed to identify reduced reactive sediments.



LEGEND

- Mining Lease ML1331
- Approved development consent boundary
- Historical mining
- Vibrating Wire Piezometers
- Standpipe monitoring bore
- Surface water quality location
- Waterway

Paper Size ISO A4

0 0.1 0.2 0.3 0.4 0.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Airly Pty Ltd
Airly Mine Water Monitoring
2024 Annual Water Monitoring Report

Genowlan Creek monitoring sites and mining schedule

Project No. **12602550**
Revision No. **0**
Date **13/03/2025**

FIGURE 6.1

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12602550\AWR\12602550_AWR.aprx
Print date: 13 Mar 2025 - 09:04

Data source: LPI: DTDB 2012; Centennial: Aerial Imagery, boundaries, 2013, Monitoring Locations, 2017 public_NSW_Imagery: © Department of Customer Service 2020. Created by: tmorton

6.1.4 Production bore AM2B-1

Approximately 5.7 ML of groundwater was extracted from the production bore during 2024 for mining production purposes. This is within the annual extraction limit of 158 ML/year. All monitoring data for AM2B-1 are shown in Appendix B.

No significant water quality changes were observed throughout 2024, water results were consistent with historical records and there were no trends of concern.

6.1.5 Old production bore

Water level monitoring data for the old production bore are presented in Appendix A. The groundwater level showed a general increasing trend from December 2023 through to December 2024. The level varied between 21.46 m bgl to 10.94 m bgl. The greatest fluctuation occurred in July 2024, with an increase of 5.23 m, consistent with the above average rainfall recorded in June and July of 2024. Some fluctuations may be associated with volume of groundwater extraction.

6.1.6 Site water balance

A site water balance model was previously developed for Airly Mine as part of the Airly Mine Extension Project (GHD 2014) to quantify transfers within the site under future operational conditions using various rainfall patterns. The site water balance was updated to reflect the current mine plan and operational conditions as part of 2024 Water Assurance Reporting (GHD 2025b). The site water balance for the 2024 calendar year is presented in Table 6.1.

Table 6.1 Annual water balance – average existing conditions (2024)

Water flow	Volume (ML/year)
INPUTS	
Direct rainfall onto storages and catchment runoff	98
External potable water supply	2
Groundwater inflows into underground workings	0
Extraction from production bore	6
In situ coal moisture	23
TOTAL INPUTS	**129**
OUTPUTS	
Evaporation	45
Dust suppression	5
Sewage to Ecomax effluent treatment system	3
Discharge through LDP001	0
Discharge through LDP002	0
Discharge through LDP003	0
Product coal moisture	80
Clean water diversions	4
TOTAL OUTPUTS	**137**
CHANGE IN STORAGE	
Surface water storages	-8
Underground workings	0
TOTAL CHANGE IN STORAGE	**-8**
BALANCE	
Inputs – outputs – change in storage	0

The observed water flows during 2024 at Airly Mine were reviewed:

Rainfall/runoff is a major water resource at Airly Mine with approximately 113 ha captured by the water management infrastructure on site. Over the 2024 calendar year, modelling suggests rainfall/runoff accounts for 76% of the total water inputs to the site. Other inflows include extraction from production bore and insitu coal moisture accounts for approximately 5% and 18% of the total inputs at Airly Mine over the 2024 calendar year, owing to a below average rainfall year.

The major outflows at Airly Mine included ROM coal moisture (entrained) (58.6%), evaporation (32.9%), and losses from the dust suppression and sewage system (3.7%).

6.2 2025 operations

6.2.1 Groundwater

The groundwater model for Airly Mine (GHD 2025c) was rebuilt to represent interactions between surface waters and alluvial groundwater, more accurately estimate storativity in fractured rock aquifers to reflect the negligible mine voids inflows to date and demonstrate the vertical interconnectivity between hydrogeological strata, or the lack of.

The updated model simulates negligible groundwater inflows into mined voids during 2024 increasing to approximately 10 ML/year towards 2025. The Lithgow Seam mined during the calibration period was largely unsaturated, with the water table hosted within units perched above the Illawarra Coal Measures. As mining progresses to the northeast under Genowlan Mountain, saturated conditions are anticipated, which is predicted to result in significantly higher void inflow rates.

No changes to groundwater quality along Gap and Genowlan Creek were expected as assessed by the EIS. Yet notable changes that have occurred, which are not considered to be associated with mining activity, will continue to be monitored and further investigation supported.

6.2.2 Surface water

Subsidence impacts assessed in the Surface Water Subsidence Impact Assessment (GHD 2023) indicates there were no evidence of subsidence related impacts to surface water flows at the gauged locations along Gap and Genowlan Creeks, post mining. In addition, there have been no adverse impacts predicted for these hydrological or hydraulic conditions of catchments or waterways. The upper reaches of Gap and Genowlan Creeks are undermined. Existing mine workings are generally within 200 m of Gap Creek and 500 m of Genowlan Creek.

Changes to the site water balance and mine water discharges from surface facilities area are not expected. Water levels within the Production Dam are typically managed to maintain sufficient freeboard in case of significant rain events. However, based on available water quality data for Production Dam (and as assessed in Section 5.2.3), it is unlikely that a discharge would adversely impact Airly Creek.

Ongoing monitoring and investigation of water quality in Gap Creek and Genowlan Creek will continue as part of ongoing investigations of groundwater quality adjacent to these creeks.

7. Summary

Table 7.1 consolidates the monitoring locations and monitoring status for 2025 into a single table.

Table 7.1 Summary of monitoring

	ID	Lithology	Level/Flow Monitored	Quality Monitored	Level/Flow Triggered	Quality Triggered
Groundwater						
VWPs	ARP01	Narrabeen Sandstone	No, logger dysfunctional since 2018	NA	NA	NA
		Irondale Coal Seam			NA	
		Lithgow coal seam			NA	
		Marrangaroo Formation			NA	
	ARP02A	Narrabeen Sandstone	No, logger dysfunctional since 2023		NA	
		Irondale Coal Seam	No, logger dysfunctional since 2020		NA	
		Lithgow Seam			NA	
		Marrangaroo Formation			NA	
	ARP03A	Narrabeen sandstone	No, logger dysfunctional since 2020		NA	
		Middle River Coal Seam	No, logger dysfunctional since 2023		NA	
		Lithgow Seam	No, dry since installation and dysfunctional since 2021		NA	
		Marrangaroo Formation	No, logger dysfunctional since 2022		NA	
	ARP04	Lithgow Seam	Yes		No, (737.3)	
		Marrangaroo Formation			No, (735.5 m AHD)	
		Shoalhaven			No, (672.1 m AHD)	
	ARP06	Narrabeen Sandstone	Yes		No, (867.6 m AHD)	
		Irondale Coal Seam	Yes, dry since 2013		NA, possible dysfunctional logger from November 2024	

	ID	Lithology	Level/Flow Monitored	Quality Monitored	Level/Flow Triggered	Quality Triggered
		Lithgow coal seam	Yes, dry since installation		NA, possible dysfunctional logger from November 2024	
		Marrangaroo Formation	Yes, dry since 2016		NA, possible dysfunctional logger from November 2024	
	ARP07	Middle River coal seam	Yes, dry since installation		NA	
		Lithgow coal seam			NA	
	ARP08	Narrabeen sandstone	No, dry since 2016		NA	
		Lower Irondale	No, blocked throughout 2023		NA	
	ARP13	Shoalhaven	Yes		No, (686.3 m AHD)	
		Devonian formation			Yes, (558.7 m AHD)	
	ARP15	Lithgow Coal Seam	Yes		No, (727.2 m AHD)	
		Shoalhaven			No, (639.1 m AHD)	
		Devonian formation			No, (571.2 m AHD)	
Standpipes	AM2B-1		NA	2009–present	NA	NA
	Old Production Bore		Yes	May 2017-present	NA	NA
	ARP05	Gap Creek Alluvium	Yes	August 2012–present	NA (751.8 m AHD)	WMP 2024 SSGV
	ARP07	Narrabeen Sandstone	Yes	July 2013–present	NA	No
	ARP08	Lithgow Seam	Decommissioned	September 2013– March 2023	NA	NA
	ARP09	Genowlan Creek Alluvium	Yes (only until October 2024 due to dry conditions)	June 2013–present	NA (854.1 m AHD)	2024 SSGV
	ARP11	Permian Strata	Yes	January 2017–present	NA (741.7 m AHD)	WMP 2023 SSGV
	ARP12	Genowlan Creek Alluvium	Yes (only until October due to malfunctioning logger)	January 2017–present	NA (891.5 m AHD)	2024 SSGV
	ARP13SP	Lithgow Seam	Yes	January 2017–present	NA (718.7 m AHD)	WMP 2024 SSGV

	ID	Lithology	Level/Flow Monitored	Quality Monitored	Level/Flow Triggered	Quality Triggered
	ARP14	Genowlan Creek Alluvium	Yes	January 2017–present	No (782.6 m AHD)	WMP 2024 SSGV
	ARP15SP	Narrabeen Sandstone	Yes	January 2017–present	No (834.3 m AHD)	WMP 2024 SSGV
	ARP16 (Nissan Hut)	NA	Yes, dry since installation in 2021	December 2021 – present	NA	No
Landholder bores	Nioka	Devonian Strata	NA	January 2017 – present	NA	2024 SSGV
	Kingdom	Devonian Strata	NA	November 2019– present	NA	2024 SSGV
	GW800787	NA	NA	December 2021 - present	NA	2024 SSGV
Seepage	Village Spring	Permian Strata	Yes	February 2011–present	NA	WMP 2024 SSGV
	Mine workings		Yes	December 2009–present	NA	NA
Surface Water						
Creeks	Airly Creek		NA	Yes	NA	WMP 2024 SSGV
	Airly Upstream		NA	Yes	NA	WMP 2024 SSGV
	Airly Tributary		NA	No – Dry conditions	NA	WMP 2024 SSGV
	Genowlan Creek 2		Yes	Yes	NA	WMP 2024 SSGV
	Gap Creek		Yes	Yes	NA	WMP 2024 SSGV
	The Grotto		NA	Yes	NA	WMP 2024 SSGV
Discharge Points	LDP001		Yes	No	No	NA
	LDP002		NA continuous monitoring not available	No	No	NA
	LDP003		Yes	No	No	NA

8. References

ALS (2023). ALS Client Data Portal, obtained from: **https://hydportal.alsglobal.com/web.htm**

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

Centennial Coal (2024). *Airly Mine Water Management Plan*, Revision 9, March 2024.

GHD (2014) Airly Mine Extension Project: Water and Salt Balance Assessment, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2017) *Airly Mine – 2016 Annual Water Monitoring Report.*

GHD (2018a) *SSGV Update and EPL Review*: Letter prepared for Centennial 14 February 2018.

GHD (2018b) *Airly aquatic ecology 2017.*

GHD (2023) *Surface Water Subsidence Impact Review*. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025) *Airly Mine Water Management Plan.* Revision 9. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025a) *Airly Mine Water Management Plan.* Revision 10. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited. In draft.

GHD (2025b) *Airly Mine Water Assurance Reporting.* Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025c) *Airly Mine Groundwater Model.* Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025d) *Airly Mine Watercourse Stability Monitoring Report 2024*. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025e) *Airly Mine Aquatic Ecology Annual Report 2024*. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

Appendices

Appendix A

Groundwater hydrographs

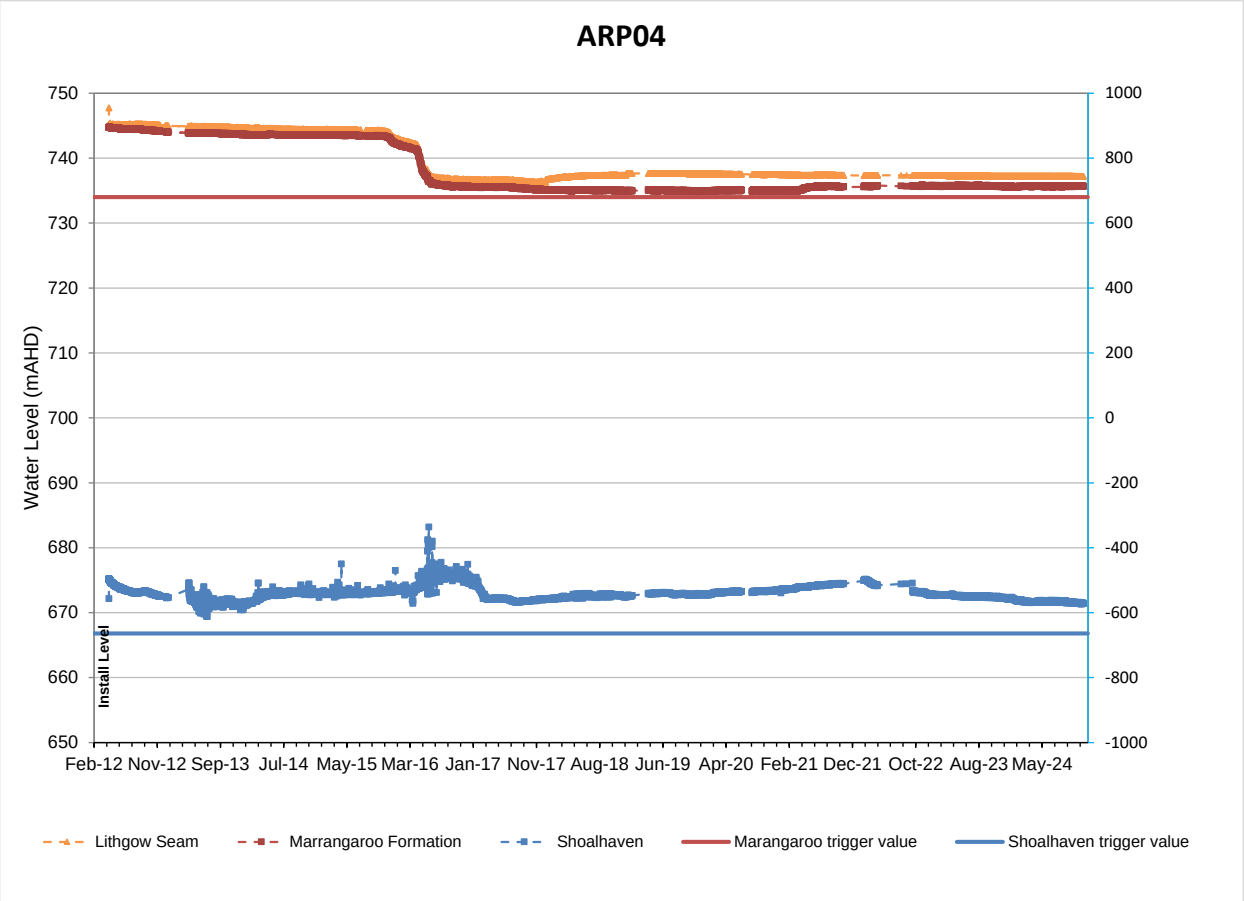


Figure A.1 ARP04

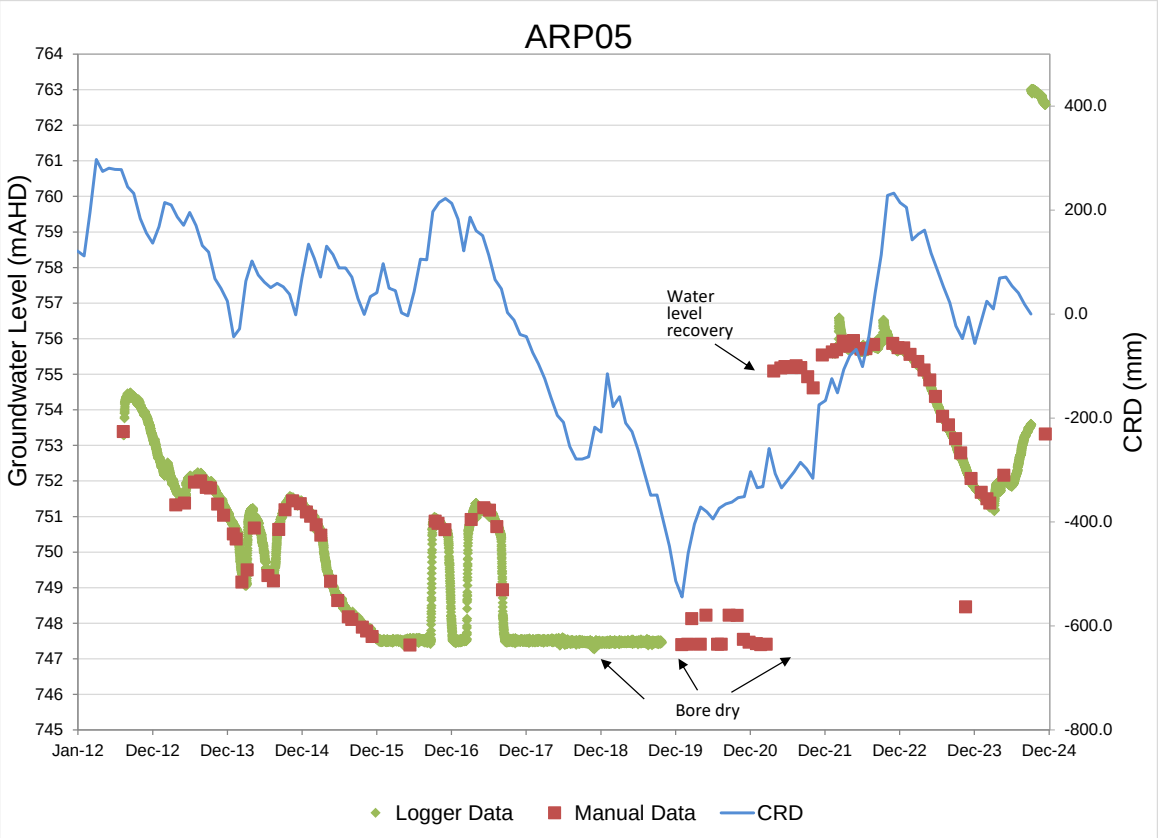


Figure A.2 ARP05

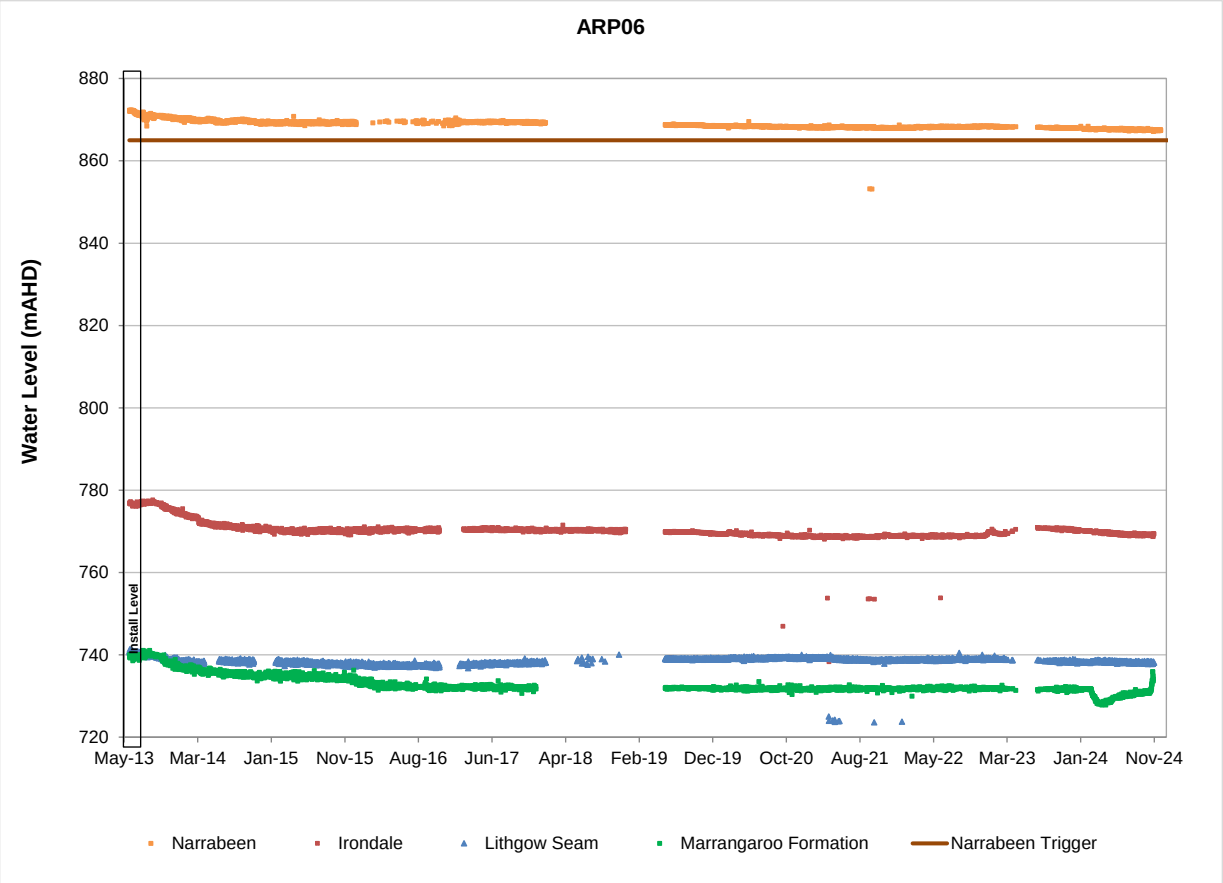


Figure A.3 ARP06

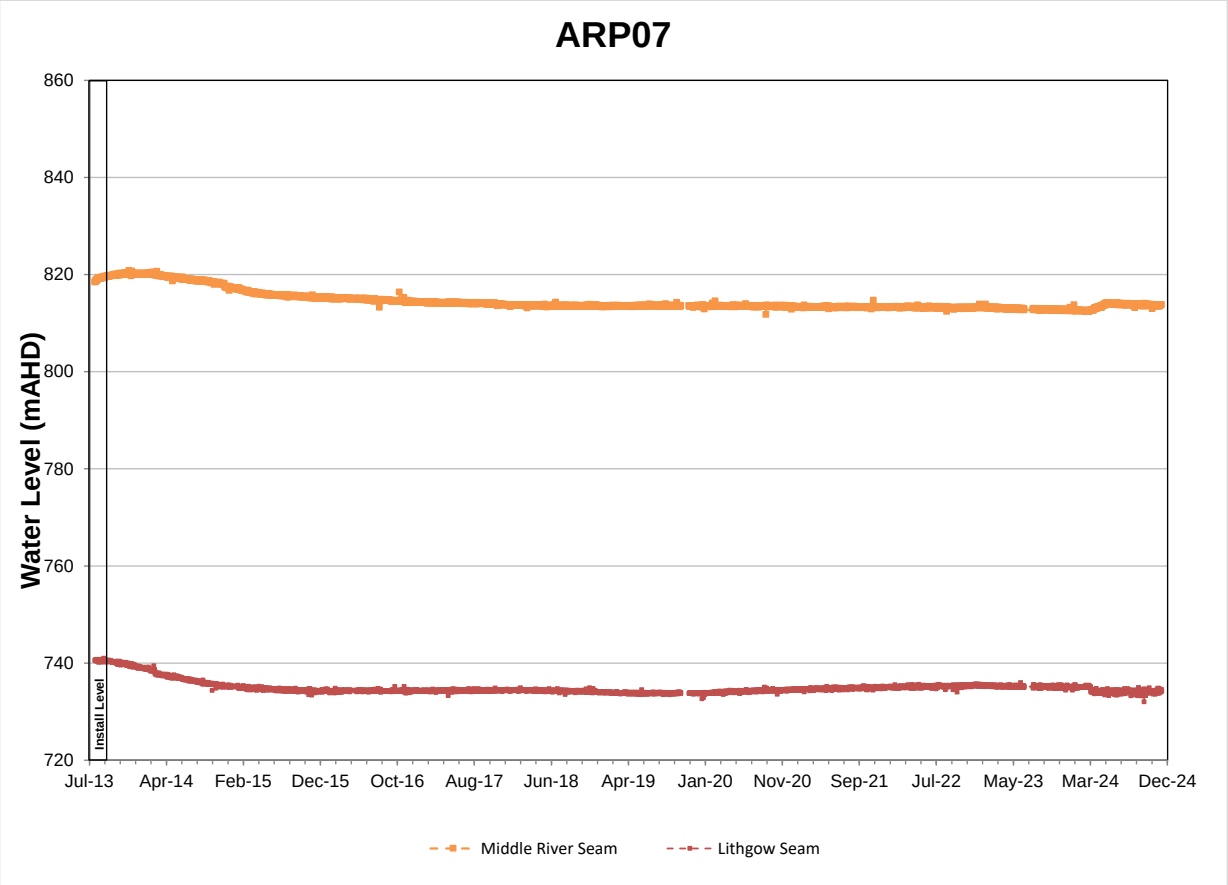


Figure A.4 ARP07

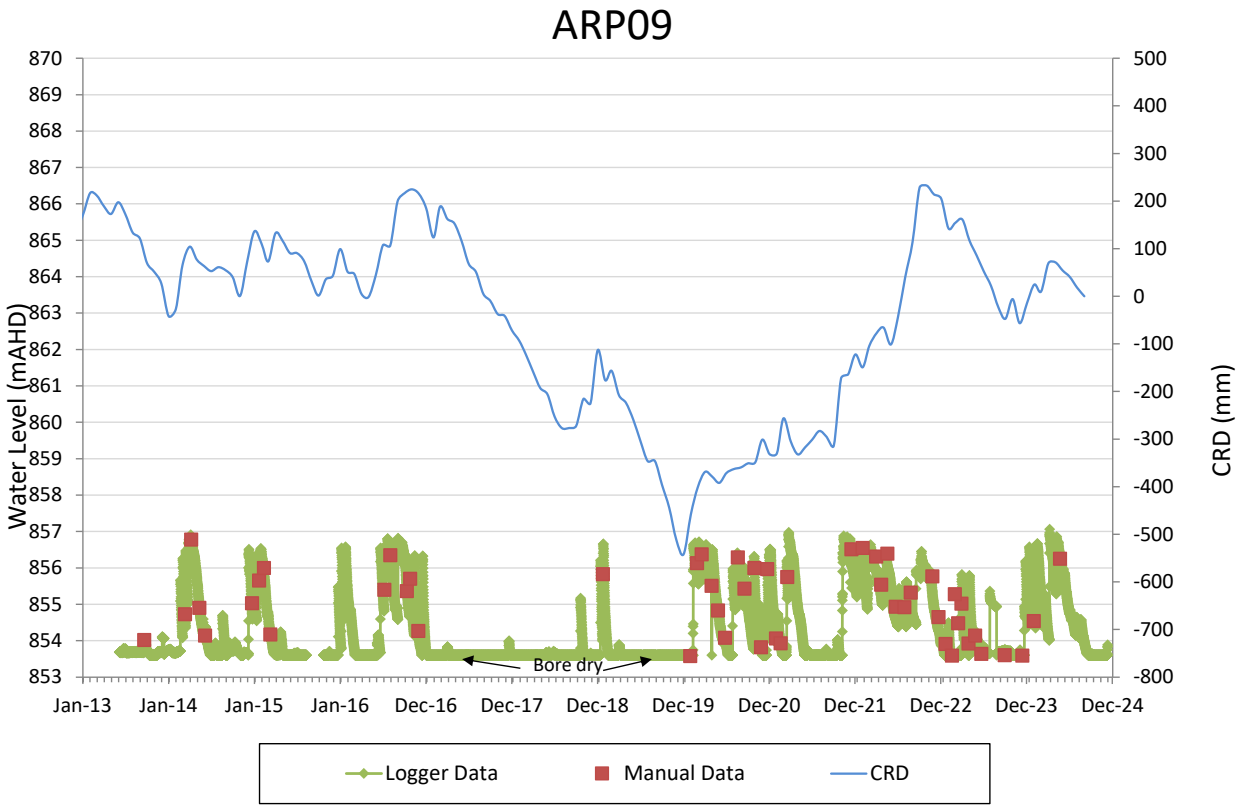


Figure A.5 *ARP09*

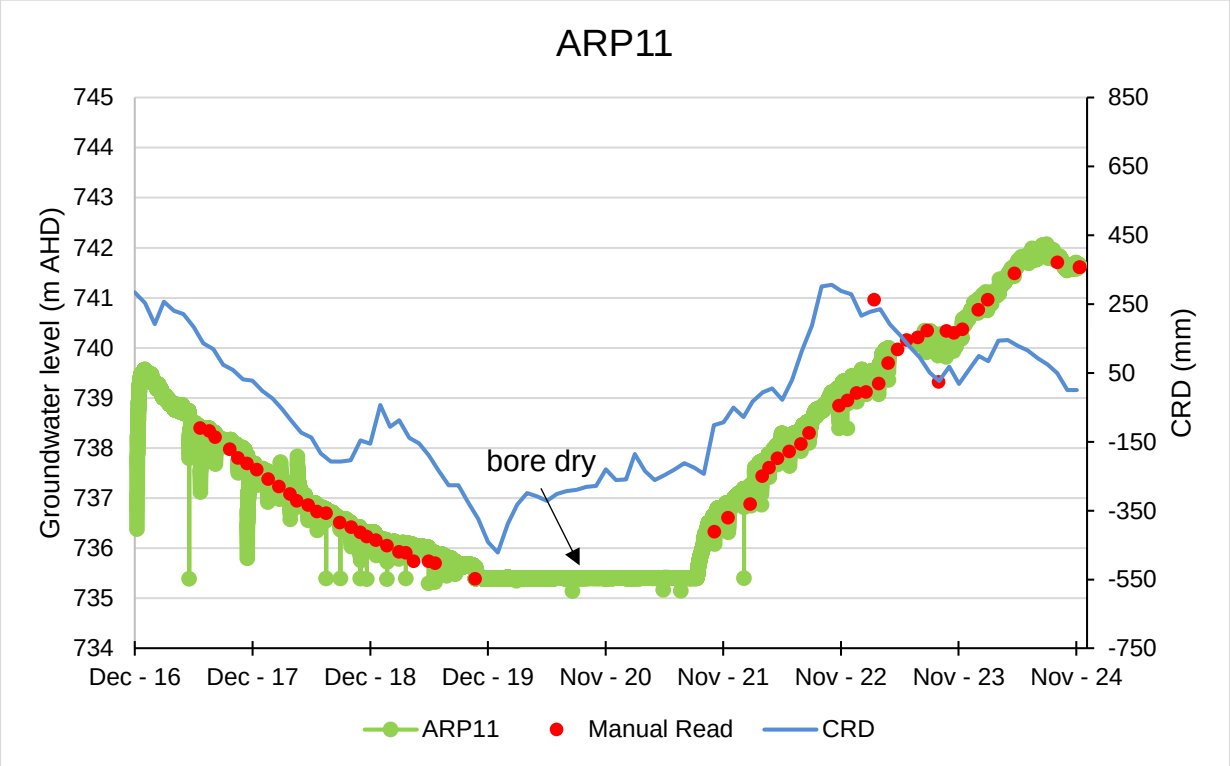


Figure A.6 *ARP11*

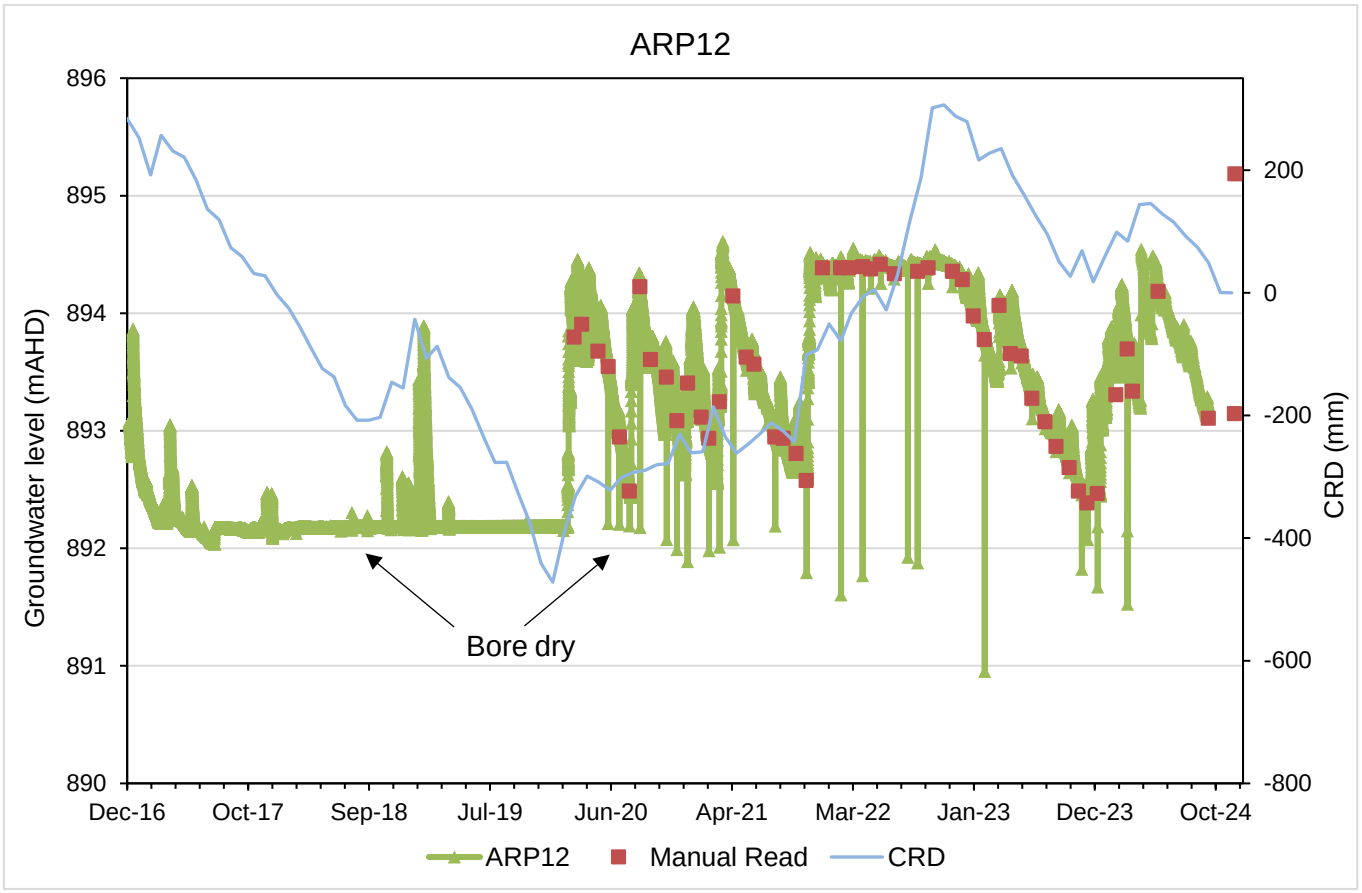


Figure A.7 ARP12

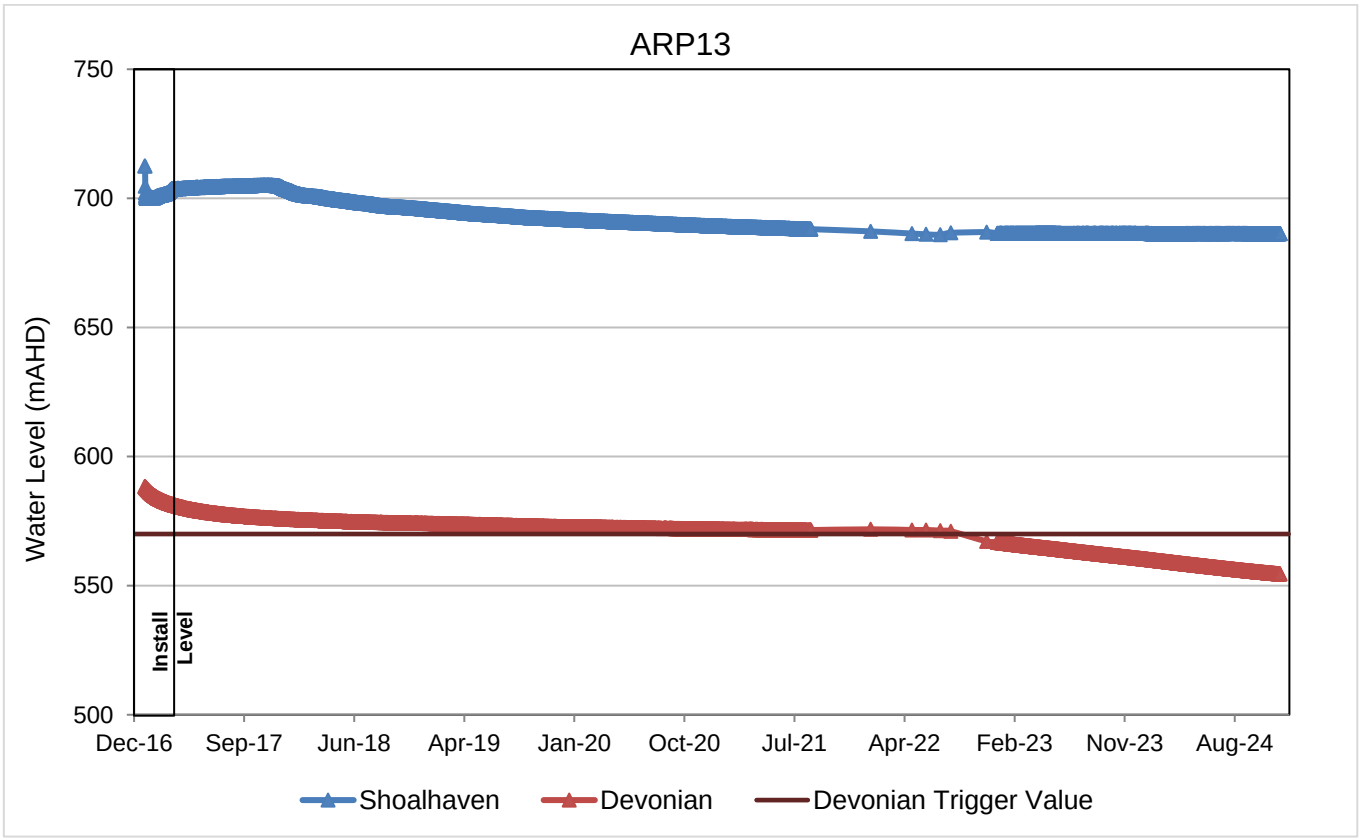


Figure A.8 ARP13

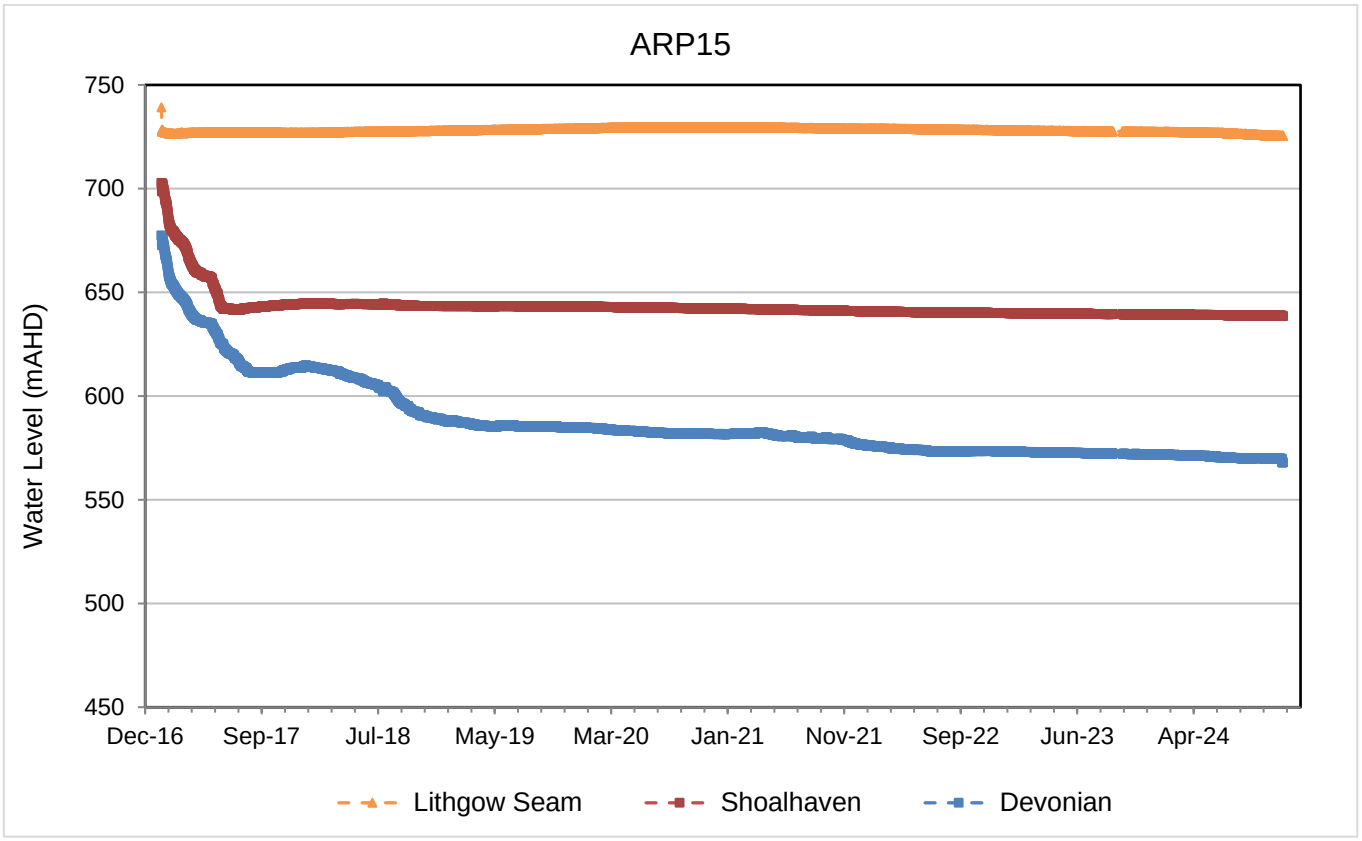


Figure A.9 *ARP15*

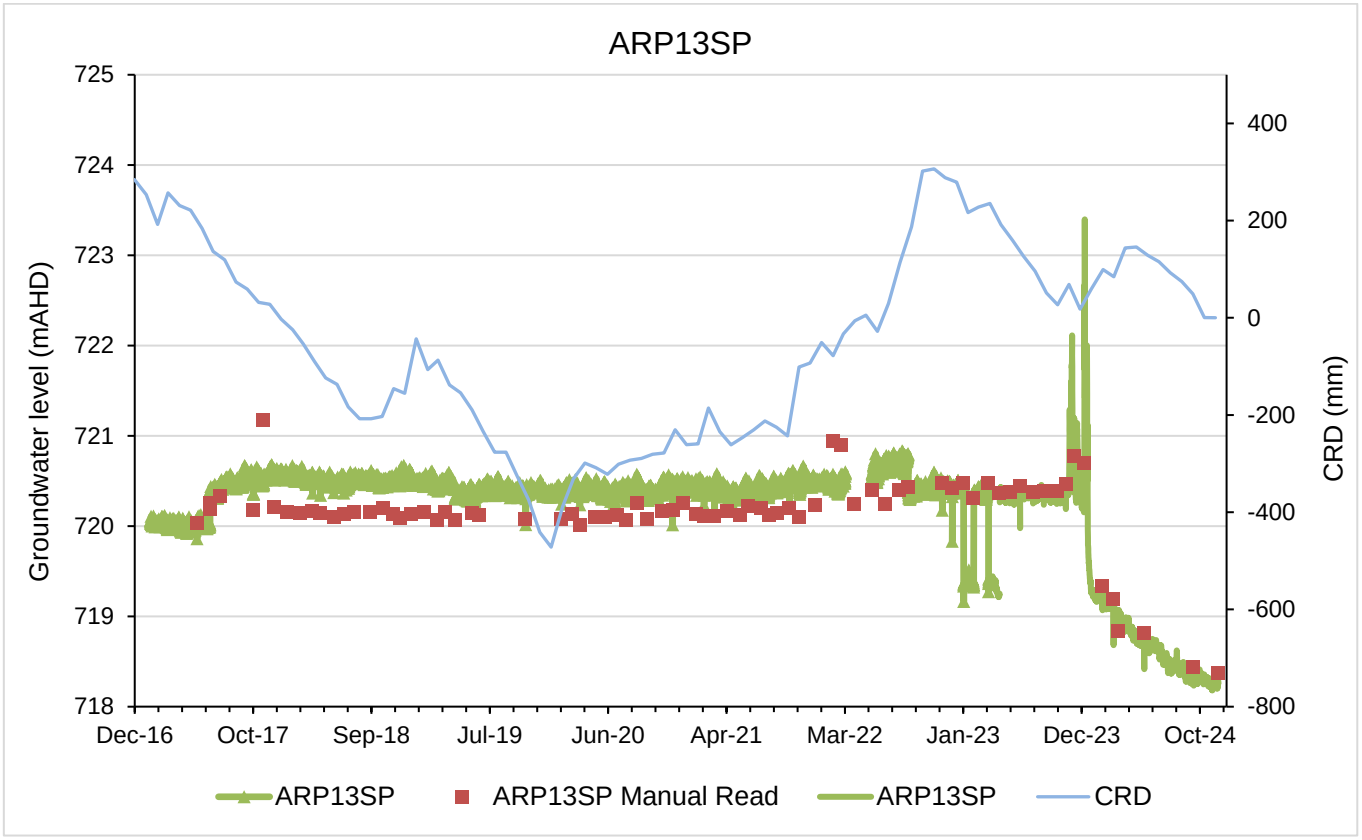


Figure A.10 *ARP13SP*

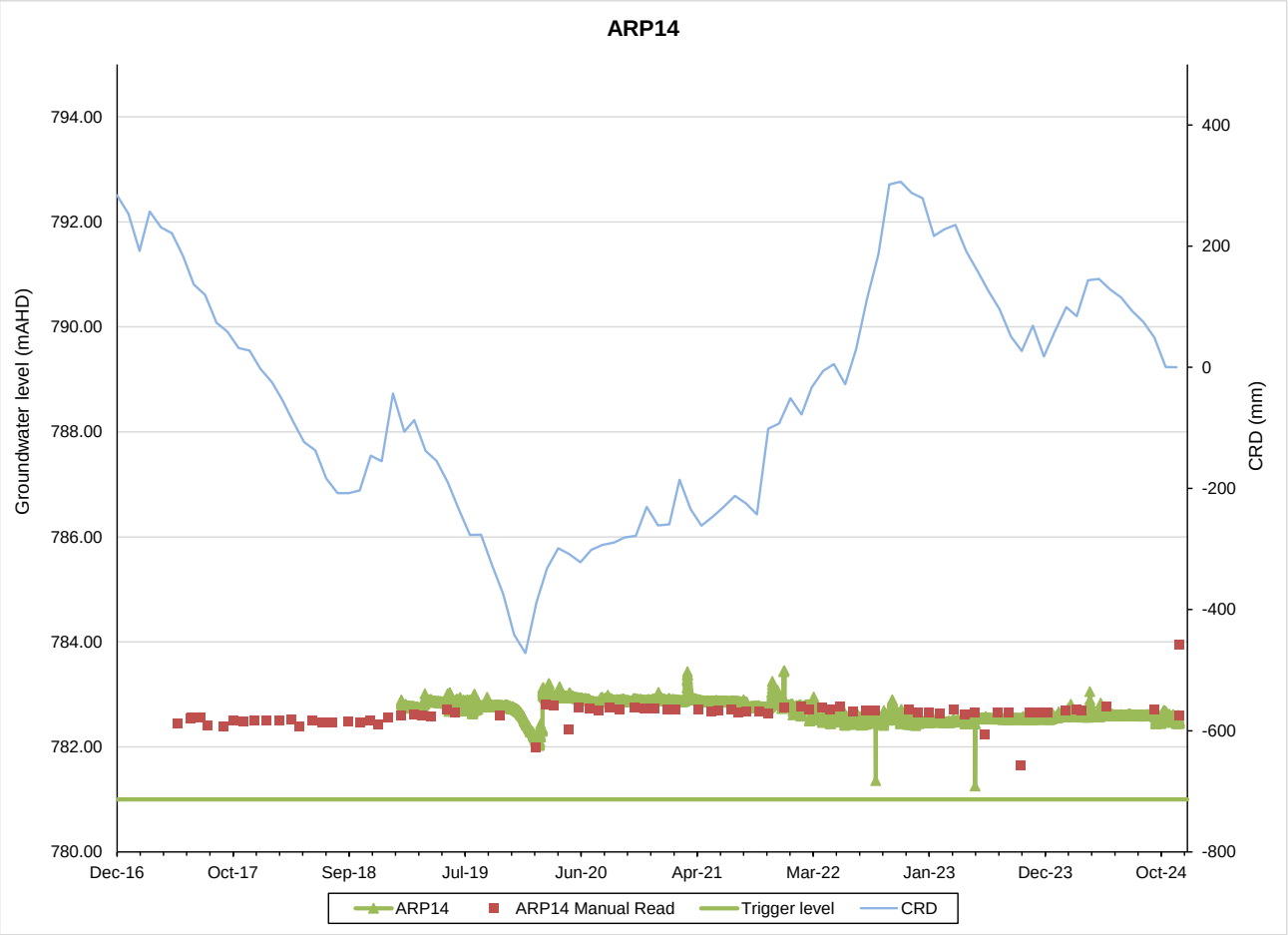


Figure A.11 ARP14

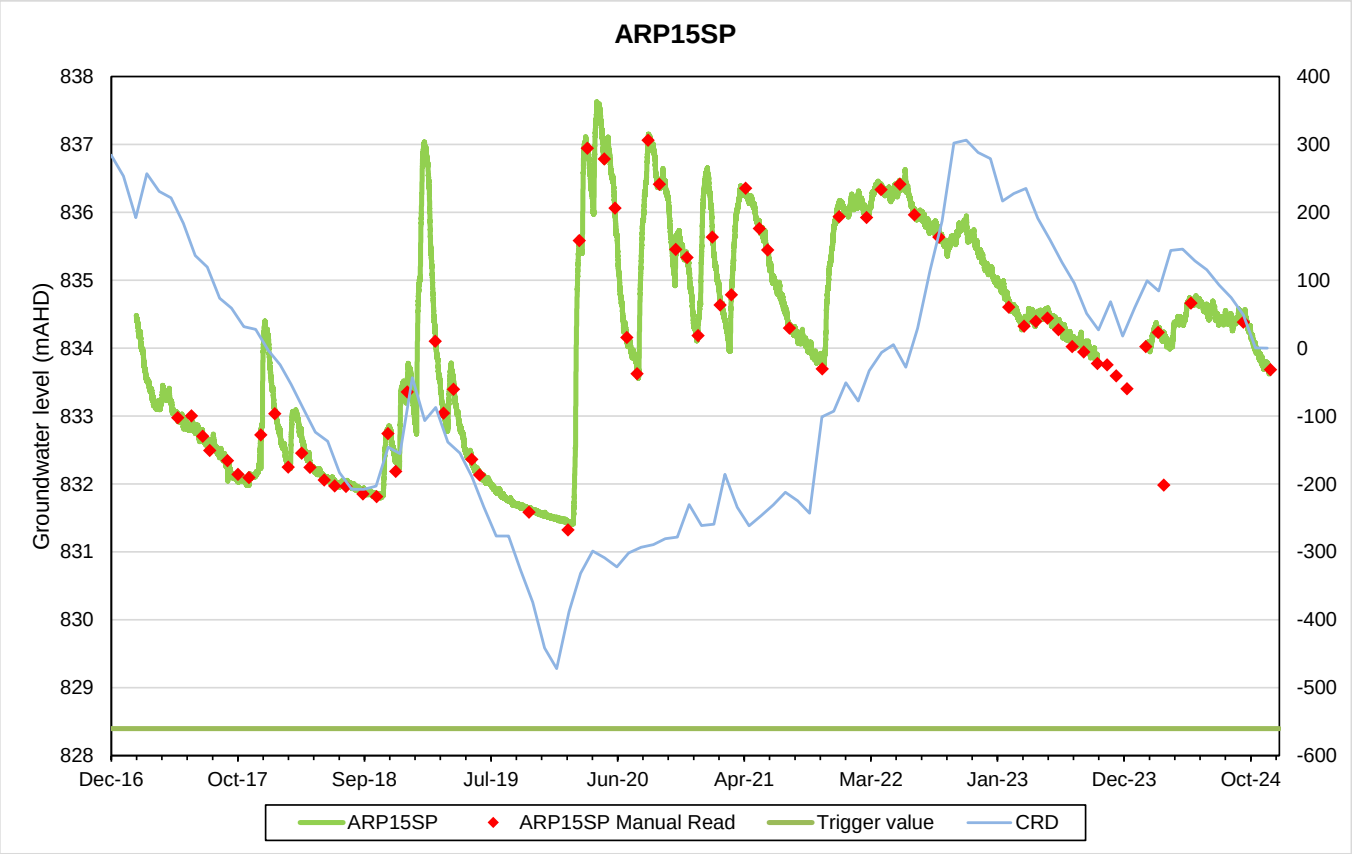


Figure A.12 ARP15SP

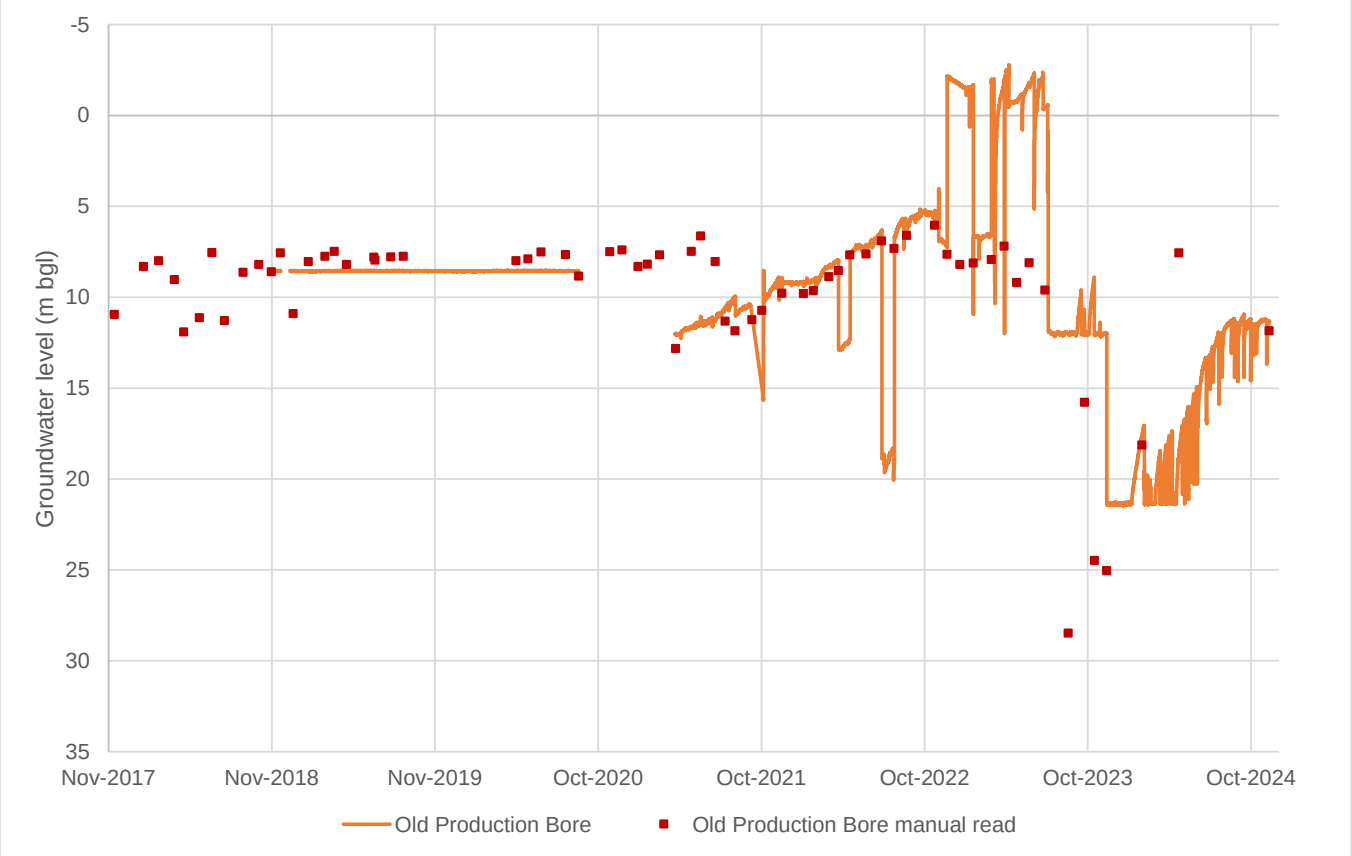


Figure A.13 Old Production Bore

Appendix B

Water quality timeseries

Fractured Rock groundwater bores

Physicochemical parameters

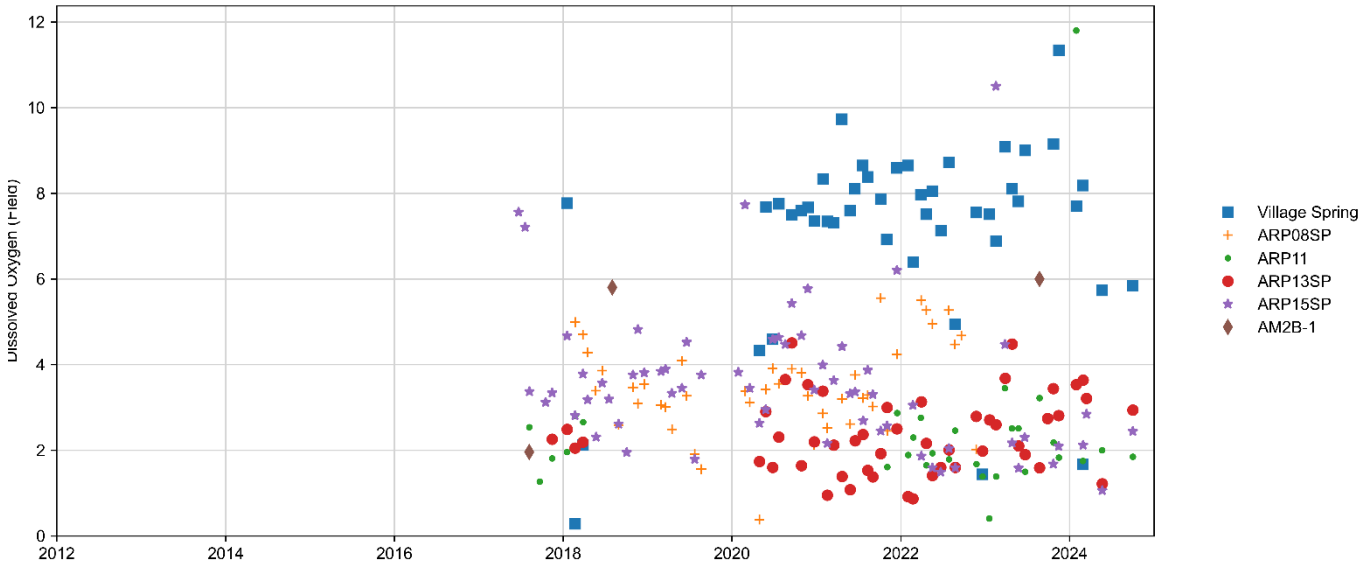


Figure B.1

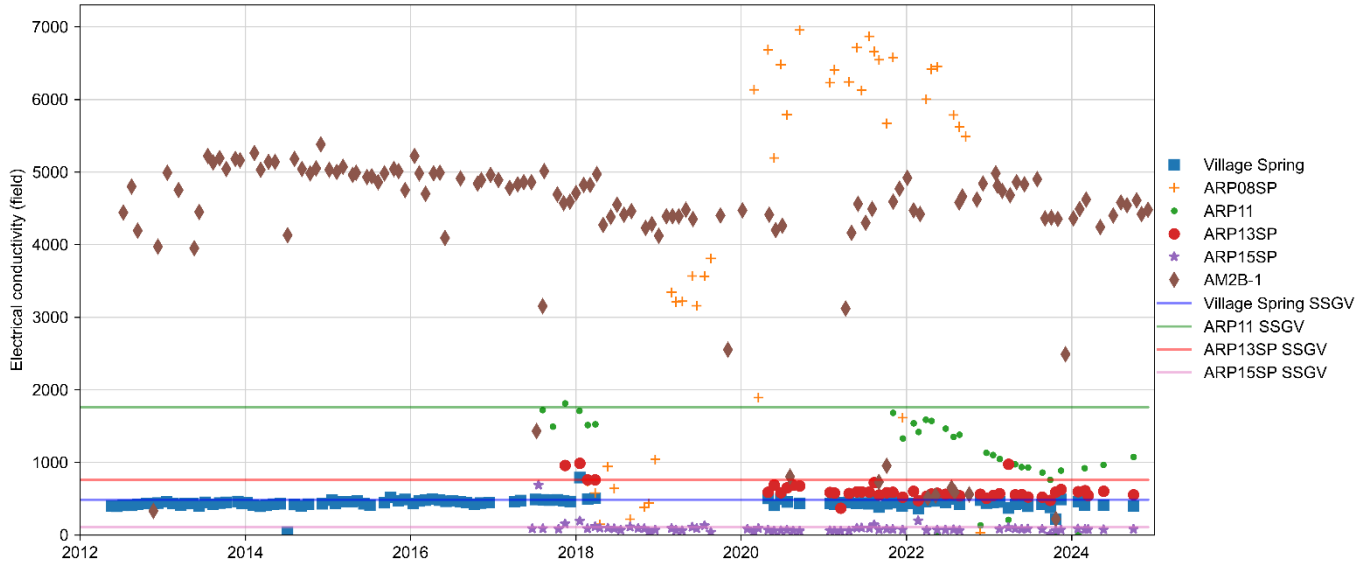


Figure B.2

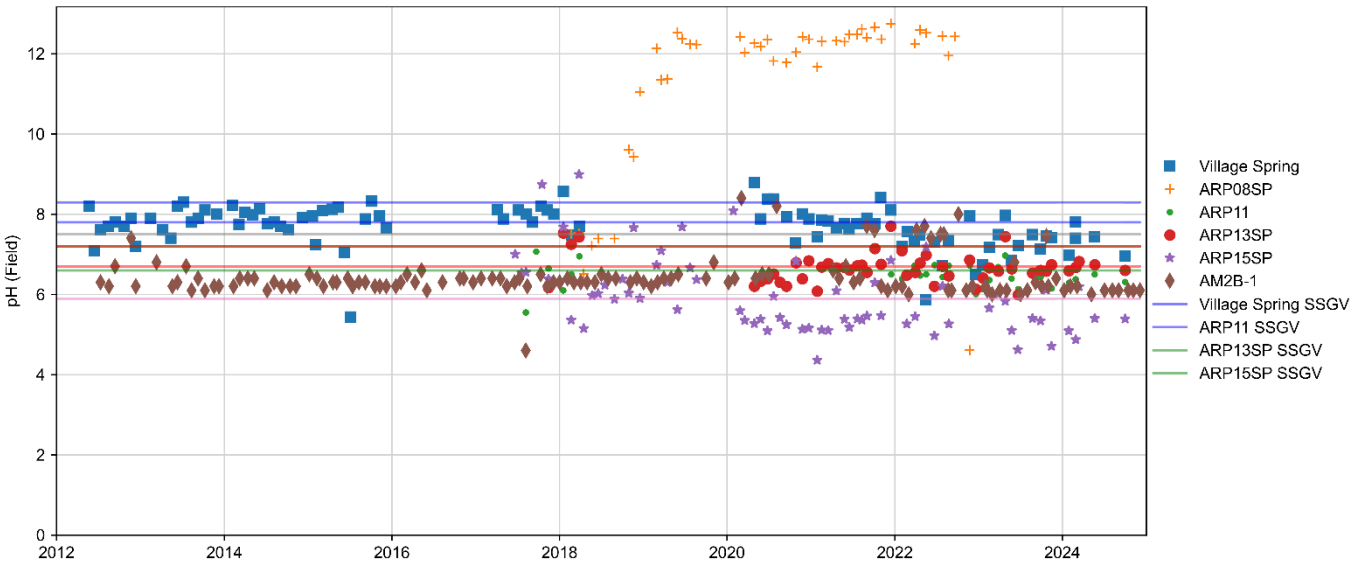


Figure B.3

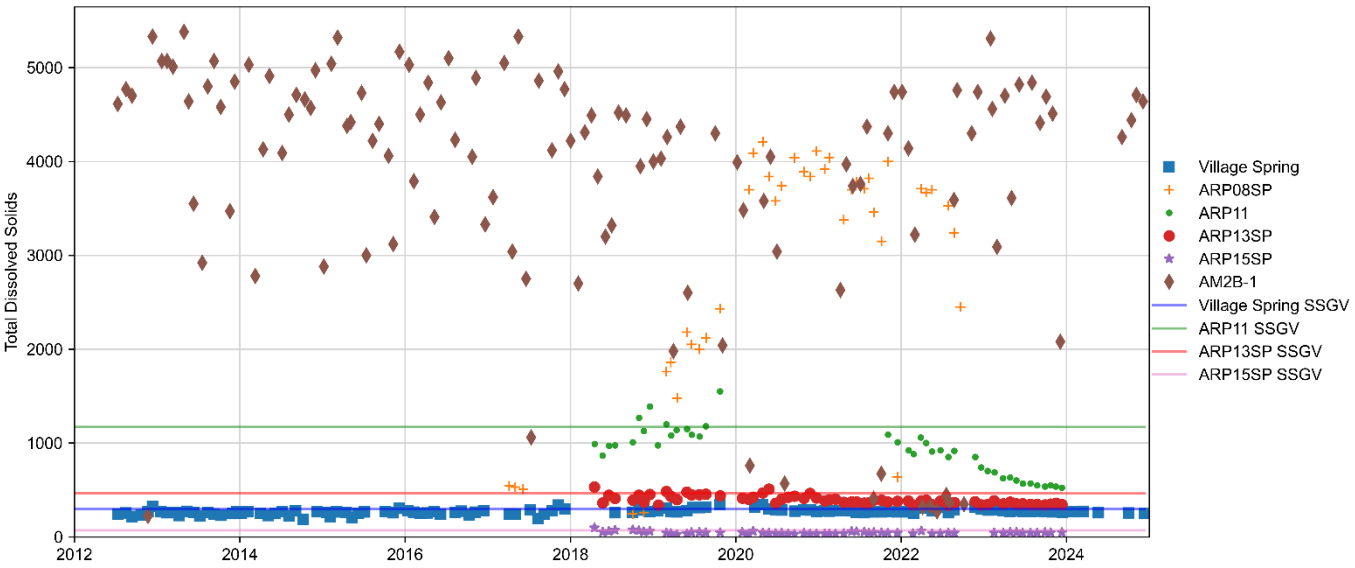


Figure B.4

Metals (dissolved)

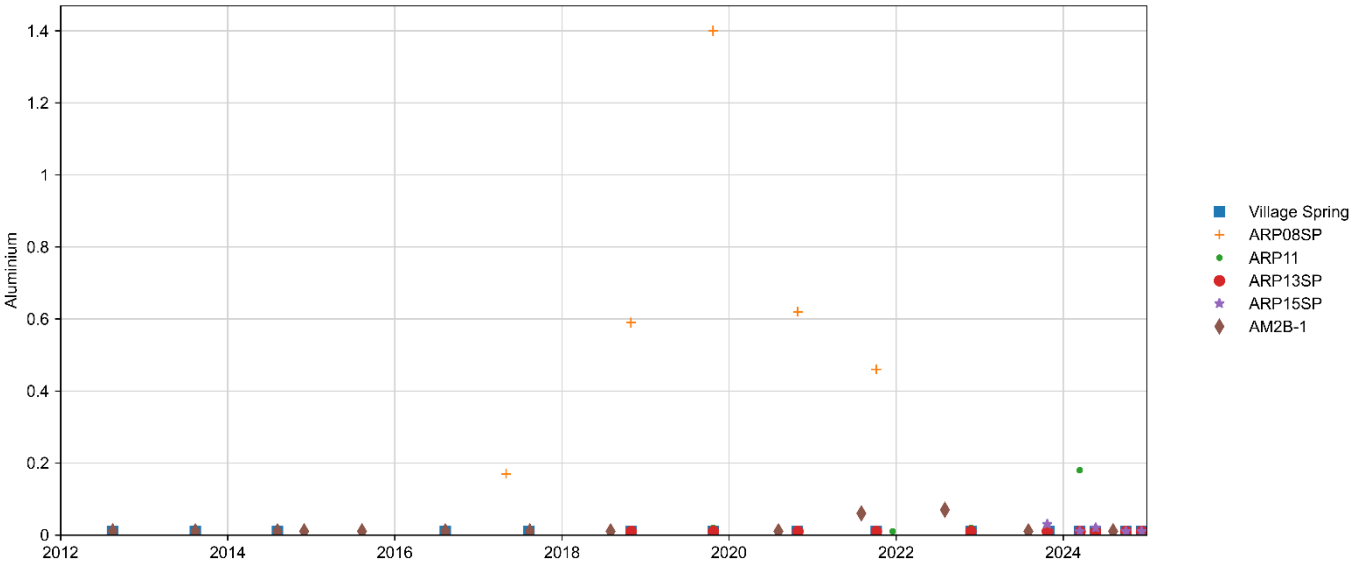


Figure B.5

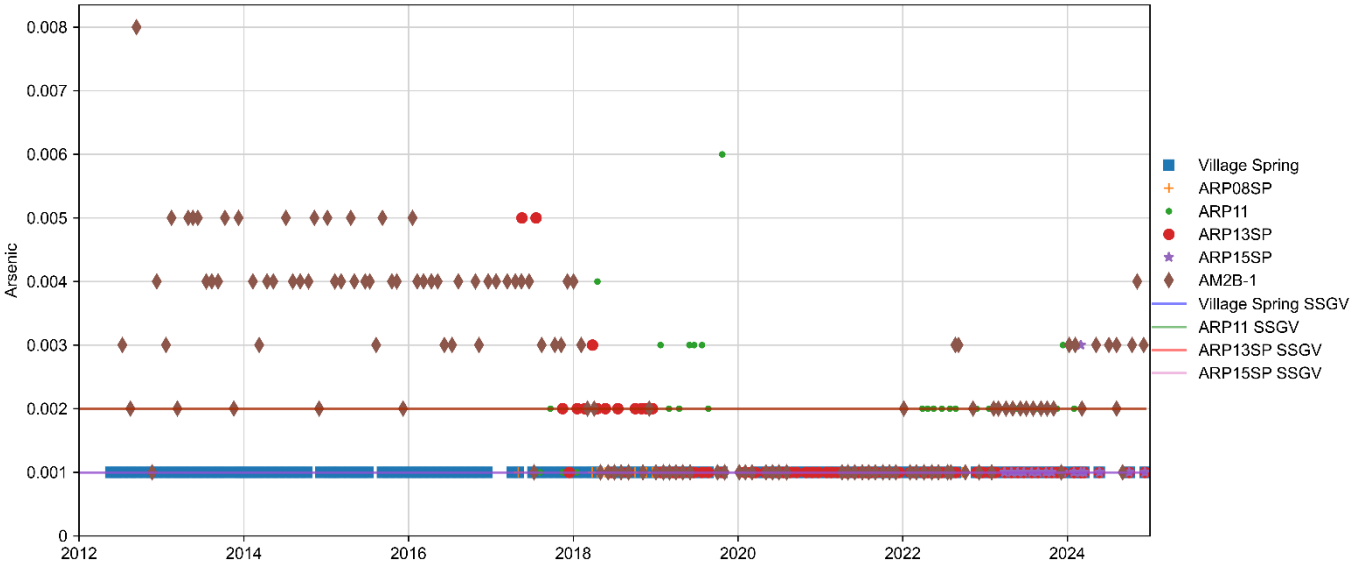


Figure B.6

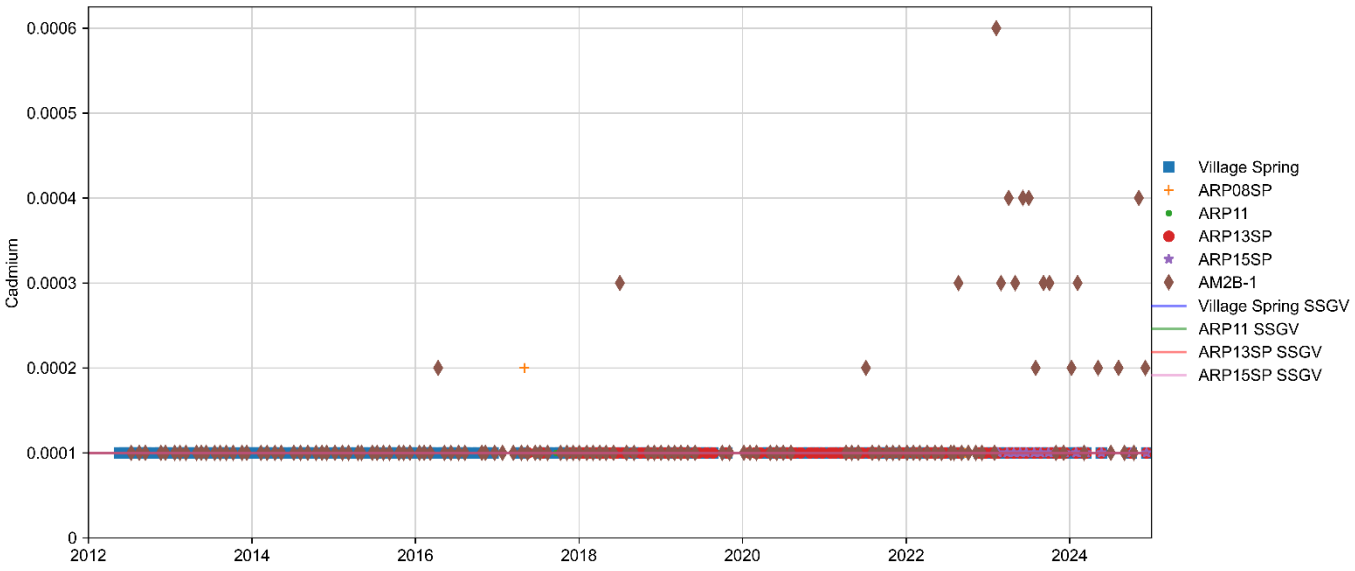


Figure B.7

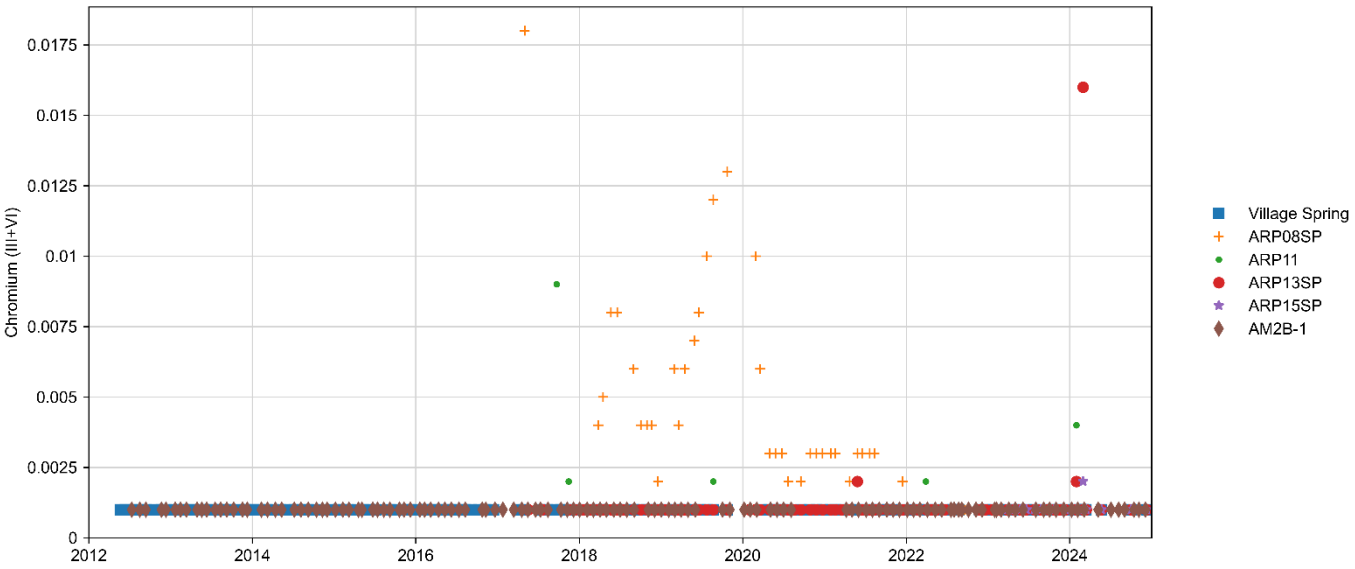


Figure B.8

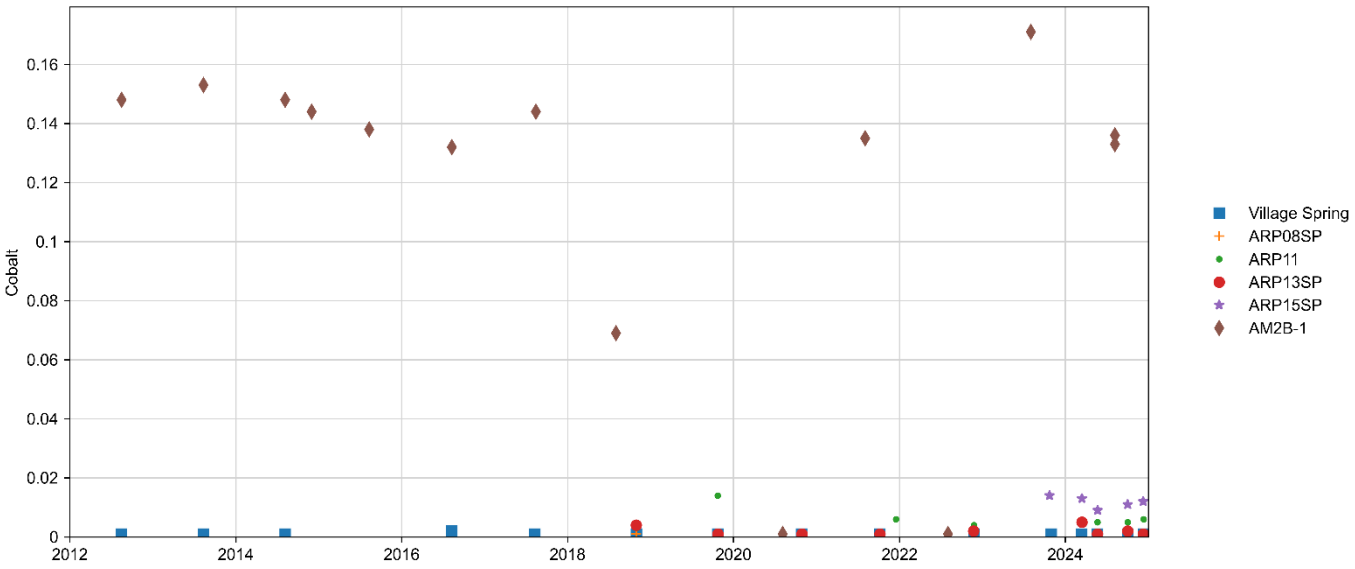


Figure B.9

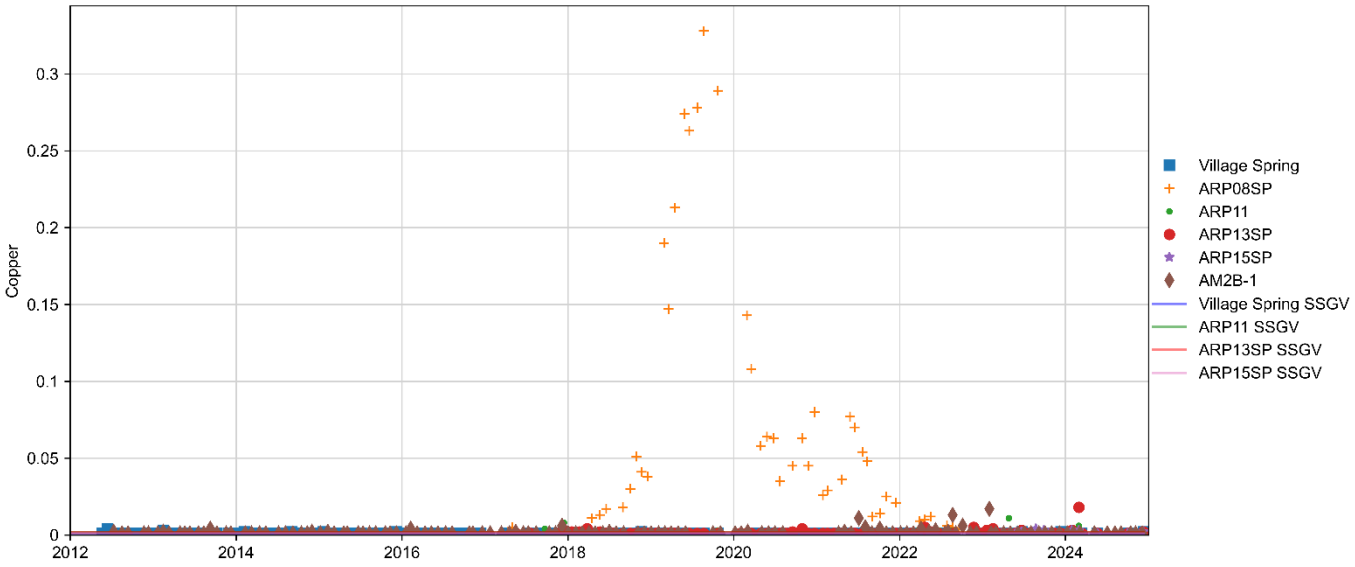


Figure B.10

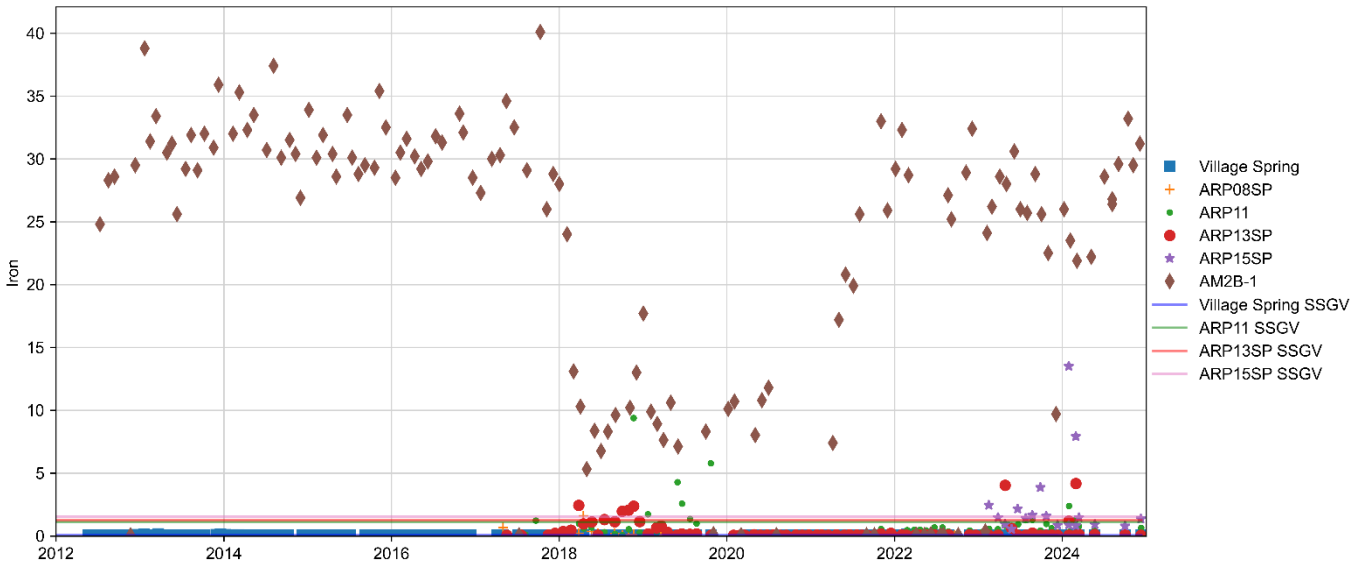


Figure B.11

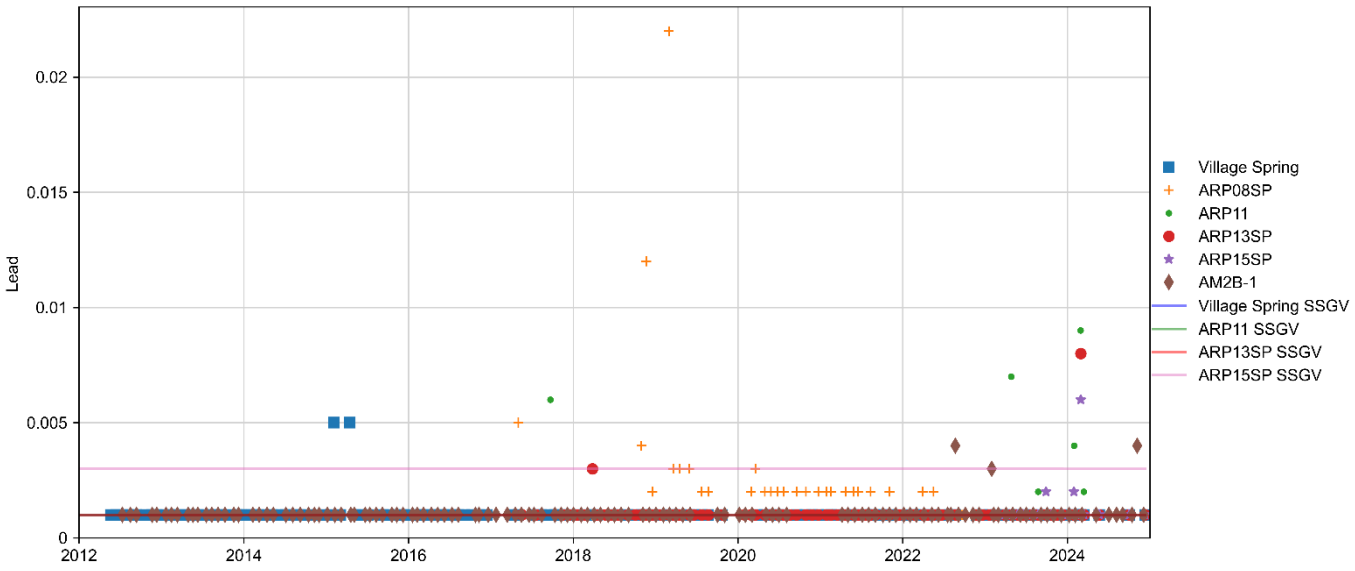


Figure B.12

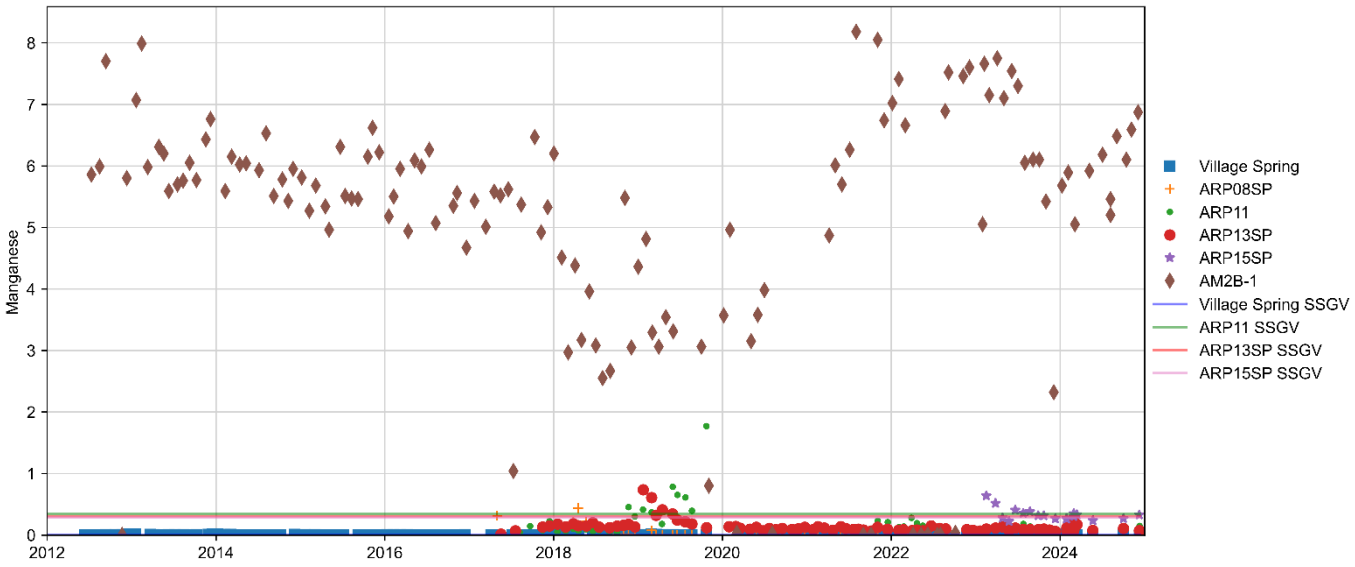


Figure B.13

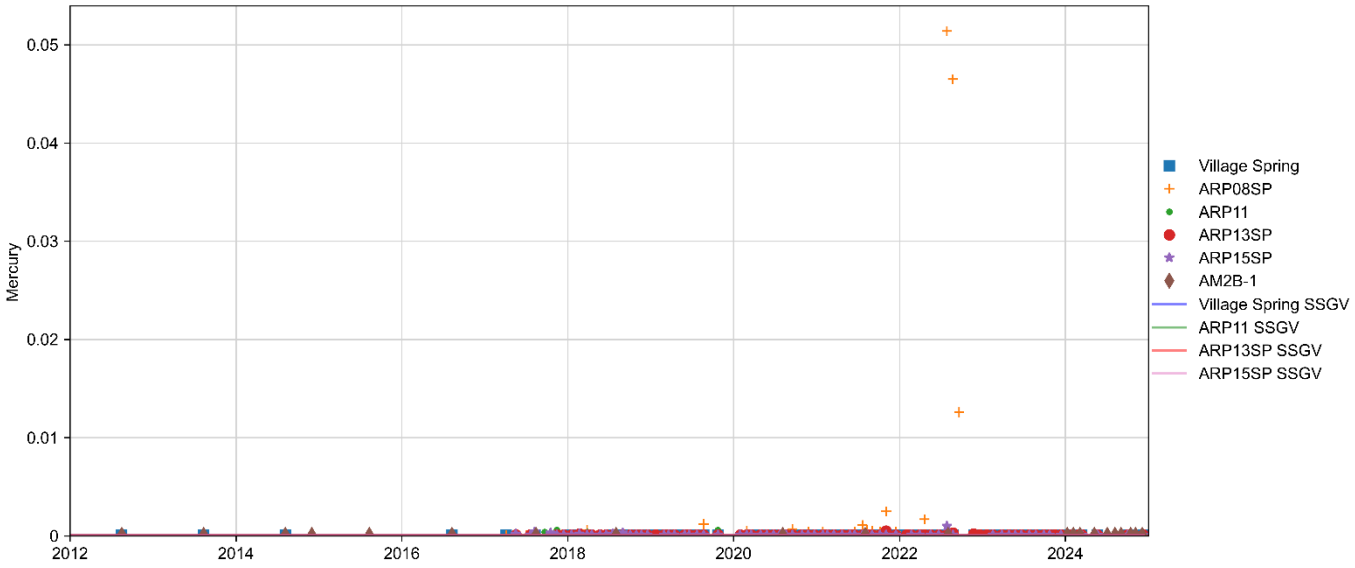


Figure B.14

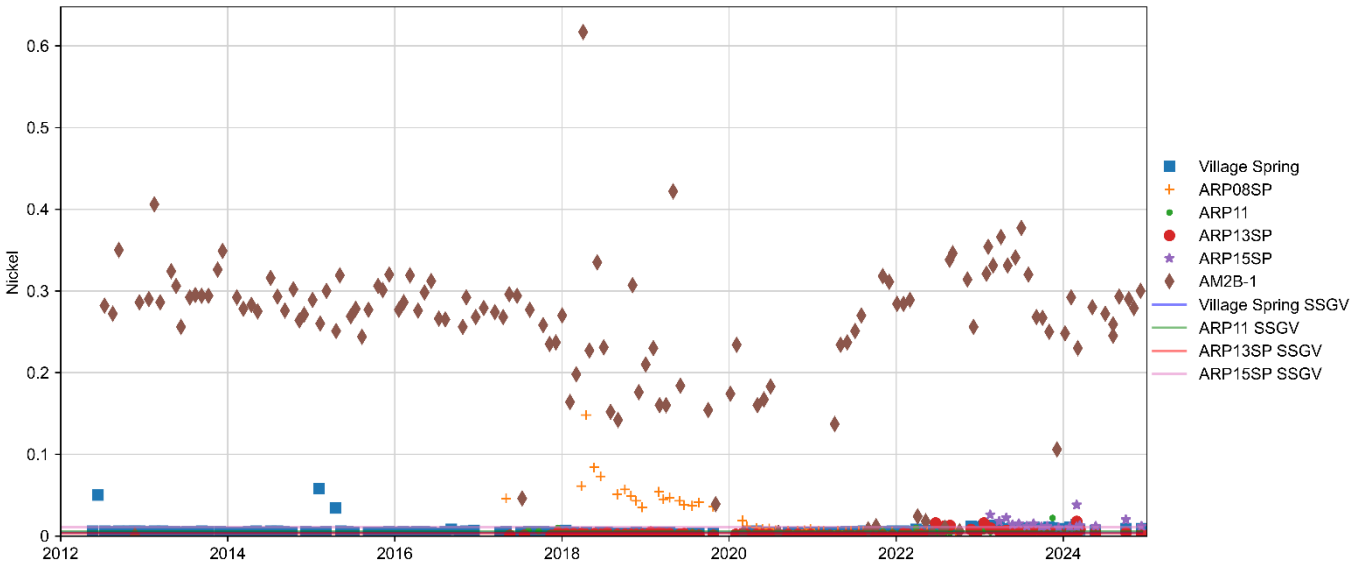


Figure B.15

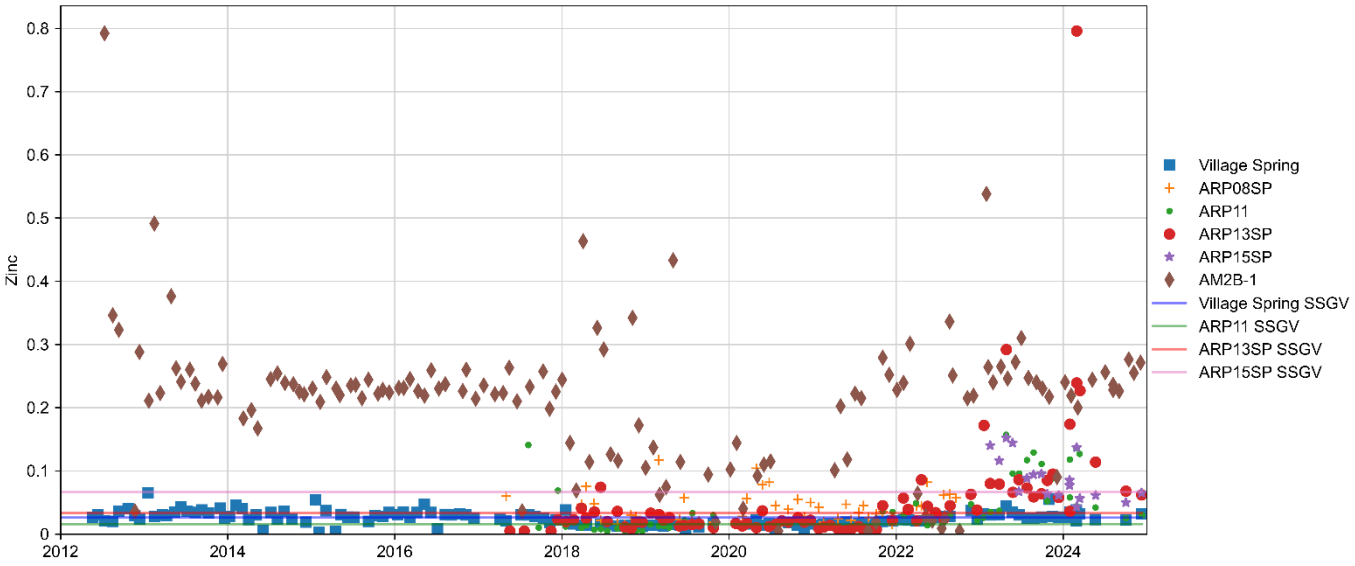


Figure B.16

Landholder bores

Physicochemical

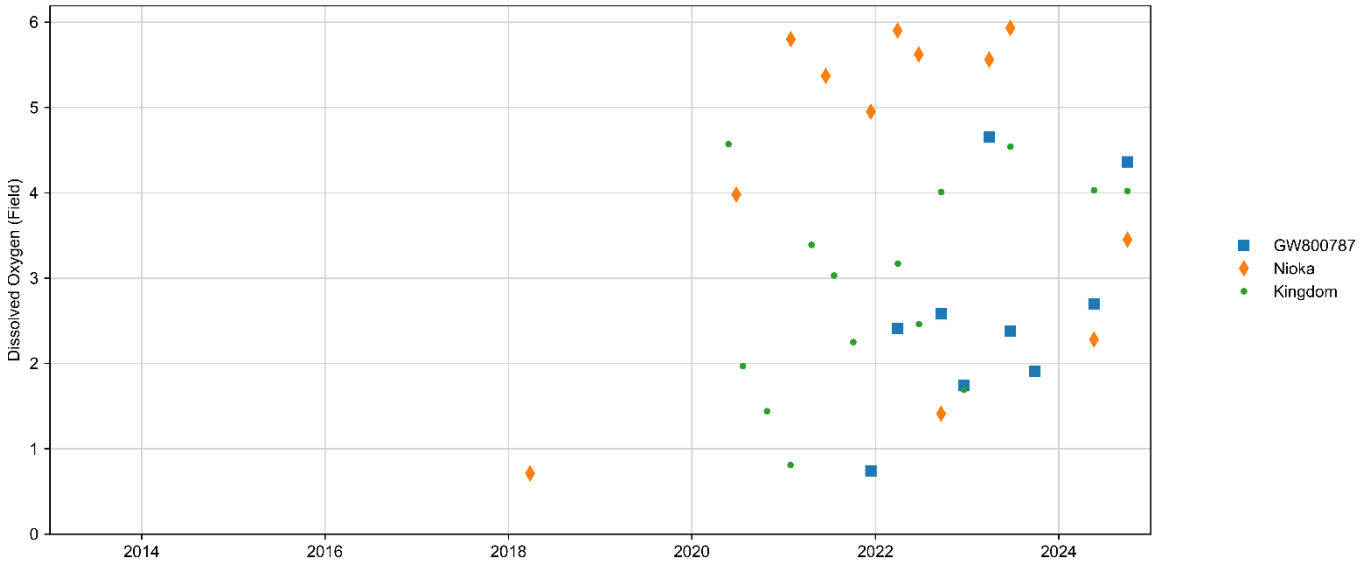


Figure B.17

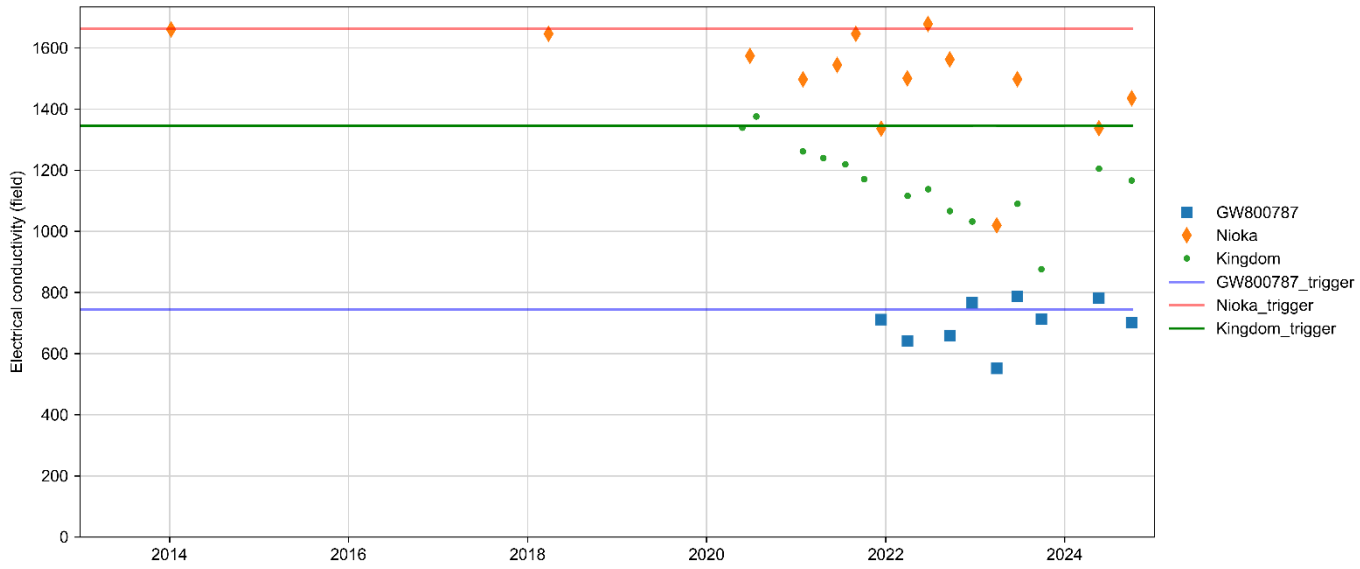


Figure B.18

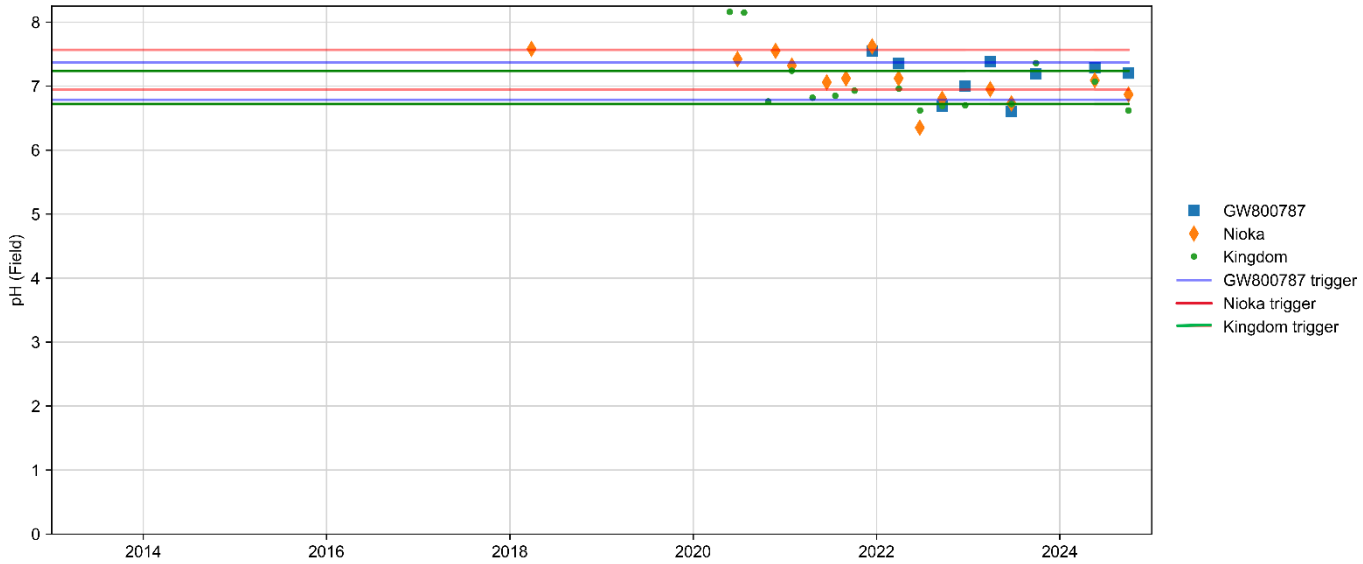


Figure B.19

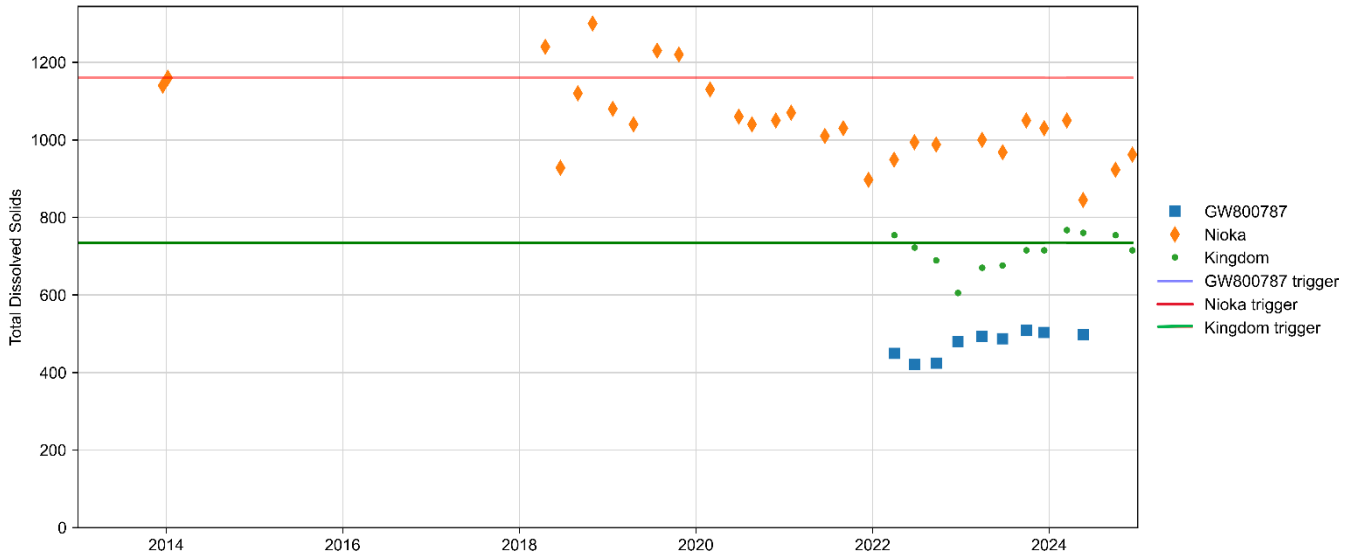


Figure B.20

Dissolved metals

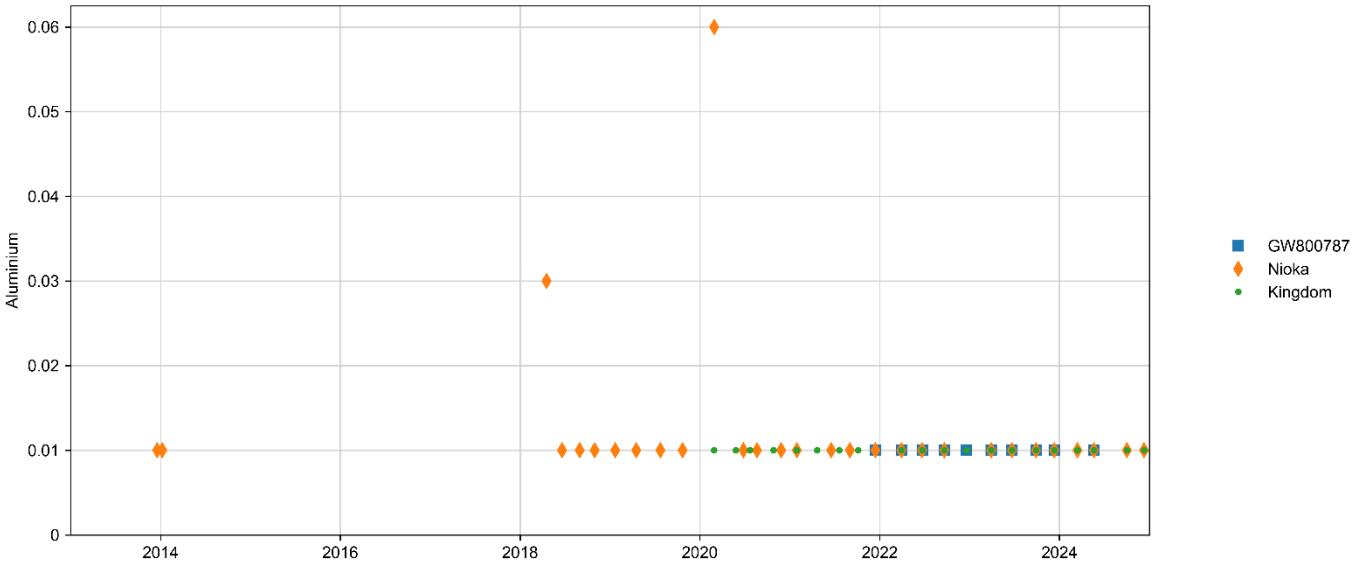


Figure B.21

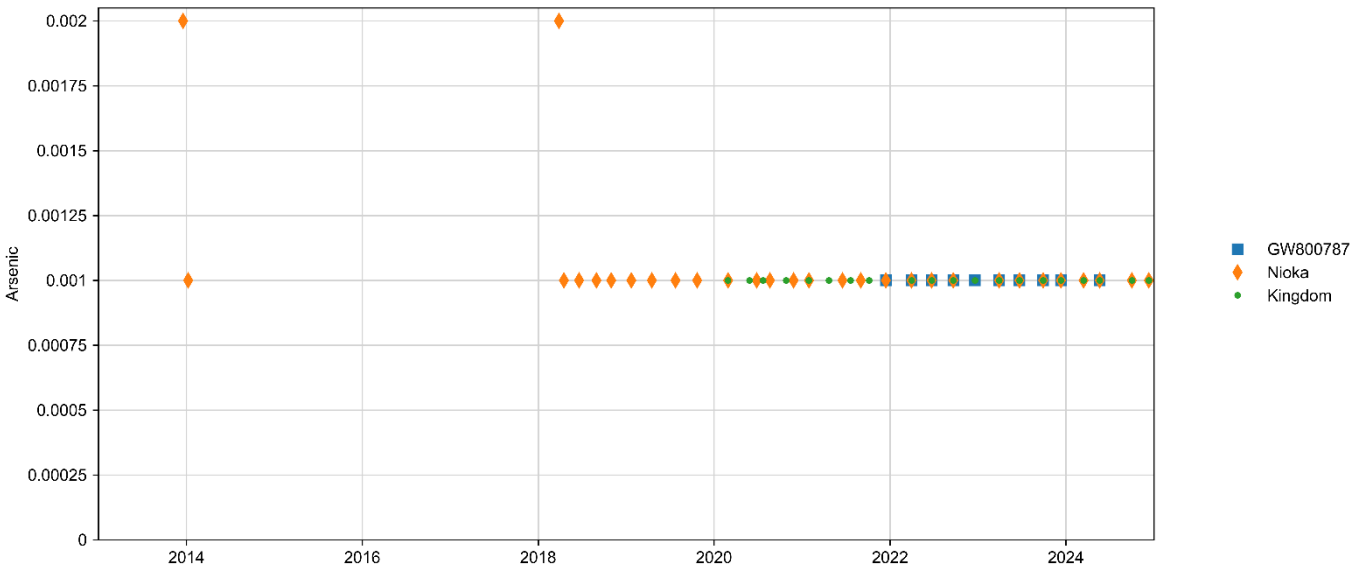


Figure B.22

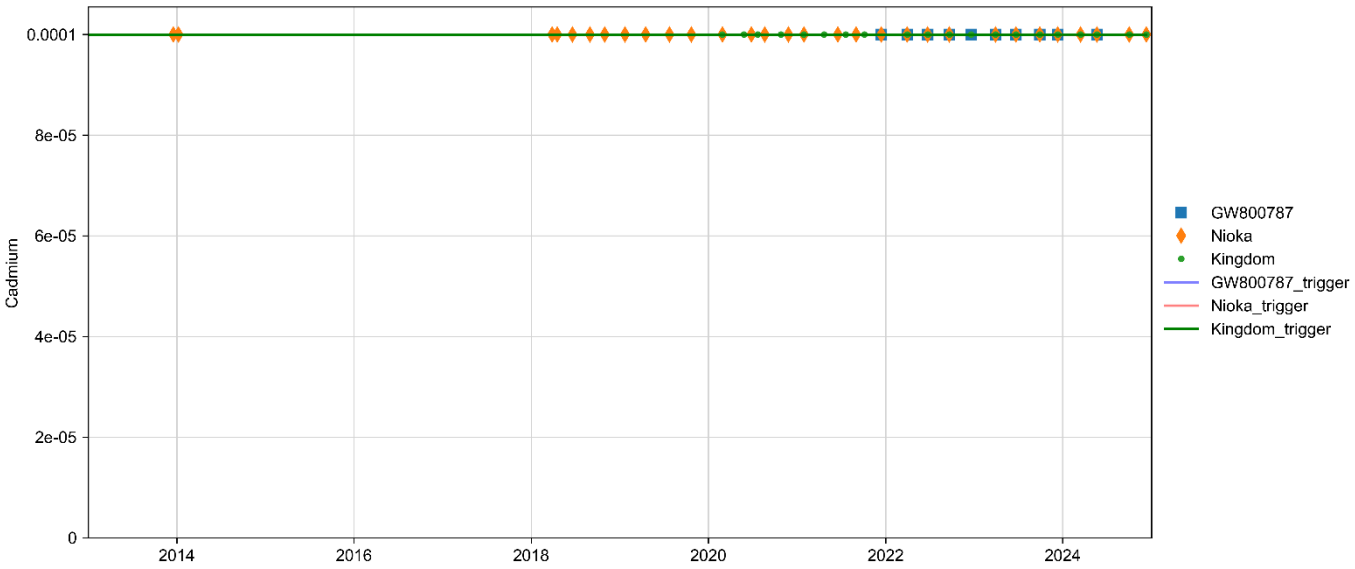


Figure B.23

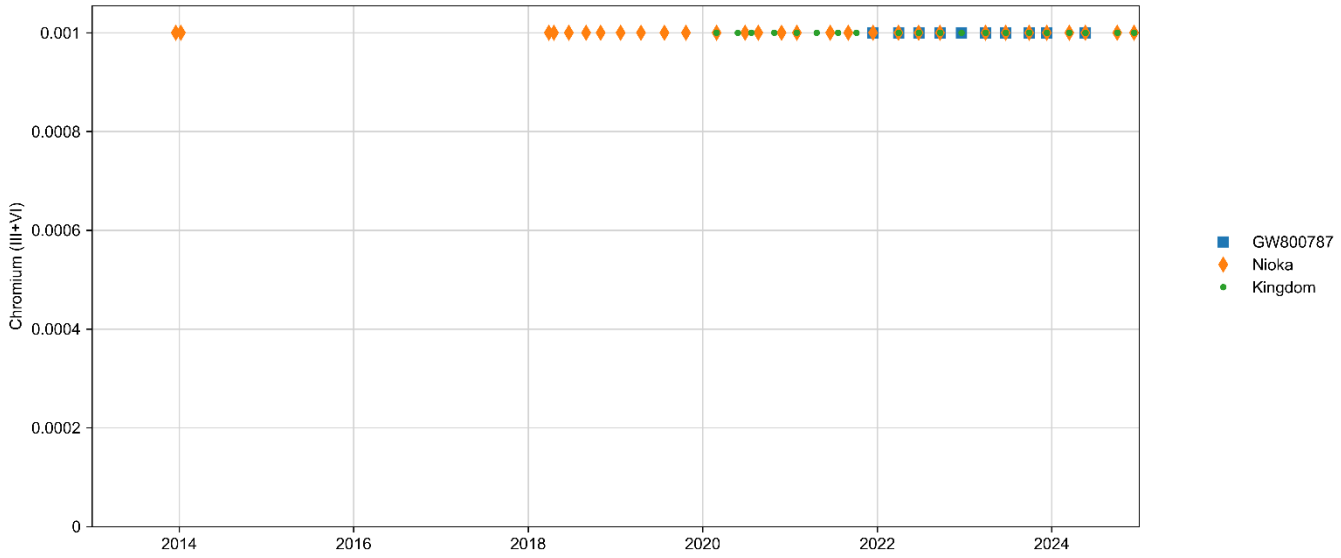


Figure B.24

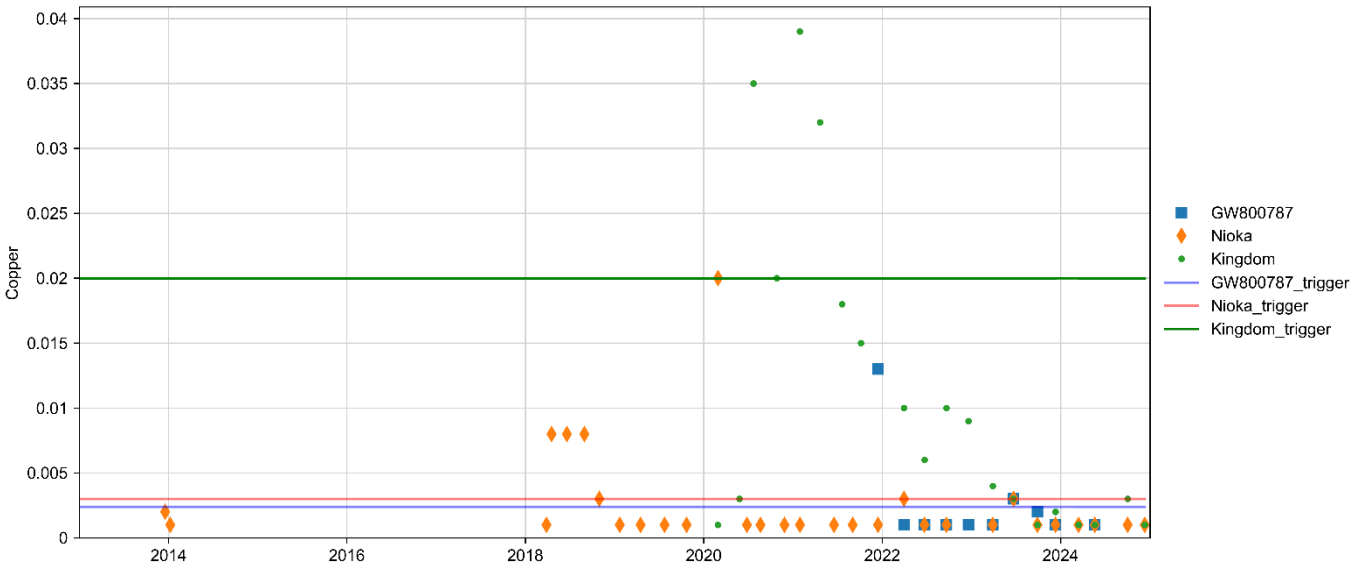


Figure B.25

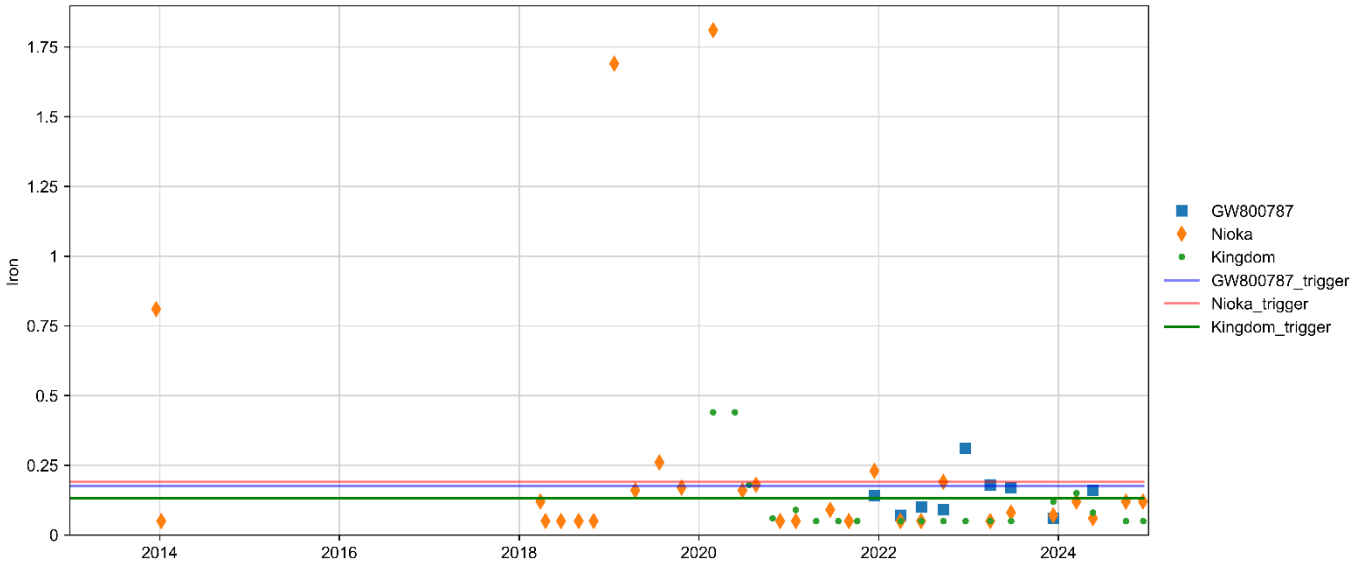


Figure B.26

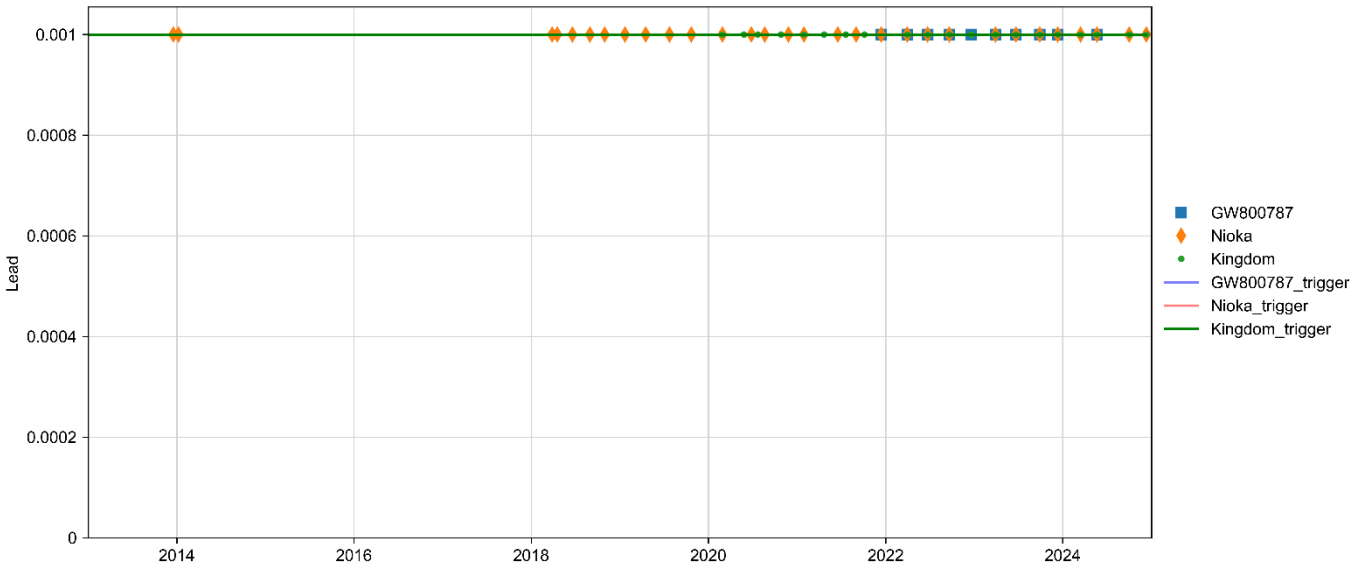


Figure B.27

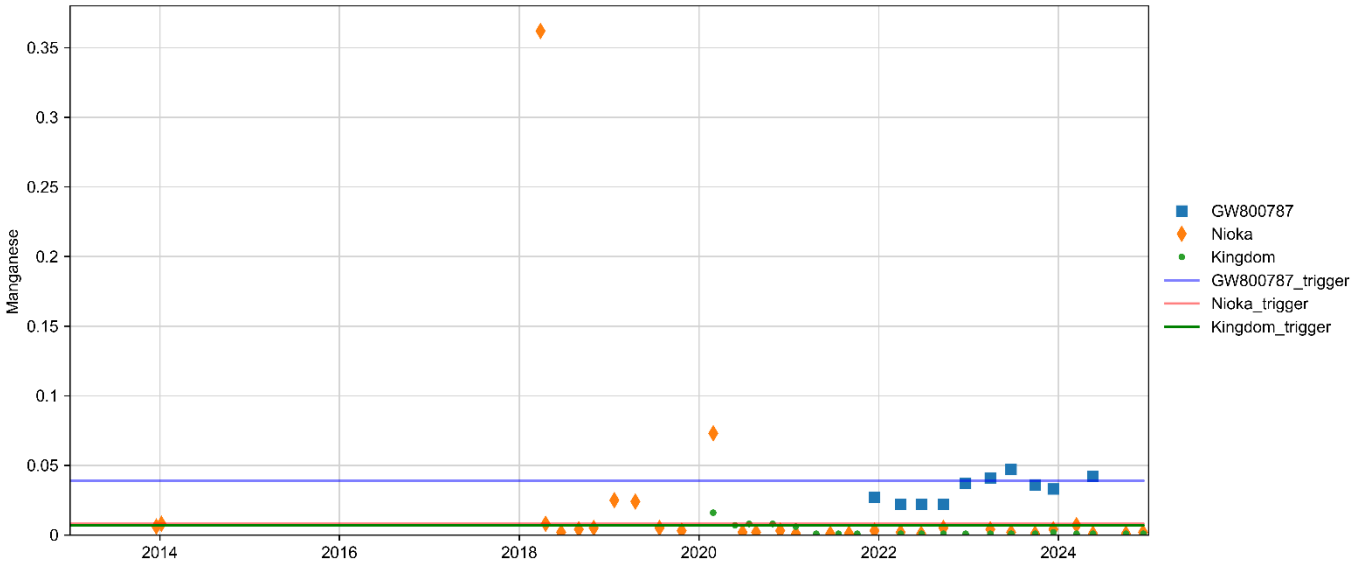


Figure B.28

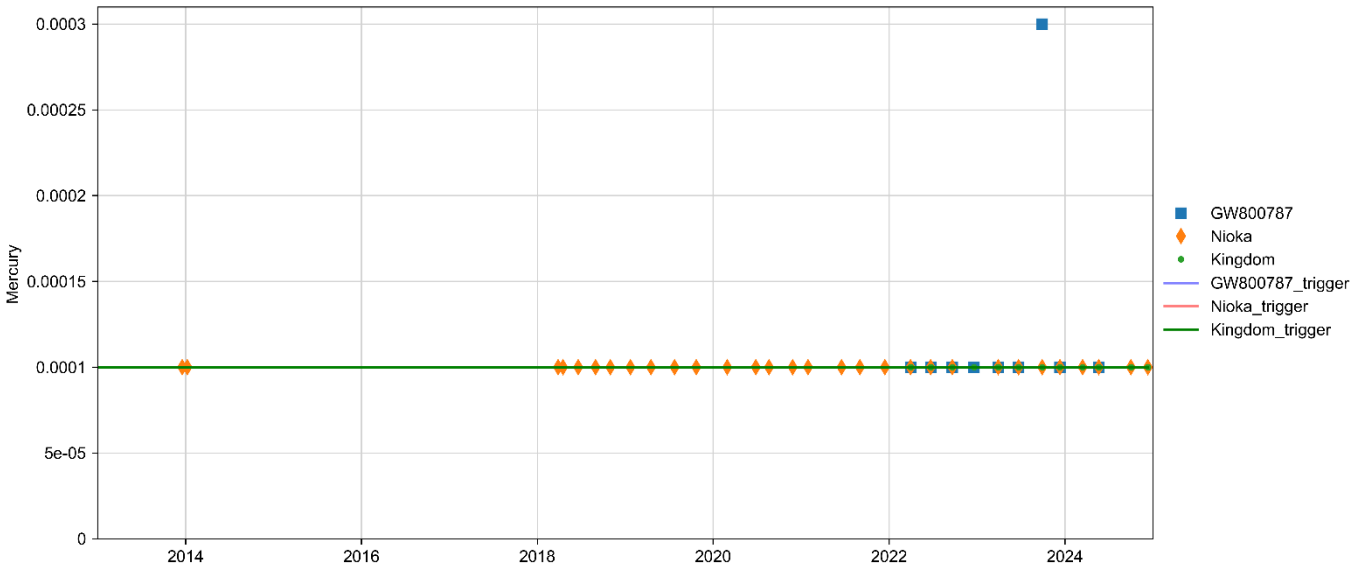


Figure B.29

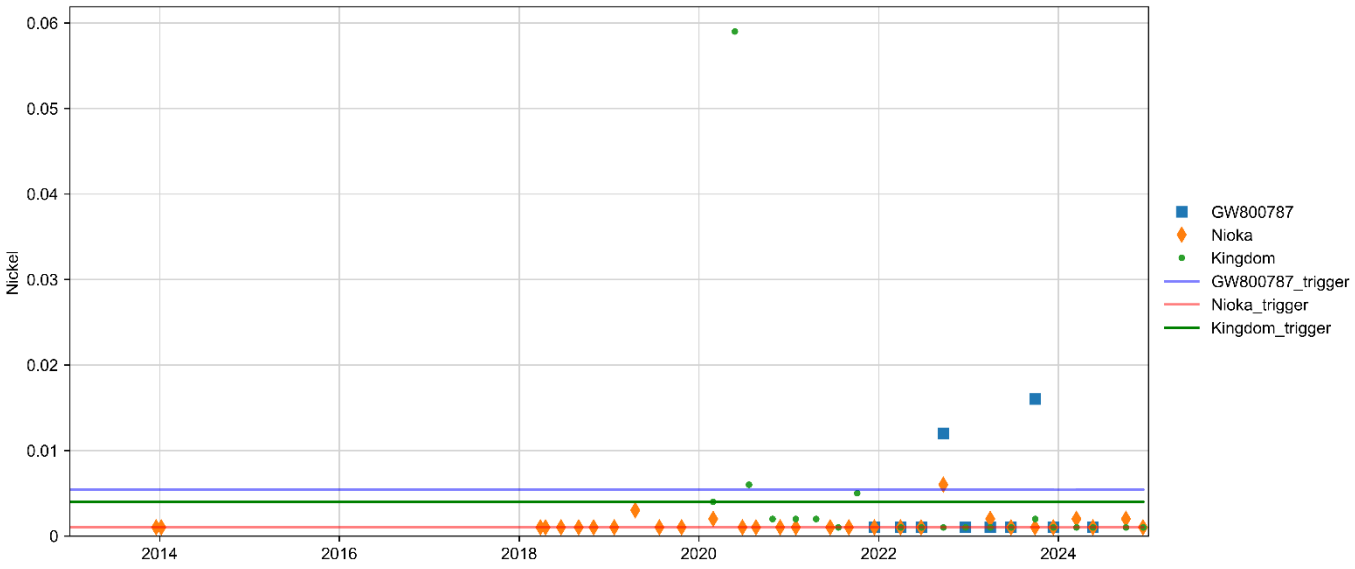


Figure B.30

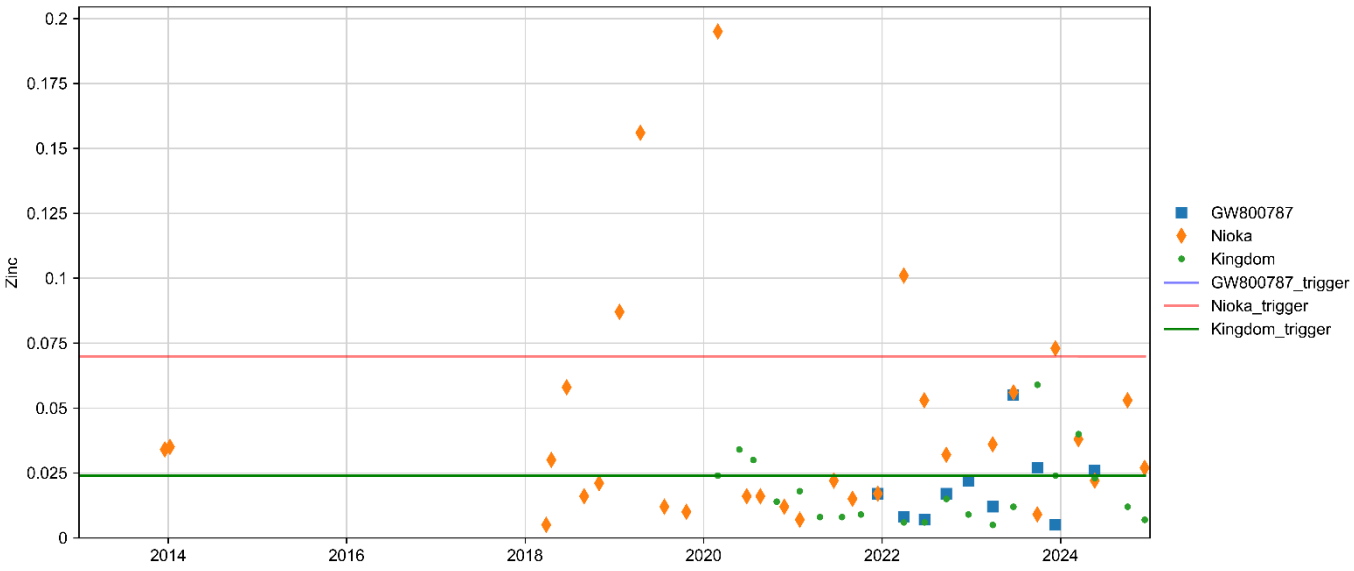


Figure B.31

Genowlan Creek Catchment - Surface water

Physicochemical

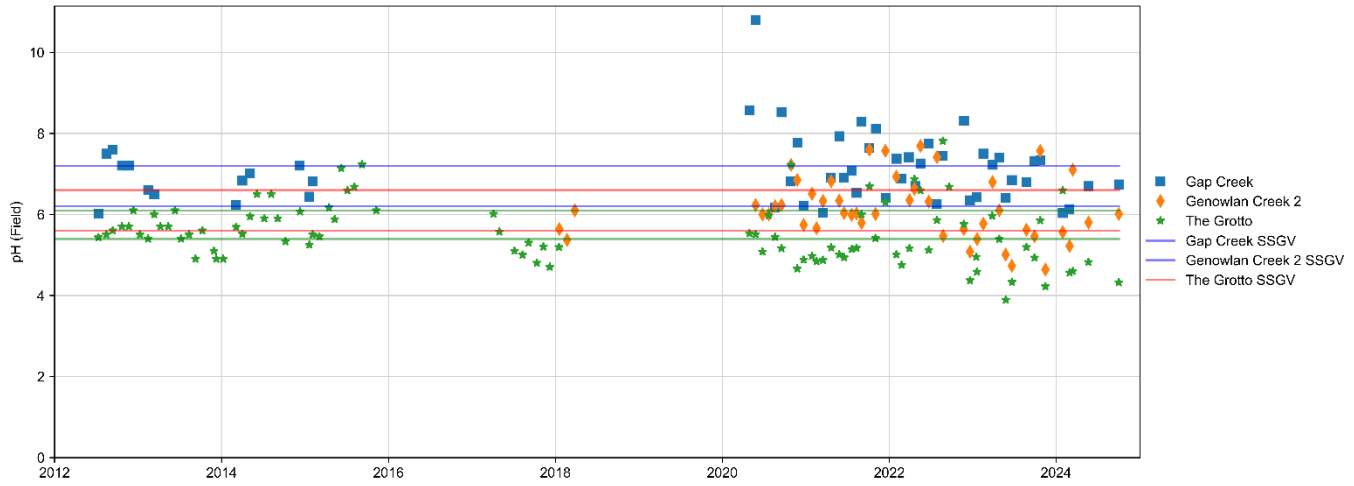


Figure B.32

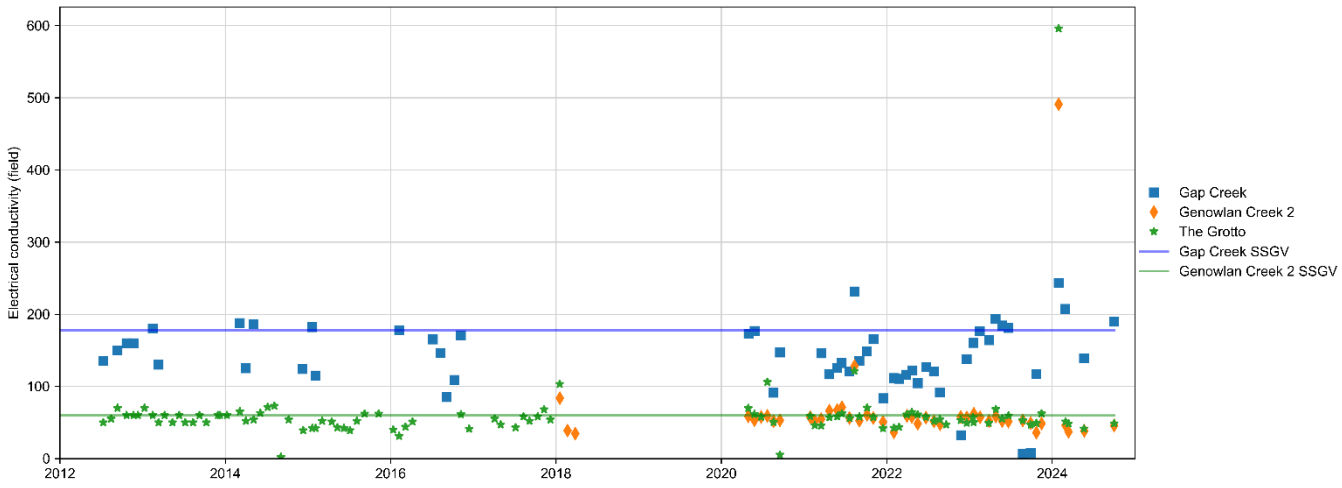


Figure B.33

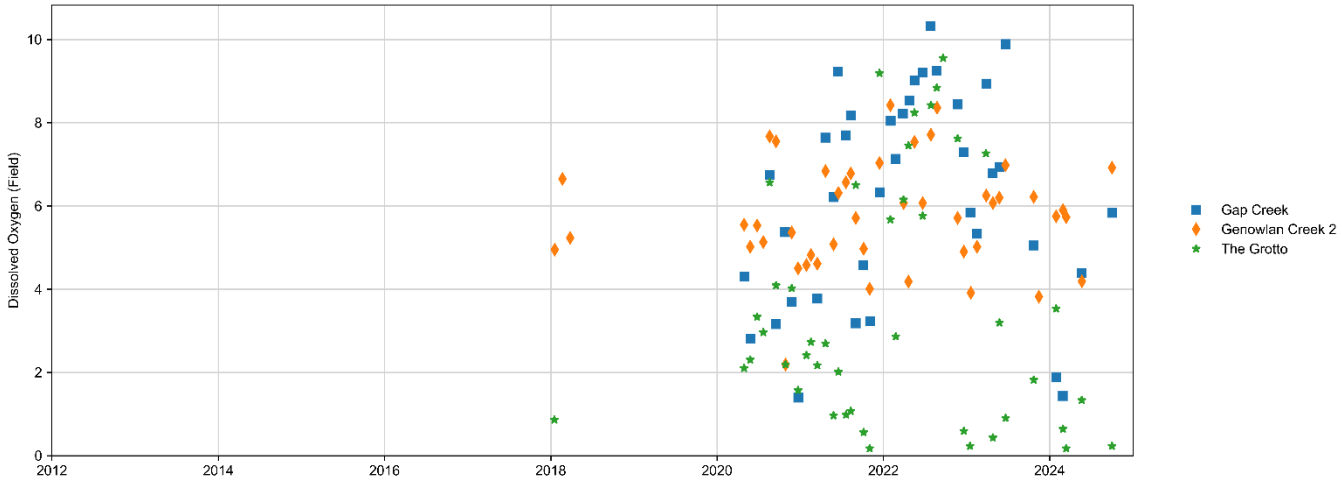


Figure B.34

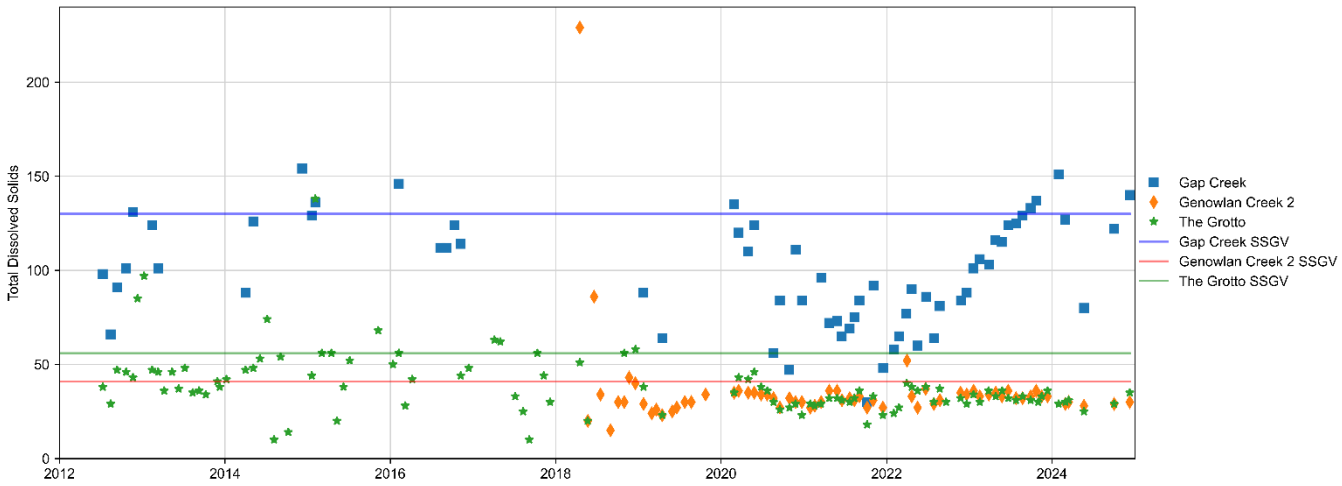


Figure B.35

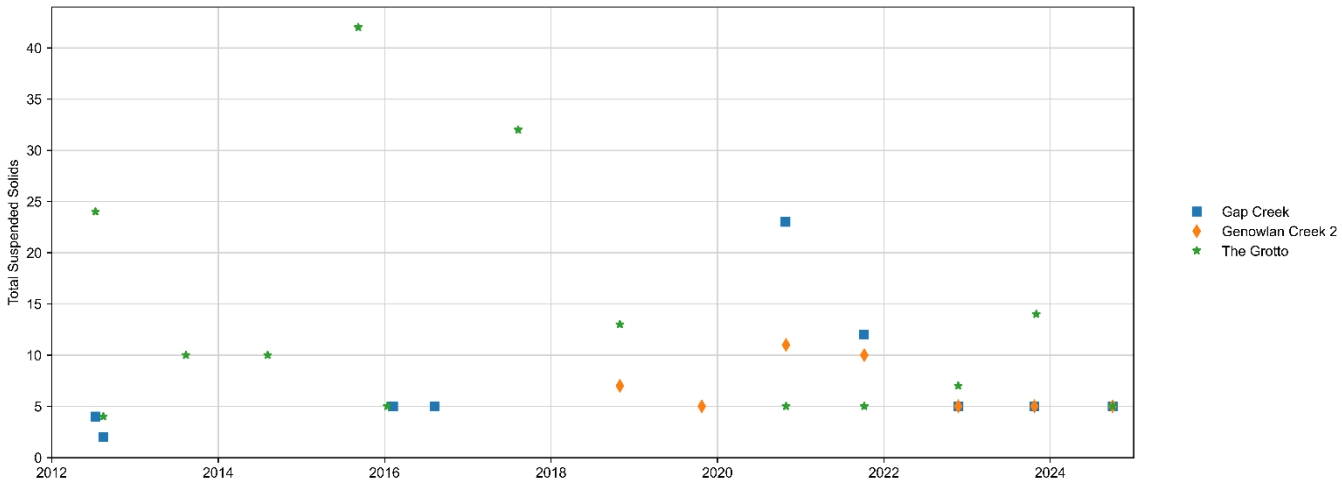


Figure B.36

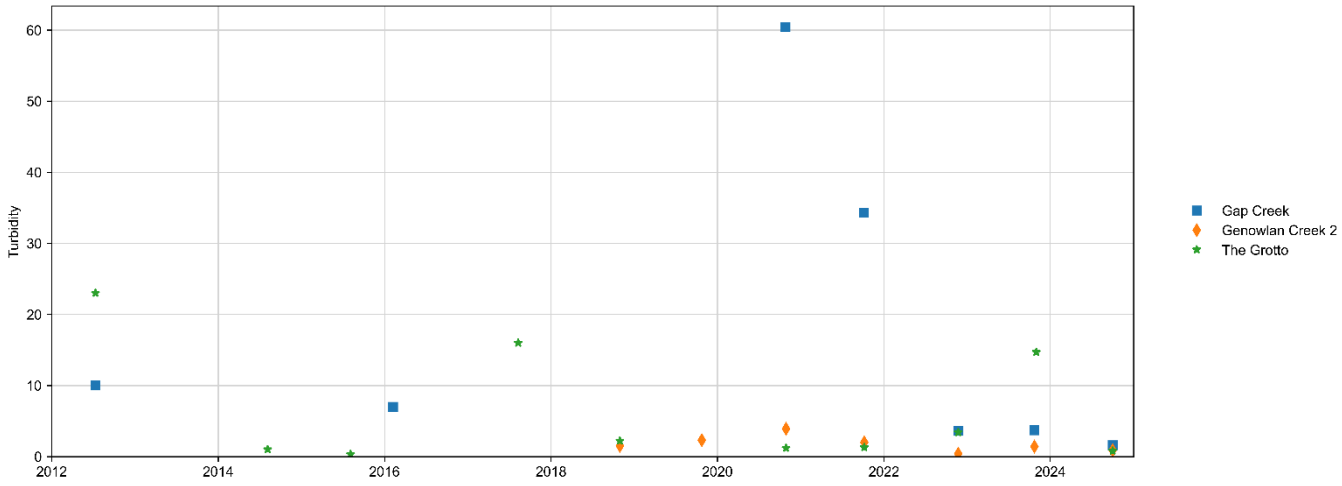


Figure B.37

Dissolved metals

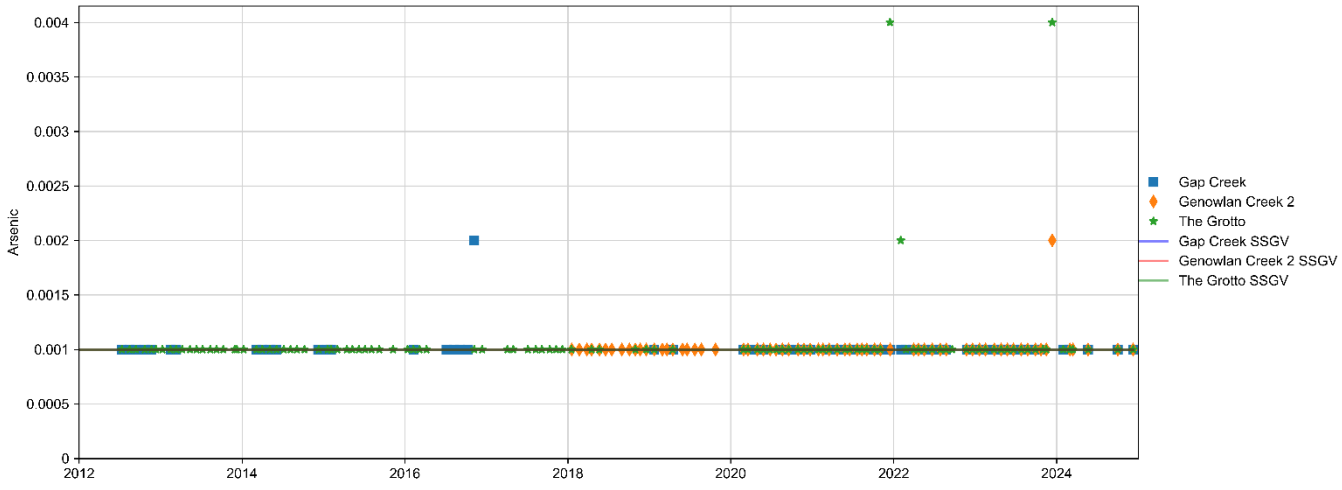


Figure B.38

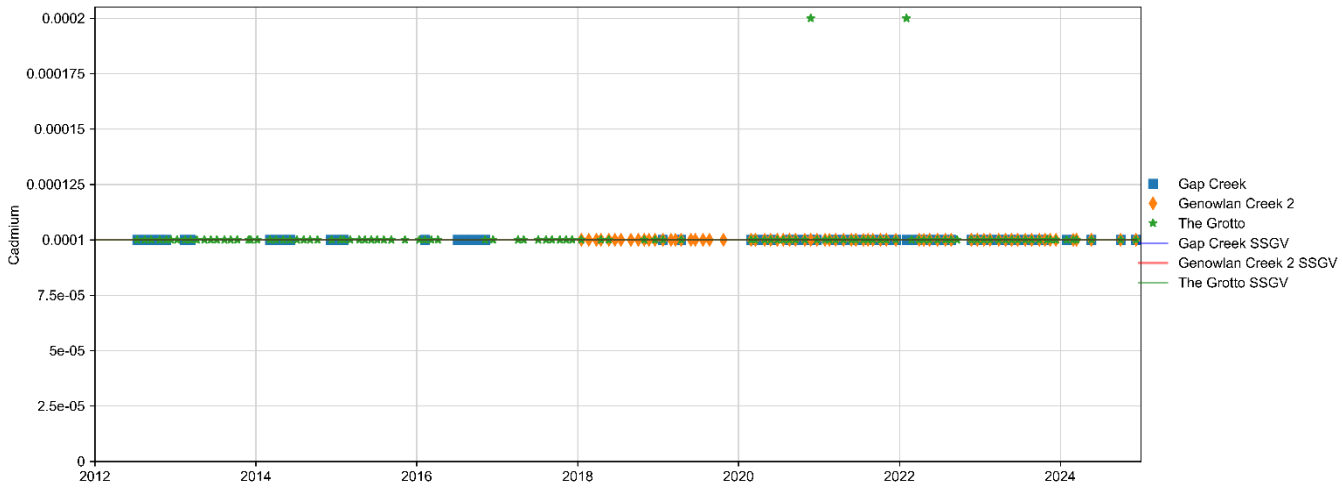


Figure B.39

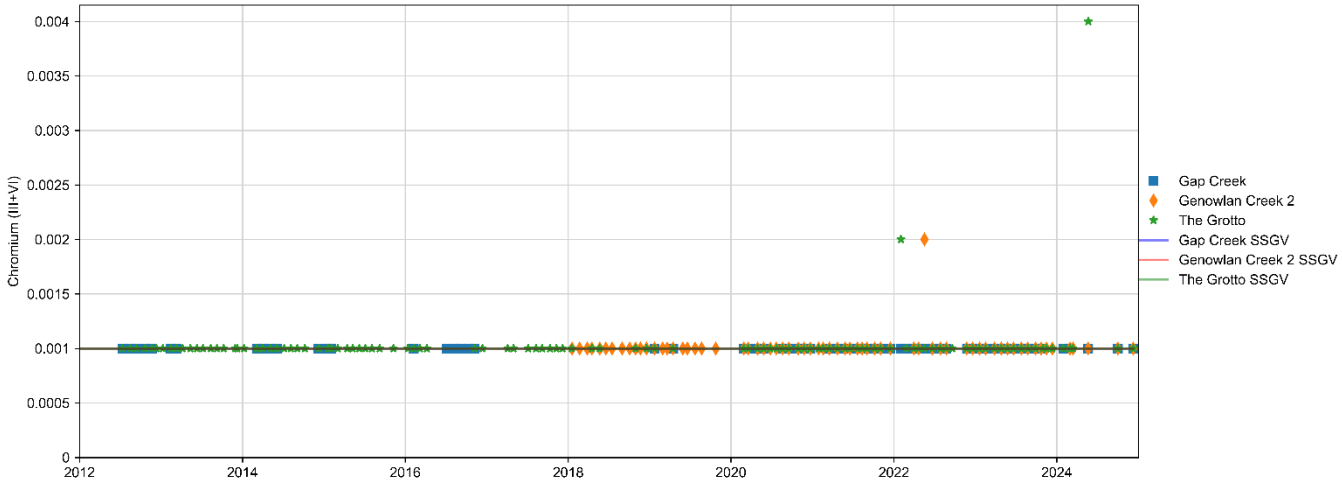


Figure B.40

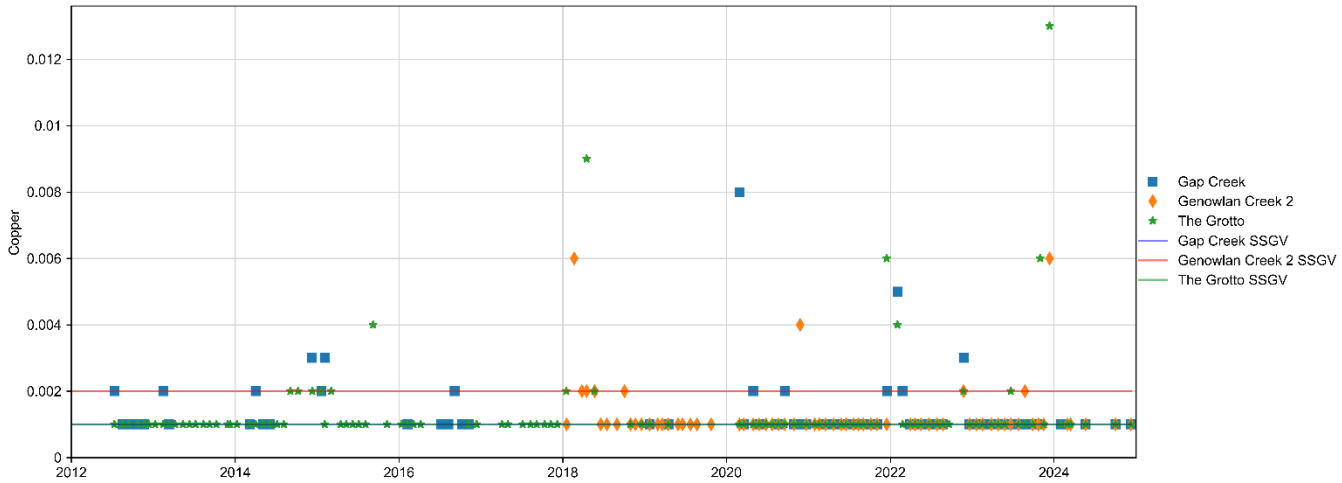


Figure B.41

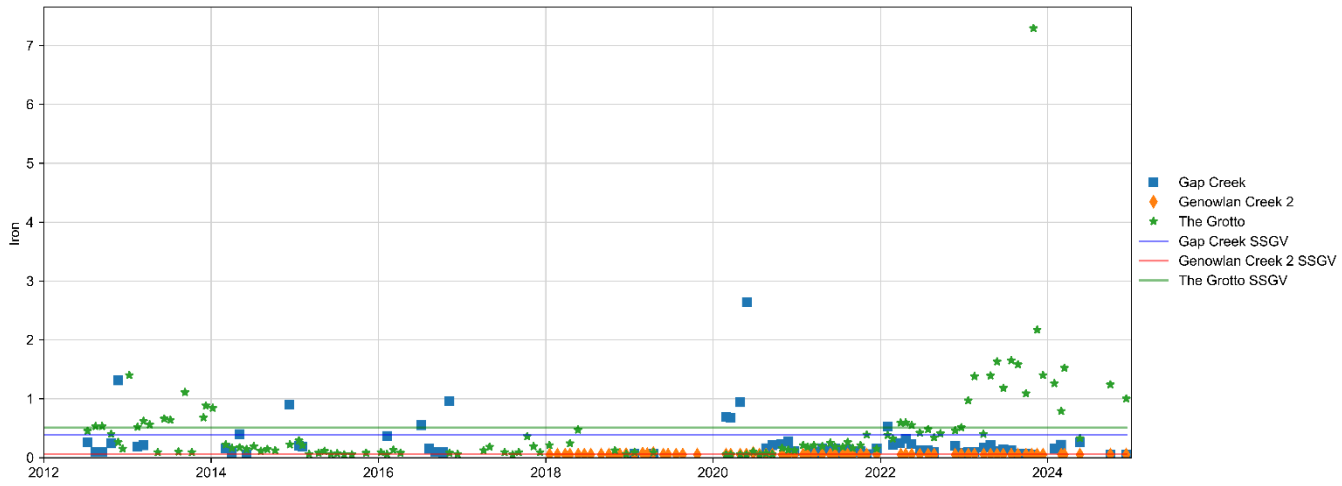


Figure B.42

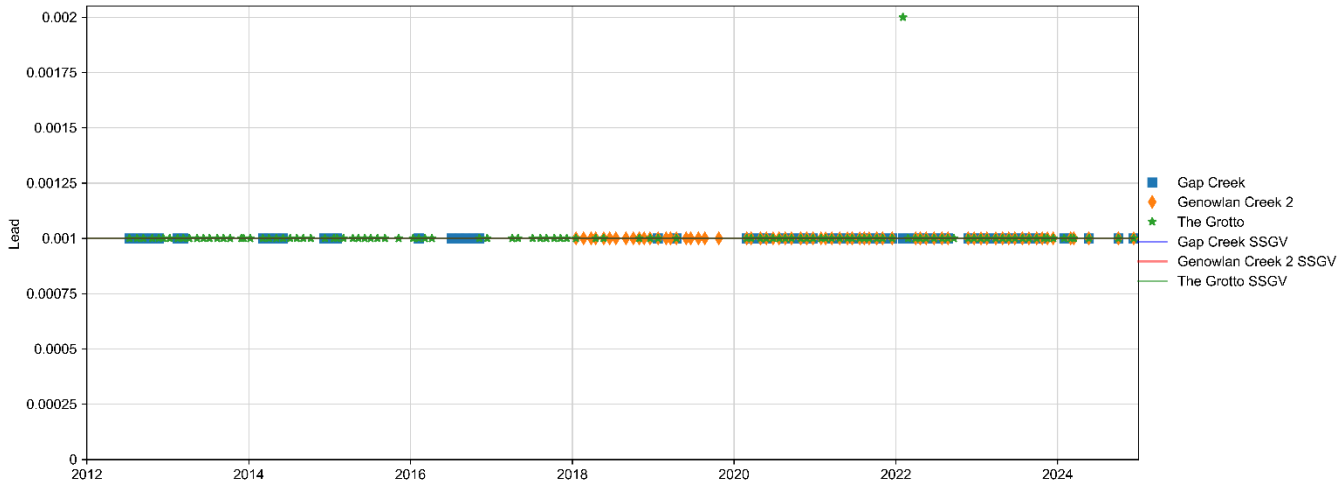


Figure B.43

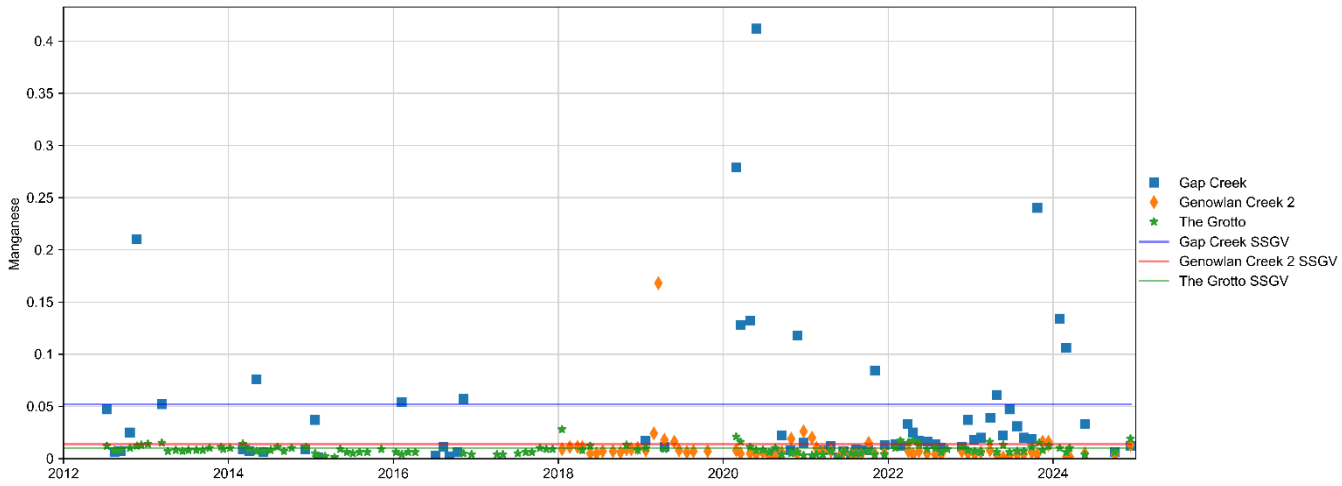


Figure B.44

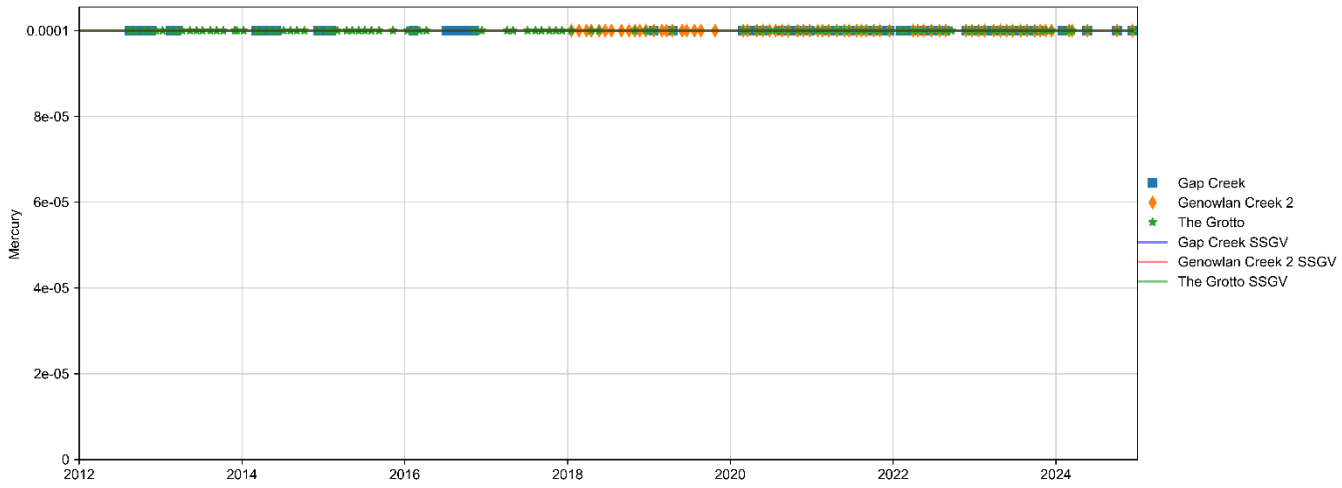


Figure B.45

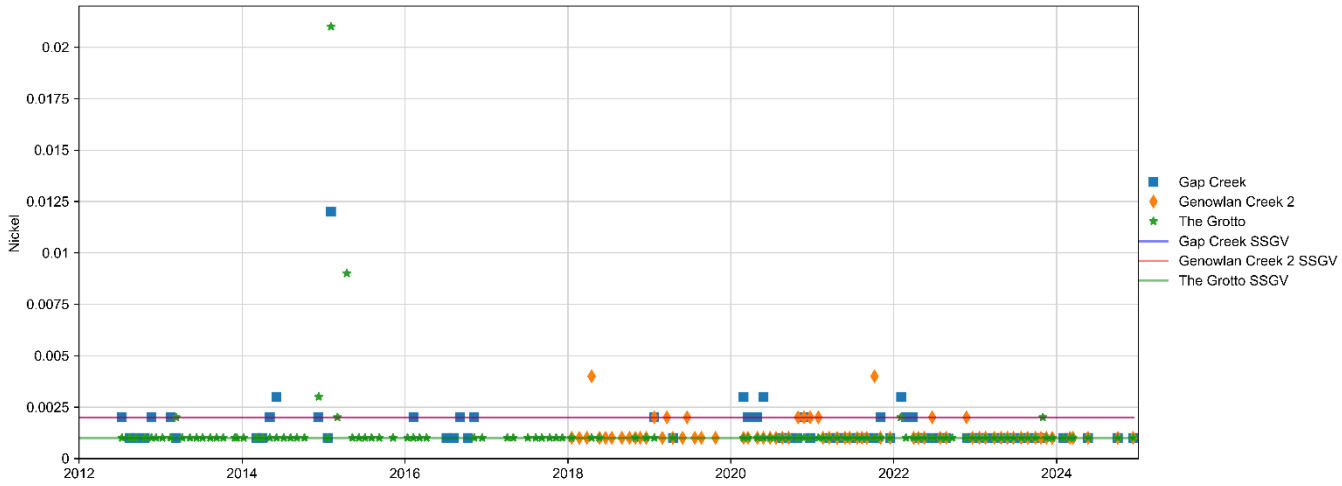


Figure B.46

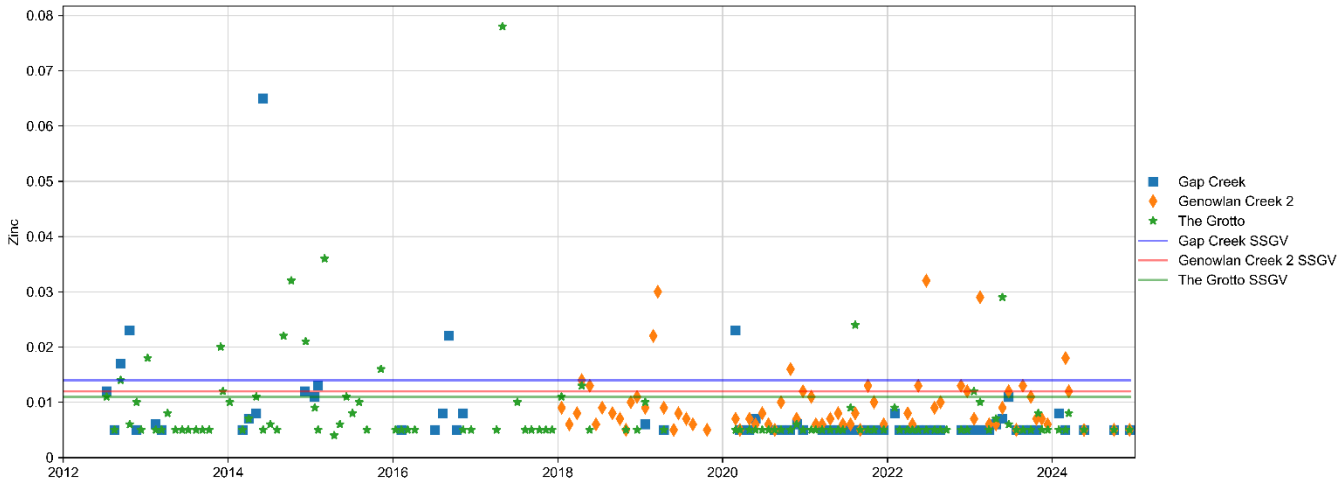


Figure B.47

Total metals

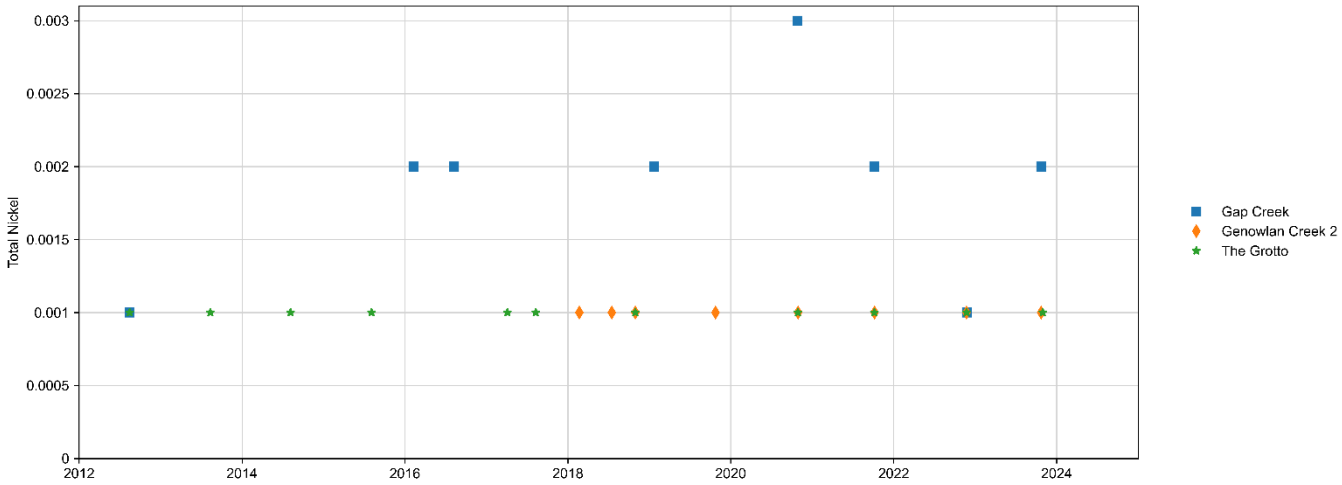


Figure B.48

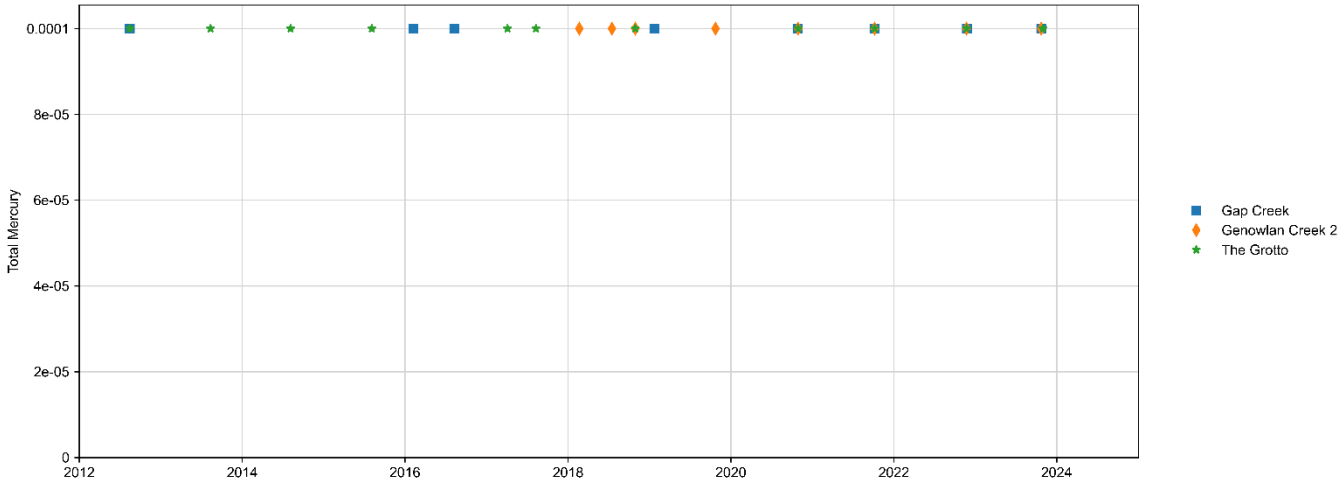


Figure B.49

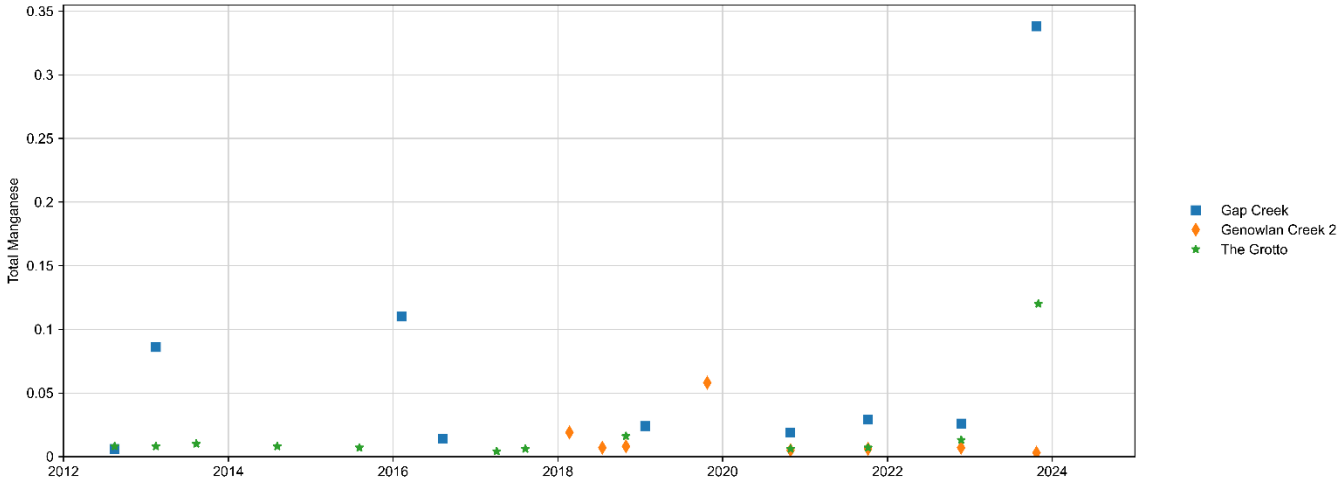


Figure B.50

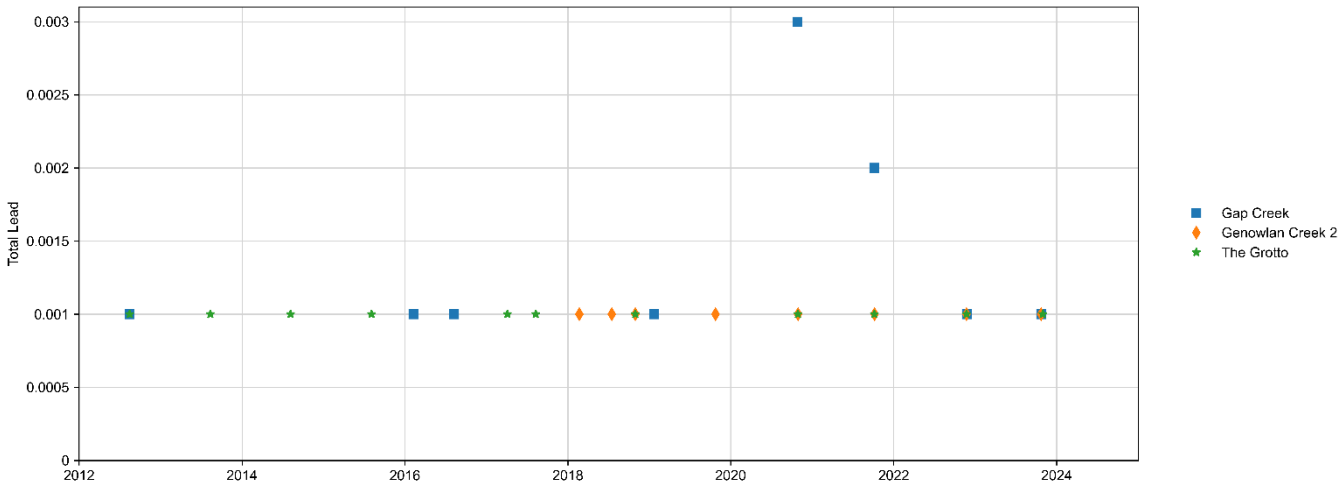


Figure B.51

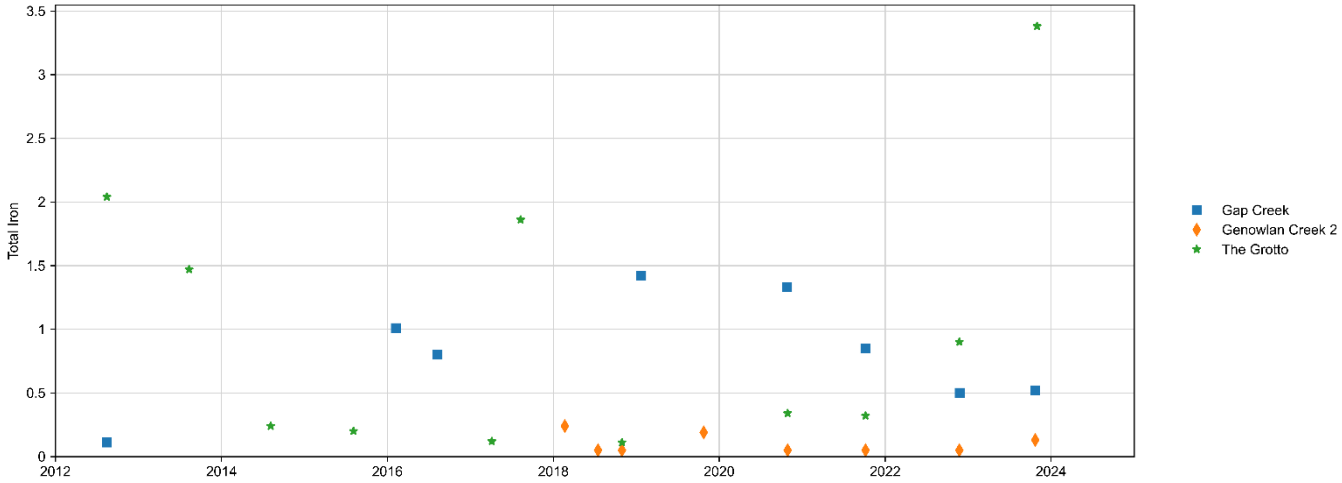


Figure B.52

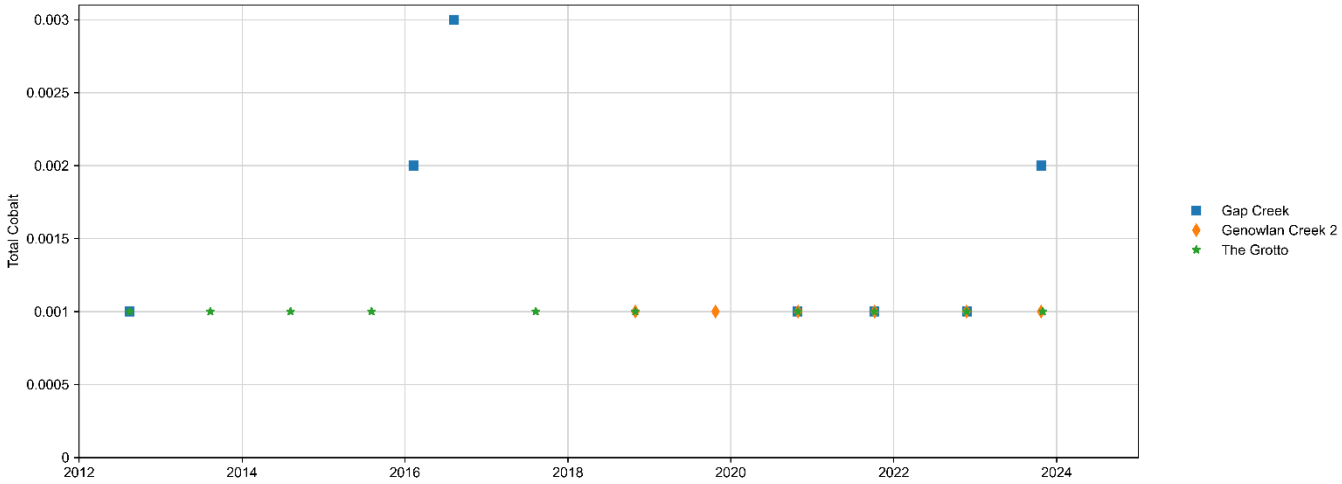


Figure B.53

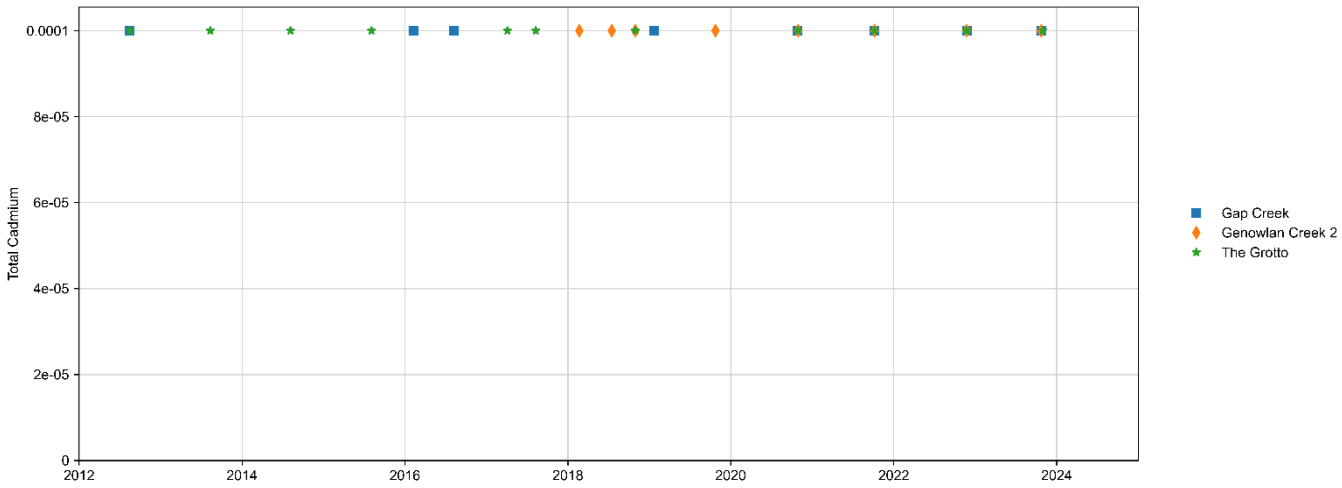


Figure B.54

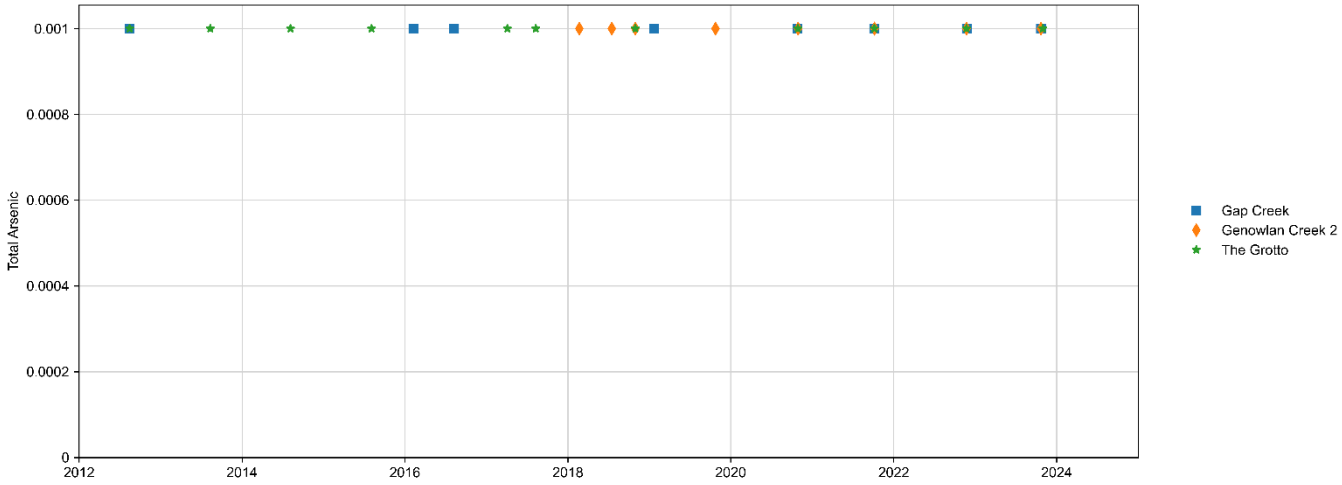


Figure B.55

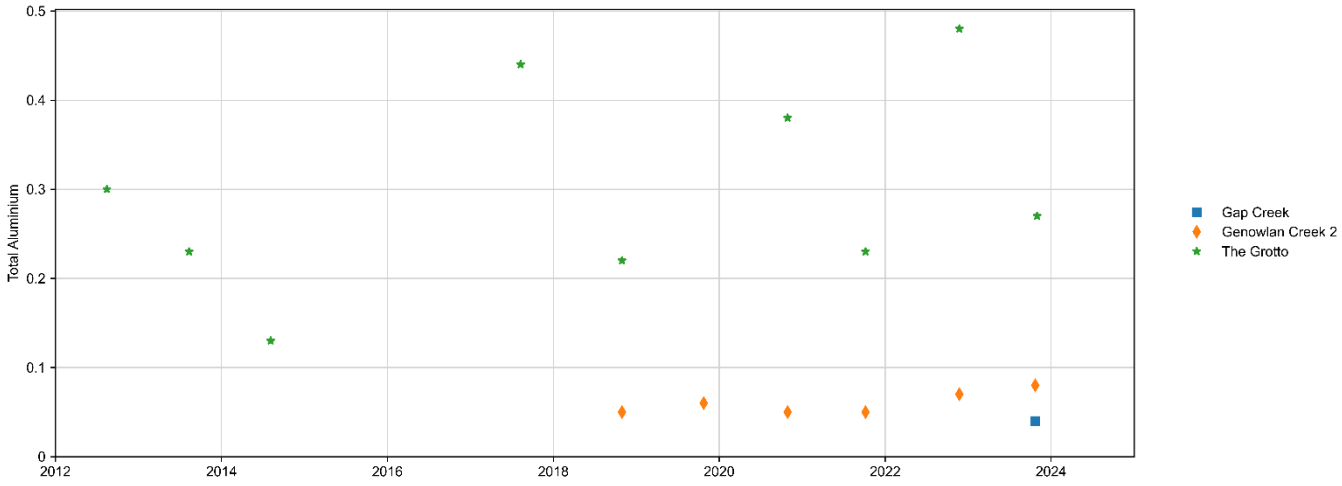


Figure B.56

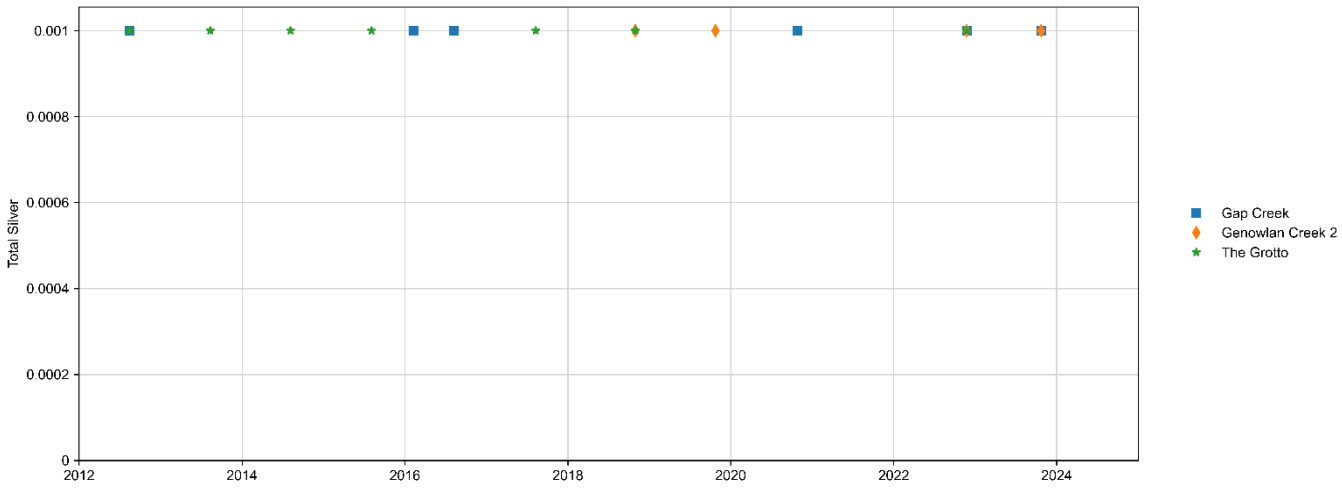


Figure B.57

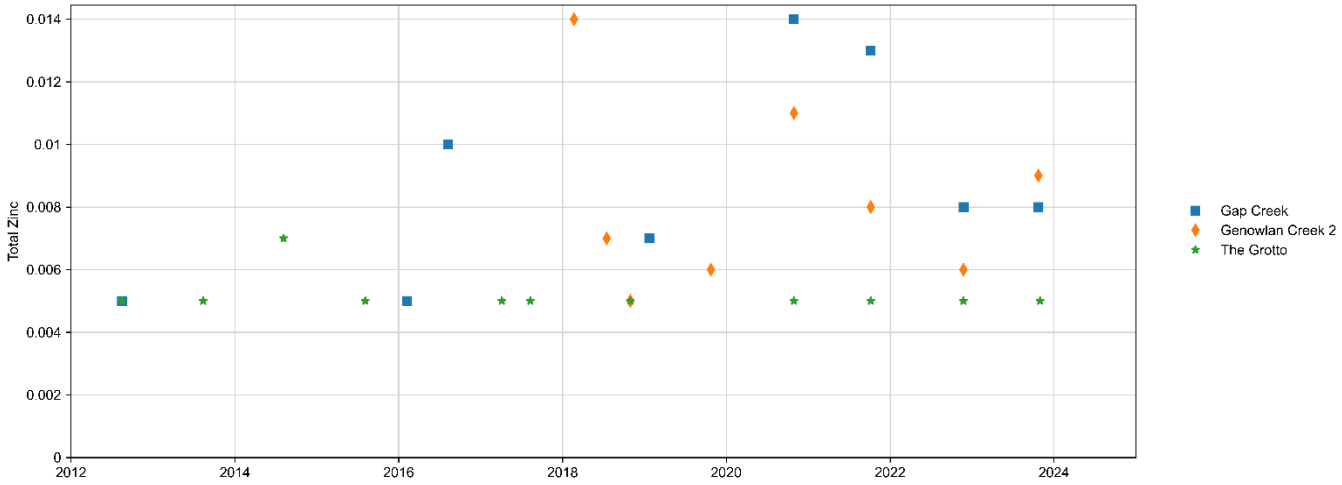


Figure B.58

Genowlan Creek Catchment - Alluvial bores

Physicochemical

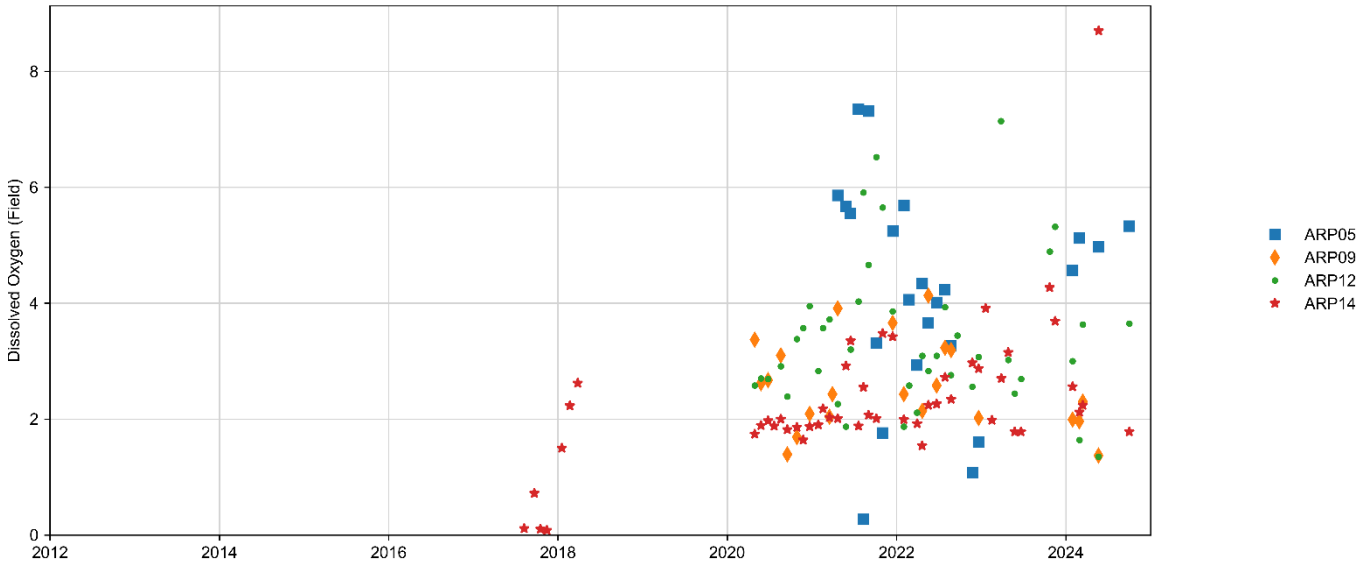


Figure B.59

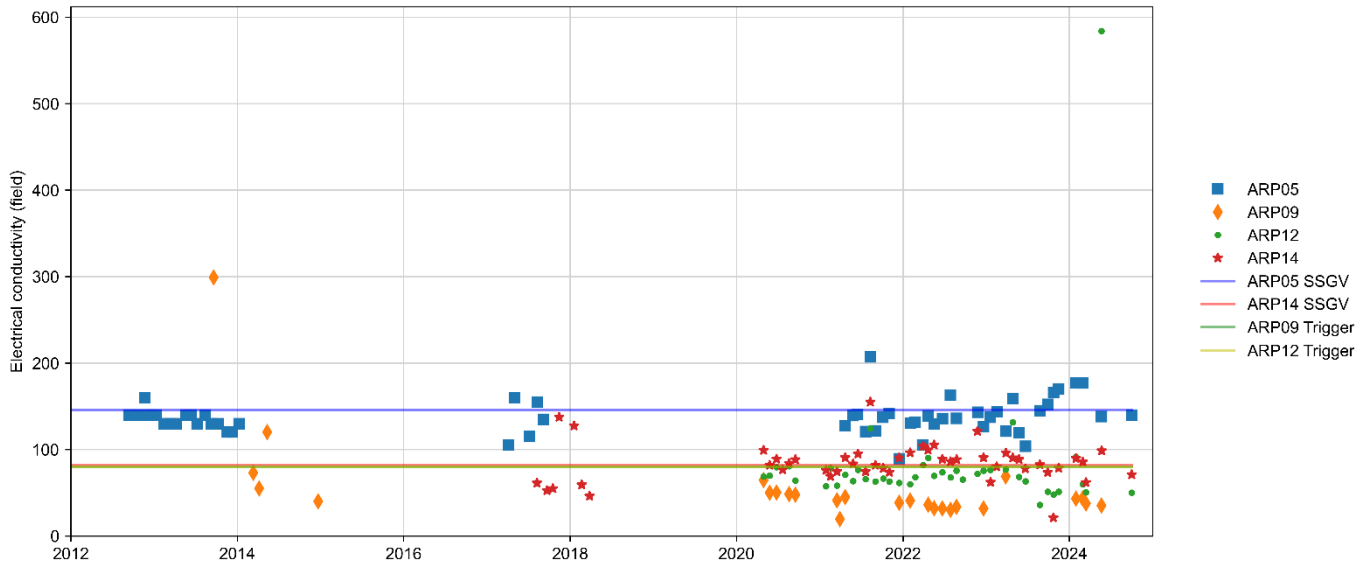


Figure B.60

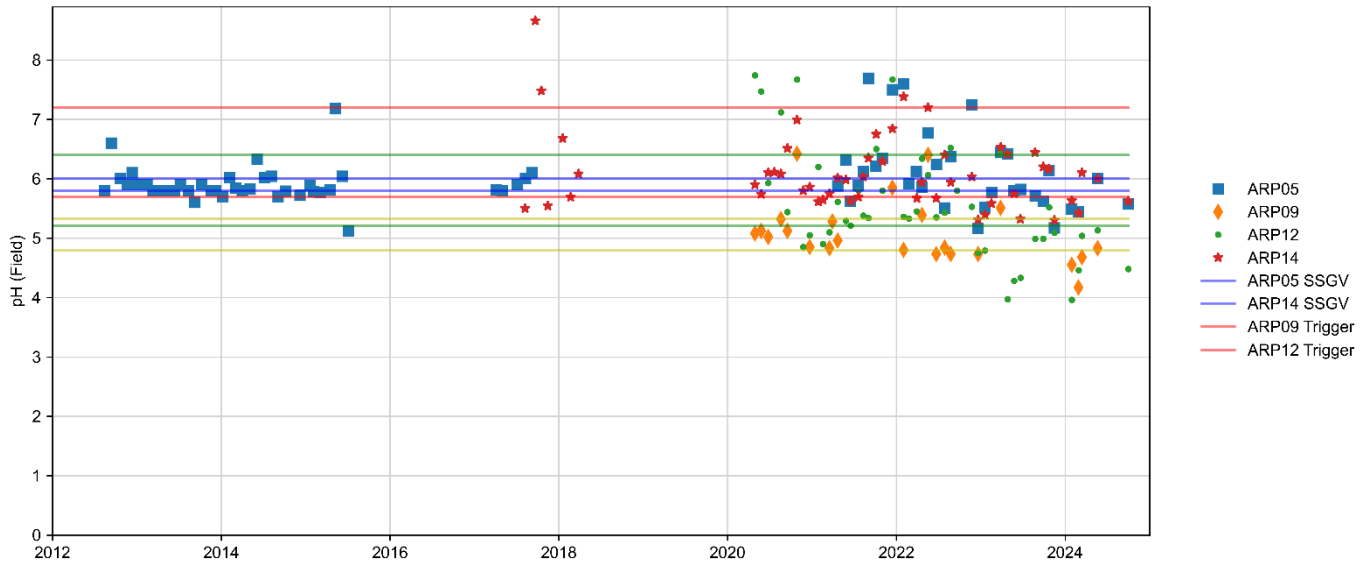


Figure B.61

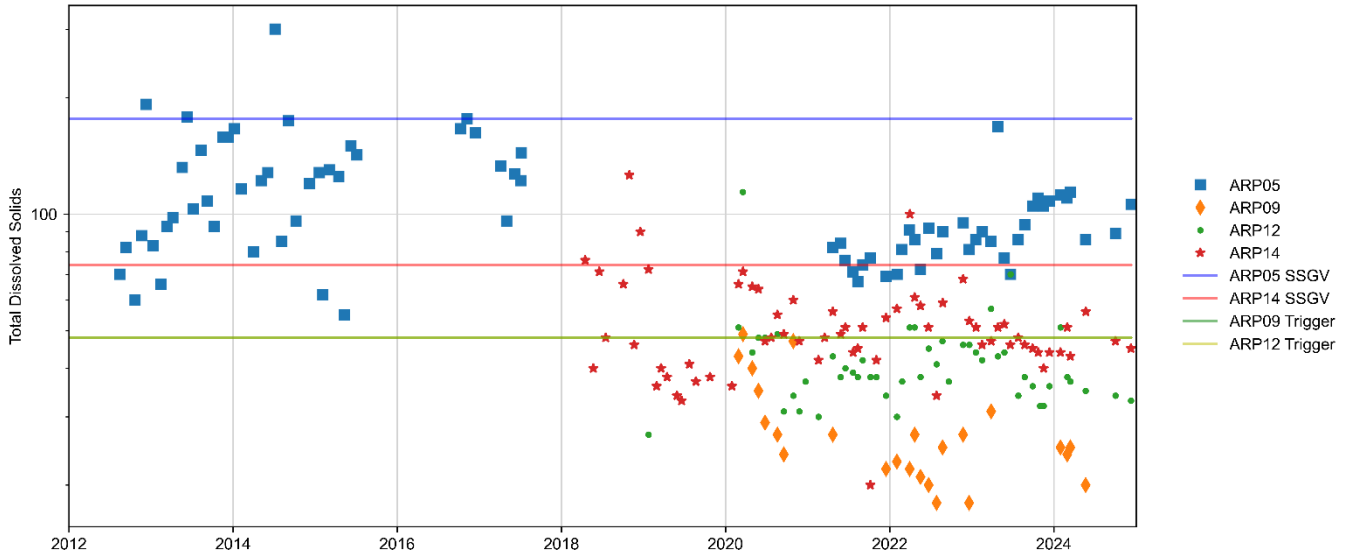


Figure B.62

Dissolved metals

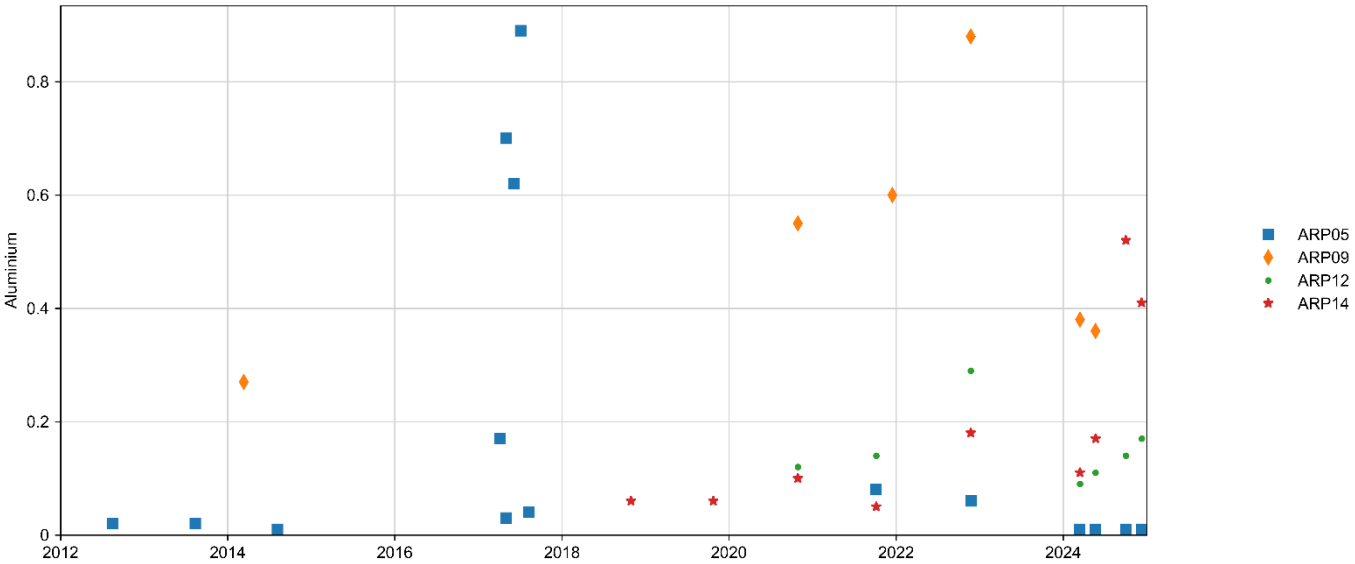


Figure B.63

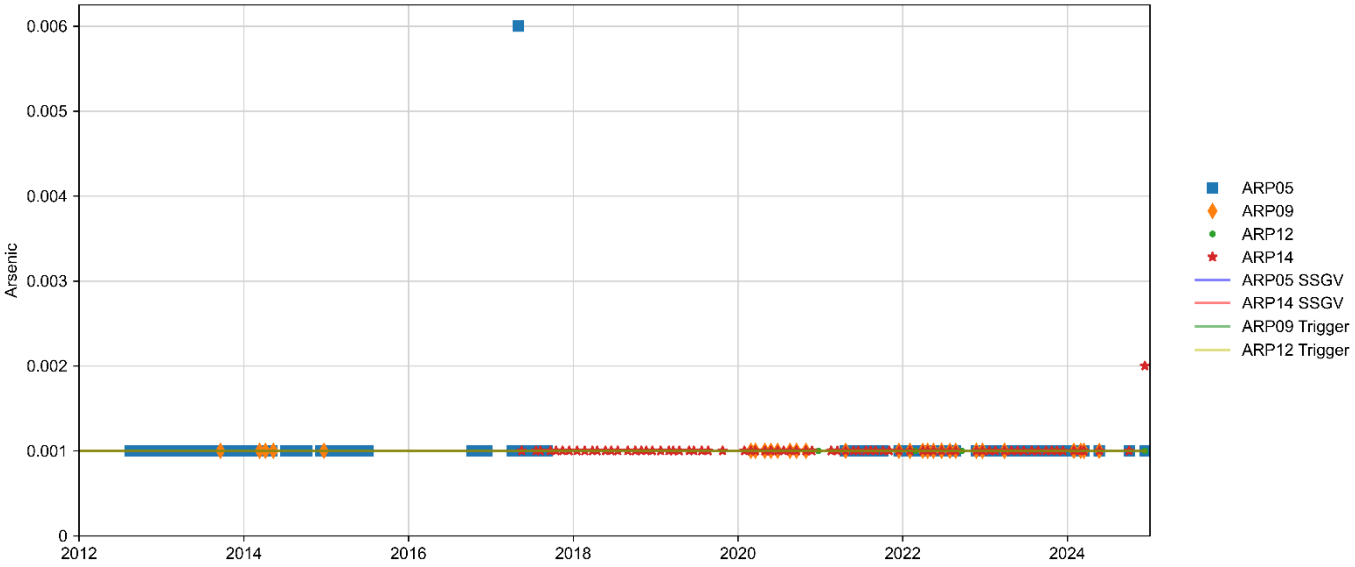


Figure B.64

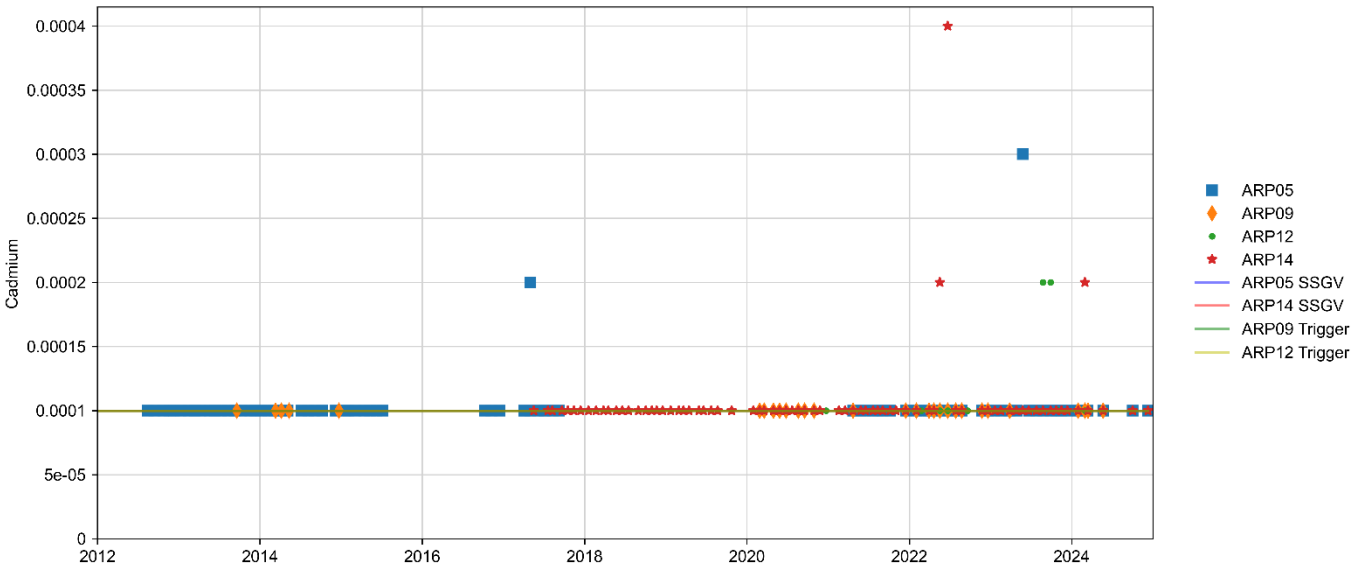


Figure B.65

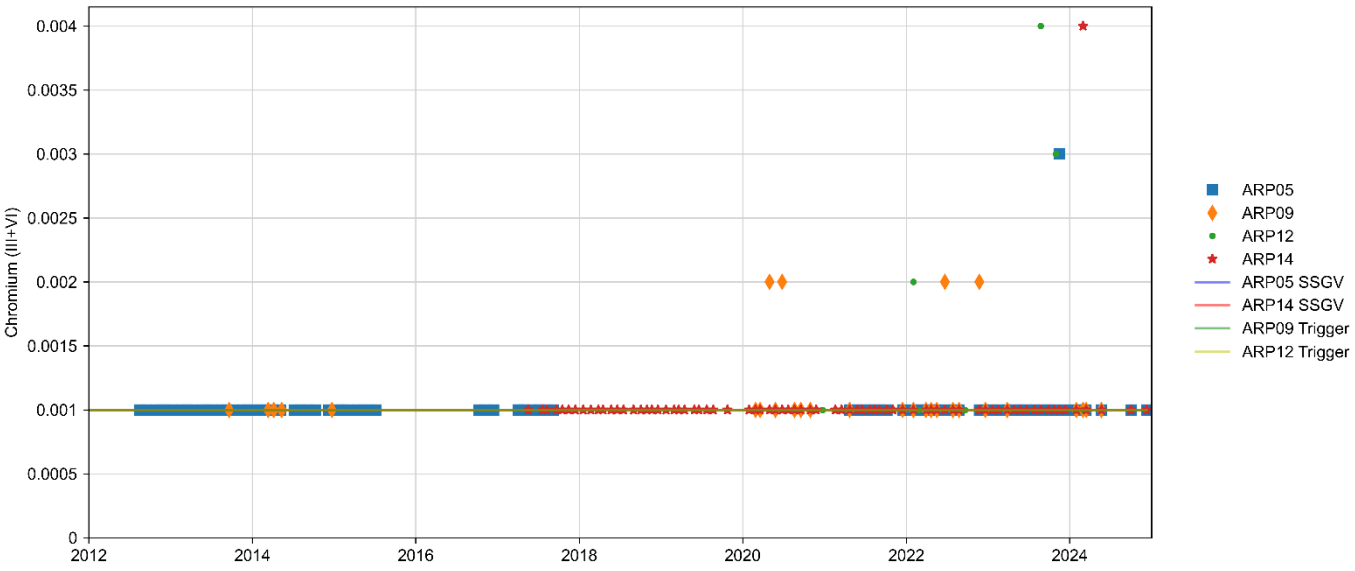


Figure B.66

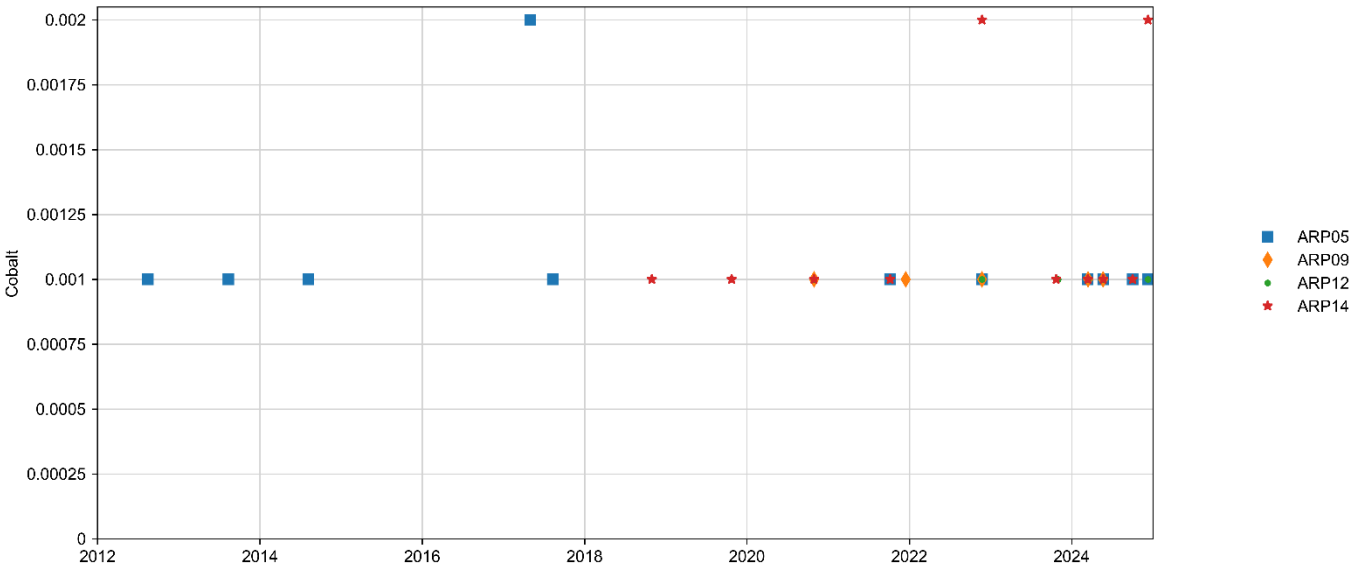


Figure B.67

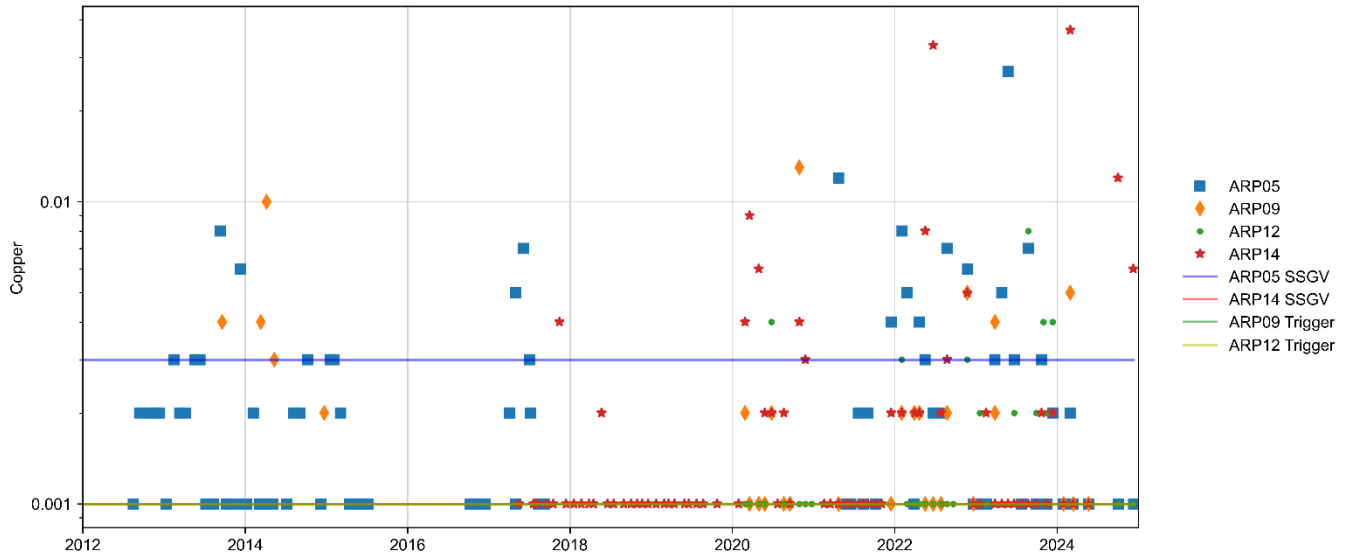


Figure B.68

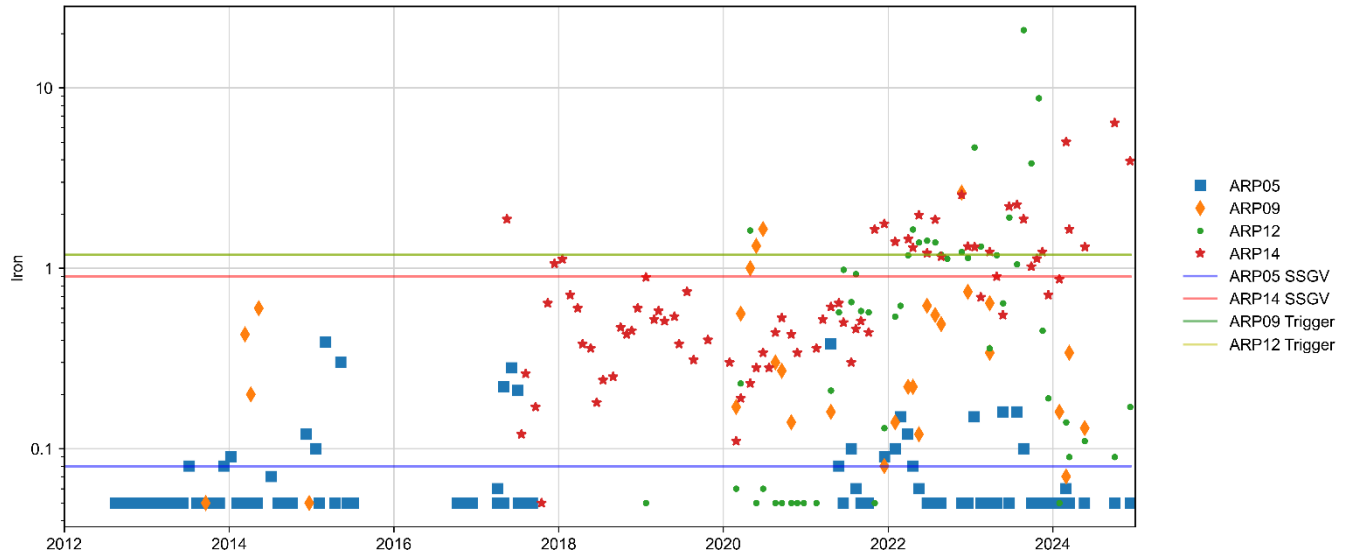


Figure B.69

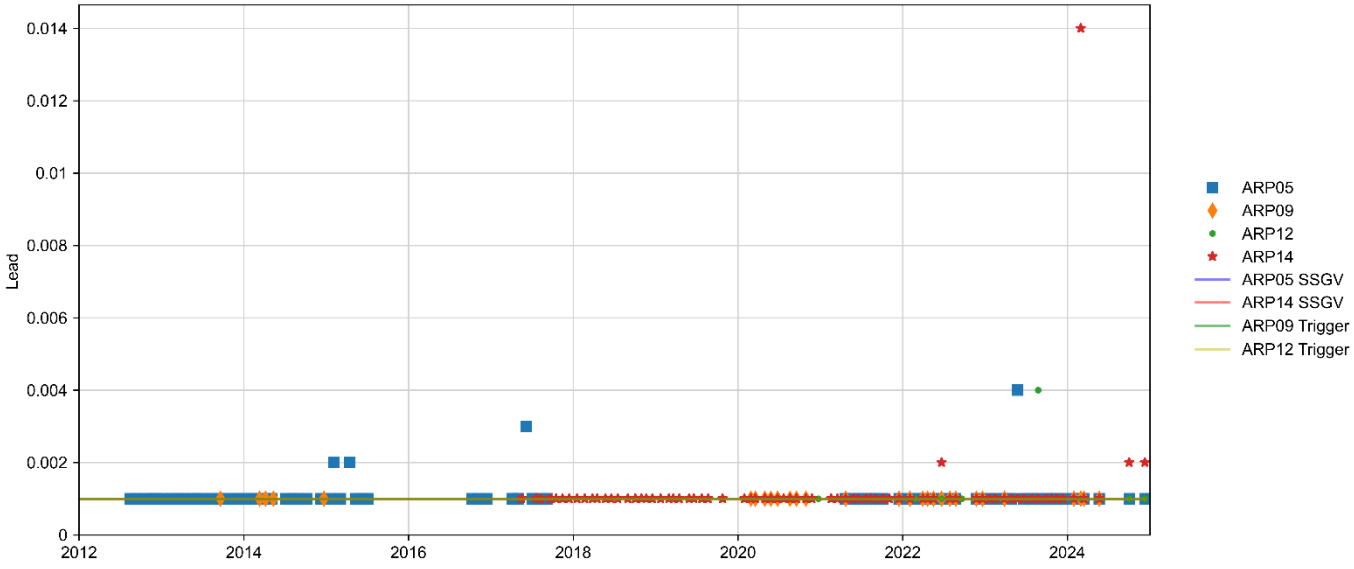


Figure B.70

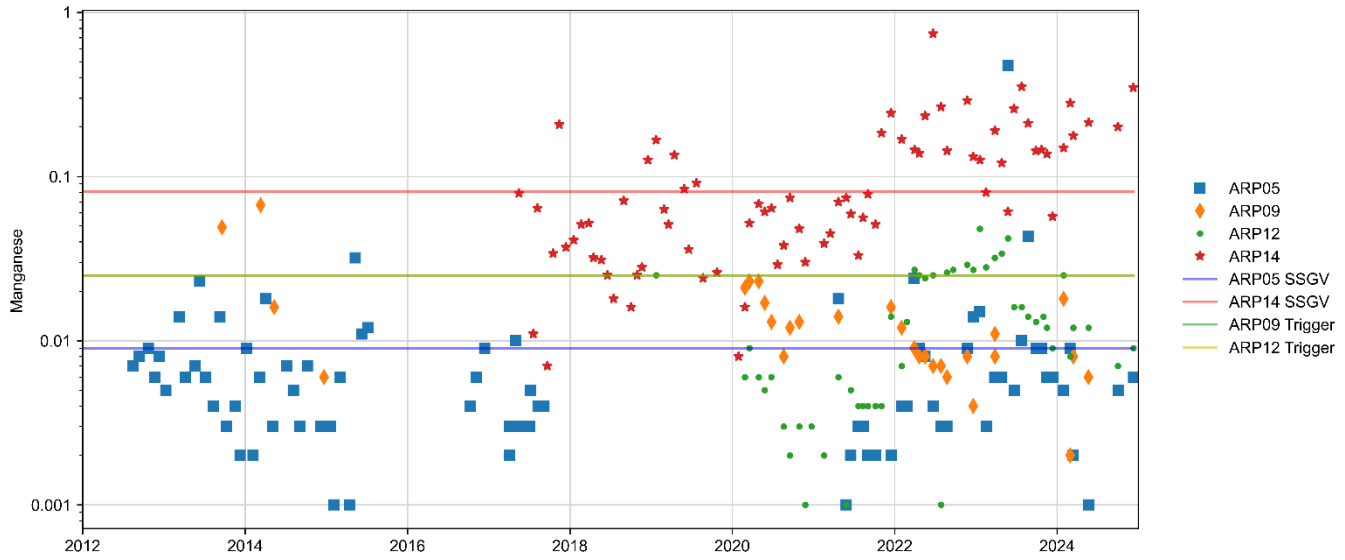


Figure B.71

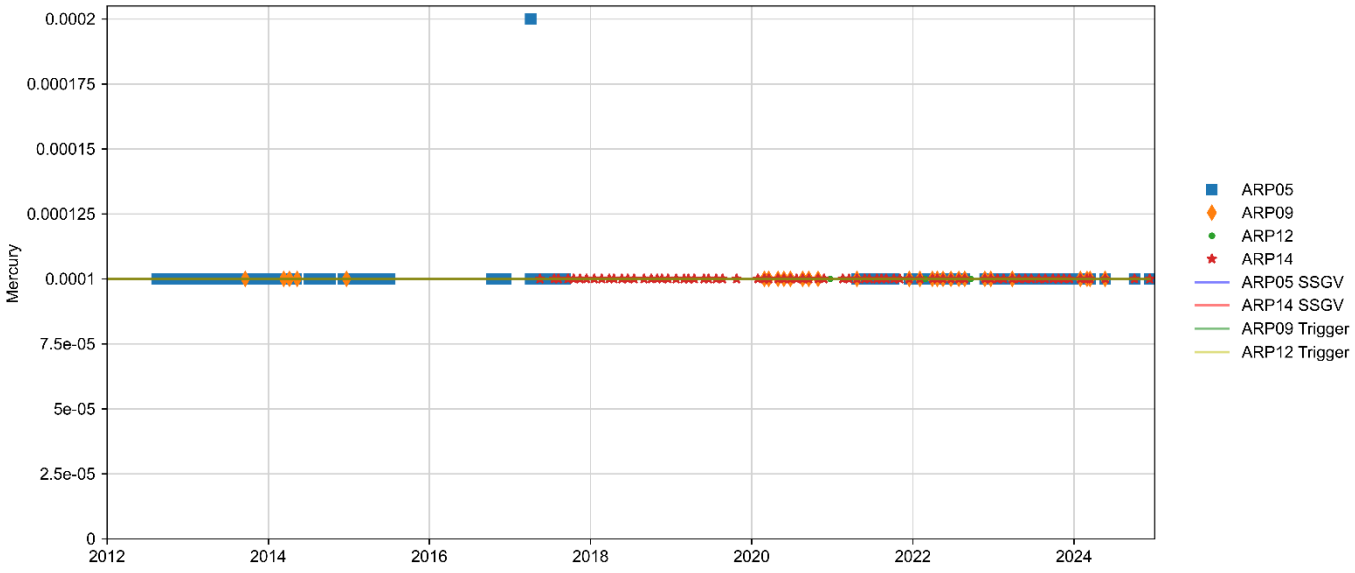


Figure B.72

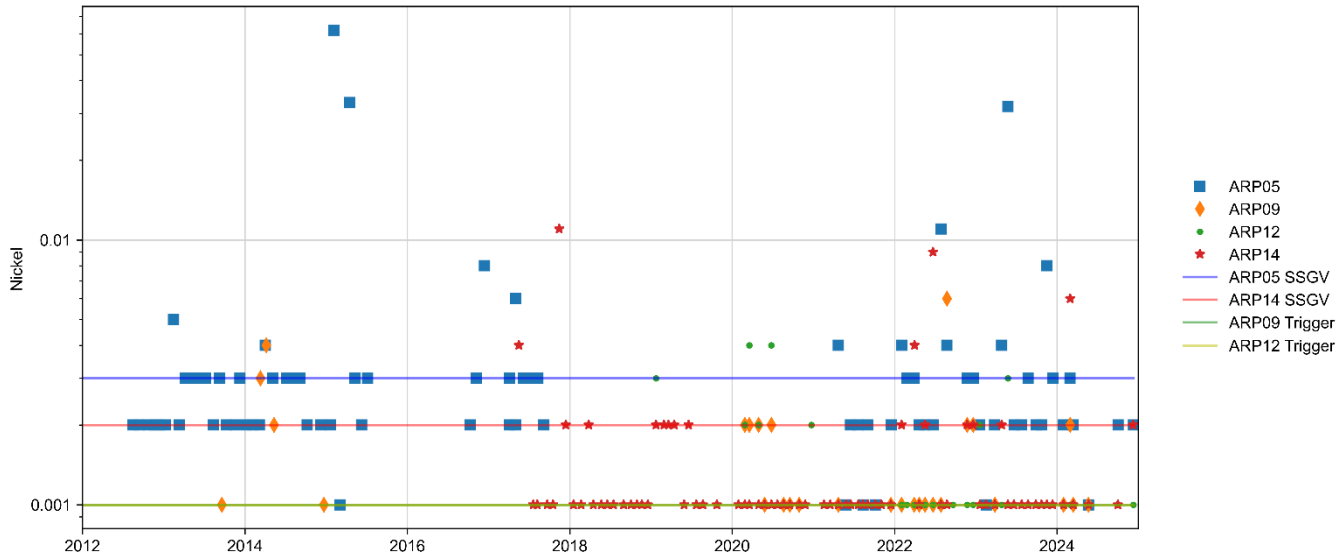


Figure B.73

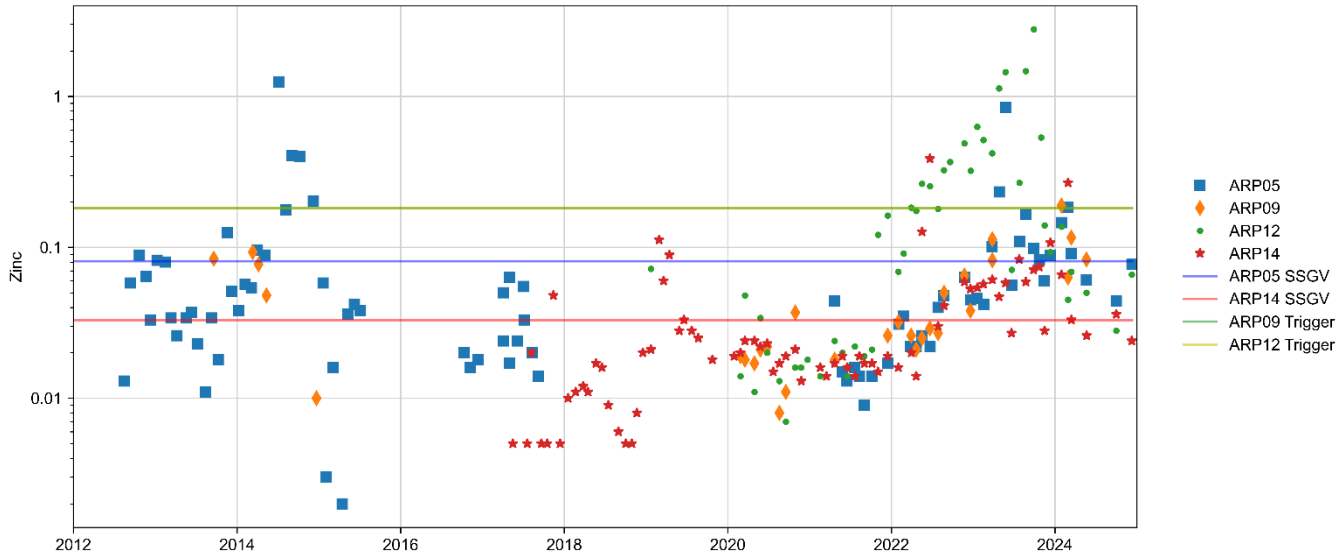


Figure B.74

Airly Creek Catchment

Physicochemical

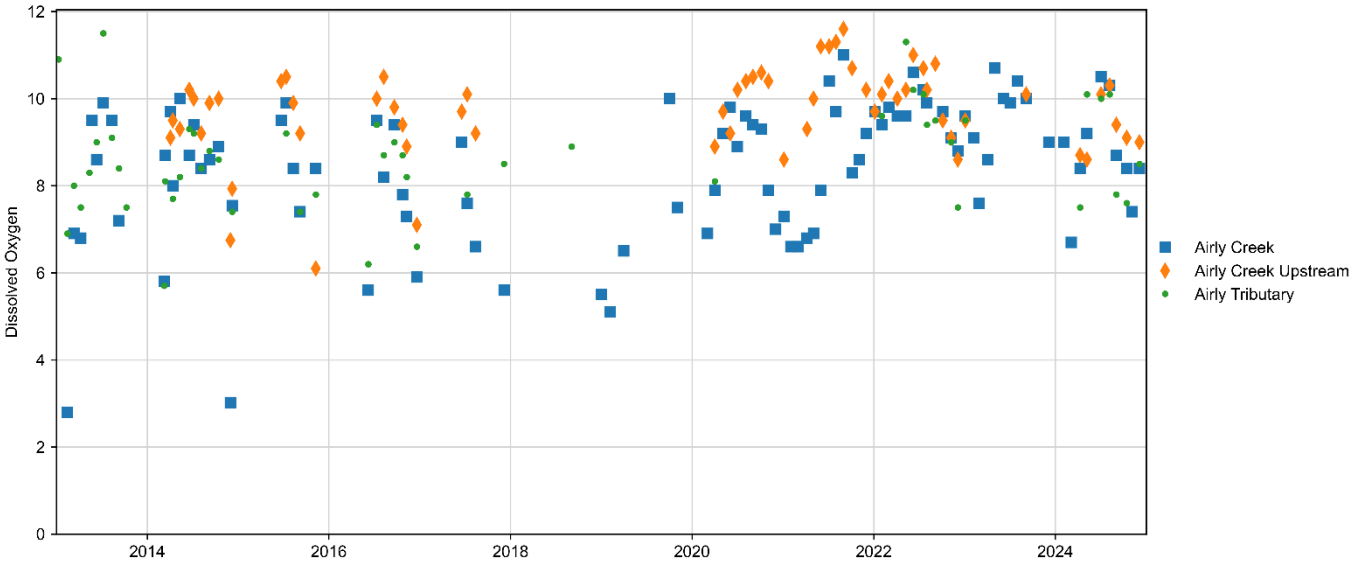


Figure B.75

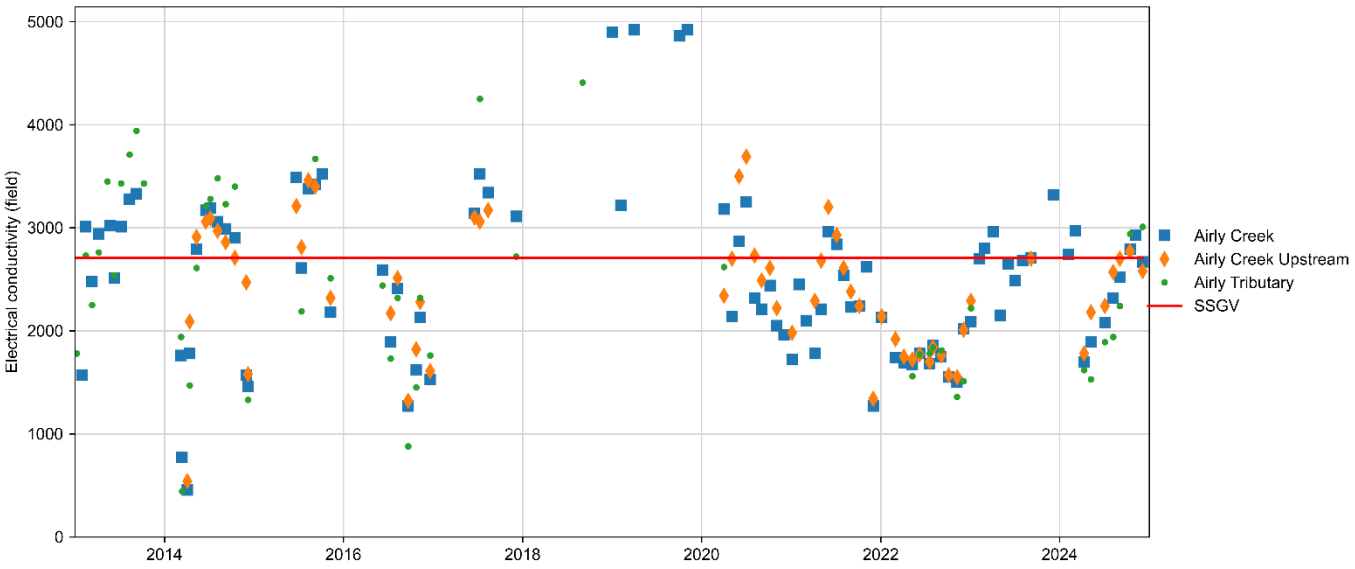


Figure B.76

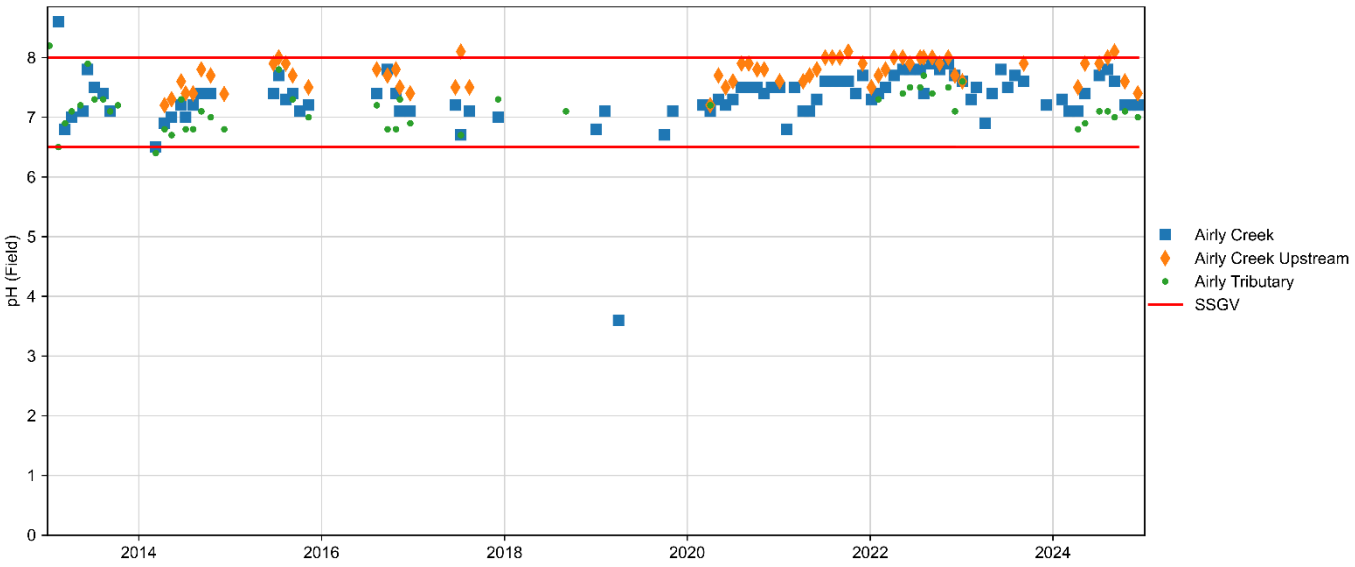


Figure B.77

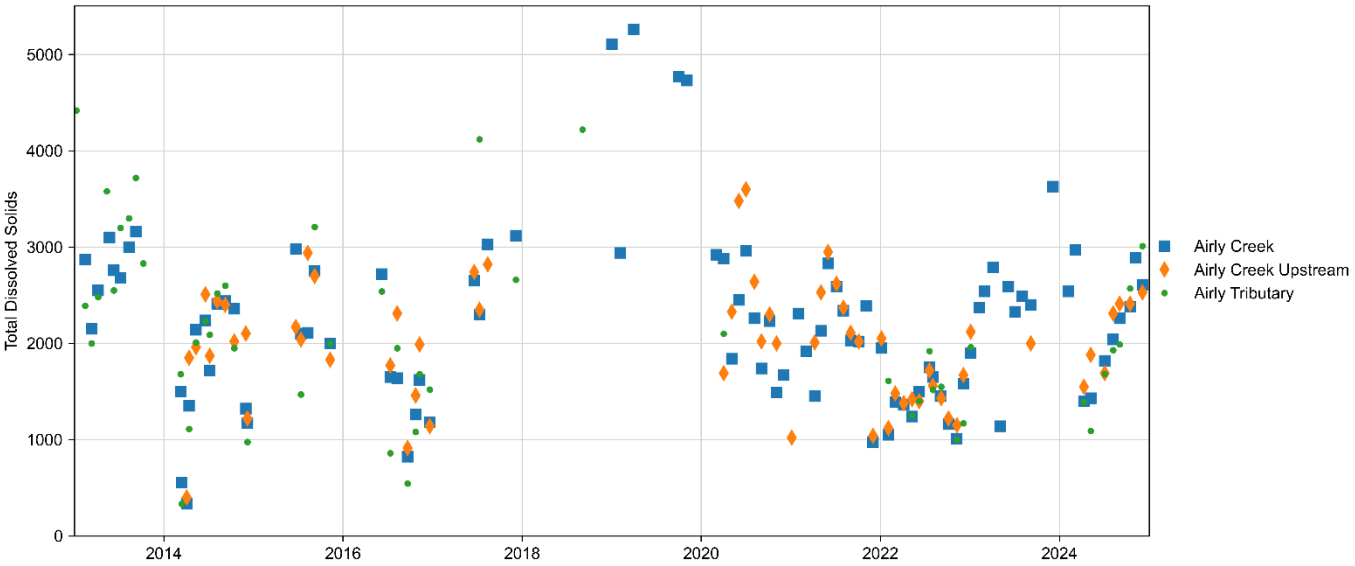


Figure B.78

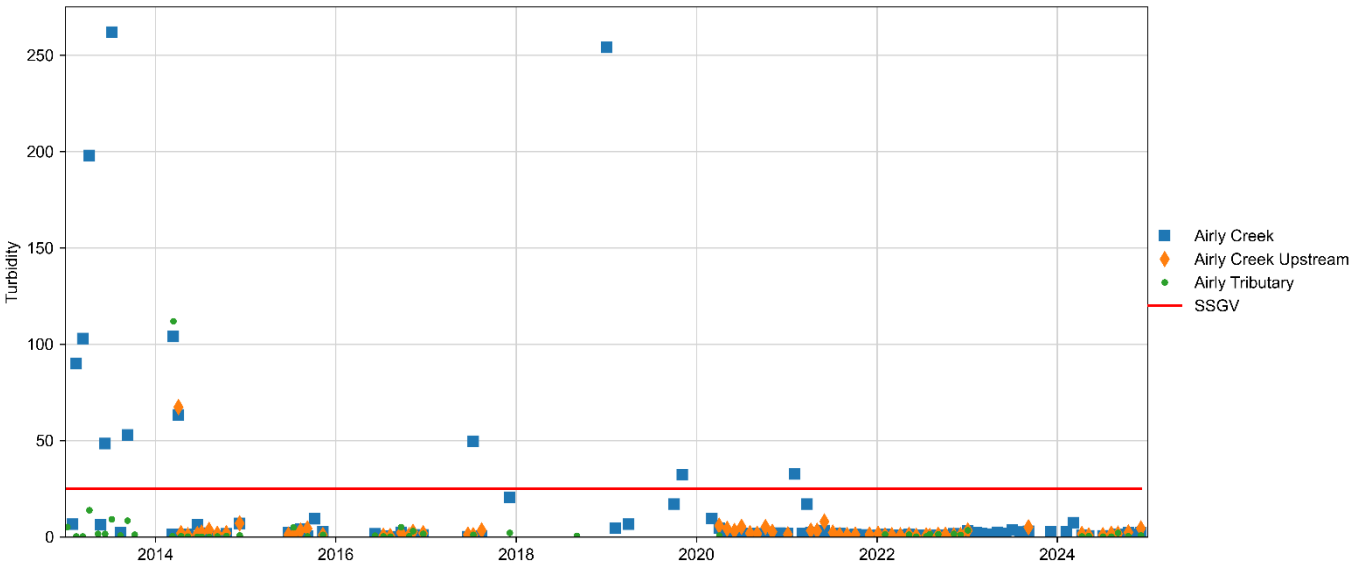


Figure B.79

Dissolved metals

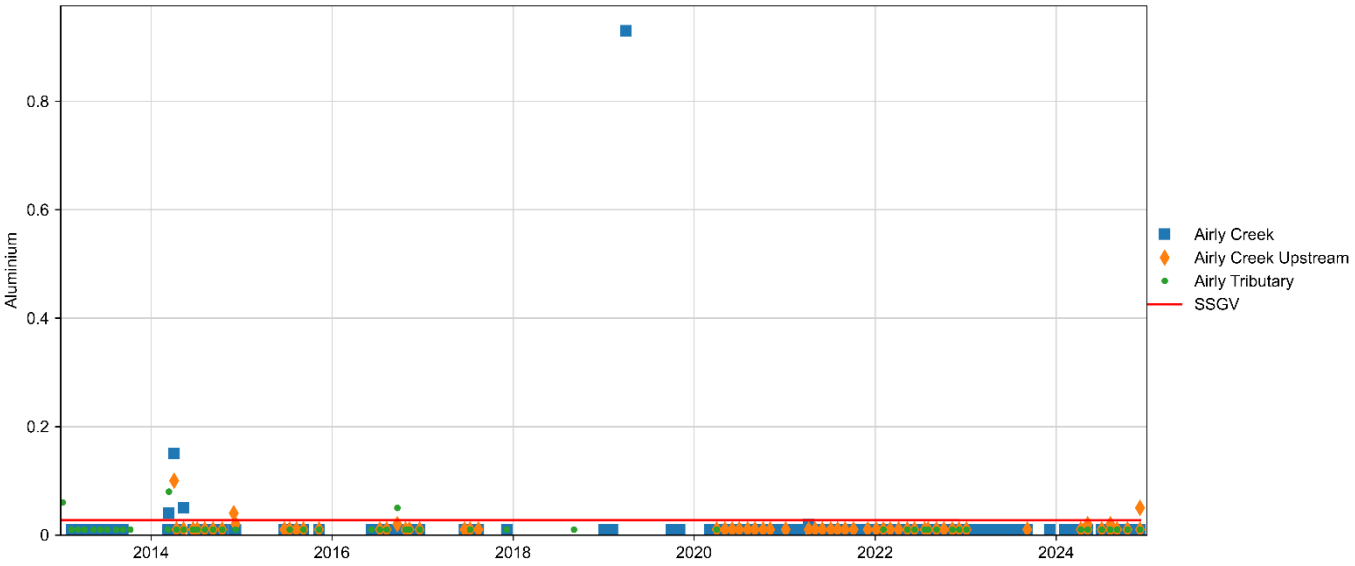


Figure B.80

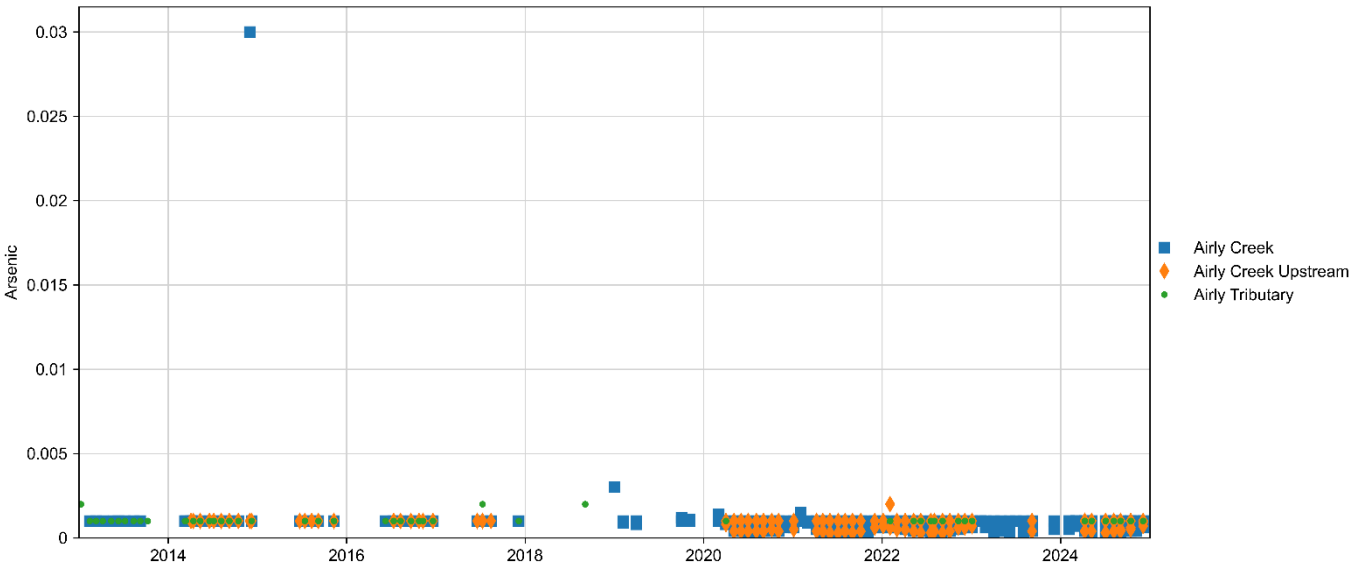


Figure B.81

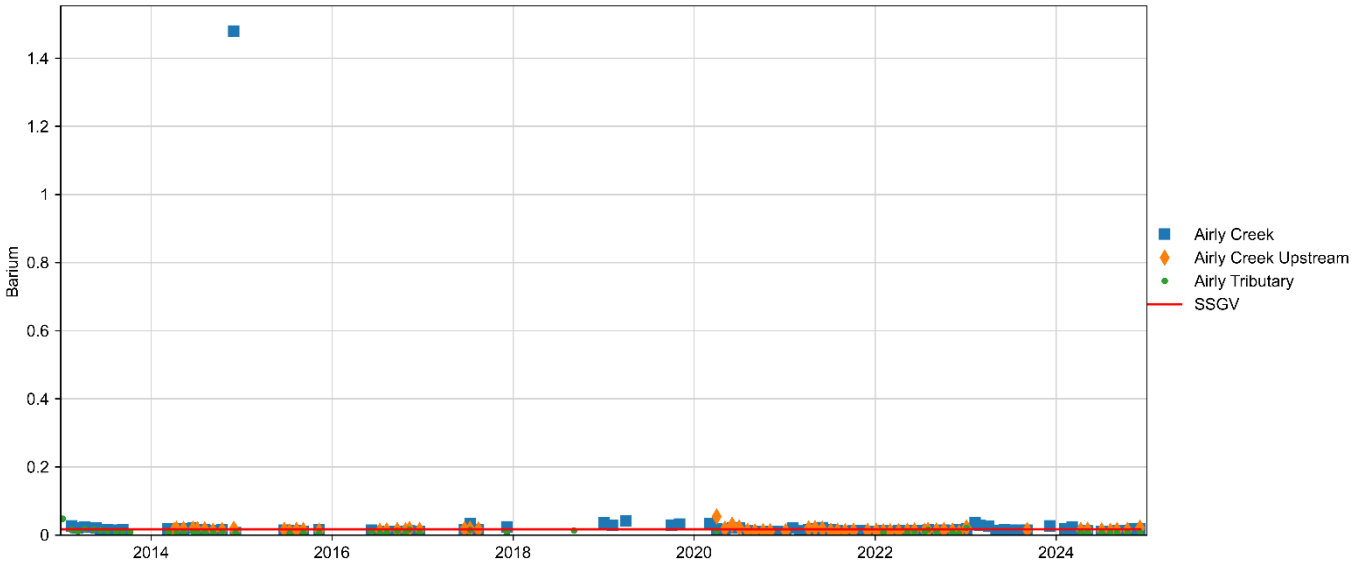


Figure B.82

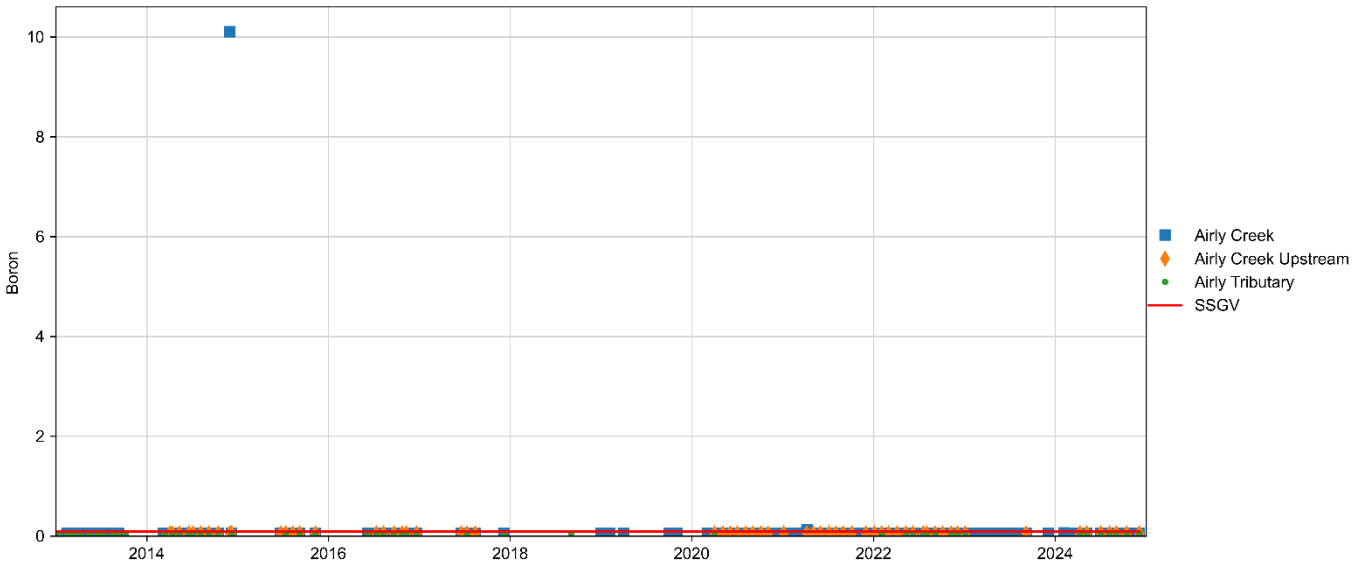


Figure B.83

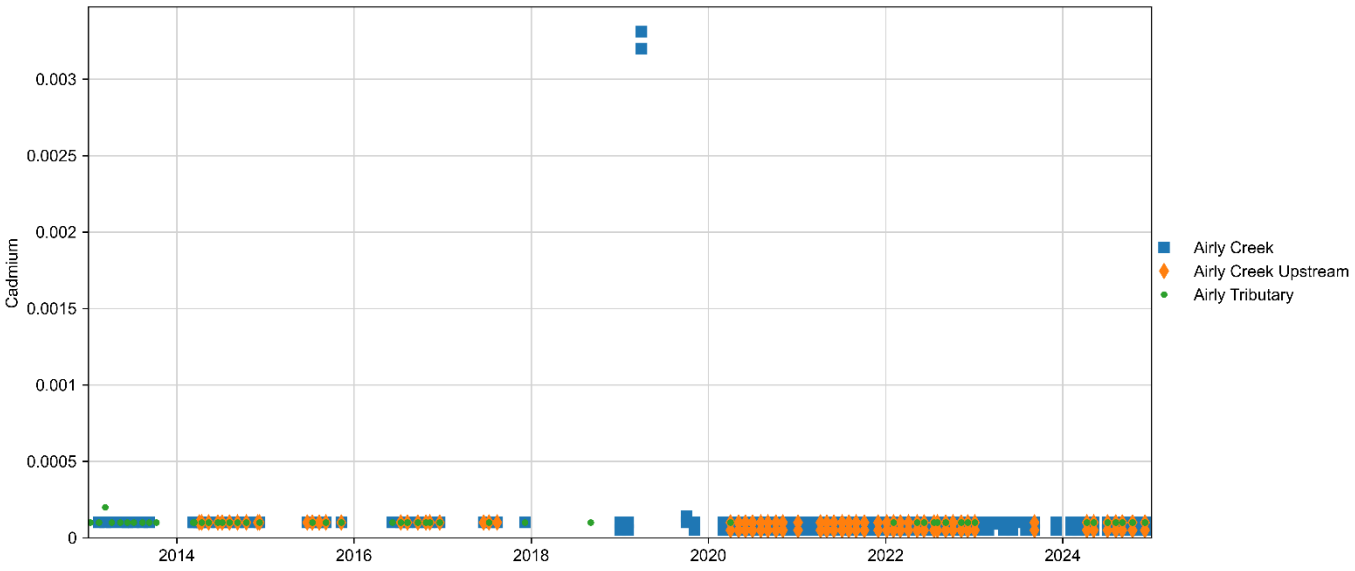


Figure B.84

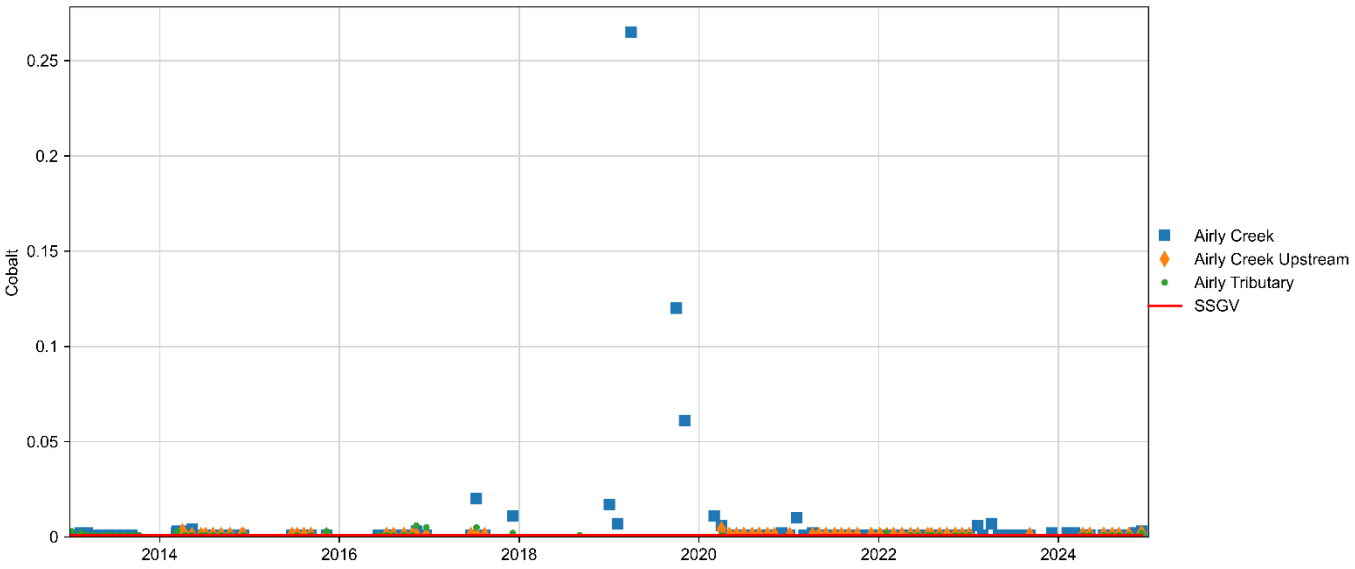


Figure B.85

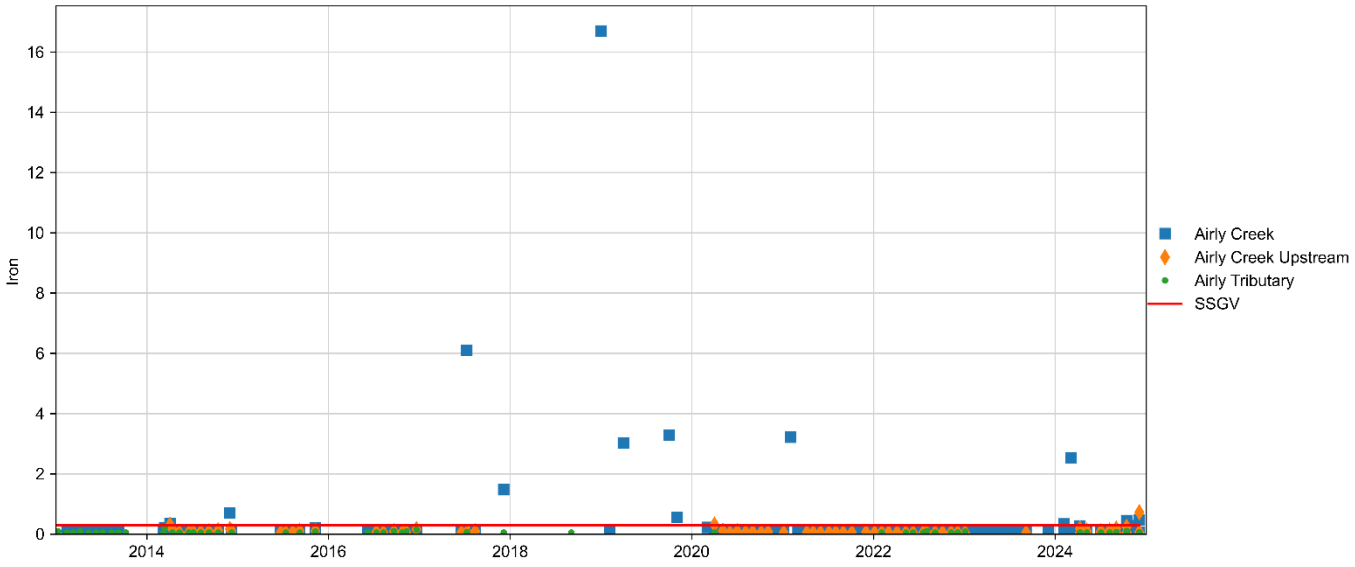


Figure B.86

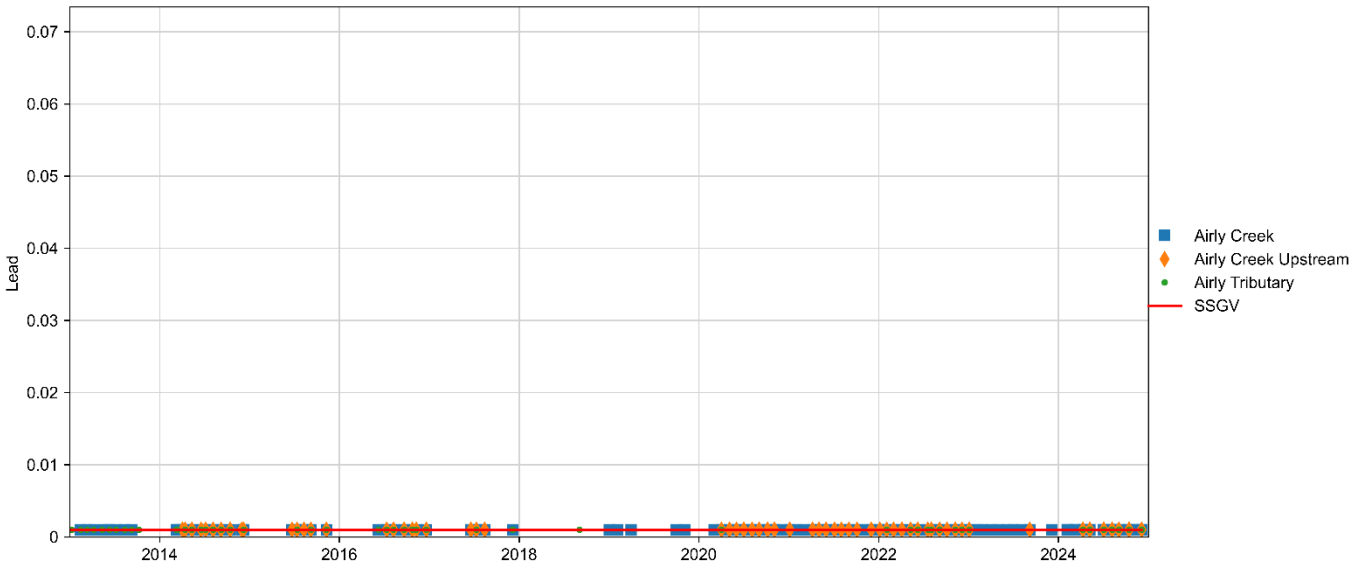


Figure B.87

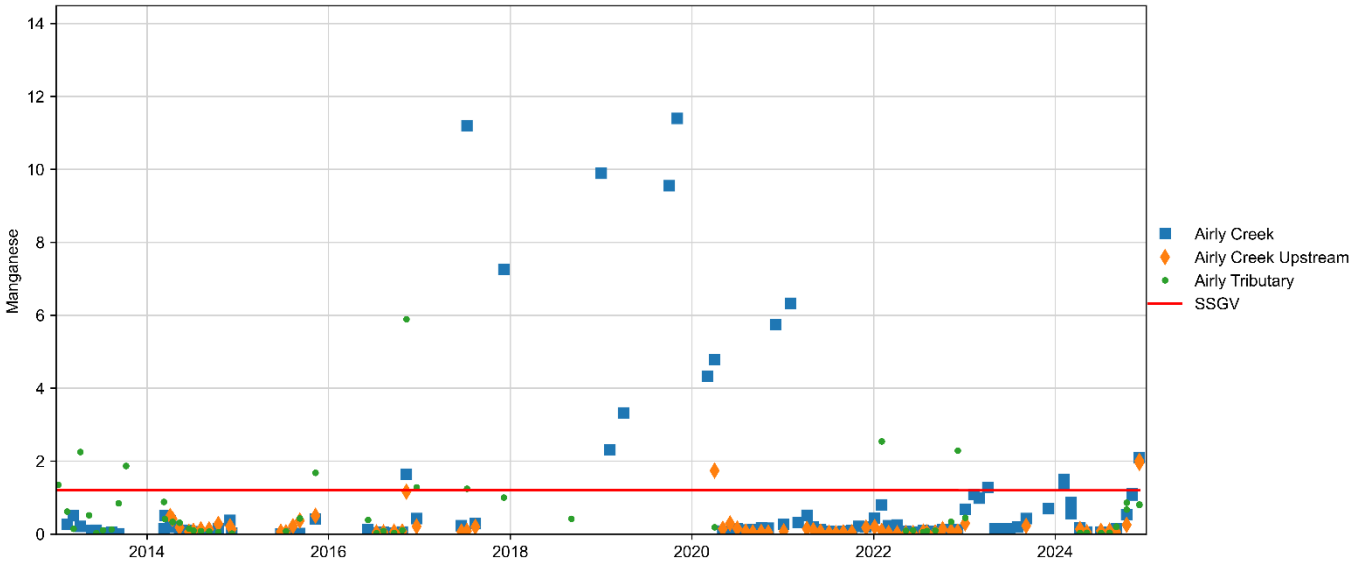


Figure B.88

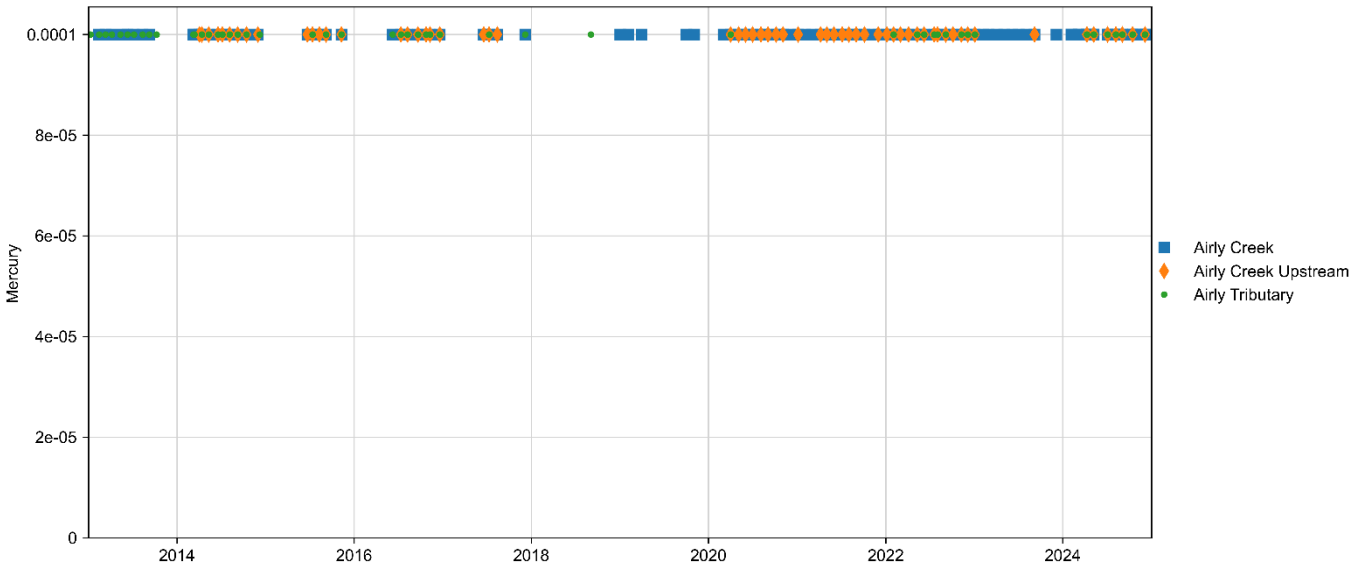


Figure B.89

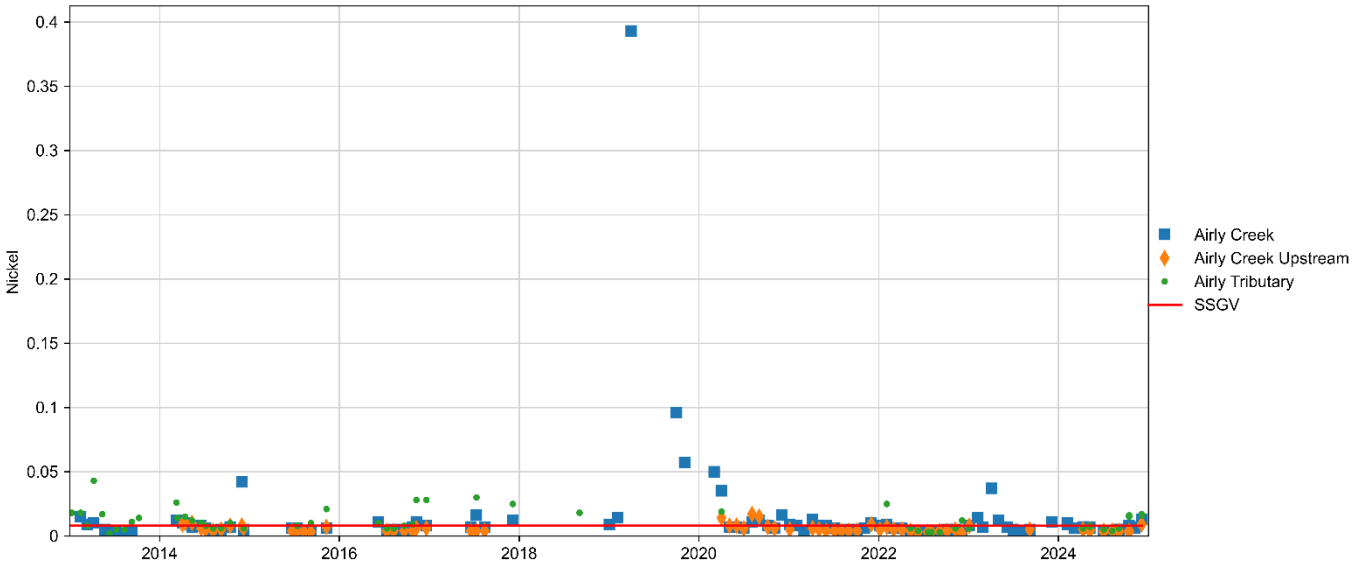


Figure B.90

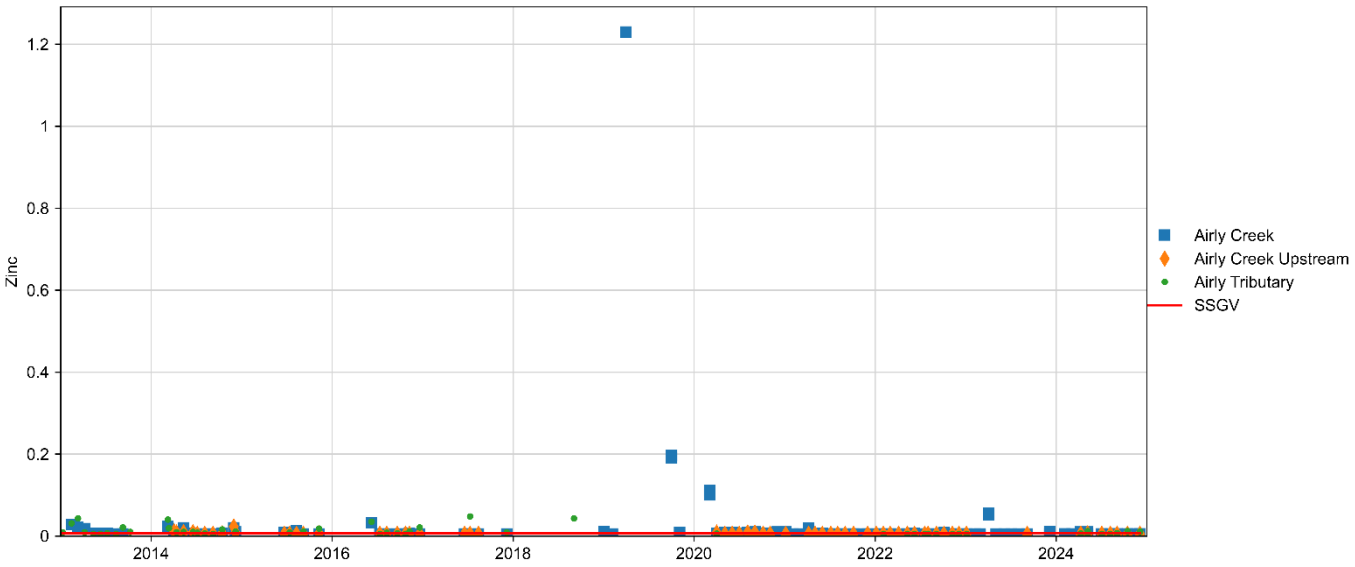

Zinc
1.2
1
0.8
0.6
0.4
0.2
0
2014
2016
2018
2020
2022
2024
Airly Creek
Airly Creek Upstream
Airly Tributary
SSGV

Figure B.91

Dam water quality

Physiochemical parameters

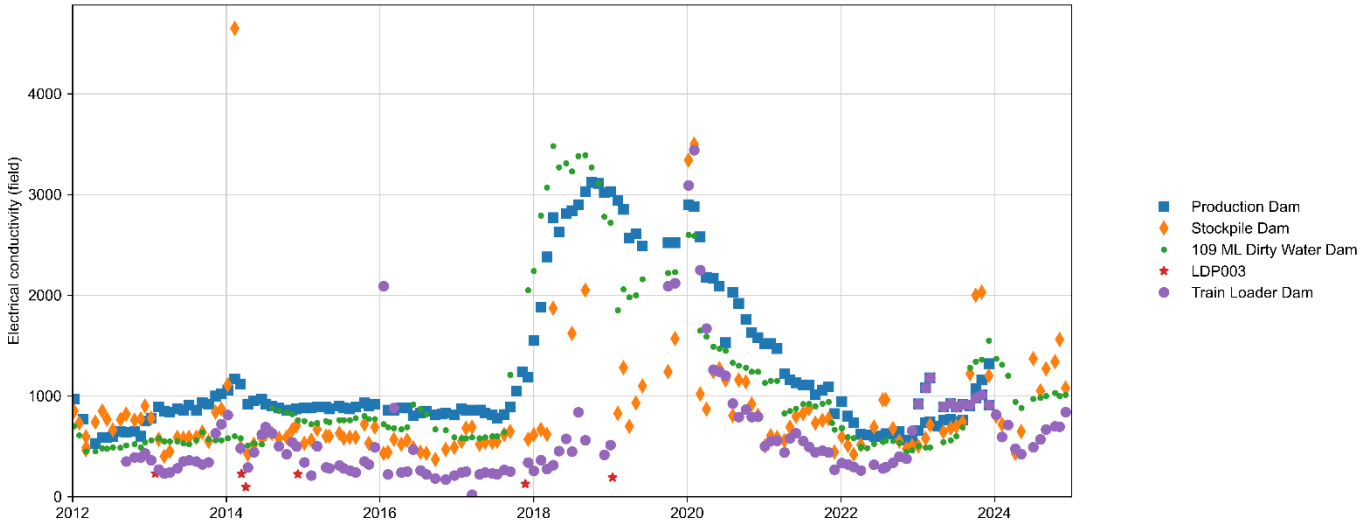


Figure B.92

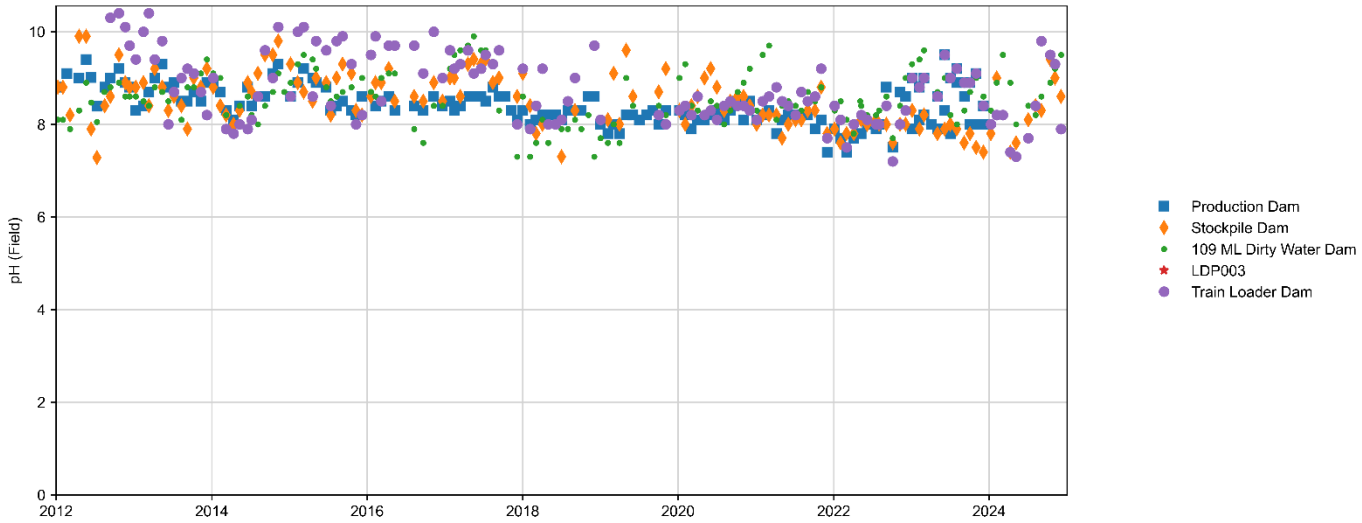


Figure B.93

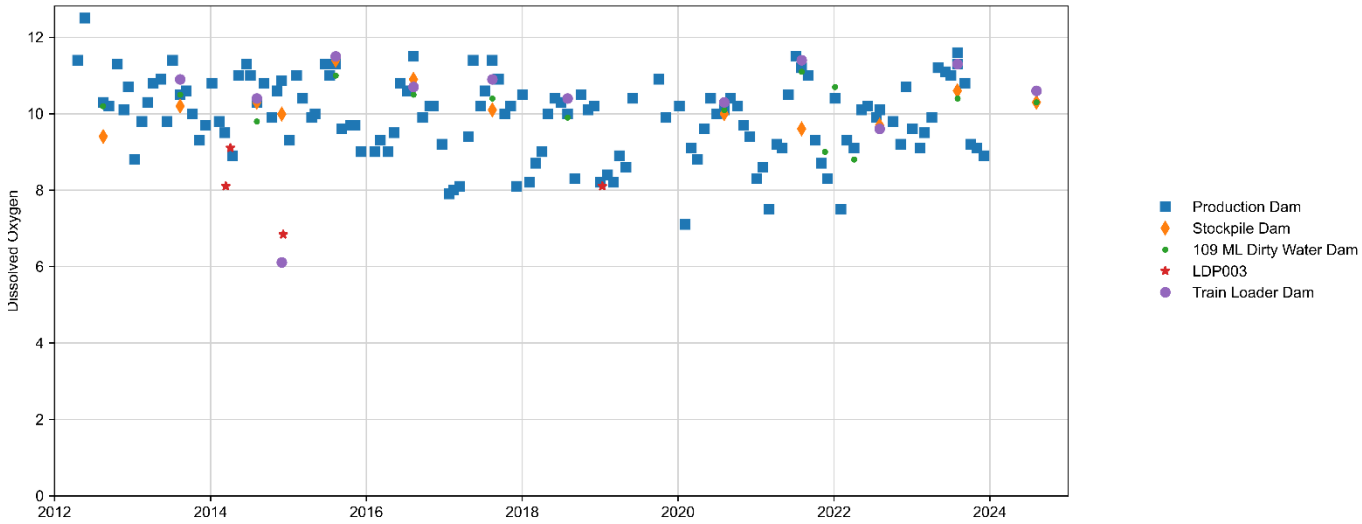


Figure B.94

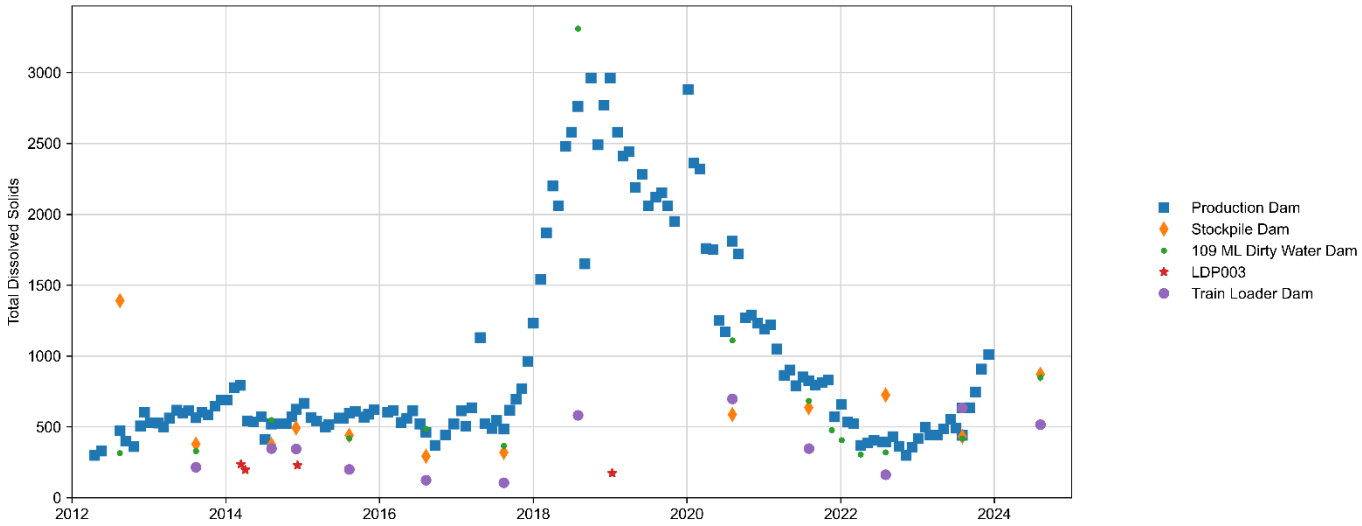


Figure B.95

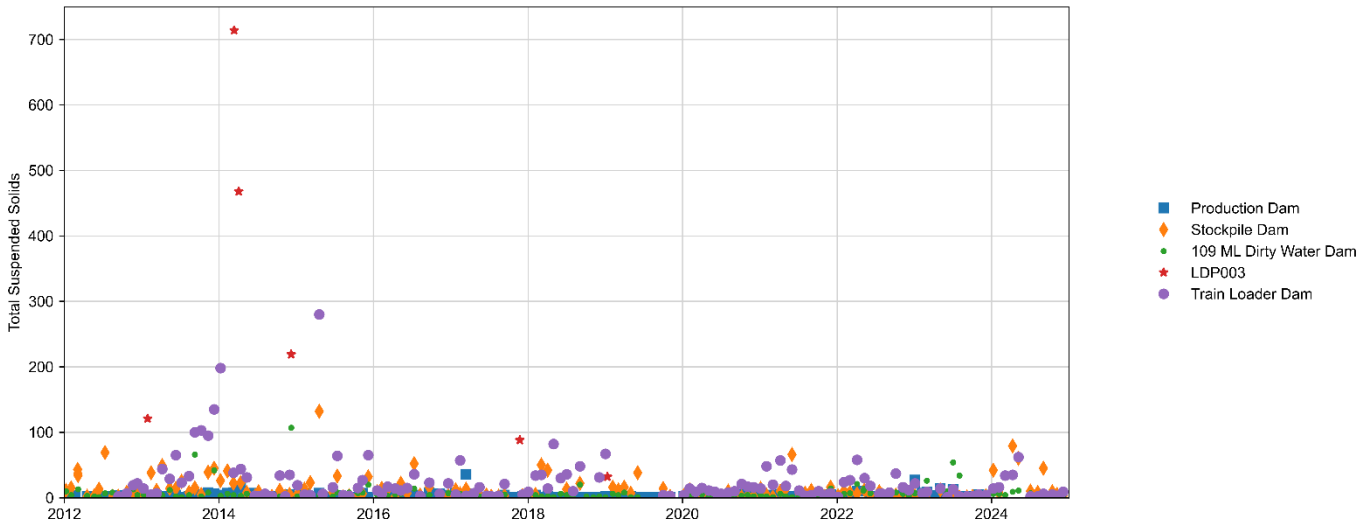


Figure B.96

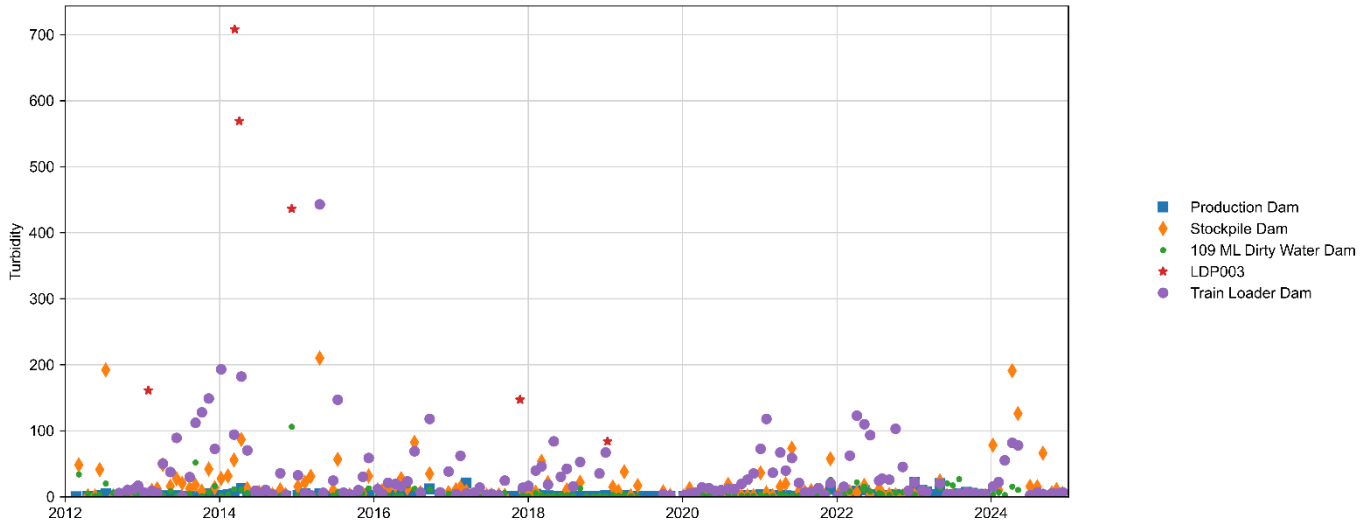

Turbidity
700
600
500
400
300
200
100
0
2012
2014
2016
2018
2020
2022
2024
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

Figure B.97

Nutrients

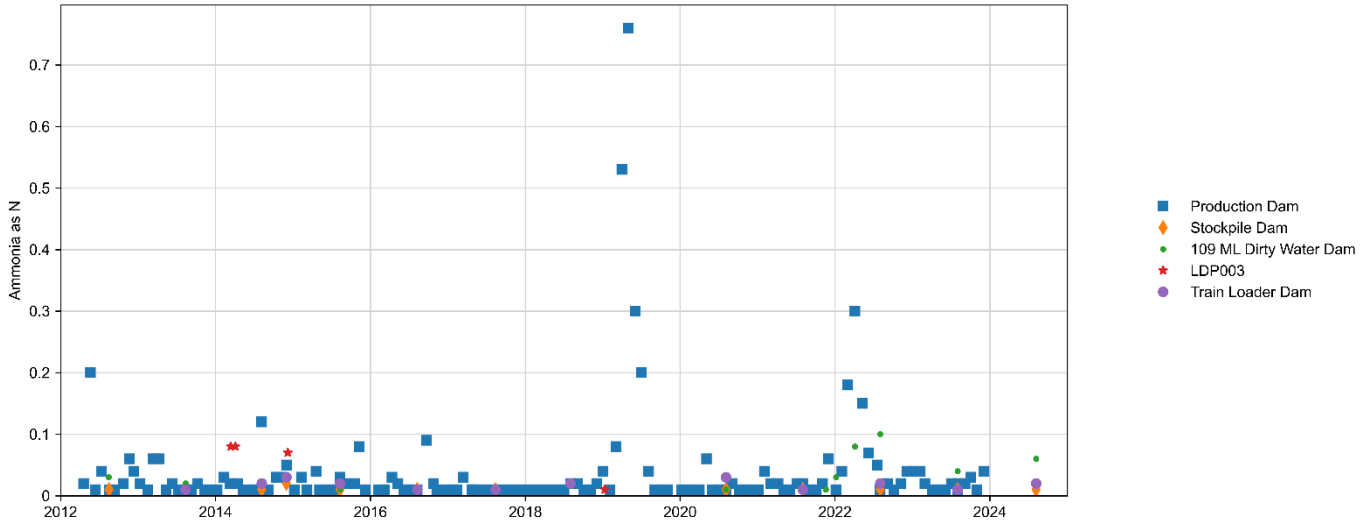


Figure B.98

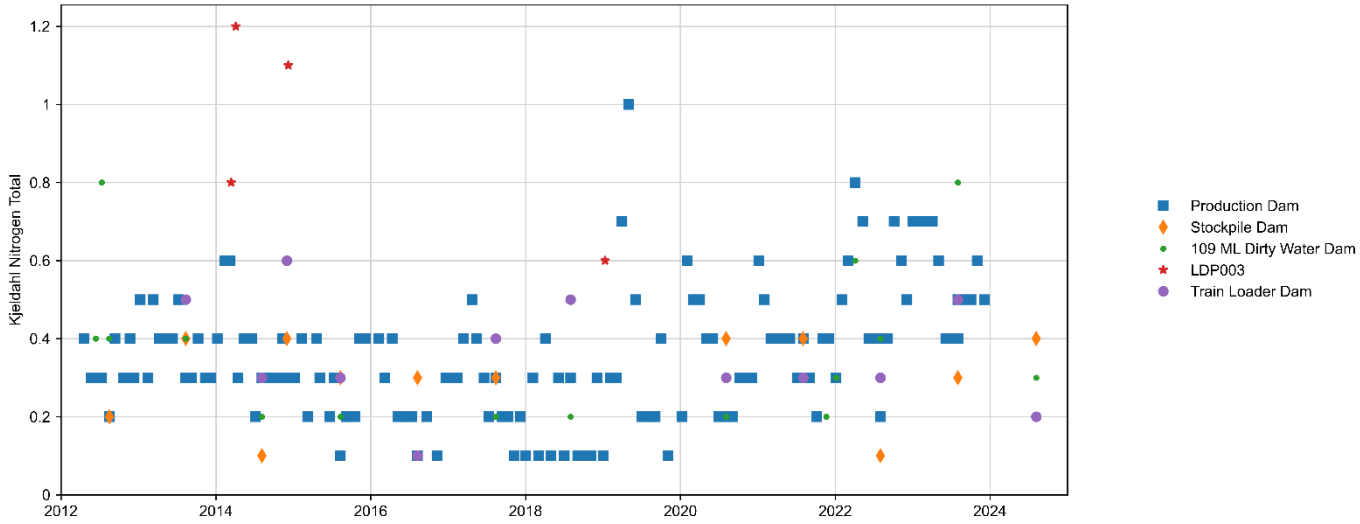


Figure B.99

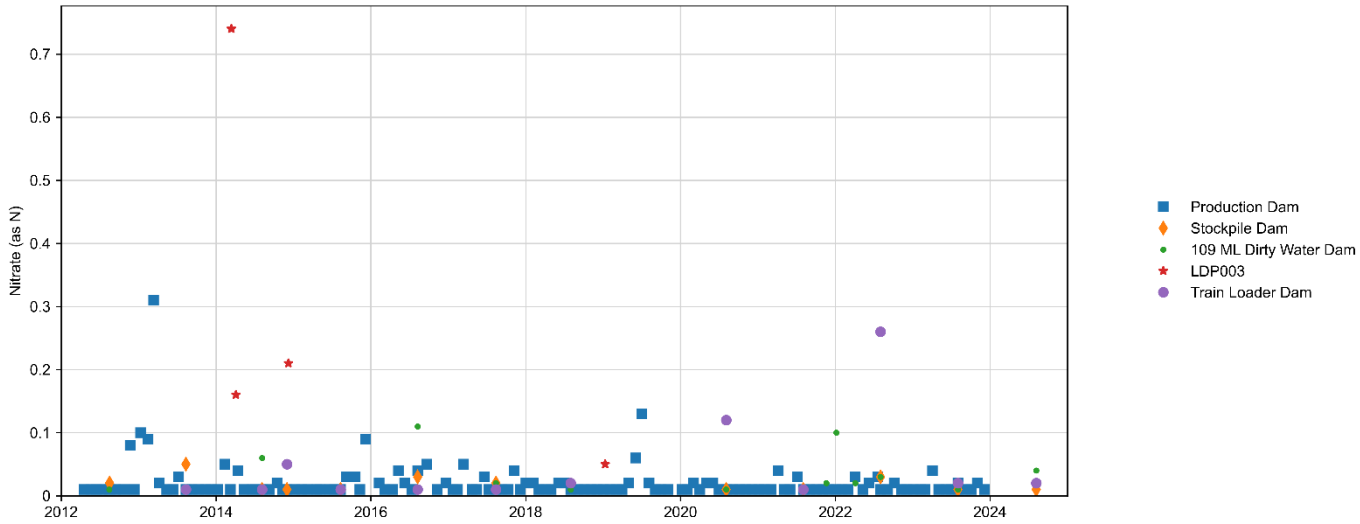


Figure B.100

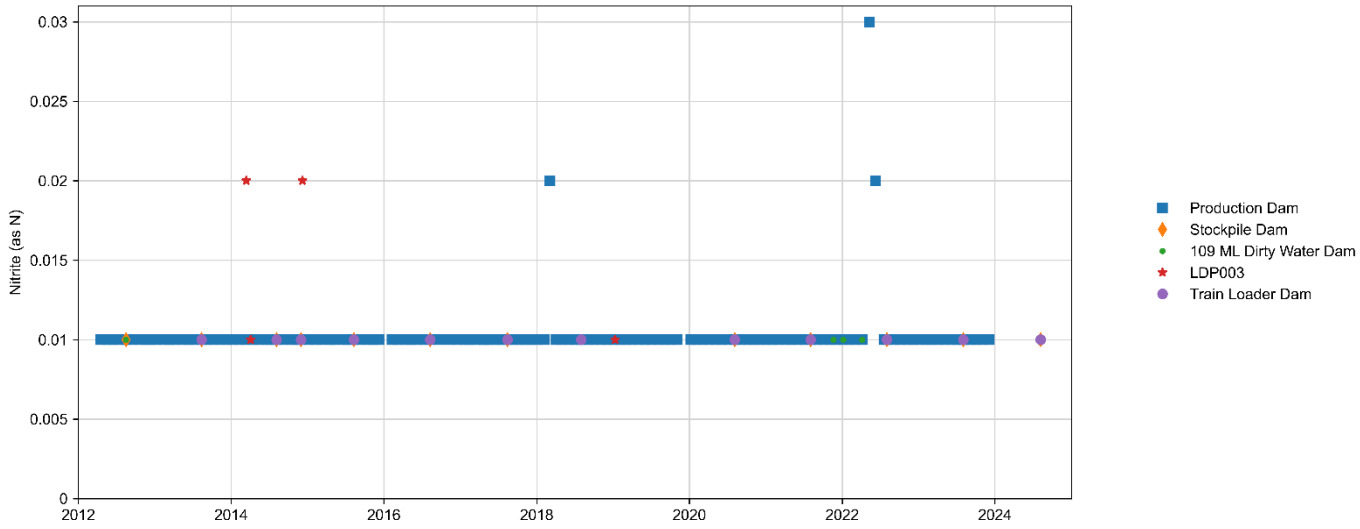


Figure B.101

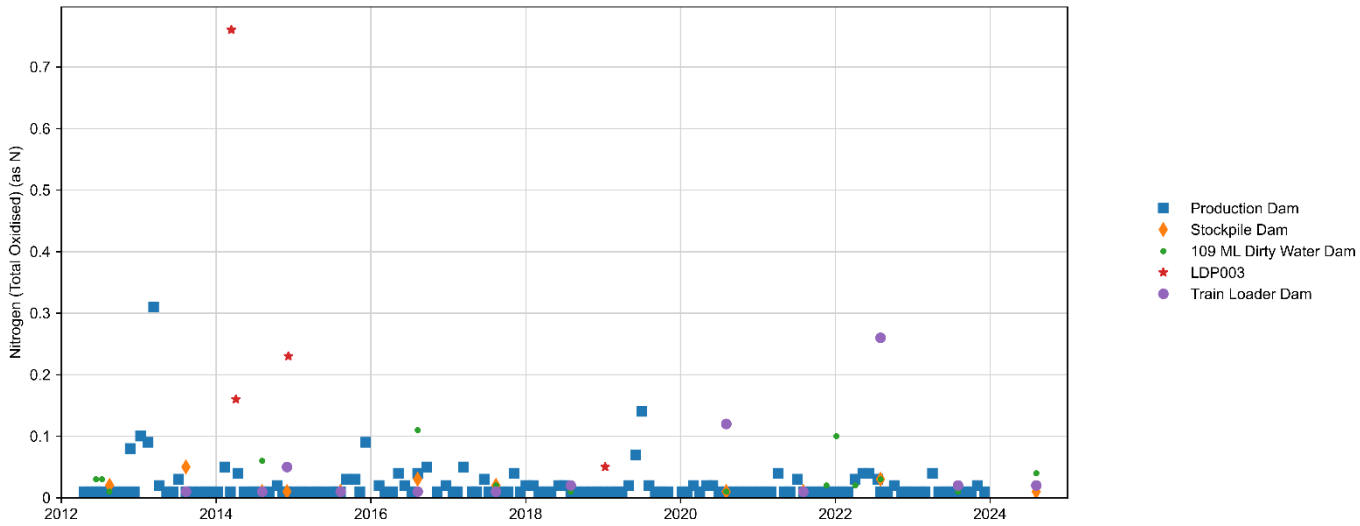


Figure B.102

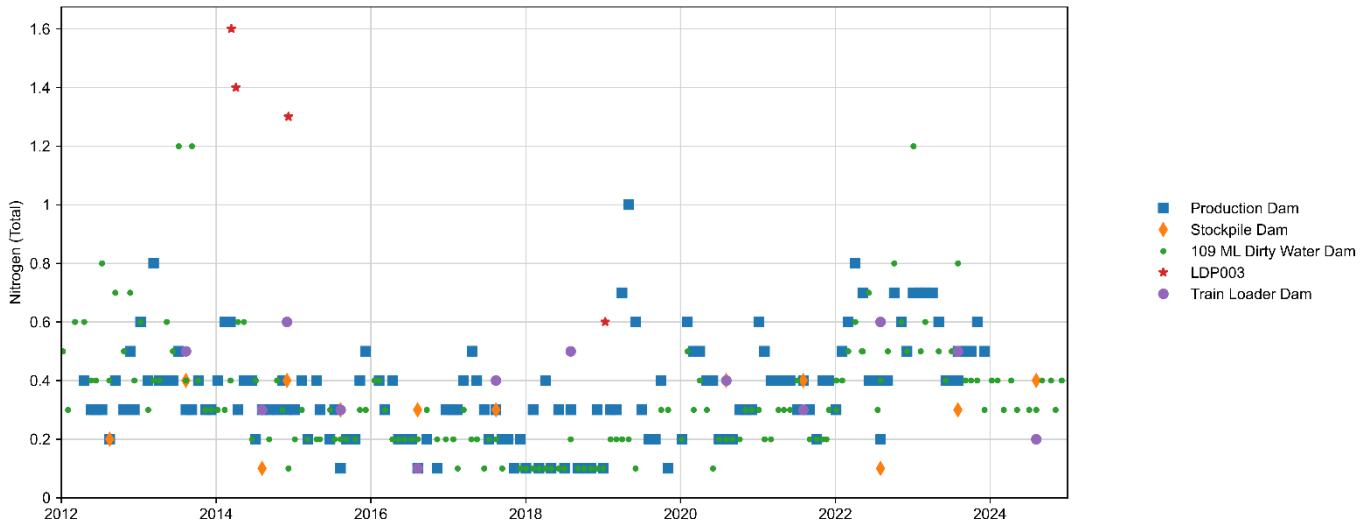


Figure B.103

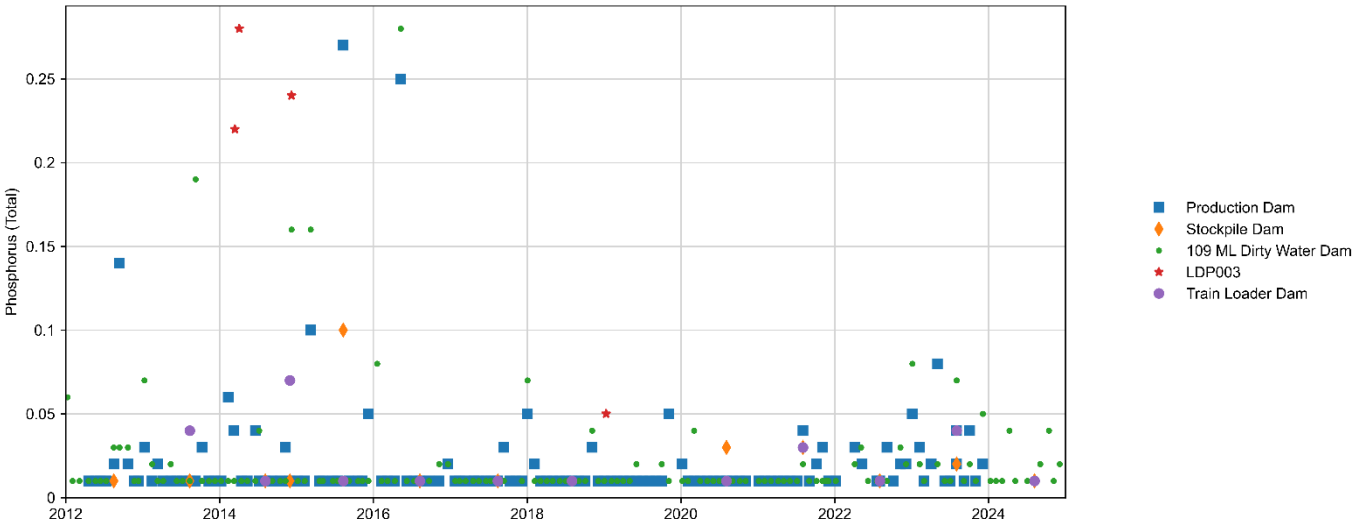

Phosphorus (Total)
0
0.05
0.1
0.15
0.2
0.25
2012
2014
2016
2018
2020
2022
2024
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

Figure B.104

Major ions

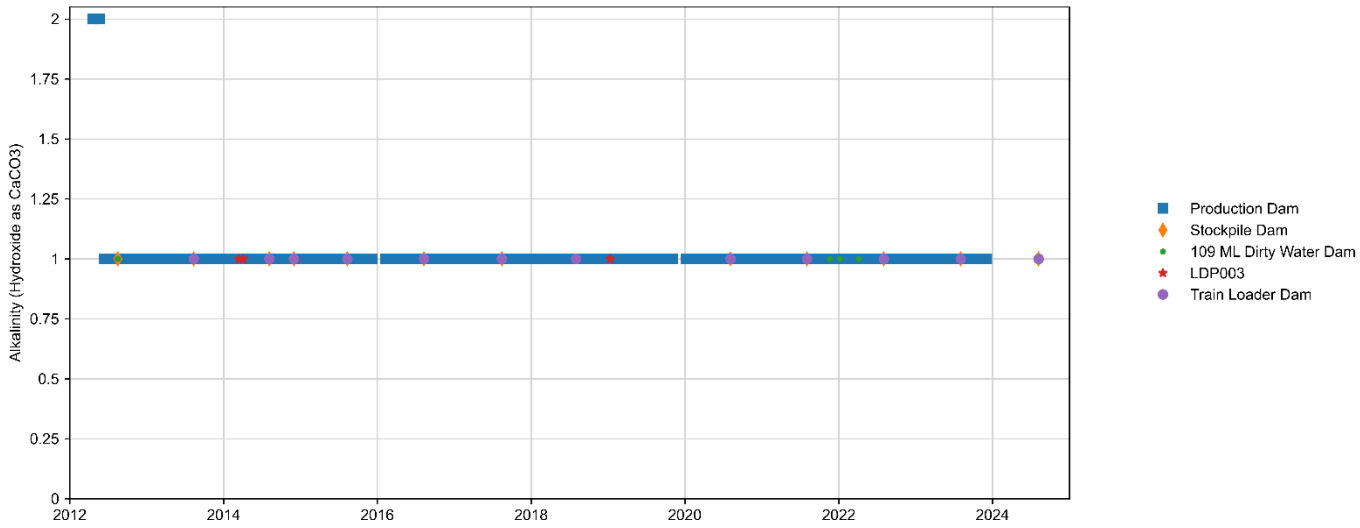


Figure B.105

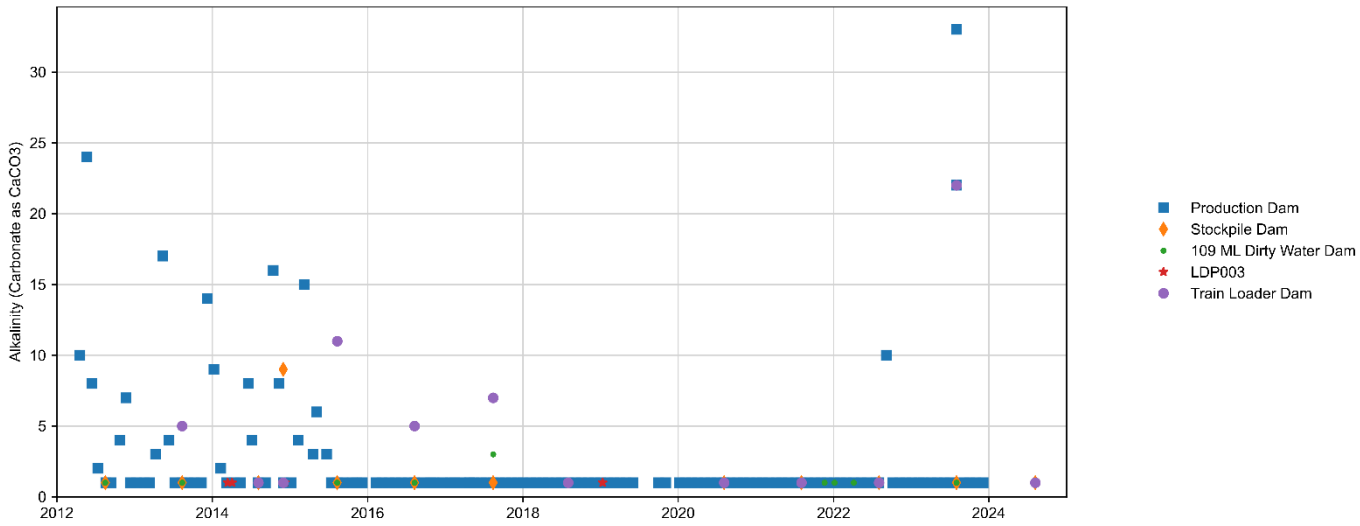


Figure B.106

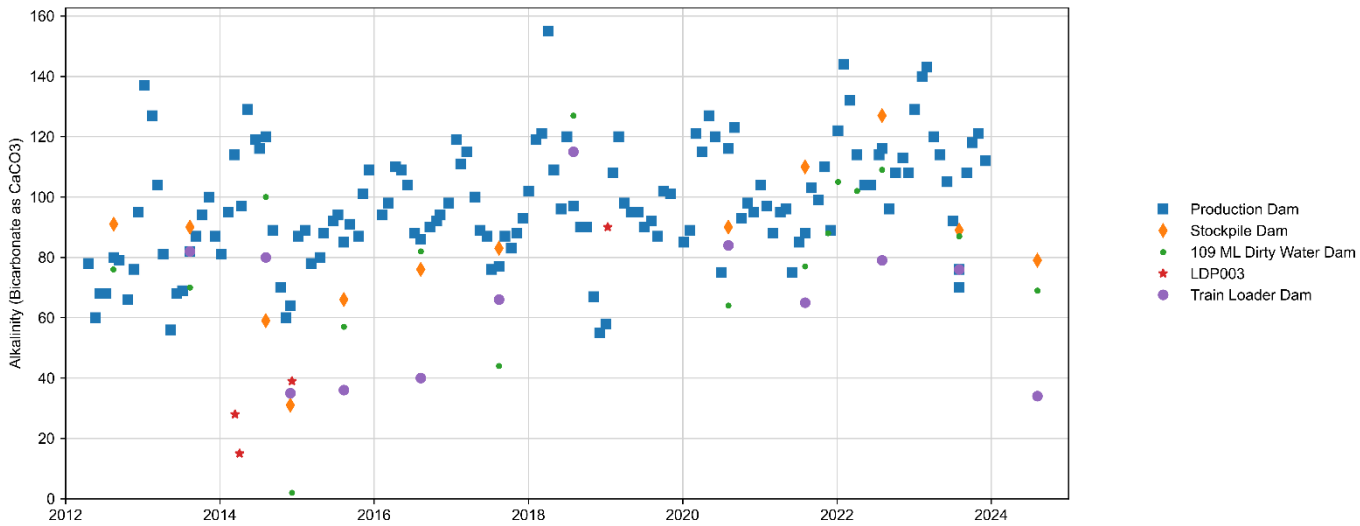


Figure B.107

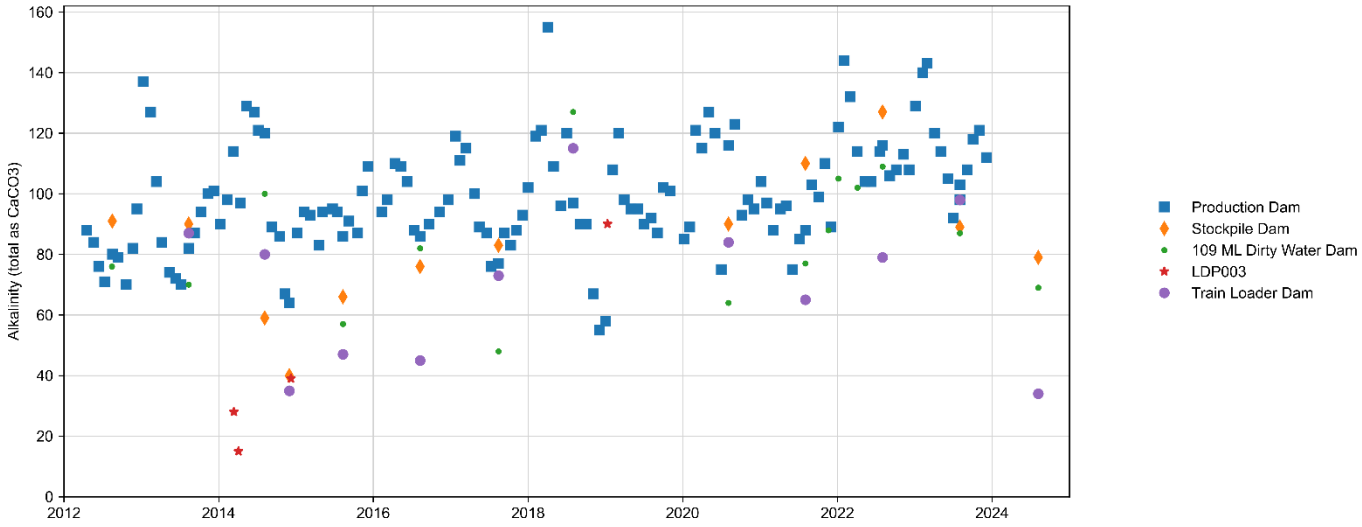


Figure B.108

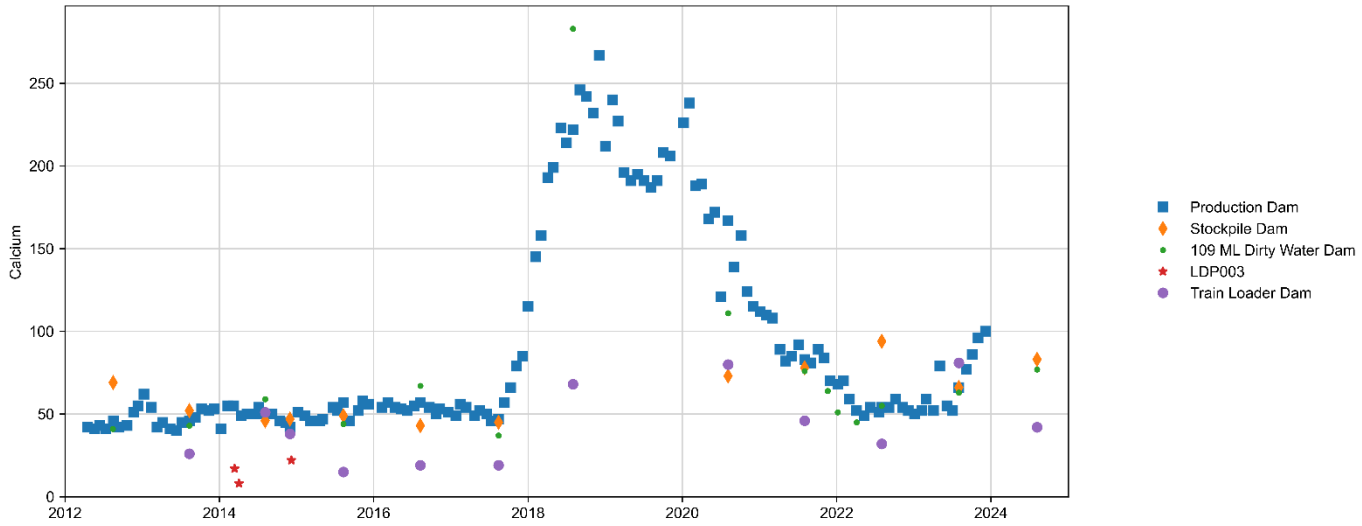


Figure B.109

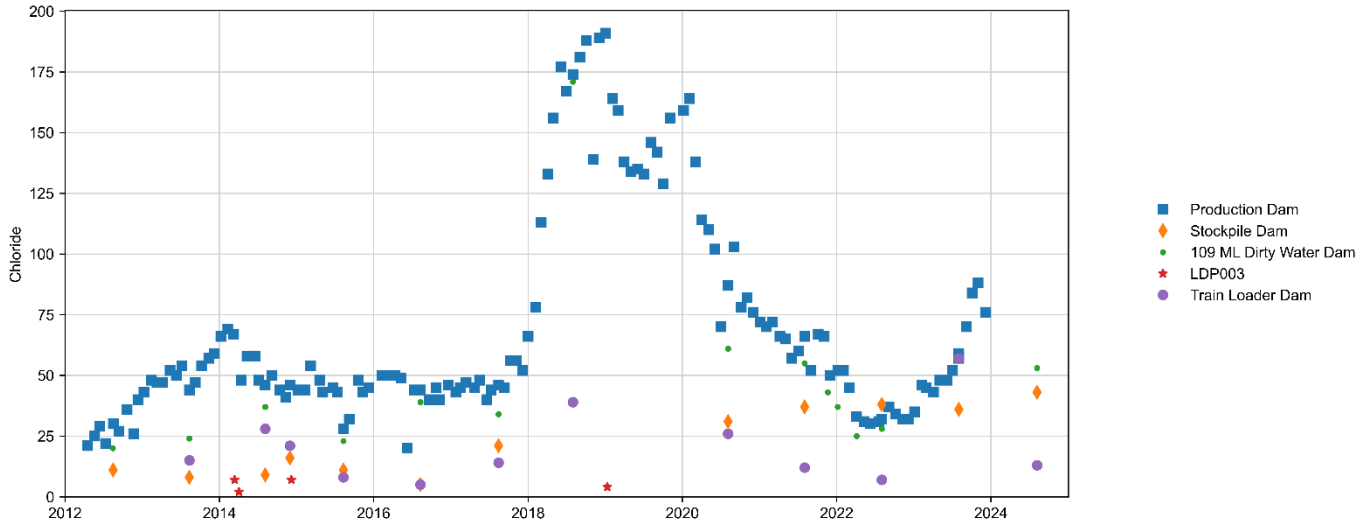


Figure B.110

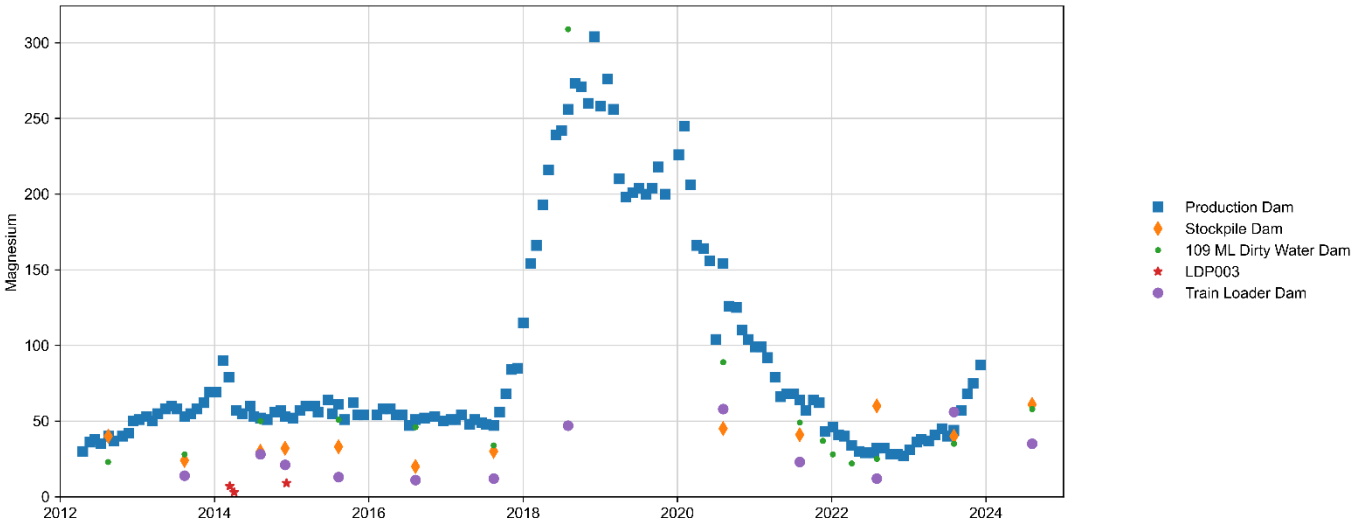


Figure B.111

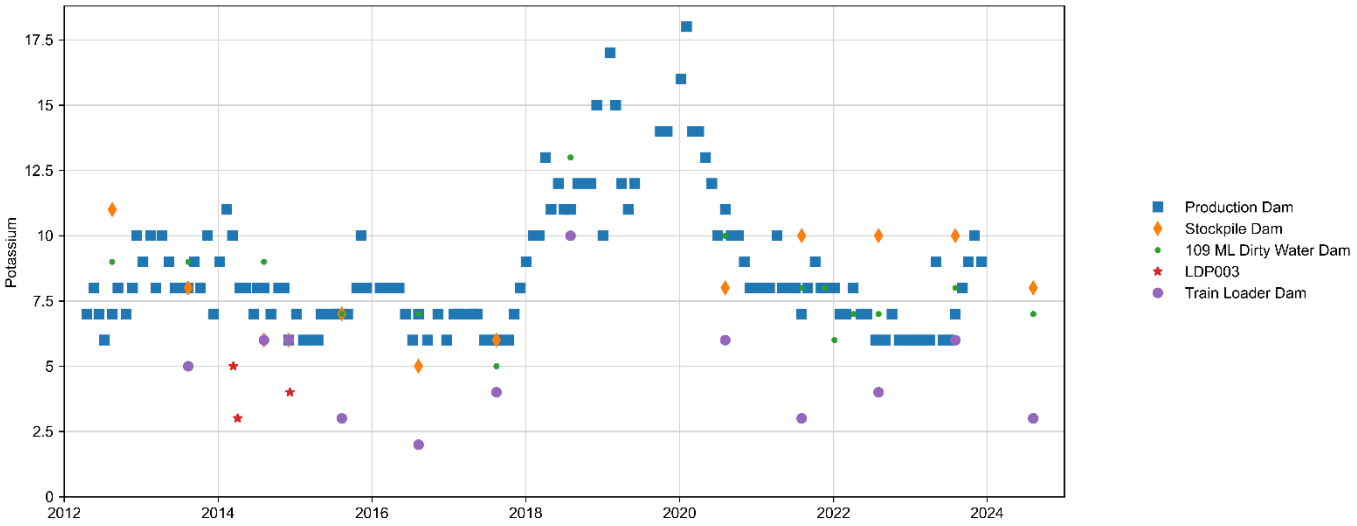


Figure B.112

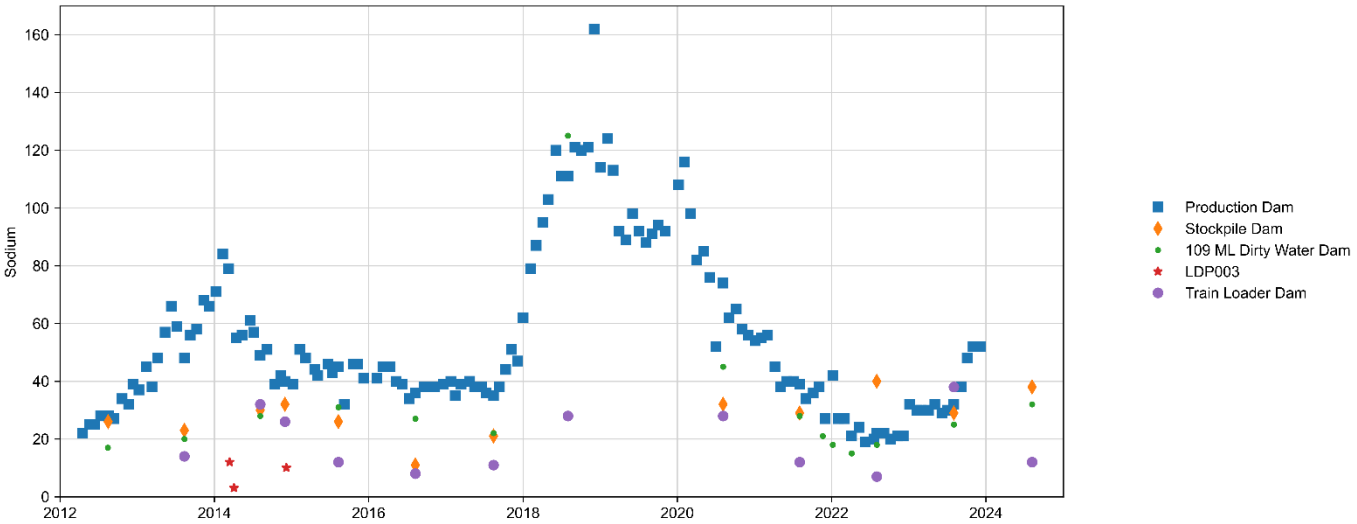


Figure B.113

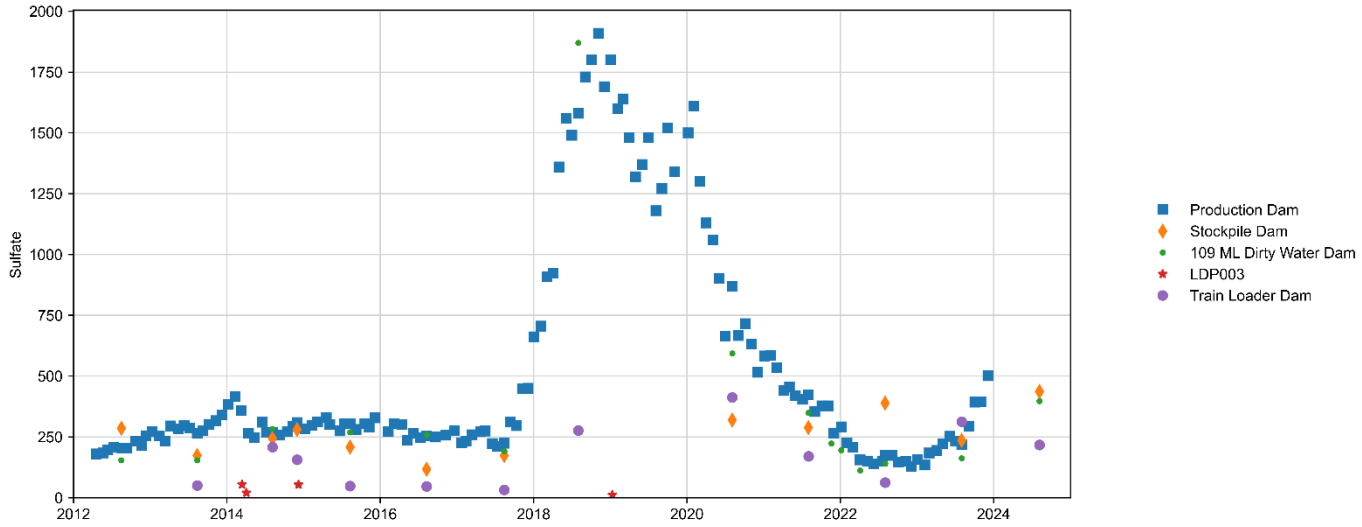

Sulfate
2000
1750
1500
1250
1000
750
500
250
0
2012
2014
2016
2018
2020
2022
2024
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

Figure B.114

Metals (dissolved)

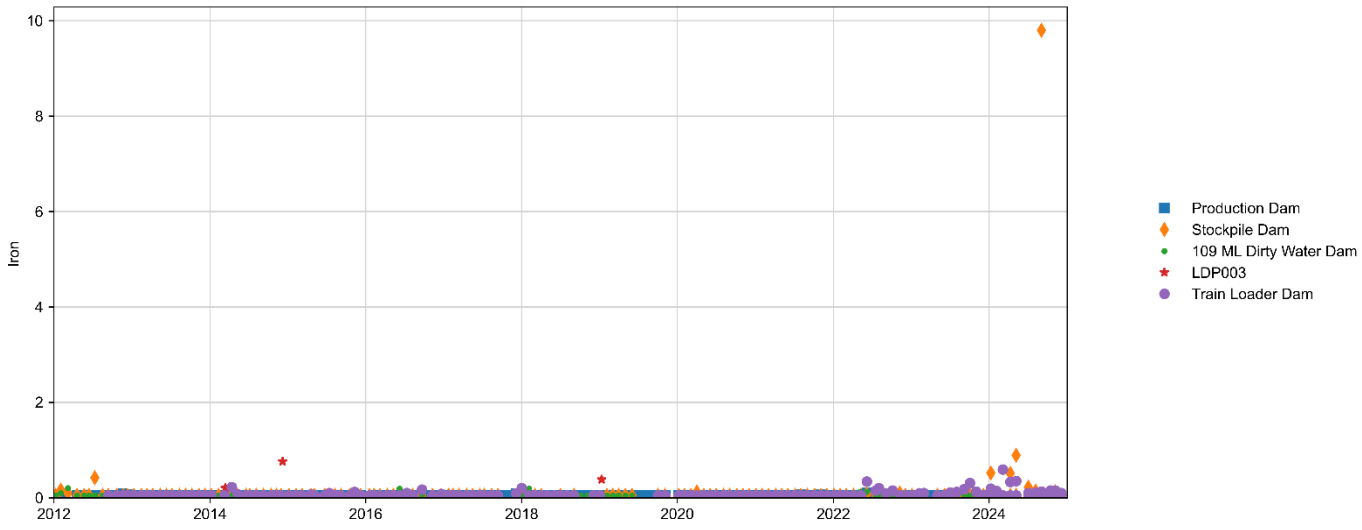


Figure B.115

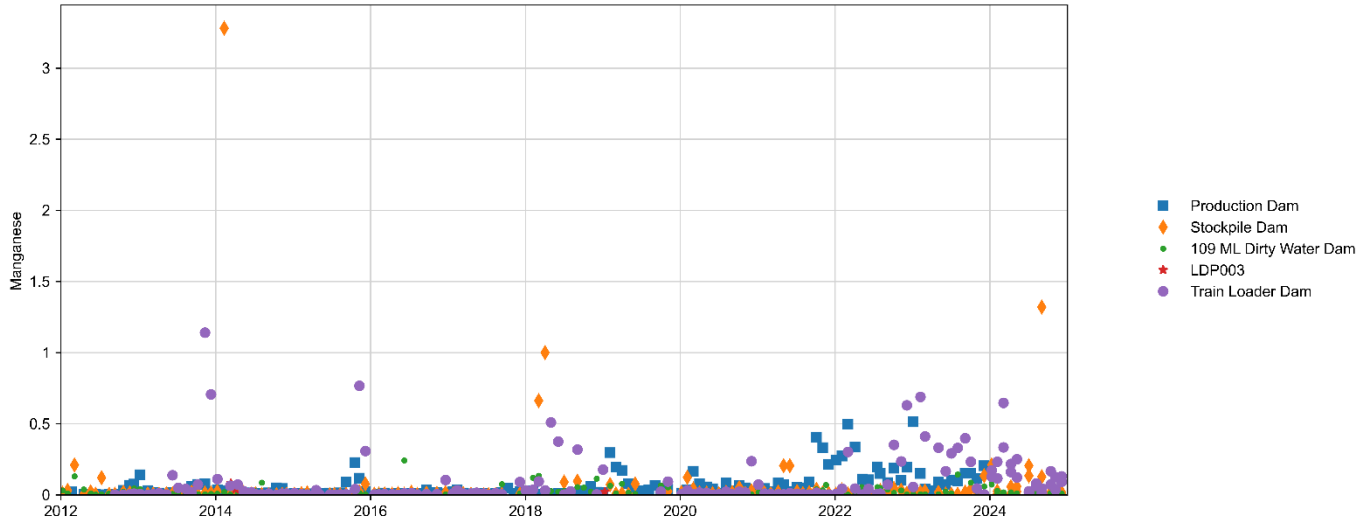


Figure B.116

Total Metals

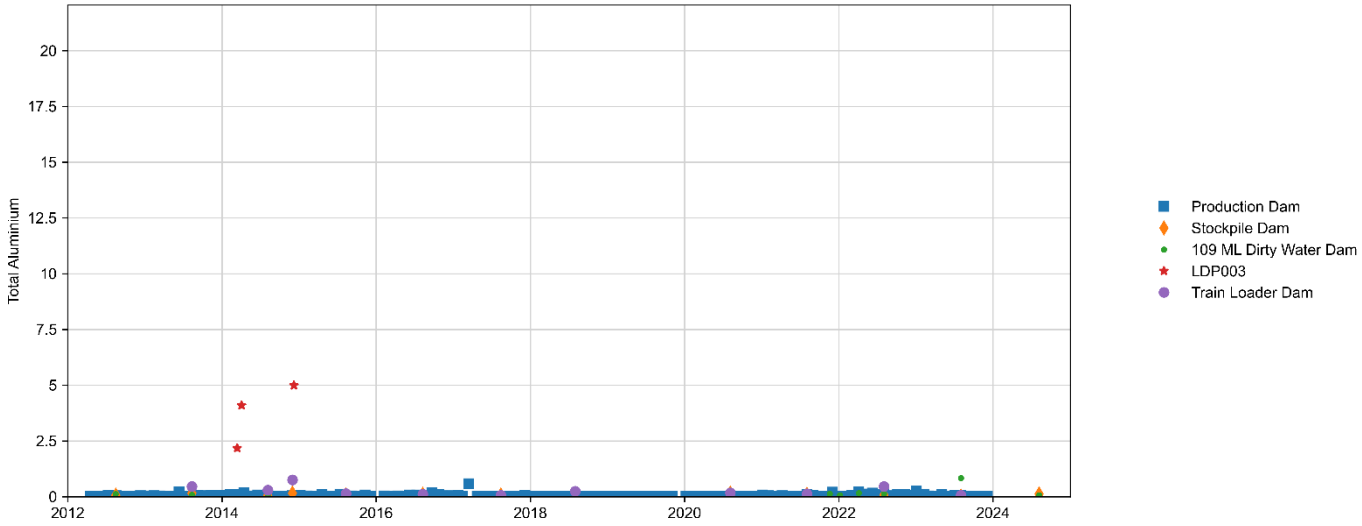


Figure B.117

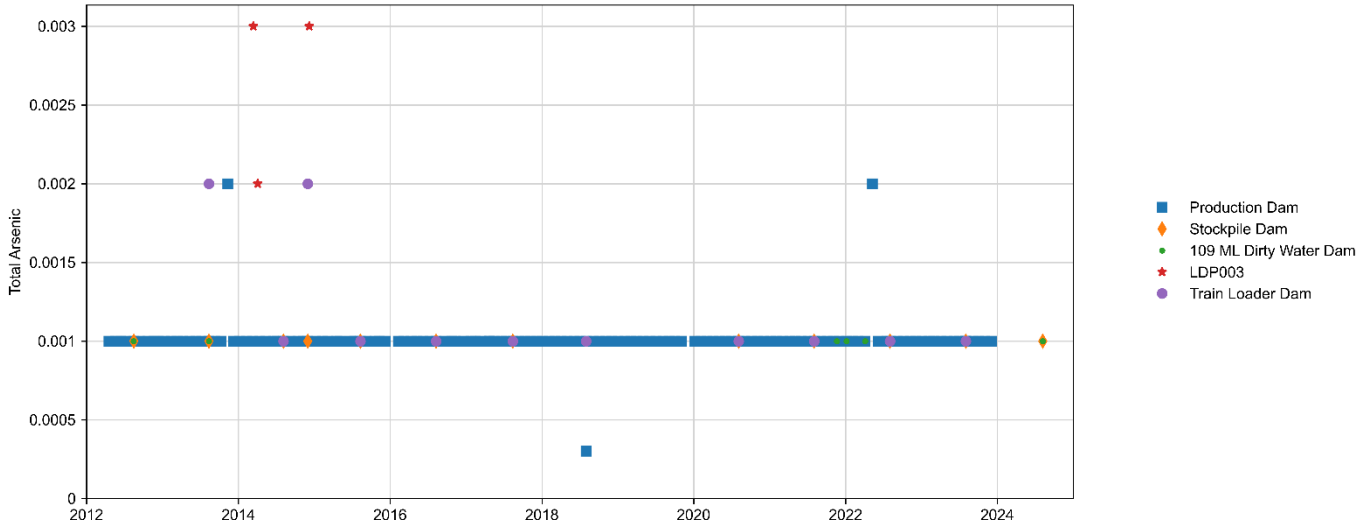


Figure B.118

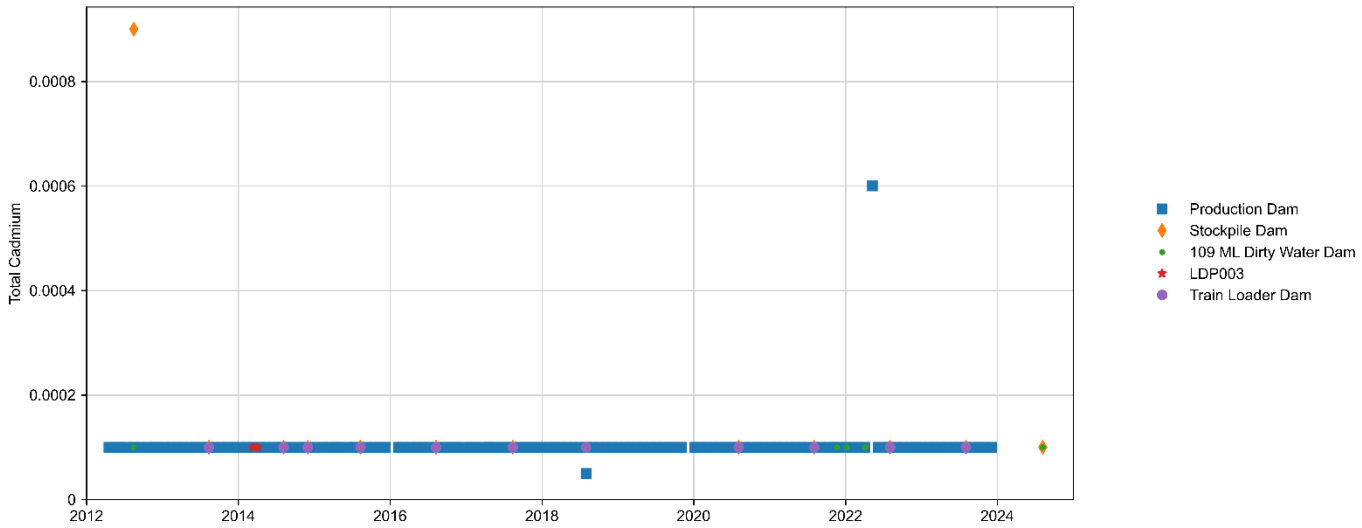


Figure B.119

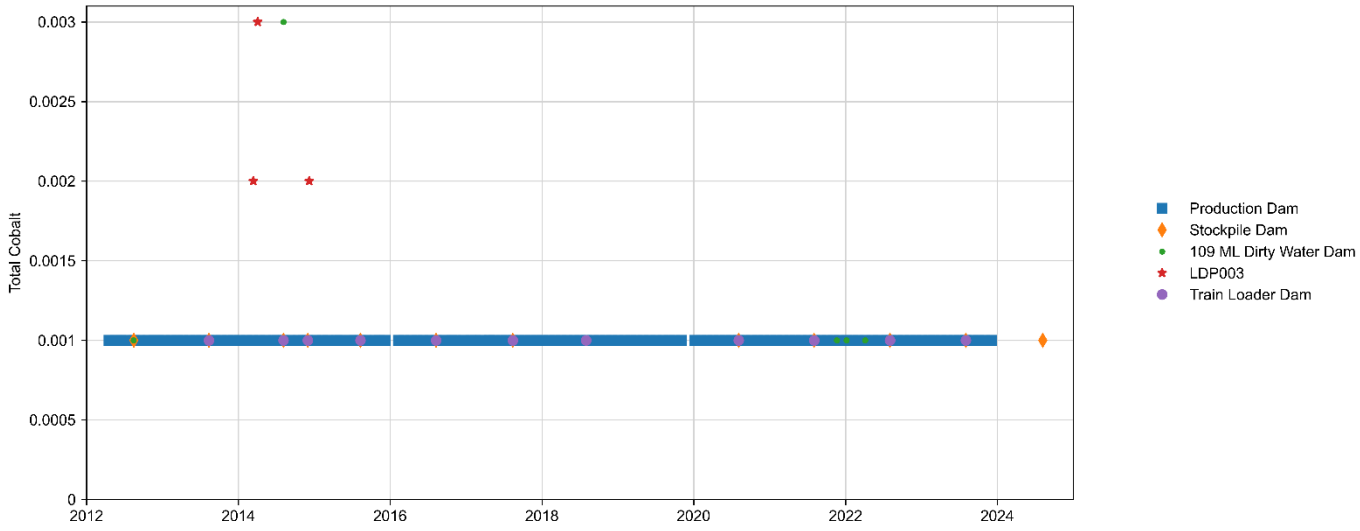


Figure B.120

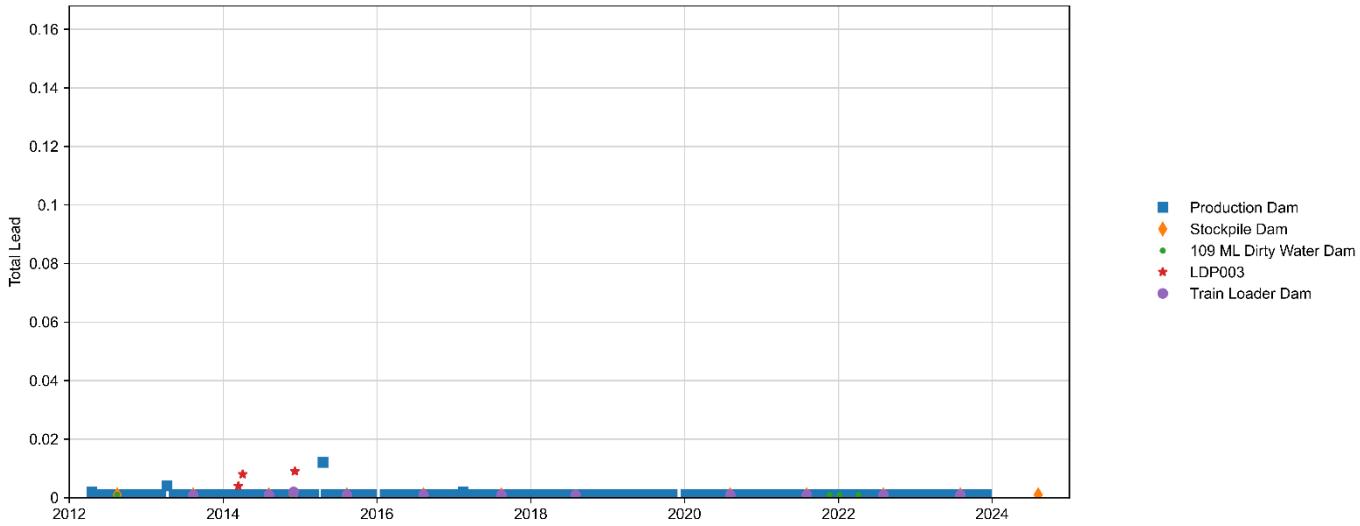


Figure B.121

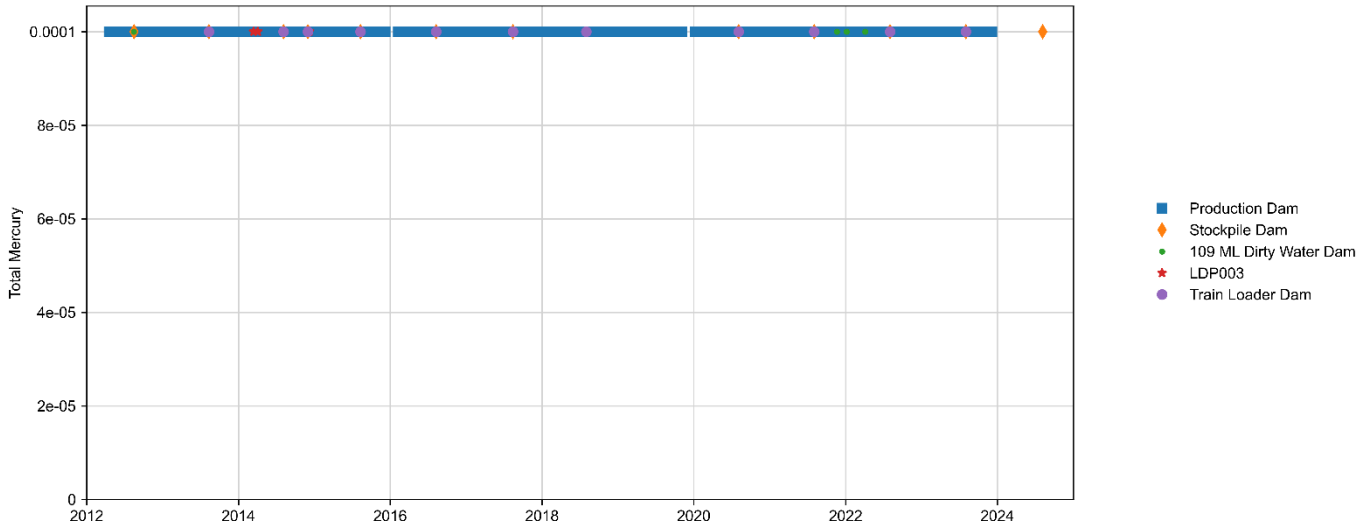


Figure B.122

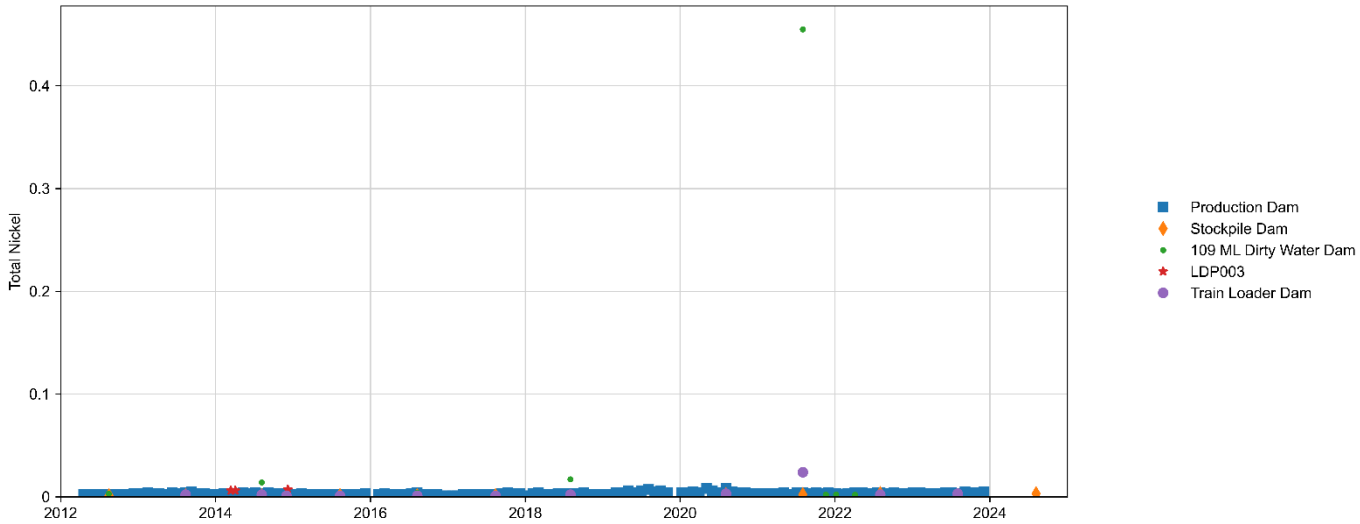


Figure B.123

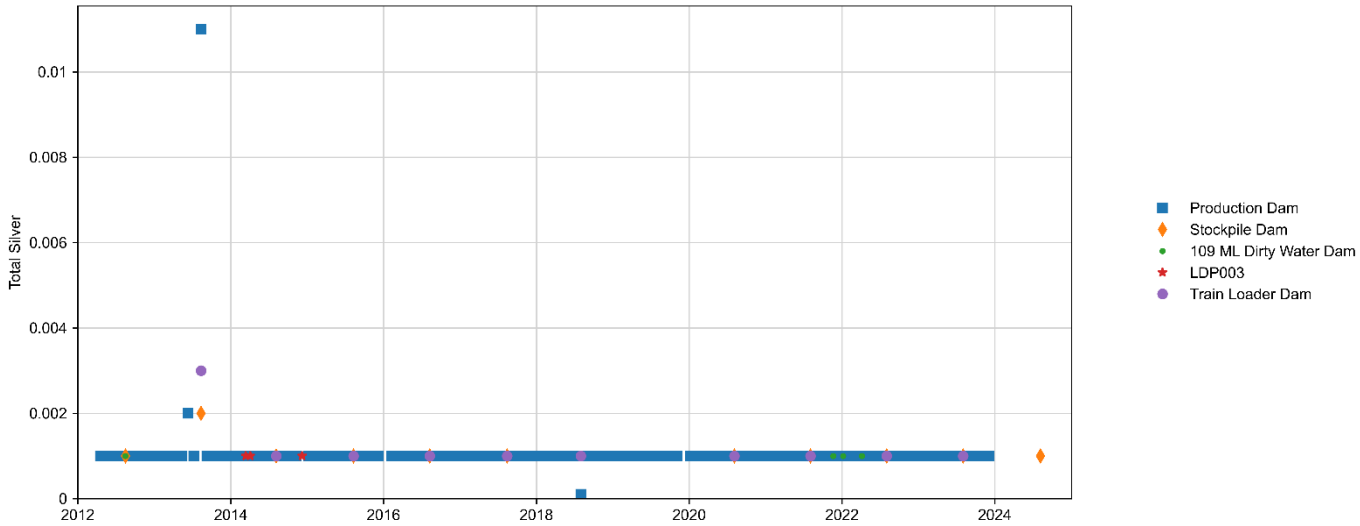


Figure B.124

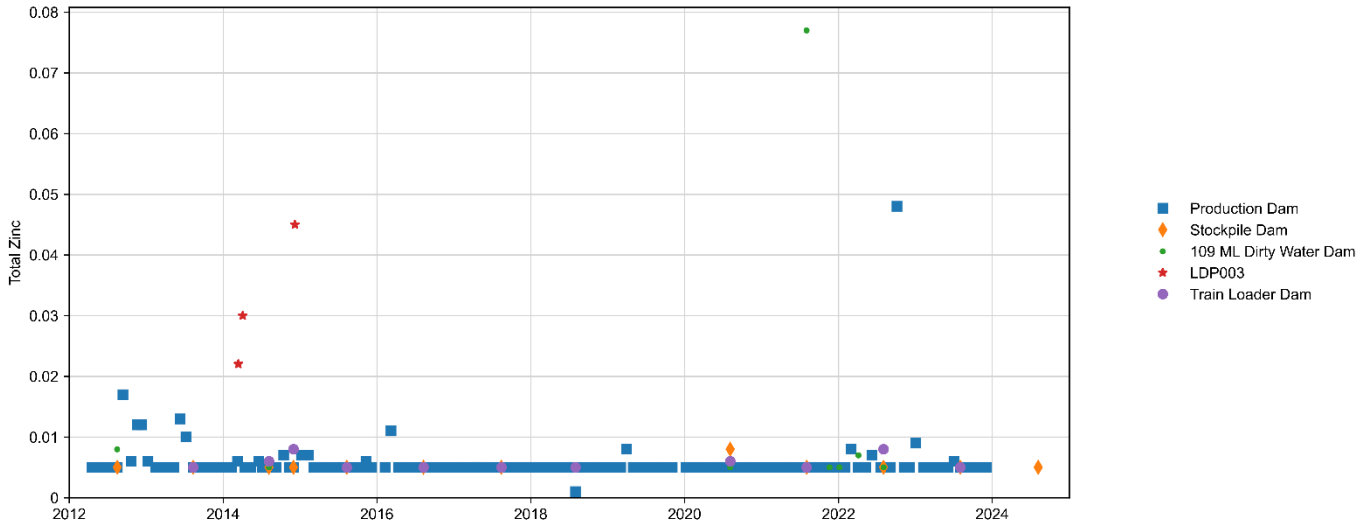


Figure B.125

Other

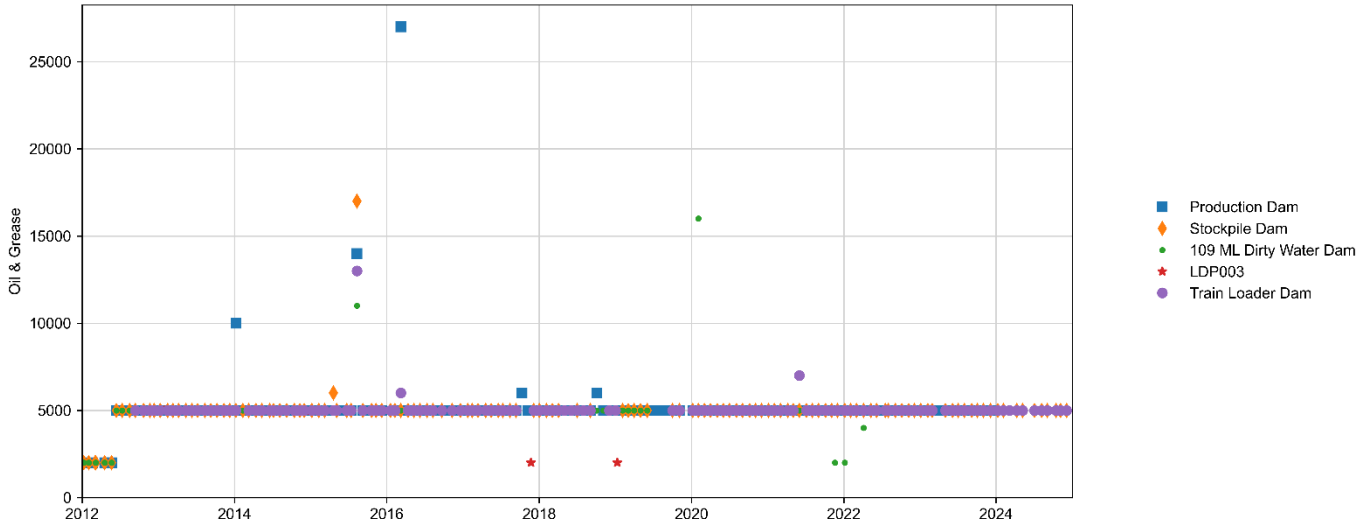


Figure B.126

Appendix C

SSGV and DGV summary

Surface water

Table C.1

Parameter	Units	Trigger Values (WMP (GHD, 2024))	Maximum Observed Concentration		
			2024		
			Airly Creek	Airly Creek Upstream	Airly Tributary
Physiochemical Parameters					
EC	µS/cm	2709	**2,970**	**2,770**	*
DO	mg/L	-	10.5	10.3	*
pH	pH units	6.5 – 8.0	7.8	**8.1**	*
TDS	mg/L	-	2890	2530	*
TSS	mg/L	25	3	4	*
Turbidity	NTU	25	7.4	4.4	*
Nutrients					
Ammonia	mg/L	0.32	0.18	0.24	*
Total nitrogen	mg/L	0.7	**1**	**1**	*
Total phosphorus	mg/L	0.056	**0.060**	0.040	*
Dissolved metals					
Aluminium	mg/L	0.027	0.001	0.001	*
Arsenic	mg/L	0.001	0.001	0.001	*
Barium	mg/L	0.017	**0.018**	**0.021**	*
Boron	mg/L	0.09	0.06	0.01	*
Cadmium	mg/L	0.00005	0.00005	0.00005	*
Cobalt	mg/L	0.001	**0.003**	**0.002**	*
Iron	mg/L	0.3	**2.53**	**0.72**	*
Lead	mg/L	0.001	0.001	0.001	*
Manganese	mg/L	1.2	**2.09**	**1.95**	*
Mercury	mg/L	0.0001	0.0001	0.0001	*
Nickel	mg/L	0.008	**0.013**	**0.009**	*
Silver	mg/L	0.001	0.001	0.001	*
Zinc	mg/L	0.0076	0.010	0.003	*

Cells highlighted RED denote exceedance of concern.
Cells containing – indicate dry conditions.
Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.
Cells containing '*" denotes data unavailable.

Table C.2

Parameter	Units	Genowlan Creek 2	
		Trigger value (WMP (GHD, 2024))	Maximum Observed concentration 2024
Physiochemical parameters			
DO	mg/L	-	5.9
EC	µS/cm	52	**491**
pH	pH units	5.6 - 6.6	**7.1**
TDS	mg/L	41	30
TSS	mg/L	-	5
Turbidity	NTU	-	0.9
Dissolved metals			
Aluminium	mg/L	-	0.03
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Cobalt	mg/L	-	0.001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.002	0.001
Iron	mg/L	0.06	0.01
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.014	0.013
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.002	0.001
Silver	mg/L	-	0.001
Zinc	mg/L	0.012	**0.018**

Cells highlighted RED denote exceedance of concern.
Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.3

Parameter	Units	The Grotto	
		Trigger value (WMP (GHD, 2024))	Maximum Observed concentration 2024
Physiochemical parameters			
DO	mg/L	-	3.53
EC	µS/cm	60	54
pH	pH units	5.4 - 6.1	**5.2**
TDS	mg/L	56	30
TSS	mg/L	-	5
Turbidity	mg/L	-	0.8
Dissolved metals			
Aluminium	mg/L	-	0.20
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Cobalt	mg/L	-	0.001
Chromium	mg/L	0.001	**0.004**
Copper	mg/L	0.001	0.001
Iron	mg/L	0.51	**1.52**
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.01	**0.019**
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.001	0.001
Silver	mg/L	-	0.001
Zinc	mg/L	0.011	0.008

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.4

Parameter	Units	Gap Creek	
		Trigger value (WMP (GHD, 2024))	Maximum Observed concentration 2024
Physiochemical parameters			
DO	mg/L	-	1.88
EC	µS/cm	178	**232**
pH	pH units	6.2 - 7.2	6.7
TDS	mg/L	130	**151**
TSS	mg/L	-	5
Turbidity	NTU	-	1.6
Dissolved metals			
Aluminium	mg/L	-	0.03
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Cobalt	mg/L	-	0.001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.002	0.001
Iron	mg/L	0.39	0.26
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.052	**0.134**
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.002	0.001
Silver	mg/L	-	0.001
Zinc	mg/L	0.014	0.008

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Groundwater

Table C.5

Parameter	Units	Village Spring	
		Trigger value (WMP (GHD, 2024))	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	5.84
EC	µS/cm	487	418
pH	pH units	7.8-8.3	8.0
TDS	mg/L	300	272
TSS	mg/L	16	**17**
Dissolved metals			
Aluminium	mg/L	-	0.01
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Cobalt	mg/L	-	0.001
Copper	mg/L	0.001	**0.002**
Iron	mg/L	0.05	0.001
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.004	**0.01**
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.004	0.009
Zinc	mg/L	0.026	**0.032**

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.6

Parameter	Units	ARP05	
		Trigger value (WMP (GHD, 2024))	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	5.33
EC	µS/cm	146	**967**
pH	pH units	5.8 – 6.0	6.0
TDS	mg/L	176	114
Dissolved metals			
Aluminium	mg/L	-	0.01
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Cobalt	mg/L	-	0.001
Chromium	mg/L	0.001	**0.002**
Copper	mg/L	0.003	0.002
Iron	mg/L	0.08	0.06
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.009	0.009
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.003	0.003
Zinc	mg/L	0.081	**0.184**

Cells highlighted RED denote exceedance of concern.
Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.7

Parameter	Units	ARP09	
		Trigger value SSGV (2024)	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	2.30
EC	µS/cm	56	43.2
pH	pH units	4.79 – 5.33	4.8
TDS	mg/L	35	25
Dissolved metals			
Aluminium	mg/L	-	0.38
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.00001
Chromium	mg/L	0.001	**0.002**
Cobalt	mg/L	-	0.01
Copper	mg/L	0.001	**0.005**
Iron	mg/L	1.14	0.34
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.017	0.018
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.002	0.002
Zinc	mg/L	0.032	**0.082**

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.8

Parameter	Units	ARP11	
		Trigger value (WMP (GHD, 2024))	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	11.8
EC	µS/cm	1760	1079
pH	pH units	6.7 - 7.2	7.1
TDS	mg/L	1170	696
Dissolved metals			
Aluminium	mg/L	-	0.18
Arsenic	mg/L	0.002	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	**0.004**
Cobalt	mg/L	-	0.005
Copper	mg/L	0.002	0.001
Iron	mg/L	1.14	0.77
Lead	mg/L	0.001	**0.002**
Manganese	mg/L	0.343	0.148
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.006	**0.014**
Zinc	mg/L	0.016	**0.127**

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.9

Parameter	Units	ARP12	
		Trigger value SSGV (2024)	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	3.63
EC	µS/cm	79	91
pH	pH units	5.21 - 6.40	**3.96**
TDS	mg/L	48	**51**
Dissolved metals			
Aluminium	mg/L	-	0.17
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	**0.022**
Cobalt	mg/L	-	0.001
Copper	mg/L	0.001	0.001
Iron	mg/L	1.19	0.17
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.025	0.025
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.001	0.001
Zinc	mg/L	0.182	0.137

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.10

Parameter	Units	ARP13SP	
		Trigger value (WMP (GHD, 2024))	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	3.64
EC	µS/cm	760	611
pH	pH units	6.7 – 7.2	6.93
TDS	mg/L	463	420
Dissolved metals			
Aluminium	mg/L	-	0.01
Arsenic	mg/L	0.002	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	**0.016**
Cobalt	mg/L	-	0.005
Copper	mg/L	0.002	0.002
Iron	mg/L	1.28	0.12
Lead	mg/L	0.001	**0.014**
Manganese	mg/L	0.31	0.17
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.003	**0.008**
Zinc	mg/L	0.033	**0.239**

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.11

Parameter	Units	ARP14	
		Trigger value (WMP (GHD, 2024))	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	2.56
EC	µS/cm	82	**98.4**
pH	pH units	5.7 - 7.2	6.1
TDS	mg/L	74	56
Dissolved metals			
Aluminium	mg/L	-	0.52
Arsenic	mg/L	0.001	**0.002**
Cadmium	mg/L	0.0001	**0.0002**
Chromium	mg/L	0.001	**0.041**
Cobalt	mg/L	-	0.002
Copper	mg/L	0.001	**0.037**
Iron	mg/L	0.9	**6.39**
Lead	mg/L	0.001	**0.014**
Manganese	mg/L	0.081	**0.347**
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.002	**0.006**
Zinc	mg/L	0.033	**0.268**

Cells highlighted RED denote exceedance of concern.
Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.12

Parameter	Units	ARP15SP	
		Trigger value (WMP (GHD, 2024))	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	2.84
EC	µS/cm	109	84
pH	pH units	5.9 – 7.5	6.19
TDS	mg/L	71	44
Dissolved metals			
Aluminium	mg/L	-	0.02
Arsenic	mg/L	0.001	**0.003**
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	**0.002**
Cobalt	mg/L	-	0.013
Copper	mg/L	0.009	0.002
Iron	mg/L	1.54	1.47
Lead	mg/L	0.003	**0.006**
Manganese	mg/L	0.282	**0.348**
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.011	**0.038**
Zinc	mg/L	0.067	**0.137**

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.13

Parameter	Units	Nioka	
		Trigger value SSGV (2024)	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	3.45
EC	µS/cm	1,669	1,607
pH	pH units	7.04- 7.77	7.15
TDS	mg/L	1160	1,050
Dissolved metals			
Aluminium	mg/L	-	0.01
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Cobalt	mg/L	-	0.001
Copper	mg/L	0.004	0.001
Iron	mg/L	0.21	0.12
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.018	0.007
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.001	**0.002**
Zinc	mg/L	0.08	0.053

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.14

Parameter	Units	Kingdom	
		Trigger value SSGV (2024)	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	4.02
EC	µS/cm	1,346	1,180
pH	pH units	6.72 - 7.24	7.40
TDS	mg/L	735	767
Dissolved metals			
Aluminium	mg/L	-	0.01
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Cobalt	mg/L	-	0.001
Copper	mg/L	0.02	0.003
Iron	mg/L	0.13	**0.150**
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.007	0.001
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.004	0.001
Zinc	mg/L	0.024	**0.04**

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Table C.15

Parameter	Units	GW800878	
		Trigger value SSGV (2024)	Maximum observed concentration 2024
Physicochemical parameters			
DO	mg/L	-	4.36
EC	µS/cm	744	**802**
pH	pH units	6.79 - 7.37	**7.56**
TDS	mg/L	461	**521**
Dissolved metals			
Aluminium	mg/L	-	0.01
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Cobalt	mg/L	-	0.001
Copper	mg/L	0.001	0.001
Iron	mg/L	1.19	0.16
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.025	**0.042**
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.001	0.001
Zinc	mg/L	0.182	0.026

Data in **bold** denote exceedance of SSGV.
- No SSGV/trigger value exists for this parameter.

Appendix D

Piper Charts

Permian and Fractured Rock Groundwater

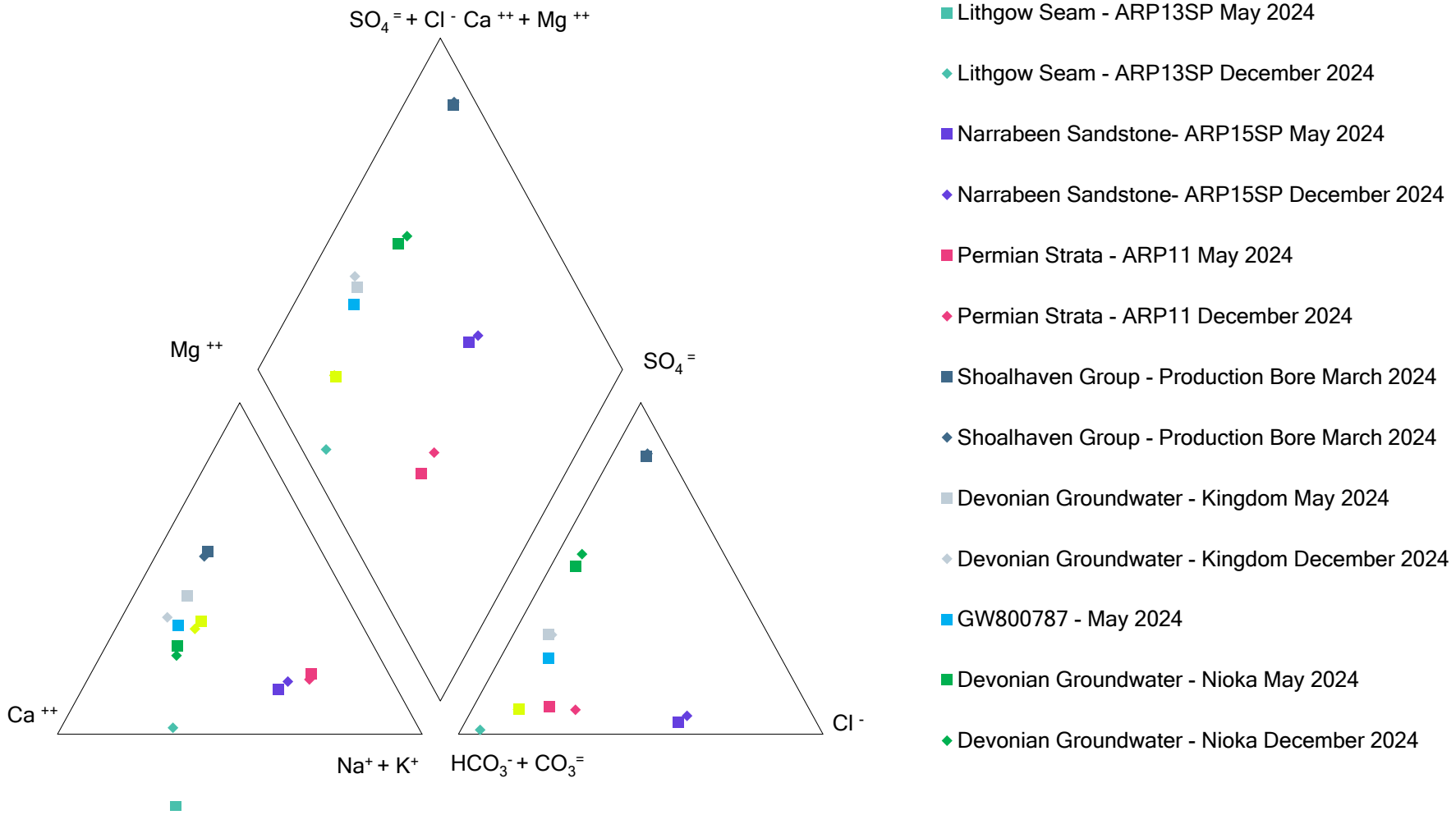


Figure D.1

Genowlan Creek surface water

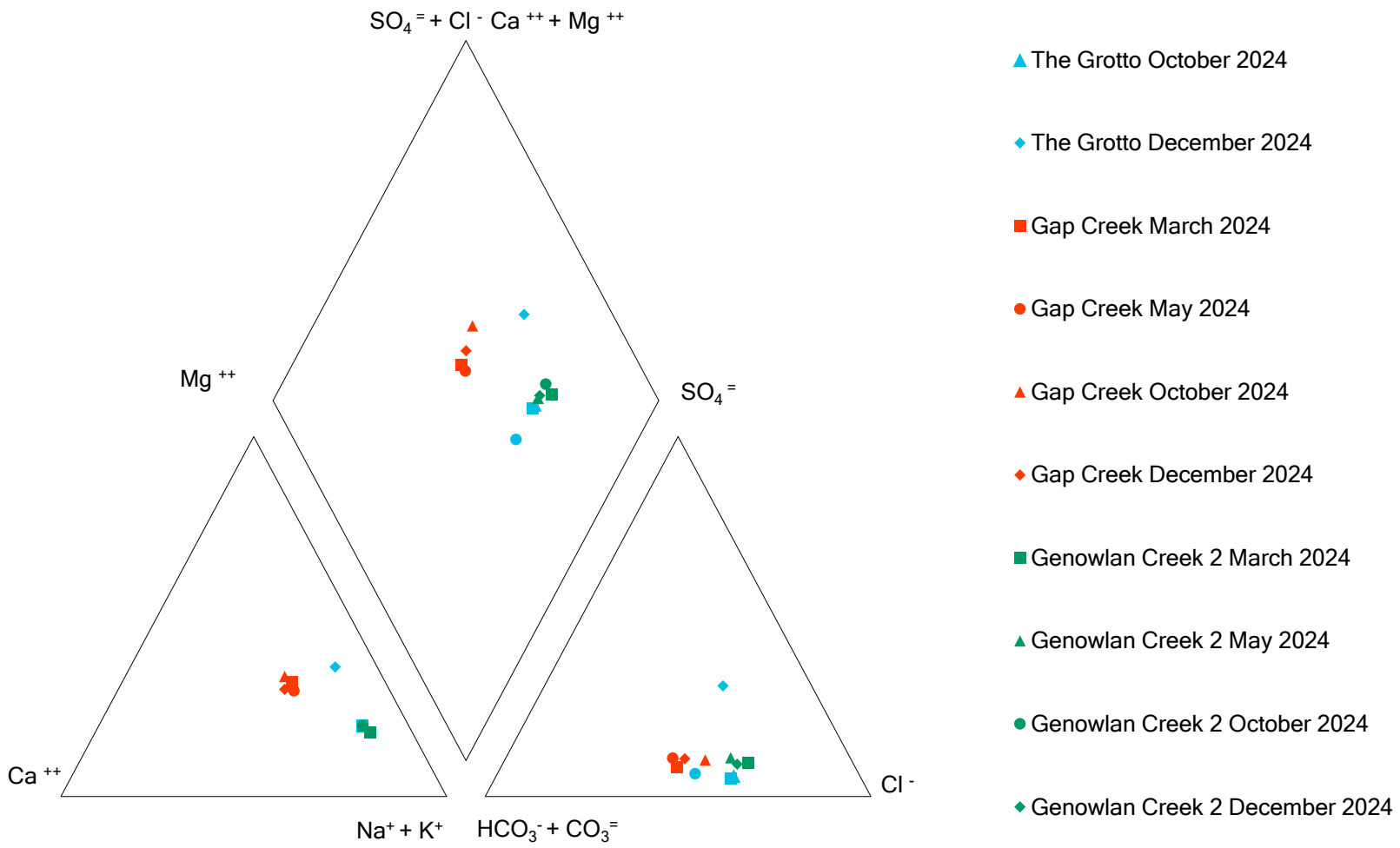


Figure D.2

Genowlan Creek alluvial bores

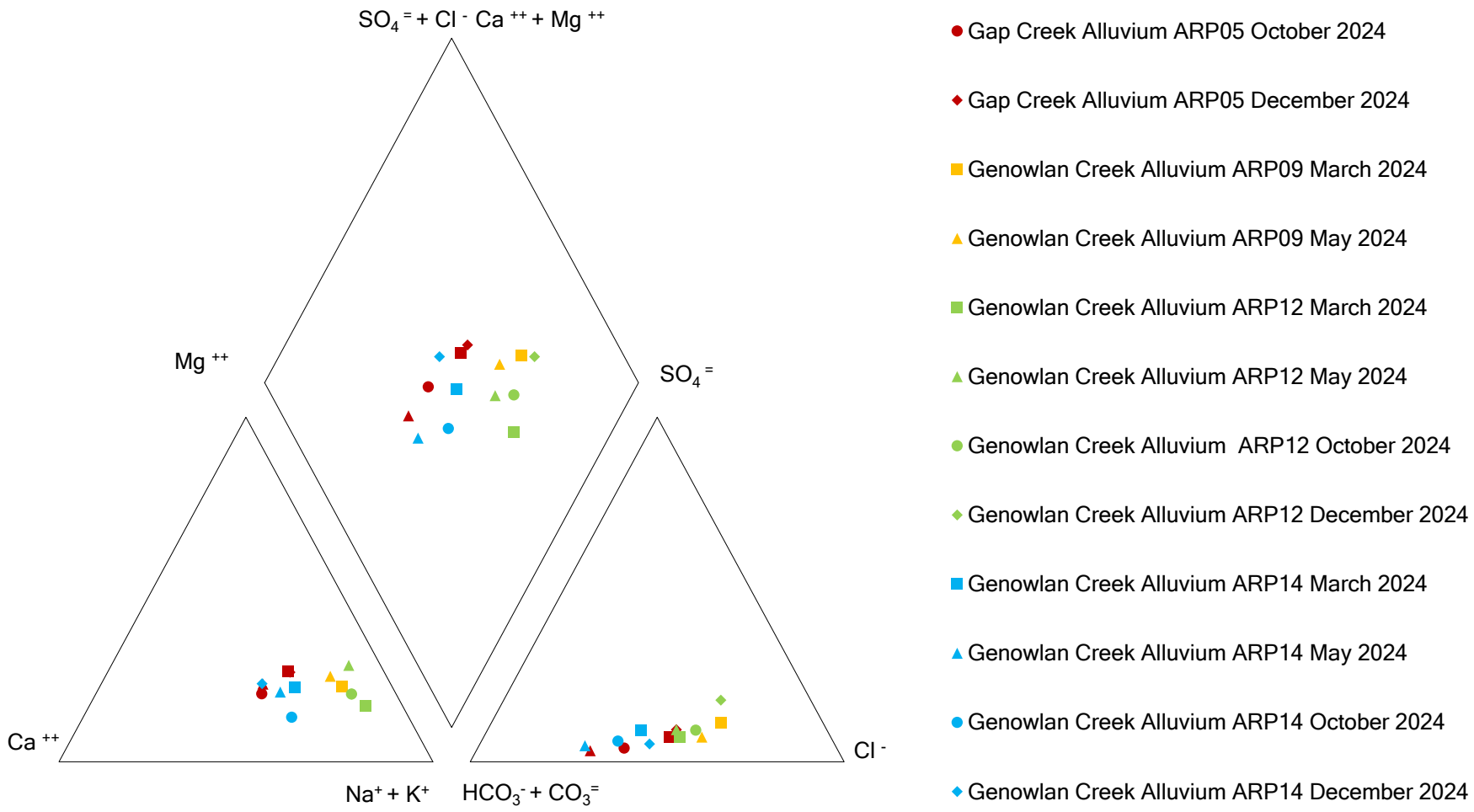


Figure D.3

Airly Creek

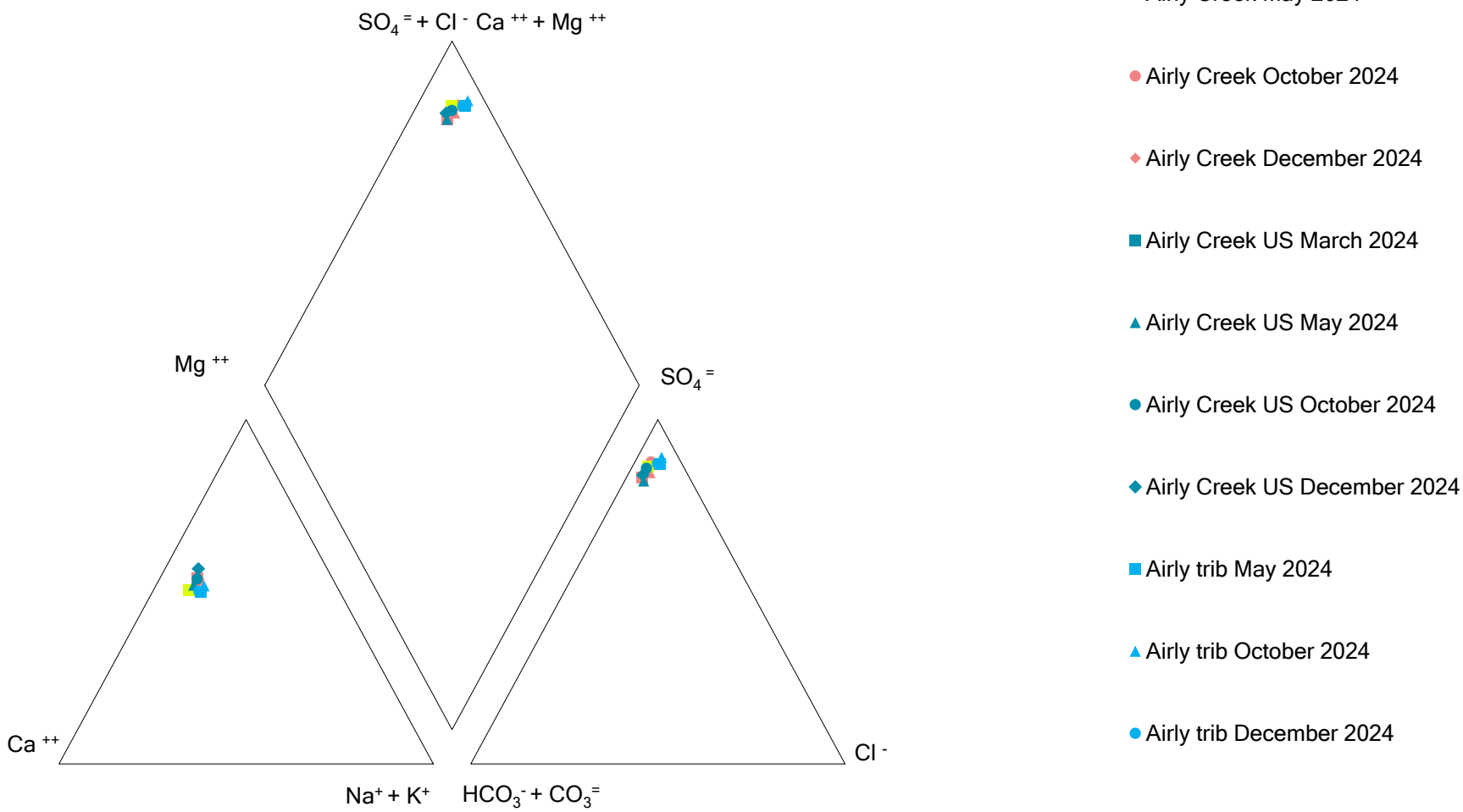


Figure D.4

Surface dam storages

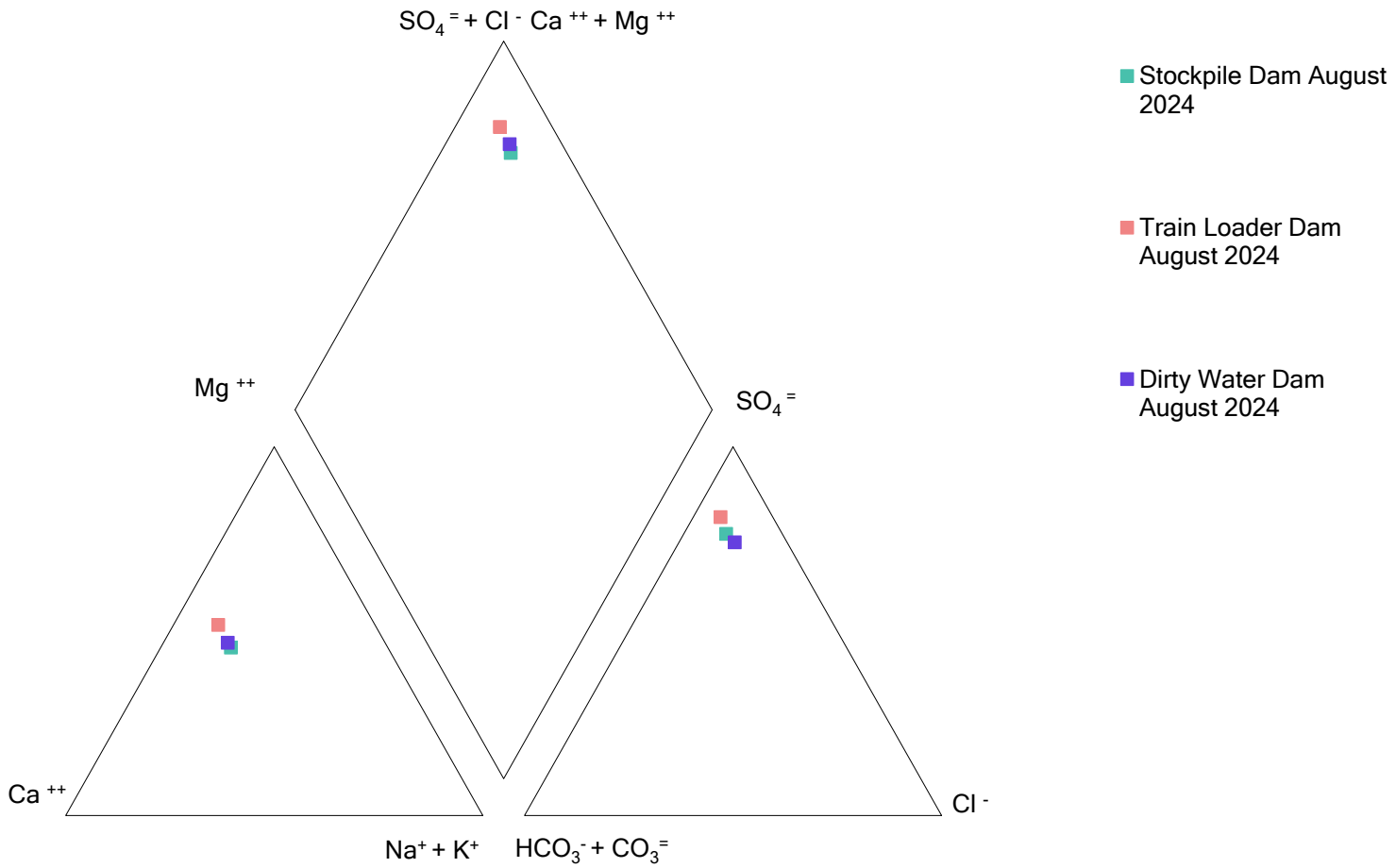


Figure D.5

ghd.com

→ The Power of Commitment

Appendix 7: Airly Mine Watercourse Stability 2024 Monitoring Report

Airly Mine

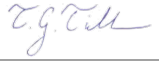
Watercourse Stability Monitoring Report 2024

Centennial Airly Pty Ltd

20 March 2025

→ The Power of Commitment



Project name		Centennial Airly aquatic ecology, stygofauna and geomorphology 2024					
Document title		Airly Mine | Watercourse Stability Monitoring Report 2024					
Project number		12633750					
File name		12633750-REP-Airly 2024 watercourse stability monitoring report.docx					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	T. Hopwood	T. Tinkler		Z. Lagerroth		20/03/25

GHD Pty Ltd | ABN 39 008 488 373

GHD Tower, Level 3, 24 Honeysuckle Drive

Newcastle, New South Wales 2300, Australia

T +61 2 4979 9999 | **F** +61 2 9475 0725 | **E** ntlmail@ghd.com | **ghd.com**

© GHD 2025

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Statement of compliance

Overarching review

Statement of compliance question	Statement of compliance answer
Were all conditions of SSD_5581 and the Airly Mine Water Management Plan relating to geomorphology complied with?	Yes – There were no non-compliances relating to watercourse geomorphology or watercourse stability in the 2024 reporting period.

Details of non-compliances

Relevant approval	Condition #	Condition summary	Compliance status	Comment	Reference # addressed in annual review
NA			Compliant		

Development consent SSD-5581 (Modification 5) conditions relating to geomorphic condition and watercourse stability

Condition	Condition description	Compliant	Relevant section of this document
Water management performance measures			
Aquatic and riparian ecosystems			
Schedule 4 12.	Maintain or improve baseline channel stability	Yes	Refer to Section 3.
Surface water management plan			
Schedule 4 13. (c) (ii)	A program to monitor and report on:		
	Surface water flows, quality and geomorphology of the watercourses potentially affected by the development within and immediately outside of the site.	Yes	Refer Section 3. Monitoring program for surface water flows, quality and geomorphology outlined in Section 4 of WMP (GHD 2024). Monitoring results for water quality and flow addressed in the 2024 Annual Water Monitoring Report (GHD 2025a) and Aquatic Ecology 2024 Annual Report (GHD 2025b).

NA – not applicable to this report

Statement of commitments relating to geomorphology (GHD 2024)

Commitment	Compliant	Relevant section of this document
The monitoring of geomorphic condition of third order streams, which will be undertaken approximately every two years.	Yes	Section 3.2.

Stream health performance criteria relating to geomorphology (GHD 2024)

Aspect	Criteria	Compliant	Relevant section of this document
Geomorphic condition and watercourse stability (required every two years)			
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. Maintain or improve baseline channel stability.	Yes, no changes to watercourse stability for Gap and Genowlan Creek were identified. Yes, no changes to baseline channel stability were identified for Gap Creek, Genowlan Creek and Dog Trap Creek.	Section 3.
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.	Yes, no changes to erosional processes potentially related to subsidence were identified.	
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.	NA, refer to Subsidence Monitoring Report.	
Watercourse subsidence	No connective cracking between the surface and underground workings. Subsidence does not vary beyond predictions of modelling.	Yes, no connective cracking was identified based on visual inspection of watercourses. Refer to Subsidence Monitoring Report for subsidence monitoring.	

Contents

1. Introduction **1**
- 1.1 Background 1
- 1.2 Purpose of this report 1
- 1.3 Scope and limitations 1
- 1.4 Development consent conditions 1

2. Methodology **5**
- 2.1 Watercourse stability inspections 5
- 2.2 River Styles assessment 5
- 2.3 Geomorphic condition assessment 6

3. Results **8**
- 3.1 River Styles assessment 8
  - 3.1.1 Airly Creek 8
  - 3.1.2 Gap Creek 8
  - 3.1.3 Genowlan Creek 8
  - 3.1.4 Dog Trap Creek 8
- 3.2 Geomorphic condition assessment 10
  - 3.2.1 Airly Creek 10
  - 3.2.2 Gap Creek – east arm 12
  - 3.2.3 Gap Creek – west arm 18
  - 3.2.4 Genowlan Creek 21
  - 3.2.5 Dog Trap Creek 23

4. Conclusions **27**

5. References **28**

Table index

Table 1.1 Stream health performance criteria from Airly Mine Water Management Plan 2
Table 2.1 Geomorphic condition categories 6
Table 3.1 Site photos and geomorphic condition notes for Airly Creek 10
Table 3.2 Site photos and geomorphic condition notes for Gap Creek – east arm 12
Table 3.3 Site photos and geomorphic condition notes for Gap Creek – west arm 18
Table 3.4 Site photos and geomorphic condition notes for Genowlan Creek 21
Table 3.5 Site photos and geomorphic condition notes for Dog Trap Creek 23

Figure index

Figure 1.1 Locality plan 3
Figure 1.2 Watercourse stability monitoring locations 4
Figure 2.1 The river styles procedural tree (adapted from Brierly and Fryirs 2005) 6
Figure 3.1 River styles of the assessed reaches 9
Figure 3.2 Geomorphic condition of the assessed reaches 26

1. Introduction

1.1 Background

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, owned by Centennial Airly Pty Ltd (Centennial), as shown in the locality plan in Figure 1.1. Airly Mine was granted Development Consent (SSD-5581) for the extension of its underground coal mine on 15 December 2016. Since this time, Development Consent SSD-5581 has been modified to remove some restrictions on mining (Modification 1), to allow the receipt of up to 170 ML/year of water from Charbon Colliery by rail (Modification 2) and changes to approved workforce (Modification 5).

Airly Mine currently has approval to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal from the Lithgow Seam using mining methods that incorporate extraction by first workings, partial pillar extraction or panel and pillar mining. ROM and product coal are transported off site by rail for the export and domestic markets.

SSD-5581 required the development of a water management plan (WMP), including a program to monitor and report on the "geomorphology of the watercourses potentially affected by the development within and immediately outside of the site". Airly Mine's WMP (GHD 2024) states that watercourse stability monitoring is undertaken on third order streams within and immediately outside the site boundary (subject to access limitations), as shown in Figure 1.2, every two years. In 2024, the surveyed extent of one of the reaches was slightly limited by lack of access to private property, compared to the monitored reaches in Airly Mine's WMP (GHD 2024). The topography of the landscape also limits the surveys in some reaches due to safety reasons.

1.2 Purpose of this report

The purpose of this report is to document the outcomes of the watercourse stability monitoring for 2024 to support the Annual Review for Airly Mine.

1.3 Scope and limitations

The scope of this report is to present the results of the watercourse stability monitoring undertaken at Airly Mine during spring 2024 (5 to 8 November 2024) and assess the results against the relevant develop consent conditions (refer to Section 1.4).

This report has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and Centennial Airly Pty Ltd as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

1.4 Development consent conditions

Airly Mine has development consent under Section 89E of the Environmental Planning & Assessment Act 1979 for the extension of the mine (approved 15 December 2016).

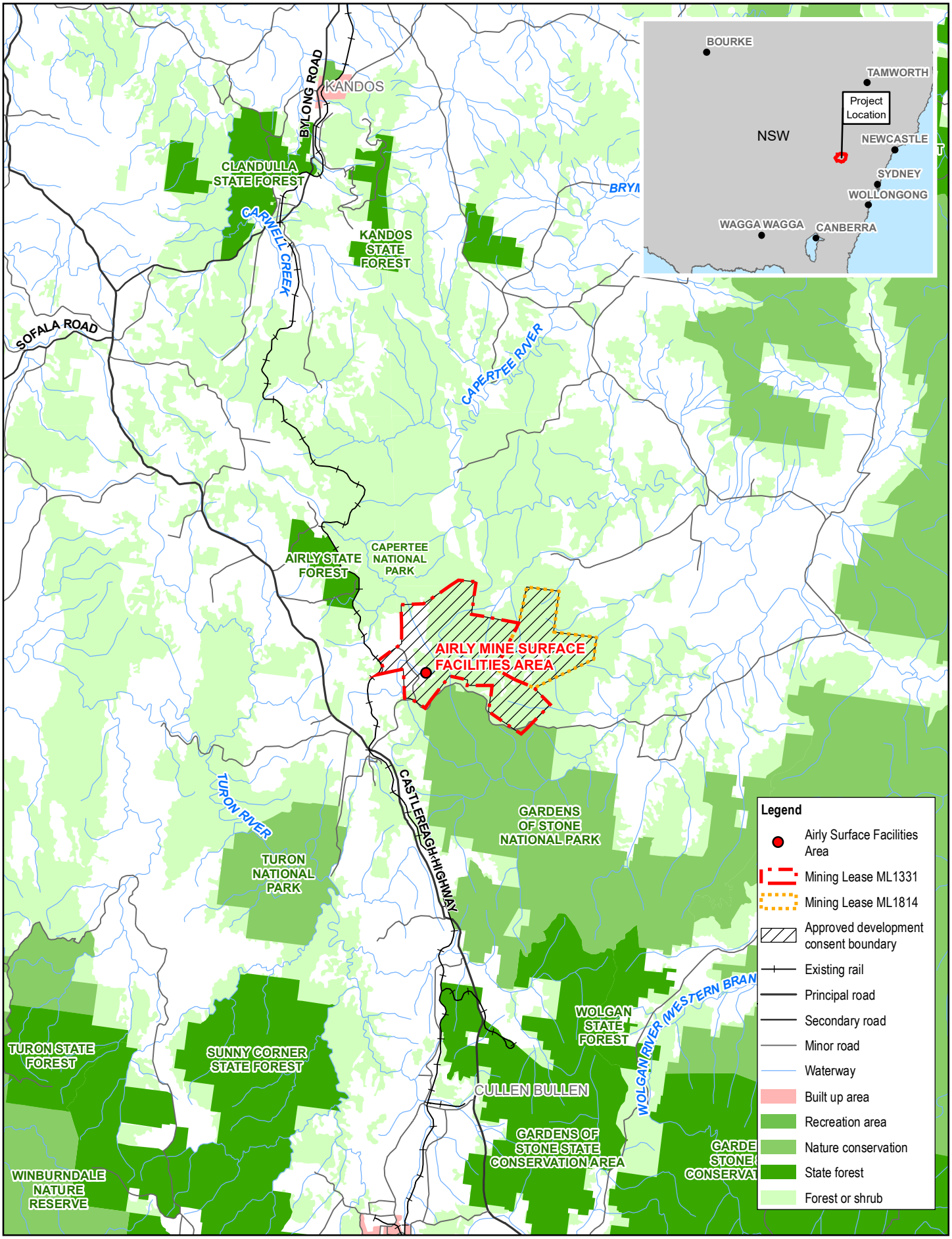
Stream health performance criteria related to geomorphic condition and watercourse stability in waterways surrounding Airly Mine have been outlined in the Airly Mine WMP (GHD 2024) and are displayed in Table 1.1.

These criteria have been developed to assess whether the impacts as a result of mining operations are greater than those predicted by the EIS and approved by development consent SSD-5581.

Table 1.1 Stream health performance criteria from Airly Mine Water Management Plan

Aspect	Criteria
Geomorphic condition and watercourse stability (required every two years)	
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. Maintain or improve baseline channel stability.
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.
Watercourse subsidence	No connective cracking between the surface and underground workings. Subsidence does not vary beyond predictions of modelling.

The visual inspection methodology for the assessment does not include quantitative measurements of stream gradient. Subsidence monitoring is conducted separately.



Paper Size ISO A4

0 1 2 3 4 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

[redacted]

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

Project No. **12633750**
Revision No. **0**
Date **19 Mar 2025**

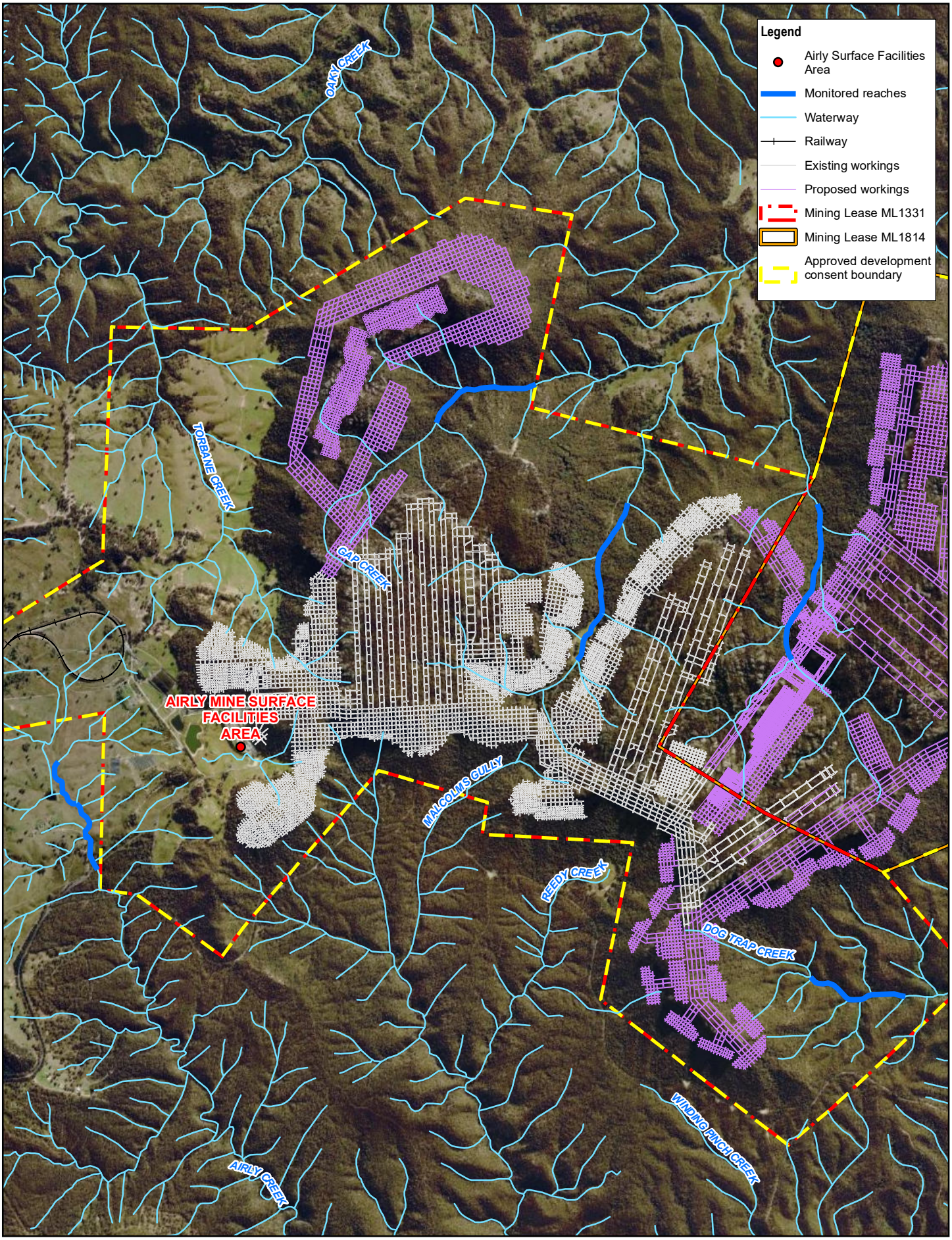
Site location

FIGURE 1.1

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12633750\WatercourseStability\12633750_WSM001_Locality_0.mxd
Print date: 19 Mar 2025 - 08:28

Data source: Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3 2006; Centennial: Boundaries, 2013.. Created by: fmackay

© 2025. Whilst every care has been taken to prepare this map, GHD, Geoscience Australia and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

Watercourse stability monitoring locations

Project No. **12633750**
Revision No. **0**
Date **19 Mar 2025**

FIGURE 1.2

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12633750\WatercourseStability\12633750_WSM002_StabilityLocations_0.mxd
Print date: 19 Mar 2025 - 08:28

Data source: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: fmackay

© 2025. Whilst every care has been taken to prepare this map, GHD, LPI and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

2. Methodology

2.1 Watercourse stability inspections

Watercourse stability inspections were in spring 2024 between 5 and 8 November.

Following the 2018 inspection, the extents of inspected reaches were refined, as shown in Figure 1.2. Inspected reaches during 2020, 2022 and 2024 focused on third order streams in proximity to existing or future mining areas.

Visual monitoring of the watercourses was carried out by suitably qualified professionals to identify any instabilities that could form as a result of mining operations and general geomorphic condition, including:

- Degree of valley confinement and bedrock influences.
- Presence and continuity of a channel.
- Channel planform (number of channels and sinuosity).
- Channel and floodplain geomorphic features.
- Nature of channel and floodplain sediments.
- Presence of head cuts and other instabilities.
- Riparian vegetation associations.
- Bed and bank stability (extent and severity of erosion).
- Geomorphic features (such as bars, pools, riffles and benches).
- Evidence of channel lateral migrations, expansion, incision and/or straightening.
- Evidence of excessive sediment deposition.
- Evidence of geomorphic recovery from past disturbances.
- Evidence of connective cracking (loss of streamflow, surface discontinuities not associated with bedrock channel).

The results of this monitoring were compared with the baseline data collected during the Airly Mine Extension Project (GHD 2014) and the 2020 (GHD 2020) and 2022 (GHD 2023) monitoring.

2.2 River Styles assessment

The River Styles® framework (Brierley and Fryirs 2005) is a river characterisation process that allows interpretation of river form and behaviour from which appropriate management approaches can be formulated. The first level of assessment places a waterway reach into one of three river style groups based on valley setting and channel continuity as shown in Figure 2.1. Further characterisation is determined based on the identification of key geomorphic units, channel substrate and channel form. These attributes provide the basis for interpretation of stream behaviour, condition and recovery potential. The river style of a stream that exists at any one point within a valley is dependent upon a large number of physical factors upstream, downstream and adjacent to the point of assessment.

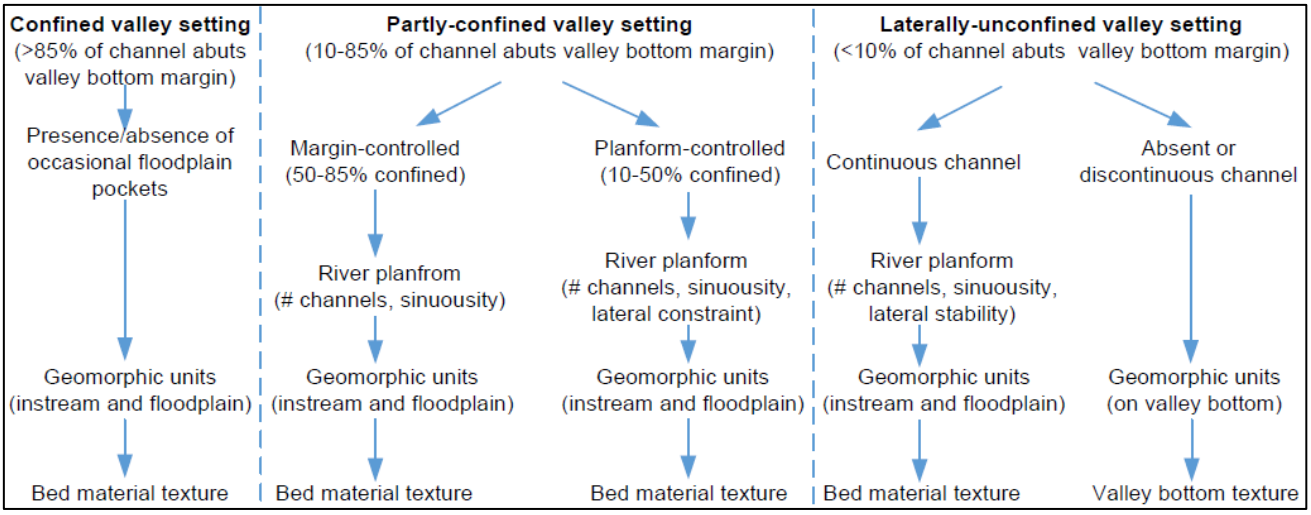


Figure 2.1 The river styles procedural tree (adapted from Brierly and Fryirs 2005)

2.3 Geomorphic condition assessment

The inspection included the categorisation of geomorphic condition following the methods of Outhet and Cook (2004), and Brierley and Fryirs (2005), which are detailed briefly below. This categorisation provides an indication of the degree of alteration that reaches within the tributaries have experienced, and the likely response of these reaches to changes in flow rates and durations.

Outhet and Cook (2004) describe a rapid method of condition assessment that frames geomorphic condition in the context of natural and human induced variability to divide stream condition into three broad categories:

– Good (generally natural and intact)
– Moderate (noticeably impacted by human disturbances)
– Poor (degraded)

This method combines the observation of physical features and their interactions with a set of defined characteristics/criteria. The method considers the floodplain and its features in conjunction with the instream channel features as well as an assessment of the role and condition of vegetation for maintaining the condition of river styles.

The characteristics of each of these categories of geomorphic condition, as described by Outhet and Cook (2004), are outlined in Table 2.1. These condition categories align with the geomorphic condition definitions in Brierley and Fryirs (2005), also presented in Table 2.1.

Table 2.1 Geomorphic condition categories

Geomorphic condition	Outhet and Cook (2004)	Brierly and Fryirs (2005)
Good	River character and behaviour is similar to the pre-development state presenting a high potential for ecological diversity. Minimal alteration to catchment controls such as sediment supply and the hydrological regime allowing fast recovery from any natural disturbance. Relatively intact and effective vegetation coverage dominated by native species, giving resistance to natural disturbance and accelerated erosion.	River character and behaviour are appropriate for the River Style given the valley setting and within-catchment position. Geomorphic structures are in the right place and operating as expected for the River Style. These reaches have near-natural potential for ecological diversity and associated vegetation associations.

Geomorphic condition	Outhet and Cook (2004)	Brierly and Fryirs (2005)
Moderate	Localised degradation of river character and behaviour, typically marked by modified patterns of geomorphic units. Patchy effective vegetation coverage allowing some localised accelerated erosion.	Certain characteristics are out-of-balance or inappropriate for the River Style. Localised degradation of river character and behaviour is typically marked by modified patterns of geomorphic units. Key geomorphic structures are in the wrong places. Locally anomalous processes are occurring. In general, these reaches have poor vegetation associations and/or cover.
Poor	Abnormal or accelerated geomorphic instability (reaches are prone to accelerated and/or inappropriate patterns or rates of planform change and/or bank and bed erosion). Excessively high volumes of sediment inputs which blanket the bed, reducing flow diversity. Absent or geomorphologically ineffective coverage by vegetation (allowing most locations to have accelerated rates of erosion).	River character is divergent from the natural reference condition. Abnormal or accelerated geomorphic behaviour occurs. Key geomorphic units are located inappropriately along the reach, and processes are out-of-balance or anomalous. These reaches generally have low levels of bank vegetation and/or are weed infested. If fundamental threshold conditions are breached, irreversible geomorphic change would transform the reach into a new River Style.

3. Results

3.1 River Styles assessment

The River Styles of each of the assessed creek reaches are discussed below and are consistent with the those identified within the baseline assessment prepared for the Airly Mine Extension Project (GHD 2014). The River Styles of each of the assessed creek reaches are shown on Figure 3.1. No changes to River Styles have been observed within any of the assessed reaches.

3.1.1 Airly Creek

The River Style of the assessed reach of Airly Creek is laterally unconfined, discontinuous channel, valley fill. These systems are characterised by a relatively flat, featureless valley floor surface that lacks a continuous, well-defined channel. Valley fill systems typically act as long-term sediment accumulation zones, as any material eroded within the catchment is generally not transported through the reach. Degradation of valley fill systems most commonly occurs through incisional processes such that a continuous channel forms within the valley fill sediments.

3.1.2 Gap Creek

The assessed reaches of Gap Creek (east and west) contain the following River Styles:

– Confined, bedrock margin controlled, occasional floodplain pockets
– Partly confined, continuous channel, channelised fill

The steep gradient sections of both arms of Gap Creek are bedrock dominated, with limited deposits of sediment within the channel. These confined reaches are geomorphologically stable reaches that are subject to very slow rates of change due to the high degree of bedrock confinement. Small floodplain pockets composed primarily of sand were observed in flatter sections of these reaches. The generally steep gradients but small catchment areas mean that the larger grained materials in the catchments are moved only in rare, high magnitude rainfall events.

The upper reach of Gap Creek – east arm was partly confined, with channelised fill and a flatter bed grade. The upper parts were vegetated, with evidence of bank instability close to the pre-existing stock dam.

A small section of the downstream extent of the west arm of Gap Creek had a flatter bed grade, with evidence of sediment deposition. The bed load in this section of the creek was dominated by sand and gravels.

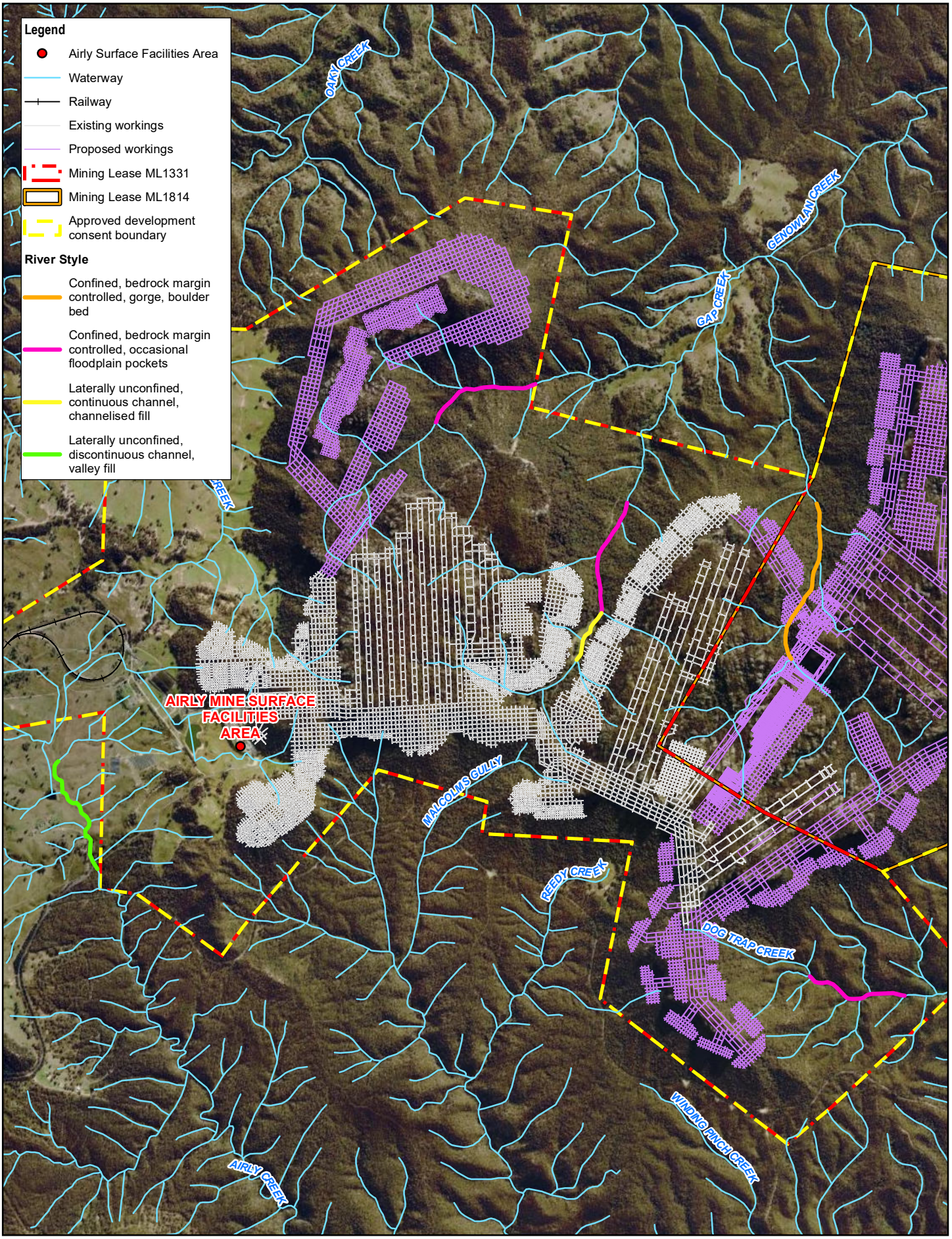
3.1.3 Genowlan Creek

The steep gradient, upstream section of Genowlan Creek is bedrock dominated, with no floodplain present. Due to the steep valley margins, this reach has been classified as a gorge, with the dominant bed material size being boulders.

Further downstream, small floodplain pockets were observed, resulting in the River Style: confined, bedrock margin controlled, occasional floodplain pockets.

3.1.4 Dog Trap Creek

The assessed reach of Dog Trap Creek is of the River Style: confined, bedrock margin controlled, occasional floodplain pockets. The substrate of the creek is dominated by cobble, with finer grained sediments (sand and silt) observed in the exposed banks where concave bank erosion into the floodplain is occurring.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

River Styles of assessed reaches

Project No. **12633750**
Revision No. **0**
Date **19 Mar 2025**

FIGURE 3.1

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12633750\WatercourseStability\12633750_WSM003_RiverStyles_0.mxd
Print date: 19 Mar 2025 - 08:28

Data source: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: fmackay

© 2025. Whilst every care has been taken to prepare this map, GHD, LPI and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

3.2 Geomorphic condition assessment

Geomorphic condition in each of the assessed creek reaches and photo locations are presented in Figure 3.2 and discussed below.

3.2.1 Airly Creek

Site photographs and the results of the geomorphic condition assessment for Airly Creek are presented in Table 3.1.

Table 3.1 Site photos and geomorphic condition notes for Airly Creek

Photo location	2020	2022	2024
1			
	Notes on geomorphic condition		
	Photo location 1 is representative of the downstream extent of the assessed reach of Airly Creek, looking upstream. In most of the assessed reach there is no continuous channel with occurrence of several pools and areas of ponding. At this location in 2020, there was presence of a shallow pool with dense *Typha sp.* coverage. Riparian vegetation is dominated by exotic grasses. In 2022, macrophyte coverage increased obscuring the defined ponded area observed in 2020. In 2024, there was additional growth of *Typha* sp. observed, with complete coverage of the channel observed. This portion of the reach is in moderate condition.		

Photo location	2020	2022	2024
2			
	Notes on geomorphic condition		
	Photo location 2 shows a headcut in Airly Creek, which has been armoured by imported rock. This armouring has been largely effective in mitigating scouring in the exposed area of valley fill sediments, though some migration of the headcut has occurred and bypass of the armouring has resulted in small headcuts developing adjacent to the armouring. In 2022 and 2024, minimal migration of this headcut was observed at photo location 2, with rock armouring largely remaining in place. Increases in instream vegetation growth are also noted in 2024. This headcut marks the upstream extent of the assessed reach.		

3.2.2 Gap Creek – east arm

Site photographs and the results of the geomorphic condition assessment for Gap Creek – east arm are presented in Table 3.2.

Table 3.2 Site photos and geomorphic condition notes for Gap Creek – east arm

Photo location	2020	2022	2024
3			
	Geomorphic condition comparison		
	Photo location 3 shows the upstream extent of the east arm of Gap Creek. This section of the creek has been channelised into the narrow valley of fine-grained sediments. Though there was no active headcut observed during any monitoring event in this area this reach was in poor condition due to accelerated bank erosion and poor coverage of effective vegetation. Despite increased coverage of grasses in 2020, 2022 and 2024, the banks remain in poor condition in this area.		

Photo location	2020	2022	2024
4			
	Geomorphic condition comparison		
	Photo location 4 in 2020 shows bank erosion (approximately 0.5 m deep) at the incised and widened channel of the creek. In 2022 and 2024, the headcut was not observable due to high water level and increased vegetation growth along the bank.		

Photo location	2020	2022	2024
5			
	Geomorphic condition comparison		
	Photo location 5 in 2020 was taken looking downstream at the incised and widened channel of the creek, showing scattered cobbles within a bed of fine sand and shows the dam at the end of the channelised reach. The dam appears to capture the majority of the flows in the small catchment, only overtopping towards the left valley margin as a result of rainfall events. In 2022 and 2024 photo location 5 was taken looking downstream from the opposite bank along the dam embankment, noting a high creek and dam water level with no visible sediment accumulation. Vegetation growth has also increased on the embankment and is stabilised by trees.		

Photo location	2020	2022	2024
6		Not accessible	
	Geomorphic condition comparison		
	Photo location 6 was taken looking downstream in 2020, just below the dam wall. The steep slopes and boulders are evident. The reach is in good condition downstream from this point. In 2022 this location was not photographed due to surface water flow limiting access. The 2024 photo was taken from the top of the dam wall looking downstream into the gorge channel. There is some localised erosion at this point where the dam spills into the channel, however, no additional erosion was observed in 2024 compared to previous conditions. This marks the downstream extent of the poor condition section of the reach.		

Photo location	2020	2022	2024
7			
	Geomorphic condition comparison		
	Photo location 7 shows the large boulders present in much of this reach which has resulted in a small, forced pool with cobble substrate. The reach in this location is in good condition. Similar behaviour was observed in both 2020 and 2022. In 2024, the reach downstream from the dam was almost entirely dry due to lower rainfall in 2024 prior to the survey.		

Photo location	2020	2022	2024
8			
	Geomorphic condition comparison		
	Photo location 8 shows the east arm of Gap Creek in an area of lesser gradient facing downstream, where a small pocket of floodplain is observed on the right bank. Increased water is present in 2022, though the floodplain is utilised with minimal alteration to sediment. In 2024, sandbars remained in some sections, deposited by previous flows, although the reach was dry in this section due to lower rainfall preceding the surveys in 2024.		

3.2.3 Gap Creek – west arm

Site photographs and the results of the geomorphic condition assessment for Gap Creek – west arm are presented in Table 3.3. The downstream section of this reach was not able to be surveyed due to lack of access to private property for this monitoring event, with the survey terminating at the mining lease boundary.

Table 3.3 Site photos and geomorphic condition notes for Gap Creek – west arm

Photo location	2020	2022	2024
9			
	Notes on geomorphic condition		
	Photo location 9 shows the upstream extent of the assessed reach of the west arm. The gradient of the watercourse in this area is lower than that of downstream areas (such as that shown by Photo location 10) allowing for some sand to accumulate in the bed and pockets of floodplain.		

Photo location	2020	2022	2024
10			
	Notes on geomorphic condition		
	Some sections of the west arm of Gap Creek have bedrock substrate with step pools, as shown at Photo location 10. Such reaches are geomorphologically stable and subject to only very slow rates of change. Subsidence in such areas has the potential to result in surface cracking in the bedrock substrate, however this was not observed at photo location 10 during any visit.		

Photo location	2020	2022	2024
11			
	Notes on geomorphic condition		
	Photo location 11 shows the downstream extent of the bedrock confined reach of the west arm, with coarse sediment deposition in the foreground of the photo. The stream flow transitions to subsurface at this location. Slight changes observed between 2020 and 2022 include silty sand deposited at the base of the bedrock in 2022, which remained in 2024. Flowing water was observed in both 2020 and 2022 following secondary extraction in the contributing catchment. In 2024, only minimal flow was observed and there was no pooling at the base of the rock.		

3.2.4 Genowlan Creek

Site photographs and the results of the geomorphic condition assessment for Genowlan Creek are presented in Table 3.4.

Table 3.4 Site photos and geomorphic condition notes for Genowlan Creek

Photo location	2020	2022	2024
12			
	Notes on geomorphic condition		
	Photo location 12 shows the V notch weir and flow gauge installed in the upper part of the inspected reach of Genowlan Creek.		

Photo location	2020	2022	2024
13			
	Notes on geomorphic condition		
	There are various small pools formed within the bedrock confined boulder substrate, as shown in the upstream facing photos in 2020, 2022 and 2024. This reach is in good condition.		
14			
	Notes on geomorphic condition		
	Photo location 14 shows the bedrock margins and boulder substrate which dominates much of Genowlan Creek. The large boulders present in Genowlan Creek create steps in the creek profile. Some instream ponding and cascading is evident throughout the reach in areas with presence of large boulders.		

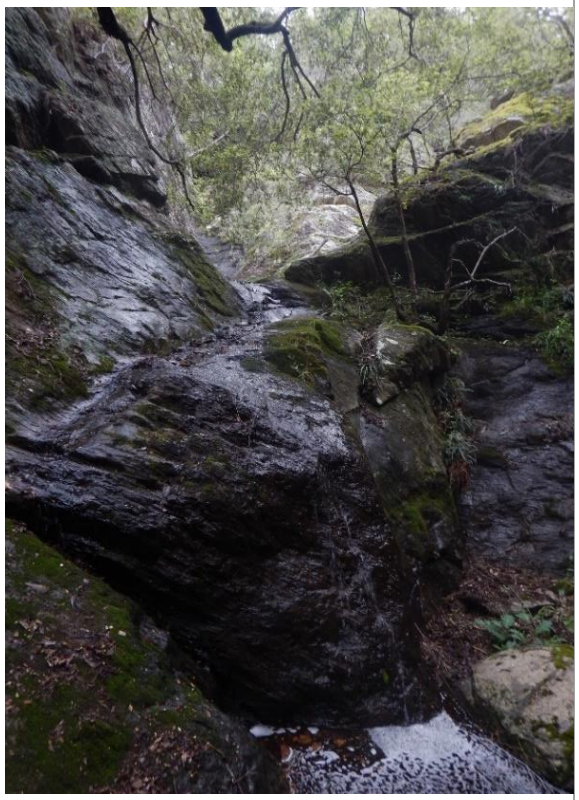
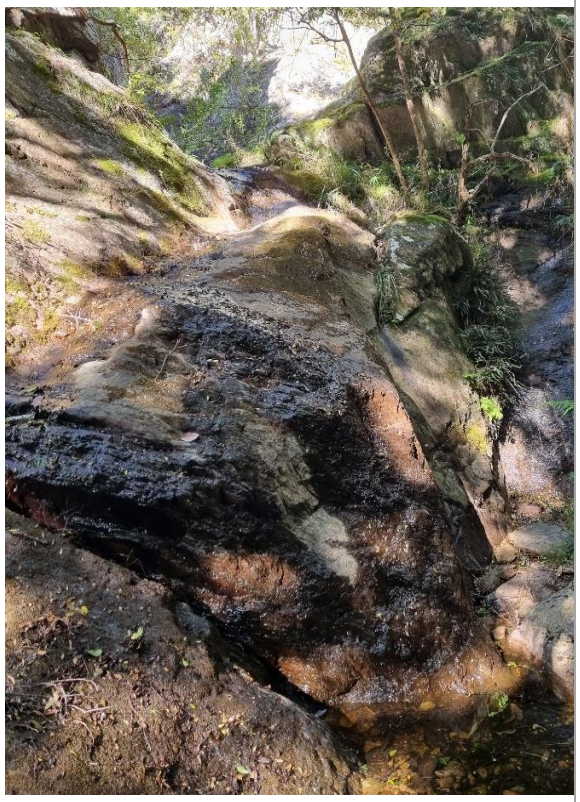
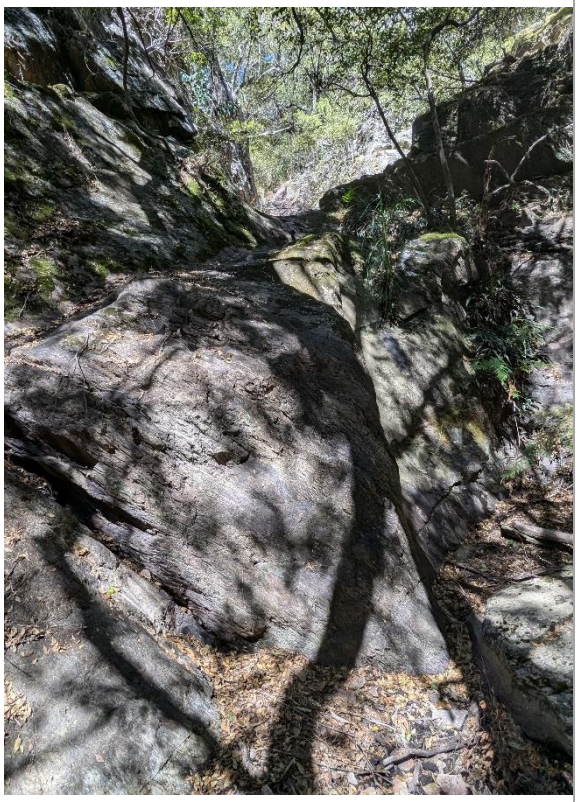
3.2.5 Dog Trap Creek

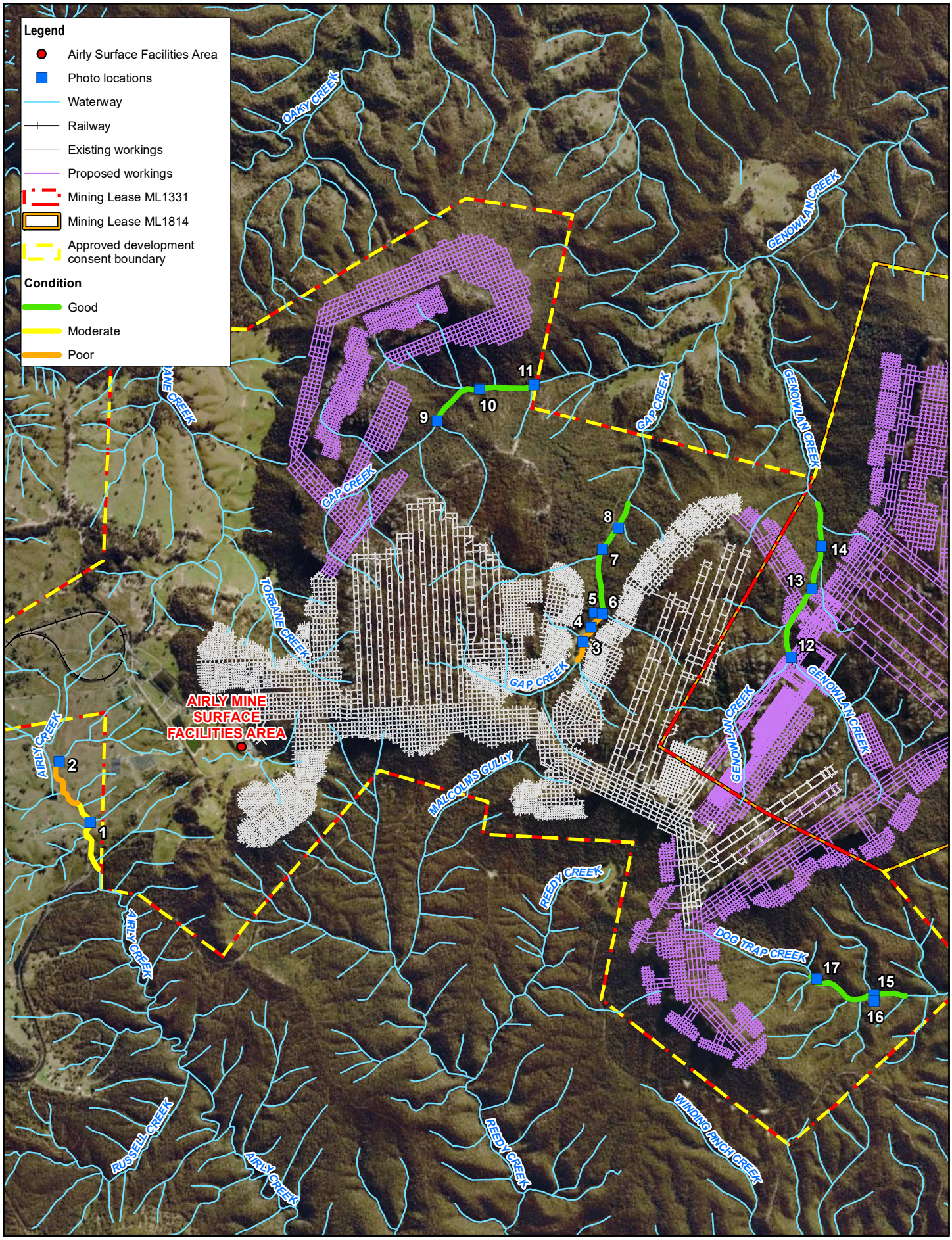
Site photographs and the results of the geomorphic condition assessment for Dog Trap Creek are presented in Table 3.5.

Table 3.5 Site photos and geomorphic condition notes for Dog Trap Creek

Photo location	2020	2022	2024
15			
	Notes on geomorphic condition		
	Photo 15 was taken looking upstream at the eastern (downstream) extent of the Dog Trap Creek reach. The bedrock margins of the creek are shown. The entire reach is in good condition. In 2024, there was no water present in any part of the reach.		

Photo location	2020	2022	2024
16			
	Notes on geomorphic condition		
	Photo location 16 shows a floodplain pocket to the right of the photo. Similar floodplain pockets are observed in the downstream portion of the reach.		

Photo location	2020	2022	2024
17			
	Notes on geomorphic condition		
	Photo location 17 shows an area of outcropping bedrock that forms a cascade/waterfall during flows, at the upstream extent of the reach. There was no flow over this boulder in 2024. Upstream of this location, several small pools and steps which form small cascades are observed.		



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

Geomorphic condition of the assessed reaches

Project No. **12633750**
Revision No. **0**
Date **19 Mar 2025**

FIGURE 3.2

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12633750\WatercourseStability\12633750_WSM004_GeomorphicCondition_0.mxd
Print date: 19 Mar 2025 - 08:28

Data source: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: fmackay

©2025. Whilst every care has been taken to prepare this map, GHD, LPI and Centennial make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

4. Conclusions

Watercourse stability monitoring was undertaken at Airly Mine between 5 and 8 November 2024. The findings of the assessment were:

– Geomorphic condition in Airly Creek was mostly moderate, though poor condition reaches were identified, associated with active headcuts. Between 2020 and 2022 monitoring events, minimal migration of the headcut has been observed located adjacent to instream rock armouring (which has largely remained in place). In 2024, there was dense coverage by most of the channel by emergent macrophytes primarily *Typha* sp., which impeded visibility of the channel. There was no evidence of additional erosion, and the instream rock armouring had remained in place.
– Geomorphic condition in Gap, Genowlan and Dog Trap Creeks was good, with the exception of an upstream section of Gap Creek (east arm) where land clearing (unrelated to mining activities) has resulted in the channelisation of a narrow valley of fine-grained sediments, and historical widening of the channel to create a dam. At the immediate downstream extent of the dam, some localised erosion remains where the dam spills into the creek channel, although this was unchanged from previous surveys. Apart from that poor condition reach, Gap, Genowlan and Dog Trap Creeks are characterised by confined, bedrock-controlled valley settings, which are geomorphologically stable and subject to only slow rates of change, and as such, are considered to be low risk for impacts related to subsidence. The potential impacts of subsidence on confined, bedrock-controlled valley settings would most likely be observable in areas of bedrock outcropping in the substrate, where any large cracks would be evident during inspections. No change was observed in the bedrock confined, upstream portions of the reaches and no subsidence or subsidence related impacts were observed.
– Overall, based on the visual assessment undertaken, there is no evidence of exceedances of the stream health performance criteria for geomorphic condition and watercourse stability, as presented in the WMP (GHD 2024).

The next site inspections to assess geomorphic condition and watercourse stability will be undertaken in 2026.

5. References

Brierly G and Fryirs K (2005) Geomorphology and River Management: Applications of the River Styles Framework. Blackwell Publishing, Oxford, UK, 398pp.

GHD (2014) Airly Mine Extension Project: Surface Water Impact Assessment, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2020) Airly Mine 2020 Watercourse Stability Monitoring Report, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2023) Airly Mine 2022 Watercourse Stability Monitoring Report, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2024) Airly Mine Water Management Plan, revision 9, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2025a) Airly Mine Water Monitoring 2024 Annual Report, prepared by GHD Pty Ltd for Centennial Airly Pty Limited, in draft.

GHD (2025b) Airly Aquatic Ecology Annual Report 2024, prepared by GHD Pty Ltd for Centennial Airly Pty Limited, in draft.

Outhet, D. and Cook, N. (2004) “Definitions of Geomorphic Condition Categories for Streams” Unpublished internal draft paper for use throughout NSW by the Department of Infrastructure, Planning and Natural Resources.

ghd.com

The Power of Commitment

Appendix 8: Airly Mine Aquatic Ecology 2024 Annual Report

Airly Aquatic Ecology

Annual Report 2024

Centennial Airly Pty Ltd

25 March 2025

→ **The Power of Commitment**



Project name		Centennial Airly aquatic ecology, stygofauna and geomorphology 2024					
Document title		Airly Aquatic Ecology | Annual Report 2024					
Project number		12633750					
File name		12633750-REP_Airly Aquatic Ecology 2024 Annual Report.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	0	T. Hopwood	C. Chargulaf	Craig Chargulaf	Z. Lagerroth		25/03/25

GHD Pty Ltd | ABN 39 008 488 373

GHD Tower, Level 3, 24 Honeysuckle Drive

Newcastle, New South Wales 2300, Australia

T +61 2 4979 9999 | **F** +61 2 9475 0725 | **E** ntlmail@ghd.com | **ghd.com**

© GHD 2025

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Overarching review

Statement of Compliance Question	Statement of Compliance Answer
Were all conditions of SSD_5581 and the Airly Mine Water Management Plan relating to aquatic ecosystems and stream health complied with?	Yes – There were no non-compliances relating to aquatic ecology or stream health in the 2024 reporting period.

Details of non-compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Reference # addressed in Annual Review
N/A - No non-compliances relating to aquatic ecosystems or stream health during the 2024 reporting period.			Compliant		

Development consent SSD-5581 (Modification 5) performance conditions relating to surface waters

Condition	Condition description	Compliant	Relevant section of this document
Water management performance measures			
Water discharge to Airly Creek			
Schedule 4 12.	Negligible environmental consequences for water quality (i.e. protection to 99% of all species in accordance with ANZECC guidelines) and flow in Airly Creek where it enters the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area.	Yes	See discharge volumes in Section 3.2 and water quality results in Section 3.4.1 of this report. Also in the 2024 Annual Water Monitoring Report (GHD 2025b).
Gap and Genowlan Creeks			
Schedule 4 12.	No greater impact than predicted in the EIS for water, flow and quality.	Yes	NA See 2024 Annual Water Monitoring Report (GHD 2025b).
Aquatic and riparian ecosystems			
Schedule 4 12.	Maintain or improve baseline channel stability.	Yes	NA See watercourse stability assessment (GHD 2025c).
	Develop site-specific water quality objectives in accordance with ANZECC Guidelines and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC 2006) or its latest version.	Yes	SSGVs in Section 2.7.1. Refer to Site Specific Guideline Values document (GHD 2018). Also refer to Section 6 of WMP (GHD 2024a).
Water management plan			
Schedule 4 13.	Prior to carrying out any development under this consent, unless the Planning Secretary agrees otherwise, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:		
Schedule 4 13. (a)	Be prepared in consultation with the DCCEEW, EPA and DPE Water, by suitably qualified and experienced person/s whose appointment has been approved by the Planning Secretary.	Yes	NA Refer to Appendix A and Appendix B of WMP (GHD 2024a).
Schedule 4 13. (b)	Include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 6).	Yes	NA Refer to Section 6 of WMP (GHD 2024a).

Condition	Condition description	Compliant	Relevant section of this document
Site water balance			
Schedule 4 13. (c) (i)	Details of sources and security of water supply, including contingency supply for future reporting periods.	Yes	NA Refer to Section 3.1 and Section 3.5.1 of the WMP (GHD 2024a).
	Details of water use and management on site.	Yes	NA Refer to Section 3 of WMP (GHD 2024a), and 2024 Annual Water Monitoring Report (GHD 2025b).
	Details of any off-site water discharges.	Yes	NA Refer to Section 3.5.2 of WMP (GHD 2024a) and 2024 Annual Water Monitoring Report (GHD 2025b).
	Reporting procedures, including the preparation of a site water balance for each calendar year.	Yes	NA Refer to 2024 Annual Water Monitoring Report (GHD 2025b) and Section 7.4 of WMP (GHD 2024a).
	Investigates and implements all reasonable and feasible measures to minimise water use on site.	Yes	NA Refer to Section 3.5.1 of WMP (GHD 2024a).
Surface water management plan			
Schedule 4 13. (c) (ii)	Detailed baseline data on water flows and quality in the watercourses that could potentially be affected by the development, including, but not limited to Gap, Genowlan and Airly Creeks.	Yes	Water quality monitoring has been undertaken in conjunction with aquatic ecology monitoring (see Section 3.4). Also refer to Section 5.1 of WMP (GHD 2024a) and 2024 Annual Water Monitoring Report (GHD 2025b).
	Continuous flow monitoring at Airly village spring and the Grotto.	Yes	NA Refer to Section 5.1.2 and Section 5.3.1 of WMP (GHD 2024a) and 2024 Annual Water Monitoring Report (GHD 2025b).
	Provisions for the recalculation of site-specific trigger values in relation to water discharges to Airly Creek once a minimum of two years data is obtained from the Airly Creek 'U/S' monitoring location in accordance with ANZECC guidelines.	Yes	NA Refer to Site Specific Guideline Values document (GHD 2018) and Section 6.1.1 of WMP (GHD 2024a).
	The provision and implementation of adaptive management measures to ensure that subsequent water discharges to Airly Creek comply with the recalculated site-specific trigger values derived from the Airly Creek 'U/S' monitoring location.	Yes	NA Refer to TARPs in Appendix E of the WMP (GHD 2024a).
	A detailed description of the water management system, including the: – Clean water diversion systems – Erosion and sediment controls (mine water system) – Mine water management systems	Yes	NA Refer to Section 3.2 and Section 3.3 of WMP (GHD 2024a).
	Detailed objectives and performance criteria, including trigger levels for investigating any potentially adverse impacts associated with the development for:		

Condition	Condition description	Compliant	Relevant section of this document
Schedule 4 13. (c) (ii)	Downstream surface water quality.	Yes	SSGVs in Section 2.7.1. Also refer to Section 6 of WMP (GHD 2024a) and 2024 Annual Water Monitoring Report (GHD 2025b) and Section 3.4 of this report.
	Downstream water users, including with respect to any subsidence-related flow reductions in Gap and Genowlan Creeks.	Yes	NA Refer to Section 6 of WMP (GHD 2024a).
	Stream and riparian vegetation health in Gap, Genowlan and Airly Creeks within and immediately outside of the site.	Yes	Performance criteria for instream health outlined in Table 1.1. Also refer to Section 6.2 of WMP (GHD 2024a). Riparian vegetation assessment outlined in Airly Site specific Biodiversity Management Plan (BMP).
	A program to monitor and report on:		
	Effectiveness of the mine water management system.	Yes	NA Refer to Section 4 of the WMP (GHD 2024a).
	Surface water flows, quality and geomorphology of the watercourses potentially affected by the development within and immediately outside of the site.	Yes	Monitoring program for surface water flows, quality and geomorphology outlined in Section 4 of WMP (GHD 2024a). Monitoring results for water quality and flow addressed in the 2024 Annual Water Monitoring Report (GHD 2025b). Watercourse stability assessment (GHD 2025c).
	The performance measures listed in Table 6 including, but not limited to event-based monitoring of the hydrology, quality, ecotoxicology and chemical composition of water in Airly Creek under discharge conditions at points 5 and 6, or as otherwise determined in consultation with the EPA, to ensure that protection is provided to 99% of all species in the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area in accordance with ANZECC guidelines.	Yes	NA Refer to Section 4 and Appendix E of WMP (GHD 2024a) and 2024 Annual Water Monitoring Report (GHD 2025b).
	Reporting procedures for the results of the monitoring program.	Yes	NA Refer to Section 7.1 of WMP (GHD 2024a) and Regional WMP (GHD 2016).
	A plan to respond to any exceedances of performance measures, and repair, mitigate and/or offset any adverse surface water impacts of the development, including measures to provide compensatory water supply to any affected downstream water user.	Yes	NA Refer to Section 6.3 and Appendix E of WMP (GHD 2024a).

NA – not applicable to this report.

Statement of commitments relating to aquatic ecosystems (GHD 2024a)

Commitment	Compliant	Relevant section of this document
Monitor macroinvertebrate ecology in Airly Creek at appropriate upstream and downstream locations biannually (spring and autumn).	Yes	Section 3.6.

Stream health performance criteria relating to aquatic ecosystems (GHD 2024a)

Aspect	Criteria	Compliant	Relevant section of this document
Geomorphic condition and watercourse stability (required every two years)			
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. Maintain or improve baseline channel stability.	Yes	NA Watercourse stability assessment (GHD 2025c). Subsidence monitoring is conducted as outlined the Airly Mine Annual Review.
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.	Yes	
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.	Yes	
Watercourse subsidence	No connective cracking between the surface and underground workings. Subsidence does not vary beyond predictions of modelling.	Yes	
Aquatic ecology (required annually in autumn and spring)			
Instream/riparian vegetation	RCE scores relating to riparian and instream vegetation within historical range and/or consistent with reference sites.	Yes	Observations regarding instream vegetation were collected as part of aquatic ecology monitoring, See Section 3.3 of this document.

Executive Summary

Airly Mine has development consent under Section 89E of the *Environmental Planning & Assessment Act 1979* for the extension of the mine (approved 15 December 2016) and commenced operations under this consent on 31 January 2017. Since this time, the wording of Development Consent SSD-5581 has been modified to remove restrictions on mining (Modification 1), to allow the receipt of up to 170 ML/year of water from Charbon Colliery by rail (Modification 2), and to provide clarification of the Remediation Management Plan and allow changes to the approved workforce (Modification 5). The development consent requires a program to monitor and report on stream health for waterways that have the potential to be impacted by Airly Mine operations through subsidence or discharge of water. The purpose of this report is to present the results of aquatic ecology monitoring undertaken in 2024. The results of 2024 stygofauna monitoring (GHD 2024b) and watercourse stability monitoring (GHD 2025c) have been provided in separate reports.

Aquatic ecology monitoring has been undertaken biannually since spring 2015 within waterways with the potential to be impacted by Airly Mine. GHD conducted autumn 2024 monitoring between 21 and 23 May 2024, and spring 2024 monitoring between 5 and 8 November 2024. The monitoring program involved assessment of seven sites, consisting of three baseline sites, two subsidence impact sites, one background site on Airly Creek upstream from Airly Mine discharges and one impact site on Airly Creek downstream from Airly Mine's licensed discharge points (LDPs). Macroinvertebrate, water and sediment samples were collected from each site in autumn 2024, however, dry conditions in spring 2024 meant that samples were not able to be collected from Gap Creek. Instream habitat surveys were also undertaken in autumn and spring 2024 noting the coverage and condition of riparian and instream vegetation through completion of the RCE inventory (Peterson 1992).

Airly Mine has three LDPs under Environment Protection Licence (EPL) 12374. There were no discharges from Airly Mine LDPs into Airly Creek in 2024 (last discharge November 2022), and therefore, no impacts to water or sediment quality due to discharges in 2024. There were few water quality toxicants observed in elevated concentrations at Airly Creek impact site AIR in 2024, and little impact to aquatic organisms expected due to water quality. The elevated water hardness would ameliorate the toxicity of the observed dissolved zinc concentration, and the low-level arsenic exceedance (below the 95 percent species protection value) indicates impacts to only the most sensitive species are likely. There were more water quality toxicant DGV exceedances observed at background site AIRUS in 2024, suggesting a higher probably of biological impacts due to water quality than was observed at AIR. However, historical results indicate that several dissolved metals concentrations, including cobalt, manganese, nickel and zinc, have been commonly elevated at both AIR and AIRUS across the historical monitoring period in absence of Airly Mine discharges, particularly during dry conditions. Other impacts to water quality observed in 2024 include higher salinity and concentrations of major ions at the low altitude sites (Airly Creek, Torbane Creek and Dog Trap Creek) compared to the higher altitude sites (Genowlan and Gap Creeks). This is indicative of historical land clearing, the agricultural landuse in the lowland catchments, and the influence of saline groundwater from marine-deposited geology on Airly Creek.

Sediment quality has been consistently good at all sites except background site AIRUS across the historical monitoring period, with very few exceedances of the DGVs observed. Sediment quality in 2024 remained good at these sites, and only one low-level DGV exceedance for sediment nickel was observed at AIRUS in autumn 2024.

The macroinvertebrate community condition in 2024 strongly reflected the individual site conditions, including lower water levels, reduced flow, overgrowth of algae, and landuse practices. Macroinvertebrate community composition reflected the site differences, with samples collected from more pristine, higher altitude sites on Gap and Genowlan Creeks showing similarities, which contrasted to the macroinvertebrate communities observed at lower lying sites in Dog Trap, Torbane and Airly creeks. There is no evidence of impacts to macroinvertebrate communities in 2024 from Airly Mine operations. Despite the drier conditions influencing the water quality and water and habitat availability, the macroinvertebrate community at Airly Creek impact site AIR was in a similar condition to that at Airly Creek background site AIRUS in 2024.

Panel and pillar mining was undertaken below a small section of the first order headwaters of Torbane Creek in 2019 and Gap Creek between 2020 and 2021. There was no evidence of impacts to flows or water quality in Gap Creek (GAP) since panel and pillar mining commenced in this catchment. Similarly, there has not been any observed impacts to water availability in Torbane Creek (TOR) since mining commenced in the catchment. Any impairment observed in the macroinvertebrate community condition at GAP or TOR in 2024 compared to historical conditions is considered to be due to lower water levels, reduced flows, and overgrowth of nuisance algae. Therefore, the results of 2024 monitoring do not suggest any impacts to the macroinvertebrate community due to mining activity.

The next round of aquatic ecology monitoring will be conducted in autumn 2025.

Contents

1. Introduction **1**
1.1 Background 1
1.2 Scope 1
1.3 Purpose of this report 1
1.4 Licenced discharges and development consent conditions 1
1.4.1 Licensed discharges 1
1.4.2 Development consent conditions 2
1.5 Assumptions 2
1.6 Limitations 2

2. Methodology **4**
2.1 Study area and site selection 4
2.2 Habitat assessment 7
2.3 Water quality monitoring 7
2.3.1 *In situ* water quality 7
2.3.2 Laboratory analysis 7
2.4 Sediment quality monitoring 8
2.5 Macroinvertebrate monitoring 8
2.5.1 Field sampling 8
2.5.2 Laboratory processing and identification 9
2.6 Quality assurance 9
2.7 Data analysis 9
2.7.1 Water quality 9
2.7.2 Sediment quality 11
2.7.3 Macroinvertebrates 11

3. Results **14**
3.1 Environmental conditions 14
3.2 Discharges from Airly Mine in 2024 15
3.3 Aquatic habitat assessment 16
3.3.1 RCE inventory 23
3.4 Water quality 24
3.4.1 Water quality – 2024 24
3.4.2 Historical review – Airly Creek 31
3.5 Sediment quality 35
3.6 Macroinvertebrates 38
3.6.1 Univariate results – autumn and spring 2024 38
3.6.2 AUSRIVAS 41
3.6.3 Multivariate analysis – 2024 45
3.6.4 Historical review 47
Univariate analysis 47
Multivariate analysis 50

4. Discussion **54**
4.1 Water quality 54
4.2 Sediment quality 55

4.3 Macroinvertebrates 56
5. Conclusions 59
6. References 60

Table index

Table 1.1 Stream health performance criteria from Airly Mine Water Management Plan (from Table 6.11 in GHD 2024a) 2
Table 2.1 Sites sampled in autumn and spring 2024 4
Table 2.2 Analytical testing – water quality 7
Table 2.3 Analytical testing – sediment quality 8
Table 2.4 DGVs and SSGVs applicable to Airly sites (GHD 2018) 10
Table 2.5 NSW combined-season eastern edge AUSRIVAS bands and descriptions 12
Table 3.1 RCE scores (percentage) from monitoring in 2024 and 2023 23
Table 3.2 Results of laboratory analysis of water samples collected in autumn 2024 26
Table 3.3 Results of laboratory analysis of water samples collected in spring 2024 28
Table 3.4 HMGVs (in mg/L) for nickel and zinc in autumn and spring 2024 30
Table 3.5 Laboratory analysis of sediment samples collected in autumn 2024 36
Table 3.6 Laboratory analysis of sediment samples collected in spring 2024 37
Table 3.7 Inventory of macroinvertebrate taxa predicted at ≥50% by AUSRIVAS modelling but not collected in 2024 43

Figure index

Figure 2.1 Aquatic ecology monitoring locations 5
Figure 2.2 Mining progress in 2024 6
Figure 3.1 Daily rainfall at Airly Mine in 2024 14
Figure 3.2 Yearly rainfall at Airly Mine from 2013 to 2024, compared to long-term yearly rainfall statistics (1899-2024) 15
Figure 3.3 Piper plot displaying cation and anion composition of water samples collected in autumn and spring 2024 30
Figure 3.4 EC in Airly Creek, 2010 to 2024 32
Figure 3.5 pH in Airly Creek, 2010 to 2024 32
Figure 3.6 Dissolved cobalt in Airly Creek, 2010 to 2024 (note logarithmic scale) 33
Figure 3.7 Dissolved copper in Airly Creek, 2010 to 2024 33
Figure 3.8 Dissolved manganese in Airly Creek, 2010 to 2024 33
Figure 3.9 Dissolved nickel in Airly Creek, 2010 to 2024 (note logarithmic scale) 34
Figure 3.10 Dissolved zinc in Airly Creek, 2010 to 2024 (note logarithmic scale) 34
Figure 3.11 Taxa richness in macroinvertebrate samples, autumn and spring 2024 39
Figure 3.12 EPT richness in macroinvertebrate samples, autumn and spring 2024 40
Figure 3.13 SIGNAL-2 scores for macroinvertebrate samples, autumn and spring 2024 40
Figure 3.14 Proportion of sensitive taxa in macroinvertebrate samples, autumn and spring 2024 41
Figure 3.15 AUSRIVAS O/E50 results for 2024 42

Figure 3.16 Cluster plot demonstrating relative similarity in community composition between samples, autumn and spring 2024 46
Figure 3.17 Taxa richness at all sites in EIS (2013 to 2014) and post-EIS (2015 to 2024) sampling events 47
Figure 3.18 EPT richness at all sites in EIS (2013 to 2014) and post-EIS (2015 to 2024) sampling events 48
Figure 3.19 SIGNAL-2 at all sites in EIS (2013 to 2014) and post-EIS (2015 to 2024) sampling events 48
Figure 3.20 Taxa richness results, 2020 to 2024 49
Figure 3.21 EPT richness results, 2020 to 2024 49
Figure 3.22 SIGNAL-2 results, 2020 to 2024 49
Figure 3.23 nMDS demonstrating relative similarity in community composition between sites, 2013-2024 51
Figure 3.24 nMDS demonstrating relative similarity in community composition between EIS and post-EIS sampling, 2013-2024 52
Figure 3.25 nMDS demonstrating relative similarity in community composition between Airly Creek samples, 2013-2024 53

Appendices

Appendix A Laboratory certificates of analysis (water quality)
Appendix B Laboratory certificates of analysis (sediment quality)
Appendix C Raw macroinvertebrate data
Appendix D Water quality QA
Appendix E Sediment quality QA
Appendix F Macroinvertebrate taxonomy QA
Appendix G RCE Scores, 2023-2024
Appendix H ANOSIM Output

1. Introduction

1.1 Background

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, owned by Centennial Airly Pty Ltd (Centennial). Airly Mine was granted Development Consent (SSD-5581) for the extension of its underground coal mine on 15 December 2016. Since this time, Development Consent SSD-5581 has been modified to remove some restrictions on mining (Modification 1), to allow the receipt of up to 170 ML/year of water from Charbon Colliery by rail (Modification 2), and to provide clarification of the Remediation Management Plan and allow changes to the approved workforce (Modification 5).

Airly Mine currently has approval to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal from the Lithgow Seam using mining methods that incorporate extraction by first workings, partial pillar extraction or panel and pillar mining. ROM and product coal are transported off site by rail for the export and domestic markets.

Aquatic ecology monitoring was undertaken by Cardno (2014) to support the Environmental Impact Statement (EIS) for the Airly Mine Extension Project. Sampling was undertaken in autumn and spring of 2013 and 2014 at twelve aquatic ecology monitoring sites, located on six creeks (Cardno 2014).

Nineteen rounds of aquatic ecology monitoring have been conducted since the EIS, during autumn and spring each year from spring 2015 to spring 2024. This report outlines the results of the autumn 2024 monitoring conducted between 21 and 23 May 2024 and the spring 2024 monitoring conducted between 5 and 8 November 2024.

1.2 Scope

GHD Pty Ltd (GHD) was engaged by Centennial to undertake autumn and spring 2024 aquatic ecology monitoring in waterways upstream and downstream of Airly Mine as required by the conditions of consent of the extension of the mine (see Section 1.4.2). Aquatic ecology monitoring involved the collection of macroinvertebrate, water and sediment samples in autumn and spring 2024. This report presents the results of autumn and spring 2024 aquatic ecology monitoring and also considers the previous monitoring results to assess the condition of the sites, and any potential impacts from mining on aquatic ecosystems.

1.3 Purpose of this report

The purpose of this report is to present the results of aquatic ecology monitoring undertaken in autumn and spring 2024 and to fulfil the requirements of the development consent conditions outlined in the Airly Mine Water Management Plan (WMP) (GHD 2024a). This report is intended as a supporting document to Airly Mine's Annual Review.

1.4 Licenced discharges and development consent conditions

1.4.1 Licensed discharges

Airly Mine currently holds environment protection licence (EPL) 12374, with water currently licensed to be discharged from the site through the following licensed discharge points (LDPs):

– LDP1 – Discharge to Airly Creek via the Production Dam
– LDP2 – Discharge to Airly Creek via the Stockpile Dam
– LDP3 – Discharge to Airly Creek via the Train Loader Dam

LDPs are monitored monthly during discharge and tested for several water quality parameters. EPL 12374 stipulates discharge water sampling concentrations limits, however, this report will not assess discharges for compliance to these limits, which is conducted through the Annual Review report.

1.4.2 Development consent conditions

Airly Mine has development consent under Section 89E of the *Environmental Planning & Assessment Act 1979* for the extension of the mine (approved 15 December 2016).

The performance criteria relating to stream health in waterways surrounding Airly Mine is outlined in the Airly Mine WMP (GHD 2024a) and below in Table 1.1. These criteria have been developed to check that impacts from mining operations are not greater than predicted by the environmental impact assessments for the approved Airly Mine Extension Project and subsequent modifications.

Geomorphic condition and watercourse stability monitoring is required every two years and was conducted in 2024. The results of the geomorphic condition and watercourse stability monitoring are presented in a separate report (GHD 2025c).

Aquatic ecology monitoring is undertaken twice per year in autumn and spring and includes an assessment of riparian and instream vegetation as part of the riparian, channel and environmental (RCE) inventory (Peterson 1992) (see Section 2.2).

Table 1.1 Stream health performance criteria from Airly Mine Water Management Plan (from Table 6.11 in GHD 2024a)

Aspect	Criteria	Addressed in this report
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks.	No – visual watercourse stability monitoring conducted every two years. Monitoring was conducted in 2024 and is presented in a separate report (GHD 2025c).
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.	
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.	No – Centennial maintains a subsidence monitoring program, which includes visual inspections, physical markers and satellite technology.
Watercourse subsidence	No connective cracking between the surface and underground workings.	
Instream/riparian vegetation	RCE scores relating to riparian and instream vegetation within historical range and/or consistent with reference sites.	Yes – see Section 3.3.1.

1.5 Assumptions

Historical water quality data and monthly water quality results for Airly Creek sites were obtained from ALS. It is assumed that the data provided to GHD has been collected using suitable methods and procedures to ensure the accuracy of the results.

Rainfall records were obtained from Centennial. It is assumed that rainfall data sourced from Centennial for the Airly Mine station are accurate, and that data have been validated via standard quality control procedures.

1.6 Limitations

This report: has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and Centennial Airly Pty Ltd as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methodology

2.1 Study area and site selection

Seven sites near Airly Mine were visited in autumn and spring 2024. The monitoring locations are detailed in Table 2.1 and Figure 2.1.

Site DOG on Dog Trap Creek and GRO and GEN on Genowlan Creek are considered to be in a baseline state, as there has been no panel and pillar mining beneath these areas to date. Panel and pillar mining was undertaken beneath small headwater sections of Torbane Creek and Gap Creek between 2019 and 2022, although only a very small area was within the Torbane Creek catchment. Under the Airly Mine Plan, additional panel and pillar mining will be undertaken below the headwaters of Gap Creek, Genowlan Creek and Dog Trap Creek in the future, although third order streams and higher will be avoided.

Mining came within 500 m of GRO in April 2023, and within 500 m of GEN in July 2023. A very small section of a minor (first order) tributary to Genowlan Creek has been undermined (refer Figure 2.1); however, this is not considered likely to have influenced GEN and GRO, so the status of these sites as in baseline condition remains current at this time. Mining progress in relation to the high-altitude sites is presented in Figure 2.2.

Site AIR on Airly Creek is classified as an impact site as it is downstream of LDP1, LDP2 and LDP3, and receives infrequent licensed discharges of mine affected water (MAW) from Airly Mine. AIRUS is a background site located on Airly Creek, upstream of the licensed discharges from Airly Mine. Airly Creek will not be undermined.

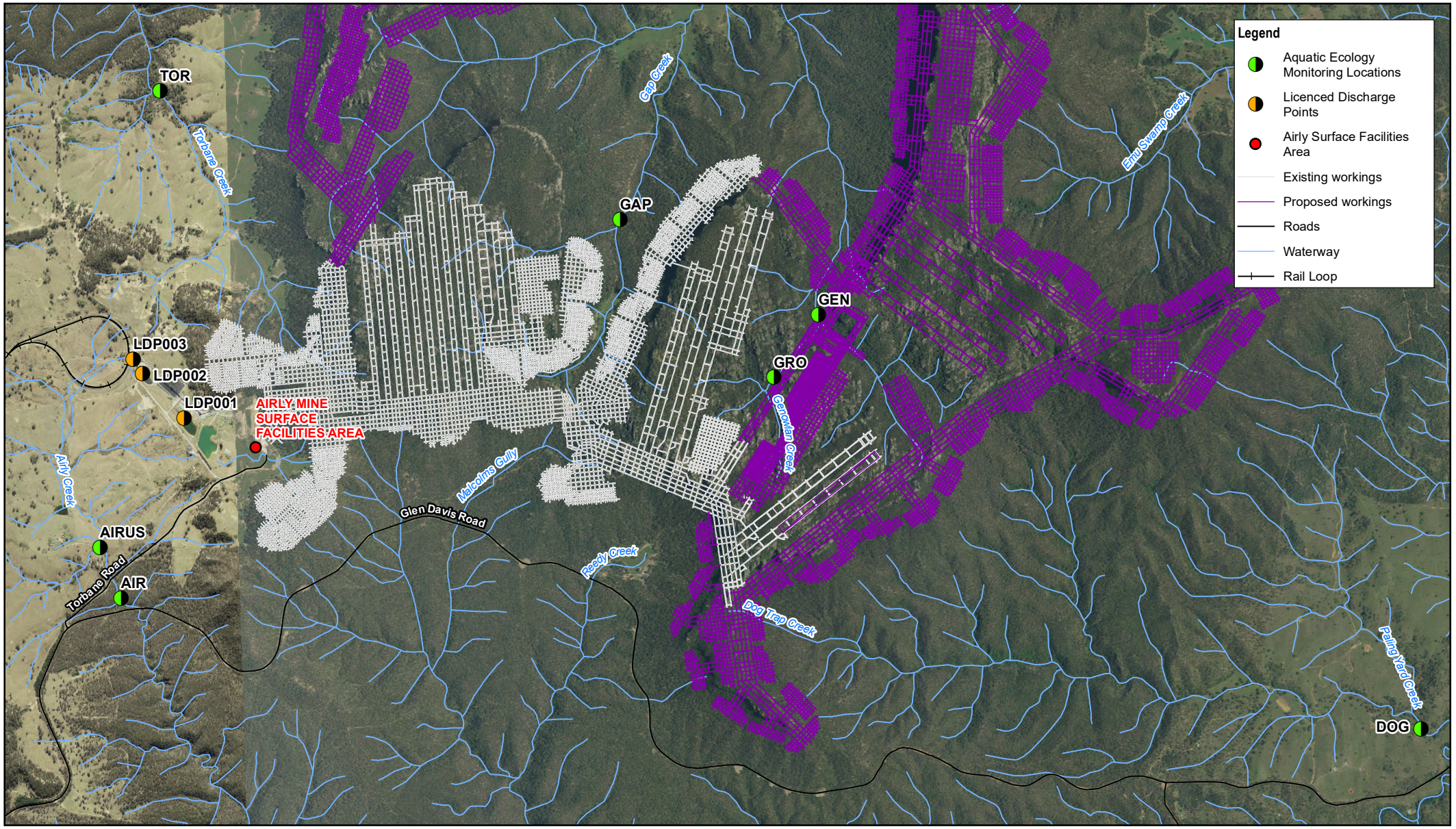
All sites were sampled for water quality, sediment quality and macroinvertebrates in autumn 2024. GAP was dry in spring 2024 and was not able to be sampled.

Table 2.1 Sites sampled in autumn and spring 2024

Site code	Site name	Site type	Dates visited		Latitude	Longitude	Altitude (m AHD)
			Autumn	Spring			
DOG	Dog Trap Creek	Baseline (no current undermining)	23/05/24	08/11/24	-33.13475°	150.11087°	401
GEN	Genowlan Creek		22/05/24	05/11/24	-33.10456°	150.06123°	827
GRO	Upper Genowlan Creek		22/05/24	05/11/24	-33.10860°	150.05760°	890
GAP	Gap Creek	Potentially influenced (headwaters undermined) *	21/05/24	06/11/24	-33.09753°	150.04483°	701
TOR	Torbane Creek		23/05/24	07/11/24	-33.08764°	150.00706°	666
AIRUS	Airly Creek upstream of Airly Mine	Background (discharge)	23/05/24	08/11/24	-33.11967°	150.00018°	715
AIR	Airly Creek downstream of Airly Mine	Impact (discharge)	23/05/24	07/11/24	-33.12286°	150.00262°	714

Note: Locations in GDA94.

*Relates to secondary workings (panel and pillar mining).



CENTENNIAL

Paper Size ISO A4

0 0.3 0.6 0.9

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Pty Ltd
Airly Mine
Aquatic Ecology Monitoring Program

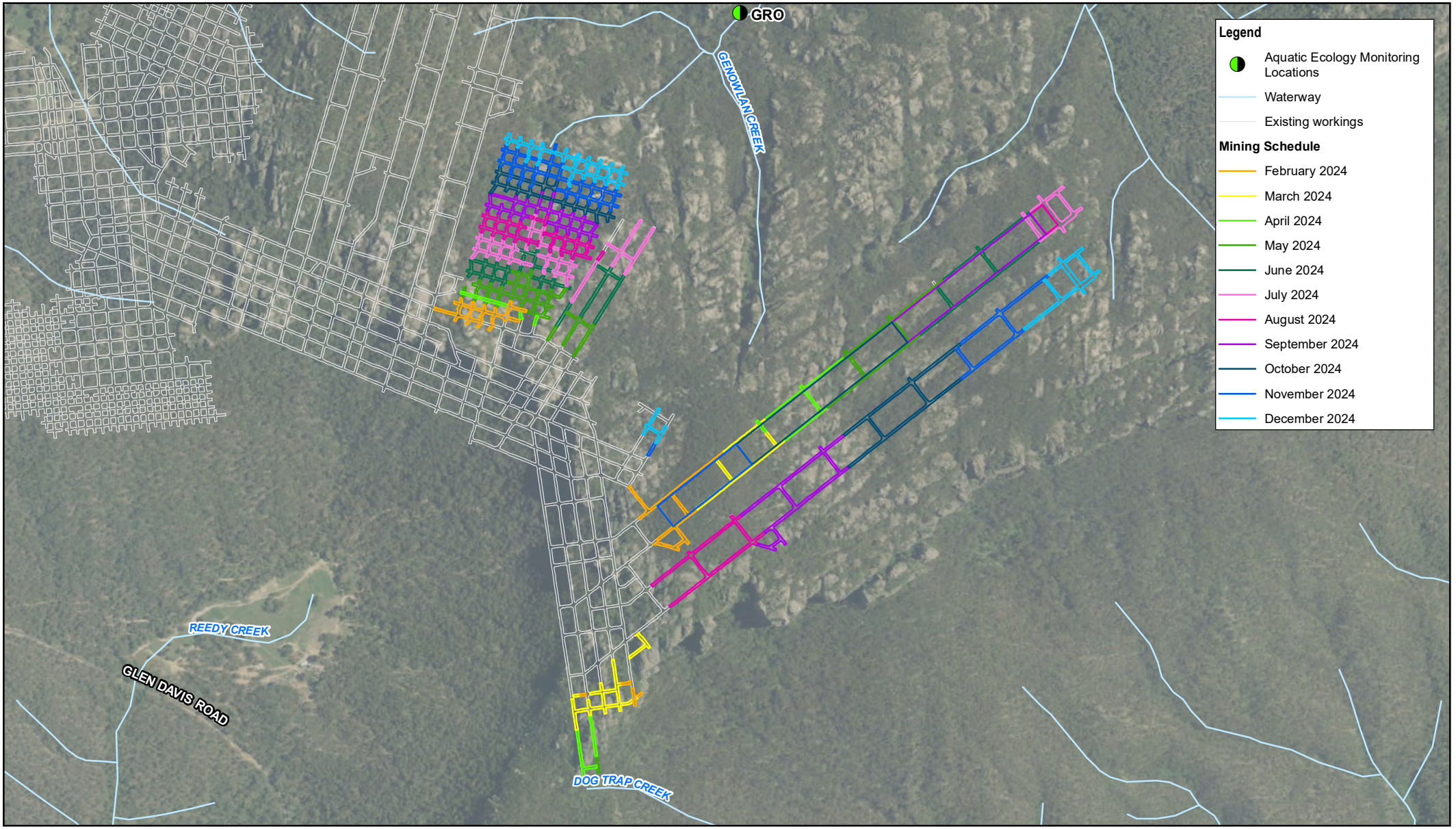
Project No. **12633750**
Revision No. **0**
Date **15 Jan 2025**

Aquatic ecology monitoring locations

FIGURE 2-1

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12633750\AquaticEcology\12633750_AEM001_MonitoringLocations_0.mxd
Print date: 15 Jan 2025 - 11:17

Data source: Centennial: Mine data, 2025, Aerial Imagery; LPI: DTDB / DCDB, 2017; © Department of Finance, Services & Innovation 2018. Created by: akildea



CENTENNIAL

Paper Size ISO A4

0 100 200 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Airly Pty Ltd
Airly Mine
Aquatic Ecology Monitoring Program

Project No. **12633750**
Revision No. **0**
Date **15 Jan 2025**

2024 mining progress

FIGURE 2.2

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12633750\AquaticEcology\12633750_AEM002_2024_MineProgress_0.mxd
Print date: 15 Jan 2025 - 11:17

Data source: LPI: DTDB 2012; Centennial: Mine workings 2025; © Department of Customer Service 2020. Created by: fmackay

2.2 Habitat assessment

Habitat descriptions were made in the field based on visual estimates of characteristics such as stream bed composition (percentage of each substrate category e.g., sand or cobble), aquatic and riparian vegetation cover, amount of instream organic material, type of aquatic habitats and canopy cover. The mean wetted width and sample depth were also estimated.

Assessments of disturbance related to human activities were made for each site following the methodology prescribed by Turak *et al*. (2004), which ranks habitat disturbance based on instream habitat, riparian vegetation and the land-use in the greater catchment area. The assessment also included sketches of the longitudinal and cross-sectional profiles of the river reach.

Assessment of the condition of the aquatic habitat was also conducted using the RCE inventory (Peterson 1992). RCE provides a standardised approach to assess the adjacent land, condition of the banks, channel and bed using 13 indicators. The RCE Inventory has been modified by Chessman *et al*. (1997) to suit Australian conditions. The scoring system has been simplified to a range of 0 to 4 for each descriptor with 0 indicating the poorest condition. The total score is derived by summing the scores for each descriptor. Scores can be expressed as a percentage of the maximum score of 52.

2.3 Water quality monitoring

2.3.1 *In situ* water quality

Physico-chemical water quality parameters were measured *in situ* at each of the sampling sites using a YSI Pro Plus multi-parameter water quality meter. This meter was calibrated in accordance with Quality System/Quality Assurance (QS/QA) requirements and the manufacturer's specifications prior to its use in the field. Turbidity was measured *in situ* using a WTW Turb 430 IR portable turbidity meter.

In situ physico-chemical measurements recorded included:

– Temperature (°C)
– pH (pH units)
– Electrical conductivity (µS/cm) – EC
– Dissolved oxygen (mg/L and % saturation) – DO
– Turbidity (NTU)

2.3.2 Laboratory analysis

Water quality samples were collected from the sampling sites shown in Table 2.1 prior to the collection of sediment and macroinvertebrate samples. Disposable nitrile gloves were worn to prevent sample contamination and for staff safety. Samples requiring analysis of dissolved metals were field filtered using a high volume 0.45 µm filter prior to collection in the sample bottle.

The chemical analyses in Table 2.2 were performed by a National Association of Testing Authorities (NATA) accredited laboratory. Ultra-trace analysis was performed in some cases as required for comparison to the relevant ANZG (2018) GVs for protection of 99 percent of species. Laboratory certificates of analysis (COAs) are presented in Appendix A.

Table 2.2 Analytical testing – water quality

Suite	Analytes
Metals (dissolved and total)	Aluminium, arsenic*, boron, cadmium*, chromium*, copper, iron, lead, manganese, mercury*, nickel, selenium*, silver*, zinc*
Anions	Chloride, sulfate, alkalinity
Cations	Calcium, sodium, potassium, magnesium

Suite	Analytes
Nutrients	Ammonia, nitrate, nitrite, nitrite plus nitrate (NO_x), Total Kjeldahl Nitrogen (TKN), total nitrogen (TN), total phosphorus (TP) and reactive phosphorus
Other	Total dissolved solids (TDS), dissolved organic carbon (DOC), total suspended solids (TSS), water hardness, turbidity

* denotes that ultra-trace analysis was performed.

2.4 Sediment quality monitoring

Sediment grab samples were collected following the sediment-water interface hand corer methods as outlined in the Sediment Quality Assessment guide (Simpson and Batley 2016).

Sediment samples were collected using a plastic trowel. To account for potential variability of sediment quality within a site, sediment was collected from a minimum of three locations at each site and homogenised to produce one composite sediment sample.

The sediment samples were analysed for the parameters presented in Table 2.3 by a NATA accredited laboratory. The laboratory COAs are presented in Appendix B.

Table 2.3 Analytical testing – sediment quality

Suite	Analytes
Metals (totals and 1M HCl extractable)	Aluminium, antimony, arsenic, cadmium, chromium, copper, manganese, nickel, lead, zinc, mercury
Nutrients	Ammonia, nitrite, nitrate, NO_x, TKN, TN, TP
Other	Total organic carbon (TOC)

2.5 Macroinvertebrate monitoring

2.5.1 Field sampling

Field sampling followed Rapid Bioassessment (RBA) protocols in accordance with the NSW AUSRIVAS Sampling and Processing Manual (Turak *et. al.* 2004). The AUSRIVAS program is a nationally recognised, standardised sampling protocol used to assess the health of Australian rivers and was developed for Australia's National River Health Program.

In accordance with the AUSRIVAS protocol, the autumn 2024 macroinvertebrate sampling was conducted between 15 March and 15 June (21 to 23 May 2024), and spring 2024 macroinvertebrate monitoring was conducted between 15 September and 15 December (5 to 8 November 2024).

Two samples were collected from Edge habitat at each site, per season, except GAP, which contained insufficient water for the collection of macroinvertebrate samples in spring 2024. Edge habitat is defined as areas within 1 m of the edge of the water, in areas of little or no flow. Sampling was conducted using a standard ISO 7828 (1983) design sweep-net with 250 µm mesh. Sampling of the Edge habitat was undertaken by sweeping the net perpendicular to the bank over approximately 10 m of discontinuous edge habitat. All available microhabitats were targeted, including overhanging terrestrial vegetation, snags, backwaters, and macrophytes. The net was washed thoroughly between each sample to remove any invertebrates retained on it.

For each RBA sample, the collected material was placed into a sorting tray and macroinvertebrates picked for a minimum of 40 minutes by experienced aquatic ecologist using forceps and pipettes. If new taxa were found between 30 and 40 minutes, sorting continued for a further 10 minutes. The processing cycle was continued up to a total maximum sorting time of 1 hour.

The objective of the RBA sorting protocol is to obtain a sample containing as diverse a fauna as possible, and hence provide a useful measure of taxa richness. Attempts were made to collect all taxa present in the sample, including rare or cryptic animals. Samples were preserved in 70 percent methylated spirits and clearly labelled with information including site, habitat, sampling method, date and sampler.

2.5.2 Laboratory processing and identification

Macroinvertebrates were examined in a GHD laboratory using Leica MZ 9.5 stereo-dissection microscopes with planachromat objectives and a zoom capability between 6.3-60x. Macroinvertebrates were identified using published taxonomic keys (Hawking 2000), unpublished working keys and an extensive specimen reference collection maintained by GHD.

Most macroinvertebrates were identified to family level with some exceptions following standard conventions of the NSW AUSRIVAS sampling and processing manual (Turak *et al*. 2004). Chironomidae (Diptera) were identified to sub-family (e.g. Orthocladiinae, Chironominae, and Tanypodinae). Groups such as Nematoda, Oligochaeta and Acarina were identified to class or order level. Microcrustacea (Ostracoda, Copepoda and Cladocera) were also identified to the order level but were not included in richness counts to align with historical results. Microcrustacea were included in the datasets analysed using the AUSRIVAS software. The raw macroinvertebrate counts can be viewed in Appendix C.

Upon completion of identification all samples were returned to 100% ethanol for long-term archiving. GHD will ensure that archived samples are retained for the life of the project. Reference specimens will remain the property of GHD.

2.6 Quality assurance

In accordance with GHD's Quality Assurance (QA) protocol, one duplicate water and sediment sample was collected from autumn and spring 2024 at the same time as primary sample collection. The collection of a duplicate sample allows for the assessment of the potential level of uncertainty associated with the sampling method, preservation, transport, or laboratory analysis, as well as the intra-site variability. The results of the primary and duplicate water and sediment samples are presented in Appendix D and Appendix E, respectively.

One macroinvertebrate sample was examined by a second taxonomist to check the accuracy of identification, the results of which can be seen in Appendix F.

2.7 Data analysis

2.7.1 Water quality

Water quality results for all baseline and potentially influenced sites (DOG, GAP, GEN, GRO and TOR) were compared to the default guideline values (DGVs) in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality as detailed below:

– DGV ranges for physical and chemical stressors outlined in Table 3.3.2 of ANZECC (2000a) for upland rivers (>150 metres altitude) in south-east Australia.
– DGVs for EC and turbidity outlined in Table 3.3.3 of ANZECC (2000a) for upland rivers in south-east Australia.
– DGV for TSS outlined in Table 8.2.12 of the ANZECC (2000b) guidelines – Volume 2, for NSW upland rivers.
– Toxicant DGVs for protection of 99 percent of freshwater species as outlined in ANZG (2018) and more recent updates.
– DGV for cobalt of unknown species protection as outlined in ANZECC (2000b).

The 99 percent species protection level was used in this analysis due to the proximity of Airly Mine to State Conservation Areas and National Parks and the conditions of consent (refer Section 1.4.2).

Water quality results for AIRUS and AIR (i.e. sites potentially influenced by Airly Mine discharges) were compared to the Site-Specific Guideline Values (SSGVs) for Airly Creek (GHD 2018) that were derived from the background Airly Creek site AIRUS and the DGVs outlined above (ANZECC 2000; ANZG 2018).

The DGVs and SSGVs are presented in Table 2.4.

Table 2.4 DGVs and SSGVs applicable to Airly sites (GHD 2018)

Parameter	ANZECC (2000) DGV	ANZG (2018) DGV	SSGV
Physicochemical parameters			
EC (µS/cm)	350	-	2709
pH (pH units)	6.5-8.0	-	6.5-8.0
DO (% saturation)	90-110	-	-
TSS (mg/L)	25	-	25
Turbidity (NTU)	25	-	25
Oil and grease (mg/L)	-	-	5
Metals (dissolved)			
Aluminium (mg/L)	-	0.027	0.027
Antimony (mg/L)	-	-	0.001
Arsenic (mg/L)	-	0.0008	-
Barium (mg/L)	-	-	0.017
Beryllium (mg/L)	-	-	0.001
Boron (mg/L)	-	0.34	0.09
Cadmium (mg/L)	-	0.00006	-
Chromium (III+VI) (mg/L)	-	0.00001	-
Cobalt (mg/L)	-	0.0014*	0.001
Copper (mg/L)	-	0.001	0.001
Iron (mg/L)	-	-	0.3
Lead (mg/L)	-	0.001	0.001
Manganese (mg/L)	-	1.2	1.2
Mercury (mg/L)	-	0.00006	-
Molybdenum (mg/L)	-	-	0.001
Nickel (mg/L)	-	0.008	0.008
Selenium (mg/L)	-	0.005	-
Silver (mg/L)	-	0.00002	0.001
Zinc (mg/L)	-	0.0024	0.0076
Nutrients			
Ammonia as N (mg/L)	-	0.32	0.32
NO_x (mg/L)	0.015	-	-
TN (mg/L)	0.25	-	0.7
TP (mg/L)	0.02	-	0.056
RP (mg/L)	0.015	-	-
Other parameters			
Fluoride	-	0.29	

* DGV for cobalt is of unknown species protection.

Dissolved metal and metalloid concentrations are more applicable for comparison to the water quality DGVs than total metal concentrations, as they are more representative of the bioavailable fractions of metals and metalloids within the water. Therefore, only dissolved concentrations have been assessed against the water quality DGVs/SSGVs.

Hardness modified guideline values (HMGVs) were calculated using the algorithms presented in Table 3.4.3 of ANZECC (2000) and the water hardness values observed during the corresponding sampling event in 2024. HMGVs are applicable to dissolved cadmium, lead, nickel and zinc concentrations in water samples with a water hardness greater than 30 mg/L (as $CaCO_3$). However, HMGVs were only calculated if dissolved concentrations of the relevant metal exceeded the SSGV/DGV.

Multivariate analysis

A Piper plot was created for water samples collected in autumn and spring 2024. A Piper plot is a graphical method of presenting the major ionic chemistry of a water sample. The plot displays water samples in regard to their cation composition in the left triangle, anion composition in the right triangle, and a combination of the two in the centre diamond plot. Convergence of the sample symbols indicates a similar chemical composition.

Historical review

Long-term, time series water quality graphs were created for key analytes at impact site AIR and background site AIRUS. Analysis of these results allows for assessment of the influence of Airly Mine discharges on water quality in Airly Creek, as well as changes in Airly Creek water quality over time (including EIS vs. post-EIS). Data collected monthly by ALS on behalf of Centennial Airly has been graphed, along with data collected by GHD during the biannual aquatic ecology monitoring program. At AIR, data are available for a total collection period from January 2010 to December 2024, while at AIRUS data are available between April 2014 and December 2024.

2.7.2 Sediment quality

Sediment quality results were compared to the revised DGVs for sediment quality outlined in ANZG (2019). The sediment DGVs represent the thresholds above which biological effects are possible. GV-high values are also outlined, which are the thresholds above which there is a high probability of biological effects. It was identified in ANZG (2019) that the <2 mm sediment fraction should be compared to the DGVs for acid-extractable metals. As such, sediment samples collected in 2024 were sieved, and analysis of metals was undertaken on the <2 mm fraction only.

Acid-extractable (1M HCl-extractable) metal and metalloid concentrations are more applicable for comparison to the DGVs than total metals, as they are more representative of the bioavailable fractions of metals and metalloids found in sediments. Therefore, only acid-extractable metals have been assessed against the DGVs/GV-highs.

2.7.3 Macroinvertebrates

Univariate metrics

The following metrics have been calculated to allow for assessment of macroinvertebrate community health:

– Taxa richness
– EPT richness
– SIGNAL-2
– Proportion of sensitive taxa (taxa with SIGNAL-2 score ≥ 8)

Taxa richness

Taxonomic richness refers to the number of different taxa contained in a sample identified to family level, apart from certain taxa that were identified to order/class only (e.g., Oligochaeta) or to sub-family (i.e., members of the family Chironomidae). Rare and common taxa are considered equally, as richness does not take abundance into account.

EPT richness

The EPT richness is the number of collected families belonging to the Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) orders. These groups of macroinvertebrates have been found to be particularly sensitive to changes in their environment (Karr and Chu 1999) and, therefore, can be used to assess impacts due to chemical and physical changes (Plafkin *et al*. 1989).

SIGNAL-2

SIGNAL-2 (Stream Invertebrate Grade Number – Average Level) (Chessman 2003) is a simple scoring system for macroinvertebrates of Australian rivers. SIGNAL-2 is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrates that have been derived from published and unpublished information on their tolerance to pollutants, such as sewage, salinity and nitrification.

Macroinvertebrates are assigned a grade between 1 (most tolerant) and 10 (most sensitive) and grades have been calculated for both the Order and Family taxonomic levels. Families in a sample that have not been assigned a grade are excluded from the analysis and the total number of families that have a SIGNAL-2 grade is the SIGNAL-2 richness. Animals that could not be identified to family level due to damage or immaturity are excluded from this analysis to avoid “double-counting”. The overall SIGNAL-2 score for each site is calculated by the sum total of the SIGNAL-2 grade for each taxon within a sample divided by the SIGNAL-2 richness. A SIGNAL-2 score was calculated for each replicate from each site.

Proportion of sensitive taxa

The proportion of sensitive taxa is calculated as the percentage of taxa within the sample with a SIGNAL-2 of 8 or higher (Marshall *et al*. 2001). This metric is an additional measure of the sensitivity of the macroinvertebrate community at each site.

NSW AUSRIVAS Model

NSW AUSRIVAS Models provide a river health assessment based on predictive models of macroinvertebrate distribution. Physical and chemical data collected at each site is used to determine the predicted (expected) composition of the macroinvertebrate fauna if the site is in an undisturbed or reference condition. The AUSRIVAS assessment compares the macroinvertebrates collected at a site (Observed) to those predicted to occur (Expected) and the ratio derived indicates the band assessment of the sample data and an assessment of the departure of the community from reference conditions. The resulting statistic is known as the O/E50 and expresses the ratio of observed taxa to those with a 50% or greater probability of being collected, given the physical/chemical input variables (e.g. altitude or distance from source).

The NSW combined-season eastern edge model was used for all sites in 2024, except GAP. The autumn season eastern edge model was used for the GAP samples, as macroinvertebrate samples were not collected from GAP in spring. The upper limits for the AUSRIVAS model are provided in Table 2.5, along with the AUSRIVAS band labels, names and descriptions.

Rainfall data required for the AUSRIVAS environmental variables input file were obtained from the Running Stream (Brooklyn) Station (63012), which is the nearest active weather station with long-term data (BOM 2025).

Table 2.5 NSW combined-season eastern edge AUSRIVAS bands and descriptions

Band Label	Upper Limit (O/E50)		Band Name	Band Description
	Combined	Autumn		
Band X	Infinity		More biologically diverse than reference sites	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	1.17		Reference condition	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.

Band Label	Upper Limit (O/E50)		Band Name	Band Description
	Combined	Autumn		
Band B	0.82	0.81	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	0.48	0.46	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0.14	0.11	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

Multivariate metrics

Multivariate analyses were conducted to identify spatial and temporal trends in macroinvertebrates. Multivariate analysis allows comparisons between sites based upon macroinvertebrate community composition.

The following multivariate analyses were performed using PRIMER 7 (Clarke and Gorley 2015) statistical analysis software:

– Classification/Hierarchical agglomerative clustering
– Non-metric Multi-Dimensional Scaling (nMDS) ordination
– ANalysis Of SIMilarities (ANOSIM)

Initially, the data were transformed to presence/absence as the AUSRIVAS sampling protocol is not a quantitative technique. Bray-Curtis was the resemblance measure used to derive the resemblance matrix between samples, which are suitable for biological data (Bray and Curtis 1957).

Classification or cluster analysis is a mathematical method of grouping entities according to the relative similarity of their attributes. In an ecological setting these techniques can be used to group sites according to how similar their macroinvertebrate community is. This technique is used to identify if there are differences in the macroinvertebrate communities between sites or between sampling events. Cluster analysis was used to analyse the autumn and spring 2024 data.

A nMDS ordination plot was produced to identify temporal and spatial trends in macroinvertebrate community composition. nMDS plots provide a graphical representation of the relative similarity of entities (i.e., samples) based on their attributes (i.e., macroinvertebrate community composition) within a reduced dimensional space. The more similar samples are to each other in their community composition, the closer they are located within the ordination space. The nMDS ordination was performed on Bray-Curtis similarity coefficients, which are suitable for biological data (Bray and Curtis 1957). The 2-dimensional ordination plot has been displayed as this is more easily interpreted than the 3-dimensional plot. To determine if the 2-dimensional ordinations accurately represent patterns amongst the samples, the stress levels associated were considered. The stress level is a measure of the distortion produced by compressing multi-dimensional data into a reduced set of dimensions and would increase as the number of axes (i.e., dimensions) is reduced. If the stress is over 0.2, the MDS ordination must be interpreted with caution.

An ANOSIM test was performed on the macroinvertebrate similarity matrix to test whether macroinvertebrate communities were statistically different between sites. This method permutes the observed data and tests the between group similarity observed under this “random” data set. The significance of the test is determined based on whether higher or lower similarity was experienced under the permuted (i.e. simulated through randomisation) datasets. Interpretation of this technique is based on significance (p<5%) and strength of the relationship, denoted as R.

3. Results

3.1 Environmental conditions

Rainfall during 2024, as recorded by Centennial at Airly Mine, is displayed in Figure 3.1. April 2024 was the wettest month with 117.0 mm of rainfall recorded. The driest month was October 2024, during which 21.0 mm of rainfall was recorded. The largest rainfall event was on 6 April 2024, approximately six weeks prior to sampling in autumn 2024, during which 79.2 mm of rainfall was recorded.

In the 30 days prior to the autumn 2024 sampling event (21 April to 20 May 2024), 64.8 mm of rainfall was recorded, most of which (36.8 mm) was recorded on 5 and 6 May. In the week prior to sampling only 0.2 mm was recorded. There was no rainfall recorded during the three days of sampling in autumn 2024. In the 30 days prior to the spring 2024 sampling event (6 October to 4 November 2024), 20.0 mm of rainfall was recorded, of which 0.6 mm was recorded in the week prior to sampling. There was no rainfall recorded during the spring 2024 sampling event.

Figure 3.2 displays yearly rainfall totals for 2013 to 2024, as recorded by Centennial at Airly Mine. Rainfall data from Running Stream (Brooklyn) BOM station (63012) (BOM 2025) were used for the period January to October 2013 as rainfall monitoring by Centennial began in November 2013. Long-term 10th percentile, median and 90th percentile annual rainfall data were sourced from BOM (2025) for a period from 1899 to 2024.

Rainfall in 2024 was relatively low, with the total annual rainfall in 2024 well below the long-term median, and only slightly above the 10th percentile value. Rainfall in 2023 was also very low, with the total annual rainfall recorded below the long-term 10th percentile value, and similar to the annual rainfall recorded during the 2017 to 2019 drought period. The lowest annual rainfall was recorded in 2019, during which 398.4 mm of rainfall was recorded. Rainfall in 2022 totalled 1019.4 mm, which is the highest annual rainfall recorded during the 11-year period from 2013 to 2023. Rainfall was close to the median result in 2021, and just above the median in 2020. During the 2013 to 2019 period, rainfall only exceeded the long-term median once, in 2016.

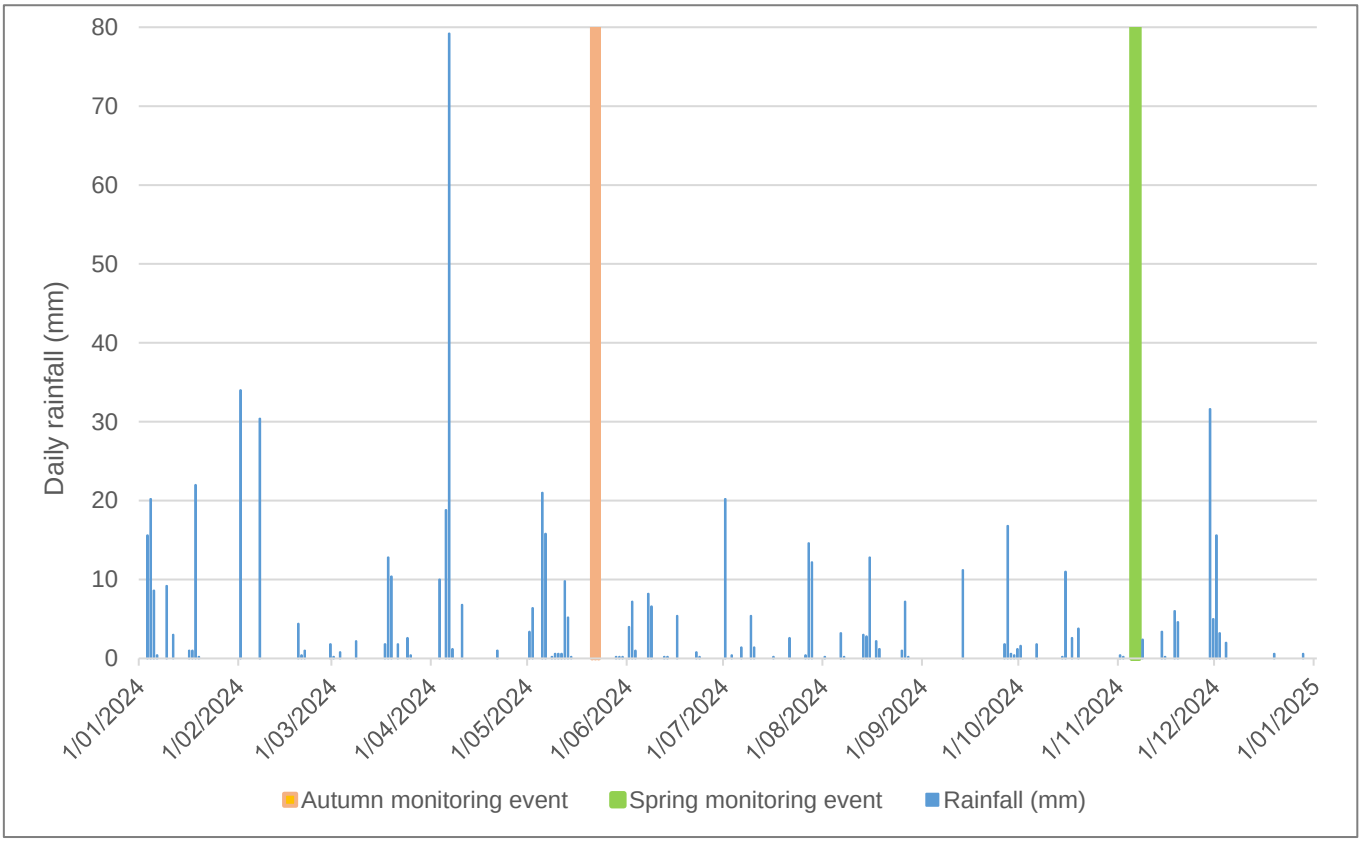


Figure 3.1 Daily rainfall at Airly Mine in 2024

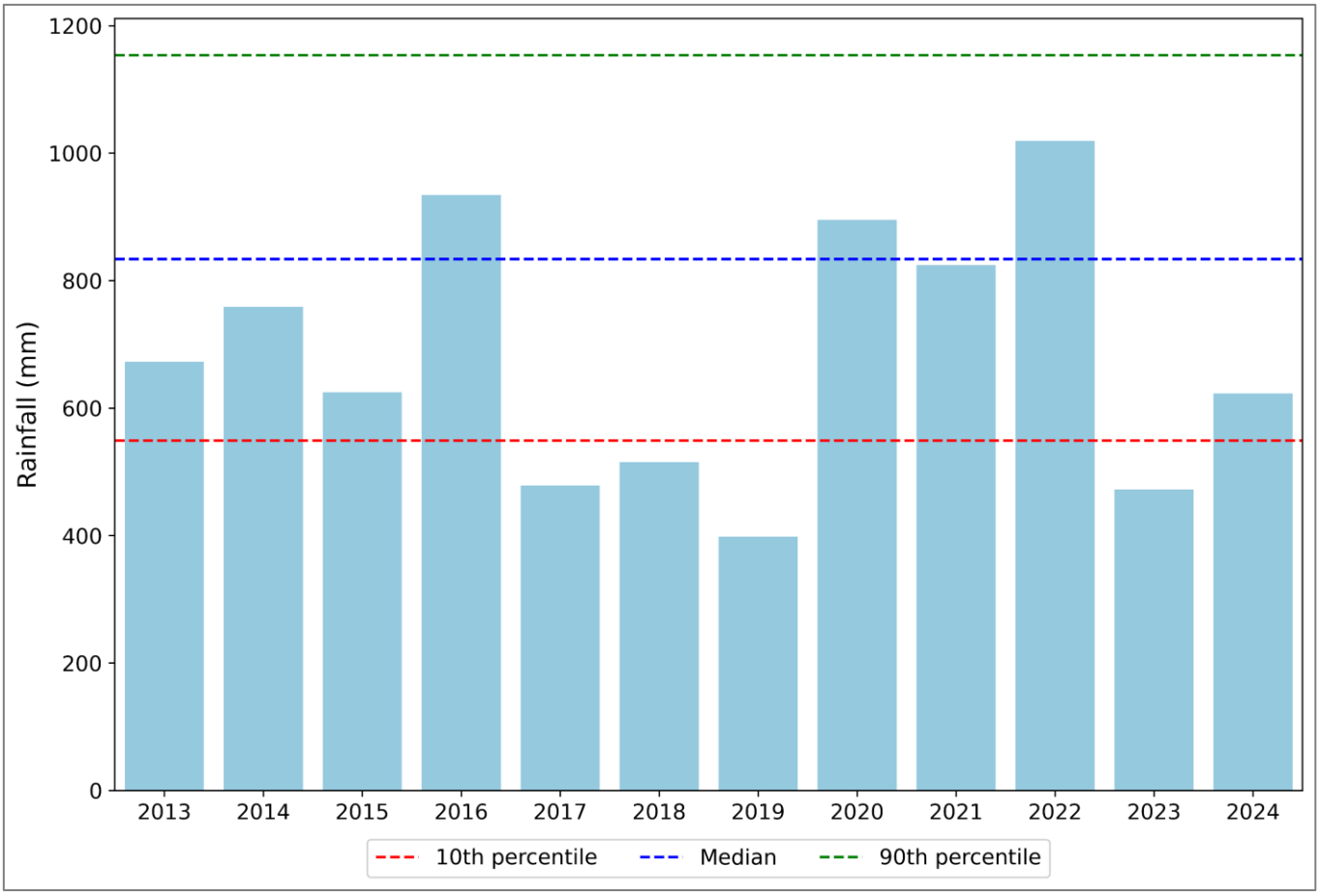


Figure 3.2 Yearly rainfall at Airly Mine from 2013 to 2024, compared to long-term yearly rainfall statistics (1899-2024)

3.2 Discharges from Airly Mine in 2024

There were no discharges recorded from LDP1, LDP2 or LDP3 in 2024. The last recorded discharge from LDP1 in Airly Creek was in November 2022.

During the historical monitoring period (2013 to 2024) discharges into Airly Creek from LDP1 have occurred at the following times:

– 2022: Frequent discharges (approximately monthly) throughout 2022 totalling 241.1 ML
– 2021: One discharge event in November 2021 (after spring 2021 sampling) totalling 15.6 ML
– No discharges in 2013 to 2020

Discharges from LDP2 have been infrequent and of very low volumes. The last discharge from LDP2 was in March 2021. There have been no recent discharges from LDP3.

3.3 Aquatic habitat assessment

Descriptions of the riparian vegetation, stream substrate and key instream habitats observed at each site in autumn and spring 2024 are provided below, along with site photographs taken in autumn and spring 2024. The substrate composition and other instream habitat information has been used in interpreting the macroinvertebrate data in Section 3.6.

The higher altitude sites in Genowlan and Gap Creeks are characterised by a narrow and steep series of cascades and shallow pools. These creeks are located in an upland area where riparian vegetation is almost entirely native and includes an abundance of ferns and shrubs overhanging the streams, providing shading and edge habitat for macroinvertebrates. The channels of Dog Trap, Torbane and Airly Creeks are at a lower altitude and exhibit extensive disturbance of the stream and riparian vegetation, with potential non-point source pollution from grazing, clearing for agriculture, nearby roads, and growth of some exotic vegetation including grasses, blackberry (*Rubus fruticosus*) and willows (*Salix* sp.).

GEN

GEN in Genowlan Creek is spring-fed and has contained water consistently since early-2020, after having dried completely for a brief period during the 2019-2020 summer/drought period. A flow gauging weir was installed at the site in early 2019 and a clearing containing groundwater monitoring bores, and historical access track is the only other anthropogenic disturbance near the site, although, there is a four-wheel-drive track upstream of the site.

The reach at GEN consists of two sections - a wider pool in the downstream extent of the reach, and a narrower channel from the flow gauging weir upstream. The downstream pool has a sandy substrate, with *Chara sp.*, trailing ferns and grasses and some leaf litter. The upstream channel has substrate consisting of more rocks, with instream habitats primarily trailing grasses and ferns, with more sticks and branches. Instream habitats at GEN were similar in both autumn and spring 2024.

GEN (Genowlan Creek)



Downstream pool, facing upstream at GEN, autumn 2024



Downstream pool, facing upstream at GEN, spring 2024



Upstream channel, facing upstream at GEN, autumn 2024



Upstream channel, facing downstream at GEN, spring 2024

GRO

GRO is located in upper Genowlan Creek, but water is from the Grotto. Riparian habitat at GRO is similar to GEN with abundant native vegetation including overhanging ferns. This site was historically disturbed during maintenance of the adjacent four-wheel-drive track, which has caused a buildup of sandy sediment in the downstream section of the reach.

The site consists of a small pool at the downstream extent, downstream of a rocky cascade, which had a small amount of trickle flow in both autumn and spring 2024. Upstream of the cascade is a narrow channel, completely overgrown with ferns. Aquatic habitats at GRO in 2024 included overhanging ferns, sandy banks, leaf packs and some submerged woody habitat. The substate is mostly sand and some bedrock, which was covered by a layer of brown periphyton/algae. There was some impact to the site in spring 2024 due to track maintenance, which had pushed trees into the channel.

GRO (The Grotto)



Downstream pool and rock cascade, facing upstream at GRO, autumn 2024



Downstream pool and rock cascade, facing upstream at GRO, spring 2024



Downstream pool, facing downstream at GRO, autumn 2024



Upstream channel, facing upstream at GRO, spring 2024

GAP

GAP is located on Gap Creek, which flows through a steep valley area of large boulders in native bushland, with riparian vegetation of *Eucalyptus sp.*, shrubs and grasses. A steep four-wheel drive track runs parallel to Gap Creek, although there is a narrow section of riparian vegetation remaining as a buffer along most of the reach. Gap Creek contains a flow gauging v-notch weir and small, isolated pools between boulders, with a bedrock or sandy substrate.

Aquatic habitats at GAP in autumn 2024 included a small section of *Chara* sp. (branched algae), overhanging *Lomandra* sp. (mat rush), leaf packs and sticks, and the substrate was accumulated sand in amongst pools formed between boulders and cobbles. In spring 2024, GAP was dry providing no habitat for aquatic fauna.

GAP (Gap Creek)



Upstream pool, facing upstream to flow gauging weir at GAP, autumn 2024



Facing upstream to flow gauging weir in dry channel at GAP, spring 2024



Pools amongst boulders channel, facing downstream at GAP, autumn 2024



Dry channel amongst boulders at GAP, spring 2024

DOG

DOG is located on Dog Trap Creek, which flows through private property that is used for cattle grazing. The riparian vegetation at DOG has shown improvement across recent sampling events, with the emergence of many eucalypt saplings and other native shrubs on the left bank, though the right bank remains mostly bare and the area contains many weeds.

Aquatic habitats at DOG in 2024 was primarily *Chara* sp. and other algae, with almost all of the previously present *Typha* sp. dead. In both autumn and spring 2024, there was no flow through the site and water was confined to the main pool. The substrate in the main pool at DOG consists of soft, sticky silt.

DOG (Dog Trap Creek)	
	
Main pool, facing upstream at DOG, autumn 2024	Main pool, facing upstream at DOG, spring 2024
	
Algae and dead *Typha* sp. at DOG, autumn 2024	Very dense *Chara* and algae in the main pool at DOG, spring 2024

TOR

TOR is located on Torbane Creek, which flows though Centennial owned land that is used for cattle grazing. The riparian vegetation consists of native eucalyptus and tea trees, as well as many areas of very dense invasive blackberry growth. When water levels are high, TOR consists of a series of connected pools, with some rocky cascades.

In autumn and spring 2024 there was no flow, and water was confined to the main deeper pools. The site was in generally poor condition, particularly in spring 2024, when there was a complete coverage of very dense algal growth. Aquatic habitats at TOR in autumn and spring 2024 were exclusively dense *Chara* sp. and filamentous algae. The substrate at TOR is mostly silt and sand, with gravel and cobbles in sections of the reach that were dry in 2024.

TOR (Torbane Creek)	
	
Main pool, facing downstream at TOR, autumn 2024	Main pool, facing downstream at TOR, spring 2024
	
Chara sp. and filamentous algae in the main pool at TOR, autumn 2024	Dense *Chara* sp. and filamentous algae in the main pool at TOR, spring 2024

AIRUS

AIRUS is located on Airly Creek, upstream of the confluence where Airly Mine discharges enter (on a separate tributary of Airly Creek), and upstream of AIR. The catchment area is used for cattle grazing and the riparian vegetation at this site is mostly cleared, except for several patches of *Salix* sp. (willows). AIRUS consists of a series of pools that were isolated in both autumn and spring 2024, with water levels in spring 2024 particularly low.

In autumn and spring 2024 both replicate macroinvertebrate samples were collected from the main pool due to limited water in other areas of the reach. Aquatic habitats at AIRUS in 2024 included the macrophytes *Typha* sp. and rushes, as well as *Chara* sp., algae and trailing grasses. The substrate at AIRUS was mostly firm silt/consolidated clay.

AIRUS (Airly Creek upstream)



Main pool, facing upstream at AIRUS, showing *Typha* sp. and rushes, autumn 2024



Main pool, facing upstream at AIRUS, showing *Typha* sp., rushes, *Chara* sp., and the lower water level, spring 2024



Main pool, facing downstream at AIRUS, showing willow trees, trailing grasses and *Juncus* sp., autumn 2024



Main pool, facing downstream at AIRUS, showing willow trees, *Juncus* sp. and *Typha* sp., spring 2024

AIR

AIR is located on Airly Creek downstream of Airly Mine discharges (and AIRUS). The riparian vegetation at AIR is less disturbed than that at AIRUS, and is primarily native species, including eucalypts, native shrubs and mat rush, though some blackberry patches are present. In autumn 2024, there was connectivity between the pools and the water was flowing. In spring 2024, water levels were much lower, and pools were isolated.

Aquatic habitats at AIR in 2024 included a small amount of *Typha sp.*, trailing grasses and roots from undercut banks, and some submerged woody habitat. Habitats were reduced in spring compared to autumn, as the water level had receded away from the trailing vegetation. In both autumn and spring 2024, the substrate was mostly cobbles, and there was very little deposition of silt or other loose sediments.

AIR (Airly Creek downstream)



Main pool, facing upstream at AIR, autumn 2024



Main pool, facing upstream at AIR, showing notably reduced water level and turbid water, spring 2024



Facing downstream from the main pool at AIR, showing connectivity between the pools and flow over the raised cobble section, autumn 2024



Facing downstream from the main pool at AIR, dry in spring 2024

3.3.1 RCE inventory

RCE scores for each site in autumn and spring 2024 are presented in Table 3.1 and have been compared to results from 2023 monitoring, as well as results for monitoring conducted by Cardno prior to the Airly Mine extension EIS (Cardno 2014). Individual category scores were not provided in the EIS and, therefore, comparisons can only be made to the overall scores in the EIS (Cardno 2014). As GAP was dry in spring 2024, RCE scores were not calculated.

There was little change in the scores for RCE categories relating to riparian vegetation (see Appendix G, category 2, 3, 4) between 2023 and 2024, although, the scores at some sites did change between seasons.

Overall RCE scores at impact site AIR in 2023 and 2024 were higher than those at background site AIRUS, despite being downstream of Airly Mine LDPs, which reflects the differences in riparian vegetation coverage and substrate between the two sites. RCE scores at AIR also indicated no notable change from EIS conditions.

Changes between seasons were observed at AIRUS, DOG and TOR, where the reduced score in spring 2024 score reflected the complete coverage of algae and macrophyte present in spring 2024, as well as the change in stream bottom from stable to mobile silt (AIRUS) and the lack of stream detritus present in spring 2024 (DOG).

The waterway condition of baseline site DOG, as estimated by the overall RCE score, has degraded most substantially since EIS monitoring, though this site is not impacted by mining. Degradation is due to impacts from agricultural landuse, including cattle grazing, and the long-term drought (2017 to 2019), which caused dieback of riparian vegetation and altered the waterway hydraulics. During this drought period, and again in the spring 2023 to spring 2024 period, water in Dog Trap Creek receded to a single isolated waterhole with poor riparian cover and a substrate dominated by silt. Conversely, during sampling in earlier historical monitoring events (e.g. 2016), there was flow along the entire 100 m reach and water present within sections with bedrock, boulder, cobble and good riparian (casuarina) cover. Condition at TOR has also degraded since EIS monitoring, mostly due to a severe overgrowth of blackberry within the riparian zone, as well as the total coverage of algae within the channel in spring 2024, as mentioned above.

The condition at baseline site GRO has also declined since EIS monitoring, likely due to damage to the riparian vegetation infilling of sand within the channel caused by repair works to the adjacent vehicle track in recent years.

Table 3.1 RCE scores (percentage) from monitoring in 2024 and 2023

Site	Spring 2024	Autumn 2024	Spring 2023	Autumn 2023	EIS average (Cardno 2014)
DOG	38	46	54	54	71
GAP	Dry	90	88	83	83
GEN	87	85	90	90	90
GRO	83	79	81	77	90
TOR	58	62	67	69	73
AIRUS	42	52	46	52	NA
AIR	77	77	69	83	75

NA indicates site was not sampled prior to the EIS.

3.4 Water quality

3.4.1 Water quality – 2024

The results of *in situ* and laboratory water quality analyses in autumn and spring 2024 are presented in Table 3.2 and Table 3.3 respectively. Results at Airly Creek sites AIRUS and AIR have been compared to the SSGVs, derived by GHD from the 80th percentile value of historical water quality results from AIRUS (GHD 2018). For parameters where SSGVs did not exist, the ANZG (2018) DGV was applied. Results for potential toxicants at all other sites have been compared to the DGVs (ANZG 2018) for 99% species protection. HMGVs have been calculated, where applicable (see Section 2.7.1). These HMGVs are displayed in Table 3.4.

Parameters measured at concentrations below the laboratory limit of reporting (LOR) at all sites have not been displayed in Table 3.2 and Table 3.3. Laboratory COAs showing data for all measured parameters are provided in Appendix A. Despite ultra-trace analysis, the LORs for chromium and silver remain higher than the DGVs (for protection of 99% of species). Only values above the LOR will be counted as exceedances; however, it is noted that these may not be reflective of all exceedances of these parameters, and a low level of risk remains due to chromium and silver concentrations.

EC exceeded the DGV at baseline site DOG and impacted site TOR in both autumn and spring 2024. At the Airly Creek sites AIRUS and AIR, EC exceeded the SSGV at background site AIRUS in autumn 2024, and at both AIRUS and impact site AIR in spring 2024. The EC result at AIR in autumn 2024 exceeded the DGV but was below the SSGV. In autumn 2024, EC was highest of all sites at background site AIRUS, followed by TOR, while in spring 2024, EC was highest at AIR and AIRUS. EC was higher at all sites in spring than autumn 2024, except at DOG where the autumn result was higher.

Results for pH were within the DGV/SSGV range at all sites in autumn and spring 2024, except for results at baseline sites GEN and GRO, at which pH results were more acidic than the lower DGV, and were similar between the sampling events at both sites. The lowest pH results in both sampling events were observed at GRO. pH results at the lowland sites (DOG, TOR, AIRUS and AIR) were very consistent between sites and sampling events with all results between 7.4 and 7.8.

DO saturations were below the lower DGV at all sites in both autumn and spring 2024. In autumn 2024, DO saturations were highest at impact site AIR (61.0%) and were similarly low at all other sites (ranging from 31.5 to 44.7%). In spring 2024, DO saturations were highest at GRO (70.9%) followed by the two Airly Creek sites. DO was lowest at DOG (26.5%) and TOR (34.1%).

TSS and turbidity results were below the DGV at all sites in autumn and spring 2024. In autumn 2024, turbidity was highest at TOR, while TSS was highest at DOG. Turbidity was lowest in autumn 2024 at impact site AIR, while TSS was equally low (below LOR) at GEN, GRO, GAP, AIRUS and AIR. In spring 2024, turbidity was highest at AIR, while TSS was highest at DOG and AIRUS. Turbidity and TSS in spring 2024 were lowest at GEN.

Water was very hard at AIRUS, AIR, DOG and TOR in both autumn and spring 2024, with water similarly high at TOR, AIRUS and AIR. Water at GEN and GRO was very soft during both sampling events of 2024. Water was harder in spring than autumn 2024 at all sites except at DOG, where hardness was higher in autumn, and GRO, where water hardness was below the LOR in both seasons.

The Piper plot displays the cation and anion composition of water samples (Figure 3.3) collected in 2024. The ionic composition of water was very similar between seasons at every site. Water at GEN and GRO was sodium chloride type, though water was very dilute with low concentrations of all ions. The ionic composition of water at GAP was similar to that at GEN and GRO, but was of mixed chloride/bicarbonate anion type, and more dominance of the magnesium cation. The ionic composition of water at TOR was very similar to Airly Creek sites AIRUS and AIR, and consistent between seasons, with water displaying a calcium/magnesium sulfate ionic composition. Water at DOG was of a similar composition to the other lowland sites, though contained a stronger dominance of calcium and bicarbonate ions.

Concentrations of bicarbonate alkalinity were highest at baseline site DOG in autumn 2024, and at background site AIRUS in spring 2024. In autumn 2024, concentrations of most other ions were highest at background site AIRUS, except for calcium and potassium that were highest at TOR. In spring 2024, concentrations of all major ions were highest at AIR, AIRUS or TOR, with no clear pattern of results between the sites. Concentrations of most major ions were higher in spring than autumn 2024, with the largest exception to this being bicarbonate alkalinity at DOG, which was much higher in autumn than spring.

In 2024 at the Airly Creek sites, concentrations of dissolved metals were variable between the sampling events. In autumn 2024, concentrations of dissolved arsenic and zinc exceeded the DGV/SSGV at impact site AIR, while concentrations of all dissolved metals were below the DGVs/SSGVs at background site AIRUS. In spring 2024, however, concentrations of dissolved arsenic, cobalt, manganese, nickel and zinc exceeded the DGVs/SSGVs at background site AIRUS. At impact site AIR in spring 2024, concentrations of all dissolved metals were below the SSGVs, with only dissolved zinc exceeding the DGV. The exceedances observed for nickel and zinc were below the calculated HMGVs at AIRUS and AIR in autumn and spring 2024 (see Table 3.4).

At the upland sites GEN, GRO and GAP, concentrations of dissolved aluminium exceeded the DGV in all samples, with the concentrations observed at GRO the highest of all sites in both sampling events. The DGV for aluminium applies to water with a pH of >6.5 only, and therefore does not apply to the observed exceedances at GEN or GRO, as water was more acidic. However, aluminium is known to be more toxic to aquatic species in acidic water (an interim low reliability value of 0.0008 mg/L has been suggested by ANZECC (2000) for water with pH <6.5). Concentrations of dissolved chromium exceeded the DGV at GAP in autumn 2024 (highest concentration of all sites) and GRO in autumn and spring 2024 (higher in autumn than spring 2024). Concentrations of dissolved zinc also exceeded the DGV at GEN in both autumn and spring 2024, and GRO in spring 2024 only. As the water hardness at GEN and GRO was below 30 mg/L HMGVs did not apply. Dissolved iron concentrations were highest at GRO in both sampling events.

At DOG and TOR, concentrations of all dissolved metals were below the DGVs in autumn 2024, while in spring 2024, there was only one DGV exceedance observed at each site. Dissolved arsenic exceeded the DGV at DOG, with the concentration higher than the arsenic concentration at AIRUS in spring 2024, while the dissolved zinc concentration at TOR exceeded the DGV and was the highest zinc concentration observed at any site in 2024. However, as with the results from Airly Creek sites, the elevated water hardness at TOR meant that this zinc concentration was below the HMGVs (see Table 3.4).

Concentrations of NO_x exceeded the DGV at GEN in autumn and spring, and GAP in autumn 2024 only (GAP was dry in spring 2024). The concentration observed at GAP was the highest of all NO_x concentrations recorded, while the NO_x was higher at GEN in autumn than spring 2024. NO_x concentrations were below the LOR at all other sites in both autumn and spring.

TN concentrations exceeded the DGV at TOR, AIRUS and AIR in autumn 2024, and at DOG, TOR, AIRUS and AIR in spring 2024. The TN concentrations at all sites were higher in spring than autumn, and the highest TN concentration in both sampling events was recorded at AIRUS. The TN concentration at AIRUS in spring 2024 also exceeded the SSGV.

TP concentrations were also higher at all sites in spring than autumn, except at GAP where there was no spring sample collected. TP concentrations exceeded the DGV at DOG and TOR, and exceeded the SSGV at AIRUS in spring 2024. The TP concentration at DOG was the highest of all sites. The concentration of RP also exceeded the DGV in spring 2024 at AIRUS only.

DOC concentrations were variable between the sampling events, with results at all sites except GEN higher in spring than autumn. The highest DOC concentration was observed at GRO in spring 2024.

Fluoride was observed in similar concentrations at the lower elevation sites in both autumn and spring, slightly exceeding the DGV at TOR in autumn and spring 2024 and at AIRUS in spring 2024 only. All fluoride concentrations at the higher elevation sites were below the LOR in autumn and spring 2024.

Table 3.2 Results of laboratory analysis of water samples collected in autumn 2024

Analyte	Unit	LOR	Baseline			Headwaters undermined		DGV	Background	Impact	SSGV
			DOG	GEN	GRO	GAP	TOR		AIRUS	AIR	
Date			23/05/2024	22/05/2024	22/05/2024	21/05/2024	23/05/2024		23/05/2024	23/05/2024	
Time			8:00	10:10	13:30	10:45	10:30		14:30	12:45	
Physico-chemical parameters											
Temperature^	° C	0.1	8.2	12.4	12.6	12.1	7.4	NA	8.2	7.5	NA
Electrical Conductivity^	µS/cm	1	**1,373**	38	37	141	**2,683**	350	**2,809**	**2,157**	2709
pH^	pH unit	0.1	7.2	**5.8**	**5.2**	6.9	7.8	6.5-8.0	7.4	7.6	6.5-8.0
DO^	% sat.	0.1	**31.5**	**39.2**	**41.0**	**39.7**	**37.1**	90-110	**44.7**	**61.0**	NA
DO^	mg/L	0.01	3.7	4.19	4.34	4.26	4.41	NA	5.20	7.24	NA
Turbidity^	NTU	0.1	7.5	5.6	8.5	5.5	10.7	25	3.0	0.8	25
TSS	mg/L	5	12	<5	<5	<5	10	25	<5	<5	25
TDS	mg/L	1	916	29	22	82	1,780	NA	1,850	1,580	NA
Total Hardness as $CaCO_3$	mg/L	1	723	<1	<1	31	1660	NA	1660	1410	NA
Major ions											
Bicarbonate alkalinity	mg/L	1	390	5	4	29	192	NA	206	137	NA
Total alkalinity	mg/L	1	390	5	4	29	192	NA	206	137	NA
Sulfate as SO_4	mg/L	1	349	2	<1	6	1,470	NA	1,550	1,290	NA
Chloride	mg/L	1	44	9	7	18	51	NA	55	52	NA
Calcium	mg/L	1	156	<1	<1	6	282	NA	257	240	NA
Magnesium	mg/L	1	81	<1	<1	4	231	NA	248	198	NA
Potassium	mg/L	1	2	1	<1	3	10	NA	6	6	NA
Sodium	mg/L	1	59	5	5	11	68	NA	79	72	NA
Dissolved metals											
Aluminium	mg/L	0.01	<0.01	**0.03**	**0.27**	**0.04**	<0.01	0.027*	<0.01	<0.01	0.027
Arsenic	mg/L	0.0002	0.0004	<0.0002	<0.0002	<0.0002	0.0003	0.0008	0.0003	**0.0020**	NA

Analyte	Unit	LOR	Baseline			Headwaters undermined		DGV	Background	Impact	SSGV
			DOG	GEN	GRO	GAP	TOR		AIRUS	AIR	
Date			23/05/2024	22/05/2024	22/05/2024	21/05/2024	23/05/2024		23/05/2024	23/05/2024	
Time			8:00	10:10	13:30	10:45	10:30		14:30	12:45	
Chromium	mg/L	0.0002	<0.0002	<0.0002	**0.0009**	**0.0012**	<0.0002	0.00001	<0.0002	<0.0002	NA
Iron	mg/L	0.05	<0.05	<0.05	0.23	0.07	<0.05	NA	<0.05	<0.05	0.3
Manganese	mg/L	0.001	0.013	0.002	0.003	0.016	0.130	1.2	0.038	0.058	1.2
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.008	0.003	0.003	0.008
Zinc	mg/L	0.001	<0.001	**0.006**	0.002	0.002	0.002	0.0024	0.002	**0.008**	0.0076
Nutrients											
Ammonia as N	mg/L	0.01	<0.01	<0.01	0.02	<0.01	0.03	0.32	0.03	<0.01	0.32
Nitrite as N	mg/L	0.01	<0.01	0.01	<0.01	<0.01	<0.01	NA	<0.01	<0.01	NA
Nitrate as N	mg/L	0.01	<0.01	0.09	<0.01	0.14	<0.01	NA	<0.01	<0.01	NA
Nitrite + Nitrate as N	mg/L	0.01	<0.01	**0.10**	<0.01	**0.14**	<0.01	0.015	<0.01	<0.01	NA
TKN	mg/L	0.1	<0.1	<0.1	0.1	0.1	0.3	NA	0.4	0.3	NA
TN	mg/L	0.1	<0.1	0.1	0.1	0.2	**0.3**	0.25	**0.4**	**0.3**	0.7
TP	mg/L	0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.02	<0.01	<0.01	0.056
Other parameters											
DOC	mg/L	1	2	3	6	5	6	NA	8	6	NA
Fluoride	mg/L	0.1	0.3	0.1	<0.1	<0.1	**0.3**	0.29	0.2	0.2	NA

Values in **yellow** indicate exceedances of the DGV and/or SSGV.
Values in **blue** exceed the DGV but are below the relevant SSGV.
Values in **green** exceed the DGV but are below the relevant HMGV (See Table 3.6).
NA = No DGV applies.
* The DGV applies to aluminium concentrations for pH >6.5.
^ Denotes parameter was recorded *in situ*.

Table 3.3 Results of laboratory analysis of water samples collected in spring 2024

Analyte	Unit	LOR	Baseline			Headwaters undermined	DGV	Background	Impact	SSGV
			DOG	GEN	GRO	TOR		AIRUS	AIR	
Date			08/11/24	05/11/24	05/11/24	07/11/24		08/11/24	07/11/24	
Time			8:00	13:00	15:05	10:30		11:50	13:00	
Physicochemical parameters										
Temperature^	º C	0.1	18.1	13.6	14.9	19.7	NA	20.8	22.1	NA
EC^	µS/cm	1	**1,222**	54	39	**2,823**	350	**2,963**	**2,972**	2709
pH^	pH Unit	0.1	7.8	**5.8**	**5.5**	7.6	6.5-8.0	7.8	7.7	6.5-8.0
DO^	% sat.	0.1	**26.5**	**48.2**	**70.9**	**34.1**	90-110	**58.7**	**64.4**	NA
DO^	mg/L	0.01	2.50	5.02	7.15	3.13	NA	5.20	5.6	NA
Turbidity^	NTU	0.1	4.6	1.0	1.2	3.7	25	5.3	12.5	25
TSS	mg/L	1	20	<1	4	9	25	20	14	25
TDS	mg/L	1	760	32	21	1,900	NA	1,950	2,040	NA
Total hardness as $CaCO_3$	mg/L	1	555	4	<1	1,690	NA	1,760	1,750	NA
Major ions										
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	258	10	5	213	NA	280	240	NA
Total alkalinity as $CaCO_3$	mg/L	1	258	10	5	213	NA	280	240	NA
Sulfate as SO_4	mg/L	1	371	2	1	1,600	NA	1,580	1,660	NA
Chloride	mg/L	1	65	10	7	78	NA	76	101	NA
Calcium	mg/L	1	82	<1	<1	263	NA	263	262	NA
Magnesium	mg/L	1	85	1	<1	250	NA	267	266	NA
Potassium	mg/L	1	3	1	<1	8	NA	3	6	NA
Sodium	mg/L	1	67	7	5	83	NA	89	94	NA
Dissolved metals										
Aluminium	mg/L	0.01	<0.01	**0.04**	**0.16**	<0.01	0.027*	<0.01	<0.01	0.027

Analyte	Unit	LOR	Baseline			Headwaters undermined	DGV	Background	Impact	SSGV
			DOG	GEN	GRO	TOR		AIRUS	AIR	
Arsenic	µg/L	0.2	**0.0015**	<0.0002	<0.0002	0.0004	0.0008	**0.0012**	0.0005	NA
Chromium	µg/L	0.2	<0.0002	<0.0002	**0.0006**	<0.0002	0.00001	<0.0002	<0.0002	NA
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.0014	**0.003**	<0.001	0.001
Iron	mg/L	0.05	0.05	<0.05	0.11	0.06	NA	0.08	<0.05	0.3
Manganese	mg/L	0.001	0.256	0.007	0.007	0.064	1.2	**6.63**	0.491	1.2
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	0.003	0.008	**0.010**	0.006	0.008
Zinc	µg/L	0.001	0.001	**0.006**	**0.003**	**0.047**	0.0024	**0.008**	**0.007**	0.0076
Nutrients										
Ammonia	mg/L	0.01	0.01	<0.01	<0.01	0.01	0.32	0.02	0.02	0.32
Nitrate	mg/L	0.01	<0.01	0.06	<0.01	<0.01	NA	<0.01	<0.01	<0.7
NO_x	mg/L	0.01	<0.01	**0.06**	<0.01	<0.01	0.015	<0.01	<0.01	NA
TKN	mg/L	0.1	0.8	<0.1	0.2	0.6	NA	1.2	0.6	NA
TN	mg/L	0.1	**0.8**	<0.1	0.2	**0.6**	0.25	**1.2**	**0.6**	0.7
TP	mg/L	0.01	**0.08**	<0.01	0.01	**0.03**	0.02	**0.06**	<0.01	0.056
RP	mg/L	0.01	<0.01	<0.01	0.01	<0.01	0.015	**0.02**	<0.01	NA
Other parameters										
DOC	mg/L	1	6	2	24	11	NA	15	9	NA
Fluoride	mg/L	0.1	0.2	<0.1	<0.1	**0.4**	0.29	**0.3**	0.2	NA

Values in **yellow** indicate exceedances of the DGV and/or SSGV.
Values in **blue** exceed the DGV but are below the relevant SSGV.
Values in **green** exceed the DGV but are below the relevant HMGV (See Table 3.6).
NA = No DGV applies.
* The DGV applies to aluminium concentrations for pH >6.5.
^ Denotes parameter was recorded *in situ*.

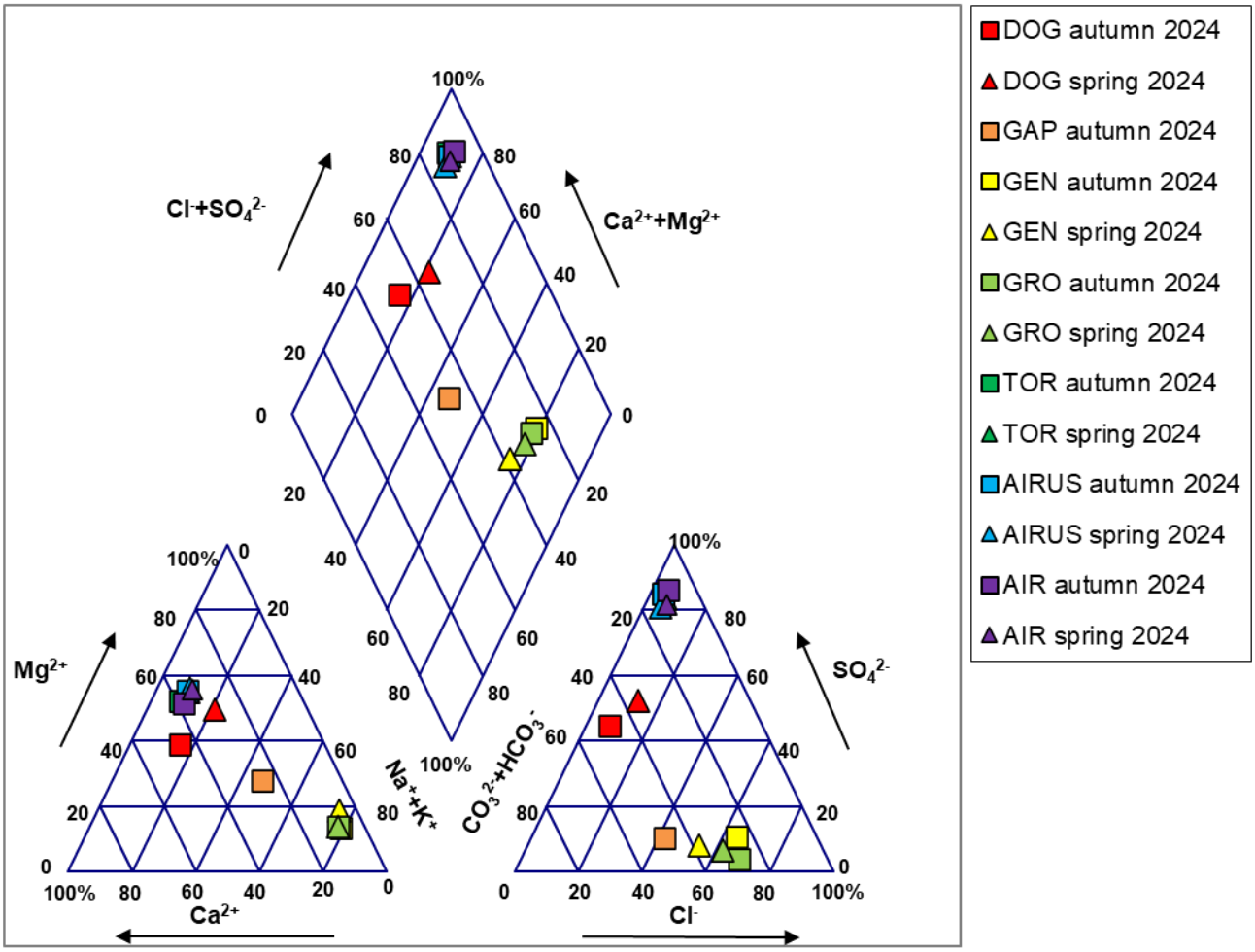


Figure 3.3 Piper plot displaying cation and anion composition of water samples collected in autumn and spring 2024

Table 3.4 HMGVs (in mg/L) for nickel and zinc in autumn and spring 2024

Sampling Event	Site	Hardness	Analyte	Observed concentration	HMGV	Result
Autumn 2024	AIR	1,410	Zinc	0.008	0.064	No exceedance
Spring 2024	TOR	1,690	Zinc	0.047	0.074	No exceedance
	AIRUS	1,760	Zinc	0.008	0.076	No exceedance
			Nickel	0.01	0.254	No exceedance
	AIR	1,750	Zinc	0.007	0.076	No exceedance

3.4.2 Historical review – Airly Creek

Long-term, time series water quality graphs are provided in Figure 3.4 to Figure 3.10 for key analytes at impact site AIR and background site AIRUS. This historical review has been undertaken for Airly Creek sites as there is licensed discharge from Airly Mine to Airly Creek only.

Results are displayed for samples collected during monthly water quality sampling, as well as samples collected during biannual aquatic ecology sampling. In 2024, samples were not collected from Airly Creek impact site AIR during monthly sampling in June, but samples were collected during every other month. At background site AIRUS, monthly samples were not collected in February, March, June or November. It is assumed these sites were dry during months in which samples were not collected. Samples were also collected from AIR and AIRUS in May and November 2024 during aquatic ecology sampling. Samples collected from impact site AIR have been labelled according to whether they were collected during the EIS sampling events (autumn 2013 to spring 2014) or post-EIS sampling events (2015 to 2024).

There was a consistent increasing trend in EC observed in Airly Creek throughout 2024, with results very similar between the two sites during most sampling events (Figure 3.4). A similar trend was observed in 2023, with EC results increasing throughout the year, before decreasing notably in early-2024. EC exceeded the SSGV in approximately one-third of all samples collected in 2023 and 2024, with similar proportions of samples from AIR and AIRUS exceeding the SSGV. During all sampling events in 2022, EC was below the SSGV at both AIR and AIRUS, which continued the mostly decreasing trend in EC observed since 2019, during which EC was very high. There has been no notable difference observed between the background and impact site during the majority of historical sampling events in which samples were collected from both sites. There were some low (<1000 µS/cm) EC results at AIR in the EIS period, however, the majority of EC results during this period were similar to those observed during the post-EIS period.

In situ pH at both AIR and AIRUS was within the SSGV range during all sampling events in 2024, except for during September 2024 at AIRUS when the pH was slightly above the upper SSGV (Figure 3.5). pH was generally higher at AIRUS than AIR, throughout the historical monitoring period, though pH has remained within the SSGV range for most of the monitoring period, and was similar in the EIS and post-EIS periods.

Elevated concentrations of dissolved cobalt (above the LOR and SSGV) have been commonly observed at AIR, particularly in the post-EIS period (Figure 3.6). Although water samples were not commonly collected from AIR between late-2017 and early-2020 due to dry conditions, all dissolved cobalt concentrations during this period exceeded the SSGV. From early-2020 to 2024, dissolved cobalt concentrations were most commonly observed below the LOR, however, there were some SSGV exceedances, although concentrations were lower than those observed in the 2017 to 2019 period. The dissolved cobalt concentration observed at background site AIRUS in November 2024 was the first exceedance of the SSGV at AIRUS since early-2020. In December 2024, the dissolved cobalt concentration at AIRUS was lower but remained above the DGV.

Dissolved copper concentrations were below detectable limits at both sites in all samples collected in 2024 and were therefore below the SSGV (Figure 3.7). Dissolved copper concentrations were commonly elevated at AIR during the EIS period, as well as in 2019 to 2020, while several results from AIRUS were also above the SSGV in 2014, but not in the post-EIS period.

Dissolved manganese concentrations were below the SSGV during all sampling events between June 2010 and October 2016 (Figure 3.8). In more recent years, dissolved manganese concentrations at AIR and AIRUS have been much higher, with the majority of results between July 2017 and April 2020 exceeding the SSGV at both sites, though results were generally higher at AIR than AIRUS. In 2024, there was low-level exceedance of the SSGV at AIR (February 2024), and one very high concentration at background site AIRUS in November 2024, during which the concentrations was the highest observed at the site since 2017. During most other sampling events, dissolved manganese concentrations were generally lower than results at AIR, as has been commonly observed throughout the historical monitoring period.

Dissolved nickel concentrations at AIR prior to 2019 (in both the EIS and post-EIS periods) were generally consistent and remained below or close to the SSGV (Figure 3.9). However, during 2019 and early-2020, nickel concentrations at AIR were elevated above the SSGV and the historical range of results, with the highest result from the historical monitoring period observed in April 2019 at AIR. There were no corresponding results at AIRUS for this sample as the site was dry. Results from April 2020 onward had returned to within the historical range and were generally similar between AIR and AIRUS. Across the 2021 to 2024 period, there were fluctuations observed in the dissolved nickel concentrations, with concentrations generally higher in summer and lower in winter months. Some elevated dissolved nickel concentrations were observed in 2023 during the dry conditions, while in 2024, most concentrations returned to below the SSGV.

Dissolved zinc concentrations were below the SSGV in the majority of Airly Creek samples in the 2021 to 2024 period (Figure 3.10). The majority of dissolved zinc concentrations observed in 2024 were below the SSGV, with only two low-level exceedances of the SSGV observed at AIR and one low-level exceedance at AIRUS. The highest dissolved zinc concentrations of the historical monitoring period were recorded at AIR in 2019. There were also frequent exceedances of the dissolved zinc SSGV at both sites between 2012 and 2016. In general, dissolved zinc concentrations have been more variable and slightly higher at AIR than AIRUS across the historical monitoring period including pre-EIS when there was no mining activity.

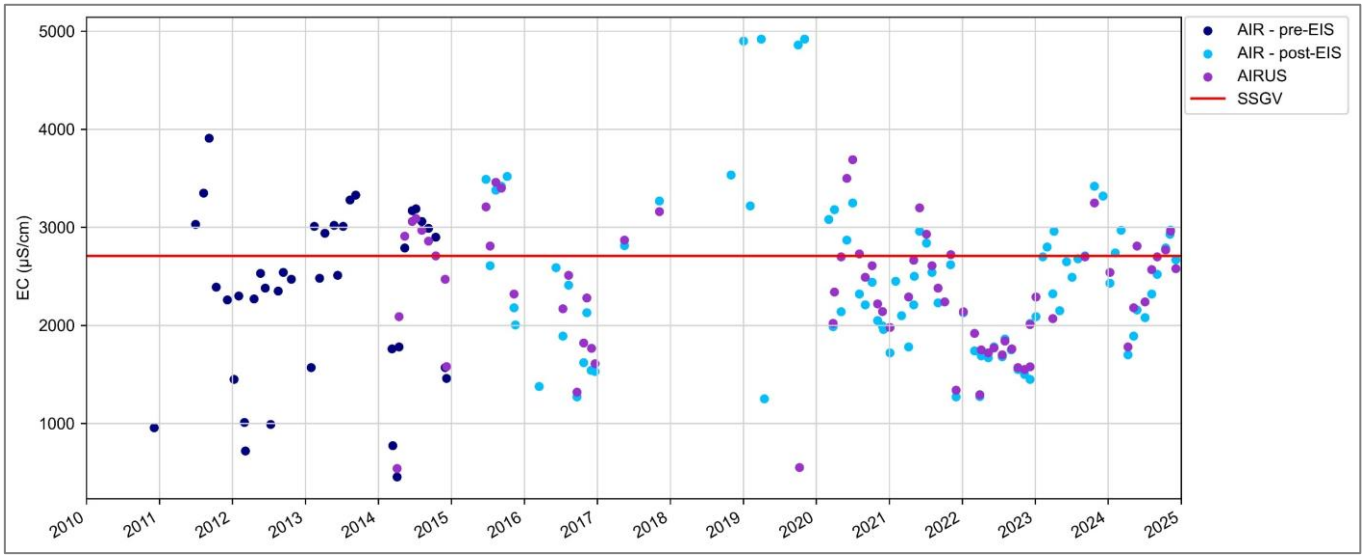


Figure 3.4 EC in Airly Creek, 2010 to 2024

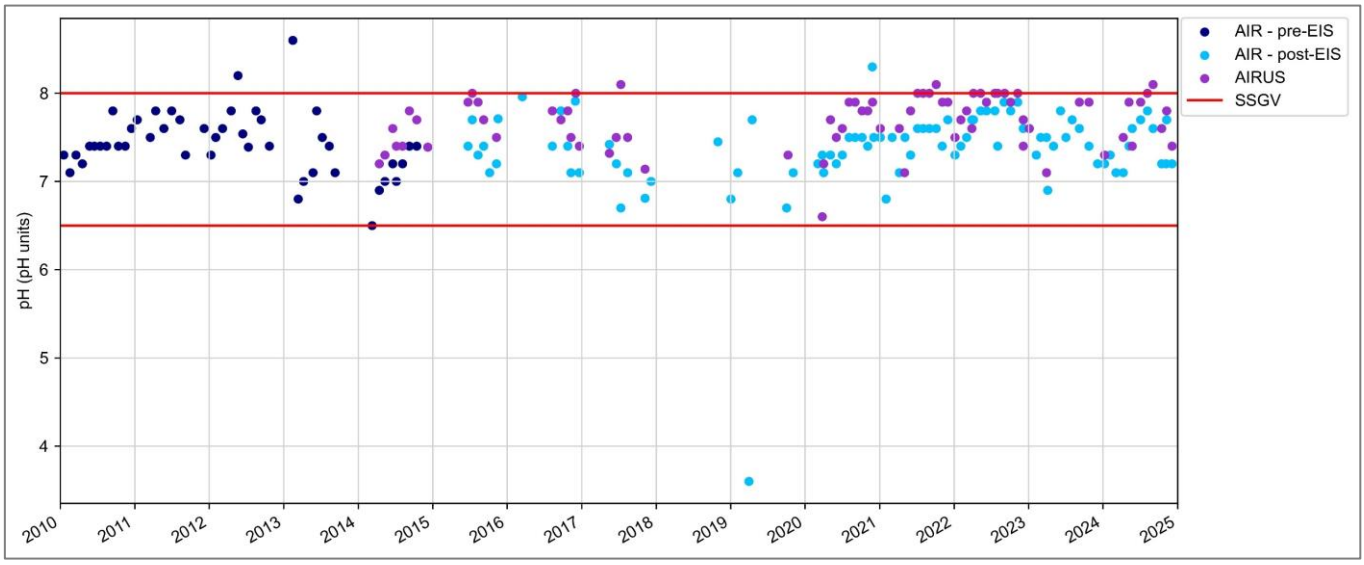


Figure 3.5 pH in Airly Creek, 2010 to 2024

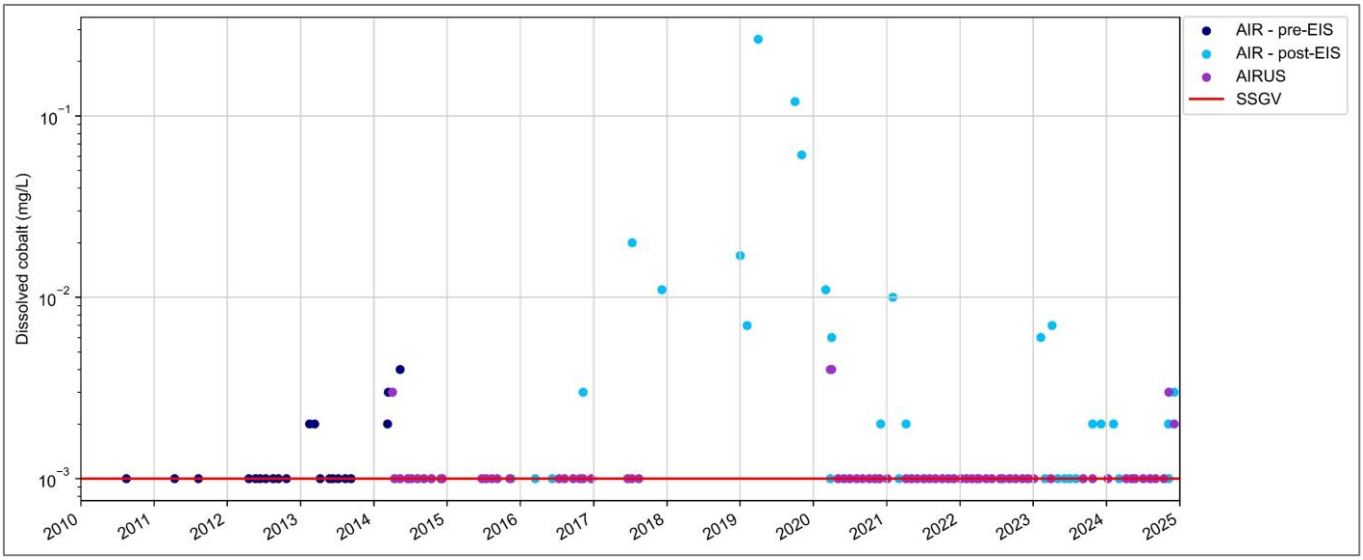


Figure 3.6 Dissolved cobalt in Airly Creek, 2010 to 2024 (note logarithmic scale)

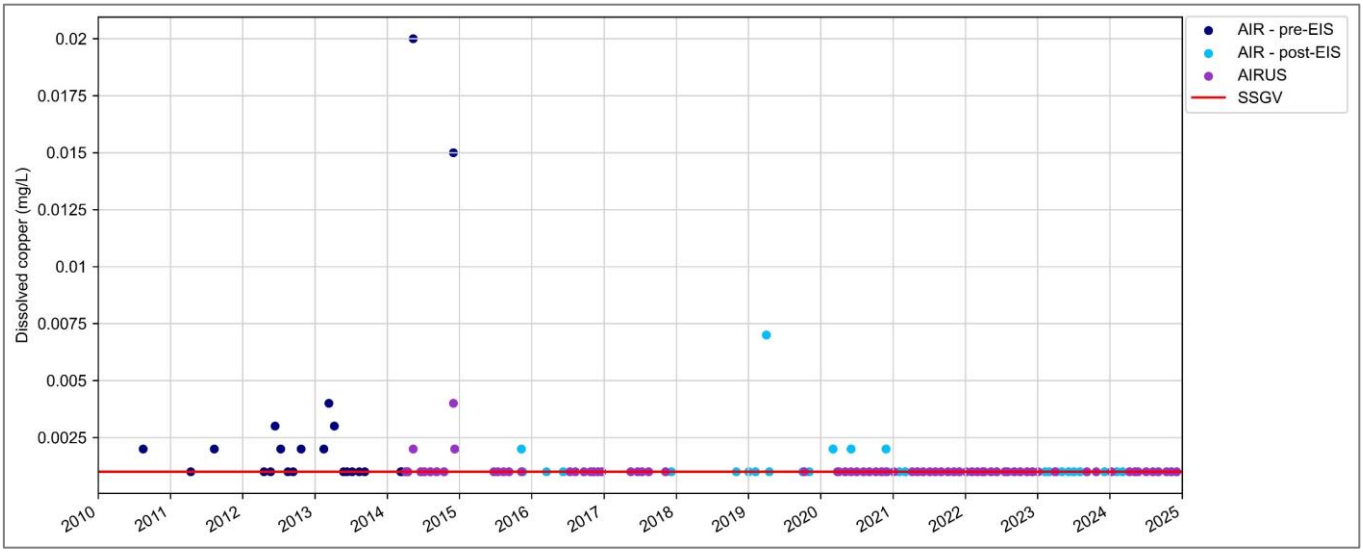


Figure 3.7 Dissolved copper in Airly Creek, 2010 to 2024

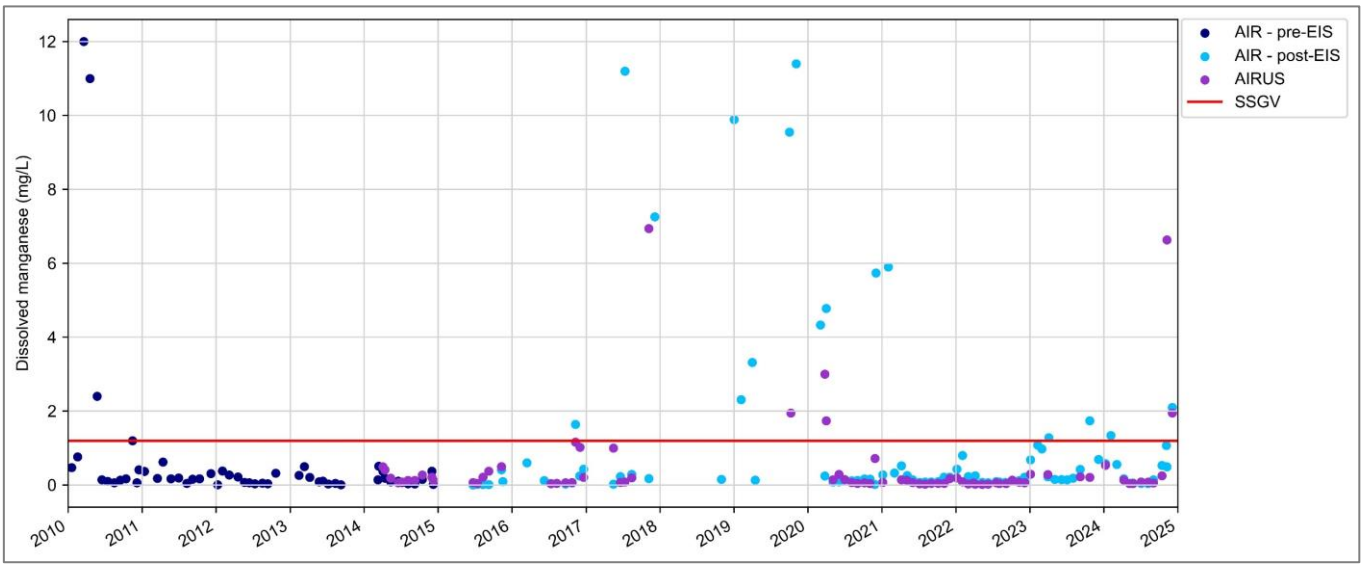


Figure 3.8 Dissolved manganese in Airly Creek, 2010 to 2024

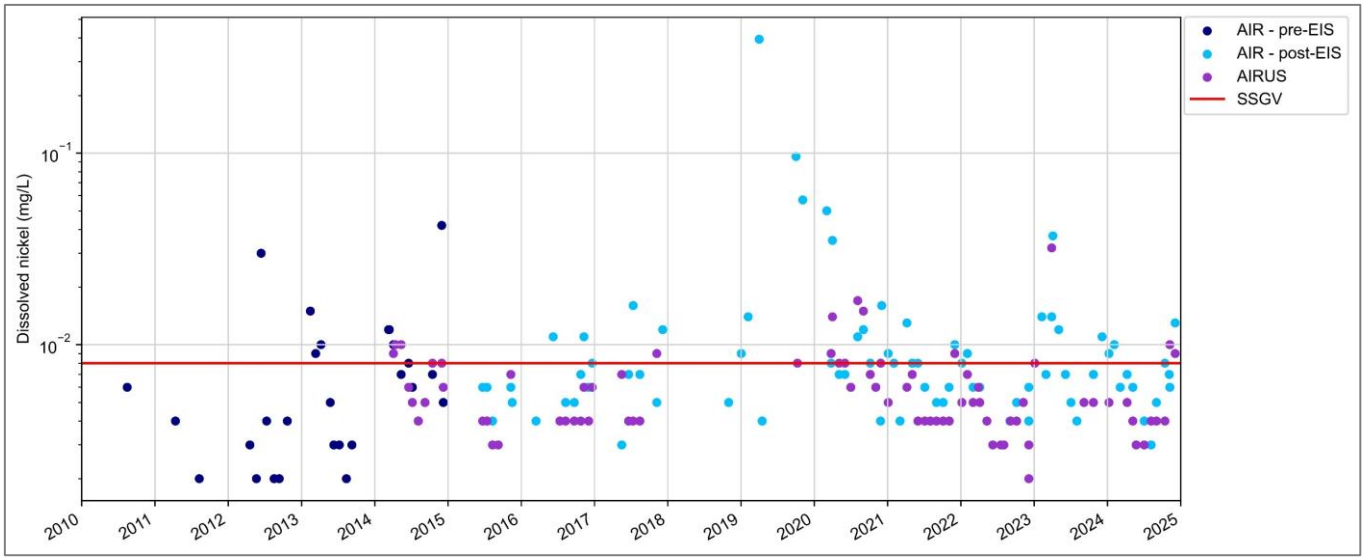


Figure 3.9 Dissolved nickel in Airly Creek, 2010 to 2024 (note logarithmic scale)

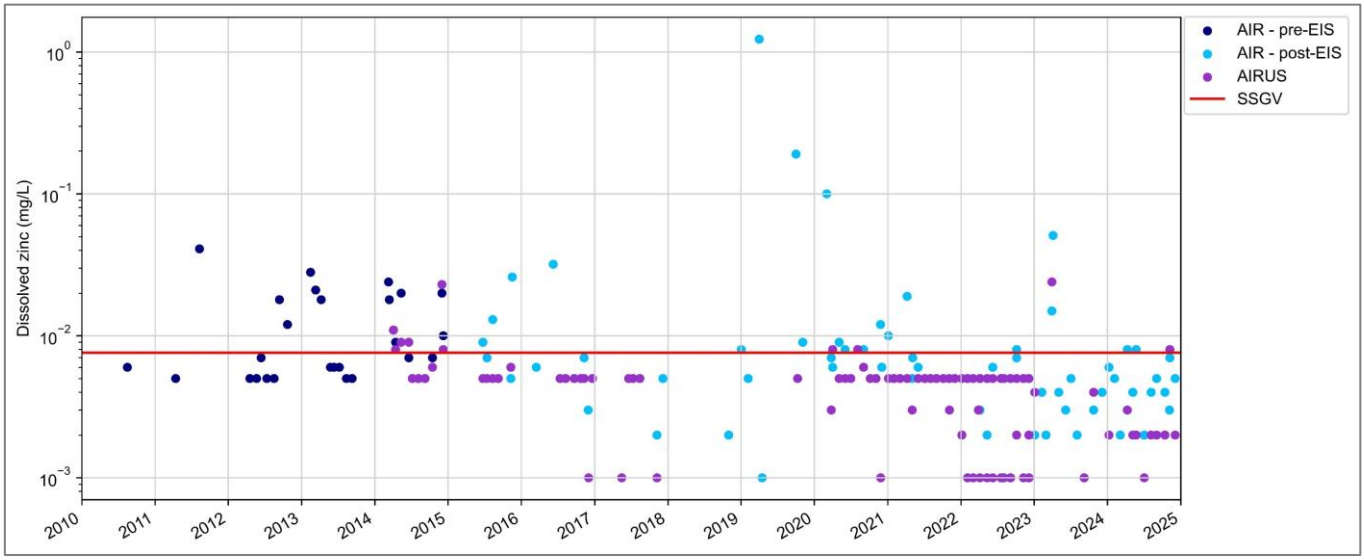


Figure 3.10 Dissolved zinc in Airly Creek, 2010 to 2024 (note logarithmic scale)

3.5 Sediment quality

Laboratory analysis results for the autumn and spring 2024 sediment samples are presented in Table 3.5 and Table 3.6, respectively, including a comparison to the sediment DGVs in ANZG (2019). Parameters measured at concentrations below the LOR at all sites have not been presented in Table 3.5 and Table 3.6. Laboratory COAs showing data for all measured parameters are provided in Appendix B.

The only exceedance of a DGV for any sediment quality parameter in 2024 was acid-extractable nickel, the concentration of which exceeded the DGV at background site AIRUS in autumn 2024 but was below the GV-high value. There were no other exceedances of any sediment DGVs in autumn or spring 2024 at any site.

Concentrations of all sediment metals were highest at either background site AIRUS or impact site AIR in both autumn and spring 2024, with the majority of sediment metals highest at AIRUS in autumn and AIR in spring. At the baseline and undermined sites in 2024, sediment metals concentrations were lower, although concentrations of most sediment metals were observed in higher concentrations at the lowland sites (TOR and DOG) than at the higher altitude sites (GEN, GRO and GAP).

Concentrations of TKN (and TN) and TP were highest at background site AIRUS, and concentrations were much higher in autumn 2024 than spring 2024.

Concentrations of sediment TOC were highest in both autumn and spring 2024 at AIRUS, although the concentration observed in autumn 2024 (25.2%) was more than 10 times higher than that observed in spring 2024 (2.32%). TOC concentrations at all other sites, including impact site AIR, were low (between 0.21% and 2.1%).

Table 3.5 Laboratory analysis of sediment samples collected in autumn 2024

Analyte	Unit	LOR	Baseline			Headwaters undermined		Background	Impact	DGV	GV-high
			DOG	GEN	GRO	GAP	TOR	AIRUS	AIR		
			23/05/2024	22/05/2024	22/05/2024	21/05/2024	23/05/2024	23/05/2024	23/05/2024		
1M HCl-Extractable Metals											
Aluminium	mg/kg	50	290	320	270	70	400	1,220	870	NA	NA
Arsenic	mg/kg	1	1.2	<1.0	<1.0	<1.0	<1.0	2.3	<1.0	20	70
Cadmium	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	1.5	10
Cobalt	mg/kg	0.5	2.0	1.8	<0.5	<0.5	<0.5	5.0	4.2	NA	NA
Copper	mg/kg	1	3.1	<1.0	<1.0	<1.0	2.6	10.6	8.5	65	270
Lead	mg/kg	1	7.0	<1.0	<1.0	1.5	3.6	6.9	9.3	50	220
Manganese	mg/kg	10	65	38	<10	30	60	111	323	NA	NA
Nickel	mg/kg	1	2.6	<1.0	<1.0	<1.0	1.6	**29.2**	6.9	21	52
Zinc	mg/kg	1	8.7	1.7	<1.0	1.8	2.6	68.2	10.1	200	410
Nutrients											
Nitrate	mg/kg	0.1	0.1	0.3	0.2	0.2	0.2	0.6	0.7	NA	NA
NO_x	mg/kg	0.1	0.1	0.3	0.2	0.2	0.2	0.6	0.7	NA	NA
TKN	mg/kg	20	1,370	320	200	120	280	11,600	720	NA	NA
TN	mg/kg	20	1,370	320	200	120	280	11,600	720	NA	NA
TP	mg/kg	2	241	57	34	33	170	1,090	308	NA	NA
Other parameters											
TOC	%	0.02	2.11	0.27	0.69	0.28	0.33	25.2	0.90	NA	NA

Values in **yellow** indicate exceedances of the DGV. Values in **red** exceed the GV-high.

Table 3.6 Laboratory analysis of sediment samples collected in spring 2024

Analyte	Unit	LOR	Baseline			Headwaters undermined	Background	Impact	DGV	GV-high
			DOG	GEN	GRO	TOR	AIRUS	AIR		
Date			08/11/24	05/11/24	05/11/24	07/11/24	08/11/24	07/11/24		
1M HCl-extractable metals										
Aluminium	mg/kg	50	300	290	220	560	840	1,190	NA	NA
Arsenic	mg/kg	1	1.6	<1.0	<1.0	<1.0	1.8	1.5	20	70
Chromium	mg/kg	1	1.2	<1.0	<1.0	1.2	1.6	1.7	80	370
Cobalt	mg/kg	0.5	2.1	1.8	<0.5	2.6	1.6	5.0	NA	NA
Copper	mg/kg	1	3.0	<1.0	<1.0	3.6	5.6	9.9	65	270
Lead	mg/kg	1	4.5	<1.0	<1.0	4.7	6.1	10.4	50	220
Manganese	mg/kg	10	90	42	<10	268	166	424	NA	NA
Nickel	mg/kg	1	2.8	<1.0	<1.0	4.2	6.1	9.1	21	52
Zinc	mg/kg	1	4.8	2.2	<1.0	4.4	13.0	21.4	200	410
Nutrients										
Nitrate	mg/kg	0.1	<0.1	0.3	0.2	<0.1	0.3	0.1	NA	NA
NO_x	mg/kg	0.1	<0.1	0.3	0.2	<0.1	0.3	0.1	NA	NA
TKN	mg/kg	20	440	60	250	270	1,940	1,270	NA	NA
TN	mg/kg	20	440	60	250	270	1,940	1,270	NA	NA
TP	mg/kg	2	140	18	32	207	352	349	NA	NA
Other parameters										
TOC	%	0.02	1.03	0.21	0.59	0.40	2.32	1.23	NA	NA

Values in **yellow** indicate exceedances of the DGV. Values in **red** exceed the GV-high.

3.6 Macroinvertebrates

3.6.1 Univariate results – autumn and spring 2024

Macroinvertebrate metrics results from autumn and spring 2024 are presented in Figure 3.11 to Figure 3.14. Results from autumn and spring 2024 have been compared to the average result for each metric at each site obtained from data from the EIS monitoring conducted in autumn and spring of 2013 and 2014 by Cardno (Cardno 2014). AIRUS was not sampled as part of the EIS, so no EIS average data are available for this site.

In spring 2024, macroinvertebrate samples were not collected from GAP due to insufficient water.

Airly Creek sites

At the Airly Creek sites, taxa richness was similar between background site AIRUS and impact site AIR, with more variability observed between replicates than between the sites (Figure 3.11). All taxa richness results at AIRUS and AIR in autumn and spring 2024 were between 12 and 16 taxa, and results were similar to most results observed at other sites in 2024. All taxa richness results at AIR in 2024 were similar to or slightly above the EIS average.

EPT richness was higher at background site AIRUS than impact site AIR and consistent between the sampling events (Figure 3.12), although the highest EPT richness result at AIR (one replicate from autumn 2024) was equal to the lowest EPT richness result at AIRUS (one replicate from autumn 2024). However, all EPT richness results at AIR in autumn and spring 2024 were above the EIS average.

SIGNAL-2 scores at background site AIRUS in autumn 2024, and at impact site AIR in autumn and spring 2024 were similar, ranging between 3.33 and 3.54 (above the EIS average), while SIGNAL-2 scores from AIRUS in spring 2024 were lower (3.00 and 3.13) (Figure 3.13). Sensitive taxa (taxa with SIGNAL-2 of 8 or higher) were not collected in any sample from AIRUS or AIR in autumn or spring 2024 (Figure 3.14). The very low EIS average shows that the dominance of pollution tolerant taxa at these sites observed in 2024 is consistent with historical results.

Baseline and potentially influenced sites

At baseline sites DOG, GEN and GRO, and potentially influenced (undermined headwater) sites GAP and TOR, there was some variability in taxa richness observed between sites, replicates and sampling events (Figure 3.11). Taxa richness was highest in autumn 2024 at TOR (21 and 20 taxa), although the spring 2024 results at TOR were much lower (14 and 16 taxa). In spring 2024, taxa richness was highest at one replicate from DOG (20 taxa), although the second replicate contained only 15 taxa. The lowest taxa richness was recorded at GRO in one replicate collected in spring 2024 (10 taxa). There was no clear pattern of results between sampling events, with results from GEN much higher in spring 2024, while results at TOR were much higher in autumn 2024. Results at DOG and GRO showed variability between the replicates in spring 2024.

Taxa richness results were below the EIS average results in all samples collected from DOG, all but one sample collected from GRO, both samples collected from GAP (samples were collected from GAP in autumn 2024 only) and both samples collected from TOR in spring 2024.

EPT richness results were highest at GEN and lowest at impact site AIR in both autumn and spring 2024 (Figure 3.12). EPT richness results were mostly consistent between the sampling events at all sites, although results at TOR were lower in spring than autumn. At GEN, GAP and AIR, all EPT richness results in 2024 were above the EIS average, while at DOG and GRO, all results in 2024 were well below the EIS average. At TOR, results were above the average in autumn 2024, but were below in spring 2024.

SIGNAL-2 scores were notably higher at the upland sites (GEN, GRO and GAP) than at the lowland sites in both autumn and spring 2024 (Figure 3.13). Results at most sites were similar between the sampling events although results at TOR were lower in spring than autumn 2024. SIGNAL-2 results at most sites were similar to the EIS average results, except for at GAP, where SIGNAL-2 scores were much higher in autumn 2024 than the historical result, and TOR, where SIGNAL-2 results in both seasons were below the EIS average.

Sensitive taxa (taxa with SIGNAL-2 of 8 or higher) were collected in all samples from GEN, GRO and GAP in 2024 (GAP sampled in autumn 2024 only), and at DOG in spring 2024 only (Figure 3.14). The proportion of sensitive taxa was highest at GEN in spring 2024, and was similar between the three upland sites in autumn 2024, but was much lower than the GEN spring 2024 results. The proportion of sensitive taxa observed were below the EIS averages at GEN, GRO, GAP and TOR, and DOG in autumn 2024, but were above the EIS average at DOG in spring 2024.

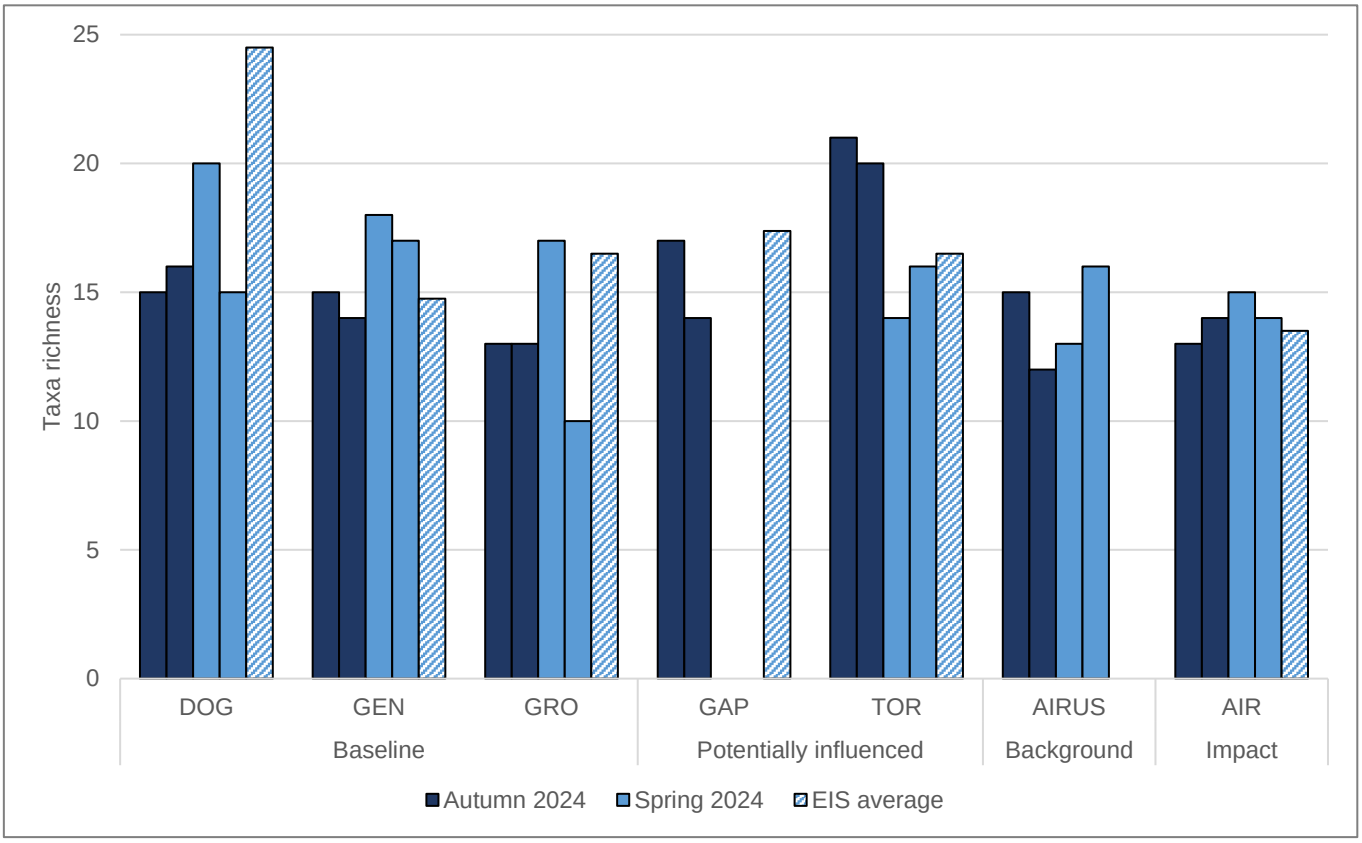


Figure 3.11 Taxa richness in macroinvertebrate samples, autumn and spring 2024

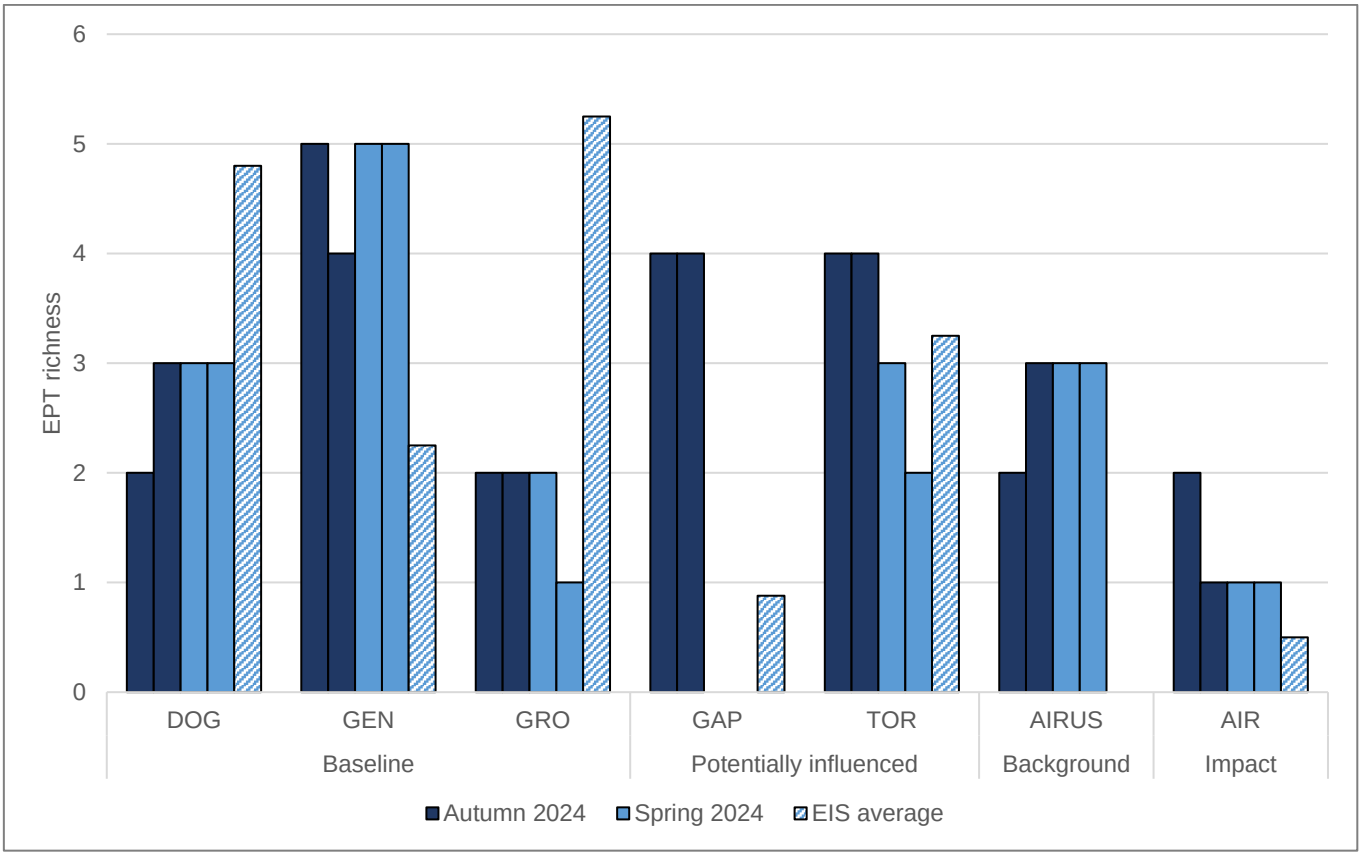


Figure 3.12 EPT richness in macroinvertebrate samples, autumn and spring 2024

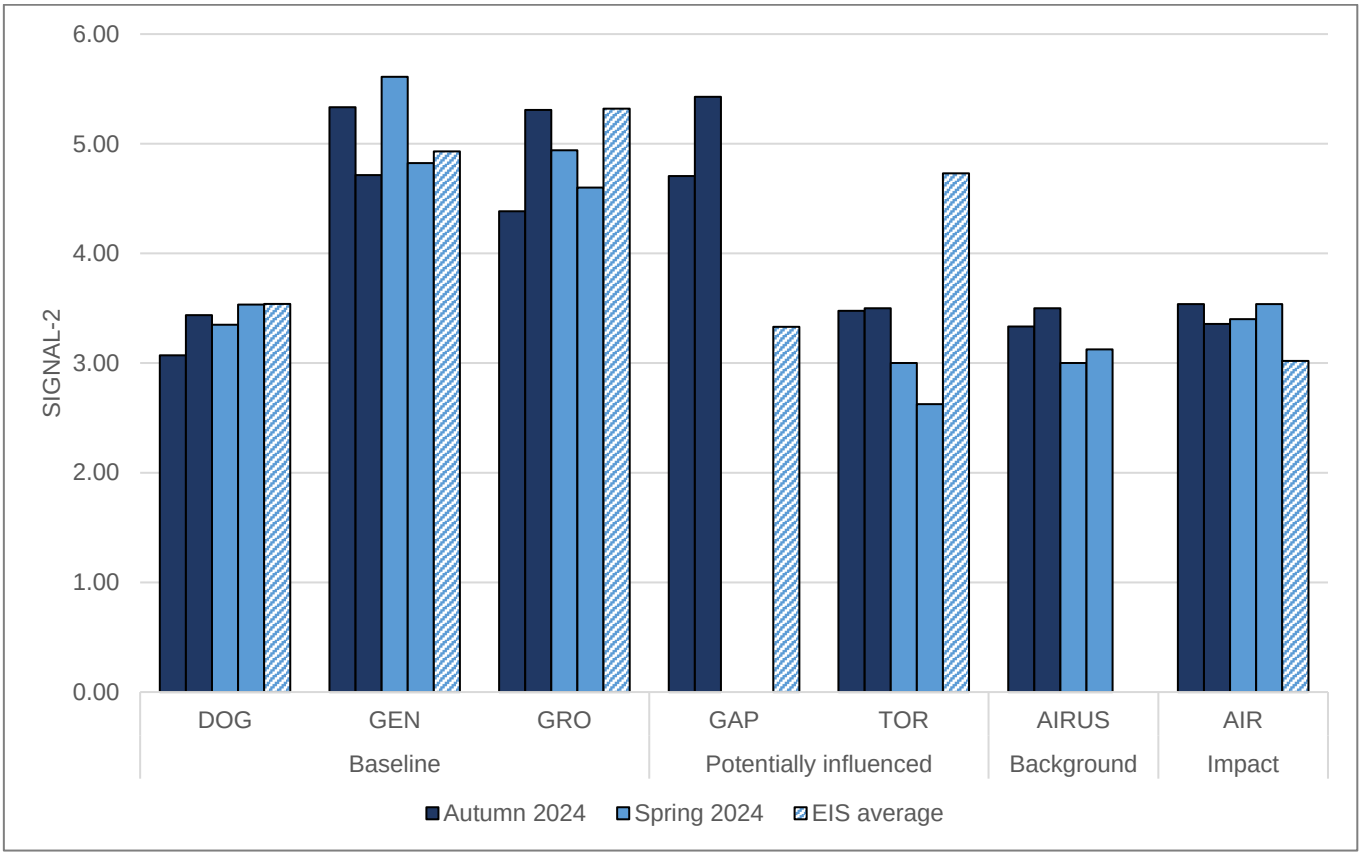


Figure 3.13 SIGNAL-2 scores for macroinvertebrate samples, autumn and spring 2024

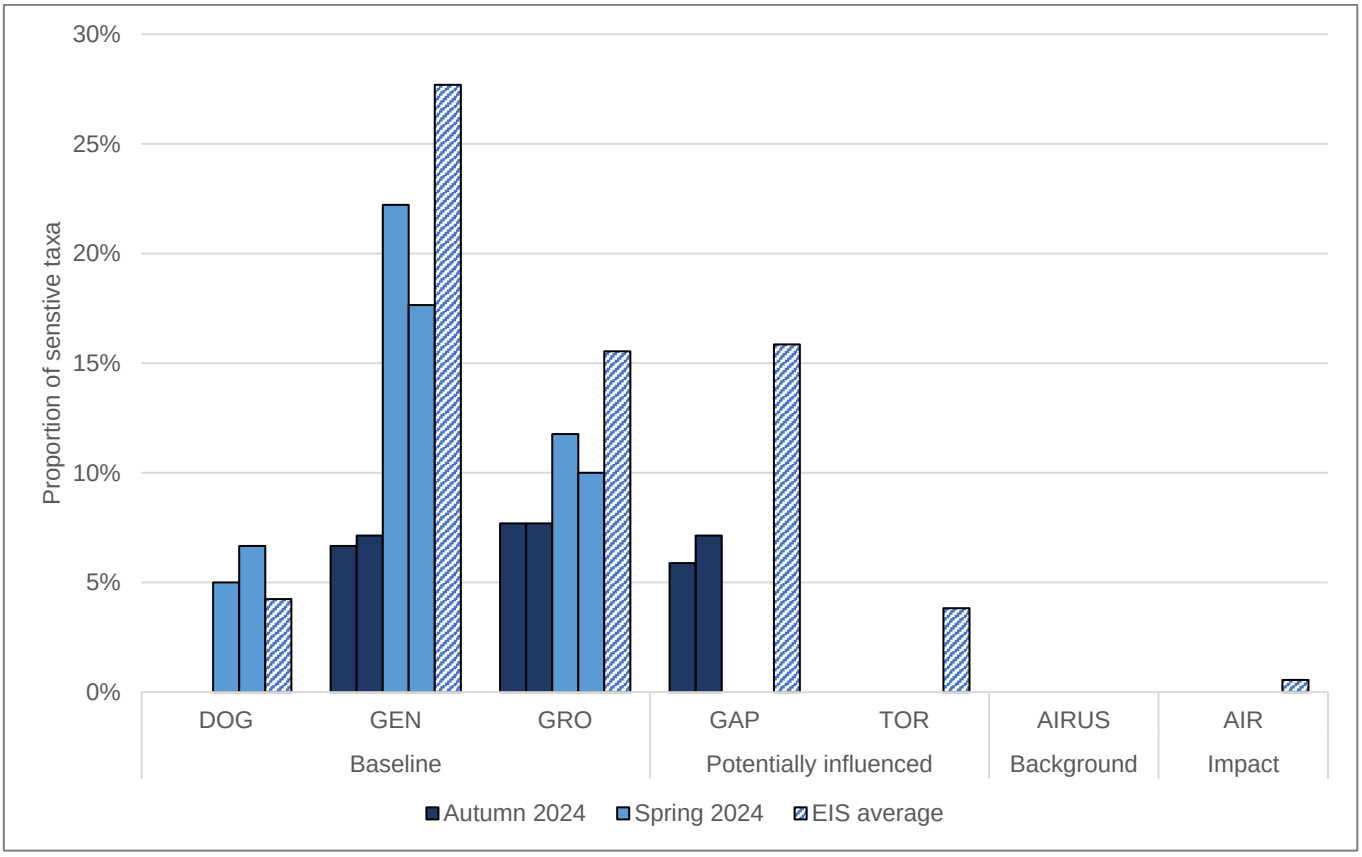


Figure 3.14 Proportion of sensitive taxa in macroinvertebrate samples, autumn and spring 2024

3.6.2 AUSRIVAS

The results of AUSRIVAS modelling are presented in Figure 3.15. The NSW combined-season eastern edge model was used for all sites in 2024, except at GAP where the autumn eastern edge model was used, as samples were not collected from GAP in spring 2024.

The highest O/E50 results in 2024 were observed at baseline site DOG, which received one band A result, although there was a wide variability between the replicates, with the O/E50 score of the second replicate much lower, receiving a band B result. This gives DOG an overall band B grading, based on AUSRIVAS convention that the overall site grade is based on the lowest result. The lowest O/E50 was observed in one replicate from GRO, which was placed in band C, indicating severe impairment in the macroinvertebrate community (refer Table 2.5). As with the results at DOG, there was variability between the replicates at GRO, with the other replicate receiving a band B result.

The remaining sites, including baseline site GEN, potentially influenced sites GAP and TOR, background site AIRUS, and impact site AIR, have been allocated to band B, indicating some impairment in the macroinvertebrate communities at these sites.

Table 3.7 displays the inventory of taxa that were predicted by the AUSRIVAS model to be found at these sites at a probability of 50 percent or greater but were not collected during 2024. It is noted that in samples in which the autumn edge model was applied (both results from GAP), the number of missing taxa cannot be directly compared to that from the combined model, as fewer taxa are expected to be collected in a single season.

In samples analysed with the combined season model, one sample from baseline site DOG (eight missing taxa), followed by one sample from each of baseline site DOG and impact site AIR (11 missing taxa) contained the fewest missing taxa (i.e. had the community most comparable to the AUSRIVAS reference dataset, with similar environmental conditions). One sample collected from baseline site GRO (18 missing taxa) was missing the most taxa that were expected by the model to be collected, followed by one sample from each of background site GEN and potentially influenced site TOR (15 missing taxa). The autumn 2024 samples collected at GAP, were each missing 10 taxa.

Based on the SIGNAL-2 scores of the missing taxa, background site AIRUS and potentially influenced site TOR were missing more pollution sensitive taxa with an average SIGNAL-2 scores of the missing taxa equalling 5.92 and 5.85 at AIRUS, and 5.67 and 5.92 at TOR (Table 3.7). GAP was also missing mostly sensitive taxa, with the average SIGNAL-2 scores of the missing taxa equalling 5.30 in both replicates. Taxa that were missing at AIRUS, TOR and GAP in 2024 included the beetles Elmidae and Dixidae (both SIGNAL-2 = 7), the stonefly Gripopterygidae (SIGNAL-2 = 8), and the caddisfly Calamoceratidae (SIGNAL-2 = 7). These taxa were not recorded as missing from any other site in 2024.

Baseline site GEN had the lowest average SIGNAL-2 of the missing taxa meaning that most of the macroinvertebrate groups not collected were pollution tolerant (average SIGNAL-2 of 3.27 and 3.23 for the two replicates). The average SIGNAL-2 score of missing taxa at baseline sites DOG and GRO were also relatively low, with all scores less than 4.00. Taxa missing at GEN, DOG and GRO (but no other sites) in 2024 included the snail Physidae (SIGNAL-2 = 1), and the shrimp Atyidae (SIGNAL-2 = 3).

At impact site AIR, the SIGNAL-2 scores of missing taxa were moderate (4.14 and 4.00). Samples collected from AIR were missing the caddisfly Leptoceridae (SIGNAL-2 = 6), which was collected from all other sites in 2024. The only taxa identified by the AUSRIVAS model as being expected at all sites (at a 50 percent or greater probability) but not collected from any site in 2024 was the true bug Gerridae (SIGNAL-2 = 4).

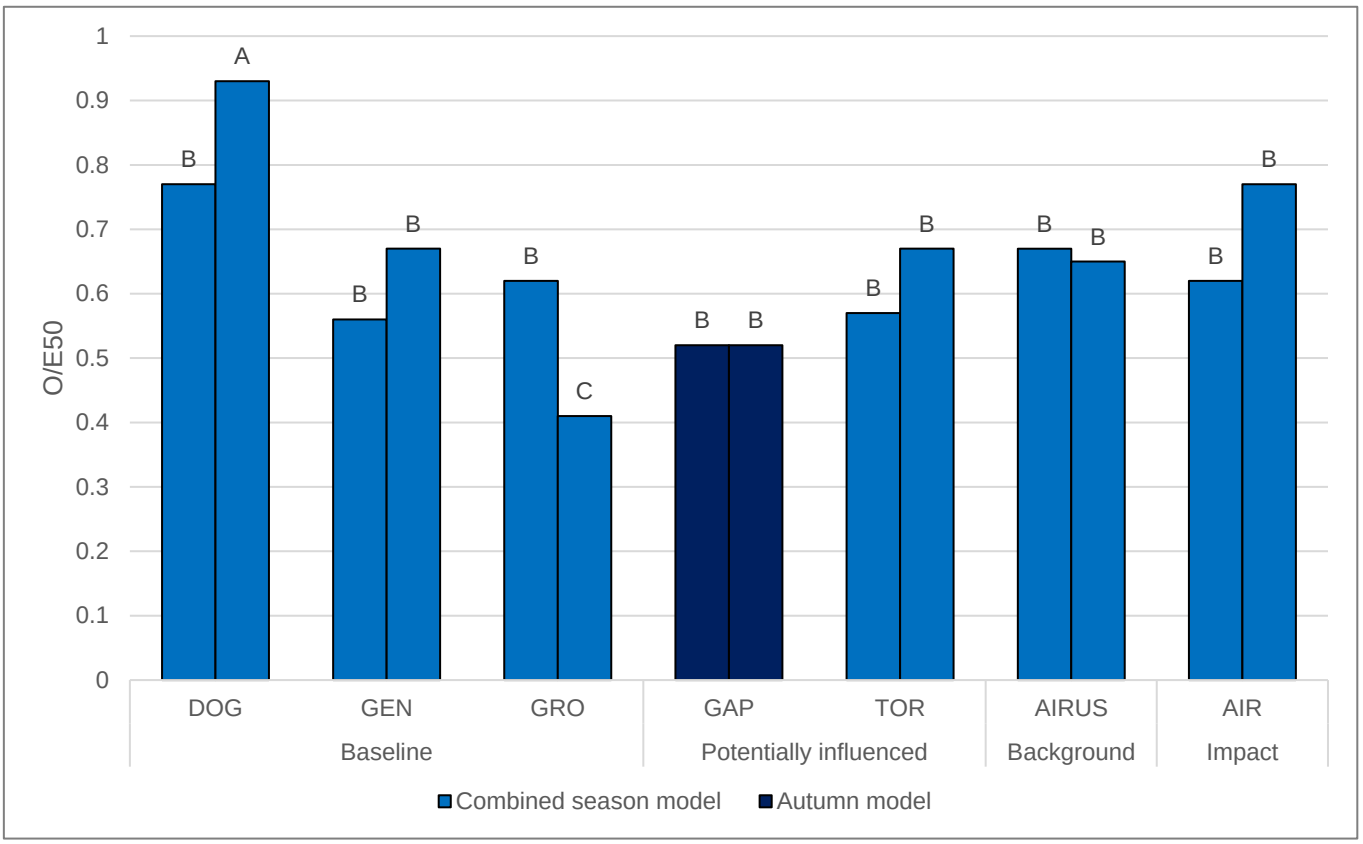


Figure 3.15 AUSRIVAS O/E50 results for 2024

Table 3.7 Inventory of macroinvertebrate taxa predicted at ≥50% by AUSRIVAS modelling but not collected in 2024

Taxon	SIGNAL-2	Baseline						Potentially influenced				Background		Impact	
		DOG		GEN		GRO		GAP^		TOR		AIRUS		AIR	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Physidae	1	X	X	X	X	X	X								
Oligochaeta	2						X								X
Acarina	6						X	X	X					X	
Atyidae	3	X	X	X	X	X	X								
Gyrinidae	4	X	X	X	X	X	X			X	X	X		X	
Hydrophilidae	2			X	X	X				X				X	
Hydraenidae	3	X	X	X	X		X			X	X	X	X	X	X
Scirtidae	6									X			X		
Elmidae	7							X	X	X	X	X	X		
Tipulidae	5	X	X	X										X	X
Dixidae	7							X	X	X	X	X	X		
Ceratopogonidae	4				X		X								
Simuliidae	5									X	X	X	X		
Tanypodinae	4													X	
Orthocladiinae	4	X													
Baetidae	5			X		X	X	X	X						
Leptophlebiidae	8					X	X			X	X	X	X	X	X
Caenidae	4			X	X	X	X	X	X	X	X	X		X	X
Veliidae	3							X	X						
Gerridae	4	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Corixidae	2			X	X	X	X	X	X				X	X	X
Notonectidae	1			X		X	X							X	X
Coenagrionidae	2			X	X	X	X								

Taxon	SIGNAL-2	Baseline						Potentially influenced				Background		Impact	
		DOG		GEN		GRO		GAP^		TOR		AIRUS		AIR	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Synlestidae	7									X	X	X	X		
Aeshnidae	4	X		X	X	X	X								
Gomphidae	5	X	X	X	X	X	X			X	X	X		X	X
Gripopterygidae	8							X	X	X	X	X	X		
Hydrobiosidae	8									X	X	X	X		
Hydroptilidae	4	X				X	X								
Ecnomidae	4	X	X	X	X		X						X	X	X
Calamoceratidae	7							X	X	X	X	X	X		
Leptoceridae	6													X	X
Total missing taxa		11	8	15	13	14	18	10	10	15	13	13	13	14	11
Average SIGNAL-2 of missing taxa		3.73	3.63	3.27	3.23	3.50	3.67	5.30	5.30	5.67	5.92	5.92	5.85	4.14	4.00

^ Samples are modelled with the autumn season model, so are not directly comparable to other samples (those analysed with the combined season model).

3.6.3 Multivariate analysis – 2024

The cluster plot demonstrates the relative similarity in macroinvertebrate community composition of samples collected in autumn and spring 2024 (Figure 3.16).

There are two distinct groupings in the plot, one containing all samples collected at the higher altitude sites (baseline sites GEN and GRO, and potentially influenced site GAP), while the second grouping contains all samples collected from agriculturally influenced lowland sites, including baseline site DOG, potentially influenced site TOR, background site AIRUS and impact site AIR.

The high-altitude grouping has clustered indicating approximately 60 percent similarity between the samples. Within this grouping, samples have separated into two subgroups. One group contains samples collected from GRO (one from autumn and both from spring 2024), while the other grouping contains the second GRO autumn 2024, and all samples collected from GEN and GAP. Within this second subgroup there are pairs of sampling grouped indicating approximately 80 percent similarity, including one replicate from GEN in each of autumn and spring 2024, one replicate from both GEN and GAP in autumn 2024, and samples from GAP in autumn and GEN in spring 2024.

In the lowland site grouping, samples are mostly grouped based on site, but indicate lower similarity in composition between the sites. Samples from DOG, TOR and AIRUS are each grouped indicating approximately 60 percent similarity in the macroinvertebrate community composition within each site. Samples collected from TOR in autumn 2024 are very similar in composition, while samples collected in spring 2024 are quite different, with one being similar to the autumn samples, and the second showing few similarities with any other sample. A similar trend was observed at impact site AIR, where the autumn samples and one sample from spring 2024 are grouped with approximately 60 percent similarity, while the second spring sample is the most distinct of all sites, showing only approximately 40 percent similarity with any other sample. Overall, the macroinvertebrate community composition at impact site AIR is most distinct, indicating only approximately 45 percent similarity with the remainder of the lowland site grouping.

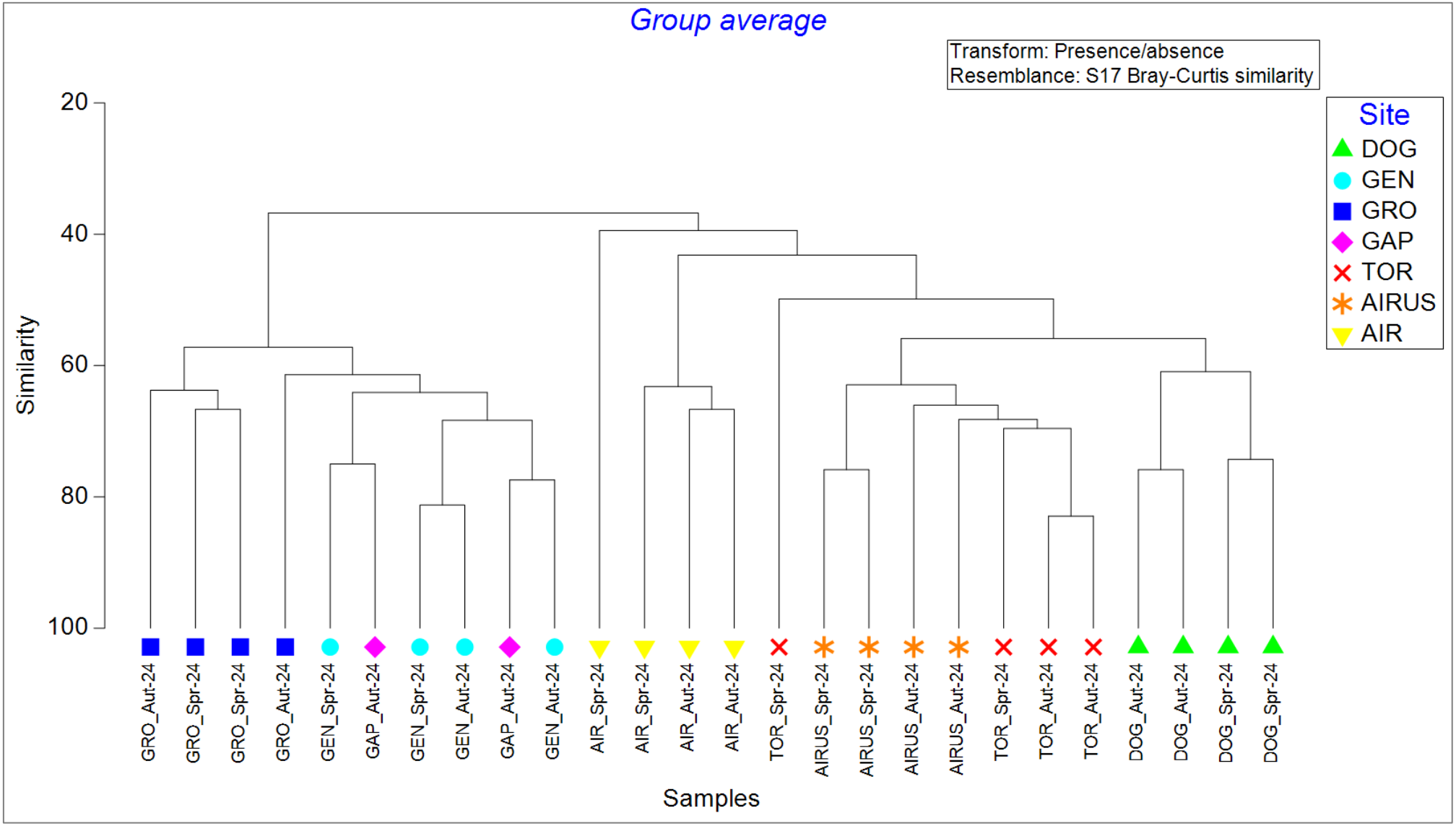


Figure 3.16 *Cluster plot demonstrating relative similarity in community composition between samples, autumn and spring 2024*

3.6.4 Historical review

Univariate analysis

Historical metrics results for taxa richness, EPT richness and SIGNAL-2 have been compared at each site between EIS sampling events (autumn 2013 to spring 2014) and post-EIS sampling events (autumn 2015 to spring 2024). These historical metrics have been presented as boxplots in Figure 3.17 to Figure 3.19. Note that samples were not collected from background site AIRUS in the EIS period.

Variability in the range and medians was observed at all sites for all macroinvertebrate metrics between the two sampling periods. Welch's t-tests were conducted to compare the means of the two groups (EIS samples and post-EIS samples) at each site. Results of these t-tests found no significant difference in the means for most sites and metrics between the EIS and post-EIS samples, with the following exceptions:

– EPT richness was significantly ($p < 0.05$) higher at impact site AIR ($p = 0.0034$) and potentially influenced site TOR ($p = 0.0014$) in the post-EIS period.
– EPT richness at GRO (p =0.0330) was significantly lower in the post-EIS period.
– SIGNAL-2 at baseline site GEN (p = 0.0103) was significantly lower in the post-EIS period.
– Taxa richness ($p = 0.0115$), EPT richness ($p = 0.0136$), and SIGNAL-2 ($p = 0.0054$) at DOG were significantly lower in the post-EIS period.

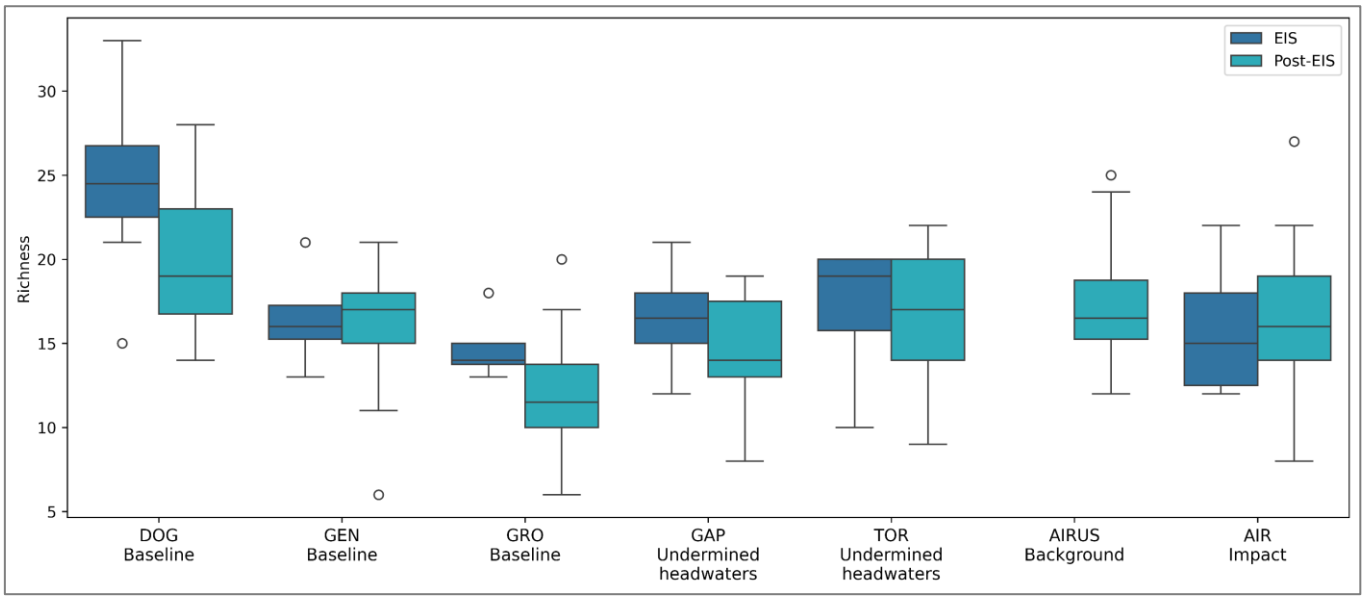


Figure 3.17 Taxa richness at all sites in EIS (2013 to 2014) and post-EIS (2015 to 2024) sampling events

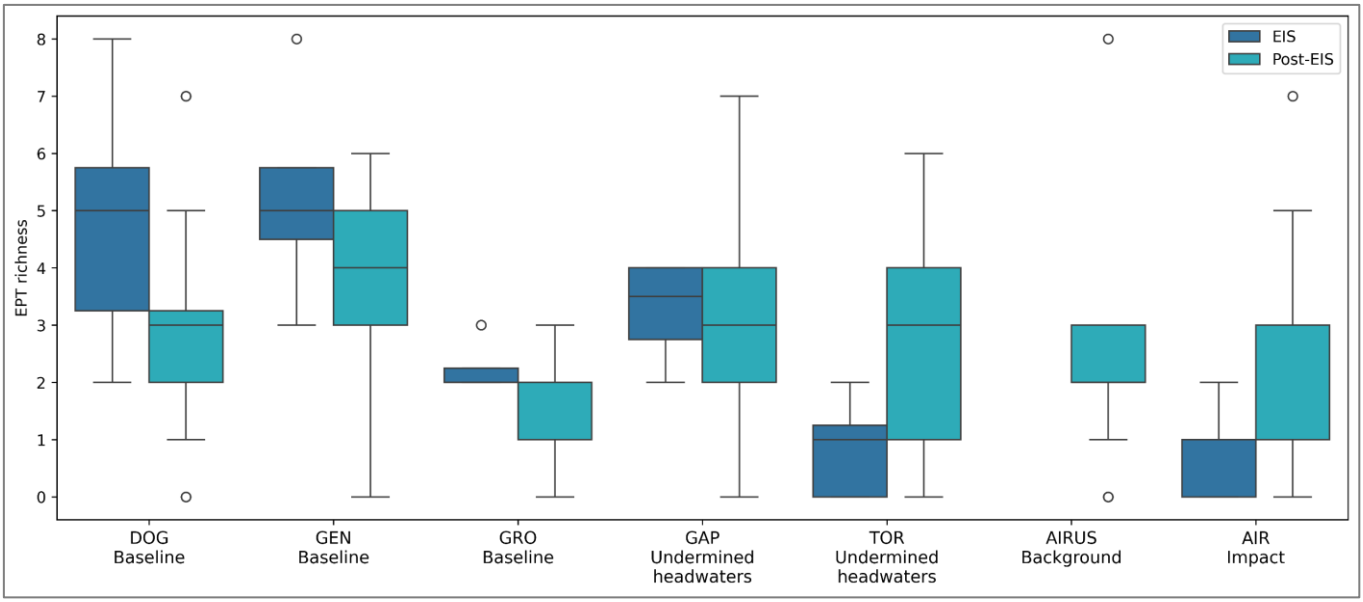


Figure 3.18 EPT richness at all sites in EIS (2013 to 2014) and post-EIS (2015 to 2024) sampling events

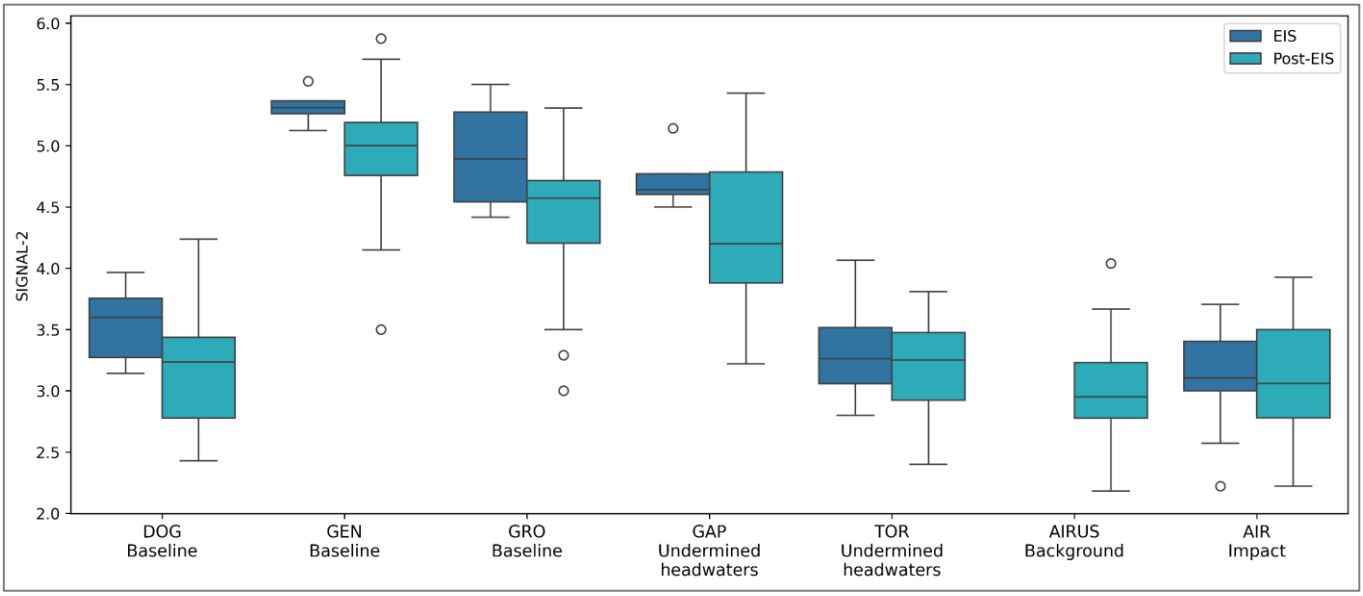


Figure 3.19 SIGNAL-2 at all sites in EIS (2013 to 2014) and post-EIS (2015 to 2024) sampling events

Recent historical results of macroinvertebrate metrics for the last five years of monitoring (2020 to 2024) are presented in Figure 3.20 to Figure 3.22. This period covers the relatively wet period (2020 to 2022) following the drought period of 2017 to 2019. The result displayed is the average of the two replicate samples (where two replicates were able to be collected) with error bars.

Taxa richness was lowest at GEN, GRO, GAP and TOR in 2020 (Figure 3.20). Taxa richness at DOG, AIR and AIRUS were all lowest in either spring 2023 or in 2024. Taxa richness and EPT richness (Figure 3.21) were highest at most sites in 2022 or 2023. Taxa richness and EPT richness results at AIR have seen a decreasing trend between 2022 and 2024. EPT richness results have been lowest, but most consistent between sampling events at GRO.

SIGNAL-2 scores have generally been higher at the higher altitude sites GEN, GRO and GAP, and lower at the lower altitude sites (Figure 3.22). SIGNAL-2 scores at most sites were lowest in 2020 and highest in 2022. SIGNAL-2 scores in 2024 were within the historical range of results at most sites, although low SIGNAL-2 results were observed at TOR in spring 2024.

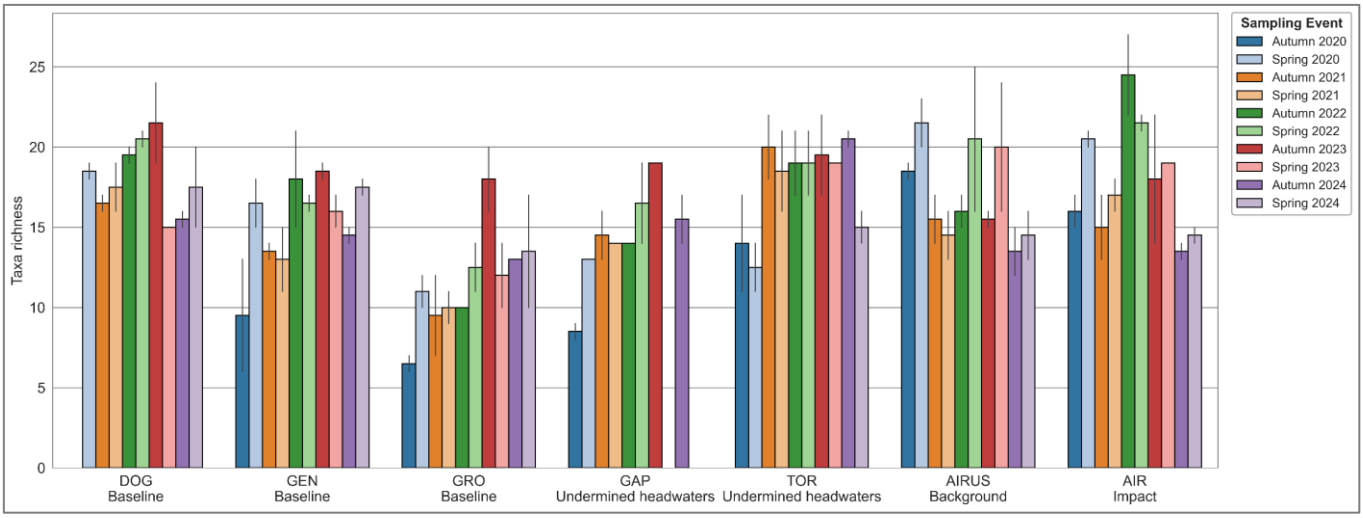


Figure 3.20 Taxa richness results, 2020 to 2024

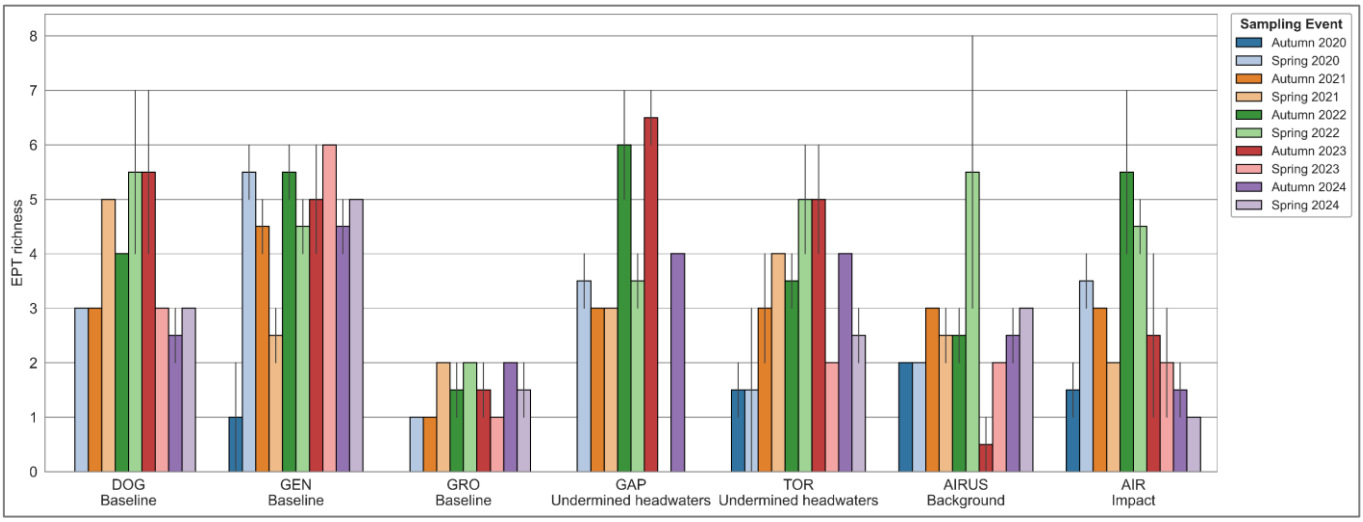


Figure 3.21 EPT richness results, 2020 to 2024

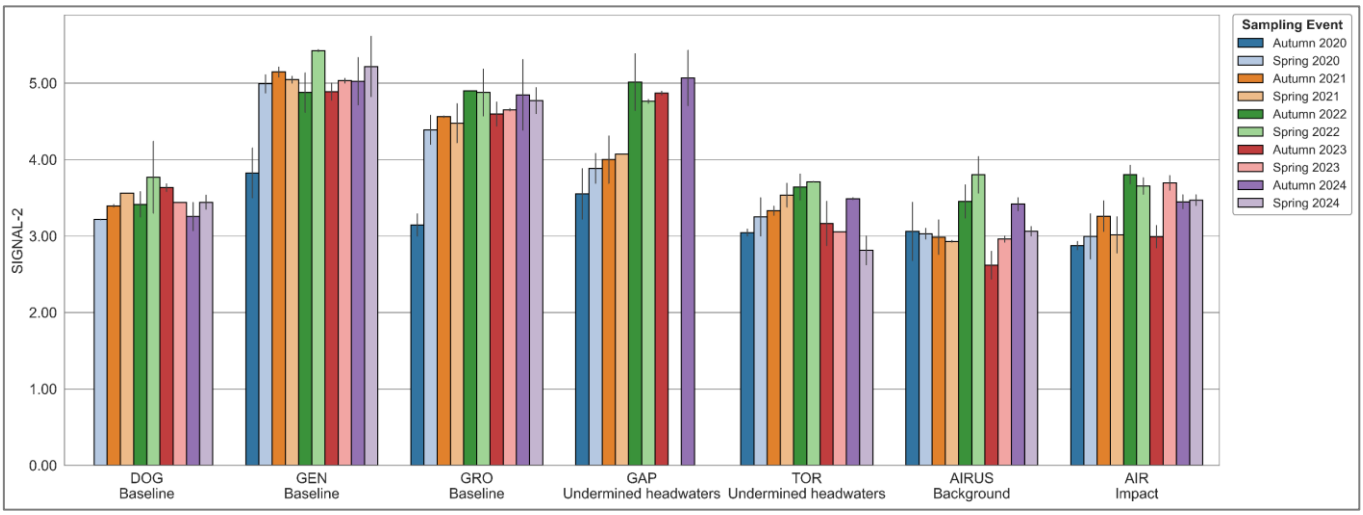


Figure 3.22 SIGNAL-2 results, 2020 to 2024

Multivariate analysis

The non-metric MDS (nMDS) presented as Figure 3.23 shows the relative similarity in the macroinvertebrate community of samples collected between 2013 and 2024. As the stress level for the nMDS exceeded 0.20, the nMDS plot should be interpreted with caution. Data from replicate samples were pooled to create a single point for each site and sampling event. It is noted that there were seven occasions during which only one replicate sample was able to be collected, including autumn 2016 at AIR, autumn and spring 2018 at DOG, autumn 2019 and spring 2021 at GAP, autumn 2016 and autumn 2019 at GRO, and spring 2023 at TOR. These samples were with the range of results for other sampling events so have been left in the plot, but any variability in placement should be interpreted with caution. Sites GAP, GRO and TOR have been frequently dry across the historical monitoring period accounting for the reduced number of points for these sites. Sites GAP, GRO and GEN were only sampled on two occasions during the EIS survey period (in May and June 2013), and AIRUS was added to the program in spring 2016.

Samples from the higher altitude sites GEN, GAP and GRO are grouped together within the plot, indicating that the composition of macroinvertebrate communities at these sites are similar, and have remained so over time (Figure 3.23). Similarly, samples from DOG, TOR, AIR and AIRUS are also grouped together in the plot, but are separated from samples collected at the higher altitude sites. Greater variability in the macroinvertebrate composition has been observed over time at some sites, particularly at GAP, TOR and AIR.

Most samples collected in 2024 are positioned within the historical range of results at each site, indicating a similarity in the community composition in 2024 compared to historical results. The exception to this is the result from AIR in autumn 2024, which is separated within the plot, indicating a difference in the community condition at AIR compared to previous results.

ANOSIM detected a significant difference ($p < 0.05$) in community composition between sites, based on the community composition of all individual macroinvertebrate sample collected throughout the historical monitoring period. Pairwise tests determined that the macroinvertebrate community composition of all pairs of sites were significantly different ($p < 0.05$) except for AIRUS and AIR, and AIRUS and TOR (Appendix H).

The additional nMDS in Figure 3.24 presents the same results, coloured to highlight differences in community composition between samples collected for the EIS (2013 and 2014) and after the EIS (2015 to 2024). Data from AIRUS has been removed from this plot as AIRUS was not sampled for the EIS. The plot shows that most samples collected in the post-EIS period are interspersed with samples from the EIS period. There are some outlier samples from the post-EIS period, however, these are rare, suggesting seasonal fluctuations due to water and habitat availability, rather than a consistent change in community composition at any site. There is a large spread in the EIS samples collected from TOR and AIR, indicating as much variability in the community composition at these sites between the 2013 and 2014 sampling events, as between sampling events from 2015 to 2024.

A third nMDS has been presented as Figure 3.25, which shows the similarity in macroinvertebrate community composition for all individual samples collected at Airly Creek sites AIR and AIRUS, noting that AIRUS was not sampled prior to spring 2016. As the stress level for the MDS exceeded 0.20, the MDS plot should be interpreted with caution. The plot indicates a minimum of 40 percent similarity between all Airly Creek samples, except one sample from AIR in autumn 2014 (Figure 3.25). All samples collected from AIRUS during the 2016 to 2024 monitoring period are plotted within the range of results at AIR, indicating that the between-site variability in community composition is similar to within-site variability or temporal variability. There has been a minor shift in the community composition at AIR over time, with the majority of samples collected from 2013 to 2019 separating around the edge of the plot, while a large grouping which contains all samples collected from AIR and AIRUS in the 2020 to 2022 period, as well as most samples from 2024, is clustered in the centre of the plot.

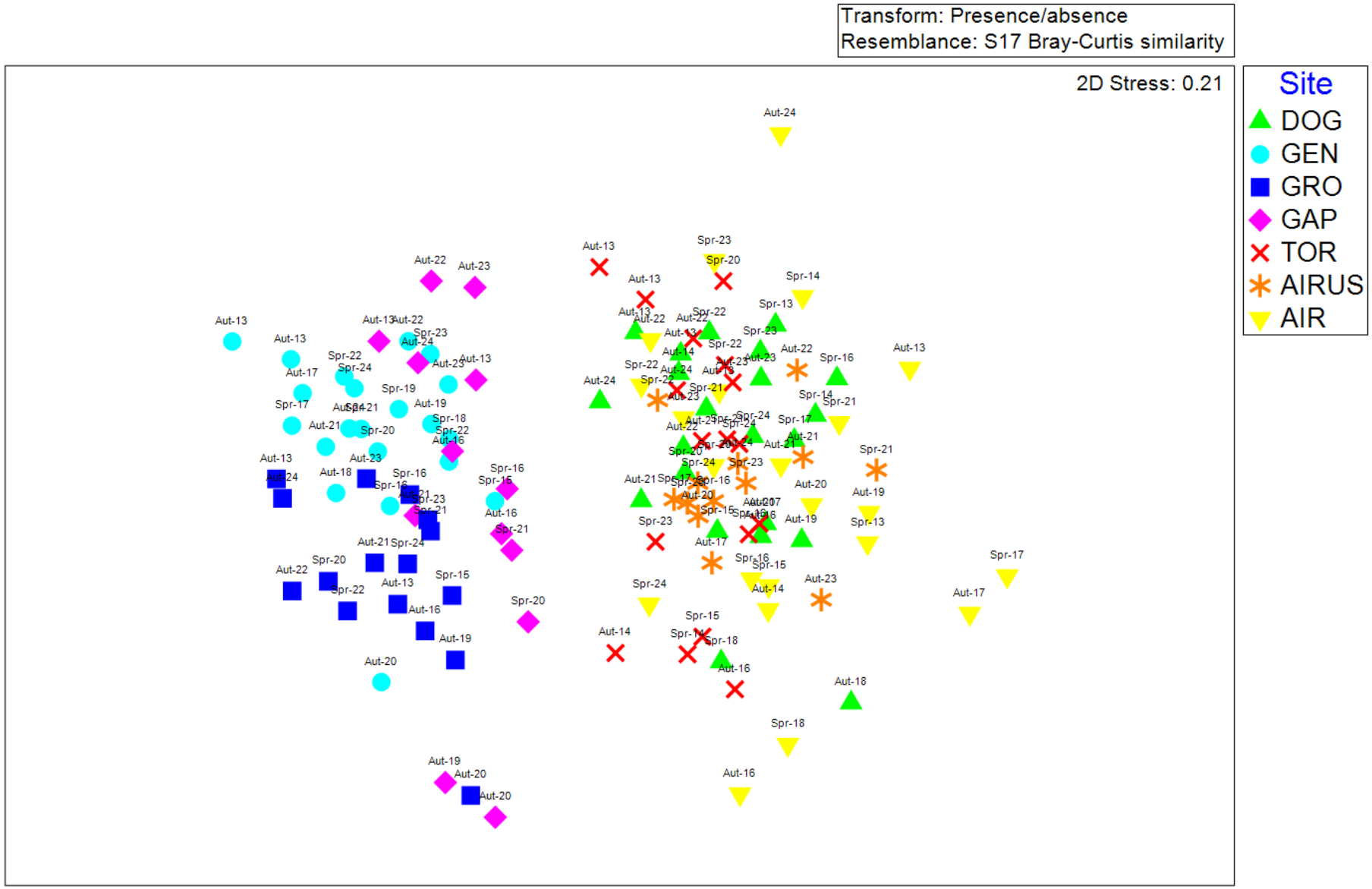


Figure 3.23 nMDS demonstrating relative similarity in community composition between sites, 2013-2024

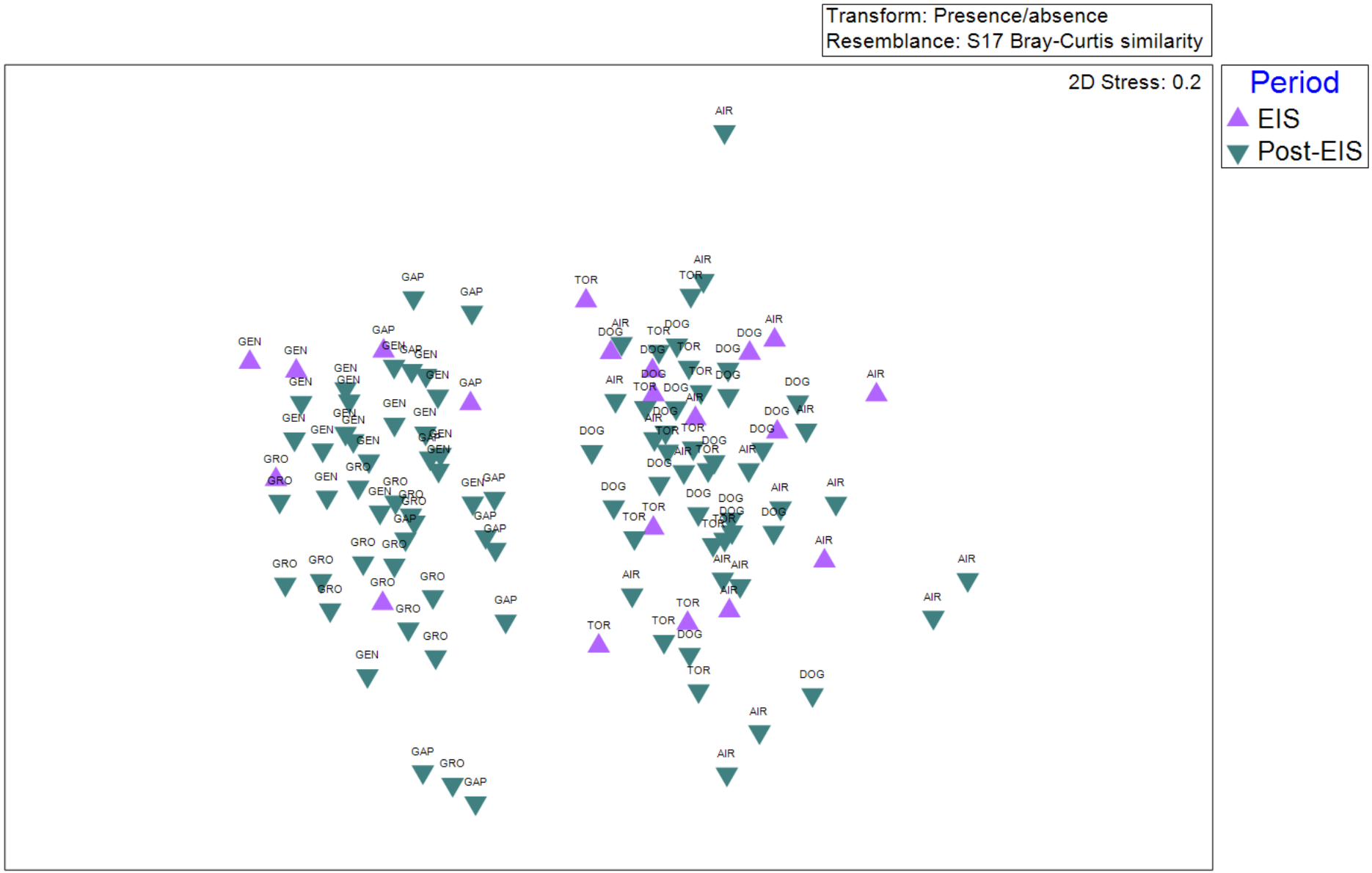


Figure 3.24 nMDS demonstrating relative similarity in community composition between EIS and post-EIS sampling, 2013-2024

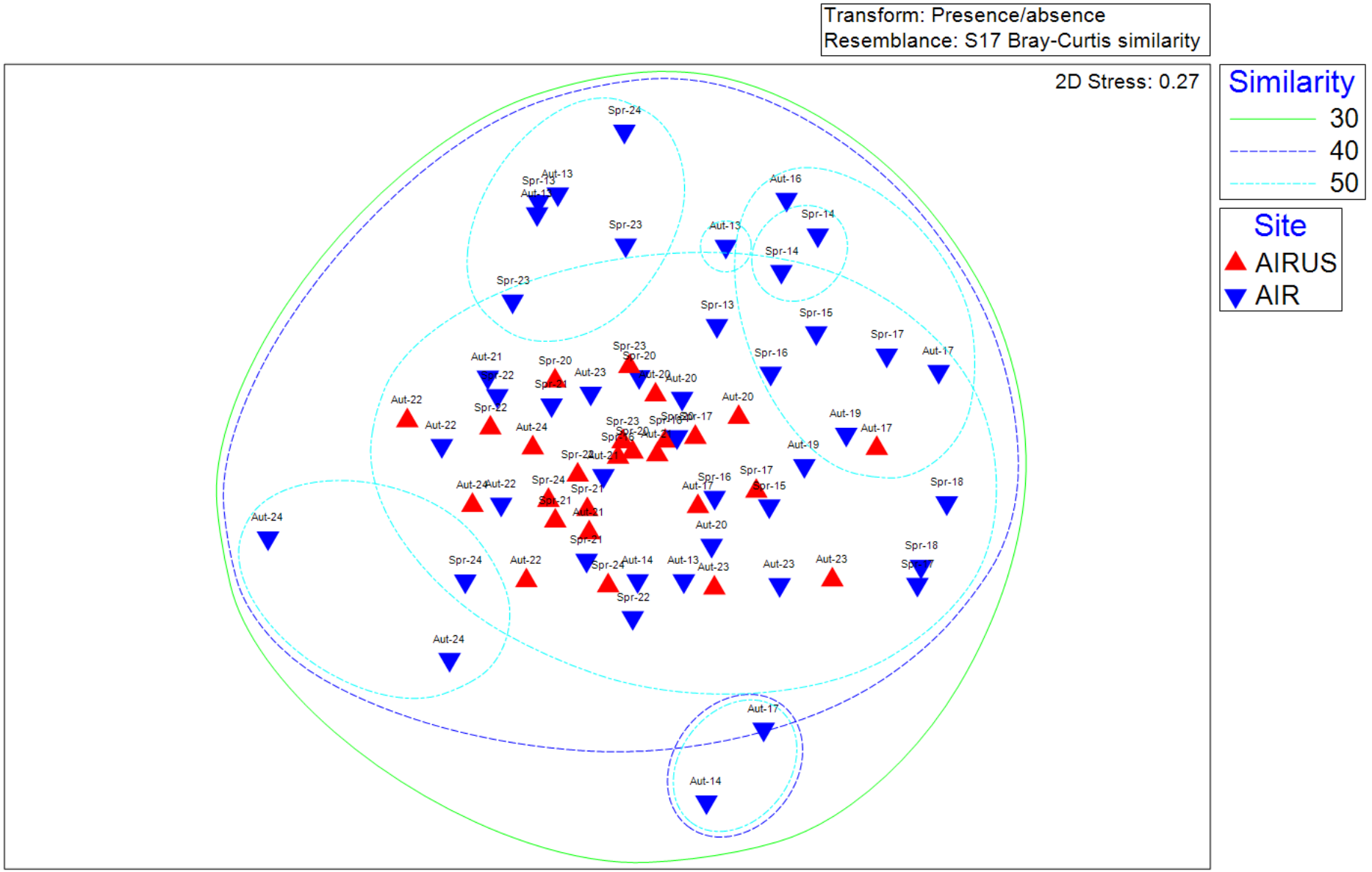


Figure 3.25 nMDS demonstrating relative similarity in community composition between Airly Creek samples, 2013-2024

4. Discussion

4.1 Water quality

There were no discharges into Airly Creek from Airly Mine LDPs in 2024. The last recorded discharge was in November 2022 from LDP1.

Water quality monitoring results from 2024 show that the salinity and ionic composition at Airly Creek sites (background site AIRUS and impact site AIR) are similar to that at other lower altitude sites on Dog Trap and Torbane Creeks (sites DOG and TOR). These sites all contained water of elevated salinity, and a dominance of calcium, magnesium and sulfate ions (and bicarbonate at DOG). This is indicative of the cattle grazing in the upstream catchments of Airly, Torbane and Dog Trap creeks and groundwater inputs from the Shoalhaven Group, which is an early Permian marine formation in which groundwater typically has an elevated EC in the order of 4000 µS/cm (GHD 2024a). In contrast, the higher altitude sites on Genowlan and Gap Creeks (GEN, GRO and GAP), which are bedrock-confined waterways in forested areas had water of a dilute sodium chloride type.

EC in 2024 reflected the weather conditions in the study area, as has been observed in recent years. Generally higher EC was observed in spring than autumn in 2024, and an increasing trend was observed at Airly Creek sites between April and December 2024. A large volume of rainfall was recorded in early April (99 mm total on 5 and 6 April) which contributed to a notable decrease observed in EC at AIR between March and April 2024 sampling (decrease from 2,970 µS/cm in March to 1,700 on 9 April, soon after the rainfall). Rainfall remained generally low over the remainder of 2024, which likely contributed to the consistent increase in EC observed during monthly sampling at the Airly Creek sites, due to lower dilution. EC in 2023 also demonstrated an increasing trend during very dry conditions, following on from a year of above average rainfall in 2022, and consequently, lower EC results. Elevated salinity (that is, EC higher than the DGV of 350 µS/cm) in fresh waters, such as that observed at sites AIR, AIRUS, TOR and DOG in 2024 and historically, can be a stressor to aquatic communities, including macroinvertebrates.

In 2024, there were few exceedances of the toxicant DGVs observed at impact site AIR, with only the dissolved arsenic concentration in autumn 2024, and the dissolved zinc concentrations in autumn and spring 2024 exceeding the 99 percent species protection DGVs (ANZG 2018). As there were no discharges from Airly Mine in 2024 or 2023, catchment influences other than discharges from Airly Mine are likely the source of these metals. The dissolved zinc concentrations at AIR in autumn 2024 and spring 2024 were below the calculated HMGV, indicating these concentrations would not be likely to cause harm to aquatic organisms. Similarly, the dissolved arsenic concentration observed in autumn 2024, although elevated compared to the DGV for protection of 99 percent of species, did not exceed the DGV for the protection of 95 percent of aquatic species (0.013 mg/L). As such, the potential impact to macroinvertebrates would be limited only to the most sensitive taxa. Therefore, water quality at AIR in 2024 was not expected to have had a notable adverse impact to aquatic species, and as mentioned, elevated metals are not attributable to Airly Mine.

At background site AIRUS in spring 2024, there were several dissolved metals that were observed in elevated concentrations above DGVs and or SSGVs. This includes dissolved arsenic, cobalt, manganese, nickel and zinc, and follows from results in autumn 2024 during which all dissolved metals concentrations at AIRUS were below DGVs. Water levels were much lower in spring 2024 than autumn 2024 at AIRUS, suggesting that evapoconcentration and lack of dilution may have contributed to these elevated metals concentrations. The toxicity of nickel and zinc is known to be reduced in hard water. Therefore, based on the recorded water hardness at AIRUS in spring 2024, it is not expected that the nickel and zinc concentrations observed at AIRUS in spring 2024 would cause adverse impacts to aquatic biota. As with the arsenic concentration observed at AIR in autumn 2024, the arsenic concentration observed at AIRUS in spring 2024 was lower than the DGV for the protection of 95 percent of aquatic species, meaning the potential impact to macroinvertebrates due to the observed dissolved arsenic concentration would likely be limited only to the most sensitive taxa. The observed dissolved manganese concentration, however, was above both the 95 and 99 percent species protection DGVs, indicating that impacts to aquatic organisms due to the water quality observed at AIRUS in spring 2024 remains possible. As AIRUS is located upstream of where Airly Mine discharges enter Airly Creek, Airly Mine discharges are not considered to be the source of these metals at AIRUS.

As was observed at AIR in autumn 2024 and AIRUS in spring 2024, the dissolved arsenic concentration at DOG in spring 2024 exceeded the DGV for 99 percent species protection, but was below the 95 percent species protection value. This indicates a possible impact to sensitive taxa at DOG in spring 2024. There were no other exceedances of any water quality DGV at DOG in 2024. There was also only one exceedance of a toxicant DGV at TOR in 2024 – an exceedance of the DGV for dissolved zinc in spring 2024 only. The zinc concentration at TOR in spring 2024 was the highest of all sites in 2024; however, given the elevated water hardness observed at TOR in spring 2024, this concentration was below the calculated HMGV, indicating a reduced probability of biological impacts to aquatic species. As was observed at AIRUS in spring 2024, the water level at TOR was low in spring 2024, with no connectivity between the pools. Consequently, this elevated zinc concentration was likely exacerbated by the dry conditions that led to decreased dilution.

Dissolved chromium has consistently been observed in elevated concentrations (above the LOR, and therefore, above the DGV) in at least one sampling event at all sites except DOG and TOR since autumn 2019. However, results during all sampling events since this time have been highest at baseline site GRO (except in spring 2019 when GRO was dry, and autumn 2024 when dissolved chromium was higher at GAP). Similarly, concentrations of dissolved aluminium and zinc have also been elevated above DGVs/SSGVs, both in 2024 and across the historical monitoring period, particularly at the higher elevation sites (baseline sites GRO and GEN, and potentially influenced site GAP). Given the distribution of these metals across different site types, and primarily at the unimpacted baseline sites, it is likely that the source of chromium, aluminium and zinc is the local lithology, and Airly Mine is unlikely to be a contributing factor. However, these observed dissolved metals concentrations in excess of the DGV may cause impacts to aquatic organisms, particularly the dissolved aluminium concentrations at GRO, which are consistently well above the DGV, and when combined with the acidic water commonly observed at GRO, suggests a high probability of toxicity to aquatic organisms. Although zinc concentrations were elevated at the baseline sites compared to the DGV for protection of 99 percent of species, as the zinc concentrations observed did not exceed the DGV for the protection of 95 percent of aquatic species (0.008 mg/L), the potential impact to macroinvertebrates would be limited to the most sensitive taxa at these sites.

Low DO saturations were observed at several sites in 2024, with the lowest DO in both autumn and spring 2024 recorded at DOG. Water at DOG in 2024 was confined to one small, isolated pool which, along with decomposition of detritus (due to dead/dying macrophytes caused by the reduced water level), likely contributed to the very low DO result. At other sites, flow rates were low in 2024, which contributed to lower DO through reduced aeration. Low DO conditions are considered a physical stressor to aquatic organisms, which may have influenced the macroinvertebrate community at all sites, but especially DOG, in 2024 (ANZECC 2000).

Overall, catchment landuse and the continuation of dry conditions were the primary factors influencing water quality in 2024. As there have been no discharges from Airly Mine into Airly Creek since November 2022, the higher concentrations of some metals observed at AIR compared to AIRUS in autumn 2024 are not attributable to Airly Mine discharges. Therefore, based on the water quality data collected during 2024 aquatic ecology sampling, Airly has met the EIS prediction of negligible environmental consequences to water quality. There was also no evidence of impacts to flows or water quality in Gap Creek or Torbane Creek due to undermining of some of the headwater streams of these watercourses.

4.2 Sediment quality

At the Airly Creek sites in 2024, the only exceedance of any sediment DGV was for sediment nickel at background site AIRUS in autumn 2024 only. There has only been one exceedance observed for any sediment DGV at AIR during the historical monitoring period, which was for sediment nickel in autumn 2022. Conversely, sediment nickel concentrations at background site AIRUS have exceeded the DGV on several occasions during the historical monitoring period, including autumn 2017, autumn 2023 and autumn 2024, when the DGV was exceeded, as well as spring 2017, autumn 2022 and spring 2022, when the GV-high was exceeded. As concentrations of sediment nickel, as well as all other sediment metals, are consistently higher at background site AIRUS than at impact site AIR, discharges from Airly Mine are not considered to be the source of these sediment metals. However, the sediment DGVs represent the thresholds at which impacts to aquatic organisms are possible, while the GV-high values represent the sediment metal concentration at which biological effects are likely. As such, the concentrations of sediment nickel observed commonly at AIRUS, and in autumn 2022 only at AIR, had a potential to cause adverse impacts aquatic species, including macroinvertebrates.

Concentrations of all sediment metals were below DGVs at all other sites in autumn and spring 2024, with the concentrations of most metals lowest at GRO. At GRO, the sediments are mostly sand, which is not prone to metal accumulation, as metals bind preferentially to finer sediment particles such as clay and silt. Low concentrations of sediment metals have been common at the baseline and undermined headwater sites across the historical monitoring period, with the last exceedance of any sediment DGV at these sites for antimony at baseline site GEN in spring 2018. These results indicate that no impact to aquatic organisms due to sediment quality are likely at these sites in 2024, or during the majority of the historical monitoring period.

4.3 Macroinvertebrates

In 2024, rainfall was well below average conditions in the study area, and followed from conditions in 2023, during which total rainfall was below the 10th percentile at the BOM Running Stream station (BOM 2024). These low rainfall conditions contributed to GAP being dry in spring 2024, and several other sites being in poor condition due to low water levels and the subsequent reduction in aquatic habitats and flow. During the 2020 to 2022 period, however, rainfall was above the long-term average, and these improved conditions helped to create more favourable conditions for macroinvertebrates (GHD 2021). This trend continued throughout 2021 and 2022, thereby creating a more stable environment of consistent water sources at all sites, which allowed for the recovery of the macroinvertebrate communities. This variability in rainfall conditions in the study area is likely the primary factor influencing the macroinvertebrate community at each site during the historical monitoring period.

At Airly Creek impact site AIR in autumn and spring 2024, the macroinvertebrate community condition indicated a decline in all metrics from the autumn and spring 2023 results. This follows from the decline observed in autumn and spring 2023 results compared to 2022 results, when the macroinvertebrate community was in the best condition at AIR since sampling began in 2013. There were no discharges from Airly Mine into Airly Creek in 2023 or 2024, with the last discharge occurring in November 2022. As such, the decline in macroinvertebrate community condition observed at AIR in 2024 and 2023, compared to 2022 results, is likely due to factors unrelated to mine discharges. The reduced water levels at AIR, particularly in spring 2023 and spring 2024, contributed to a reduction in instream habitat availability and quality, as the sampleable area (i.e. suitable macroinvertebrate edge habitat) was notably reduced, with trailing grasses mostly above the water line, and several pools not able to be sampled (refer Section 3.3). This is likely to be the primary factor impacting the macroinvertebrate community in 2023 and 2024 compared to 2022 results, when water levels were high. Similarly, EC was notably elevated in spring 2024 and spring 2023 compared to other recent conditions, and the ANZECC (2000) DGV of 350 µS/cm. This was likely caused by a reduction in dilution of naturally elevated salts in these catchments (refer Section 4.1) due to reduced rainfall. Elevated EC can be a stressor to aquatic communities, including macroinvertebrates, either physically (e.g. by influencing osmoregulation) or indirectly through changing the community structure (e.g. loss of salinity sensitive taxa) (ANZECC 2000, Chessman 2003) but, as discussed in Section 4.1, salinity in Airly Creek is related to the geology and was similarly elevated at background site AIRUS.

In autumn and spring 2024, the macroinvertebrate community condition at impact site AIR was in a similar condition to background site AIRUS, with higher SIGNAL-2 scores, particularly in spring 2024, but lower EPT richness. This is despite the difference in aquatic habitat availability and variety between the two sites. The substrate at AIRUS is entirely soft silt, with diverse instream habitats consisting of a wide variety of emergent and submerged macrophytes, large woody debris, and willow leaf detritus. At AIR, the substrate comprises mainly coarser particles including boulders and cobbles, but instream habitats are much more limited, with little emergent macrophyte surviving in the dryer conditions in 2023 and 2024, and reduced water levels such that trailing vegetation from banks was no longer submerged, particularly in spring 2024 (refer photos in Section 3.3). As water and sediment quality at AIR and AIRUS were very similar in 2024, with most metals observed in higher concentrations at background site AIRUS, any impairment to the macroinvertebrate community observed at AIR compared to conditions at AIRUS, is likely due to these habitat factors.

These results therefore do not indicate impacts from Airly Mine operations on Airly Creek in 2024, which is to be expected given there has been no discharge from Airly Mine LDPs since 2022. The historical monitoring results demonstrate that community composition at AIR has generally been similar to the background Airly Creek site, and that there was significantly ($p < 0.05$) higher EPT richness (one of the measures of pollution sensitivity) at AIR in the post-EIS period with no significant difference in the other macroinvertebrate metrics. These results do not provide evidence of impacts from Airly Mine discharges on the macroinvertebrate community of Airly Creek, which is commensurate with their infrequency except in 2022, during periods of high rainfall and dilution.

In 2024, as well as during recent years of monitoring, samples collected at baseline site GEN contained the highest SIGNAL-2 scores, and the highest proportion of sensitive taxa. Located in the headwaters of Genowlan Creek, site GEN is spring fed, and is therefore less prone to impacts from drying conditions. GEN contains a heterogenous substrate including boulders, cobbles, gravel, and sand, as well as low proportions of silt and clays blanketing the substrate. GEN is also well shaded and contains other aquatic habitats including detritus, small woody debris and algae. Therefore, the site displays good quality and diverse aquatic habitat and with greater water reliability, can support more sensitive macroinvertebrate taxa than other high-altitude sites.

As mentioned in Section 4.1, dissolved aluminium concentrations at baseline site GRO were elevated above the DGV and above results at all other sites in autumn and spring 2024, which has been common throughout the historical monitoring period. This elevated dissolved aluminium may have contributed to the poorer macroinvertebrate community condition (particularly EPT richness) recorded at the site in 2024 and historically, compared to the other high elevation sites. However, the generally low taxa richness and EPT richness results observed at GRO compared to other upland sites may also be due to the habitat limitations in this section of Genowlan Creek. Due to previous disturbances from maintenance of the adjacent four-wheel-drive track, this site has been reduced to a very narrow section of bedrock covered by ferns, with limited variety of habitat. Despite persistent water at the site throughout 2022 to 2024, the macroinvertebrate community condition is still impaired relative to the EIS sampling period (2013-2014). However, as Genowlan Creek has not yet been undermined, the results are not likely to be associated with Airly mining.

At baseline site DOG, taxa richness and EPT richness were notably lower during the spring 2023 to spring 2024 period, compared to results from the spring 2021 to autumn 2023 period. During the spring 2021 to autumn 2023 period, the waterway at DOG was in a good condition, with water flowing through the site, and the downstream channel section of the creek was able to be sampled. This section contains a heterogenous substrate including bedrock, cobbles, pebbles and sand, which likely supports different macroinvertebrate families than the main pool which has been the only available water in the drier sampling events. During the spring 2023 to spring 2024 period, remaining water at the site was limited to this pool, which was observed to be in poor condition, with reduced water levels, and direct access by cattle. This pool is completely infilled with soft silt, and is limited in aquatic habitat diversity, containing only dead *Typha* sp. in spring 2023, and a severe overgrowth of *Chara* sp. and other algae in autumn and spring 2024 (refer photos in Section 3.3 and in GHD 2024b). This overgrowth of algae and stagnant conditions likely contributed to the very low DO saturations observed at DOG in the spring 2023 to spring 2024, with decomposing algae consuming much of the available oxygen in the water, contributing to the observed hypoxic conditions. As outlined in Section 4.1, low DO conditions are considered a physical stressor to aquatic organisms, which may have influenced the macroinvertebrate community at DOG (ANZECC 2000). This combination of reduced habitat diversity, choking of the pool with algae, and hypoxic conditions is likely to have contributed to the decline in macroinvertebrate metrics observed at DOG in the spring 2023 to spring 2024 period.

At DOG, taxa richness, EPT richness and SIGNAL-2 scores were all shown to be significantly lower in the post-EIS period (2015-2024) compared to the EIS sampling period (2013 to 2014). Along with this, RCE scores have also reduced between the EIS period and 2024 (refer Section 3.3.1). DOG has not been influenced by undermining, so this decline in macroinvertebrate condition is not attributable to Airly Mine. Instead, these changes have been attributed to degradation from cattle grazing, and the long-term drought (2017 to 2019) which caused dieback of riparian vegetation and altered the waterway hydraulics.

A small section of the first order headwaters of Torbane Creek was undermined in 2019. However, the results of the 2020 to 2024 sampling events do not suggest any impacts to the macroinvertebrate community of potentially influenced Torbane Creek site TOR as a result. A substantial and continued improvement in the macroinvertebrate community condition (metrics results) was observed at TOR in the period following mining (between 2020 and 2022) (GHD 2023c, 2022, 2021), which is likely the result of the sustained water availability during this period. TOR is prone to drying in low-rainfall conditions, with no water present at the site between autumn 2017 and spring 2018 (which was prior to the undermining of the headwaters of Torbane Creek), or in spring 2019. Following re-wetting, the recolonisation of a site by aquatic macroinvertebrates can take an extended period of time, which explains the continued improvement in macroinvertebrate results between 2020 and 2022, during which flow and higher water levels persisted.

In 2024 (particularly spring 2024), TOR was in poor condition, with a dense overgrowth of algae (refer to photos in Section 3.3). As was observed at DOG, this likely contributed to the suppressed DO observed, along with the reduced water levels which meant there was no flow or connectivity between the pools, which may have influenced the macroinvertebrate results. Taxa richness and SIGNAL-2 scores at TOR in spring 2024 were the lowest observed during the post-drought (2020 to 2024) period. This decline in site condition and subsequent decrease observed in macroinvertebrate community condition at TOR in spring 2024 is not considered to be attributable to mining.

The macroinvertebrate community condition at GAP in autumn 2024 was reasonably good compared to recent (post-drought) results, particularly as GAP was dry in spring 2023 and spring 2024, and recolonisation of the macroinvertebrate communities would have had to have occurred. This may reflect the near-permanent water present within the dam upstream in Gap Creek, which is likely to sustain macroinvertebrates that are then released to the downstream environment during periods of higher flows. Macroinvertebrate metrics results, however, were generally highest at GAP in autumn 2023, which likely reflects of the consistent supply of water observed at GAP over the 2020 to early-2023 period. There was sufficient pooled water during all sampling events between autumn 2020 and autumn 2023 for macroinvertebrate samples to be collected, and water was consistently flowing at GAP from November 2021 to September 2023 (as recorded by the flow gauge located at the upstream extent of the aquatic ecology monitoring location at GAP).

Secondary workings (panel and pillar mining) commenced under the first order stream headwaters of Gap Creek in 2020, with further undermining occurring in 2021. GAP was dry in both autumn 2023 and autumn 2024, after an extended wet period during which there has been no evidence of changes to flows in Gap Creek following the undermining, as determined through monthly water quality monitoring and the Gap Creek flow gauge (GHD 2024a, 2025b). The flows in Gap Creek in 2021 and 2022 were increased relative to the pre-mining monitoring history, mirroring the increased rainfall, and the dry conditions at GAP in spring 2023 and spring 2024, likewise reflected the low rainfall prior to sampling. Therefore, there is no evidence that there is any impact from Airly mining on the aquatic biota of Gap Creek.

The macroinvertebrate communities at lowland sites DOG, TOR, AIRUS and AIR were dominated by tolerant taxa, with very few sensitive taxa collected from these sites. These results were consistent with catchments impacted by grazing and historical land clearing and the lower altitude. Samples collected from these sites commonly contained Coenagrionidae (Odonata (damselfly), SIGNAL-2 = 2), Coleoptera (beetle) Hydrophilidae (SIGNAL-2 = 2), and assorted Gastropoda (snails) (SIGNAL-2 = 1 to 4) and Hemiptera (true bug) (SIGNAL-2 = 1 to 2) families, that were not collected, or collected only rarely from upland sites GEN, GRO or GAP in autumn or spring 2024. Conversely, the communities at upland sites contained sensitive taxa including Telephlebiidae (Odonata (dragonfly), SIGNAL-2 = 9), Helicopsychidae (Trichoptera (caddisfly), SIGNAL-2 = 8), Megaloptera (toe-biter) Corydalidae (SIGNAL-2 = 7) and Ephemeroptera (mayfly) Leptophlebiidae (SIGNAL-2 = 8) that were not commonly found at any of the lowland, more disturbed, sites. Overall, the greater sensitivity of the taxa observed at the upland sites, evidenced by the greater number and proportion of sensitive taxa present at each site and the higher average SIGNAL-2 scores, reflects the minimal anthropogenic impacts, and generally improved water and sediment quality, relative to the lowland sites. These differences in macroinvertebrate sensitivity were also reflected in the nMDS, which indicated similar macroinvertebrate community compositions at lowland sites DOG, TOR, AIR and AIRUS, compared to upland sites GEN, GRO and GAP. The different macroinvertebrate community composition at upland sites is reflective of natural site differences including different ionic composition and different environmental conditions (e.g. altitude, temperature, position in the catchment). Some more pollution sensitive macroinvertebrates such as stoneflies are preferential in cooler, flowing, high altitude streams, which is why altitude and distance of the site from the stream’s headwaters are key environmental variables in AUSRIVAS for determining the expected macroinvertebrate community at a site.

Overall, the results of 2024 aquatic ecology monitoring reflect the continuation of drier conditions in the study area, and the catchment landuse practices of each site, and do not indicate impacts from Airly Mine discharges to Airly Creek, or impacts from undermining on the macroinvertebrate communities of Gap Creek or Torbane Creek.

5. Conclusions

There were no discharges from Airly Mine into Airly Creek in 2024, and therefore no impacts to water or sediment quality due to discharges in 2024. The last discharges from Airly Mine were in November 2022. There were few water quality toxicants observed in elevated concentrations at Airly Creek impact site AIR in 2024, and little impact to aquatic organisms expected due to water quality. The elevated water hardness would ameliorate the toxicity of the observed dissolved zinc concentration, and the low-level arsenic exceedance (below the 95 percent species protection value) indicates impacts to only the most sensitive species are likely. There were more water quality toxicant DGV exceedances observed at background site AIRUS in 2024, suggesting a higher probability of biological impacts due to water quality than was observed at AIR. However, historical results indicate that several dissolved metals concentrations, including cobalt, manganese, nickel and zinc, have been commonly elevated at both AIR and AIRUS across the historical monitoring period in absence of Airly Mine discharges, particularly during dry conditions. Other impacts to water quality observed in 2024 include higher salinity and concentrations of major ions at the low altitude sites (Airly Creek, Torbane Creek and Dog Trap Creek) compared to the higher altitude sites (Genowlan and Gap Creeks). This is indicative of historical land clearing, the agricultural landuse in the lowland catchments, and the influence of saline groundwater from marine-deposited geology on Airly Creek.

Sediment quality has been consistently good at all sites across the historical monitoring period, with very few exceedances of the DGVs observed. Sediment quality in 2024 remained good, with only a single, low-level exceedance of the DGV for sediment nickel at AIRUS, mirroring the results from 2023.

The macroinvertebrate community condition in 2024 strongly reflected the individual site conditions, including lower water levels, reduced flow, overgrowth of algae, and landuse practices. Macroinvertebrate community composition reflected the site differences, with samples collected from more pristine, higher altitude sites on Gap and Genowlan Creeks showing similarities, which contrasted to the macroinvertebrate communities observed at lower lying sites in Dog Trap, Torbane and Airly creeks. There is no evidence of impacts to macroinvertebrate communities in 2024 from Airly Mine operations. Despite the drier conditions influencing the water quality and water and habitat availability, the macroinvertebrate community at Airly Creek impact site AIR was in a similar condition to that at Airly Creek background site AIRUS in 2024. Similarly, there has been no evidence of impacts to flows in Gap Creek following the undermining of its headwaters, or any evidence of impacts to the macroinvertebrate community of Torbane Creek or Gap Creek due to undermining.

The next round of aquatic ecology monitoring will be conducted in autumn 2025.

6. References

ANZECC and ARMCANZ (2000a) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1: The Guidelines*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZECC and ARMCANZ (2000b) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 2: Aquatic Ecosystems – Rationale and Background Information*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZG (2019) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Toxicant default guideline values for sediment quality*, https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Australian and New Zealand Governments and Australian state and territory governments.

Bray, JR and Curtis, JT (1957) *An ordination of the upland forest communities of Southern Wisconsin*. Ecol. Monogr. 27:325-349.

Bureau of meteorology [BOM] (2025) Rainfall obtained for station 063012 from http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=063012

Cardno (2014) *Aquatic Ecology and Stygofauna Assessment*, Airly Mine Extension Project, report prepared for Centennial Airly Pty Ltd.

Chessman BC (2003) New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* 54, 95-104.

Chessman, BC, Growns, JE and Kotlash, AR (1997) Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: application to the Hunter River system, New South Wales, *Marine and Freshwater Research*, 48(2), 159–72.

Clarke, KR and Gorley, RN (2015) *PRIMER v7: User Manual/Tutorial*. PRIMER-E, Plymouth, 296pp.

GHD (2025a) *Airly Stygofauna Monitoring Report 2024.* Prepared for Centennial Airly Pty Ltd.

GHD (2025b) *Airly Annual Water Monitoring Report 2024*. Prepared for Centennial Airly Pty Ltd, in draft.

GHD (2025c) *Airly 2024 Watercourse Stability Monitoring Report*. Prepared for Centennial Airly Pty Ltd, in draft.

GHD (2024a) *Airly Mine Water Management Plan*, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2024b) *Airly Annual Water Monitoring Report 2023*. Prepared for Centennial Airly Pty Ltd.

GHD (2023c) *Airly Aquatic Ecology Monitoring Annual Report 2022.* Prepared for Centennial Airly Pty Ltd.

GHD (2022) *Airly Aquatic Ecology Monitoring Annual Report 2021.* Prepared for Centennial Airly Pty Ltd.

GHD (2021) *Airly Aquatic Ecology Monitoring Annual Report 2020*. Prepared for Centennial Airly Pty Ltd.

GHD (2018) *Airly Mine: Site specific guideline values,* prepared for Centennial Airly Pty Ltd.

GHD (2016) *Western Operations: Regional Water Management Plan*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

Hawking, JH (2000) Key to Keys. A guide to keys and zoological information to identify invertebrates from Australian inland waters. Identification Guide No. 2, 2nd Edition. Cooperative Research Centre for Freshwater Ecology.

ISO (1983) *Water Quality: Methods of Biological Sampling - Handnet Sampling of Aquatic Benthic Macroinvertebrates*. Draft ISO International Standard.

Karr, JR and Chu, EW (1999) *Restoring life in running waters: Better biological monitoring*, Island Press, Washington, D.C.

Marshall, C, Harch, BD, Choy, SC, Smith, MJ (2001) Chapter 8: Aquatic macroinvertebrates as indicators of ecosystem health, Design and Implementation of Baseline Monitoring (DIBM3) final report, http://www.watercentre.org/portfolio/rhef/project-resources/publications/SmithStorey2001_Ch11.pdf

Peterson RC (1992) The RCE: a Riparian, Channel, and Environment Inventory for small streams in the agricultural landscape, *Freshwater Biology,* 27(2), 295–306.

Plafkin, JL, Barbour, MT, Porter, KD, Gross, SK, Hughes, RM (1989) *Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish*, United States Environmental Protection Agency, Washington.

Simpson SL and Batley G (2016) *Sediment Quality Assessment*, A Practical Guide, second edition, CSIRO Publishing.

Turak E, Waddell N and Johnstone G (2004) *New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual 2004* http://ausrivas.ewater.com.au/index.php/manuals-a-datasheets?id=55

Appendices

Appendix A

Laboratory certificates of analysis (water quality)

CERTIFICATE OF ANALYSIS

Work Order	: **ES2416967**	Page	: 1 of 10
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS Tegan Hopwood	Contact	: Samiksha Sathish
Address	: Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4910 7760	Telephone	: +61-2-8784 8555
Project	: 125633750	Date Samples Received	: 24-May-2024 10:59
Order number	: Airly autumn 2024	Date Analysis Commenced	: 24-May-2024
C-O-C number	: ----	Issue Date	: 31-May-2024 11:20
Sampler	: Tegan Hopwood		
Site	:		
Quote number	: EN/000		
No. of samples received	: 8		
No. of samples analysed	: 8		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Gregory Towers	Technical Officer	Chemistry, Newcastle West, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EG094: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GAP	GEN	GRO	DOG	TOR
				Sampling date / time	21-May-2024 10:45	22-May-2024 08:40	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30
Compound	CAS Number	LOR	Unit		ES2416967-001	ES2416967-002	ES2416967-003	ES2416967-004	ES2416967-005
					Result	Result	Result	Result	Result
EA005: pH									
pH Value	----	0.01	pH Unit		7.36	6.80	5.86	7.90	7.86
EA006: Sodium Adsorption Ratio (SAR)									
^ Sodium Adsorption Ratio	----	0.01	-		0.85	1.20	1.20	0.95	0.73
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		126	44	34	1410	2740
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		82	29	22	916	1780
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	<5	12	10
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		31	<1	<1	723	1660
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		29	5	4	390	192
Total Alkalinity as CaCO3	----	1	mg/L		29	5	4	390	192
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		6	2	<1	349	1470
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		18	9	7	44	51
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		6	<1	<1	156	282
Magnesium	7439-95-4	1	mg/L		4	<1	<1	81	231
Sodium	7440-23-5	1	mg/L		11	5	5	59	68
Potassium	7440-09-7	1	mg/L		3	1	<1	2	10
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.04	0.03	0.27	<0.01	<0.01
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GAP	GEN	GRO	DOG	TOR
				Sampling date / time	21-May-2024 10:45	22-May-2024 08:40	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30
Compound	CAS Number	LOR	Unit		ES2416967-001	ES2416967-002	ES2416967-003	ES2416967-004	ES2416967-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.016**	**0.002**	**0.003**	**0.013**	**0.130**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.004**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		**0.07**	<0.05	**0.23**	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.22**	**0.07**	**0.36**	<0.01	<0.01
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.047**	**0.004**	**0.005**	**0.010**	**0.142**
Nickel	7440-02-0	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	**0.006**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		**0.13**	<0.05	**0.29**	**0.10**	**0.07**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Arsenic	7440-38-2	0.2	µg/L		<0.2	<0.2	<0.2	**0.4**	**0.3**
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	7440-47-3	0.2	µg/L		**1.2**	<0.2	**0.9**	<0.2	<0.2
Selenium	7782-49-2	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	1	µg/L		**2**	**6**	**2**	<1	**2**
EG094T: Total metals in Fresh water by ORC-ICPMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GAP	GEN	GRO	DOG	TOR
				Sampling date / time	21-May-2024 10:45	22-May-2024 08:40	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30
Compound	CAS Number	LOR	Unit		ES2416967-001	ES2416967-002	ES2416967-003	ES2416967-004	ES2416967-005
					Result	Result	Result	Result	Result
EG094T: Total metals in Fresh water by ORC-ICPMS - Continued									
Arsenic	7440-38-2	0.2	µg/L		<0.2	<0.2	<0.2	**0.4**	**0.3**
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	7440-47-3	0.2	µg/L		**0.4**	**0.2**	**0.9**	<0.2	<0.2
Selenium	7782-49-2	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	1	µg/L		**2**	**5**	**4**	**2**	**8**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	**0.1**	<0.1	**0.3**	**0.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	<0.01	**0.02**	<0.01	**0.03**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.01**	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.14**	**0.09**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.14**	**0.10**	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.1**	<0.1	**0.1**	<0.1	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.1**	**0.1**	<0.1	**0.3**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**1.21**	**0.40**	**0.28**	**16.3**	**35.9**
ø Total Cations	----	0.01	meq/L		**1.18**	**0.24**	**0.22**	**17.1**	**36.3**
ø Ionic Balance	----	0.01	%		**----**	**----**	**----**	**2.30**	**0.58**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GAP	GEN	GRO	DOG	TOR
				Sampling date / time	21-May-2024 10:45	22-May-2024 08:40	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30
Compound	CAS Number	LOR	Unit		ES2416967-001	ES2416967-002	ES2416967-003	ES2416967-004	ES2416967-005
					Result	Result	Result	Result	Result
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**5**	**3**	**6**	**2**	**6**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIR	AIRUS	AIRD	----	----
				Sampling date / time	23-May-2024 12:45	23-May-2024 14:30	22-May-2024 14:00	----	----
Compound	CAS Number	LOR	Unit		ES2416967-006	ES2416967-007	ES2416967-008	--------	--------
					Result	Result	Result	----	----
EA005: pH									
pH Value	----	0.01	pH Unit		7.77	7.71	6.30	----	----
EA006: Sodium Adsorption Ratio (SAR)									
^ Sodium Adsorption Ratio	----	0.01	-		0.83	0.84	1.20	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		2430	2840	35	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		1580	1850	23	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	<5	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		1410	1660	<1	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		137	206	4	----	----
Total Alkalinity as CaCO3	----	1	mg/L		137	206	4	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		1290	1550	<1	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		52	55	7	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		240	257	<1	----	----
Magnesium	7439-95-4	1	mg/L		198	248	<1	----	----
Sodium	7440-23-5	1	mg/L		72	79	5	----	----
Potassium	7440-09-7	1	mg/L		6	6	<1	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	0.27	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIR	AIRUS	AIRD	----	----
				Sampling date / time	23-May-2024 12:45	23-May-2024 14:30	22-May-2024 14:00	----	----
Compound	CAS Number	LOR	Unit		ES2416967-006	ES2416967-007	ES2416967-008	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L		**0.058**	**0.038**	**0.004**	----	----
Nickel	7440-02-0	0.001	mg/L		**0.003**	**0.003**	<0.001	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.23**	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	**0.36**	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L		**0.066**	**0.047**	**0.004**	----	----
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.004**	<0.001	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	**0.22**	**0.28**	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	----	----
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Arsenic	7440-38-2	0.2	µg/L		**0.2**	**0.3**	<0.2	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	----	----
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	**0.8**	----	----
Selenium	7782-49-2	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	1	µg/L		**8**	**2**	**2**	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIR	AIRUS	AIRD	----	----
				Sampling date / time	23-May-2024 12:45	23-May-2024 14:30	22-May-2024 14:00	----	----
Compound	CAS Number	LOR	Unit		ES2416967-006	ES2416967-007	ES2416967-008	--------	--------
					Result	Result	Result	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS - Continued									
Arsenic	7440-38-2	0.2	µg/L		**0.3**	**0.4**	<0.2	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	----	----
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	**0.9**	----	----
Selenium	7782-49-2	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	1	µg/L		**5**	**2**	**1**	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	<0.1	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.03**	<0.01	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.3**	**0.4**	**0.1**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.3**	**0.4**	**0.1**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**31.1**	**37.9**	**0.28**	----	----
ø Total Cations	----	0.01	meq/L		**31.6**	**36.8**	**0.22**	----	----
ø Ionic Balance	----	0.01	%		**0.79**	**1.49**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIR	AIRUS	AIRD	----	----
				Sampling date / time	23-May-2024 12:45	23-May-2024 14:30	22-May-2024 14:00	----	----
Compound	CAS Number	LOR	Unit		ES2416967-006	ES2416967-007	ES2416967-008	--------	--------
					Result	Result	Result	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**6**	**8**	**6**	**----**	**----**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	**----**	**----**

Inter-Laboratory Testing

Analysis conducted by ALS Newcastle - Water, NATA accreditation no. 825, site no. 1656 (Chemistry) 9854 (Biology).

(WATER) EA005: pH

CERTIFICATE OF ANALYSIS

Work Order	: **ES2436563**	Page	: 1 of 10
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS Tegan Hopwood	Contact	: Samiksha Sathish
Address	: Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4910 7760	Telephone	: +61-2-8784 8555
Project	: 125633750	Date Samples Received	: 11-Nov-2024 08:23
Order number	: Airly spring 2024	Date Analysis Commenced	: 13-Nov-2024
C-O-C number	: ----	Issue Date	: 18-Nov-2024 11:32
Sampler	: Tegan Hopwood		
Site	:		
Quote number	: EN/000		
No. of samples received	: 7		
No. of samples analysed	: 7		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EG094: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EG094-F: Poor matrix spike recovery was obtained for Chromium on sample ES2436231-007. Confirmed by reanalysis.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	GEN	GRO	DOG	TOR	AIR
			Sampling date / time	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00	07-Nov-2024 10:30	07-Nov-2024 13:00
Compound	CAS Number	LOR	Unit	ES2436563-001	ES2436563-002	ES2436563-003	ES2436563-004	ES2436563-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.89	5.83	7.74	7.64	7.74
EA006: Sodium Adsorption Ratio (SAR)								
^ Sodium Adsorption Ratio	----	0.01	-	1.31	1.20	1.24	0.88	0.98
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	49	33	1170	2920	3140
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	32	21	760	1900	2040
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	1	mg/L	<1	4	20	9	14
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	4	<1	555	1690	1750
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	10	5	258	213	240
Total Alkalinity as CaCO3	----	1	mg/L	10	5	258	213	240
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	1	371	1600	1660
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	10	7	65	78	101
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	82	263	262
Magnesium	7439-95-4	1	mg/L	1	<1	85	250	266
Sodium	7440-23-5	1	mg/L	7	5	67	83	94
Potassium	7440-09-7	1	mg/L	1	<1	3	8	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.04	0.16	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GEN	GRO	DOG	TOR	AIR
				Sampling date / time	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00	07-Nov-2024 10:30	07-Nov-2024 13:00
Compound	CAS Number	LOR	Unit		ES2436563-001	ES2436563-002	ES2436563-003	ES2436563-004	ES2436563-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.007**	**0.007**	**0.256**	**0.064**	**0.491**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	**0.003**	**0.006**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	**0.11**	**0.05**	**0.06**	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.06**	**0.18**	**0.24**	<0.01	**0.08**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.006**	**0.008**	**0.351**	**0.099**	**0.482**
Nickel	7440-02-0	0.001	mg/L		**0.001**	<0.001	**0.001**	**0.004**	**0.007**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	**0.15**	**1.25**	**0.40**	**0.12**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Arsenic	7440-38-2	0.2	µg/L		<0.2	<0.2	**1.5**	**0.4**	**0.5**
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	7440-47-3	0.2	µg/L		<0.2	**0.6**	<0.2	<0.2	<0.2
Selenium	7782-49-2	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	1	µg/L		**6**	**3**	**1**	**47**	**7**
EG094T: Total metals in Fresh water by ORC-ICPMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GEN	GRO	DOG	TOR	AIR
				Sampling date / time	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00	07-Nov-2024 10:30	07-Nov-2024 13:00
Compound	CAS Number	LOR	Unit		ES2436563-001	ES2436563-002	ES2436563-003	ES2436563-004	ES2436563-005
					Result	Result	Result	Result	Result
EG094T: Total metals in Fresh water by ORC-ICPMS - Continued									
Arsenic	7440-38-2	0.2	µg/L		<0.2	<0.2	**2.0**	**0.5**	**0.6**
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	7440-47-3	0.2	µg/L		<0.2	**0.7**	**0.2**	<0.2	**0.2**
Selenium	7782-49-2	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	**0.2**
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	1	µg/L		**7**	**4**	**4**	**57**	**5**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	**0.2**	**0.4**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	<0.01	**0.01**	**0.01**	**0.02**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.06**	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.06**	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	**0.2**	**0.8**	**0.6**	**0.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	**0.2**	**0.8**	**0.6**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	**0.01**	**0.08**	**0.03**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.01**	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.52**	**0.32**	**14.7**	**39.8**	**42.2**
ø Total Cations	----	0.01	meq/L		**0.41**	**0.22**	**14.1**	**37.5**	**39.2**
ø Ionic Balance	----	0.01	%		**----**	**----**	**2.20**	**2.92**	**3.68**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GEN	GRO	DOG	TOR	AIR
				Sampling date / time	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00	07-Nov-2024 10:30	07-Nov-2024 13:00
Compound	CAS Number	LOR	Unit		ES2436563-001	ES2436563-002	ES2436563-003	ES2436563-004	ES2436563-005
					Result	Result	Result	Result	Result
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**2**	**24**	**6**	**11**	**9**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIRUS	AIRD	----	----	----
				Sampling date / time	08-Nov-2024 11:50	08-Nov-2024 08:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2436563-006	ES2436563-007	--------	--------	--------
					Result	Result	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.71**	**7.84**	----	----	----
EA006: Sodium Adsorption Ratio (SAR)									
^ Sodium Adsorption Ratio	----	0.01	-		**0.92**	**1.17**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**3000**	**1160**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		**1950**	**754**	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**20**	**32**	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		**1760**	**528**	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**280**	**247**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**280**	**247**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**1580**	**350**	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**76**	**65**	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**263**	**78**	----	----	----
Magnesium	7439-95-4	1	mg/L		**267**	**81**	----	----	----
Sodium	7440-23-5	1	mg/L		**89**	**62**	----	----	----
Potassium	7440-09-7	1	mg/L		**3**	**3**	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.003**	<0.001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIRUS	AIRD	----	----	----
				Sampling date / time	08-Nov-2024 11:50	08-Nov-2024 08:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2436563-006	ES2436563-007	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**6.63**	**0.245**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.010**	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.08**	<0.05	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.05**	**0.04**	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.004**	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**7.77**	**0.294**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.012**	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.62**	**0.33**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	----	----	----
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Arsenic	7440-38-2	0.2	µg/L		**1.2**	**1.6**	----	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	----	----	----
Selenium	7782-49-2	0.2	µg/L		**0.2**	<0.2	----	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	----	----	----
Zinc	7440-66-6	1	µg/L		**8**	<1	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIRUS	AIRD	----	----	----
				Sampling date / time	08-Nov-2024 11:50	08-Nov-2024 08:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2436563-006	ES2436563-007	--------	--------	--------
					Result	Result	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS - Continued									
Arsenic	7440-38-2	0.2	µg/L		**1.5**	**2.2**	----	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	----	----	----
Selenium	7782-49-2	0.2	µg/L		**0.2**	<0.2	----	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	----	----	----
Zinc	7440-66-6	1	µg/L		**13**	**4**	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.2**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.02**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.2**	**1.2**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.2**	**1.2**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	**0.13**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	<0.01	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**40.6**	**14.0**	----	----	----
ø Total Cations	----	0.01	meq/L		**39.0**	**13.3**	----	----	----
ø Ionic Balance	----	0.01	%		**1.99**	**2.64**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	AIRUS	AIRD	----	----	----
				Sampling date / time	08-Nov-2024 11:50	08-Nov-2024 08:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2436563-006	ES2436563-007	--------	--------	--------
					Result	Result	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**15**	**6**	**----**	**----**	**----**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	**----**	**----**	**----**

Appendix B

Laboratory certificates of analysis (sediment quality)

CERTIFICATE OF ANALYSIS

Work Order	: **ES2416966**	Page	: 1 of 9
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS Tegan Hopwood	Contact	: Samiksha Sathish
Address	: Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4910 7760	Telephone	: +61-2-8784 8555
Project	: 12633750	Date Samples Received	: 24-May-2024 11:00
Order number	: Airly sediment autumn 2024	Date Analysis Commenced	: 25-May-2024
C-O-C number	: ----	Issue Date	: 10-Jun-2024 20:17
Sampler	: Tegan Hopwood		
Site	:		
Quote number	: EN/000		
No. of samples received	: 16		
No. of samples analysed	: 16		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Vincent Muller	Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- EK057G: LOR raised for Nitrite due to sample matrix.
- EK059G: LOR raised for NOx due to sample matrix.
- EG005T (Total Metals by ICP-AES): Sample EB2418942-032 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- It is recognised that EG005T (Total Metals by ICP-AES) is less than EG005-SDH (1M HCl Extractable Metals by ICP-AES) for some samples. However, the difference is within experimental variation of the methods.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	GAP	GEN	GRO	DOG	TOR
				Sampling date / time	21-May-2024 10:45	22-May-2024 08:40	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30
Compound	CAS Number	LOR	Unit		ES2416966-001	ES2416966-002	ES2416966-003	ES2416966-004	ES2416966-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		**16.5**	**20.9**	**17.5**	**31.5**	**21.4**
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		**0.2**	**0.3**	**0.2**	**0.1**	**0.2**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.2**	**0.3**	**0.2**	**0.1**	**0.2**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**120**	**320**	**200**	**1370**	**280**
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		**120**	**320**	**200**	**1370**	**280**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**33**	**57**	**34**	**241**	**170**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.28**	**0.27**	**0.69**	**2.11**	**0.33**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	AIR	AIRUS	AIRD	GAP Sieving (fine to -2mm)	GEN Sieving (fine to -2mm)
				Sampling date / time	23-May-2024 12:45	23-May-2024 14:30	22-May-2024 14:00	21-May-2024 10:45	22-May-2024 08:40
Compound	CAS Number	LOR	Unit		ES2416966-006	ES2416966-007	ES2416966-008	ES2416966-009	ES2416966-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		**33.9**	**82.6**	**20.3**	**----**	**----**
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES									
Aluminium	7429-90-5	50	mg/kg		**----**	**----**	**----**	**70**	**320**
Antimony	7440-36-0	1.0	mg/kg		**----**	**----**	**----**	<1.0	<1.0
Arsenic	7440-38-2	1.0	mg/kg		**----**	**----**	**----**	<1.0	<1.0
Cadmium	7440-43-9	0.1	mg/kg		**----**	**----**	**----**	<0.1	<0.1
Cobalt	7440-48-4	0.5	mg/kg		**----**	**----**	**----**	<0.5	**1.8**
Chromium	7440-47-3	1.0	mg/kg		**----**	**----**	**----**	<1.0	<1.0
Copper	7440-50-8	1.0	mg/kg		**----**	**----**	**----**	<1.0	<1.0
Lead	7439-92-1	1.0	mg/kg		**----**	**----**	**----**	**1.5**	<1.0
Manganese	7439-96-5	10	mg/kg		**----**	**----**	**----**	**30**	**38**
Nickel	7440-02-0	1.0	mg/kg		**----**	**----**	**----**	<1.0	<1.0
Silver	7440-22-4	1.0	mg/kg		**----**	**----**	**----**	<1.0	<1.0
Zinc	7440-66-6	1.0	mg/kg		**----**	**----**	**----**	**1.8**	**1.7**
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**----**	**----**	**----**	**430**	**670**
Antimony	7440-36-0	5	mg/kg		**----**	**----**	**----**	<5	<5
Cobalt	7440-48-4	2	mg/kg		**----**	**----**	**----**	<2	**2**
Manganese	7439-96-5	5	mg/kg		**----**	**----**	**----**	**84**	**50**
Silver	7440-22-4	2	mg/kg		**----**	**----**	**----**	<2	<2
Arsenic	7440-38-2	5	mg/kg		**----**	**----**	**----**	<5	<5
Cadmium	7440-43-9	1	mg/kg		**----**	**----**	**----**	<1	<1
Chromium	7440-47-3	2	mg/kg		**----**	**----**	**----**	<2	<2
Copper	7440-50-8	5	mg/kg		**----**	**----**	**----**	<5	<5
Lead	7439-92-1	5	mg/kg		**----**	**----**	**----**	**8**	<5
Nickel	7440-02-0	2	mg/kg		**----**	**----**	**----**	<2	<2
Zinc	7440-66-6	5	mg/kg		**----**	**----**	**----**	**6**	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	AIR	AIRUS	AIRD	GAP Sieving (fine to -2mm)	GEN Sieving (fine to -2mm)
				Sampling date / time	23-May-2024 12:45	23-May-2024 14:30	22-May-2024 14:00	21-May-2024 10:45	22-May-2024 08:40
Compound	CAS Number	LOR	Unit		ES2416966-006	ES2416966-007	ES2416966-008	ES2416966-009	ES2416966-010
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
EG035-SDH: 1M HCl extractable Mercury by FIMS									
Mercury	7439-97-6	0.10	mg/kg		----	----	----	<0.10	<0.10
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		----	----	----	<0.1	<0.1
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	<20	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	<0.2	<2.5	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		**0.7**	**0.6**	<5.0	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.7**	**0.6**	<5.0	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**720**	**11600**	**260**	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**720**	**11600**	**260**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**308**	**1090**	**53**	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.90**	**25.2**	**0.55**	----	----
GEO26: Sieving									
-2000µm	----	0.01	%		----	----	----	**88.8**	**96.6**

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	GRO Sieving (fine to -2mm)	DOG Sieving (fine to -2mm)	TOR Sieving (fine to -2mm)	AIR Sieving (fine to -2mm)	AIRUS Sieving (fine to -2mm)
				Sampling date / time	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30	23-May-2024 12:45	23-May-2024 14:30
					ES2416966-011	ES2416966-012	ES2416966-013	ES2416966-014	ES2416966-015
					Result	Result	Result	Result	Result
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES									
Aluminium	7429-90-5	50	mg/kg		**270**	**290**	**400**	**870**	**1220**
Antimony	7440-36-0	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	7440-38-2	1.0	mg/kg		<1.0	**1.2**	<1.0	<1.0	**2.3**
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	**0.2**
Cobalt	7440-48-4	0.5	mg/kg		<0.5	**2.0**	<0.5	**4.2**	**5.0**
Chromium	7440-47-3	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	<1.0
Copper	7440-50-8	1.0	mg/kg		<1.0	**3.1**	**2.6**	**8.5**	**10.6**
Lead	7439-92-1	1.0	mg/kg		<1.0	**7.0**	**3.6**	**9.3**	**6.9**
Manganese	7439-96-5	10	mg/kg		<10	**65**	**60**	**323**	**111**
Nickel	7440-02-0	1.0	mg/kg		<1.0	**2.6**	**1.6**	**6.9**	**29.2**
Silver	7440-22-4	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	7440-66-6	1.0	mg/kg		<1.0	**8.7**	**2.6**	**10.1**	**68.2**
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**490**	**1450**	**2570**	**5070**	**4160**
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
Cobalt	7440-48-4	2	mg/kg		<2	**4**	<2	**9**	**7**
Manganese	7439-96-5	5	mg/kg		<5	**88**	**104**	**645**	**118**
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg		<5	<5	**6**	**8**	<5
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	**6**	**8**	**12**	**11**
Copper	7440-50-8	5	mg/kg		<5	<5	**6**	**15**	**14**
Lead	7439-92-1	5	mg/kg		<5	**9**	**8**	**16**	**9**
Nickel	7440-02-0	2	mg/kg		<2	**7**	**15**	**21**	**37**
Zinc	7440-66-6	5	mg/kg		<5	**20**	**45**	**48**	**84**
EG035-SDH: 1M HCl extractable Mercury by FIMS									
Mercury	7439-97-6	0.10	mg/kg		<0.10	<0.10	<0.10	<0.10	<0.10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	GRO Sieving (fine to -2mm)	DOG Sieving (fine to -2mm)	TOR Sieving (fine to -2mm)	AIR Sieving (fine to -2mm)	AIRUS Sieving (fine to -2mm)
			Sampling date / time	22-May-2024 13:30	23-May-2024 08:00	23-May-2024 10:30	23-May-2024 12:45	23-May-2024 14:30
Compound	CAS Number	LOR	Unit	ES2416966-011	ES2416966-012	ES2416966-013	ES2416966-014	ES2416966-015
				Result	Result	Result	Result	Result
EG035-SDH: 1M HCl extractable Mercury by FIMS - Continued								
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	**80.5**	**97.6**	**83.0**	**83.4**	**76.0**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	AIRD Sieving (fine to -2mm)	----	----	----	----
				Sampling date / time	22-May-2024 14:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES2416966-016	--------	--------	--------	--------
					Result	----	----	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES									
Aluminium	7429-90-5	50	mg/kg		**260**	----	----	----	----
Antimony	7440-36-0	1.0	mg/kg		<1.0	----	----	----	----
Arsenic	7440-38-2	1.0	mg/kg		<1.0	----	----	----	----
Cadmium	7440-43-9	0.1	mg/kg		<0.1	----	----	----	----
Cobalt	7440-48-4	0.5	mg/kg		<0.5	----	----	----	----
Chromium	7440-47-3	1.0	mg/kg		<1.0	----	----	----	----
Copper	7440-50-8	1.0	mg/kg		<1.0	----	----	----	----
Lead	7439-92-1	1.0	mg/kg		<1.0	----	----	----	----
Manganese	7439-96-5	10	mg/kg		<10	----	----	----	----
Nickel	7440-02-0	1.0	mg/kg		<1.0	----	----	----	----
Silver	7440-22-4	1.0	mg/kg		<1.0	----	----	----	----
Zinc	7440-66-6	1.0	mg/kg		<1.0	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**350**	----	----	----	----
Antimony	7440-36-0	5	mg/kg		<5	----	----	----	----
Cobalt	7440-48-4	2	mg/kg		<2	----	----	----	----
Manganese	7439-96-5	5	mg/kg		<5	----	----	----	----
Silver	7440-22-4	2	mg/kg		<2	----	----	----	----
Arsenic	7440-38-2	5	mg/kg		<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg		<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg		<2	----	----	----	----
Copper	7440-50-8	5	mg/kg		<5	----	----	----	----
Lead	7439-92-1	5	mg/kg		<5	----	----	----	----
Nickel	7440-02-0	2	mg/kg		<2	----	----	----	----
Zinc	7440-66-6	5	mg/kg		<5	----	----	----	----
EG035-SDH: 1M HCl extractable Mercury by FIMS									
Mercury	7439-97-6	0.10	mg/kg		<0.10	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	AIRD Sieving (fine to -2mm)	----	----	----	----
				Sampling date / time	22-May-2024 14:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES2416966-016	--------	--------	--------	--------
					Result	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	**----**	**----**	**----**	**----**
GEO26: Sieving									
-2000µm	----	0.01	%		**80.2**	**----**	**----**	**----**	**----**

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

(SOIL) EG035T: Total Recoverable Mercury by FIMS

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

(SOIL) GEO26: Sieving

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

CERTIFICATE OF ANALYSIS

Work Order	: **ES2436564**	Page	: 1 of 7
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS Tegan Hopwood	Contact	: Samiksha Sathish
Address	: Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4910 7760	Telephone	: +61-2-8784 8555
Project	: 12633750	Date Samples Received	: 11-Nov-2024 08:23
Order number	: Airly sediment spring 2024	Date Analysis Commenced	: 13-Nov-2024
C-O-C number	: ----	Issue Date	: 26-Nov-2024 15:01
Sampler	: Tegan Hopwood		
Site	:		
Quote number	: EN/000		
No. of samples received	: 14		
No. of samples analysed	: 14		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- EG035SDH (1M HCl Extractable Mercury by FIMS): DOG (ES2436564-009) shows poor matrix spike recovery due to sample heterogeneity. This has been confirmed by visual inspection.
- It is recognised that EG005T (Total Metals by ICP-AES) is less than EG005-SDH (1M HCl Extractable Metals by ICP-AES) for some samples. However, the difference is within experimental variation of the methods.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	GEN	GRO	DOG	TOR	AIR
			Sampling date / time	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00	07-Nov-2024 10:30	07-Nov-2024 13:00
Compound	CAS Number	LOR	Unit	ES2436564-001	ES2436564-002	ES2436564-003	ES2436564-004	ES2436564-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**20.1**	**23.5**	**25.1**	**18.9**	**34.2**
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.3**	**0.2**	<0.1	<0.1	**0.1**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.3**	**0.2**	<0.1	<0.1	**0.1**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**60**	**250**	**440**	**270**	**1270**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**60**	**250**	**440**	**270**	**1270**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**18**	**32**	**140**	**207**	**349**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.21**	**0.59**	**1.03**	**0.40**	**1.23**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	AIRUS	AIRD	GEN Sieving (fine to -2mm)	GRO Sieving (fine to -2mm)	DOG Sieving (fine to -2mm)
				Sampling date / time	08-Nov-2024 11:50	08-Nov-2024 08:30	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00
					ES2436564-006	ES2436564-007	ES2436564-008	ES2436564-009	ES2436564-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		36.9	25.7	----	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES									
Aluminium	7429-90-5	50	mg/kg		----	----	290	220	300
Antimony	7440-36-0	1.0	mg/kg		----	----	<1.0	<1.0	<1.0
Arsenic	7440-38-2	1.0	mg/kg		----	----	<1.0	<1.0	1.6
Cadmium	7440-43-9	0.1	mg/kg		----	----	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.5	mg/kg		----	----	1.8	<0.5	2.1
Chromium	7440-47-3	1.0	mg/kg		----	----	<1.0	<1.0	1.2
Copper	7440-50-8	1.0	mg/kg		----	----	<1.0	<1.0	3.0
Lead	7439-92-1	1.0	mg/kg		----	----	<1.0	<1.0	4.5
Manganese	7439-96-5	10	mg/kg		----	----	42	<10	90
Nickel	7440-02-0	1.0	mg/kg		----	----	<1.0	<1.0	2.8
Silver	7440-22-4	1.0	mg/kg		----	----	<1.0	<1.0	<1.0
Zinc	7440-66-6	1.0	mg/kg		----	----	2.2	<1.0	4.8
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		----	----	870	500	1520
Antimony	7440-36-0	5	mg/kg		----	----	<5	<5	<5
Cobalt	7440-48-4	2	mg/kg		----	----	2	<2	3
Manganese	7439-96-5	5	mg/kg		----	----	47	<5	108
Silver	7440-22-4	2	mg/kg		----	----	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg		----	----	<5	<5	5
Cadmium	7440-43-9	1	mg/kg		----	----	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		----	----	3	<2	7
Copper	7440-50-8	5	mg/kg		----	----	<5	<5	<5
Lead	7439-92-1	5	mg/kg		----	----	<5	<5	6
Nickel	7440-02-0	2	mg/kg		----	----	2	<2	7
Zinc	7440-66-6	5	mg/kg		----	----	<5	<5	16

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	AIRUS	AIRD	GEN Sieving (fine to -2mm)	GRO Sieving (fine to -2mm)	DOG Sieving (fine to -2mm)
				Sampling date / time	08-Nov-2024 11:50	08-Nov-2024 08:30	05-Nov-2024 13:00	05-Nov-2024 15:00	08-Nov-2024 08:00
Compound	CAS Number	LOR	Unit		ES2436564-006	ES2436564-007	ES2436564-008	ES2436564-009	ES2436564-010
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
EG035-SDH: 1M HCl extractable Mercury by FIMS									
Mercury	7439-97-6	0.10	mg/kg		----	----	<0.10	<0.10	<0.10
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		----	----	<0.1	<0.1	<0.1
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	<0.1	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		**0.3**	<0.1	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.3**	<0.1	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**1940**	**540**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**1940**	**540**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**352**	**271**	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**2.32**	**1.22**	----	----	----
GEO26: Sieving									
-2000µm	----	0.01	%		----	----	**95.5**	**91.3**	**98.8**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	TOR Sieving (fine to -2mm)	AIR Sieving (fine to -2mm)	AIRUS Sieving (fine to -2mm)	AIRD Sieving (fine to -2mm)	----
			Sampling date / time	07-Nov-2024 10:30	07-Nov-2024 13:00	08-Nov-2024 11:50	08-Nov-2024 08:30	----
Compound	CAS Number	LOR	Unit	ES2436564-011	ES2436564-012	ES2436564-013	ES2436564-014	--------
				Result	Result	Result	Result	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	**560**	**1190**	**840**	**300**	----
Antimony	7440-36-0	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	----
Arsenic	7440-38-2	1.0	mg/kg	<1.0	**1.5**	**1.8**	**1.6**	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Cobalt	7440-48-4	0.5	mg/kg	**2.6**	**5.0**	**1.6**	**2.1**	----
Chromium	7440-47-3	1.0	mg/kg	**1.2**	**1.7**	**1.6**	**1.0**	----
Copper	7440-50-8	1.0	mg/kg	**3.6**	**9.9**	**5.6**	**2.6**	----
Lead	7439-92-1	1.0	mg/kg	**4.7**	**10.4**	**6.1**	**4.8**	----
Manganese	7439-96-5	10	mg/kg	**268**	**424**	**166**	**91**	----
Nickel	7440-02-0	1.0	mg/kg	**4.2**	**9.1**	**6.1**	**2.4**	----
Silver	7440-22-4	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	----
Zinc	7440-66-6	1.0	mg/kg	**4.4**	**21.4**	**13.0**	**3.8**	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**3500**	**6180**	**3760**	**1490**	----
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	----
Cobalt	7440-48-4	2	mg/kg	**5**	**9**	**2**	**3**	----
Manganese	7439-96-5	5	mg/kg	**391**	**526**	**174**	**122**	----
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	----
Arsenic	7440-38-2	5	mg/kg	**10**	**10**	<5	<5	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	**10**	**14**	**12**	**6**	----
Copper	7440-50-8	5	mg/kg	**10**	**15**	**7**	<5	----
Lead	7439-92-1	5	mg/kg	**10**	**15**	**8**	**6**	----
Nickel	7440-02-0	2	mg/kg	**23**	**22**	**10**	**6**	----
Zinc	7440-66-6	5	mg/kg	**67**	**62**	**23**	**15**	----
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	TOR Sieving (fine to -2mm)	AIR Sieving (fine to -2mm)	AIRUS Sieving (fine to -2mm)	AIRD Sieving (fine to -2mm)	----
			Sampling date / time	07-Nov-2024 10:30	07-Nov-2024 13:00	08-Nov-2024 11:50	08-Nov-2024 08:30	----
Compound	CAS Number	LOR	Unit	ES2436564-011	ES2436564-012	ES2436564-013	ES2436564-014	--------
				Result	Result	Result	Result	----
EG035-SDH: 1M HCl extractable Mercury by FIMS - Continued								
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**----**
GEO26: Sieving								
-2000µm	----	0.01	%	**87.8**	**51.3**	**90.4**	**98.4**	**----**

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry / Biology).

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) GEO26: Sieving

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

(SOIL) EG035T: Total Recoverable Mercury by FIMS

Appendix C

Raw macroinvertebrate data

Autumn 2024

Class/Order	Lowest taxon	Baseline						Headwaters undermined				Background		Impact	
		DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Acarina	Acarina sp.	4	6	1		4				3	2	1	1		
Coleoptera	Dytiscidae	6	4	3	3	2	1	3		5	4	6	1	3	1
Coleoptera	Hydraenidae					1			1						
Coleoptera	Hydrophilidae											2			1
Coleoptera	Scirtidae			5		4	4	4	2		1	1		1	1
Crustacea	Branchiura sp.						1								
Crustacea	Cladocera sp.	2						1						1	
Crustacea	Copepoda sp.	1	1					1				5	1	3	6
Crustacea	Ostracoda sp.			2	4			8	3	4	9	4	1	6	4
Decapoda	Atyidae													1	2
Diptera	Athericidae				1		1								
Diptera	Ceratopogonidae		2					2	1	3	2		4	1	4
Diptera	Chironominae		2	8	7	5	6	4	5	1	2	11	10		
Diptera	Dixidae													1	
Diptera	Orthocladiinae		1	2	2	7	4	3	3	2	3	2	5	3	3
Diptera	Podonominae														1
Diptera	Simuliidae													1	
Diptera	Stratiomyidae								1		1	2		1	5
Diptera	Tanypodinae	6	3	3	6	1	2	5	1	1	1	1			
Diptera	Tipulidae				1	1	2	3		1					
Ephemeroptera	Baetidae	5	5							2	2	4	7	3	2
Ephemeroptera	Caenidae												2		

Class/Order	Lowest taxon	Baseline						Headwaters undermined				Background		Impact	
		DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Ephemeroptera	Leptophlebiidae			3	4			5	4						
Gastropoda	Ancylidae		1												
Gastropoda	Gastropoda sp.	1													1
Gastropoda	Hydrobiidae						1								
Gastropoda	Lymnaeidae											1		1	
Gastropoda	Physidae									4	3	4	3	3	4
Gastropoda	Planorbidae									2	1			1	1
Hemiptera	Corixidae	1								2					
Hemiptera	Gelastocoridae														1
Hemiptera	Hebridae						1								
Hemiptera	Mesoveliidae	3													
Hemiptera	Micronectidae	3	4								1	1			
Hemiptera	Notonectidae	3	4		1			1		1	1		1		
Hemiptera	Veliidae	1		1		2				2	4				2
Hydrazoa	Hydridae	1	1							1					
Megaloptera	Corydalidae			4			2	2	2						
Odonata	Aeshnidae									4	7	3	1		
Odonata	Corduliidae										3				
Odonata	Epiprocta sp.	1		5	3	2		2			2				
Odonata	Libellulidae	3	4							2					
Odonata	Synthemistidae			2	2										
Odonata	Telephlebiidae			1	5	2	1	3	1						
Odonata	Argiolestidae							1	1	1					
Odonata	Coenagrionidae	4	6					1		2	5	4	1		1

Class/Order	Lowest taxon	Baseline						Headwaters undermined				Background		Impact	
		DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Odonata	Zygoptera sp.							1							
Oligochaeta	Oligochaeta sp.	7	1		1	1		1							
Trichoptera	Ecnomidae					2				2	1				
Trichoptera	Helicopsychidae			5	2		1	2	1						
Trichoptera	Hydroptilidae		2	2	2			1		4	5			1	
Trichoptera	Leptoceridae	3	5	5	5	5	3	4	5	3	4	1	1		
Trichoptera	Philorheithridae			1											
Trichoptera	Polycentropodidae								1						

Spring 2024

Class/Order	Lowest taxon	Baseline						Headwaters undermined		Background		Impact	
		DOG	DOG	GEN	GEN	GRO	GRO	TOR	TOR	AIRUS	AIRUS	AIR	AIR
		1	2	1	2	1	2	1	2	1	2	1	2
Acarina	Acarina sp.	8	1	1	1	2		3					2
Coleoptera	Dytiscidae	8	7		1	4		5	10	1	4	8	6
Coleoptera	Gyrinidae												1
Coleoptera	Hydrochidae											1	
Coleoptera	Hydrophilidae	4	3				2		3	4	6		
Coleoptera	Scirtidae			2	1	4	1					1	
Crustacea	Cladocera sp.	1	2										
Crustacea	Copepoda sp.	3	1		1	1	5		1	1	1	1	3
Crustacea	Ostracoda sp.	4	1	3	12	1		2	7	9	8	5	6
Decapoda	Atyidae											1	1
Decapoda	Parastacidae												1

Class/Order	Lowest taxon	Baseline						Headwaters undermined		Background		Impact	
		DOG	DOG	GEN	GEN	GRO	GRO	TOR	TOR	AIRUS	AIRUS	AIR	AIR
		1	2	1	2	1	2	1	2	1	2	1	2
Diptera	Athericidae			1									
Diptera	Ceratopogonidae	4		1		1			2	1	1	1	2
Diptera	Chironominae	1	1	6	6	5	8	2	6	2	6	8	1
Diptera	Culicidae					1		2	2				5
Diptera	Dixidae				2	1						1	
Diptera	Orthocladiinae			9	10	3	2		3		1	1	
Diptera	Psychodidae				1								
Diptera	Sciomyzidae										1		
Diptera	Stratiomyidae	1										2	1
Diptera	Tanypodinae	4	1	6	1	1	3				1		4
Diptera	Thaumaleidae			1									
Diptera	Tipulidae					2							
Ephemeroptera	Baetidae	3	1		1			1		3	2		
Ephemeroptera	Caenidae	1	2										
Ephemeroptera	Leptophlebiidae	3	1	3	4								
Gastropoda	Gastropoda sp.								1	5	7		1
Gastropoda	Physidae							1	4		1	4	
Gastropoda	Planorbidae	2	1							1	2		
Hemiptera	Corixidae							3					
Hemiptera	Hemiptera sp.								1	1	1		
Hemiptera	Mesoveliidae	2	1										
Hemiptera	Micronectidae	1											
Hemiptera	Notonectidae	2						1	2	1			
Hemiptera	Pleidae							1	1				

Class/Order	Lowest taxon	Baseline						Headwaters undermined		Background		Impact	
		DOG	DOG	GEN	GEN	GRO	GRO	TOR	TOR	AIRUS	AIRUS	AIR	AIR
		1	2	1	2	1	2	1	2	1	2	1	2
Hemiptera	Veliidae	3	2	1	1	2	1	2	1	1	1	3	
Hydrazoa	Hydridae		1						1				
Mecoptera	Nannochoristidae					1							
Megaloptera	Corydalidae	1		1		1	1						
Odonata	Aeshnidae		2					1		3	3	1	2
Odonata	Corduliidae								2				1
Odonata	Epiprocta sp.	3	6	3	2	3		1	2	1	3	10	2
Odonata	Libellulidae	5	2										
Odonata	Synthemistidae				1								
Odonata	Telephlebiidae			3	2	4	3						
Odonata	Argiolestidae			1									
Odonata	Coenagrionidae	3	3					5	4	3	3	2	
Odonata	Lestidae									1			
Odonata	Zygoptera sp.		1										
Oligochaeta	Oligochaeta sp.	3		2	1						2	2	
Plecoptera	Notonemouridae					1							
Trichoptera	Ecnomidae							1	2				
Trichoptera	Helicopsychidae			6	5								
Trichoptera	Hydroptilidae			5	4				7	2	1	1	1
Trichoptera	Leptoceridae			6	8	6	2	1		3	1		
Trichoptera	Polycentropodidae			1									
Trichoptera	Trichoptera sp.			1	1								
Turbellaria	Dugesiidae	1				1	1		1				

Appendix D

Water quality QA

Analyte	Units	Autumn 2024		Spring 2024	
		GRO	Duplicate	DOG	Duplicate
Date		22/05/24	22/05/24	08/11/24	08/11/24
Physicochemical parameters					
pH	pH unit	5.86	6.3	7.74	7.84
EC	µS/cm	34	35	1170	1160
TDS	mg/L	22	23	760	754
TSS	mg/L	<5	<5	20	32
Total hardness as CaCO3 mg/L	mg/L	<1	<1	555	528
Major ions					
Bicarbonate alkalinity	mg/L	4	4	258	247
Carbonate alkalinity	mg/L	<1	<1	<1	<1
Hydroxide alkalinity	mg/L	<1	<1	<1	<1
Total alkalinity	mg/L	4	4	258	247
Sulfate	mg/L	<1	<1	371	350
Chloride	mg/L	7	7	65	65
Calcium	mg/L	<1	<1	82	78
Magnesium	mg/L	<1	<1	85	81
Potassium	mg/L	<1	<1	3	3
Sodium	mg/L	5	5	67	62
Dissolved metals					
Aluminium	mg/L	0.27	0.27	<0.01	<0.01
Arsenic	mg/L	<0.0002	<0.0002	0.0015	0.0016
Boron	mg/L	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	<0.00005	<0.00005	<0.00005	<0.00005
Chromium	mg/L	0.0009	0.0008	<0.0002	<0.0002
Cobalt	mg/L	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	<0.001	<0.001	<0.001
Iron	mg/L	0.23	0.23	0.05	<0.05
Lead	mg/L	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.003	0.004	0.256	0.245
Mercury	mg/L	<0.00004	<0.00004	<0.00004	<0.00004
Nickel	mg/L	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Silver	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Zinc	mg/L	0.002	0.002	0.001	<0.001
Nutrients					
Ammonia	mg/L	0.02	<0.01	0.01	0.02
Nitrite	mg/L	<0.01	<0.01	<0.01	<0.01
Nitrate	mg/L	<0.01	<0.01	<0.01	<0.01
NOx	mg/L	<0.01	<0.01	<0.01	<0.01
TKN	mg/L	0.1	0.1	0.8	1.2

Analyte	Units	Autumn 2024		Spring 2024	
		GRO	Duplicate	DOG	Duplicate
TN	mg/L	0.1	0.1	0.8	1.2
TP	mg/L	<0.01	<0.01	0.08	0.13
RP	mg/L	<0.01	<0.01	<0.01	<0.01
Other parameters					
DOC	mg/L	6	6	6	6
Oil & Grease	mg/L	<5	<5	<5	<5
Fluoride	mg/L	<0.1	<0.1	0.2	0.2

Appendix E

Sediment quality QA

Analyte	Units	Autumn 2024		Spring 2024	
		GRO	Duplicate	DOG	Duplicate
Date		22/05/24	22/05/24	08/11/24	08/11/24
1M HCl-extractable metals					
Aluminium	mg/kg	270	260	300	300
Antimony	mg/kg	<1.0	<1.0	<1.0	<1.0
Arsenic	mg/kg	<1.0	<1.0	1.6	1.6
Cadmium	mg/kg	<0.1	<0.1	<0.1	<0.1
Chromium	mg/kg	<1.0	<1.0	1.2	1
Cobalt	mg/kg	<0.5	<0.5	2.1	2.1
Copper	mg/kg	<1.0	<1.0	3	2.6
Lead	mg/kg	<1.0	<1.0	4.5	4.8
Manganese	mg/kg	<10	<10	90	91
Mercury	mg/kg	<0.10	<0.10	<0.10	<0.10
Nickel	mg/kg	<1.0	<1.0	2.8	2.4
Silver	mg/kg	<1.0	<1.0	<1.0	<1.0
Zinc	mg/kg	<1.0	<1.0	4.8	3.8
Nutrients					
Ammonia	mg/kg	<20	<20	<20	<20
Nitrite	mg/kg	<0.1	<2.5	<0.1	<0.1
Nitrate	mg/kg	0.2	<5.0	<0.1	<0.1
NOx	mg/kg	0.2	<5.0	<0.1	<0.1
TKN	mg/kg	200	260	440	540
TN	mg/kg	200	260	440	540
TP	mg/kg	34	53	140	271
Other parameters					
TOC	%	0.69	0.55	1.03	1.22
-2000 µm	%	80.5	80.2	98.8	98.4
Moisture content	%	17.5	20.3	25.1	25.7

Appendix F

Macroinvertebrate taxonomy QA

Macroinvertebrate Identification QA/QC Data Sheet

Identifier: WP Processing Date: 30-7-24

Project #: 12633750 LIMS/Sample #: 119614 Sample Code: 124GRoP

Site Name: Site Code: GRO

Collection Date: 22.5.24 Method/Habitat: Edge Collected By:

Taxonomic Id Level: Family Pass/Fail Rate: 95% QA/QC By: ZB

Incorrect Identification	Correct Identification	Error Code

Number of Taxa (species/families): 13

Number Identified Incorrectly: 0

Percentage Correct: 100%

Pass or Fail: Pass

Training Received For Incorrect Taxa? (Yes/No) QA Date: 30-7-24

Senior Taxonomist Identifier

Note: 90% pass rate for species level and 95% for family level

Error Codes:

1. ID adult/larvae not identified
2. Complete misidentification
3. Could *reasonably* be identified to a finer taxonomic resolution*
4. Identification has been taken too far based on specimen condition (small or damaged)
5. Miscount*
6. Taxon not recorded on the data sheet
7. Inappropriate Identification based on larval exuviae, shells or if the specimen was obviously dead when collected

* These are NOT included in error rate calculations

Macroinvertebrate Identification QA/QC Data Sheet

Identifier: TL **Processing Date:** 16-12-24

Project #: 126337S0 **LIMS/Sample #:** _____ **Sample Code:** 126TORP

Site Name: _____ **Site Code:** TOR

Collection Date: 7.11.24 **Method/Habitat:** Edge **Collected By:** TH+AC

Taxonomic Id Level: Family **Pass/Fail Rate:** 95% **QA/QC By:** ZB

Incorrect Identification	Correct Identification	Error Code

Number of Taxa (species/families): 15
Number Identified Incorrectly: 0
Percentage Correct: 100
Pass or Fail: Pass

Training Received For Incorrect Taxa? (Yes/No) **QA Date:** 3.1.25

Senior Taxonomist Identifier _____

Note: 90% pass rate for species level and 95% for family level

Error Codes:

1. **ID adult/larvae not identified**
2. **Complete misidentification**
3. **Could *reasonably* be identified to a finer taxonomic resolution***
4. **Identification has been taken too far based on specimen condition (small or damaged)**
5. **Miscount***
6. **Taxon not recorded on the data sheet**
7. **Inappropriate Identification based on larval exuviae, shells or if the specimen was obviously dead when collected**

* These are NOT included in error rate calculations

Appendix G

RCE Scores, 2023-2024

RCE scores – 2024 and 2023, GAP, GEN, GRO

Site		GAP			GEN				GRO			
Category	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**
1. Land use pattern beyond immediate riparian zone	DRY	4	3	4	4	4	4	4	4	4	4	4
2. Width of riparian strip of woody vegetation		4	3	3	4	4	4	4	4	3	4	3
3. Completeness of riparian strip of woody vegetation		3	3	2	3	3	4	3	4	3	3	1
4. Vegetation of riparian zone within 10 m of channel		4	4	4	4	4	4	4	4	4	4	4
5. Stream bank structure		4	4	4	4	3	4	4	3	4	3	2
6. Bank undercutting		4	4	2	4	3	3	4	3	3	3	2
7. Channel form		4	4	3	3	4	3	3	3	3	3	3
8. Riffle/pool sequence		4	3	4	3	4	3	4	2	3	2	4
9. Retention devices in stream		4	4	4	4	3	3	3	4	3	4	4
10. Channel sediment accumulations		2	3	3	2	2	4	3	3	2	2	2
11. Stream bottom		3	4	3	3	2	4	3	3	2	3	3
12. Stream detritus		3	4	3	4	4	4	4	3	3	3	4
13. Aquatic vegetation		4	3	4	3	4	3	4	4	4	4	4
RCE score	**NA**	**47**	**46**	**43**	**45**	**44**	**47**	**47**	**44**	**41**	**42**	**40**
RCE percentage (%)	**NA**	**90%**	**88%**	**83%**	**87%**	**85%**	**90%**	**90%**	**85%**	**79%**	**81%**	**77%**

RCE scores – 2024 and 2023, TOR, DOG

Site	TOR				DOG			
Category	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**
1. Land use pattern beyond immediate riparian zone	3	3	2	3	3	3	3	2
2. Width of riparian strip of woody vegetation	4	4	3	3	2	2	2	2
3. Completeness of riparian strip of woody vegetation	3	3	3	3	2	2	2	1
4. Vegetation of riparian zone within 10 m of channel	3	3	3	3	3	3	3	3
5. Stream bank structure	2	2	2	2	2	1	2	2
6. Bank undercutting	2	2	2	2	2	2	3	3
7. Channel form	3	3	3	3	3	3	3	3
8. Riffle/pool sequence	2	3	3	3	2	3	2	2
9. Retention devices in stream	2	1	2	2	1	2	2	1
10. Channel sediment accumulations	2	2	3	2	0	0	0	2
11. Stream bottom	2	2	3	3	0	0	2	2
12. Stream detritus	2	3	3	3	0	2	2	3
13. Aquatic vegetation	0	1	3	4	0	1	2	2
RCE score	**30**	**32**	**35**	**36**	**20**	**24**	**28**	**28**
RCE percentage (%)	**58%**	**62%**	**67%**	**69%**	**38%**	**46%**	**54%**	**54%**

RCE scores – 2024 and 2023, AIRUS, AIR

Site	AIRUS				AIR			
Category	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**	**Spr-24**	**Aut-24**	**Spr-23**	**Aut-23**
1. Land use pattern beyond immediate riparian zone	2	2	2	2	3	3	3	3
2. Width of riparian strip of woody vegetation	2	2	1	2	4	4	3	4
3. Completeness of riparian strip of woody vegetation	2	1	1	0	3	3	2	3
4. Vegetation of riparian zone within 10 m of channel	2	2	2	2	3	4	3	3
5. Stream bank structure	2	3	3	3	2	2	2	3
6. Bank undercutting	3	3	3	2	2	2	2	3
7. Channel form	4	4	4	4	4	3	3	4
8. Riffle/pool sequence	2	2	2	2	3	4	3	3
9. Retention devices in stream	1	3	1	3	2	3	2	2
10. Channel sediment accumulations	0	0	0	2	4	3	4	4
11. Stream bottom	0	1	2	2	3	3	3	3
12. Stream detritus	2	2	2	2	3	3	3	4
13. Aquatic vegetation	0	2	1	1	4	3	3	4
RCE score	**22**	**27**	**24**	**27**	**40**	**40**	**36**	**43**
RCE percentage (%)	**42%**	**52%**	**46%**	**52%**	**77%**	**77%**	**69%**	**83%**

Appendix H

ANOSIM Output

ANOSIM
Analysis of Similarities

One-Way - A

Resemblance worksheet
Name: Resem4
Data type: Similarity
Selection: All

Factors

Place	Name	Type	Levels
A	Site	Unordered	7

Site levels
AIR
AIRUS
DOG
GAP
GEN
GRO
TOR

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.595
Significance level of sample statistic: 0.01%
Number of permutations: 9999 (Random sample from a large number)
Number of permuted statistics greater than or equal to R: 0

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
AIR, AIRUS	-0.001	46.4	Very large	9999	4636
AIR, DOG	0.353	0.01	Very large	9999	0
AIR, GAP	0.628	0.01	Very large	9999	0
AIR, GEN	0.871	0.01	Very large	9999	0
AIR, GRO	0.852	0.01	Very large	9999	0
AIR, TOR	0.069	4.8	Very large	9999	480
AIRUS, DOG	0.321	0.01	Very large	9999	0
AIRUS, GAP	0.737	0.01	5200300	9999	0
AIRUS, GEN	0.959	0.01	927983760	9999	0
AIRUS, GRO	0.927	0.01	67863915	9999	0
AIRUS, TOR	0.074	7.5	119759850	9999	749
DOG, GAP	0.777	0.01	Very large	9999	0
DOG, GEN	0.943	0.01	Very large	9999	0
DOG, GRO	0.94	0.01	Very large	9999	0
DOG, TOR	0.308	0.01	Very large	9999	0
GAP, GEN	0.295	0.01	927983760	9999	0
GAP, GRO	0.398	0.01	67863915	9999	0
GAP, TOR	0.65	0.01	119759850	9999	0
GEN, GRO	0.44	0.01	Very large	9999	0
GEN, TOR	0.908	0.01	Very large	9999	0
GRO, TOR	0.888	0.01	Very large	9999	0

Outputs
Plot: Graph26

ghd.com

The Power of Commitment

Appendix 9: Airly Mine Stygofauna 2024 Monitoring Report

Airly Mine Ecology Monitoring 2024

Stygofauna Monitoring Report

Centennial Airly Pty Ltd

24 February 2025

→ **The Power of Commitment**



GHD Pty Ltd | ABN 39 008 488 373
GHD Tower, Level 3, 24 Honeysuckle Drive
Newcastle, New South Wales 2300, Australia
T +61 2 4979 9999 | **F** +61 2 4975 0725 | **E** ntlmail@ghd.com | **ghd.com**

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	T. Hopwood	Z. Lagerroth		Z. Lagerroth		24/02/25

© GHD 2025

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Overarching Review

Statement of Compliance Question	Statement of Compliance Answer
Were all conditions of SSD_5581 and the Airly Mine Water Management Plan relating to stygofauna complied with?	Yes – There were no non-compliances relating to stygofauna monitoring in the 2024 reporting period.

Details of Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Reference # addressed in Annual Review
N/A - No non-compliances relating to stygofauna during the 2024 reporting period			Compliant		

Development consent SSD-5581 (Modification 5) performance conditions relating to groundwater

Condition	Condition description	Compliant	Document
Groundwater management plan			
Schedule 4 13. (c) (iii)	Groundwater Management Plan, which is consistent with the NSW Government guideline entitled Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities, and includes:		
	Detailed baseline data of groundwater levels, yield and quality in the region that could be affected by the development, including licensed privately-owned groundwater bores and a detailed survey/schedule of groundwater dependent ecosystems (including springs and their discharge quantity and quality).	Yes	Refer to Section 5 of the WMP (GHD 2024a).
Schedule 4 13. (c) (iii)	Consultation with DPE Water on the installation of all new monitoring bores, the scheduled sampling and quality determination of parameters for monitoring bores.	Yes	NA Refer to Section 4.4 of the WMP (GHD 2024a).
Schedule 4 13. (c) (iii)	Groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts.	Yes	Refer to Section 6 of the WMP (GHD 2024a).
	A program to monitor and report on: – Springs and their discharge quantity and quality. – Groundwater inflows transferred to the surface water management system. – The seepage/leachate from water storages and emplacements. – Impacts of the development on: • Regional and local (including alluvial) aquifers. • Groundwater supply of potentially affected landowners. • Groundwater dependent ecosystems (including rules for the management of groundwater level impacts to protect GDEs), and riparian vegetation.	Yes	Refer to: Annual Water Monitoring Report (GHD 2025). Section 4.4 of the WMP (GHD 2024a). Annual flora and fauna monitoring report.
	A program to monitor and report on stygofauna and hyporheic fauna.	Yes	This report
	A program to review and validate the groundwater model for the development, including independent expert review.	Yes	NA Refer to Section 7.6 of the WMP (GHD 2024a).
	A plan to respond to any exceedances of the performance measures.	Yes	NA Refer to Appendix F of the WMP (GHD 2024a).

NA – not applicable to this report

Executive Summary

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, and owned by Centennial Airly Pty Ltd (Centennial). Airly Mine was granted Development Consent (SSD_5581) for the extension of its underground coal mine on 15 December 2016. The development consent allows Airly Mine to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal within the mining leases ML1331 and ML1814. The development consent requires a program to monitor and report on stygofauna in bores surrounding Airly Mine. Stygofauna sampling and reporting in 2024 was compliant with this development consent.

Stygofauna monitoring has been conducted annually by GHD since 2016, with the currently monitored bores (ARP05, ARP09, ARP11, ARP13SP, ARP14, ARP15SP) having been sampled annually since 2018. In May 2024, obligate stygofauna were collected from three bores, ARP05, ARP09 and ARP14. These three bores are very shallow (<10 m) in alluvial aquifers, and had water of low salinity (<150 µS/cm electrical conductivity), which are favourable attributes for stygofauna. ARP05, ARP09 and ARP14 are also all located adjacent to waterways, allowing for strong connectivity to surface waters.

In May 2024, there were an increased number of bores where stygofauna were collected, as well as increased stygofauna abundance, compared to sampling in October 2023, with 2024 results more similar to those observed in the 2020 to 2022 period. The increased stygofauna richness and abundance in 2024 compared to 2023 is likely to be primarily in response to the wetter conditions observed in early-2024, contributing to increased groundwater levels in 2024 compared to much of 2023. Stygofauna were also not commonly collected during the previous drought period (2017 to 2019), but were prevalent in the 2020 to 2022 period with recovery of water levels.

No animals were collected from ARP15SP in May 2024, as also occurred in October 2023. Stygofauna had consistently been observed at ARP15SP in each sampling event between March 2019 and August 2022, although a decreasing trend in both richness and abundance had been observed since October 2020. There was a consistent decrease in the water levels at ARP15SP between mid-2022 and late-2023 in response to the lower rainfall volumes observed during this period. Water levels recovered slightly between January and May 2024, but remained low relative to most water levels observed during the 2020 to 2023 period. As such, the absence of stygofauna from ARP15SP in May 2024 likely demonstrates the continuation of impacts due to the relatively dry conditions observed through 2023, or the patchy distribution and occurrence of these animals.

One family (eight individuals) of edaphobite (i.e. soil dwelling fauna) was collected at ARP11 in May 2024. This is the same family that was collected from ARP11 in October 2023, which represented the first animal collected since the prolonged period in which the bore was dry between October 2019 and September 2021. However, no true stygofauna (i.e. obligate groundwater animal) have been collected from ARP11 since November 2018. ARP11 has high electrical conductivity and turbidity compared to other shallow bores, potentially as a result of limited flushing since re-wetting, which may explain the absence of stygofauna. Water levels at ARP11 are exhibiting a delayed response to rainfall and have continued to increase since recharge of the aquifer was first observed in late-2021. Therefore, stygofauna may return to this bore is water levels continue to recover over time.

No stygofauna were collected from ARP13SP in May 2024. ARP13SP is a deep bore associated with the coal seam (Lithgow Seam) that is targeted by mining under Airly Mine's development consent. Water levels decreased approximately 1.5 metres at ARP13SP between December 2023 and May 2024, due to drawdown from mining. However, the Lithgow Seam (represented by ARP13SP) is not prospective for stygofauna as it is deeper than 50 m (approximately 73 m), and this was supported by the absence of stygofauna in this bore during the 2021 to 2023 period.

Patterns in fauna presence and abundance have generally reflected groundwater levels. Water levels in most bores, fluctuate in response to rainfall conditions, and variations in water levels are not associated with impacts from mining. The exception to this is ARP13SP, at which water levels have been impacted by mining. However, ARP13SP is not prospective for stygofauna due to its significant depth. This suggests that there have been no impacts from mining on stygofauna. Based on Airly Mine's extraction plan, there is a low likelihood of surface cracking or groundwater drawdown in the shallow alluvium and sandstone, and, therefore, a low likelihood of impact from Airly Mine operations on the groundwaters that support the stygofauna identified in the Airly Mine bores.

This report is subject to, and must be read in conjunction with the limitations, assumptions and qualifications contained throughout the report.

Contents

1. Introduction **1**
1.1 Background 1
1.2 Development consent and commitments 1
1.3 Scope 1
1.4 Purpose of this report 2
1.5 Assumptions 2
1.6 Limitations 2

2. Stygofauna **3**
2.1 Types of subterranean fauna 3
2.2 Characteristics and risks 3
2.3 Stygofauna research in Australia 3
2.3.1 Favourable bore attributes for stygofauna 3
2.3.2 Review of stygofauna in Australia (Hose *et al.* 2015) 4

3. Project and site background **5**
3.1 Environmental conditions 5
3.1.1 Geology 5
3.1.2 Hydrogeology 5
3.2 Mining operations 7
3.3 Historical stygofauna monitoring 7
3.3.1 Baseline monitoring 7
3.3.2 Stygofauna monitoring assessment program (SMAP) 7
3.3.3 Summary of historical sampling events and bores 7
3.3.4 Stygofauna historically observed (2018 to 2023) 8

4. Methods for 2024 survey **10**
4.1 Survey bores 10
4.2 Physical observations 10
4.3 Water quality monitoring 12
4.4 Stygofauna 12
4.4.1 Sample collection 12
4.4.2 Taxonomy 12

5. Results **13**
5.1 Environmental conditions 13
5.2 Water quality 14
5.3 Fauna 14

6. Discussion **16**

7. Conclusion **18**

8. References **19**

Table index

Table 2.1	Favourable bore attributes for stygofauna	4
Table 3.1	Historical stygofauna sampling events, 2013 to 2023	8
Table 3.2	Obligate stygofauna collected from Airly bores between 2018 and 2023	9
Table 4.1	Bores sampled for stygofauna, May 2024	10
Table 5.1	Water quality in Airly bores, May 2024	14
Table 5.2	Animals collected from Airly bores in May 2024	15

Figure index

Figure 3.1	Geology of Airly Mine (GHD 2014)	6
Figure 4.1	Groundwater bores monitored for stygofauna	11
Figure 5.1	Yearly rainfall at Airly Mine from 2013 to 1 July 2024, compared to long-term yearly rainfall statistics (1899-2023)	13

Appendices

Appendix A	All fauna collected from Airly Bores, 2016 - 2023
Appendix B	Bore photographs and surrounds
Appendix C	Historical water levels at Airly stygofauna bores

1. Introduction

1.1 Background

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, and owned by Centennial Airly Pty Ltd (Centennial). Airly Mine was granted Development Consent (SSD_5581) for the extension of its underground coal mine on 15 December 2016. The development consent allows Airly Mine to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal within the mining leases ML1331 and ML1814.

Stygofauna monitoring was undertaken by Cardno (2014) to support the Environmental Impact Statement (EIS) for the Airly Mine Extension Project. A total of six bores were sampled by Cardno over four sampling events between autumn 2013 and winter 2014. No stygofauna were collected from Airly Mine bores during this period.

GHD has undertaken 11 rounds of stygofauna monitoring of Airly Mine bores since the EIS, with biannual sampling in 2016 and 2017, and annual sampling since 2018. This report outlines the results of stygofauna monitoring conducted in May 2024 (i.e. autumn 2024).

1.2 Development consent and commitments

Airly Mine has development consent under Section 89E of the Environmental Planning & Assessment Act 1979 for the extension of the mine (approved 15 December 2016; NSW Government 2016).

In relation to stygofauna, the development consent states the commitment to comply with the following condition:

– 13 (c) (iii) – a program to monitor and report on stygofauna and hyporheic fauna.

The program to monitor stygofauna is documented in the Airly Mine Water Management Plan and requires annual monitoring at the following bore locations:

– ARP05
– ARP09
– ARP11
– ARP13SP
– ARP14
– ARP15SP

The stygofauna monitoring methodology includes:

– Measurement of groundwater quality parameters including alkalinity, dissolved oxygen (DO), electrical conductivity (EC), pH, temperature and turbidity.
– Sampling of groundwater bores and identification of stygofauna in accordance with guidelines by WA EPA (2007; 2013).

1.3 Scope

GHD Pty Ltd (GHD) was engaged by Centennial to undertake stygofauna monitoring in Airly Mine groundwater bores in 2024 as required by the conditions of consent of the mine extension (see Section 1.2).

The project scope is as follows:

– Collection of stygofauna samples from available groundwater bores that are suitable for sampling, once annually.
– Identification of animals to Family level or below.
– Provision of a report (annually) summarising the results of stygofauna monitoring.

1.4 Purpose of this report

This report outlines the results of stygofauna monitoring conducted in relation to Airly Mine in 2024. A summary of results from this report will be incorporated into Airly Mine's Annual Review.

1.5 Assumptions

Data have been obtained from Cardno (2014) in addition to assessments undertaken by GHD. It is assumed that the methods used by Cardno were suitable for collection of stygofauna and executed correctly.

1.6 Limitations

This report has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and the Centennial Airly Pty Ltd as set out in Section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Centennial Airly Pty Ltd and others who provided information to GHD, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has not been involved in the preparation of the annual review and has had no contribution to, or review of, the annual return other than in the completion of the stygofauna report. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of annual return.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Stygofauna

2.1 Types of subterranean fauna

Aquifers host a complex biodiversity of aquatic invertebrates called stygofauna. Stygofauna is a collective term for all groundwater animals (Hancock *et al*. 2005). Stygofauna can have varying levels of dependence on groundwater. A number of specific terms are used to differentiate the types of stygofauna and other subterranean fauna, as follows:

- **Stygoxenes** and **stygophiles** are able to utilise groundwater during at least part of their lifecycle but are not reliant upon it.
- **Stygobites** are obligate groundwater species (Hancock *et al.* 2005), meaning they only live in groundwater environments.
- **Phreatobites** are a type of stygobite that are specially adapted to live in the interstitial spaces of alluvial aquifers.
- **Troglofauna** are also subterranean animals but are distinct from stygofauna as they are not associated with groundwater (Humphreys 2008) e.g. cave dwelling.
- **Edaphobites** are terrestrial soil dwelling animals which can accidentally or opportunistically colonise subterranean environments.

2.2 Characteristics and risks

Stygofauna are highly endemic, often have ancient lineages with Gondwana (350 million years ago), and typically have narrow environmental tolerance ranges (Serov 2016). Because of the adaptation of stygofauna to the groundwater environment and limited connectivity between favourable habitats, some obligate stygofauna species can have restricted distributions (i.e. short-range endemism) (Humphreys 2008).

Stygofauna are threatened by activities that change the quality or quantity of groundwater, disrupt the connectivity between different aquifers or between aquifers and surface systems, or remove soil pores. Disturbance of aquifers could potentially result in local population extinctions, loss of genetic diversity and even species extinctions in the case of isolated populations.

2.3 Stygofauna research in Australia

In Australia, stygofauna research has increased greatly over the last two decades, particularly in Western Australia and Queensland, where large scale mining projects have provided the impetus to develop specific guidelines or guidance documents in relation to stygofauna. Comparatively, there has been relatively little research done on stygofauna in NSW, where many large mining leases have been long-established and risks to stygofauna are only addressed in environmental impact assessments for new projects.

2.3.1 Favourable bore attributes for stygofauna

Favourable bore conditions have been defined by Hancock and Boulton (2008), the WA EPA (2007) and unpublished work conducted by GHD. The bore attributes and value ranges that are favourable for stygofauna habitation and/or collection are summarised in Table 2.1. These attributes were used to determine suitable Airly bores for stygofauna monitoring (see Section 3.3.2 for more detail).

Table 2.1 Favourable bore attributes for stygofauna

Attribute	Favourable values
Lithology	Alluvial (sand and gravel)
Bore depth	<50 m (max <200 m)
Bore diameter	>50 mm (to accommodate sampling equipment)
Bore construction	Preferably cased and slotted/screened through the water column. Vertically aligned (not angled)
Bore use	Observation/monitoring
pH	6.5-8.5
Electrical conductivity (EC)	<2,000 µS/cm (max <5,000 µS/cm)

Note: Preferences based on Hancock and Boulton (2008); WA EPA (2007) and unpublished data collected by GHD.

2.3.2 Review of stygofauna in Australia (Hose *et al.* 2015)

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) published a study funded by the Australian Coal Association Research Program (ACARP) titled *Stygofauna in Australian Groundwater Systems: Extent of knowledge* (Hose *et al.* 2015). The report detailed the current extent of knowledge in terms of factors determining the presence of stygofauna, regional water accounts associated with groundwater use and threats that mining and Coal Seam Gas activities may have on stygofauna. Of most relevance to the Airly Mine stygofauna monitoring is that Hose *et al*. (2015) details the most up to date knowledge on the characteristics of environments where stygofauna have been collected.

The Hose *et al*. (2015) paper identified that greater numbers and/or diversity of stygofauna are found under the following conditions:

– Coarse gravel/sand dominated alluvium (Korbel and Hose 2015).
– Fractured rock aquifers and unconsolidated sediments with larger pore spaces (Hancock and Boulton 2008).
– “Bores from which large volumes of sediment were removed when sampling (by pump), which may reflect greater hydraulic conductivity and sediment mobility” (Korbel and Hose 2015).
– Shallow bores (< 10 m below ground) rather than deeper areas of aquifers (Hancock and Boulton 2008).

These findings are generally in agreement with the environmental preference information used to select the Airly Mine bores, as detailed in Table 2.1.

3. Project and site background

3.1 Environmental conditions

3.1.1 Geology

The topography near Airly Mine is dominated by Mount Airly and Genowlan Mountain. The Grose sandstone of the Triassic Narrabeen Group outcrops throughout the plateau and cliffs of Mount Airly and Genowlan Mountain with small areas of Tertiary basalt outcrop at the higher elevations. The Triassic strata are up to 200 m thick.

The Permian Illawarra Coal Measures outcrop around the Triassic formations at lower elevations, including the zone between Mount Airly and Genowlan Mountain. The Lithgow Seam, within the lower Illawarra Coal Measures, is the target coal seam at Airly Mine. The seam outcrops completely within the proposed mining area for the Airly Mine Extension Project and is therefore disconnected to the areas of occurrence of this seam located several kilometres to the south and northwest, as shown in Figure 3.1.

3.1.2 Hydrogeology

Local groundwater sources

The alluvium associated with Gap Creek and Genowlan Creek is generally a silty sand material and recharged from rainfall as well as inter-aquifer flow from adjacent (primarily Permian) strata. Alluvial groundwater discharges to connected streams.

The local porous and fractured rock groundwater sources include the Narrabeen Sandstone and coal seams of the Illawarra Coal Measures. These sources are recharged by rainfall via fractures within overlaying strata and seep out of the side of the mountains or directly into watercourses. With the majority of discharge from these sources being to seepage areas, there is minimal inter-aquifer flow to underlying regional groundwater sources.

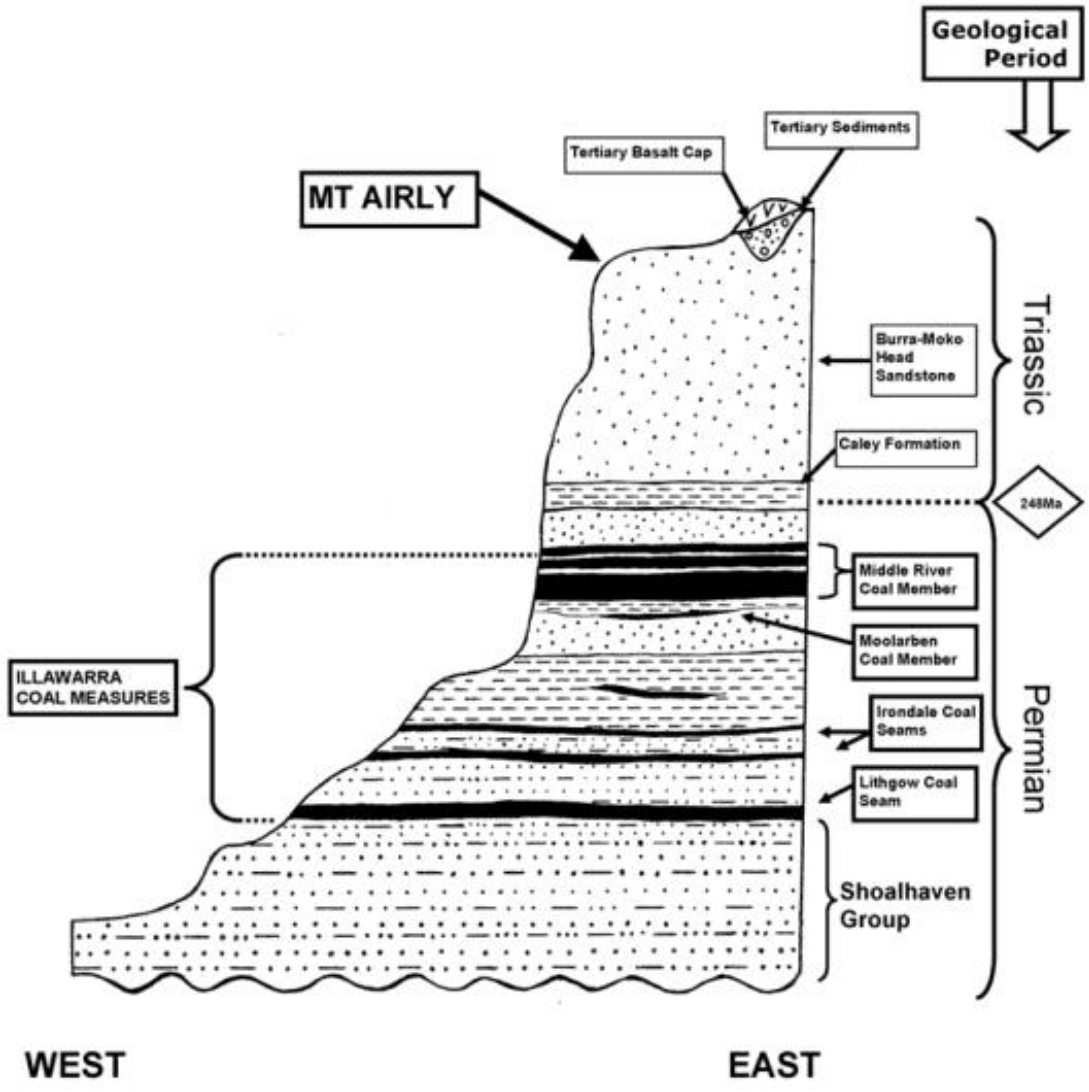
Regional groundwater sources

Regional groundwater sources occur within strata well below the coal measures and extend beyond the Airly Mine lease area.

The upper regional groundwater source occurs within siltstone and sandstone of the Shoalhaven Group. According to the Western Coalfield (Southern Part) Regional Geology 1:100,000 map, this rock formation was deposited in a marine environment and therefore the groundwater is highly brackish to saline. The existing production bore at the Airly Mine surface facilities area is installed within this groundwater source. The recharge area is predominantly to the west of Airly Mine where the Shoalhaven Group outcrops.

The lower regional groundwater source occurs within Devonian metamorphic strata containing shale, sandstone and limestone. The groundwater has a lower salt content than the Shoalhaven Group and it is less sulfate dominant. Recharge areas occur to the north, south and east of Airly Mine and groundwater flow is generally to the east.

It is considered that there is minimal inter-aquifer hydraulic connection between the upper and lower regional groundwater sources, based on differences in groundwater chemistry discussed in GHD (2014).



Legend:

- Basalt
- Gravel and Sand
- Coal
- Sandstone
- Siltstone
- Interbedded Sandstone and Siltstone

NB: Not to Scale

© 2013. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Airly
SEAM	NA
DRAWN	SM
CHECKED	SG
APPROVED	SG
SCALE	NTS

Airly Mine
Geological Cross-Section

CENTENNIAL

DATE Feb 2024

Figure 3.1

\\ghdnet\ghd\AU\Newcastle\Projects\22\12602698\Tech\Visio\Airly Mine Geological Cross-Section\Figure2-3_Geological Cross Section.vsd

3.2 Mining operations

Coal mining to date at Airly Mine has been bord and pillar mining within the Lithgow Seam since 2014 as well as panel and pillar mining since June 2019. Observed groundwater drawdown impacts associated with these workings have been isolated to the Lithgow Seam and the underlying Marrangaroo Formation (occurred in late 2015 and early 2016). These impacts are consistent with the predictions approved under SSD_5581.

There are also old shale workings within the Glen Davis Formation, developed between the late 1800s to early 1900s beneath the northern end of the Mount Airly plateau. These workings resulted in some cracking to the surface and the drainage of overlying groundwater sources (primarily Narrabeen Sandstone) into the old workings.

3.3 Historical stygofauna monitoring

3.3.1 Baseline monitoring

Potential impacts to stygofauna from underground mining were assessed as part of the EIS for the Airly Mine Extension Project (Cardno 2014). Stygofauna samples were collected from three bores (ARP05, AM2B, AM2B-1) over three sampling events between May 2013 and December 2013 with an additional three bores sampled in June 2014 (ARP07SP, ARP08SP, ARP09) (Cardno 2014). Bores were sampled using bailers or pumping depending on the attributes of the bore (Cardno 2014). Cardno (2014) concluded that the results of this monitoring program may not be representative of the current environment given the small sampling effort and the limited number of available bores.

3.3.2 Stygofauna monitoring assessment program (SMAP)

Airly bores were first sampled by GHD for stygofauna under the regional program known as the stygofauna monitoring assessment program (SMAP). The SMAP was designed by GHD in 2016 to monitor stygofauna across the regional network of Centennial's bores (GHD 2016).

A Multi-Criteria Analysis (MCA) Protocol was used as a bore prioritisation tool to select the bores most likely to contain stygofauna, based on key bore attributes such as water quality, hydrogeological characteristics and bore construction details.

The following was also considered in the selection of bores for the SMAP:

– **Hydrogeology** - Cover all hydrogeological units present[1].
– **Bore location** - Geographically spread across the western region and ideally include reference bores outside the potential zone of impact (i.e. water drawdown zone)[1].
– **Bore age** - Be of varying age, in excess of six months old, and preferably undisturbed (i.e. not regularly pumped or purged)[1].
– **Historical collection of stygofauna -** presence of stygofauna in historical sampling.

The resulting score out of a maximum of five identified the suitability for stygofauna, with 5 being the most suitable. The scores were divided into four categories denoting Very Low, Low, Medium and High priority for stygofauna monitoring. Additional Airly bores have been added since development of the SMAP, as outlined in Section 3.3.3.

3.3.3 Summary of historical sampling events and bores

Prior to the current monitoring event (May 2024), GHD had monitored a total of seven bores across ten sampling events between autumn 2016 and spring 2023. The bores monitored by GHD and Cardno in historical sampling events are outlined in Table 3.1.

[1] As required by WA EPA (2007).

ARP07SP and ARP08SP, which were sampled by Cardno in June 2014 as part of the EIS, have not been sampled by GHD. ARP07SP has been consistently dry since installation, as indicated by monthly groundwater sampling (GHD 2025). ARP08SP was not sampled for stygofauna as it does not have favourable bore attributes for stygofauna (see Table 2.1) or stygofauna net sampling, including a narrow bore diameter (40 mm), greater than 200 metre depth below ground level, and very high EC (>6000 µS/cm) and pH (pH > 12). ARP08SP was mined through in October 2022 and is no longer operational. AM2B (production bore), which was also sampled by Cardno, has not been sampled by GHD as the bore is sealed, encasing a permanent logger which prevents sampling with a net. AM2B-1 (old production bore) was historically monitored by GHD but was eliminated from the monitoring program following the winter 2017 monitoring event as conditions within this bore are unsuitable for the presence of stygofauna based on the water chemistry and presence of iron floc (GHD 2018).

Table 3.1 Historical stygofauna sampling events, 2013 to 2023

Sampling event	Month of monitoring	Bores sampled	Company	Purpose
Autumn 2013	May 2013	ARP05, AM2B, AM2B-1	Cardno	Airly Mine Extension EIS
Winter 2013	June 2013			
Summer 2013	December 2013			
Winter 2014	June 2014	ARP07SP, ARP08SP, ARP09		
Autumn 2016	March 2016	ARP09, ARP05, AM2B-1	GHD	Post EIS monitoring
Summer 2016	December 2016			
Summer 2017	February 2017			
Winter 2017	August 2017	ARP09, ARP05, AM2B-1, ARP11, ARP14, ARP15SP		
Spring 2018	November 2018	ARP05, ARP09, ARP11, ARP13SP ARP14, ARP15SP		
Autumn 2019	March 2019			
Spring 2020	October 2020			
Autumn 2021	April 2021			
Winter 2022	August 2022			
Spring 2023	October 2023			

3.3.4 Stygofauna historically observed (2018 to 2023)

Complete results for all animals (stygofauna and edaphobites) collected by GHD in bores associated with Airly Mine between 2016 and 2023 are presented in Appendix A.

No stygofauna were collected from groundwater bores associated with Airly Mine by Cardno / GHD between autumn 2013 and winter 2017. Some edaphobites (i.e. soil dwelling fauna) were collected during this period but these are not true stygofauna.

In spring 2018, two individuals of one obligate stygofauna group (Cyclopoida) were collected from ARP11. Installed in late 2016, ARP11 is a shallow bore targeting Permian sandstone (Table 3.2).

In autumn 2019, a total of three animals were collected from ARP15SP (GHD 2020a). All animals were from the Melitidae family of Amphipods. No animals were collected from ARP11, ARP13SP or ARP14 in autumn 2019, which represented a low rainfall period, during which ARP05 and ARP09 were dry.

In spring 2020, one obligate stygofauna from the Cyclopidae family of Copepoda (GHD 2020b) was collected from each of ARP09 and ARP13SP. A total of 42 animals were collected from ARP14, all from the Parabathynellidae family of Syncarida. At ARP15SP, 34 obligate stygofauna were collected: 27 from the Paramelitidae family of Amphipoda, four from the Psammaspididae family of Syncarida and three from the Cyclopidae family of Copepoda.

In autumn 2021, a total of six obligate stygofauna were collected from ARP14, all from the Parabathynellidae family of Bathynellacea (GHD 2022a). A total of 29 animals were collected from ARP15SP in autumn 2021: 24 were from the Cyclopidae family of Cyclopoida, three were from the Neoniphargidae family of Amphipoda and two were from the Psammaspididae family of Anaspidacea.

In winter 2022, a total of two obligate stygofauna (phreatobites) were collected from ARP05, one from the Parabathynellidae family of the Bathynellacea sub-order, the other from the Cyclopidae family of the Cyclopoida order (GHD 2023). A total of 24 phreatobite individuals were collected from ARP14. Six were from the Parabathynellidae family of the Bathynellacea order and 16 were from the Haplotaxidae family of the Haplotaxida sub-order. A total of two animals phreatobite individuals were collected from ARP15SP in August 2022, both from the Melitidae family of the Amphipoda order.

In spring 2023, a total of nine individuals were collected from ARP05 in October 2023 (GHD 2024b. Two were from the Bathynellidae family of the Bathynellacea order, and seven from the Cyclopidae family of the Cyclopoida order. All animals collected from ARP05 were obligate stygofauna. A total of four obligate stygofauna were collected from ARP14 in October 2023, (from the Parabathynellidae family of the Bathynellacea order).

The obligate stygofauna collected between 2018 and 2023 are summarised in Table 3.2. The sampling method for all samples was 6 hauls with a 50 µm net.

Table 3.2 Obligate stygofauna collected from Airly bores between 2018 and 2023

Sampling event	Site	Number of animals (abundance)	Number of taxa (richness)	Taxa collected
Spring 2018	ARP11	2	1	Copepoda: Cyclopoida
Autumn 2019	ARP15SP	3	1	Amphipoda: Melitidae
Spring 2020	ARP09	1	1	Copepoda: Cyclopidae
	ARP13SP	1	1	Copepoda: Cyclopidae*
	ARP14	42	1	Syncarida: Parabathynellidae
	ARP15SP	34	3	Amphipoda: Paramelitidae Syncarida: Psammaspididae Copepoda: Cyclopidae
Autumn 2021	ARP14	6	1	Bathynellacea: Parabathynellidae
	ARP15SP	29	3	Copepoda: Cyclopidae Anaspidacea: Psammaspididae Amphipoda: Neoniphargidae
Winter 2022	ARP05	2	2	Bathynellacea: Parabathynellidae Cyclopoida: Cyclopidae
	ARP14	24	2	Bathynellacea: Parabathynellidae Haplotaxida: Haplotaxidae
	ARP15SP	2	1	Amphipoda: Melitidae
Spring 2023	ARP05	9	2	Bathynellacea: Parabathynellidae Cyclopoida: Cyclopidae
	ARP14	4	1	Bathynellacea: Parabathynellidae

* Investigation determined that the stygofauna collected from ARP13SP in 2020 was likely to have been transferred to the sample from another bore.

4. Methods for 2024 survey

4.1 Survey bores

Sampling was conducted at six bores on 21 and 22 May 2024 as shown in Table 4.1. The locations of these bores are shown in Figure 4.1.

The priority of some bores are identified in Figure 4.1 based on the attributes of the bore (see Section 2.3.1) as identified in the SMAP (see Section 3.3.2). Bores ARP11, ARP13SP, ARP14 and ARP15SP have not been assigned a priority as they were installed after the SMAP was developed.

Approximate depths to end of hole (EoH) for each bore, as measured in May 2024, are outlined in Table 4.1.

Photographs of bores sampled in May 2024 are presented in Appendix B.

Table 4.1 Bores sampled for stygofauna, May 2024

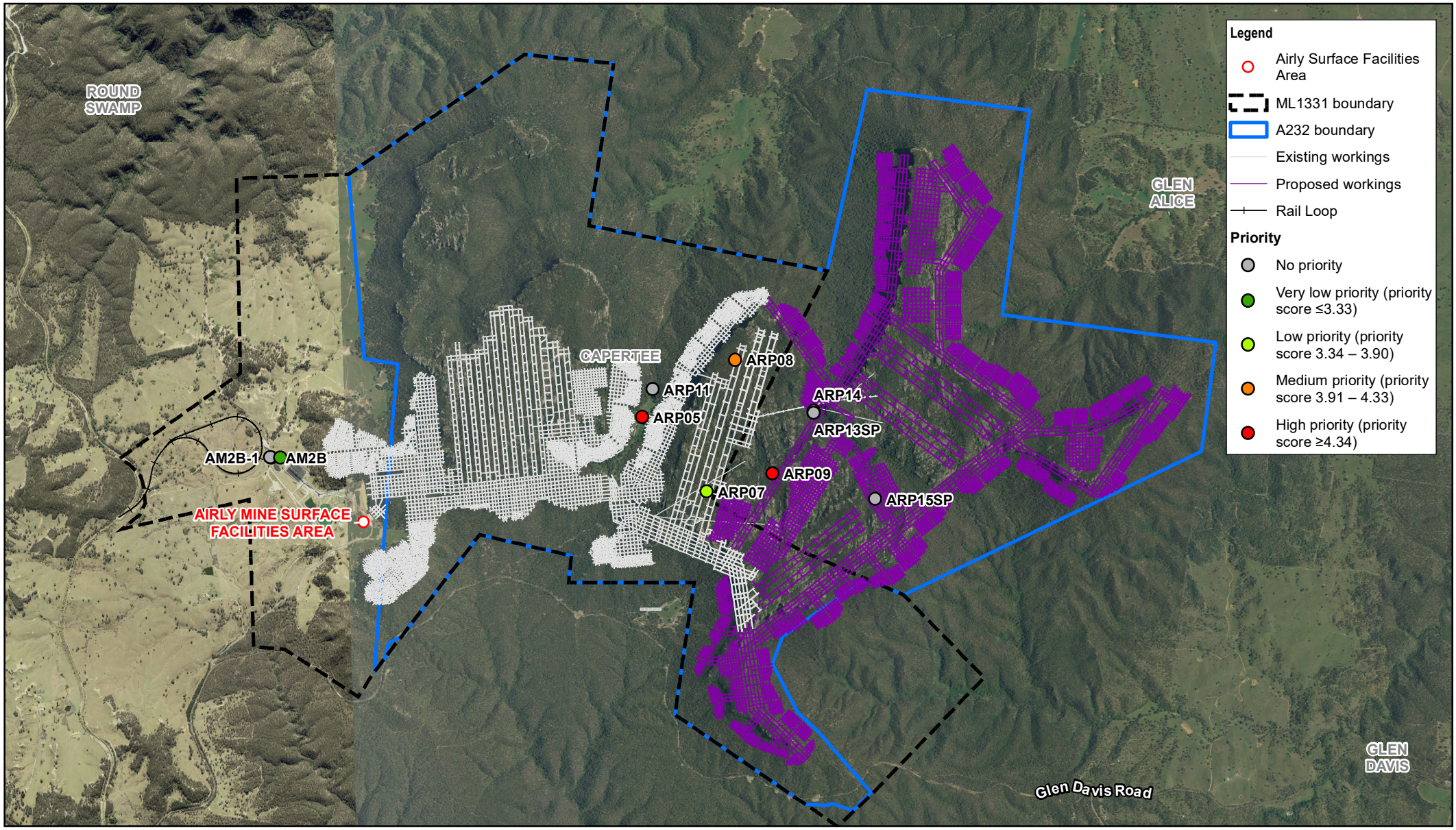
Bore code	Easting (Zone 56H)	Northing (Zone 56H)	Approximate bore depth (EoH, m BGL)	Aquifer	Screen interval (m BGL) if known	Location
ARP05	224066	6333269	11.63	Alluvial	8 – 11	Gap Creek
ARP09	225334	6332733	3.98	Alluvial	3 – 4	Genowlan Creek
ARP11	224168	6333547	15.17	Sandstone	1.25 – 15.3	Gap Creek
ARP13SP	225741	6333314	72.03	Lithgow Seam	67.5 – 70.5	Genowlan Creek
ARP14	225738	6333335	2.07	Alluvial	0.5 – 2.3	Genowlan Creek
ARP15SP	226319	6332492	19.67	Sandstone	10 – 16	Upstream of The Oasis

Note: Locations in GDA94. BGL = Below ground level.

4.2 Physical observations

The following were collected during the field survey:

– Measurements of standing water level (SWL) and EoH bore depth of each bore using an electronic dip probe. The SWL is defined as the depth from the ground to the groundwater and is used to calculate the total depth of the water column.
– Recording of bore diameter, construction, purpose of bore, condition, GPS location and bore ID, presence of tree roots, surrounding land use, sampling date, time and sampling team.



CENTENNIAL

Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Pty Ltd
Airly Mine
Stygofauna Monitoring

Groundwater bores monitored for stygofauna

Project No. **12602698**
Revision No. **0**
Date **12 Feb 2024**

FIGURE 4-1

N:\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\Airly\12602698\Stygofauna\12602698_SFM001_MonitoringLocations_0.mxd
Print date: 12 Feb 2024 - 16:13

Data source: Centennial: Mine data, 2021, Aerial Imagery; LPI: DTDB / DCDB, 2017; © Department of Finance, Services & Innovation 2018. Created by: tmackay

4.3 Water quality monitoring

Physico-chemical water quality parameters were measured *in situ* at each sampling site using a YSI Pro Plus multi-parameter water quality meter. Turbidity was measured *in situ* using a WTW Turb 430 IR portable turbidity meter.

In situ physico-chemical measurements recorded included:

- Temperature (°C)
- pH (pH units)
- EC (µS/cm) as specific conductance
- Dissolved oxygen (DO) (mg/L and percent saturation)
- Turbidity (NTU)

The meters were fully calibrated prior to use, in accordance with the manufacturer's specifications. Water was extracted from the bore using a bailer and transferred to the sample cup before collecting the readings. Note that the bore was not purged prior to sampling to minimise interference to the water column. However, water quality sampling of all bores was conducted monthly by GHD prior to 2024, and quarterly in 2024.

A water sample from each sampling location was also collected and analysis for alkalinity (mg/L) was performed by a National Association of Testing Authorities (NATA) accredited laboratory.

4.4 Stygofauna

4.4.1 Sample collection

Stygofauna monitoring was undertaken by GHD using methods consistent with the requirements for baseline surveys as defined by the WA EPA (2007; 2013) guidelines.

All sampled bores were 50 mm in diameter and a 40 mm diameter net was used for stygofauna sampling (GHD nets conform to WA EPA guideline (2007; 2013) specifications).

Nets are constructed of 50 µm nybolt mesh material, weighted at the bottom with a brass fixture and with an attached plastic collecting jar. The net was attached to a fishing rod, lowered to the bottom of the bore, agitated four times to dislodge resting animals and slowly retrieved by winding the fishing rod reel. At the top of each haul, the collecting jar was rinsed into a 50 µm mesh brass sieve and the net lowered again.

Six hauls were completed for each bore following water quality sampling. Water remaining in the bailer following water quality sampling is also passed through the sieve to maximise the chance of collecting stygofauna. For each sample, the entire sieve contents were transferred to a labelled sample jar and preserved in 100% food (AR) grade ethanol.

4.4.2 Taxonomy

Family level identification is the requirement under the Springvale Mine Extension Project Development Consent (NSW Government 2015) and has been used as the standard for Airly Mine for consistency. Stygofauna and other animals were identified under a microscope to Family level, where possible. In some cases, the specimens were too immature or damaged to allow for identification to family level and there are some groups for which no key is available. Specimens were preserved in 100% AR grade ethanol, to allow for future genetic sequencing, if necessary.

5. Results

5.1 Environmental conditions

Yearly rainfall totals for 2013 to 2024, as recorded by Centennial at Airly Mine, are presented in Figure 5.1. Rainfall data from the Running Stream (Brooklyn) BOM station (63012) (BOM 2024) were used for the period January to October 2013 as rainfall monitoring by Centennial began in November 2013. Long-term 10th percentile, median (i.e. 50th percentile) and 90th percentile annual rainfall data were sourced from BOM (2024) for a period from 1899 to 2023.

Rainfall in 2024 totalled 623 mm, which was well below the long-term median. Below-median rainfall was also recorded during eight of the 11 years of monitoring between 2013 and 2023. The highest annual rainfall during the monitoring period was in 2022. The annual rainfall was higher than the median in 2016, 2020 and 2022. Yearly rainfall during the 2017 to 2019 period, and again in 2023, was well below the long-term median, as well as being below the 10th percentile of rainfall in the area. The lowest annual rainfall of 398.4 mm in the 2013 to 2023 monitoring period was recorded in 2019.

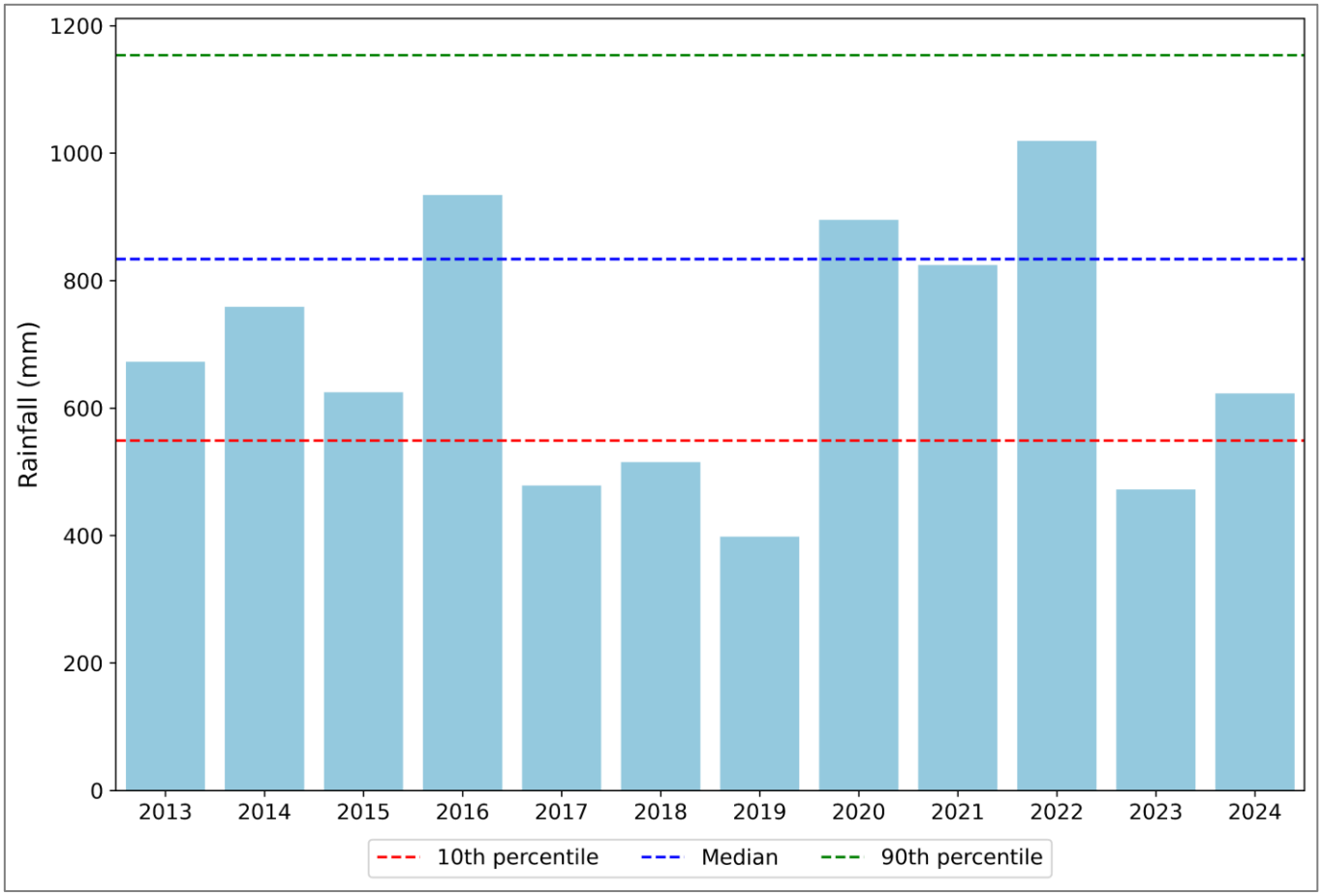


Figure 5.1 Yearly rainfall at Airly Mine from 2013 to 1 July 2024, compared to long-term yearly rainfall statistics (1899-2023)

Historical water levels in all bores monitored for stygofauna are presented in Appendix C, with comparison to cumulative rainfall departure (CRD). CRD represents the cumulative difference between the observed monthly rainfall and long-term average monthly rainfall. The CRD curve only deviates from zero due to atypical (above and below average) rainfall. An increase in the CRD reflects above average rainfall while a decrease reflects below average rainfall.

5.2 Water quality

Water quality and depth to water measurements recorded by GHD during stygofauna sampling in May 2024 are summarised in Table 5.1.

EC was below 2,000 µS/cm in all six bores in May 2024, which is favourable for stygofauna. The highest EC (976 µS/cm) was observed at ARP11, while EC at ARP13SP (602 µS/cm) was also elevated relative to the shallow bores (other than ARP11). pH was within the favourable range at ARP11 and ARP13SP, but was below the prospective range (i.e. more acidic) in all other bores. The lowest pH of 4.8 was recorded in ARP09. DO saturations were low in all bores, but were highest at ARP05. Turbidity was highest at ARP11 and ARP14, and was lowest at ARP09. Although there was no favourable turbidity range identified in the literature, the turbidity in ARP11 and ARP14 was extremely high relative to the stressor value of 25 NTU identified in ANZECC (2000) for aquatic ecosystem protection in upland rivers (surface waters). The turbidity in ARP15SP and ARP13SP were also elevated (though much lower than at ARP11 and ARP14), relative to the surface water guideline value, while turbidity was much lower in ARP05 and ARP09. Alkalinity followed a similar pattern to EC, with the highest results observed at ARP11 and ARP13SP, and the lowest concentration at ARP05.

Table 5.1 Water quality in Airly bores, May 2024

Site	Units	ARP05	ARP09	ARP11	ARP13SP	ARP14	ARP15SP	Favourable value*
Date		21/05/24	21/05/24	21/05/24	22/05/24	22/05/24	22/05/24	NA
Time		08:30	15:10	09:30	08:30	09:10	12:15	NA
Depth to water^	metres	5.9	1.35	8.7	66.18	0.52	12.29	<50
Temperature	° C	15.4	13.4	14.9	16.1	13.1	13.9	NA
EC	µS/cm	138	35	976	602	98	72	<2,000
pH	pH units	6.0	4.8	6.5	6.7	6.0	5.4	6.5-8.5
DO	% sat.	44.8	13.1	19.8	12.4	8.7	10.1	NA
Turbidity	NTU	19.4	2.8	463	131	457	87.9	NA
Alkalinity	mg/L	42	4	345	312	29	10	NA

*Based on criteria outlined in Section 2.3.1.
Results in **blue** are outside the favourable values.
^Depth below ground level.

5.3 Fauna

The animals collected from Airly bores in May 2024 are presented in Table 5.2. Animals were collected from four of the six bores sampled in May 2024; however, obligate stygofauna were only collected from ARP05, ARP09 and ARP14. No animals were collected from ARP13SP or ARP15SP in May 2024.

A total of 25 individuals were collected from ARP05 in May 2024. Five were from the Bathynellidae family of the Bathynellacea order, 19 were from the Cyclopidae family of the Cyclopoida order, and one was from the Canthocamptidae family of the Harpacticoida order. All animals collected from ARP05 are obligate stygofauna.

A total of eight individuals were collected from ARP09 in May 2024, seven of which were obligate stygofauna (from the Naididae family of the Tubificida order). One edaphobite (i.e. soil-dwelling fauna), from the Isotomidae family of the Entomobryomorpha order, was also collected from ARP09.

A total of 10 animals were collected from ARP14 in May 2024, nine of which were obligate stygofauna. This includes eight individuals from the Parabathynellidae family of the Bathynellacea order, and one from the Naididae family of the Tubificida order. One edaphobite (from the Sminthuridae family of the Entomobryomorpha order) was also collected from ARP14.

Eight edaphobites, from the Geophilidae family of the Geophilomorpha order, were collected from ARP11 in May 2024. No obligate stygofauna were collected from ARP11.

Table 5.2 Animals collected from Airly bores in May 2024

Site	Sampling method	Order or sub-Order: Family	Type of stygofauna	Abundance	Total number of taxa (richness)	Number of obligate stygofauna (richness)
ARP05	50 µm net, 6 hauls	Bathynellacea: Bathynellidae	Phreatobite (obligate groundwater fauna)	5	1	1
		Cyclopoida: Cyclopidae	Phreatobite (obligate groundwater fauna)	19	1	1
		Harpacticoida: Canthocamptidae	Phreatobite (obligate groundwater fauna)	1	1	1
Total number of animals (ARP05)				**25**	**3**	**3**
ARP09	50 µm net, 6 hauls	Entomobryomorpha: Isotomidae	Edaphobite (soil dwelling fauna)	1	1	0
		Tubificida: Naididae	Phreatobite (obligate groundwater fauna)	7	1	1
Total number of animals (ARP09)				**8**	**2**	**1**
ARP11	50 µm net, 6 hauls	Geophilomorpha: Geophilidae	Edaphobite (soil dwelling fauna)	8	1	0
Total number of animals (ARP11)				**8**	**1**	**0**
ARP14	50 µm net, 6 hauls	Bathynellacea: Parabathynellidae	Phreatobite (obligate groundwater fauna)	8	1	1
		Tubificida: Naididae	Phreatobite (obligate groundwater fauna)	1	1	1
		Entomobryomorpha: Sminthuridae	Edaphobite (soil dwelling fauna)	1	1	0
Total number of animals (ARP14)				**10**	**3**	**2**
ARP13SP	50 µm net, 6 hauls	NA	NA	0	0	0
Total number of animals (ARP13SP)				**0**	**0**	**0**
ARP15SP	50 µm net, 6 hauls	NA	NA	0	0	0
Total number of animals (ARP15SP)				**0**	**0**	**0**

6. Discussion

Animals were collected from four bores in May 2024, although only three of these bores (ARP05, ARP09 and ARP14) contained obligate stygofauna. ARP05, ARP09 and ARP14 are very shallow bores (<10 m) in alluvial aquifers, and had low EC (<150 µS/cm) water, all of which are favourable attributes for stygofauna. These bores are also all located adjacent to waterways, allowing for strong connectivity to surface waters which would increase the availability of nutrients. While pH in these bores was more acidic than the reported favourable range (see Section 2.3.1), stygofauna have also been observed in other bores in the region with naturally acidic water, including areas of the Blue Mountains (GHD 2019b). Turbidity was also relatively low in ARP05 and ARP09, but was much higher in ARP14. Although there was no favourable turbidity range identified in the literature, the turbidity in ARP14 (457 NTU) was extremely high relative to the stressor value of 25 NTU identified in ANZECC (2000) for aquatic ecosystem protection in upland rivers (surface waters).

The highest diversity and abundance of obligate stygofauna was observed in ARP05 in May 2024, with three obligate stygofauna families (Bathynellacea: Bathynellidae, Cyclopoida: Cyclopidae and Harpacticoida: Canthocamptidae) collected, and a total of 25 individual animals. This bore contained slightly higher EC water than the other stygofauna-containing bores (ARP09 and ARP14), though turbidity was much lower at ARP05 than was observed at ARP14 (19.4 NTU compared to 457 NTU at ARP14). Stygofauna have been collected from ARP05 in all annual sampling events (April 2021, August 2022, October 2023 and May 2024) since water levels recovered following the extended period that the bore was dry between September 2017 and March 2021. Over the 2021 to 2024 period, abundance of stygofauna collected from ARP05 has consistently increased, indicating continued colonisation of this aquifer following recovery of water levels. Water levels at ARP05 are dependent on rainfall, though response to rainfall has been delayed and is more gradual than that at some other sampled bores (ARP09 and ARP15SP), at which water levels fluctuate immediately following rainfall (refer Appendix C).

Two obligate stygofauna taxa were collected at ARP14 in May 2024 (eight individuals of Bathynellacea: Parabathynellidae, and one Tubificida: Naididae). ARP14 is the sampled bore which has most commonly contained stygofauna, with obligate stygofauna collected in each of the past five sampling events. The primary factors explaining the consistent presence of stygofauna at ARP14 are that this bore has a shallower depth, is in closer proximity to a watercourse (Genowlan Creek) and has more reliable water than some of the other shallow bores, such as ARP05 and ARP09. Other than a brief period in December 2019 to January 2020, where there was a rapid decline in water levels, at a time when the adjacent Genowlan Creek had dried completely due to the extended drought period, water levels have remained relatively consistent at ARP14. Water levels at ARP14 do not fluctuate as widely as those at ARP09 and ARP15SP in response to rainfall (refer Appendix C).

Obligate stygofauna were also collected from ARP09 in May 2024 (seven individuals of Tubificida: Naididae). As mentioned above, water levels in ARP09 are strongly responsive to rainfall, increasing soon after any significant rainfall event, and decreasing quickly in drier periods, including during sampling in October 2023, when ARP09 was dry. In addition to the stygofauna collected in May 2024, stygofauna have previously been collected from ARP09 in 2020 and 2021, despite frequent fluctuations of wet and dry conditions in the bore during this period (Appendix C).

In addition to the obligate stygofauna collected in May 2024, edaphobites were also collected from ARP09, ARP11 and ARP14. Edaphobites are terrestrial, soil dwelling animals, which can colonise subterranean environments, but are not reliant on groundwater for survival like obligate stygofauna. These animals are uncommon in groundwater and likely fell into the bore during stygofauna or groundwater sampling. At ARP09 and ARP14, one individual of the Entomobryomorpha order were collected at each site (Isotomidae and ARP09, Sminthuridae at ARP14). At ARP11, eight individual Geophilomorpha: Geophilidae (centipedes) were collected, which is the same family that was also collected from ARP11 in October 2023. These edaphobites at ARP11 represent the only animals collected since the prolonged period in which the bore was dry between October 2019 and September 2021. However, no true stygofauna have been collected from ARP11 since November 2018. ARP11 has a comparatively high EC and turbidity, potentially as a result of limited flushing since re-wetting, which may explain the absence of stygofauna in this shallow bore.

No animals were collected from ARP15SP in May 2024, as also occurred in October 2023. Stygofauna had consistently been observed at ARP15SP in all of the four sampling events between March 2019 and August 2022, although a decreasing trend in both richness and abundance had been observed since October 2020. There was a consistent decrease in the water levels at ARP15SP between mid-2022 and late-2023 (see Appendix C) in response to the lower rainfall volumes observed during this period. Water levels recovered slightly between January and May 2024, but remained low relative to most water levels observed during the 2020 to 2023 period. There was no significant change to measured water quality parameters in May 2024 compared to previous sampling events during which stygofauna were collected, with the exception of an increase in turbidity, for which there are no reported favourable values. As such, the absence of stygofauna from ARP15SP in May 2024 likely demonstrates the continuation of impacts due to the relatively dry conditions observed through 2023 (impacting the October 2023 sampling event), or simply the patchy distribution and occurrence of stygofauna (Hahn and Matzke 2005).

No stygofauna were collected from ARP13SP in May 2024. After an extended period of very stable water levels at ARP13SP, water levels experienced a sharp decrease in December 2023 (a decline of approximately one metre over a one week period), followed by a continual gradual decrease between December 2023 and May 2024 (a further decline of approximately half a metre) (refer Appendix C). This decline in water levels is likely to be due to mining activities (GHD 2024c), but is unlikely to be the reason for the absence of stygofauna collected in May 2024. ARP13SP is not prospective for stygofauna as it is deeper than 50 m (approximately 73 m), and stygofauna had not commonly been collected from ARP13SP during previous sampling events. In spring 2020, a single individual of the Copepoda family, Cyclopidae, was collected from ARP13SP but it was determined that this individual was likely to have been transferred to the ARP13SP sample from another bore. The monitoring methods were altered in 2021 to reduce the potential for cross-contamination between samples. No animals were collected from ARP13SP in April 2021, August 2022, October 2023 or May 2024, despite stygofauna being collected from other bores, which supports the theory of cross-contamination in spring 2020.

In May 2024, there was an increased number of bores where stygofauna were collected, as well as increased stygofauna abundance, compared to sampling in October 2023, in a return to similar numbers observed in October 2020, April 2021 and August 2022. The results of the May 2024 survey indicate that stygofauna are prevalent in the shallow aquifers of the Airly Mine area, with the bores from which stygofauna were collected in May 2024 all installed in the shallow alluvium. The relatively high abundance and richness of stygofauna in the 2024 samples, as well as 2020, 2021 and 2022 samples, is likely attributable to the near- or above-average annual rainfall during these years, and the subsequent recovery or maintenance of groundwater levels in the shallow alluvium. Conversely, the reduced stygofauna richness and abundance in 2023 was likely to be primarily in response to the drying conditions in the area and the well below average rainfall observed in 2023 (refer Figure 5.1). This contributed to lower groundwater levels in 2023 (compared to much of the 2020 to 2022 period) in all bores except for at ARP13SP, which as a deeper bore, water levels are not influenced by rainfall, and ARP11, at which water levels were exhibiting a delayed response to rainfall and have continued to increase since recharge of the aquifer was first observed in late-2021 (refer Appendix C).

Surface subsidence cracks have been previously observed at Mount Airly and are potentially associated with mining within the panel and pillar area in 2020 and 2021. This cracking was found not to have impacted nearby groundwater levels at ARP05 or ARP11 (GHD 2022b), with water levels in these bores increasing since this time. The presence of stygofauna at ARP05 has also increased over the same period. The Airly Mine extraction plan has since been updated to reduce the area of panel extraction, and increase the width of the pillars, which is expected to reduce the likelihood of surface cracking. Consequently, there have been no observed impacts, nor any expected impacts due to Airly Mine operations, on the shallow alluvial and shallow sandstone aquifers that support the stygofauna identified in the Airly Mine bores.

7. Conclusion

Obligate stygofauna were collected from three of the six bores surveyed during May 2024 sampling. The bores from which stygofauna were collected (ARP05, ARP09 and ARP14) intersected the shallow alluvium, contained low EC water, and are well-connected to the adjacent Genowlan and Gap creeks, providing prospective conditions for stygofauna. ARP14 has consistently exhibited diverse and abundant stygofauna populations, relative to other Airly Mine bores, while a consistent increase in stygofauna abundance has been observed at ARP05 since recovery of water levels in early-2021, following an extended period (approximately 3.5 years) during which the bore was dry. ARP09 is frequently dry during times of low rainfall, although water levels in ARP09 are strongly responsive to rainfall, increasing soon after any significant rainfall event. Despite frequent fluctuations of wet and dry conditions, stygofauna have been commonly collected from ARP09 during sampling events when water was present.

Stygofauna were collected from all the most prospective bores in May 2024, which suggests that there have been no mining impacts to the aquifers associated with these bores. With the exception of ARP15SP, bores where stygofauna were not collected in May 2024 were considered less prospective for stygofauna due to either their significant depth (ARP13SP) or recent re-wetting and the potentially associated elevated EC and turbidity (ARP11). The lack of fauna in ARP15SP in May 2024 may simply reflect the patchy distribution and variable abundances of stygofauna, or sustained impacts due to the drier conditions and the consistent decline observed in water levels at ARP15SP across 2023, which was not expected to be related to Airly mining.

Wetter conditions throughout early-2024 contributed to an increase in water levels in those bores that are strongly responsive to rainfall (ARP05, ARP09 and ARP15SP) compared to water levels observed in late-2023. This may have contributed to the higher abundance and richness of stygofauna taxa observed in Airly bores in 2024, compared to 2023 results. The continued presence of stygofauna in Airly bores compared to earlier (pre-2020) surveys is likely due to the presence of water in bores that were previously dry for extended periods (ARP05 and ARP11) or are frequently dry periodically (ARP09).

Based on Airly Mine’s extraction plan, there is a low likelihood of surface cracking or groundwater drawdown in the shallow alluvium and sandstone, and, therefore, a low likelihood of impact from Airly Mine operations on the groundwaters that support the stygofauna identified in the Airly Mine bores.

8. References

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

BOM (2024) *Monthly Rainfall: Running Stream (Brooklyn) (station 63012)*, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=063012

Cardno (2014) *Aquatic Ecology and Stygofauna Assessment, Airly Mine Extension Project*, report prepared for Centennial Coal Company Limited.

GHD (2025) *Airly Mine Water Monitoring 2024 Annual Report*, in draft.

GHD (2024a) *Airly Mine Water Management Plan*, prepared for Centennial Coal Company Limited.

GHD (2024b) *Airly Mine Stygofauna Monitoring 2023*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2024c) *Airly Mine Water Monitoring, Quarterly Report (Q1 2024)*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2023) *Airly Mine Stygofauna Monitoring 2022*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2022a) *Airly Mine Stygofauna Monitoring 2021*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2022b) *Surface Water Subsidence Impact Review – Airly Mine*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2020a) *Airly Mine Stygofauna Monitoring 2019*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2020b) *Airly Mine Stygofauna Monitoring 2020*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2019a) *Airly Mine Stygofauna Monitoring 2018*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2019b) *Western Region Stygofauna Monitoring Program – Stygofauna Monitoring Report 2017 – 2019,* prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2018) *Airly Mine Stygofauna Monitoring 2016 - 2017*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2016) *Western Region Stygofauna Monitoring and Assessment Plan*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2014) *Groundwater Impact Assessment, Airly Mine Extension Project*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

Hahn, HJ, Matzke, D (2005) *A comparison of stygofauna communities inside and outside groundwater bores*. Limnologica 35, 31-44.

Hancock, PJ, Boulton AJ and Humphreys WF (2005) Aquifers and hyporheic zones: Towards an ecological understanding of groundwater. *Hydrogeology Journal* 13, 98-111.

Hancock, PJ and Boulton, AJ (2008) *Stygofauna biodiversity and endemism in four alluvial aquifers in eastern Australia*. Invertebrate Systematics 22, 117-126.

Hose GC, J Sreekanth, Barron O, Pollino C (2015) *Stygofauna in Australian Groundwater Systems: Extent of knowledge*. CSIRO, Australia.

Humphreys, W.F (2008) Rising from Down Under: developments in subterranean biodiversity in Australia from a groundwater perspective. *Invertebrate Systematics* 22, 85-102.

Korbel, K and Hose, GC (2015) Water quality, habitat, site or climate? Identifying environmental correlates of the distribution of groundwater biota*. Freshwater Sciences* 34:329-343.

NSW Government (2016) *Developments Consent, Airly Mine extension project*, Department of Planning and Environment.

NSW Government (2015) *Developments Consent*, Springvale Coal Mine Underground mine extension project, Department of Planning and Environment.

Serov P. (2016) http://www.stygoecologia.com.au/aquatic.php (date accessed 14 January 2016).

WA EPA (2013) *Environmental Assessment Guideline No. 12: Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia*. Environmental Protection Authority, Western Australia.

WA EPA (2007) *Guidance for the Assessment of Environmental Factors, Sampling Methods and Survey Considerations for Subterranean Fauna* (in accordance with the Environmental Protection Act 1986), Technical appendix to Guidance Statement No. 54, Environmental Protection Authority, Western Australia.

Appendix A

All fauna collected from Airly Bores, 2016 - 2023

Sampling event	Bore ID	Date sampled	Phylum	Class	Order	Family	Genus	Habitus	No. of animals
Mar-16	AM2B-1	15/03/16	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*	*Isotomodes c.f*	*Edaphobite*	2
Dec-16	AM2B-1	02/12/16							0
Dec-16	ARP09	05/12/16	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*	*Isotomodes c.f*	*Edaphobite*	1
Feb-17	AM2B-1	17/02/17							0
Aug-17	ARP05	09/08/17							0
Aug-17	ARP09	08/08/17							0
Aug-17	ARP11	07/08/17							0
Aug-17	ARP14	08/08/17							0
Aug-17	ARP15SP	08/08/17							0
Aug-17	AM2B-1	07/08/17	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	3
Nov-18	ARP11	01/11/18	*Arthropoda*	*Maxillopoda*	*Copepoda*	*Cyclopoida*		*Phreatobite*	2
Nov-18	ARP13SP	01/11/18	*Arthropoda*	*Insecta*	*Plecoptera*	*Gripopterygidae*		*Stygoxene*	1
Nov-18	ARP14	01/11/18	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	19
Nov-18	ARP14	01/11/18	*Arthropoda*	*Arachnida*	*Trombidiformes*	*Trombidiidae*		*Edaphobite*	1
Nov-18	ARP15SP	01/11/18							0
Mar-19	ARP11	21/03/19							0
Mar-19	ARP13SP	20/03/19							0
Mar-19	ARP14	20/03/19							0
Mar-19	ARP15SP	20/03/19	*Arthropoda*	*Malacostraca*	*Amphipoda*	*Melitidae*		*Phreatobite*	3
Oct-20	ARP09	28/10/20	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	5
			Arthropoda	*Entognatha (Collembola)*	*Poduromorpha*	*Hypogastruridae*		*Edaphobite*	3
			Arthropoda	*Crustacea*	*Copepoda*	*Cyclopidae*		*Phreatobite*	1
Oct-20	ARP15SP	28/10/20	*Arthropoda*	*Crustacea*	*Amphipoda*	*Paramelitidae*		*Stygobite*	27
			Arthropoda	*Crustacea*	*Syncarida*	*Psammaspididae*		*Stygobite*	4
			Arthropoda	*Crustacea*	*Copepoda*	*Cyclopidae*		*Phreatobite*	3

Sampling event	Bore ID	Date sampled	Phylum	Class	Order	Family	Genus	Habitus	No. of animals
			Annelida	*Oligochaeta*	*Lumbriculida*	*Lumbriculidae*		*Stygoxene*	1
Oct-20	ARP13SP	28/10/20	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	1
			Arthropoda	*Crustacea*	*Copepoda*	*Cyclopidae*		*Phreatobite*	1
Oct-20	ARP14	28/10/20	*Arthropoda*	*Crustacea*	*Syncarida*	*Parabathynellidae*		*Stygobite*	42
Apr-21	ARP05	22/04/21	*Arthropoda*	*Entognatha (Collembola)*	*Poduromorpha*	*Hypogastruridae*		*Phreatobite*	1
Apr-21	ARP09	22/04/21	*Arthropoda*	*Entognatha (Collembola)*	*Poduromorpha*	*Hypogastruridae*		*Phreatobite*	6
Apr-21	ARP13SP	22/04/21							0
Apr-21	ARP14	22/04/21	*Arthropoda*	*Malacostraca*	*Bathynellacea*	*Parabathynellidae*		*Phreatobite*	6
			Arthropoda	*Entognatha (Collembola)*	*Poduromorpha*	*Hypogastruridae*		*Phreatobite*	1
Apr-21	ARP15SP	22/04/21	*Arthropoda*	*Maxillopoda*	*Cyclopoida*	*Cyclopidae*		*Phreatobite*	24
			Arthropoda	*Malacostraca*	*Anaspidacea*	*Psammaspididae*		*Phreatobite*	2
			Arthropoda	*Malacostraca*	*Amphipoda*	*Neoniphargidae*		*Phreatobite*	3
Aug-22	ARP05	23/08/22	*Arthropoda*	*Malacostraca*	*Bathynellacea*	*Parabathynellidae*	*Notobathynella*	*Phreatobite*	1
			Arthropoda	*Maxillipoda*	*Cyclopoida*	*Cyclopidae*		*Phreatobite*	1
Aug-22	ARP09	24/08/22							0
Aug-22	ARP11	23/08/22							0
Aug-22	ARP13SP	24/08/22							0
Aug-22	ARP14	24/08/22	*Arthropoda*	*Malacostraca*	*Bathynellacea*	*Parabathynellidae*	*Notobathynella*	*Phreatobite*	6
			Annelida	*Oligochaeta*	*Haplotaxida*	*Haplotaxidae*	*Haplotaxis*	*Phreatobite*	16
Aug-22	ARP15SP	24/08/22	*Arthropoda*	*Malacostraca*	*Amphipoda*	*Melitidae*	*Melita*	*Phreatobite*	2
Oct-23	ARP05	23/10/23	*Arthropoda*	*Malacostraca*	*Bathynellacea*	*Bathynellidae*		*Phreatobite*	2
			Arthropoda	*Maxillipoda*	*Cyclopoida*	*Cyclopidae*		*Phreatobite*	7
Oct-23	ARP11	23/10/23	*Arthropoda*	*Chiopoda*	*Geophilomorpha*	*Geophilidae*		*Edaphobite*	1
Oct-23	ARP13SP	23/10/23							0

Sampling event	Bore ID	Date sampled	Phylum	Class	Order	Family	Genus	Habitus	No. of animals
Oct-23	ARP14	23/10/23	*Arthropoda*	*Malacostraca*	*Bathynellacea*	*Parabathynellidae*		*Phreatobite*	4
			Arthropoda	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	2
			Arthropoda	*Entognatha (Collembola)*	*Symphypleona*	*Sminthuridae*		*Edaphobite*	1
Oct-23	ARP15SP	23/10/23							0

Appendix B

Bore photographs and surrounds

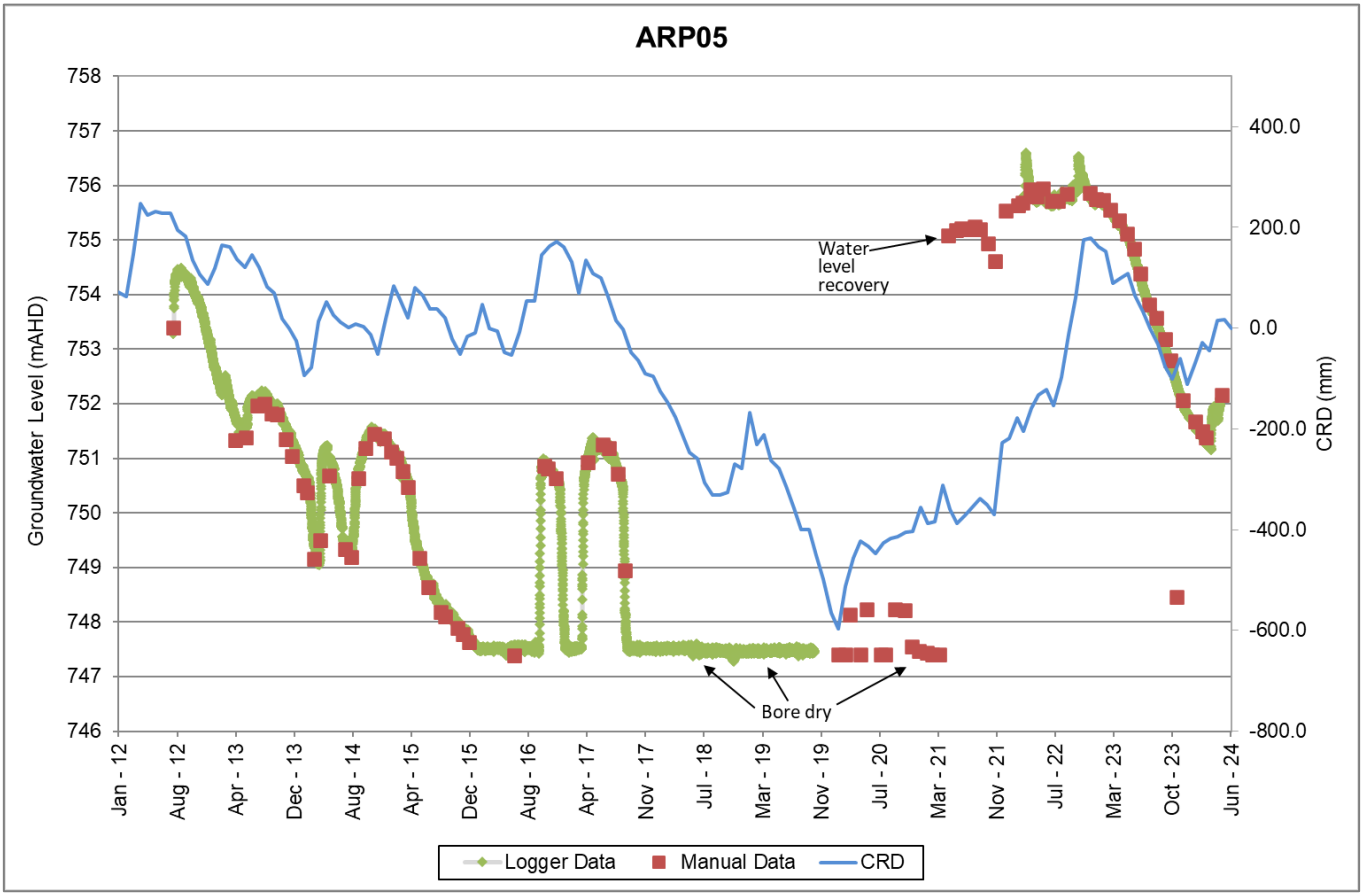
Bore	Photograph
ARP05	
ARP09	

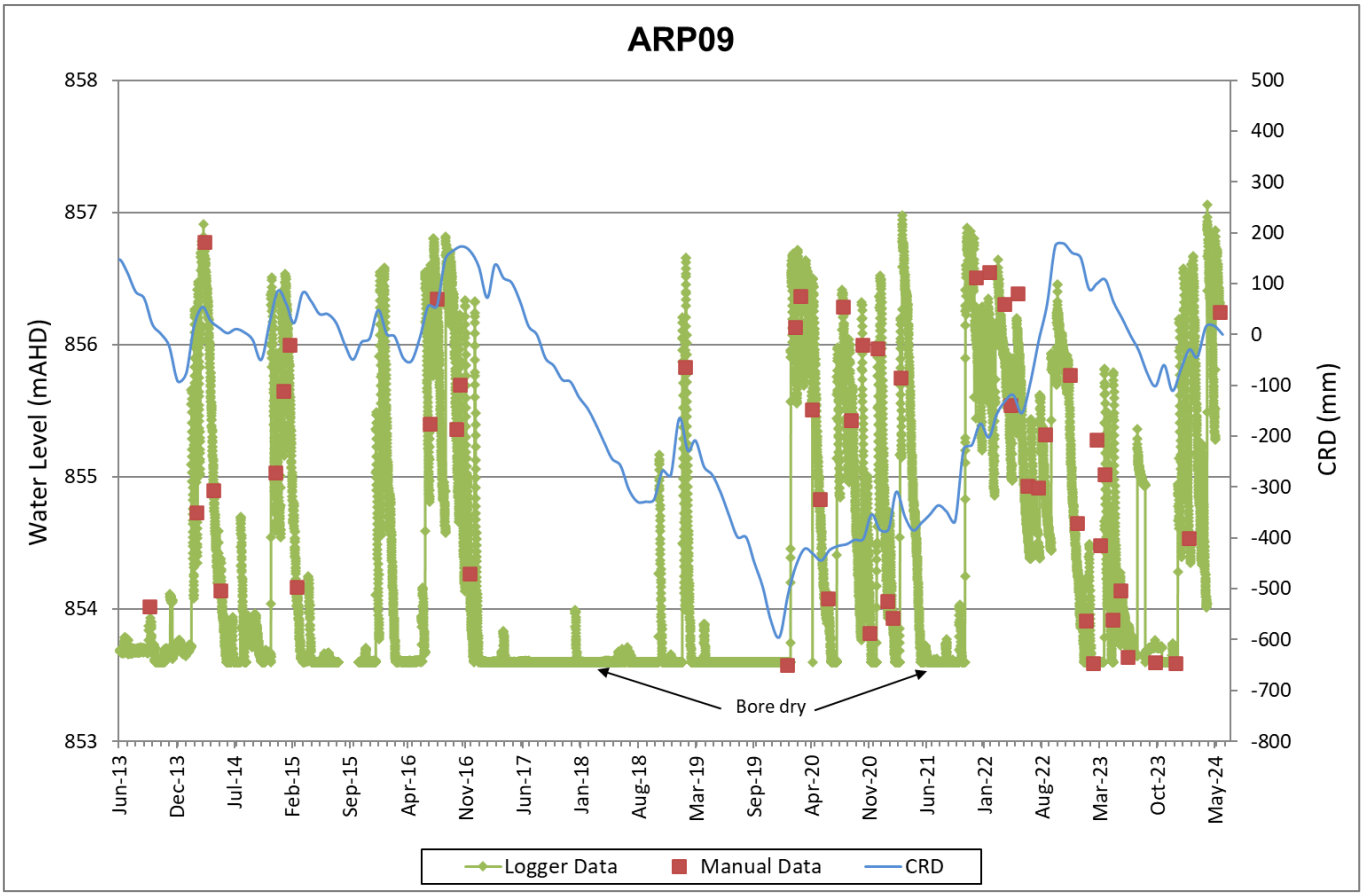
Bore	Photograph
ARP11	
ARP13SP	

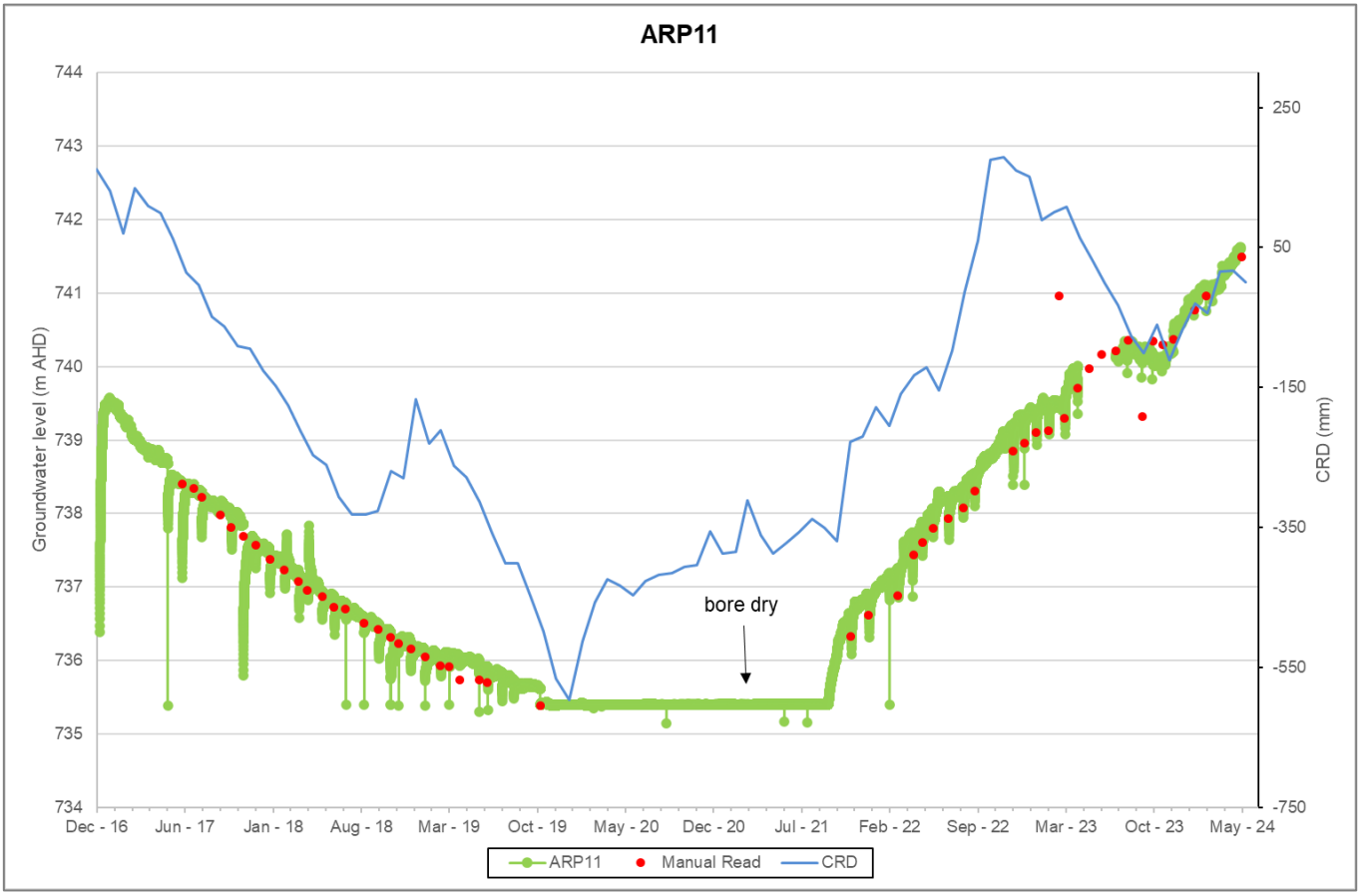
Bore	Photograph
ARP14	
ARP15SP	

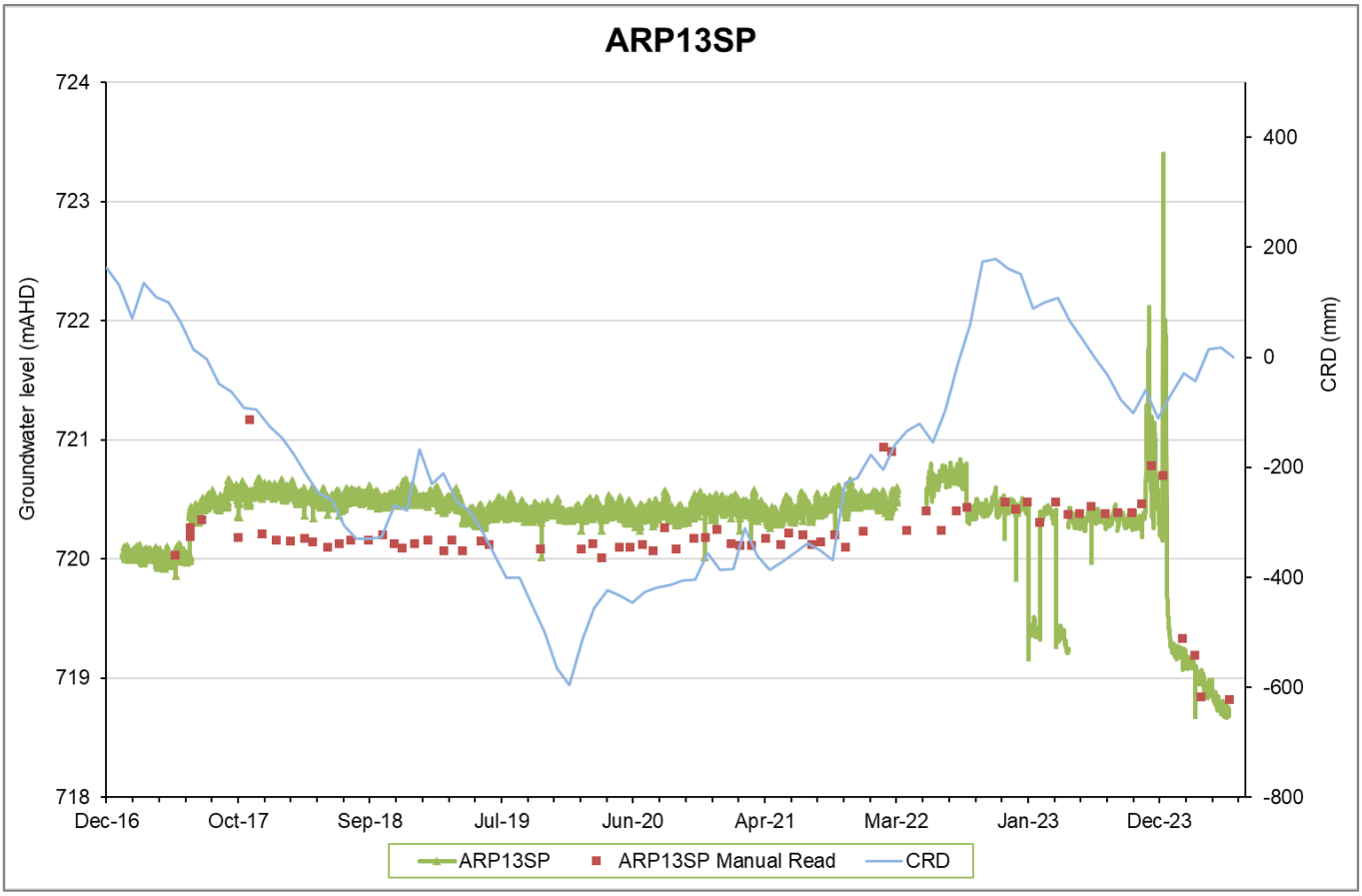
Appendix C

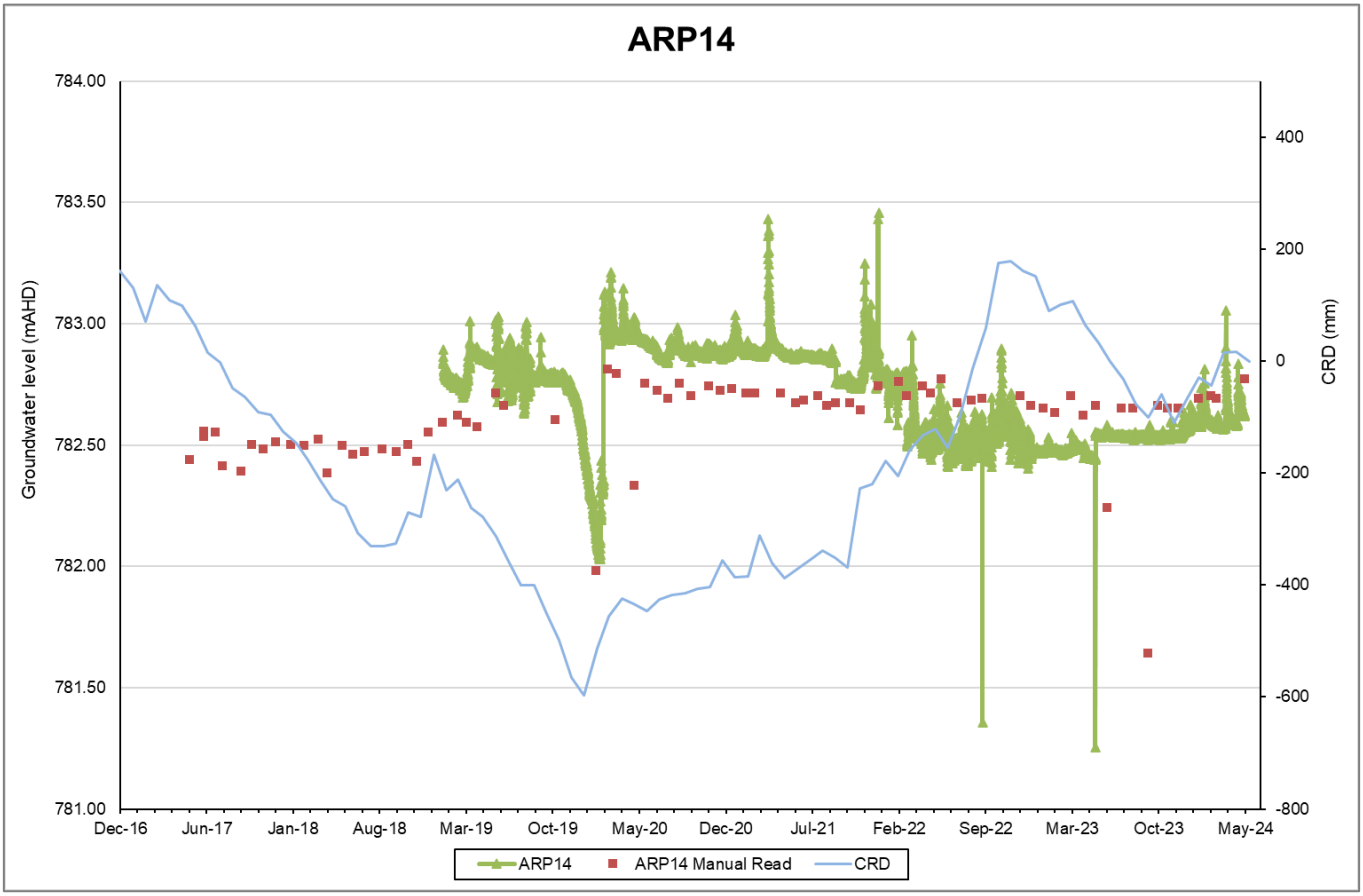
Historical water levels at Airly stygofauna bores

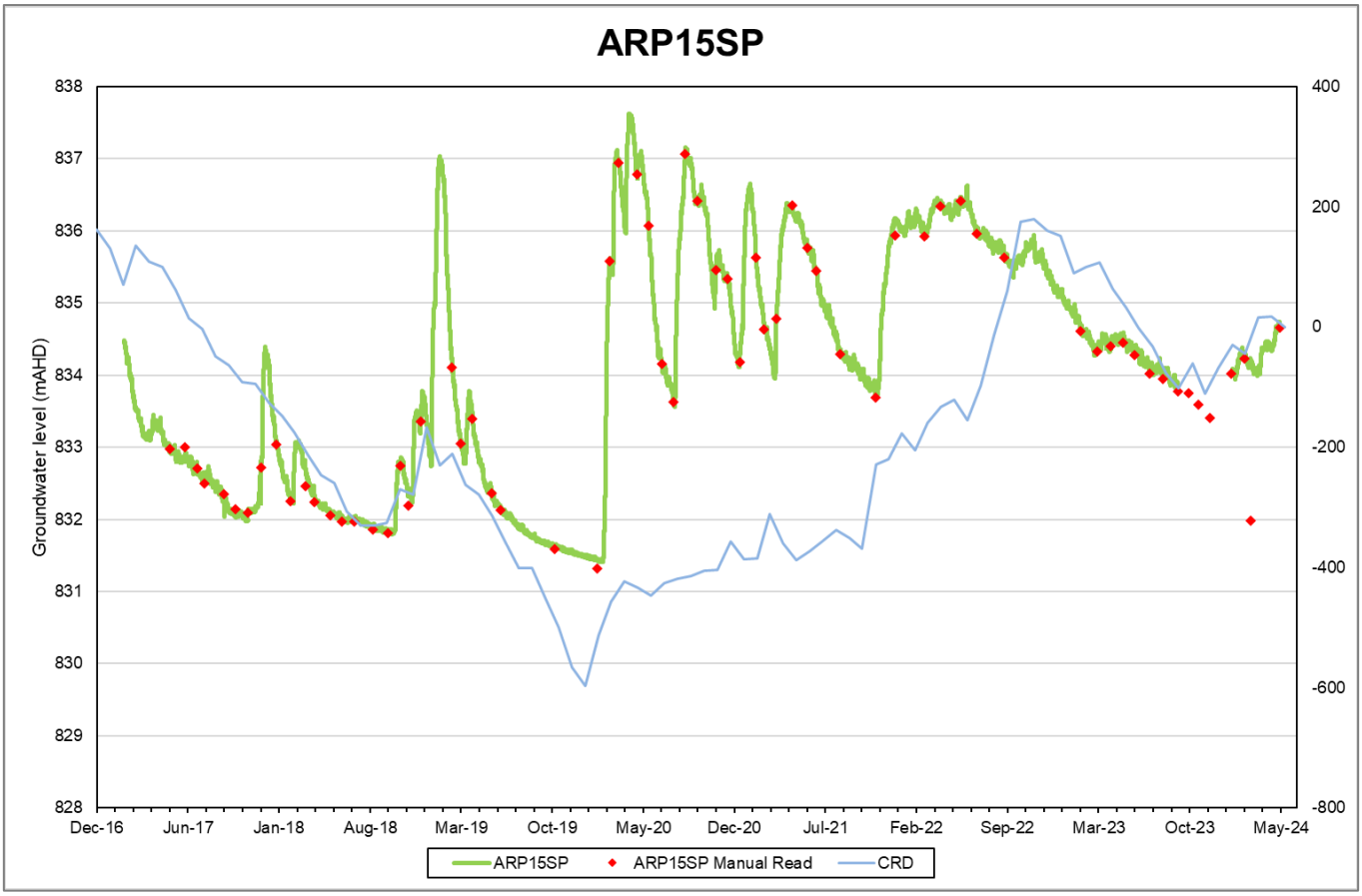

ARP05
Groundwater Level (mAHD)
CRD (mm)
Water level recovery
Bore dry
Logger Data
Manual Data
CRD


ARP09
Water Level (mAHD)
CRD (mm)
Bore dry
Logger Data
Manual Data
CRD


ARP11
Groundwater level (m AHD)
CRD (mm)
744
743
742
741
740
739
738
737
736
735
734
250
50
-150
-350
-550
-750
bore dry
Dec - 16
Jun - 17
Jan - 18
Aug - 18
Mar - 19
Oct - 19
May - 20
Dec - 20
Jul - 21
Feb - 22
Sep - 22
Mar - 23
Oct - 23
May - 24
ARP11
Manual Read
CRD


ARP13SP
Groundwater level (mAHD)
CRD (mm)
724
723
722
721
720
719
718
400
200
0
-200
-400
-600
-800
Dec-16
Oct-17
Sep-18
Jul-19
Jun-20
Apr-21
Mar-22
Jan-23
Dec-23
ARP13SP
ARP13SP Manual Read
CRD

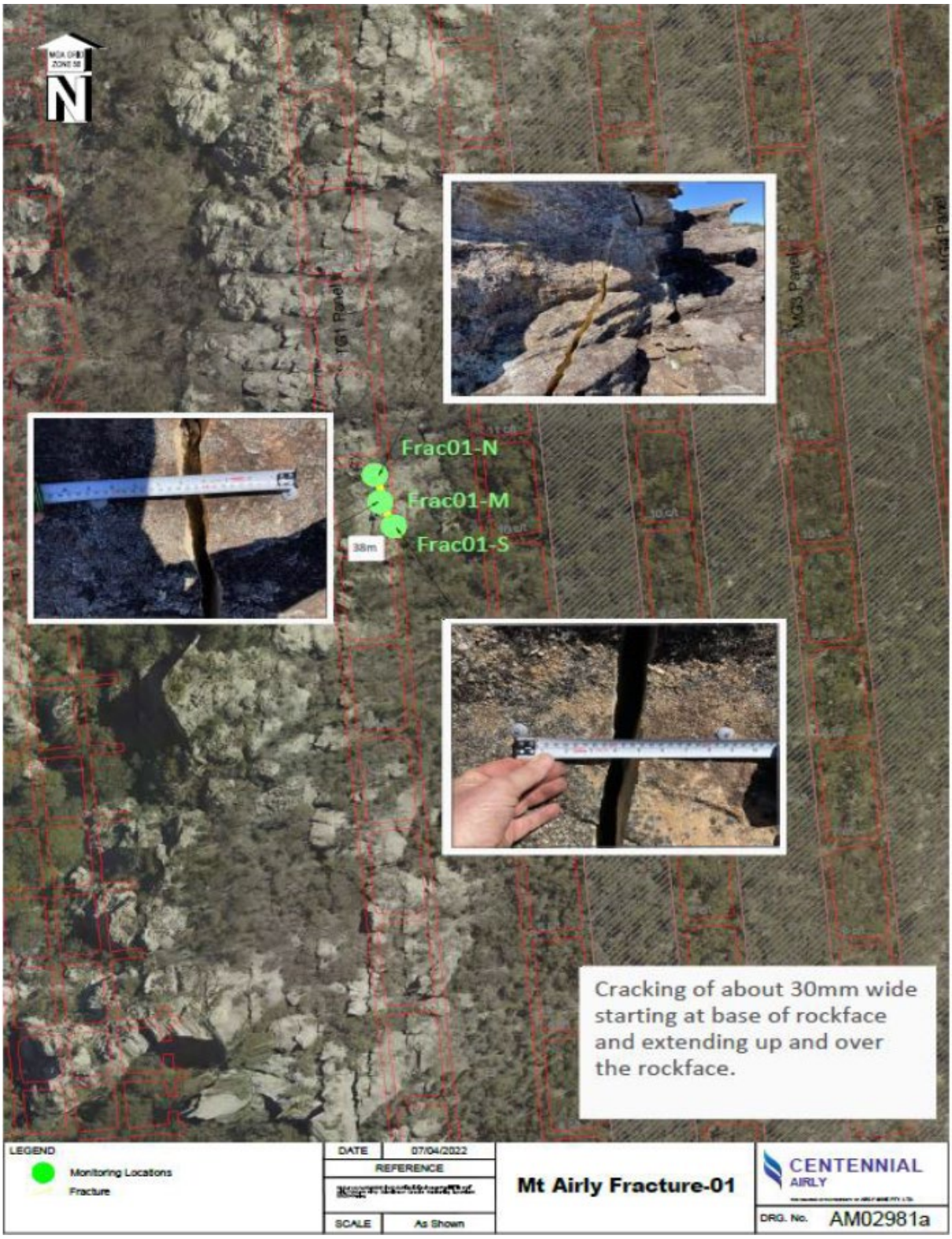

ARP14
784.00
783.50
783.00
782.50
782.00
781.50
781.00
Groundwater level (mAHD)
400
200
0
-200
-400
-600
-800
CRD (mm)
Dec-16
Jun-17
Jan-18
Aug-18
Mar-19
Oct-19
May-20
Dec-20
Jul-21
Feb-22
Sep-22
Mar-23
Oct-23
May-24
ARP14
ARP14 Manual Read
CRD

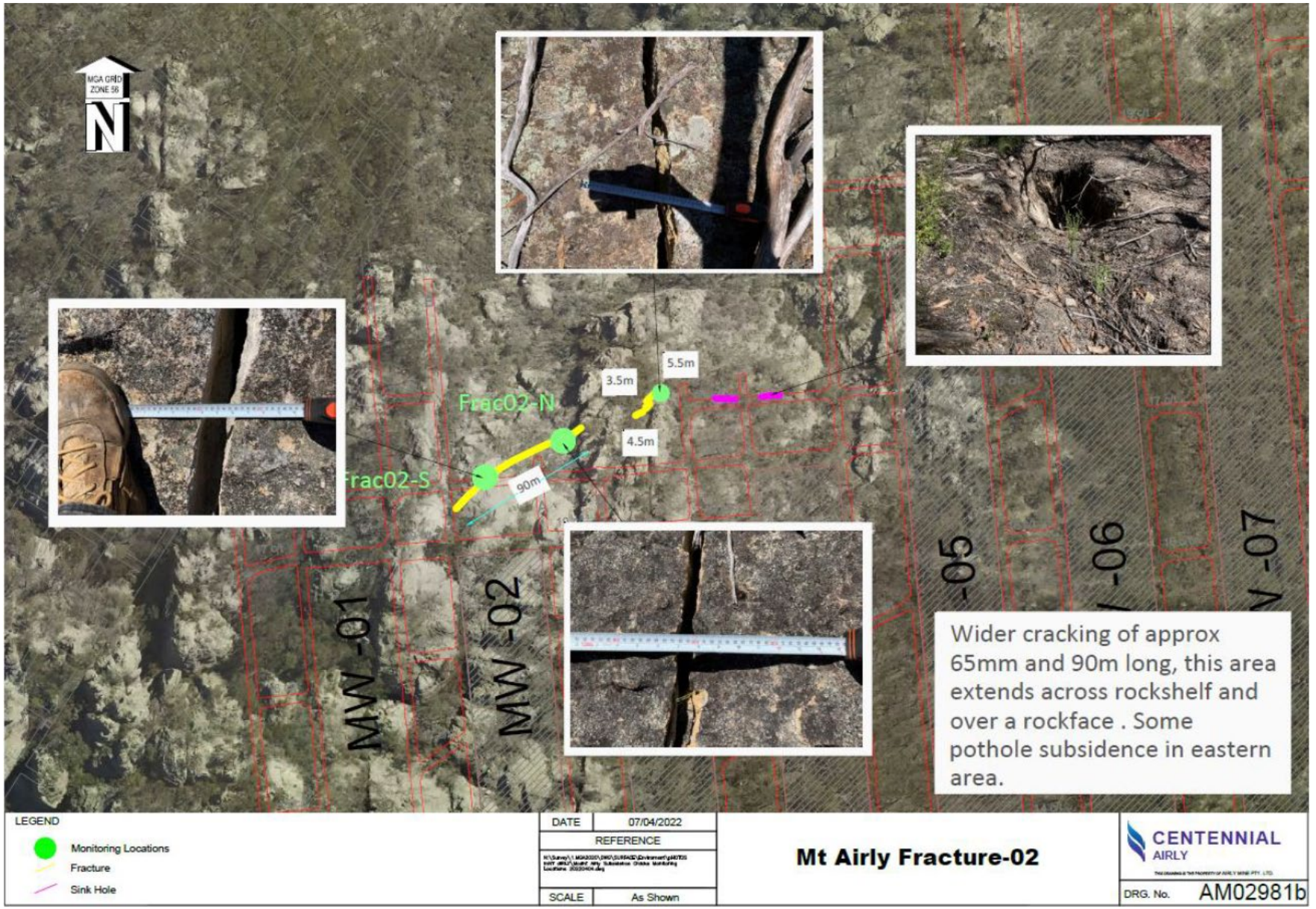

ARP15SP
838
837
836
835
834
833
832
831
830
829
828
Groundwater level (mAHD)
400
200
0
-200
-400
-600
-800
Dec-16
Jun-17
Jan-18
Aug-18
Mar-19
Oct-19
May-20
Dec-20
Jul-21
Feb-22
Sep-22
Mar-23
Oct-23
May-24
ARP15SP
ARP15SP Manual Read
CRD

ghd.com

→ The Power of Commitment

Appendix 10: Mount Airly Fracture Locations and Descriptions




MGA GRID ZONE 56
N
Frac02-N
Frac02-S
3.5m
5.5m
4.5m
90m
MW-01
MW-02
-05
-06
-07
Wider cracking of approx 65mm and 90m long, this area extends across rockshelf and over a rockface . Some pothole subsidence in eastern area.
LEGEND
Monitoring Locations
Fracture
Sink Hole
DATE
07/04/2022
REFERENCE
SCALE
As Shown
Mt Airly Fracture-02
CENTENNIAL AIRLY
DRG. No.
AM02981b


MGA GRID ZONE 56
N
209
10m
Frac07-S
Frac06-02
16m
Frac06-01
MG4 Panel
MG5 Panel
MG8 Panel
MG9 Panel
Cracking over rockface/pagodas 10mm-20mm wide.
Accessibility significantly more difficult.
LEGEND
Monitoring Locations
Fracture
Sink Hole
DATE 07/04/2022
REFERENCE
SCALE As Shown
Mt Airly Fracture-06 & Fracture-07
CENTENNIAL AIRLY
DRG. No. AM02981c


Narrow cracking extending over along distance over a number of pagodas
MW -08
MW -09
MW -10
147m
Frac10-02
66m
21m
Frac10-01
147m
MG11 Panel
MG12 Panel
Narrow cracking extending over a number of pagodas.
LEGEND
Monitoring Locations
Fracture
DATE
07/04/2022
REFERENCE
SCALE
As Shown
Mt Airly Fracture-10
CENTENNIAL AIRLY
DRG. No.
AM02981d



Centennial Coal Company Limited
P O Box 1000
Toronto NSW 2283
www.centennialcoal.com.au