CENTENNIAL COAL

Clarence Colliery

2024 ANNUAL REVIEW

March 2025

Annual Review Title Block

Name of Operation	Clarence Colliery
Name of Operator	Clarence Colliery Pty Limited
Development Consent/ Project Approval #	DA 504-00
Name of holder of Development Consent/ Project Approval	Centennial Coal Company Limited
Mining Lease #	CCL705, ML1353, ML1354, ML1583, ML1721, (A307, A416, A451, EL5072)
Name of Holder of Mining Lease	Coalex Pty Ltd & Clarence Coal Investments Pty Ltd
Water License #	WAL 36479, WAL 41882
Name of Holder of Water License	Coalex Pty Limited & Clarence Coal Investments Pty Limited
RMP Start Date	1 August 2022 to perpetuity (RMP Version 1.2 dated 29 November 2023)
Annual Review Start Date	1 January 2024
Annual Review End Date	31 December 2024

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

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	Dennis Wallace
Title of Authorised Reporting Officer	Mine Manager
Signature of Authorised Reporting Officer	
Date	31 March 2025

Contents

List of Tables

List of Figures

Plans

Appendices

1 STATEMENT OF COMPLIANCE

The compliance status of Clarence Colliery in 2024 is provided in **Table 1-1**. There were twelve (12) non-compliances during the Reporting Period.

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 504-00	**No**
Development Consent IRM.GE.76	**Yes**
Development Consent 174/93	**Yes**
Mining Lease (ML) 1353	**Yes**
ML 1354	**Yes**
ML 1583	**Yes**
ML 1721	**Yes**
CCL 705	**Yes**
Authorisation (A) 307	**Yes**
A 416	**Yes**
A 451	**Yes**
Exploration Lease (EL) 5072	**Yes**
Environmental Protection Licence (EPL) 726	**No**
Water Access Licence (WAL) 36479	**Yes**
WAL 41882	**Yes**
Subsidence Management Plan (SMP) Approvals	**Yes**
Statement of Commitments	**Yes**

Table 1-2: 2024 Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Where Addressed in Annual Review
EPL 726	L2.1	Water and/or Land Concentration Limits	Non-compliant	Exceedances of concentration limits specified in condition L2.4 at EPL Point 2 (LDP002) during the Reporting Period in January, February, March, May, June, July, August, September October, November and December.	**Section 7.3.2** and **Section 11**
DA 504-00	DA 504-00 Schedule 3, Condition 9(b)	Surface water impact assessment criteria;			
EPL 726	L2.4	Water and/or Land Concentration Limits	Non-compliant	Non-compliance with Condition L2.4 due to a dirty water discharge on 5 to 6 April 2024	**Section 11**
EPL 726	M2.3	Water and/or Land Monitoring Requirements	Non-compliant	Unable to comply with continuous monitoring of pH and Conductivity at Point 9	**Section 11**
EPL 726	M8.1	Requirement to Monitor Mass	Non-compliant	Did not estimate discharge volume/flow for point 3 (on 6/4/2024 and 8/4/2024) and point 4 (on 6/4/2024), as required in condition M8.1	**Section 11**

Note: Compliance Status Key for Table 1-2

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 the government later than required under approval conditions)

2 INTRODUCTION

Clarence Colliery is an underground coal mining operation located within the NSW Western Coalfields (**Figure 2-1**). Up to 3 million tonnes per annum (Mtpa) of coal is extracted from the Katoomba Seam using the bord and pillar partial extraction method, supplying coal to both domestic and export markets. Up to 300,000 tonnes per annum (tpa) of coal products are transported by road in total. Operations at Clarence Colliery commenced in 1979.

Clarence Colliery Pty Limited (Clarence) operates Clarence Colliery under two Lithgow City Council (LCC) development consents and one State Government development consent. Development Consent IRM.GE.75 was granted in 1976 to allow the extraction of coal from the Katoomba Seam and was modified in 1993 to amend the Reject Emplacement Areas (REAs) proposed in the original Environmental Impact Statement (EIS). Development Consent 174/93 was granted in 1994 to extend underground coal mining operations and upgrade REAs, water management facilities and ancillary structures within the Clarence Colliery Pit Top and was amended in 2019 to allow changes to REA III design. Development Consent DA 504-00 was granted in 2005 to expand operations and convert four exploration tenements into a new mining lease (ML 1583). There have been ten modification applications, the most recent modification 10 (MOD10) was granted in May 2024.

The Clarence Colliery holding includes Consolidated Coal Lease (CCL) CCL 705 and Mining Leases (ML) ML 1353, ML 1354, ML 1583 and ML 1721. Clarence Colliery undertake exploration activities in accordance with Exploration Licence (EL) 5072 and Authorisation (A) A307, A416 and A451. Underground mining at Clarence Colliery is undertaken in accordance with approved Subsidence Management Plans[1] (SMPs) which are prepared to satisfy the requirements of relevant mining authorities. Clarence operates under Environmental Protection Licence (EPL) 726, issued under the *Protection of the Environment Operations Act 1997* (POEO Act). The licence has an anniversary date of 1 January and allows three licenced discharge points (LDPs) and requires three dust monitoring points.

2.1 SCOPE

This Annual Review (AR) details the compliance and environmental management performance of Clarence over the Period 1 January 2024 to 31 December 2024. It has been prepared to demonstrate the site's performance and community engagement activities for Clarence. The AR has been prepared in accordance with the *Annual Review Guideline* (DPIE 2015), and satisfies:

- Schedule 5, Condition 5 of DA 504-00;
- Schedule A, General Terms of Approval of IRM. GE 76; and
- Reporting requirements of Extraction Plans / Subsidence Management Plans.

Subject to approval from the Department of Planning, Housing and Infrastructure (DPHI), this AR will be available at the Centennial Clarence website https://www.centennialcoal.com.au/operations/clarence/

[1] MOD 7 approved the incorporation of Extraction Plan conditions to DA 504-00 to apply to areas that are not covered by an existing Subsidence Management Plan (refer to **Section 3.1.2**).

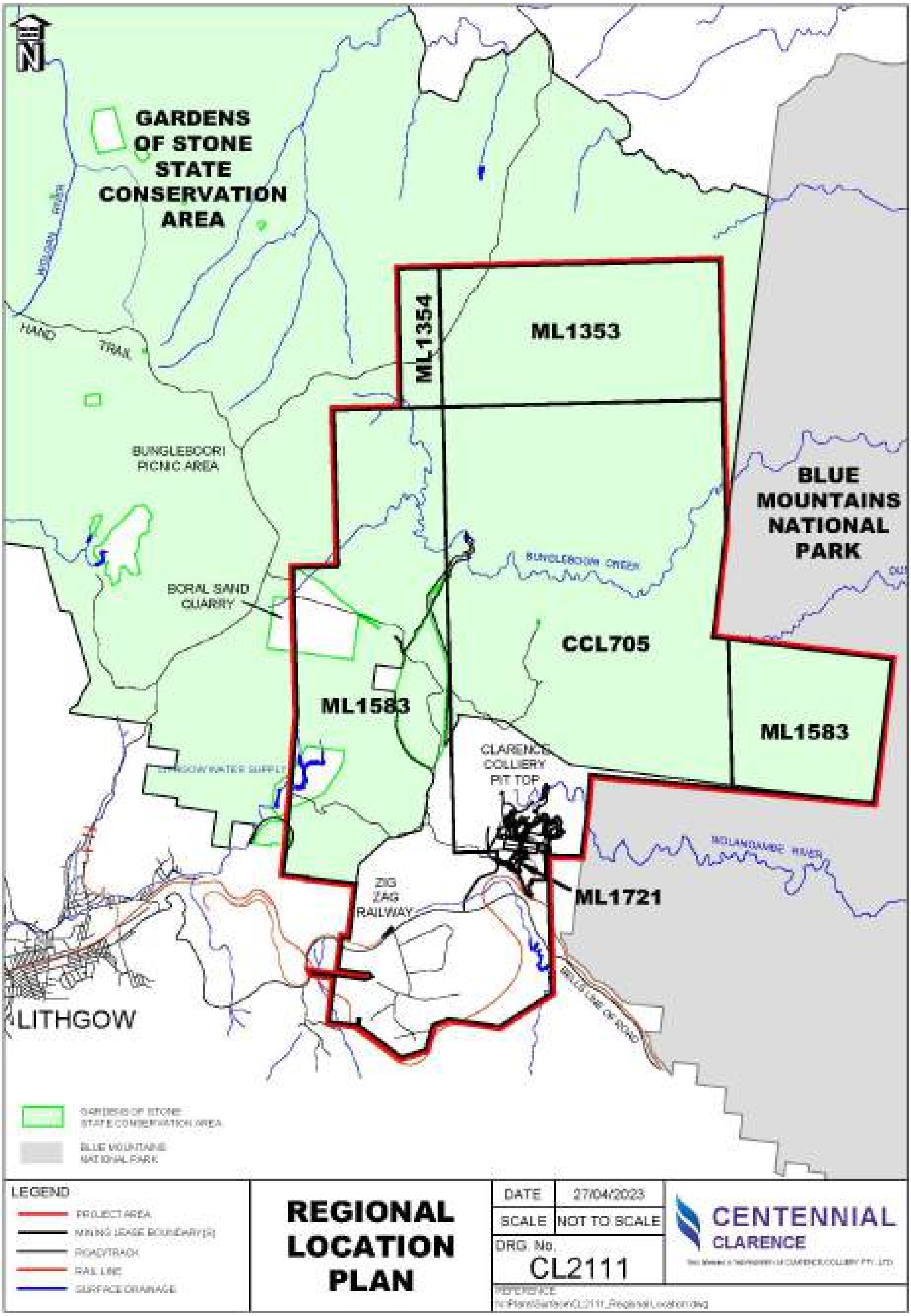


Figure 2-1: Regional Context & Site Layout

2.2 MINE CONTACTS

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

Table 2-1: Clarence Environmental Contact Details

Name	Position	Contact Details
Dennis Wallace	Mine Manager	T: 02 6353 8033
		E: dennis.wallace@centennialcoal.com.au
Matt Ribas	Environment & Community Coordinator	T: 02 6353 8039
		E: matt.ribas@centennialcoal.com.au
Community Information and Complaints Line		T: 02 6353 8010

3 APPROVALS

3.1 PROJECT APPROVALS, MINING AUTHORISATIONS, AND OTHER LICENCES

A summary of Project Approvals, Mining Authorisations, and other Licences relevant to Clarence Colliery is provided in **Table 3-1**. Current Project Approvals, EPBC Approvals, Exploration Licences, and Mining Leases are available on the Clarence Colliery website.[1]

Table 3-1: Environmental Approvals held by Clarence Colliery

<table>
<tr><th>Approval</th><th>Description</th><th>Expiry Date</th><th>Change during Reporting Period (Y/N)</th></tr>
<tr><td colspan="4">Development Consent - Lithgow City Council</td></tr>
<tr><td rowspan="3">IRM.GE.76</td><td>Original development consent – construction of surface infrastructure and mining operation</td><td rowspan="3">Perpetuity</td><td rowspan="3">No</td></tr>
<tr><td>MOD 1 – amend the REAs</td></tr>
<tr><td>MOD 2 – REA 3 decommissioning and rehabilitation</td></tr>
<tr><td rowspan="2">Development Consent 174/93</td><td>Extension of underground coal mining and surface REAs</td><td rowspan="2">Perpetuity</td><td rowspan="2">No</td></tr>
<tr><td>MOD 1 - Relocation of REA 5 access and associated vegetation clearing</td></tr>
<tr><td colspan="4">Development Consent - NSW Department of Planning, Housing and Infrastructure (DPHI),</td></tr>
<tr><td rowspan="10">Development Approval DA 504-00</td><td>Extension of the Clarence Underground Coal Mine</td><td rowspan="10">31/12/2026</td><td rowspan="10">Yes</td></tr>
<tr><td>MOD 1 – Increased Road haulage (withdrawn)</td></tr>
<tr><td>MOD 2 – REA VI</td></tr>
<tr><td>MOD 3 – Road haulage to the west</td></tr>
<tr><td>MOD 4 – Road haulage to Mt Piper Power Station</td></tr>
<tr><td>MOD 5 – Manning increase</td></tr>
<tr><td>MOD 6 – CCR transfer to Charbon via rail</td></tr>
<tr><td>MOD 7 – Addition of Extraction Plan conditions</td></tr>
<tr><td>MOD 9 - Temporary Coal Transport Modification</td></tr>
<tr><td>MOD 10 – Coal Transport Modification</td></tr>
<tr><td colspan="4">Subsidence Management Plans</td></tr>
<tr><td>SMP</td><td>700 Area (Variation 6)</td><td>01/06/2025</td><td>No</td></tr>
<tr><td>SMP</td><td>900 Area (Variation 6)</td><td>24/12/2025</td><td>No</td></tr>
</table>

[1] https://www.centennialcoal.com.au/operations/clarence/

Approval	Description	Expiry Date	Change during Reporting Period (Y/N)
SMP	800 Area (Variation 9)	2/12/2025	Yes (Refer to **Section 6.8**)
Mining Leases – NSW Resource Regulator (RR)			
ML 1353	Title to Northern Mining Area includes some surface land, some environmental conditions	21/07/2036	No
ML 1354	Title to Mining Area adjacent to ML1353 includes some surface land, some environmental conditions	21/07/2036	No
ML 1583	Title to 700 & 800 Area Workings include some surface land, some environmental conditions	9/07/2027	No
ML 1721	Surface Lease to some of the Pit Top Areas includes some environmental conditions	7/12/2036	No
Consolidated Coal Leases (CCL) - RR			
CCL705	Title to Central Workings includes some surface land, some environmental conditions	20/12/2026	No
Exploration Authorisations - RR			
Exploration Licence (EL) EL5072	Exploration License for 800 area	31/07/2022[1]	No
Authorisation 307	Exploration License for Southern areas of Workings	24/08/2019[1]	No
Authorisation 416	Exploration License for Western area of Workings	24/08/2025	No
Authorisation 451	Exploration License for Northern area of Workings	24/08/2019[1]	No
Rehabilitation Management Plan (RMP) – RR			
RMP	RMP as required by the Mining Amendment Regulation & DA 504-00	Perpetuity (Version Date 29/11/2023)	No (refer to **Section 3.1.1**)
Environmental Protection Licence - NSW Environment Protection Agency (EPA)			
EPL726	Environment Protection Licence	Renewed Annually 1st of January	No
Water Licences – DPHI Water			
Bore Licences			
CLRP1	10BL161964	Perpetuity	No
CLRP2	10BL161965		No
CLRP3	10BL602213		No
CLRP4	10BL161962		No

Approval	Description	Expiry Date	Change during Reporting Period (Y/N)
CLRP5, CLRP7, CLRP10	10BL602211		No
CLRP6	10BL602212		No
CLRP 12	10BL604063		No
CLRP 11, 13, 14	10BL604099		No
CLRP 17, 20	10BL605316		No
CC114	10BL602819		No
HV1, HV2, HVU1, HVU2	10BL603337		No
Bore Licence	10BL605494		No
CLRP18, 22	10BL605612		No
CLRP40, 42	10BL605941		No
CLRP 41	10BL605936		No
Bore Licence	10BL156676		No
Bore Licence	10BL161963		No
Water Supply Works			
Surface Licence Main Dam	10WA118714	30/06/2034	Yes (Renewal)
WAL 36479	10WA118758	11/12/2027	No
Water Supply Works	10WA10715	18/05/2026	No
Water Access Licence			
Water Access Licence	10AL122285	Perpetuity	No
Water Access Licence	WAL41882		No
Water Access Licence	WAL36479		No
Joint Water Supply Works			
Joint Water Supply Works	10WA103852	29/07/2027	No
Joint Water Supply Works	10UA103853	29/07/2027	No
Surface Authority			
Surface Authority	10SA001409	30/09/2017	No

Approval	Description	Expiry Date	Change during Reporting Period (Y/N)
Threatened Species Licenses – DCCEEW Biodiversity, Conservation and Science Directorate (BCS)			
Section 95 Certificate C0002449	Installation and operation of two shallow piezometers within Paddy's Swamp	31/12/2026	No
Threatened Species Licence C0003012	Installation and operation of one shallow piezometer within Oleria Swamp	22/09/2022	No
Threatened Species Licence C0004884	Installation of two shallow piezometers and two soil moisture probes within Pagoda Swamp	31/12/2026	No
Threatened Species Licence C0006510	Installation and operation of 14 shallow piezometers	31/12/2026	No
Threatened Species Licence C0006729	Installation and operation of 16 shallow piezometers	31/12/2026	No
State Rail Authority			
Q648-100	Access Agreement	Life of Rail Loop	No
WorkCover Authority NSW			
NDG020999	Dangerous Goods Permit	Perpetuity	No
NSW EPA			
RML 5078394	Radiation Management Licence	08/02/2025	Yes (Renewal)

Notes: [1] Expired ELs, renewals sought.

3.1.1 Changes During the Reporting Period

The following changes to Approvals, Mining Tenements, and other Licences occurred during the Reporting Period:

- Modification 9 to DA504-00 was approved on 17 May 2024. This modification was to continue to allow increased trucking of coal until 31 December 2026.

3.1.2 Extraction Plan / Subsidence Management Plan Status

Subsidence Management Plans (SMPs) were a condition of the mining leases and approved under the *Mining Act 1992*. Underground mining at Clarence Colliery is undertaken in accordance with approved SMP which are prepared to satisfy the requirements of relevant mining authorities (refer to **Table 3-1**).

During the reporting period Variation 9 to the 800 SMP was approved by the Resources Regulator on 20 December 2024.

At the time of preparing this 2024 Annual Review, a new Extraction Plan for the 918 Panel was under preparation and anticipated for submission into DPHI for approval in the next Reporting Period.

3.2 ANNUAL REPORTING REQUIREMENTS

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

In accordance with Schedule 5, Condition 11, of DA 504-00 a copy of the 2024 Annual Review, once approved by the DPHI, will be provided on the Clarence website: https://www.centennialcoal.com.au/operations/clarence/

4 OPERATIONS SUMMARY

4.1 PRODUCTION

Details of production and associated waste generated by the site for the reporting period and the next reporting are provided in **Table 4-1**. A summary of the other operations and coal processing, handling and transport relevant to Clarence Colliery is provided in **Table 4-2**. 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 (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Waste Rock / Overburden	N/A	N/A	N/A	N/A
ROM Coal	3,000,000 TPA	955,629 (T)	928,758 (T)	1,282,325 (T)
Coarse reject	250,000 TPA*	105,299 (T)	109,982 (T)	196,046 (T)
Fine reject (tailings)	N/A	0	0	0
Saleable Product	N/A	847,288 (T)	817,741 (T)	1,061,279 (T)

TPA = Tonnes Per Annum.
*Approval limit of 250,000T Coarse Coal Rejects (CCR) applies to emplacement within REA IV only.

Table 4-2: Other Operations

Approved Operation	Approved Limit	Previous Reporting Period (Actual)	This Reporting Period (Actual)
Hours of Operation	24/7	24/7	24/7
Transport (rail)	N/A	836,376 (T)	813,595 (T)
Transport (road)	300,000 TPA*	130,907 (T)	56,295 (T)

24/7 = 24hrs a day/7 days a week.
TPA = Tonnes Per Annum.
* in accordance with Condition 7AA in Schedule 2 of DA 504-00, until 31 December 2026, Clarence may transport up to 300,000 tonnes of coal by road per calendar year in total, including up to 200,000 tonnes of coal by road per calendar year to the Mount Piper Power Station or to the Lidsdale Siding, and up to 200,000 tonnes of coal by road per calendar year to locations north of Sydney or Eastern NSW

Table 4-3: Coal Processing, Handling and Transport Summary

Month	Product Transported via Rail	Product Transported via Road
January 2024	37,414	920
February 2024	64,032	8,721
March 2024	92,600	5,714
April 2024	98,682	3,190
May 2024	57,799	3,678
June 2024	85,592	13,949
July 2024	64,478	9,148
August 2024	64,206	4,683
September 2024	74,766	5,757
October 2024	63,769	5,139
November 2024	52,999	4,050
December 2024	57,258	4,067
Total 2024	**813,595**	**56,295**

4.2 MINING OPERATIONS

During 2024, the following mining activities included:

- 800 Area
  - Development of the 806A Mains Panel continued and completed;
  - Development of the 806A Panel was commenced and completed;
  - Development of 830 Panel was completed;
  - Development of 832 Panel was completed;
  - Development of 834 Panel was commenced;
  - Extraction of 804 Panel (limited to 52-70 cut through) commenced and completed;
- 900 Area
  - Development of the 918 Panel continued; and
  - Development of 919 Panel continued.

The mining activities completed during the Reporting Period are displayed in **Plan 1**.

REA V stage 2 remained in operational use during the 2024 reporting period with all activities undertaken being within the HRA consent conditions as submitted in August 2016.

4.3 EXPLORATION

There was no exploration completed for Clarence in 2024.

4.4 LAND DISTURBANCE

There was no land disturbance outside of the REA V stage 2 design boundary and construction was completed as per the HRA consent conditions.

4.5 CONSTRUCTION

There were no construction activities at the site during the Reporting Period.

4.6 NEXT REPORTING PERIOD

During 2025, the following mining activities plan to be undertaken:

- Development and extraction of the 804 panel;
- Development and extraction of the 806A panel;
- Development of the 834 panel;
- Development of the 918 panel; and
- Development of the 900 Mains

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

Table 5-1 Summarises the outcomes of the 2023 Annual Review, including actions issued by the relevant government departments and actions taken by Clarence.

Table 5-1: Actions from Previous Annual Review

Action Required	Requested By	Action Taken	Annual Review Section
Regulator Requirements			
Make publicly available a copy of the 2023 Annual Review on the company website.	DPHI	The 2023 Annual Review is available on the Clarence website	**NA**
2023 Annual Review			
Conduct a sound power level assessment during the reporting period to determine possible areas of improvement associated with the equipment currently in service at Clarence.	Clarence	Assessment completed in May 2024	**Section 12**
Further consultation with DPHI regarding the latest revision to the WRBMP (Version 6).	Clarence	The WRBMP was submitted in July 2023 with the current RFI open to amend the document by April 2025	**Section 6.6**

6 ENVIRONMENTAL PERFORMANCE

Clarence 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, Clarence undertakes a comprehensive monitoring program. The environmental monitoring program is shown in **Figure 6-1**.

This section provides a summary of environmental performance in the Reporting Period, including:

- **Section 6.1** – Meteorological Summary
- **Section 6.2** – Noise
- **Section 6.3**– Blasting
- **Section 6.4**– Air Quality
- **Section 6.5** – Greenhouse Gas
- **Section 6.6** – Biodiversity
- **Section 6.7** – Heritage
- **Section 6.8**– Subsidence

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

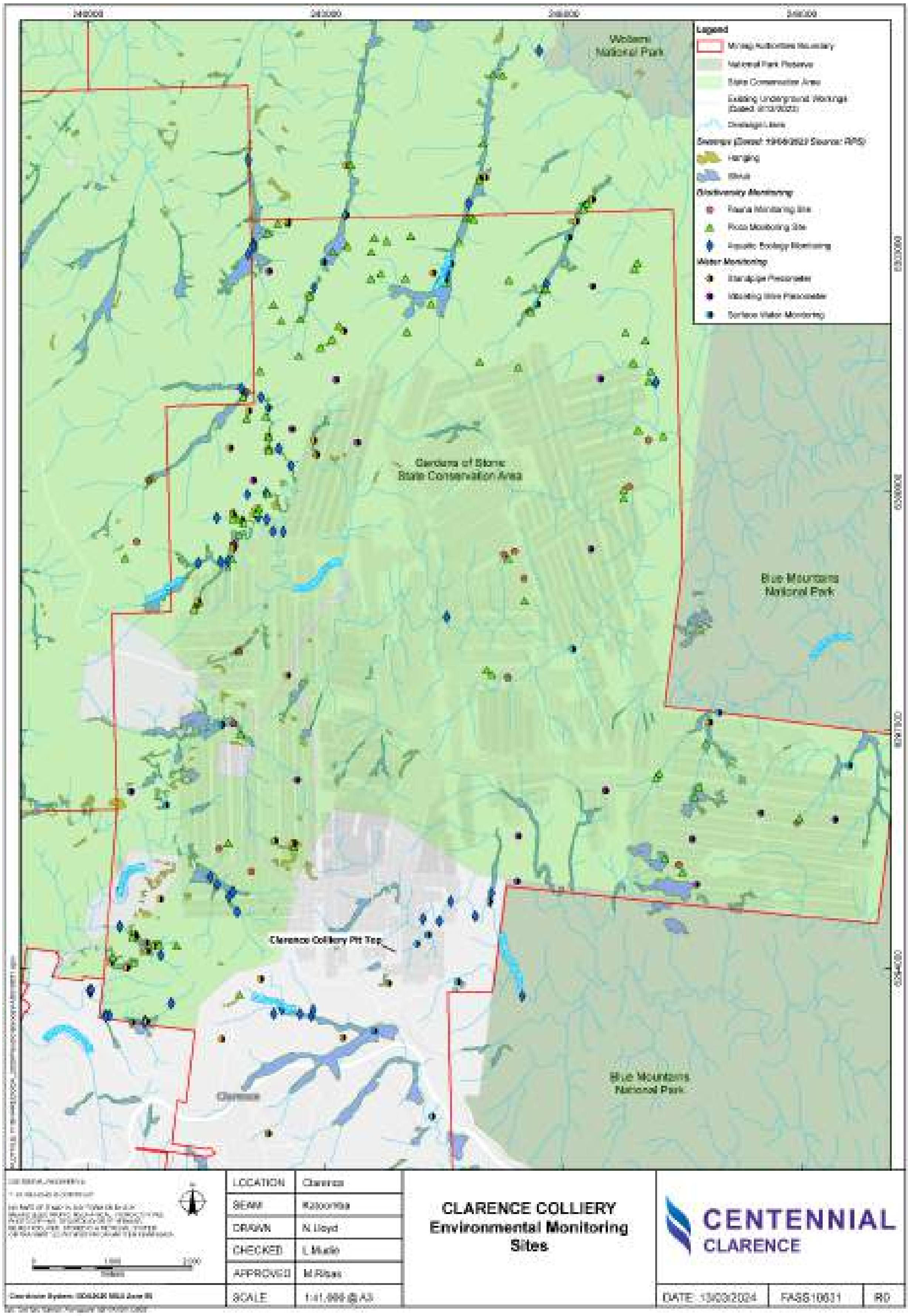


Figure 6-1: Clarence Environmental Monitoring Program

6.1 METEOROLOGICAL SUMMARY

Meteorological monitoring is undertaken at the Clarence Automated Weather Station (AWS). The weather station is required under M5.1 of EPL726 and Schedule 3, Condition 17 of DA 504-00.

A meteorological summary is presented below in **Table 6-1** and graphically in **Figure 6-2.** Clarence AWS recorded a total rainfall of 914.8mm during the Reporting Period. April had the highest rainfall of 169.4mm, with the lowest rainfall of 26.2mm recorded during August. The minimum temperature at Clarence Colliery was during June at -1.9°C. The maximum recorded temperature was 33.3°C during February.

Wind direction and speed are continuously measured at the Clarence AWS. The wind direction was predominantly from the west-south-westerly direction throughout the Reporting Period. These trends are displayed in **Figure 6-3.**

Table 6-1: Meteorological Summary at Clarence Colliery

Month (2024)	Rainfall (mm)	Cumulative Rainfall (mm)	Min Temperature (Deg C)	Max Temperature (Deg C)
January	124	124	9.4	31.6
February	81.8	205.8	9.7	33.3
March	30	235.8	7.3	29.6
April	169.4	405.2	3.6	26.5
May	99.2	504.4	1.2	17.9
June	71.2	575.6	-1.9	14.7
July	71.4	647	-1.2	15.5
August	26.2	673.2	-0.5	20.2
September	30	703.2	-1.6	28.0
October	53.6	756.8	3.2	25.6
November	131	887.8	5.8	31.9
December	27	914.8	7.5	31.8

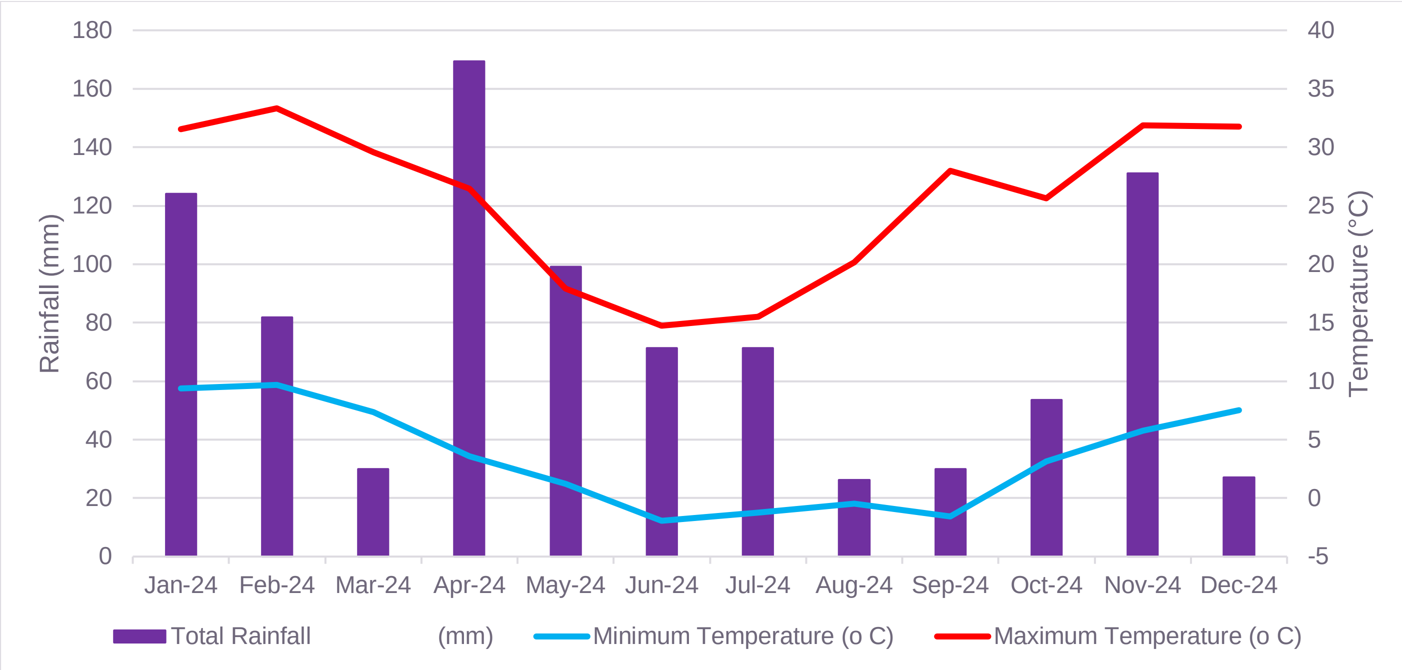


Figure 6-2: 2024 Rainfall and Temperature Summary

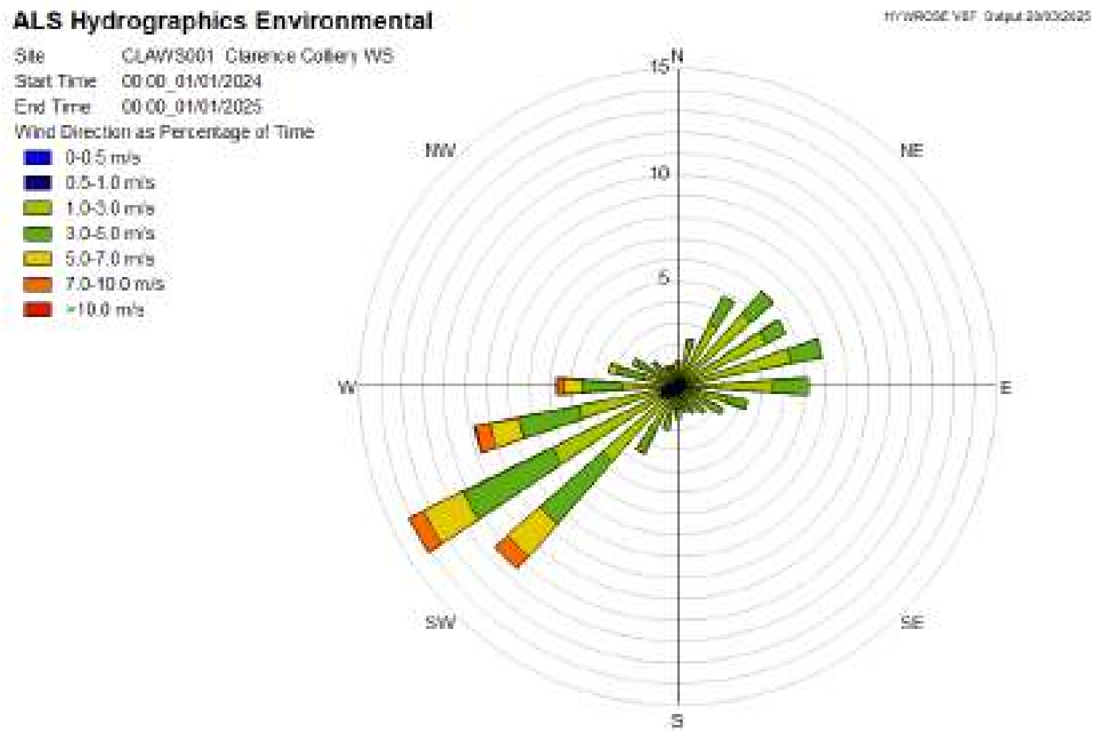


Figure 6-3: Wind Rose Plot for Clarence AWS 2024

6.2 NOISE

6.2.1 Environmental Management

Clarence manages noise in accordance with the Western Region Noise Management Plan (WRNMP). This plan was approved by DPHI in November 2021. The following sources of noise identified in the WRNMP are relevant for Clarence Colliery operations:

- Operation of mobile equipment – e.g. trucks, dozers, loaders;
- Coal handling and preparation plant (CHPP);
- Train loading operations and rail loop;
- Coal transporting activities – e.g. overland conveyors, haul trucks, rail; and
- Ventilation fans.

Key noise mitigation measures for Clarence Colliery include:

- Maintaining all plant and equipment to manufacturer specifications.
- Operate mobile plant in a quiet, efficient manner and regular training of operators.
- Installation of frequency-modulated reversing alarms or "Quakers" on mobile plant to replace reversing alarms.
- Installing acoustic enclosures around processing plants, and
- Switching off vehicles and plant when not in use.

6.2.2 Environmental Performance

In accordance with DA 504-00 and EPL726 noise monitoring is undertaken annually at CNM1 as required by the WRNMP. Clarence's annual monitoring (attended) commenced on Monday 16 December 2024 and concluded on Friday 27 December 2024. Supplementary attended noise monitoring was also conducted at C3 and C6.

The noise assessment and analysis of the measured data have shown that Clarence Colliery's noise emission levels complied with the noise limits at all monitoring locations during the day, evening and night-time noise monitoring periods during the survey.

Table 6-2: 2024 Attended Noise Monitoring Results

Receiver ID	Time of Day	Performance criteria dB(A) Laeq (15 min)	Performance during the Reporting Period (actual) dB(A)L
CNM1	Day	38	30
	Evening	36	27
	Night	35	30

Notes: (a) The noise criteria do not apply where the Applicant and the affected landowner have reached a negotiated agreement concerning noise, and a copy of the agreement has been forwarded to the Planning Secretary and EPA. (b) Noise generated by the development must be monitored and measured per the relevant procedures and exemptions (including certain meteorological conditions) of the NSW Noise Policy for Industry (EPA, 2017).

6.2.3 Comparison Against Predictions

Noise modelling emissions were completed for MOD2 Environmental Assessment for REA 6 (2013). MOD2 EA predicted noise emissions will not significantly increase or decrease during the construction of REA VI and will be similar to the typical emissions during mine operations.

Noise emissions from construction activities are predicted to fall considerably within the relevant construction noise criteria (GHD 2013).

The Clarence Colliery MOD5 Statement of Environmental Effects (SEE) (EMM 2019) was prepared to modify DA 504-00 to increase the number of full-time equivalent personnel at Clarence Colliery from 300 to 400. This SEE is being used as the two subsequent modification reports are to implement the transfer of Coarse Coal Reject (CCR) to Charbon Colliery (MOD6) and to provide extraction plan conditions for the site moving forward (MOD7). These two projects have not yet been implemented and therefore the predictions are not yet applicable.

Section 7.4 of the SEE states that the modification does not include any demolition of surface activities that may generate additional noise or vibration impacts. Therefore, the noise environment should remain unchanged from previous years (EMM 2019).

There was no exceedance of the noise criteria during the Reporting Period. The noise predictions in MOD2, MOD5 and MOD9 were upheld during the Reporting Period.

6.2.4 Long Terms Analysis

A summary of exceedances recorded at Clarence Colliery over the last five years is presented below in **Table 6-3**. There have been no exceedances at Clarence Colliery during this period.

As displayed in **Figure 6-4** to **Figure 6-6** , the attended noise monitoring results have not exceeded the relevant noise criteria in the past five years.

Table 6-3: Summary of Exceedances from CNM1 2020 – 2024

	2020	2021	2022	2023	2024	Total
Day	0	0	0	0	0	0
Evening	0	0	0	0	0	0
Night	0	0	0	0	0	0

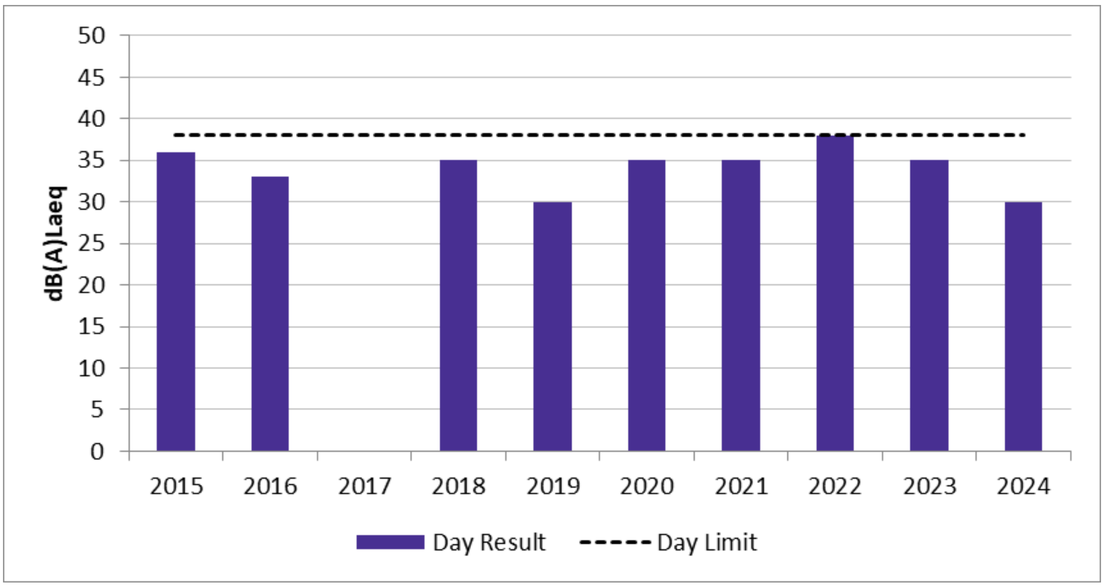


Figure 6-4: Day Noise Monitoring Summary (2015 to 2024)

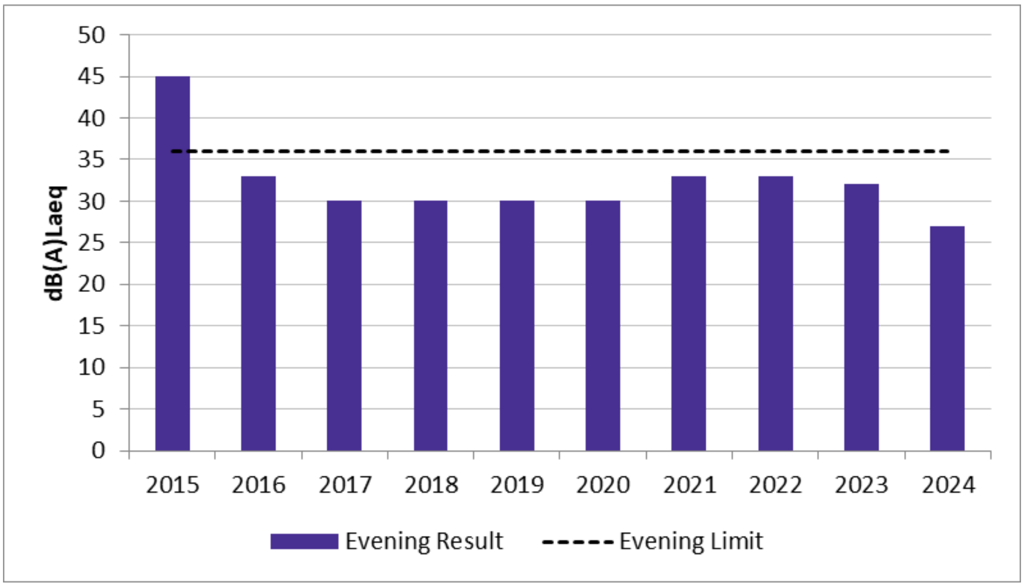


Figure 6-5: Evening Noise Monitoring Summary (2015 to 2024)

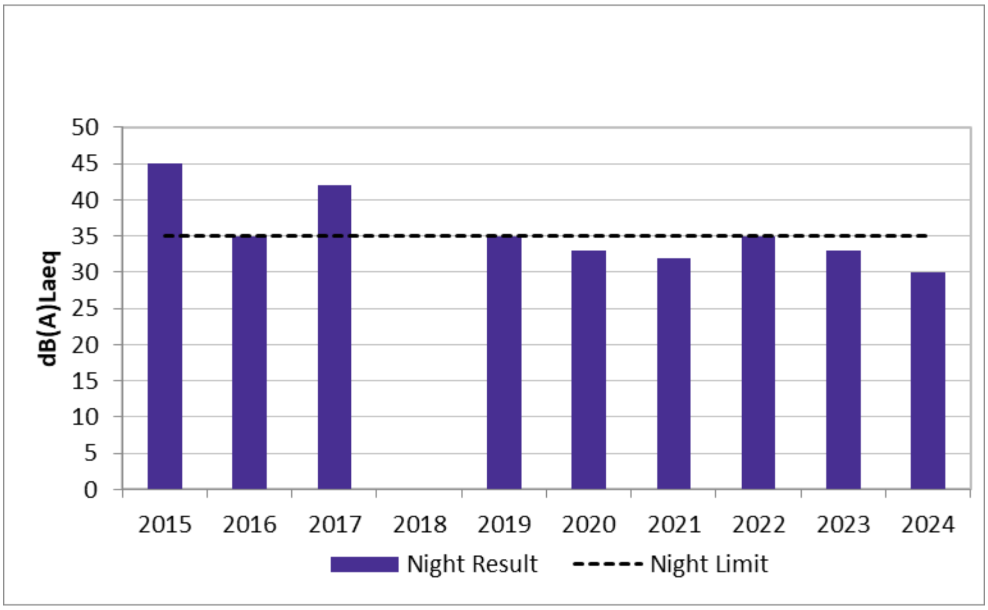


Figure 6-6: Night Noise Monitoring Summary (2015 to 2024)

6.2.5 Implemented / Proposed Improvements

Clarence has previously installed a reinforced noise barrier at the rotary breaker to shield the hopper to mitigate any potential noise from this source.

Noise management controls are considered effective based on compliance with the noise criteria. Clarence will continue to implement the WRNMP.

A sound power level assessment was conducted during the 2024 reporting period to determine possible areas of improvement associated with the equipment currently in service at Clarence. The assessment found that levels are consistent with predictions of the consent.

6.3 BLASTING

There was no blasting carried out at Clarence Colliery in the 2024 Reporting Period.

6.4 AIR QUALITY

6.4.1 Environmental Management

Clarence monitors air quality aspects in accordance with the *Western Region Air Quality and Greenhouse Gas Management Plan, 2021* (AQGHGMP), as required by Condition 14 Schedule, 3 of DA 504-00. Impact assessment criteria for air quality aspects are outlined in Schedule 3, Condition 13 of DA 504-00. Monitoring requirements are also specified in Condition M2.2 of EPL 726.

Key dust mitigation measures for Clarence Colliery operations include:

- Signage to display speed limits on all unsealed roads in the surface facilities area;
- A water truck in unsealed areas during use or windy conditions; and
- Water sprays (sprinkler system) on main roads, hard stand areas and the coal product stockpile during dry and windy conditions.

All mitigation measures identified in the AQGHGMP are utilised as required and implementation of appropriate dust controls is triggered by a range of methods, including:

- Dust monitoring results, indicating an elevated level of dust beyond the site boundary;
- Site inspections and observation of visible dust plumes; and
- Meteorological data from the Pit Top weather station.

Clarence Colliery operates in accordance with the Trigger Action Response Plan (TARP) provided in Section 5.2 of the AQGHGMP.

As required by the AQGHGMP, current dust monitoring consists of:

- Three dust deposition gauges, collected monthly; and
- High Volume Air Sampler (HVAS) which measures PM_{10} and total suspended particulate (TSP), operating over twelve months of a calendar year.

The Air Quality Monitoring Locations at Clarence Colliery are displayed in **Figure 6-7** and outlined in **Table 6-4**.

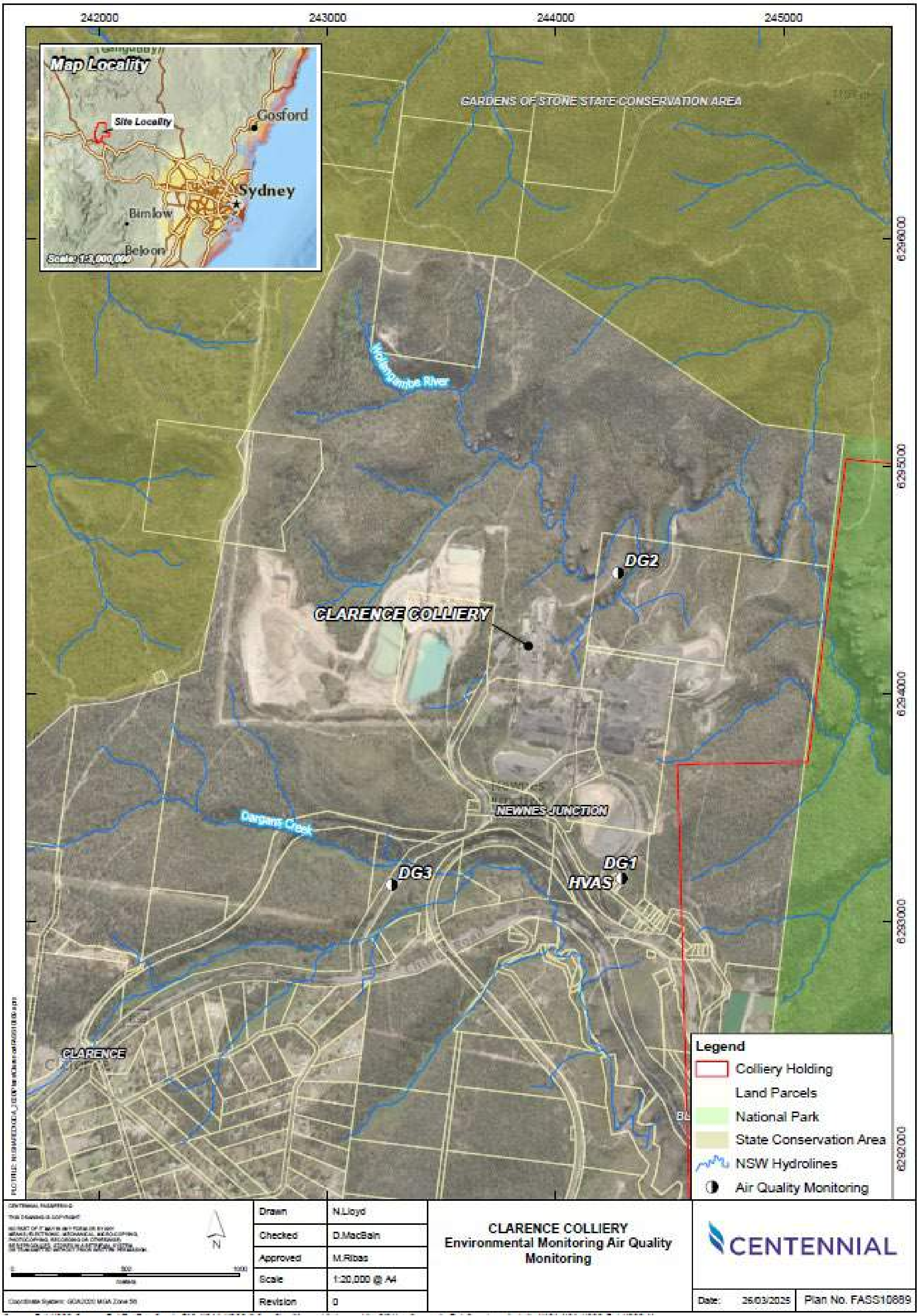


Figure 6-7: Clarence Colliery Air Quality Monitoring Locations

Table 6-4: Clarence Colliery Air Quality Monitoring Locations

Monitoring Point Reference	Description / Location
DG1	Located south-east of Clarence Operations
DG2	Located on the northern side of Clarence Operations
DG3	Located south-west of Clarence Operations
HVAS	Located south-east of Clarence Operations

6.4.2 Environmental Performance

Schedule 3, Condition 13 of DA 504-00 provides the air quality criteria at any residence on privately owned land in **Table 6-5**, **Table 6-6** and **Table 6-7**.

Table 6-5: Long-Term Criteria for Deposited Dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited Dust	Annual	2 g/m^2/month	4 g/m^2/month

Table 6-6: Short Term Criteria for Particulate Matter

Pollutant	Averaging Period	Criterion
Particulate matter < 10 µm (PM_{10})	24-hour	50$\mu g/m^3$

Table 6-7: Long-Term Criteria for Particulate Matter

Pollutant	Averaging Period	Criterion
Total suspended particulate matter (TSP)	Annual	90$\mu g/m^3$
Particulate matter < 10 µm (PM_{10})	Annual	25$\mu g/m^3$

Notes: (a) 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. (b) The air quality criteria in the Tables above do not apply where the Applicant and the affected landowner have reached a negotiated agreement regarding air quality, and a copy of the agreement has been forwarded to the Planning Secretary and EPA.

Depositional Dust

A summary of monthly data for insoluble solids at DG1, DG2 and DG3 is shown in **Table 6-8**. The deposition dust results for 2024 ranged from between 0.0 g/m^2/month and 2.5 g/m^2/month, with the lowest being at DG3 during January and the highest being at DG3 during November. **Figure 6-8** displays the rolling annual average of dust deposition for 2024.

The annual averages for deposited dust are below the annual criterion of 4g/m^2/month (**Table 6-8** and **Figure 6-8**) and remain compliant with the limits in the DA 504-00 and the AQGHGMP.

DG2 is the background dust gauge while DG1 and DG3 are the compliance monitoring points. The AQGHGMP stipulates air quality criteria of no more than a 2 g/m^2/month increase above the background dust gauge. The maximum increase in the annual average against the background was 0.3 g/m^2/month recorded by DG1, which is below the air quality criteria (i.e. no more than 2g/m^2/month increase).

Table 6-8: Monthly Summary of Insoluble Solids g/m^2/month during 2024

Month	DG1	DG2	DG3	Criteria
January	0.3	0.1	0	Maximum 2g/m^2/month increase of the annual average against the background (DG2)
February	0.2	0.1	0.1	
March	0.2	0.2	0.3	
April	0.3	0.3	0.4	
May	0.7	0.7	0.8	
June	0.2	0.2	0.1	
July	0.2	0.1	0.1	
August	0.4	0.2	0.1	
September	0.3	0.6	0.3	
October	0.3	0.4	0.7	
November	0.1	0.1	2.5	
December	2.3	0.6	2.0	
Annual Average	**0.5**	**0.3**	**0.6**	4 g/m^2/month

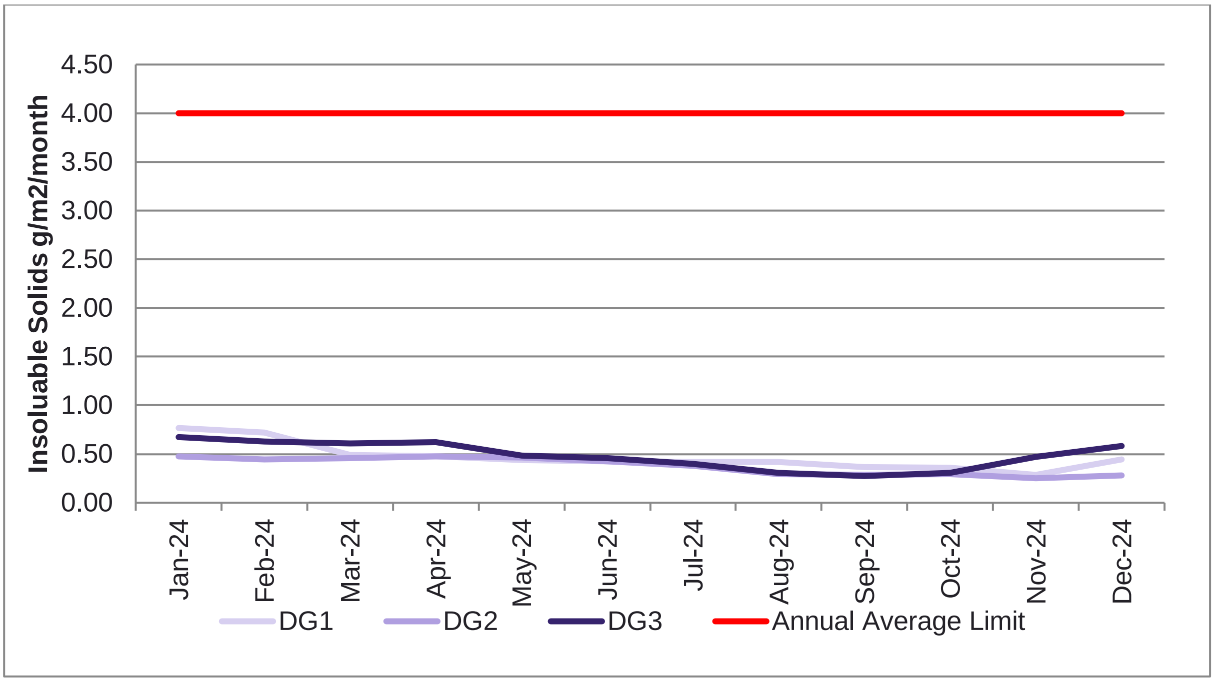


Figure 6-8: 2024 Depositional Dust Annual Results

PM_{10} and TSP

Air quality monitoring for PM_{10} and TSP utilises a HVAS unit (as shown on **Figure 6-7**).

Table 6-9 presents the PM_{10} and TSP monitoring results obtained during the Reporting Period. **Figure 6-9** and **Figure 6-10** displays the monitoring results for 2024, including the rolling annual average of PM_{10} and TSP respectively.

The 24hr average and annual average results for PM_{10} are below the criterion of 50µg/m^3 and 25µg/m^3 respectively (**Table 6-9** and **Figure 6-9**) and remain compliant with the limits in DA 504-00 and the AQGHGMP.

The annual average results for TSP are below the criterion of 90µg/m^3 (**Table 6-9 and Figure 6-10**) and remain compliant with the limits in DA 504-00 and the AQGHGMP.

Table 6-9: 2024 Results Particulate Matter

	Criteria (µg/m^3)	Maximum (µg/m^3)	Mean (µg/m^3)
24hr PM_{10} (short term)	50	23.4	N/A
PM_{10} (long term)	25	N/A	7.9
TSP (long term)	90	N/A	14.4

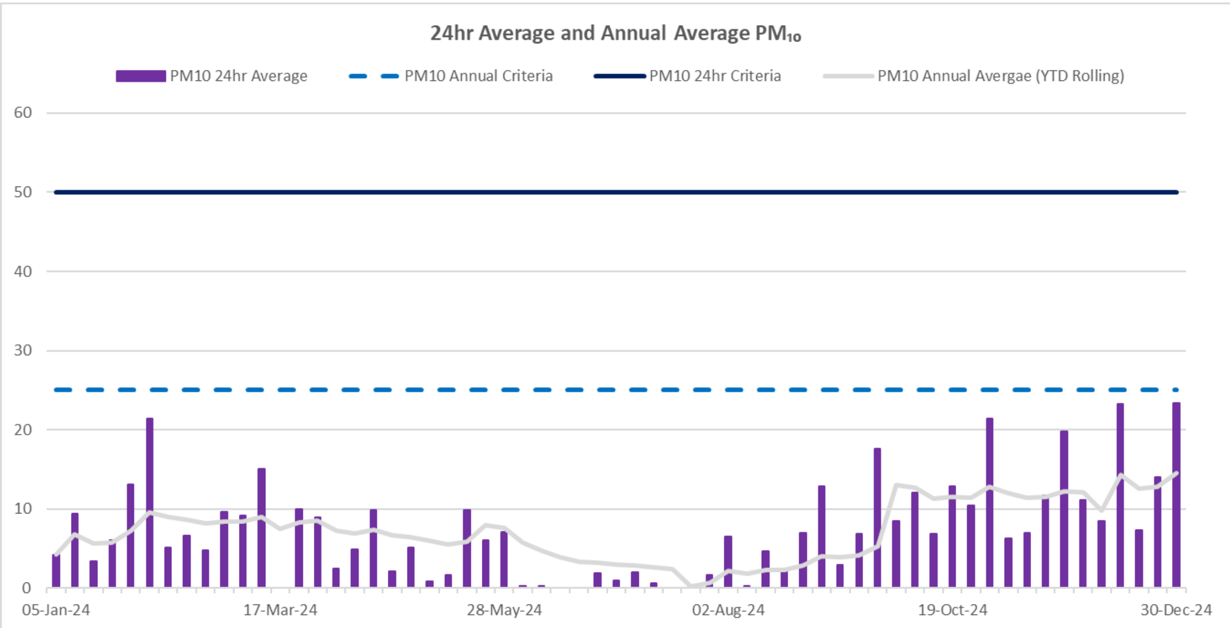


Figure 6-9: 24hr and Annual Average PM_{10}

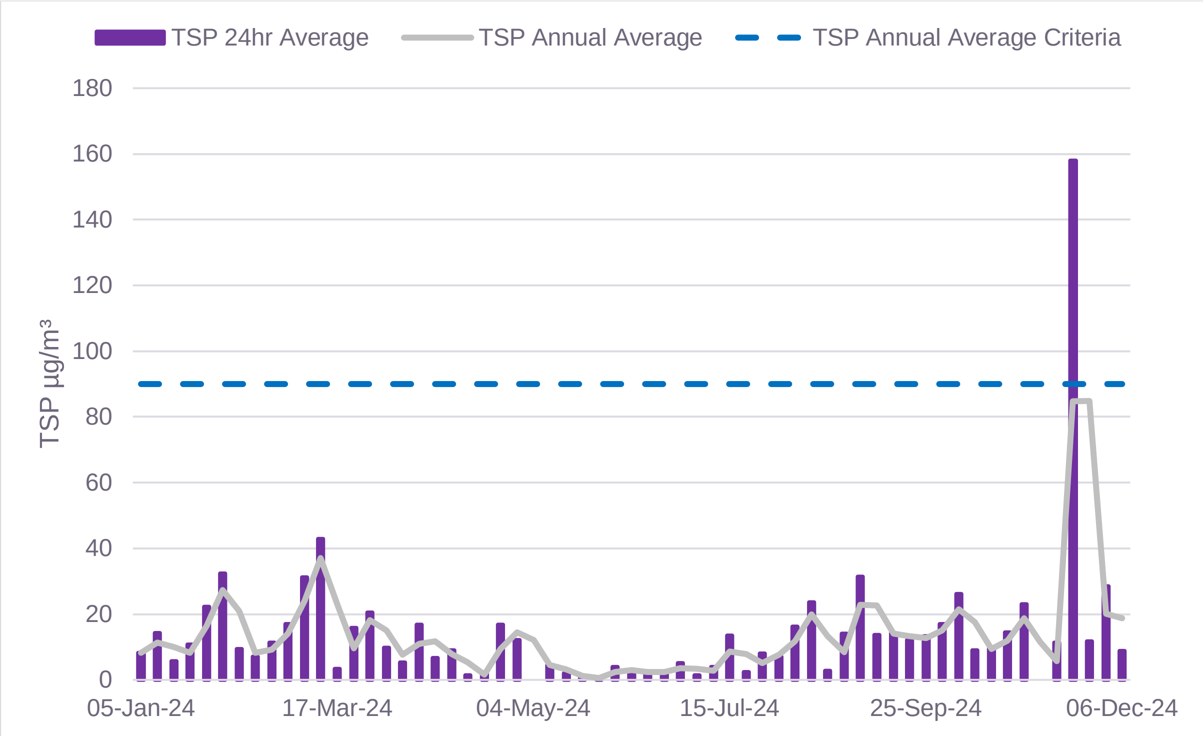


Figure 6-10: Annual TSP Summary Results at HVAS

6.4.3 Comparison Against Predictions

Dispersion modelling predictions of dust deposition rates and TSP and PM_{10} were completed for the MOD2 Environmental Assessment for Reject Emplacement Area (REA) VI by SLR (2013) and are shown in **Table 6-10**.

The results of the air quality modelling (SLR, 2013) show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM10, PM2.5 and dust deposition) were below the applicable impact assessment criteria at all assessment locations for all modelled scenarios (GHD 2013).

The modification report for MOD9, identified there will be a small increment in particulate emissions from the additional trucks being loaded and unloaded, however, this is unlikely to result in an exceedance of air quality criteria (JBA 2022).

All air quality monitoring results are well below annual criteria and consistent with predicted results.

Table 6-10: Predicted Air Quality Concentrations

Parameter	Averaging Period	Assumed Background Ambient Level	Predicted Air Quality Concentrations (Background + Project)[1]
Deposited Dust[2]	Annual	2 g/m²/month	2.1 g/m²/month
TSP[3]	Annual	18.5 µg/m³	20.9 µg/m³
PM_{10}[4]	24-hour	43.3 µg/m³	44.2 µg/m³
	Annual	9.4 µg/m³	10.5 µg/m³

[1] Maximum increment due to Clarence Colliery operations at identified sensitive receiver locations (GHD, 2013)
[2] Project criterion – 2 g/m^2/month (incremental), 4 g/m^2/month (cumulative)
[3] Project criterion – 90 µg/m^3
[4] Project criterion – 50 µg/m^3 (24-hour averaging period), 25 µg/m^3 (annual averaging period)

6.4.4 Long Terms Analysis

Table 6-11 Provides a summary of air quality monitoring results for the previous 5 years from 2019 to 2023, including the annual averages for deposition dust (insoluble solids), PM_{10} and TSP. Note, 2019 was affected by regional drought and bushfire events.

A summary of air quality exceedances recorded at Clarence Colliery over the last five (5) years is displayed in **Table 6-12**.

Air quality monitoring during the Reporting Period confirmed dust deposition, TSP and PM_{10} results were below their respective 24-hour and annual average criteria and are consistent with long-term data trends and predictions.

Table 6-11: Long-Term Air Quality Monitoring Summary (2019 - 2024)

Monitoring Location	Annual Averages						Development Consent Criteria (Annual Average)
	2019	2020	2021	2022	2023	2024	
Insoluble Solids (g/m²/month)							
DG1	1.5	1.1	0.6	0.4	0.8	0.5	4 g/m²/month
DG2	1.2	1.2	0.6	0.3	0.5	0.3	
DG3	1.1	0.6	0.7	0.8	0.7	0.6	
PM_{10} (µg/m^3)							
HVAS	14.95	5.76	9.35	4.4	7.6	7.9	25 µg/m^3
TSP (µg/m^3)							
HVAS	17.76	7.92	17.98	10	14.3	14.1	90 µg/m^3

Table 6-12: Exceedances for Particulate Matter

	2020	2021	2022	2023	2024
24hr PM_{10} (short term)	0	0	0	0	0
PM_{10} (long term)	0	0	0	0	0
TSP	0	0	0	0	0

6.4.5 Implemented / Proposed Improvements

Dust emission controls are considered effective based on compliance with the air quality criteria during the Reporting Period.

Clarence Colliery will continue to implement the AQGHGMP.

6.5 GREENHOUSE GAS MONITORING

6.5.1 Environmental Management

Schedule 3, Condition 23 of DA 504-00 requires Clarence to monitor greenhouse gas emissions generated by the development, as well as investigate ways to reduce greenhouse gas emissions on site and report on these investigations in the Annual Review.

Greenhouse gas (GHG) reporting and management measures are provided in the AQGHGMP. GHG emissions from Clarence Colliery will 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).

In accordance with the AQGHGMP (2021), in addition to tracking energy demand and GHG emissions per tonne of ROM coal produced, measures to minimise GHG emissions, to the greatest extent practicable, are implemented. These include:

- Cost-effective measures to improve energy efficiency;
- Regular maintenance of plant and equipment to minimize fuel consumption; and
- Consideration of energy efficiency in plant and equipment selection

6.5.2 Environmental Performance

Table 6-13 Reports the Scope 1 Emissions (Direct) and Scope 2 Emissions (Indirect) in tonnes of CO2-e produced for the current period and compares these against EIS predictions.

Table 6-13: Summary of GHG Emissions Reporting for 2020 to 2024

Emission Source	Estimated Emissions (tonnes CO_2-e)					Predicted Emissions
	FY20	FY21	FY22	FY23	FY24	
Scope 1 Emissions						
Fuel combustion	2,602	2,516	2,501.2	2,334	2,142	*1,419*
Oil/Grease consumption	123	79	58.9	92	84.7	*124*
SF_6	0.2	0.2	0.2	0.2	0.1	*1.0*
Fugitives	9,573	9,303	8,059	7,130	8,562	
Total Scope 1	**5,306**	**7,572**	**8,701**	**9,556**	**10,789**	***15,233***
Scope 2 Emissions						
Electricity consumption	40,911	39,456	39,555	34,494	33,659	*40,911*
Total Scope 2	**40,911**	**39,456**	**39,555**	**34,494**	**33,659**	***40,911***
Total Greenhouse Gas Emissions						
Scope 1 and 2 Emissions	**46,028**	**47,028**	**48,256**	**44,050**	**44,448**	***56,144***

6.5.3 Comparison Against Predictions

Table 6-13 Summarises greenhouse gas emissions predicted for the project in the Clarence Colliery - Modification 6 Greenhouse Gas Assessment (EMM, 2020), with comparison to actual emissions during the current and previous reporting periods.

During the 2024 Reporting Period, the calculated Scope 1 and Scope 2 GHG emissions for Clarence Colliery were 10,789 (t CO_2-e) and 33,659 (t CO_2-e) respectively and the combined total GHG emissions of 44,448 (t CO_2-e) were approximately -21% less than the 56,144 (t CO_2-e) as predicted in the EIS (EMM, 2020).

It is noted there have been subsequent project modifications, however, MOD7 involved administrative condition changes to provide extraction plan conditions for the site moving forward and therefore no change to predicted emissions.

For MOD9, a modification report was prepared by James Bailey & Associates Pty Ltd (JBA) which identified there would be an incremental increase in (Scope 3) GHG emissions resulting from the additional truck movements required (as opposed to this coal being transported by rail), however, this increase will be immaterial in relation to NSW's or Australia's total GHG emissions (JBA, 2022). There was no associated change to the predicted Scope 1 or Scope 2 emissions for the project (as presented in **Table 6-13)**.

6.5.4 Long Term Analysis

Table 6-13 Presents a summary of GHG emissions reported over the last five years. Based on the information reported, GHG emissions have been below EIS estimates for the project and have generally been decreasing year on year.

6.5.5 Implemented / Proposed Improvements

Mitigation measures to minimise to the greatest extent practicable GHG emissions from Clarence Colliery included regular maintenance of plant and equipment to minimise fuel consumption and consideration of energy efficiency in plant and equipment selection/phase.

6.6 BIODIVERSITY

6.6.1 Environmental Management

Ecology monitoring, assessment and reporting are currently managed through the Western Region Biodiversity Management Plan (WRBMP). In 2023 Revision 6 of the WR-BMP was submitted in February 2023 to address the requirements of Western Coal Services Modification. BCS Feedback was incorporated into Revision 7 in July 2023. Springvale received feedback from DPHI on 20 November 2024 (SSD-5579-PA-34) requesting further information and document revision. These revisions are forecast to be addressed in 2025 as required under the Request for Information (RFI). Management measures within the WRBMP specific to Clarence include, but are not limited to access management, bushfire management, erosion control, salinity management, preclearance surveys and waste management.

Eight native vegetation communities have been mapped as occurring within the Clarence Colliery holding. Two of these communities include the Temperate Highland Peat Swamps on Sandstone (THPSS) community which is listed under the *EPBC Act*.

This community is commensurate with the Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps, with Newnes Plateau Shrub Swamps listed as an Endangered Ecological Community (EECs) under the *Biodiversity Conservation Act 2016* (BC Act). Within the mining area, the partial extraction technique ensures minimal subsidence of less than 100 mm. It is therefore extremely unlikely that mining at Clarence Colliery will have an impact on the local flora and ecological communities.

A flora monitoring program was set up as part of the Subsidence Management Plan (SMP) process to verify that this is the case and to identify any natural variations. Risk and potential impacts to threatened flora over the mining area are managed through the SMPs, Extraction Plans and the WRBMP.

6.6.2 Environmental Performance

Clarence has obligations for the management and monitoring of offset sites and undertakes monitoring in accordance with the Subsidence Management Plans for Flora and Fauna. The results of this monitoring are detailed in the following sections.

Flora Monitoring

During the Reporting Period, EcoResolve completed flora monitoring across six broad areas: Clarence East (Eastern SMP area), Clarence West (also known as the '700 area'), Outbye, 800 Area, 900 Area and Pagoda Swamp. Flora monitoring occurred in Summer, Autumn and Spring in 2023. The results of the Summer, Autumn and Spring flora monitoring are summarised below with the complete reports provided in **Appendix 3**.

Locations of the sites and their sampling type are provided in **Table 6-14.**

Table 6-14: 2024 Flora Survey Sites

Site	Location	Type	Easting (GDA)	Northing (GDA)
Clarence East				
PAG_01	Gorilla Rock	Impact	246753	6300035
PAG_02	Gorilla Rock	Impact	246755	6299924
PAG_03	Waratah East	Impact	247251	6300707
PAG_04	Waratah East	Impact	246938	6300784
PAG_05	Waratah North	Control	247962	6303960
PAG_06	Waratah North	Control	247888	6303910
BNS_01	Bungleboori North Swamp	Impact	245582	6302273
BNS_02	Bungleboori North Swamp	Impact	246290	6303633
Clarence West				
CLW_01	Heath	Impact	241774	6295584
CLW_02	Swamp	Impact	242596	6295527
CLW_03	Happy Valley Swamp	Impact	241923	6296954
CLW_04	Hanging swamp	Impact	241904	6298016
CLW_05	Pine Swamp	Control	240804	6300186
CLW_06	Heath—Paddys Creek Ridge	Control	240472	6299171

Site	Location	Type	Easting (GDA)	Northing (GDA)
Outbye				
CLAO_01	S of Bungleboori Creek	Impact	245023	6297763
CLAO_02	S of Bungleboori Creek	Impact	245092	6297707
CLAO_03	N of Bungleboori Creek	Impact	245504	6298627
CLAO_04	N of Bungleboori Creek	Impact	245294	6299168
800 Area				
CLAE_01	Gully N of Dumbano Fire Trail dam	Impact	248971	6295894
CLAE_02	Heath ridge	Impact	247495	6295216
CLAE_03	Heath ridge	Impact	247271	6295388
CLAE_04	Secret Swamp	Impact	247203	6296462
CLAE_05	Secret Swamp	Impact	247159	6296404
CLAE_06	Olearia Swamp	Impact	247648	6296165
CLAE_07	Olearia Swamp	Impact	247701	6296288
CLAE_08	Olearia Swamp	Impact	247789	6296830
900 Area				
PSB_01	Paddys Swamp Branch	Impact	241338	6298523
PSB_02	Paddys Swamp Branch	Impact	241404	6298617
PS_03	Paddy Swamp (lower)	Impact	241822	6299156
Pagoda Swamp				
PAS_01	Pagoda Swamp	Impact	242878	6300496

Clarence East & Clarence West, Heath & Pagoda Sites

Most of the species across the seven heath and pagoda sites in Clarence East and West areas were in a healthy condition. Only three sites had > 10% of species with some level of damage at any time during 2024; PAG_05 in autumn, PAG_06 at all three survey times, and CLW_01 in summer and autumn. The reduced plant condition at PAG_05 and CLW_01 does not appear to be a cause for concern; by the spring survey, the percentage of healthy species had increased to above 90% at these sites, with a minimal proportion of species suffering either minor-some damage or significant-severe damage (<5%).

Vegetation conditions at the six swamp sites in Clarence's East and West areas were variable. All the sites had >10% of species with some level of damage in at least one season. However, as of the most recent survey (November 2024), vegetation conditions had improved so that all sites excluding two control sites, BNS_01 and CLW_05, had >90% of species in a healthy condition. These two control sites persistently showed plant species with severe damage throughout the year. Furthermore, these two control sites recorded non-swamp species. It is noted that BNS_01 is more than 500m away from 612-panel extraction (undertaken approximately 20 years ago) and CLW_05 is located approximately 1.4km away from Panel 913 partial extraction activities.

The condition of species at PAG_06, however, does appear to warrant continued attention. At all three survey times across 2024, >10% of species were recorded as having some damage, with an average of 7.3% species suffering minor-some damage and 6.4% suffering significant-severe damage/dieback over the year. It is however noted that PAG_06 and PAG_05 are control sites and are located approximately 2.5km from the nearest partial extraction activity.

The species richness of the heath and pagoda sites in Clarence East and West areas generally followed a seasonal pattern with a peak in Spring and reductions in Summer and Autumn. There does not appear to be any large difference in species richness between the control and impact sites during any season. The exception to this is the higher number of species recorded at impact site PAG_01 in summer (44 species) compared to that at control sites PAG_05 / PAG_06 (26 and 30 species, respectively) in the same month. However, the discrepancy between species richness in the control and impact site does not appear to be a cause for concern; the extra species recorded at impact site PAG_01 during the summer are native species and the number of species recorded at each of the sites is similar to previous years. Species richness was variable throughout the year and there is no discerning pattern apparent over the years of monitoring conducted.

Clarence Outbye

The vegetation condition of species across the four heath sites in the Clarence Outbye area was variable across 2024. As of the most recent survey (November 2024), vegetation conditions had improved so that all sites had >90% of species in a healthy condition. No exotic species were recorded at any of the Clarence Outbye sites in 2024. This is consistent with records from 2023 and earlier.

The species richness of the sites in the Clarence Outbye area (all heath) roughly followed a seasonal pattern in 2024; species richness was similar in summer and autumn and then peaked in spring.

Clarence 800 Area

Summer surveys were carried out between the 6th and 7th of March 2024, Autumn surveys were carried out on the 13th and 15th of May 2024 and Spring surveys were carried out between 25th – 27th November 2024.

Most of the species in the three heath sites were healthy across the three survey seasons, with <10% of species having any level of damage and <5% of species having significant severe damage. Vegetation conditions at the five swamp sites were somewhat poorer, with four of the five sites having >10% of species with some level of damage at least once throughout the year. However, as of the most recent survey effort (November 2024), vegetation conditions had improved so that all sites (except CLAE_05) had >90% of species in a healthy condition.

At swamp sites CLAE_06, CLAE_07 and CLAE_08, there was a large decrease in the percentage of species with minor-some damage over 2024. Between the summer and spring surveys, the percentage of species with minor-some damage decreased by 17.1%, 12.0% and 25.9%, respectively. At swamp sites CLAE_04 and CLAE_05 there was an increase in the percentage of species with minor-some damage, but a decrease in the percentage of species with significant-severe damage/dieback. This overall trend of improvement in plant health is likely in part due to natural regeneration and improved climactic conditions.

The species richness of the three heath sites and five swamp sites in the Clarence 800 area roughly followed a seasonal pattern in 2024. At the heath sites (CLAE_01, CLAE_02, and CLAE_03), species richness was similar in summer and autumn and then peaked in spring. At the swamp sites, species richness was relatively high in summer and decreased in winter, increasing again to peak in spring.

Clarence 900 Area

Summer surveys were carried out on 5th March 2024, Autumn surveys were carried out on 15th and 16th May 2024 and Spring surveys were carried out between 19th – and 21st November 2024.

There are a range of human disturbance factors already operating in the vicinity of PSB_01 and PSB_02 in Paddy's Swamp upper catchment. This includes drainage works associated with the nearby sand quarry 600 metres to the south, extensive recent clearing at the quarry and a trail bike track to the north of PSB_01. Site PS_03, in the main section of Paddy's Swamp, is in an area substantially free of past human disturbance, although an old, defunct pipeline passes by the eastern edge of the swamp.

Vegetation conditions improved throughout 2024 across the three (3) swamp sites in the Clarence 900 area, with a greater percentage of species in a healthy condition in the spring survey compared with the summer survey. All the sites had >10% of species with some level of damage at least once during the year. As of the spring survey in November >90% of the species at PSB_02 and PS_03 were in a healthy condition, while at PSB_01 (600m from the quarry) plant health remained relatively poor, with >10% of species still with at least some level of damage. Further, at PSB_01 *Leptospermum grandifolium* decreased in condition from minor damage in the summer survey to severe damage/dieback in the spring survey.

The percentage of species in a healthy condition at PAS_01 increased from 83.3% in the summer survey in February to 100% in the spring survey in November. Further, the percentage of species with significant-severe damage/dieback decreased over the year, from 4.2% in summer to 0% in spring.

The species richness of the three swamp sites in the Clarence 900 area was variable in 2024. At PS_03 and PSB_01 species richness was lowest in summer, increased in autumn and then increased again to peak in spring. At PSB_02 species richness was similar across the year, with minimal differences between seasons. The species richness at the Pagoda Swamp site was lowest in summer, increased in autumn and then increased again to peak in spring.

Clarence East & West Swamp Sites

In the Clarence East and West areas, the two control swamp sites BNS_01 and CLW_05 had worsening conditions over the year, with increased damage to several swamp species, as well as an increase in the presence and vigour of non-swamp species from drier environments. At least one exotic species was recorded at five of the six swamp sites in the Clarence East and West areas, with particularly high disturbance at CLW_05. These are not likely to be partial extraction-related impacts as there are no nearby mining activities associated with Clarence.

Overall, vegetation conditions at the Clarence 800 area, 900 area, and Pagoda Swamp area swamp sites improved over the year. However, this overall trend masks the decline of some swamp species and general poor conditions at specific sites.

In the 900 area, although vegetation condition improved at PSB_01 (located 600m to the north of an active sand quarry), there were still >10% of species with at least some damage as of the November survey. Also at this site, damage in *Leptospermum grandifolium* increased from a minor in the summer survey to severe in the spring survey. It is noted that PBS_01 is located in the very upper reaches and near the edge of Paddy's Swamp. Edge effects may also be contributing to the 2024 survey results.

In the 800 area, swamp species *Eucalyptus mannifera* at CLAE_04 and *Juncus continuus* at CLAE_05 remained in a damaged condition over the year. The incidence of exotic species at the 800, 900 and Pagoda Swamp sites was sporadic and similarly rare to historic records.

In summary, the health of the swamp sites across the entire monitoring area was variable, and generally poorer than that of the heath sites, particularly at control sites or where there has been no or limited secondary partial extraction including:

- BNS_01 (control site with no mining activity within 500m);
- CLW_05 (historically a control site situated within the Springvale Mining Lease);
- CLAE_04 and CLAE_05 (a small swamp site above first workings only); and
- PSB_01 (situated 600m north of the nearby sand quarry and at the edge of the swamp), noting that the spring survey at PSB_02 (located 110m to the north, downstream of PSB_01) showed that >90% of the species were in a healthy condition).

There is no evidence to suggest that there are any mining-related impacts.

Fauna Monitoring

Fauna monitoring during the Reporting Period at Clarence Colliery was undertaken by Biodiversity Monitoring Services (BMS) (**Table 6-15**). The complete fauna monitoring reports are included in **Appendix 4**.

Table 6-15: 2024 Fauna Survey Sites

Site Name	Easting	Northing	Landscape	Establishment date	Undermining date
Clarence East Area/Outbye					
Heath 1	245245	6299216	Pagoda heath above the steep-sided valley	Autumn 2008	1998 (development)
Heath 2	245294	6297667	Woodland below Pagoda heath in steep-sided valley	Autumn 2008	1998 (development)
Gully	245497	6298910	Woodland above the steep-sided valley	Autumn 2008	1999 (development)
BNS02	245560	6302277	Heath Swamp with shallow-sided valley	Spring 2004	NA
PAG01	246801	6300654	Pagoda heath above the steep-sided valley	Spring 2004	September 2006 (development), December 2008 (extraction)

Site Name	Easting	Northing	Landscape	Establishment date	Undermining date
PAG03	247064	6300657	Pagoda heath above the steep-sided valley	Spring 2004	NA
Clarence 800 Area					
800 Swamp 1	247193	6296433	Heath Swamp within the steep-sided valley	Autumn 2009	Dec 2013 (development)
800 Swamp 2	248940	6295833	Woodland with small patches of hanging swamp within the steep-sided valley	Autumn 2009	June 2015 (development), June 2016 (extraction)
800 Heath	247448	6295310	Ridgetop heathland	Autumn 2009	April 2018 (extraction), development unknown
Clarence 900 Area					
A North	241839	6299342	Heath Swamp within the steep-sided valley	Spring 2014	October 2022
B South	241374	6298571	Woodland moving into a healthy swamp within the shallow-sided valley	Spring 2014	August 2022 (extraction)
900 C	242283	6300823	Woodland moving into a healthy swamp within the shallow-sided valley	Autumn 2024	NA
900 D	242442	6300155	Hanging Swamp within steep-sided valley	Autumn 2024	NA
Clarence West Area					
CLW01	240634	6299166	Pagoda heath above the steep-sided valley	Spring 2006	Mid-2018 (extraction)
CLW02	242610	6295587	Heath swamp within shallow-sided valley	Spring 2006	March 2010 (extraction)
CLW03	241840	6297085	Heath swamp within steep-sided valley	Spring 2006	Sept 2010 (development), Dec 2010 (extraction)
CLW04	241899	6297998	Heath swamp within steep-sided valley	Spring 2006	April 2015 (development), November 2015 (extraction)
CLW05	240772	6300158	Heath swamp within steep-sided valley	Spring 2006	December 2018
CLW06	241657	6295513	Pagoda heath above the steep-sided valley	Spring 2006	March 2011 (development),

Site Name	Easting	Northing	Landscape	Establishment date	Undermining date
					December 2011 (extraction)
Nine Mile Swamp	242000	6301270	Heath Swamp within the steep-sided valley	Autumn 2018	NA
Paddy's Swamp	241375	6299055	Heath Swamp within the steep-sided valley	Autumn 2018	NA
Clarence North Area					
Murrays Swamp	243217	6303467	Heath swamp within shallow-sided valley	Autumn 2024	NA
Upper Dingo	243898	6302462	Heath swamp within shallow-sided valley	Autumn 2024	NA

Clarence 800 Area

The results from the survey of the Clarence Colliery 800 Area in 2024 show that the assemblages found are more typical of that found throughout the Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Bird Simpson's[3] was declining as of 2017 but has recovered to previously high levels this year. Despite the previous decline, bird species richness has remained within the natural level of variation since then and this year is the highest it has been since 2019. Mammal Simpson's has been declining steadily since 2019. This is not the case for species richness, being slightly lower this year but still close to average. Reptile richness and Simpson's have been declining since 2017 but for 2024 Simpson's has recovered to the second highest on record, while species richness returns to average levels.

Amphibian Simpson's[3] is highly variable, probably due to climactic changes and resulting impacts on survey results, particularly in this dry collection of sites. A similar trend is seen in amphibian species richness which again is a result of a paucity of suitable habitat or poor (dry) survey conditions. Amphibian Simpson's[3] fluctuates wildly with survey conditions. Survey conditions have a large influence on survey success, and this year's summer conditions were generally wetter than last year allowing some recovery of amphibian diversities. With conditions being slightly wetter in 2024, amphibian richness was equal highest on record in 2021. The effects of the fire are not as obvious as the long-term rainfall deficit.

Mammal trapping rates have remained low since the 2013 fire, with recovery hindered by dry conditions and a second burn in 2019. Trapping rates have dropped from the slight recovery seen in 2023 but remain well below the pre-fire figures. In the context of surrounding areas, however, the actual trapping rates are recovering from the fire on par with other Clarence areas. The only pre-fire data we have for the 800 Area was an extraordinarily high trapping rate in 2012. It should be noted that bat activity is still within the normal level of variation (though activity is relatively low), suggesting the invertebrate food source that this group relies on is slowly returning to the landscape. As is often the case with fire, once the vegetation and

[3] Simpson's indices quantify the biodiversity of communities. This index reflects both the variety of species within a community and the evenness of their population distribution.

associated food source is wiped out, there is a delay in seeing the return of species to the landscape. Overall, the trend in trapping rates has fallen over the years being strongly influenced by the impacts from the State Mine and Gosper's Mountain fires, and the drought conditions over 2018-2019. Capture rates have again fallen since last year (2023 being the highest since 2013), and they are still only a fraction of the potential seen pre-fire. Having said that, there were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database.

Only three threatened species were located during 2024, as well as several bird species dependent upon woodland habitats. Threatened species included the Large Bent-winged Bat, Scarlet Robin and Giant Dragonfly. Though many Giant Dragonfly were seen after both fires, only one was observed in 2024. This was actually located in Opera Swamp while conducting due diligence searches for piezo locations.

The proportion of woodland-dependent birds has remained relatively stable over the years, whilst the number of threatened species has been more variable. It is noted that there has been an increase in the diversity of threatened species since the surveys began, though a number of species have been uplisted at State and Federal levels in recent years. One new species (Crescent Honeyeater) was recorded that has not been located in the area previously. This species is known from the neighbouring Outbye and Eastern SMP areas where it typically inhabits moister gullies.

Both the State Mine and Gosper's Mountain fires affected the fauna and habitats within the Clarence 800 area, with many measured parameters falling after each. With the inclusion of control data from PAG03, Nine Mile Swamp and Paddy's Swamp, we can now start to analyse the impact of underground mining and development on the surface habitats and associated fauna. There are some differences between habitat characteristics in mined and non-mined areas. Six cover characteristics were higher in undermined sites with four of these being consistent between seasons. This compares to only two higher in control sites, both being consistent between seasons. One of these differences is rock cover which clearly does not change with undermining and simply reflects natural differences between groups of sites.

Fauna diversities also showed differences by undermining status. Again, indices that differed were inconsistent over the season and between seasonal and yearly analyses. Seven seasonal diversity indices differed, with four lower in undermined sites. Only one was consistently lower across seasons (bird richness). The paucity of frog habitat in the area (and dry survey conditions) meant amphibian abundance was significantly lower in undermined 800 Area sites compared to the control swamps over the extended yearly analysis and bird diversities that were also lower in undermined sites. These results could also be biased by inappropriate control site choice (control swamps are much wetter and more productive than the drier, stony, stunted habitats of the 800 Area).

At this stage, there is little conclusive evidence to suggest any impact due to undermining in the 800 Area, particularly when you take into account differences in habitat quality between the two large Springvale control swamps and the small 800 Area impact swamps. There were more significant differences over time, suggesting the magnitude of change in habitat and fauna diversities is more dependent on climatic conditions or fire events.

Given the low levels of subsidence from previous mining at Clarence Colliery, the risk of adverse impacts on fauna within this area is considered to be low. Mining (first workings only) commenced in 800 Area in July 2012. Since this time, all monitoring sites have been undermined. The monitoring of recovery from fire within mined and un-mined sites will be an important tool in the on-going assessment of mining activities.

Clarence Outbye Area

The Outbye Area sites were surveyed between the 6th and 17th of May, the 14th of October and the 1st of November, and the 25th of November and 24th of December 2024. Throughout the 2024 surveys, 25 native mammals (plus one introduced), 45 birds, four reptiles, four amphibians and zero invertebrate species were recorded in the Outbye Area. Since monitoring commenced within the Outbye Area a total of 93 birds, 31 native mammals (plus 6 introduced), 23 reptiles and 7 amphibian species have been recorded. This includes one new amphibian species (Eastern Sign-bearing Froglet) located in the area this year.

The results from the survey of the Clarence Outbye SMP Area in 2024 show that the assemblages found are more typical of that found throughout Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed.

Bird species richness has recovered from an all-time low in 2023, which was most likely due to reduced survey effort in autumn that year. Native non-bat mammal numbers have increased slightly since last year and remain in the expected range of variation. Small mammal trapping rates had only just returned to normal levels after the 2013 State Mine fire when the 2019 fire hit. Autumn 2024 saw a large spike in small mammal captures (due to high Agile and Brown Antechinus captures along with Bush Rat captures). Despite the reduced survey effort in spring 2024, the trapping rates are still similar to levels seen prior to the 2013 fire. The fast recovery (four years) in small mammal capture rates to pre-fire levels in the Outbye SMP Area is ahead of most other areas on the Plateau. This likely reflects a lower intensity burn in the 2019 fire combined with extensive rocky refugia available near the sites, which have allowed small mammals and reptiles to survive.

Reptile species richness dropped this year to low levels only seen previously in 2021. This is likely due to cool/wet survey conditions. The only week that was sunny had reduced access to sites (spring). Amphibian richness is variable and generally low in this area due to the lack of swamp habitats. However, amphibian richness was relatively high (still only four species) in 2024 and included one new species for the area; the Eastern Sign-bearing Froglet. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database.

The proportion of woodland-dependent birds has been depressed since the years of drought before the 2019 fires, indicating the dry conditions and fire may have affected the suitability of the habitat for this largely mobile fauna group. The proportion of declining bird species in 2024 is the lowest on record for the area confirming that this suite of bird species is genuinely in decline. This again may point to changes in the condition of the woodland habitat. Alternatively, the heath communities prevalent in the Outbye SMP Area may not be optimal habitats for these species. Bat richness has been steadily increasing since 2015 but peaked in 2021. Bat activity was within the normal level of variation in 2024 suggesting the invertebrate food source that this group relies on may have returned to the landscape.

Eight threatened species were located during 2024, as well as several bird species dependent upon woodland habitats. Threatened species included Eastern Pygmy-possum, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Gang-gang Cockatoo, Pilotbird, Scarlet Robin and Flame Robin. This is within expected levels of variation, and an increase in the diversity of threatened species since the surveys began (although this may be an artifact of additional species being added to the threatened species list in recent years).

The State Mine fire definitely affected the fauna and habitats within the Clarence Outbye SMP Area, with many measured parameters falling between spring 2013 and 2014. Further changes in habitat and fauna diversities were seen after the Gosper's Mountain fire. All fauna groups have survived the fire, though individual species' responses differ.

Robust analyses testing for undermining impacts are likely to be irrelevant since none of the monitoring sites have been subject to partial extraction activities. The sites from this area will likely be used to boost the robustness of other area reports. Having said that impacts from partial extraction are highly unlikely as there have been no contemporary partial extraction activities since monitoring commenced at:

- Heath 1 – within a radius of 500m;
- Gully – within a radius of 400m; and
- Heath 2 – within a radius of 850m.

There are plans in 2025 to cease fauna monitoring within the Outbye SMP Area for the reasons discussed above.

Clarence East Area

Pagoda complex and Endangered Ecological Community swamp environments within the Eastern SMP Area (CLE Area) at Clarence Colliery were sampled. The three sites surveyed were:

- BNS02 – Control site, not undermined, swamp and plateau forest landscape monitored since spring 2004;
- PAG01/02 – Overlies 602 panel which was extracted in January 2009, pagoda landscape monitored since spring 2004; and
- PAG03/04 – Control site, not undermined, pagoda landscape and surrounding woodland monitored since spring 2004

As set out above, there has been no development nor extraction activities associated with BNS02 or PAG3. This equates to a baseline monitoring program spanning 21 years of monitoring 3 times per year. Extraction beneath PAG1 occurred in January 2009, more than 15 years ago. Generally, mining in the Eastern Area SMP occurred during the 2006 – 2009 period.

In a similar vein to the Outbye SMP Area, the Eastern Area monitoring program was established before extraction commenced in the proposed panels. Panel 611B was terminated shorter than planned and did not extend underneath site PAG3, falling 160m short of the monitoring site. Furthermore, the 611 Panel fell short of developing and extracting beneath BNS02 by 400m.

The CLE Area sites were surveyed from the 8th of April to the 14th of May, the 9th of September to the 1st of November, and the 25th of November to the 24th of December 2024. Throughout the 2024 survey period, 20 native mammals (plus two introduced), 58 birds, five reptiles, five amphibians and zero invertebrate species were recorded from the CLE Area. Since monitoring commenced, a total of 121 birds, 34 native mammals (plus 8 introduced), 28 reptiles and 8 amphibian species have been located within the Clarence Eastern Area SMP.

The results from the survey of the Clarence Eastern Area SMP monitoring in 2024 show that the assemblages found are more typical of that found throughout Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Most diversity measures have fluctuated slightly over time, but birds and mammals have shown a stable or increasing trajectory over the longer term.

Reptile species richness trends downwards over time, but the decline does not look to be associated with mining activity (from a statistical standpoint), and climatic conditions can change survey results drastically. Despite the dry conditions from 2017-2019, mammal and reptile species richness have increased between 2016 and the 2019 fire.

Bird species richness peaked in 2018, fell to the second lowest on record in 2019, and recovered to average levels in 2021 and 2024. The seasonal reports show that bird abundance is pushing slightly above average levels, suggesting habitat is recovering well.

Mammal trapping rates were starting to recover from the State Mine 2013 fire/pine clearing when the drought and subsequent fire hit in late 2019. The second fire barely impacted small mammal captures though, and both autumn 2023 and 2024 saw a return to pre State Mine fire levels. Extensive rocky refugia near sites, combined with lower intensity burn in recently burnt vegetation, may have allowed small mammals and reptiles to survive the 2019 Gospers Mountain fire.

Bat activity for 2024 remains low in autumn as it did in 2023, usually due to lower temperatures at the end of this session. Spring activity and species richness are average. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. Above-average rainfall in three years post-fire started the regeneration process on the Plateau. Fauna results have followed with most functional groups represented.

Nine threatened species were located during 2024, as well as several bird species dependent upon woodland habitats. Threatened species include the Spotted-tailed Quoll, Southern Greater Glider, Large-eared Pied Bat, Large Bent-winged Bat, Gang-gang Cockatoo, Pilotbird, Dusky Woodswallow, Scarlet Robin and Flame Robin. The number of threatened species is highly variable through time, but current levels are the highest on record.

Woodland-dependent bird species were under-represented from 2017-2024, as were declining species. Either the burning of the area or clearing of the pine around BNS02 may have discouraged these rarer species, though it has also led to some species uncommon to the Plateau (Diamond Firetail, Black-shouldered Kite) turning up in 2021 and 2023. We would expect the habitat to become more suitable for woodland species as the fire opens the landscape, but the heath communities prevalent in the Eastern Area SMP may not form optimal habitat for these species anyway.

Fire has affected the fauna and habitats within the Clarence Eastern Area SMP, but impacts are more subtle than many other areas. All fauna groups have survived the fire, though individual species responses differ. Statistical analyses suggest these fires, along with drought conditions, are more likely to be driving changes than any impacts from undermining.

As extraction in the Eastern Area SMP was completed in 2009, it is evident from the above analyses that there has been little detrimental change in the fauna diversity indices measured since the period of undermining. At present, there is no suggestion of potential impacts from subsidence on the fauna diversity within the Clarence Eastern Area SMP. Two of three undermined sites had to be added from other areas to allow statistical analysis as only one monitoring site within the Eastern Area has been undermined. An extensive analysis of fauna and habitat data from the Eastern and Outbye SMP Areas4 in 2017 provided the following conclusions:

"Because of the amount of data available, it is possible to assess any impacts from mining activities using the BACI process and, importantly, the Beyond BACI process. Analysis of the data shows that, for both the Eastern SMP and Outbye SMP Areas, there are no significant changes in Simpson's Index of Diversity, population numbers, species richness, trapping rates and woodland-dependent birds. Comparison between data from Impact and Control areas show no significant differences and Bray-Curtis Similarity Indices are relatively high.

Overall, it is difficult to relate changes in fauna populations over the years to any quantifiable parameter, including mining activities. The assessment of the data from Clarence Eastern SMP and Outbye SMP Areas shows that mining activities do not appear to be a significant factor in determining changes in fauna populations at Newnes Plateau. It is postulated that fauna population numbers are determined by climate, fire and predators". Feral horses also add to that pressure, however, no evidence of living horses has been found since 2022.

Clarence 900 Area

With the expansion of mining into Area 900 at Clarence Colliery it is necessary to monitor fauna populations within the area, particularly within any swamps considered Endangered. Two sites have been selected in the north and south of the area.

- Site A North – Not undermined, swamp landscape; and
- Site B South – Undermined (production) February 2022, swamp landscape

[4] BMS (2016). *Rationalisation of Fauna Monitoring program at Clarence Colliery – An Analysis by Biodiversity Monitoring Services, October 2016*. A report to Centennial Coal Pty Ltd.

It is noted that CLW04 lies within the southern portion of the Clarence 900 Area SMP Area, close to the 700 Area.

Springvale mine undermined the previous Clarence control sites CLW01 and CLW05 in mid-late 2018, therefore two replacement control sites were established:

- Nine Mile Swamp – Control site, not undermined, swamp landscape; and
- Paddy's Swamp – Control site, not undermined, swamp landscape

The Paddy's Swamp monitoring site now currently sits just to the north of Panel 915 first workings development. In 2024, additional controls were established within the Northern Mining area, including:

- Upper Dingo Swamp – Control site, not undermined, swamp landscape;
- Murrays Swamp – Control site, not undermined, swamp landscape;
- 900C (Lower Nine Mile Swamp) - Control site, not undermined, swamp landscape; and
- 900D (Lower Nine Mile Swamp) - Control site, not undermined, swamp landscape.

The 900 Area sites were surveyed between the 15th April and 24th May, the 19th September and 4th October and 25th November and 24th December 2024. The addition of the new 900 Area control sites in 2024 represents a doubling of survey efforts in the 900 Area. This should be kept in mind especially when considering fauna abundance metrics over time.

Twenty-five native mammals (plus one introduced), 61 birds, 11 reptiles, six amphibians and zero invertebrate species were recorded from the 900 Area during the 2024 surveys. Since monitoring commenced in 2014, a total of 86 birds, 29 native mammals (plus six introduced), 21 reptiles, eight amphibians and one invertebrate species have been recorded within the 900 Area.

The results from the survey of the 900 SMP Area in 2024 show that the assemblages found are more typical of that found throughout the Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Species richness was within expected variation for all groups, with the two additional sites surveyed in 2024 possibly explaining the all-time highs in three of four groups (and almost in the fourth). Bird and mammal Simpson's are stable over the long term. Trapping rates declined sharply post-2019 fire. They had been tracking up since the State Mine fire in 2013, but the Gosper's Mountain fire reset the system. Recovery of small mammal captures was tracked in advance of the previous fire in 2023 but declined again in 2024. Reptile Simpson's was average. Low numbers in 2014 are due to the fact surveys only began in the spring of 2014, so survey effort was greatly reduced compared to other years. Amphibian Simpson's showed stability over the last three years, with richness back to pre-fire levels in 2021 to 2023.

Swamps in this area had peat mostly consumed and canopy layers were fully burnt, so finding Blue Mountains Water Skink in 2020 was surprising. This species has been found in the area every year since. The swamps (particularly 900 North) of the 900 Area likely form an important refuge for the species which was only located in the 900 and Springvale New area in 2024. The availability of rock outcropping near 900 North means refugia for small mammals allowed some to survive the fire, particularly Antechinus. Bat species richness and activity were very low in 2022, but 2024 exhibited the highest activity and species richness for this group in comparison to other years. As is often the case with fire, once the vegetation and associated food source is wiped out, there is a delay in seeing the return of species to the landscape. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. Above-average rainfall in most months since fire appears to have helped start the regeneration process on the Plateau.

Fourteen threatened species were located during 2024, as well as several bird species dependent upon woodland habitats. Threatened species included the Spotted-tailed Quoll, Eastern Pygmy-possum, Southern Greater Glider, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Gang-gang Cockatoo, Masked Owl, Pilotbird, Varied Sittella, Dusky Woodswallow, Scarlet Robin, Flame Robin and Blue Mountains Water Skink. The swamps of the 900 SMP Area have always contained suitable habitat for the Blue Mountains Water Skink. Reptiles often have lower detection rates due to their cryptic nature and requirement for particular survey conditions, so it is good to record this species for the fifth year running. The Gosper's Mountain fire affected the fauna and habitats within the 900 SMP Area, with a number of measured parameters falling.

Now that 900 South and 900 North have been undermined, we can start to look for potential impacts from undermining in the 900 Area. However, the new control sites have only just been added in 2024. These too will become undermined in due time, but for now, allow a comparison of control vs impact. Because of the progressive undermining of sites, sites from the surrounding Clarence and Springvale Areas are added to the analysis. Analyses from the post-fire recovery period suggest reptile species richness is lower in undermined sites compared to control sites. The same relationship was not observed in the seasonal analyses which were conducted over the full survey period, suggesting reptile richness has not always been higher in the selected control sites. Other seasonal differences were not consistent between seasons, and the differences seen in 2024 analyses were not mirrored in 2023. This could be due to the addition of new sites to the analyses. Overall, however, there is little evidence to suggest differences in fauna diversities in recovering sites by undermining status, despite inconsistent differences seen in seasonal and previous yearly reports. To date, the monitoring provides important baseline data for tracking the recovery of fauna from fire in the future. It also provides important data to compare the rates of recovery within areas that have been previously mined and those still to be mined or used as controls.

Given the low levels of subsidence from previous mining at Clarence Colliery, the risk of adverse impacts on fauna within this area is considered to be low. The monitoring of recovery from fire within those sites mined and un-mined will be an important tool in the on-going assessment of mining activities.

Clarence West Area

The CLW sites were surveyed between the 15th of April and 31st of May 2024, the 19th of September and 25th of October, and the 25th of November and 24th of December 2024. Twenty-five native mammals (plus four introduced), 74 birds, 11 reptiles, eight amphibians and one invertebrate species were recorded during the 2024 surveys. Since the commencement of monitoring, a total of 137 birds, 36 native mammals (plus nine introduced), 26 reptiles, 14 amphibians and one invertebrate species have been recorded.

CLW01 and CLW05, located over the Springvale mining area, were previously included as control sites. These two sites have since been undermined by Springvale and are no longer appropriate to be considered as control sites. CLW01 was undermined by Springvale in the spring of 2018. CLW05 is approximately 1.4km northwest of Clarence's partial extraction mining activities and approximately 100m to the east of Springvale's Longwall 425. Consequently, these two sites will be removed from the Clarence monitoring schedule and reporting as they have been impacted by longwall mining activities, the effects of which are irrelevant with respect to monitoring impacts from partial extraction mining activities.

It is noted that the three sites located in the 700 Area have been monitored for at least 15 years post-secondary extraction activities.

The Western SMP Areas appear to be productive, in terms of fauna diversity values. At this stage 27 threatened species are known to occur within the area, and several species that have been located are considered as being of conservation concern in this region e.g. Beautiful Firetail, Rufous Fantail, Long-nosed Bandicoot. The area should be considered heavily disturbed by recreational activities, particularly trail bikes and 4WDs. This must be brought into consideration when assessing any changes.

The major influence upon the fauna populations (and vegetation) within the Western SMP Area has been the 2013 State Mine and 2019 Gosper's Mountain fires that burnt out all the sites in the area. Fire is a natural part of Australian ecosystems and both fires were typical of a high intensity burn. The frequency of fire is the issue here, as sufficient time is required for vegetation and fauna populations to recover before they can withstand another knockdown. The data we have obtained over the years provides an important analysis of recovery from fire by fauna. Surveys from 2020 focus on comparing rates of recovery within burnt areas that have been previously mined and those still to be mined or used as controls.

The results from the survey of the Western SMP Area in 2024 show that the assemblages found are more typical of that found throughout the Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the surveys was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Most diversity parameters have remained stable over the long term, except bird and amphibian species richness which increased to 2018 (several years after the majority of Clarence's extraction activities were completed) and showed declines over the 2019-2023 period post bushfire. However, bird, reptile and amphibian appear to have increased in 2024 (again, several years after the majority of Clarence's extraction activities were completed) and are all back at pre-fire levels. Small mammal capture rates almost returned to pre-fire levels in 2019, six years post-fire, but crashed in 2020 to an all-time low. Although capture rates in autumn 2023 were similar to 2013 pre-fire levels, there was a substantial decline again in both seasons of 2024. In contrast to pre-fire years, small mammal captures are now predominantly driven by Agile Antechinus, rather than Bush Rats.

Mean bat activity and species richness in 2024 were similar to that of 2023, where both were the highest on record. As is often the case with fire, once the vegetation and associated food source is wiped out, there is a delay in seeing the return of species to the landscape. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. Above-average rainfall in most months over the 2020-2022 period appears to have helped start the post-fire regeneration process on the Plateau. Fauna results have followed with overall richness and Simpson's diversity mostly within expected ranges, except for reptile and amphibian Simpson's Diversity which declined in 2023 but recovered in 2024. Most functional groups were represented.

Fourteen threatened species were located during 2024, as well as several bird species dependent upon woodland habitats. Threatened species included Eastern Pygmy-possum, Southern Greater Glider, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Greater Broad-nosed Bat, Gang-gang Cockatoo, Masked Owl, Pilotbird, Dusky Woodswallow, Scarlet Robin, Flame Robin, Blue Mountains Water Skink and Giant Dragonfly. This is about average, considering several species have been listed since surveys began. Woodland-dependent seemed to be dropping slowly over time until 2017 when they fell sharply. The decline has continued to 2024 which is now the lowest year on record for both groups. Both the State Mine and Gosper's Mountain fires affected the fauna and habitats within the Western SMP areas, with many measured parameters falling after each.

Given the low levels of subsidence from previous mining at Clarence, the risk of adverse impacts on fauna within this area is low. Statistical analysis of fauna populations in the Western SMP areas suggests changes in diversities are primarily due to climatic changes, though some evidence of lower diversity measures in undermined sites is shown at this stage (noting the results from sites undermined by Springvale have been used in the statistical analysis for 2024). The differences seen this year were similar to last year, but different to previous years (except bird Simpson's and richness), so continued monitoring of these indices will tell whether we have evidence of ongoing change due to mining, or simply a temporal anomaly. At present, there appears to be little conclusive evidence of subsidence impacts on the fauna diversity within the Western SMP areas at Clarence.

Aquatic Ecology Monitoring

As required by the Clarence Colliery Water Management Plan (June 2022), Marine Pollution Research Pty Ltd (MPR) was commissioned to undertake the biannual (Autumn and Spring) stream health monitoring in 2024, to assess the possible effects on aquatic ecology of:

- Wollangambe River below the Clarence Colliery Licensed Discharge Point 2 (LDP2).
- The upper Bungleboori Creek catchment; and
- The upper Carne and Dingo Creek catchments.

The stream health surveys are being conducted using standardised methods applied to other Centennial Coal stream health studies in the Coxs and Wolgan River upper catchments. A summary of the stream health results for the Wollangambe River is provided below. For the complete report and all of the aquatic ecological monitoring completed during the 2024 Reporting Period refer to **Appendix 5**.

Wollangambe River

For the 2023 sample year, the study area catchments were influenced by dry weather throughout the middle of the year with increasing rain periods following the spring survey in September, including periodic intense wet weather events. While early 2024 saw variable rainfall patterns on a month-to-month basis, the overriding conditions were wet leading into the autumn (May) 2024 survey, which included an intense storm system in April where 107mm was recorded on a single day and almost continuous rainfall activity two weeks prior to the autumn sampling with 97mm recorded over 13 rainfall days. Rainfall patterns eased following the autumn survey with below-average rainfall throughout August and September, and the lead-up to the spring sample in mid-November saw a continuation of the prevailing weather conditions, with light rain occurring over the two-week period prior to the commencement of sampling.

In 2024 discharges from LDP002 were generally lower and more stable than in 2023. There was a brief spike (peaking at 37 ML/day) during the April wet weather event, several brief reductions in discharge flow rates (to 4 ML/day) in February, April and June, and a prolonged period of reduced flow ranging between 9 ML/day and 18 ML/day in September to October.

Snapshot water quality results for the inline Wollangambe River downstream of LDP002 discharges waters were variable throughout the study area length for both surveys in 2024. Conductivity values exceeded the ANZG (2018) default guideline value (DGV) range for slightly disturbed upland rivers for both surveys at LDP002d and WGRdam and at WGRXdown for the autumn 2024 survey only, however, were within the range of values recorded previously at each site.

Both the upstream and tributary reference sites (WGRup and WGRref) maintain conductivity and pH values below the respective ANZG (2018) DGV ranges as these sites are fed by naturally acidic, very low conductivity runoff from catchments containing Newnes Plateau Shrub swamps. Tributary site WGRtrib1 is a mixing zone for natural creek runoff and Wollangambe River downstream of discharge water, with water quality largely mediated by rainfall and runoff regimes.

Several sites, including reference site WGRref, recorded low diversity values for the autumn survey, which was attributed to the after effects of scouring from a flow event which occurred one month prior to sampling.

The low diversity at WGRdam and Wollangambe inline sites downstream from LDP002 may have also been influenced by biofilms which were smothering submerged aquatic habitats and compromised the retention of macroinvertebrates during the sampling process.

In terms of SIGNAL grades, the most sensitive taxa (mayfly family Leptophlebiidae, stonefly family Gripopterygidae and dragonfly family Telephlebiidae) occur among the inline sites downstream of LDP002 however their temporal and spatial patterns of distribution and anecdotal trends in abundance are generally less than the reference sites.

When coupled with the presence of smothering biofilms which are generally ubiquitous throughout the sites, the recruitment of macroinvertebrates to stream channel areas downstream of LDP002 following scouring flow events may be slower than the reference sites. After these high flow events when flow rates decline, recruitment of macroinvertebrates to edge habitats at WGRup and WGRref is possible via settlement among isolated edge backwaters from downstream invertebrate drift, however, there are very few settlement areas, the types of backwater habitat areas which are targeted for AusRivAS ‘edge’ samples, downstream of LDP002 owing to the constant flow velocity throughout the study area channels. It is plausible that the low diversity of macroinvertebrates recorded in autumn 2024 was owing to the after-effects from the scouring impacts of aquatic habitats and associated macroinvertebrate fauna from a single day 107mm flood event the month prior.

Furthermore, while the physical structure of riffle sections sampled at WGRXdown is suitable and conforms to the definition provided in the AusRivAS sample protocol manual (areas of broken water with rapid current, containing cobbles and boulder substrates), they consistently appear to be highly consolidated (difficult to dislodge while sampling) and when combined with the strength of the flow, may compromise the ability for macroinvertebrates to be retained in the sample net.

This combination likely contributed to the low diversity values recorded at WGRXdown riffle samples over recent surveys. The WGRXdown edge samples produced similar trends to other inline Wollangambe River sites downstream of LDP002 in 2024, and to a lesser extent, the reference sites, being relatively low in autumn with improved taxa richness in spring, indicating that the (limited) availability of backwater edge areas to sample at WGRXdown still supports higher diversity of macroinvertebrate taxa.

In contrast, site WGRtrib1 is the only site that is protected from the effects of scouring due to its channel shape (broad and deep) and presence of macrophytes which provide a buffer from potential high-velocity runoff at the upstream end of the site, and WGRtrib1 recorded its highest macroinvertebrate diversities for both surveys in 2024.

It is therefore recommended that an additional site be considered in addition to WGRXdown, to remove these variables from the sample analysis. This would require finding a suitable nearby site with a broader channel area to accommodate and disperse the flow over a larger area, producing a relative decrease in flow velocity.

There were no threatened or protected invertebrate or vertebrate aquatic species (as listed under the BCA, NSW Fisheries Management Act 1994 or Commonwealth Environment Protection & Biodiversity Conservation Act 2000) caught or observed for aquatic habitats during the 2024 Clarence Aquatic Ecology monitoring surveys. Concerning aquatic mammals there were no indications of platypus or Australian water rat usage within the study area noted for either survey in 2024.

6.6.3 Comparison Against Predictions

Sections 5.6 and 5.7 of the 1993 EIS (R. W. Corkery & Co. 1993) for the Clarence Colliery Northern Extension discuss the predicted effects on flora and fauna to be caused by the development. The EIS concludes that the impacts on flora and fauna by underground mining would be minor if any occurs at all. Section 6.6.2 concludes that there have not been any measurable impacts at those sites monitored, caused by mining activities within the lease area during the Reporting Period.

6.6.4 Long Terms Analysis

A long-term analysis of the threatened species is presented below for the Clarence 900 Area (see **Table 6-16** and **Figure 6-11**) and the CLW Area (see **Table 6-17** and **Figure 6-12**).

It is observed that the number of threatened species in the Clarence 900 Area has varied over the years but remains stable over the long term. Whilst in the CLW Area the number of threatened species has been increasing over time, peaking in spring 2023.

For the complete fauna monitoring reports and long-term analysis refer to **Appendix 4**.

Table 6-16: Threatened species in 900 Area in autumn (A) and spring (S) over time

Category	2016		2017		2018		2019		2020		2021		2022		2023		2024	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Woodland-dependent bird species (%)	-	-	64.5	65.4	64.9	74.5	65.6	72.7	75.0	71.1	82.8	77.4	73.1	75.8	67.7	70.4	67.7	70.4
Declining bird species (%)	-	-	6.5	7.7	2.7	8.5	9.4	6.8	4.2	7.9	10.3	9.7	3.8	6.1	6.5	7.4	6.5	7.4
Threatened species	4	4	5	8	5	7	5	5	6	4	6	3	4	3	4	2	4	2

Table 6-17: Threatened species in CLW Area in autumn (A) and spring (S) over time

Category	2016		2017		2018		2019		2020		2021		2022		2023		2024	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Woodland-dependent bird species (%)	-	-	65	59	59	63	63	64	61	60	70	66	64	62	70.6	66.7	59	52
Declining bird species (%)	-	-	5	7	7	9	8	8	3	7	10	8	8	6	8.8	10.4	8	5
Threatened species	3	6	7	7	9	11	6	6	8	7	7	9	7	10	6	12	9	9

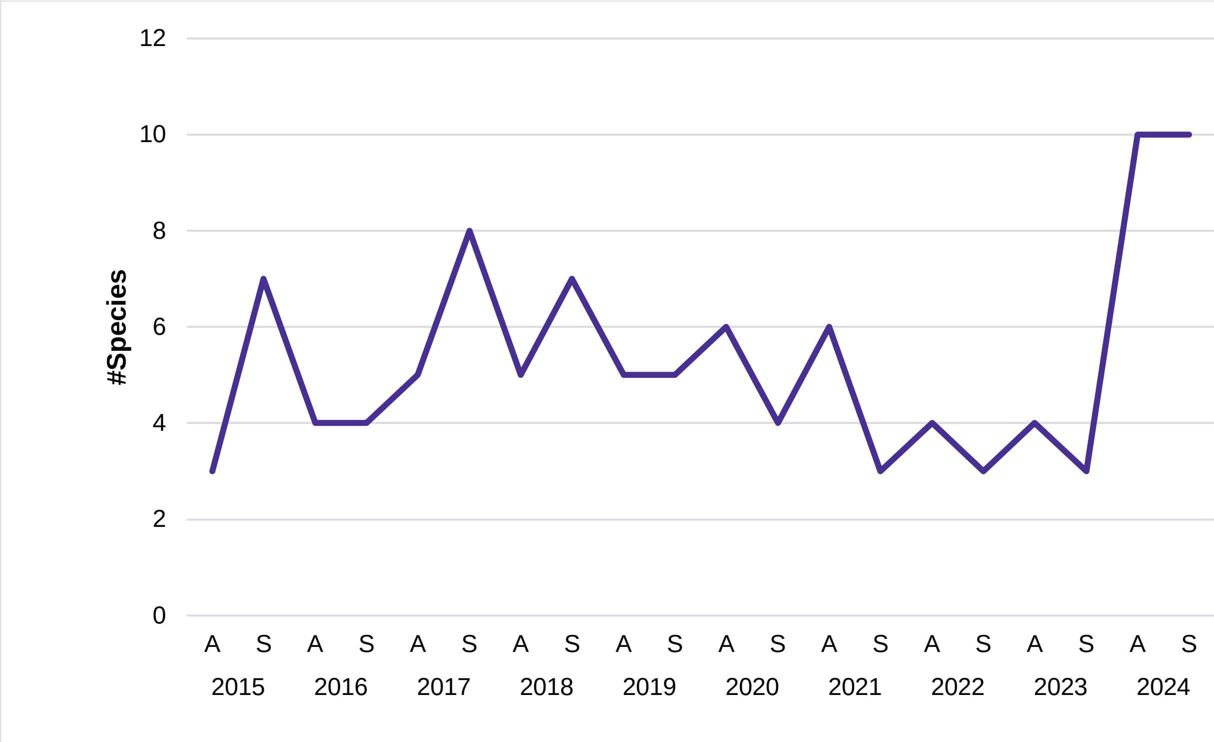


Figure 6-11: Number of threatened species in the 900 Area over time

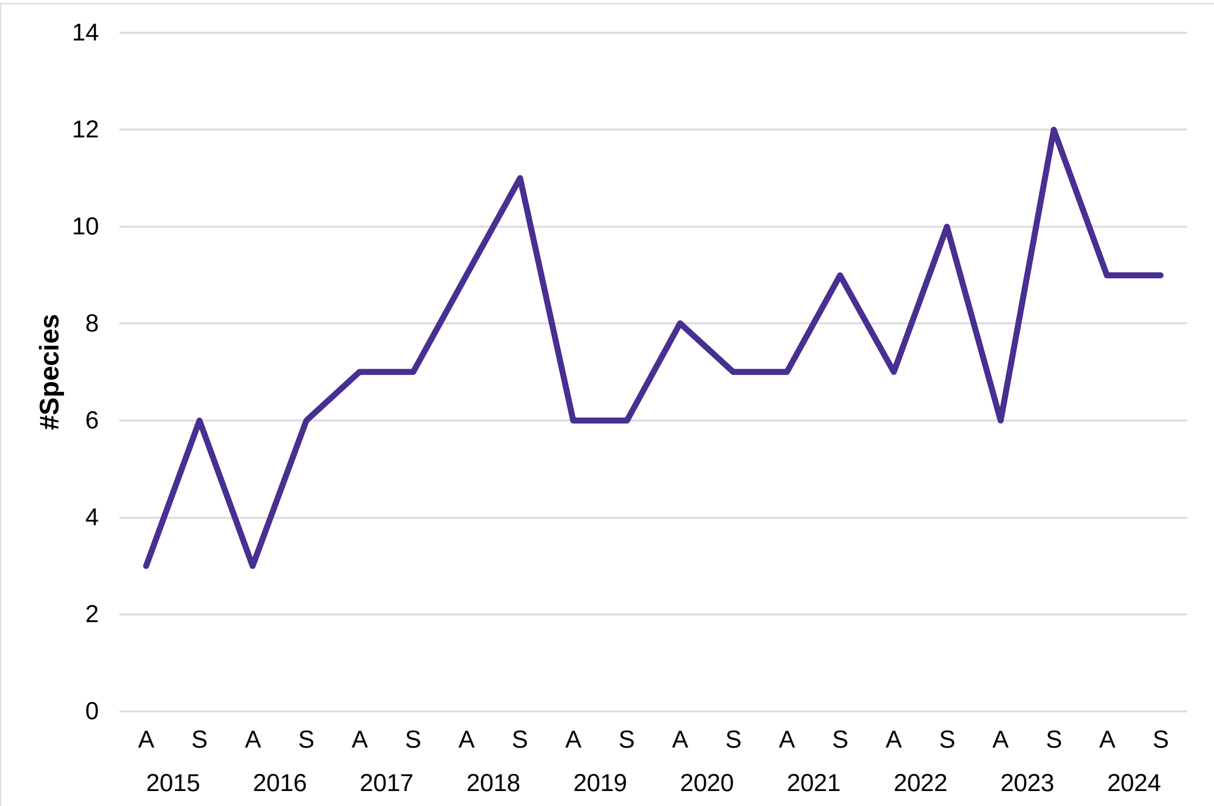


Figure 6-12: Number of Threatened Species in the CLW Area over time

6.6.5 Implemented / Proposed Improvements

Monitoring and inspections during the next Reporting Period will be undertaken to assess the effectiveness of the management measures for Clarence Colliery in accordance with the revised WRBMP, subject to its approval from the DPHI.

Further consultation with DPHI regarding the latest revision to the WRBMP, will be undertaken during the next Reporting Period. Revision of the WRBMP will be undertaken in the next Reporting Period as required.

6.6.6 Biodiversity Offsets

In accordance with Schedule 3, Condition 12A, Clarence has provided a suitable offset for the clearing of 4.1 hectares of Newnes Plateau Narrow-leaved Peppermint- Silvertop Ash layered open forest and the loss of related biodiversity values including threatened species. This offset is part of the Western Region Biodiversity Offset Strategy (WRBOS).

The WRBOS identifies retirement 204 ecosystem biodiversity offset credits by Clarence. Clarence's biodiversity offset requirements will be satisfied with the retirement of land utilising a Conservation Agreement in perpetuity under the *Biodiversity Conservation Act 2016*.

The conservation agreement for Carinya Lot 163 (**Figure 6-13**) was finalised in October 2020. Springvale Colliery submits an Annual Management Report to BCS for the Carinya offset area as required by the WRBOS.

A draft Conservation Bond calculation was submitted to the Secretary with the WRBOS. The Conservation Bond is proposed to include the completion of management actions for the first 10 years of the WRBOS. The site has no active restoration. Management activities are limited to limiting human disturbance and maintaining site security, weed management, pest management and ecological monitoring.

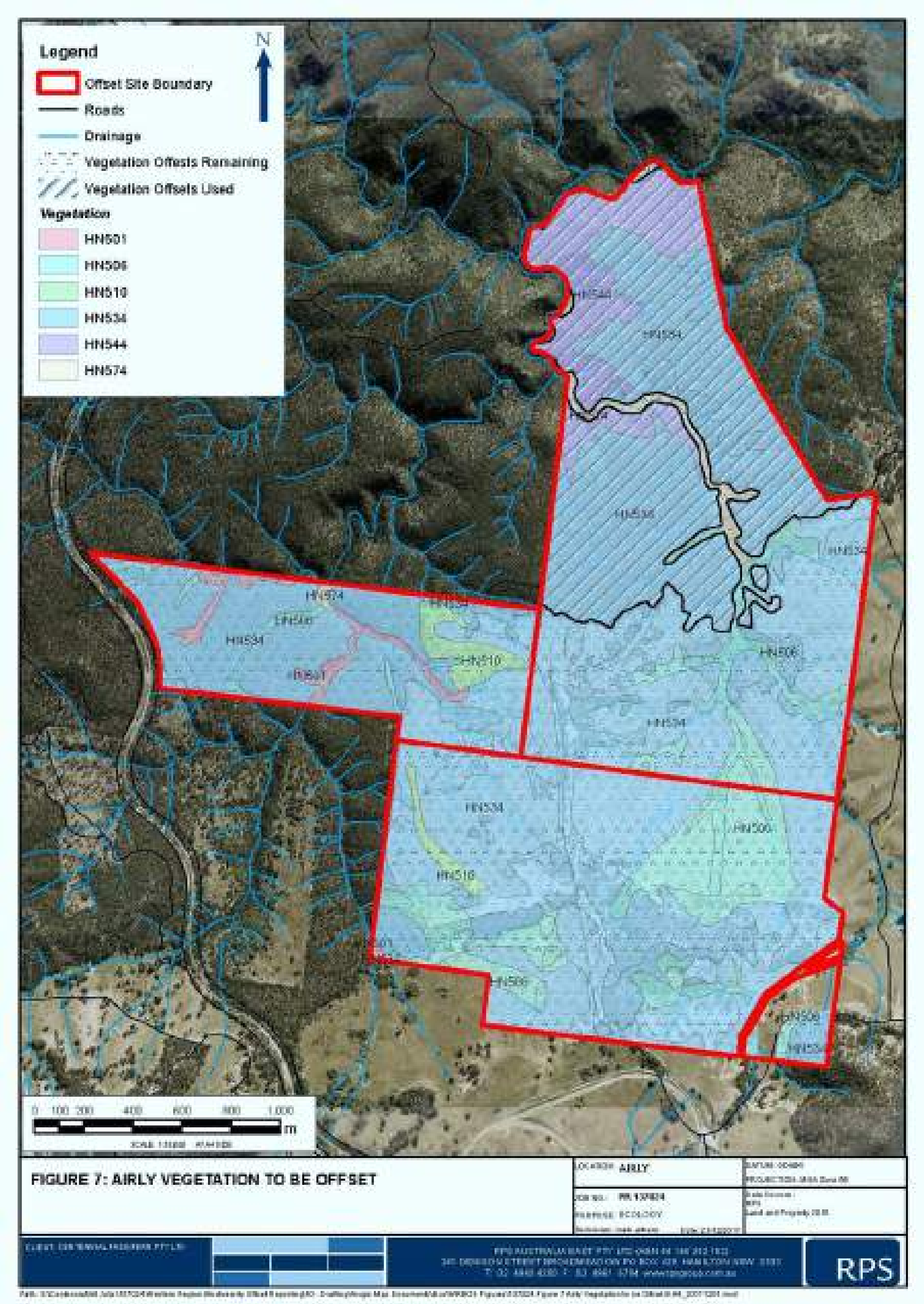


Figure 6-13: Carinya Offset Site & BioMetric Vegetation Types (BVTs)

6.7 HERITAGE

6.7.1 Environmental Management

Clarence manages Aboriginal heritage in accordance with the Western Region Aboriginal Cultural Heritage Management Plan (WRACHMP) which was approved by DPHI in 2021. Clarence manages European heritage in accordance with the Historic Heritage Management Plan (HHMP) dated June 2018. The HHMP was approved by DPHI in 2018 and satisfies Schedule 3, Condition 30 of DA 504-00.

The WRACHMP identified forty-seven registered Aboriginal Heritage Information Management System (AHIMS) items within the Clarence Colliery Lease Boundary.

In accordance with the WRACHMP monitoring program, Clarence will record the condition of the site before mining (baseline survey and baseline check) and the condition of the site after mining (post-mining initial condition) and post-mining (secondary condition check) and thus has been separated into three phases.

- Phase 1: Baseline recording (prior to the site being undermined)
- Phase 2: Post-mining initial condition (immediately after undermining)
- Phase 3: Post-mining secondary condition (approximately 8 months after undermining)

There are no heritage items within the Clarence Lease Boundary that are listed on the Commonwealth Heritage Register, on the NSW State Heritage Register (SHR), or on the s170 registers (state-owned items). There are no known unlisted heritage items in the Clarence Lease Boundary (HHMP 2018).

6.7.2 Environmental Performance

There were no Phase inspections or Due Diligence surveys were required during the Reporting Period.

6.7.3 Comparisons Against Predictions

Page 114 of the 900 Area SMP Written Report (2013) states that Clarence Colliery has identified no discernible impacts on the surface of previously mined areas using the partial extraction mining methods, and as such it is expected that mining in the 900 Area will also have no impacts on any Aboriginal cultural heritage sites. A similar statement is made in the 800 Area SMP Report (2011).

There were no Phase inspections undertaken during the reporting period.

6.7.4 Long Term Analysis

There have been no recorded impacts on Aboriginal Heritage items at Clarence.

6.7.5 Implemented / Proposed Improvements

The Western Region Aboriginal Cultural Heritage Committee (ACHC) Meetings were held in March and September 2024. Clarence will continue to undertake Western Region ACHC Meetings in the next Reporting Period on a bi-annual basis.

Clarence will continue to manage and monitor Aboriginal Cultural Heritage in accordance with the WRACHMP.

The pre-clearance permit systems in the WRACHMP provides the land disturbance due diligence process, implemented by the site and is considered appropriate for the management of Aboriginal heritage items.

6.8 MINE SUBSIDENCE

6.8.1 Environmental Management

Clarence Colliery currently operates under several Subsidence Management Plans (SMP). During 2023, the following SMP applications and variations occurred:

- 900 Area – There were no SMP variations to the 900 Area in the 2023 Reporting Period. The last variation to the 900 SMP was submitted on the 28 of February 2022. This was Clarence's sixth variation and sought a modification to the extraction layouts of the 906, 915 and 917 panels within the 900 area. This variation also requested the extension of the 900 Area SMP expiry date to 24 December 2025 to coincide with the expected completion of extraction in the 900 Area SMP. This 900 Area SMP variation received approval on 12 April 2022
- 800 Area – A variation to the 800 SMP Area was submitted on 28 November 2024. This was Clarence's ninth variation and sought a modification to assess the proposed changes associated with secondary extraction within the 806A panel. This was approved on the 20 December 2024
- 700W Area – There were no SMP variations to the 700W Area in the 2023 Reporting Period. The last variation to the 700 Area SMP was submitted on 11 May 2021. This was Clarence's sixth variation and requested the extension of the 700W area SMP expiry date to 1 June 2025. Approval for this variation was granted on 28 May 2021.

A request to reduce environmental monitoring associated with expired SMPs was submitted to the NSW Resource Regulator on 21 March 2014. A response was received on the 2 April 2015. The approval to reduce environmental monitoring in the Eastern Area was not forthcoming and monitoring was completed throughout 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023 and 2024, again showing no impacts from subsidence. Clarence is currently reviewing environmental monitoring being undertaken for consultation with the NSW Resource Regulator.

6.8.2 Environmental Performance

During 2024, the following mining activities included:

- 800 Area
    - o Development of the 806A Mains Panel continued and completed;
    - o Development of 806A Panel was commenced and completed;
    - o Development of 830 Panel was completed;
    - o Development of 832 Panel was completed;
    - o Development of 834 Panel was commenced;
    - o Extraction of 804 Panel (limited to 52-70 cut through) commenced and completed;
- 900 Area

- o Development of the 918 Panel continued; and
- o Development of 919 Panel continued.

During the Reporting Period, the following subsidence monitoring was undertaken:

- 800D line surveyed on the 19th July 2024;
- 800E line surveyed on the 10th July 2024;
- 800C line surveyed on the 27th June 2024;
- 800B line surveyed on the 24th June 2024
- 800A line surveyed on the 23rd April 2024;
- 800G line surveyed on the 12th of April 2024;
- 800J line surveyed on the 22nd April 2024;
- 800I line surveyed on the 9th of April 2024 Resurvey of the 700A line on 15th August 2024;
- Resurvey of the 700B line on 5th August 2024;
- Resurvey of 707 Sub line on 30th August 2024; and
- Resurvey of the 700F line on 25th September 2024900D line surveyed on the 13th May 2024, 16th August 2024 and 12th November 2024;
- 900E line surveyed on the 3rd June 2024 and 3rd October 2024;
- 900B line surveyed on the 3rd June 2024 and 3rd October 2024;
- 903 lines surveyed on the 19th of September 2024;
- 900C line surveyed on the 20th June 2024; and
- 900A line surveyed on the 12th September 2024.
- W and Z lines surveyed on the 11th of October 2024;
- U line surveyed on the 20th of September 2024;
- H and I Lines surveyed on the 20th of September 2024.

Subsidence Monitoring

Subsidence monitoring results from previously extracted panels are discussed in detail in the Subsidence Management Status Report (SMSRs).

Subsidence and environmental monitoring have been carried out generally in accordance with the relevant Subsidence and Environmental Monitoring Programs required under the various SMP approvals.

Flora and fauna monitoring has shown no measurable impact from mining.

No effect of land subsidence has been observed from the monitoring conducted over 2024.

Groundwater impact has been minimal with the main effects being at seam level. Piezometric height has decreased in the seam level aquifers as expected. There has been no adverse impact on upper aquifers (i.e., above the Mt York Claystone) as a consequence of mining activities (including the Clarence aquifer). Piezometers and inspections within swamps have found no impact from mining.

Surface water quality monitoring indicates no adverse impact from mining with upstream and downstream results for Farmers Creek (700 Area) and Newnes Plateau Swamps.

Cliff line and pagoda photographic monitoring, combined with visual surface inspections, has found no evidence of any mining related impact.

6.8.3 Comparisons Against Predictions

The panel geometry and mine plan are designed around the need to achieve subsidence that is limited to a value well within that considered to be characteristic of 'elastic' overburden behaviour (i.e., no caving to surface), which is defined as 100±25 mm (SEA, 2005). This limit is conditioned within Development Consent DA 504-00 Schedule 3, Condition 1, which states that: 'The Applicant must ensure that surface subsidence generated by the development does not exceed the criteria listed in Table 1 of DA 504-00 (First Workings – 20mm subsidence, 1.0mm/m tilt, 1.0mm/m horizontal strain. Partial Extraction – 100mm subsidence, 3.0mm/m tilt, 2.0mm/m horizontal strain).' It should be noted that the 900D line is outside of DA 504-00.

6.8.4 Long Term Analysis

All subsidence results for the past 5 years since 2020-2024 have been below the 100mm maximum predicted (with the exception of the older panels within the IRM.GE.76 development consent area and the 2022 900D exceedance).

6.8.5 Implemented / Proposed Improvements

Clarence Colliery will continue to implement the approved SMPs during the next Reporting Period. DA 504-00 (MOD10) included the addition of conditions for future secondary extraction at Clarence to be undertaken in accordance with an approved Extraction Plan.

6.9 OTHER MATTERS

6.9.1 Waste

Schedule 3, Condition 24 of DA 504-00 states Clarence Colliery must minimise the amount of waste generated by the development to the satisfaction of the Planning Secretary. During the Reporting Period, the following items are collected to minimise waste to landfill including, waste oil, oily water and oil filters, paper and cardboard packaging, scrap steel, other recyclables (e.g., glass and plastics) and solid wastes.

All general waste is collected by the licensed waste contractor for disposal at a licensed landfill site. **Table 6-18** provides a summary of the waste recycled and disposed during the reporting period with a comparison of waste consumed over the last five years.

In 2024, 347.675 tonnes of waste was sent offsite for disposal with 253.972 tonnes of recycled waste, at a total yield recycling rate of 42.21%. This compares to a recycling rate of 50.09% in 2023 and 42.44% in 2022.

Table 6-18: Waste Summary

	2020	2021	2022	2023	2024
Recycling					
Hazardous Recycled (Waste Oil, Oily Water / kL, Batteries, Oil Filters / tonnes)	31.400	23.704	21.102	26.946	26.880
Non-Hazardous Recycled (Paper & Cardboard, Scrap Steel / tonnes)	280.858	230.343	197.991	268.584	227.092
Total Waste Recycled	**312.258**	**254.047**	**219.093**	**295.53**	**253.972**
Disposal					
Hazardous Disposal (Oily Rags / tonnes)	24.533	16.322	15.840	5.910	4.922
Non-Hazardous Disposal (Mixed Solid Waste / tonnes)	346.126	370.365	281.275	285.580	342.753
Total Waste Disposal	**370.659**	**386.687**	**297.115**	**291.49**	**347.675**
Total Offsite Waste					
Waste recycled and disposed	**682.917**	**640.734**	**516.208**	**584.02**	**601.647**
Percentage Waste Recycled	*45.72%*	*39.65%*	*42.44%*	*50.09%*	*42.21%*

7 WATER MANAGEMENT

Clarence have developed a site-specific Water Management Plan (WMP) to address Conditions 5, 6, 6A, 6B, 7, 8, 9, 10, 11 and 12 of Schedule 3, of DA 504-00. DPHI approved the WMP (June 2022) on 9 May 2023. The WMP has been developed to address the approvals and licensing requirements through the completion of the following:

- Collate and review existing information and studies relating to the operation of the water management system at Clarence Colliery;
- Establish an understanding of the water management system at the site;
- Categorise the existing conditions that are specific to water management requirements;
- Identify the clean, dirty, and contaminated water management systems and maximise the separation of these systems;
- Undertake a review of the capacity of dirty and contaminated surface water storages in accordance with Managing Urban Stormwater: Soils and Construction, Volume 1, and Volume 2E (Landcom 2004; DECC 2008);
- Undertake a water quality assessment and review existing water quality assessment criteria;
- Manage water discharged from the site, in terms of volume and quality, to a level that is acceptable for environmental management and community expectations and in accordance with EPL conditions;
- Minimise water discharges from the premises by maximising, where practicable, opportunities for the reuse and recycling of water on site;
- Determine the future water management requirements; and
- Review and develop water monitoring requirements.

7.1 WATER LICENSES

Clarence Colliery holds two water access licenses (WAL), in which **Table 7-1** displays passive take/inflows and active pumping against entitlements. It is noted that water takes are reported over the financial year (i.e., the Water Year), which is from 1 July 2023 to 30 June 2024. During the Reporting Period, WAL36479 and WAL41882 were compliant with the assigned entitlement.

Table 7-1: Water Licenses and Take

Licence	Water sharing plan, source and management zone	Entitlement (ML)	Passive take/inflows (ML)	Active pumping (ML)	TOTAL (ML)
WAL36479 and WAL41882	Sydney Basin Richmond and Coxs River Groundwater Source	7718	0	6,578	6,578

On 1 July 2023 the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023 commenced. As a result, the Sydney Basin Richmond Groundwater Source

and Sydney Basin Coxs River Groundwater Source have been amalgamated to reflect their connectivity, now named the Sydney Basin West Groundwater Source.

Centennial submitted Water Supply Works Approvals on 28 October 2024 in this newly formed groundwater source however at the time of report preparation these approvals were still under assessment.

Centennials compliance with the extraction limits for the new Sydney Basin West Groundwater source for is shown in **Table 7-2**.

Table 7-2 Centennial Amalgamated Groundwater Licences and Take

Groundwater source	Total WAL volume (ML/Annum)	2023/24 Water Take (ML/Annum
Sydney Basin Richmond Groundwater Source - Angus Place - Springvale - Clarence	15,139 ML/Annum	20, 203.3 ML / Annum
Sydney Basin Cox's River Groundwater Source - Angus Place - Springvale - Clarence	9,152 ML/Annum	2,424.8ML / Annum
Sydney Basin West Ground water source - **Angus Place** - **Springvale** - **Clarence**	**24,629 ML/Annum**	**22,628.1 ML/Annum** **(-2000.9 ML)**

7.2 WATER BALANCE

A site water balance model has been developed for Clarence Colliery to quantify water transfers within the site under existing operational conditions using various rainfall patterns (GHD 2023). A schematic of the overall water management system is presented in **Figure 7-1**. A summary of the predicted average annual inputs and outputs for the Clarence Colliery water management system for the 2024 calendar year is provided in **Table 7-2**. Results were based on the predicted average site conditions in 2024.

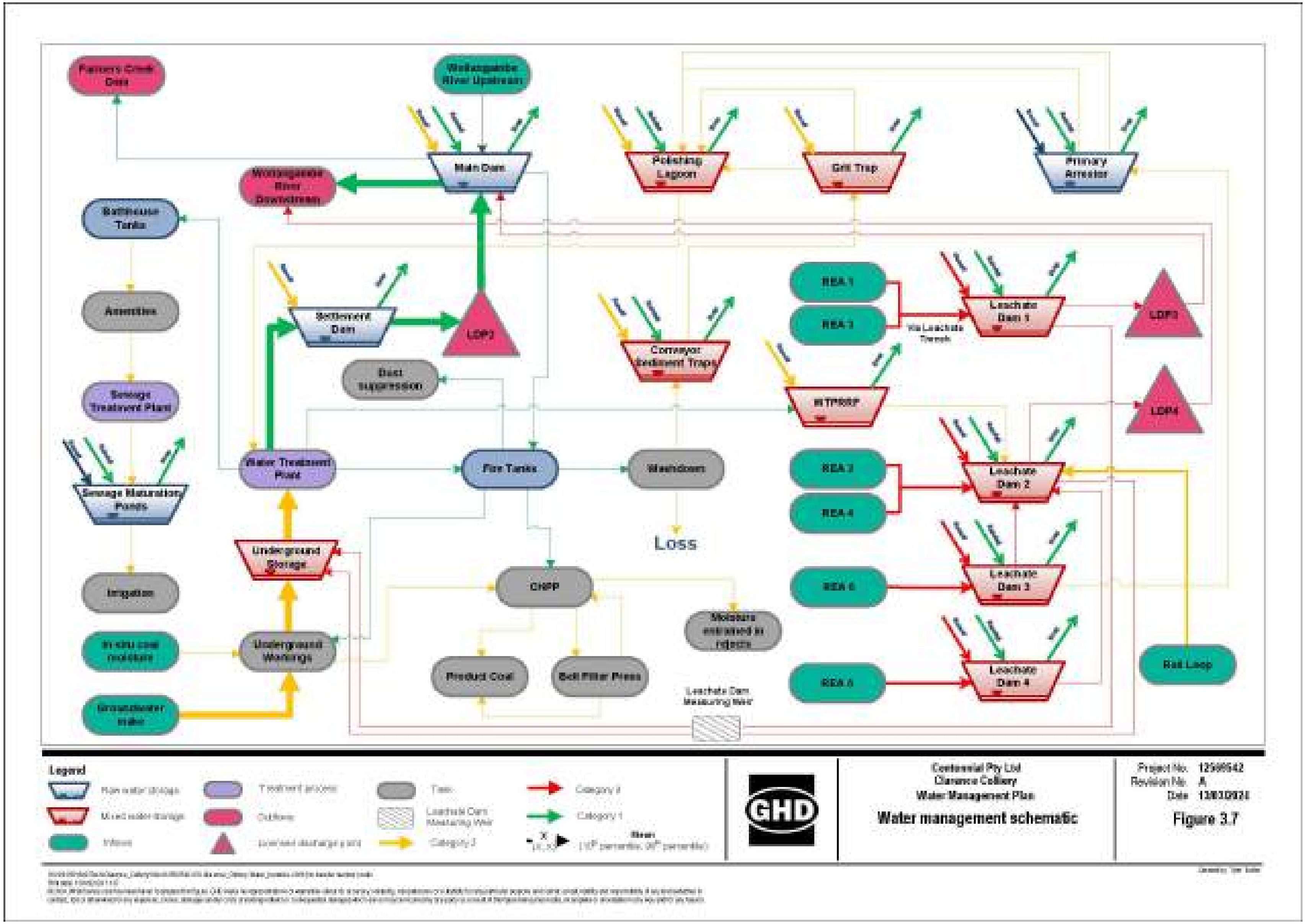
Table 7-2 shows that the largest transfer at Clarence Colliery is the dewatering of groundwater inflows to the underground workings of the WTP and discharge to the Wollangambe River via LDP002. The Main Dam is located downstream of LDP002, which is where site operational demands of approximately 600ML/year on average are extracted under 10WA103852[5]. Water from the Main Dam is pumped to the three fire tanks for use as process water (e.g., underground process water and washery make-up water) and as a permanent supply of water for fire-fighting purposes.

[5] Clarence holds joint water supply works approval 10WA103852 with Lithgow City Council (LCC) and water use approval 10UA103853, linked to Water Access Licence WAL26195 for 1293 units for the transfer of water stored in Main Dam to Farmers Creek Dam as part of the Clarence Water Transfer Scheme.

Table 7-2: Site Water Balance – Clarence Colliery

Clarence Colliery 2024 Water Balance	Volume (ML)
Water Sources (Inflows)	
Direct rainfall onto storages	10
Catchment runoff	74
Groundwater inflows into underground workings	5,706
In-situ coal moisture	44
Transfers from Main Dam	280
Total Inputs (rounded)	**6,114**
Water Loss (Outflows)	
Evaporation from storages	12
Discharge through LDP002	6,988
Discharge through LDP003	19
Discharge through LDP004	2
Irrigation	14
Dust suppression losses	172
Wash down losses	47
Coal product	123
Moisture entrained in reject material	16
Total Outputs (rounded)	**7,393**
Change in Storage	
Total Change in Storages	-1039
Water Balance	
Change in water inventory (inputs – outputs – change in storage)	**0**

Figure 7-1: Site Water Management Schematic



7.3 SURFACE WATER

7.3.1 Environmental Management

The water management system at Clarence Colliery is comprised of clean, dirty, coal contact and leachate water. Sources of water at the site include rainfall, catchment runoff and groundwater inflow to the underground mine workings.

Surface water monitoring is undertaken in accordance with the Clarence Colliery Water Management Plan (WMP), Development Consent DA 504-00 and EPL726 requirements.

The site has also developed TARPs to identify and manage potentially adverse impacts, as well as assist with managing the site's surface water during storm events.

Surface water monitoring at Clarence Colliery includes:

- **Discharge water quality monitoring,** undertaken monthly and during discharge events as per the requirements of EPL726 and the WMP at Licensed Discharge Point (LDP) LDP002, LDP003 and LDP004.[6]
- **Discharge volume monitoring,** undertaken at LDP002 continuously in accordance with the requirements of EPL 726. Discharge volumes through LDP003 and LDP004 are estimated.
- **Monthly surface water quality monitoring**, undertaken at the following locations. Main Dam; Polishing Lagoon, Leachate Dam 1, Leachate Dam 2, Farmers Creek below Lithgow Dam No. 2, Farmers Creek at Cooerwull Road Bridge, Wollangambe River US and Wollangambe River DS (note this monitoring point is also water quality monitoring Point 9 identified by EPL726).
- **Quarterly surface water quality monitoring** at the following locations including Farmers Creek US and Farmers Creek DS.
- **Stream health monitoring** including watercourse stability monitoring (only if triggered by subsidence greater than predictions) and aquatic ecology monitoring (see **Section 6.6**).

Surface water monitoring results are compared against relevant concentration limits or criteria.

Water quality limits are specified by EPL726 for LDP002, LDP003 and LDP004. These limits do not apply to discharges from LDP003 and LDP004 when the discharge occurs solely as a result of rainfall measured at the site which exceeds 56 mm over any consecutive five-day period.

EPL726 also specifies a volumetric limit of 25,000 KL/day for discharges through LDP002. However, discharges through LDP002 may exceed this limit on any day where greater than 10 mm of rainfall is recorded on site.

Performance criteria have also been developed for the Wollangambe River and Farmers Creek and these form the basis of the TARP in the WMP. Water quality monitored at the Wollangambe River DS monitoring site is assessed against site specific guideline values (SSGVs)**.** SSGVs are based on a review of ANZECC (2000) default guideline values (DGVs)

[6] Note that EPL726 specifies monitoring requirements and concentration limits for LDP001, however this LDP is not currently used and hence has been excluded from the monitoring program.

and water quality observed at reference sites. Water quality monitored at Farmers Creek is assessed against the 80th percentile historical concentrations for Farmers Creek**.**

The key surface water monitoring, as specified in EPL726, is required at four locations as detailed in **Table 7-3**.

Table 7-3: Surface Water Discharge Monitoring Locations

Monitoring Point Reference	Description / Creek Catchment
LDP002	Discharge from the Water Treatment Plant via a drainage channel to Main Dam.
LDP003	Discharge from Leachate Dam 1 to Main Dam.
LDP004	Discharge from Leachate Dam 2 to the Wollangambe River downstream of Main Dam.
Wollangambe River DS (EPL Point 9)	Wollangambe River downstream of LDP002 (and main dam).

7.3.2 Environmental Performance

Discharge Water (LDP002)

As required by EPL726 conditions and the WMP, water discharged from LDP002 is tested monthly (with some additional analytes tested monthly during discharge) and analysed against the applicable concentration limits. During the Reporting Period LDP002 discharged daily. A summary of LDP002 water quality sampling results from discharge events during the Reporting Period are presented in **Table 7-4**.

Long term water quality monitoring results and trends for LDP002 are provided in **Appendix 7**.

During the Reporting Period water quality monitoring for LDP002 has been undertaken in accordance with EPL726 and the WMP. LDP002 did not comply with EPL water quality limits on several occasions during the Reporting Period in January, February, March, May, June, July, August, September, October, November and December. For further information refer to **Section 11**. [7]

Table 7-4: Summary of Water Quality Results at LDP002

Pollutant	No. of samples required by licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL726 Limit
Physiochemical						
pH	12	14	7.1	8.1	8.5	6 – 8.5
Electrical Conductivity (µs/cm)	12	14	279	331.9	378	N/S

[7] The non-compliances are reported in **Table 1-1** (Statement of Compliance) and **Section 11.**

Pollutant	**No. of samples required by licence**	**No. of samples collected and analysed**	**Lowest sample value**	**Mean of sample**	**Highest sample value**	**EPL726 Limit**
Total Suspended Solids (mg/L)	12	14	LOR	1.8	19	30
Major Ions						
Chloride (mg/L)	12	14	14	15	17.9	25
Sulfate (mg/L)	12	14	90	111.7	139	250
Nutrients						
Total Fluoride (mg/L)	12	14	LOR	0.02	0.2	1
Total Nitrogen (mg/L)	12	14	LOR	**0.2**	**0.3**	0.25
Total Phosphorus (mg/L)	12	14	LOR	**0.023**	**0.06**	0.02
Dissolved Metals						
Arsenic (mg/L)	12	15	LOR	LOR	LOR	0.013
Boron (mg/L)	12	14	LOR	LOR	LOR	0.1
Cadmium (mg/L)	12	15	LOR	LOR	LOR	0.0002
Chromium (mg/L)	12	15	LOR	LOR	LOR	0.001
Cobalt (mg/L)	12	15	0.002	0.0105	**0.0474**	0.0025
Copper (mg/L)	12	15	LOR	0.0004	**0.004**	0.0014
Iron (mg/L)	12	15	LOR	0.04	0.21	0.3
Lead (mg/L)	12	15	LOR	LOR	LOR	0.0034
Lithium (mg/L)	12	15	LOR	0.016	0.018	0.1
Manganese (mg/L)	12	15	0.019	0.15	0.343	0.5
Mercury (mg/L)	12	15	LOR	0.00001	**0.0002**	0.00006
Nickel (mg/L)	12	15	0.004	**0.025**	**0.106**	0.011
Silver (mg/L)	12	15	LOR	0.00002	0.00032	0.0005
Zinc (mg/L)	12	15	LOR	**0.045**	**0.126**	0.008
Total Metals						
Selenium (mg/L)	12	15	LOR	0.00004	0.0003	0.005
Other						
Oil and Grease	12	14	LOR	LOR	LOR	10

Notes: *N/S = Performance criteria or site-specific guideline values are not specified within either the Clarence Colliery Water Management Plan (2022) or EPL726. LOR means limit of reporting. The **bolded** text indicates a non-compliance at least once with WMP and EPL726 limits.

Discharge Water (LDP003)

As required by EPL726 conditions and the WMP, water discharged from LDP003 is tested monthly during discharges and analysed against the applicable concentration limits. Condition L2.5 of EPL726 was applicable during the discharges from LDP003 as the discharge occurred solely as a result of rainfall exceeding 56mm of rainfall over a consecutive 5 day period.

Table 7-5: Summary of Water Quality Results at LDP003

Pollutant	No. of samples required by licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL726 Limit
Physiochemical						
pH	1	2	4.3	4.35	4.4	6 – 8.5
Electrical Conductivity (µs/cm)	1	2	189	223	256	N/S
Total Suspended Solids (mg/L)	1	2	LOR	11	22	30
Major Ions						
Chloride (mg/L)	1	2	3	3	3	25
Sulfate (mg/L)	1	2	83	93	103	250
Nutrients						
Total Fluoride (mg/L)	1	2	LOR	LOR	LOR	1
Total Nitrogen (mg/L)	1	2	LOR	0.05	0.1	0.25
Total Phosphorus (mg/L)	1	2	LOR	0.005	0.01	0.02
Dissolved Metals						
Arsenic (mg/L)	1	2	LOR	LOR	LOR	0.013
Boron (mg/L)	1	2	LOR	LOR	LOR	0.1
Cadmium (mg/L)	1	2	0.0009	0.0011	0.0013	0.0002
Chromium (mg/L)	1	2	LOR	LOR	LOR	0.001
Cobalt (mg/L)	1	2	0.352	0.408	0.463	0.0025
Copper (mg/L)	1	2	0.005	0.006	0.007	0.0014
Iron (mg/L)	1	2	LOR	LOR	LOR	0.3
Lead (mg/L)	1	2	LOR	LOR	LOR	0.0034
Lithium (mg/L)	1	2	0.037	0.0395	0.042	0.1
Manganese (mg/L)	1	2	1.35	1.415	1.48	0.5
Mercury (mg/L)	1	2	LOR	LOR	LOR	0.00006
Nickel (mg/L)	1	2	0.912	1.076	1.24	0.011
Silver (mg/L)	1	2	LOR	LOR	LOR	0.0005
Zinc (mg/L)	1	2	1.03	1.155	1.28	0.008

Pollutant	No. of samples required by licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL726 Limit
Total Metals						
Selenium (mg/L)	1	2	LOR	0.00045	0.0009	0.005
Other						
Oil and Grease	1	2	LOR	LOR	LOR	10

Discharge Water (LDP004)

As required by EPL726 conditions and the WMP, water discharged from LDP004 is tested monthly during discharges and analysed against the applicable concentration limits. Condition L2.5 of EPL726 was applicable during the discharges from LDP004 as the discharge occurred solely as a result of rainfall exceeding 56mm of rainfall over a consecutive 5 day period.

Table 7-6: Summary of Water Quality Results at LDP004

Pollutant	No. of samples required by the licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL726 Limit
Physiochemical						
pH	1	1	3.1	3.1	3.1	6 – 8.5
Electrical Conductivity (µs/cm)	1	1	484	484	484	N/S
Total Suspended Solids (mg/L)	1	1	18	18	18	30
Major Ions						
Chloride (mg/L)	1	1	LOR	LOR	LOR	25
Sulfate (mg/L)	1	1	243	243	243	250
Nutrients						
Total Fluoride (mg/L)	1	1	0.1	0.1	0.1	1
Total Nitrogen (mg/L)	1	1	0.3	0.3	0.3	0.25
Total Phosphorus (mg/L)	1	1	0.01	0.01	0.01	0.02
Dissolved Metals						
Arsenic (mg/L)	1	1	0.001	0.001	0.001	0.013
Boron (mg/L)	1	1	LOR	LOR	LOR	0.1
Cadmium (mg/L)	1	1	0.0049	0.0049	0.0049	0.0002
Chromium (mg/L)	1	1	0.003	0.003	0.003	0.001
Cobalt (mg/L)	1	1	1.92	1.92	1.92	0.0025

Pollutant	No. of samples required by the licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL726 Limit
Copper (mg/L)	1	1	0.152	0.152	0.152	0.0014
Iron (mg/L)	1	1	3.86	3.86	3.86	0.3
Lead (mg/L)	1	1	0.015	0.015	0.015	0.0034
Lithium (mg/L)	1	1	0.023	0.023	0.023	0.1
Manganese (mg/L)	1	1	6.38	6.38	6.38	0.5
Mercury (mg/L)	1	1	LOR	LOR	LOR	0.00006
Nickel (mg/L)	1	1	4.58	4.58	4.58	0.011
Silver (mg/L)	1	1	LOR	LOR	LOR	0.0005
Zinc (mg/L)	1	1	5.29	5.29	5.29	0.008
Total Metals						
Selenium (mg/L)	1	1	LOR	LOR	LOR	0.005
Other						
Oil and Grease	1	1	LOR	LOR	LOR	10

LDP002, LDP003 and LDP004 Discharge Volumes

The volume of water discharged is required to be monitored daily at the licenced discharge points LDP002, LDP003 and LDP004 in accordance with EPL 726. The total volume discharged from LDP002 may exceed 25,000kL/day on any day where greater than 10mm of rainfall is recorded at the premises, for that day.

Table 7-5 Provides the discharge volume results for the Annual Review period. **Figure 7-2** Displays the daily discharge volumes for the licenced discharge points during the reporting period.

Table 7-5: LDP002, LDP003 and LDP004 Discharge Volumes

Discharge Point	No. of Measurements made	Lowest result (KL)	Mean result (KL)	Highest result (KL)	EPL Limit (KL/day)	Comments
LDP002	366	4,309	19,244	36,085[1]	25,000	Continuous Monitoring
LDP003	Nil	N/A	N/A	N/A	N/A	Flow estimate was not recorded at time of discharge

Discharge Point	No. of Measurements made	Lowest result (KL)	Mean result (KL)	Highest result (KL)	EPL Limit (KL/day)	Comments
LDP004	Nil	N/A	N/A	N/A	N/A	Flow estimate was not recorded at time of discharge

[1] All occasions where discharge was >25,000Kl/day coincided with >10mm of rainfall.

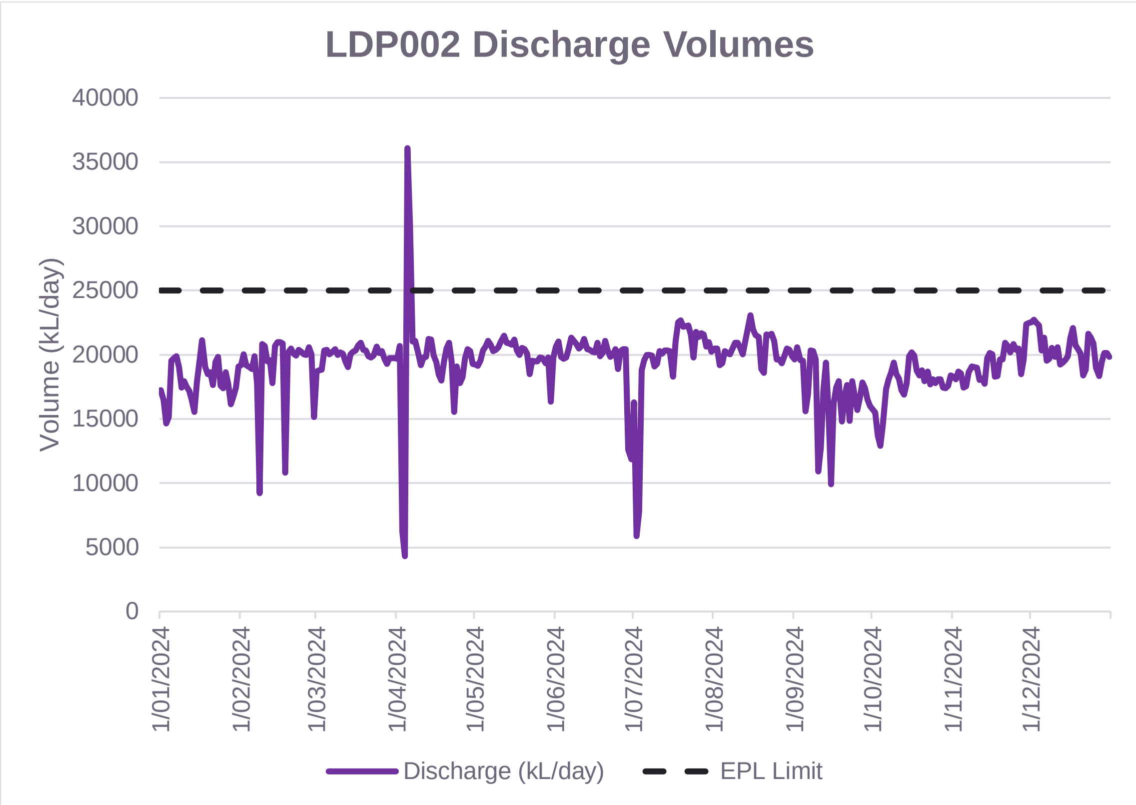


Figure 7-2: Summary of LDP002 Daily Discharge Volumes

Wollangambe Downstream Water Quality (EPL Point 9)

Wollangambe Downstream (EPL Point 9) is located downstream of LDP002 in the Wollangambe River. The requirement to undertake water quality monitoring at this point was introduced into EPL726 in March 2017.

Water quality criteria is not specified in EPL726 for EPL Point 9. The WMP (May 2017) specifies site-specific guideline values (SSGVs) that are based on a review ANZECC (2000) default guideline values (DGVs). DGVs for a species protection level of 99% were used for the Wollangambe River due to high conservation value of the receiving environment within the Blue Mountains National Park.

Table 7-6 Below summarises the water quality monitoring results against SSGVs during the Reporting Period. Water quality monitoring results are presented graphically in **Appendix 7.**

Table 7-6: Summary of Water Quality Results at Wollangambe River Downstream

Pollutant	No. of samples required by the licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	SSGV limit
Physiochemical						
Dissolved Oxygen	12	14	6.30	7.87	12.60	N/S*
Electrical Conductivity	12	14	**111**	**292**	**363**	100
pH	12	14	5.8	6.8	7.8	5.7 - 9.0
Temperature	12	14	9.7	15.12	19.40	N/S
Total Suspended Solids	12	14	LOR	**57**	**220**	25
Turbidity	12	14	0.7	7.77	**70**	25
Major Ions						
Bicarbonate	12	14	4	18.13	29	N/S
Carbonate	12	14	17	19.75	25	N/S
Hydroxide	12	14	LOR	LOR	LOR	N/S
Total Alkalinity	12	14	4	18.13	29	N/S
Calcium	12	14	27	31.6	38	N/S
Chloride	12	14	5	20	40	N/S
Magnesium	12	14	3	8.57	14	N/S
Potassium	12	14	1	31.79	149	N/S
Sodium	12	14	2	3.53	5	N/S
Sulfate	12	14	2	61	124	N/S
Total Hardness	12	14	0.02	93.93	165	N/S
Nutrients						
Ammonia	12	14	LOR	0.013	0.03	0.32
Nitrate	12	14	LOR	**0.215**	**2.46**	0.03
Nitrite	12	14	LOR	LOR	LOR	N/S
Nitrate + Nitrite	12	14	LOR	**0.215**	**2.46**	0.1
Total Fluoride	12	14	LOR	LOR	LOR	N/S
Total Kjeldahl Nitrogen	12	14	LOR	0.18	0.80	N/S
Total Nitrogen	12	14	LOR	**0.36**	**2.70**	0.24
Total Phosphorus	12	14	LOR	**0.90**	**3.48**	0.02
Dissolved Metals						
Aluminium	12	14	0.02	0.04	0.07	0.11
Arsenic	12	14	LOR	0.0002	0.001	0.001
Barium	12	14	0.00	**0.02**	**0.03**	0.011
Beryllium	12	14	LOR	0.0076	0.03	N/S
Boron	12	14	**LOR**	0.021	**0.1**	0.05

Pollutant	No. of samples required by the licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	SSGV limit
Cadmium	12	14	LOR	LOR	LOR	0.0001
Chromium	12	14	LOR	**0.0263**	**0.285**	0.00001
Cobalt	12	14	0.00	0.01	0.04	N/S
Copper	12	14	LOR	0.00025	**0.002**	0.001
Iron	12	14	LOR	0.13	0.40	0.8
Lead	12	14	LOR	**0.0043**	**0.02**	0.001
Lithium	12	14	**0.005**	**0.252**	**2.23**	0.001
Manganese	12	14	LOR	0.123	0.26	1.2
Mercury	12	14	LOR	LOR	LOR	0.00006
Molybdenum	12	14	LOR	**0.067**	**0.72**	0.001
Nickel	12	14	**0.011**	**0.028**	**0.101**	0.008
Silver	12	14	LOR	**0.013**	**0.058**	0.00002
Selenium	12	14	LOR	LOR	LOR	N/S
Strontium	12	14	**LOR**	**0.0315**	**0.061**	0.004
Vanadium	12	14	LOR	0.132	1.41	N/S
Zinc	12	14	LOR	**0.0398**	**0.144**	0.012
Total Metals						
Aluminium	12	14	LOR	0.106	0.48	N/S
Arsenic	12	14	LOR	LOR	LOR	N/S
Barium	12	14	LOR	0.018	0.031	N/S
Beryllium	12	14	LOR	LOR	LOR	N/S
Boron	12	14	LOR	LOR	LOR	N/S
Cadmium	12	14	LOR	LOR	LOR	N/S
Cobalt	12	14	0.007	0.0177	0.054	N/S
Copper	12	14	LOR	0.0005	0.002	N/S
Iron	12	14	0.05	0.23	0.69	N/S
Lead	12	14	LOR	0.000083	0.001	N/S
Manganese	12	14	0.11	0.23	0.424	N/S
Nickel	12	14	0.02	0.048	0.132	N/S
Mercury	12	14	LOR	LOR	LOR	N/S
Molybdenum	12	14	LOR	LOR	LOR	N/S
Selenium	12	14	LOR	LOR	LOR	N/S
Silver	12	14	LOR	LOR	LOR	N/S
Strontium	12	14	0.003	0.045	0.062	N/S
Vanadium	12	14	LOR	LOR	LOR	N/S

Pollutant	No. of samples required by the licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	SSGV limit
Zinc	12	14	0.03	0.075	0.197	N/S
Other						
Oil and Grease	12	14	LOR	LOR	LOR	N/S
Dissolved Organic Carbon	12	14	LOR	2.3	6	N/S
Total Organic Carbon	12	14	1	2.3	6	N/S

Note: N/S (Not Stated) is given for values that have no SSGV in the WMP 2022

7.3.3 Comparisons Against Predictions

Section 3.8.3 of the WMP (Version 3) discusses discharge frequency predictions for each of the Licenced Discharge Points at Clarence.

Discharge frequency for each LDP location has been estimated from the water balance modelling. The scenarios assessed included future conditions that considered minor differences in groundwater predictions. The accuracy of the annual exceedance probability of discharge from the site water balance model is limited by the daily rainfall record, a daily time step of the hydraulic simulations and the use of the sub-module, the Australian Water Balance Model (AWBM). Therefore, these estimates should be considered as relative indicators only and are unlikely to reflect the actual design performance of these water management structures.

Discharge frequency has been assessed through the use of a cumulative probability distribution. The modelling indicates that LDP002 discharge volumes are predicted to be mostly within a typical discharge rate of 17 ML/day to 20 ML/day (50^{th} percentile is equal to 0.5 cumulative frequency), although discharges due to rare rainfall events are expected in less than 5% of years.

Modelling predicts discharges through LDP003 are likely to occur often with an estimated daily maximum of up to 29 ML/day under rare rainfall conditions. Modelling predicts that discharges through LDP004 were simulated to occur in approximately 25% of years under future conditions, with an estimated daily maximum discharge of up to 36 ML/day under rare rainfall conditions.

During the Reporting Period discharge volumes from LDP002 were within predicted expectation. Discharge volumes from LDP003 and LDP004 were below predicted expectation.

Modification 2 (MOD2) of DA 504-00 was for the establishment of a reject emplacement area (REA) VI to the south of the ‘Run of Mine’ (ROM) area, upgrade facilities and increase personnel. MOD2 was approved in June 2014. MOD2 predicted all rainfall falling directly on REA VI will be captured in the leachate management system described above and will not have the potential to impact the quality of water entering the Newnes Plateau Hanging Swamp (NPHS).

7.3.4 Long Term Analysis

Long-term water quality results for the period 2020 to 2024 at LDP002 and Wollangambe Downstream (EPL Point 9) are provided in **Appendix 7**, including comparison against their relevant water quality criteria or guideline values.

A five-year summary of water quality and water volume discharge exceedances from LDP002 is presented in **Table 7-7**. It is important to note that these exceedances are of a minor nature, and the limits are extremely low to ensure a neutral or beneficial impact on the surrounding environment. It is therefore determined that these exceedances have not resulted in material harm to the environment, as reported to the relevant government agencies within the reporting period.

Table 7-7: 5 Year Water Quality and Volume Exceedance Summary

Reporting Period	LDP002 Water Quality	LDP002 Water Volume	Total Exceedances
2020	7	0	7
2021	7	0	7
2022	6	0	6
2023	22	0	22
2024	11	0	11

7.3.5 Implemented / Proposed Improvements

The WMP (Version 3) was revised in June 2022 to include Leachate Dam 4 and response to regulator comments. This was approved by DPHI on 9 May 2023.

The site will continue to focus on improvements to the water management and monitoring system to ensure ongoing compliance with the WMP's SSGVs and EPL limits applicable to Clarence Colliery. Clarence has engaged impendent water treatment specialists and will trial a filter media water treatment plant in 2025, the treatment plant will utilise various physical media in order to improve on dissolved metal removal.

Clarence has been working closely with the EPA for several years as part of a Pollution Reduction Program (PRP) focused on discharges into the Wollangambe River. Clarence has committed to the cessation of discharge via LDP002 and is working with the EPA and the Lithgow City Council to meet this obligation.

Clarence is committed to maintaining compliance with our various environmental performance indicators and treats any instances of non-compliance with utmost seriousness. For all exceedances, non-compliances, or incidents that occurred at Clarence Colliery during the Reporting Period, a comprehensive and detailed report has been submitted to the EPA and DPHI.

7.3.6 Surface Water Flows

Clarence is within the Hawkesbury-Nepean catchment and covers three adjacent catchments for the Wollangambe River, Wolgan River and upper Coxs River. Both the Wollangambe River and Wolgan River have their headwaters on the Newnes Plateau and join the Colo River to the east of the project area, which contributes to the Hawkesbury River and Broken Bay.

The dominant surface water and groundwater interactions on the Newnes Plateau involve recharge to shallow groundwater and groundwater discharge to surface water. Surface water leakage to shallow groundwater occurs from overlying watercourses. Groundwater discharge to surface water occurs as seepages and drips from exposed faces of cliff lines or exposed bedrock in drainage lines and as seepage from sub-cropping bedrock to regolith or residual soil profiles on valley flanks and valley floors. Where sufficient seepage occurs, the seepages may support the development of NPHS or NPSS. Groundwater seepage may contribute to stream baseflow either directly as discharge to drainage lines in the valley floor or indirectly as a contribution to catchment subsurface flow. During the reporting period there has been no observed surface water impacts.

7.4 GROUNDWATER

As part of the development consent, Clarence was required to establish several environmental monitoring programs. These programs include the Clarence Water Management Plan (WMP) and the Clarence 800 Area Subsidence Management Plan (SMP).

The WMP and SMP detail intensive monitoring programmes that have been implemented to monitor potential impacts from underground mining on the groundwater regime, and in particular, the Newnes Plateau Shrub Swamps (NPSS) and Newnes Plateau Hanging Swamps (NPHS) which are an Endangered Ecological Community under the *Environmental Protection and Biodiversity Conservation* (EPBC) *Act 1999*.

Clarence engaged EMM Consulting Pty Ltd (EMM) to undertake a review of groundwater monitoring undertaking during the Reporting Period. Summaries from EMM are provided throughout the following sections, with their complete report provided in **Appendix 8**.

EMM's groundwater data analysis presents a review of observed anomalies and possible mining-induced groundwater-related impacts during the reporting period (01 January 2024 to 31 December 2024). Any observed impacts that exceed trigger levels set out in the WMP and SMP are also identified so that appropriate management or engineering solutions may be implemented.

7.4.1 Environmental Management

As required by the WMP, the groundwater monitoring program at Clarence Colliery includes vibrating wire piezometers (VWPs) and standpipes. All VWPs are continuously logged for piezometric head and groundwater levels. Groundwater levels are recorded once a day. Data is downloaded every two months.

All groundwater monitoring sites remained in normal condition, meeting the criteria outlined in the Water Management Plan Trigger Action Response Plan (TARP) The following observations were recorded during the reporting period:

Swamp Piezometers: Groundwater levels in swamp piezometers were generally stable or slightly decreasing, reflecting above-average rainfall from January to April, followed by below-average rainfall from May to late November 2024. Mining activities in Panel 919 were located 300 m south of PHS1 and 400 m south of PHS2 in September, while Panel 918 extraction occurred within 50 m east of PHS1 and 100 m east of PHS2 in March. No mining-related impacts were observed, with water levels maintaining stable trends consistent with daily CRD.

Perched and Shallow Aquifer Piezometers: Groundwater levels in perched and shallow aquifer standpipe piezometers exhibited trends consistent with climatic conditions. Most piezometers showed stable or slightly declining levels due to the below-average rainfall from May to late November 2024. No mining-related impacts were identified within 1 km of active mining areas.

Vibrating Wire Piezometers (VWP): All sensors located above the Mount York Claystone (MYC) remained stable or responded in line with climatic conditions. However, some VWP sensors below the MYC, specifically at CC115, CLRP13, CLRP14, CLRP18, CLRP19, and CLRP27, displayed depressurisation effects linked to mining activities. Additionally, four VWP sensors have experienced long-term issues due to malfunctioning loggers or sensor failures.

Following download, data is analysed for any trends or potential mining-related impacts and presented in the SMSR submitted to relevant stakeholders every four months as required by the SMP. At the time of the preparation of the Annual Review, the latest SMSR report was submitted in March 2025, summarising the results from November 2024 – February 2025.

7.4.2 Environmental Performance

Swamp Piezometers

Hydrographs for monitoring sites have been compared to daily CRD (mm) to distinguish between meteorological trends and potential mining impacts. The dashed red vertical lines indicate the reporting period (1 January 2024 to 31 December 2024).

General groundwater level trends and trigger status during the reporting period are detailed in **Table 7-8**. A general overview of historical observations, mining history and hydrographs for swamp piezometers is provided in the EMM report (**Appendix 8**).

Table 7-8: Swamp Piezometer Trigger Status 2024

Swamp	Bore ID	Trigger status and trend during the reporting period (1 January 2024 – 31 December 2024)
Clarence	MW05	There were three piezometers in the swamp: CS1, CS2, and CS3. CS1 was destroyed by bushfires, while CS2 and CS3 were decommissioned for REA 6 construction. Water level data is available until October, with no active mining within 1 km of MW05 during this period. Groundwater levels align with climatic observations.
Hanson	HS1 HS2 HS3	Hanson Swamp was part of a monitoring program for a proposed reject emplacement area linked to the adjacent Hanson Quarry sand pit, which did not advance beyond pre-feasibility. It is monitored at three locations: HS1, HS2, and HS3. The swamp was undermined by Panel 205 South over 30 years ago, and there was no mining near the piezometers during the reporting period. Data for HS1, HS2, and HS3 was previously unavailable for 2023 and 2024 due to access issues. In November 2024, EMM conducted maintenance, downloading data from HS1 and replacing loggers at HS2 and HS3. HS1 groundwater levels align with climatic observations.

Swamp	Bore ID	Trigger status and trend during the reporting period (1 January 2024 – 31 December 2024)
Happy Valley Upper	HVU1	Happy Valley Swamp was monitored by piezometers HV1, HV2, and HVU2 until they were destroyed by bushfire in 2013, and they have not been replaced. No mining occurred near the swamp during this period. There is a data gap from 14 October 2022 to 18 April 2023 due to an expired logger, which was replaced in April 2023. Groundwater trends align with the CRD, showing short-term declines between rainfall events.
Paddy's Swamp East	PSE1 PSE2	Piezometers PSE1 and PSE2 in Paddy's Swamp East are situated over Panels 919 and 915, respectively. Active mining occurred about 200 m from PSE1 in August 2022, while PSE2 was undermined with no observed impacts. During the reporting period, mining of Panel 919 took place 800 m northeast of PSE2, and PSE1 was undermined in September 2024. PSE1 shows quick water level responses to rainfall, tracking daily CRD, while PSE2 remains stable with a slight downward trend. Drawdown spikes at PSE2 are from sampling, not actual trends. No mining-related impacts were detected.
Pagoda	PG1 PG2	The two swamp piezometers (PG1 and PG2) are located over Panel 906. Active mining began in August 2022, moving southwest and nearing PG1 by December 2022. In early 2024, mining continued approximately 800 to 900 meters southwest of both piezometers. During the reporting period, no mining impacts were observed, with both piezometers showing stable trends and muted responses to rainfall.
Oleria	OS1	Oleria Swamp (OS1) sits above panel 804, which was first mined in July 2022. In 2019, extraction in panel 806, 1.5 km from OS1, showed no mining impacts. As of October 2023, mining has progressed eastward, with activity about 1 km from OS1, and no negative impacts or groundwater level changes have been observed.
Upper Dingo	UD1 (CSP8) UD2 (CSP9)	UD1 (CSP8) and UD2 (CSP9) piezometers were installed in September 2022 to collect baseline data for the northern mining area, north of Panel 900. No mining took place within 1 km of Upper Dingo Swamp during this period. UD1 and UD2 exhibited trends consistent with CRD observations, but UD2

Swamp	Bore ID	Trigger status and trend during the reporting period (1 January 2024 – 31 December 2024)
		data is unavailable after October due to time constraints.
Bungleboori North	BN1 (CSP10) BN2 (CSP11)	The swamp piezometers BN1 (CSP10) and BN2 (CSP11) were installed in mid-November 2022 to gather baseline monitoring data for the northern mining area. No active mining took place within 1 km of the piezometers during the reporting period. BN1 and BN2 display trends consistent with the CRD trend. Data after October is unavailable due to time constraints in the last sampling round.
Bungleboori South East	BSE1 (CSP1) BSE2 (CSP2)	The swamp piezometers BSE1 (CSP1) and BSE2 (CSP2) were installed in August 2022 to collect baseline data for the 918 and 920 panels. During the reporting period, mining activity for Panel 918 occurred about 500 m southwest of the piezometers. BSE1 has exhibited a groundwater decline since April, mirroring the declining daily CRD, while BSE2 has shown consistent decline since October 2023, with a brief increase between August and September likely due to rainfall recharge. Given their proximity to mining and observed trends, these piezometers will be monitored closely for potential impacts.
Murrays	MU1 (CSP6) MU2 (CSP7)	The swamp piezometers MU1 (CSP6) and MU2 (CSP7) were installed in early August 2022 for baseline data in the northern mining area. No mining occurred within 1 km of Murrays Swamp during the reporting period. MU1 and MU2 showed fluctuating groundwater levels due to above-average rainfall in January and April, stabilizing with the CRD. Data is unavailable after October due to time constraints during the last sampling round.
Paddys Hanging	PHS1 (CSP4) PHS2 (CSP5)	The swamp piezometers PHS1 and PHS2 were installed in October 2022 for baseline monitoring of Panels 918 and 920. Panel 919's first workings were 300 m south of PHS1 and 400 m south of PHS2 in September. By March, Panel 918 extraction was 50 m east of PHS1 and 100 m east of PHS2. Water levels remained stable, showing no mining impact, although a slight increase in October may be due to logger retrieval error.
Island	IS1 (CSP24) IS2 (CSP25) IS3 (CSP26) IS4 (CSP15)	Island Swamp, located southeast of Lithgow number one dam in the 700 area, had five new piezometers hand augured and In-situ Rugged Troll loggers installed in late August

Swamp	Bore ID	Trigger status and trend during the reporting period (1 January 2024 – 31 December 2024)
	IS5 (CSP16)	2023 for baseline data collection. During the reporting period, all piezometers showed stable or slightly increasing trends. The IS5 (CSP16) level logger malfunctioned, so no data is available post-October, and it will be replaced.
Waterfall	WS1 (CSP17) WS2 (CSP18)	Waterfall Swamp is located east of Lithgow's number one dam, south-west of the 700 area. Piezometers WS1 (CSP17) and WS2 (CSP18) were installed in August and December 2023 to collect baseline data. Groundwater levels were stable until September 2024. On October 17, 2024, WS1 showed a drop due to the logger being reinstalled at a different level because of sediment buildup. WS2 recorded sharp fluctuations starting November 9, 2024, coinciding with daily rainfall.
Muddy	MD1 (CSP19) MD2 (CSP20)	Muddy Swamp is located south of Lithgow number one dam in the 700 area. Piezometers MD1 (CSP19) and MD2 (CSP20) were installed in December 2023 for baseline data collection. In 2024, groundwater levels responded significantly to rainfall, especially from July. MD2 showed reduced groundwater recharge during lower rainfall periods, indicating influences beyond rainfall, like hydrological shifts or subsurface flow changes.

Shallow Groundwater System

Two standpipe piezometers (CSP21A and CSP21C) were installed in 2024. These piezometers were installed to collect baseline monitoring data for proposed mining developments. Data loggers were installed in the two piezometers.

Standpipe piezometer groundwater levels have been reviewed against their respective trigger values in the WMP. Where triggers have occurred, the groundwater level response has been assessed against the TARP to determine if a mining impact has occurred and if further investigation is required.

General comments on historical observations and mining history for open borehole standpipe piezometers and hydrographs are provided in EMM's report (**Appendix 8**). Comments on groundwater level trends and standpipe piezometer trigger status during the reporting period are detailed in **Table 7-9**.

Table 7-9: Open borehole standpipe piezometer trigger status 2024

Bore ID	Target formation	Mining area	Trigger status and trend during the reporting period (1 January 2024 – 31 December 2024)

CLRP4	Banks Wall Sandstone	Unmined area southwest of Clarence Pit top	CLRP4 overlies an unmined area adjacent to Browns Swamp. The groundwater level at CLRP4 is closer to the surface compared to the other standpipe piezometers at Clarence and displays a response that is influenced by short-term trends in rainfall. The logger was replaced in August 2019 after being removed or misplaced in December 2018. No active mining occurred within 4 km of CLRP4 during the reporting period and groundwater levels correspond with daily CRD.
CLRP5	Banks Wall Sandstone	Panel 902	CLRP5 was undermined by Panel 902 in December 2013 and January 2014. Pillar extraction occurred in 2015, but no extraction occurred directly beneath CLRP5. During the reporting period, there was no active mining within 1 km of CLRP5. Historically, there have been no mining impacts and groundwater levels have trended with daily CRD. From July 2019 to September 2020, an abnormal groundwater level decline was verified by manual gauging to coincide with the rainfall deficit prior to February 2020; then the decline was likely climatically controlled. During the reporting period groundwater levels displayed a decreasing trend since November 2022 which is consistent with longer term decreasing trend in daily CRD since November 2022.
CLRP7	Banks Wall Sandstone	Unmined area west of Clarence Pit top	CLRP7 overlies an unmined area south of the 700 Area, nearby the proposed Panel 713. Groundwater levels at CLRP7 indicate a subdued and delayed response to the CRD. The stepped declines (late 2013–early 2019) are attributed to drawdown from groundwater sampling events. Minor spikes in water level following September 2019 are attributed to rainfall infiltration. No active mining occurred within 5 km of CLRP7 during the reporting period. The groundwater level at CLRP7 steadily decreased from January to May due to reduced rainfall during 2023. From May 2024, the groundwater level at CLRP7 plateaued following a recharge from a positive daily CRD trend from January to May.
CLRP8	Banks Wall Sandstone	Unmined area at Clarence Village	CLRP8 is located on private property above an unmined block in Clarence Village. Historical groundwater level trends indicate a subdued response to daily CRD, with declines attributed to domestic abstraction. No active mining occurred within 5 km of CLRP8 during the reporting period, and groundwater levels remained stable, aligning with daily CRD trends.
CLRP10	Banks Wall Sandstone	Panel 706	CLRP10 was directly undermined by Panel 706 in September 2011. In April 2011, partial pillar extraction occurred in Panel 708, approximately 250 m west of CLRP10. Panel 704, approximately 150 m east of CLRP10, was developed in April 2009, with partial pillar extraction in March 2010. In January and February 2014, partial pillar extraction occurred in

			Panel 700, approximately 700–900 m west-south-west of CLRP10. Historically there have been no observable mining impacts. There was no active mining within 3 km of CLRP10 during the reporting period. CLRP10 shows a to rainfall recharge with groundwater level continuing to gradually increase during reporting period. The increasing trend is a delayed response following groundwater recharge between August 2021 and November 2022.
CC113	Banks Wall Sandstone	-	Decommissioned.
CLRP15[1]	Banks Wall Sandstone	Unmined area adjacent to the Lithgow water supply dam	CLRP15 is located above an unmined block west of the 700 area, between the Lithgow water supply dam and the 700 area workings. Between June 2014 and August 2019, changes to the logger installation depth caused abnormal functionality and erroneous data. As a result, groundwater level data from this period did not accurately reflect pressure head and was omitted from the hydrograph. The logger was correctly reinstalled in August 2019, aligning with manual water level measurements. No active mining occurred near CLRP15 during the reporting period and groundwater levels remained stable.
CLRP28[1]	Banks Wall Sandstone	Northern mining area	CLRP28 was installed in May 2020 and overlies an undeveloped mining lease owned by Clarence which is located north of the 900 area. No active mining occurred during the reporting period within 2 km of CLRP28. Since installation, the groundwater level has shown a stable trend consistent with daily CRD.
CLRP31[1]	Banks Wall Sandstone	Northern mining area	CLRP31 is located north of the 900 area and overlies an undeveloped mining lease owned by Clarence. A data gap occurred between 25 September 2022 and 25 November 2022 due to an obstruction within the piezometer. No active mining took place within 3 km of CLRP31 during the reporting period. Since installation, groundwater levels showed a stable increasing trend from early 2023, followed by a decline. During the reporting period, water levels remained stable with a slight delayed increase from April in response to rising daily CRD between January and April.
CLRP40[1]	Burralow Formation	Panel 920	CLRP40 (installed on 18 April 2023) was installed to the Burralow Formation to collect baseline data. During the reporting period, active first workings with Panel 918 occurred approximately 1 km south of CLRP40. Groundwater levels at CLRP40 remained stable, with a slight peak following the large rainfall event in April.
CLRP41A[1]	Burralow Formation	-	CLRP41A (installed adjacent VWP CLRP41) was installed in the Burralow Formation at the beginning of the year to collect baseline data for Panel 918. The

			groundwater level was stable during the reporting period.
CLRP42[1]	Burralow Formation	Panel 920	CLRP42 (installed on 9 March 2023) was installed in the Burralow Formation to collect baseline data. During the reporting period, active mining of Panel 918 occurred approximately 600 m south-east of CLRP42. CLRP42 exhibits a delayed response to recharge. The piezometer shows a gradual decreasing groundwater level throughout the reporting period, consistent with the long term declining trend in CRD since November 2022.
(PA1) CSP12[1]	Burralow Formation	Northern mining area	PA1 (CSP12) was installed 8 December 2022 to collect baseline data for the northern mining area (NMA), which is north of the 900 area. No active mining occurred near PA1 during the reporting period. Due to time constraints during the last sampling round of the report period, groundwater data is available until October 2024. The groundwater level was stable during the reporting period.
(PA2) CSP13[1]	Burralow Formation	Northern mining area	PA2 (CSP13) was Installed 9 December 2022 to collect baseline data for the NMA, which is north of the 900 area. No active mining occurred near PA2 (ie within 5 km) during the reporting period. Due to time constraints during the last sampling round of the report period, groundwater data is available until October 2024. The groundwater level was stable during the reporting period.
(PA3) CSP14[1]	Banks Wall Sandstone	Northern mining area	PA3 (CSP14) was installed 9 December 2022 to collect baseline data for the NMA, which is north of the 900 area. No active mining occurred near PA3 (ie within 5 km) during the reporting period. Due to time constraints during the last sampling round of the report period, groundwater data is available until October 2024. PA3 shows a slightly increasing trend correlating with daily CRD.
CSP21A[1]	Burralow Formation	Unmined 700 area	CSP21A and CSP21C were installed February 2024 and is a paired site (i.e. two standpipe piezometers on the one drill pad). Loggers were installed in April 2024. CSP21A targets the Burralow Formation and CSP21C targets the Banks Wall Sandstone. A perched aquifer is present in CSP21A while CSP21C is representative of the regional Banks Walls Sandstone aquifer. Piezometers were installed to provide baseline data for a proposed mining in the 700 area. CSP21A displayed a slightly declining trend and CSP21C was stable during reporting period.
CSP21C	Banks Wall Sandstone		
CSP22A[1]	Banks Wall Sandstone	Unmined 700 area	CSP22A, CSP22B, and CSP22C were installed in February 2024 as a paired site (three standpipe piezometers on the same drill pad). Loggers were installed in April 2024. The geology at CSP22 differs from CSP21, suggesting the Burralow Formation may have weathered away. CSP22A and CSP22B were designed to target clay-
CSP22B[1]			
CSP22C[1]			

			rich sandstones that may support groundwater perching. CSP22A has been dry since installation. The piezometers were installed to provide baseline data for proposed mining in the 700 area. CSP22B briefly recorded a water level following rainfall events in April but was dry for the remainder of the reporting period. CSP22C represents the regional aquifer in the Banks Wall Sandstone and has shown stable water levels since logger installation.

Vibrating Wire Piezometers

VWP piezometric pressures have been reviewed against their respective trigger values in the WMP. Where triggers have been realised, the piezometric response has been assessed against the TARP to determine if a mining impact has occurred and if further investigation is required.

General comments on historical observations, mining history and hydrographs for VWP's are provided in EMM's report (**Appendix 8**). Each VWP contains several piezometers (piezo) that target certain formations and depths. This along with comments on piezometric pressure trends and trigger status are detailed in **Table 7-10**.

Table 7-10: Vibrating Wire Piezometer Trigger Status 2024

VWP ID	Piezo number & target formation	Trigger status and trend during the reporting period (1 January 2022 – 31 December 2022)
CLRP1	#1 Katoomba Seam (175 m bgl) #2 Burra-Moko head Formation/Caley Formation (150 m bgl) #3 Banks Wall Sandstone (100 m bgl) #4 Banks Wall Sandstone (60 m bgl)	During the reporting period Piezo #3 and #4 telemetry data became unavailable in July and October respectively. Both trends are moderately stable and show reactivity to the CRD trend up until the failure. Piezo's #1 and #2 (below the MYC) show depressurisation in February 2024. Following this, Piezo #1 depressurised in late April to late June 2024 and recovered for the remainder of the reporting period. Piezo #2 did not show the same depressurisation event but does show a gradual declining trend. The depressurisation observed in Piezo #1 is unlikely to be attributed to first workings in Panels 806 and 832 which is about 3.5 km away. Piezometric pressure data for both Piezo's became unavailable in September due to telemetry issues and was returned to supplier for service.
CLRP2	#1 Katoomba Seam (276 m bgl) #2 Banks Wall Sandstone (190 m bgl) #3 Banks Wall Sandstone (130 m bgl)	No active mining occurred near CLRP2 during the reporting period. Historically, no mining impacts have been observed within Piezo's #2, #3 and #4 which lie above the MYC. Communication with Sensor #1 (below the MYC) was lost following undermining in August 2007. For the reporting period, Piezo's #2, #3

VWP ID	Piezo number & target formation	Trigger status and trend during the reporting period (1 January 2022 – 31 December 2022)
	#4 Banks Wall Sandstone (70 m bgl)	and #4 (above the MYC) displayed stable groundwater levels consistent with climatic observations.
CLRP3	#1 Burra-Moko head Formation/Caley Formation (198 m bgl)	During the reporting period, active mining of Panel 834 occurred approximately 1 km east of CLRP3. Piezo #1 (below the MYC) has exhibited fluctuations since the installation of a new logging system in October 2021, with the magnitude of these fluctuations increasing over time, likely due to a faulty sensor. Piezo #2 (within the MYC) previously failed, and no new data is available. Repairs were conducted during the maintenance round in November, allowing data collection to resume for Piezo #1. Piezo #3 (above the MYC) continues to display stable piezometric pressure
	#2 Banks Wall Sandstone (138 m bgl)	
	#3 Banks Wall Sandstone (85 m bgl)	
CLRP6	#1 Burra-Moko head Formation/Caley Formation (160 m bgl)	No data was available over the reporting period due to data logger failure, likely from water damage. No active mining occurred near CLRP6 during the reporting period.
	#2 Banks Wall Sandstone (100 m bgl)	
	#3 Banks Wall Sandstone (60 m bgl)	
CLRP11	#1 Burra-Moko head Formation/Caley Formation (165 m bgl)	A new datalogger was installed on 9 February 2024 and shows a stable trend throughout reporting period. No active mining occurred near CLRP11 during the reporting period.
	#2 Burra-Moko head Formation/Caley Formation (134.5 m bgl)	
	#3 Banks Wall Sandstone (74.5 m bgl)	
	#4 Banks Wall Sandstone (61 m bgl)	
CLRP12	#1 Burra-Moko head Formation/Caley Formation (230 m bgl)	Access restrictions due to nearby sand quarry – decommissioned.
	#2 Burra-Moko head Formation/Caley Formation (180 m bgl)	
	#3 Banks Wall Sandstone (120 m bgl)	

VWP ID	Piezo number & target formation	Trigger status and trend during the reporting period (1 January 2022 – 31 December 2022)
	#4 Banks Wall Sandstone (100 m bgl)	
CLRP13	#1 Burra-Moko head Formation/Caley Formation (240 m bgl)	During the reporting period Piezo's #1 and #2 (below the MYC) showed a slightly decreasing trend. Piezo #3 (below the MYC) and Piezo #4 (above the MYC) were stable.
	#2 Burra-Moko head Formation/Caley Formation (210 m bgl)	
	#3 Banks Wall Sandstone (140 m bgl)	
	#4 Banks Wall Sandstone (110 m bgl)	
	#5 Banks Wall Sandstone (80 m bgl)	
CLRP14	#1 Burra-Moko Head Formation (220 m bgl)	During the reporting period Piezo #1 was stable and Piezo #2 shows a slight decreasing trend.
	#2 Burra-Moko Head Formation (185 m bgl)	
	#3 Banks Wall Sandstone (130 m bgl)	Communication was lost with this piezo in early 2019.
	#4 Banks Wall Sandstone (100 m bgl)	Communication was lost with this piezo in early 2019.
CLRP15	#1 Burra-Moko Head Formation (160 m bgl)	No trigger levels defined in the WMP - Piezo #2 (below the MYC) shows a sudden drop on 2 Aug 2024 followed by recovery through the remainder of the reporting period. This response was not observed at Piezo #1 (below MYC) which is located deeper than Piezo #2 and shows an increasing trend. No mining is located near CLRP15, and it is believed the response observed at Piezo #2 is due to logger or piezo malfunction. Piezo #3 (above the MYC) displayed a slight decreasing trend.
	#2 Burra-Moko Head Formation (130 m bgl)	
	#3 Banks Wall Sandstone (90 m bgl)	
	#4 Banks Wall Sandstone (60 m bgl)	No data sensor not functional.
CLRP16	#1 Burra-Moko Head Formation (115 m bgl)	No trigger levels defined in the WMP. CLRP16 was vandalised in in March 2024 and in the November maintenance round an attempt to fix the logger was made, however, the telemetry data is still
	#2 Burra-Moko Head Formation (70 m bgl)	

VWP ID	Piezo number & target formation	Trigger status and trend during the reporting period (1 January 2022 – 31 December 2022)
		unavailable, but the logger is still recording data.
CLRP17	#1 Burra-Moko Head Formation (200 m bgl)	Communication was lost with this piezo in October 2015.
	#2 Burra-Moko Head Formation (170 m bgl)	No trigger – Piezo #2 (below the MYC) displayed a stable trend and Piezo #3 (above the MYC) continues to display an increasing trend.
	#3 Banks Wall Sandstone (70 m bgl)	
CLRP18	#1 Burra-Moko Head Formation/Caley Formation (230 m bgl)	Displayed a stable trend.
	#2 Banks Wall Sandstone (75 m bgl)	Communication was lost with this piezo in February 2021.
CLRP19	#1 Burra-Moko Head Formation (170 m bgl)	No trigger - During the reporting period, active mining occurred in Panels 804 and 806, located approximately 0.6 km north and northeast of CLRP19, respectively. Over this period, Piezo #1 (below the MYC) exhibited a stable trend following a prolonged depressurisation since August 2021. Piezo #2 (above the MYC) remained stable, while Piezo #3 (above the MYC) showed a slight increasing trend.
	#2 Burra-Moko Head Formation (120 m bgl)	
	#3 Banks Wall Sandstone (90 m bgl)	
CLRP22	#1 Burra-Moko Head Formation (220 m bgl)	Communication was lost with this piezo in November 2020 due to lightning strike.
	#2 Banks Wall Sandstone (90 m bgl)	No trigger – showed a slight decreasing trend which is consistent with climatic observations.
CLRP27	#1 Katoomba Seam (275 m bgl)	No trigger levels defined in the WMP. During the reporting period, Piezo #1 and #3 showed a slight decline, while Piezo #2 (below the MYC) exhibited an increasing trend. Piezo #4 and #5 (above the MYC) showed a slight decreasing trend consistent with climatic observations.
	#2 Caley Formation (220 m bgl)	
	#3 Caley Formation (190 m bgl)	
	#4 Banks Wall Sandstone (130 m bgl)	
	#5 Banks Wall Sandstone (90 m bgl)	
CLRP29	#1 Katoomba Seam (260 m bgl)	No trigger levels defined in the WMP. Over the reporting period Piezo's #1 and

VWP ID	Piezo number & target formation	Trigger status and trend during the reporting period (1 January 2022 – 31 December 2022)
	#2 Katoomba Seam (248 m bgl)	#2 (below the MYC) showed slightly increasing trends. Piezo's #3 and #4 (above the MYC) showed stable slightly decreasing trends.
	#3 Caley Formation (189 m bgl)	
	#4 Banks Wall Sandstone (70 m bgl)	
CLRP33	#1 Katoomba Seam (287 m bgl)	No trigger levels defined in the WMP. During the reporting period Piezo's #1 and #2 showed an increasing trend while Piezo's #3 and #4 (below and above the MYC, respectively) showed stable trends.
	#2 Caley Formation (276 m bgl)	
	#3 Burra-Moko Head Formation (236 m bgl)	
	#4 Banks Wall Sandstone (67 m bgl)	
CLRP41	# 2 Below Mount York claystone (225 m bgl)	Stable – Stable trend.
	# 3 Below Mount York claystone (195 m bgl)	Logger has failed.
CC114	#1 Burra-Moko Head Formation (165 m bgl)	No trigger – Piezo #1 (below the MYC) displayed a slightly increasing trend from the start of reporting period until mid-April. From mid-April a declining trend was observed, like CLRP1, noting that first workings mining activities occurred 4 km away from CC114 at Panels 806 and 832. Piezo's #2 and #4 (below and above the MYC, respectively) displayed a stable trend. Piezo #3 (above the MYC) displayed slightly increasing trend consistent with CRD.
	#2 Burra-Moko Head Formation (135 m bgl)	
	#3 Banks Wall Sandstone (75 m bgl)	
	#4 Banks Wall Sandstone (45 m bgl)	
CC115	#1 Burra-Moko Head Formation (270 m bgl)	No trigger – Mining occurred approximately 0.8 km northeast of CC115 in June. Piezo #1 (below the MYC) showed a slight declining trend, while Piezo's #2 and #3 (below the MYC) remain stable. Piezo #4 (above the MYC) displayed a slightly increasing trend.
	#2 Burra-Moko Head Formation (200 m bgl)	
	#3 Banks Wall Sandstone (170 m bgl)	
	#4 Banks Wall Sandstone (120 m bgl)	

REA III GROUNDWATER MONITORING PROGRAM

Three groundwater monitoring piezometers were installed (REA302, REA304 and REA305) with REA III in 2016. All piezometers were drilled at least 2 – 2.5m below the base of REA III. In 2024, piezometers REA302 and REA304 were decommissioned due to ongoing progressive rehabilitation of REA3. Currently, groundwater level is measured quarterly, and the water is sampled for quality bi-annually. A summary of the last 12 months quality data is displayed below in **Table 7-11**. REA III standing water heights are displayed in **Appendix 8**.

Table 7-11: Summary of REA III Groundwater Monitoring Results

Parameter	REA305	
mg/L	Jun-24	Dec-24
pH (pH units)	3.1	2.8
Sulfate as SO_4	628	868
Electrical Conductivity (µS/cm)	677	1099
Dissolved Aluminium	39.6	62.6
Dissolved Arsenic	<0.001	0.002
Dissolved Beryllium	0.132	0.166
Dissolved Barium	0.022	0.015
Dissolved Cadmium	0.0153	0.0187
Dissolved Chromium	0.002	0.001
Dissolved Cobalt	5.65	7.4
Dissolved Copper	0.09	0.036
Dissolved Lead	0.024	0.03
Dissolved Lithium	0.285	0.336
Dissolved Manganese	7.74	8.99
Dissolved Molybdenum	<0.001	<0.001
Dissolved Nickel	13.4	17.7
Dissolved Selenium	0.02	0.13
Dissolved Strontium	0.277	0.283
Dissolved Vanadium	<0.01	<0.01
Dissolved Zinc	17.1	19.2
Dissolved Iron	7.92	24.1

7.4.3 Comparison Against Predictions

Page 87 of the 900 Area SMP Written Report (2013) discusses the groundwater environment at the time of the submission and discusses predicted impacts. The Aurecon (2013) report referenced in the document concludes that the proposed mining will have no significant impact on the groundwater regime on both a local and regional scale provided subsidence is maintained at the predicted low levels. Consequently, it is highly unlikely that there will be an impact on the shallow groundwater regime in areas adjacent to the proposed mining areas.

As discussed in **Section 6.8**, subsidence remained within the predicted low levels. The results reported above in **Section 7.4.2**, groundwater levels remained unimpacted by mining activities during the Reporting Period.

As predicted in MOD2, groundwater flow will originate from the southwest of the site in the area surrounding the access road to the mine and has minimal potential to be disrupted by the establishment of REA VI. However, the western portion of REA VI is proposed to be located near the southern portion of the NPHS posing a greater risk to the NPHS. As described in **Section 7.4**, excavation for the establishment of the REA VI will be restricted to ensure no disruption to groundwater seepage to the hanging swamp.

7.4.4 Long-Term Analysis

Where groundwater triggers are investigated and found to be a result of mining-related activity as defined in the Clarence WMP, this is considered an exceedance of the triggers. A five-year summary of trigger exceedances is presented in **Table 7-12**.

Table 7-12: 5-Year Groundwater Trigger Exceedance Summary

Reporting Period	Groundwater Levels	Groundwater Quality	Total Exceedances
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
2024	0	0	0

7.4.5 Implemented / Proposed Improvements

The Clarence Colliery WMP will be updated during the next reporting period to include the most current groundwater model and TARP triggers will be reviewed and updated where required based on the model.

8 REHABILITATION

Clarence Colliery manages rehabilitation in accordance with the Rehabilitation Management Plan (RMP).

The RMP was prepared in accordance with the NSW Resources Regulator (NSW RR) Form and Way-Rehabilitation Management Plan for Large Mines (NSW RR, July 2021) required under the Mining Regulation 2016 and submitted on the 29 July 2022 via the NSW RR Portal.

The RMP also satisfies Schedule 3, Condition 29 of DA 504-00, and the requirements of ML1353, ML1354, ML1583, ML1721 and CCL705. The RMP describes the management of rehabilitation at the Clarence Colliery. The RMP is available on the website https://www.centennialcoal.com.au/operations/clarence/

The Forward Program sets out the three-year forecast for both proposed surface disturbance and rehabilitation schedule for Clarence Colliery.

This section addresses the annual rehabilitation reporting requirements for the Annual Review as required by Schedule 5, Condition 5 of DA 504-00. Annual reporting requirements in the RMP will be reported in the Annual Rehabilitation Report and Forward Program (ARR&FP) and submitted using the online form accessible via the NSW Resource Regulator's mine rehabilitation portal.

8.1.1 Summary of Rehabilitation

Table 8-1: Rehabilitation Status

Mine Area Type	Previous Reporting Period (Actual) 2023 (ha)	This Reporting Period (Actual) 2024 (ha)	Next Reporting Period (Forecast) 2025(ha)
A. Total mine footprint[1]	101.72	101.72	101.72
B. Total active disturbance[2]	76.76	76.76	76.76
C. Land being prepared for rehabilitation[3]	1.47	1.47	1.47
D. Land under active rehabilitation[4]	24.96	24.96	24.96
E. Completed rehabilitation[5]	0	0	0

Notes: **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

At the end of the Reporting Period, a total of approximately 24.96 hectares (ha) of native woodland are under active rehabilitation at Clarence Colliery across REAs I, II, III, IV and VI. Rehabilitation activities on REA II were completed in 1996, while REA I and III were rehabilitated in 2002. The rehabilitation of REA IV started in late 2012 with completion in late 2016. Rehabilitation works on REA VI started in 2019 with approximately 2.0 ha established.

Final land use at Clarence is not specified under tenement and Developmental Consent conditions. The post-mining land use goal is to provide a self-sustaining, low maintenance, geotechnically stable and safe landform that is commensurate with the surrounding area.

The preferred post-mining land use is to return disturbed areas around Clarence Colliery to a woodland/forest community commensurate with the adjacent native vegetation. Some water bodies and drainage structures will be maintained to manage surface water flows and provide water resources for native fauna.

For further information refer to the RMP.

8.1.2 Rehabilitation Monitoring

The 2024 monitoring survey involved the established six rehabilitation monitoring sites and three control (analogue) sites used in recent years (**Table 8-2**).

Annual rehabilitation monitoring has been undertaken at Clarence since 2012, tracking rehabilitation success against previous completion criteria and informing any maintenance requirements. Clarence has undertaken a Rehabilitation Review to establish a site-specific monitoring program to support the ongoing refinement of rehabilitation objectives and completion criteria assessment, and alignment with associated guidelines. This includes transitioning Centennial operations to the NSW Biodiversity Assessment Method ('BAM', OEH 2020) to align with new rehabilitation objectives and completion criteria assessment (refer to the RMP).

Analogue sites are a central component of the rehabilitation monitoring program at Clarence and are used to derive target benchmarks against which rehabilitation performance can be assessed, particularly regarding species diversity, assemblages and vegetation structure. The analogue sites are located in nearby areas of undisturbed native vegetation representative of local vegetation type and condition, and are generally mapped as 'Exposed Blue Mountains Sydney Peppermint – Silver-top Ash Shrubby Woodland'.

All vegetation monitoring plots are surveyed following the methodology detailed in Section 4.2.2 of the Biodiversity Assessment Method ('BAM', DPIE 2020). This involves a 20 x 20 m floristic plot to assess species diversity and cover, a 20 x 50 m structural attribute plot to collect tree stem size, ground log lengths and hollow-bearing tree data and five 1m x 1m plots to assess ground litter percentages. An overview of the monitoring program is presented in **Table 8-2** and **Figure 8-1**.

Table 8-2: Clarence Rehabilitation Monitoring Sites

Site Code	Type	Rehabilitation Establishment	Slope (deg)	Coordinates (GDA94 Zone 56)	
				Easting	Northing
RHB 1	Rehabilitation	2002	12	244291	6294105
RHB 2	Rehabilitation	1996	12	244563	6293796
RHB 3a	Rehabilitation	2002	17	244665	6294303
RHB3b	Rehabilitation	2002	22	244752	6294210
RHB 4b	Rehabilitation	2016	20	244299	6293670
RHB 6a	Rehabilitation	2019	20	243889	6293733
ANA 1	Analogue	N/A	3	244632	6293686

Site Code	Type	Rehabilitation Establishment	Slope (deg)	Coordinates (GDA94 Zone 56)	
				Easting	Northing
ANA 2	Analogue	N/A	12	244659	6294391
ANA 3	Analogue	N/A	10	244521	6294450

SLR was commissioned by Clarence to undertake the 2024 annual rehabilitation monitoring. A summary of the 2023 rehabilitation monitoring program is provided below with the complete report provided in **Appendix 9**.

The rehabilitation monitoring program has been designed to measure the progress of rehabilitation against the objectives and completion criteria developed for the RMP. Following the RMP criteria, results are presented according to the three main attributes of the Biodiversity Assessment Method (BAM), namely: composition, structure and function.

8.1.3 Rehabilitation Performance Summary

Overall, rehabilitation performance scores at most sites are currently below the PCT benchmarks. However, these scores are comparable to control plot values for plant diversity and cover. In 2024, the cover of exotic species is low at most sites, indicating that the rehabilitation at Clarence includes plant species characteristic of the surrounding bushland and associated PCTs. The vegetation, soils, and ecosystem functions at the monitoring sites are progressing and showing early signs of native woodland and forest regeneration.

Assuming the established native vegetation continues to develop, along with improvements in soil function, it is likely that the ecosystem composition and structural attributes will progress further toward the completion criteria in the coming years. The vegetation within the rehabilitation areas varies in terms of native plant species diversity, cover (foliage projective cover), and structure, depending on the age of the rehabilitation.

The overall composition and structure of vegetation at the rehabilitation sites are largely comparable to those at control sites. However, native species diversity appears to be lower at RHB6A, particularly for species in the 'forb' and 'fern' growth forms, which are particularly limited at this site. Additionally, native species cover in the 'tree' growth form is lower at all rehabilitation sites compared to the control sites, likely due to the age of the trees and their smaller canopy sizes.

At this stage, no planting efforts are recommended. Table 12 of the RMP presents draft completion criteria for several parameters. For vegetation composition, the RMP suggests that the presence of one tree species, two shrub species, and six ground layer species characteristic of the target vegetation type represents an adequate level of floristic diversity to meet completion criteria. on criterion.

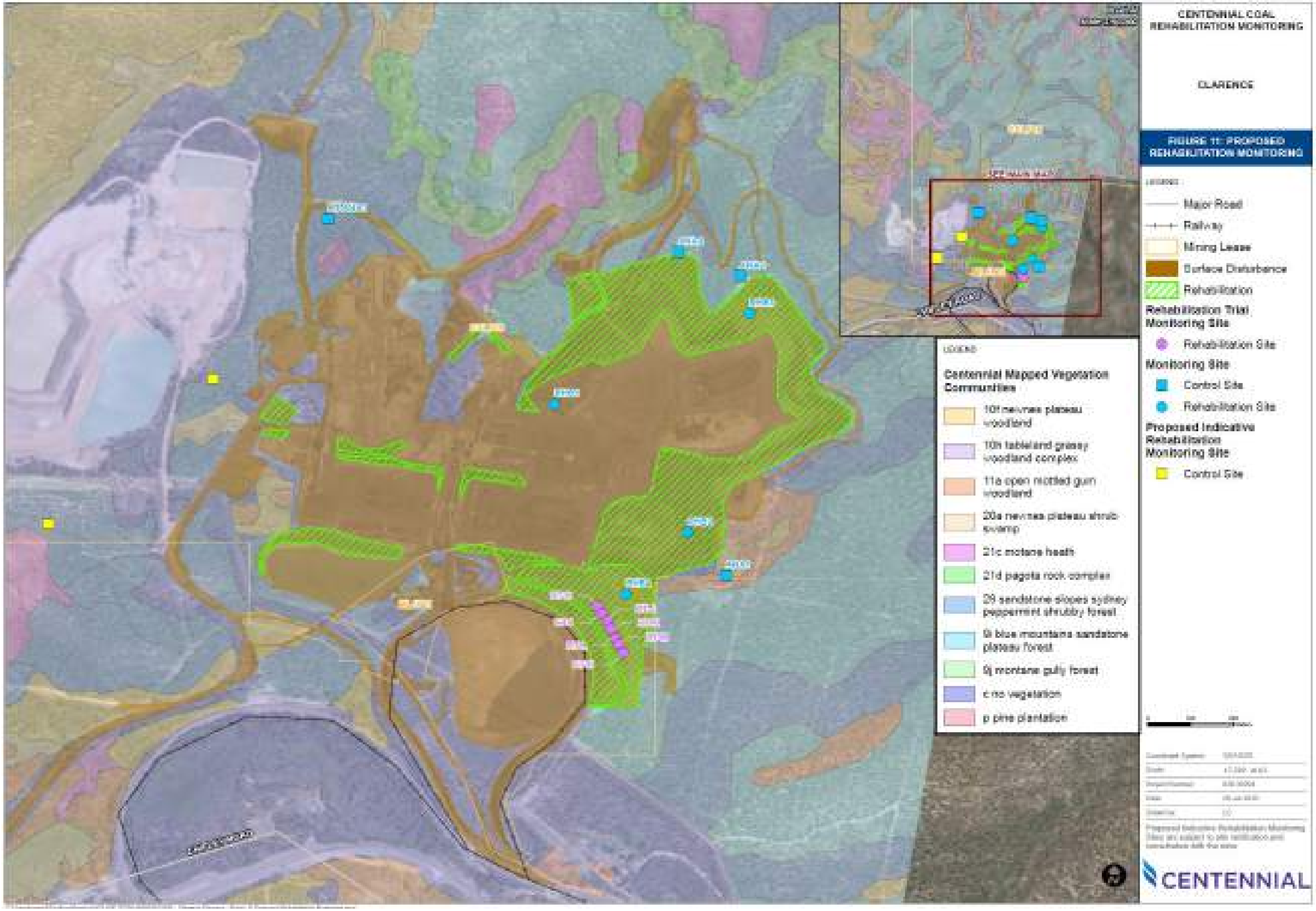
8.1.4 Soil Microbiology

Microorganisms in soil remain dependent on moisture availability, with rainfall events providing critical windows for microbial activity. The slight increase in soil moisture observed in 2024 appears to have alleviated some of the water limitations affecting microbial communities. No soil samples currently exhibit Aw values below 1.00, implying improved conditions that may have reduced water stress on bacterial communities.

There was continued variability in decomposer microbial communities across both control and rehabilitation soils. The decomposer microbial communities of the older rehabilitated soils from 1996 and 2002 (RHB1, RHB2, RHB3A and RHB3B) were generally more similar to native soils than those of more recently rehabilitated soils from 2016 and 2019 (RHB4B and RHB6A).

As rehabilitation sites continue to develop along different recovery trajectories, regular monitoring will be essential to track changes in microbial communities and identify any factors that may influence their recovery.

Figure 8-1: Clarence Colliery Rehabilitation Monitoring



8.2 DECOMMISSIONING

There were no decommissioning activities at Clarence Colliery during the Reporting Period.

8.3 OTHER REHABILITATION ACTIVITIES

Other rehabilitation management and maintenance activities undertaken during the reporting period include:

- Ongoing monitoring, site inspections identifying weeds, erosion and sediment control, pest species; and
- Weed control was undertaken.

8.4 REHABILITATION TRIALS AND RESEARCH

Clarence Colliery proposes to undertake trials to improve ground cover within existing rehabilitation areas during the LOM. These trials will involve supplementary planting of native grasses and shrubs. Species may include but not be limited to: Basket Grass *(Lomandra longifolia*), Poa Tussock (*Poa labillardierei*), *Rytidosperma pallidum* (*Joycea pallida*), Sunshine Wattle (*Acacia terminalis*), Silky Hakea (*Hakea sericea*), Red-stemmed Wattle (*Acacia rubida*), Yellow Tea Tree (*Leptospermum polygalifolium*) and *Geranium solanderi*.

In addition to these trials, SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Clarence to implement a rehabilitation trial within Reject Emplacement Area 4 (REA 4) at the colliery. The results of the proposed trials will be used to identify suitable methods for the rehabilitation of REA 3. The trial design will test the most effective methods to minimise erosion, maximise biodiversity and promote long-term cost-effective rehabilitation. This will be completed by trailing a variety of:

- Erosion control products;
- Ameliorants including Nitrohumus® and topsoil stripped from REA 5; and
- Native seed species endemic to the Newnes Plateau

The rehabilitation trial forms part of a ‘High-Risk Activity Notification’ process to allow for operational activities in preparation for the rehabilitation and decommissioning of REA 3. Monitoring reports are delivered annually to capture the following:

- Estimated soil loss from each trial area, with a comparison to the average soil loss rates (year 1 only)
- Ecological trends
- Assessment of rehabilitation performance against prescribed criteria (as set out in the Clarence Mining Operations Plan ‘MOP’)
- Recommendations for any necessary remedial works and/or changes to treatment that provide cost-effective improvements to rehabilitation performance.

Appendix 10 describes the methods and results of the annual monitoring survey undertaken within REA 4 in December 2024 (SLR, 2025). A summary of the annual monitoring survey of this rehabilitation trial is provided below.

Monitoring data collected at year five (2024) has been compared to baseline data from 2019 and data from year one (2020), year two (2021), year three (2022) and year four (2023), enabling comparison of several rehabilitation techniques (growth medium, erosion control and supplementary planting) applied at the seven trial plots.

Monitoring data collected at year five (2024) has been compared to baseline data from 2019 and subsequent annual monitoring years (2020-2023), enabling comparison of several rehabilitation techniques (growth medium, erosion control and supplementary planting) applied at the seven trial plots.

Results of the surveys suggest most sites have performed well with improving scores across most variables. Site H, native species covers improved substantially. Many of the components are thought to be at or trending towards the values required to meet MOP completion criteria. Additionally, the trial plots are generally stable, and no remediation actions are required.

8.5 NEXT REPORTING PERIOD

In 2025, the following major activities will be conducted:

- Material balance considering change of excavation depths in REA 5.
- Consider pit top rehabilitation material balance;
- Continued annual rehabilitation monitoring across REAs 1, 2, 3 and 4; and
- Continued progressive rehabilitation of Reject Emplacement Area REA 3.

9 COMMUNITY CONSULTATION

Clarence consults with the community through forums such as the Clarence Colliery Community Consultative Committee (CCC) and community-organised events. Meetings of the Clarence Colliery CCC were held on:

- 12 March
- 11 June
- 10 September; and
- 10 December.

Representatives of the Lithgow and Clarence communities, appointed community representatives, relevant government organisations and company representatives attended the meetings. A detailed presentation was provided to attendees at each CCC meeting on the Mine's production, geological update, subsidence results, environmental monitoring, Extraction Plan updates, approval updates and upcoming projects. Key agenda items discussed in 2024, included:

- Environmental compliance and community complaints summary;
- Environmental performance summary;
- Update on the REA III fines removal project;
- Update on Clarence pipeline project associated with planned cessation of discharge from LDP002;
- Update on MOD 8, MOD 10 and the Clarence Continuance project;
- Update on proposed Extraction Plan; and
- Aboriginal cultural heritage monitoring update

Extensive community consultation with landowners in and around the Clarence Colliery mining lease area is undertaken. As there are no current or proposed workings underneath private properties, no mining-related subsidence has been reported or measured. In general, the Clarence Colliery community consultation has been conducted during the CCC meetings.

Clarence continues to support the local community through various sponsorship avenues to the following community activities, groups, and associations in 2024.

9.1 COMMUNITY COMPLAINTS

During the 2024 Reporting Period, there were no community complaints received. **Table 9-1** below summarises the annual community complaints received by Clarence since 2017.

A complaint register is made publicly available on the Centennial Coal website in accordance with Schedule 5 Condition 11 of DA 504-00
https://www.centennialcoal.com.au/operations/clarence/

Table 9-1: Record of Annual Community Complaints for 2018 to 2023

Community Complaints						
Year	**Air**	**Water**	**Noise**	**Waste**	**Other**	**Total**
2019	0	0	0	0	0	0
2020	0	0	0	0	0	0
2021	0	0	0	0	0	0
2022	0	0	0	0	0	0
2023	0	0	0	0	0	0
2024	0	0	0	0	0	0

10 INDEPENDENT ENVIRONMENTAL AUDIT

The three-yearly Independent Environmental Audit (IEA) was conducted in October 2023. The audit scope included:

- DA 504-00 and associated Statement of Commitments (SOC);
- Mining tenements CCL 705, ML 1353, ML 1354, ML 1583, and ML 1721) – Note due to the Rehabilitation Reform IEMA has reviewed the leases in place up to 2 July 2022 and then the newer lease conditions from 2 July 2022 to 26 October 2023);
- WAL 36479 (note that WAL 41882 was inactive during the IEA period);
- SMP Approvals;
- Environmental Management Plans (under DA 504-00); and
- The status of previous IEA recommendations.

The IEA found that Clarence was non-compliant with 14 conditions out of a total of 279 conditions. A total of 15 recommendations were given to address the identified non-compliances. A response to the IEA recommendations was submitted to DPHI in January 2024.

A summary of the remaining actions from the IEA and their status is provided in **Table 10-1**.

Table 10-1: Non-Compliance Findings and Action Status from the 2023 IEA Report

IEA Recommendation	Response to Recommendation	Status at the end of the Reporting Period
NC REC 01: Once the water treatment infrastructure is upgraded, testing and functional; then the Water MP should be updated.	NC REC 01 Action: Clarence Colliery will update the WMP once the new infrastructure is tested and functional.	NC REC 01: Within 3 months of completion of the infrastructure upgrade. Not yet triggered as further updates are planned for 2025

IEA Recommendation	Response to Recommendation	Status at the end of the Reporting Period
NC REC 02: The discharge incidents should outline details about rainfall in the period prior to the exceedance and discuss whether that may have contributed to an exceedance.	NC REC 02 Action: Clarence Colliery will include details about rainfall in the reporting of exceedances.	NC REC 02: Ongoing where required
NC REC 03: The Annual Groundwater Assessment should discuss how the site tracked against Schedule 3, Condition 5 of the Project Approval - Water Resources Impact Assessment Criteria. In particular there should be a discussion on surface flows and groundwater baseflows to the nominated creeks and whether mining is causing any impacts.	NC REC 03 Action: Clarence Colliery will include a discussion on surface flow and groundwater baseflows to the nominated creeks and whether mining is causing any impacts in the annual groundwater assessment.	NC REC 03: To be included in the Annual Review Section 7.3.6
NC REC 04: The next update to the Water MP should include triggers for groundwater/ surface water baseflows, with these then reported as per the Water Management Plan commitments.	NC REC 04 Action: Clarence Colliery will include triggers for groundwater/ surface water baseflows in the WMP.	NC REC 04: Due 24 May 2024 – Completed
NC REC 05: Update the water monitoring spreadsheet to have some automatic triggers set up based on the WMP, Appendix J TARP. This would likely link back to baseline for water flow and SSGVs for water quality for the Wollangambe River.	NC REC 05 Action: Clarence Colliery will implement an automatic trigger on the monthly monitoring spreadsheet to identify triggers for the Wollangambe downstream.	NC REC 05: Due 24 May 2024 - Completed
NC REC 06: If reviewing the triggers does not require additional response (i.e. due to mining impacts) then the rationale behind that decision should be recorded internally i.e. in a memo or within a spreadsheet. This illustrates evidence of checking whether exceedances are caused by site activities.	NC REC 06 Action: Clarence will implement an internal Recording of reviews of the trigger and the rationale behind decision making.	NC REC 06: Due 24 May 2024 - Completed
NC REC 07: Annual Review needs to reflect current air quality monitoring. It incorrectly refers to the HVAS PM10 as a TEOM.	NC REC 07 Action: Clarence Colliery will Rectify this going forward in Annual reviews.	NC REC 07: 31 March 2024 Section 6.4 has been updated to reflect current monitoring.
NC REC 08: The next update to the AQMP needs to define what "long term" is in regard to when a TEOM will be established at site.	NC REC 08 Action: Clarence Colliery will update to the AQMP to dictate in what time frame a TEOM will be established.	NC REC 08: Due 24 May 2024 – Completed
NC REC 09: Send a link to the EMS to the required agencies as per Schedule 4 Condition 2 (a).	NC REC 09 Action: Clarence Colliery will send link to EMS to the required agencies within 14 days.	NC REC 09: Completed. 23 January 2024

IEA Recommendation	Response to Recommendation	Status at the end of the Reporting Period
NC REC 10: Ensure that within 3 months of the submission of this IEA, the EMP is updated	NC REC 10 Action: EMP to be updated within 3 months of the submission of this IEA	NC REC 10: Due 24 April 2024 – Completed and submitted to major projects portal for approval
NC REC 11: Liaise with DPHI about changing the definition of an incident within the Consent. Rather than a modification, see if a letter can be sent that confirms the change of this definition.	NC REC 11 Action: Clarence Colliery will liaise with DPHI to change the definition of an incident.	NC REC 11: Due 31 December 2024 – Not complete
NC REC 12: In future, request that the IEA is required to be submitted within 12 weeks of the site inspection, rather than 3 months of commissioning an auditor (note this is more consistent with other sites).	NC REC 12 Action: Clarence Colliery will liaise with DPHI to change the requirement that the IEA is submitted 3 months after commissioning to 12 weeks after the site inspection.	NC REC 12: Due 24 October 2026
NC REC 13: Send any MPs to the required agencies within 1 month of approval.	NC REC 13: Clarence will send any MPs to the required agencies within 1 month of approval.	NC REC 13: An action has been entered into the Centennial compliance database. Ongoing
NC REC 14: Clarence to complete subsidence status reports every 4 months to meet these requirements.	NC REC 14 Action: Clarence Colliery will complete a subsidence report every four months for 700 W and 800 areas.	NC REC 14: An action has been entered into the Centennial compliance database. Ongoing
NC REC 15: Clarence to complete Subsidence Management, End of Year reports to meet these requirements.	NC REC 15 Action: Clarence Colliery to complete end of year subsidence reports	NC REC 15: An action has been entered into the Centennial compliance database. Ongoing
IMP REC 01: If there are future exceedances within the SMP area but not within the SSD area these should be clearly noted in the Annual Review as currently the approval boundaries are complex between the SSD and SMP approvals. Site to note this comment, however not currently actionable.	IMP REC 01: Improvement noted, no further action required.	IMP REC 01: N/A No exceedance in 2024 reporting period.

IEA Recommendation	Response to Recommendation	Status at the end of the Reporting Period
IMP REC 02: The Annual Review should include a figure showing the extraction area for that calendar year, as well as the boundaries of the Council consent, the SSD and the SMPs.	IMP REC 02: Clarence Colliery will include a figure displaying the extraction area for the calendar year, as well as the boundaries of the council consent, the SSD and the SMP's	IMP REC 02: 31 March 2024 SMP areas included as Plan 3
IMP REC 03: Include the author of each management plan update in the next revision of the WMP as well as any other management plans.	IMP REC 03: Clarence Colliery will implement this going forward for the Water Management Plan	IMP REC 03: Due 24 May 2024 – Complete
IMP REC 04: The REA inspections need to have more information about the specific issue, the severity of the issue, and include recommendations on how to repair the issue. The current inspection reports lack some of these details.	IMP REC 04: Clarence Colliery will revise the REA inspections to be more specific of issues and remediation.	IMP REC 04: Due 31 December 2024- Complete
IMP REC 05: Construct a contour drain at Leachate Dam 1 to ensure all dirty water from this catchment is captured in the dam.	IMP REC 05: Clarence Colliery to construct a contour drain at Leachate Dam 1 to ensure all dirty water from this catchment is captured in the dam.	IMP REC 05: 31 December 2024 Drain installed in February 2024.
IMP REC 06: Install some coir logs at the Main Dam to reduce sediment going into the dam.	IMP REC 06: Clarence Colliery will install coir logs at the Main Damn to reduce sediment run off into the dam.	IMP REC 06: 31 December 2024 Coir logs installed at Main Dam February 2024
IMP REC 07: Install sediment fence along the section of road behind the stores/FCT shed.	IMP REC 7: Clarence Colliery will install a set of sediment fences behind the FCT shed.	IMP REC 7: Clarence Colliery will install a set of sed fences behind the FCT shed – Not complete
IMP REC 08: Re-grade access track alongside the stores/FCT shed.	IMP REC 8: Clarence Colliery will regrade access track behind the stores area.	IMP REC 08: Due 31 December 2024 – Complete as part of a larger road improvement program
IMP REC 09: Update Reject Management Strategy (2014) to reflect current operations.	IMP REC 09: Update Reject Management Strategy (2014) to reflect current operations.	IMP REC 09: Due 24 May 2024 - Complete

IEA Recommendation	Response to Recommendation	Status at the end of the Reporting Period
IMP REC 10: Include spontaneous combustion as a line item in the monthly REA inspection form template.	IMP REC 10: Clarence Colliery will revise REA inspection to include spontaneous combustion.	IMP REC 10: Due 31 March 2024 - Complete
IMP REC 11: The Fuchs lubricant drums at the workshop require bunding.	IMP REC 11: Clarence Colliery will install additional bunding at the workshop area.	IMP REC 11: Completed, drums have been removed.
IMP REC 12: The drains at workshop were full and require clean out.	IMP REC 12: Clarence Colliery will clean sediment of drains in front of workshop.	IMP REC 12: Completed in February 2024
IMP REC 13: The portable bunds stored out in the open need to be emptied after rainfall. Include this on the monthly inspection checklist rainfall. Include this on the monthly inspection checklist,	IMP REC 13: Clarence Colliery will include the inspection of bunds stored in the open to be checked for liquid levels and be pumped out.	IMP REC 13: 29 February 2024 - Complete
IMP REC 14: Centennial to send a letter to DPHI seeking an extension to the Mine Closure Strategy condition (Schedule 3 Condition 28).	Completed.	
IMP REC 15: Recommendation: Site to update the Historic Heritage Management Plan to reflect current Consent Conditions.	IMP REC 15: Clarence Colliery will update the heritage management plan to reflect the current Consent Conditions.	IMP REC 15: Due 24 May 2024 - Complete
IMP REC 16: IEMA recommends liaising with DPHI to remove this condition. Letter to DPHI should state where the different monitoring is covered within the different management plans.	IMP REC 16: Centennial to liaise with DPHI regarding the Environmental Monitoring Program.	IMP REC 16: Due 24 April 2024 - Complete
IMP REC 17: In the next RMP update, provide an update to the further studies/action plan from the risk assessment (Table 11 in the RMP).	IMP REC 17: In the next revision of the RMP, Clarence Colliery will provide an update to the further studies/action plan from the risk assessment (Table 11 in the RMP).	IMP REC 17: Due 24 October 2026
IMP REC 18: Include water management features on the Final Landform and Rehabilitation Plan (FLRP) (e.g. significant final landform drainage features) or update the RMP (domains) to be consistent with the FLRP. Centennial may need to liaise with the RR.	IMP REC 18: Include water management features on the FLRP (e.g. significant final landform drainage features) or update the RMP (domains) to be consistent with the FLRP. Clarence Colliery may need to liaise with the RR.	IMP REC 18: Due 24 October 2026

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

During the 2024 calendar year Reporting Period there were a total of 12 reportable incidents and non-compliances (excluding community complaints). A Summary of Reportable incidents and regulatory action is provided in **Table 11-1**.

Table 11-2 provides a summary of the incidents and non-compliances, including the actions taken by Clarence Colliery in response to the incident/non-compliance.

Table 11-1: Summary of Reportable Incidents and Regulatory Action

Compliance Type	Agency	Number
Incidents / non-compliances	EPA / DPHI	12
Caution Notices	-	0
Warning Letters	EPA	1
Prevention Notice	EPA	1
Penalty Notices	-	0
Prosecutions	EPA	1[1]

[1]On 20 December Clarence was issued with a prosecution proceeding five (5) alleged offences against the *Protection of the Environment Operations Act 1997* (NSW).

Table 11-2: Incidents and Non-Compliances during the Reporting Period

Compliance[8]	Overview of incident/non-compliance	Description of incident/non-compliance	Actions	Status of Actions
Non-Compliance 1	Exceedance of concentration limits as per EPL726, Condition L2.4 and DA 504-00 Schedule 3, Condition 9(b)	During the reporting period there were 11 events where grab samples were taken from LDP002, in which exceedances were detected. A summary pf these exceedances can be viewed in **Table 11-2**.	Notified and reported to EPA and DPHI. Actions taken include: Additional treatment tank with increased treatment capacity - project complete. Clarence has committed to a pilot plant trial which will implement media filtration to remove colloidal particles. Investigation of further WTP improvements - engaged with two third-party consultants. Ongoing optimisation of the WTP and upgraded infrastructure - including multi-staged pH adjustment. Conduct regular reviews of pH calibration of critical probes monitoring the WTP. Routine desilting of the treated water lagoon Pre-treatment of the WTP feed water (via chemical dosing) to improve DAF performance. Weekly meetings with relevant senior management regarding LDP002 management.	**Ongoing**

[8] See Compliance Status Key beneath Table 1-2 for risk level, colour code and description.

Compliance[8]	Overview of incident/non-compliance	Description of incident/non-compliance	Actions	Status of Actions
			Clarence is in consultation with the EPA with regards to a Water Treatment Plant (WTP) upgrade. PRP in place to cease all discharge in to the Wollangambe River, by the end of 2025.	
Non-Compliance 2	Non-compliance with Condition L2.4 due to a dirty water discharge on 5 to 6 April 2024	The event was caused by heavy rainfall, with 104.6mm of rainfall falling in 24 hours. The rainfall event commenced on Thursday 4 April 2024 and continued the following two days with rainfall ceasing during the morning of 6 April 2024, totalling 149.2mm.	Borehole transfer pump in place. Improved drainage conditions on site. EPA, DPHI, DCCEEW and RR notified on 5 April 2024. Incident Report submitted on 12 April 2024. Continued improvements in drainage infrastructure, continued monitoring of dam levels on SCADA and activation of surface to underground pumping where required.	**Complete**
Non Compliance 3	Failure to monitor continuously as per EPL 726, M2.3 Water and/ or Land Monitoring Requirements at EPL Point 9 (Wollangambe River Downstream)	Probe was nearing the end of its service life and began to return an error code when downloading the monitoring data.	Reported to EPA in the Annual Return. Monthly grab samples have been undertaken for pH and Conductivity at EPL Point 9 for the reporting period. New probe was ordered and has been installed. Probe has been tested and functioning as required.	**Complete**
Non Compliance 4	Did not estimate discharge volume/flow for point 3 (on 6/4/2024 and 8/4/2024) and point 4 (on 6/4/2024), as required in condition M8.1	Process failure by contract sampler.	Communicated to contract company to ensure compliance with condition M8.1. Develop a procedure for protocol during rainfall discharge to address all EPA requirements.	**Ongoing**

Compliance[8]	Overview of incident/non-compliance	Description of incident/non-compliance	Actions	Status of Actions
	Requirement to monitor mass on EPL726			

Table 11-3: Summary of LDP002 Exceedances

Analyte	EPL726 Limit (mg/L)	Result (mg/L) – *Recorded exceedances only*											
		10/01	14/02	13/03	8/05	12/05	11/06	9/07	13/08	17/09	8/10	12/11	10/12
Copper	**0.0014**									0.004			
Nickel	**0.011**					0.015	0.056	0.044	0.013	0.024	0.014		
Zinc	**0.008**	0.017	0.028	0.029	0.01		0.098	0.096	0.032	0.065	0.022	0.013	0.029
Nitrogen	**0.25**										0.3	0.3	
Phosphorus	**0.02**		0.03	0.03	0.04		0.04				0.06		0.05
Silver	**0.00005**		0.0032										
Cobalt	**0.0025**	0.0026	0.0031	0.0028		0.0036	0.0212	0.0199	0.005	0.0093	0.0093		0.0034
Mercury	**0.00006**									0.0002			

12 ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Table 12-1 presents activities that are currently planned for the next Reporting Period.

Table 12-1: Forecast Operations for 2025

Improvement Actions
• Continue to implement non-compliance and improvement recommendations listed in the endorsed IEA action plan. • Clarence has committed to a pilot plant trial (as recommended by two independent experts) which will implement media filtration to remove colloidal particles and aim to improve on dissolved metals removal.
Management Plan Revisions
• Further consultation with DPHI regarding the latest revision to the WRBMP (Version 7), will be undertaken during the next Reporting Period. Revision of the WRBMP is to be undertaken in the next Reporting Period as required. • The Clarence WMP will be updated during the next reporting period to include the most current groundwater model and TARP triggers will be reviewed and updated where required based on the model. • In accordance with Condition 28 in Schedule 3 of DA 504-00 a Mine Closure Strategy for the Clarence Colliery will be developed in consultation with Council, Resources Regulator, DPHI Water and EPA, and to the satisfaction of the Planning Secretary.
Condition Triggers
• In accordance with Condition 13(b) in Schedule 5 of DA 504-00 strategies, plans, and programs required under the consent will be reviewed within three months of the submission of this annual review. If necessary, the strategies, plans, and programs required under the approval will be revised and within 4 weeks of the review the revised documents must be submitted for the approval of the Secretary.

13 REFERENCES

Biodiversity Monitoring Services (2024). *Fauna Report – 900 Area Terrestrial Fauna Monitoring Report*, Prepared for Clarence Colliery Pty Ltd.

Biodiversity Monitoring Services (2024). *Fauna Report – Western SMP Application Area Terrestrial Fauna Monitoring Report*, Prepared for Clarence Colliery Pty Ltd.

EMM (2019a). *Clarence Colliery: Modification to DA 504-00 Statement of Environmental Effects (Mod 4)*, Prepared for Centennial Coal Company Limited

EMM (2019b). *Clarence Colliery: Modification to DA 504-00 – Employee Increase (Mod 5)*, Prepared for Centennial Coal Company Limited

EMM (2020). *Clarence Colliery - Modification 6 Greenhouse gas assessment*, Prepared for Centennial Coal Company Limited

EMM (2024). Clarence Colliery – Annual Environmental Monitoring Report (AEMR), Prepared for Centennial Coal Company Limited.

GHD (2013). *Environmental Assessment: Clarence Colliery Reject Emplacement Area VI, Section 75W Modification to Development Consent DA 504-00 (Mod 2)*, Prepared for Centennial Coal Company Limited

EcoResolve Pty Ltd (2024). *Clarence Quadrat Monitoring – 2024 Annual Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Wollangambe River Aquatic Ecology – Autumn 2024 Data Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Wollangambe River Aquatic Ecology – Spring 2024 Data Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Bungleboori Creek Catchment Aquatic Ecology – Autumn 2024 Data Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Bungleboori Creek Catchment Aquatic Ecology – Spring 2043 Data Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Dingo Creek Catchment Aquatic Ecology – Autumn 2024 Data Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Dingo Creek Catchment Aquatic Ecology – Spring 2024 Data Report*, Prepared for Clarence Colliery Pty Ltd.

Marine Pollution Research Pty Ltd (2024). *Wollangambe River Aquatic Ecology Monitoring – Annual 2024 Summary Report*, Prepared for Clarence Colliery Pty Ltd.

SLR (2013). *Clarence Colliery Pty Ltd Air Quality Impact Assessment*, Report Number 630.10123-R6, Prepared for Clarence Colliery Pty Ltd.

SLR (2025). *Reject Emplacement Area 4 Rehabilitation Trial Annual Monitoring*, SLR Ref No: 630.030946.00001-R01-v1.0, Prepared for Clarence Colliery Pty Ltd.

SLR (2025) *2024 Annual Rehabilitation Monitoring Report*, SLR Ref No: 630.031007.00002-R01-v2.0, Prepared for Clarence Colliery Pty Ltd.

PLANS

Plan Reference	Plan Name
Plan 1	Production for 2024 Shown Monthly
Plan 2	Forecast Mining Activities for 2024
Plan 3	Clarence Colliery SMP Areas

Plan 1: Production for 2024 Shown Monthly

LEGEND

- EXISTING BOREHOLE / PIEZOMETERS
- SWAMP PIEZOMETERS
- NEWNES PLATEAU HANGING SWAMP
- NEWNES PLATEAU SHRUB SWAMP
- FAULT
- STRIKE SLIP FAULT
- STRUCTURED ROOF ZONE
- INTRUSION
- COLLIERY HOLDING BOUNDARY
- RIVERS\CREEKS
- ROADS\TRACKS

NOTE:
1. The workings and scale shown on this plan are **indicative only**
2. Mine workings pre 2005 - refer to hard copy Mine Working Plan (in I.S.G.format)
3. Current mine workings - refer to digital mine working plan
4. Any queries on the workings - refer to the survey department at Clarence Colliery
5. The workings for the month that are shown (coloured hatching) are correct to the best of my knowledge (Mine Surveyor - Karl Harisson)

DATE	09.01.2025
SEAM	KATOOMBA
REFERENCE	
N:\Plans\EOM\2024\Monthly & Quarterly_prodn_2024.dwg	
SCALE	DIAGRAM

PRODUCTION FOR 2024 SHOWN MONTHLY

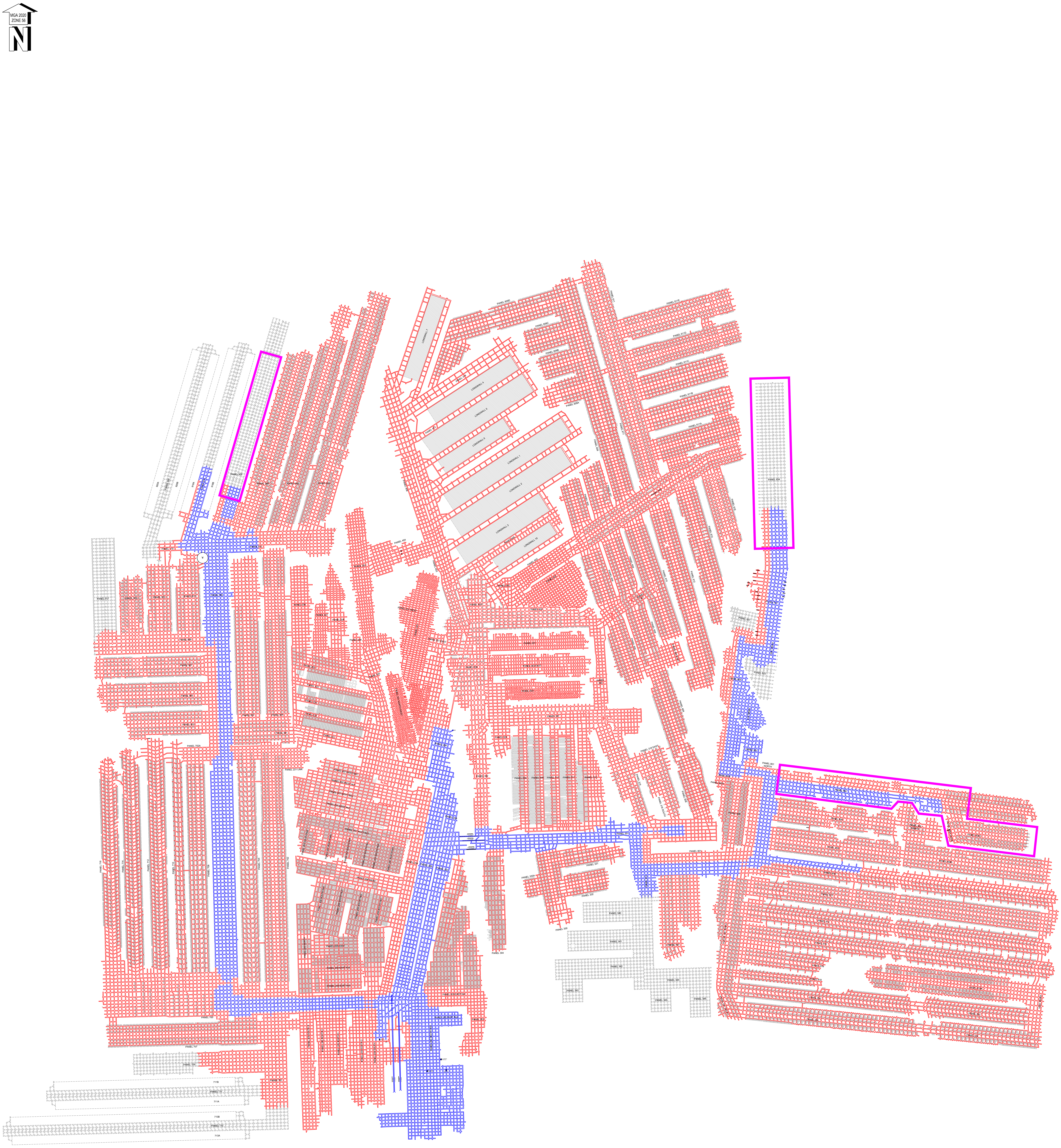
ENVIRONMENTAL REPORT

CENTENNIAL CLARENCE

THIS DRAWING IS THE PROPERTY OF CLARENCE COLLIERY PTY. LTD.

DRG. No. CL 2253

Plan 2: Forecast Mining Activities for 2025



NOTE

- The workings and scale shown on this plan are **indicative only**
- Mine workings pre 2005 - refer to hard copy Mine Working Plan (in I.S.G.format)
- Current mine workings - refer to digital mine working plan
- Any queries on the workings - refer to the survey department at Clarence Colliery

LEGEND

- First Workings Intake
- First Workings Returns
- First Workings Proposed
- Second Workings
- Proposed 2025 Production

CLARENCE COLLIERY
PROPOSED 2025 PRODUCTION

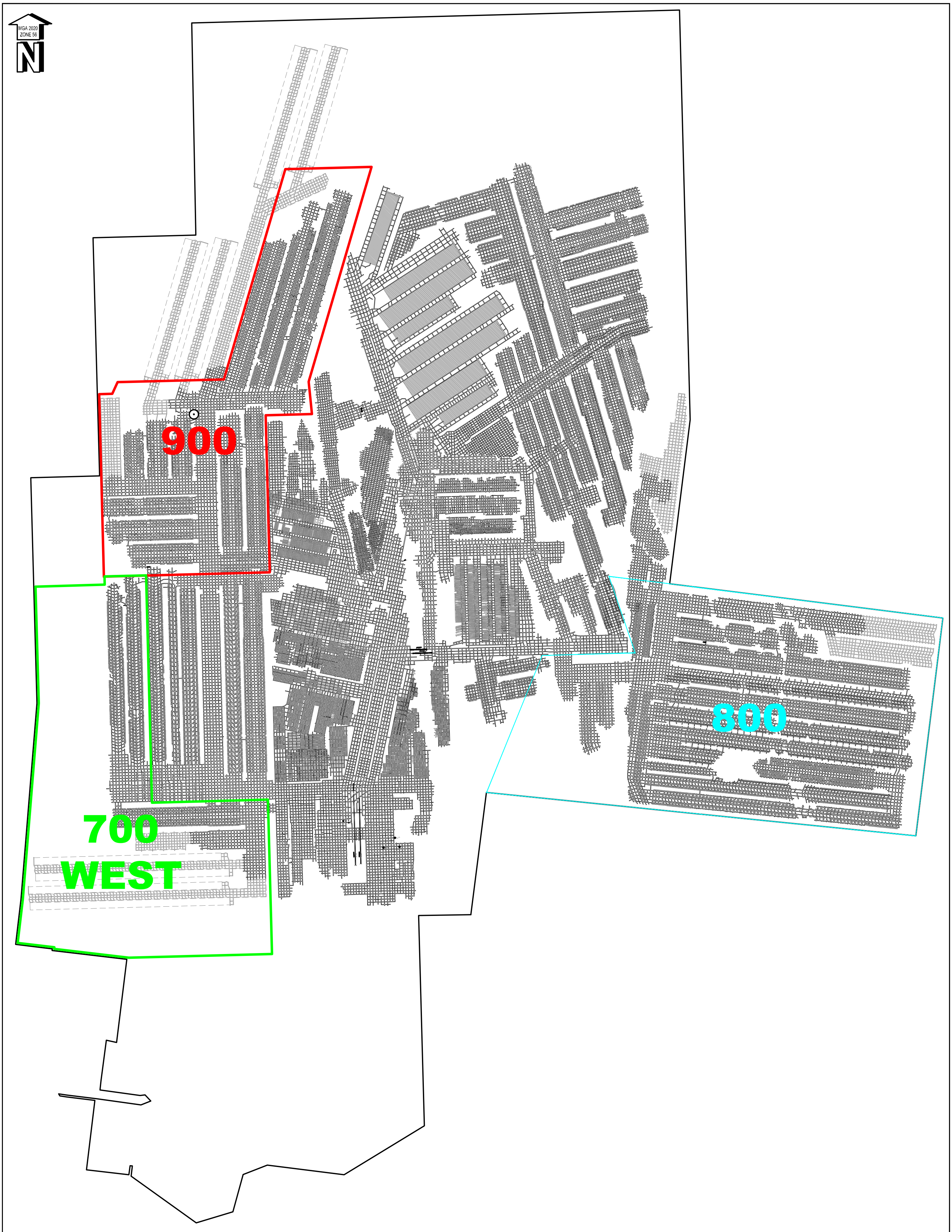
DATE	31/03/2025
SCALE	NOT TO SCALE
DRG. No.	CL2282

CENTENNIAL
CLARENCE

THIS DRAWING IS THE PROPERTY OF CLARENCE COLLIERY PTY. LTD.

REFERENCE
N:\Plans\Surface\Enviro

Plan 3: Clarence Colliery SMP Areas



LEGEND

CLARENCE COLLIERY SMP AREAS

DATE	27/11/2023
SCALE	NOT TO SCALE
DRG. No.	CL2149

REFERENCE
N:\Plans\SMP\CL2149_SMP Areas.dwg

CENTENNIAL CLARENCE

THIS DRAWING IS THE PROPERTY OF CLARENCE COLLIERY PTY. LTD.

APPENDICES

Appendix No.	Appendix Name
1	Annual Review Reporting Requirements Checklist
2	Noise Monitoring Report
3	Air Monitoring Results
4	Flora Monitoring Reports
5	Fauna Monitoring Reports
6	Aquatic Monitoring Reports
7	Subsidence Monitoring Results
8	Water Quality Monitoring Results
9	Groundwater Monitoring Report
10	Rehabilitation Monitoring Report
11	REA IV Rehabilitation Monitoring Report

Appendix 1: Annual Review Reporting Requirements

Approval / Condition	Requirement	Annual Review Section
DA 504-00, Schedule 5 Condition 5	The applicant must prepare and submit an annual review to the Planning Secretary and the relevant agencies. This report must:	This document
	(a) Identify the standards and performance measures that apply to the development	Section 3
	(b) Describe the works carried out in the last 12 months	Section 4, 6, 7, and 8
	(c) Describe the works that will be carried out in the next 12 months	Section 12
	(d) Include a summary of complaints received during the past year, and compare this to the complaints received in previous years	Section 9
	(e) Include a summary of the monitoring results for the development during the past year	Section 6 to 8
	(f) Include an analysis of these monitoring results against the relevant: • Impact assessment criteria • Monitoring results from previous years • Predications in the EIS	Section 6 to 8
	(g) Identify any trends in the monitoring results over the life of the development	Section 6 to 8
	(h) Identify any non-compliance during the previous year	Section 1 & 11
	(i) Describe what actions were, or are being taken to ensure compliance	Section 11
DA 504-00, Schedule 3 Condition 7	The Water Balance must: (a) include details of all water extracted, dewatered, transferred, used and/or discharged by the mine; and (b) provide for the annual re-calculation of the water balance and reporting of the review in the Annual Review.	Section 7.2
DA 504-00, Schedule 3 Condition 12	Each year, the Applicant must: (a) review the Water Management Plan; (b) update each sub-plan; and (c) report the results of this review in the Annual Review, including; (d) the results of monitoring; (e) details of the review for each sub-plan; (f) amendments to the sub-plans; and (g) details of the measures undertaken / proposed to address any identified issues.	Section 7

Approval / Condition	Requirement	Annual Review Section
DA 504-00, Schedule 3 Condition 23	The Applicant must: (a) monitor the greenhouse gas emissions generated by the development; (b) investigate ways to reduce greenhouse gas emissions on site; and (c) report on these investigations in the Annual Review, to the satisfaction of the Planning Secretary.	Section 6.5

Appendix 2: Attended Noise Monitoring Report

Clarence Colliery

Annual Noise Monitoring December 2024

Clarence Colliery Pty Ltd

Clarence Colliery Pty Ltd
Centennial Western Accounts
Locked Bag 1002
WALLERAWANG NSW 2845

Prepared by:

SLR Consulting Australia

SLR Project No.: 630.19245

Client Reference No.: R07

21 January 2025

Revision: v1.0

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
v1.0	21 January 2025	Adam Sirianni	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 Clarence Colliery 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

Tables in Text

Figures in Text

Appendices

1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Clarence Colliery to conduct the 2024 annual noise compliance monitoring for the Clarence Colliery as guided by the Centennial Coal Noise Management Plan Western Region (NMP) April 2018.

The purpose of this assessment was to determine the noise contribution from Clarence Colliery operations, in accordance with the Clarence Colliery Environment Protection Licence (EPL) No. 726 and the Conditions of Approval (CoA) DA 504-00 Mod 10. In April 2024 the EPA requested Clarence Colliery conduct further attended noise monitoring at locations C3 and C6 in April and May 2024 to assess compliance with the EPL noise limits at sensitive receivers. As a result, during this annual compliance assessment, noise monitoring was conducted at CNM1 in accordance with the NMP, as well as additional monitoring at C3 and C6.

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

Condition 15 of the Development Approval DA 504-00 provides noise impact assessment criteria. The noise limits are applicable to noise “generated from the premises, excluding train loading and rail operations” and are reproduced in **Table 1**. EPL 726 provides the same noise limits for site operations.

Table 1 Noise Impact Assessment Criteria dBA

Land	Day $L_{Aeq(15min)}$	Evening $L_{Aeq(15min)}$	Night $L_{Aeq(15min)}$
Any residence on privately-owned land	38	36	35

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.

Notes:

a) For the purpose of these noise criteria, 5dB(A) must be added to the measured level if the noise is substantially tonal or impulsive in character.

b) The noise criteria do not apply where the Applicant and the affected landowner have reached a negotiated agreement in regard to noise, and a copy of the agreement has been forwarded to the Secretary and EPA.

c) Noise from the development is to be measured at the most affected point or within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the $L_{Aeq(15\ minute)}$ noise limits in the above table. Where it can be demonstrated that direct measurement of noise from the development is impractical, the EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.

d) The noise criteria apply under prevailing meteorological conditions (winds up to 3m/s), except under conditions of temperature inversions. Noise impacts that may be enhanced by temperature inversions must be addressed by:

e) documenting noise complaints received to identify any higher level of impacts or patterns of temperature inversions; and

f) where levels of noise complaints indicate a higher level of impact then actions to quantify and ameliorate any enhanced impacts under temperature inversion conditions shall be developed and implemented.

Condition M4 of EPL 726 also specifies requirements relating to noise monitoring:

M4.1 The licensee must undertake yearly (in-line with the reporting period) noise monitoring as outlined below, to determine compliance with the noise limits stipulated by condition L5.1:

a) 1 day attended noise monitoring covering the day, evening and night time periods; and

b) 5 days unattended noise monitoring (monitor and logger) covering each day, evening and night time periods.

M4.2 The results of the noise monitoring required by condition M4.1, and an interpretation of these results, must be provided as an attachment to each corresponding years Annual Return.

M4.3 The licensee, following the receipt of a noise related complaint and if required by the EPA, must undertake noise monitoring as required by the EPA to determine compliance with the noise limits stipulated by condition L5.1.

M4.4 The results of the noise monitoring required by condition M4.3, and an interpretation of these results, must be provided to the EPA within 21 days of the completion of the noise monitoring.

3.0 Operational Noise Monitoring Methodology

3.1 General Requirements

The 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 additional noise monitoring assessment were as follows:

- Measure the noise contribution from Clarence Colliery operations at NMP ‘Representative Noise Monitoring Location’ CNM1 and at receivers, C3 and C6.
- Determine all sources of noise within each of the noise surveys, including estimated contribution and maximum level of each source.
- Assess the noise emissions of Clarence Colliery operations, in relation to the EPL 726 and DA 504-00 limits for the site and with regard to wind speed and direction during the noise surveys.

3.2 Operator Attended Noise Monitoring

The acoustic instrumentation used during the monitoring programme has been designed to comply with the requirements of AS IEC 61672.1 – 2019 Electroacoustics - Sound level meters - Specifications and carries current National Association of Testing Authorities (NATA) or manufacturer calibration certificates.

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

3.2.1 Methodology

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

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

3.2.2 Attended Noise Monitoring Locations

Operator attended noise surveys were conducted at the locations noted in **Table 2** to determine the character and contribution of noise sources, including Clarence Colliery 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
CNM1	Annual Attended Monitoring Location - To the south-east of Clarence Colliery.
C3	Nearest residential receiver to the south-east of Clarence Colliery on Sandham Road.
C6	Nearest residential receiver to the south-west of Clarence Colliery on Chifley Road.

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 Monday 16 December 2024.

A summary of the operator attended measurements conducted for CNM1, C3 and C6, including the estimated contribution of noise sources, is shown in **Table 3** to **Table 5**.

Table 3 Attended Noise Survey Results Location – CNM1

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Criteria	Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}		
Day	16/12/2024 14:03 28 °C 1.5m: 1-2 m/s NE 10m: 2.9 m/s NE	63	51	46	40	44	38 dBA $L_{Aeq(15min)}$	*Site related noise events:* *CHPP Plant – 33 to 32 dBA* *Haul Trucks – 33 to 38 dBA* **Clarence Colliery Contribution – 30 dBA $L_{Aeq(15minute)}$** *Other noise events:* *Birds – 44 to 63 dBA* *Insects – 44 to 49 dBA* *Traffic – 39 to 45 dBA*
Evening	16/12/2024 20:27 21 °C 1.5m: 0-1 m/s N 10m: 0.5 m/s N	64	55	42	33	43	36 dBA $L_{Aeq(15min)}$	*Site related noise events:* *CHPP Plant – 25 to 29 dBA* **Clarence Colliery Contribution – 27 dBA $L_{Aeq(15minute)}$** *Other noise events:* *Traffic – 41 to 44 dBA* *Insects – 42 to 45 dBA* *Birds – 50 to 64 dBA* *Train – 41 to 43 dBA*
Night	16/12/2024 22:01 21 °C 1.5m: 0-2 m/s N 10m: 1.7 m/s N	52	40	36	32	35	35 dBA $L_{Aeq(15min)}$	*Site related noise events:* *CHPP Plant – 28 to 35 dBA* *Onsite Alarm – 30 dBA* **Clarence Colliery Contribution – 30 dBA $L_{Aeq(15minute)}$** *Other noise events:* *Traffic – 40 to 42 dBA* *Insects – 45 to 45 dBA* *Train – 40 to 52 dBA*

Table 4 Attended Noise Survey Results Location – C3

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Criteria	Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}		
Day	16/12/2024 14:21 28 °C 1.5m: 0-1 m/s NE 10m: 3 m/s NE	70	57	42	36	44	38 dBA $L_{Aeq(15min)}$	*Site related noise events:* *CHPP Plant – 25 to 28 dBA* *Haul Truck – 30 to 34 dBA* **Clarence Colliery Contribution – 28 dBA $L_{Aeq(15minute)}$** *Other noise events:* *Dog – 50 to 68 dBA* *Traffic – 40 to 51 dBA* *Offsite impacts – 41 to 44 dBA* *Local Traffic – 70 dBA*
Evening	16/12/2024 20:46 21 °C 1.5m: 0-1 m/s E 10m: 0.5 m/s E	57	49	38	27	36	36 dBA $L_{Aeq(15min)}$	*Site related noise events:* *Clarence Colliery noise events barely audible above ambient levels* **Clarence Colliery Contribution – Not Measurable above ambient level** *Other noise events:* *Traffic – 35 to 43 dBA* *Train – 40 to 50 dBA* *Birds – 48 to 57 dBA*
Night	16/12/2024 22:23 20 °C 1.5m: 0-1 m/s N 10m: 1.2 m/s N	48	38	33	26	30	35 dBA $L_{Aeq(15min)}$	*Site related noise events:* *CHPP Plant – 25 to 33 dBA* **Clarence Colliery Contribution – 27 dBA $L_{Aeq(15minute)}$** *Other noise events:* *Traffic – 42 to 49 dBA* *Insects – 30 to 35 dBA* *Offsite impact – 48 dBA*

Table 5 Attended Noise Survey Results Location – C6

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Criteria	Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq		
Day	16/12/2024 14:45 28 °C 1.5m: 0-1 m/s NE 10m: 3.2 m/s NE	81	71	60	37	59	38 dBA LAeq(15min)	*Site related noise events:* *CHPP Plant – 28 to 30 dBA* **Clarence Colliery Contribution – 28 dBA LAeq(15minute)** *Other noise events:* *Traffic – 67 to 81 dBA* *Insects – 37 to 40 dBA* *Birds – 38 to 47 dBA*
Evening	16/12/2024 21:24 21 °C 1.5m: 0-1 m/s N 10m: 0.9 m/s N	78	71	56	30	57	36 dBA LAeq(15min)	*Site related noise events:* *CHPP Plant – 27 to 35 dBA* **Clarence Colliery Contribution – 28 dBA LAeq(15minute)** *Other noise events:* *Insects – 30 to 33 dBA* *Traffic – 70 to 78 dBA*
Night	16/12/2024 22:49 19 °C 1.5m: 0-1 m/s NW 10m: 0.8 m/s NW	83	70	63	31	58	35 dBA LAeq(15min)	*Site related noise events:* *CHPP Plant – 25 to 38 dBA* **Clarence Colliery Contribution – 31 dBA LAeq(15minute)** *Other noise events:* *Traffic – 71 to 83 dBA* *Insects – 35 to 50 dBA*

4.1.1 Noise Compliance Assessment

The contributions from Clarence Colliery operations are summarised in **Table 6**.

Table 6 Overall Clarence Colliery Noise Contribution

Location	Estimated $L_{Aeq(15minute)}$ Contribution dBA			Noise Criteria $L_{Aeq(15minute)}$ dBA			Compliance		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
CNM1	30	27	30	38	36	35	Yes	Yes	Yes
C3	28	N/M[1]	27				Yes	Yes	Yes
C6	28	28	31				Yes	Yes	Yes

Note 1: Clarence Colliery noise barely audible above ambient levels and not estimated to be significant in relation to the noise criteria.

The above shows that the noise levels complied with the appropriate criteria in all periods during the monitoring survey.

4.2 Results of Unattended Noise Monitoring

The noise monitoring equipment was deployed on Monday 16 December 2024 and collected on Friday 27 December 2024.

A summary of the daily and overall noise levels for the monitoring period is provided in **Table 7**. Results are also displayed in **Appendix C**.

Table 7 Unattended Noise Monitoring Results – CNM1

Location	Period	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}
CNM1	Daytime	52	46	35	51
	Evening	50	43	30	46
	Night	50	44	31	46

Notes: 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.

No further analysis of the unattended noise monitoring has been undertaken. The noise levels are likely to be influenced by various sources including local traffic and traffic along Chifley Road, the nearby railway as well as insects and other ambient noise sources.

5.0 Conclusion

An assessment of noise emissions from Clarence Colliery has been conducted by SLR in December 2024.

Operator attended noise measurements were conducted at noise monitoring locations CNM1, C3 and C6 during the daytime, evening and night-time periods on Monday 16 December 2024.

The assessment and analysis of the measured data has shown that Clarence Colliery noise emission levels were in compliance with the PA/EPL/CoA noise limits at all monitoring locations during the day, evening and night-time periods during the survey.

Appendix A   Acoustic Terminology

Clarence Colliery

Annual Noise Monitoring December 2024

Clarence Colliery Pty Ltd

SLR Project No.: 630.19245

21 January 2025

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is 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 L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 '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 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA 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.

3 Sound Power Level

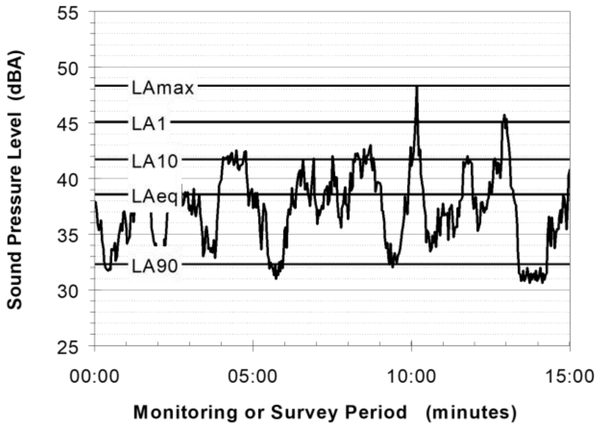
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to 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.

4 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 L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} 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:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} 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.

L_{Aeq} 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.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition, the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components) and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

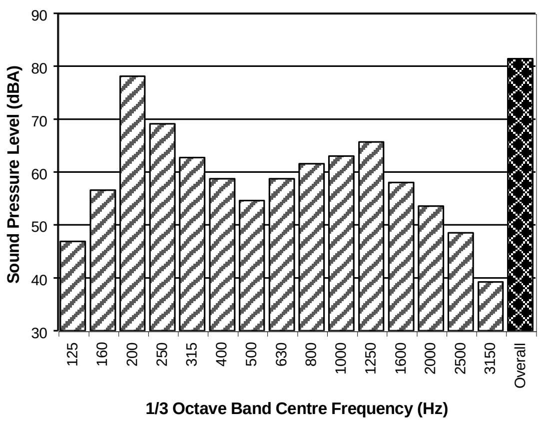
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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 (3 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.



8 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. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) 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/V_o), where V_o is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 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.

10 Over-Pressure

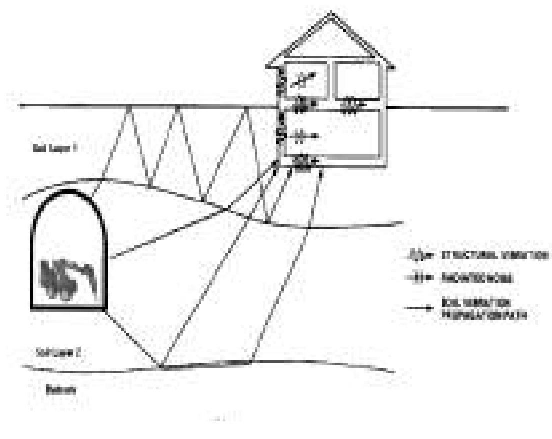
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 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 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

Clarence Colliery

Annual Noise Monitoring December 2024

Clarence Colliery Pty Ltd

SLR Project No.: 630.19245

21 January 2025

NVMS

Sydney Calibration Laboratory
Unit 21, 1 Talavera Road, Macquarie Park NSW 2113, Australia
Accredited for compliance with ISO/IEC 17025 - Calibration. Laboratory No. 1301

NATA

CERTIFICATE OF CALIBRATION

Certificate No: CAU2400840

Page 1 of 11

CALIBRATION OF:

Sound Level Meter:	Brüel & Kjær	2270	No: 3029485
Microphone:	Brüel & Kjær	4189	No: 3260622
Preamplifier:	Brüel & Kjær	ZC-0032	No: 30123
Supplied Calibrator:	None		
Software version:	BZ7222 Version 4.7.6	Pattern Approval:	-
Instruction manual:	BE1712-22	Identification:	N/A

CUSTOMER:

SLR Consulting Australia Pty Ltd
202 Submarine School, Sub Base Platypus
North Sydney NSW 2060

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 °C
Environment conditions: *see actual values in **Environmental conditions** sections*

SPECIFICATIONS:

The Sound Level Meter has been calibrated in accordance with the requirements as specified in IEC61672-1:2013 class 1. Procedures from IEC 61672-3:2013 were used to perform the periodic tests. The measurements included in this document are traceable to Australian / International standards through accredited calibration of all relevant reference equipment.

PROCEDURE:

The measurements have been performed with the assistance of Brüel & Kjær Sound Level Meter Calibration System B&K 3630 with application software type 7763 (version 8.6 - DB: 8.60) and test procedure 2270-4189.

RESULTS:

	Initial calibration		Calibration prior to repair/adjustment
X	Calibration without repair/adjustment		Calibration after repair/adjustment

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor k = 2 providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of Calibration: 29/08/2024

Certificate Issued: 29/08/2024

Barath Chandar Rajendran
Calibration Technician

Sajeeb Tharayil
Approved signatory

Reproduction of the complete certificate is allowed. Parts of the certificate may only be reproduced after written permission.

Certificate Of Calibration

Certificate No: SLM50561

Equipment Tested: Sound Level Meter

Manufacturer:	Svantek		
Type No:	SVAN 957	**Serial No:**	20666
Mic. Type:	ACO 7052E	**Serial No:**	54741
Pre-Amp. Type:	SV 12L	**Serial No:**	10690
Filter Type:	1/3 Octave	**Test No:**	F050563

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	998	hPa ±1 hPa	**Date of Receipt :**	11/07/2024
Temperature	23	°C ±1° C	**Date of Calibration :**	19/07/2024
Relative Humidity	41	% ±5%	**Date of Issue :**	19/07/2024

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

Checked by: KB

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

Page 1 of 2 Calibration Certificate
AVCERT10.14 Rev.2.0 14/04/2021

Certificate Of Calibration

Certificate No: C50268

Equipment Tested : Acoustic Calibrator

Manufacturer:	B&K		
Type No:	4231	**Serial No:**	2218228
Class:	1		
Owner:	SLR Consulting Australia Pty Ltd 120 High Street North Sydney, NSW 2060		
Tests Performed:	Measured Output Pressure level, Frequency & Distortion		
Comments:	See Details and Class Tolerance overleaf.		

Condition Of Test:

Ambient Pressure	1006	hPa ±1 hPa	**Date of Receipt :**	19/06/2024
Temperature	23	°C ±1° C	**Date of Calibration :**	24/06/2024
Relative Humidity	44	% ±5%	**Date of Issue :**	24/06/2024

Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017

Checked by: .... **Authorised Signature:** ....

Hain Sae

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

Page 1 of 2 Calibration Certificate
AVCERT02.1 Rev 2.0 14.04.2021

Appendix C Noise Monitoring Graphs

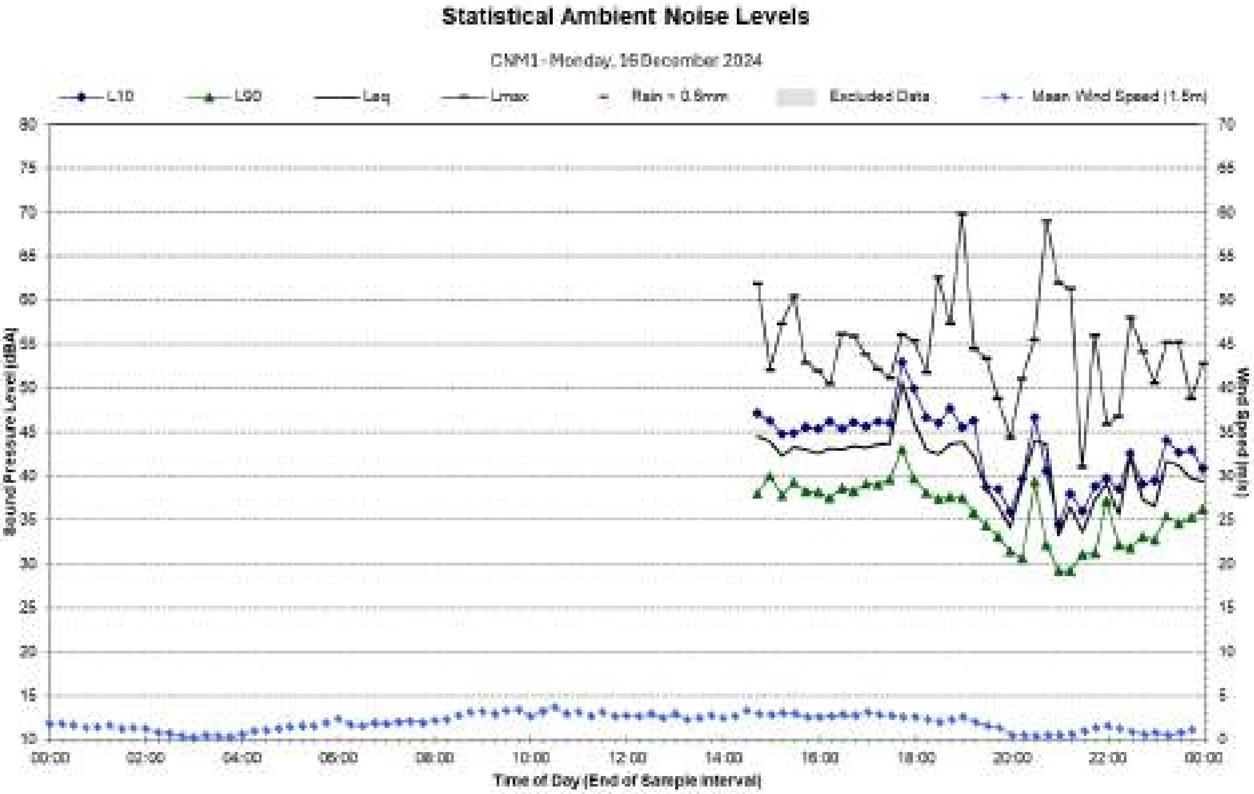
Clarence Colliery

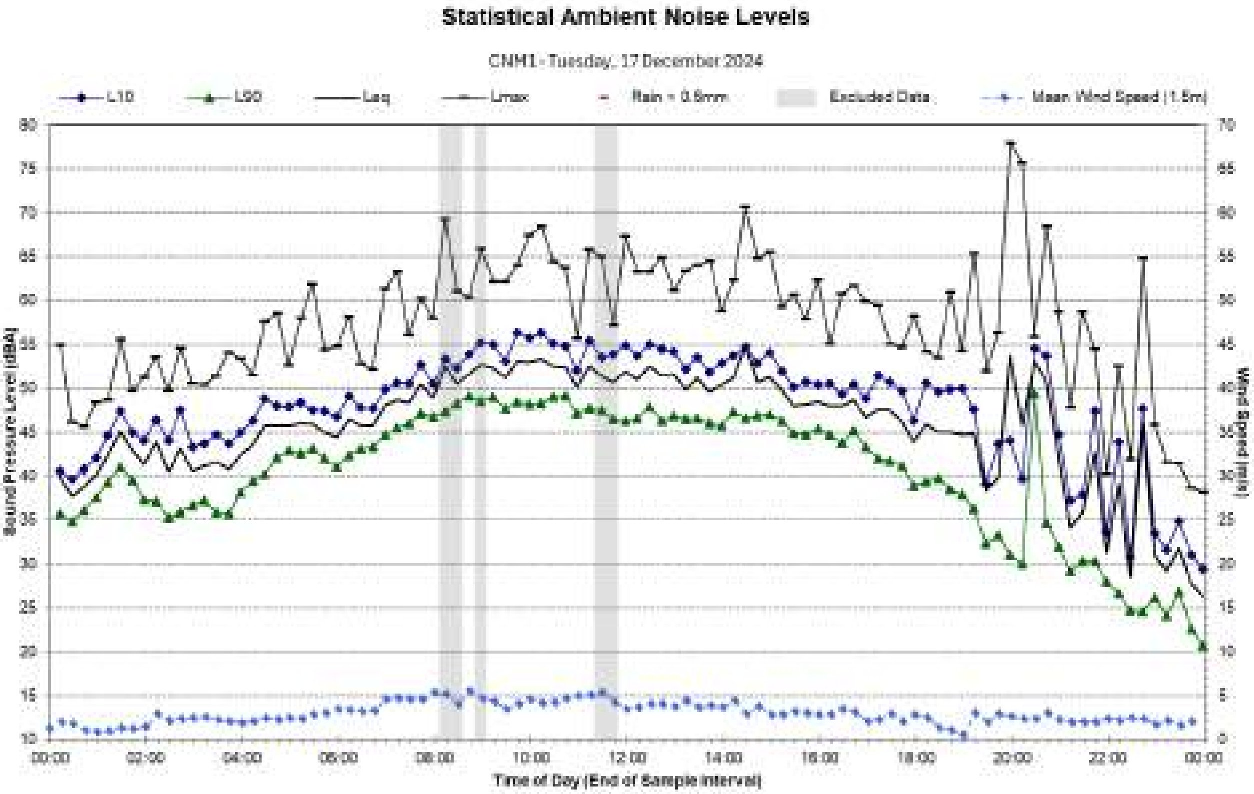
Annual Noise Monitoring December 2024

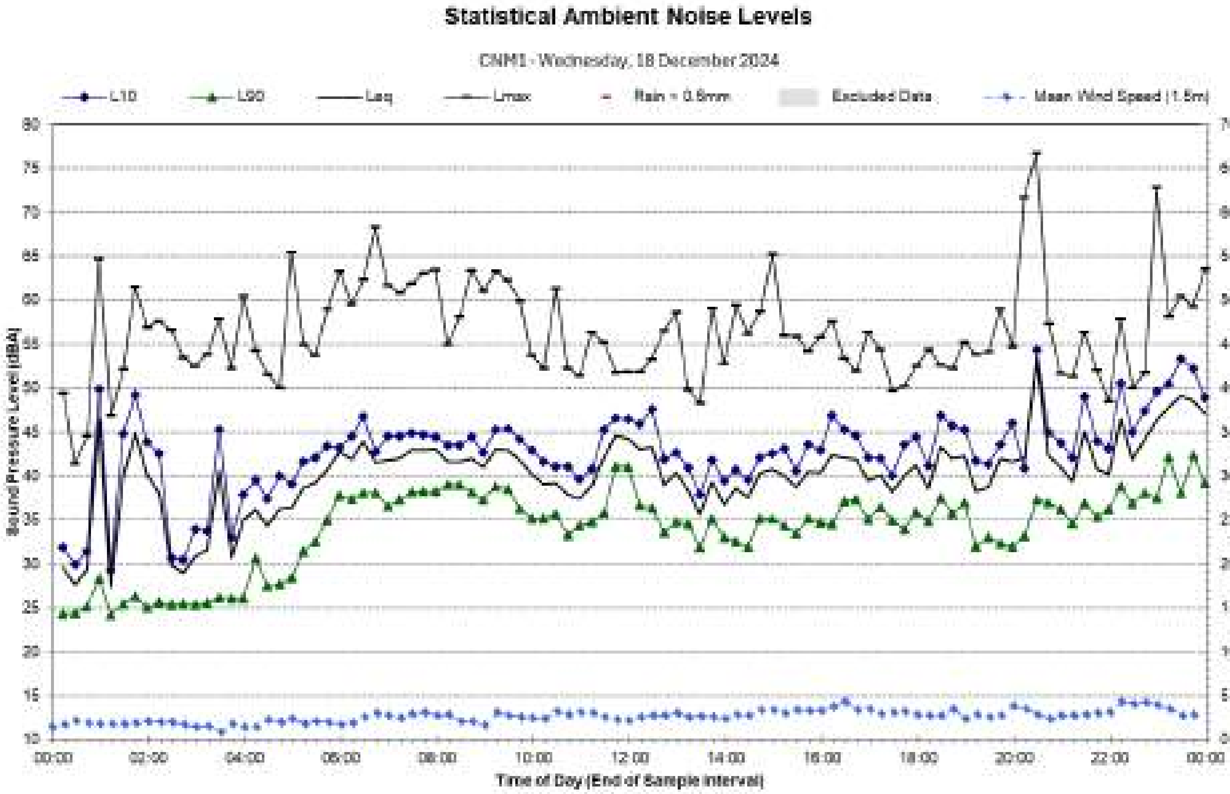
Clarence Colliery Pty Ltd

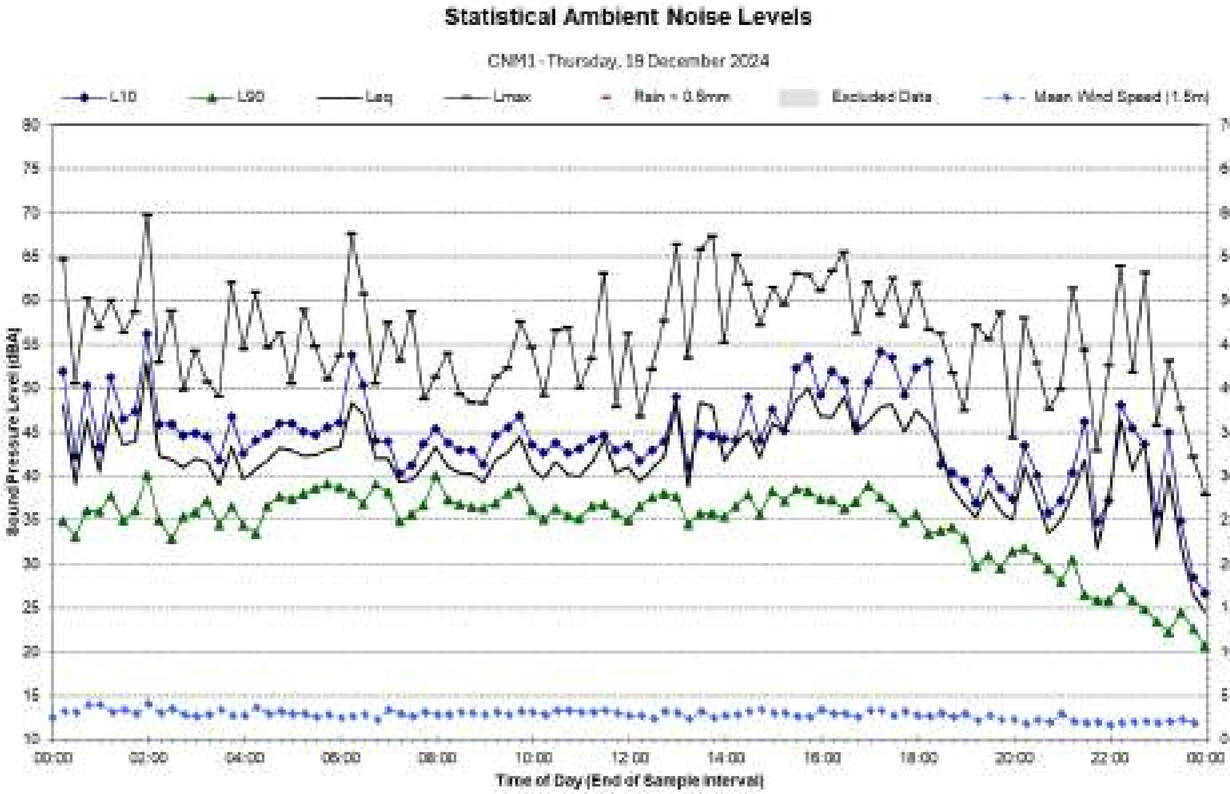
SLR Project No.: 630.19245

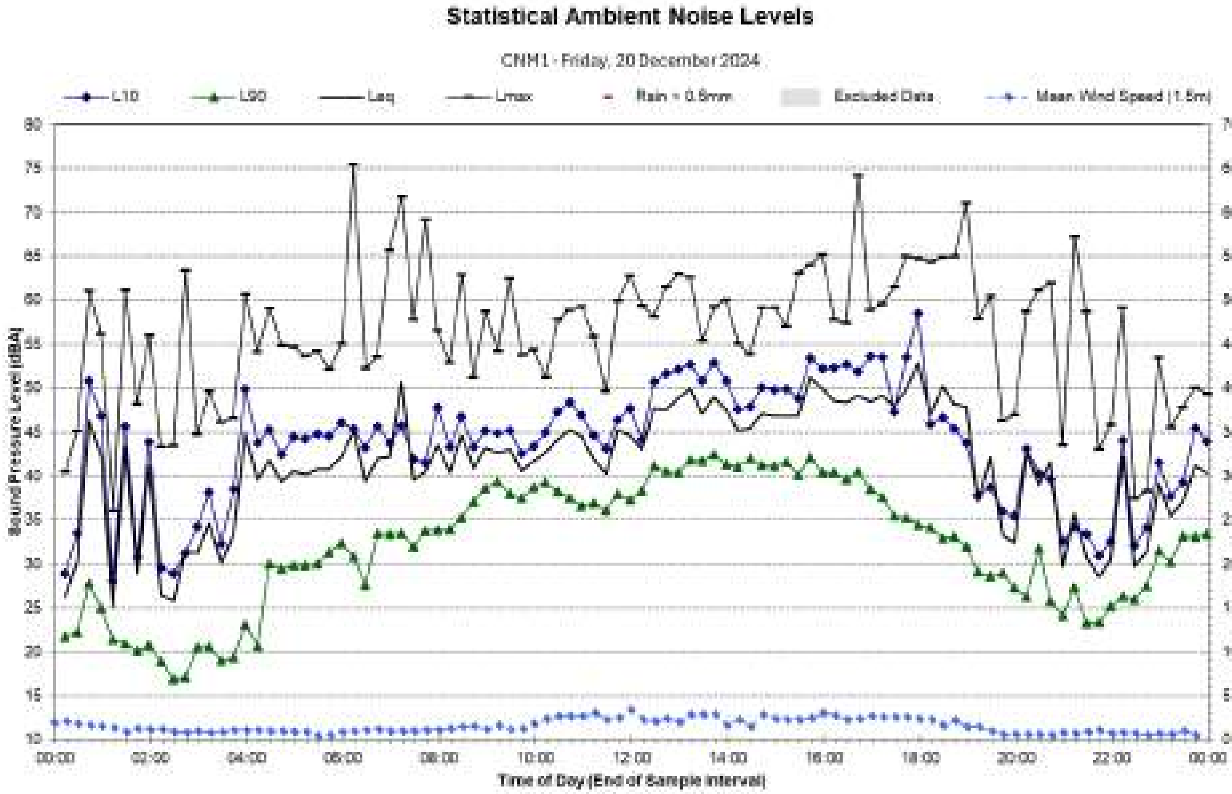
21 January 2025

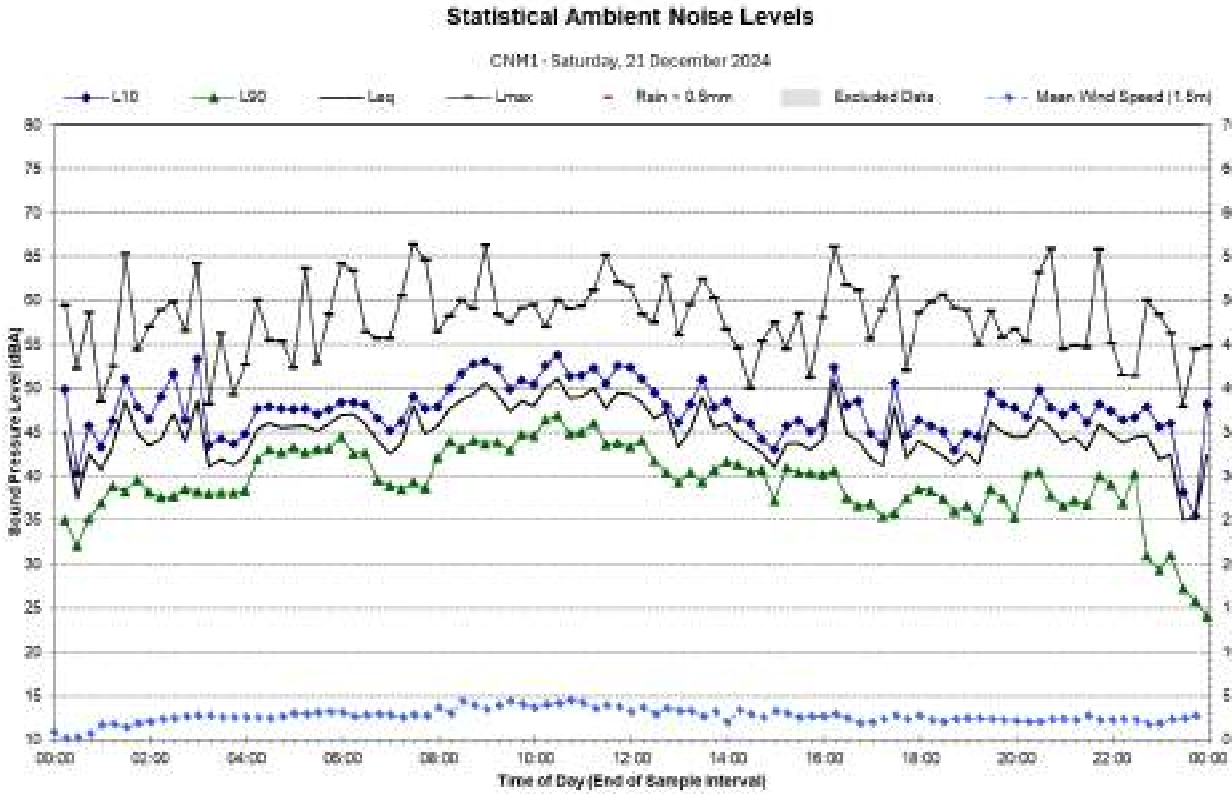

Statistical Ambient Noise Levels
CNM1 - Monday, 16 December 2024
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

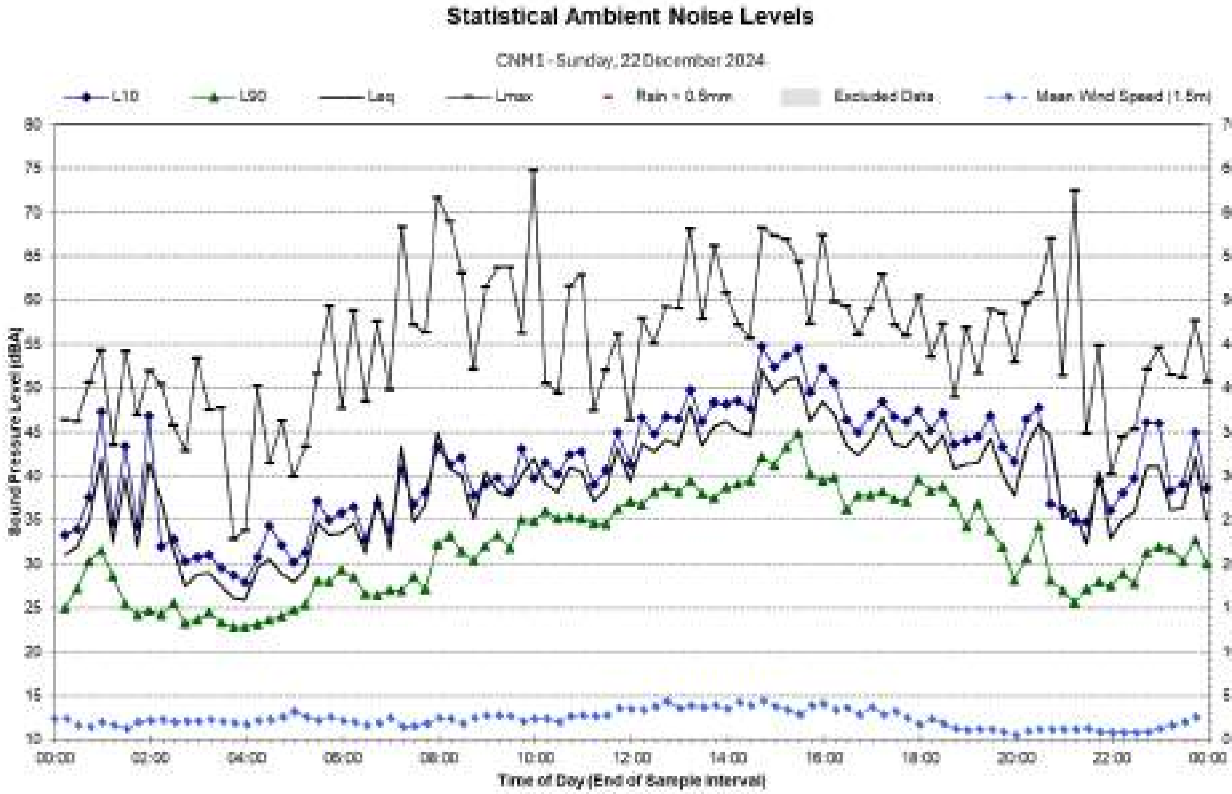

Statistical Ambient Noise Levels
CNM1 - Tuesday, 17 December 2024
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

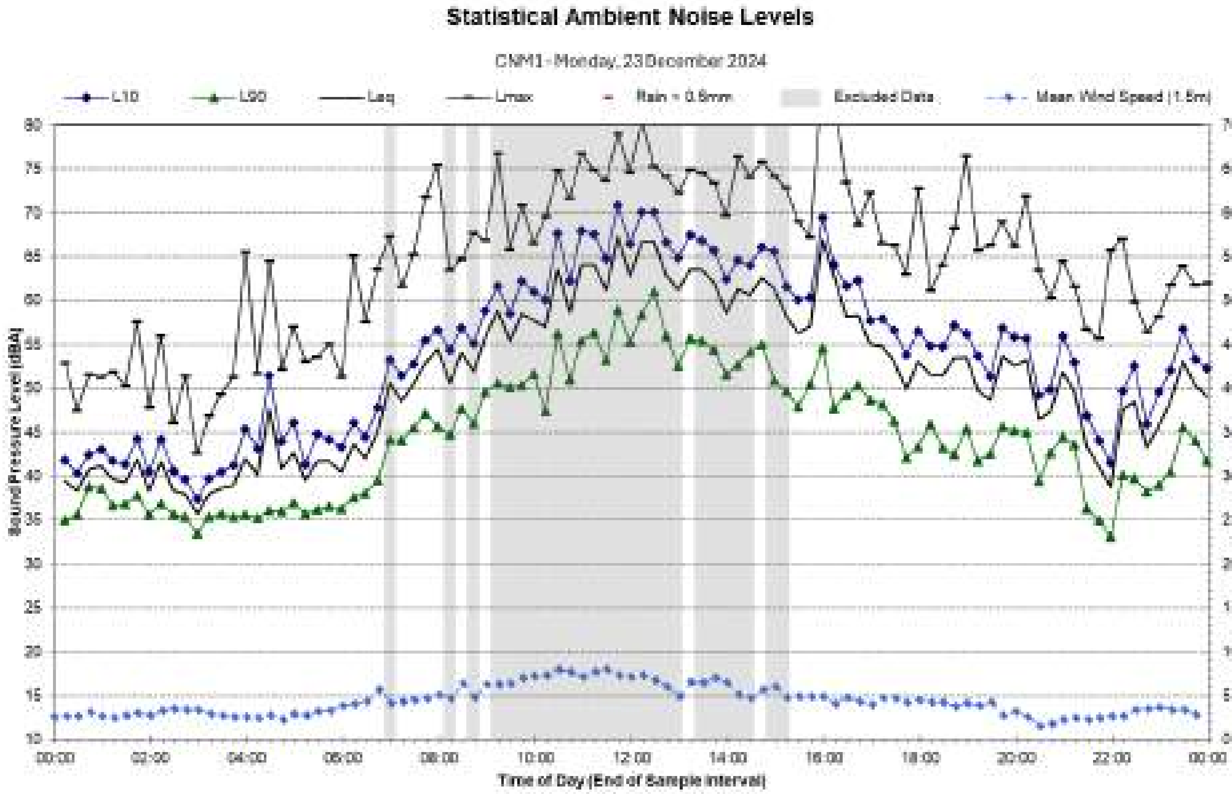

Statistical Ambient Noise Levels
CNM1 - Wednesday, 18 December 2024
L10
L90
Leq
Lmax
Rain > 0.6mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

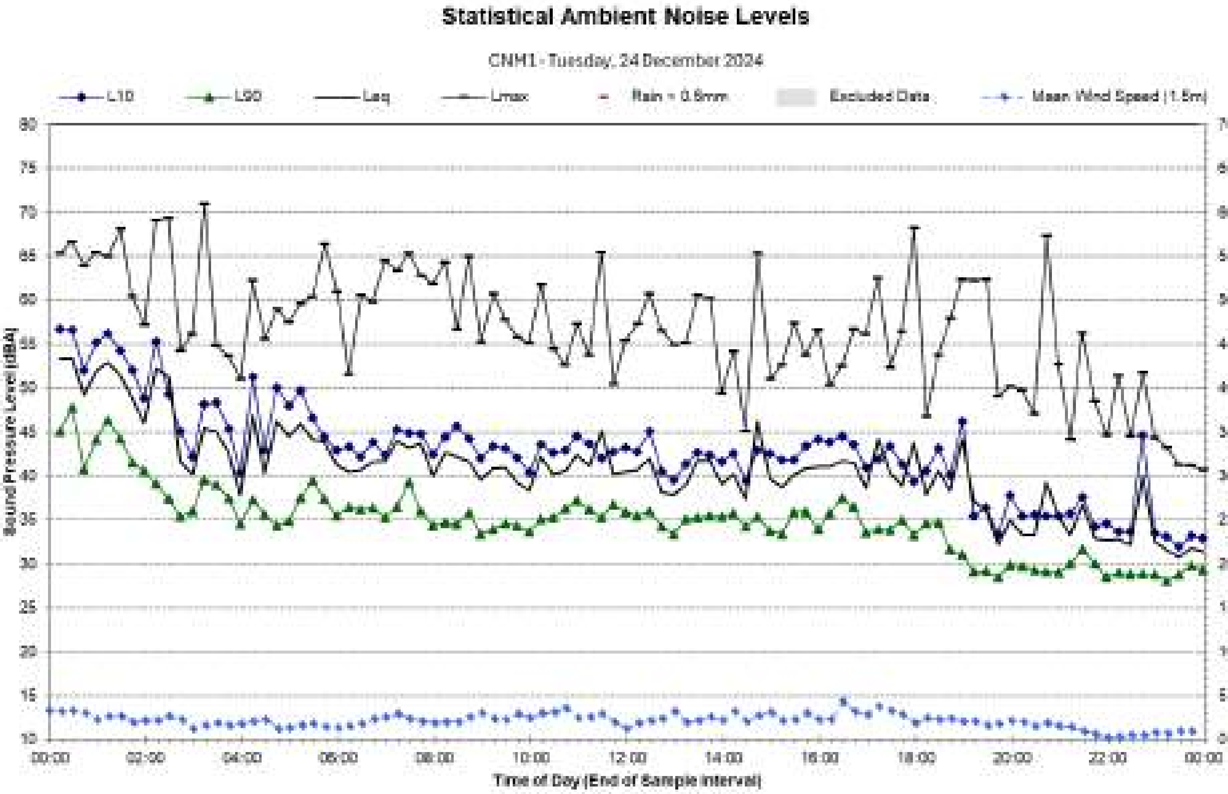

Statistical Ambient Noise Levels
CNM1 - Thursday, 19 December 2024
L10
L90
Leq
Lmax
Rain > 0.6mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

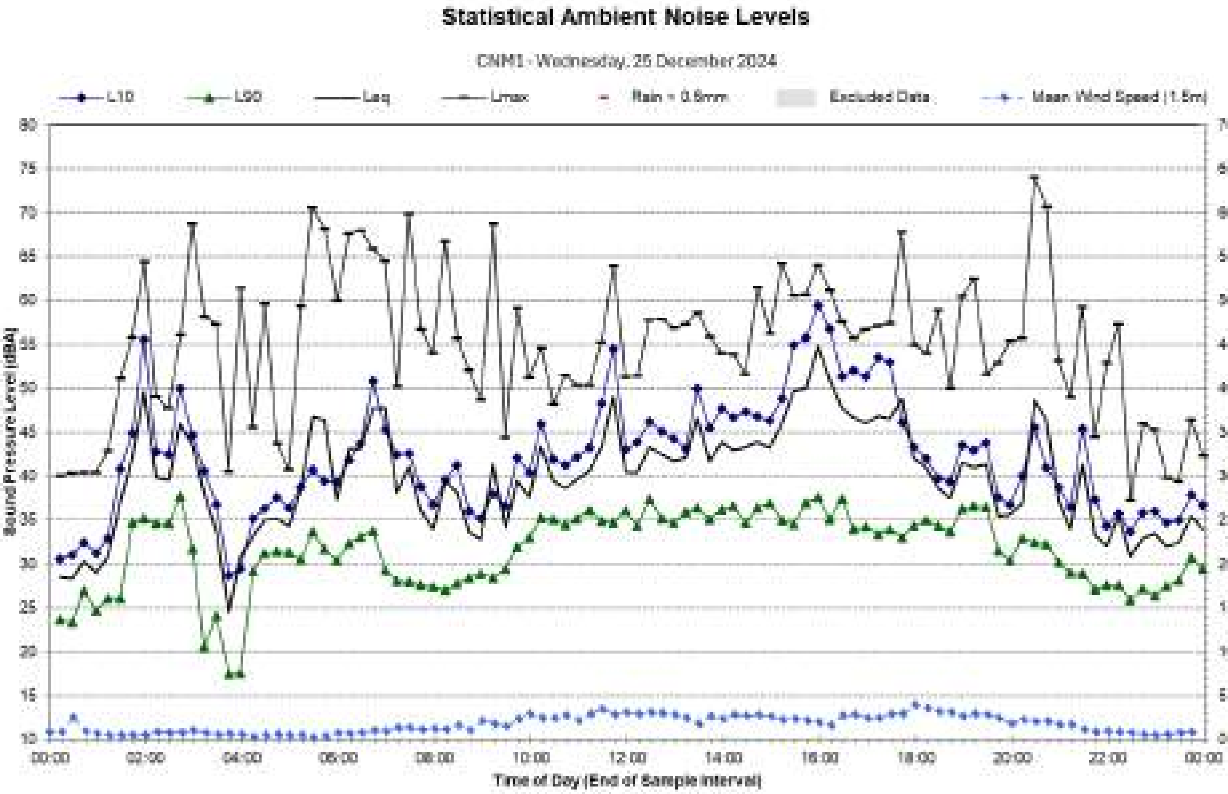

Statistical Ambient Noise Levels
CNM1 - Friday, 20 December 2024
L10
L90
Leq
Lmax
Rain > 0.6mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

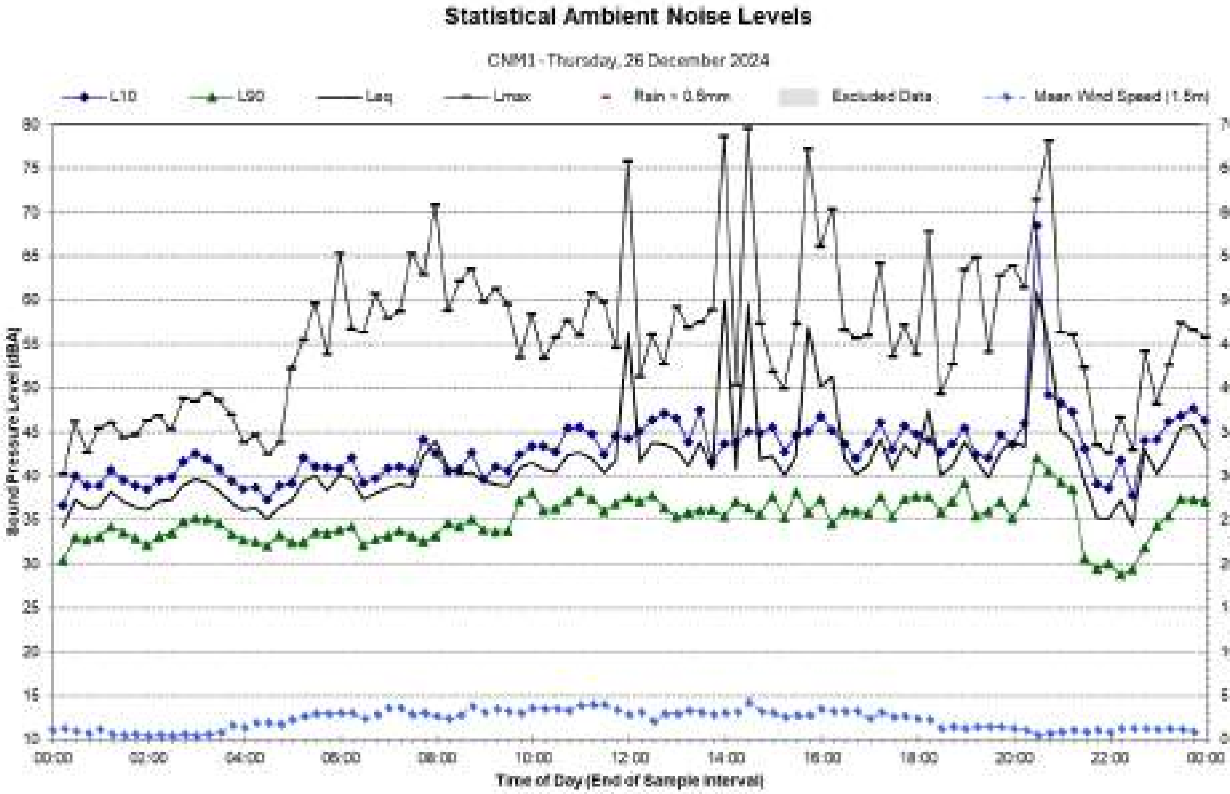

Statistical Ambient Noise Levels
CNM1 - Saturday, 21 December 2024
L10
L90
Leq
Lmax
Rain > 0.6mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

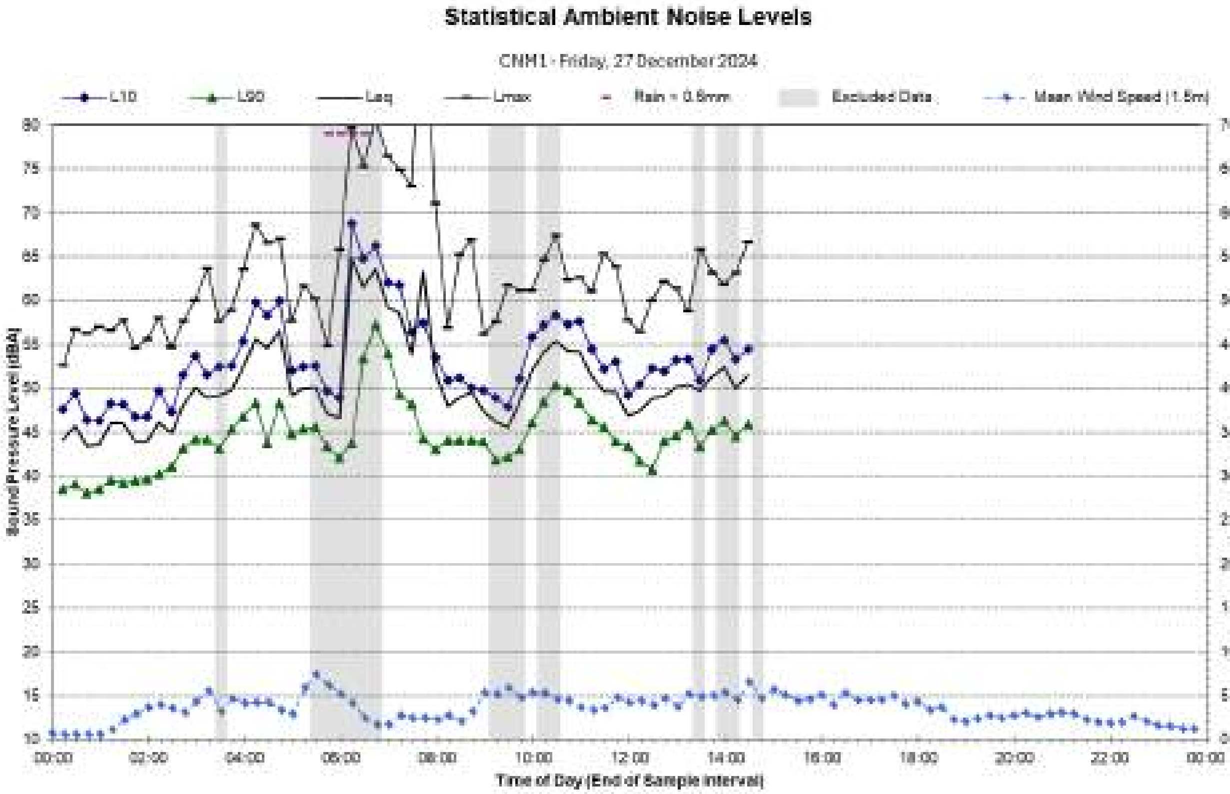

Statistical Ambient Noise Levels
CNM1 - Sunday, 22 December 2024
L10
L90
Leq
Lmax
Rain > 0.8mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
CNM1 - Monday, 23 December 2024
L10
L90
Leq
Lmax
Rain > 0.8mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
CNM1 - Tuesday, 24 December 2024
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
CNM1 - Wednesday, 25 December 2024
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
CNM1 - Thursday, 26 December 2024
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
CNM1 - Friday, 27 December 2024
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Making Sustainability Happen

Appendix 3: Flora Monitoring Reports

Appendix	Report Name
Appendix 3	Flora Monitoring Program - Annual Report 2024 (EcoResolve Pty Ltd, 2024)

EcoResolve

Environment & Design

Clarence Quadrat Monitoring – 2024 Annual Report

Clarence Colliery, Newnes Plateau, NSW

Prepared for: Matt Ribas – Environment and Community Coordinator
Centennial Clarence
E: matt.ribas@centennialcoal.com.au

Prepared by: **EcoResolve Pty Ltd**
Arne Bishop - Ecology Director
M: 0401 630 475
E: arne@ecoresolve.com.au

Date: **06 February 2025**

Project no: **ER211**

Document Control

Version - date	Purpose	Authors	Reviewer	Approved by
V1 – 06/03/2025	Draft for Client review	Alyce Dowling	Patrick McEvoy	Arne Bishop

Disclaimer

This report is not intended to be a comprehensive source of information and should not be interpreted as constituting legal advice. EcoResolve Pty Ltd (EcoResolve) will not be liable in respect of any business losses, including without limitation loss of or damage, damage to profits, income, revenue, use, production, anticipated savings, business, contracts, commercial opportunities, or goodwill.

This report is supplied for the sole and specific purpose for use by the client who engaged EcoResolve, and it is not intended for third party use. If a Third Party uses or relies on the facts, content, opinions or subject matter contained in this report, EcoResolve disclaims all risk from any loss, damage, claim or liability arising directly or indirectly, and incurred by any third party, from the use of or reliance on this report.

Details and experience of author/s and contributors

Name	BAM Assessor Accreditation no.	Position/Role	Tasks performed	Relevant qualifications
Arne Bishop	BAAS 17065	Ecology Director Accredited Assessor	Field surveys, document review.	BEnvSc
Brea Heidke	BAAS 24058	Ecologist / Team Lead	Field surveys.	MEnvMgt, BEnvScMgt.
Toneya Smith	-	Field Ecologist	Field surveys.	B.Sc. (Marine Science)
Lucy Dunton		Field Ecologist	Field surveys.	BEnvSc
Alyce Dowling	-	Field Ecologist	Field surveys, data management, report preparation.	Ph.D (Agroecology) B. Adv. Sci. (Hons Ecology)
Stephanie Nieto Cordoba	-	Field Ecologist	Field surveys.	B. Zoology
Simon Danielsen		Senior Ecologist, Astrebla Ecology	Field surveys.	B.Sc(Australian Environmental Studies)

Contents

1.0 INTRODUCTION

This report describes flora monitoring at sites within the Clarence Colliery lease. Six broad areas are now subject to monitoring: Clarence East (Eastern SMP area), Clarence West (also known as the '700 area'), Outbye, 800 Area, 900 Area, and Pagoda Swamp.

Background

The flora monitoring program commenced at Clarence Colliery in July 2004. Initially, eight sites supporting heath and pagoda complex vegetation were included: six at Clarence East and two at Clarence West. Clarence East includes areas to the north and east of the Clarence Pit Top, in the catchment of the Bungleboori and Wollangambe Creeks while Clarence West is located to the north-west of the Clarence Pit Top.. The monitoring sites are in the catchments of Farmers Creek or upper Bungleboori Creek. Mining within the Clarence Eastern SMP area was completed in February 2009 but remains ongoing in the Clarence West SMP area.

Subsequently, sites in the Outbye area which stretches across Bungleboori Creek about 3 km south-east of Mount Horne were added to the program. In 2009, eight sites were added in the Clarence 800 Area located in the section of Newnes State Forest adjacent to Blue Mountains National Park. Another three sites are located along tributaries of Paddys Creek. A new site was established in February 2021 in Pagoda Swamp, which is located to the south of Waratah Ridge, south-west of Mount Horne.

During 2016, Gingra Ecological Surveys recommenced monitoring swamp sites in the Clarence East and Clarence West areas. These swamps were monitored by the University of Queensland between 2008 and 2013. In 2024 EcoResolve took over the monitoring project.

In 2023 mining occurred in the 800 Area beneath areas to the east of Olearia Swamp, and in the Bungleboori Creek area near the northern end of Paddys Swamp.

Sites

This report provides information on monitoring undertaken in summer, autumn and spring 2024. Locations of the sites and their sampling dates are provided in Table 1. Sites are grouped according to their location and vegetation community type. Figure 1 shows the location of sites within the Newnes Plateau.

Table 1. Locations of Flora Survey Sites

Site	Location	Vegetation Community	Type	Easting (GDA)	Northing (GDA)	Survey Date		
1. Clarence East and West Heath and Pagoda Sites						**Summer**	**Autumn**	**Spring**
PAG_01	Gorilla Rock	Pagoda	Impact	246753	6300035	05/03/2024	14/05/2024	20/11/2024
PAG_02	Gorilla Rock	Pagoda	Impact	246755	6299924	06/03/2024	14/05/2024	20/11/2024
PAG_03	Waratah East	Pagoda	Impact	247251	6300707	05/03/2024	14/05/2024	20/11/2024
PAG_04	Waratah East	Pagoda	Impact	246938	6300784	05/03/2024	14/05/2024	25/11/2024
PAG_05	Waratah North	Pagoda	Control	247962	6303960	04/03/2024	14/05/2024	18/11/2024
PAG_06	Waratah North	Pagoda	Control	247888	6303910	04/03/2024	14/05/2024	18/11/2024
CLW_01	Heath	Heath	Impact	241774	6295584	06/03/2024	15/05/2024	18/11/2024
CLW_06	Paddys Creek Ridge	Heath	Control	240472	6299171	DNS	16/05/2024	21/11/2024
2. Clarence East and West Swamp Sites						**Summer**	**Autumn**	**Spring**
BNS_01	Bungleboori North Swamp	Swamp	Impact	245582	6302273	05/03/2024	15/05/2024	19/11/2024
BNS_02	Bungleboori North Swamp	Swamp	Impact	246290	6303633	05/03/2024	14/05/2024	19/11/2024
CLW_02	Swamp	Swamp	Impact	242596	6295527	06/03/2024	16/05/2024	21/11/2024
CLW_03	Happy Valley Swamp	Swamp	Impact	241923	6296954	06/03/2024	16/05/2024	24/11/2024
CLW_04	Hanging swamp	Swamp	Impact	241904	6298016	DNS	16/05/2024	24/11/2024
CLW_05	Pine Swamp	Swamp	Control	240804	6300186	DNS	16/05/2024	21/11/2024
3. Clarence Outbye						**Summer**	**Autumn**	**Spring**
CLAO_01	S of Bungleboori Creek	Heath	Impact	245023	6297763	06/03/2024	16/05/2024	25/11/2024
CLAO_02	S of Bungleboori Creek	Heath	Impact	245092	6297707	06/03/2024	16/05/2024	25/11/2024
CLAO_03	N of Bungleboori Creek	Heath	Impact	245504	6298627	05/03/2024	16/05/2024	20/11/2024

CLAO_04	N of Bungleboori Creek	Heath	Impact	245294	6299168	04/03/2024	16/05/2024	20/11/2024
4. Clarence 800 Area						**Summer**	**Autumn**	**Spring**
CLAE_01	Gully N of Dumbano Fire Trail dam	Heath	Impact	248971	6295894	06/03/2024	15/05/2024	26/11/2024
CLAE_02	Heath ridge	Heath	Impact	247495	6295216	06/03/2024	13/05/2024	25/11/2024
CLAE_03	Heath ridge	Heath	Impact	247271	6295388	07/03/2024	13/05/2024	26/11/2024
CLAE_04	Secret Swamp	Swamp	Impact	247203	6296462	06/03/2024	15/05/2024	26/11/2024
CLAE_05	Secret Swamp	Swamp	Impact	247159	6296404	06/03/2024	15/05/2024	26/11/2024
CLAE_06	Olearia Swamp	Swamp	Impact	247648	6296165	06/03/2024	DNS	26/11/2024
CLAE_07	Olearia Swamp	Swamp	Impact	247701	6296288	06/03/2024	DNS	26/11/2024
CLAE_08	Olearia Swamp	Swamp	Impact	247789	6296830	07/03/2024	15/05/2024	27/11/2024
5. Clarence 900 Area						**Summer**	**Autumn**	**Spring**
PSB_01	Paddys Swamp Branch	Swamp	Impact	241338	6298523	05/03/2024	15/05/2024	21/11/2024
PSB_02	Paddys Swamp Branch	Swamp	Impact	241404	6298617	05/03/2024	16/05/2024	21/11/2024
PS_03	Paddys Swamp (lower)	Swamp	Impact	241822	6299156	05/03/2024	16/05/2024	21/11/2024
6. Pagoda Swamp						**Summer**	**Autumn**	**Spring**
PAS_01	Pagoda Swamp	Swamp	Impact	242878	6300496	05/03/2024	16/05/2024	19/11/2024

Figure 1. *Location of sites within the Newnes Plateau*

Bushfire

The entire study area was burnt during the Gospers Mountain bushfire in November and December 2019. Most sites experienced very high intensity fire, but fire intensity at a small number of plots was lower with small areas of shrubs and ground cover plants remaining unburnt. Plots with some unburnt patches included PAG_01, PAG_03, PAG_05, CLAO_01, CLAO_03 and CLAO_04.

Another high intensity bush fire, known as the State Mine Fire, burnt through the study area in October 2013. Vegetation across the study area was showing clear signs of recovery by November 2019, although in many places the tree canopy had not returned to the height and extent of September 2013.

The State Mine Fire burnt above-ground vegetation with only very localised and patchy, shallow peat consumption within monitored swamps. In contrast, the Gospers Mountain bushfire caused deep peat consumption and subsequent sediment movement at some swamps, which was particularly evident at plot CLAE_08.

Weather

Above average rainfall was recorded between February 2020 and December 2022. Total rainfall over the 2020-21 summer was somewhat above average and wet weather continued into March 2021 when 193 mm was recorded at Lithgow. April 2021 was the driest April in the last 40 years and May rainfall was slightly below the long-term average. Winter and early spring rainfall in 2021 was about average. November 2021 had the highest rainfall recorded in Lithgow for that month since records began. January 2022 was also very wet whilst December and February were close to average. March 2022 rainfall was the wettest for that month in over 30 years and July 2022 also saw very high rainfall. By the end of November, the total rainfall at Lithgow had exceeded the previous annual total record. Rainfall in summer 2022-23 was average with a wetter than average January and a dry February. Rainfall for 2023 was slightly below average. Rainfall for summer 2023/24 average, rainfall in autumn 2024 was far above average and rainfall for spring 2024 was average.

EcoResolve

2.0 SURVEY METHODS

Permanently marked 20 m x 20 m (400 m^2) quadrats have been established at each monitoring site. The sites are sampled three times each year (in summer, autumn and spring).

Monitoring surveys involve recording vegetation structure, dominant species, estimated cover and height for each stratum, full floristics, estimated cover abundance for each species using a modified Braun-Blanquet scale (Table 2) and condition ranking for plant species using a five-point scale (Table 3). Observations of general condition of vegetation in less sensitive forest and woodland habitats are also recorded, where relevant, as are fauna sightings.

Table 2. Modified Braun-Blanquet scale used for quadrat monitoring

Score	Description
1	cover of less than 5% of site and rare
2	cover of less than 5% of site and uncommon
3	cover of less than 5% of site and common
4	cover of 5–20% of site
5	cover of 20–50% of site
6	cover of 50–75% of site
7	cover of greater than 75% of site

Table 3. Vegetation condition scale used for quadrat monitoring

Score	Description
1	severe damage/dieback
2	Significant damage/many dead stems
3	some dead branches
4	minor damage
5	healthy

3.0 RESULTS

3.1. Clarence East and West heath and pagoda sites

Plant Condition

Most of the species across the seven heath and pagoda sites in Clarence East and West were in a healthy condition (Table 4).

Table 4. Vegetation condition (% of species) at the Clarence East and West heath and pagoda sites during 2024

Site	Season	Healthy (% of spp)	Minor-some damage (% of spp)	Significant-severe damage/dieback (% of spp)
PAG_01	Summer	100.0	0.0	0.0
	Autumn	94.6	2.7	2.7
	Spring	100.0	0.0	0.0
PAG_02	Summer	100.0	0.0	0.0
	Autumn	93.5	3.2	3.2
	Spring	97.0	3.0	0.0
PAG_03	Summer	100.0	0.0	0.0
	Autumn	90.5	9.5	0.0
	Spring	96.4	3.6	0.0
PAG_04	Summer	96.4	3.6	0.0
	Autumn	92.6	7.4	0.0
	Spring	95.5	2.3	2.3
PAG_05	Summer	92.3	0.0	7.7
	Autumn	88.9	3.7	7.4
	Spring	93.5	3.2	3.2
PAG_06	Summer	83.3	6.7	6.7
	Autumn	87.1	6.5	9.7
	Spring	88.2	8.8	2.9
CLW_01	Summer	40.7	59.3	0.0
	Autumn	70.0	23.3	6.7
	Spring	97.6	2.4	0.0
CLW_06	Autumn	96.7	3.3	0.0
	Spring	97.8	6.5	2.2

Only three sites had > 10% of species with some level of damage at any time during 2024; PAG_05 in autumn, PAG_06 at all three survey times, and CLW_01 in summer and autumn. The reduced plant condition at PAG_05 and CLW_01 does not appear to be a cause for concern; by the spring survey the percentage of healthy species had increased to above 90% at these sites, with a minimal proportion of species suffering either minor-some damage or significant-severe damage (<5%).

The condition of species at PAG_06, however, does appear to warrant continued attention. At all three survey times across 2024, >10% of species were recorded as having some damage, with an average of 7.3% species suffering minor-some damage and 6.4% suffering significant-severe damage/dieback over the year. In all three 2024 surveys *Leptospermum arachanoides* was recorded as having minor damage, while *Banksia pencillata* was recorded as having severe damage/dieback. *Allocasurina distyla* was recorded as having severe damage/dieback in summer and autumn, with all mature individuals recorded as dead in spring. However, healthy *A. distyla* juveniles were recorded in spring, with a coverage score of <5% and common, suggesting natural regrowth from the seedbank under favourable rainfall conditions.

Exotic Species

Only one of the seven heath sites in the Clarence East and West areas recorded an exotic species. At PAG_02 an exotic grass was recorded as rare in the spring survey. This is a slight increase from 2023, when no exotic species were recorded at any of the sites. Exotic species do not appear to be an issue at the Clarence East and West heath and pagoda sites.

Species Richness

The species richness of the seven heath and pagoda sites in Clarence East and West generally followed a seasonal pattern with a peak in Spring and reductions in Summer and Autumn (Figure 2).

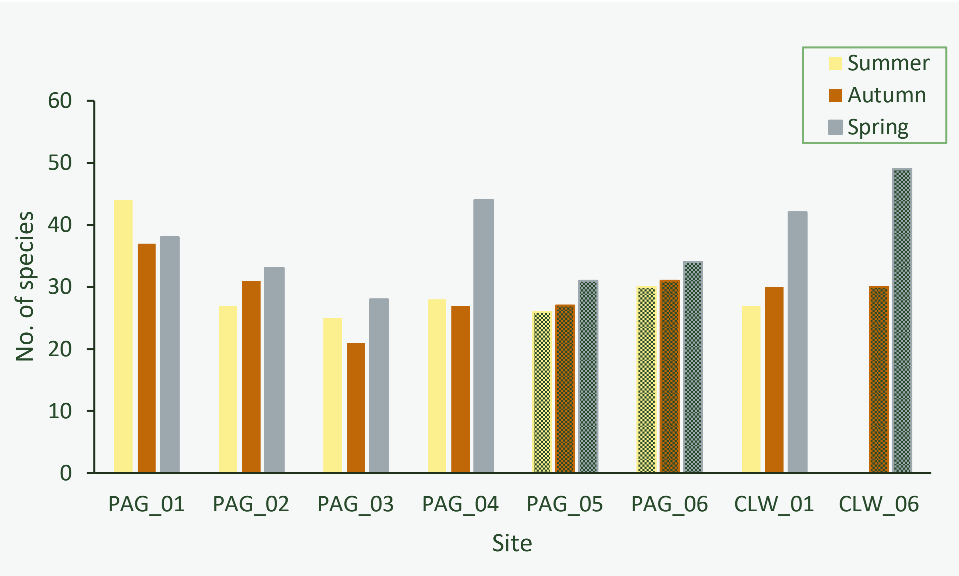


***Figure 2**. Species richness at the Clarence East and West heath and pagoda sites in 2024. Solid fill indicates an impact site, patterned fill indicates a control site.*

There does not appear to be any large difference in species richness between the control and impact sites during any season. The exception to this is the higher number of species recorded at impact site PAG_01 in summer (44 species) compared to that at control sites PAG_05 and PAG_06 (26 and 30 species, respectively) in the same month. However, the discrepancy between species richness in the control and impact site does not appear to be a cause for concern; the extra species recorded at impact site PAG_01 during the summer are native species and the number of species recorded at each of the sites is similar to previous years.

3.2. Clarence East and West Swamp Sites

Background

CLW_05 and CLW_06 were not surveyed in summer 2024 because they used to be control monitoring plots. However, they're located within the Springvale trigger investigation area for longwall mining which has potential for far greater impacts than the partial extraction they're designed to provide reference for at Clarence. Consequently, they should no longer be used as control plots.

Plant Condition

Vegetation condition at the six swamp sites in Clarence East and West was variable (Table 5). All the sites had >10% of species with some level of damage in at least one season. However, as of the most recent survey (November 2024), vegetation condition had improved so that all sites excluding two (BNS_01 and CLW_05) had >90% of species in a healthy condition.

Table 5. Vegetation condition (% of species) at the Clarence East and West swamp sites during 2024

Site	Season	Healthy (% of spp)	Minor-some damage (% of spp)	Significant-severe damage/dieback (% of spp)
BNS_01	Summer	95.0	0.0	5.0
	Autumn	94.1	0.0	5.9
	Spring	87.5	12.5	0.0
BNS_02	Summer	90.5	7.1	2.4
	Autumn	86.7	0.0	13.3
	Spring	93.8	6.3	0.0
CLW_02	Summer	64.3	35.7	0.0
	Autumn	57.9	42.1	0.0
	Spring	90.9	9.1	0.0
CLW_03	Summer	83.3	14.6	0.0
	Autumn	92.9	0.0	7.1
	Spring	96.7	0.0	0.0
CLW_04	Autumn	85.7	14.3	0.0
	Spring	100.0	0.0	0.0
CLW_05	Autumn	81.4	18.6	0.0
	Spring	65.5	13.8	20.7

Both BNS_01 and CLW_05 (a control site) warrant continued attention. As of November 2024, BNS_01 had 12.5% of species with minor-some damage, while CLW_05 had 13.8% of species with minor-some damage and 20.7% of species with significant-severe damage.

At CLW_05, *Leptospermum grandifolium*, *L. polygalifolium*, *L. obovatum* and *Blechnum nudum* were recorded as having minor-some damage in autumn but significant-severe damage in spring. The large increase in species with severe damage between autumn and spring indicates rapid decline in vegetation condition at this site. Similarly, *Xyris ustulata*, *Lepirodia scariosa*, *Eucalytpus dives* and *E. dalrympliana* were recorded as being healthy in the autumn survey, but as having minor-some damage in the spring survey.

Further, at both BNS_01 and CLW_05 non-swamp species were recorded. At BNS_01, *Baeckea linifolia*, which typically grows in drier heath environments, was recorded as being in a healthy condition and covering 5–20% of the site. At CLW_05, *Hakea dactyloides* and *Hakea laevipes*, both heath species, were recorded as common and in healthy condition in autumn. The presence and vigour of these non-swamp species, combined with the worsening swamp species' condition indicates drying and a decline in overall swamp health at these sites.

Exotic Species

At least one exotic species was recorded in five of the six swamp monitoring plots in the Clarence East and West areas during 2024.

At BNS_02 *Hypochaeris radicata* (Catsear) was recorded as uncommon in both the summer and autumn surveys. *Conyza* sp. (Fleabane) was recorded as uncommon in the summer survey, increasing to common in autumn. However, neither of these two species were recorded in spring.

At CLW_02 *Conyza* sp. was recorded as rare in both the summer and autumn surveys, but not the spring survey. An Asteraceae weed was recorded as rare in the spring survey. The presence of these three species is an increase from 2023, when no exotics were recorded at this site.

At CLW_03 *Conyza* sp. was recorded as common in the autumn but had decreased to rare by spring. This is an increase from 2023, when Conyza was not recorded at all. *H. radicata* was recorded in the summer survey as uncommon, a hangover presence from the spring of 2023, but had died out by autumn; it was not recorded in either the autumn or spring surveys.

At CLW_04 an exotic weed was recorded as rare in the spring survey, marking a slight increase from 2023 when no exotics were recorded at this site.

At CLW_05 *H. radicata* and *Holcus lanatus* (Yorkshire Fog Grass) were both recorded as common in the autumn survey but had died out by spring; their presence was not recorded in the spring survey. *Conyza* sp was recorded as common in the autumn but had decreased to rare by spring. An Asteraceae weed was recorded as rare in the spring survey. The relatively high disturbance (compared with other swamp sites in the same area) is not unexpected, as CLW_05 lies adjacent to the cleared former pine plantation and has been subject to historic disturbance. The presence of these four exotic species at CLW_05 represents a maintenance of the 2023 status quo.

Species Richness

The species richness of the six swamp sites in Clarence East and West was variable in 2024. Unlike the species richness of the heath and pagoda sites in the same area, the swamp sites did not follow a seasonal pattern (Figure 3).

***Figure 3**. Species richness at the Clarence East and West swamp sites in 2024. Solid fill indicates an impact site, patterned fill indicates a control site.*

3.3

Clarence Outbye

Plant Condition

The vegetation condition of species across the four heath sites in the Clarence Outbye area was variable across 2024 (Table 6). All sites had >10% of species with some level of damage at least once during the year. However, as of the most recent survey November 2024), vegetation condition had improved so that all sites had >90% of species in a healthy condition. Plant health at these sites does not appear to be an issue.

Table 6. Vegetation condition (% of species) at the Clarence Outbye heath sites during 2024

Site	Season	Healthy (% of spp)	Minor-some damage (% of spp)	Significant-severe damage/dieback (% of spp)
CLAO_01	Summer	92.6	7.4	0.0
	Autumn	51.9	48.1	0.0
	Spring	94.4	5.6	0.0
CLAO_02	Summer	57.1	42.9	0.0
	Autumn	65.2	34.8	0.0
	Spring	97.1	2.9	0.0
CLAO_03	Summer	59.3	37.0	3.7
	Autumn	79.2	16.7	4.2
	Spring	97.3	2.7	0.0
CLAO_04	Summer	60.9	39.1	0.0
	Autumn	7 6.0	24.0	0.0
	Spring	94.4	5.6	0.0

Exotic Species

No exotic species were recorded at any of the Clarence Outbye sites in 2024. This is consistent with records from 2023 and earlier.

Species Richness

The species richness of the sites in the Clarence Outbye area (all heath) roughly followed a seasonal pattern in 2024; species richness was similar in summer and autumn and then peaked in spring (Figure 4).

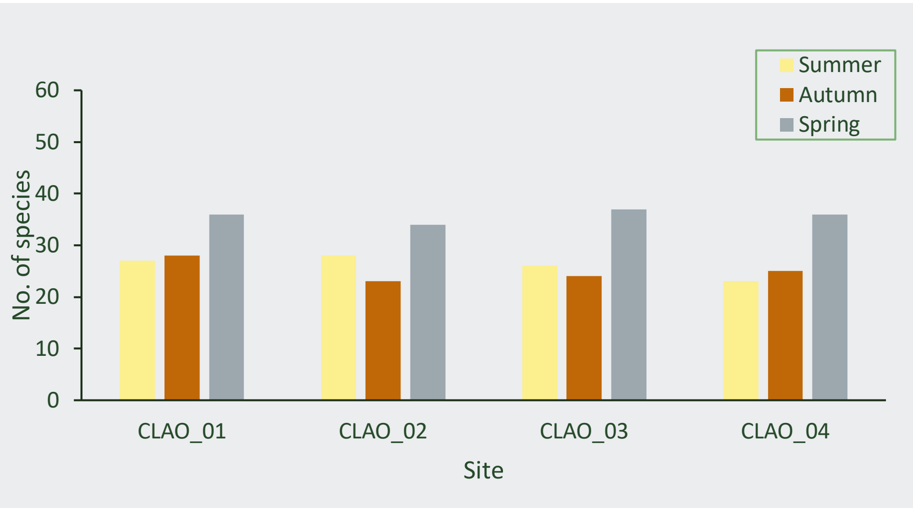


Figure 4*. Species richness at the Clarence Outbye heath sites in 2024. Solid fill indicates an impact site, patterned fill indicates a control site.*

3.4 Clarence 800 Area

Background

In 2023 mining occurred in the 800 Area beneath areas to the east of Olearia Swamp, and in the Bungleboori Creek area near the northern end of Paddys Swamp.

CLAE_06 and CLAE_07 were not surveyed in autumn 2024 as access to these sites was not possible during the survey period.

Plant Condition

The vegetation condition of species across the three heath sites and five swamp sites in the Clarence 800 area was variable across 2024 (Table 7).

Table 7. Vegetation condition (% of species) at the Clarence 800 sites during 2024

Site	Season	Healthy (% of spp)	Minor-some damage (% of spp)	Significant-severe damage/dieback (% of spp)
Heath Sites				
CLAE_01	Summer	100.0	0.0	0.0
	Autumn	97.3	0.0	2.7
	Spring	96.3	1.9	1.9
CLAE_02	Summer	100.0	0.0	0.0
	Autumn	96.8	3.2	0.0
	Spring	94.6	5.4	0.0
CLAE_03	Summer	100.0	0.0	0.0
	Autumn	100.0	0.0	0.0
	Spring	97.7	2.3	0.0
Swamp Sites				
CLAE_04	Summer	93.6	3.2	3.2
	Autumn	96.2	0.0	3.8
	Spring	93.2	6.8	0.0
CLAE_05	Summer	93.3	0.0	6.7
	Autumn	88.5	3.8	7.7
	Spring	90.2	4.9	4.9
CLAE_06	Summer	82.9	17.1	0.0
	Spring	100.0	0.0	0.0
CLAE_07	Summer	88.0	12.0	0.0
	Spring	100.0	0.0	0.0
CLAE_08	Summer	70.4	29.6	0.0
	Autumn	96.8	3.2	0.0
	Spring	96.6	3.4	0.0

Most of the species in the three heath sites were healthy across the three survey seasons, with <10% of species having any level of damage and <5% of species having significant-severe damage. However, at all three heath sites the percentage of healthy plants decreased over the year, albeit only slightly. Given this trend, continued attention to the heath sites in this area is warranted.

Vegetation condition at the five swamp sites was somewhat poorer, with four of the five sites having >10% of species with some level of damage at least once throughout the year. However, as of the most recent survey effort (November 2024), vegetation condition had improved so that all sites (excepting CLAE_05) had >90% of species in a healthy condition. In the November survey 88.1% of species at CLAE_05 were recorded as being in a healthy condition.

At swamp sites CLAE_06, CLAE_07 and CLAE_08, there was a large decrease in the percentage of species with minor-some damage over 2024. Between the summer and spring surveys, the percentage of species with minor-some damage decreased by 17.1%, 12.0% and 25.9%, respectively. At swamp sites CLAE_04 and CLAE_05 there was an increase in the percentage of species with minor-some damage, but a decrease in the percentage of species with significant-severe damage/dieback. This overall trend of improvement in plant health is likely in part due to natural regeneration and improved climactic conditions, but may also be artificially amplified by human error, considering that a different team of ecologists undertook each round of surveys. As such, although plant condition appears to be improving at the Clarence 800 swamp sites continued close monitoring of all the swamp sites is still recommended, particularly given that mining has recently occurred in this area (in 2023). *Eucalyptus mannifera* at CLAE_04 and *Juncus continuus* at CLAE_05 remained in the same damage class (some damage and significant damage, respectively) from the summer survey to the spring survey, suggesting that these species are not naturally regenerating.

Exotic Species

No exotic species were recorded at the three heath sites in the Clarence 800 area. Conversely, of the five swamp sites in the area, three sites had ed at least one exotic species in 2024.

At CLAE_05 *Hypochaeris radicata* was recorded as rare in the spring survey. This weed has been recorded sporadically over the course of the monitoring project. It was recorded as rare in the summer 2023 survey and the autumn 2022 survey.

At CLAE_06 an exotic grass was recorded as rare in the summer survey, the first record of an exotic species since summer 2021 and the third since the beginning of monitoring.

At CLAE_08 *Conyza* sp. was recorded as uncommon in the autumn survey. This represents the first record of an exotic species since summer 2022 when *H. radicata* was recorded as rare.

Species Richness

The species richness of the three heath sites and five swamp sites in the Clarence 800 area roughly followed a seasonal pattern in 2024. At the heath sites (CLAE_01, CLAE_02, and CLAE_03), species richness was similar in summer and autumn and then peaked in spring (Figure 5a). At the swamp sites, species richness was relatively high in summer and decreased in winter, increasing again to peak in spring (Figure 5b).

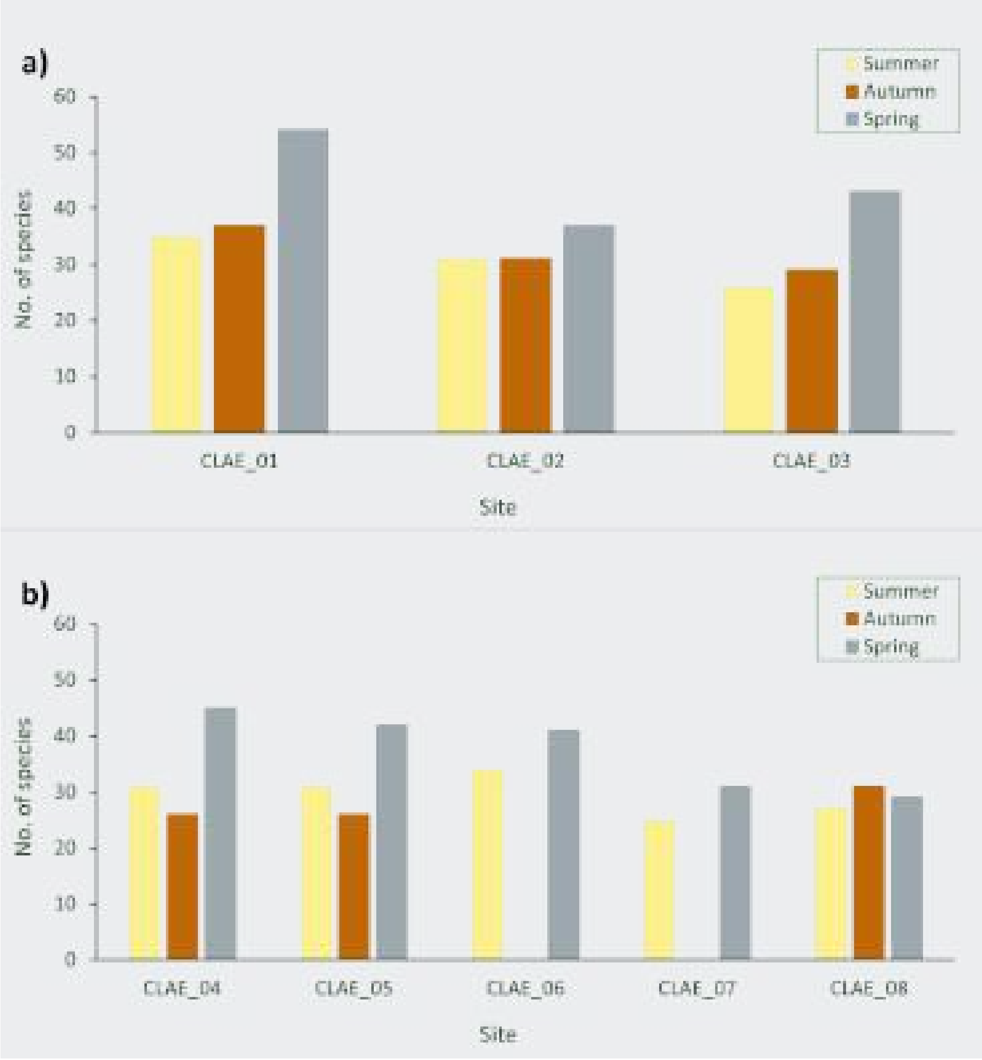


***Figure 5**. Species richness at the Clarence 800 a) heath sites and b) swamp sites in 2024. Solid fill indicates an impact site, patterned fill indicates a control site.*

3.5 Clarence 900 Area

Background

Monitoring of the three sites in the Clarence 900 area began in 2014. All three sites are located along different sections of Paddys Swamp: PSB_01 and PSB_02 in the upper catchment, and PS_03 in the main section. The 900 area was affected by the State Mine Fire and the sites were burnt again in the December 2019 Gospers Mountain fire.

There are a range of human disturbance factors already operating in the vicinity of PSB_01 and PSB_02 in Paddys Swamp upper catchment. This includes drainage works associated with earlier operation of the sand quarry 600 metres to the south, extensive recent clearing of the quarry which is now operational and a trail bike track to the north of PSB_01. Site PS_03, in the main section of Paddys Swamp, is in an area substantially free of past human disturbance, although an old, defunct pipeline passes by the eastern edge of the swamp. Mining has recently taken place near this site.

Plant Condition

Vegetation condition improved throughout 2024 across the three (3) swamp sites in the Clarence 900 area, with a greater percentage of species in a healthy condition in the spring survey compared with the summer survey (Table 8).

Table 8. Vegetation condition (% of species) at the Clarence 900 swamp sites during 2024

Site	Season	Healthy (% of spp)	Minor-some damage (% of spp)	Significant-severe damage/dieback (% of spp)
PSB_01	Summer	56.5	43.5	0.0
	Autumn	71.1	28.9	0.0
	Spring	82.6	13.0	2.2
PSB_02	Summer	78.3	21.7	0.0
	Autumn	76.0	20.0	0.0
	Spring	91.3	8.7	0.0
PS_03	Summer	78.3	21.7	0.0
	Autumn	92.6	0.0	7.4
	Spring	93.9	3.0	0.0

Within this overall trend of improved condition, however, vegetation condition at the three sites was variable. All the sites had >10% of species with some level of damage at least once during the year. As of the spring survey in November >90% of the species at PSB_02 and PS_03 were in a healthy condition, while at PSB_01 plant health remained relatively poor, with >10% of species still with at least some level of damage. Further, at PSB_01 *Leptospermum grandifolium* decreased in condition from minor damage in the summer survey to severe damage/dieback in the spring survey.

The overall trend of improvement in plant health across the 900 area sites is likely in part due to natural regeneration and improved climatic conditions (high spring rainfall), but may also be artificially amplified by human variability, considering that different a different team of ecologists undertook each round of surveys. Combined with the increased damage/dieback of *Leptospermum grandifolium* at PSB_01, continued close monitoring of the Clarence 900 swamp sites is warranted, despite an overall trend of improved plant condition.

Exotic Species

Exotic species were recorded at one out of the three swamp sites in the Clarence 900 Area. At PSB_01 *Hypochaeris radicata, Conyza sp* and an Asteraceae weed were all recorded as rare in the autumn survey. However, by spring, these species appeared to have died out as they were not recorded in the spring 2024 survey. No exotic species were recorded at this site in previous years (since summer 2022).

Species Richness

The species richness of the three swamp sites in the Clarence 900 area was variable in 2024. At PS_03 and PSB_01 species richness was lowest in summer, increased in autumn and then increased again to peak in spring. At PSB_02 species richness was similar across the year, with minimal differences between seasons (Figure 6).

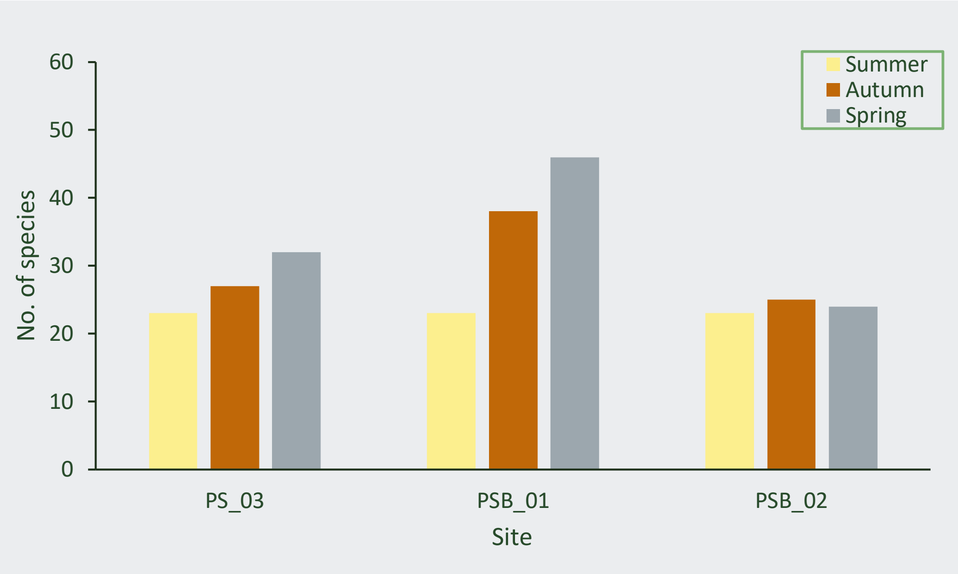


Figure 6*. Species richness at the Clarence 900 sites (all swamp) in 2024. Solid fill indicates an impact site, patterned fill indicates a control site.*

3.6 Pagoda Swamp

Background

PAS_01 was established at Pagoda Swamp in February 2021. During 2021 mining operations occurred to the south of this Swamp, but outside the angle of influence.

Plant condition

The condition of the vegetation at the Pagoda Swamp site (PAS_01) improved over the year (Table 9).

Table 9. Vegetation condition (% of species) at the Clarence Pagoda Swamp site during 2024

Site	Season	Healthy (% of spp)	Minor-some damage (% of spp)	Significant-severe damage/dieback (% of spp)
PAS_01	Summer	83.3	12.5	4.2
	Autumn	96.3	0	3.7
	Spring	100.0	0	0.0

The percentage of species in a healthy condition increased from 83.3% in the summer survey in February to 100% in spring survey in November. Further, the percentage of species with significant-severe damage/die back decreased over the year, from 4.2% in summer to 0% in spring.

Exotic Species

Hypochaeris radicata was recorded as rare at PAS_01 in the summer survey. It was not recorded again in the autumn or spring surveys. In the previous year, 2023, no exotic species were recorded at this site.

Species richness

The species richness at the Clarence Pagoda Swamp site was lowest in summer, increased in autumn and then increased again to peak in spring (Figure 7).

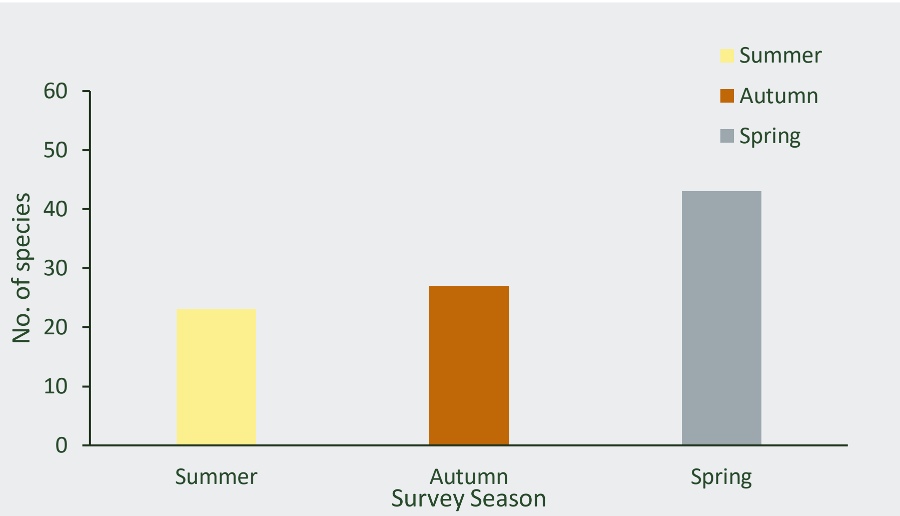


***Figure 7**. Species richness at the Clarence Pagoda Swamp site in 2024.*

4.0 SUMMARY

Overall, heath sites were in good condition while swamp sites were more variable.

Heath Sites

Heath sites had minimal weeds and vegetation damage in 2024. Vegetation condition at the heath sites in the Clarence East and West areas was good, except at PAG_06 where *Leptospermum arachnoides* and *Bankksia pencillata* were recorded as having significant to severe damage in the spring survey. Vegetation condition in the Clarence Outbye area heath sites improved over the year as a response to consistent rainfall. Vegetation condition in the 800 area heath sites decreased slightly over the year but the percentage of species with damage remained under 10% at all three sites in the area. The incidence of exotic species at the heath sites across all areas was sporadic and similar to historic levels.

In summary, the health of the heath sites across the entire monitoring area does not appear to be an issue, excepting at PAG_06.

Swamp Sites

Swamp sites in the Clarence East and West areas were in worse condition than those in the 800, 900 and Pagoda Swamp areas.

In the Clarence East and West areas swamp sites BNS_01 and CLW_05 had worsening condition over the year, with increased damage to several swamp species, as well as an increase in the presence and vigour of non-swamp species from drier environments. At least one exotic species was recorded at five of the six swamp sites in the Clarence East and West areas, with particularly high disturbance at CLW_05.

Overall, vegetation condition at the Clarence 800 area, 900 area, and Pagoda Swamp area swamp sites improved over the year. However, this overall trend masks the decline of some swamp species and general poor condition at specific sites. In the 900 area, although vegetation condition improved at PSB_01, there were still >10% of species with at least some damage as of the November survey. Also at this site, damage in *Leptospermum grandifolium* increased from minor in the summer survey to severe in spring survey. In the 800 area, swamp species *Eucalyptus mannifera* at CLAE_04 and *Juncus continuus* at CLAE_05 remained in a damaged condition over the year. The incidence of exotic species at the 800, 900 and Pagoda Swamp sites was sporadic and similarly rare to historic records.

In summary, the health of the swamp sites across the entire monitoring area was variable, and generally poorer than that of the heath sites. The sites BNS_01, CLW_05, CLAE_04, CLAE_05, and PSB_01 warrant close attention, as continued damage to swamp species and presence of non-swamp species indicates poor swamp health. Although there is no doubt that the Gospers Mountain fire and human disturbance are playing a role in the relatively poor health of these swamp sites, particularly as one of the most disturbed sites, CLW_05, is a control site, there is some indication that undermining may also be contributing. Specifically, the potential for a decrease in groundwater levels and depressurisation of aquifers due to subsidence, which could dry out the swamps. These effects may have been masked by the high rainfall in 2022, but drier conditions (around average rainfall) over 2023 and 2024 have potentially identified some decline. Continued monitoring of all swamp sites across the entire monitoring area will aim to confirm if there is an impact and if so if it is potentially mining related or otherwise.

5.0 RECOMMENDATIONS

5.1 Rationalisation of monitoring program

Clarence is working towards cessation of flora monitoring for the following areas:

- Outbye Area;
- Eastern Area; and
- 700 Area

Dry sclerophyll floristic community environments comprise the majority of habitat types present within the Clarence colliery. These environments are generally not regarded as sensitive to underground mining, except for Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps (hereafter collectively referred to as swamps). Clarence proposes continuation of partial extraction mining methods where subsidence will be limited to c. 100 mm (i.e., 0.1 m). Over the last 20–25 years, Clarence has demonstrated that impacts to dry sclerophyll floristic community environments caused by the partial extraction mining method are negligible, imperceptible and insignificant. Therefore, the rigour with which the monitoring is conducted should be fit for purpose in relation to the scale of the mining related change that is both predicted and observed. Consequently, it is proposed that monitoring of dry sclerophyll floristic community environments should cease and monitoring of swamps should be the primary focus for flora monitoring going forward.

EcoResolve propose that quadrats with condition scores are an outdated and obsolete method for swamp monitoring. EcoResolve propose to transition to the Biodiversity Assessment Method (BAM) for both baseline and future monitoring events. The BAM is not just a cover/abundance monitoring method, and it contains; composition, structure and function data attributes that can be used to indicate change in a much more fine-grained manner. The BAM uses qualitative and quantitative data analysis to demonstrate change in Vegetation Integrity (VI) scores that can be replicated over time. Where possible, monitoring is proposed to take place before and after impact (mining) and between control and impact treatments (e.g., a Before-After-Control-Impact (BACI) designed monitoring program).

These BAM plots should be spatially stratified and included throughout the swamps which are currently being monitored using the obsolete Quadrat Method for a transitional period of one year (three seasons) to ensure a representative measure of baseline condition was achieved for these ecologically sensitive EECs.

The accepted practice of using the BAM to detect VI change is evidenced by its adoption in the *Biodiversity Conservation Trust Ecological Monitoring Module* (BCT 2021) publication. The BCT (2021) recommends using the BAM to monitor for change at Biodiversity Stewardship Sites for the following reasons:

- *the BAM is used to assess biodiversity values for the establishment of BSAs and a related method – Rapid VI (derived from the BAM, applies a coarser estimation method producing categorical data for attributes rather than continuous) – is used by the BCT to assess site values as part of its Conservation Management Program (CMP);*
- *NSW Government continues to invest in the collection and management of data relating to benchmark values for ecological attributes and vegetation types referenced by the BAM; and*
- *the method is consistent with BioNet systematic flora survey method, so can contribute to (and be informed by) the >60,000 plot data set in NSW.*

The recent feedback from the Independent Expert Panel (IEP) with regards to the recent Extraction Plan for 918 & 920 suggested considering an alternative sampling method such as that set out in Brownstein et al., 2014. The Brownstein et al., (2014) monitoring method is a very intensive monitoring program that is being used to detect potential mining-related change at Centennial Coal's Springvale Mine where the mining method is longwall mining with up to 1.29 metres (Centennial, 2024) of subsidence. As aforementioned, at Clarence the mining method is partial extraction, and the subsidence is limited to less than 100 mm (i.e., 0.1 m). Longwall mining and partial extraction are producing vastly different predicted and actual mining related impacts. Consequently, the rigour with which the monitoring is conducted should reflect the scale of the mining related change that is both predicted and observed using these two very different mining techniques.

Rationalisation of monitoring should also take into consideration that the current control sites should be relocated. CLW_05 and CLW_06 are located within the Springvale trigger investigation area for longwall mining which has potential for far greater impacts than the partial extraction they're designed to provide reference for at Clarence. Consequently, they should no longer be used as control plots and new control plots should be installed as part of this proposed rationalisation.

EcoResolve proposes that the above logic is applied to the current monitoring program to remove the requirement of monitoring at the following sites (**Table 5**).

Table 10. Proposed rationalisation of the current monitoring program

Site	Location	Vegetation Community	Type	Easting (GDA)	Northing (GDA)
1. Clarence East and West Heath and Pagoda Sites					
~~PAG_01~~	~~Gorilla Rock~~	~~Pagoda~~	~~Impact~~	~~246753~~	~~6300035~~
~~PAG_02~~	~~Gorilla Rock~~	~~Pagoda~~	~~Impact~~	~~246755~~	~~6299924~~
~~PAG_03~~	~~Waratah East~~	~~Pagoda~~	~~Impact~~	~~247251~~	~~6300707~~
~~PAG_04~~	~~Waratah East~~	~~Pagoda~~	~~Impact~~	~~246938~~	~~6300784~~
~~PAG_05~~	~~Waratah North~~	~~Pagoda~~	~~Control~~	~~247962~~	~~6303960~~
~~PAG_06~~	~~Waratah North~~	~~Pagoda~~	~~Control~~	~~247888~~	~~6303910~~
~~CLW_01~~	~~Heath~~	~~Heath~~	~~Impact~~	~~241774~~	~~6295584~~
~~CLW_06~~	~~Paddys Creek Ridge~~	~~Heath~~	~~Control~~	~~240472~~	~~6299171~~
2. Clarence East and West Swamp Sites					
BNS_01	Bungleboori North Swamp	Swamp	Impact	245582	6302273
BNS_02	Bungleboori North Swamp	Swamp	Impact	246290	6303633
CLW_02	Swamp	Swamp	Impact	242596	6295527
CLW_03	Happy Valley Swamp	Swamp	Impact	241923	6296954
CLW_04	Hanging swamp	Swamp	Impact	241904	6298016
~~CLW_05~~	~~Pine Swamp~~	~~Swamp~~	~~Control~~	~~240804~~	~~6300186~~
3. Clarence Outbye					
~~CLAO_01~~	~~S of Bungleboori Creek~~	~~Heath~~	~~Impact~~	~~245023~~	~~6297763~~
~~CLAO_02~~	~~S of Bungleboori Creek~~	~~Heath~~	~~Impact~~	~~245092~~	~~6297707~~
~~CLAO_03~~	~~N of Bungleboori Creek~~	~~Heath~~	~~Impact~~	~~245504~~	~~6298627~~
~~CLAO_04~~	~~N of Bungleboori Creek~~	~~Heath~~	~~Impact~~	~~245294~~	~~6299168~~
4. Clarence 800 Area					
~~CLAE_01~~	~~Gully N of Dumbano Fire Trail dam~~	~~Heath~~	~~Impact~~	~~248971~~	~~6295894~~
~~CLAE_02~~	~~Heath ridge~~	~~Heath~~	~~Impact~~	~~247495~~	~~6295216~~
~~CLAE_03~~	~~Heath ridge~~	~~Heath~~	~~Impact~~	~~247271~~	~~6295388~~
CLAE_04	Secret Swamp	Swamp	Impact	247203	6296462
CLAE_05	Secret Swamp	Swamp	Impact	247159	6296404

CLAE_06	Olearia Swamp	Swamp	Impact	247648	6296165
CLAE_07	Olearia Swamp	Swamp	Impact	247701	6296288
CLAE_08	Olearia Swamp	Swamp	Impact	247789	6296830
5. Clarence 900 Area					
PSB_01	Paddys Swamp Branch	Swamp	Impact	241338	6298523
PSB_02	Paddys Swamp Branch	Swamp	Impact	241404	6298617
PS_03	Paddys Swamp (lower)	Swamp	Impact	241822	6299156
6. Pagoda Swamp					
PAS_01	Pagoda Swamp	Swamp	Impact	242878	6300496

In addition, it is EcoResolves opinion, that the BAM is a suitable method to monitor the change in VI of Swamps at Clarence. This assertion is based on the facts that; the BAM has been utilised to collect the baseline datasets for newer extraction plans and it's proposed to transition to BAM for other areas where quadrat monitoring is currently taking place, it's widely accepted use in monitoring programs, and the negligible scale of both predicted and previous impacts to Swamps at Clarence.

Appendix 4: Fauna Monitoring Reports

Appendix	Report Name
Appendix 4A	Fauna Report – 900 Area Terrestrial Fauna Monitoring Report (Biodiversity Monitoring Services, 2024a)
Appendix 4B	Fauna Report – Western SMP Application Area Terrestrial Fauna Monitoring Report (Biodiversity Monitoring Services, 2024b)

Biodiversity Monitoring Services

www.biodiversitymonitoring.com.au

Biodiversity Research Pty Ltd

167 McKanes Falls Rd, South Bowenfels, NSW 2790

Telephone: 0421 841 726

Email: andrew.lothian@biodiversitymonitoring.com.au

ABN: 54 617 530 686

Eastern Grey Kangaroo at CLW05

Fauna Report

Western SMP Application Area Terrestrial Fauna Monitoring Report (2024 Final)
for
Clarence Colliery Pty Ltd

Prepared for: Matt Ribas
Prepared by: Biodiversity Monitoring Services
Date: 21 February 2025

Document History

Report	Version	Prepared by	Checked by	Submission Method	Date
Fauna	Issue 1	Alix Bouffet-Halle	Andrew Lothian	email	21 Feb 2025

Biodiversity Research Pty Ltd
trading as Biodiversity Monitoring Services
ACN 617 530 686

167 McKanes Falls Road
South Bowenfels, NSW 2790
E: andrew.lothian@biodiversitymonitoring.com.au

FAUNA MONITORING WITHIN THE WESTERN SMP APPLICATION AREA AT CLARENCE COLLIERY

2024 FINAL

A report by Biodiversity Monitoring Services, February 2025

Table of Contents

www.biodiversitymonitoring.com.au
andrew.lothian@biodiversitymonitoring.com.au

Figures and tables

1.0 Background

Six long-term fauna monitoring sites have been established at Clarence Colliery to identify potential impacts of mining induced subsidence on native fauna within the Western Subsidence Management Plan (SMP) areas. The Western SMP areas now include the existing approved 700 SMP Area plus the proposed 700 West SMP application area. The 700 West SMP application area is an extension of the 700 Area, and an application was submitted for approval in December 2011. For the purposes of this report, the existing 700 SMP Area and the proposed 700 West SMP Area will be collectively known the CLW Area.

The aim of the surveys to date has been to collect terrestrial fauna baseline data within the SMP area to be used to monitor changes (if any) in populations that may occur over time. Information regarding the presence of fauna, species diversity, population numbers and habitat characteristics were also obtained. This is the 19th year of these surveys.

Sites were chosen to ensure sampling of fauna within areas where underground mining (secondary extraction) has occurred (treatment sites), and areas where mining will not occur (control sites). The separation of control and treatment sites will provide comparative data to monitor any effects from underground mining within the CLW Area. The six sites surveyed were:

1) ***CLW01*** Located along the ridge to the east of the start of the (now cleared) pine plantation on Glowworm Tunnel Rd. The site covers the low heath of the pagoda complex and surrounding woodland. This site was affected by both the State Mine and Gospers Mountain fires. This site was undermined in spring 2018 so can now be used as a treatment site. <u>Not sampled in summer 2019</u>.

2) ***CLW02*** Located to the west of Old Bells Line of Rd where the powerline makes its second crossing, before the turnoff to the motorbike park. The site covers the shrub swamp, as well as the surrounding woodland. At the time of the survey there was no ground water in the swamp, though there was water in an old drillers pit. This site was affected by both the State Mine and Gospers Mountain fires. This site is subject to undermining so is considered as a treatment site. <u>Not sampled in spring-summer 2019. Only sampled for two nights/three days in autumn 2022</u>.

3) ***CLW03*** Located to the north of the motorbike park in Happy Valley Springs catchment. The site samples the shrub swamp, as well as the surrounding woodland. The site begins just beyond the big gate installed by Forestry Corporation. This site was affected by both the State Mine and Gospers Mountain fires. Burnt vegetation is recovering well. This site is subject to undermining so is considered as a treatment site. <u>Not sampled in spring-summer 2019</u>. <u>Only sampled for two nights/three days in autumn 2022</u>.

4) ***CLW04*** Located to the north of Old Bells Line of Rd to the south of Clarence 900 Area. The site samples shrub swamp and surrounding woodland. This site was affected by both the State Mine and Gospers Mountain fires. This site is subject to undermining so is considered as a treatment site. <u>Not sampled in spring-summer 2019</u>. <u>Only sampled for two nights/three days in autumn 2022</u>.

5) ***CLW05*** Located to the east of Bungleboori camping area downslope of the (now cleared and burnt) pine plantation. The site samples shrub swamp, as well as the surrounding woodland. Though the swamp has been through periods of drying and wetting over the years, it is currently in a dry state with no water pooling in any part of the site. The site only partially burnt in the 2013 State Mine fire and large patches of Leptospermum shrubs remained unburnt. It burnt in full during the 2019 Gospers Mountain fire. This site entered into the influence of drawdown in December 2018, so will be considered a treatment site from autumn 2019. Not sampled in summer 2019.

6) ***CLW06*** Located on the ridge above the Lithgow water supply valley to the south of the motorbike park and west of Old Bells Line of Rd. The site samples hanging swamp/pagoda community, as well as surrounding woodland. This site was affected by both the State Mine and Gospers Mountain fires. Cages were set back up the track in the closest woodland. This site is subject to undermining so is considered as a treatment site. Not sampled in spring-summer 2019. Only sampled for two nights/three days in autumn 2022.

The Clarence West Area (CLW) is close to the 900 Area, and historically the two 900 sites (A North, B South) have been included as control sites. This is no longer the case, as both have since been undermined in the last few years (August 2022 for B South; April 2023 for A North), making them unsuitable for control sites in the CLW analyses. It is important to note, while both are now considered impact sites in 2023, A North was still considered a control site in 2022. The use of CLW01 and CLW05 as controls has now ceased as late 2018 saw them undermined or under the influence of drawdown as part of Springvale ALA5 Southern Longwall Area. Through previous discussion with Catherine Suggate, Springvale have agreed to monitor two replacement control sites - Nine Mile Swamp and Paddy's Swamp. The results from the on-going monitoring surveys of the two additional sites will complement the data from the existing sites. Details for the two new control sites are as follows:

7) ***Nine Mile Swamp*** Located to the northeast of Bungleboori camping area at the intersections of Nine Mile and Pine Swamps (down swamp of CLW05). The swamp is situated downslope of the (now cleared and burnt) pine plantation to the south and north. This site was affected by both the State Mine and Gospers Mountain fires, though the burn in 2013 could have been part of asset protection by Forestry Corp. The swamp is a good representative of Newnes Plateau Shrub Swamp and is to be used as a control site.

8) ***Paddy's Swamp*** Located at the eastern edge of Springvale Colliery near the Clarence 900 Area. The swamp is surrounded by native woodland. The swamp is surrounded by native woodland. This site was heavily affected by the State Mine and Gospers Mountain fires. Work started on the sand quarry upstream of the swamp in early 2020. The swamp is a good representative of Newnes Plateau Shrub Swamp and is to be used as a control site. Reduced sampling in spring 2022.

Two new sites were added to the Clarence 900 Area in 2024: 900C and 900D. Another two new sites were added to a new Clarence North Area in 2024: Murray's Swamp and Upper Dingo. Details on these sites can be found in the 900 Area Final report[1] and CLN Area Final report[2]. These sites will be added as controls to analyses until such time as they are undermined.

It is important to note that this baseline monitoring program has focussed on the Newnes Plateau Shrub Swamp and Hanging Swamp environments (albeit slightly different types) as they are considered to be the most sensitive habitat overlying the proposed mining area. It is also noted, that by virtue of the fauna monitoring methods, woodland habitats are also surveyed. The locations of the fauna monitoring sites are shown in **Figure 1-1**, with surrounding monitoring sites from Springvale and Clarence Collieries also included. The main roads and creeklines are shown along with the Clarence SMP Area boundary.

All of the sites in the CLW and CL900 Areas burnt in both the 2013 State Mine and 2019 Gospers Mountain fires. According to fire mapping it looks like all sites were burnt around the mid-late December 2019. Maps of the extents from each fire are shown in **Figure 1-2**. No summer surveys were conducted in 2019, with spring 2019 surveys for CLW02, CLW03, CLW04 and CLW06 also cancelled. Data used in the 2019 final report is pre fire, while all 2020 onwards data is post fire. CLW04, CLW05 and Paddy's swamps all had their peat layers almost fully consumed by the 2019 fire. Peat layers at CLW02, CLW03 and Nine Mile were only partially burnt. Most sites exhibited full canopy burn.

Due to the threatening snow conditions and subsequent State Conservation Area closure, sampling effort in autumn 2022 was reduced to two nights at four of the monitoring sites rather than the usual four-night week. Approximately half of the usual sampling effort at sites CLW02/03/04/06 will be missing from the data, so comparative analyses over time should be wary of including the autumn 2022 data. High rainfall through 2022 meant the road to Paddy's swamp became impassable at the time of spring surveys. Physical trapping at Paddy's Swamp was not undertaken, so the restricted sampling effort must be considered when interpreting results for mammals. Bird surveys were undertaken over a reduced number of days (3 instead of 5).

Surveys were first undertaken during spring 2006, and were repeated in autumn, spring and summer thereafter to ensure a complete set of baseline data. The spring 2006 surveys used standardised methodology to establish baseline data for fauna populations to be used for on-going monitoring of the potential impacts from the development of the CLW Area. The methodology used is similar to that applied to long-term fauna monitoring surveys by Centennial Coal throughout Newnes Plateau. Surveys of the two new Springvale controls began in autumn 2018.

Table 1-1 provides information about each site, in terms of landscape characteristics and vegetation communities sampled. Vegetation communities were obtained from the Vegetation of the Western Blue Mountains mapping by Office of Environment and Heritage (OEH). In addition, habitat characteristics were measured at each site and these are provided in Section 4.

[1] BMS (2024). *900 Area Terrestrial Fauna Monitoring Report (Final 2024)* for Clarence Colliery Pty Ltd

[2] BMS (2024). *North Area Terrestrial Fauna Monitoring Report (2024 Final)* for Clarence Colliery Pty Ltd

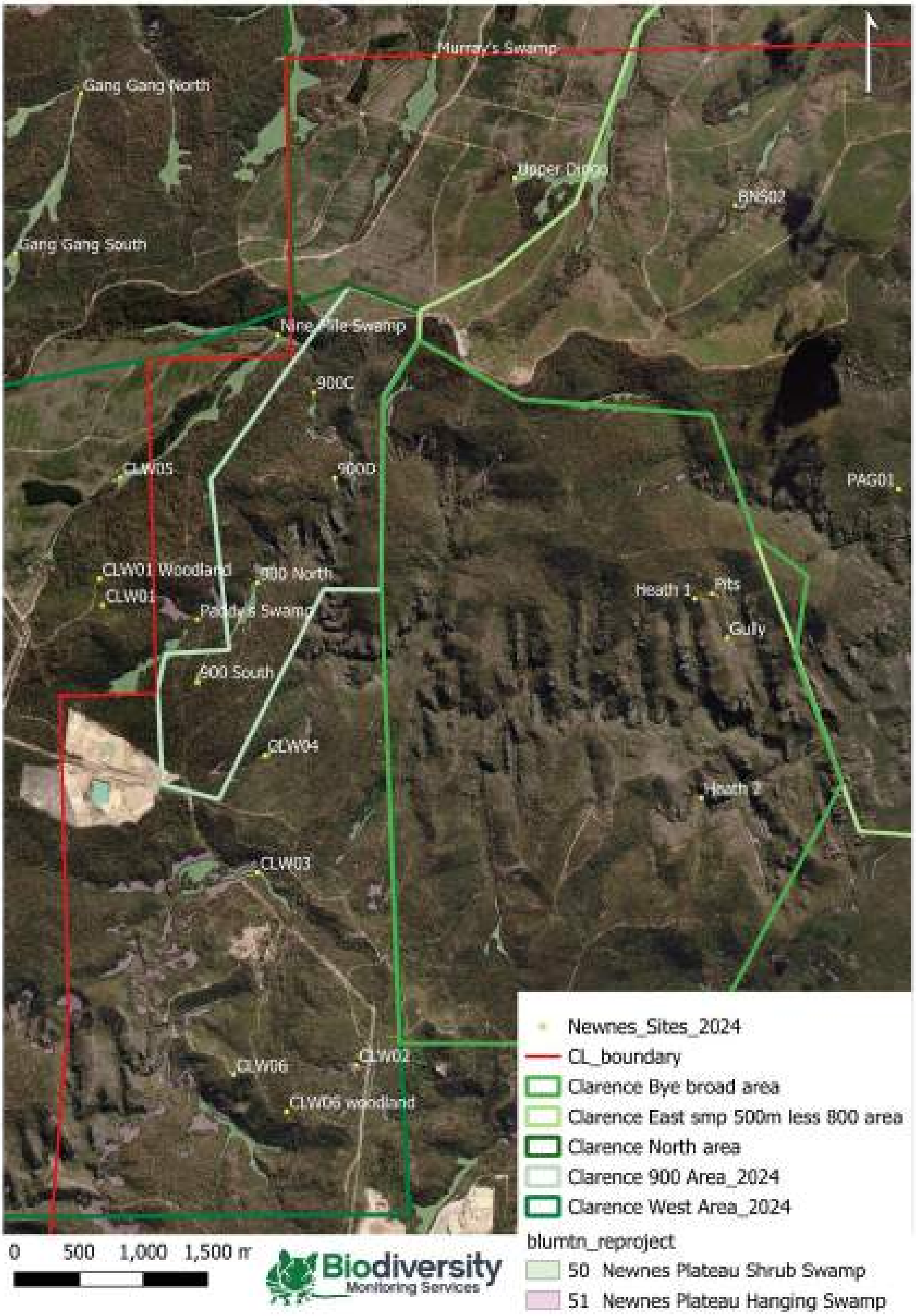


Figure 1-1: Locations of survey monitoring sites

Table 1-1: Locations of the monitoring sites at CLW Area

Site name	Easting	Northing	Landscape	Vegetation	Establishment date	Undermining date
CLW01	240634	6299166	Pagoda heath above steep-sided valley	Newnes Plateau Tea Tree – Banksia – Mallee Heath (high disturbance)	spring 2006	Mid 2018 (extraction)
CLW02	242610	6295587	Heath swamp within shallow-sided valley	Newnes Plateau Hanging Swamp (low disturbance), Newnes Plateau Gum Hollows variant: Brittle Gum – Mountain Gum, Scribbly Gum - Snow Gum Shrubby Open Forest (moderate disturbance)	spring 2006	March 2010 (extraction)
CLW03	241840	6297085	Heath swamp within steep-sided valley	Newnes Plateau Shrub Swamp (moderate disturbance)	spring 2006	Sept 2010 (development), Dec 2010 (extraction)
CLW04	241899	6297998	Heath swamp within steep-sided valley	Newnes Plateau Shrub Swamp (low disturbance), Newnes Plateau Narrow-leaved Peppermint – Silver-top Ash Layered Open Forest (high disturbance)	spring 2006	April 2015 (development), November 2015 (extraction)
CLW05	240772	6300158	Heath swamp within steep-sided valley	Newnes Plateau Shrub Swamp (moderate disturbance)	spring 2006	Dec 2018 (drawdown)
CLW06	241657	6295513	Pagoda heath above steep-sided valley	Newnes Plateau Dwarf Sheoak – Banksia Heath (high disturbance)	spring 2006	March 2011 (development), December 2011 (extraction)
Nine Mile Swamp	242000	6301270	Heath Swamp within steep-sided valley	Newnes Plateau Shrub Swamp (moderate disturbance)	autumn 2018	NA
Paddy's Swamp	241375	6299055	Heath Swamp within steep-sided valley	Newnes Plateau Shrub Swamp (low disturbance)	autumn 2018	NA

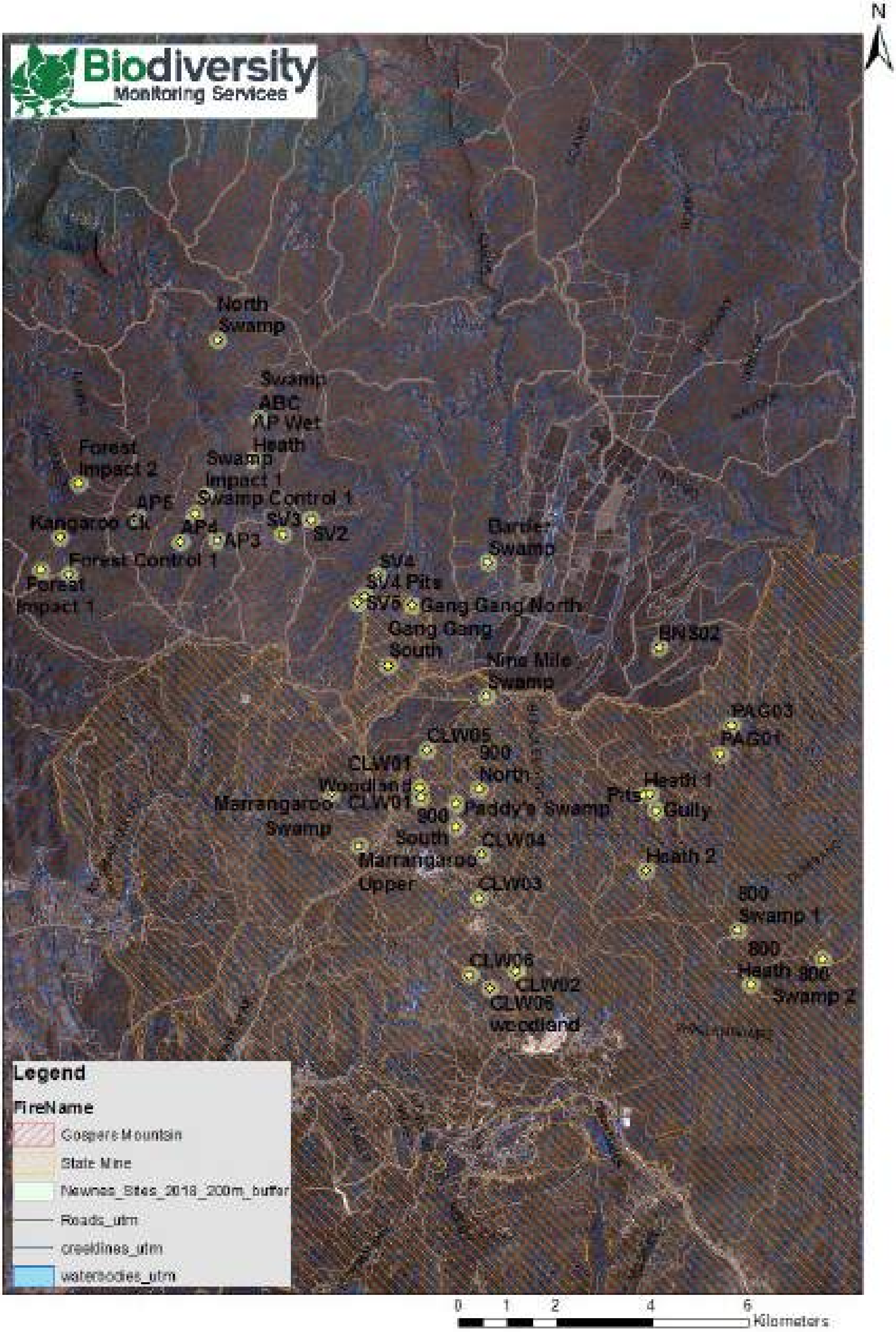


Figure 1-2: Extent of State Mine Fire in 2013 and Gospers Mountain Fire in 2019

2.0 Survey methodologies and survey efforts

The CLW sites were surveyed between the 15th April and 31st May 2024, 19th September and 25th October, and 25th November and 24th December 2024 by Andrew Lothian, Elyse Tomkins, Matt Dobson, Alix Bouffet-Halle and Mikaela Cole using NPWS Scientific Licence No. SL101725 and DPI's Animal Research Authority No. 16/559. Autumn surveys focussed on small mammals (including bats) colonising new areas, reptiles and birds still active. Spring surveys targeted breeding activity by birds. Summer surveys targeted the activity period for reptiles (Blue Mountains Water Skink), bats, amphibians and Giant Dragonfly.

The methodology follows that established during surveys in previous years and other monitoring areas at Clarence, Angus Place and Springvale, to ensure consistency of approach and provide a basis for comparative studies. A summary of the survey effort at each site is given in **Tables 2-1** to **2-2**. A full description of the survey methodologies is provided below and in the BMS methods supplement[3]. The techniques used during the survey followed, as closely as possible, the draft working guidelines produced by DECC (2004)[4]. Although these guidelines are in draft form and still subject to review, they provide an important direction on survey methodology, including suggested survey effort. The survey techniques have remained constant over the years during the surveys undertaken at Newnes Plateau. This will continue into the future to ensure comparative data is obtained. The survey techniques are consistent with methodologies outlined in the *Clarence Colliery Subsidence Management Plan Application – Partial Extraction of Areas 700 West and 800*. Results from 21 years of surveys on Newnes Plateau have shown that little additional information about mammalian fauna is obtained during summer. Hence, summer surveys normally focus on threatened species likely to be active during this season (i.e. Giant Dragonfly and Blue Mountains Water Skink), as well as avifauna (particularly summer migrants), reptiles and amphibians.

Targeted surveys for each of the threatened species known from the locality were undertaken and **Table 2-3** summarises the methods used for each group of species.

***From spring 2023 hair funnels are no longer used due to animal welfare concerns (skinks getting stuck).*

[3] BMS (2017). *Methodologies Supplement (2017)* - Methodologies Used to Conduct Terrestrial Fauna Surveys and Monitoring (2017).

[4] DECC (2004). *Threatened Species Survey & Assessment: Guidelines for Developments and Activities - Working Draft Report*, prepared by DECC.

Table 2-1: Different techniques used during the autumn and spring surveys

Survey technique	CLW01	CLW02	CLW03	CLW04	CLW05	CLW06	Nine Mile	Paddy's Swamp
Ground Elliott traps	25	25	25	25	25	25	25	25
Tree-mounted Elliott traps	5	5	5	5	5	5	5	5
Ground Tomahawk traps	3	3	3	3	3	3	3	3
Tree-mounted Tomahawk traps	3	3	3	3	3	3	3	3
Large Elliott traps	2	2	2	2	2	2	2	2
Glider tubes	2	2	2	2	2	2	2	2
Pit traps	4	4	5	-	3	-	-	3
Remote IR cameras	2	2	2	2	2	2	2	2
Anabat recording	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Call broadcasting	-	-	Yes	-	-	-	Yes	-
Bird counts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Litter searches	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Amphibian searches	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reptile walks	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rock turning	50	150	-	-	-	300	-	-

**Note*: due to lack of vehicle access, these traps were not deployed in spring 2022.*

Table 2-2: Number of trap nights undertaken during autumn and spring surveys

Survey technique	Autumn	Spring	Total
Ground Elliott traps	800	800	1600
Tree-mounted Elliott traps	160	160	320
Tomahawk traps	192	192	384
Large Elliott traps	64	64	128
Glider tubes	64	64	128
Pit traps	76	76	152
Remote IR cameras	64	64	128
Anabat recording	16	16	32
Rock/log turning	500	500	1000
Spotlighting transects	55.2 km; 7.5 hr	65.9 km; 8.5 hr	121.1 km; 16 hr

Table 2-3: Methods used to target threatened species

Fauna group	Targeted survey methodology
Threatened amphibians	Searching preferred habitat, pit trapping, call analysis, reptile funnels
Threatened reptiles	Searching preferred habitat, searching under rocks, pit trapping, reptile funnels, tiles
Threatened diurnal birds	General observation, call recognition
Threatened nocturnal birds	General observation, spotlighting, call broadcasting
Threatened arboreal marsupials	General observation, tree traps, spotlighting, call broadcasting, pit trapping, detection of characteristic sap cuts and scratches on trunks, scat identification
Threatened large ground marsupials	General observation, ground traps, spotlighting, searching for characteristic diggings, recognition of tracks, scat identification
Threatened small ground mammals	Elliott trapping, pit trapping, recognition of tracks
Threatened bats	Ultrasonic call detection (Anabat)
Threatened invertebrates	Searches in preferred habitats

As each Elliott trap was laid, habitat description of the trap site was recorded. This included the upper, middle and lower storey vegetation, as well as the ground cover, within an area formed by a one metre radius around each trap. For example, if 10 trap sites out of a trap line of 25 Elliott traps contained a shrub, then it was estimated that the shrub cover in that survey site was 40%.

AUTUMN AND SPRING SURVEYS

Methodologies used in autumn and spring surveys are as follows:

a. Elliott Trapping

Twenty-five small (8x10x33cm) Elliott traps were laid in straight lines for five days through the habitats at each site. This is equivalent to 100 trap nights over four consecutive nights at each site. The traps were baited with a mixture of rolled oats, peanut butter and devon, and a small piece of Dacron was placed within each trap (as protection against the cold). A freezer bag was placed over the end of each trap to prevent the contents becoming wet from the rain. At each trap site a description of the physical characteristics of the habitat within a one metre radius was noted. This information was used in the analysis of habitat values.

To sample any small arboreal mammals, five small Elliott traps were mounted on trees at equal distances along each transect (20 trap nights over five consecutive days at each site). Aluminium tree mounts were attached to trees and a baited Elliott trap attached to the mount. The tree trunk and trap were sprayed with a honey-water mixture to assist in attracting any nectar or sap feeding arboreal mammals. Again, Dacron and freezer bags were used to combat the cold and wet conditions.

b. Cage Traps

Three Tomahawk cage traps were laid on the ground and three Tomahawk traps were mounted on trees at each site (24 trap nights). Two large Elliott traps were placed at each site (8 trap nights). The large Elliott traps and the Tomahawk traps were baited with apple, muesli bar and devon.

c. Spotlighting

Two forms of spotlighting transect were undertaken. Tracks within the CLW Area were spotlighted from a moving vehicle. In addition, spotlighting on foot was undertaken at the detailed fauna survey sites.

d. Glider Traps

Two vertical plastic tube traps were set up at each site and used as a tree mounted pitfall traps. These have been developed to trap small gliders (Squirrel and Sugar Gliders) and have been used successfully in coastal areas[5].

e. Remote Cameras

Tree mounted remote cameras (Reconyx and Swann) were used at selected sites to capture images of any animal using the area, particularly near the traps.

f. Bird Surveys

In addition to the results obtained from general observations and spotlighting, listening, and observing periods were undertaken at the six sites. Taking into consideration the discussion in the working draft on methods to survey diurnal birds (DECC 2006), an area-search method was used at each site. A 30 minute search was used where the observer walked around each site, as well as observing and

[5] Winning, G. and King, J. 2008. A new trap design for capturing squirrel gliders and sugar gliders. *Australian Mammalogy* **29**: 245-249.

listening for calls from a single point. At each site up to four periods of observation were undertaken (two in the morning and two in the late morning).

g. Call Broadcasting

Calls of several species of nocturnal bird were broadcast during the night in the general area. Calls were broadcast through a megaphone for approximately five minutes, with a ten minute listening time. Calls from the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*), Southern Boobook (*Ninox boobook*), Tawny Frogmouth (*Podargus strigoides*), Eastern Barn Owl (*Tyto javanica*) and the White-throated Nightjar (*Eurostopodus mystacalis*). Koala (*Phascolarctos cinereus*), Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*) and Sugar Glider (*Petaurus breviceps*) were also broadcast.

h. Pitfall Traps

Pit traps were established at CLW01, CLW02, CLW03, CLW05 and Paddy's. The rocky ground associated with the heath at CLW06 and the steep valley around CLW04 prevented pitfalls being constructed in these locations. Nine Mile was flooded in 2021 so pits could not be installed.

i. Herpetological Searches

Systematic searches for reptiles and amphibians were undertaken within each habitat type at each survey site. Litter was raked and rocks and logs turned over. Loose bark was prised from the trunks of dead trees. Each search took approximately 30 minutes and was repeated at each site. Searches for amphibians took place at night using spotlights (particularly after rain) and recognition of characteristic calls. Spotlighting searches were also attempted for reptiles.

j. Bat Call Detection

An Anabat Express ultrasonic bat detector was placed at selected sites for two nights and any recorded bat calls analysed by Andrew Lothian and Glenn Hoye.

k. Animal Track Recognition

Areas of sand on tracks were inspected for evidence of animal movement. Paw prints and other animal signs were identified and recorded.

l. Opportunistic Observations

Any sightings of fauna were recorded whilst moving throughout the CLW Area and located using a Global Positioning System (GPS). Any scats were collected, and their contents analysed.

m. Estimation of Diversity

Because of the accumulation of data under formal survey conditions (consistent survey effort and techniques at each survey site) it is possible to calculate some comparisons and relationships from the results of the survey.

Total numbers and species richness (number of species per site) are the simplest measures used to determine biodiversity of a site. However, these indices miss the information that some species may be rare and others common. The Simpson's Index of Dominance (D) takes into account both the abundance patterns and the species richness of a community. This index measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). It was possible to calculate Simpson's Index of Diversity for mammal, bird and sometimes reptile and amphibian populations from each survey site for most survey periods.

An Evenness score was also calculated. Evenness is a measure of the relative abundance of different species making up the richness of an area. A low value for Evenness means that the sample is dominated by a large number of one or two species. A high Evenness value means that most species in the sample have a similar abundance.

SUMMER SURVEY

An area that included each survey site and a surrounding buffer of about 1km radius was searched over a period of three days for signs of fauna. In particular, searches targeted threatened species such as the Giant Dragonfly and Blue Mountains Water Skink. Both these species are associated with wet areas so the swamps and creeklines were searched at and around each site. Bird surveys were also undertaken. The census period was at least 30 minutes at each site. Spotlighting surveys were also undertaken at each site, mainly on foot using a 50 watt light. Whilst spotlighting each site, calls from nocturnal fauna were also recorded (i.e. frogs, gliders, owls etc.). Of particular interest were threatened species that would be more active during the warm summer period. Fauna results from this summer survey are presented below.

3.0 Weather during the trapping survey

Data from weather station at Lithgow Cooerwull (from Bureau of Meteorology) is given in **Table 3-1**. Total monthly rainfall at Lithgow Cooerwull (from BOM) is graphed against the long-term average in **Figure 3-1**.

Table 3-1: Weather records from Lithgow during 2024 surveys

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)
13/04/2024	3.8	20.7	0
14/04/2024	7.5	21.3	0.2
15/04/2024	3.2	20.9	0
16/04/2024	3.4	21.4	0
17/04/2024	8.0	21.7	0
18/04/2024	10.9	18.8	0
19/04/2024	1.6	14.5	0
18/05/2024	4.4	8.7	0
19/05/2024	-2.0	11.6	0
20/05/2024	-3.4	11.8	0
21/05/2024	-0.1	14.8	0
22/05/2024	0.5	12.0	0.2
23/05/2024	-1.7	16.4	0
24/05/2024	-1.0	16.6	0
25/05/2024	3.0	15.5	0
26/05/2024	4.0	14.5	0
27/05/2024	-0.7	15.5	0
28/05/2024	0.1	18.6	0.2
29/05/2024	-1.6	17.9	0
30/05/2024	-0.1	17.2	0
31/05/2024	10.0	14.3	0
17/09/2024	-2.6	15.2	0
18/09/2024	-2.3	17.8	0
19/09/2024	8.3	19.0	0
20/09/2024	6.0	15.6	0
21/09/2024	7.4	15.0	0
22/09/2024	8.4	17.2	0

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)
23/09/2024	3.3	20.0	0
24/09/2024	2.7	22.8	0
25/09/2024	12.9	21.2	0
26/09/2024	6.2	7.2	10.2
27/09/2024	4.7	10.3	14.8
28/09/2024	6.0	13.3	1.4
29/09/2024	8.5	17.3	0.2
30/09/2024	9.4	18.2	7.2
01/10/2024	4.4	18.6	0
02/10/2024	9.9	15.3	0.4
03/10/2024	7.9	17.2	0
04/10/2024	3.4	19.2	0
19/10/2024	12.0	19.5	0.2
20/10/2024	5.7	21.2	0.4
21/10/2024	8.6	18.7	0
22/10/2024	2.3	24.4	0
23/10/2024	5.1	23.7	0
24/10/2024	8.4	19.9	0
25/10/2024	1.6	16.1	0
23/11/2024	9.8	27.4	0
24/11/2024	10.9	29.8	0
25/11/2024	11.3	31.7	0
26/11/2024	13.8	30.5	0
27/11/2024	12.3	28.4	0
28/11/2024	15.5	25.2	0.4
29/11/2024	14.9	18.6	63.0
30/11/2024	16.0	20.2	21.4
01/12/2024	16.1	24.2	14.8
02/12/2024	12.0	28.8	0.4
03/12/2024	14.6	23.9	0
04/12/2024	17.4	24.5	9.6
05/12/2024	15.4	27.3	0
06/12/2024	16.8	27.4	1.8
07/12/2024	19.0	25.3	15.8
08/12/2024	15.9	26.6	17.8

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)
09/12/2024	12.5	25.2	0
10/12/2024	12.8	25.0	0
11/12/2024	13.0	24.5	0
12/12/2024	7.7	26.5	0
13/12/2024	10.7	27.8	0
14/12/2024	14.9	30.0	0
15/12/2024	14.6	30.7	0
16/12/2024	13.6	31.1	0
17/12/2024	12.8	31.2	0
18/12/2024	12.9	17.7	0.4
19/12/2024	11.1	19.5	0.4
20/12/2024	6.8	26.9	0
21/12/2024	9.9	29.4	0
22/12/2024	15.2	29.4	0
23/12/2004	8.5	19.8	0
24/12/2024	7.0	24.5	0

The extended dry periods of 2018-2019 were broken in 2020 with many months in 2020, 2021 and 2022 showing greater than average rainfall. Overall rainfall in 2024 was above average, with 39.4mm more than the long term average. Monthly rainfall in 2024 was roughly double the long term average in January, April and November (**Figure 3-1**). Rainfall in March, August and October was less than half the long term average while the remaining months were similar to the long term average. Most of NSW has been in rainfall surplus over the last 36 months (**Figure 3-2**), particularly in the central tablelands/western slopes. If we drop this to the last 12-month period, it shows a mix of surplus and deficit over NSW, but average conditions over the central tablelands (**Figure 3-2**).

0.6mm rain fell over the autumn survey period. 34.8mm of rain fell over the spring survey period, predominantly at the end of the second survey week, and the start of the third survey week. There were heavy rainfalls over the summer survey period, with a total of 145.8mm, a large portion of which fell on a single day. This event led to November recording nearly twice the long term average rainfall, while December rainfall was similar to its long-term average (**Figure 3-1**).

Maximum temperatures in summer were about 2°C above the long-term average, while minimum temperatures were about 1.5°C above average. March maximum temperatures were 1.5°C above average, and May minimum temperatures were 1.4°C above average, while other autumn maximum and minimum temperatures were similar to long term averages. September minimum temperatures were 1.1°C above average, while other spring maximum and minimum temperatures were around long term average. A large rainfall event during summer surveys meant frog survey conditions were very good for a short period of time.

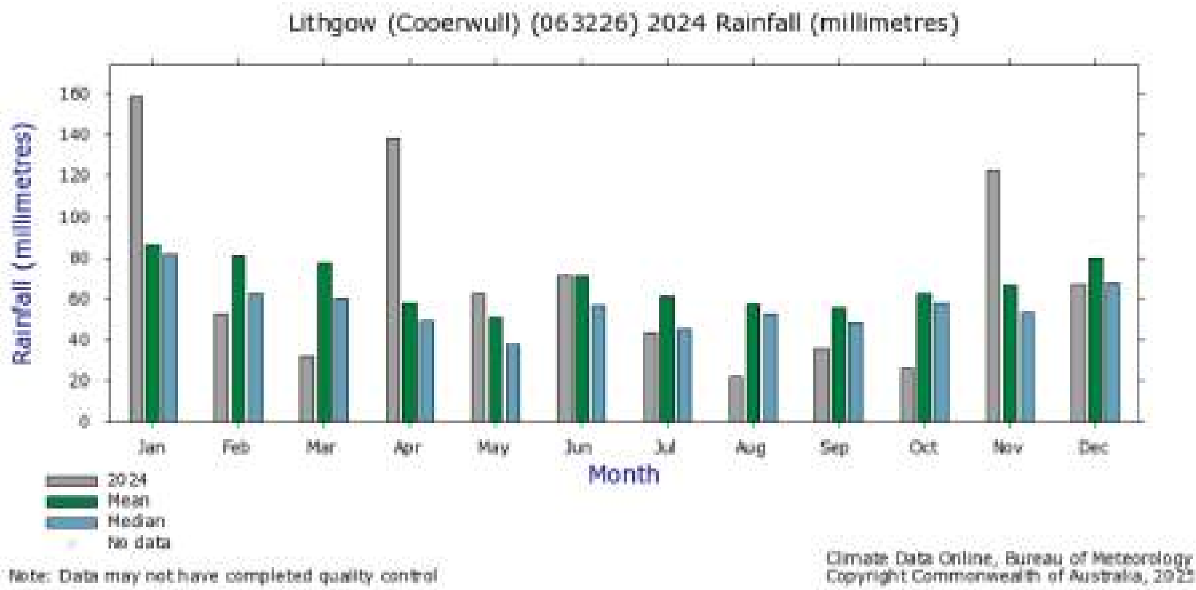


Figure 3-1: Total monthly rainfall in 2024 vs long-term mean monthly rainfall 1994-2024 (BOM, 2025)

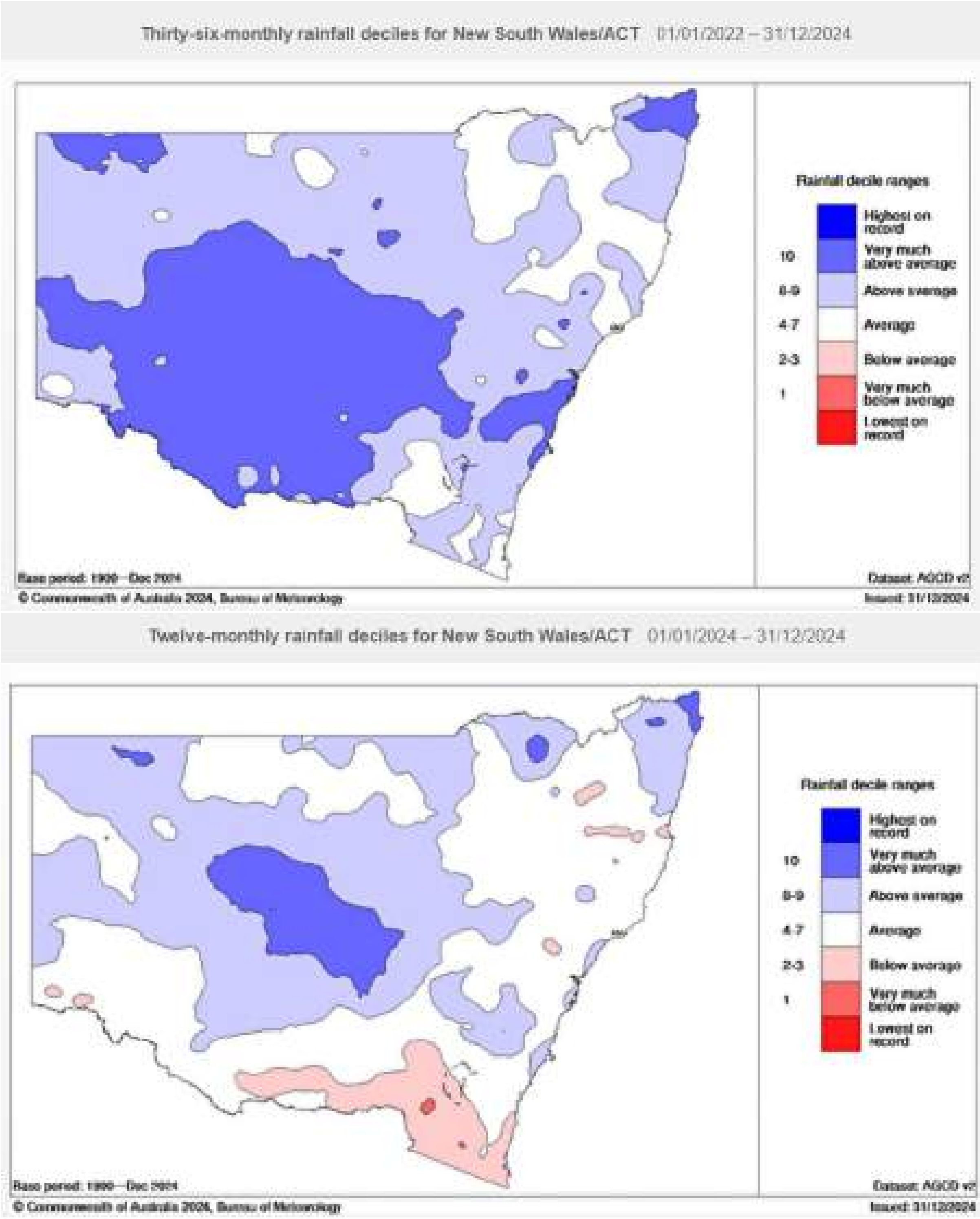


Figure 3-2: 36-month (top) and 12-month (bottom) rainfall deficiency map (BOM, 2025)

4.0 Results - habitat measurement

Measurements from descriptions of each Elliott trap site were used to provide an index of habitat condition. It has been found that the use of walking transects to determine habitat condition in swamp and rocky areas did not provide an accurate picture of habitat characteristics. Consequently, information derived from the trap placement descriptions is now used. **Table 4-1** provides the data obtained from the autumn and spring surveys since 2009. Habitat assessment is illustrated in **Figures 4-1** and **4-2**.

CLW01, CLW02, CLW03, CLW04, CLW05 and CLW06 swamps are now all directly or indirectly affected by drawdown from undermining. Therefore, they can be used as "impact" data for assessing the impacts from mining on swamp habitat. Paddy's, Nine Mile, 900 North and 900 South have previously been used as control sites as they remain outside the influence of potential drawdown. 900 South was undermined in spring 2022, and 900 North was undermined in autumn 2023. As such, these sites will be removed as controls in some of the 2022-23 analyses, but will be retained as additional impact sites. The four new sites started in 2024 (900C, 900D, Murray's Swamp and Upper Dingo Swamp) will be used as control sites until such time as they are undermined.

Two-way Repeated Measures ANOVAs were previously conducted to examine mining impact on habitat characteristics over time. However, due to progressive undermining dates at different sites and recent undermining at both 900 South and 900 North (previous control sites), this analysis can no longer be conducted. As such, statistical analyses of habitat characteristics at just the six CLW sites (CLW01-06) over time were conducted using One-way Repeated Measures ANVOAs (analysis of variance).

Autumn One-way Repeated Measures ANOVAs revealed all except two habitat characteristics (vine and rock cover) differed significantly over time. Tree cover was significantly higher in 2011 compared to 2007 and 2013-22; significantly higher in 2024 compared to 2013-19 and 2021-22; significantly higher in 2010 compared to 2013, 2016-19 and 2022; and significantly higher in 2023 compared to 2019 ($p < 0.001$). Hollow cover was significantly higher in 2023 compared to all years except 2020 ($p < 0.001$). Tall shrub cover was significantly higher in 2010 compared to all years except 2009 & 2013; significantly higher in 2009 compared to 2014-18 and 2020-24; significantly higher in 2013 compared to 2014-17 and 2020-24, significantly higher in 2007 compared to 2014-16 and 2020-23; significantly higher in 2011 compared to 2014-15 and 2020-23; and significantly higher in 2019 compared to 2015, 2020-21 and 2023 ($p < 0.001$). Tall sapling cover was significantly higher in 2023 compared to 2007, 2009, 2011, 2013-14, 2020 and 2024; and significantly higher in 2021-22 compared to 2020 ($p < 0.001$). Low shrub cover was significantly lower in 2020; and significantly lower in 2021 compared to 2007, 2009-10 and 2017-19 ($p < 0.001$). Low sapling cover was significantly higher in 2020-23; significantly higher in 2014-15 and 2024 compared to 2007, 2009-11 and 2013; and significantly higher in 2016-18 compared to 2007 and 2009-10 ($p < 0.001$). Grass cover was significantly higher in 2007, 2009-11, 2021-22 and 2024 compared to 2014-19; and significantly higher in 2013 compared to 2014 and 2016-19 ($p < 0.001$). Fern cover was significantly lower in 2009 compared to 2015 and 2017-19; significantly lower in 2020 compared to 2015, 2017 and 2019; and significantly lower in 2010 compared to 2019 ($p < 0.001$). Forb cover was significantly lower in 2023 compared to 2022 ($p = 0.010$). Cutting grass cover was significantly higher in 2014 and 2024 compared to 2018 and 2020 ($p = 0.024$). Reed cover was significantly lower in 2023 compared to 2013-19 and 2024; significantly lower in 2020 compared to 2014-15, 2017-19 and 2024; and significantly lower in 2021-22 compared to 2018-19 ($p < 0.001$).

Litter cover was significantly lower in 2014 ($p < 0.001$). Log cover was significantly higher in 2020 compared to 2007, 2009-10, 2013-14, 2016-19; and significantly higher in 2023 compared to 2007 and 2019 ($p < 0.001$)

Spring One-way Repeated Measures ANOVAs revealed all except one habitat characteristic (vine cover) differed significantly over time. Tree cover was significantly lower in 2017 and 2019 compared to 2008-10, 2013 and 2023-24 ($p < 0.001$). Hollow cover was significantly higher in 2013 compared to all years except 2023; and 2023 was significantly higher than all other years except 2016 ($p < 0.001$). Tall shrub cover was significantly higher in 2007-11 than most other years except 2019 ($p < 0.001$). Tall sapling cover was significantly higher in 2023 compared to 2014 and 2020 ($p = 0.022$). Low shrub cover was significantly lower in 2013 and 2020 than most other years; and 2020 was lower than 2007-12, 2016-19 and 2023-24 ($p < 0.001$). Low sapling cover was significantly higher in 2020-21 and 2023; and significantly lower in 2007 and 2013 compared to compared to most other years ($p < 0.001$). Grass cover was significantly higher in 2008-10; and significantly lower in 2013-14 and 2016 compared to most other years ($p < 0.001$). Fern cover was significantly lower in 2013 compared to 2014-19; lower in 2010 compared to 2014 and 2016-19; and lower in 2024 compared to 2018 ($p < 0.001$). Forb cover was significantly lower in 2013; lower in 2023 compared to 2010, 2020-22; and lower in 2016 compared to 2010 and 2020 ($p < 0.001$). Cutting grass cover was significantly higher in 2024; and significantly lower in 2007, 2011 and 2013 compared to most other years ($p < 0.001$). Reed cover was significantly lower in 2013 and 2023 compared to other years; and lower in 2020-22 compared to 2014, 2016-19 and 2024 ($p < 0.001$). Litter cover was significantly lower in 2013-14 ($p < 0.001$). Log cover was significantly higher in 2013 and 2020 compared to 2018-19 ($p = 0.001$). Rock cover was significantly higher in 2013 and 2020 compared to 2010 ($p = 0.049$).

Due to step wise changes in sites becoming classed as impact (differing years of undermining), we could not use Two-way Repeated Measures ANOVAs to analyse data by mining impact over the whole 2007-2024 survey period. Statistical analyses testing for potential impacts of undermining were conducted using a series of pooled t-tests. These were conducted on data from 2007 to 2024, and included the six CLW sites (CLW01-06) as well as 900 South and 900 North as undermined (impact) sites, and Nine Mile, Paddy's, plus four new Clarence sites (900C, 900D, Murrays Swamp and Upper Dingo) as control sites.

In autumn, tall shrub, fern and reed covers were significantly lower at undermined sites compared to control sites ($p = 0.001$, $p = 0.002$ and $p = 0.002$ respectively). Conversely, hollow, low sapling, cutting grass and rock covers were significantly lower at control sites ($p = 0.004$, $p = 0.003$, $p = 0.018$ and $p = 0.012$ respectively). Spring analyses supported the autumn results. Tall shrub, fern and reed covers were significantly lower at undermined sites compared to control sites ($p < 0.001$, $p < 0.001$ and $p = 0.010$ respectively). Conversely, hollow, low sapling, cutting grass and rock covers were significantly lower at control sites ($p = 0.002$, $p = 0.002$ and $p = 0.015$ respectively). In a situation where swamps were being drained of water, we would expect to see less sedges (reed) and more trees/saplings. Separating these differences from changes due to fire, or differences due to broad habitat type is complicated. Saplings are sought out for cover after fire, until structural complexity returns to the site. Rock cover is higher in pagoda heath sites, and since both CLW01 and CLW06 are on the impact side of the equation, it is not surprising to have increased rock cover at undermined sites.

The two fires led to obvious declines in shrub, fern and reed covers, with corresponding increases in low sapling, log and rock covers (as trap cover was sought post fire). A number of characteristics showed differing changes in response to the first and second fires (grass, forb, cutting grass and litter), probably demonstrating the limitation of this metric for monitoring change in vegetation over time, or nuances relating to fire intensity/response.

andrew.lothian@biodiversitymonitoring.com.au

Table 4-1: Overall mean habitat characteristics in autumn (A) and spring (S) each year

% Cover	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Tree	29	30	37	33	45	29	21	21	18	30	20	15	19	22	15	23	17	10	13	14
Tree hollow	-	-	-	-	-	-	-	-	-	19	6	5	7	5	6	7	4	3	2	5
Tall shrub	61	67	66	55	35	53	43	45	45	28	5	3	4	5	7	7	16	19	29	27
Tall sapling	15	23	22	31	18	29	23	18	13	15	15	10	23	24	21	17	21	21	22	20
Low shrub	96	95	95	93	85	83	87	85	88	37	80	75	87	79	87	87	91	91	95	92
Low sapling	3	12	3	5	9	6	15	13	13	1	40	41	37	35	31	31	29	29	30	30
Grass	91	95	91	93	85	75	69	75	66	25	33	17	37	31	33	21	36	31	32	33
Fern	6	15	8	1	20	19	20	22	21	0	23	23	29	23	27	25	29	25	42	43
Forb	89	77	86	89	59	65	61	59	64	4	80	72	74	63	67	55	69	75	68	63
Cutting grass	-	-	-	-	14	7	51	61	57	32	79	79	69	78	69	57	64	58	53	58
Reed (sedge)	-	-	-	-	-	-	6	33	42	11	51	52	59	47	44	61	61	61	70	63
Vine	8	8	9	11	16	13	16	16	10	0	2	0	4	4	5	5	7	8	7	10
Litter	100	99	99	100	99	99	100	100	100	83	81	54	94	95	99	100	100	98	100	100
Log	15	11	15	18	17	20	16	13	15	27	15	13	21	11	15	14	15	17	19	13
Rock	11	6	7	4	11	8	11	9	11	22	18	14	13	11	10	15	12	8	9	4

% Cover	2019		2020		2021		2022		2023		2024	
	A	S	A	S	A	A	A	S	A	S	A	S
Tree	10	5	26	26	21	29	18	14	29	37	33	25
Tree hollow	3	1	8	5	6	18	6	4	18	14	2	2
Tall shrub	36	27	0	0	0	2	4	4	2	10	14	19
Tall sapling	24	20	2	10	25	38	29	22	38	32	18	17
Low shrub	84	96	43	59	71	80	84	80	80	91	77	84
Low sapling	24	13	66	76	74	66	61	46	66	58	36	31
Grass	32	32	56	60	67	56	61	57	56	54	66	78
Fern	47	53	18	28	24	25	29	23	25	22	22	34
Forb	62	50	65	85	79	54	86	77	54	51	69	77
Cutting grass	56	51	55	70	70	69	68	54	69	78	74	81
Reed (sedge)	71	62	28	24	32	20	36	35	20	16	63	66
Vine	6	3	0	4	4	8	8	8	8	7	12	14
Litter	100	100	100	100	100	100	100	100	100	100	100	100
Log	14	15	35	30	23	27	20	20	27	21	18	13
Rock	6	1	14	14	7	9	12	14	9	8	8	6

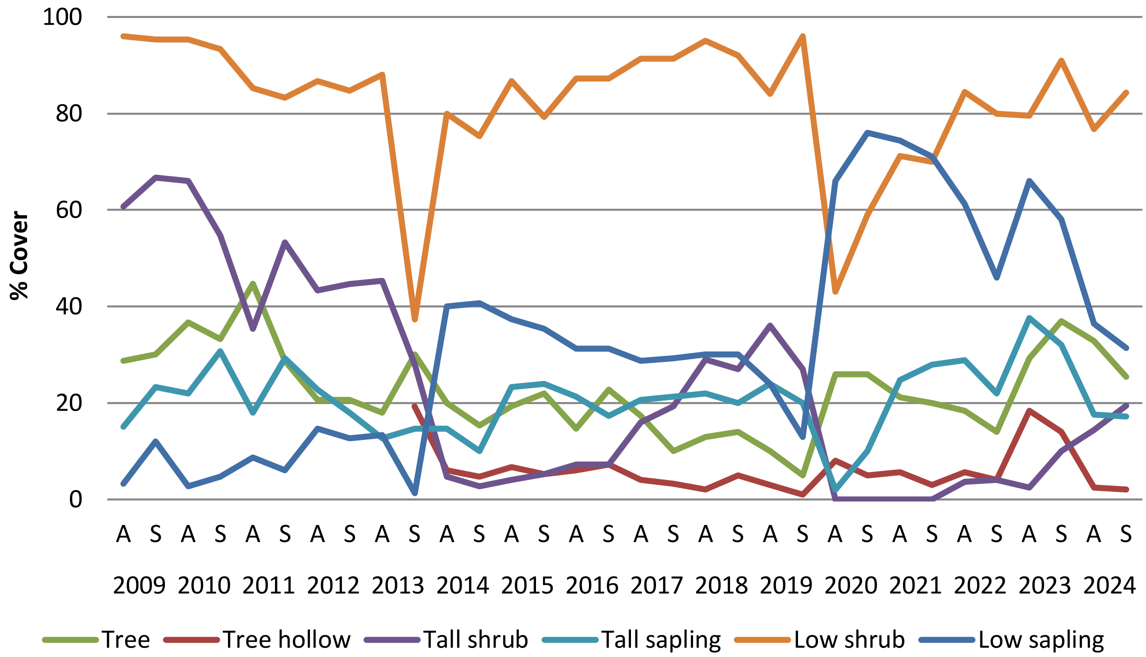


Figure 4-1: Overall mean habitat characteristics over time – upper and middle strata

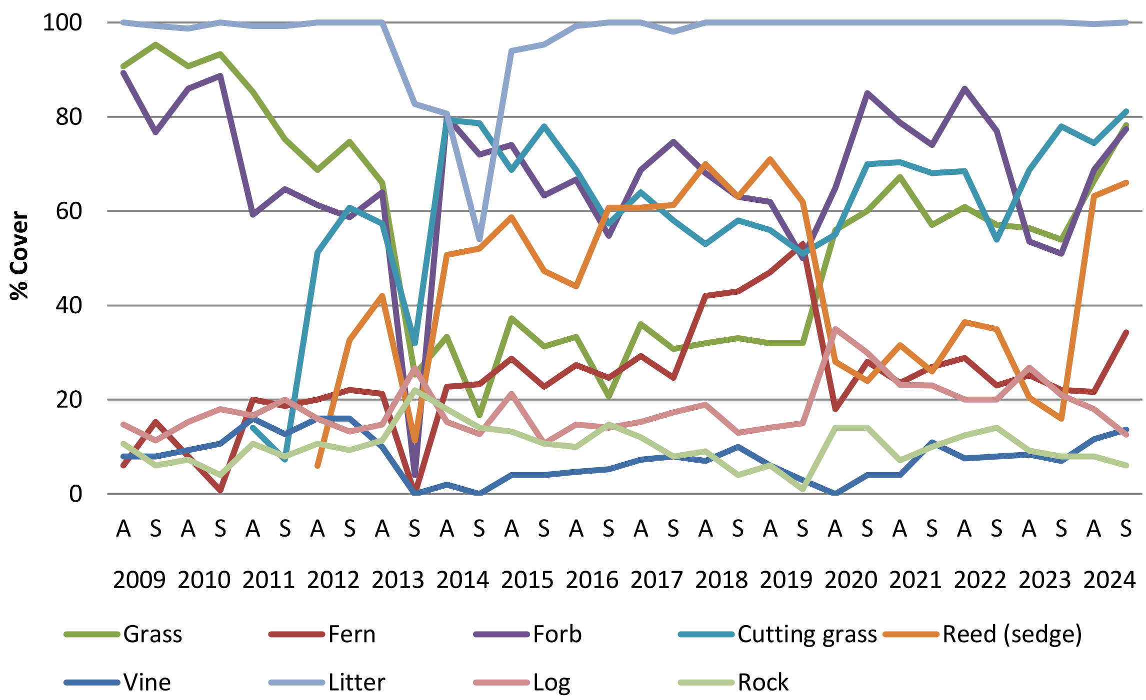


Figure 4-2: Overall mean habitat characteristics over time - lower strata and ground cover

Measurements of habitat characteristics derived from trap site descriptions have been used to provide an index of habitat complexity. This can then be used to determine changes in habitat through time in the study area. One index system used is that developed by Catling and Burt (1995[6]) called the Habitat Complexity Score. This system scores the following parameters: tree cover, tall and short shrub cover, ground cover, logs/rocks, and litter cover. Parameter scores range from 0 to 3, hence the maximum score is 18 for a site overall. The Habitat Complexity Scores for each site are given in **Table 4-2** and **Figure 4-3.**

Despite the fire five years ago, the scores still indicate moderate habitat complexity. There are a number of reasons why this might be the case. As habitat features such as trees and logs are sought out for sheltering traps, structural complexity is artificially inflated. This system is a coarse method for assessing structural change in habitats. As it relies on presence/absence of cover components (rather than repeated cover estimates), and certain components can be biased by movements of the trap line, the scope to pick up changes from fire is limited if regrowth of certain components has already begun[7].

One-way Repeated Measures ANOVAs conducted on the six CLW sites revealed that autumn HCS differed significantly over the years. HCS in autumn 2023 were significantly higher than 2014-17, 2019-20 and 2022; scores in 2010-11 were significantly higher than 2014 and 2016; and scores in 2009 and 2024 were significantly higher than 2014 ($p < 0.001$). In spring, HCS in 2014 were significantly lower than all years except 2019; HCS in 2019 were significantly lower than 2008 and 2010-11; scores in 2013 and 2017-18 were significantly lower than 2008 and 2011; and scores in 2015-16 and 2024 were significantly lower than 2008 ($p < 0.001$). Pooled t-tests (using the six CLW sites, four CL900 sites and four control sites) did not detect any significant difference in HCS by undermining status in autumn or spring.

Complexity scores declined steeply after the State Mine fire, but showed partial recovery through the post fire period, albeit at a slightly lower level than before. There was no evidence of decline after the 2019 fire, with 2020 showing an increase from the dry year leading into the Gospers Mountain fire. Perhaps damage to complexity scores was done after the first fire, with minimal impact from the second fire during the recovery period. Also, good rainfall in the 2021-22 period has led to rapid vegetation growth, and 2023 saw HCS return to levels seen pre 2013. These scores show that all sites structurally provide moderate habitat for ground dwelling mammals and woodland birds, but only as food resources begin to return to the landscape.

[6] Catling P. C. and Burt R.J. (1995). Studies of the ground-dwelling mammals of eucalypt forests in south-eastern New South Wales: the effect of habitat variables on distribution and abundance. *Wildlife Research* **22**: 271-288.

[7] Lothian, A.J., Denny, M.J.S. and Tong, N.W. (2022). Mammalian responses to fire on Newnes Plateau: A yardstick for future recovery. *Australian Zoologist* **42(2)**: 278-303.

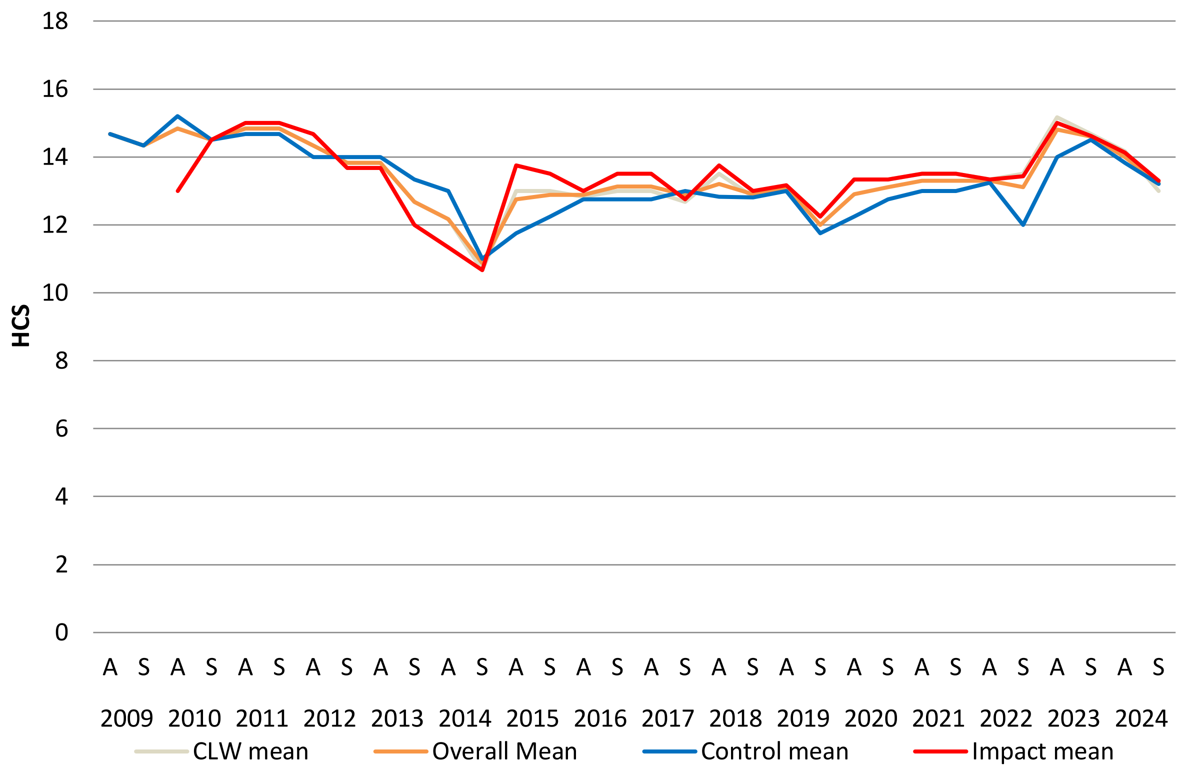


Figure 4-3: Changes in Habitat Complexity Scores over time

Table 4-2: Habitat Complexity Scores for autumn (A) and spring (S) over time (overall mean based off 6x CLW sites, 2x CLN sites, 4x CL900 sites Nine Mile and Paddy's)

Site	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
CLW01	14	14	15	13	14	15	14	14	14	16	14	12	11	12	13	11	12	12	14	13
CLW02	13	13	13	14	13	14	14	13	13	11	11	10	12	13	12	13	13	11	13	13
CLW03	15	14	15	15	16	15	15	14	14	12	11	10	14	15	14	14	13	14	14	12
CLW04	15	15	15	15	16	14	14	14	14	11	12	10	14	11	11	12	13	12	13	13
CLW05	15	15	15	15	14	15	14	14	14	13	13	10	12	12	12	13	12	13	12	12
CLW06	16	15	16	15	16	16	15	14	14	13	12	12	15	15	15	15	15	14	15	14
Nine Mile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	13
Paddy's	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	14
CLW mean	14.7	14.3	14.8	14.5	14.8	14.8	14.3	13.8	13.8	12.7	12.2	10.7	13.0	13.0	12.8	13.0	13.0	12.7	13.5	12.8
Overall mean	**14.7**	**14.3**	**14.8**	**14.5**	**14.8**	**14.8**	**14.3**	**13.8**	**13.8**	**12.7**	**12.2**	**10.9**	**12.8**	**12.9**	**12.9**	**13.1**	**13.1**	**12.9**	**13.2**	**12.9**

Site	2019		2020		2021		2022		2023		2024	
	A	S	A	S	A	A	A	S	A	S	A	S
CLW01	13	12	15	14	13	15	14	14	15	13	14	13
CLW02	13	-	11	11	11	13	11	11	13	14	14	12
CLW03	14	14	13	14	13	16	12	13	16	14	15	13
CLW04	12	12	12	14	15	15	14	14	15	15	13	13
CLW05	12	11	14	14	15	15	14	14	15	16	15	14
CLW06	15	-	15	13	14	17	15	15	17	16	14	13
Nine Mile	12	10	13	13	11	13	12	11	13	13	12	12
Paddy's	13	13	12	12	14	15	14	-	15	16	15	15
CLW mean	13.2	12.3	13.3	13.3	13.5	13.5	13.3	13.5	15.2	14.7	14.2	13.0
Overall mean	**13.1**	**12.0**	**12.9**	**13.1**	**13.3**	**14.8**	**13.3**	**13.1**	**14.8**	**14.6**	**14.0**	**13.2**

5.0 Results - fauna located

Twenty-five native mammal (plus four introduced), 74 bird, 11 reptile, eight amphibian and one invertebrate species were recorded from the CLW Area. **Tables 5-1** to **5-5** provide a list of species located within the CLW Area during the 2024 surveys. Calculations of diversity indices were undertaken where possible and presented in **Table 5-6**.

P – Protected species V – Vulnerable species U – Introduced species
C/J/K – China/Japan/Korea Australia Migratory Bird Agreement

Threatened species highlighted in green

Table 5-1: Mammals located within CLW Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Dasyuridae			
Antechinus agilis	Agile Antechinus	P	
Antechinus stuartii	Brown Antechinus	P	
Vombatidae			
Vombatus ursinus	Bare-nosed Wombat	P	
Burramyidae			
Cercartetus nanus	Eastern Pygmy-possum	V	
Petauridae			
Petaurus breviceps	Sugar Glider	P	
Pseudocheiridae			
Petauroides volans	Southern Greater Glider	E	E
Pseudocheirus peregrinus	Common Ringtail Possum	P	
Phalangeridae			
Trichosurus vulpecula	Common Brushtail Possum	P	
Macropodidae			
Macropus giganteus	Eastern Grey Kangaroo	P	
Macropus rufogriseus	Red-necked Wallaby	P	
Wallabia bicolor	Swamp Wallaby	P	
Rhinolophidae			
Rhinolophus megaphyllus	Eastern Horseshoe-bat	P	
Molossidae			
Austronomus australis	White-striped Freetail-bat	P	
Ozimops ridei	Eastern Free-tailed Bat	P	
Vespertilionidae			

andrew.lothian@biodiversitymonitoring.com.au

Scientific Name	Common Name	NSW Status	Cwlth Status
Chalinolobus dwyeri	Large-eared Pied Bat	E	E
Chalinolobus gouldii	Gould's Wattled Bat	P	
Chalinolobus morio	Chocolate Wattled Bat	P	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	
Nyctophilus sp.	Long-eared Bat sp.	P	
Scoteanax rueppellii	Greater Broad-nosed Bat	V	
Vespadelus darlingtoni	Large Forest Bat	P	
Vespadelus regulus	Southern Forest Bat	P	
Muridae			
Rattus fuscipes	Bush Rat	P	
Rattus lutreolus	Swamp Rat	P	
Rattus rattus	Black Rat	U	
Canidae			
Canis lupus	Dingo, domestic dog	U	
Vulpes vulpes	Fox	U	
Leporidae			
Oryctolagus cuniculus	Rabbit	U	

Table 5-2: Birds located within CLW Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Anatidae			
Chenonetta jubata	Australian Wood Duck	P	
Columbidae			
Phaps chalcoptera	Common Bronzewing	P	
Aegothelidae			
Aegotheles cristatus	Australian Owlet-nightjar	P	
Accipitridae			
Aquila audax	Wedge-tailed Eagle	P	
Elanus axillaris	Black-shouldered Kite	P	
Falconidae			
Falco berigora	Brown Falcon	P	
Falco cenchroides	Nankeen Kestrel	P	
Rallidae			
Fulica atra	Eurasian Coot	P	

Scientific Name	Common Name	NSW Status	Cwlth Status
Cacatuidae			
Cacatua galerita	Sulphur-crested Cockatoo	P	
Callocephalon fimbriatum	Gang-gang Cockatoo	E	E
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	P	
Psittacidae			
Alisterus scapularis	Australian King-Parrot	P	
Platycercus elegans	Crimson Rosella	P	
Platycercus eximius	Eastern Rosella	P	
Cuculidae			
Cacomantis flabelliformis	Fan-tailed Cuckoo	P	
Cacomantis variolosus	Brush Cuckoo	P	
Scythrops novaehollandiae	Channel-billed Cuckoo	P	
Strigidae			
Ninox novaeseelandiae	Southern Boobook	P	
Tytonidae			
Tyto novaehollandiae	Masked Owl	V	
Alcedinidae			
Dacelo novaeguineae	Laughing Kookaburra	P	
Todiramphus sanctus	Sacred Kingfisher	P	
Menuridae			
Menura novaehollandiae	Superb Lyrebird	P	
Climacteridae			
Climacteris erythrops	Red-browed Treecreeper	P	
Cormobates leucophaea	White-throated Treecreeper	P	
Ptilonorhynchidae			
Ptilonorhynchus violaceus	Satin Bowerbird	P	
Maluridae			
Malurus cyaneus	Superb Fairy-wren	P	
Malurus lamberti	Variegated Fairy-wren	P	
Stipiturus malachurus	Southern Emu-wren	P	
Dasyornithidae			
Pycnoptilus floccosus	Pilotbird	V	V
Acanthizidae			
Acanthiza lineata	Striated Thornbill	P	
Acanthiza pusilla	Brown Thornbill	P	
Acanthiza reguloides	Buff-rumped Thornbill	P	
Gerygone olivacea	White-throated Gerygone	P	

Scientific Name	Common Name	NSW Status	Cwlth Status
Hylacola pyrrhopygia	Chestnut-rumped Heathwren	P	
Sericornis citreogularis	Yellow-throated Scrubwren	P	
Sericornis frontalis	White-browed Scrubwren	P	
Pardalotidae			
Pardalotus punctatus	Spotted Pardalote	P	
Pardalotus striatus	Striated Pardalote	P	
Meliphagidae			
Acanthorhynchus tenuirostris	Eastern Spinebill	P	
Anthochaera carunculata	Red Wattlebird	P	
Caligavis chrysops	Yellow-faced Honeyeater	P	
Melithreptus brevirostris	Brown-headed Honeyeater	P	
Melithreptus lunatus	White-naped Honeyeater	P	
Nesoptilotis leucotis	White-eared Honeyeater	P	
Philemon corniculatus	Noisy Friarbird	P	
Phylidonyris niger	White-cheeked Honeyeater	P	
Phylidonyris novaehollandiae	New Holland Honeyeater	P	
Phylidonyris pyrrhoptera	Crescent Honeyeater	P	
Psophodidae			
Cinclosoma punctatum	Spotted Quail-thrush	P	
Psophodes olivaceus	Eastern Whipbird	P	
Campephagidae			
Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	
Coracina tenuirostris	Cicadabird	P	
Pachycephalidae			
Colluricincla harmonica	Grey Shrike-thrush	P	
Falcunculus frontatus	Eastern Shrike-tit	P	
Pachycephala pectoralis	Golden Whistler	P	
Pachycephala rufiventris	Rufous Whistler	P	
Artamidae			
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	
Cracticus tibicen	Australian Magpie	P	
Cracticus torquatus	Grey Butcherbird	P	
Strepera graculina	Pied Currawong	P	
Strepera versicolor	Grey Currawong	P	
Rhipiduridae			
Rhipidura albiscapa	Grey Fantail	P	
Rhipidura leucophrys	Willie Wagtail	P	

Scientific Name	Common Name	NSW Status	Cwlth Status
Corvidae			
Corvus coronoides	Australian Raven	P	
Monarchidae			
Myiagra cyanoleuca	Satin Flycatcher	P	
Corcoracidae			
Corcorax melanorhamphos	White-winged Chough	P	
Petroicidae			
Eopsaltria australis	Eastern Yellow Robin	P	
Petroica boodang	Scarlet Robin	V	
Petroica phoenicea	Flame Robin	V	
Timaliidae			
Zosterops lateralis	Silvereye	P	
Hirundinidae			
Hirundo neoxena	Welcome Swallow	P	
Petrochelidon nigricans	Tree Martin	P	
Estrildidae			
Neochmia temporalis	Red-browed Finch	P	
Stagonopleura bella	Beautiful Firetail	P	

Table 5-3: Amphibians located within CLW Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Myobatrachidae			
Crinia signifera	Common Eastern Froglet	P	
Limnodynastes dumerilii	Eastern Banjo Frog	P	
Limnodynastes peronii	Brown-striped Frog	P	
Limnodynastes tasmaniensis	Spotted Grass Frog	P	
Pseudophryne bibronii	Bibron's Toadlet	P	
Uperoleia laevigata	Smooth Toadlet	P	
Hylidae			
Litoria peronii	Peron's Tree Frog	P	
Litoria verreauxii verreauxii	Verreaux's Tree Frog (subsp)	P	

Table 5-4: Reptiles located within CLW Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Scincidae			
Eulamprus heatwolei	Yellow-bellied Water-skink	P	
Eulamprus leuraensis	Blue Mountains Water skink	E	E
Lampropholis delicata	Dark-flecked Garden Sunskink	P	
Lampropholis guichenoti	Pale-flecked Garden Sunskink	P	
Liopholis whitii	White's Skink	P	
Pseudemoia pagenstecheri	Tussock Skink	P	
Tiliqua nigrolutea	Blotched Blue-tongue	P	
Tiliqua scincoides	Eastern Blue-tongue	P	
Agamidae			
Amphibolurus muricatus	Jacky Lizard	P	
Rankinia diemensis	Mountain Dragon	P	
Elapidae			
Notechis scutatus	Tiger Snake	P	

Table 5-5: Invertebrates located within Angus Place SMP Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Petaluridae			
Petalura gigantea	Giant Dragonfly	E	

Table 5-6: Biodiversity indices for fauna in CLW Area

Site	Evenness	Simpson's Index of Diversity	Abundance	Species Richness
		BIRDS		
CLW Area	0.840	0.964	2415	74
CLW01	0.850	0.921	275	30
CLW02	0.879	0.956	321	45
CLW03	0.886	0.962	399	53
CLW04	0.895	0.945	194	32
CLW05	0.814	0.926	431	43
CLW06	0.881	0.942	148	33

Site	Evenness	Simpson's Index of Diversity	Abundance	Species Richness
Nine Mile	0.867	0.954	307	47
Paddy's	0.888	0.947	229	36
		NATIVE MAMMALS (non-bat)		
CLW Area	0.790	0.839	299	13
CLW01	0.739	0.725	28	7
CLW02	1.000	0.519	27	2
CLW03	0.862	0.808	29	7
CLW04	0.645	0.543	24	4
CLW05	0.849	0.779	41	7
CLW06	1.000	0.800	5	3
Nine Mile	0.834	0.823	32	9
Paddy's	0.770	0.764	46	8
		REPTILES		
CLW Area	0.757	0.810	56	11
CLW01	0.896	0.786	8	4
CLW02	0.910	0.733	6	3
CLW03	0.881	0.733	10	4
CLW04	1.000	0.833	4	3
CLW05	0.774	0.500	4	2
CLW06	0	0	1	1
Nine Mile	0.890	0.806	9	5
Paddy's	0.713	0.628	13	5
		AMPHIBIANS		
CLW Area	0.374	0.333	778	8
CLW01	-	-	0	0
CLW02	0.585	0.366	82	3
CLW03	0.456	0.408	287	7
CLW04	-	-	0	0
CLW05	1.000	1.000	2	2
CLW06	0	0	21	1
Nine Mile	0.275	0.180	279	4
Paddy's	0.230	0.083	47	2

The fauna assemblage is similar to that recorded from other areas within Clarence Colliery and Newnes Plateau, with similar species richness values and similar species located. A list of species located within the CLW Area from 2006 to 2024 is given in **Table 5-7**. The cumulative number of new species located each year is given in **Figure 5-1**. It is expected that the number of new species located each year will level out and the final maximum species richness for the area can be estimated from the value of the asymptote. By 2024, 137 bird, 36 native mammal (plus nine introduced), 26 reptile, 14 amphibian and one invertebrate species have been located within the CLW Area. In terms of cumulative species curves, the trend for all groups has mostly plateaued, but three species were added to the bird group in 2024 (Eurasian Coot, Welcome Swallow and Yellow-throated Scrubwren). Reptiles and amphibians have been stable for four years, and mammals for one. Yellow-throated Scrubwren have been recorded by BMS on Newnes before, but generally from wetter gullies off the edges of the Plateau. Welcome Swallow are known to nest in human constructions, like the fan and pump sites that are spread around the Plateau, so it is surprising we have not come across these earlier in the CLW area. Eurasian Coot have not been recorded on the Plateau before in by BMS or from a BioNet search. They are known from various ponds around the sewerage treatment works in Lithgow. One may have flown up Farmers Creek into the CLW area to take advantage of the rainfall event that occurred in November 2024.

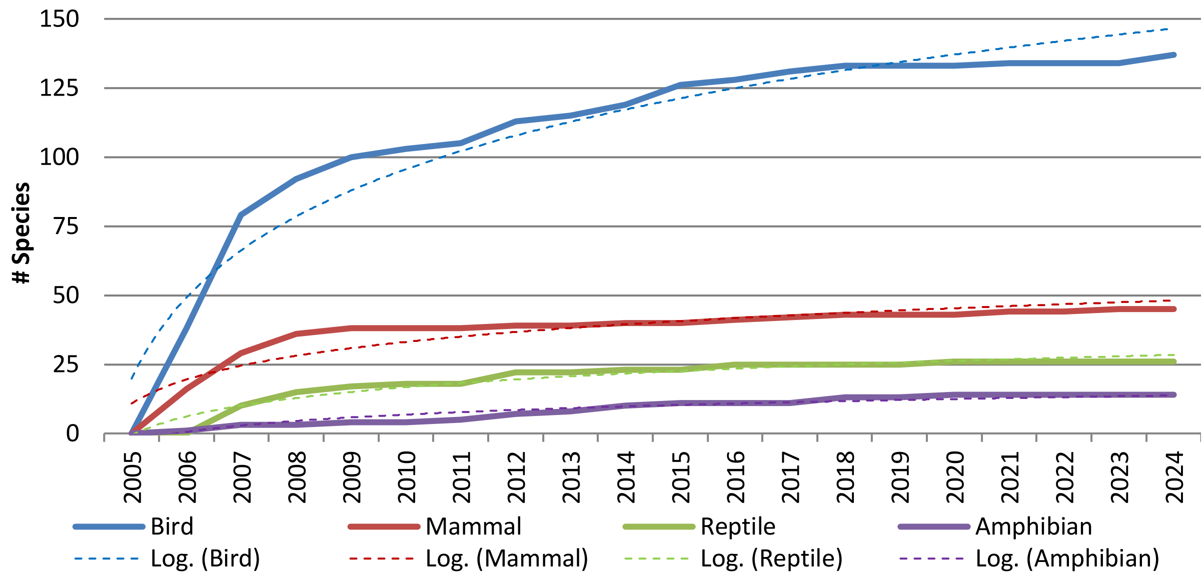


Figure 5-1: Cumulative new species in the CLW Area (including exotic species)

Table 5-7: Species located in CLW Area from the results of surveys since 2006 (threatened species highlighted in green)

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
MAMMALS																			
Agile Antechinus	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bare-nosed Wombat	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Black Rat																X	X	X	X
Brown Antechinus	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Brown Hare																		X	
Bush Rat	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cat	X	X	X			X	X	X	X	X	X	X	X	X	X	X		X	
Chocolate Wattled Bat		X	X	X					X		X	X	X	X	X	X	X	X	X
Common Brushtail Possum	X				X		X	X	X	X	X		X	X	X	X	X	X	X
Common Dunnart			X	X	X					X	X		X	X		X	X		
Common Ringtail Possum	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X
Dingo, domestic dog	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Eastern Broad-nosed Bat		X															X		
Eastern False Pipistrelle		X		X					X		X	X	X		X	X	X	X	X
Eastern Free-tailed Bat		X											X			X	X	X	X
Eastern Grey Kangaroo	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern Horseshoe-bat		X											X	X	X	X	X	X	X
Eastern Pygmy-possum		X				X		X	X	X			X			X	X	X	X

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Feral Pig									X										
Fox	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gould's Wattled Bat		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Greater Broad-nosed Bat				X													X	X	X
Horse												X		X	X	X			
House Mouse			X	X					X	X	X	X				X	X		
Large Bent-winged Bat		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Large Forest Bat		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Large-eared Pied Bat			X	X			X		X		X	X	X	X	X	X	X	X	X
Little Forest Bat			X	X					X										
Long-eared Bat sp.			X	X		X					X	X	X	X	X	X	X	X	X
Long-nosed Bandicoot			X	X		X	X		X	X	X								
Mainland Dusky Antechinus	X			X	X	X	X	X	X	X			X						
Rabbit	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-necked Wallaby	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Short-beaked Echidna		X	X																
South-eastern Free-tailed Bat			X									X			X	X	X	X	
Southern Forest Bat		X	X	X		X			X			X	X	X	X	X	X	X	X
Southern Greater Glider	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Southern Myotis				X															
Squirrel Glider		X		X															

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Sugar Glider											X	X	X	X	X	X	X	X	X
Swamp Rat	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Swamp Wallaby	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Water Rat							X												
White-striped Freetail-bat		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Yellow-bellied Sheathtail-bat													X		X				
BIRDS																			
Australian Crake										X									
Australian Hobby		X																	
Australian King-Parrot	X	X	X	X			X		X	X	X	X	X	X	X				X
Australian Magpie	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Australian Owlet-nightjar								X		X	X	X							X
Australian Pipit	X										X	X	X	X			X		
Australian Raven	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Australian Wood Duck			X		X		X	X	X	X	X	X	X		X		X		X
Bar-shouldered Dove		X																	
Bassian Thrush				X	X		X	X	X										
Beautiful Firetail		X	X			X	X	X	X		X	X	X	X			X		X
Black Kite				X															
Black-faced Cuckoo-shrike	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Black-faced Woodswallow		X		X															

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Black-shouldered Kite							X	X											X
Brown Falcon							X								X		X		X
Brown Goshawk											X		X		X		X		
Brown Thornbill		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brown Treecreeper	X	X	X	X	X														
Brown-headed Honeyeater		X		X			X		X	X	X	X	X	X	X				X
Brush Cuckoo		X	X				X		X	X		X					X		X
Buff-rumped Thornbill					X		X	X	X	X	X	X	X	X	X	X	X	X	X
Channel-billed Cuckoo										X		X			X				X
Chestnut-rumped Heathwren		X							X	X		X	X	X	X				X
Cicadabird						X	X	X	X	X	X	X	X		X	X		X	X
Collared Sparrowhawk							X												
Common Bronzewing	X	X	X	X	X	X				X	X	X	X						X
Crescent Honeyeater													X	X					X
Crimson Rosella	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dollarbird		X												X					
Dusky Woodswallow		X					X	X	X	X	X	X	X	X		X	X	X	X
Eastern Rosella			X	X	X		X	X	X	X	X	X	X		X	X	X	X	X
Eastern Shrike-tit		X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X
Eastern Spinebill	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern Whipbird	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Eastern Yellow Robin	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eurasian Coot																			X
Fairy Martin		X																	
Fan-tailed Cuckoo			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Flame Robin	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Forest Kingfisher		X																	
Galah		X	X																
Gang-gang Cockatoo	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
South-eastern Glossy Black-Cockatoo		X	X																
Golden Whistler		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Green Catbird			X																
Grey Butcherbird			X	X	X		X	X	X	X			X		X		X		X
Grey Currawong	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grey Fantail		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grey Shrike-thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hooded Robin		X	X																
Horsfield's Bronze-Cuckoo									X	X	X	X							
Jacky Winter	X	X																	
Laughing Kookaburra	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Leaden Flycatcher		X			X		X	X	X	X	X	X	X		X		X		
Lewin's Honeyeater					X														

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Lewin's Rail							X	X			X								
Little Eagle	X																		
Little Friarbird			X																
Little Lorikeet												X	X						
Little Raven	X														X				
Magpie-lark												X							
Masked Lapwing		X						X	X	X			X	X					
Masked Owl			X																X
Masked Woodswallow										X		X	X			X		X	
Mistletoebird													X						
Musk Lorikeet											X								
Nankeen Kestrel									X	X	X	X	X	X	X	X	X	X	X
New Holland Honeyeater	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Noisy Friarbird		X	X	X	X	X		X	X		X	X	X		X	X	X	X	X
Olive-backed Oriole							X	X	X				X						
Pacific Black Duck				X								X							
Painted Button-quail										X					X	X	X	X	
Pallid Cuckoo		X													X				
Peaceful Dove								X											
Peregrine Falcon					X		X				X	X							
Pied Butcherbird			X	X		X													

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Pied Currawong	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pilotbird							X									X	X	X	X
Powerful Owl			X																
Rainbow Bee-eater										X									
Red Wattlebird	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Red-backed Kingfisher		X																	
Red-browed Finch			X	X		X	X	X	X	X	X		X	X	X	X	X	X	X
Red-browed Treecreeper	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-capped Robin										X									
Restless Flycatcher																X			
Rose Robin							X			X									
Rufous Fantail			X										X						
Rufous Songlark												X							
Rufous Whistler		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sacred Kingfisher		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Satin Bowerbird		X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X
Satin Flycatcher		X					X	X	X		X	X	X	X	X		X		X
Scarlet Honeyeater				X															
Scarlet Robin	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Shining Bronze-Cuckoo							X		X	X		X	X	X					
Silvereye		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Southern Boobook		X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
Southern Emu-wren		X			X		X		X	X	X	X	X						X
Spiny-cheeked Honeyeater		X	X																
Spotted Pardalote	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spotted Quail-thrush	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X
Striated Pardalote		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Striated Thornbill	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulphur-crested Cockatoo	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Superb Fairy-wren		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Superb Lyrebird	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Tawny Frogmouth	X	X		X	X	X	X	X		X		X	X	X			X		
Tawny-crowned Honeyeater		X																	
Tree Martin		X	X	X	X		X	X	X	X	X	X	X	X	X		X		X
Turquoise Parrot									X	X	X					X		X	
Varied Sittella		X	X		X				X	X	X	X	X	X			X		
Variegated Fairy-wren	X	X			X		X		X		X	X	X		X	X	X	X	X
Welcome Swallow																			X
Wedge-tailed Eagle	X	X	X				X	X	X	X	X	X	X	X	X				X
Whistling Kite				X	X														
White-bellied Cuckoo-shrike						X													
White-browed Scrubwren		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
White-browed Woodswallow									X	X		X	X						
White-cheeked Honeyeater		X	X																X
White-eared Honeyeater	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White-naped Honeyeater	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
White-plumed Honeyeater		X																	
White-throated Gerygone			X		X				X	X	X	X	X						X
White-throated Needletail		X												X					
White-throated Nightjar				X															
White-throated Treecreeper	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White-winged Chough	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White-winged Triller										X			X			X		X	
Willie Wagtail				X					X			X		X		X	X	X	X
Wonga Pigeon				X	X				X		X								
Yellow Thornbill			X		X	X		X											
Yellow-faced Honeyeater	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Yellow-rumped Thornbill		X																	
Yellow-tailed Black-Cockatoo	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Yellow-throated Scrubwren																			X
REPTILES																			
Black Rock-skink							X	X			X								
Blotched Blue-tongue		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Blue Mountains Water Skink			X										X			X	X	X	X
Common Scaly-foot							X		X	X									
Copper-tailed Skink		X	X							X					X				
Cunningham's Skink															X				
Dark-flecked Garden Sunskink			X	X	X	X	X		X	X		X	X	X	X	X	X	X	X
Eastern Blue-tongue		X							X		X								X
Eastern Brown Snake		X	X																
Eastern Three-lined Skink					X	X			X			X	X	X					
Eastern Water Dragon							X			X	X								
Highland Copperhead		X		X		X					X	X			X	X	X	X	
Jacky Lizard		X	X																X
Lace Monitor		X																	
Litter Skink				X															
Mountain Dragon				X	X		X				X	X	X	X	X	X	X	X	X
Pale-flecked Garden Sunskink			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-bellied Black Snake			X	X	X					X	X				X				
Red-throated Skink		X	X	X			X			X	X	X		X		X	X	X	
South-eastern Morethia Skink		X																	
Southern Rainbow Skink									X										
Tiger Snake											X					X			X
Tussock Skink											X			X	X				X

Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Weasel Skink							X		X						X				
White's Skink		X		X						X		X			X				X
Yellow-bellied Water-skink			X	X			X		X		X	X	X	X	X	X	X	X	X
AMPHIBIANS																			
Bibron's Toadlet										X	X	X	X	X	X	X	X	X	X
Screaming Tree Frog									X							X			
Blue Mountains Tree Frog													X		X				
Brown-striped Frog				X			X	X	X		X		X			X	X	X	X
Common Eastern Froglet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern Banjo Frog		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern Sign-bearing Froglet															X		X		
Giant Burrowing Frog						X													
Leaf-green Tree Frog													X		X	X			
Lesueur’s Frog							X												
Peron's Tree Frog							X		X		X	X	X	X	X	X	X		X
Smooth Toadlet									X		X	X	X		X	X	X		X
Spotted Grass Frog		X	X	X					X			X							X
Verreaux’s Tree Frog								X	X	X	X	X	X	X	X	X	X	X	X
INVERTEBRATES																			
Giant Dragonfly							X	X	X	X	X	X			X				X

CRITERIA USED TO MONITOR FAUNA

Most fauna monitoring surveys produce a species list that shows what animals were found within a specified area. Lists alone however do not provide the necessary criteria to determine whether an activity is affecting fauna populations through time. Consequently, it is important to provide a set of criteria that can be used to compare fauna populations within an area over time. The criteria must be relatively simple, easy to interpret, and the processes required to develop each criterion must be consistent and repeatable.

To ensure such criteria are used in the long-term monitoring of fauna within the CLW Area, a set of quantifiable indices have been developed and adopted for this project.

The detailed surveys now provide sufficient information to establish a series of 'monitoring trigger points' i.e. single values that can be used to determine whether any significant changes have occurred in fauna populations over time. Monitoring trigger points being developed are:

- Species richness of faunal groups
- Diversity indices of faunal groups
- Population status of individual species
- Capture rates of individual species
- Population status of faunal groups
- Contribution to the faunal assemblages by threatened species, species dependent upon woodland and by species declining in the Central West of NSW
- Habitat complexity scores

Species richness of faunal groups

The number of species within each faunal group provides an index of its biodiversity. It is assumed that the higher the species richness, the higher the biodiversity. A high biodiversity index value indicates an area containing a complex variety of natural habitats in good condition. The species richness values for the surveys from 2006 to 2024 are given in **Table 5-8** and are graphed in **Figures 5-3** and **5-4**.

Simpson's diversity index of faunal groups

Simpson's diversity index combines species richness and species abundance to provide a better indication of biodiversity. The closer the Simpson's Index of Diversity is to one, the higher the biodiversity, and by implication, the better the area is for fauna. Simpson's Index of Diversity for the four main faunal groups over time are given in **Table 5-8** and the values of the diversity index are illustrated in **Figure 5-2**. This provides an indication of the productivity of each faunal group over time.

2018 saw the inclusion of a two new control sites, as Springvale moved longwall activity under two existing Clarence control sites. Another two control sites were added in 2024. As such, sampling effort is greater in 2018-2023 compared to previous years, and even greater again from 2024.

Abundance differences over time should be treated with caution, but other indices should not be greatly impacted by the increased sampling effort. Whilst the figures presented below are sourced from the overall value for the area, the statistical analyses work on the mean values between groups (year or impact), thus taking into account the increased sampling effort. The inclusion of CLW01 and CLW05 has been taken back to 2010 and data recalculated.

Two-way Repeated Measures ANOVAs were previously conducted to examine mining impact on diversity indices over time. However, due to progressive undermining dates at different sites, and recent undermining at both 900 South and 900 North (previous control sites), this analysis can no longer be conducted. As such, statistical analyses of fauna diversity indices over time were conducted using One-way Repeated Measures ANVOAs (analysis of variance). These analyses now use only the six CLW sites (CLW01-06).

In autumn, One-way repeated measured ANOVAs revealed that a number of bird, mammal and reptile diversity indices varied significantly over time. Bird Evenness was significantly lower in 2017-18 compared to 2011 and 2022 ($p < 0.001$). Bird Simpson's was significantly lower in 2013 compared to 2011 ($p = 0.005$). Bird abundance was significantly lower in 2022 compared to 2017-18; and significantly lower in 2015-16 and 2020 compared to 2017 ($p < 0.001$). Bird species richness was significantly lower in 2022 compared to 2011-12 and 2017-18 ($p < 0.001$). Mammal abundance was significantly higher in 2012 compared to 2011, 2014-18 and 2020-22; significantly higher in 2013 compared to 2011, 2014-17 and 2020-21; significantly higher in 2023 compared to 2011 and 2014-17; and significantly higher in 2019 compared to 2011 and 2014 ($p < 0.001$). Mammal species richness was significantly higher in 2012 compared to 2011 and 2016-17 ($p = 0.007$). Reptile abundance was significantly higher in 2023 compared to 2022 ($p = 0.023$).

Spring One-way repeated measured ANOVAs also revealed a number of bird, mammal and reptile diversity indices varied over time. Bird Evenness was significantly lower in 2011 compared to 2020 ($p = 0.011$). Bird abundance was significantly higher in 2014 compared to 2020-23 ($p = 0.001$). Bird species richness was significantly lower in 2023 compared to 2017-18; and significantly lower in 2011 and 2022 compared to 2017 ($p < 0.001$). Mammal Evenness was significantly lower in 2020 compared to 2021 ($p = 0.035$). Mammal abundance was significantly higher in 2012 compared to 2013-17, 2020-22 and 2024; and significantly higher in 2011 compared to 2013-15 and 2020-21 ($p < 0.001$). Mammal species richness was significantly lower in 2020 compared to 2011-12 ($p = 0.017$). Reptile abundance was significantly higher in 2013 compared to 2011-12, 2015-16 and 2021; and significantly higher in 2020 compared to 2015 ($p < 0.001$). Reptile species richness was significantly higher in 2013 compared to 2011-12, 2015 and 2021; and significantly higher in 2014 compared to 2015 ($p < 0.001$).

Statistical analyses testing for impacts of undermining were conducted usings a series of pooled t-tests. These were conducted on data from 2011 to 2024, and included the six CLW sites (CLW01-06) as well as 900 South and 900 North as undermined (impact) sites, and Nine Mile, Paddy's plus four new Clarence sites (900C, 900D, Murrays Swamp, Upper Dingo) as control sites. Autumn pooled t-tests revealed significant differences between undermined and control sites for all four fauna groups. Bird Simpson's and species richness, as well as reptile and amphibian species richness were all significantly lower at impact sites compared to control sites ($p = 0.013$, $p = 0.026$, $p = 0.015$ and $p = 0.047$ respectively). Conversely, mammal Evenness and Simpson's were significantly higher at impact sites compared to control sites ($p = 0.003$ and $p = 0.009$ respectively).

Spring pooled t-tests revealed significantly lower diversities at impact (undermined) sites for birds, mammals and amphibians. Bird Evenness, Simpson's and species richness; mammal abundance; and amphibian species richness were all significantly lower at impact sites compared to control sites ($p = 0.033$, $p = 0.008$, $p = 0.025$, $p = 0.032$ and $p = 0.016$ respectively).

Bird species richness was trending upwards over time, until a reduction in 2019 (before the Gospers Mountain fire hit; **Figure 5-3**). Even with the large fire in 2019, richness was still lower in 2006 and 2011. 2024 has seen a return to levels seen prior to the 2019 fire. Bird Simpson's remained stable over the long term (**Figure 5-2**). Mammal diversity has also remained relatively stable over time with the highest Simpson's diversity on record in 2021 (**Figure 5-2**). With 2020 mammal species richness the lowest on record since surveys began, 2021-24 saw a quick return to average levels (**Figure 5-4**). Though also relatively stable over the long term, reptile Simpson's diversity has been somewhat more variable, with declines in 2013, 2020 and 2023 to lower than average levels (with 2023 the lowest on record; **Figure 5-2**). Conversely, reptile species richness was comparatively high in 2016, 2020 and 2024, with a slight increasing trend being confounded by high variability (**Figure 5-4**). Amphibian Simpson's diversity is generally much lower than other groups, suggesting large numbers of one species often sway the results (**Figure 5-2**). Amphibian richness appeared to be trending upwards over time though levelling out over the 2019-2024 period (**Figure 5-4**). 2023 saw a decline in amphibian richness, which corresponded with all time low Simpson's Diversity. This bias associated with a group of few species with sometimes large abundances make confident interpretation of trends difficult.

Of the eight seasonal diversity indices that differ by undermining status, six are higher in control and two higher in undermined sites. Statistics suggest changes in diversity are predominantly due to climatic changes over time. There may be an indication of impacts from undermining, though they are inconsistent across seasons, with bird Simpson's diversity and species richness, and amphibian species richness the only indices to be consistently higher at control sites in both seasons. Mammal indices were higher in control sites in autumn, but higher in impact sites in spring. Reptile richness was higher in control sites in autumn, but not different in spring. The difference between impact and control site frog assemblages is most likely a natural difference between the choice of sites, with Nine Mile containing one of the best (and consistent) frog habitat locations on the Plateau (still pond with emergent vegetation). There may be differences in how habitats and fauna assemblages recover post fire in mined and non-mined sites. This will be investigated further as sites continue to recover from the Gospers Mountain fire. Overall, the biodiversity indices are similar to that found elsewhere in Newnes Plateau and indicate a representative base-line sample to be used for on-going monitoring.

Capture rates of individual species

It is possible to calculate the trapping rates for small ground mammals within the CLW Area. Such values can be used as a surrogate for population size of each species captured and is important for long-term monitoring. Trapping rates for all small mammals captured from 2012 to 2024 are given in **Table 5-9** and shown in **Figure 5-5**.

There was a large decrease in trapping rates from spring 2013. The decline is due to the loss of animals and habitat from the State Mine fire. Numbers started building in 2015, with numbers in 2019 almost back to levels seen pre fire (**Figure 5-5**). Post fire recovery of small mammals in the CLW Area took six years after the State Mine fire. Numbers in 2020 were the lowest on record, with potential cumulative impacts from two successive fires. Recovery post Gospers Mountain fire appears to be faster than the last fire, with trap rates in autumn 2023 surpassing levels seen six years after the first fire, and back to levels seen pre State Mine fire. However, trapping rates have decreased again in 2024. Bush Rat numbers traditionally drive trapping rates, though Swamp Rats increased their presence after the first fire. Agile Antechinus numbers started to build in 2019 and exceeded rodent numbers for the first time in 2020, continuing to dominate through to 2024. House Mice were captured in the CLW Area from 2015 through 2017, and started being caught again in 2021. None have been captured since autumn 2022. This species is known to invade disturbed areas. Black Rats (another introduced species) were trapped from autumn 2021 to autumn 2024, but were not seen in spring 2024. Trapping rates might be ahead of where we expect them to be five years post fire, but the composition of the small mammal community has changed. We will monitor Bush Rat numbers going forward to see whether successive fires have permanently impacted their population.

Table 5-8: Biodiversity indices for birds, mammals and reptiles, and amphibians over time

Group	Diversity index	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Birds	Simpson's	0.86	0.95	0.91	0.92	0.94	0.96	0.94	0.94	0.95	0.97
	Species richness	40	72	64	59	63	49	72	62	71	73
***Native**	Simpson's	0.70	0.71	0.70	0.82	0.82	0.79	0.77	0.76	0.84	0.86
	Species richness	12	13	11	12	14	12	15	13	14	15
Reptiles	Simpson's	NA	0.82	0.86	0.81	0.76	0.75	0.84	0.63	0.82	0.86
	Species richness	0	10	10	10	6	5	10	3	9	9
Amphibians	Simpson's	-	-	-	-	0.39	0.40	0.11	0.42	0.57	0.49
	Species richness	1	3	3	4	2	2	5	4	8	4

Group	Diversity index	2016	2017	2018	2019	2020	2021	2022	2023	2024
Birds	Simpson's	0.96	0.95	0.95	0.95	0.96	0.96	0.95	0.94	0.96
	Species	69	76	76	61	63	65	62	55	74
***Native**	Simpson's	0.82	0.81	0.85	0.81	0.84	0.87	0.84	0.79	0.84
	Species	13	11	15	12	10	14	14	13	13
Reptiles	Simpson's	0.93	0.73	0.82	0.85	0.67	0.80	0.8	0.56	0.81
	Species	12	9	7	8	11	9	8	8	11
Amphibians	Simpson's	0.74	0.78	0.57	0.50	0.56	0.44	0.2	0.08	0.33
	Species	7	7	9	5	9	9	8	5	8

*Bats not included

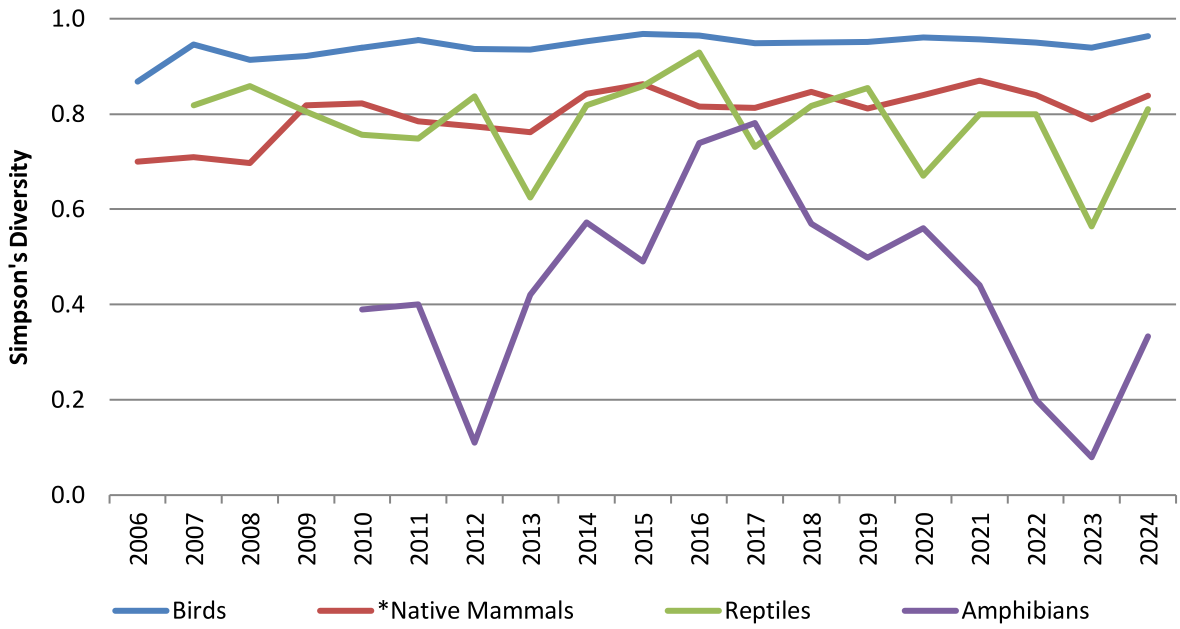


Figure 5-2: Simpson's Diversity for the CLW Area over time

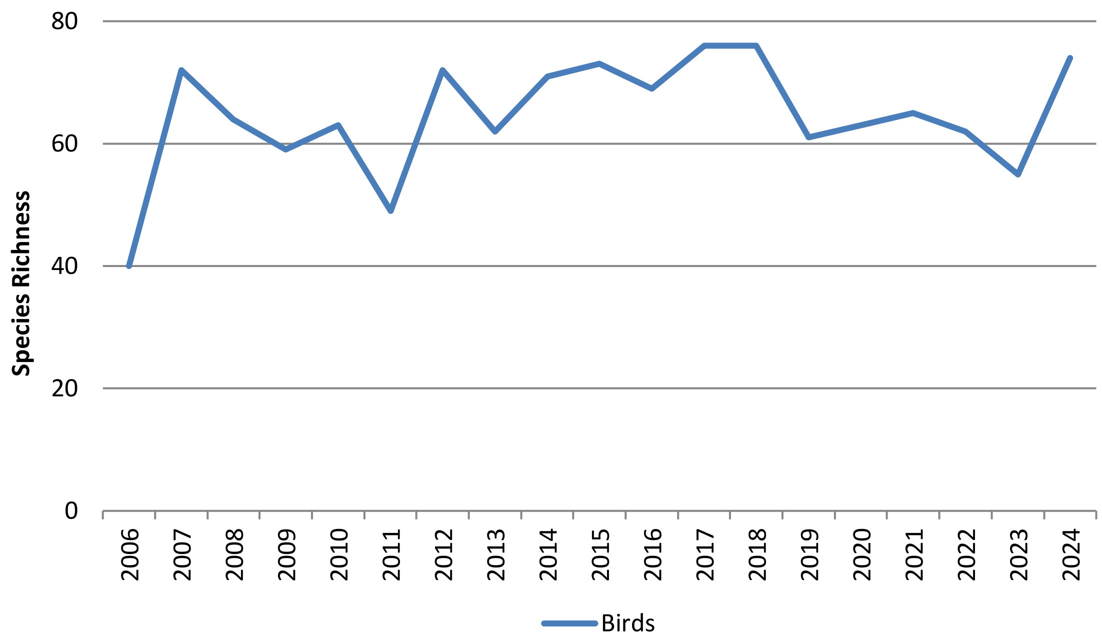


Figure 5-3: Species Richness for birds of the CLW Area over time

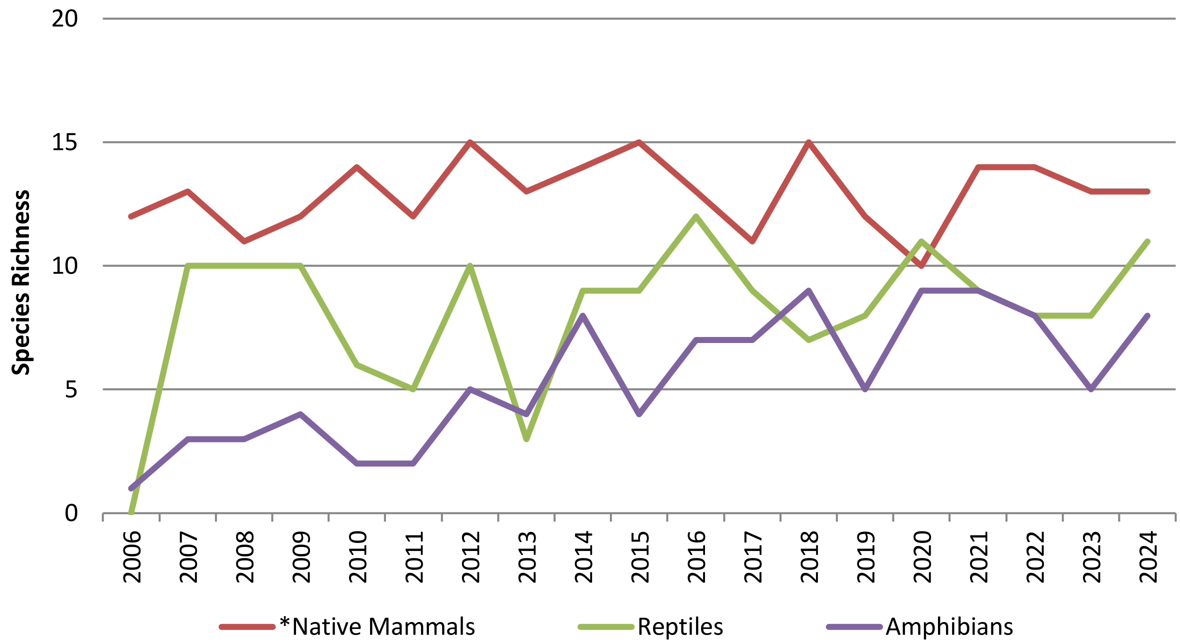


Figure 5-4: Species richness for mammals, reptiles and amphibians of the CLW Area over time

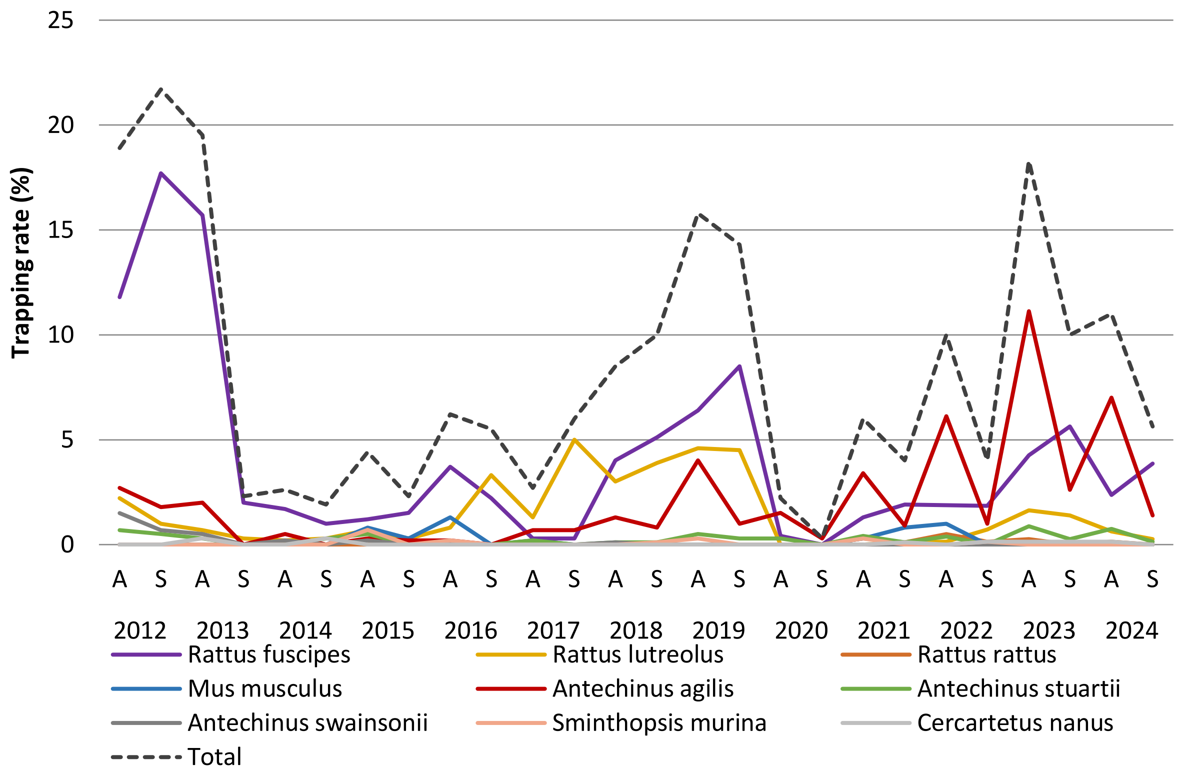


Figure 5-5: Trapping rates for small ground mammals over time

Table 5-9: Mean trapping rates of small mammals in autumn and spring over time

Species	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S*	A	S	A	S	A	S**	A	S
Rattus fuscipes	11.8	17.7	15.7	2	1.7	1	1.2	1.5	3.7	2.2	0.3	0.3	4	5.1	6.4	8.5	0.4	0	1.3	1.9	1.9	1.9	4.3	5.6
Rattus lutreolus	2.2	1	0.7	0.3	0.2	0.3	0.7	0.3	0.8	3.3	1.3	5	3	3.9	4.6	4.5	0	0	0	0.1	0.1	0.7	1.6	1.4
Rattus rattus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.1	0.5	0.1	0.3	0
Mus musculus	0	0	0	0	0	0	0.8	0.3	1.3	0	0.2	0	0	0	0	0	0	0	0.3	0.8	1	0	0	0
Antechinus agilis	2.7	1.8	2	0	0.5	0	0.3	0.2	0.2	0	0.7	0.7	1.3	0.8	4	1	1.5	0.3	3.4	0.9	6.1	1	11.1	3
Antechinus stuartii	0.7	0.5	0.3	0	0	0.3	0.5	0	0	0	0.2	0	0.1	0.1	0.5	0.3	0.3	0	0.4	0.1	0.4	0	0.9	0
Antechinus swainsonii	1.5	0.7	0.5	0	0.2	0	0.2	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Sminthopsis murina	0	0	0	0	0	0	0.7	0	0.2	0	0	0	0	0.1	0.3	0	0	0	0.3	0	0	0.1	.0	0
Cercartetus nanus	0	0	0.3	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0.1	0.1
Total	**18.9**	**21.7**	**19.5**	**2.3**	**2.6**	**1.9**	**4.4**	**2.3**	**6.2**	**5.5**	**2.7**	**6.0**	**8.5**	**10.0**	**15.8**	**14.3**	**2.2**	**0.3**	**6.0**	**4.0**	**10.0**	**4.0**	**18.3**	**10.0**

*only four of eight sites were surveyed in spring 2019 due to threatening fire conditions (two control, two impact)

** Paddy's not surveyed in spring 2022

Data based on 6 sites from 2012-2017, and eight sites from 2018 onwards.

Table 5-10 cont.: Mean trapping rates of small mammals in autumn and spring over time

Species	2024	
	A	S
Rattus fuscipes	2.4	3.9
Rattus lutreolus	0.6	0.3
Rattus rattus	0.1	0
Mus musculus	0	0
Antechinus agilis	7.0	1
Antechinus stuartii	0.8	0
Antechinus swainsonii	0	0
Sminthopsis murina	0	0
Cercartetus nanus	0.1	0
Total	**11.0**	**5.6**

Population status of a species

Derivation of the local population status of species located at CLW Area requires a relatively large dataset. Population status is based upon the numbers and distribution of each species within the CLW Area. This data is still being collected and is part of an ongoing process to provide sufficient information to allow assignment of population status of species known to occur.

Contribution to the faunal assemblages by threatened species, species dependent upon woodland, and species declining in Central West NSW

Bird species have been classed by Reid (2000)[8] into woodland dependant and declining in the Central West. These lists were used to calculate the proportion of birds located within the CLW Area that are considered under threat. The higher the proportion, the greater the value that can be placed on the present habitat in the area.

On inspection of the bird species list (**Table 5-2**), the following proportions calculated for the CLW Area over time are given in **Table 5-11** and **Figure 5-6**. The proportion of woodland-dependent and declining bird species is decreasing slowly over time, with drought and fire conditions leading to lower levels of both. It appears the data for this area supports the fact that these groups of species are in decline, with 2024 the lowest on record for the area in both metrics. After the 2013 fire the habitat may have become temporarily unsuitable for woodland birds, a situation which has not yet been rectified. There was no obvious change in 2024 that appears to have driven this decline. Significant changes to this figure may indicate changes to the condition of the woodland habitat.

Conversely, the number of threatened species has been increasing over time, peaking in spring 2018 and 2023 (**Table 5-10** and **Figure 5-7**). Fourteen threatened species were located during the 2024 surveys. These were the Eastern Pygmy-possum, Southern Greater Glider, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Greater Broad-nosed Bat, Gang-gang Cockatoo, Masked Owl, Pilotbird, Dusky Woodswallow, Scarlet Robin, Flame Robin, Blue Mountains Water Skink and Giant Dragonfly. Locations of threatened species are given in **Figure 5-8**. Despite searching preferred habitats during the warmer months, there was no evidence of the presence of Giant Burrowing Frog or Bathurst Copper Butterfly in the area. However, Giant Dragonfly was seen 17 times across four sites: CLW03, CLW05, Nine Mile and Paddy's Swamp. CLW05 used to be a good site for the Giant Dragonfly, but since the undermining the survey location dried out substantially. The record this year occurred down swamp of the survey location where wet swamp still exists (towards Nine Mile). One Blue Mountains Water Skink was located at Paddy's Swamp.

[8] Reid J.R.W. (2000). *Threatened and Declining Birds in the New South Wales Sheep Wheat Belt2. Landscape relationships – Modelling bird atlas data against vegetation cover*. Consultancy Report to NSW National Parks and Wildlife Service. CSIRO Wildlife and Ecology, Canberra.

Table 5-11: Threatened species in CLW Area in autumn (A) and spring (S) over time

Category	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Woodland-dependent bird species (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Declining bird species (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Threatened species	1	3	5	7	6	7	3	2	6	4	2	3	4	3	4	5	3	6	3	6

Category	2017		2018		2019		2020		2021		2022		2023		2024	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Woodland-dependent bird species (%)	65	59	59	63	63	64	61	60	70	66	64	62	71	67	59	52
Declining bird species (%)	5	7	7	9	8	8	3	7	10	8	8	6	9	10	8	5
Threatened species	7	7	9	11	6	6	8	7	7	9	7	10	6	12	9	9

Table 5-12: Proportion of woodland-dependent or declining birds in CLW Area each year over time

Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Woodland-dependent	83	67	72	77	82	84	74	79	72	79	77	58	62	59	59	62	61	65	50
Declining	13	14	12	15	14	12	13	13	15	14	13	8	8	8	6	9	8	9	5

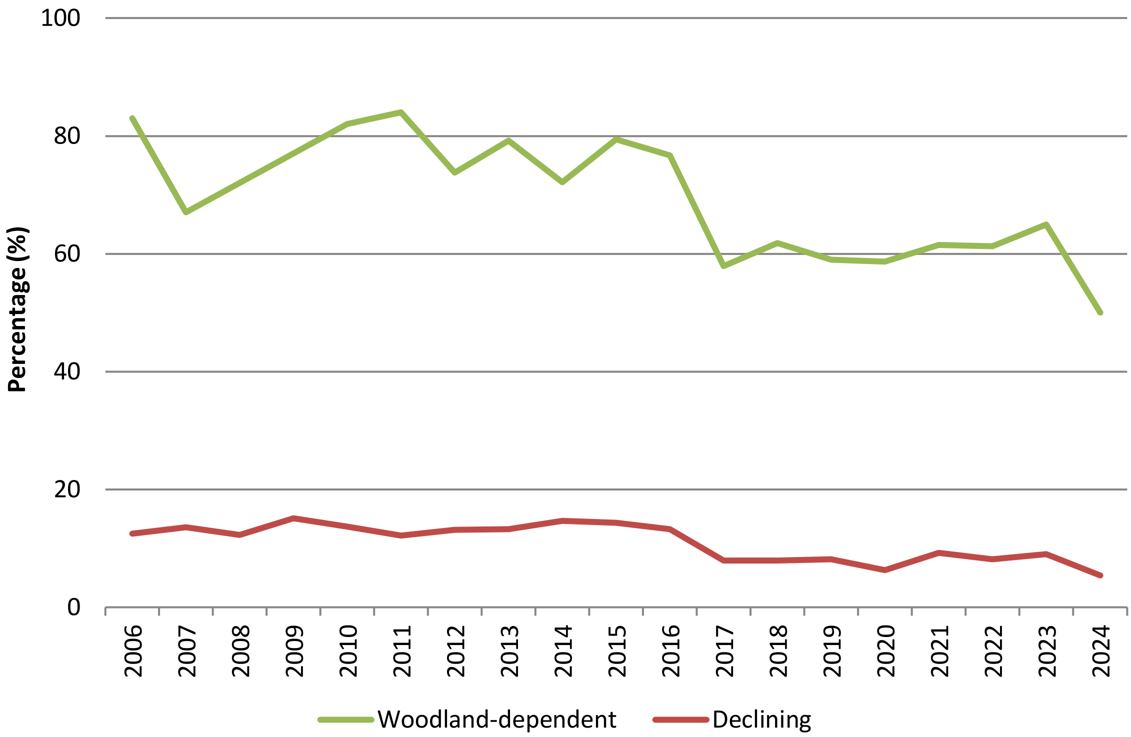


Figure 5-6: Proportion of woodland-dependent and declining bird species in CLW Area each year

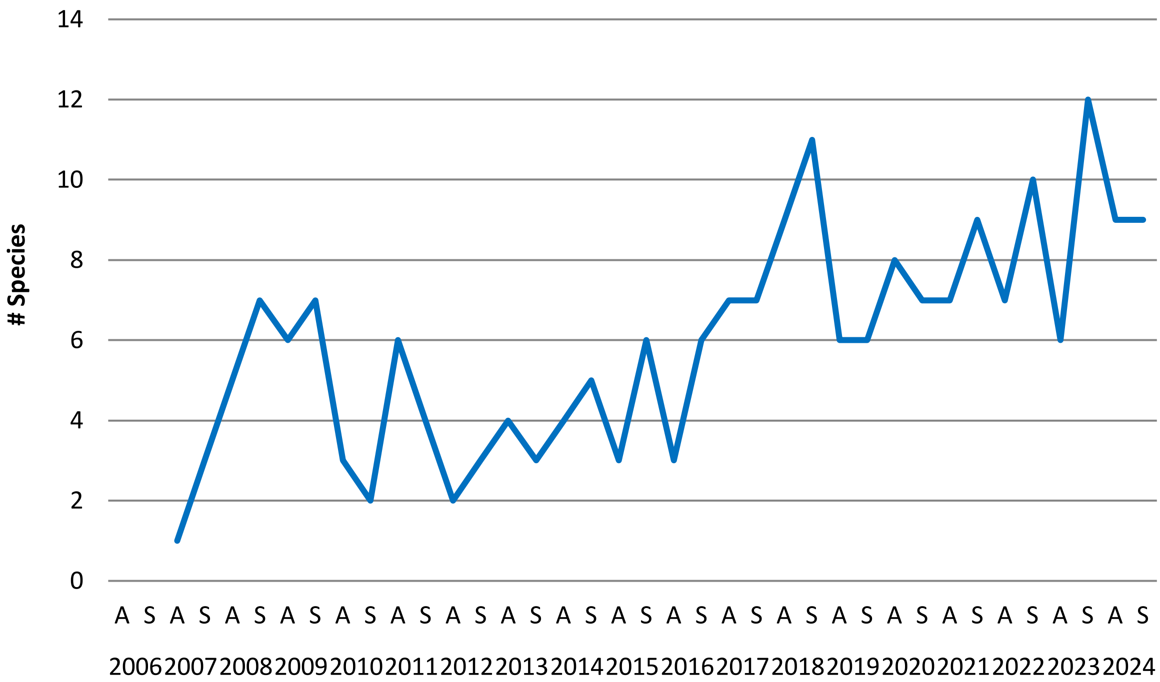


Figure 5-7: Number of threatened species in the CLW Area over time

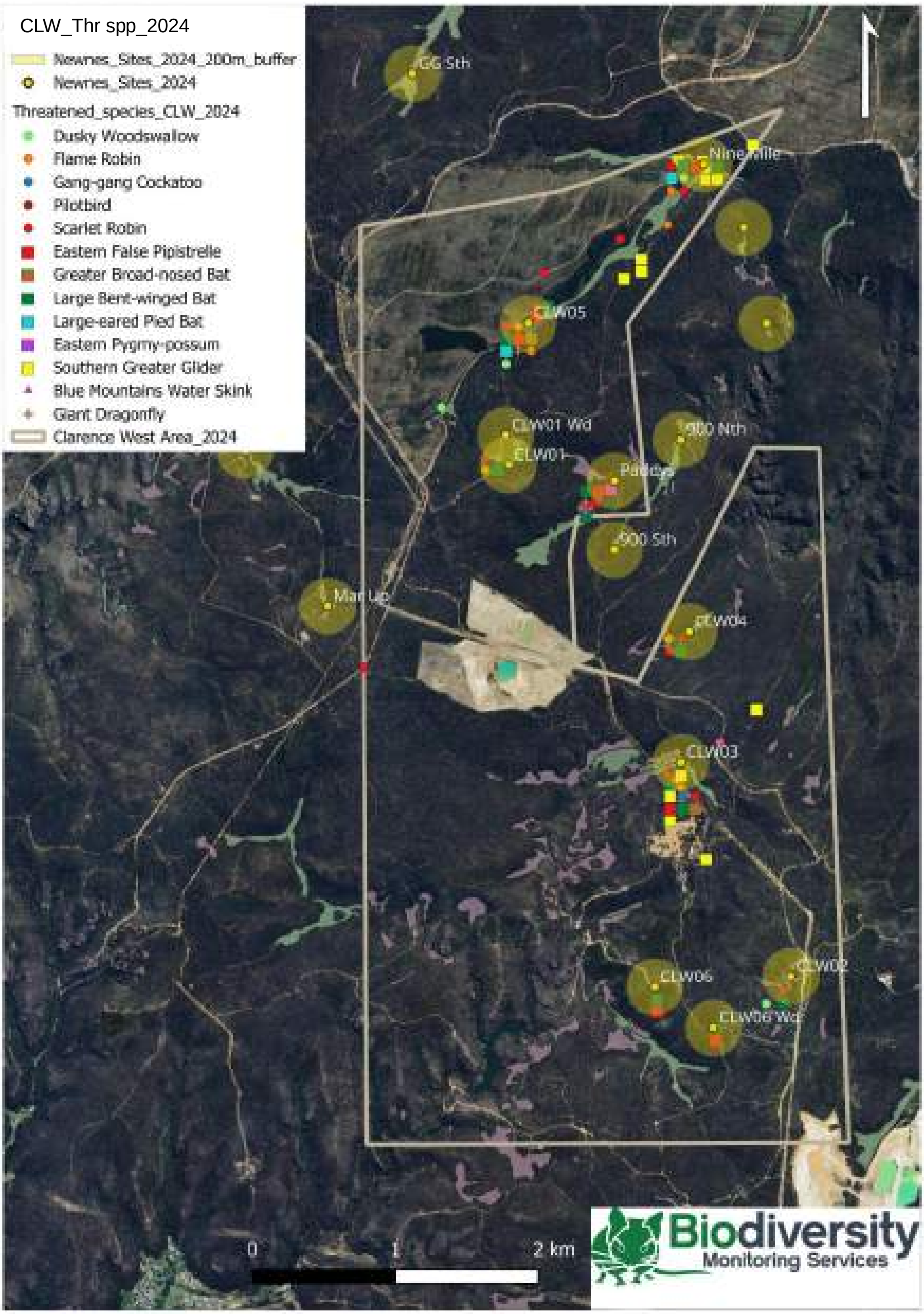


Figure 5-8: Threatened species located within CLW Area this year (locations shifted to allow visualisation of stacked data at single sites)

Habitat Complexity Scores

Data on Habitat Complexity Scores are covered in Section 4 (see **Table 4-2** and **Figure 4-3**). The main benefit from this approach is the production of a single number that can represent habitat values. By tracking such numbers over time some insight into changes in habitat values may be possible.

Comparison between Treatment and Control sites

The sites within the CLW and surrounding Area cover land where secondary extraction has occurred (treatment/impact), and land where undermining has not occurred (control). Treatment sites are CLW01 (undermined spring 2018), CLW02 (undermined Nov 2009), CLW03 (undermined Oct 2010), CLW04 (undermined Nov 2015), CLW05 (undermined spring 2018), CLW06 (undermined Nov 2011), 900 North (undermined from Apr 2023) and 900 South (undermined from Aug 2022). Historically, two additional sites from the Springvale New Area (Nine Mile and Paddy's Swamp) were added to the analysis as control sites. An additional two sites from the 900 Area (900C and 900D) as well as two sites from the North Area (Murray's ad Upper Dingo) are added from 2024 as control sites. Further details on these sites are included in **Table 1-1** of this and the Clarence 900[1] and Clarence North[2] 2024 Final Fauna Reports. **Figure 5-9** to **5-11** show the control and impact fauna diversity values pooled for 2019-2024. **Figure 5-12** shows the HCS for control and impact sites pooled for 2019-2024. The following data is used in this comparison: bird, mammal, reptile and amphibian biodiversity indices, habitat cover characteristics and Habitat Complexity Scores. All sites burnt in both the 2013 and 2019 fires.

Pooled t-tests were conducted on all bird, native non-bat mammal, reptile and amphibian diversity measures to look for differences between control and impact sites in the fire recovery period. Bird Evenness, Simpson's and species richness were higher in control sites (pooled t-test; $p = 0.043$, $p = 0.003$ and $p = 0.004$ respectively). There was no difference in mammal diversity between control and impact sites. Reptile abundance and richness were significantly higher in control sites (pooled t-test; $p = 0.002$ and $p < 0.001$ respectively). Amphibian abundance was higher in control sites ($p = 0.047$), but Simpson's was higher at impact sites ($p = 0.049$). T-tests from autumn and spring generally concur with these assumptions, though seasonal mammal differences (higher at undermined sites in autumn, lower at undermined sites in spring) in the yearly data were not significantly different.

Over the recovery period, there were significant differences in HCS in autumn (pooled t-test; $p = 0.042$) with HCS higher at impact compared to control sites. In spring, HCS was also significantly higher at impact sites ($p = 0.047$).

Overall, there is evidence to suggest reduced bird and reptile diversity in undermined sites post fire. However, the magnitude of the difference in bird diversities was small. Bird Simpson's Diversity Index was only 0.945 at control vs. 0.923 at impact sites. Bird Evenness was 0.884 at control vs. 0.864 at impact sites, which means bird diversities are still good at both groups of sites. Reptile species richness was 3.6 at control sites and 2.2 at impact sites. 900 North (previously a control site) also has a productive reptile search area above the canyon, with lots of exfoliating rock. As this site has changed to impact, it will be interesting to see if the difference between control and impact sites is eroded as time goes on. Frog abundance was much higher at control sites, yet frog Simpson's was much lower at control sites. It should be noted that one of the best frog survey spots on the Plateau is situated at the control site Nine Mile, where a track across the swamp has resulted in a dam with emergent vegetation. Results are inconsistent across taxa and season, so severe impact is unlikely. There is far greater variation in fauna diversities over time, which come from the effects of fire, drought and other climatic changes. Some changes are consistent with previous years findings (bird and reptile), others are new (HCS). Monitoring for consistent differences going forward will be important.

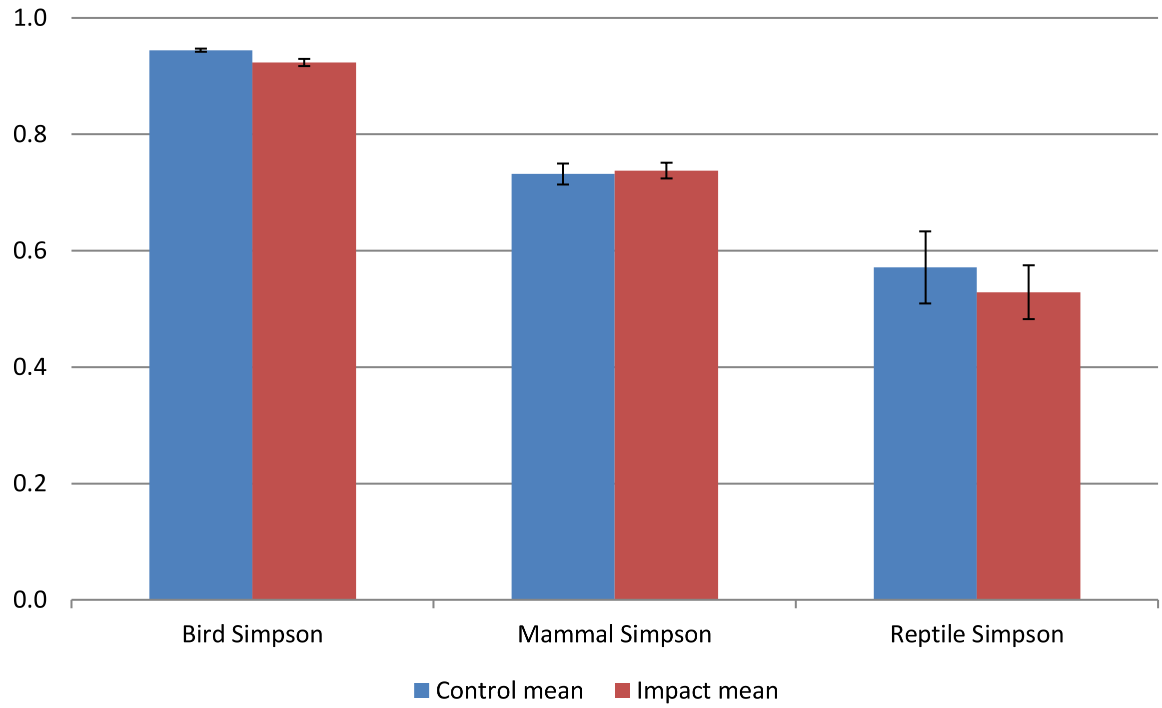


Figure 5-9: Simpson's Diversity Index for birds, mammals and reptiles in control and impact sites

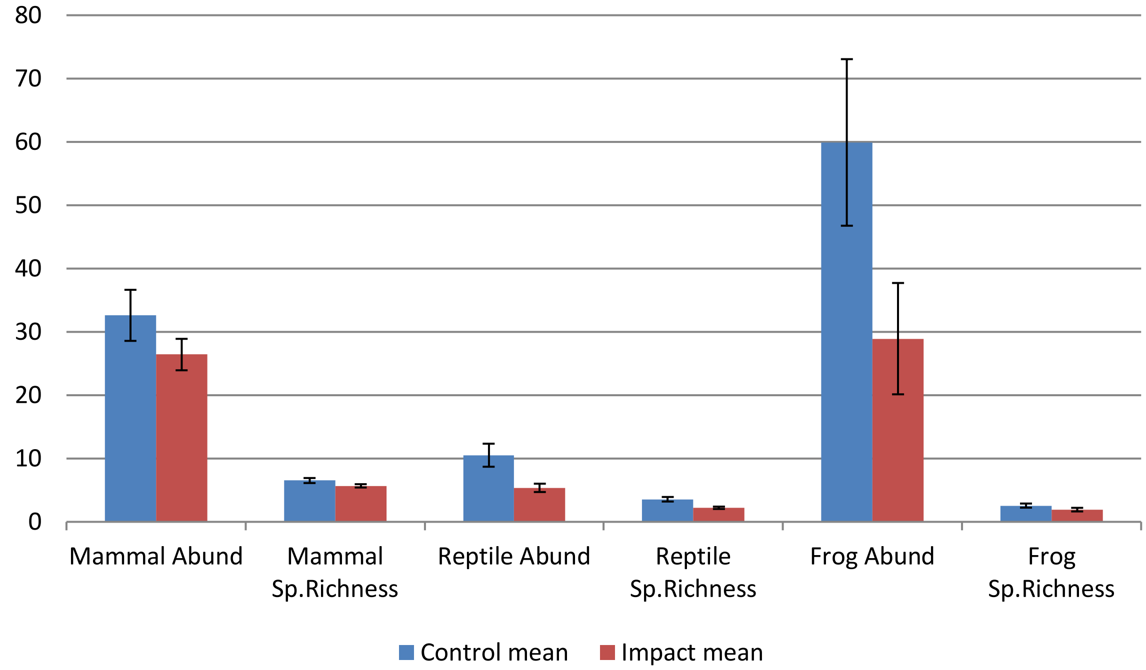


Figure 5-10: Abundance and Species Richness for mammals, reptiles and amphibians in control and impact sites

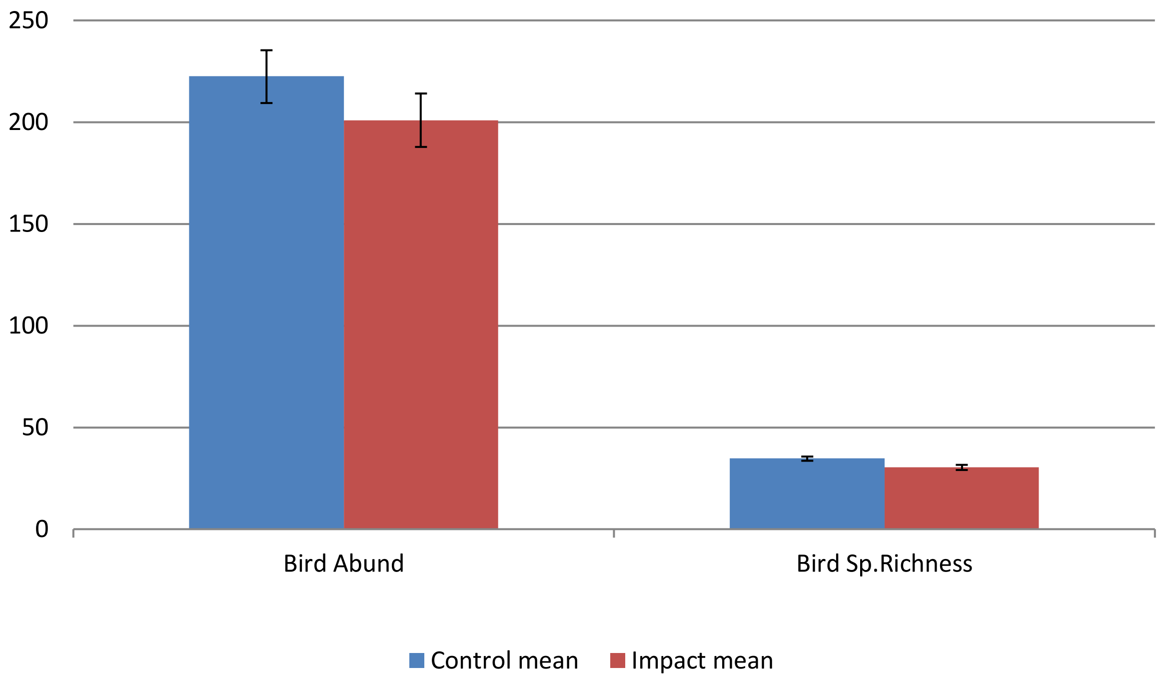


Figure 5-11: Abundance and Species Richness for birds in control and impact sites

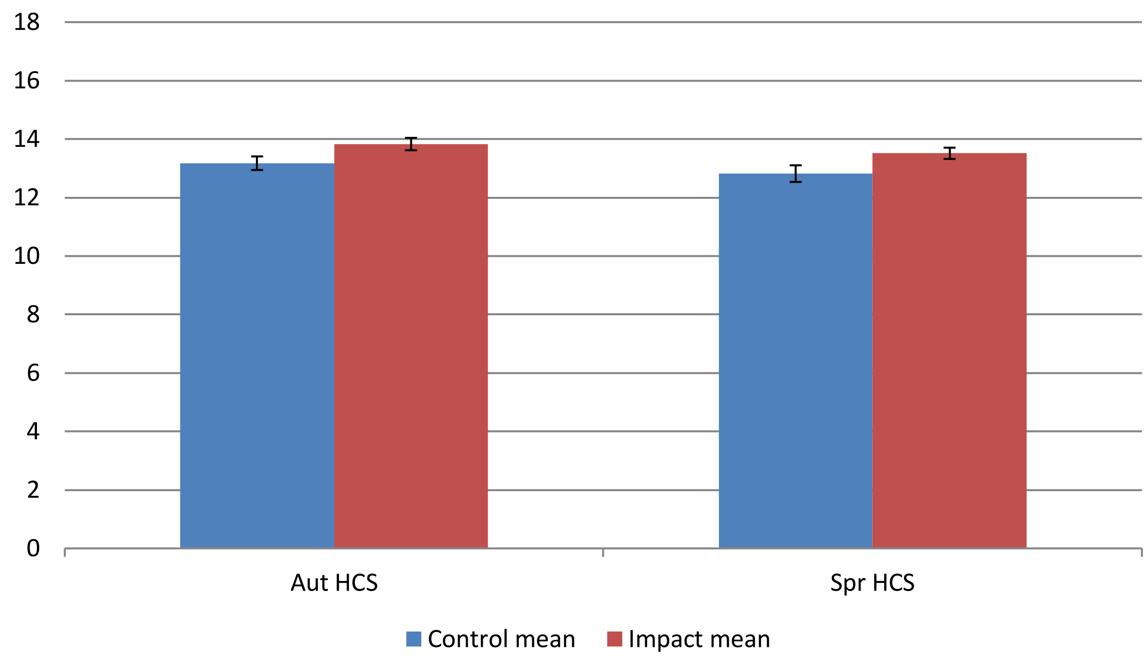


Figure 5-12: Autumn and spring Habitat Complexity Scores for control and impact sites

Bat Activity

Another index that can be derived from the survey data is the species richness and activity of bats over time. Ultrasonic recording with the Anabat device does not allow individual numbers of bats to be ascertained. It does however, let us get an idea of species richness and overall bat activity in an area. Results from the years bat surveys are presented in **Figure 5-13**.

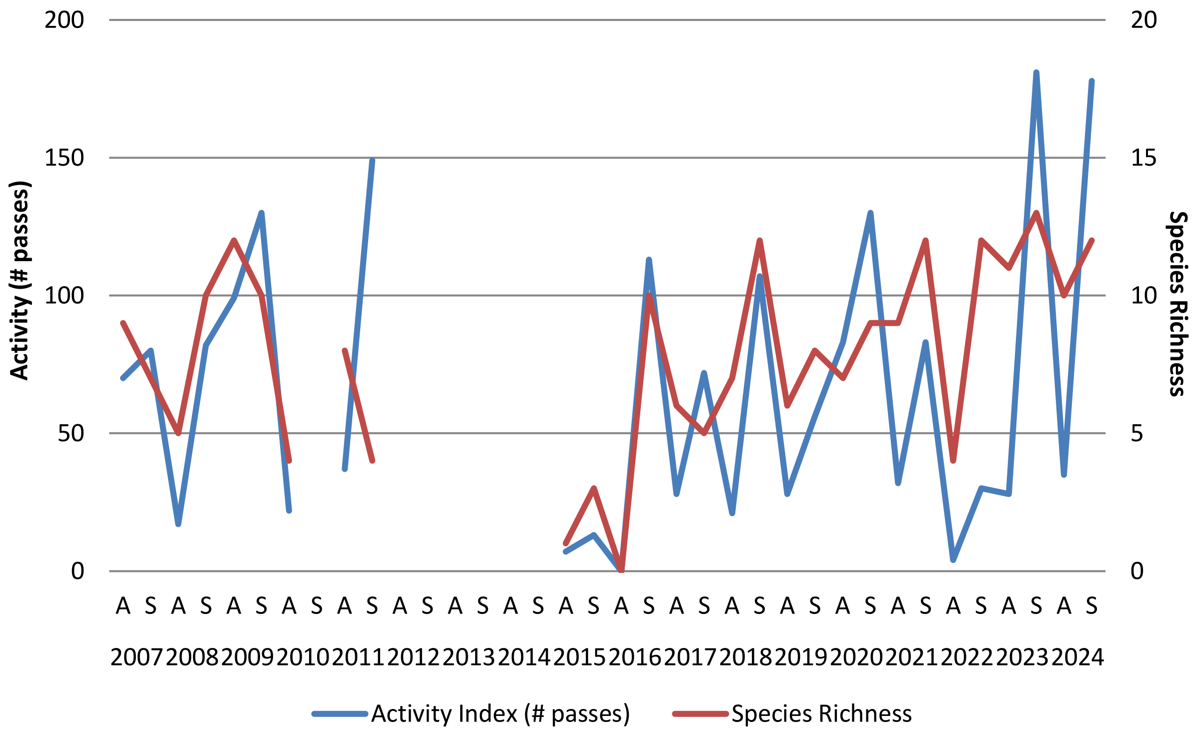


Figure 5-13: Bat species richness and activity index over time

6.0 Conclusion

The configuration of survey sites established in 2006 adequately samples the two major environments within Clarence Colliery Western SMP Application Area i.e. pagoda and wetland (swamp). Pagoda habitat mainly comprises low heath that is characteristic of pagoda and hilltop environments on Newnes Plateau. These sites will provide the best possible data for the long-term monitoring of terrestrial vertebrates. The survey techniques used have been successful in locating a wide range of species. Three new native species were found in the area this year: Eurasian Coot, Welcome Swallow and Yellow-throated Scrubwren.

The Western SMP Area appears to be productive, in terms of fauna diversity values. At this stage 27 threatened species are known to occur within the area, and several species that have been located are considered as being of conservation concern in this region e.g. Beautiful Firetail, Rufous Fantail, Long-nosed Bandicoot. The area should be considered heavily disturbed by recreational activities, particularly trail bikes and 4WDs. This must be brought into consideration when assessing any changes.

The major influence upon the fauna populations (and vegetation) within Clarence West has been the 2013 State Mine and 2019 Gospers Mountain fires that burnt out all the sites in the area. Fire is a natural part of Australian ecosystems and both fires were typical of a high intensity burn. The frequency of fire is the issue here, as sufficient time is required for vegetation and fauna populations to recover before they can withstand another knock down. The data we have obtained over the years provides an important analysis of recovery from fire by fauna. Surveys from 2020 focus on comparing rates of recovery within burnt areas that have been previously mined and those still to be mined or used as controls.

The results from the survey of the Clarence Colliery Western SMP Area in 2024 show that the assemblages found are more typical of that found throughout Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Most diversity parameters have remained stable over the long term, except bird and amphibian species richness which increased to 2018 and showed declines over the 2019-2023 period. However, bird, reptile and amphibian appear to have increased in 2024 and are all back at pre fire levels. Small mammal capture rates almost returned to pre fire levels in 2019, six years post fire, but crashed in 2020 to an all time low. Although capture rates in autumn 2023 were similar to 2013 pre fire levels, there was a substantial decline again in both seasons of 2024. In contrast to pre fire years, small mammal captures are now predominantly driven by Agile Antechinus, rather than Bush Rats. Mean bat activity and species richness in 2024 were similar to that of 2023, where both were the highest on record. As is often the case with fire, once the vegetation and associated food source is wiped out, there is a delay in seeing return of species to the landscape. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. Above average rainfall in most months over the 2020-2022 period appears to have helped start the post fire regeneration process on the Plateau. Fauna results have followed with overall richness and Simpson's diversity mostly within expected ranges, except for reptile and amphibian Simpson's Diversity which declined in 2023 but recovered in 2024. Most functional groups were represented.

Fourteen threatened species were located during 2024, as well several bird species dependent upon woodland habitats. Threatened species included Eastern Pygmy-possum, Southern Greater Glider, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Greater Broad-nosed Bat, Gang-gang Cockatoo, Masked Owl, Pilotbird, Dusky Woodswallow, Scarlet Robin, Flame Robin, Blue Mountains Water Skink and Giant Dragonfly. Their locations are shown in **Figure 5-8**. This is about average, considering a number of species have been listed since surveys began. Woodland-dependant seemed to be dropping slowly over time until 2017 where they fell sharply. The decline has continued to 2024 which is now the lowest year on record for both groups. Both the State Mine and Gospers Mountain fires affected the fauna and habitats within the CLW area, with many measured parameters falling after each.

Most of the variation seen is over time. Seven habitat characteristics varied by mining impact, with six consistent across seasons. Three were higher in undermined sites (hollow, low sapling and rock), and three lower in undermined sites (tall shrub, fern and reed). These results reflect the fact that two of the undermined sites are stunted pagoda heath communities which tend to have shorter mallee eucalypts and absence of a tall shrub layer. Results suggest that the variation in habitat characteristics are driven more by changes in environmental conditions on Newnes Plateau, particularly fire and drought.

Fauna diversities showed some difference by mining impact, but results were inconsistent over season. Bird Simpson's, bird Evenness, bird richness, mammal abundance, reptile richness and frog richness were all lower in undermined sites (only bird Simpson's and richness and frog richness consistently across season). On the other hand, mammal Simpson's and Evenness were higher in undermined sites during autumn analyses only. Yearly analysis restricted to the period where new control sites were added and CLW previous controls were undermined (2019 on), suggest bird Evenness, Simpson's and species richness, reptile abundance and richness, and amphibian abundance are all significantly higher in control sites. Frog Simpson's was lower in control sites. Frog abundance could be biased by optimal frog habitat being present at Nine Mile (control site). Reptile abundance could be biased by an abundance of exfoliated rock habitat nearby 900 North (transitioned from control to impact in 2023). These metrics will be monitored going forward, but if we look at the actual magnitude of difference, Simpson's diversities are still good at both control and undermined sites. Reptile species richness differed by only one species. There were more significant differences over time, suggesting the magnitude of change in habitat and fauna diversities is more dependent on climatic conditions or fire events. While the survey methodology and effort has not changed dramatically since 2010, the sites used in calculations have changed over time as some sites became undermined. Mining commenced in the CLW Area in November 2009, and is now affecting all of the impact survey sites. Undermining of the two control sites by Springvale began in November/December 2018, so these sites have also become impact sites. While the two 900 Area sites were added to analyses as controls previously, these have also both been undermined in 2022-2023. Four new control sites were added from the 900 and North Areas in 2024, but this still leaves the analyses unbalance, which can bias results. As such, results should be interpreted with caution until more complex statistical analysis is developed incorporating a multitude of potentially influencing factors.

Given the low levels of subsidence from previous mining at Clarence Colliery, the risk of adverse impacts on fauna within this area is considered to be low. Statistical analysis of fauna populations in the CLW areas suggest changes in diversities are primarily due to climatic changes, though some evidence of lower diversity measures in undermined sites is shown. The differences seen this year were similar to last year, but different to previous years (except bird Simpson's and richness), so continued monitoring of these indices will tell whether we have evidence of ongoing change due to mining, or simply a temporal anomaly. At present, there appears to be little conclusive evidence of subsidence impacts upon the fauna diversity at CLW Area.

Andrew Lothian BComm/BSc (Hons), BAM Accredited Assessor (BAAS18110), NSW AUSRIVAS Accredited, ECANSW CPEC, President ECANSW, MRZSNSW, MAMS, MABS, MNSWBA

ECA ECOLOGICAL CONSULTANTS ASSOCIATION of NSW Inc
2025 PRACTISING MEMBER

ECOLOGICAL CONSULTANTS ASSOCIATION OF NSW
CERTIFIED PRACTISING ECOLOGICAL CONSULTANT

Alix Bouffet-Halle BSc, MSc, PhD, MECANSW

ECA ECOLOGICAL CONSULTANTS ASSOCIATION of NSW Inc
2025 PRACTISING MEMBER

21 February 2025

Biodiversity Research Pty Ltd
167 McKanes Falls Rd, South Bowenfels, NSW 2790
Telephone: 0421 841 726
Email: andrew.lothian@biodiversitymonitoring.com.au
ABN: 54 617 530 686

www.biodiversitymonitoring.com.au

Pied Currawong at 900 North

Fauna Report

900 Area (Panels 913 and 917) Terrestrial Fauna Monitoring Report (2024 Final)
for
Clarence Colliery Pty Ltd

Prepared for: Matt Ribas
Prepared by: Biodiversity Monitoring Services
Date: 27 February 2025

Document History

Report	Version	Prepared by	Checked by	Submission Method	Date
Fauna	Issue 1	Alix Bouffet-Halle	Andrew Lothian	email	27 Feb 2025

FAUNA MONITORING OF 900 AREA AT CLARENCE COLLIERY

2024 FINAL

A report by Biodiversity Monitoring Services, February 2025

Table of Contents

Figures and tables

1.0 Background

With the expansion of mining into the central part of Clarence Colliery holdings it is necessary to monitor fauna populations within the area, particularly within any swamps considered as Endangered Ecological Communities. Clarence Colliery plans to extend their underground mining into an area termed the '900 Area'. An initial fauna survey was undertaken in spring 2014 and two sites were established:

1) ***Site A 900 North*** Located along Paddy's Creek, a tributary to Bungleboori Creek. The site covers the creekline and surrounding woodland and low heathy shrub. Along the western edge of the site is a cliffline about 50 m high. Vegetation in the swamp was still growing back after the 2013 fire when the more recent fire hit. The creek was flowing during the survey. Site A North sampled land north of Panel 913 and 911. A new quarry operation began upstream of the site in January 2020. <u>Reduced sampling in autumn 2022</u>. It is considered an impact site from autumn 2023.

2) ***Site B 900 South*** Also located along Paddy's Creek, but further towards the headwaters. The site covers the creekline and associated riparian area, as well as the surrounding woodland. At the time of the survey water in the creek was flowing. A deep trench had been dug beside the creek, presumably to drain the area. Site B South sampled land above Panel 915. A new quarry operation has begun upstream of the site in January 2020. It has been considered an impact site since spring 2022.

The 900 Area plans to move north in the coming years. To ensure all undermined swamp habitats are monitored, two new sites have been established in autumn 2024. The addition of these sites will help boost the power of analyses testing for undermining impacts in the 900 Area. For now the two new sites will form controls, but will move to the impact side of the equation in coming years. The two new sites are:

3) **900C** Located in Nine Mile Lower swamp, 400m downstream of the intersection of Pine and Nine Mile swamps (where the Nine Mile control site is currently located). The site covers the creeline and surrounding woodland. The swamp is relatively narrow in this location. Like other areas on the Plateau, vegetation is regenerating post fire. The creek was flowing at the time of survey. Site 900C samples land above the northern end of Panel 920B and 918 A. As it is not yet undermined, the site is currently considered a control site.

4) **900D** Located in Nine Mile Lower swamp, approximately 1000m downstream of 900C, and 600m northeast of A 900 North. The site covers hanging swamp above the creekline where it runs through a deep gully with a tall cliff on the northern side. Like other areas on the Plateau, vegetation is regenerating post fire. The creek has what looks to be a permanent flow in it at this point, as it is located at a lower elevation than 900C. Site 900D samples land just to the east of Panel 918B. As it is not yet undermined, the site is currently considered a control site.

All four sites within Clarence Colliery 900 Area were surveyed for fauna during April and May 2024. The addition of two new 900 Area sites in 2024 represents a doubling of survey effort in the 900 Area. This should be kept in mind especially when considering fauna abundance metrics over time.

The 900 Area is close to the Clarence Western SMP Area. Until spring 2023, 900 Area surveys had included an additional three existing impact sites (CLW01, CLW05 and CLW04) to facilitate statistical analyses. Given that both A 900 North and B 900 South have now been undermined and are now impact sites, the addition of CLW01 is no longer needed to balance the analyses and will be removed as it samples a different habitat to the swamp sites. Nine Mile Swamp (downstream of CLW05) and Paddy's Swamp (between the 900 Area and CLW01) will remain in the 900 Area analyses as additional control sites. Sites included in analyses for the 900 Area include:

1) ***CLW04*** Located to the north of Old Bells Line of Rd to the south of Clarence 900 Area. The site samples shrub swamp and surrounding woodland. This site was undermined in April 2015 so can be used as an impact site. Threatening fire conditions in spring 2019 prevented survey of this site. <u>Not sampled in spring-summer 2019</u>. <u>Only sampled for two nights/three days in autumn 2022</u>.

2) ***CLW05*** Located to the east of Bungleboori camping area downslope of the (now cleared) Pine plantation. The site samples shrub swamp, as well as the surrounding woodland. The swamp has been dry over the last few years. The site only partially burnt in the 2013 State Mine fire, but fully burnt in the 2019 Gospers Mountain fire. This site was within the influence of drawdown from Springvale as of December 2018 so will be used as an impact site.

3) ***Nine Mile Swamp*** Located to the northeast of Bungleboori camping area at the intersections of Nine Mile and Pine Swamps. The swamp is situated downslope of the (now cleared) pine plantation to the south, and some poisoned pine forest to the north. This site looked to have been affected by the 2013 State Mine fire, though this could have been management burning to protect the pine plantation. It burnt again in the 2019 Gospers Mountain fire. The swamp is a good representative of Newnes Plateau Shrub Swamp and is to be used as a control site.

4) ***Paddy's Swamp*** Located at the eastern edge of Springvale Colliery near the Clarence 900 Area. The swamp is surrounded by native woodland. The swamp is a good representative of Newnes Plateau Shrub Swamp and is to be used as a control site. This site currently sits over Panel 915 and may need to be moved upswamp to maintain Control status. Mining came near Paddy's Swamp in July 2022. Though Paddy's is proximal to Clarence underground mining operations, drawdown does not typically occur as a result of bord and pillar mining (only longwall mining). As such, it remains a control site in the analyses. <u>Reduced sampling in spring 2022.</u> Boggy ground prevented vehicle access to the site, so only bird surveys were conducted over three days in spring 2024.

It is important to note that this baseline monitoring program has focussed on the Newnes Plateau Shrub Swamp and Hanging Swamp environments (albeit slightly different types) as they are considered to be the most sensitive habitat overlying the proposed mining area. It is also noted, that by virtue of the fauna monitoring methods, woodland habitats are also surveyed. The locations of the two fauna monitoring sites are shown in **Figure 1-1**, with surrounding monitoring sites from the Clarence Area also included. The main watercourses and roads are shown along with the Clarence mining lease boundary.

Survey areas within the Clarence 900 Area were directly affected by the 2013 State Mine fire. They were impacted again by the Gospers Mountain fire in mid-December 2019. Maps of the extents from each fire are shown in **Figure 1-2**. All sites included in the analysis burnt in 2013 and 2019. No summer surveys were conducted in 2019, and spring surveys for CLW02, CLW03, CLW04 and CLW06 had to be cancelled. Data used in the 2019 final report is pre fire, while all 2020-24 data is post fire.

Surveys were first undertaken during spring 2014 (after the State Mine fire), and were repeated in autumn, spring and summer thereafter to ensure a complete set of baseline data. The spring 2014 surveys used standardised methodology to establish baseline data for fauna populations to be used for on-going monitoring of the potential impacts from the development of Clarence 900 Area. The methodology used is similar to that applied to long-term fauna monitoring surveys by Centennial Coal throughout Newnes Plateau.

Table 1-1 provides information about each site, in terms of landscape characteristics and vegetation communities sampled. Vegetation communities were obtained from the Vegetation of the Western Blue Mountains mapping by Office of Environment and Heritage (OEH). In addition, habitat characteristics were measured at each site and these are provided in Section 4.

Table 1-1: Locations of the monitoring sites at Clarence 900 Area

Site name	Easting	Northing	Landscape	Vegetation	Establishment date	Undermining date
A 900 North	241839	6299342	Heath Swamp within steep-sided valley	Newnes Plateau Shrub Swamp (low disturbance), Newnes Plateau Hanging Swamp (low disturbance)	spring 2014	October 2022 (potential drawdown), April 2023 (extraction)
B 900 South	241374	6298571	Woodland moving into heath swamp within shallow-sided valley	Newnes Plateau Shrub Swamp (moderate disturbance), Tableland Mountain Gum – Snow Gum – Daviesia Montane Open Forest (high disturbance)	spring 2014	August 2022 (extraction)
900C	242283	6300823	Woodland moving into heath swamp within shallow-sided valley	Newnes Plateau Shrub Swamp (low disturbance), Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest (moderate disturbance)	autumn 2024	NA
900D	242442	6300155	Hanging Swamp within steep-sided valley	Newnes Plateau Hanging Swamp (low disturbance), Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest (low disturbance)	autumn 2024	NA
CLW04	241899	6297998	Heath swamp within steep-sided valley	Newnes Plateau Shrub Swamp (low disturbance), Newnes Plateau Narrow-leaved Peppermint – Silver-top Ash Layered Open Forest (high disturbance)	spring 2006	April 2015 (development), November 2015 (extraction)
CLW05	240772	6300158	Heath swamp within steep-sided valley	Newnes Plateau Shrub Swamp (moderate disturbance)	spring 2006	December 2018 (drawdown)
Nine Mile	242000	6301270	Heath Swamp within steep-sided valley	Newnes Plateau Shrub Swamp (moderate disturbance)	autumn 2018	NA
Paddy's Swamp	241375	6299055	Heath Swamp within steep-sided valley	Newnes Plateau Shrub Swamp (low disturbance)	autumn 2018	mining proximal from July 2022

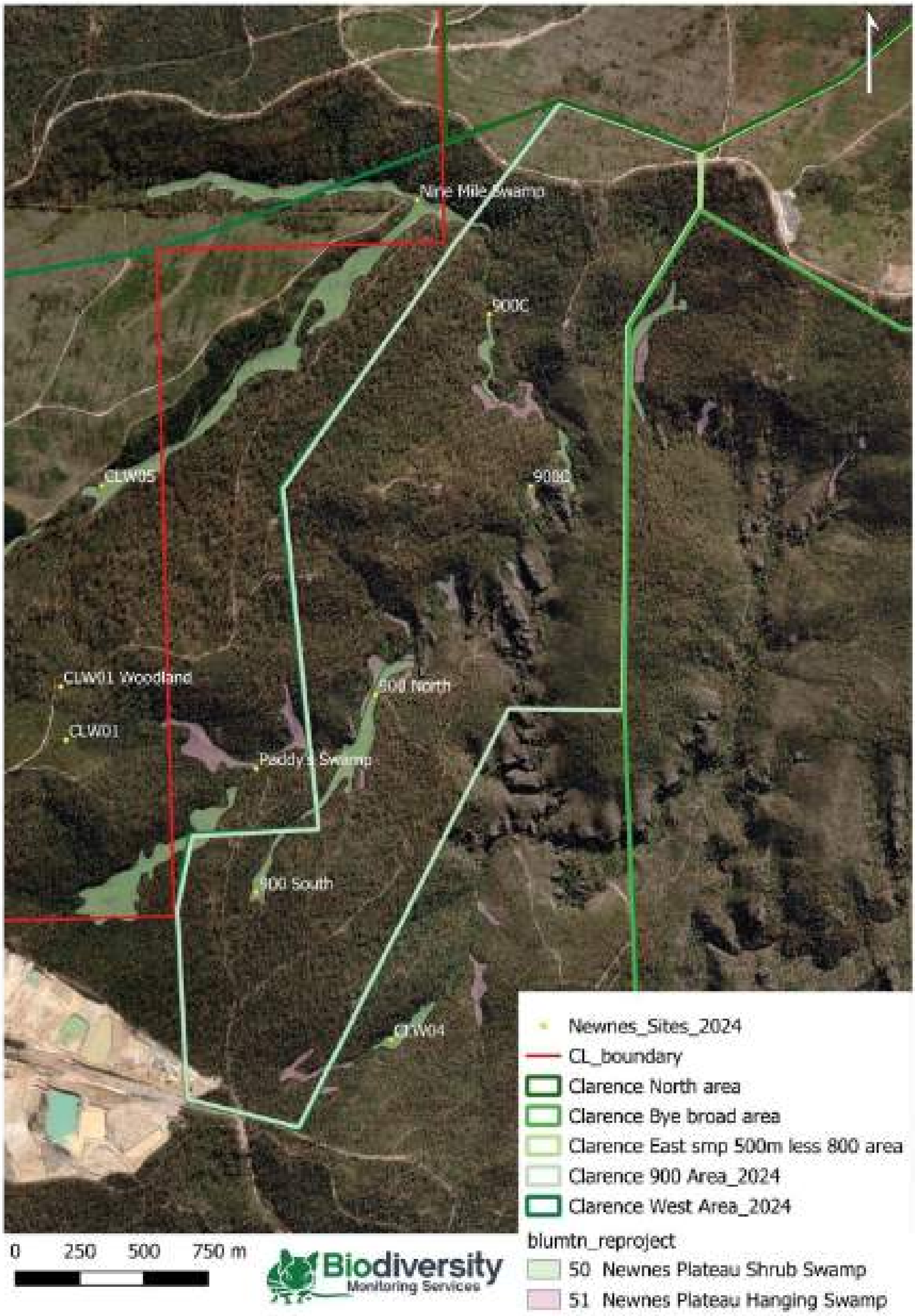


Figure 1-1: Locations of survey sites and nearby monitoring sites

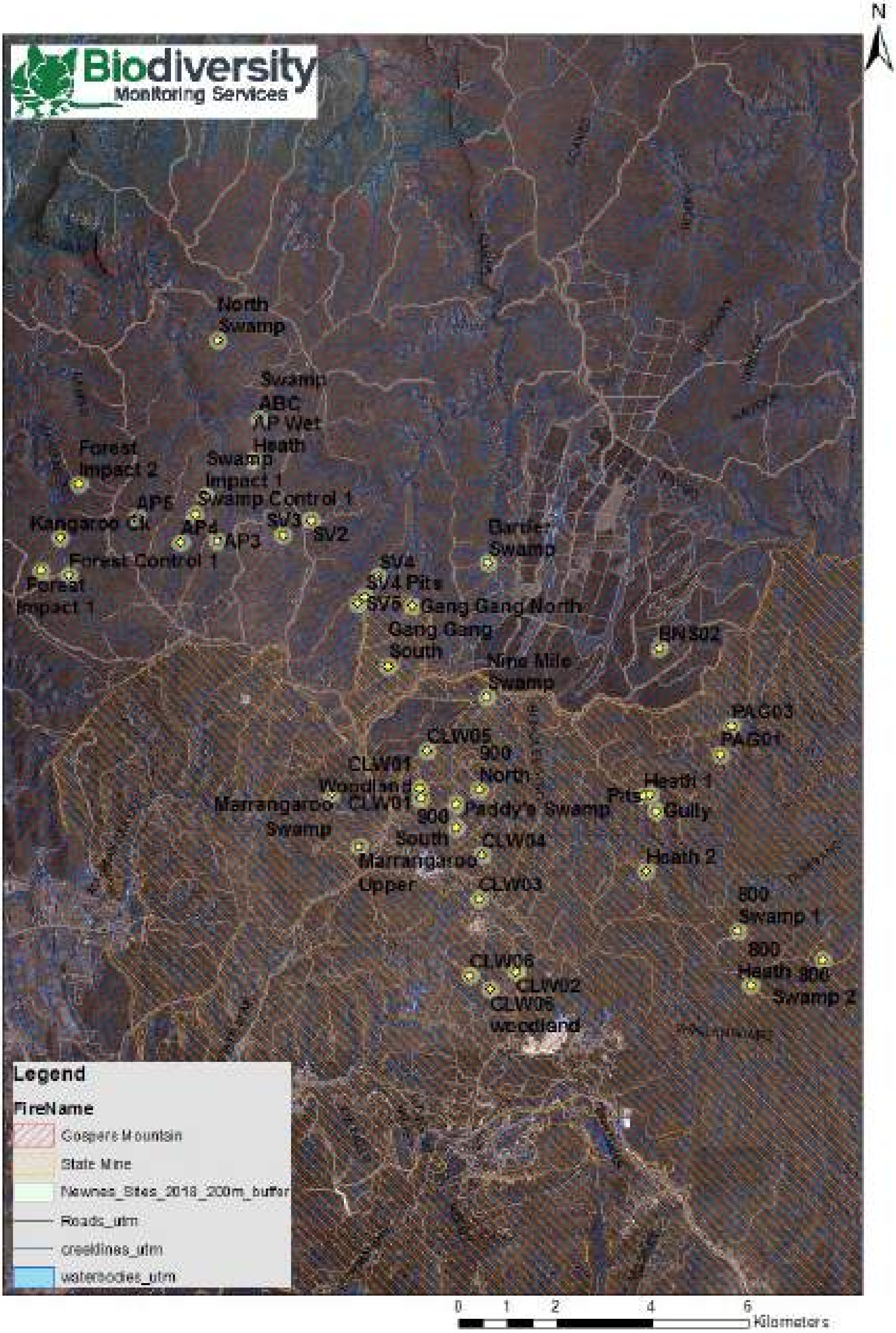


Figure 1-2: Extent of State Mine Fire in 2013 and Gospers Mountain Fire in 2019

2.0 Survey methodologies and survey efforts

The 900 Area sites were surveyed between the 15th April and 24th May, the 19th September and 4th October and 25th November and 24th December 2024 by Andrew Lothian, Matt Dobson, Elyse Tomkins, Alix Bouffet-Halle and Mikaela Cole using NPWS Scientific Licence No. SL101725 and DPI's Animal Research Authority No. 16/559. Autumn surveys focussed on small mammals (including bats) colonising new areas, reptiles and birds still active. Spring surveys targeted breeding activity by birds. Summer surveys targeted the activity period for reptiles (Blue Mountains Water Skink), bats, amphibians and Giant Dragonfly.

Because of the amount of existing information available on the fauna populations within and surrounding the Clarence Colliery area (surveys have been undertaken for 21 years), it is now possible to refine the approach to undertaking baseline and monitoring surveys. Any data obtained from the surveys of the two sites in the 900 Area can be placed into the context of a large body of information about fauna populations inhabiting areas with different treatments at Newnes Plateau. Trap lines were established across each site to ensure the maximum sampling of the dominant habitats. Pit traps were re-established at 900 North and South, but pits were not used at 900 North in 2024 due to waterlogged ground. Pit traps were established at 900C, but not at 900D (hanging swamp and rocky ground not suited to pitfall trapping).

The methodology follows that established during surveys in previous years and other monitoring areas at Clarence, Angus Place and Springvale, to ensure consistency of approach and provide a basis for comparative studies. A summary of the survey effort at each site is given in **Tables 2-1** to **2-2**. A full description of the survey methodologies is provided below and in the BMS methods supplement[1]. The techniques used during the survey followed, as closely as possible, the draft working guidelines produced by DECC (2004)[2]. Although these guidelines are in draft form and still subject to review, they provide an important direction on survey methodology, including suggested survey effort. The survey techniques have remained constant over the years during the surveys undertaken at Newnes Plateau. This will continue into the future to ensure comparative data is obtained. The survey techniques are consistent with methodologies outlined in the *Clarence Colliery 900 Area SMP Environmental Monitoring Program*. Results from 21 years of surveys on Newnes Plateau have shown that little additional information about mammalian fauna is obtained during summer. Hence, summer surveys normally focus on threatened species likely to be active during this season (i.e. Giant Dragonfly and Blue Mountains Water Skink), as well as avifauna (particularly summer migrants), bats, reptiles and amphibians.

Targeted surveys for each of the threatened species known from the locality were undertaken and **Table 2-3** summarises the methods used for each group of species.

---

[1] BMS (2017). *Methodologies Supplement (2017)* - Methodologies Used to Conduct Terrestrial Fauna Surveys and Monitoring (2017).

[2] DECC (2004). *Threatened Species Survey & Assessment: Guidelines for Developments and Activities - Working Draft Report*, prepared by DECC.

**Note: From spring 2023 hair funnels are no longer used due to animal welfare concerns (skinks getting stuck).*

Table 2-1: Different techniques used during the autumn and spring surveys

Survey technique	900 North	900 South	900C	900D	Nine Mile	Paddy's Swamp
Ground Elliott traps	25	25	25	25	25	25
Tree-mounted Elliott traps	5	5	5	5	5	5
Ground Tomahawk traps	3	3	3	3	3	3
Tree-mounted Tomahawk traps	3	3	3	3	3	3
Large Elliott traps	2	2	2	2	2	2
Glider tubes	2	2	2	2	2	2
Pit traps	-	3	4	-	-	3
Remote IR cameras	2	2	2	2	2	2
Anabat recording	Yes	Yes	Yes	Yes	Yes	Yes
Call broadcasting	Yes	-	-	-	Yes	-
Bird counts	Yes	Yes	Yes	Yes	Yes	Yes
Litter searches	Yes	Yes	Yes	Yes	Yes	Yes
Amphibian searches	Yes	Yes	Yes	Yes	Yes	Yes
Reptile walks	Yes	Yes	Yes	Yes	Yes	Yes
Rock turning	400	-	-	400	-	-

Table 2-2: Number of trap nights undertaken in four 900 Area sites during autumn and spring surveys

Survey technique	Autumn	Spring	Total
Ground Elliott traps	400	400	800
Tree-mounted Elliott traps	80	80	160
Tomahawk traps	96	96	192
Large Elliott traps	32	32	64
Glider tubes	32	32	64
Pit traps	28	28	56
Remote IR cameras	32	32	64
Anabat recording	9	8	17
Rock/log turning	800	750	1550
Spotlighting transects	21.0 km; 3.5 hr	41.3 km; 5.5 hr	62.3 km; 9.0 hr

Table 2-3: Methods used to target threatened species

Fauna group	Targeted survey methodology
Threatened amphibians	Searching preferred habitat, pit trapping, call analysis, reptile funnels
Threatened reptiles	Searching preferred habitat, searching under rocks, pit trapping, reptile funnels, tiles
Threatened diurnal birds	General observation, call recognition
Threatened nocturnal birds	General observation, spotlighting, call broadcasting
Threatened arboreal marsupials	General observation, tree traps, spotlighting, call broadcasting, pit trapping, detection of characteristic sap cuts and scratches on trunks, scat identification
Threatened large ground marsupials	General observation, ground traps, spotlighting, searching for characteristic diggings, recognition of tracks, scat identification
Threatened small ground mammals	Elliott trapping, pit trapping, recognition of tracks
Threatened bats	Ultrasonic call detection (Anabat)
Threatened invertebrates	Searches in preferred habitats

As each Elliott trap was laid, habitat description of the trap site was recorded. This included the upper, middle and lower storey vegetation, as well as the ground cover, within an area formed by a one metre radius around each trap. For example, if 10 trap sites out of a trap line of 25 Elliott traps contained a shrub, then it was estimated that the shrub cover in that survey site was 40%.

AUTUMN AND SPRING SURVEYS

Methodologies used in autumn and spring surveys are as follows:

a. Elliott Trapping

Twenty-five small (8x10x33cm) Elliott traps were laid in straight lines for five days through the habitats at each site. This is equivalent to 100 trap nights over four consecutive nights at each site. The traps were baited with a mixture of rolled oats, peanut butter and devon, and a small piece of Dacron was placed within each trap (as protection against the cold). A freezer bag was placed over the end of each trap to prevent the contents becoming wet from the rain. At each trap site a description of the physical characteristics of the habitat within a one metre radius was noted. This information was used in the analysis of habitat values.

To sample any small arboreal mammals, five small Elliott traps were mounted on trees at equal distances along each transect (20 trap nights over five consecutive days at each site). Aluminium tree mounts were attached to trees and a baited Elliott trap attached to the mount. The tree trunk and trap were sprayed with a honey-water mixture to assist in attracting any nectar or sap feeding arboreal mammals. Again, Dacron and freezer bags were used to combat the cold and wet conditions.

b. Cage Traps

Three Tomahawk cage traps were laid on the ground and three Tomahawk traps were mounted on trees at each site (24 trap-nights). Two large Elliott traps were placed at each site (8 trap-nights). The large Elliott traps and the Tomahawk traps were baited with apple, muesli bar and devon.

c. Spotlighting

Two forms of spotlighting transect were undertaken. Tracks within the 900 Area were spotlighted from a moving vehicle. In addition, spotlighting on foot was undertaken at the detailed fauna survey sites.

d. Glider Traps

Two vertical plastic tube traps were set up at each site and used as a tree-mounted pit-fall traps. These have been developed to trap small gliders (Squirrel and Sugar Gliders) and have been used successfully in coastal areas[3].

e. Remote Cameras

Tree-mounted remote cameras (Scoutguard, Reconyx and Swann) were used at selected sites to capture images of any animal using the area, particularly near the traps.

f. Bird Surveys

In addition to the results obtained from general observations and spotlighting, listening and observing periods were undertaken at the two sites. Taking into consideration the discussion in the working draft on methods to survey diurnal birds (DECC 2006), an area-search method was used at each site. A 30 minute search was used where the observer walked around each site, as well as observing and listening for calls from a single point. At each site up to four periods of observation were undertaken (two in the early morning and two in the late morning).

g. Call Broadcasting

Calls of several species of nocturnal bird were broadcast during the night in the general area. Calls were broadcast through a megaphone for approximately five minutes, with a ten minute listening time. Calls from the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*), Southern Boobook (*Ninox boobook*), Tawny Frogmouth (*Podargus strigoides*), Eastern Barn Owl (*Tyto javanica*) and the White-throated Nightjar (*Eurostopodus mystacalis*). Koala (*Phascolarctos cinereus*), Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*) and Sugar Glider (*Petaurus breviceps*) were also broadcast.

h. Pitfall Traps

Pit traps were established at 900 North, 900 South and 900C. None were established at 900 D due to rocky ground not being suited to pitfall trapping..

i. Herpetological Searches

Systematic searches for reptiles and amphibians were undertaken within each habitat type at each survey site. Litter was raked and rocks and logs turned over. Loose bark was prised from the trunks of dead trees. Each search took approximately 30 minutes and was repeated at each site. Searches

[3] Winning, G. and King, J. 2008. A new trap design for capturing squirrel gliders and sugar gliders. *Australian Mammalogy* **29**: 245-249.

for amphibians took place at night using spotlights (particularly after rain) and recognition of characteristic calls. Spotlighting searches were also attempted for reptiles.

j. Bat Call Detection
An Anabat Express ultrasonic bat detector was placed at selected sites for two nights and any recorded bat calls analysed by Andrew Lothian and Glenn Hoye.

k. Animal Track Recognition
Areas of sand on tracks were inspected for evidence of animal movement. Paw prints and other animal signs were identified and recorded.

l. Opportunistic Observations
Any sightings of fauna were recorded whilst moving throughout the 900 area and located using a Global Positioning System (GPS). Any scats were collected and their contents analysed.

m. Estimation of Diversity
Because of the accumulation of data under formal survey conditions (consistent survey effort and techniques at each survey site) it is possible to calculate some comparisons and relationships from the results of the survey.

Total numbers and species richness (number of species per site) are the simplest measures used to determine biodiversity of a site. However, these indices miss the information that some species may be rare and others common. The Simpson's Index of Dominance (D) takes into account both the abundance patterns and the species richness of a community. This index measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). It was possible to calculate Simpson's Index of Diversity for mammal, bird and sometimes reptile and frog populations from each survey site for most survey periods.

An evenness score was also calculated. Evenness is a measure of the relative abundance of different species making up the richness of an area. A low value for evenness means that the sample is dominated by a large number of one or two species. A high evenness value means that most species in the sample have a similar abundance.

SUMMER SURVEY

An area that included each survey site and a surrounding buffer of about 1km radius was searched over a period of three days for signs of fauna. In particular, searches targeted threatened species such as the Giant Dragonfly and Blue Mountains Water Skink. Both these species are associated with wet areas so the swamps and creeklines were searched at and around each site. Bird surveys were also undertaken. The census period was at least 30 minutes at each site. Spotlighting surveys were also undertaken at each site, mainly on foot using a 50 watt light. Whilst spotlighting each site, calls from nocturnal fauna were also recorded (i.e. frogs, gliders, owls etc.). Of particular interest were threatened species that would be more active during the warm summer period. Fauna results from this summer survey are presented below.

3.0 Weather during the trapping survey

Data from weather station at Lithgow Cooerwull (from Bureau of Meteorology) is given in **Table 3-1**. Total monthly rainfall at Lithgow Cooerwull (from BOM) is graphed against the long-term average in **Figure 3-1**.

Table 3-1: Weather records from Lithgow during 2024 surveys

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)
13/04/2024	3.8	20.7	0
14/04/2024	7.5	21.3	0.2
15/04/2024	3.2	20.9	0
16/04/2024	3.4	21.4	0
17/04/2024	8.0	21.7	0
18/04/2024	10.9	18.8	0
19/04/2024	1.6	14.5	0
18/05/2024	4.4	8.7	0
19/05/2024	-2.0	11.6	0
20/05/2024	-3.4	11.6	0
21/05/2024	-0.1	14.8	0.2
22/05/2024	0.5	12.0	0
23/05/2024	-1.7	16.4	0
24/05/2024	-1.0	16.6	0
17/09/2024	-2.6	15.2	0
18/09/2024	-2.3	17.8	0
19/09/2024	8.3	19.0	0
20/09/2024	6.0	15.6	0
21/09/2024	7.4	15.0	0
22/09/2024	8.4	17.2	0
23/09/2024	3.3	20.0	0
24/09/2024	2.7	22.8	0
25/09/2024	12.9	21.2	0
26/09/2024	6.2	7.2	10.2
27/09/2024	4.7	10.3	14.8
28/09/2024	6.0	13.3	1.4
29/09/2024	8.5	17.3	0.2

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)
30/09/2024	9.4	18.2	7.2
01/10/2024	4.4	18.6	0
02/10/2024	9.9	15.3	0.4
03/10/2024	7.9	17.2	0
04/10/2024	3.4	19.2	0
23/11/2024	9.8	27.4	0
24/11/2024	10.9	29.8	0
25/11/2024	11.3	31.7	0
26/11/2024	13.8	30.5	0
27/11/2024	12.3	28.4	0
28/11/2024	15.5	25.2	0.4
29/11/2024	14.9	18.6	63.0
30/11/2024	16.0	20.2	21.4
01/12/2024	16.1	24.2	14.8
02/12/2024	12.0	28.8	0.4
03/12/2024	14.6	23.9	0
04/12/2024	17.4	24.5	9.6
05/12/2024	15.4	27.3	0
06/12/2024	16.8	27.4	1.8
14/12/2024	14.9	30.0	0
15/12/2024	14.6	30.7	0
16/12/2024	13.6	31.1	0
17/12/2024	12.8	31.2	0
18/12/2024	12.9	17.7	0.4
19/12/2024	11.1	19.5	0.4
20/12/2024	6.8	26.9	0
21/12/2024	9.9	29.4	0
22/12/2024	15.2	29.4	0
23/12/2024	8.5	19.8	0
24/12/2024	7.0	24.5	0

The extended dry periods of 2018-2019 were broken in 2020 with many months in 2020, 2021 and 2022 showing greater than average rainfall. Overall rainfall in 2024 was above average, with 39.4mm more than the long-term average. Monthly rainfall in 2024 was roughly double the long-term average in January, April and November (**Figure 3-1**). Rainfall in March, August and October was less than half the long-term average while the remaining months were similar to the long-term average. Most of NSW has been in rainfall surplus over the last 36 months (**Figure 3-2**), particularly in the central tablelands/western slopes. If we drop this to the last 12-month period, it shows a mix of surplus and deficit over NSW, but average conditions over the central tablelands (**Figure 3-2**).

0.4mm rain fell over the autumn survey period. 34.2mm of rain fell during the spring survey period. There were heavy rainfalls over the summer survey period, with a total of 145.8mm, a large portion of which fell on a single day. This event led to November recording near twice the long-term average rainfall, while December rainfall was similar to its long-term average (**Figure 3-1**).

Maximum temperatures in summer were about 2°C above the long-term average, while minimum temperatures were about 1.5°C above average. March maximum temperatures were 1.5°C above average, and May minimum temperatures were 1.4°C above average, while other autumn maximum and minimum temperatures were similar to long term averages. September minimum temperatures were 1.1°C above average, while other spring maximum and minimum temperatures were around long term average. The large rainfall event during summer surveys meant frog survey conditions were very good for a short period of time.

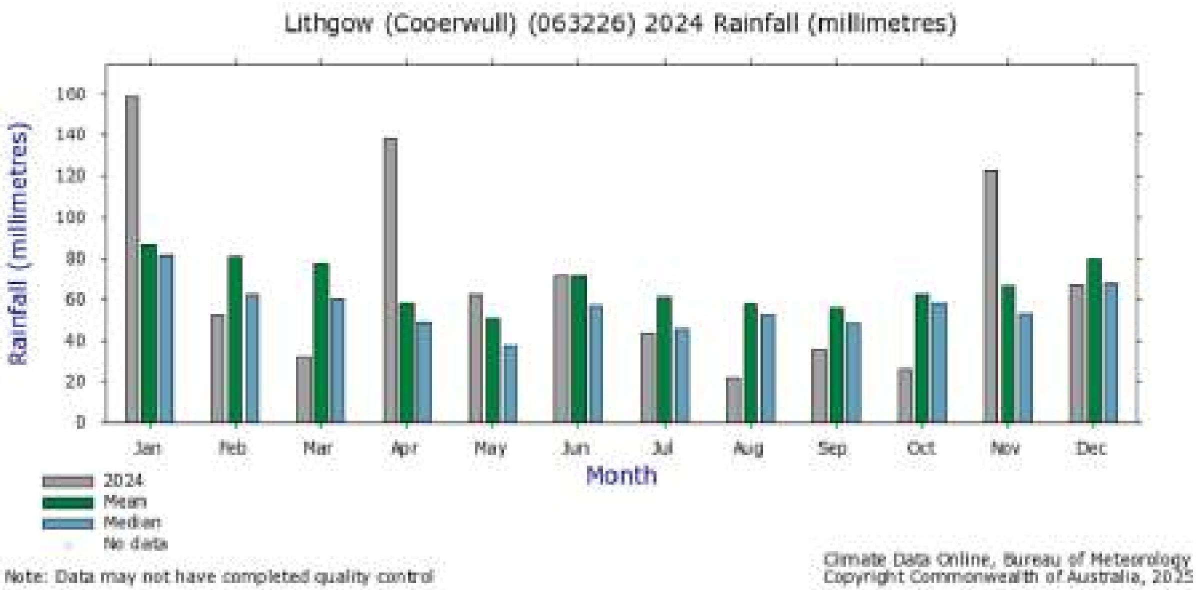


Figure 3-1: Total monthly rainfall in 2024 vs long-term mean monthly rainfall 1994-2024 (BOM, 2025)

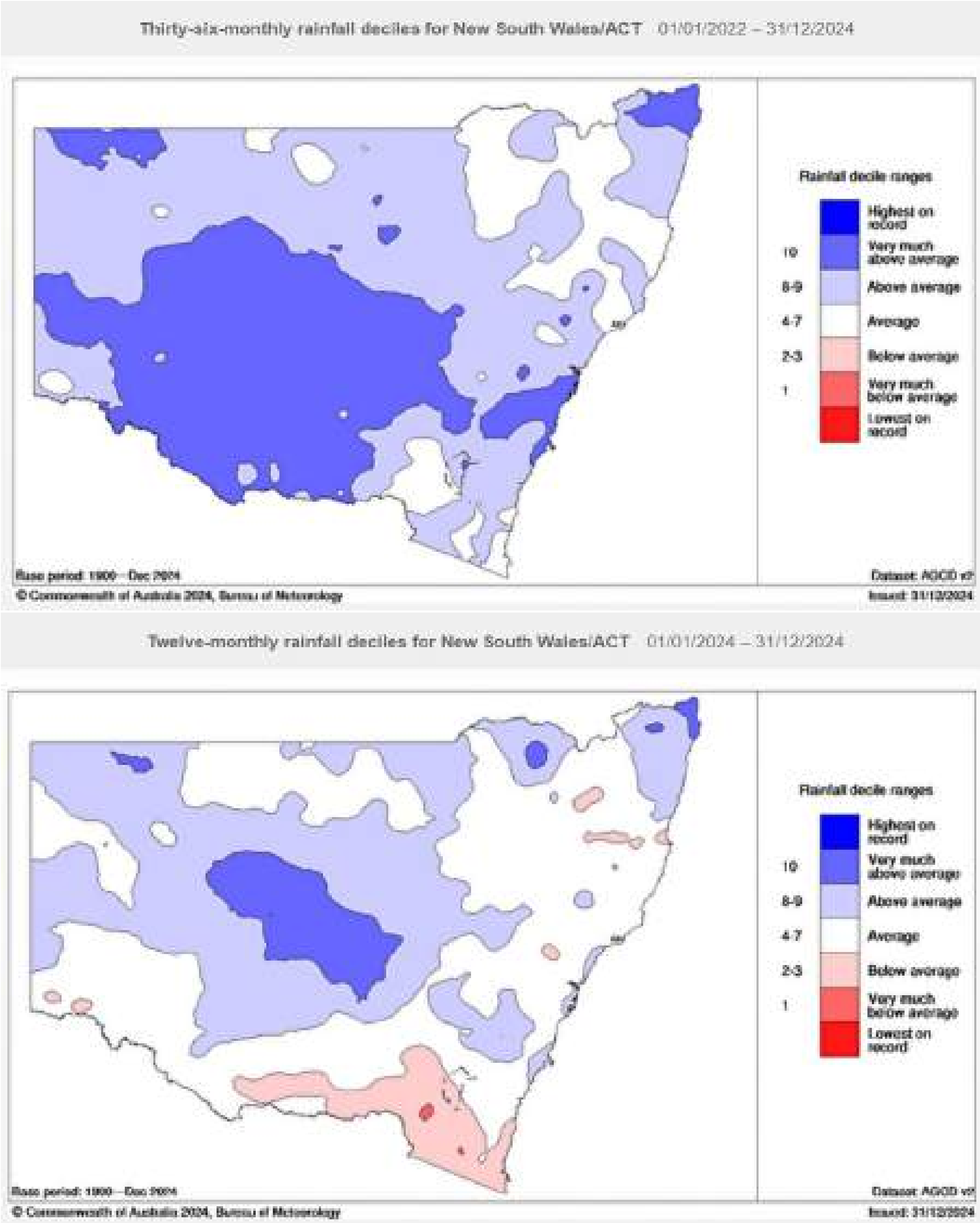


Figure 3-2: 36-month (top) and 12-month (bottom) rainfall deficiency map (BOM, 2025)

4.0 Results - habitat measurement

Measurements from descriptions of each Elliott trap site were used to provide an index of habitat condition. It has been found that the use of walking transects to determine habitat condition in swamp and rocky areas did not provide an accurate picture of habitat characteristics. Consequently, information derived from the trap placement descriptions is now used. **Table 4-1** provides the data obtained from the autumn and spring surveys since 2014. Habitat assessment is illustrated in **Figures 4-1** and **4-2**.

Autumn analyses restricted to the four 900 Area site habitat cover characteristics showed significant variation over time (One-way Repeated Measures ANOVAs), noting two of the sites only started being surveyed in 2024. Tree cover was significantly higher in 2023 compared to 2015 and 2019 ($p = 0.013$). Hollow cover was significantly higher in 2023 compared to all years except 2017 ($p = 0.005$). Tall shrub cover was significantly lower in 2015 and 2020-23 ($p = 0.035$). Low sapling cover was significantly higher in 2021 compared to 2019 ($p = 0.024$). Grass cover was significantly higher in 2021 and 2023 compared to 2016 ($p = 0.029$). Fern cover was significantly lower in 2020 compared to 2018-19 ($p = 0.010$). Reed cover was significantly lower in 2023 compared to 2017, 2019 and 2024 ($p = 0.012$).

There were also a number of significant differences in the spring habitat cover characteristics over time (One-way Repeated Measures ANOVAs). Tree cover was significantly higher in 2023 compared to 2019 ($p = 0.041$). Tall shrub cover in 2016-19 and 2024 was significantly higher than all other years; and 2023 was significantly higher than 2020-22 ($p = 0.030$). Low shrub cover was significantly lower in 2020 compared to 2016-19 and 2023; and significantly lower in 2021 compared to 2017, 2019 and 2023 ($p = 0.005$). Low sapling cover was significantly higher in 2020 compared to 2015-16 and 2019; and significantly higher in 2021 and 2023 compared to 2019 ($p = 0.006$). Grass cover was significantly higher in 2024 compared to 2014-17 and 2019 ($p = 0.003$). Fern cover was significantly lower in 2023-24 compared to 2019 ($p = 0.012$). Forb cover was significantly higher in 2020, 2022 and 2024 compared to 2015-16 and 2019 ($p = 0.003$). Litter cover was significantly lower in 2014 compared to all years except 2016 ($p = 0.016$). Log cover was significantly higher in 2017 compared to 2015 and 2022 ($p = 0.021$). Most of these differences line up with expected changes post-fire.

We can now conduct statistical analysis on the impacts of mining in the 900 Area, though with undermining only recently taking place in the area (August 2022 and April 2023) the analyses for Clarence West are more comprehensive, and better examine the impacts of mining on habitat characteristics at Clarence. A series of t-tests were conducted on impact (undermined) and control site habitat characteristics (pooled over 2015-2024). These analyses include the two CL900 impact sites, the two CLW impact sites, the two new CL900 control sites and the two Springvale control sites. In autumn, fern cover was significantly lower at undermined sites compared to control sites ($p < 0.001$). In contrast tall sapling, low sapling, grass, forb, cutting grass and vine covers were all significantly higher at impact sites compared to control sites ($p = 0.016$, $p = 0.013$, $p = 0.034$, $p < 0.001$, $p = 0.009$ and $p = 0.002$ respectively).

T-tests were also run on impact and control site spring habitat characteristic data (pooled over 2014-2024). Fern and reed covers were significantly lower at undermined sites compared to control sites ($p < 0.001$ and $p = 0.044$ respectively). Conversely, tall sapling, low sapling, grass, forb and vine covers were significantly lower at control sites compared to impact sites ($p = 0.031$, $p = 0.007$, $p = 0.030$, $p = 0.019$ and $p = 0.004$ respectively).

As with most areas on Newnes Plateau, the habitat characteristics vary from year to year due to changes in the prevailing weather each year. Many characteristics were increasing as they recovered from the 2013 fire, which occurred before sampling in this area started. Tall shrub, tall sapling, low shrub, fern and reed covers all fell after the most recent fire. Tree, low sapling, grass, forb and log covers all increased. Most of these increases are due to trap placement near cover in a post fire landscape, but the increase in grass (native grasses in particular) has been seen across the region with the good rains received in 2020-2022.

Table 4-1: Overall mean habitat characteristics in autumn (A) and spring (S) each year

% Cover	2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Tree	-	7	8	10	16	14	20	8	14	10	12	4	32	36	28	28	20	18	38	38
Tree hollow	-	2	0	3	4	6	8	2	4	2	2	2	6	6	4	4	2	4	18	12
Tall shrub	-	5	2	8	18	16	20	25	16	32	30	24	0	2	0	0	0	2	2	8
Tall sapling	-	12	14	16	14	13	22	14	18	20	28	22	4	12	28	28	24	18	32	30
Low shrub	-	78	76	84	96	90	90	97	96	95	50	96	30	48	70	56	78	84	72	94
Low sapling	-	45	34	36	36	36	40	36	36	33	28	8	74	78	82	66	58	50	54	64
Grass	-	18	26	22	20	18	26	30	36	32	32	14	48	40	62	50	50	38	60	50
Fern	-	28	54	38	66	41	62	42	70	57	68	72	34	50	40	48	52	42	40	36
Forb	-	69	58	55	38	51	58	70	50	59	46	42	54	80	74	70	72	80	58	60
Cutting grass	-	75	80	74	60	50	86	66	76	59	68	64	56	80	66	72	66	64	76	88
Reed (sedge)	-	46	68	62	70	70	80	70	60	71	72	62	42	36	34	44	54	40	18	16
Vine	-	0	0	4	0	5	4	8	0	8	4	0	0	2	2	0	8	10	8	8
Litter	-	80	98	98	100	99	100	98	100	100	100	100	100	100	100	100	100	100	100	100
Log	-	11	24	9	22	16	18	26	24	15	18	22	34	30	24	24	20	12	22	20
Rock	-	3	2	2	2	2	0	2	0	1	0	0	2	2	2	2	4	6	2	0

Table 4-2 cont.: Overall mean habitat characteristics in autumn (A) and spring (S) each year

% Cover	2024	
	A	S
Tree	31	23
Tree hollow	3	5
Tall shrub	16	21
Tall sapling	18	22
Low shrub	67	82
Low sapling	26	24
Grass	44	68
Fern	56	57
Forb	68	73
Cutting grass	58	75
Reed (sedge)	54	60
Vine	2	4
Litter	99	100
Log	20	14
Rock	12	4

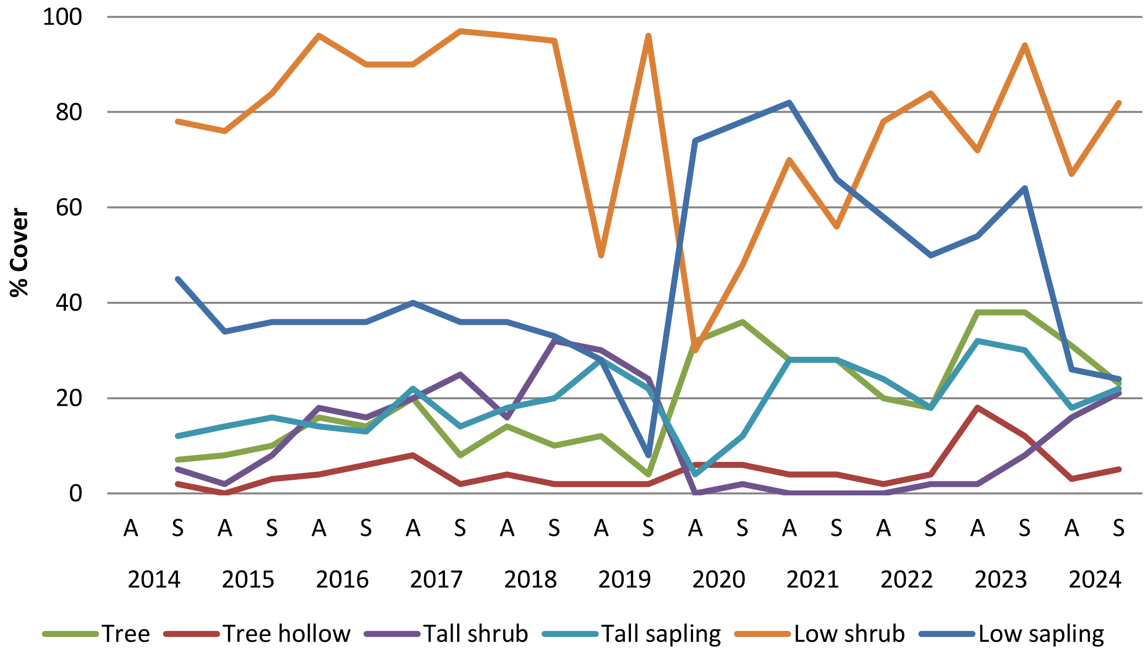


Figure 4-1: Overall mean habitat characteristics over time – upper and middle strata

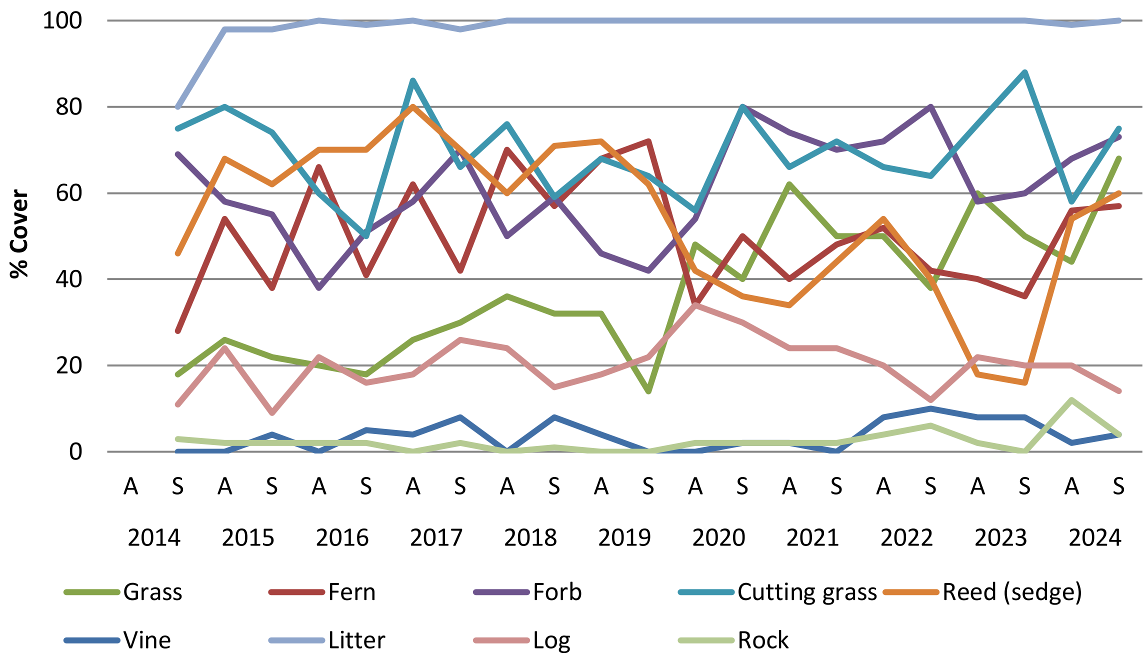


Figure 4-2: Overall mean habitat characteristics over time - lower strata and ground cover

Measurements of habitat characteristics derived from trap site descriptions have been used to provide an index of habitat complexity. This can then be used to determine changes in habitat through time in the study area. One index system used is that developed by Catling and Burt (1995[4]) called the Habitat Complexity Score (HCS). This system scores the following parameters: tree cover, tall and short shrub cover, ground cover, logs/rocks and litter cover. Parameter scores range from 0 to 3, hence the maximum score is 18 for a site overall. HCS for each site are given in **Table 4-2**.

Despite the fire in 2019, the scores still indicate high habitat complexity. There are a number of reasons why this might be the case. As habitat features such as trees and logs are sought out for sheltering traps, structural complexity is artificially inflated. This system is a coarse method for assessing structural change in habitats. As it relies on presence/absence of cover components (rather than repeated cover estimates), and certain components can be biased by movements of the trap line, the scope to pick up changes from fire is limited if regrowth of certain components has already begun[5]. Also, since surveys in the area only began after the 2013 fire, traps have always been set near sparse cover in a post fire landscape.

Habitat Complexity Scores for the 900 Area were increasing slowly as sites recovered from the State Mine fire in October 2013 (**Figure 4-3**). Dry conditions in 2017-19 caused renewed decline in HCS, though the second fire did not drive scores as low as the first. Rainfall saw an increase in 2020-22 scores, with both autumn and spring 2023 presenting the highest HCS on record for the area. Autumn scores did not differ significantly over the years (One-way Repeated Measures ANOVA on the four 900 Area sites). Pooled t-tests on data from 2015 to 2024 from eight sites (the four 900 sites plus four nearby sites from CLW and Springvale) showed that HCS were significantly higher at impact sites compared to control sites ($p = 0.019$).

Spring HCS did not differ significantly over time (One-way Repeated Measures ANOVA on the four 900 Area sites). A pooled t-test (over the years 2014-2024 using the four 900 Area sites and the four additional sites) showed spring HCS to be significantly higher in impact compared to control sites ($p = 0.023$). These scores show that all sites structurally provide good habitat for ground dwelling mammals and woodland birds, but only as food resources begin to return to the landscape.

[4] Catling P. C. and Burt R.J. (1995). Studies of the ground-dwelling mammals of eucalypt forests in south-eastern New South Wales: the effect of habitat variables on distribution and abundance. *Wildlife Research* **22**: 271-288.

[5] Lothian, A.J., Denny, M.J.S. and Tong, N.W. (2022). Mammalian responses to fire on Newnes Plateau: A yardstick for future recovery. *Australian Zoologist* **42(2)**: 278-303.

Table 4-3: Habitat Complexity Scores for autumn (A) and spring (S) over time

Site	2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
A North	-	12	13	12	13	13	13	14	12	12	13	12	12	12	13	14	13	13	15	14
B South	-	11	11	13	13	14	14	13	13	13	14	12	12	14	14	14	14	13	14	15
900C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
900D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overall mean	**-**	**11.5**	**12.0**	**12.5**	**13.0**	**13.5**	**13.5**	**13.5**	**12.5**	**12.5**	**13.5**	**12.0**	**12.0**	**13.0**	**13.5**	**14.0**	**13.5**	**13.0**	**14.5**	**14.5**

Site	2024	
	A	S
A North	14	15
B South	14	13
900C	13	13
900D	15	14
Overall mean	**14.0**	**13.8**

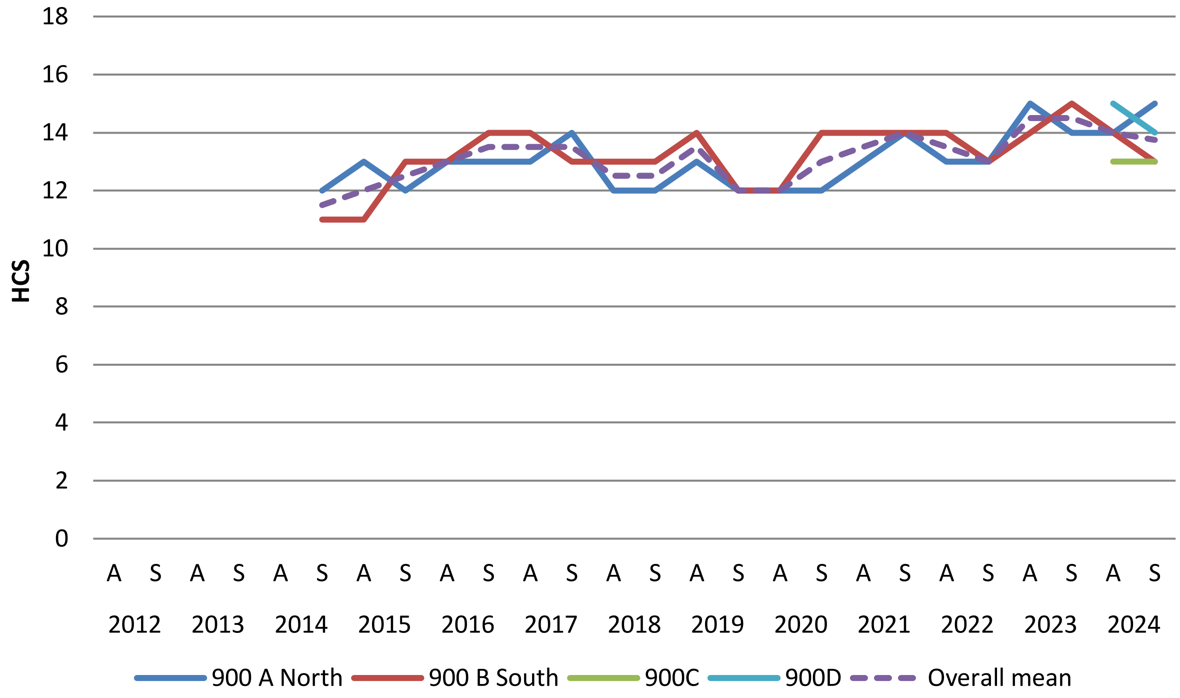


Figure 4-3: Changes in Habitat Complexity Scores over time

5.0 Results - fauna located

Twenty-five native mammal (plus one introduced), 61 bird, 11 reptile, six amphibian and zero invertebrate species were recorded from the 900 Area. **Tables 5-1** to **5-5** provide a list of species located within the 900 Area during the 2024 surveys. Calculations of diversity indices were undertaken where possible and presented in **Table 5-6**.

P – Protected species V – Vulnerable species U – Introduced species

Threatened species highlighted in green

Table 5-1: Mammals located within Clarence Colliery 900 Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Dasyuridae			
Antechinus agilis	Agile Antechinus	P	
Antechinus stuartii	Brown Antechinus	P	
Dasyurus maculatus	Spotted-tailed Quoll	V	E
Vombatidae			
Vombatus ursinus	Bare-nosed Wombat	P	
Burramyidae			
Cercartetus nanus	Eastern Pygmy-possum	V	
Petauridae			
Petaurus breviceps	Sugar Glider	P	
Pseudocheiridae			
Petauroides volans	Southern Greater Glider	E	E
Pseudocheirus peregrinus	Common Ringtail Possum	P	
Phalangeridae			
Trichosurus vulpecula	Common Brushtail Possum	P	
Macropodidae			
Macropus giganteus	Eastern Grey Kangaroo	P	
Macropus rufogriseus	Red-necked Wallaby	P	
Wallabia bicolor	Swamp Wallaby	P	
Rhinolophidae			
Rhinolophus megaphyllus	Eastern Horseshoe-bat	P	
Molossidae			
Austronomus australis	White-striped Freetail-bat	P	
Ozimops ridei	Eastern Free-tailed Bat	P	

Scientific Name	Common Name	NSW Status	Cwlth Status
Vespertilionidae			
Chalinolobus dwyeri	Large-eared Pied Bat	E	E
Chalinolobus gouldii	Gould's Wattled Bat	P	
Chalinolobus morio	Chocolate Wattled Bat	P	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	
Nyctophilus sp.	Long-eared Bat sp.	P	
Vespadelus darlingtoni	Large Forest Bat	P	
Vespadelus regulus	Southern Forest Bat	P	
Muridae			
Rattus fuscipes	Bush Rat	P	
Rattus lutreolus	Swamp Rat	P	
Canidae			
Vulpes vulpes	Fox	U	

Table 5-2: Birds located within Clarence Colliery 900 Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Podargidae			
Podargus strigoides	Tawny Frogmouth	P	
Aegothelidae			
Aegotheles cristatus	Australian Owlet-nightjar	P	
Falconidae			
Falco cenchroides	Nankeen Kestrel	P	
Cacatuidae			
Cacatua galerita	Sulphur-crested Cockatoo	P	
Callocephalon fimbriatum	Gang-gang Cockatoo	E	E
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	P	
Psittacidae			
Alisterus scapularis	Australian King-Parrot	P	
Platycercus elegans	Crimson Rosella	P	
Cuculidae			
Cacomantis flabelliformis	Fan-tailed Cuckoo	P	
Strigidae			
Ninox novaeseelandiae	Southern Boobook	P	
Tytonidae			

Scientific Name	Common Name	NSW Status	Cwlth Status
Tyto novaehollandiae	Masked Owl	V	
Alcedinidae			
Dacelo novaeguineae	Laughing Kookaburra	P	
Todiramphus sanctus	Sacred Kingfisher	P	
Menuridae			
Menura novaehollandiae	Superb Lyrebird	P	
Climacteridae			
Climacteris erythrops	Red-browed Treecreeper	P	
Cormobates leucophaea	White-throated Treecreeper	P	
Ptilonorhynchidae			
Ptilonorhynchus violaceus	Satin Bowerbird	P	
Maluridae			
Malurus cyaneus	Superb Fairy-wren	P	
Malurus lamberti	Variegated Fairy-wren	P	
Dasyornithidae			
Pycnoptilus floccosus	Pilotbird	V	V
Acanthizidae			
Acanthiza lineata	Striated Thornbill	P	
Acanthiza pusilla	Brown Thornbill	P	
Acanthiza reguloides	Buff-rumped Thornbill	P	
Gerygone olivacea	White-throated Gerygone	P	
Hylacola pyrrhopygia	Chestnut-rumped Heathwren	P	
Sericornis citreogularis	Yellow-throated Scrubwren	P	
Sericornis frontalis	White-browed Scrubwren	P	
Pardalotidae			
Pardalotus punctatus	Spotted Pardalote	P	
Pardalotus striatus	Striated Pardalote	P	
Meliphagidae			
Acanthorhynchus tenuirostris	Eastern Spinebill	P	
Anthochaera carunculata	Red Wattlebird	P	
Caligavis chrysops	Yellow-faced Honeyeater	P	
Melithreptus brevirostris	Brown-headed Honeyeater	P	
Melithreptus lunatus	White-naped Honeyeater	P	
Nesoptilotis leucotis	White-eared Honeyeater	P	
Philemon corniculatus	Noisy Friarbird	P	
Phylidonyris novaehollandiae	New Holland Honeyeater	P	
Psophodidae			

Scientific Name	Common Name	NSW Status	Cwlth Status
Cinclosoma punctatum	Spotted Quail-thrush	P	
Psophodes olivaceus	Eastern Whipbird	P	
Neosittidae			
Daphoenositta chrysoptera	Varied Sittella	V	
Campephagidae			
Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	
Pachycephalidae			
Colluricincla harmonica	Grey Shrike-thrush	P	
Falcunculus frontatus	Eastern Shrike-tit	P	
Pachycephala pectoralis	Golden Whistler	P	
Pachycephala rufiventris	Rufous Whistler	P	
Artamidae			
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	
Cracticus tibicen	Australian Magpie	P	
Cracticus torquatus	Grey Butcherbird	P	
Strepera graculina	Pied Currawong	P	
Strepera versicolor	Grey Currawong	P	
Rhipiduridae			
Rhipidura albiscapa	Grey Fantail	P	
Rhipidura rufifrons	Rufous Fantail	P	
Corvidae			
Corvus coronoides	Australian Raven	P	
Petroicidae			
Eopsaltria australis	Eastern Yellow Robin	P	
Petroica boodang	Scarlet Robin	V	
Petroica phoenicea	Flame Robin	V	
Timaliidae			
Zosterops lateralis	Silvereye	P	
Hirundinidae			
Petrochelidon nigricans	Tree Martin	P	
Turdidae			
Zoothera lunulata	Bassian Thrush	P	
Estrildidae			
Neochmia temporalis	Red-browed Finch	P	
Stagonopleura bella	Beautiful Firetail	P	

Table 5-3: Amphibians located within Clarence Colliery 900 Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Myobatrachidae			
Crinia signifera	Common Eastern Froglet	P	
Pseudophryne bibronii	Bibron's Toadlet	P	
Hylidae			
Litoria citropa	Blue Mountains Tree Frog	P	
Litoria peronii	Peron's Tree Frog	P	
Litoria verreauxii verreauxii	Verreaux's Tree Frog (subsp)	P	
Litoria lesueuri	Lesueur's Frog	P	

Table 5-4: Reptiles located within Clarence Colliery 900 Area

Scientific Name	Common Name	NSW Status	Cwlth Status
Scincidae			
Acritoscincus platynota	Red-throated Skink	P	
Ctenotus taeniolatus	Copper-tailed Skink	P	
Eulamprus heatwolei	Yellow-bellied Water-skink	P	
Eulamprus leuraensis	Blue Mountains Water Skink	E	E
Lampropholis delicata	Dark-flecked Garden Sunskink	P	
Lampropholis guichenoti	Pale-flecked Garden Sunskink	P	
Liopholis whitii	White's Skink	P	
Pseudemoia entrecasteauxii	Tussock Cool-skink	P	
Tiliqua nigrolutea	Blotched Blue-tongue	P	
Agamidae			
Rankinia diemensis	Mountain Dragon	P	
Elapidae			
Pseudonaja textilis	Eastern Brown Snake	P	

Table 5-5: Invertebrates located within Clarence Colliery 900 Area

Scientific Name	Common Name	NSW Status	Cwlth Status
None found*			

andrew.lothian@biodiversitymonitoring.com.au

Table 5-6: Biodiversity indices for fauna in 900 Area

Site	Evenness	Simpson's Index of Diversity	Abundance	Species Richness
		BIRDS		
900 Area	0.861	0.964	1088	61
900 North	0.881	0.951	284	41
900 South	0.925	0.962	194	35
900C	0.904	0.959	261	40
900D	0.893	0.949	327	36
		NATIVE MAMMALS (non-bat)		
900 Area	0.685	0.776	193	14
900 North	0.816	0.754	33	6
900 South	0.677	0.694	69	8
900C	0.825	0.787	36	7
900D	0.682	0.656	40	7
		REPTILES		
900 Area	0.664	0.700	72	11
900 North	0.395	0.257	15	3
900 South	0.774	0.500	4	2
900C	1.000	0.762	7	3
900D	0.753	0.711	36	7
		AMPHIBIANS		
900 Area	0.207	0.181	264	6
900 North	0.370	0.232	152	3
900 South	1.000	0.667	3	2
900C	0.152	0.075	105	3
900D	0.000	0.000	1	1

The fauna assemblage is similar to that recorded from other areas within Clarence Colliery and Newnes Plateau, with similar species richness values and similar species located. A list of species located within the 900 Area from 2014 to 2024 is given in **Table 5-7**. The cumulative number of new species located each year is given in **Figure 5-1**. It is expected that the number of new species located each year will level out and the final maximum species richness for the area can be estimated from the value of the asymptote. By 2024, 86 bird, 29 native mammal (plus six introduced), 21 reptile, eight amphibian and one invertebrate species have been located within the 900 Area.

Table 5-7: Species located in 900 Area from the results of surveys since 2014 (threatened species highlighted in green)

Common Name	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
MAMMALS											
Agile Antechinus				X	X	X	X	X	X	X	X
Bare-nosed Wombat	X	X	X	X	X	X	X	X	X	X	X
Black Rat										X	
Brown Antechinus				X		X		X	X	X	X
Bush Rat	X	X	X	X	X	X	X	X	X	X	X
Cat							X				
Chocolate Wattled Bat		X	X	X		X	X	X		X	X
Common Brushtail Possum			X	X		X					X
Common Dunnart								X		X	
Common Ringtail Possum				X	X						X
Dingo, domestic dog		X		X	X	X	X	X	X		
Eastern False Pipistrelle		X	X	X	X	X	X	X	X	X	X
Eastern Free-tailed Bat					X		X				X
Eastern Grey Kangaroo	X	X	X	X		X	X	X		X	X
Eastern Horseshoe-bat				X	X	X		X			X
Eastern Pygmy-possum		X	X				X				X
Fox		X		X	X	X	X	X	X		X
Gould's Long-eared Bat			X								
Gould's Wattled Bat		X	X	X	X	X	X	X		X	X
House Mouse		X	X					X			
Large Bent-winged Bat		X	X	X	X	X	X	X	X	X	X
Large Forest Bat			X	X	X	X	X	X	X	X	X
Large-eared Pied Bat		X		X	X	X	X	X			X
Long-eared Bat sp.				X		X	X	X		X	X
Long-nosed Bandicoot										X	
Rabbit		X					X	X			
Red-necked Wallaby	X	X		X	X	X	X	X	X	X	X
Southern Forest Bat			X	X	X	X	X	X	X	X	X
Southern Greater Glider				X		X				X	X
Spotted-tailed Quoll											X
Sugar Glider				X							X
Swamp Rat		X	X	X	X	X			X	X	X
Swamp Wallaby	X	X	X	X		X		X			X

Common Name	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
White-striped Freetail-bat	X	X	X	X	X	X	X	X	X	X	X
Yellow-bellied Sheath-tailed Bat				X	X						
BIRDS											
Australian Crake		X									
Australian King-Parrot		X	X		X		X				X
Australian Magpie	X	X	X	X	X	X	X	X		X	X
Australian Owlet-nightjar		X		X	X				X		X
Australian Raven	X	X	X	X	X	X	X	X	X	X	X
Australian Wood Duck							X		X		
Bassian Thrush			X								X
Beautiful Firetail			X		X				X		X
Black-faced Cuckoo-shrike	X	X	X	X	X	X	X	X	X		X
Brown Thornbill	X	X	X	X	X	X	X	X	X	X	X
Brown-headed Honeyeater	X	X	X	X	X	X	X				X
Brush Cuckoo			X								
Buff-rumped Thornbill		X		X	X	X	X	X	X	X	X
Channel-billed Cuckoo		X									
Chestnut-rumped Heathwren				X		X					X
Cicadabird		X		X	X		X				
Collared Sparrowhawk							X		X		
Common Bronzewing								X		X	
Crescent Honeyeater				X	X						
Crimson Rosella	X	X	X	X	X	X	X	X	X	X	X
Dusky Woodswallow					X						X
Eastern Rosella		X		X			X	X			
Eastern Shrike-tit	X	X	X	X	X	X	X	X			X
Eastern Spinebill	X	X	X	X	X	X	X	X	X	X	X
Eastern Whipbird		X	X	X	X	X	X	X	X	X	X
Eastern Yellow Robin	X	X	X	X	X	X	X	X	X	X	X
Fan-tailed Cuckoo	X	X	X	X	X	X	X	X	X	X	X
Flame Robin	X	X	X	X	X	X	X		X		X
Gang-gang Cockatoo	X	X	X	X	X	X	X	X		X	X
Golden Whistler	X	X	X	X	X	X	X	X		X	X
Grey Butcherbird			X	X	X		X	X	X		X
Grey Currawong	X	X	X	X	X	X	X	X	X	X	X
Grey Fantail	X	X	X	X	X	X	X	X	X	X	X

Common Name	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Grey Shrike-thrush	X	X	X	X	X	X	X	X	X	X	X
Horsfield's Bronze-Cuckoo			X								
Laughing Kookaburra	X	X	X	X	X	X	X	X	X	X	X
Leaden Flycatcher		X	X	X	X				X		
Little Pied Cormorant										X	
Masked Owl											X
Masked Woodswallow		X									
Nankeen Kestrel											X
New Holland Honeyeater	X	X	X	X	X	X		X	X	X	X
Noisy Friarbird				X	X	X	X	X	X		X
Olive-backed Oriole			X		X						
Painted Button-quail				X			X	X	X		
Pallid Cuckoo							X				
Pied Currawong	X	X	X	X	X	X	X	X	X	X	X
Pilotbird					X	X		X	X	X	X
Powerful Owl				X	X						
Red Wattlebird	X	X	X	X	X	X	X	X	X	X	X
Red-browed Finch		X			X				X	X	X
Red-browed Treecreeper	X	X	X	X	X	X	X	X			X
Red-capped Robin		X		X							
Rufous Fantail				X						X	X
Rufous Whistler	X	X	X	X	X	X	X	X	X	X	X
Sacred Kingfisher	X	X	X	X	X	X	X	X		X	X
Satin Bowerbird	X				X	X			X		X
Satin Flycatcher	X			X		X	X	X			
Scarlet Robin		X	X	X	X	X	X	X	X	X	X
Shining Bronze-Cuckoo				X	X	X					
Silvereye	X	X	X	X	X	X		X	X	X	X
Southern Boobook	X		X	X	X	X	X	X	X	X	X
Southern Emu-wren			X		X	X					
Spotted Pardalote	X	X	X	X	X	X	X	X	X	X	X
Spotted Quail-thrush				X	X	X	X			X	X
Striated Pardalote	X	X	X	X	X	X	X	X	X	X	X
Striated Thornbill	X	X	X	X	X	X	X	X	X		X
Sulphur-crested Cockatoo						X					X
Superb Fairy-wren	X	X	X	X	X	X		X	X	X	X

Common Name	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Superb Lyrebird		X		X	X	X	X	X	X	X	X
Tawny Frogmouth			X				X	X	X	X	X
Tree Martin	X	X	X		X	X				X	X
Varied Sittella		X			X	X		X			X
Variegated Fairy-wren				X	X					X	X
Wedge-tailed Eagle	X		X	X							
Welcome Swallow					X					X	
White-browed Scrubwren	X	X	X	X	X	X	X	X	X	X	X
White-eared Honeyeater	X	X	X	X	X	X	X	X	X	X	X
White-naped Honeyeater	X		X	X	X	X	X	X	X	X	X
White-throated Gerygone	X	X	X	X	X				X		X
White-throated Treecreeper	X	X	X	X	X	X	X	X	X	X	X
White-winged Chough				X	X	X	X	X			
White-winged Triller		X									
Yellow-faced Honeyeater	X	X	X	X	X	X	X	X	X	X	X
Yellow-tailed Black-Cockatoo	X	X	X	X	X	X	X	X	X	X	X
Yellow-throated Scrubwren											X
REPTILES											
Blue Mountains Water Skink							X	X	X	X	X
Blotched Blue-tongue						X				X	X
Common Scaly-foot		X									
Copper-tailed Skink		X		X	X	X	X	X	X	X	X
Cunningham's Skink				X							
Dark-flecked Garden Sunskink		X	X	X	X	X	X	X		X	X
Eastern Brown Snake						X					X
Eastern Small-eyed Snake				X		X			X		
Eastern Water Dragon		X	X								
Highland Copperhead								X			
Lesueur's Velvet Gecko				X					X		
Mountain Dragon				X		X	X				X
Pale-flecked Garden Sunskink		X	X	X	X	X	X	X	X	X	X
Red-bellied Black Snake				X							
Red-throated Skink		X				X		X	X		X
Robust Ctenotus										X	
Tussock Cool-skink											X

Common Name	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Tussock Skink								X			
Weasel Skink					X		X				
White's Skink		X									X
Yellow-bellied Water-skink	X		X	X	X	X	X	X			X
AMPHIBIANS											
Bibron's Toadlet				X	X		X	X	X	X	X
Blue Mountains Tree Frog							X	X	X	X	X
Common Eastern Froglet	X	X	X	X	X	X	X	X	X	X	X
Eastern Banjo Frog		X	X		X						
Lesueur's Frog											X
Peron's Tree Frog								X			X
Southern Brown Tree Frog										X	
Verreaux's Frog					X					X	X
INVERTEBRATES											
Giant Dragonfly	X	X	X	X			X				

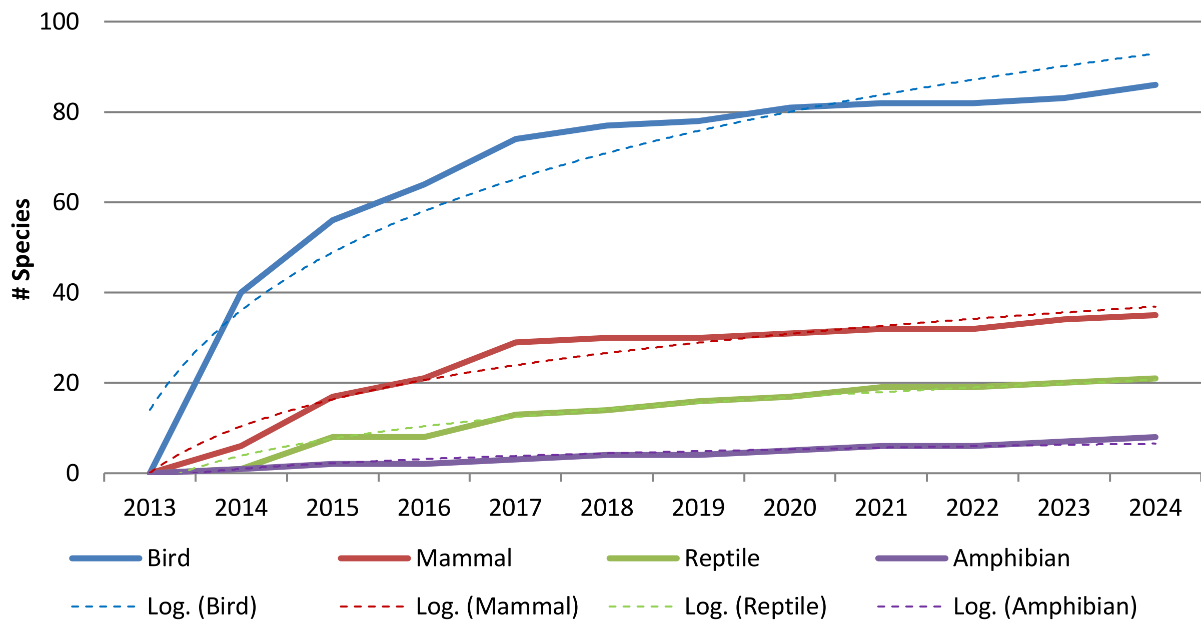


Figure 5-1: Cumulative new species in the 900 Area (including exotic species)

In terms of cumulative species curves, the trends for all groups are starting to level off, which is to be expected with 10 years of surveys. It will be a while until the curves level out completely, as there are many Newnes Plateau species yet to be discovered in the area. The accumulation of new species is slowing, with six new species recorded in 2024 (Spotted-tailed Quoll, Masked Owl, Nankeen Kestrel, Yellow-throated Scrubwren, Tussock Cool-skink and Lesueur's Frog). Spotted-tailed Quolls have been found in increasing numbers since the 2019 fires. Masked Owl is only known from four records on the Plateau between 2008 and 2022. Similar to Sooty Owl, the species is likely present but hard to come across. Nankeen Kestrel records are predominantly restricted to the cleared pine areas when the habitat was opened up, and has been recorded by BMS previously. Yellow-throated Scrubwren has also been recorded by BMS previously, though typically in the wetter gullies off the edges of the Plateau. Tussock Cool-skinks are commonly recorded in the swamps across the Plateau. Lesueur's Frog is only known from three records between 2008 and 2012, two of which are from call only.

CRITERIA USED TO MONITOR FAUNA

Most fauna monitoring surveys produce a species list that shows what animals were found within a specified area. Lists alone however do not provide the necessary criteria to determine whether an activity is affecting fauna populations through time. Consequently, it is important to provide a set of criteria that can be used to compare fauna populations within an area over time. The criteria must be relatively simple, easy to interpret and the processes required to develop each criterion must be consistent and repeatable.

To ensure such criteria are used in the long-term monitoring of fauna within the 900 Area, a set of quantifiable indices have been developed and adopted for this project.

The detailed surveys now provide sufficient information to establish a series of 'monitoring trigger points' i.e. single values that can be used to determine whether any significant changes have occurred in fauna populations over time. Monitoring trigger points being developed are:

- Species richness of faunal groups
- Diversity indices of faunal groups
- Population status of individual species
- Capture rates of individual species
- Population status of faunal groups
- Contribution to the faunal assemblages by threatened species, species dependent upon woodland and by species declining in the Central West of NSW
- Habitat complexity scores

Species richness of faunal groups

The number of species within each faunal group provides an index of its biodiversity. It is assumed that the higher the species richness, the higher the biodiversity. A high biodiversity index value indicates an area containing a complex variety of natural habitats in good condition. The species richness values for the surveys from 2014 to 2024 are given in **Table 5-8** and are graphed in **Figures 5-3** and **5-4**.

Simpson's diversity index of faunal groups

Simpson's diversity index combines species richness and species abundance to provide a better indication of biodiversity. The closer the Simpson's Index of Diversity is to one, the higher the biodiversity, and by implication, the better the area is for fauna. Simpson's Index of Diversity for the three main faunal groups over time are given in **Table 5-8** and the values of the diversity index are illustrated in **Figure 5-2**. This provides an indication of the productivity of each faunal group over time.

Temporal differences in autumn bird, mammal and reptile diversity measures were analysed using a series of One-way Repeated Measures ANOVAs, using the four 900 Area sites. Mammal abundance was significantly higher in 2019 compared to 2015-16 and 2020-21; and significantly higher in 2023 and 2024 compared to 2015-16 ($p = 0.003$). Mammal species richness was significantly higher in 2019 compared to 2015-16 and 2020 ($p = 0.016$).

In spring, significant differences over time were detected for all four bird diversity indices (One-way Repeated Measures ANOVAs using four 900 Area sites). Bird Evenness was significantly lower in 2018 compared to most other years ($p = 0.004$). Bird Simpson's was significantly lower in 2018 compared to 2014, 2017 and 2019; and 2023 was lower than 2014 and 2017 ($p = 0.005$). Bird abundance was significantly higher in 2018 compared to 2022-23 ($p = 0.037$). Bird species richness was significantly lower in 2021 and 2023 compared to 2014, 2016-19 and 2024; lower in 2022 compared to 2017-19; and lower in 2020 compared to 2017-18 ($p < 0.001$). Reptile abundance was significantly lower in 2022 compared to 2017 ($p = 0.044$). Reptile species richness was significantly lower in 2022 compared to 2017 and 2019; and significantly lower in 2014 and 2024 compared to 2019 ($p = 0.012$). No other mammal, reptile or frog diversity measures showed significant differences over time.

As with the habitat data, statistical analysis of mining impact included a suite of nearby CLW and Springvale sites (CLW04, CLW05, 9 Mile and Paddy's Swamp) to boost the power of the analyses. Pooled t-tests on autumn data (2015-2024) revealed that reptile Simpson's was significantly lower at undermined sites compared to control sites ($p = 0.042$). No other fauna diversity indices showed significant differences between impact and control sites.

Pooled t-tests on spring data (2014-2024) revealed significantly lower bird abundance and species richness at undermined sites compared to control sites ($p < 0.001$ and $p = 0.002$ respectively). Frog abundance and species richness were also significantly lower at undermined sites compared to control sites ($p = 0.042$ and $p < 0.001$ respectively). Other bird, mammal, reptile and frog diversity indices did not detect significant differences between undermined and control sites. These results hint at reductions in bird and frog populations in undermined sites of the Clarence 900 and proximal sites. While the reduction in birds may not be explained by other factors, there is a large still pool with emergent vegetation and abundant frogs at our call playback location at the Nine Mile control site. No matching site is present in the 900 Area. 900 North, 900C and 900D all possess running water, but only certain frog species use the running water as compared to still ponds. With undermining only recently taking place in the 900 Area (August 2022 and April 2023) however, the analyses for Clarence West are more comprehensive and better examine the impacts of mining on habitat characteristics at Clarence.

Survey conditions have a large influence on survey success, and this year's autumn conditions were generally good with a few overcast/wet days through spring. As reptiles rely directly on their environment for energy input, any survey conducted in wet or cold conditions is likely to result in low reptile activity. Reptile Simpson's declined from 2015, though 2019-21 saw an upturn in the trend. Levels have remained relatively stable since 2019. Reptile species richness has been increasing marginally through time, with 2024 the highest on record for the area (despite the poor spring conditions). This could be due to an increase in the range of habitats sampled with the two new sites added in 2024). Amphibian Simpson's have remained level over the long term, though variability is seen (and expected) with prevailing weather conditions. 2020 was the highest amphibian Simpson's on record. Amphibian species richness has been gradually increasing since 2019 with 2024 being the highest on record. Again, the new habitats sampled are turning up new species. 900D revealed a frog species that has only been recorded from the Plateau three times on BioNet. Mammal species richness also shows a relatively stable trends, with an uptick in 2024 to the highest on record. Bird and mammal Simpson's are very stable over time. Bird richness increased from 2014 to 2018, but was declining over the period 2018 to 2023. Bird species richness started trending upward again in 2024, with richness reaching the second highest levels on record. The increases in diversities are expected as the Area has only been surveyed for 11 years. Drought conditions impacted amphibian and bird diversities in 2019, and the extensive fire that burned through in December 2019 has reset the post fire system again. Changes in abundance are probably due to climatic changes over time rather than impacts from mining, as none of the sites were undermined before spring 2022. Data from these sites were previously used as control data for other SMP area final reports, but from the 2023 report the statistical analyses were fixed to account for the undermining of 900 South in August 2022 and 900 North in April 2023. Overall, the biodiversity indices are similar to that found elsewhere in Newnes Plateau and indicate a representative base-line sample to be used for on-going monitoring.

Table 5-8: Biodiversity indices for birds, mammals and reptiles over time

Group	Diversity index	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Birds	Simpson's	0.967	0.966	0.960	0.965	0.957	0.961	0.955	0.953	0.953	0.947	0.964
	Species richness	40	51	50	59	62	51	49	47	45	43	61
***Native Mammals**	Simpson's	0.786	0.856	0.729	0.799	0.747	0.704	0.763	0.775	0.731	0.811	0.776
	Species richness	5	7	7	12	6	10	6	8	6	10	14
Reptiles	Simpson's	NA	0.911	0.750	0.671	0.538	0.727	0.699	0.787	0.638	0.783	0.700
	Species richness	1	7	4	9	5	9	7	8	6	6	11
Amphibians	Simpson's	NA	0.167	0.333	0.286	0.417	0	0.479	0.187	0.184	0.193	0.181
	Species richness	1	2	2	2	4	1	3	4	3	4	6

*Bats not included

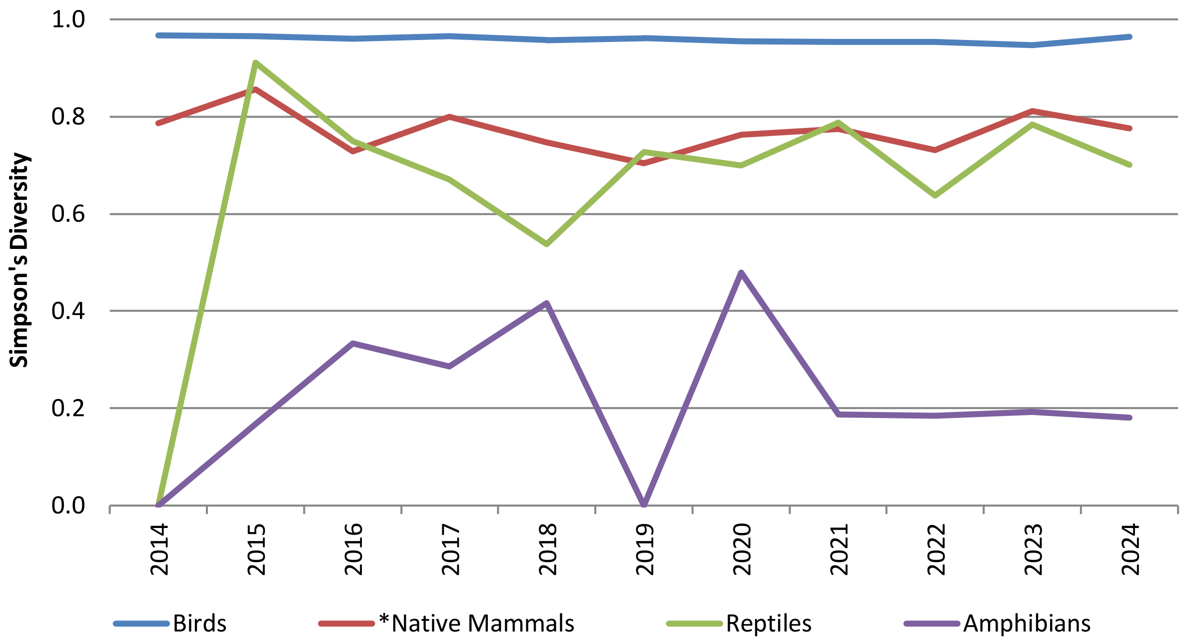


Figure 5-2: Simpson's Diversity for the 900 Area over time

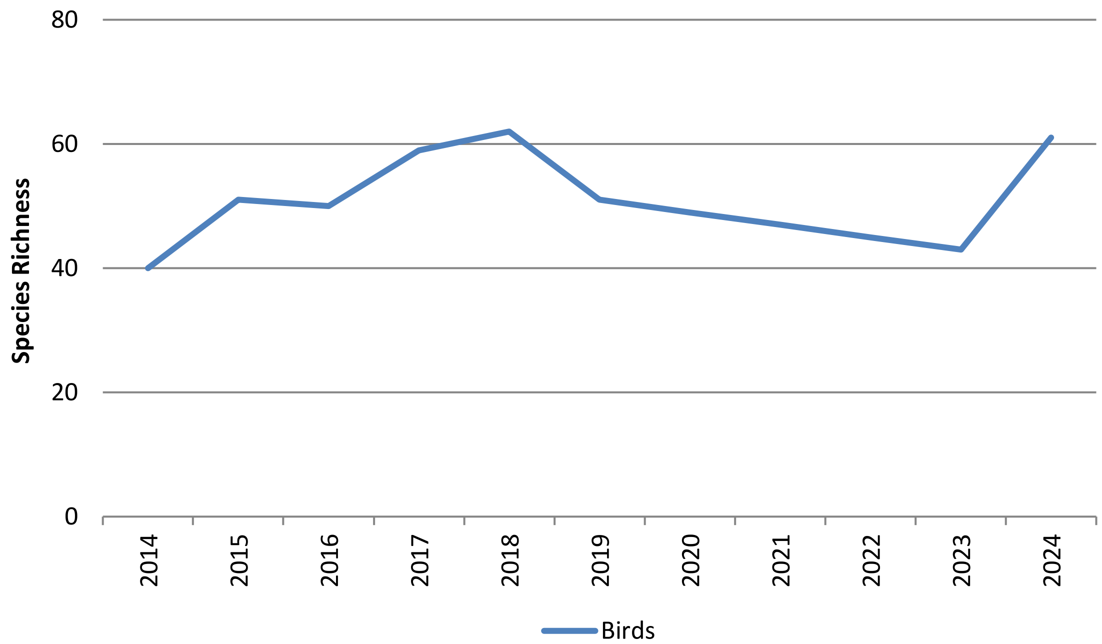


Figure 5-3: Species Richness for birds of the 900 Area over time

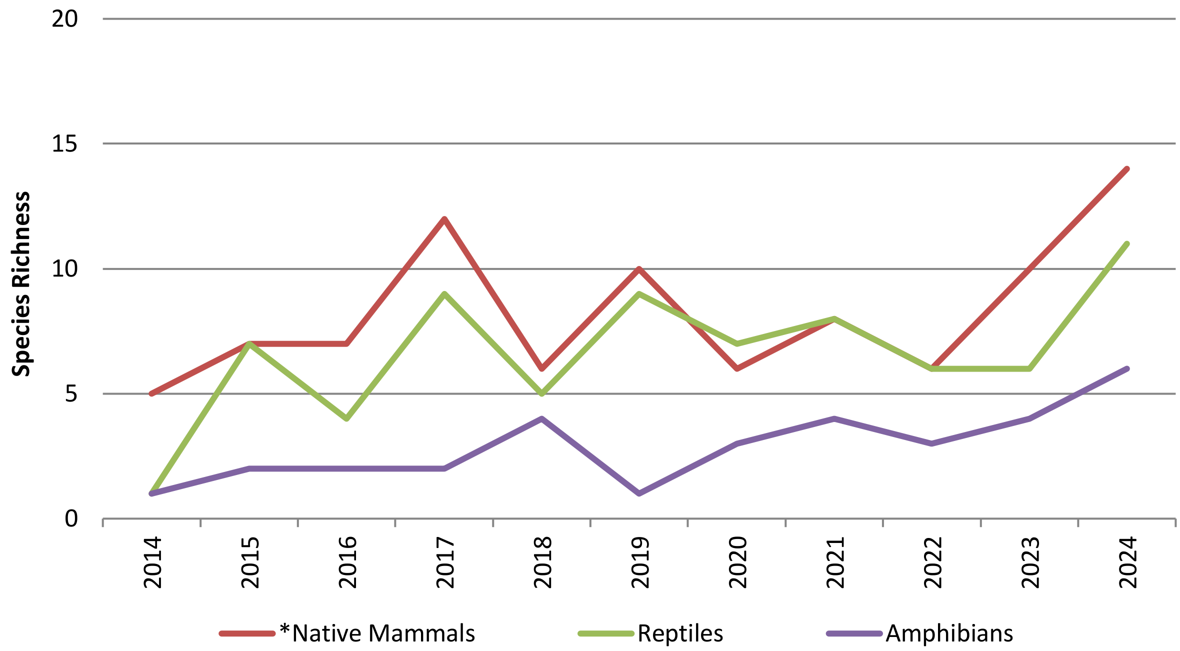


Figure 5-4: Species Richness for mammals, reptile and amphibians of the 900 Area over time

Capture rates of individual species

It is possible to calculate the trapping rates for small ground mammals within the 900 Area. Such values can be used as a surrogate for population size of each species captured and is important for long-term monitoring. Trapping rates for all small mammals captured in 2014 to 2024 are given in **Table 5-9** and shown in **Figure 5-5**.

The numbers of small mammals trapped in 2020 (after 2019 fire) dropped to similar levels seen after the 2013 fire (**Figure 5-5**). Capture rates increased from 2014 as animals recolonised or bred up post fire, but the second fire in 2019 has reset the trend. 3.5 years after the 2019 fire, autumn levels are almost equal with those seen 5.5 years after the 2013 fire, however trapping rates declined again into spring 2023. Antechinus numbers did not look to be as impaired by the second fire as rodent numbers were. Prior to 2020, Bush Rats dominated captures, while from 2020 on Agile Antechinus appear more dominant. This trend has been seen across the Plateau. Dusky Antechinus have never been captured in the 900 Area, but were historically encountered in the nearby CLW Area. House Mice were captured in the 900 Area two years after the first fire, and 1.5 years after the second fire. This species is known to invade disturbed areas, but hasn't been captured here since autumn 2021. Black Rat appeared throughout the Plateau following the 2019 fires, and made an appearance in the CL900 area in 2023 for the first time. Though still recorded in 2024, numbers of this exotic species appear to be declining throughout the Plateau overall so we hope to see an absence of this species next year.

Table 5-9: Mean trapping rates of small mammals in autumn and spring over time

Species	2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Rattus fuscipes	-	0.5	1	1	2.5	9	7	11	7.5	12.5	18	17.5	1.5	0.5	0.5	8.5	2	7.5	2	5.5
Rattus lutreolus	-	0	0.5	2	2	5	3	4	4	7.5	4.5	10.5	0	0	0	0	1.5	1	3	2
Rattus rattus	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
Mus musculus	-	0	0	3	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Antechinus agilis	-	0	0	0	0	0	2	0	6.5	1	6.5	2	4	2.5	7.5	4	8.5	1	13.5	1.5
Antechinus stuartii	-	0	0	0	0	0	1.5	0	0	0	2.5	1	0	0	1.5	0.5	1.5	0	6	0
Antechinus swainsonii	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cercartetus nanus	-	0	0	0	0.5	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0
Sminthopsis murina	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0.5	0
Total	**-**	**0.5**	**1.5**	**6**	**9**	**14**	**13.5**	**15**	**18**	**21**	**32**	**31**	**6**	**3**	**11**	**13**	**13.5**	**9.5**	**25.5**	**9**

Table 5-10. cont: Mean trapping rates of small mammals in autumn and spring over time

Species	2024	
	A	S
Rattus fuscipes	6	7.5
Rattus lutreolus	0.5	1.5
Rattus rattus	0	0
Mus musculus	0	0
Antechinus agilis	8.25	3.5
Antechinus stuartii	4	1.25
Antechinus swainsonii	0	0
Cercartetus nanus	0	0
Sminthopsis murina	0	0
Total	**18.8**	**13.8**

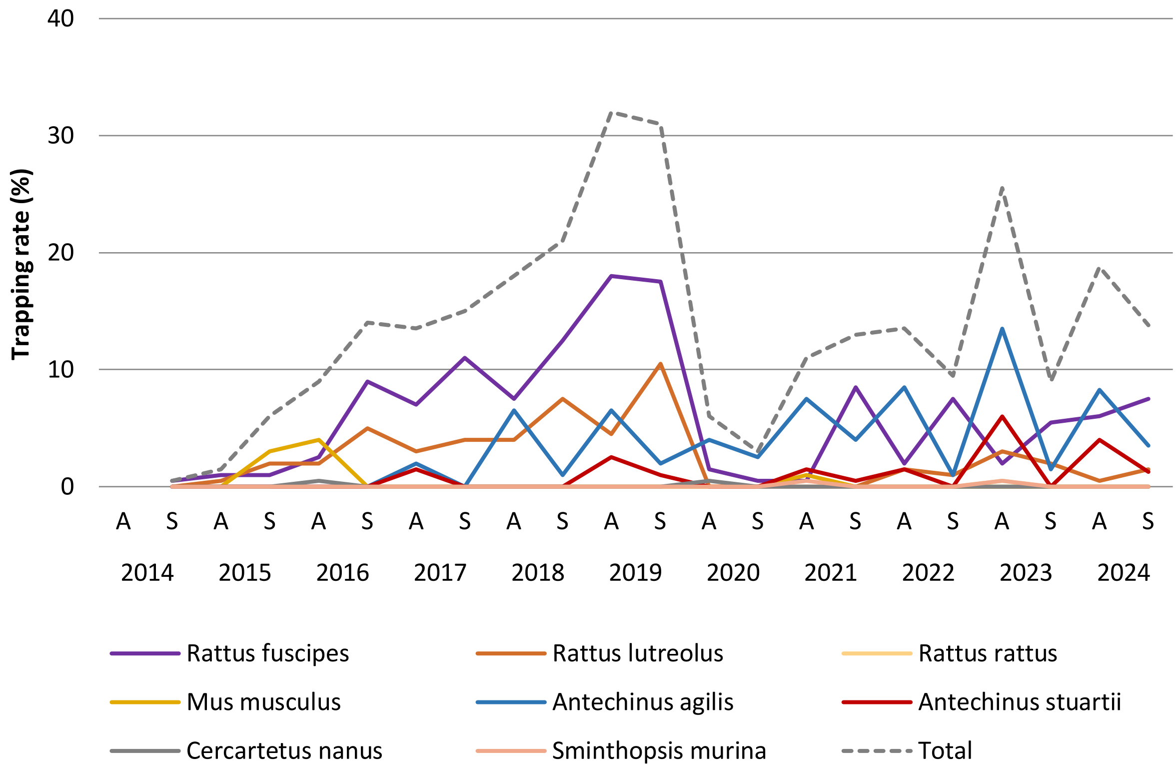


Figure 5-5: Trapping rates for small ground mammals over time

Population status of a species

Derivation of the local population status of species located at Clarence 900 Area requires a relatively large dataset. Population status is based upon the numbers and distribution of each species within the 900 Area. This data is still being collected and is part of an ongoing process to provide sufficient information to allow assignment of population status of species known to occur.

Contribution to the faunal assemblages by threatened species, species dependent upon woodland, and species declining in Central West NSW

Bird species have been classed by Reid (2000)[6] into woodland dependant and declining in the Central West. These lists were used to calculate the proportion of birds located within the 900 Area that are considered under threat. The higher the proportion, the greater the value that can be placed on the present habitat in the area.

[6] Reid J.R.W. (2000). *Threatened and Declining Birds in the New South Wales Sheep Wheat Belt2. Landscape relationships – Modelling bird atlas data against vegetation cover*. Consultancy Report to NSW National Parks and Wildlife Service. CSIRO Wildlife and Ecology, Canberra.

On inspection of the bird species list (**Table 5-2**), the following proportions calculated for the 900 Area over time are given in **Table 5-11** and **Figure 5-6**. The proportion of woodland-dependent and declining bird species has declined over the 2017 to 2024 period. This is probably due to the dry conditions experienced followed by fire. The proportion of woodland-dependent birds experienced minor recovery in 2021-22, but was the lowest on record in 2024. The proportion of declining bird species were the lowest on record in 2023 and though trending upwards in 2024, remain low overall. Significant changes to these figures may indicate changes to the condition of the woodland habitat.

In contrast to most areas on the Plateau, the number of threatened species has declined over the long term (**Table 5-10** and **Figure 5-7**), with the exception of 2024. Fourteen threatened species were located during the 2024 surveys. These were the Spotted-tailed Quoll, Eastern Pygmy-possum, Southern Greater Glider, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Gang-gang Cockatoo, Masked Owl, Pilotbird, Varied Sittella, Dusky Woodswallow, Scarlet Robin, Flame Robin and Blue Mountains Water Skink. Locations of threatened species are given in **Figure 5-8**. This is one of the few areas on the Plateau to record Blue Mountains Water Skink in 2024. Despite large numbers of Giant Dragonfly being seen in 2020, none were located since then in the 900 Area. Giant Dragonfly were located in Clarence West Area, as well as neighbouring Springvale and Angus Place areas this summer. Other areas show increases in numbers of threatened species over time, partially due to the increased number of species listed as threatened over the same period. Why this area presented declining numbers of threatened species to 2023 is unknown. Perhaps the low number of sites and low visitation time to the area were just not enough time to locate cryptic and inherently rare species. The ten threatened species found over the four sites in 2024 is more on par with other areas of the Plateau, and the 14 across the area this year is more than some other areas.

Habitat Complexity Scores

Data on Habitat Complexity Scores are covered in Section 4 (see **Table 4-2** and **Figure 4-3**). The main benefit from this approach is the production of a single number that can represent habitat values. By tracking such numbers over time some insight into changes in habitat values may be possible.

Table 5-11: Threatened species in 900 Area in autumn (A) and spring (S) over time

Category	2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Woodland-dependent bird species (%)	-	-	-	-	-	-	64.5	65.4	64.9	74.5	65.6	72.7	75.0	71.1	82.8	77.4	73.1	75.8	67.7	70.4
Declining bird species (%)	-	-	-	-	-	-	6.5	7.7	2.7	8.5	9.4	6.8	4.2	7.9	10.3	9.7	3.8	6.1	6.5	7.4
Threatened species	-	4	3	7	4	4	5	8	5	7	5	5	6	4	6	3	4	3	4	2

Category	2024	
	A	S
Woodland-dependent bird species (%)	60.5	62.0
Declining bird species (%)	7.0	8.0
Threatened species	10	10

Table 5-12: Proportion of woodland-dependent or declining birds in 900 Area each year over time

Category	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Woodland-dependent	83.7	83	83.7	66.1	64.5	64.7	69.4	74.5	73.3	62.8	60.7
Declining	13.5	14.8	13.9	8.5	8.1	7.8	8.2	10.6	6.7	4.7	8.2

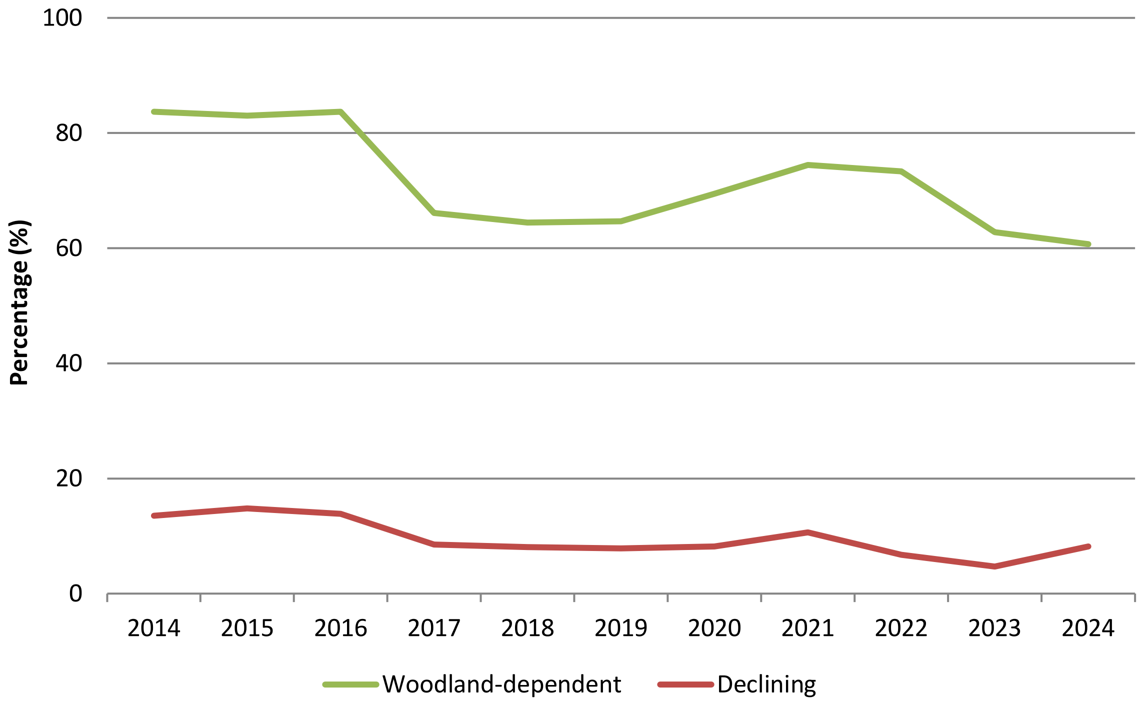


Figure 5-6: Proportion of woodland-dependent and declining bird species in 900 Area each year

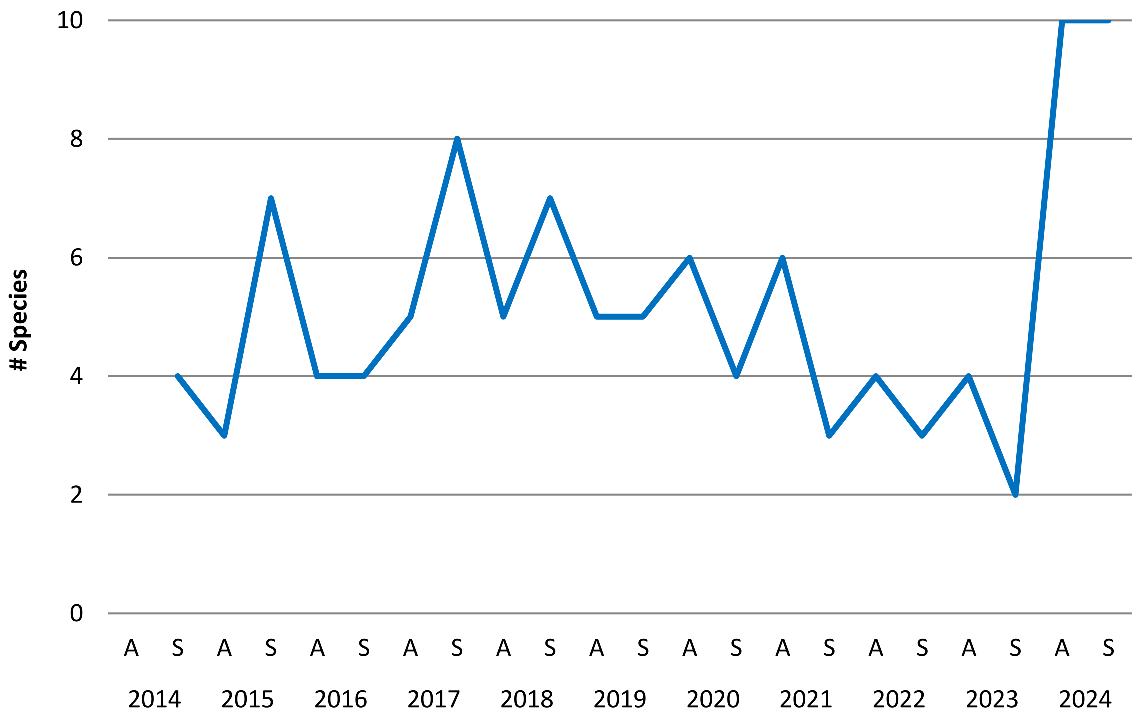


Figure 5-7: Number of threatened species in the 900 Area over time

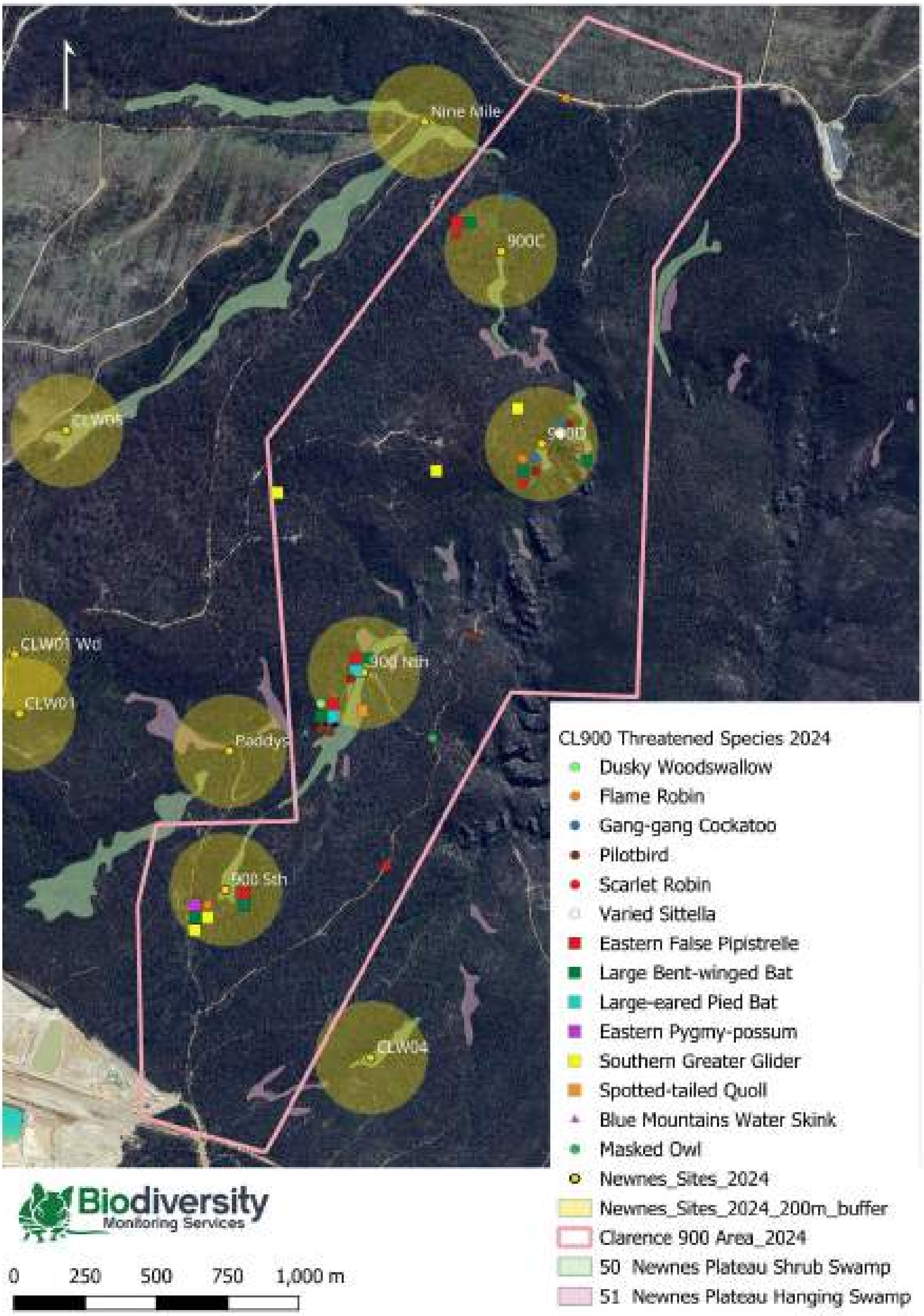


Figure 5-8: Threatened species located within Clarence 900 Area this year (locations shifted to allow visualisation of stacked data at single sites)

Comparison between Treatment and Control sites

In December 2022, we discovered that 900 South had become undermined just prior to the spring 2022 survey. 2023 is the first complete year that 900 South is considered an "impact" site. 900 North became undermined in autumn 2023 (around the same time as surveys were being conducted), so this site is also considered "impact" for the entirety of 2023. Diversity analyses are repeated here using the correct split of sites, with 900 South, 900 North and CLW05 as treatment sites, and 900C, 900D, Nine Mile and Paddy's as control sites.

Further details on these sites are included in **Table 1-1** of this and the Clarence West 2024 Final Fauna Report[7]. **Figure 5-9** to **5-11** show the control and impact fauna diversity values pooled for 2019-2024. **Figure 5-12** shows the HCS for control and impact sites pooled for 2019-2024. The following data is used in this comparison: bird, mammal, reptile and amphibian biodiversity indices, habitat cover characteristics and Habitat Complexity Scores. All sites burnt in both the 2013 and 2019 fires.

Pooled t-tests were conducted on all bird, native non-bat mammal, reptile and amphibian diversity measures to look for differences between control and impact sites in the fire recovery period. Reptile abundance was significantly higher at control sites ($p = 0.005$), but the magnitude of difference was small (3.7 vs. 2.3). Frog Evenness and Simpson's were significantly higher at impact sites ($p = 0.034$ and $p = 0.021$ respectively). This is in contrast to spring results which found frog species richness to be higher at control sites. Considering the result is not consistent across seasons, and the survey results for this group are highly erratic and dependent on climatic conditions, we should not read too much into the results. Frog Simpson's (and Evenness) were low at both groups of sites (0.16 vs. 0.40 at control and impact), suggesting neither are great frogging habitats. There were more differences in the seasonal statistics, with five bird, reptile and frog diversity metrics showing reductions in undermined sites, but none were consistent across season.

In the fire recovery period, there was a significant difference in HCS between control and impact sites in autumn ($p = 0.006$) and spring ($p = 0.048$).

Overall, there is potential evidence to suggest reduced reptile diversity in undermined sites post fire (noting one site comes from CLW Area and the 900 Area sites have only been undermined in the last few years). Bird and frog diversities also showed seasonal reductions in undermined sites. Results are inconsistent across taxa and season, so severe impact to fauna populations in the 900 Area is unlikely. There is far greater variation in fauna diversities over time, which come from the effects of fire, drought and other climatic changes. Amphibian differences are inconsistent with previous years findings. Monitoring for consistent differences going forward will be important.

[7] BMS (2024). *Western SMP Application Area Terrestrial Fauna Monitoring Report (2024 Final)* for Clarence Colliery Pty Ltd.

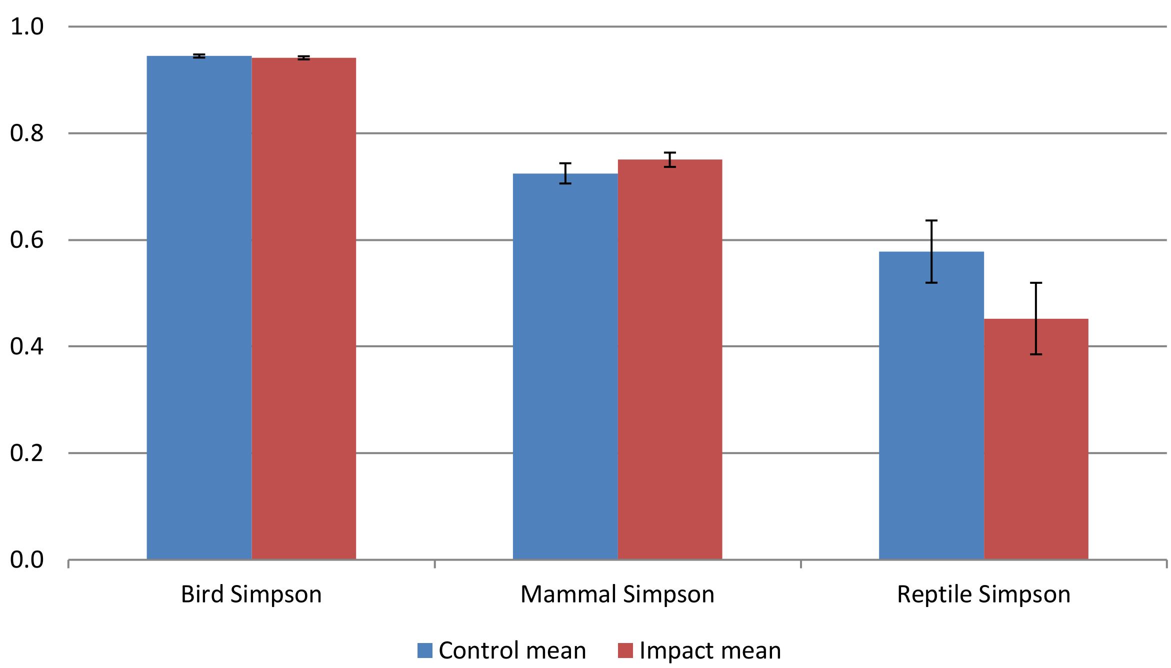


Figure 5-9: Simpson's Diversity Index for birds, mammals and reptiles in control and impact sites

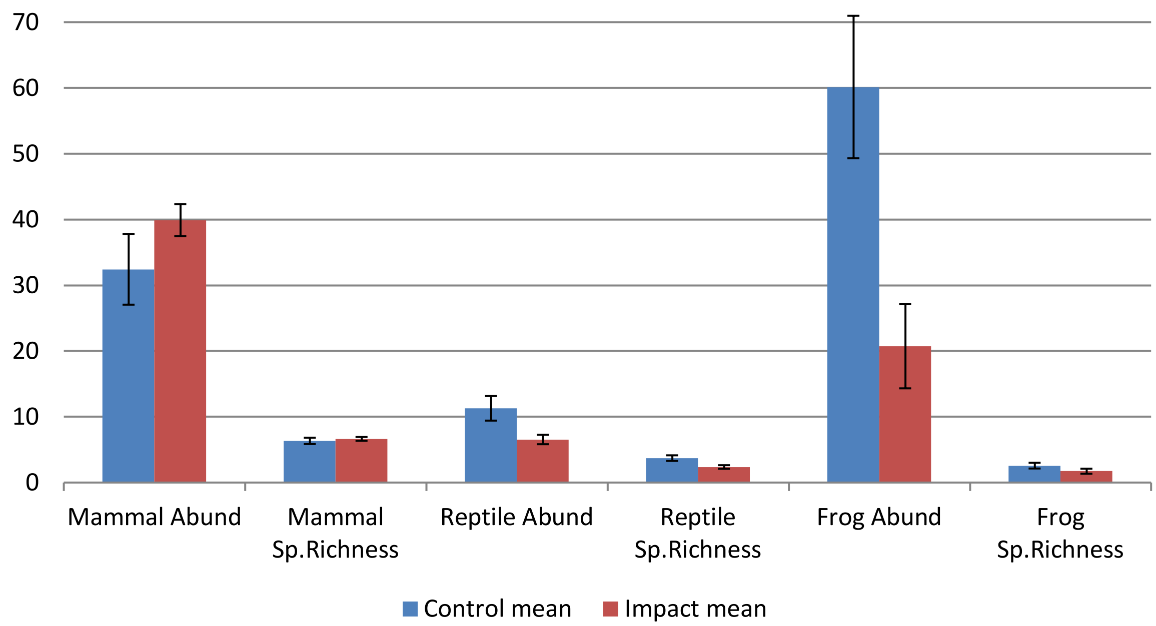


Figure 5-10: Abundance and Species Richness for mammals, reptiles and amphibians in control and impact sites

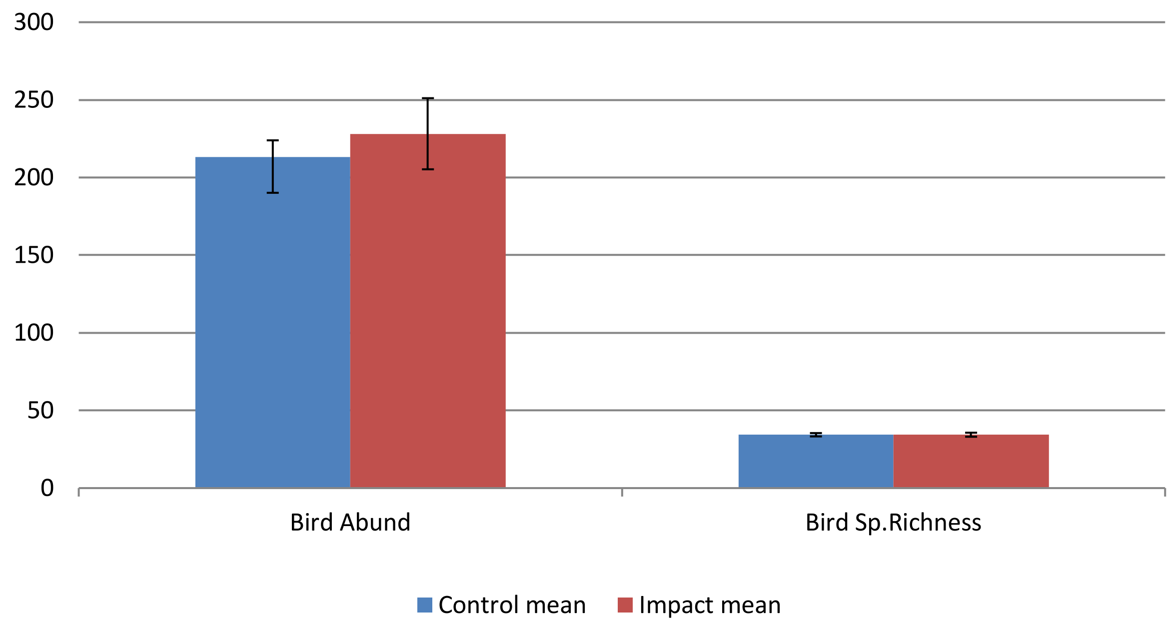


Figure 5-11: Abundance and Species Richness for birds in control and impact sites

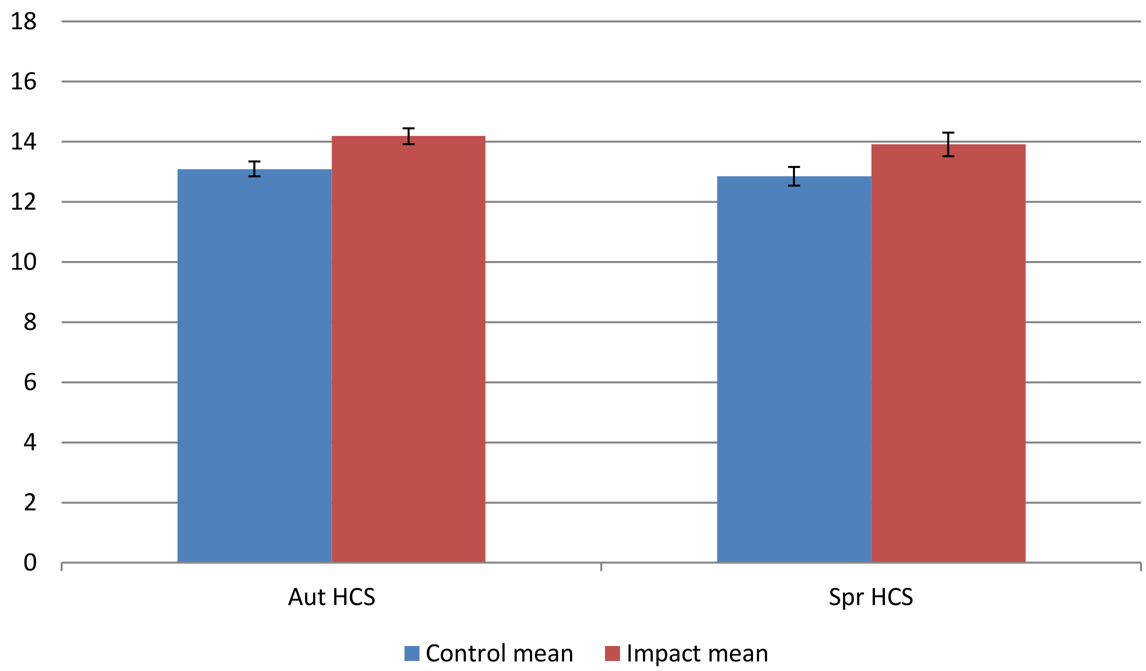


Figure 5-12: Autumn and spring Habitat Complexity Scores for control and impact sites

Bat Activity

Another index that can be derived from the survey data is the species richness and activity of bats over time. Ultrasonic recording with the Anabat device does not allow individual numbers of bats to be ascertained. It does however, let us get an idea of species richness and overall bat activity in an area. Results from the years bat surveys are presented in **Figure 5-13**.

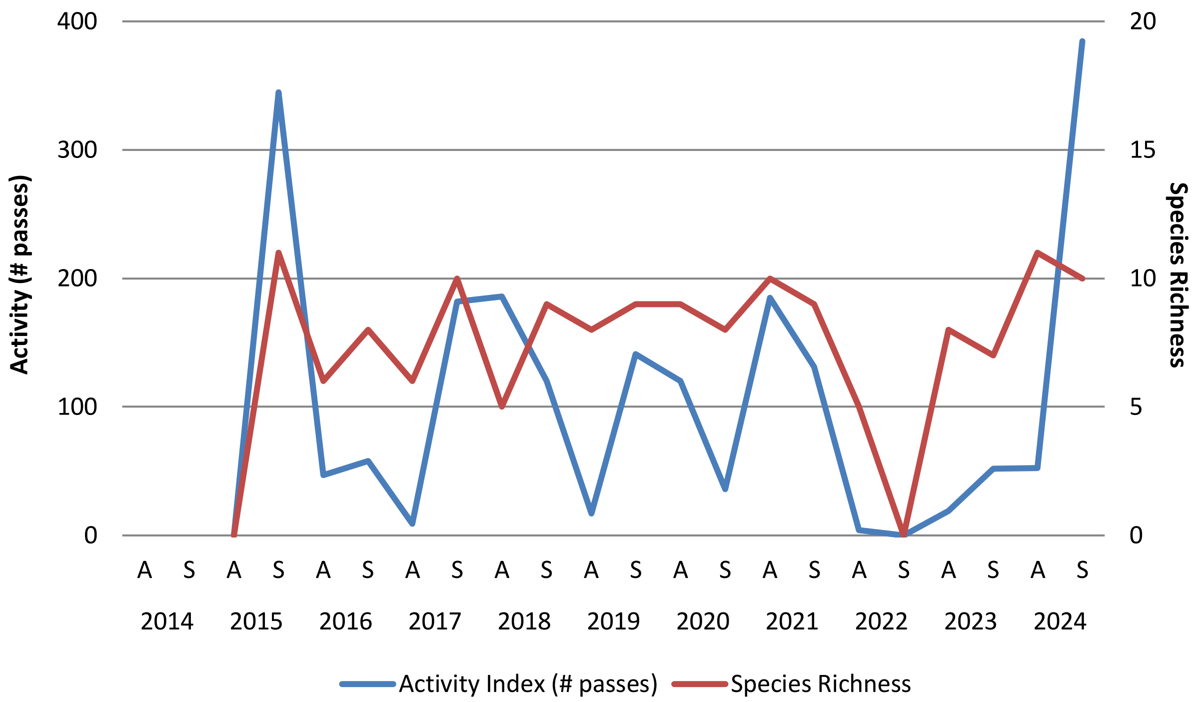


Figure 5-13: Bat species richness and activity index over time

6.0 Conclusion

The results from the survey of the Clarence Colliery 900 Area in 2024 show that the assemblages found are more typical of that found throughout Newnes Plateau than we would expect after extensive fires swept through the area in December 2019. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Species richness was within expected variation for all groups, with the two additional sites surveyed in 2024 possibly explaining the all time highs in three of four groups (and almost in the fourth). Bird and mammal Simpson's are stable over the long term. Trapping rates declined sharply post 2019 fire. They had been tracking up since the State Mine fire, but the Gospers Mountain fire reset the system. Recovery of small mammal captures was tracking in advance of the previous fire in 2023, but declined again in 2024. Reptile Simpson's was average. Low numbers in 2014 are due to the fact surveys only began in spring 2014, so survey effort was greatly reduced compared to other years. Amphibian Simpson's showed stability over the last three years, with richness back to pre fire levels in 2021 to 2023.

Swamps in this area had peat mostly consumed and canopy layers were fully burnt, so finding Blue Mountains Water Skink in 2020 was surprising. This species has been found in the area every year since. The swamps (particularly 900 North) of the 900 Area likely form an important refuge for the species which was only located in the 900 and Springvale New area in 2024. The availability of rock outcropping near 900 North means refugia for small mammals allowed some to survive the fire, particularly Antechinus. Bat species richness and activity were very low in 2022, but 2024 exhibited the highest activity and species richness for this group in comparison to other years. As is often the case with fire, once the vegetation and associated food source is wiped out, there is a delay in seeing return of species to the landscape. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. Above average rainfall in most months since fire appears to have helped start the regeneration process on the Plateau.

Fourteen threatened species were located during 2024, as well several bird species dependent upon woodland habitats. Threatened species included the Spotted-tailed Quoll, Eastern Pygmy-possum, Southern Greater Glider, Large-eared Pied Bat, Eastern False Pipistrelle, Large Bent-winged Bat, Gang-gang Cockatoo, Masked Owl, Pilotbird, Varied Sittella, Dusky Woodswallow, Scarlet Robin, Flame Robin and Blue Mountains Water Skink. Their locations are shown in **Figure 5-8**. The swamps of the 900 Area have always contained suitable habitat for Blue Mountains Water Skink. Reptiles often have lower detection rates due to their cryptic nature and requirement for particular survey conditions, so it is good to record this species for the fifth year running. The Gospers Mountain fire affected the fauna and habitats within the 900 Area, with a number of measured parameters falling.

Now that 900 South and 900 North have been undermined, we can start to look for potential impacts from undermining in the 900 Area. However, the two new sites have only just been added in 2024. These too will become undermined in due time, but for now allow comparison of control vs impact. Because of the progressive undermining of sites, sites from the surrounding Clarence and Springvale Areas are added to the analyses. Analyses from the post fire recovery period suggest reptile species richness is lower in undermined sites compared to control sites. The same relationship was not observed in the seasonal analyses which were conducted over the full survey period, suggesting reptile richness has not always been higher in the selected control sites. Other seasonal differences were not consistent between seasons, and the differences seen in 2024 analyses were not mirrored in 2023. This could be due to the addition of two new sites to the analyses. Overall however, there is little evidence to suggest differences in fauna diversities in recovering sites by undermining status, despite inconsistent differences seen in seasonal and previous yearly reports. To date, the monitoring provides important baseline data for tracking the recovery of fauna from fire into the future. It also provides important data to compare the rates of recovery within areas that have been previously mined and those still to be mined or used as controls.

Given the low levels of subsidence from previous mining at Clarence Colliery, and the predicted low levels (30mm) of subsidence for 900 Area, the risk of adverse impacts on fauna within this area is considered to be low. The monitoring of recovery from fire within those sites mined and un-mined will be an important tool in the on-going assessment of mining activities.

Andrew Lothian BComm/BSc (Hons), BAM Accredited Assessor (BAAS18110), NSW AUSRIVAS Accredited, ECANSW CPEC, President ECANSW, MRZSNSW, MAMS, MABS, MNSWBA

ECA ECOLOGICAL CONSULTANTS ASSOCIATION
2025 PRACTISING MEMBER

ECOLOGICAL CONSULTANTS ASSOCIATION OF NSW
CERTIFIED PRACTISING ECOLOGICAL CONSULTANT

Alix Bouffet-Halle BSc, MSc, PhD

ECA ECOLOGICAL CONSULTANTS ASSOCIATION
2025 PRACTISING MEMBER

27 February 2025

Appendix 5: Aquatic Monitoring Reports

Appendix	Report Name
Appendix 5A	Wollangambe River Aquatic Ecology – Autumn 2024 Data Report (Marine Pollution Research Pty Ltd, 2024a)
Appendix 5B	Wollangambe River Aquatic Ecology – Spring 2024 Data Report (Marine Pollution Research Pty Ltd, 2024b)
Appendix 5C	Bungleboori Creek Catchment Aquatic Ecology – Autumn 2024 Data Report (Marine Pollution Research Pty Ltd, 2024c)
Appendix 5D	Bungleboori Creek Catchment Aquatic Ecology – Spring 2024 Data Report (Marine Pollution Research Pty Ltd, 2024d)
Appendix 5E	Dingo Creek Catchment Aquatic Ecology – Autumn 2024 Data Report (Marine Pollution Research Pty Ltd, 2024e)
Appendix 5F	Dingo Creek Catchment Aquatic Ecology – Spring 2024 Data Report (Marine Pollution Research Pty Ltd, 2024f)
Appendix 5G	Wollangambe River Aquatic Ecology Monitoring – Annual 2024 Summary Report (Marine Pollution Research Pty Ltd, 2024)

CENTENNIAL COAL
CLARENCE COLLIERY

WOLLANGAMBE RIVER AQUATIC ECOLOGY

AUTUMN 2024 DATA REPORT

Figure 1. Looking upstream at WGRswamp

REPORT PREPARED FOR
CLARENCE COLLIERY PTY LTD

MARINE POLLUTION RESEARCH PTY LTD
MAY 2024

FIGURES

TABLES

APPENDIX

A FIELD NOTES, SITE PHOTOGRAPHS AND SAMPLING DATA

Table A-1 Daily Site Rainfall and Monthly Long-term Means 2023 to 2024
Table A-2 Daily Discharge (LDP2) and Monthly Means 2023 to 2024
Table A-3 Site Field Notes
Table A-4 Modified Riparian, Channel and Environment (RCE)
Table A-5 Macroinvertebrate and Fish results Autumn 2024
Plates 1 to 19 Site Photographs Autumn 2024

1 INTRODUCTION

Marine Pollution Research Pty Ltd (MPR) has been re-commissioned by Clarence Colliery to undertake biannual (Autumn and Spring) streamhealth monitoring to assess the possible effects on aquatic ecology of Wollangambe River below the Clarence Colliery Licensed Discharge Point 2 (LDP2). The streamhealth surveys are being conducted using standardised methods applied to other Centennial Coal stream health studies in the Coxs and Wolgan River upper catchments.

This report provides the results of the 23rd biannual streamhealth sampling program which was undertaken in autumn 2024 and follows on from the previous Wollangambe River streamhealth survey undertaken in spring 2023. MPR had previously been commissioned to undertake additional EMP seasonal monitoring in spring 2019, and as that program utilised three of the Streamhealth sampling program sites, the results were incorporated into the long-term streamhealth indices for this survey.

The mine is located within the 690 Ha upper Wollangambe River catchment, above the Blue Mountains National Park. The portions of the upper Wollangambe River catchment upstream and downstream of the mine comprise undeveloped native forest, and the upper catchment is bounded by Newnes State Forest to the north, Blue Mountains National Park to the east and Hansons’ Sand Quarry to the west. The Wollangambe River below the mine Main Storage dam flows past several tributaries that contain hanging swamp endangered ecological communities (EECs) prior to reaching the National Park boundary.

The Clarence Colliery site includes a storm water and dirty water management scheme that separates clean and dirty water streams, bunding, stilling and filtration ponds plus a Mine Water Treatment Plant (MWTP). The discharge from the MWTP is licensed by the NSW Environment Protection Authority (EPA).

Discharge from the MWTP at LDP2 flows down a small western tributary of the Wollangambe River, with the combined discharge and river flow discharged into a 70ML dam (the Colliery Main Dam). The Colliery extracts water from the dam for use on site, and during dry weather periods, additional water can be extracted and piped to Farmers Creek to provide additional source water for the Lithgow City potable water supply plant.

2 AQUATIC STUDY DESIGN

2.1 Aims and Objectives

In terms of study aims the Aquatic Ecology Sampling Program endeavoured to answer the following questions:

- Are there measurable differences in aquatic ecological habitat or riparian attributes between river or creek pools upstream and downstream of LDP2, and within reference sites?
- Are there measurable differences in aquatic macroinvertebrate assemblages at the AusRivAS level of taxonomic resolution between Wollangambe River Upstream and Downstream of Discharge sites?
- Can observed differences be attributable to spatial (between-site) differences and/or Colliery discharge?
- Do the survey sites provide suitable and sustained aquatic habitat for fish and other aquatic biota?
- Do the sites provide suitable fish passage?

To achieve these objectives the sampling program includes following features:

- Sampling the aquatic macroinvertebrate fauna twice a year (in Spring and Autumn) using the AusRivAS sampling, sorting and identification protocols (see Section 2.2 below). Note that for AusRivAS standardised sampling purposes the ‘autumn’ sample season is defined as March 15 to June15 and ‘spring’ is defined as September 15 to December 15.
- Estimation of fish occurrence by a combination of overnight and spot bait-trapping, dip netting and observation, with all captured fish identified in-situ and immediately released.
- Depth profiles of basic water quality parameters: Temperature, Electrical Conductivity (salinity), water acidity (pH), Dissolved Oxygen and Turbidity, at each site during each sampling run.
- Descriptions of creek riparian condition and aquatic plant communities within the study area.

There were seven sites sampled for the autumn 2024 Clarence aquatic ecology survey (**Table 1**), all of which have been sampled continuously since autumn 2020. In total there were four sampling sites in the Wollangambe River, one site in the Main Dam and two sites in unnamed reference creek tributaries (see **Figure 2**).

The autumn 2012 survey report (MPR 2012) provides detailed descriptions of the original sample sites, with additional descriptions for sites brought online over subsequent seasons provided in the corresponding reports; WGRXdown in autumn 2013 (MPR 2013b) and WGRtrib1 in spring 2014 (MPR 2015).

Table 1 Clarence LDP Aquatic Ecology Seasonal Sample Site Information

Site	Coordinates		Seasonal Surveys			Description
	E	N	Au 12 - Sp 12	Au 13 - Au 14	Sp 14 - Au 24	
			N=2	N=3	N=12	
WGR up	243889	6295015	x	x	x	Upstream Wollangambe River monitoring site located above LDP2 input.
WGR dam	244427	6294590	x	x	x	Site sampled at upper end of the Main Dam below the confluence of LDP2 and Wollangambe River.
WGR trib1	244568	6294840			x	Site sampled within lower limits of unnamed tributary, in 'backwaters' of discharge from Main Dam spillway.
WGR swamp	244871	6294619	x	x	x	Site located at the downstream end of the lower of two swamps in Wollangambe River, around 530m below the Main Dam weir.
WGR down	245070	6294799	x	x	x	Downstream monitoring site located in Wollangambe River around 950m below the Main Dam weir.
WGRX down	245452	6293646		x	x	Downstream monitoring site located in Wollangambe River around 2.6km downstream from the Main Dam weir.
WGR ref	245073	6294952	x	x	x	Reference tributary site which flows in a southerly direction to join Wollangambe River at WGRdown.

2.2 Macroinvertebrate Sampling Methods

The aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (the AusRivAS method (Turak et al 2004, Chessman 2003b). The AusRivAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site.

Sampling has conformed to these definitions:

- A site is "a stream reach with a length of 100 m or 10 times the stream width, whichever is the greater".
- A riffle habitat is "an area of broken water with rapid current that has some cobble or boulder substratum". However, "sampling riffles where the substratum consists predominantly of large boulders may be difficult and may not produce reliable results".
- Edge habitat is "an area along the creek with little or no current".

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation.

Site selection for sampling aquatic biota from the river is constrained by access from the road network through the forest to the river and by river access where the river flows through deep incised canyons or through boulder cascades. The river and reference tributary generally comprise narrow channels either with mobile sand or rock beds joined together by rock boulder cascades. There were few broader pools and few sand or log bar constraints.

Further, given the location of a number of the study sites in reaches of streams where there are known to be periods of little or no connecting flow between pools or where there are known to be limited riffle sections available for sampling, it was decided that only pool 'edge' samples would be sampled, as AusRivAS defined riffle samples could not be guaranteed for all (or possibly even for most) sites at all sample times.

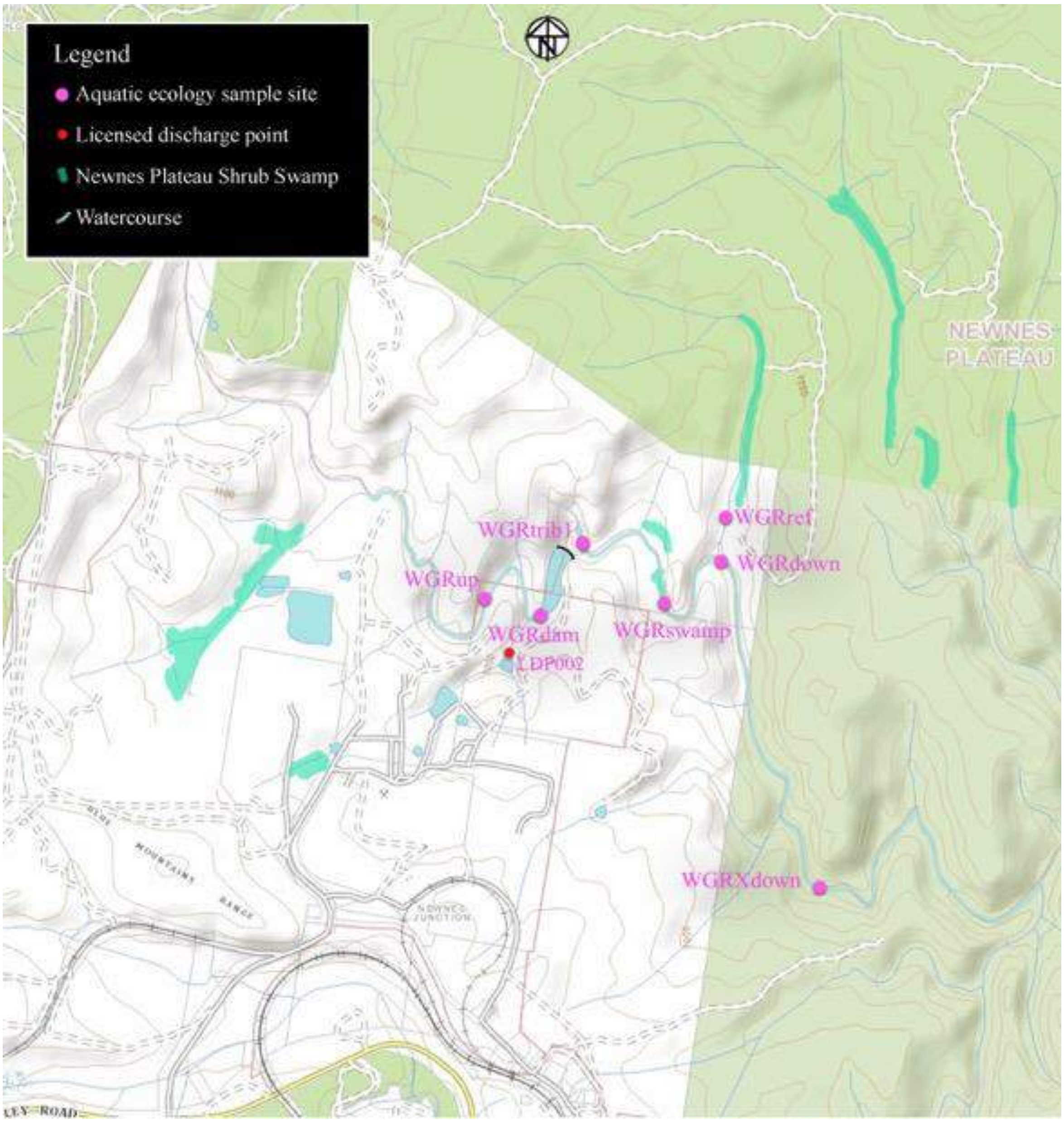


Figure 2: Clarence Aquatic Ecology Sample Sites Autumn 2024.

2.2.1 Field methods for macroinvertebrate sampling

Macroinvertebrate assemblages were sampled using a 250 µm mesh dip net over as many aquatic 'edge' habitat types as could be located within each of the pools along the defined stream reaches. Net samples were then placed into white sorting trays for in situ live sorting for up to 1 person-hour (with a minimum of 40 minutes), as per the AusRivAS protocol. Following cessation of live picking, further observations were made of the pool edge sample areas for surface aquatic macroinvertebrate taxa (e.g., water skaters and spiders) and any other taxa (such as freshwater crayfish) not collected by the dip netting process. Where possible (or necessary) representatives of these organisms were collected and added to the dip net samples.

Rarer specimens for which positive identification could be made in the field (e.g., water scorpions), were generally released. That is, for protection of the pool macroinvertebrate integrity we adopted a 'sampling with replacement' method. Notwithstanding this procedure, for all taxa that could be positively identified in the field, at least one of each of the field-identified taxa are retained as a representative of that taxa for that sampling event. For all other macroinvertebrate taxa where field identifications were not definitive, specimens were retained for later detailed taxonomic analysis in the laboratory.

Notes are also kept of the presence of burrows and holes that are present in the site aquatic habitats (i.e., as indications of yabbies or burrowing dragonflies). All retained specimens are placed in sample jars and preserved in 70% ethanol for subsequent laboratory identification. Each sample jar is labelled and paper laundry tags are inserted into the jars noting the sample site, sample date and sample collector/picker initials. Any giant dragonfly exuviae are kept for confirmation purposes.

2.2.2 Laboratory methods for macroinvertebrate samples

In the laboratory, taxonomic identifications are generally facilitated using Maggy lights or binocular dissecting microscopes and taxonomic guides such as; CSIRO, Land and Water Resources & Environment Australia (1999), Hawking & Smith (1997), Hawking & Theischinger (1999), Theischinger (2009) and Williams (1980).

Organisms are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols. These are as follows; family level for all insect taxa except Chironomids which are taken to sub-family). Collembola arthropods (Springtails) are classified as a single class and the arachnid arthropods (spiders and mites) are classified as two orders. For the mites (Order Acarina) we have taken them to sub-order classification level where possible. Crustaceans were taken to Family level where suitable keys are available. Ostracoda were left at Class level. The worm-like taxa are shown at Phylum or Class level. For all taxa, where suitable keys were available, taxa were identified to lower levels of taxonomy.

The sorted specimens are then transferred to individual glass vials (one per family/sub-family) and paper laundry tags inserted into each glass vial with the sample site, sample date and initials of taxonomist noted on the tags. Glass vials are then topped up with 70 % alcohol, sealed with plastic lids and placed back into the original field sample jars.

Where there are any individual specimens where the collected material is too indistinct or fragmented to assign a definitive identification, the samples are dispatched to relevant Australian Museum specialists or other specialists, as recommended by EPA. For all samples the following taxonomic QA/QC procedure is followed:

> At least ten percent of the samples/sites are selected at random and the individual retained taxa are identified without reference to the original identifications. A table is then made of the original identifications verses the second identifications, indicating where there were any anomalies in identification (if any). If there are no anomalies, the QA/QC sample protocol is accepted and no further QA/QC checking is undertaken. If there are differences in identifications, all the samples containing the related taxa are re-examined to clear up the anomalies.

Following this procedure, and if there have been anomalies, an additional 10 percent of the remaining samples are chosen and the QA/QC procedure re-applied. This process continues until there are no differences between original identifications and QA/QC identifications.

2.2.3 Site SIGNAL index & EPT Index calculations

The aquatic invertebrate assemblage for each sample site is described in terms of the site taxa diversity (number of individual AusRivAS taxa) and in terms of a site SIGNAL score. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates. The indices are derived by correlation analysis of macroinvertebrate occurrence against water chemical analysis (Chessman 1995). The water chemistry attributes generally used are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus (Chessman 2003a).

SIGNAL indices may be regionally specific (e.g. SIGNAL HU-97 developed for the Hunter Valley Catchment (Chessman 1997), or applicable Australia wide (e.g. SIGNAL-2, Chessman 2003a). Each macroinvertebrate Family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). For the present study SIGNAL-2 scores are applied. Taxa with no published SIGNAL score are excluded from the site SIGNAL analysis. Once taxa SIGNAL indices have been applied individual site SIGNAL indices are calculated (as the mean) from all site taxa with SIGNAL scores.

Creek SIGNAL scores are calculated as the mean of all taxa SIGNAL value occurrences recorded within each creek system for a survey. Site and creek SIGNAL scores are then summarised and compared across each survey and between surveys. As a general guide site SIGNAL Indices are graded into the following categories (Chessman *et al.* 1997):

- SIGNAL Index > 6 = Healthy Unimpaired
- SIGNAL Index 5-6 = Mildly Impaired
- SIGNAL Index 4-5 = Moderately Impaired
- SIGNAL Index < 4 = Severely Impaired.

However, as the intent of this study is to assess site condition relative to other sites over time, the site scores are used for these comparison purposes rather than as overall study area condition indices. That is, the overall changes in site indices over time are of greater interest than the basic and generalised ‘health’ scores (as per Chessman et al 1997).

The combined number of Ephemoptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site (the EPT index) is used to supplement the taxa richness (diversity) and SIGNAL index as an indicator of stream health.

2.3 Field Sampling Methods for Fish and Other Vertebrates

At each macroinvertebrate sampling site, four fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream either overnight, or for the duration of the combined macroinvertebrate sampling and live picking survey (minimum 1.5 hours) and then retrieved. Captured fish are identified i*n situ* using Allen *et. al*., (2002) and McDowall (1996) and immediately released. Fish caught or observed as part of the macroinvertebrate dip net sampling are also identified, noted and released.

Dead fish specimens and any fish that cannot be positively identified in the field are taken to the Australian Museum for confirmation of species identification. These specimens with capture details are then incorporated into the Australian Museum collection as appropriate. Following completion of the fish and macroinvertebrate sampling, any further observations of fish during the pool condition survey are also noted with fish species-name only noted if positively identified.

For each survey, tadpoles (which are not macroinvertebrates but chordates) are noted in the results. Specimens are not kept or identified. The presence of birds, reptiles and turtles that utilise the aquatic habitats are noted, and notes are made of the potential for the study area habitats to support platypus or Australian water rats where appropriate.

2.4 Field Water Quality Sampling

A calibrated submersible Yeo-Kal 618 water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. At some sites, depth profiles of water quality may also be made to test for layering/mixing. Physical observations are also taken in the field to highlight any aquatic habitat variations (e.g. recent rain, subsequent infilling, detritus in water column or on benthos, scum or flocculates in or on water body etc.) and the presence of fresh yabbie holes are also noted.

2.5 Aquatic Habitat Condition (RCE Index)

A standardised description of site aquatic habitat condition is used to compile a stream site condition index, based on a modified version of the River-Creek-Environment (RCE) method developed by Petersen (1992), as reported by Chessman *et al* (1997) for the greater Hunter River catchment. The index is compiled by giving each of the 13 RCE descriptors a score between 0 and 4, then summing the scores, to reach a maximum possible score of 52. Scores are then expressed as a percentage.

3 CLARENCE AQUATIC ECOLOGY SURVEY RESULTS

Full field sampling notes for the autumn 2024 aquatic ecology sampling are provided in **Appendix Table A3**. Sampling for the full autumn 2024 survey was undertaken over the 15th and 16th May 2024.

3.1 Sampling Conditions Spring 2023 to Autumn 2024

Appendix Tables A-1 & **A-2** provide the daily rainfall and LDP discharge results for the previous 12 months and are shown graphically in **Figure 3**. Whilst weather patterns leading into the spring 2023 survey in September were generally dry, the period between the spring 2023 and autumn 2024 surveys was characterised by frequent rainfall events and intense storm activity in December 2023 and April 2024:

- September and October 2023 were dry with only 50% of the combined mean monthly total (**Figure 3**).
- The three-month period between November 2023 and January 2024 was very wet with 377mm recorded over 50 rainfall days which was much higher than the combined mean total (231mm), and included a single day total of 108mm in mid-December.
- While February 2024 recorded an average total (82mm), March recorded below average rainfall of only 30mm over 13 rainfall says.

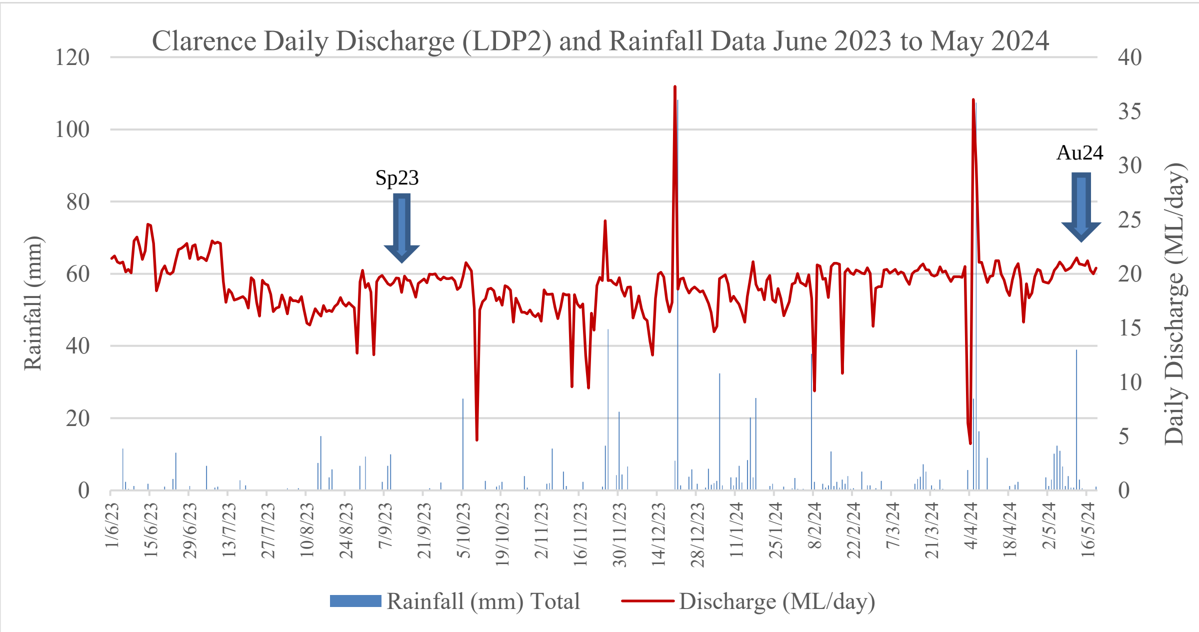


Figure 3 Monthly Rainfall & Monthly discharge 2023 to 2024.

- April was very wet with 169mm at almost three times the average (57mm), including a single day total of 107mm on April 7th.
- The two-week period leading into the autumn 2024 survey saw almost continuous rainfall activity with 97mm recorded over 13 rainfall days, including 39mm recorded two days prior to the commencement of sampling.

Discharge rates were for the most part, stable between the spring 2023 and autumn 2024 surveys, ranging between 15 and 20ML/day. There were two elevated discharge events coinciding with heavy rainfall events in mid-December and early April where discharge rates peaked at 37 and 36 ML/day respectively. LDP002 daily discharge rates were relatively stable across 2024 autumn survey and ranged between 20.7 and 21.2 ML/day..

3.2 Autumn 2024 Aquatic Ecology Survey Results

The Clarence autumn 2024 aquatic ecology survey was undertaken over 15th and 16st May 2024 following the sampling outline shown in **Table 1** and **Figure 2** above and using the methodology outlined in **Section 2**. **Appendix Table A-3** provides site field notes for the autumn 2024 sampling program and site photos are also provided **Appendix A**. Summary tables for the autumn 2024 Appendix A data are provided in the following Sections.

3.3 Metered Water Quality Results

A water quality meter is used at all aquatic ecology sampling sites plus at selected intermediary sites to record surface water quality - and where applicable, depth profiles of water temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity. **Table 2** provides the results of metered water quality sampling during the autumn 2024 aquatic ecology field sampling program.

Table 2 Site Field Water Quality Readings Autumn 2024

Site	Date	Time	Temp	Cond	DO	DO	pH	Turb
			°C	µS/cm	%sat	mg/L	Units	ntu
WGRup	15/5/24	8:58	11.33	3	95.3	10.45	5.35	38.3
WGRdam	16/5/24	9:46	16.11	369	91.1	8.97	7.57	5.0
WGRtrib1	16/5/24	11:39	11.19	6	60.6	6.66	5.53	2.2
WGRswamp	16/5/24	7:58	13.86	269	93.1	9.63	6.50	6.0
WGRdown	15/5/24	14:09	14.83	300	94.2	9.54	7.32	10.6
WGRXdown	15/5/24	11:14	13.97	360	95.0	9.80	6.46	8.2
WGRref	15/5/24	14:58	11.39	1	88.8	9.72	4.89	2.6

3.4 Aquatic & Riparian Habitat Condition

The field notes (**Appendix Table A-3**) provide details of stream reach flows, pool dimensions and available aquatic habitats for the present survey. The overall Aquatic and Riparian Habitat condition - as estimated using the RCE Index - are provided in **Appendix Table A-4** with summary provided in **Table 3**, and **Table 4** provides the site aquatic macrophyte occurrence results for the autumn 2024 survey.

Table 3 Summary of RCE Results

Category	WGRup	WGRdam	WGRtrib1	WGRswamp	WGRdown	WGRXdown	WGRref
Land-use pattern beyond immediate riparian zone	4	4	4	4	4	4	4
Width of riparian strip-of woody vegetation	4	4	4	4	4	4	4
Completeness of riparian strip of woody vegetation	2	4	4	2	2	2	2
Vegetation of riparian zone within 10 m of channel	4	4	4	4	4	4	4
Stream bank structure	1	4	4	2.5	2.5	2.5	1
Bank undercutting	2	3	3.5	1.5	2	2.5	2.5
Channel form	4	2.5	4	4	4	4	4
Riffle/pool sequence	4	0	3	3.5	4	4	4
Retention devices in stream	3	0.5	4	3	3	3.5	3.5
Channel sediment accumulations	3.5	1	2.5	2	2.5	2.5	2
Stream bottom	4	2	2.5	3	3	4	3
Stream detritus	1.5	3	3.5	3.5	3.5	3	3.5
Aquatic vegetation	4	1	1	4	4	4	3.5
Autumn 24 RCE %age – this survey	78.8	63.5	84.6	78.8	81.7	84.6	78.8
Spring 23 RCE %age - previous survey	76.9	64.4	84.6	78.8	81.7	84.6	78.8
Long-term Mean	86.6	65.8	87.5	80.5	85.0	88.3	87.1
Long-term SD	6.3	5.1	2.4	4.1	3.4	3.8	5.8
Long-term X-SD	80.4	60.7	85.1	76.4	81.6	84.5	81.3

Table 4 Clarence Aquatic Ecology Site Macrophyte Occurrence Autumn 2024

Site	Rush *Baumea rubiginosa*	Pampas Grass *Cortaderia selloana*	Tall Spikerush *Eleocharis sphacelata*	Rush *Juncus sp.*	River Clubrush *Schoenoplectus validus*	Sago Pondweed *Stuckenia pectinata*	Cumbungi *Typha spp*	Blunt Pondweed *Potamogeton ochreatus*	Charophytes
WGRup	1			1					
WGRdam	1	1	1	1			1	1	1
WGRtrib1	1	1	1	1		1	1	1	1
WGRswamp					1				1
WGRdown	1								1
WGRXdown									
WGRref				1					1

3.5 Aquatic Macroinvertebrate and Fish Survey Results

Appendix Table A-5 shows the results of aquatic macroinvertebrate taxonomic identifications to the levels required by AusRivAS, plus occurrence data for all aquatic macroinvertebrates and fish. The table also provides site SIGNAL and EPT scores (see **Section 2.2.3** for explanation of SIGNAL and EPT).

Tables 5 to 7 provide summary statistics for seasonal and site Diversity (taxa richness), SIGNAL and EPT scores, derived from the aquatic macroinvertebrate data in **Appendix Table A-4**. The Tables also provide a comparison of total and individual site results against the previous seasonal results and against site long term Mean (X) and Standard Deviation of the Mean (SD) statistics for each site:

- **Orange** highlight indicates results are below the X-SD value.
- **Yellow** highlight indicates results in the range X to X-SD.
- **Green** highlight indicates results in the range X to X+SD.
- **No highlight** indicated values > the X+SD value.
- Results in **Bold** are the site Minimum Value.

Table 5 Seasonal Long Term Site Diversity (No. Of Taxa)									
Site Season	Comb sites Edge	WGR up Edge	WGR ref Edge	WGR dam Edge	WGR trib1 Edge	WGR swamp Edge	WGR down Edge	WGRX down Edge	WGRX down Riffle
Au12	**27**	12	15	14		8	15		
Sp12	35	19	17	14		8	20		
Au13	34	14	15	16		8	11	13	11
Sp13	31	17	14	14		11	15	**11**	4
Au14	36	14	14	18		8	**7**	16	9
Sp14	42	22	16	22	20	13	19	19	8
Au15	40	16	16	16	15	8	12	16	10
Sp15	38	14	13	16	18	5	14	14	12
Au16	42	17	15	16	19	11	14	16	8
Sp16	39	18	17	20	18	8	10	15	7
Au17	34	13	17	14	17	9	11	15	7
Sp17	36	13	17	16	17	**3**	8	16	9
Au18	36	18	16	15	18	10	7	14	11
Sp18	31	13	17	12	16	6	12	14	7
Au19	37	18	18	14	17	10	8	12	8
Sp19		15					7	19	11
Au20	34	15	16	13	17	10	12	13	11
Sp20	40	20	16	14	20	8	15	16	9
Au21	35	13	15	16	19	9	12	15	5
Sp21	35	**11**	**12**	17	20	7	14	13	6
Au22	37	13	17	16	16	11	17	14	6
Sp22	29	**11**	13	12	**13**	8	14	14	**3**
Au23	39	15	14	21	15	11	14	**11**	13
Sp23	37	16	15	12	17	5	12	**11**	5
Au24	37	13	13	**10**	23	6	11	**11**	**3**
LTM	35.8	15.3	15.4	15.6	17.3	8.5	12.5	14.4	8.2
SD LTM	3.8	2.8	1.6	2.9	2.3	2.3	3.5	2.3	2.9
X-SD	32.1	12.4	13.8	12.7	15.1	6.2	9.0	12.1	5.3

Table 6 Seasonal Long-Term Signal Indices

Site Season	Comb sites Edge	WGR up Edge	WGR ref Edge	WGR dam Edge	WGR trib1 Edge	WGR swamp Edge	WGR down Edge	WGRX down Edge	WGRX down Riffle
Au12	5.27	5.92	6.07	4.14		4.50	5.73		
Sp12	4.46	5.35	5.29	2.86		4.25	4.55		
Au13	5.08	6.00	5.80	3.19		5.63	4.64	5.23	6.09
Sp13	4.79	5.67	5.79	3.36		5.00	4.87	4.09	5.50
Au14	4.67	6.14	5.21	3.94		4.13	4.50	4.13	4.67
Sp14	4.22	5.59	4.81	3.32	3.56	4.08	3.89	4.28	5.13
Au15	4.73	5.56	5.63	3.60	**3.14**	4.88	4.45	5.88	6.60
Sp15	4.30	5.08	4.77	3.73	3.47	4.60	4.15	4.29	5.00
Au16	4.31	5.00	5.00	3.13	3.72	4.09	4.62	4.65	6.25
Sp16	4.63	5.11	5.12	4.26	3.18	5.00	4.44	5.27	5.57
Au17	4.19	5.33	4.59	3.07	3.38	3.50	4.18	5.27	3.86
Sp17	4.21	5.08	5.35	3.53	3.63	**3.00**	4.75	4.12	5.56
Au18	4.01	4.71	5.53	3.00	3.41	4.20	**3.43**	3.79	6.09
Sp18	4.15	4.83	4.81	2.91	4.27	3.33	3.92	5.00	4.57
Au19	4.29	5.00	4.94	4.29	3.25	3.82	3.88	4.83	5.88
Sp19		5.43					3.86	5.11	5.82
Au20	**3.98**	**4.07**	4.64	**2.75**	3.47	5.22	4.36	**3.36**	5.91
Sp20	4.44	4.89	5.27	3.71	3.47	4.25	4.20	5.27	5.00
Au21	4.47	4.92	5.80	3.19	3.65	4.44	4.55	4.73	6.00
Sp21	4.55	5.09	5.58	4.13	3.61	4.57	3.62	5.23	4.33
Au22	4.70	5.23	4.88	4.31	3.60	4.36	5.00	5.50	4.88
Sp22	4.47	4.82	5.00	3.27	3.55	4.75	5.00	4.93	**3.33**
Au23	4.70	4.93	**5.00**	4.00	4.05	4.73	4.64	5.57	6.09
Sp23	4.45	4.81	**5.47**	4.25	4.00	4.00	4.00	4.64	5.80
Au24	4.66	5.23	4.92	4.30	3.29	4.50	5.18	5.18	6.00
LTM	4.48	5.19	5.23	3.56	3.58	4.36	4.38	4.78	5.36
SD LTM	0.32	0.46	0.42	0.52	0.29	0.61	0.51	0.64	0.83
X-SD	4.16	4.73	4.82	3.04	3.28	3.75	3.87	4.14	4.53

Table 7 Seasonal Long Term EPT Indices									
Site Season	Comb sites Edge	WGR up Edge	WGR ref Edge	WGR dam Edge	WGR trib1 Edge	WGR swamp Edge	WGR down Edge	WGRX down Edge	WGRX down Riffle
Au12	9	7	6	3		2	6		
Sp12	8	7	6	2		1	4		
Au13	8	8	5	1		3	3	3	3
Sp13	**5**	3	4	1		1	4	2	2
Au14	8	5	4	2		1	**0**	4	4
Sp14	8	7	5	3	2	2	4	5	4
Au15	9	7	**3**	3	**1**	1	2	6	5
Sp15	6	3	5	2	2	1	1	3	4
Au16	10	5	3	1	3	2	2	6	4
Sp16	10	6	5	4	2	2	1	5	4
Au17	9	4	6	1	3	2	2	5	2
Sp17	6	4	5	2	2	**0**	1	2	2
Au18	7	4	**3**	2	2	3	1	2	5
Sp18	6	3	4	**0**	3	1	2	5	**1**
Au19	10	6	**3**	4	2	1	1	3	5
Sp19		5					1	5	3
Au20	**5**	3	**3**	2	2	2	2	**1**	5
Sp20	9	6	5	1	3	2	2	6	3
Au21	7	4	5	2	2	3	2	4	4
Sp21	7	**2**	4	3	3	1	**0**	4	2
Au22	7	4	5	4	3	3	2	4	3
Sp22	**5**	3	4	1	**1**	2	4	3	0
Au23	9	5	4	3	3	4	5	5	5
Sp23	7	4	3	2	3	2	3	3	2
Au24	7	4	4	4	4	1	4	4	2
LTM	7.6	4.8	4.3	2.1	2.3	1.8	2.3	3.9	3.3
SD LTM	1.6	1.6	1.0	1.1	0.8	0.9	1.6	1.4	1.4
X-SD	6.0	3.2	3.3	1.0	1.6	0.9	0.7	2.5	1.9

4 REFERENCES

Allen, G.R., Midgley, S.H. and Allen, M. (2002)
Field Guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, WA.

ANZECC/ARMCANZ (2000)
Australian and New Zealand Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Chessman, B. C (1995)
Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology* 20, pp. 122-129.

Chessman, B. C., Growns, J. E. and Kotlash, A. R. (1997)
Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. *Marine & Freshwater Research* 48, pp. 159-172.

Chessman, B. C., (2003a)
New Sensitivity grades for Australian river macroinvertebrates. *Marine & Freshwater Research* 54, pp. 95 - 103.

Chessman, B. C., (2003b)
SIGNAL 2 – A Scoring System for Macro-invertebrate (‘Water Bugs’) in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra

CSIRO, Land and Water Resources & Environment Australia (1999)
Interactive Guide to Australian Aquatic Invertebrates. CSIRO Australia.

Hawking, J. & Smith, F. J. (1997)
Colour Guide to Invertebrates of Australian Inland Waters. Co-operative Centre for Freshwater Ecology, Albury.

Hawking, J. & Theischinger, G. (1999)
Dragonfly Larvae (Odonata). A Guide to the Identification of Larvae of Australian Families and to the Identification and Ecology of Larvae from New South Wales. Co-operative Centre for Freshwater Ecology, Albury, and Australian Water Technologies Pty Ltd, West Ryde. CRCFE Identification Guide No. 24.

McDowall, R. (1996)
Freshwater Fishes of South Eastern Australia. Reed Books, Sydney, NSW.

MPR (2012)
Aquatic Ecology Report Autumn 2012. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2012.

MPR (2013a)
Aquatic Ecology Report Spring 2012. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, April 2013.

MPR (2013b)
Aquatic Ecology Report Autumn 2013. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, September 2013.

MPR (2014a)
Aquatic Ecology Report Spring 2013. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, April 2014.

MPR (2014b)
Aquatic Ecology Report Autumn 2014. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, September 2014.

MPR (2014c)
Review of Two Reports on the Aquatic Ecology of the Wollangambe River. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, November 2014.

MPR (2015a)
Aquatic Ecology Report Spring 2014. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, January 2015.

MPR (2015b)
Aquatic Ecology Report Autumn 2015. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, August 2015.

MPR (2015c)
Aquatic Ecology Report Spring 2015. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, December 2015.

MPR (2016)
Aquatic Ecology Report Autumn 2016. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, August 2016.

MPR (2017a)
Aquatic Ecology Report Spring 2016. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, March 2017.

MPR (2017b)
Aquatic Ecology Report Autumn 2017. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, October 2017.

MPR (2018a)

Aquatic Ecology Report Spring 2017. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, February 2018.

MPR (2018b)

Aquatic Ecology Report Autumn 2018. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, August 2018.

MPR (2018c)

Aquatic Ecology Report Spring 2018. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, December 2018.

MPR (2019)

Aquatic Ecology Report Autumn 2019. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2019.

MPR (2020a)

Aquatic Ecology Report Autumn 2020. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2020.

MPR (2020b)

Aquatic Ecology Report Spring 2020. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, January 2021.

MPR (2021)

Aquatic Ecology Report Autumn 2021. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2021.

MPR (2022a)

Aquatic Ecology Report Spring 2021. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, February 2022.

MPR (2022b)

Aquatic Ecology Report Autumn 2022. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, July 2022.

MPR (2023a)

Aquatic Ecology Report Spring 2022. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, February 2023.

MPR (2023b)

Aquatic Ecology Report Autumn 2023. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, September 2023.

MPR (2024)

Aquatic Ecology Report Spring 2023. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, January 2024.

Peterson (1992)

The RCE: a Riparian Channel and Environmental Inventory for small streams in the agricultural landscape. Freshwater Biology 27: 295 – 306.

Turak, E, Waddell, N, Johnstone, G. (2004)

New South Wales Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual. Department of Environment and Conservation, Sydney.

Williams, W.D. (1980)

Australian Freshwater Life. The Invertebrates of Australia Inland Waters. The MacMillan Co. of Australia Pty Ltd, Sydney.

APPENDIX A

FIELD NOTES,

SITE PHOTOGRAPHS

AND

SAMPLING DATA

AUTUMN 2024

Appendix Table A-1 Daily Rainfall (mm) for June 2023 to May 2024												
Year	2023							2024				
Date	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1st	0	0	0	0	0	0	4.4	6	3.4	0	0	0
2nd	0	0	0	0	0	0	0	1.6	0.4	0.6	0	3.6
3rd	0	0	0.6	0	0	0	6.6	2	0	0	0	1.2
4th	0	0	0	0	0	1.8	0	2.6	0.4	2.6	5.6	3
5th	11.6	6.8	0	0	25.4	2	0.2	32.4	0	0	0	10.2
6th	2.4	0	0.2	2.4	0.2	11.6	0	1.4	0	0	25.4	12.4
7th	0.4	0	0.6	0	0.2	0.2	0	0.2	37.8	0	107.4	11
8th	0	0.8	0.2	6.8	0	0	0	0	2.4	0	16.4	6.6
9th	1.2	1	0	10	0	0	0	3.6	0.2	0	0	1.2
10th	0	0	0	0	0	5.2	0	1.4	0.2	0	0	4
11th	0	0	0	0	0	1.2	0	3.6	1.8	0	9	0.8
12th	0	0	0	0	0	0	0	6.8	0.8	0	0	0.8
13th	0	0	0	0	2.6	0	0	2.2	1.4	0	0	39
14th	1.8	0	7.6	0	0	0	0.2	0	10.8	0	0	3
15th	0	0	15	0	0	0	0.2	8.4	1.2	0	0	0.6
16th	0	0	0.2	0	0	0	0	20.2	2.4	1.8	0	0
17th	0	2.8	0	0	1	2.4	0	3.6	0.8	3.2	0	0
18th	0	0.2	3.6	0	1.4	0.2	0	25.6	3	3.8	0	0
19th	0	1.4	5.8	0	2.4	0	0	0.2	1.8	7.2	1.2	0.2
20th	1	0	0.2	0	0	0	8.2	0	4	5.2	0	1
21st	0	0	0	0	0	0	108.2	0	0.4	0.2	1.6	0
22nd	0	0	0	0	0	0	1.4	0	0.6	1.4	2.4	
23rd	3.2	0	0	0.6	0	0	0.2	1.2	0	0.4	0	
24th	10.4	0	0.2	0	0	1	0	1.8	0	0.2	0	
25th	0	0.2	0	0	0	12.4	3.8	0	5.2	3	0.2	
26th	0	0.2	0	0	0	44.6	5.8	0	0	0.4	0	
27th	0	0	0	2.2	4	0.2	0.2	0.2	1.4	0	0	
28th	0	0	0	0	0.8	0	1.8	1	1.4	0	0	
29th	1.2	0	6.8	0	0	4.2	0	0		0	0	
30th	0.2	0	0	0	0	21.8	0	0		0	0	
31st		0	9.4		0		0.8	0.6		0		
Total	33.4	13.4	50.4	22	38	108.8	142	126.6	81.8	30	169.2	98.6
Monthly Average*	71.3	61.2	57.9	55.9	62.3	65.8	79.7	85.7	81	77.7	57.2	50.7
Note: Days sampled are highlighted in yellow. *Monthly average is the long-term average from BOM Lithgow station 63226.												

Appendix Table A-2 LDP002 Daily Discharge (ML/Day) for 2023/24

Year	2023							2024				
Date	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1st	18.0	18.7	19.6	16.3	18.5	17.3	19.1	18.8	19.2	18.7	19.7	19.2
2nd	17.4	19.1	19.3	15.6	17.9	16.4	19.2	18.8	20.0	18.8	20.7	19.1
3rd	16.3	18.3	18.5	18.5	18.8	14.6	20.0	20.3	19.2	18.8	6.2	19.5
4th	17.8	12.5	18.8	18.1	18.8	15.1	19.2	20.4	19.1	20.3	4.3	20.3
5th	17.5	19.2	19.8	18.1	15.9	19.5	19.1	20.0	18.9	20.4	36.1	20.6
6th	17.5	19.7	21.0	18.1	16.9	19.7	18.9	20.2	19.9	20.0	30.0	21.1
7th	17.4	19.8	20.7	16.9	18.0	19.9	19.9	20.4	17.7	20.2	21.0	20.8
8th	17.9	19.5	20.3	15.9	16.8	19.0	17.7	20.0	9.2	20.4	21.1	20.3
9th	16.7	19.1	16.8	16.9	15.9	17.4	9.2	20.2	20.8	20.0	20.1	20.4
10th	15.5	18.9	4.6	18.2	15.7	17.9	20.8	20.1	20.7	20.2	19.2	20.6
11th	15.3	19.2	16.6	18.1	13.8	17.5	20.7	19.5	19.5	20.1	19.8	21.0
12th	16.0	19.6	17.4	18.1	12.5	17.2	19.5	19.0	19.6	19.5	19.8	21.5
13th	16.8	19.6	17.7	9.6	17.7	16.5	19.6	20.0	17.8	19.0	21.2	20.9
14th	16.4	18.3	18.6	18.1	20.0	15.5	17.8	20.2	20.7	20.0	21.2	20.9
15th	16.1	19.8	18.7	17.2	20.1	17.9	20.7	20.3	21.0	20.2	20.0	20.8
16th	17.1	19.4	18.4	16.9	19.7	19.5	21.0	20.7	21.0	20.3	19.4	21.2
17th	16.5	19.4	17.5	17.2	17.6	21.1	21.0	20.9	20.9	20.7	18.4	20.3
18th	16.6	18.7	17.8	12.5	16.5	19.0	20.9	20.4	10.8	20.9	18.0	20.0
19th	16.5	17.8	17.1	9.4	17.4	18.5	10.8	20.3	20.1	20.4	19.4	20.5
20th	17.0	19.1	18.9	16.4	37.3	18.6	20.1	19.9	20.5	20.3	20.5	
21st	17.2	19.3	18.8	14.8	18.6	17.6	20.5	19.8	20.1	19.9	20.9	
22nd	17.8	19.5	18.5	18.9	19.5	19.4	20.1	19.9	19.9	19.8	19.5	
23rd	17.3	19.2	15.5	19.7	19.6	19.9	19.9	20.6	20.4	19.9	15.5	
24th	17.0	20.0	17.7	19.4	18.7	17.6	20.4	20.1	20.2	20.6	19.1	
25th	17.3	19.9	17.2	24.9	18.2	17.4	20.2	20.3	20.0	20.1	17.8	
26th	17.1	20.0	16.4	19.4	18.6	18.6	20.0	19.7	20.0	20.3	18.2	
27th	16.9	19.6	16.5	19.4	18.8	17.7	20.0	19.3	20.6	19.7	19.7	
28th	12.7	19.4	16.3	19.1	18.6	16.1	20.6	19.7	20.0	19.3	20.4	
29th	19.2	19.7	16.7	18.9	18.3	16.7	20.0	19.7	15.1	19.7	20.3	
30th	20.3	19.5	16.2	19.6	18.4	17.4	15.1	19.7		19.7	19.3	
31st		19.5	16.0		17.9		18.7	19.7		19.7		
Total	509.1	591.4	544.1	520.1	570.9	536.8	590.5	619.1	552.8	618.1	586.8	389.0
Average	17.0	19.1	17.6	17.3	18.4	17.9	19.0	20.0	19.1	19.9	19.6	20.5

Note: Sample days are highlighted in yellow.

Table A-3 Field Comments – Seasonal Aquatic Ecology Monitoring Sites		
Date	Site	Comments
15/5/24	WGRup	Water was turbid with high flow throughout the site, with no areas of low/ back flow. Water levels appear to be unchanged from previous. Bank is undercut with bank erosion, with 70% exposed bedrock. Scoured out sections of high flow with some sandy deposits (consistent with previous) in inner channel meanders. Bank vegetation mainly consist of Juncus. Substrates comprised of primarily bedrock, with some gravelly sand and pebbles. Filamentous green alga absent.
16/5/24	WGRdam	Water was very turbid with upstream flow of LDP channel. LDP channel is increased in size to previous. Significant increase in cumbungi along LDP channel. All submerged surfaces and substrates were covered in thick algal silt biofilm, which had increased compared to the previous survey. The flat edge bank area occupied by tea tree vegetation (adjacent to the main incised channel area) were fully submerged by water. All substrates were smothered in black silt, appears to have caused a die back in macrophytes. Note, due to the abundance of the silt/ algal matrix smothering submerged surfaces, the sample net became clogged, and therefore sample contents were sorted in very small portions.
16/5/24	WGRtrib1	Water was very clear with no flow throughout the site. Upstream sections had abundant orange precipitates on macrophytes. Macrophytes appear to be consistent with previous, with slight increases in *Potamogeton* and Sago pondweed, as well as some charophytes. Water appears to be mostly derived from WGR rather than LDP. Algal silt matrix abundant throughout site. Filamentous algae abundant. Substrates as before.
16/5/24	WGRswamp	Water was slightly turbid with a cloudy grey colour. High flow evident but areas of lesser flow present. Greater damming effect in downstream areas to previous. Evidence of flow above 1.5 m to current (1.7 m). Pockets of soft sand present, appears to be recently deposited, with some channel sections scoured back to clean rocks and boulder fragments. Substrates underly sand deposits which are smothered by thick algal silt matrix. Very little charophytes present with poor edge habitat. Macrophytes consist of mainly *Schoenoplectus validus*. Filamentous algae present in small amounts. Substrates as before. Poor edge habitat.
15/5/24	WGRdown	Water clarity as previous. High flow throughout sites with limited areas of black flow or no flow. Evidence of flow 1-1.5m higher to current water level, which has increased from previous (1.6 m). Soft sand throughout main pool which appears to be recently deposited. Substrates smothered by silt and silt agal matrix. Macrophytes as before. Upstream channel appears to be more incised to previous. Filamentous algae absent.

15/5/24	WGRXdown	Water was somewhat turbid with grey colour. Flow was very strong with little areas back flow or low flow, edge habitat availability was limited to small, isolated sections of edge bank. The edge areas that were sampled in low flow were covered with dark silt. Riffle sections appear to be well consolidated and compacted with fine sediments (not loose material upon attempted disturbance). Evidence of flow 1-1.5 m higher to current, which is same as previous. Damming effect upstream. Exposed rock surfaces covered in thick algal silt matrix. Habitats sampled were mostly undercut banks. The composition of substrates was as before.
15/5/24	WGRref	Water was very clear with a low flow throughout site length, with continuous flow downstream and through to WGRdown main channel area. Detritus and debris, such as logs and branches were abundant throughout site, good edge habitat availability. Evidence of high flow occurring recently as indicated by debris lines along banks and in vegetation. The surface water connected and flowing into WGRdown main channel area. Substrates and Macrophytes as before. Filamentous algae absent.

Appendix Table A-4

Modified Riparian, Channel and Environment (RCE) Inventory (after Chessman et al 1997).

Descriptor	Category	Value	Sp23 WGRup	Sp23 WGRdam	Sp23 WGRtrib1	Sp23 WGRswamp	Sp23 WGRdown	Sp23 WGRXdown	Sp23 WGRref
1	Land-use pattern beyond immediate riparian zone								
	Undisturbed native vegetation	4	4	4	4	4	4	4	4
	Mixed native vegetation and pasture/exotics	3							
	Mainly pasture, crops or pine plantation	2							
	Urban, some vegetation	1							
	Industrial, little vegetation	0							
2	Width of riparian strip-of woody vegetation								
	More than 30 m	4	4	4	4	4	4	4	4
	Between 5 and 30 m	3							
	Less than 5 m	2							
	No woody vegetation	1							
	No Vegetation	0							
3	Completeness of riparian strip of woody vegetation								
	Riparian strip without breaks in vegetation	4		4	4				
	Breaks at intervals of more than 50 m	3							
	Breaks at intervals of 10-50 m	2	2			2	2	2	2
	Breaks at intervals of less than 10 m	1							
	No riparian strip at all	0							
4	Vegetation of riparian zone within 10 m of channel								
	Native tree and shrub species	4	4	4	4	4	4	4	4
	Mixed native and exotic trees and shrubs	3							
	Exotic trees and shrubs	2							
	Exotic grasses/weeds	1							
	No vegetation at all	0							
5	Stream bank structure								
	Banks fully stabilized by trees, shrubs, concrete	4		4	4				
	Banks firm but held mainly by grass and herbs	3							
	Banks loose, partly held by sparse grass, rubble	2				2.5	2.5	2.5	
	Banks unstable, mainly loose sand or soil	1	1						1
	Banks actively eroding	0							
6	Bank undercutting								
	None, or restricted by tree roots or man-made	4							
	Only on curves and at constrictions	3		3	3.5				
	Frequent along all parts of stream	2	2				2	2.5	2.5
	Severe; bank collapses common	1				1.5			
	Total bank collapse	0							
7	Channel form								
	Deep; width:depth ratio less than 8:1	4	4		4	4	4	4	4
	Medium; width:depth ratio 8:1 to 15:1	3							
	Shallow; width:depth ratio greater than 15:1	2		2.5					
	Artificial; concrete or excavated channel< 8:1	1							
	Artificial; concrete or excavated channel > 8:1	0							
8	Riffle/pool sequence								
	Frequent alternation of riffles and pools	4	4				4	4	4
	Long pools with infrequent short riffles	3			3	3.5			
	Natural channel without riffle/pool sequence	2							
	Artificial channel; some riffle/pool sequence	1							
	Artificial channel; no riffle/pool sequence	0		0					
9	Retention devices in stream								
	Many large boulders and/or debris dams	4			4				
	Rocks/logs present; limited damming effect	3	3			3	3	3.5	3.5
	Rocks/logs present but unstable; no damming	2							
	Stream or channel with few or no rocks/logs	1							
	Artificial channel; no retention devices	0		0.5					
10	Channel sediment accumulations								
	Little or no accumulation of loose sediments	4							
	Some gravel bars but little sand or silt	3	3.5						
	Bars of sand and silt common	2			2.5	2	2.5	2.5	2
	Braiding by loose sediment	1		1					
	Complete in-filled muddy channel	0							
11	Stream bottom								
	Mainly clean stones with obvious interstices	4	4					4	
	Mainly stones with some cover of algae/silt	3				3	3		3
	Bottom heavily silted but stable	2		2	2.5				
	Bottom mainly loose and mobile sandy sediment	1							
	Bottom mainly loose and mobile muddy sedimen	0							
12	Stream detritus								
	Mainly unsilted wood, bark, leaves	4							
	Some wood, leaves, etc. with much fine detritus	3		3	3.5	3.5	3.5	3	3.5
	Mainly fine detritus mixed with sediment	2							
	Little or no organic detritus, mainly sandy	1	1.5						
	No organic detritus, mainly mud	0							
13	Aquatic vegetation								
	Little or no macrophyte or algal growth	4	4			4	4	4	
	Substantial algal growth; few macrophytes	3							3.5
	Substantial macrophyte growth; little algal grow	2							.
	Substantial macrophyte and algal growth	1		1	1				
	Total cover of macrophytes plus algae	0							
	RCE Score		41.0	33.0	44.0	41.0	42.5	44.0	41.0
	RCE %age		78.8	63.5	84.6	78.8	81.7	84.6	78.8

Appendix Table A-5												Sample Site and Sample Date									
Wollangambe River Aquatic Ecology Survey Macroinvertebrate & Fish Results - Autumn 2024									Life Stage			15/5/24	16/5/24	16/5/24	16/5/24	15/5/24	15/5/24	15/5/24	15/5/24		
Phylum	Class	Sub-class	Order	Sub-Order	Family	Sub-Family	*Genus/spp*	Common Name	L	N	A	WGRup	WGRdam	WGRtrib1	WGRswamp	WGRdown	WGRXdown	WGRXdown-R	WGRref	Occurrence	SIG-2
Arthropoda	Insecta		Coleoptera		Dytiscidae			Diving Beetles	x		x	1		1		1			1	4	2
Arthropoda	Insecta		Coleoptera		Gyrinidae			Whirligig Beetles	x		x	1		1	1	1	1	1	1	7	4
Arthropoda	Insecta		Coleoptera		Scirtidae			Marsh Beetles	x			1								1	6
Arthropoda	Insecta		Diptera		Ceratopogonidae			Biting Midges	x			1	1	1		1				4	4
Arthropoda	Insecta		Diptera		Chironomidae	Chironominae		Bloodworms	x						1		1			2	3
Arthropoda	Insecta		Diptera		Chironomidae	Orthocladiinae		Bloodworms	x				1			1				2	4
Arthropoda	Insecta		Diptera		Chironomidae	Tanypodinae		Bloodworms	x					1						1	4
Arthropoda	Insecta		Diptera		Culicidae			Mosquitoes						1						1	1
Arthropoda	Insecta		Diptera		Tipulidae			Crane Flies	x			1	1				1		1	4	5
Arthropoda	Insecta		Ephemoptera		Leptophlebiidae			Mayflies		x		1	1	1		1	1		1	6	8
Arthropoda	Insecta		Hemiptera		Corixidae			Lesser Waterboatmen						1						1	2
Arthropoda	Insecta		Hemiptera		Gerridae			Water Striders						1						1	4
Arthropoda	Insecta		Hemiptera		Notonectidae			Backswimmers						1						1	1
Arthropoda	Insecta		Hemiptera		Veliidae			Small Water Striders								1			1	2	3
Arthropoda	Insecta		Lepidoptera		Crambidae			Moths	x					1						1	3
Arthropoda	Insecta		Neuroptera		Neurorthidae			Lacewings											1	1	6
Arthropoda	Insecta		Odonata	Epiproctophora	Aeshnidae			Dragonflies						1						1	4
Arthropoda	Insecta		Odonata	Epiproctophora	Corduliidae			Dragonflies	x					1						1	5
Arthropoda	Insecta		Odonata	Epiproctophora	Libellulidae			Dragonflies	x					1						1	4
Arthropoda	Insecta		Odonata	Epiproctophora	Synthemistidae			Dragonflies	x			1		1			1		1	4	2
Arthropoda	Insecta		Odonata	Epiproctophora	Telephlebiidae			Dragonflies	x			1				1	1		1	4	9
Arthropoda	Insecta		Odonata	Zygoptera	Argiolestidae			Damselflies	x				1		1	1			1	4	5
Arthropoda	Insecta		Odonata	Zygoptera	Coenagrionidae			Damselflies	x					1						1	2
Arthropoda	Insecta		Odonata	Zygoptera	Lestidae			Damselflies	x				1	1						2	1
Arthropoda	Insecta		Odonata	Zygoptera	Synlestidae			Damselflies	x						1					1	7
Arthropoda	Insecta		Plecoptera		Gripopterygidae			Stoneflies		x		1				1	1	1	1	5	8
Arthropoda	Insecta		Trichoptera		Ecnomidae			Caddis Flies	x				1	1		1	1			4	4
Arthropoda	Insecta		Trichoptera		Hydropsychidae			Caddis Flies	x									1		1	6
Arthropoda	Insecta		Trichoptera		Hydroptilidae			Caddis Flies	x				1	1					1	3	4
Arthropoda	Insecta		Trichoptera		Leptoceridae			Caddis Flies	x			1	1	1	1	1	1		1	7	6
Arthropoda	Insecta		Trichoptera		Philorheithridae			Caddis Flies	x			1								1	8
Arthropoda	Crustacea	Copepoda						Copepods						1						1	*
Arthropoda	Crustacea		Decapoda		Parastacidae			Freshwater Crayfish				1								1	4
Arthropoda	Crustacea	Ostracoda						Seed Shrimps						1						1	*
Annelida	Oligochaeta							Freshwater Worms				1	1	1	1		1		1	6	2
Platyhelminthes			Tricladia		Dugesiidae			Flatworms						1						1	2
Nematomorpha								Horsehair Worms									1			1	6
Chordata	Amphibia				Hylidae		*Litoria fallax*	Dwarf Green Tree Frog											1	1	
Chordata	Osteichthyes				Galaxiidae		*Galaxias olidus*	Mountain Galaxias				1								1	
							Total number of invertebrate taxa per site:					13	10	23	6	11	11	3	13	37	
							Site SIGNAL2 scores:					5.23	4.30	3.29	4.50	5.18	5.18	6.00	4.92		
Notes:	*Represents taxa for which SIGNAL grades do not apply.						Number of EPT taxa:					4	4	4	1	4	4	2	4	8	

Plate 1: Looking across site WGRup plunge pool in Autumn 2024.

Plate 2: Looking downstream at WGRup.


Plate 3: Portion of Site WGRup looking downstream.


Plate 4: Looking downstream through the LDP channel to WGRdam in Autumn 2024.

Plate 5: Looking upstream from the upstream end of the dam.

Plate 6: Looking downstream at WGRdam.

Plate 7: Looking upstream at tributary channel at upstream end of WGRtrib1 in Autumn 2024.

Plate 8: Looking upstream at WGRtrib1.

Plate 9: Looking Downstream at WGRtrib1 towards the dam spillway.

Plate 10: Looking downstream at WGRswamp in autumn 2024.

Plate 11: Looking upstream at WGRswamp.

Plate 12: Looking upstream at WGRdown.


Plate 13: Looking upstream at WGRdown in Autumn 2024.


Plate 14: Looking downstream at WGRXdown in Autumn 2024.

Plate 15: Looking upstream at WGRXdown.

Plate 16: Looking upstream at WGRXdown.


Plate 17: Looking upstream at WGRref in autumn 2024.


Plate 18: Looking upstream at WGRref.


Plate 19: Looking downstream at WGRref.

CENTENNIAL COAL
CLARENCE COLLIERY

WOLLANGAMBE RIVER AQUATIC ECOLOGY

SPRING 2024 DATA REPORT

Figure 1. Looking up from the dam overflow at WGRtrib1

REPORT PREPARED FOR
CLARENCE COLLIERY PTY LTD

MARINE POLLUTION RESEARCH PTY LTD
DECEMBER 2024

FIGURES

TABLES

APPENDIX

A FIELD NOTES, SITE PHOTOGRAPHS AND SAMPLING DATA

1 INTRODUCTION

Marine Pollution Research Pty Ltd (MPR) has been re-commissioned by Clarence Colliery to undertake biannual (Autumn and Spring) streamhealth monitoring to assess the possible effects on aquatic ecology of Wollangambe River below the Clarence Colliery Licensed Discharge Point 2 (LDP2). The streamhealth surveys are being conducted using standardised methods applied to other Centennial Coal stream health studies in the Coxs and Wolgan River upper catchments.

This report provides the results of the 24th biannual streamhealth sampling program which was undertaken in spring 2024 and follows on from the previous Wollangambe River streamhealth survey undertaken in autumn 2024. MPR had previously been commissioned to undertake additional EMP seasonal monitoring in spring 2019, and as that program utilised three of the Streamhealth sampling program sites, the results were incorporated into the long-term streamhealth indices for this survey.

The mine is located within the 690 Ha upper Wollangambe River catchment, above the Blue Mountains National Park. The portions of the upper Wollangambe River catchment upstream and downstream of the mine comprise undeveloped native forest, and the upper catchment is bounded by Newnes State Forest to the north, Blue Mountains National Park to the east and Hansons' Sand Quarry to the west. The Wollangambe River below the mine Main Storage dam flows past several tributaries that contain hanging swamp endangered ecological communities (EECs) prior to reaching the National Park boundary.

The Clarence Colliery site includes a storm water and dirty water management scheme that separates clean and dirty water streams, bunding, stilling and filtration ponds plus a Mine Water Treatment Plant (MWTP). The discharge from the MWTP is licensed by the NSW Environment Protection Authority (EPA).

Discharge from the MWTP at LDP2 flows down a small western tributary of the Wollangambe River, with the combined discharge and river flow discharged into a 70ML dam (the Colliery Main Dam). The Colliery extracts water from the dam for use on site, and during dry weather periods, additional water can be extracted and piped to Farmers Creek to provide additional source water for the Lithgow City potable water supply plant.

2 AQUATIC STUDY DESIGN

2.1 Aims and Objectives

In terms of study aims the Aquatic Ecology Sampling Program endeavoured to answer the following questions:

- Are there measurable differences in aquatic ecological habitat or riparian attributes between river or creek pools upstream and downstream of LDP2, and within reference sites?
- Are there measurable differences in aquatic macroinvertebrate assemblages at the AusRivAS level of taxonomic resolution between Wollangambe River Upstream and Downstream of Discharge sites?
- Can observed differences be attributable to spatial (between-site) differences and/or Colliery discharge?
- Do the survey sites provide suitable and sustained aquatic habitat for fish and other aquatic biota?
- Do the sites provide suitable fish passage?

To achieve these objectives the sampling program includes following features:

- Sampling the aquatic macroinvertebrate fauna twice a year (in Spring and Autumn) using the AusRivAS sampling, sorting and identification protocols (see Section 2.2 below). Note that for AusRivAS standardised sampling purposes the ‘autumn’ sample season is defined as March 15 to June15 and ‘spring’ is defined as September 15 to December 15.
- Estimation of fish occurrence by a combination of overnight and spot bait-trapping, dip netting and observation, with all captured fish identified in-situ and immediately released.
- Depth profiles of basic water quality parameters: Temperature, Electrical Conductivity (salinity), water acidity (pH), Dissolved Oxygen and Turbidity, at each site during each sampling run.
- Descriptions of creek riparian condition and aquatic plant communities within the study area.

There were seven sites sampled for the spring 2024 Clarence aquatic ecology survey (**Table 1**), all of which have been sampled continuously since autumn 2020. In total there were four sampling sites in the Wollangambe River, one site in the Main Dam and two sites in unnamed reference creek tributaries (see **Figure 2**).

The autumn 2012 survey report (MPR 2012) provides detailed descriptions of the original sample sites, with additional descriptions for sites brought online over subsequent seasons provided in the corresponding reports; WGRXdown in autumn 2013 (MPR 2013b) and WGRtrib1 in spring 2014 (MPR 2015).

Table 1 Clarence LDP Aquatic Ecology Seasonal Sample Site Information

Site	Coordinates		Seasonal Surveys			Description
	E	N	Au 12 - Sp 12	Au 13 - Au 14	Sp 14 - 24	
			N=2	N=3	N=12	
WGR up	243889	6295015	x	x	x	Upstream Wollangambe River monitoring site located above LDP2 input.
WGR dam	244427	6294590	x	x	x	Site sampled at upper end of the Main Dam below the confluence of LDP2 and Wollangambe River.
WGR trib1	244568	6294840			x	Site sampled within lower limits of unnamed tributary, in 'backwaters' of discharge from Main Dam spillway.
WGR swamp	244871	6294619	x	x	x	Site located at the downstream end of the lower of two swamps in Wollangambe River, around 530m below the Main Dam weir.
WGR down	245070	6294799	x	x	x	Downstream monitoring site located in Wollangambe River around 950m below the Main Dam weir.
WGRX down	245452	6293646		x	x	Downstream monitoring site located in Wollangambe River around 2.6km downstream from the Main Dam weir.
WGR ref	245073	6294952	x	x	x	Reference tributary site which flows in a southerly direction to join Wollangambe River at WGRdown.

2.2 Macroinvertebrate Sampling Methods

The aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (the AusRivAS method (Turak et al 2004, Chessman 2003b). The AusRivAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site.

Sampling has conformed to these definitions:

- A site is "a stream reach with a length of 100 m or 10 times the stream width, whichever is the greater".
- A riffle habitat is "an area of broken water with rapid current that has some cobble or boulder substratum". However, "sampling riffles where the substratum consists predominantly of large boulders may be difficult and may not produce reliable results".
- Edge habitat is "an area along the creek with little or no current".

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation.

Site selection for sampling aquatic biota from the river is constrained by access from the road network through the forest to the river and by river access where the river flows through deep incised canyons or through boulder cascades. The river and reference tributary generally comprise narrow channels either with mobile sand or rock beds joined together by rock boulder cascades. There were few broader pools and few sand or log bar constraints.

Further, given the location of a number of the study sites in reaches of streams where there are known to be periods of little or no connecting flow between pools or where there are known to be limited riffle sections available for sampling, it was decided that only pool 'edge' samples would be sampled, as AusRivAS defined riffle samples could not be guaranteed for all (or possibly even for most) sites at all sample times.

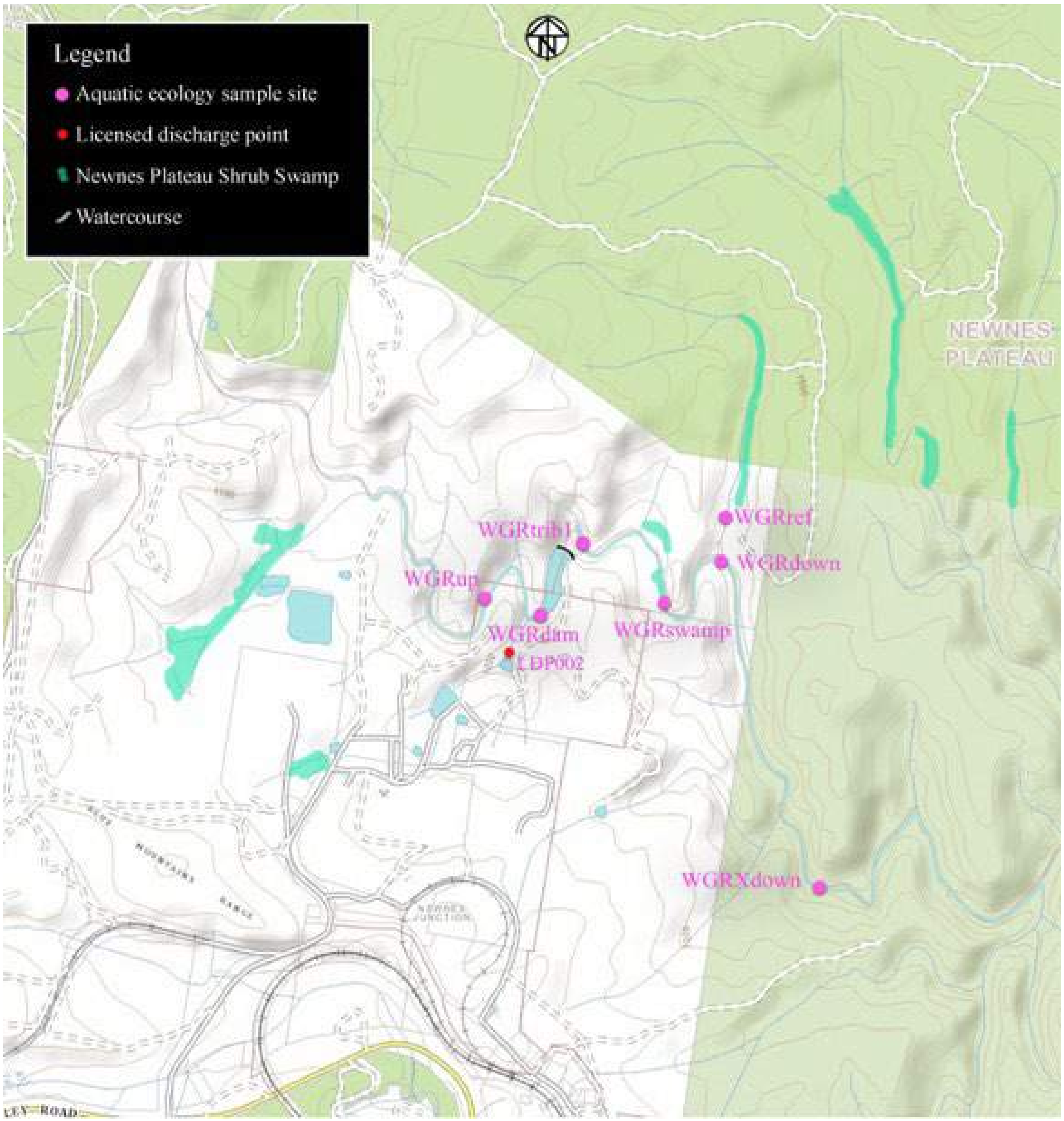


Figure 2: Clarence Aquatic Ecology Sample Sites Spring 2024.

2.2.1 Field methods for macroinvertebrate sampling

Macroinvertebrate assemblages were sampled using a 250 µm mesh dip net over as many aquatic 'edge' habitat types as could be located within each of the pools along the defined stream reaches. Net samples were then placed into white sorting trays for in situ live sorting for up to 1 person-hour (with a minimum of 40 minutes), as per the AusRivAS protocol. Following cessation of live picking, further observations were made of the pool edge sample areas for surface aquatic macroinvertebrate taxa (e.g., water skaters and spiders) and any other taxa (such as freshwater crayfish) not collected by the dip netting process. Where possible (or necessary) representatives of these organisms were collected and added to the dip net samples.

Rarer specimens for which positive identification could be made in the field (e.g., water scorpions), were generally released. That is, for protection of the pool macroinvertebrate integrity we adopted a 'sampling with replacement' method. Notwithstanding this procedure, for all taxa that could be positively identified in the field, at least one of each of the field-identified taxa are retained as a representative of that taxa for that sampling event. For all other macroinvertebrate taxa where field identifications were not definitive, specimens were retained for later detailed taxonomic analysis in the laboratory.

Notes are also kept of the presence of burrows and holes that are present in the site aquatic habitats (i.e., as indications of yabbies or burrowing dragonflies). All retained specimens are placed in sample jars and preserved in 70% ethanol for subsequent laboratory identification. Each sample jar is labelled and paper laundry tags are inserted into the jars noting the sample site, sample date and sample collector/picker initials. Any giant dragonfly exuviae are kept for confirmation purposes.

2.2.2 Laboratory methods for macroinvertebrate samples

In the laboratory, taxonomic identifications are generally facilitated using Maggy lights or binocular dissecting microscopes and taxonomic guides such as; CSIRO, Land and Water Resources & Environment Australia (1999), Hawking & Smith (1997), Hawking & Theischinger (1999), Theischinger (2009) and Williams (1980).

Organisms are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols. These are as follows; family level for all insect taxa except Chironomids which are taken to sub-family). Collembola arthropods (Springtails) are classified as a single class and the arachnid arthropods (spiders and mites) are classified as two orders. For the mites (Order Acarina) we have taken them to sub-order classification level where possible. Crustaceans were taken to Family level where suitable keys are available. Ostracoda were left at Class level. The worm-like taxa are shown at Phylum or Class level. For all taxa, where suitable keys were available, taxa were identified to lower levels of taxonomy.

The sorted specimens are then transferred to individual glass vials (one per family/sub-family) and paper laundry tags inserted into each glass vial with the sample site, sample date and initials of taxonomist noted on the tags. Glass vials are then topped up with 70 % alcohol, sealed with plastic lids and placed back into the original field sample jars.

Where there are any individual specimens where the collected material is too indistinct or fragmented to assign a definitive identification, the samples are dispatched to relevant Australian Museum specialists or other specialists, as recommended by EPA. For all samples the following taxonomic QA/QC procedure is followed:

> At least ten percent of the samples/sites are selected at random and the individual retained taxa are identified without reference to the original identifications. A table is then made of the original identifications verses the second identifications, indicating where there were any anomalies in identification (if any). If there are no anomalies, the QA/QC sample protocol is accepted and no further QA/QC checking is undertaken. If there are differences in identifications, all the samples containing the related taxa are re-examined to clear up the anomalies.

Following this procedure, and if there have been anomalies, an additional 10 percent of the remaining samples are chosen and the QA/QC procedure re-applied. This process continues until there are no differences between original identifications and QA/QC identifications.

2.2.3 Site SIGNAL index & EPT Index calculations

The aquatic invertebrate assemblage for each sample site is described in terms of the site taxa diversity (number of individual AusRivAS taxa) and in terms of a site SIGNAL score. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates. The indices are derived by correlation analysis of macroinvertebrate occurrence against water chemical analysis (Chessman 1995). The water chemistry attributes generally used are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus (Chessman 2003a).

SIGNAL indices may be regionally specific (e.g. SIGNAL HU-97 developed for the Hunter Valley Catchment (Chessman 1997), or applicable Australia wide (e.g. SIGNAL-2, Chessman 2003a). Each macroinvertebrate Family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). For the present study SIGNAL-2 scores are applied. Taxa with no published SIGNAL score are excluded from the site SIGNAL analysis. Once taxa SIGNAL indices have been applied individual site SIGNAL indices are calculated (as the mean) from all site taxa with SIGNAL scores.

Creek SIGNAL scores are calculated as the mean of all taxa SIGNAL value occurrences recorded within each creek system for a survey. Site and creek SIGNAL scores are then summarised and compared across each survey and between surveys. As a general guide site SIGNAL Indices are graded into the following categories (Chessman *et al.* 1997):

- SIGNAL Index > 6 = Healthy Unimpaired
- SIGNAL Index 5-6 = Mildly Impaired
- SIGNAL Index 4-5 = Moderately Impaired
- SIGNAL Index < 4 = Severely Impaired.

However, as the intent of this study is to assess site condition relative to other sites over time, the site scores are used for these comparison purposes rather than as overall study area condition indices. That is, the overall changes in site indices over time are of greater interest than the basic and generalised 'health' scores (as per Chessman et al 1997).

The combined number of Ephemoptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site (the EPT index) is used to supplement the taxa richness (diversity) and SIGNAL index as an indicator of stream health.

2.3 Field Sampling Methods for Fish and Other Vertebrates

At each macroinvertebrate sampling site, four fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream either overnight, or for the duration of the combined macroinvertebrate sampling and live picking survey (minimum 1.5 hours) and then retrieved. Captured fish are identified i*n situ* using Allen *et. al*., (2002) and McDowall (1996) and immediately released. Fish caught or observed as part of the macroinvertebrate dip net sampling are also identified, noted and released.

Dead fish specimens and any fish that cannot be positively identified in the field are taken to the Australian Museum for confirmation of species identification. These specimens with capture details are then incorporated into the Australian Museum collection as appropriate. Following completion of the fish and macroinvertebrate sampling, any further observations of fish during the pool condition survey are also noted with fish species-name only noted if positively identified.

For each survey, tadpoles (which are not macroinvertebrates but chordates) are noted in the results. Specimens are not kept or identified. The presence of birds, reptiles and turtles that utilise the aquatic habitats are noted, and notes are made of the potential for the study area habitats to support platypus or Australian water rats where appropriate.

2.4 Field Water Quality Sampling

A calibrated submersible Yeo-Kal 618 water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. At some sites, depth profiles of water quality may also be made to test for layering/mixing. Physical observations are also taken in the field to highlight any aquatic habitat variations (e.g. recent rain, subsequent infilling, detritus in water column or on benthos, scum or flocculates in or on water body etc.) and the presence of fresh yabbie holes are also noted.

2.5 Aquatic Habitat Condition (RCE Index)

A standardised description of site aquatic habitat condition is used to compile a stream site condition index, based on a modified version of the River-Creek-Environment (RCE) method developed by Petersen (1992), as reported by Chessman *et al* (1997) for the greater Hunter River catchment. The index is compiled by giving each of the 13 RCE descriptors a score between 0 and 4, then summing the scores, to reach a maximum possible score of 52. Scores are then expressed as a percentage.

3 CLARENCE AQUATIC ECOLOGY SURVEY RESULTS

Full field sampling notes for the spring 2024 aquatic ecology sampling are provided in **Appendix Table A3**. Sampling for the full spring 2024 survey was undertaken over the 14th and 15th November 2024.

3.1 Sampling Conditions Autumn to Spring 2024

Appendix Tables A-1 & **A-2** provide the daily rainfall and LDP discharge results for the previous 12 months and are shown graphically in **Figure 3**. The autumn (May) 2024 aquatic ecology survey was undertaken under wet conditions, however weather patterns over the following months following were characterised by frequent very light shower events which produced below average rainfall on a month-to-month basis:

- May 2024 was wet with 99mm, most of which (97mm) fell over the two-week period leading into the autumn survey in mid-May.
- The combined total for June and July (135mm) was very close the combined average (132mm), with 25 of the 29 rainfall days recording less than 8mm rainfall over the two-month period.
- The three-month period from August to October 2024 saw mostly light rain events occurring over 35 rainfall days, and the combined three-month total (111mm) was only 63% of the combined average total.

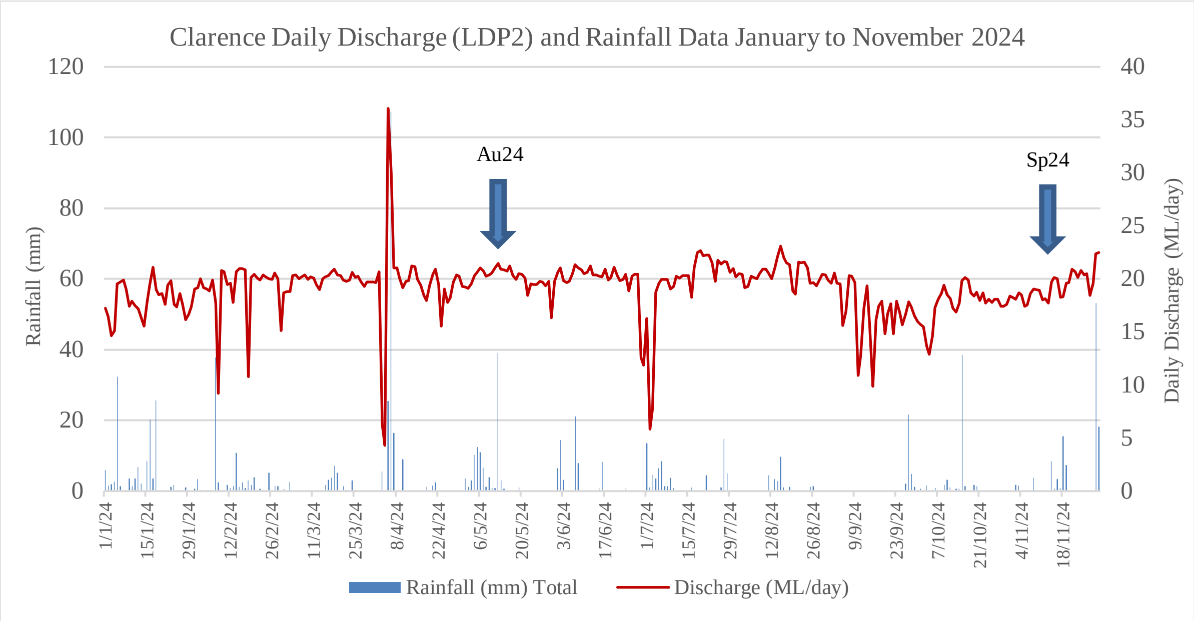


Figure 3 Clarence monthly rainfall & discharge January to November 2024.

- The lead-up to the spring sample in mid-November saw a continuation of the prevailing weather conditions with only 8mm of light rain recorded over 7 rainfall days.
- Light rainfall was recorded during sampling with a total of 9mm falling over the two-day period (14^{th} and 15^{th} November).

Discharge rates remained relatively stable between the autumn and spring 2024 surveys, ranging from 10 to 23 ML/day, with a few days of lower discharge (<10 ML/day), and an overall average of 19 ML/day during this period. A slight decline in discharge flows were observed from September 4 to October 11, where flow rate showed higher variability on a day-to-day basis (**Figure 3**), typically ranging between 9 ML/day and 18 ML/day, which coincided with drier weather conditions. The lead up to the spring 2024 survey saw discharge rates remain stable, where daily discharge rates do not exceed 20 ML/day.

3.2 Spring 2024 Aquatic Ecology Survey Results

The Clarence spring 2024 aquatic ecology survey was undertaken over 14^{th} and 15^{th} November 2024 following the sampling outline shown in **Table 1** and **Figure 2** above and using the methodology outlined in **Section 2**. **Appendix Table A-3** provides site field notes for the spring 2024 sampling program and site photos are also provided **Appendix A**. Summary tables for the spring 2024 Appendix A data are provided in the following Sections.

3.3 Metered Water Quality Results

A water quality meter is used at all aquatic ecology sampling sites plus at selected intermediary sites to record surface water quality - and where applicable, depth profiles of water temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity. **Table 2** provides the results of metered water quality sampling during the spring 2024 aquatic ecology field sampling program.

Table 2 Site Field Water Quality Readings Spring 2024								
Site	Date	Time	Temp	Cond	DO	DO	pH	Turb
			°C	µS/cm	%sat	mg/L	Units	ntu
WGRup	14/11/24	13:44	13.83	7	78.5	8.13	5.35	9.3
LDP002	14/11/24	15:11	17.24	354	79.2	7.61	7.44	6.0
WGRdam	14/11/24	15:17	17.19	385	80.4	7.74	7.37	5.3
WGRtrib1	15/11/24	11:32	16.08	149	52.3	5.16	5.71	3.3
WGRswamp	15/11/24	7:03	16.67	338	79.6	7.75	7.32	4.0
WGRdown	15/11/24	8:40	16.56	346	79.9	7.80	7.24	5.5
WGRXdown	14/11/24	10:49	17.09	328	79.9	7.71	6.94	4.4
WGRref	15/11/24	9:51	13.11	4	74.2	7.81	5.39	2.9

3.4 Aquatic & Riparian Habitat Condition

The field notes (**Appendix Table A-3**) provide details of stream reach flows, pool dimensions and available aquatic habitats for the present survey. The overall Aquatic and Riparian Habitat condition - as estimated using the RCE Index - are provided in **Appendix Table A-4** with summary provided in **Table 3**, and **Table 4** provides the site aquatic macrophyte occurrence results for the spring 2024 survey.

Table 3 Summary of RCE Results							
Category	WGRup	WGRdam	WGRtrib1	WGRswamp	WGRdown	WGRXdown	WGRref
Land-use pattern beyond immediate riparian zone	4	4	4	4	4	4	4
Width of riparian strip-of woody vegetation	4	4	4	4	4	4	4
Completeness of riparian strip of woody vegetation	2	4	4	2	2	2	2
Vegetation of riparian zone within 10 m of channel	4	4	4	4	4	4	4
Stream bank structure	1	4	4	2.5	2.5	2.5	1
Bank undercutting	2	3	3.5	1.5	2	2.5	2.5
Channel form	4	2.5	4	4	4	4	4
Riffle/pool sequence	4	0	3	3.5	4	4	4
Retention devices in stream	3	0.5	4	3	3	3.5	3.5
Channel sediment accumulations	3.5	1	2.5	2	2.5	2.5	2
Stream bottom	4	2	2.5	3	3	4	3
Stream detritus	1.5	3	3.5	3.5	3.5	3	3.5
Aquatic vegetation	4	1	1	4	4	4	3.5
Spring 2024 RCE %age – this survey	80.8	63.5	84.6	79.8	80.8	84.6	78.8
Autumn 2024 RCE %age – previous survey	78.8	63.5	84.6	78.8	81.7	84.6	78.8
Long-term Mean	86.3	65.7	87.4	80.5	84.9	88.1	86.8
Long-term SD	6.3	5.0	2.5	4.1	3.4	3.8	5.9
Long-term X-SD	80.0	60.7	85.0	76.4	81.5	84.3	80.9

Table 4 Clarence Aquatic Ecology Site Macrophyte Occurrence Spring 2024										
Site	Rush *Baumea rubiginosa*	Pampas Grass *Cortaderia selloana*	Spike Rush *Eleocharis sp.*	Tall Spikerush *Eleocharis sphacelata*	Rush *Juncus sp.*	River Clubrush *Schoenoplectus validus*	Sago Pondweed *Stuckenia pectinata*	Cumbungi *Typha spp*	Blunt Pondweed *Potamogeton ochreatus*	Charophytes
WGRup	1				1					
WGRdam	1	1	1	1	1			1	1	
WGRtrib1	1	1		1	1		1	1	1	
WGRswamp										1
WGRdown	1									1
WGRXdown	1									1
WGRref					1					1

3.5 Aquatic Macroinvertebrate and Fish Survey Results

Appendix Table A-5 shows the results of aquatic macroinvertebrate taxonomic identifications to the levels required by AusRivAS, plus occurrence data for all aquatic macroinvertebrates and fish. The table also provides site SIGNAL and EPT scores (see **Section 2.2.3** for explanation of SIGNAL and EPT).

Tables 5 to 7 provide summary statistics for seasonal and site Diversity (taxa richness), SIGNAL and EPT scores, derived from the aquatic macroinvertebrate data in **Appendix Table A-4**. The Tables also provide a comparison of total and individual site results against the previous seasonal results and against site long term Mean (LTM) and Standard Deviation of the Mean (SD) statistics for each site:

- **Orange** highlight indicates results are below the LTM-SD value.
- **Yellow** highlight indicates results in the range LTM to LTM-SD.
- **Green** highlight indicates results in the range LTM to LTM+SD.
- **No highlight** indicated values > the LTM+SD value.
- Results in **Bold** are the site Minimum Value.

Table 5 Seasonal Long Term Site Diversity (No. Of Taxa)

Site Season	Comb sites Edge	WGR up Edge	WGR ref Edge	WGR dam Edge	WGR trib1 Edge	WGR swamp Edge	WGR down Edge	WGRX down Edge	WGRX down Riffle
Au12	**27**	12	15	14		8	15		
Sp12	35	19	17	14		8	20		
Au13	34	14	15	16		8	11	13	11
Sp13	31	17	14	14		11	15	**11**	4
Au14	36	14	14	18		8	**7**	16	9
Sp14	41	22	16	22	20	13	19	19	8
Au15	40	16	16	16	15	8	12	16	10
Sp15	38	14	13	16	18	5	14	14	12
Au16	42	17	15	16	19	11	14	16	8
Sp16	39	18	17	20	18	8	10	15	7
Au17	34	13	17	14	17	9	11	15	7
Sp17	36	13	17	16	17	**3**	8	16	9
Au18	36	18	16	15	18	10	**7**	14	11
Sp18	30	13	17	**12**	16	6	12	14	7
Au19	37	18	18	14	17	10	8	12	8
Sp19		15					**7**	19	11
Au20	34	15	16	13	17	10	12	13	11
Sp20	38	20	16	14	20	8	15	16	9
Au21	34	13	15	16	19	9	12	15	5
Sp21	34	**11**	**12**	17	20	7	14	13	6
Au22	36	13	17	16	16	11	17	14	6
Sp22	29	**11**	13	12	**13**	8	14	14	**3**
Au23	37	15	14	21	15	11	14	**11**	13
Sp23	36	16	15	12	17	5	12	**11**	5
Au24	36	13	13	**11**	24	6	11	**11**	**3**
Sp24	41	23	18	19	26	6	16	15	**3**
LTM	35.5	15.2	15.3	15.4	17.7	8.4	12.4	14.3	8.0
SD LTM	3.6	2.8	1.6	2.8	2.4	2.3	3.5	2.3	2.9
LTM-SD	31.8	12.4	13.7	12.6	15.3	6.1	8.9	12.0	5.1

Table 6 Seasonal Long-Term Signal Indices									
Site Season	Comb sites Edge	WGR up Edge	WGR ref Edge	WGR dam Edge	WGR trib1 Edge	WGR swamp Edge	WGR down Edge	WGRX down Edge	WGRX down Riffle
Au12	5.34	5.92	6.07	4.14		4.50	5.73		
Sp12	4.58	5.35	5.29	**2.86**		4.25	4.55		
Au13	5.01	6.00	5.80	3.19		5.63	4.64	5.23	6.09
Sp13	4.86	5.67	5.79	3.36		5.00	4.87	4.09	5.50
Au14	4.69	6.14	5.21	3.94		4.13	4.50	4.13	4.67
Sp14	4.24	5.59	4.81	3.32	3.56	4.08	3.89	4.28	5.13
Au15	4.78	5.56	5.63	3.60	**3.14**	4.88	4.45	5.88	6.60
Sp15	4.22	5.08	4.77	3.73	3.47	4.60	4.15	4.29	5.00
Au16	4.30	5.00	5.00	3.13	3.72	4.09	4.62	4.65	6.25
Sp16	4.58	5.11	5.12	4.26	3.18	5.00	4.44	5.27	5.57
Au17	4.20	5.33	**4.59**	3.07	3.38	3.50	4.18	5.27	3.86
Sp17	4.33	5.08	5.35	3.53	3.63	**3.00**	4.75	4.12	5.56
Au18	4.05	4.71	5.53	3.00	3.41	4.20	**3.43**	3.79	6.09
Sp18	4.28	4.83	4.81	2.91	4.27	3.33	3.92	5.00	4.57
Au19	4.34	5.00	4.94	4.29	3.25	3.82	3.88	4.83	5.88
Sp19		5.43					3.86	5.11	5.82
Au20	**4.03**	**4.07**	4.64	3.42	3.47	5.22	4.36	**3.36**	5.91
Sp20	4.35	4.89	5.27	3.71	3.47	4.25	4.20	5.27	5.00
Au21	4.43	4.92	5.80	3.19	3.65	4.44	4.55	4.73	6.00
Sp21	4.46	5.09	5.58	4.13	3.61	4.57	3.62	5.23	4.33
Au22	4.70	5.23	4.88	4.31	3.60	4.36	5.00	5.50	4.88
Sp22	4.51	4.82	5.00	3.27	3.55	4.75	5.00	4.93	**3.33**
Au23	4.67	4.93	5.00	4.00	4.05	4.73	4.64	5.57	6.09
Sp23	4.52	4.81	5.47	4.25	4.00	4.00	4.00	4.64	5.80
Au24	4.53	5.23	4.92	4.27	3.41	4.50	5.18	5.18	6.00
Sp24	4.33	5.61	5.33	3.00	3.25	5.00	4.06	4.47	**3.33**
LTM	4.50	5.19	5.22	3.62	3.57	4.37	4.42	4.80	5.39
SD LTM	0.30	0.45	0.41	0.50	0.29	0.60	0.52	0.63	0.82
LTM-SD	4.20	4.74	4.81	3.12	3.28	3.77	3.89	4.17	4.57

Table 7 Seasonal Long Term EPT Indices									
Site Season	Comb sites Edge	WGR up Edge	WGR ref Edge	WGR dam Edge	WGR trib1 Edge	WGR swamp Edge	WGR down Edge	WGRX down Edge	WGRX down Riffle
Au12	9	7	6	3		2	6		
Sp12	8	7	6	2		1	4		
Au13	8	8	5	1		3	3	3	3
Sp13	**5**	3	4	1		1	4	2	2
Au14	8	5	4	2		1	**0**	4	4
Sp14	8	7	5	3	2	2	4	5	4
Au15	9	7	**3**	3	**1**	1	2	6	5
Sp15	6	3	5	2	2	1	1	3	4
Au16	10	5	**3**	1	3	2	2	6	4
Sp16	10	6	5	4	2	2	1	5	4
Au17	9	4	6	1	3	2	2	5	2
Sp17	6	4	5	2	2	**0**	1	2	2
Au18	7	4	**3**	2	2	3	1	2	5
Sp18	6	3	4	**0**	3	1	2	5	1
Au19	10	6	**3**	4	2	1	1	3	5
Sp19		5					1	5	3
Au20	8	3	**3**	2	2	2	2	**1**	5
Sp20	8	6	5	1	3	2	2	6	3
Au21	6	4	5	2	2	3	2	4	4
Sp21	6	**2**	4	3	3	1	**0**	4	2
Au22	6	4	5	4	3	3	2	4	3
Sp22	**5**	3	4	1	**1**	2	4	3	**0**
Au23	7	5	4	3	3	4	5	5	5
Sp23	6	4	**3**	2	3	2	3	3	2
Au24	6	4	4	4	4	1	4	4	2
Sp24	8	8	6	2	2	1	2	3	**0**
LTM	7.4	4.8	4.3	2.2	2.4	1.8	2.4	3.9	3.2
SD LTM	1.6	1.6	1.0	1.1	0.8	0.9	1.6	1.4	1.4
LTM-SD	5.8	3.1	3.3	1.1	1.7	0.9	0.8	2.5	1.8

4 REFERENCES

Allen, G.R., Midgley, S.H. and Allen, M. (2002)
Field Guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, WA.

ANZECC/ARMCANZ (2000)
Australian and New Zealand Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Chessman, B. C (1995)
Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology* 20, pp. 122-129.

Chessman, B. C., Growns, J. E. and Kotlash, A. R. (1997)
Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. *Marine & Freshwater Research* 48, pp. 159-172.

Chessman, B. C., (2003a)
New Sensitivity grades for Australian river macroinvertebrates. *Marine & Freshwater Research* 54, pp. 95 - 103.

Chessman, B. C., (2003b)
SIGNAL 2 – A Scoring System for Macro-invertebrate (‘Water Bugs’) in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra

CSIRO, Land and Water Resources & Environment Australia (1999)
Interactive Guide to Australian Aquatic Invertebrates. CSIRO Australia.

Hawking, J. & Smith, F. J. (1997)
Colour Guide to Invertebrates of Australian Inland Waters. Co-operative Centre for Freshwater Ecology, Albury.

Hawking, J. & Theischinger, G. (1999)
Dragonfly Larvae (Odonata). A Guide to the Identification of Larvae of Australian Families and to the Identification and Ecology of Larvae from New South Wales. Co-operative Centre for Freshwater Ecology, Albury, and Australian Water Technologies Pty Ltd, West Ryde. CRCFE Identification Guide No. 24.

McDowall, R. (1996)
Freshwater Fishes of South Eastern Australia. Reed Books, Sydney, NSW.

MPR (2012)

Aquatic Ecology Report Autumn 2012. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2012.

MPR (2013a)

Aquatic Ecology Report Spring 2012. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, April 2013.

MPR (2013b)

Aquatic Ecology Report Autumn 2013. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, September 2013.

MPR (2014a)

Aquatic Ecology Report Spring 2013. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, April 2014.

MPR (2014b)

Aquatic Ecology Report Autumn 2014. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, September 2014.

MPR (2014c)

Review of Two Reports on the Aquatic Ecology of the Wollangambe River. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, November 2014.

MPR (2015a)

Aquatic Ecology Report Spring 2014. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, January 2015.

MPR (2015b)

Aquatic Ecology Report Autumn 2015. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, August 2015.

MPR (2015c)

Aquatic Ecology Report Spring 2015. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, December 2015.

MPR (2016)

Aquatic Ecology Report Autumn 2016. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, August 2016.

MPR (2017a)

Aquatic Ecology Report Spring 2016. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, March 2017.

MPR (2017b)

Aquatic Ecology Report Autumn 2017. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, October 2017.

MPR (2018a)

Aquatic Ecology Report Spring 2017. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, February 2018.

MPR (2018b)

Aquatic Ecology Report Autumn 2018. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, August 2018.

MPR (2018c)

Aquatic Ecology Report Spring 2018. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, December 2018.

MPR (2019)

Aquatic Ecology Report Autumn 2019. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2019.

MPR (2020a)

Aquatic Ecology Report Autumn 2020. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2020.

MPR (2020b)

Aquatic Ecology Report Spring 2020. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, January 2021.

MPR (2021)

Aquatic Ecology Report Autumn 2021. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, June 2021.

MPR (2022a)

Aquatic Ecology Report Spring 2021. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, February 2022.

MPR (2022b)

Aquatic Ecology Report Autumn 2022. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, July 2022.

MPR (2023a)

Aquatic Ecology Report Spring 2022. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, February 2023.

MPR (2023b)

Aquatic Ecology Report Autumn 2023. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, September 2023.

MPR (2024a)

Aquatic Ecology Report Spring 2023. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, January 2024.

MPR (2024b)

Aquatic Ecology Report Autumn 2024. Report prepared for Clarence Colliery Pty Ltd by Marine Pollution Research Pty Ltd, October 2024.

Peterson (1992)

The RCE: a Riparian Channel and Environmental Inventory for small streams in the agricultural landscape. Freshwater Biology 27: 295 – 306.

Turak, E, Waddell, N, Johnstone, G. (2004)

New South Wales Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual. Department of Environment and Conservation, Sydney.

Williams, W.D. (1980)

Australian Freshwater Life. The Invertebrates of Australia Inland Waters. The MacMillan Co. of Australia Pty Ltd, Sydney.

APPENDIX A

FIELD NOTES,

SITE PHOTOGRAPHS

AND

SAMPLING DATA

SPRING 2024

Appendix Table A-1 Daily Rainfall (mm) for 2024												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	6	3.4	0.6	0	3.6	6.4	13.6	0	0	0.6	0	15
2nd	1.6	0.4	0	0	1.2	14.4	1	0	0	0	1.8	0.4
3rd	2	0	2.6	5.6	3	3.2	4.6	0.2	0	1.6	1.6	0.2
4th	2.6	0.4	0	0	10.2	0	3.6	0	0	0.2	0	5.2
5th	32.4	0	0	25.4	12.4	0	6.4	0	0	0	0	0.2
6th	1.4	0	0	107.4	11	0	8.4	0	0	0.8	0.2	0.2
7th	0.2	37.8	0	16.4	6.6	21.2	1.4	0	0	0	0	2.8
8th	0	2.4	0	0	1.2	8	1.4	0	0	0	3.8	11.6
9th	3.6	0.2	0	0	4	0.2	3.8	0.2	0	1.8	0.2	0
10th	1.4	0.2	0	9	0.8	0	0.8	0	0	3.2	0	0.2
11th	3.6	1.8	0	0	0.8	0	0	4.4	0	1	0.2	0
12th	6.8	0.8	0	0	39	0	0	0	0	0	0	0.4
13th	2.2	1.4	0	0	3	0.2	0	3.4	0.4	0.6	0.2	0.2
14th	0	10.8	0	0	0.6	0	0	2.8	0.2	0.6	8.4	0
15th	8.4	1.2	1.8	0	0	0.8	0	9.8	0	38.6	0.6	0
16th	20.2	2.4	3.2	0	0	8.2	1	1	0	1.4	3.4	0
17th	3.6	0.8	3.8	0	0	0	0	0.2	0	0.2	0.8	0
18th	25.6	3	7.2	1.2	0.2	0	0	1.2	0	0.2	15.6	0
19th	0.2	1.8	5.2	0	1	0	0	0	0	1.8	7.4	1.2
20th	0	4	0.2	1.6	0	0	0	0	0	1.4	0.2	0.6
21st	0	0.4	1.4	2.4	0	0	4.4	0	0	0.2	0.2	0
22nd	0	0.6	0.4	0	0	0	0	0	0	0	0	0
23rd	1.2	0	0.2	0	0	0.2	0	0	0	0	0	0
24th	1.8	0	3	0.2	0.2	0.8	0	0	0	0	0	0
25th	0	5.2	0.4	0	0	0.2	0	1.2	0	0	0	0
26th	0	0	0	0	0	0.2	1	1.4	2.2	0	0	0
27th	0.2	1.4	0	0	0	0	14.8	0.4	21.6	0	0	5.8
28th	1	1.4	0	0	0.2	0	5	0	4.8	0	0	0
29th	0	0	0	0	0.2	0	0.2	0	1.2	0	53.2	0
30th	0		0	0	0	0	0	0	0.4	0	18.2	0
31st	0.6		0		0		0	0		0		0
Total	126.6	81.8	30	169.2	99.2	64	71.4	26.2	30.8	54.2	116	44
Monthly Average*	86.3	80.7	77.3	57.9	50.8	71.3	61.0	57.6	55.7	62.0	66.3	79.7
Note: Days sampled are highlighted in yellow. *Monthly average is the long-term average from BOM Lithgow station 63226												

Appendix Table A-2 LDP002 Daily Discharge (ML/Day) for 2024												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	18.8	19.2	18.7	19.7	19.2	20.6	16.3	20.5	19.6	15.7	18.3	22.5
2nd	18.8	20.0	18.8	20.7	19.1	21.0	5.9	20.5	20.6	15.5	18.1	22.7
3rd	20.3	19.2	18.8	6.2	19.5	19.8	7.8	19.2	19.6	13.7	18.7	22.5
4th	20.4	19.1	20.3	4.3	20.3	19.7	18.8	19.3	19.5	12.9	18.5	22.3
5th	20.0	18.9	20.4	36.1	20.6	19.8	19.6	20.3	15.6	14.6	17.5	20.3
6th	20.2	19.9	20.0	30.0	21.1	20.5	20.0	20.2	16.9	17.3	17.5	21.3
7th	20.4	17.7	20.2	21.0	20.8	21.3	20.0	20.0	20.3	18.1	18.6	19.5
8th	20.0	9.2	20.4	21.1	20.3	21.1	19.9	20.5	20.3	18.6	19.1	19.7
9th	20.2	20.8	20.0	20.1	20.4	20.8	19.1	20.9	19.6	19.4	19.0	20.5
10th	20.1	20.7	20.2	19.2	20.6	20.5	19.3	20.9	10.9	18.5	19.0	19.8
11th	19.5	19.5	20.1	19.8	21.0	20.7	20.3	20.5	12.8	18.2	18.0	20.6
12th	19.0	19.6	19.5	19.8	21.5	21.2	20.1	20.0	17.2	17.2	18.1	19.2
13th	20.0	17.8	19.0	21.2	20.9	20.4	20.3	21.1	19.4	16.9	17.8	19.4
14th	20.2	20.7	20.0	21.2	20.9	20.4	20.3	22.1	15.6	17.7	19.7	19.6
15th	20.3	21.0	20.2	20.0	20.8	20.2	20.3	23.1	9.9	19.9	20.2	19.9
16th	20.7	21.0	20.3	19.4	21.2	20.2	18.3	22.0	16.2	20.2	20.1	21.3
17th	20.9	20.9	20.7	18.4	20.3	20.9	21.0	21.5	17.4	19.9	18.3	22.1
18th	20.4	10.8	20.9	18.0	20.0	19.9	22.5	21.4	17.9	18.7	18.3	20.7
19th	20.3	20.1	20.4	19.4	20.5	20.1	22.7	18.9	14.8	18.4	19.6	20.4
20th	19.9	20.5	20.3	20.5	20.5	21.1	22.2	18.6	16.7	18.8	19.6	20.1
21st	19.8	20.1	19.9	20.9	20.1	20.3	22.2	21.6	17.7	18.0	20.9	18.4
22nd	19.9	19.9	19.8	19.5	18.5	19.9	22.3	21.5	14.8	18.7	20.7	18.8
23rd	20.6	20.4	19.9	15.5	19.5	20.0	21.5	21.6	17.9	17.7	20.2	
24th	20.1	20.2	20.6	19.1	19.5	20.4	19.8	21.1	16.8	18.1	20.8	
25th	20.3	20.0	20.1	17.8	19.5	18.9	21.8	19.6	15.7	17.8	20.4	
26th	19.7	20.0	20.3	18.2	19.8	20.3	21.4	19.6	16.6	18.1	20.5	
27th	19.3	20.6	19.7	19.7	19.7	20.5	21.7	19.3	17.9	18.1	18.5	
28th	19.7	20.0	19.3	20.4	19.3	20.4	21.6	19.9	17.4	17.4	19.6	
29th	19.7	15.1	19.7	20.3	19.8	12.6	20.6	20.5	16.5	17.4	22.4	
30th	19.7		19.7	19.3	16.3	11.9	21.0	20.4	16.0	17.6	22.5	
31st	19.7		19.7		19.8		20.2	19.9		18.4		
Total	619.1	552.8	618.1	586.8	621.2	595.5	608.7	636.3	508.2	547.4	580.3	451.7
Monthly Average*	20.0	19.1	19.9	19.6	20.0	19.8	19.6	20.5	16.9	17.7	19.3	20.5
Note: Sample days are highlighted in yellow.												

Table A-3 Field Comments – Seasonal Aquatic Ecology Monitoring Sites		
Date	Site	Comments
14/11/24	WGRup	Water was mostly clear with high flow throughout the site. Water levels appear to be unchanged from previous. Abundant debris such as branches and fallen trees in main channel, causing damming effect to upstream section. Due to build up, accumulation of sand had occurred to previous survey. Upstream section was smothered by terrestrial plants. Habitats sampled consisted of undercut banks, trailing bank vegetation and detritus. No evidence of recent high flows. Filamentous green alga absent.
14/11/24	WGRdam	Water was clear with moderate upstream flow from LDP channel. All submerged surfaces and substrates were covered in thick algal silt biofilm, which had made sampling difficult. Low habitat availability due to high flow, and middle of channel almost impossible to sample because of discharge. Oily sheen on surface. Filamentous green algae very abundant.
15/11/24	WGRtrib1	Water was clear with no flow throughout the site. Upstream section of site was choked with abundant macrophytes, such as Eleocharis which had orange precipitate covering submerged stems. Site is overall similar to former surveys. Habitat sampled includes macrophytes, trailing bank vegetation and detritus in shallow sections. Filamentous green algae abundant.
15/11/24	WGRswamp	Water was clear with moderate, consistent flow throughout site length and no areas of back flow or no flow. Recent high flows evident up to 1.5m above current water level. No deposits of sands throughout swamp bed, sediments appear the same as former surveys, however, thick silt algal matrix is abundant on substrates. Habitat sampled includes undercut banks and trailing bank vegetation. Filamentous green algae present in small amounts.
15/11/24	WGRdown	Water clarity good. Flow through site was moderate with minimal areas of little to no flow. No surface flow was visible from WGRref channel area. Sediments remained similar to previous survey with thick mud layer on top. Some isolated pockets of detritus throughout site. The aquatic edge habitats sampled include undercut banks, trailing bank vegetation and submerged tree roots. Substrates smothered by silt and silt agal matrix. Crossing appears to be more incised to previous. Filamentous green algae absent.
14/11/24	WGRXdown	Clear water flowing moderately throughout site length. The LDP appeared to be discharging at the time of sampling. Sediments similar to former surveys with slightly decreased sand. Overall habitat availability was poor, it appears that recent high flows up to 1.5m above current water level scoured out channel. Habitats sampled were mostly undercut banks. Charophytes were in small amounts. Filamentous green algae absent.

15/11/24	WGRref	Water was clear with a low flow throughout site length. Detritus and debris, such as logs and branches were abundant throughout channel. Evidence of high flows up to 0.8m above current water level as indicated by debris lines along banks and in vegetation. Edge vegetation has grown since former survey. Substrates covered in brown silt throughout site. Habitat sampled included trailing bank vegetation, undercut banks and detritus. Substrates and Macrophytes were unchanged from previous survey. Filamentous green algae present in small amounts.

Appendix Table A-4

Modified Riparian, Channel and Environment (RCE) Inventory (after Chessman et al 1997).

Descriptor	Category	Value	Sp24 WGRup	Sp24 WGRdam	Sp24 WGRtrib1	Sp24 WGRswamp	Sp24 WGRdown	Sp24 WGRXdown	Sp24 WGRref
1	Land-use pattern beyond immediate riparian zone								
	Undisturbed native vegetation	4	4	4	4	4	4	4	4
	Mixed native vegetation and pasture/exotics	3							
	Mainly pasture, crops or pine plantation	2							
	Urban, some vegetation	1							
	Industrial, little vegetation	0							
2	Width of riparian strip-of woody vegetation								
	More than 30 m	4	4	4	4	4	4	4	4
	Between 5 and 30 m	3							
	Less than 5 m	2							
	No woody vegetation	1							
	No Vegetation	0							
3	Completeness of riparian strip of woody vegetation								
	Riparian strip without breaks in vegetation	4		4	4				
	Breaks at intervals of more than 50 m	3							
	Breaks at intervals of 10-50 m	2	2			2	2	2	2
	Breaks at intervals of less than 10 m	1							
	No riparian strip at all	0							
4	Vegetation of riparian zone within 10 m of channel								
	Native tree and shrub species	4	4	4	4	4	4	4	4
	Mixed native and exotic trees and shrubs	3							
	Exotic trees and shrubs	2							
	Exotic grasses/weeds	1							
	No vegetation at all	0							
5	Stream bank structure								
	Banks fully stabilized by trees, shrubs, concrete	4		4	4				
	Banks firm but held mainly by grass and herbs	3							
	Banks loose, partly held by sparse grass, rubble	2				2.5	2.5	2.5	
	Banks unstable, mainly loose sand or soil	1	1						1
	Banks actively eroding	0							
6	Bank undercutting								
	None, or restricted by tree roots or man-made	4							
	Only on curves and at constrictions	3		3	3.5				
	Frequent along all parts of stream	2	2				2	2.5	2.5
	Severe; bank collapses common	1				1.5			
	Total bank collapse	0							
7	Channel form								
	Deep; width:depth ratio less than 8:1	4	4		4	4	4	4	4
	Medium; width:depth ratio 8:1 to 15:1	3							
	Shallow; width:depth ratio greater than 15:1	2		2.5					
	Artificial; concrete or excavated channel< 8:1	1							
	Artificial; concrete or excavated channel > 8:1	0							
8	Riffle/pool sequence								
	Frequent alternation of riffles and pools	4	4				4	4	4
	Long pools with infrequent short riffles	3			3	3.5			
	Natural channel without riffle/pool sequence	2							
	Artificial channel; some riffle/pool sequence	1							
	Artificial channel; no riffle/pool sequence	0		0					
9	Retention devices in stream								
	Many large boulders and/or debris dams	4			4				
	Rocks/logs present; limited damming effect	3	3			3	3	3.5	3.5
	Rocks/logs present but unstable; no damming	2							
	Stream or channel with few or no rocks/logs	1							
	Artificial channel; no retention devices	0		0.5					
10	Channel sediment accumulations								
	Little or no accumulation of loose sediments	4							
	Some gravel bars but little sand or silt	3	**3.5**						
	Bars of sand and silt common	2			2.5	2.5	2.5	2.5	2
	Braiding by loose sediment	1		1					
	Complete in-filled muddy channel	0							
11	Stream bottom								
	Mainly clean stones with obvious interstices	4	4					4	
	Mainly stones with some cover of algae/silt	3				3	3		3
	Bottom heavily silted but stable	2		2	2.5				
	Bottom mainly loose and mobile sandy sedimen	1							
	Bottom mainly loose and mobile muddy sedimen	0							
12	Stream detritus								
	Mainly unsilted wood, bark, leaves	4							
	Some wood, leaves, etc. with much fine detritus	3		3	3.5	3.5	**3**	3	3.5
	Mainly fine detritus mixed with sediment	2	**2.5**						
	Little or no organic detritus, mainly sandy	1							
	No organic detritus, mainly mud	0							
13	Aquatic vegetation								
	Little or no macrophyte or algal growth	4	4			4	4	4	
	Substantial algal growth; few macrophytes	3							3.5
	Substantial macrophyte growth; little algal grow	2							.
	Substantial macrophyte and algal growth	1		1	1				
	Total cover of macrophytes plus algae	0							
	RCE Score		42.0	33.0	44.0	41.5	42.0	44.0	41.0
	RCE %age		80.8	63.5	84.6	79.8	80.8	84.6	78.8

Appendix Table A-5												Sample Site and Sample Date								Occurrence	SIG-2
Wollangambe River Aquatic Ecology Survey Macroinvertebrate & Fish Results - Spring 2024									Life Stage			14/11/24	14/11/24	15/11/24	15/11/24	15/11/24	14/11/24	14/11/24	15/11/24		
Phylum	Class	Sub-class	Order	Sub-Order	Family	Sub-Family	*Genus/spp*	Common Name	L	N	A	WGRup	WGRdam	WGRtrib1	WGRswamp	WGRdown	WGRXdown	WGRXdown-R	WGRref		
Arthropoda	Insecta		Coleoptera		Dytiscidae			Diving Beetles	x		x	1	1	1		1	1			5	2
Arthropoda	Insecta		Coleoptera		Gyrinidae			Whirligig Beetles	x		x	1	1	1	1	1	1		1	7	4
Arthropoda	Insecta		Coleoptera		Hydrophilidae			Scavenger Water Beetles			x			1		1	1		1	4	2
Arthropoda	Insecta		Coleoptera		Scirtidae			Marsh Beetles	x			1							1	2	6
Arthropoda	Insecta		Diptera		Ceratopogonidae			Biting Midges	x			1	1	1			1	1	1	6	4
Arthropoda	Insecta		Diptera		Chironomidae	Chironominae		Bloodworms	x			1	1	1		1	1		1	6	3
Arthropoda	Insecta		Diptera		Chironomidae	Orthocladiinae		Bloodworms	x			1		1			1	1	1	5	4
Arthropoda	Insecta		Diptera		Chironomidae	Tanypodinae		Bloodworms	x			1	1	1		1	1		1	6	4
Arthropoda	Insecta		Diptera		Culicidae			Mosquitoes	x				1	1						2	1
Arthropoda	Insecta		Diptera		Dixidae			Meniscus Midges	x			1							1	2	7
Arthropoda	Insecta		Diptera		Tipulidae			Crane Flies	x			1	1			1			1	4	5
Arthropoda	Insecta		Ephemoptera		Leptophlebiidae			Mayflies		x		1		1					1	3	8
Arthropoda	Insecta		Hemiptera		Corixidae			Lesser Waterboatmen					1	1						2	2
Arthropoda	Insecta		Hemiptera		Hydrometridae									1						1	3
Arthropoda	Insecta		Hemiptera		Notonectidae			Backswimmers					1	1						2	1
Arthropoda	Insecta		Hemiptera		Pleidae			Pygmy Backswimmers						1						1	2
Arthropoda	Insecta		Hemiptera		Veliidae			Small Water Striders					1	1		1				3	3
Arthropoda	Insecta		Lepidoptera		Crambidae			Moths	x				1							1	3
Arthropoda	Insecta		Mecoptera		Nannochoristidae			Scorpionflies	x			1								1	10
Arthropoda	Insecta		Odonata	Epiproctophora	Aeshnidae			Dragonflies	x				1	1						2	4
Arthropoda	Insecta		Odonata	Epiproctophora	Corduliidae			Dragonflies	x				1	1						2	5
Arthropoda	Insecta		Odonata	Epiproctophora	Libellulidae			Dragonflies	x					1						1	4
Arthropoda	Insecta		Odonata	Epiproctophora	Synthemistidae			Dragonflies	x			1	1	1		1	1		1	6	2
Arthropoda	Insecta		Odonata	Epiproctophora	Telephlebiidae			Dragonflies	x			1			1	1	1		1	5	9
Arthropoda	Insecta		Odonata	Zygoptera	Argiolestidae			Damselflies	x			1		1		1				3	5
Arthropoda	Insecta		Odonata	Zygoptera	Coenagrionidae			Damselflies	x					1						1	2
Arthropoda	Insecta		Odonata	Zygoptera	Lestidae			Damselflies	x				1	1		1				3	1
Arthropoda	Insecta		Odonata	Zygoptera	Synlestidae			Damselflies	x						1	1	1			3	7
Arthropoda	Insecta		Plecoptera		Gripopterygidae			Stoneflies		x		1					1		1	3	8
Arthropoda	Insecta		Plecoptera		Notonemouridae			Stoneflies		x		1							1	2	6
Arthropoda	Insecta		Trichoptera		Ecnomidae			Caddis Flies	x			1	1			1	1		1	5	4
Arthropoda	Insecta		Trichoptera		Helicophidae			Caddis Flies	x			1								1	10
Arthropoda	Insecta		Trichoptera		Hydroptilidae			Caddis Flies	x			1	1	1						3	4
Arthropoda	Insecta		Trichoptera		Leptoceridae			Caddis Flies	x			1			1	1	1		1	5	6
Arthropoda	Insecta		Trichoptera		Philorheithridae			Caddis Flies	x			1							1	2	8
Arthropoda	Arachnida		Acarina	Hydracarina				Freshwater Mites				1		1		1	1		1	5	6
Arthropoda	Crustacea	Copepoda						Copepods					1	1						2	*
Arthropoda	Crustacea		Decapoda		Parastacidae			Freshwater Crayfish				1								1	4
Arthropoda	Crustacea	Ostracoda						Seed Shrimps						1						1	*
Annelida	Oligochaeta							Freshwater Worms					1		1	1	1	1		5	2
Platyhelminthes			Tricladia		Dugesiidae			Flatworms						1	1					2	2
Chordata	Amphibia							Tadpoles						1		1	1			3	*
Chordata	Osteichthyes				Galaxiidae		*Galaxias olidus*	Mountain Galaxias											1	1	
								Total number of invertebrate taxa per site:				23	19	26	6	16	15	3	18	41	
								Site SIGNAL2 scores:				5.61	3.00	3.25	5.00	4.06	4.47	3.33	5.33		4.39
Notes:	*Represents taxa for which SIGNAL grades do not apply.							Number of EPT taxa:				8	2	2	1	2	3	0	6	8	

Plate 1: Looking across site WGRup plunge pool in Spring 2024.

Plate 2: Looking downstream at WGRup.


Plate 3: Portion of Site WGRup looking downstream.


Plate 4: Looking downstream through the LDP channel to WGRdam in Spring 2024.

Plate 5: Looking upstream from the upstream end of the dam.

Plate 6: Looking downstream at WGRdam.

Plate 7: Looking upstream at tributary channel at upstream end of WGRtrib1 in Spring 2024.

Plate 8: Looking upstream at WGRtrib1.

Plate 9: Looking Downstream at WGRtrib1 towards the dam spillway.

Plate 10: Looking downstream at WGRswamp in spring 2024.

Plate 11: Looking upstream at WGRswamp.

Plate 12: Looking upstream at WGRdown.

Plate 13: Looking upstream at WGRdown in spring 2024.

Plate 14: Looking downstream at WGRXdown in Spring 2024.

Plate 15: Looking upstream at WGRXdown.

Plate 16: Looking downstream at the lower end of WGRXdown.

Plate 17: Looking upstream at WGRref in spring 2024.

Plate 18: Looking upstream at WGRref.


Plate 19: Looking downstream at WGRref.

CENTENNIAL COAL
CLARENCE COLLIERY

BUNGLEBOORI CREEK CATCHMENT AQUATIC ECOLOGY

AUTUMN 2024 DATA REPORT

Figure 1. Looking upstream at Bungleboori Creek site BCDn3.

REPORT PREPARED FOR
CLARENCE COLLIERY PTY LTD

MARINE POLLUTION RESEARCH PTY LTD
OCTOBER 2024

FIGURES

TABLES

APPENDIX

A FIELD NOTES, SITE PHOTOGRAPHS AND SAMPLING DATA

1 INTRODUCTION

Clarence Colliery Pty Ltd owns and operates the existing Clarence Colliery underground coal mine near the village of Clarence in NSW, and is preparing an Extraction Plan (EP) to enable the partial extraction of two panels known as the 918 and 920 Panels. Each panel has two sub-panels providing for four sub-extraction areas.

The EP 918/920 area is located within the upper Bungleboori Creek catchment, one of the major tributaries to the Wollangambe River. The study area catchments are contained within the Gardens of Stone State Conservation Area (SCA), with catchment areas upstream and downstream of the proposed mine footprint comprising mixed undeveloped native forest and former state forest pine plantation, Blue Mountains National Park and Hansons' Sand Quarry. The Bungleboori and Paddys Creek catchment drainage lines overlying and downstream from the proposed extraction area contain Newnes Plateau Shrub and Hanging Swamp endangered ecological communities (EECs).

As part of the Environmental assessment process, Clarence Colliery commissioned Marine Pollution Research Pty Ltd (MPR) to review existing aquatic ecological information and initiate a baseline aquatic ecology monitoring program to describe the existing aquatic environment of the EP 918/920 proposal footprint. The aims of the baseline aquatic ecology (streamhealth) monitoring program are as follows:

- To develop an understanding of the aquatic ecological attributes of the Newnes Plateau Shrub Swamps which overly the areas of proposed mining in order to enable impact assessment and provide suitable mitigation and offset measures where necessary or desirable.
- To provide additional aquatic site base-line data that can be utilised to monitor potential impacts of partial extraction mining activities.

This data report provides the results for the sixth consecutive seasonal aquatic ecology baseline monitoring survey for Clarence EP 918/920 undertaken in autumn 2024, and follows on from baseline monitoring surveys reports for spring 2021 (MPR 2022a), autumn and spring 2022 (MPR 2022b, MPR 2023a), autumn and spring 2023 (MPR 2023b, MPR 2024).

1.1 Description of Locality and Existing Information

The two panels are located in the upper Bungleboori Creek catchment including a tributary of Paddys Creek (**Figure 2**). Several sub-catchments support Newnes Plateau Shrub Swamp (NPSS) habitats dominated by shrubs and sedges that occur on sites with impeded drainage in low slope headwater valleys on the Newnes Plateau in the upper Blue Mountains (Web Reference 1).

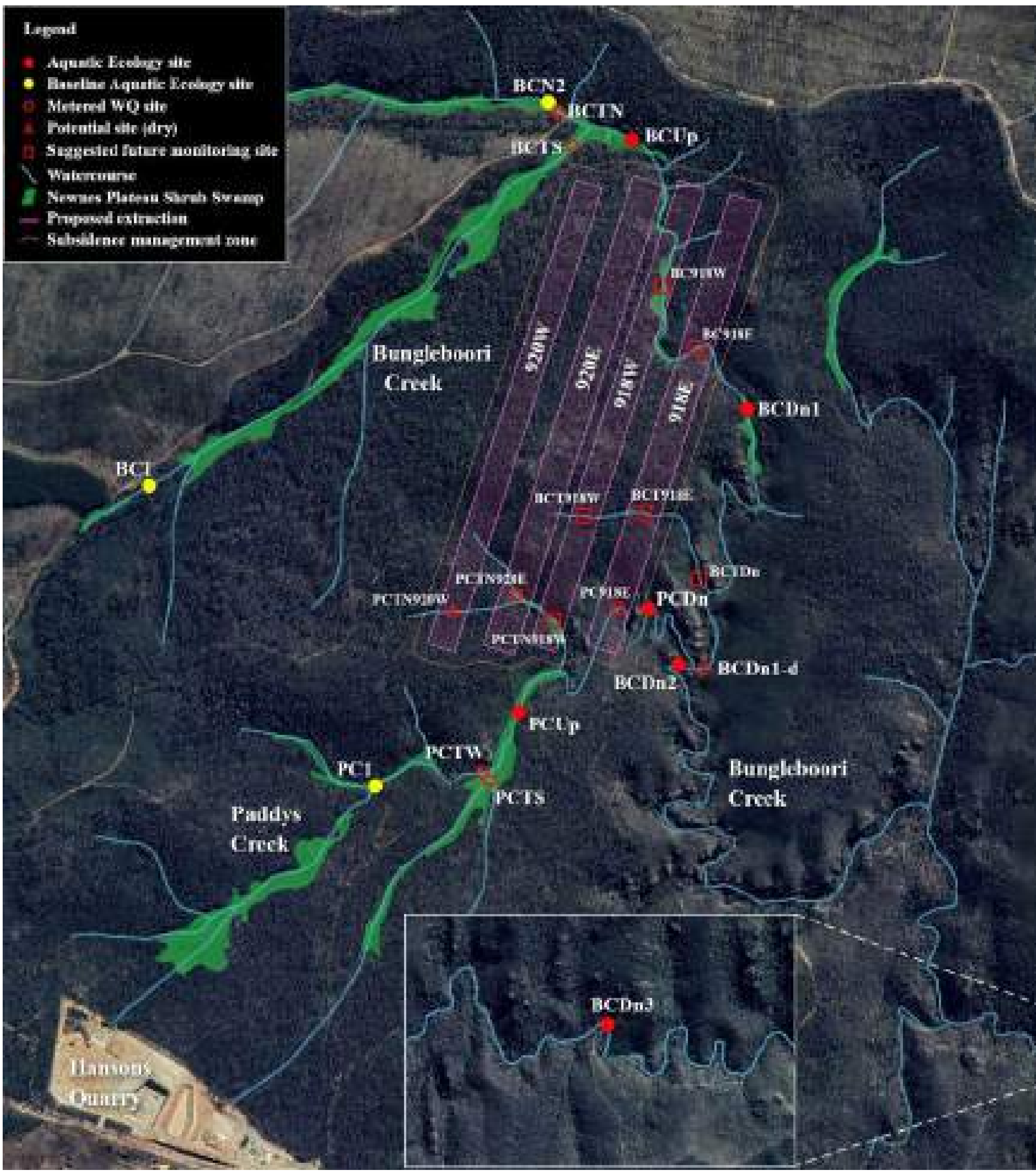


Figure 2: Clarence EP 918/920 aquatic ecology survey sites.

The NPSSs are listed as Endangered Ecological Communities (EECs) under the NSW *Biodiversity Conservation Act 2016* (BCA) and are also listed as part of the Temperate Highland Peat Swamps on Sandstone (TPHSS) under the federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Bungleboori Creek originates on the Newnes Plateau in the Blue Mountains Range at elevations reaching 1170m Australian Height Datum (AHD) and has an average annual rainfall of 1092mm. From the headwaters the creek flows in a north easterly direction for 3km where it meets Waratah Ridgeline, turns to the south for 4km flowing through narrow escarpment ridgelines, whereby it changes direction to flow in a general easterly direction before discharging into the Colo River.

The Bungleboori Creek study area is situated in the Gardens of Stone SCA, around 11km upstream from the western boundary of the Blue Mountains National Park. The upper headwaters to the south of Waratah Ridge are divided into two separate drainages of equal size, of which approximately half of the catchment area was historically (pre-May 2022) occupied by plantation pine forest, and the remainder comprises native bushland. The ridgelines bounding the drainages and bordering the adjacent creek catchment boundaries contain a complex network of access tracks, and both sub-catchment drainage channels contain NPSS's. The gradient of the entire southern drainage where the NPSS prevails consists of gentle slopes, with a 40m change in relief over the 2.6km length of the drainage line. Downstream of each NPSS in the study area sub-catchments, the channel valleys become more incised and bordered by steep sandstone escarpments, which increase in depth and frequency with increasing distance downstream.

The proposed EP 918/920 mining footprint underlies Bungleboori Creek for a distance of around 860m (**Figure 2**), which contains intermittently occurring shrub swamps and incised creek drainage channel throughout the length. There is one small 1st order unnamed sub-catchment tributary to Bungleboori Creek which overlies the mining footprint (BCT in **Figure 2**) and flows from the west to join Bungleboori Creek just above its confluence with Paddys Creek.

Paddys Creek originates on the Newnes Plateau in the Blue Mountains Range near State Mine Gully at elevations reaching 1190m AHD. The headwaters of Paddys Creek catchment border the upper Bungleboori Creek catchment to the south, and flow in a north easterly direction for a distance of around 4.1km before merging with Bungleboori Creek.

Whilst there were no pine plantation compartments within the Paddys Creek catchment area, the two main sub-catchment branches accommodate Hansons' Sand Quarry in their upper limits (**Figure 2**). The longer northern sub-catchment supports a NPSS upstream of the site that extends for approximately 1300m in length, and the smaller southern sub-catchment contains a NPSS that is around 660m in length, which continues further downstream from the confluence of the sub-catchments for a distance of 520m, after which the stream channel becomes incised and meandering through bedrock escarpment and gullies in its lower limits. A small tributary to Paddys Creek overlies the proposed underground footprint (PCTN in **Figure 2**) which merges with Paddys Creek at the downstream limits of the NPSS distribution in the main channel.

In terms of existing aquatic ecological sampling information for the study area, a previous Environmental Assessment for the adjoining Springvale Colliery mining lease area included a baseline aquatic ecology monitoring program that ran from 2010 to 2016. This study included three sites in the upper Bungleboori Creek and Paddys Creek catchments, and Springvale Colliery provided permission to incorporate these results as long-term streamhealth indices for this project which were provided in the first Clarence EP 918/920 monitoring report (MPR 2022a).

1.2 Newnes Plateau Site Threatened Species Considerations

The NPSS provide habitat for several water related terrestrial species; the giant dragonfly (*Petalura gigantea*) and the Blue Mountains water skink (*Eulamprus leuraensis*) and possible habitat for one aquatic species, the Adams emerald dragonfly (*Archaeophya adamsi*). The giant dragonfly and water skink are listed as Endangered under the BCA with the latter also being listed as Endangered under the EPBC Act. The emerald dragonfly is listed as Endangered under the NSW *Fisheries Management Act 1994* (FMA).

The giant dragonfly is semi-aquatic, living in burrows in swamps and along stream edges. The larvae emerge from the terrestrial entrances at night and in wet weather in search of insects and other arthropods to eat, and larvae are not known to swim and avoid open water (Web Reference 2). Given their crepuscular habits of the larvae it is unlikely that specimens would occur in routine macroinvertebrate sampling. Adults emerge between October and January and therefore targeted searches are undertaken for both exuviae (the larval skins shed in the process of metamorphosis into an adult) and adults in suitable swamp locations during sampling for the bi-annual spring surveys.

There is little information available on the ecology and biology of Blue Mountains water skink. The Blue Mountains water skink is restricted to sedge and shrub swamps that have boggy soils and appear to be permanently wet, and is semi-aquatic being active on warm, sunny days from September until late April (Web Reference 3). Although it is known from the Carne Creek swamps, no individuals were observed during this survey.

The Adams emerald dragonfly have been collected in small numbers from only a few localities in NSW, including six creeks in the broader Blue Mountains and Wollemi National Park areas (Theischinger et al 2011). Specimens of *A. adamsi* are extremely rare, and prior to 1998 only 5 adult specimens had been collected or observed, indicating that this species has extremely low local population sizes. Habitats where larvae have been found include small creeks with gravel or sandy bottoms, in narrow shaded riffle zones with moss and rich riparian vegetation (Web Reference 4). Considering these observations and owing to the generally poor level of knowledge of this species state-wide, the presence of *A. adamsi* in the Newnes Plateau study area (Bungleboori Creek and Paddys Creek) cannot be discounted entirely.

2 AQUATIC STUDY DESIGN

2.1 Aims and Objectives

In terms of study aims, the Aquatic Ecology Sampling Program endeavours to answer the following questions:

- Where are the aquatic habitat resources in the study area?
- What are the ecological and riparian attributes of the study area aquatic habitats?
- Do the creeks provide suitable fish passage?
- Do the aquatic resources provide suitable and sustained aquatic habitat for fish and other aquatic biota?
- Are there any protected or threatened aquatic species or communities residing within the study area, or any mammals such as platypus and Australian water rat that may utilise the aquatic resources of the study area?

To achieve these objectives the sampling program includes following features:

- Sampling the aquatic macroinvertebrate fauna twice a year (in spring and autumn) using the AusRivAS sampling, sorting and identification protocols (see Section 2.2 below). Note that for AusRivAS standardised sampling purposes the 'autumn' sample season is defined as March 15 to June 15 and 'Spring' is defined as September 15 to December 15.
- Estimation of fish occurrence by a combination of overnight and spot bait-trapping, dip netting and observation, with all captured fish identified in-situ and immediately released.
- Depth profiles of basic water quality parameters: Temperature, Electrical Conductivity (salinity), water acidity (pH), Dissolved Oxygen and Turbidity, at each site during each sampling run.
- Descriptions of creek riparian condition and aquatic plant communities within the study area.

The adopted study design to achieve the objectives outlined above incorporated aquatic ecology sampling in autumn 2024 at six in-stream sampling sites located up and down-stream of the proposed extraction area in creek drainage channels and NPSS.

Table 1 below presents the site descriptions and coordinates for all sites visited between spring 2021 and autumn 2024, and **Figure 2** (above) shows sampling site locations in relation to the proposed underground mine.

Table 1 Clarence EP 918/920 Seasonal Aquatic Ecology Sample Site Information									
Catchment	Site	Site Coordinates		Sp21	Au22	Sp22	Au23	Sp23	Au24
		E	N						
Bungleboori Ck	BCTS*	241974	6301203	X	X	X	X	X	
	BCTN*	241934	6301300	X	X	X	X	X	
	BCUp	242186	6301187	X	X	X	X	X	X
	BC918E*	242405	6300547		X				
	BCDn1	242563	6300328	X	X	X	X	X	X
	BCDn1-d*	242464	6299495	X	X	X	X	X	X
	BCDn2	242333	6299501	X	X	X	X	X	X
	BCDn3	244522	6298422	X	X	X	X	X	X
	BCT918W	242014	6299966		X				
	BCT918E	242249	6299983		X				
Paddys Creek	PCTW*	241675	6299121	X	X				
	PCTS*	241769	6299127	X	X				
	PCUp	241848	6299318	X	X	X	X	X	X
	PC918E*	242154	6299684	X					
	PCDn	242255	6299651	X	X	X	X	X	X
	PCTN920W	241630	6299674	X					
	PCTN920E	241835	6299709	X					
Note:	*Represents metered water quality sites only. Sites shaded grey were visited (not sampled) and are considered not suitable as long-term Aquatic Ecology monitoring sites.								

2.2 Macroinvertebrate Sampling Methods

The aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (the AusRivAS method (Turak et al 2004, Chessman 2003b).

The AusRivAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site.
Sampling has conformed to these definitions:

- A site is "a stream reach with a length of 100 m or 10 times the stream width, whichever is the greater".
- A riffle habitat is "an area of broken water with rapid current that has some cobble or boulder substratum", and riffle samples collected from broken waters with only pebble, gravel, sand or bedrock substratum may not produce reliable results.
- Edge habitat is "an area along the creek with little or no current".

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation.

While many of the upper catchment tributary creek and swamp sites are readily accessible, site selection for sampling aquatic biota from some of the incised catchment sites is constrained by access from the road network through the SCA to the drainages where the creek flows through deeply incised canyons bordered by escarpment.

2.2.1 Field methods for macroinvertebrate sampling

Macroinvertebrate assemblages were sampled using a 250 µm mesh dip net over as many aquatic 'edge' habitat types as could be located within each of the pools along the defined stream reaches. Net samples were then placed into white sorting trays for in situ live sorting for up to 1 person-hour (with a minimum of 40 minutes), as per the AusRivAS protocol. Following cessation of live picking, further observations were made of the pool edge sample areas for surface aquatic macroinvertebrate taxa (e.g., water skaters and spiders) and any other taxa (such as freshwater crayfish) not collected by the dip netting process. Where possible (or necessary) representatives of these organisms were collected and added to the dip net samples.

Rarer specimens for which positive identification could be made in the field (e.g., water scorpions), were generally released. That is, for protection of the pool macroinvertebrate integrity we adopted a 'sampling with replacement' method.
Notwithstanding this procedure, for all taxa that could be positively identified in the field, at least one of each of the field-identified taxa are retained as a representative of that taxa for that sampling event.

For all other macroinvertebrate taxa where field identifications were not definitive, specimens were retained for later detailed taxonomic analysis in the laboratory. Notes are also kept of the presence of burrows and holes that are present in the site aquatic habitats (i.e., as indications of yabbies or burrowing dragonflies). All retained specimens are placed in sample jars and preserved in 70% ethanol for subsequent laboratory identification. Each sample jar is labelled and paper laundry tags are inserted into the jars noting the sample site, sample date and sample collector/picker initials. Any giant dragonfly exuviae or exuviae of other threatened species are kept for confirmation purposes. Any larval threatened species specimens (*Archaeophya adamsi, Petalura gigantea* or *Austrocordulia leonardi*) retained during the macroinvertebrate sampling process are identified and counted, photographed and released.

Searches are also undertaken for threatened dragonflies (adults and exuviae; shells cast larval in the process of emergence) among suitable creek habitats (including Newnes Plateau Shrub swamp and along ridgelines) during the spring surveys.

2.2.2 Laboratory methods for macroinvertebrate samples

In the laboratory, taxonomic identifications are generally facilitated using Maggy lights or binocular dissecting microscopes and taxonomic guides such as; CSIRO, Land and Water Resources & Environment Australia (1999), Hawking & Smith (1997), Hawking & Theischinger (1999), Theischinger (2009) and Williams (1980).

Organisms are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols. These are as follows; family level for all insect taxa except Chironomids which are taken to sub-family). Collembola arthropods (Springtails) are classified as a single class and the arachnid arthropods (spiders and mites) are classified as two orders. For the mites (Order Acarina) we have taken them to sub-order classification level where possible. Crustaceans were taken to Family level where suitable keys are available. Ostracoda were left at Class level. The worm-like taxa are shown at Phylum or Class level. For all taxa, where suitable keys were available, taxa were identified to lower levels of taxonomy.

The sorted specimens are then transferred to individual glass vials (one per family/sub-family) and paper laundry tags inserted into each glass vial with the sample site, sample date and initials of taxonomist noted on the tags. Glass vials are then topped up with 70 % alcohol, sealed with plastic lids and placed back into the original field sample jars.

Where there are any individual specimens where the collected material is too indistinct or fragmented to assign a definitive identification, the samples are dispatched to relevant Australian Museum specialists or other specialists, as recommended by EPA. For all samples the following taxonomic QA/QC procedure is followed:

> At least ten percent of the samples/sites are selected at random and the individual retained taxa are identified without reference to the original identifications. A table is then made of the original identifications verses the second identifications, indicating where there were any anomalies in identification (if any). If there are no anomalies, the QA/QC sample protocol is accepted and no further QA/QC checking is undertaken. If there are differences in identifications, all the samples containing the related taxa are re-examined to clear up the anomalies.

Following this procedure, and if there have been anomalies, an additional 10 percent of the remaining samples are chosen and the QA/QC procedure re-applied. This process continues until there are no differences between original identifications and QA/QC identifications.

2.2.3 Site SIGNAL index & EPT Index calculations

The aquatic invertebrate assemblage for each sample site is described in terms of the site taxa diversity (number of individual AusRivAS taxa) and in terms of a site SIGNAL score. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates. The indices are derived by correlation analysis of macroinvertebrate occurrence against water chemical analysis (Chessman 1995). The water chemistry attributes generally used are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus (Chessman 2003a).

SIGNAL indices may be regionally specific (e.g. SIGNAL HU-97 developed for the Hunter Valley Catchment (Chessman 1997), or applicable Australia wide (e.g. SIGNAL-2, Chessman 2003a). Each macroinvertebrate Family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). For the present study SIGNAL-2 scores are applied. Taxa with no published SIGNAL score are excluded from the site SIGNAL analysis.

Once taxa SIGNAL indices have been applied individual site SIGNAL indices are calculated (as the mean) from all site taxa with SIGNAL scores. Creek SIGNAL scores are calculated as the mean of all taxa SIGNAL value occurrences recorded within each creek system for a survey. Site and creek SIGNAL scores are then summarised and compared across each survey and between surveys.

As a general guide site SIGNAL Indices are graded into the following categories (Chessman *et al.* 1997):

- SIGNAL Index > 6 = Healthy Unimpaired
- SIGNAL Index 5-6 = Mildly Impaired
- SIGNAL Index 4-5 = Moderately Impaired
- SIGNAL Index < 4 = Severely Impaired.

However, as the intent of this study is to assess site condition relative to other sites over time, the site scores are used for these comparison purposes rather than as overall study area condition indices.

That is, the overall changes in site indices over time are of greater interest than the basic and generalised ‘health’ scores (as per Chessman et al 1997).

The combined number of Ephemoptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site (the EPT index) is used to supplement the taxa richness (diversity) and SIGNAL index as an indicator of stream health.

2.3 Field Sampling Methods for Fish and Other Vertebrates

At each macroinvertebrate sampling site, four fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream either overnight, or for the duration of the combined macroinvertebrate sampling and live picking survey (minimum 1.5 hours) and then retrieved. Captured fish are identified i*n situ* using Allen *et. al*., (2002) and McDowall (1996) and immediately released. Fish caught or observed as part of the macroinvertebrate dip net sampling are also identified, noted and released.

Dead fish specimens and any fish that cannot be positively identified in the field are taken to the Australian Museum for confirmation of species identification.
These specimens with capture details are then incorporated into the Australian Museum collection as appropriate.

Following completion of the fish and macroinvertebrate sampling, any further observations of fish during the pool condition survey are also noted with fish species-name only noted if positively identified. For each survey, tadpoles (which are not macroinvertebrates but chordates) are noted in the results. Specimens are not kept or identified. The presence of birds, reptiles and turtles that utilise the aquatic habitats are noted, and notes are made of the potential for the study area habitats to support platypus or Australian water rats where appropriate.

2.4 Field Water Quality Sampling

A calibrated submersible Yeo-Kal 618 water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. At some sites, depth profiles of water quality may also be made to test for layering/mixing.

Physical observations are also taken in the field to highlight any aquatic habitat variations (e.g. recent rain, subsequent infilling, detritus in water column or on benthos, scum or flocculates in or on water body etc.) and the presence of fresh yabbie holes are also noted.

2.5 Aquatic Habitat Condition (RCE Index)

A standardised description of site aquatic habitat condition is used to compile a stream site condition index, based on a modified version of the Riparian, Channel and Environmental (RCE) Inventory developed by Petersen (1992), as reported by Chessman *et al* (1997) for the greater Hunter River catchment. The index is compiled by giving each of the 13 RCE descriptors a score between 0 and 4, then summing the scores, to reach a maximum possible score of 52. Scores are then expressed as a percentage.

3 CLARENCE EP 918/920 AQUATIC ECOLOGY SURVEY RESULTS

Full field sampling notes for the autumn 2024 aquatic ecology sampling are provided in **Appendix Table A2**. Sampling was undertaken over the 29th May and 13th June 2024. Note that for sampling purposes the AusRivAS 'autumn' season is defined as March 15th to June 15th.

3.1 Sampling Conditions Leading into Autumn 2024

Rainfall measurements are recorded at Clarence Mine Meteorological Station, with long-term mean monthly totals acquired from Bureau of Meteorology (BOM) Lithgow (Cooerwull) Gauge 63226 (recorded from 1878 to current). **Appendix Table A-1** provides the daily rainfall records for 2023 and 2024 (July 2023 to June 2024) and **Figure 3** shows the rainfall data for the period since the most recent survey (spring 2023). While the previous spring (October) 2023 survey was undertaken following a dry winter period, rainfall patterns over summer and autumn were characterised by frequent wet weather events:

- November 2023 to January 2024 saw regular rainfall with 377mm recorded over 50 rainfall days, much higher than the combined three-monthly mean total of 232mm. This included one significant event on December 21 where 109mm fell over a single day (**Figure 3**).
- While February recorded regular rain of 82mm over 22 rainfall days, March was relatively dry with only 30mm.
- Another heavy storm event in early April produced 149mm over a three-day period (including 107mm on April 6th), and the overall April total (169mm) was almost three times its monthly mean.

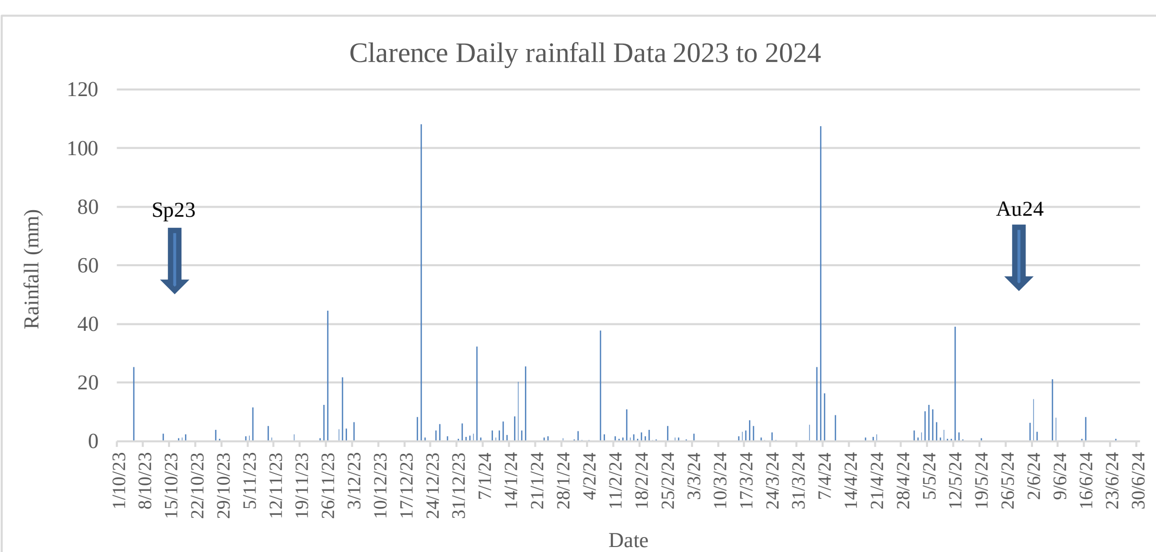


Figure 3 Clarence mine site daily rainfall October 2023 to June 2024.

- The period leading into the autumn 2024 survey saw sustained light showers with 99mm recorded over 18 rainfall days (including one 39mm rain event on May 12th), and only 1.6mm was recorded over the two weeks prior to the commencement of sampling on May 29th.
- Following the initial sample dates in late May, sampling was postponed until the 11th June due to wet weather where 53mm was recorded in early June.

3.2 Autumn 2024 Aquatic Ecology Survey Results

The Clarence EP 918/920 autumn 2024 aquatic ecology monitoring survey was undertaken between the 29th May and 13th June 2024 following the sampling outline shown in **Table 1** and **Figure 2** above and using the methodology outlined in **Section 2**. Site photos are also provided **Appendix A**. Summary tables for the autumn 2024 Appendix A data are provided in the following sections and include the results from the five previous baseline surveys (spring 2021, autumn and spring 2022, autumn and spring 2023).

3.3 Autumn 2024 Metered Water Quality Results

A calibrated water quality meter is used at all aquatic ecology sampling sites plus at selected intermediary sites to record surface water quality - and where applicable, depth profiles of water temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity to detect potential layering. **Table 2** provides the results of metered water quality sampling for the autumn 2024 aquatic ecology field survey.

Table 2 EP 918/920 Extraction Area Water Quality Results Autumn 2024

Site	Date	Time	Depth	Temp	Cond	DO	DO	pH	Turb
			m	°C	µS/cm	% sat	mg/L	Units	ntu
BCUp	31/5/24	9:39	0.1	7.09	7	85.5	10.37	5.28	0.2
BCUp	31/5/24	9:39	0.2	7.10	6	86.1	10.45	5.30	0.5
BCDn1	31/5/24	7:54	0.1	9.34	9	97.5	11.21	5.40	0.1
BCDn1	31/5/24	7:55	0.3	9.35	8	97.4	11.19	5.41	0.1
BCDn1	31/5/24	7:56	0.6	9.33	9	97.2	11.17	5.42	0.1
BCDn1-d	29/5/24	11:54	0.1	7.30	9	112.0	13.52	6.74	0.3
BCDn1-d	29/5/24	11:54	0.2	7.30	8	111.0	13.40	6.71	0.3
BCDn1-d	29/5/24	11:55	0.3	7.30	8	109.9	13.28	6.69	0.3
BCDn2	29/5/24	12:15	0.1	7.10	7	104.0	12.63	6.36	0.2
BCDn2	29/5/24	12:15	0.2	7.10	7	103.3	12.54	6.34	0.2
BCDn3	13/6/24	16:03	0.1	6.54	2	93.5	11.50	5.68	0.1
BCDn3	13/6/24	16:03	0.2	6.54	2	93.6	11.51	5.65	0.1
BCDn3	13/6/24	16:04	0.3	6.54	2	93.3	11.48	5.61	0.1
BCDn3	13/6/24	16:04	0.4	6.53	2	93.5	11.51	5.56	0.1
PCUp	11/6/24	8:08	0.1	7.20	3	90.1	10.91	5.24	0.2
PCUp	11/6/24	8:08	0.2	7.26	3	90.2	10.9	5.22	0.2
PCDn	29/5/24	9:39	0.1	8.40	7	101.3	11.90	5.81	0.2
PCDn	29/5/24	15:00	0.2	8.40	5	101.1	11.87	5.83	0.2

3.4 Aquatic & Riparian Habitat Condition

The field notes (**Appendix Table A-2**) provide details of stream reach flows, pool and channel dimensions and available aquatic habitats for the present survey. The overall Aquatic and Riparian Habitat condition - as estimated using the RCE Index - are provided in **Appendix Table A-3** with summary provided below in **Table 3**, and **Table 4** provides the results of aquatic macrophyte occurrences for the autumn 2024 aquatic ecology sampling sites.

Table 3 Summary of RCE Results Autumn 2024

Category	BCUp	BCDn1	BCDn2	BCDn3	PCUp	PCDn
Land-use pattern beyond immediate riparian zone	3.5	4	4	4	4	4
Width of riparian strip-of woody vegetation	4	4	4	4	4	4
Completeness of riparian strip of woody vegetation	4	4	4	4	4	4
Vegetation of riparian zone within 10 m of channel	4	4	4	4	4	4
Stream bank structure	4	4	4	4	4	4
Bank undercutting	2.5	2	2	2	2	2
Channel form	4	4	4	4	4	4
Riffle/pool sequence	4	4	4	4	4	4
Retention devices in stream	4	4	4	4	4	4
Channel sediment accumulations	3	3	3	2	3	3.5
Stream bottom	2.5	3	3.5	3.5	3	3
Stream detritus	4	3.5	3.5	3.5	3.5	4
Aquatic vegetation	4	4	3.5	3.5	4	4
Autumn 2024 Site RCE Score (%)	91.3	91.3	91.3	89.4	91.3	93.3
Spring 2023 Site RCE Score (%)	88.5	91.3	92.3	91.3	92.3	92.3
Autumn 2023 Site RCE Score (%)	88.5	92.3	94.2	93.3	92.3	92.3
Spring 2022 Site RCE Score (%)	89.4	93.3	94.2	93.3	94.2	93.3
Autumn 2022 Site RCE Score (%)	89.4	94.2	94.2	93.3	92.3	94.2
Spring 2021 Site RCE Score (%)	90.4	94.2	94.2	94.2	92.3	94.2

Table 4 Macrophyte Occurrence Autumn 2024

Site	Rush *Baumea rubiginosa*	Grass *Carex gaudichaundiana*	Jointed Rush *Juncus articulatus*	Bulbous Rush *Juncus bulbosus*	Rush *Juncus sp*	Water Milfoil *Myriophyllum sp?*	Tufted Algae *Batrochospermum sp*	Charophytes
BCUp		1		1			1	1
BCDn1	1	1		1		1	1	1
BCDn2							1	1
BCDn3							1	
PCUp	1		1	1	1		1	1
PCDn							1	

3.5 Aquatic Macroinvertebrate and Fish Survey Results

Appendix Table A-4 provides the results of aquatic macroinvertebrate taxonomic identifications to the levels required by AusRivAS, plus occurrence data for all aquatic macroinvertebrates and fish. The table also provides site SIGNAL and EPT scores (see **Section 2.2.3** for explanation of SIGNAL and EPT). The autumn 2024 Clarence EP 918/920 aquatic ecology monitoring site Diversity (taxa richness), SIGNAL and EPT diversity results are provided in **Figures 4** to **6** below, and include the mean (± standard deviation SD) site summary statistics calculated from five previous surveys (spring 2021, autumn and spring 2022, autumn and spring 2023).

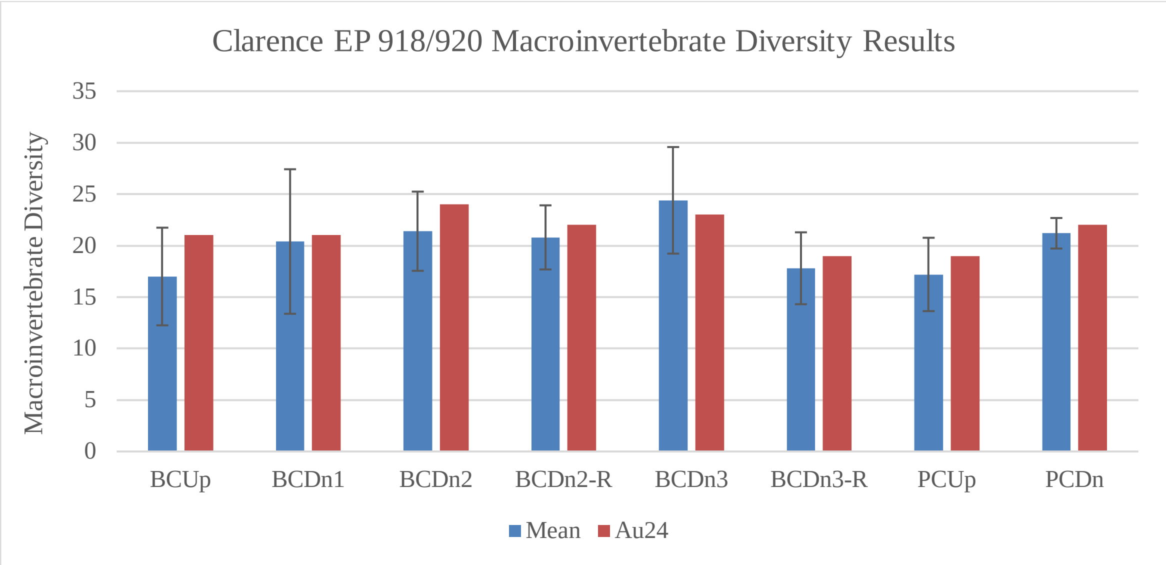


Figure 4 Clarence EP 918/920 survey macroinvertebrate taxa diversity results.

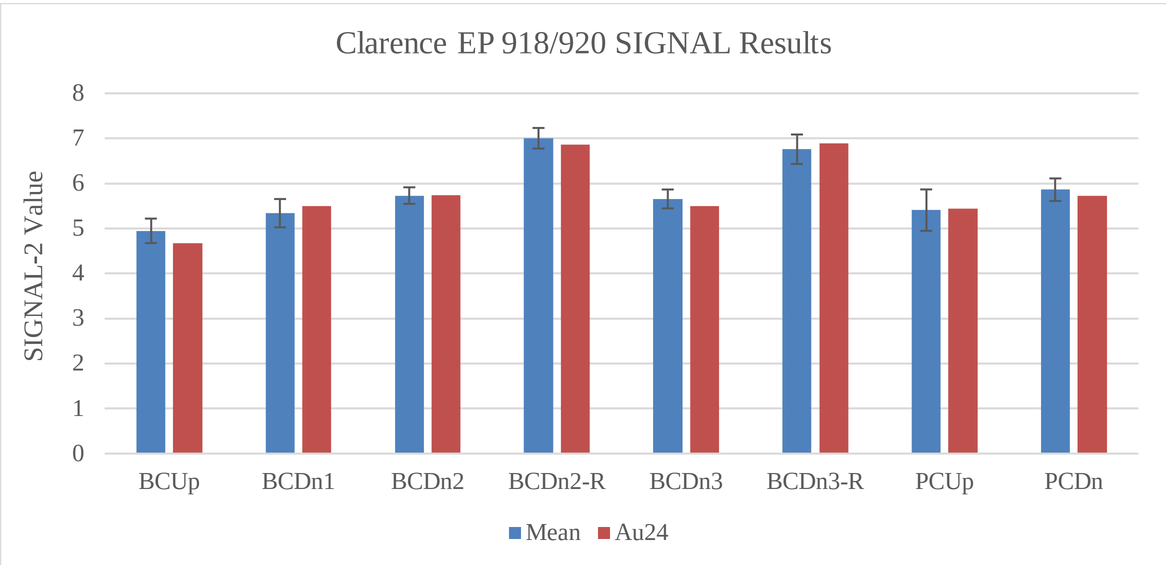


Figure 5 Clarence EP 918/920 survey SIGNAL-2 scores.

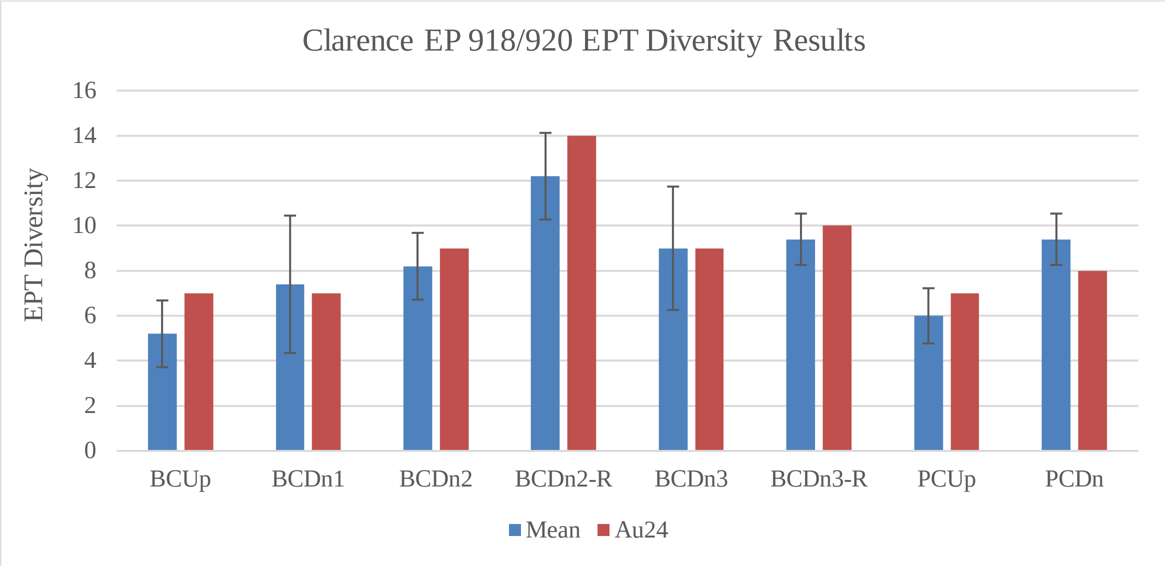


Figure 6 Clarence EP 918/920 survey EPT taxa diversity.

Native mountain galaxias (*Galaxias olidus*) fish were recorded from BCDn1 and BCDn3 in Bungleboori Creek and PCUp in Paddys Creek. There were no threatened or protected invertebrate or vertebrate aquatic species (as listed under the BCA, FMA or EPBC) caught or observed during the autumn 2024 Clarence EP 918/920 aquatic ecology monitoring survey, nor were there individuals observed, or any indications of platypus or Australian water rat usage within the study area.

4 REFERENCES

Allen, G.R., Midgley, S.H. and Allen, M. (2002)
Field Guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, WA.

ANZECC/ARMCANZ (2000)
Australian and New Zealand Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Chessman, B. C (1995)
Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology* 20, pp. 122-129.

Chessman, B. C., Growns, J. E. and Kotlash, A. R. (1997)
Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. *Marine & Freshwater Research* 48, pp. 159-172.

Chessman, B. C., (2003a)
New Sensitivity grades for Australian river macroinvertebrates. *Marine & Freshwater Research* 54, pp. 95 - 103.

Chessman, B. C., (2003b)
SIGNAL 2 – A Scoring System for Macro-invertebrate (‘Water Bugs’) in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra

CSIRO, Land and Water Resources & Environment Australia (1999)
Interactive Guide to Australian Aquatic Invertebrates. CSIRO Australia.

Hawking, J. & Smith, F. J. (1997)
Colour Guide to Invertebrates of Australian Inland Waters. Co-operative Centre for Freshwater Ecology, Albury.

Hawking, J. & Theischinger, G. (1999)
Dragonfly Larvae (Odonata). A Guide to the Identification of Larvae of Australian Families and to the Identification and Ecology of Larvae from New South Wales. Co-operative Centre for Freshwater Ecology, Albury, and Australian Water Technologies Pty Ltd, West Ryde. CRCFE Identification Guide No. 24.

McDowall, R. (1996)
Freshwater Fishes of South Eastern Australia. Reed Books, Sydney, NSW.

MPR (2022a)

Bungleboori Creek Catchment Aquatic Ecology- Spring 2021 Data Report. Report prepared for Clarence Colliery, February 2022.

MPR (2022b)

Bungleboori Creek Catchment Aquatic Ecology- Autumn 2022 Data Report. Report prepared for Clarence Colliery, September 2022.

MPR (2023a)

Bungleboori Creek Catchment Aquatic Ecology- Spring 2022 Data Report. Report prepared for Clarence Colliery, March 2022.

MPR (2023b)

Bungleboori Creek Catchment Aquatic Ecology- Autumn 2023 Data Report. Report prepared for Clarence Colliery, August 2023.

MPR (2024)

Bungleboori Creek Catchment Aquatic Ecology- Spring 2023 Data Report. Report prepared for Clarence Colliery, March 2024.

Peterson (1992)

The RCE: a Riparian Channel and Environmental Inventory for small streams in the agricultural landscape. Freshwater Biology 27: 295 – 306.

Theischinger, G. & Jacobs, S., & Krogh, M. (2011)

Archaeophya adamsi Fraser (Odonata, Gomphomacromiidae): not in Queensland, but safe in New South Wales? *Agrion* 15 (2): 64 - 68.

Turak, E, Waddell, N, Johnstone, G. (2004)

New South Wales Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual. Department of Environment and Conservation, Sydney.

Web Reference 1:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10974: NSW Threatened Species Website.

Web Reference 2:

http://www.environment.nsw.gov.au/determinations/GiantDragonflyEndSpListing.htm: NSW Dept Environment, Climate Change &Water.

Web Reference 3:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=1022: NSW Threatened Species Website.

Web Reference 4:

http://pas.dpi.nsw.gov.au/Species/Species_Profile.aspx?SpeciesListingID=10: NSW Primary Industries.

Williams, W.D. (1980)
Australian Freshwater Life. The Invertebrates of Australia Inland Waters. The MacMillan Co. of Australia Pty Ltd, Sydney.

APPENDIX A

FIELD NOTES,

SITE PHOTOGRAPHS

AND

SAMPLING DATA

AUTUMN 2024

Appendix Table A-1 Clarence Mine Meteorological Station Daily Rainfall (mm) for 2023-2024												
Date	2023						2024					
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1st	0	0	0	0	0	4.4	6	3.4	0.6	0	3.6	6.4
2nd	0	0	0	0	0	0	1.6	0.4	0	0	1.2	14.4
3rd	0	0.6	0	0	0	6.6	2	0	2.6	5.6	3	3.2
4th	0	0	0	0	1.8	0	2.6	0.4	0	0	10.2	0
5th	6.8	0	0	25.4	2	0.2	32.4	0	0	25.4	12.4	0
6th	0	0.2	2.4	0.2	11.6	0	1.4	0	0	107.4	11	0
7th	0	0.6	0	0.2	0.2	0	0.2	37.8	0	16.4	6.6	21.2
8th	0.8	0.2	6.8	0	0	0	0	2.4	0	0	1.2	8
9th	1	0	10	0	0	0	3.6	0.2	0	0	4	0.2
10th	0	0	0	0	5.2	0	1.4	0.2	0	9	0.8	0
11th	0	0	0	0	1.2	0	3.6	1.8	0	0	0.8	0
12th	0	0	0	0	0	0	6.8	0.8	0	0	39	0
13th	0	0	0	2.6	0	0	2.2	1.4	0	0	3	0.2
14th	0	7.6	0	0	0	0.2	0	10.8	0	0	0.6	0
15th	0	15	0	0	0	0.2	8.4	1.2	1.8	0	0	0.8
16th	0	0.2	0	0	0	0	20.2	2.4	3.2	0	0	8.2
17th	2.8	0	0	1	2.4	0	3.6	0.8	3.8	0	0	0
18th	0.2	3.6	0	1.4	0.2	0	25.6	3	7.2	1.2	0.2	0
19th	1.4	5.8	0	2.4	0	0	0.2	1.8	5.2	0	1	0
20th	0	0.2	0	0	0	8.2	0	4	0.2	1.6	0	0
21st	0	0	0	0	0	108.2	0	0.4	1.4	2.4	0	0
22nd	0	0	0	0	0	1.4	0	0.6	0.4	0	0	0
23rd	0	0	0.6	0	0	0.2	1.2	0	0.2	0	0	0.2
24th	0	0.2	0	0	1	0	1.8	0	3	0.2	0.2	0.8
25th	0.2	0	0	0	12.4	3.8	0	5.2	0.4	0	0	0.2
26th	0.2	0	0	0	44.6	5.8	0	0	0	0	0	0.2
27th	0	0	2.2	4	0.2	0.2	0.2	1.4	0	0	0	0
28th	0	0	0	0.8	0	1.8	1	1.4	0	0	0.2	0
29th	0	6.8	0	0	4.2	0	0	0	0	0	0.2	0
30th	0	0	0	0	21.8	0	0		0	0	0	0
31st	0	9.4		0		0.8	0.6		0		0	
Total	13.4	50.4	22	38	108.8	142	126.6	81.8	30	169.2	99.2	64
Monthly Average*	61	57.6	55.7	62	66.3	79.7	86.3	80.7	77.3	57.9	50.8	71.3

Note: Days sampled are highlighted in yellow. *Monthly average is the long-term average from BOM Lithgow station 63226.

Appendix Table A-2 Field Comments – Autumn 2024 Aquatic Ecology Monitoring Sites		
Site	Date	Comments
BCUp	31/05/24	Water was clear with low flow throughout the site length. Lower flow compared to the former survey. Maximum width was to 1.5m with and average width of 0.6-0.7m. Maximum depth was 0.9m with an average depth of 0.3m. Site has complex trailing bank vegetation structure and significantly increased edge bank riparian vegetation (particularly tea tree) to previous spring 2023 survey. Breaching edge banks have abundant silt. Evidence of a high flow event of approximately 1.0m higher than current water level, which appears to have caused changed macrophyte beds and detritus settlement. Submerged surfaces were covered in a layer of silt. Habitats sampled are unchanged from previous survey. Substrates were made up of mostly sands, gravels and bedrock with lesser amounts of boulders cobbles and pebbles. Filamentous green alga was present in small-moderate amounts.
BCDn1	31/05/24	Water very clear and flowing through site length. Maximum pool width to 7.5m, maximum depth 1.0m. The edge habitat availability was significantly decreased from previous survey and are scoured back, with some sections of edge bank lumped and fallen into creek. Evidence of a high flow event 0.5m higher than current water level presumably caused scouring of edge banks. Moderate silt settlement in main pool with some under banks, with less detritus to previous survey in constricted channel areas of the main pool. Habitat composition is unchanged to previous survey, with good macrophytes, trailing bank vegetation in main pools and pockets. Channel substrates generally equal amounts of bedrock, gravelly sands and cobbles. Filamentous green alga present in small amounts.
BCDn2	29/05/24	Water very clear with low flow through site length, flow probably lower than the spring 2023 survey. Maximum width around 8 and average width 2m, maximum depth around 1.8m and average depth around 0.4m. Overall stream condition consistent with the previous survey (available edge habitats, dominant substrate types). Moderate abundance of algae (*Batrachospermum sp*) on submerged cobbles and boulders and slightly more sand in open pool areas, and there was an increase in the density of riparian vegetation since spring 2023 (mostly wattle trees and tea trees). Evidence of a high flow event above 1.0-1.2m current water level, which appears to scoured out detritus in main channel area. Overall, detritus is decreased from previous survey, particularly in riffle sections. The edge habitats sampled consisted of trailing bank vegetation, undercut banks and detritus, and the channel substrates were dominated by cobbles and gravelly sands with some boulders. Filamentous green alga was present in small amounts.

BCDn3	13/06/24	Water very clear with low flow through site length. Maximum width 10.0m and average width 3.5m, maximum depth 1.3m and average depth 0.4m. There was a significant decrease in the abundance of algae (*Batrachospermum sp*) on submerged cobbles and boulders since the previous survey, and accumulated sandbanks that are loose and mobile in main pool area. There was significantly less aquatic habitat to sample than previous survey, with habitat sampled being fragmented, isolated pockets of trailing bank vegetation, undercut and detritus. Evidence of a high flow event above 2.0m current water level which appears to have caused significant scouring to bank beds and decreased accumulation of detritus. The site substrates were comprised of mostly of cobble and gravel banks with sections of mobile sandy deposits. Filamentous green alga is absent.
PCUp	11/06/24	Water was very clear with low flow through site length. Maximum width to 2.5m and average width around 0.8m, maximum pool depth to 0.9m-1.0m and average depth 0.4m (around half of the site averaging 0.1m and half site averaging 0.6m). General site conditions and available habitats similar to former survey, however particulate material along edges is decreased and Gahnia is flattened. Evidence of a high flow event 0.3-0.7m above current water level. Riparian vegetation was increased from previous survey, particularly tea trees. Layer of silt present on submerged surfaces in protected backwaters and an increase in dense macrophytes. The aquatic habitat availability comprised mostly undercut banks and trailing bank vegetation, detrital reservoirs and aquatic vegetation (charophytes and macrophytes), and the channel substrates were dominated by cobbles or gravelly sand accumulations in the upstream end and bedrock benches and cascades in the downstream half of the site. No filamentous green alga observed.
PCDn	29/05/24	Water very clear and flowing through site length. Maximum width around 4.5m and average width ~1.0m, maximum depth 0.8m and average depth 0.2m. There was an increase in the density of riparian vegetation since spring 2023 (mostly wattle trees and tea trees). Habitats sampled were slightly further downstream due to lack of bank habitat that had been scoured clean of detrital matter. Clear evidence of a scouring high flow event 0.5m above current water level. The channel substrates were dominated by bedrock, with small quantities of gravelly sands. Accumulative detritus was limited in edge areas. Filamentous green alga present in small amounts.

Appendix Table A-3

Modified Riparian, Channel and Environment (RCE) Inventory (after Chessman et al 1997).

Descriptor	Category	Value	BCUp	BCDn1	BCDn2	BCDn3	PCUp	PCDn
			Au24	Au24	Au24	Au24	Au24	Au24
1	Land-use pattern beyond immediate riparian zone							
	Undisturbed native vegetation	4		4	4	4	4	4
	Mixed native vegetation and pasture/exotics	3	3.5					
	Mainly pasture, crops or pine plantation	2						
	Urban, some vegetation	1						
	Industrial, little vegetation	0						
2	Width of riparian strip-of woody vegetation							
	More than 30 m	4	4	4	4	4	4	4
	Between 5 and 30 m	3						
	Less than 5 m	2						
	No woody vegetation	1						
	No Vegetation	0						
3	Completeness of riparian strip of woody vegetation							
	Riparian strip without breaks in vegetation	4	4	4	4	4	4	4
	Breaks at intervals of more than 50 m	3						
	Breaks at intervals of 10-50 m	2						
	Breaks at intervals of less than 10 m	1						
	No riparian strip at all	0						
4	Vegetation of riparian zone within 10 m of channel							
	Native tree and shrub species	4	4	4	4	4	4	4
	Mixed native and exotic trees and shrubs	3						
	Exotic trees and shrubs	2						
	Exotic grasses/weeds	1						
	No vegetation at all	0						
5	Stream bank structure							
	Banks fully stabilized by trees, shrubs, concrete	4	4	4	4	4	4	4
	Banks firm but held mainly by grass and herbs	3						
	Banks loose, partly held by sparse grass, rubble	2						
	Banks unstable, mainly loose sand or soil	1						
	Banks actively eroding	0						
6	Bank undercutting							
	None, or restricted by tree roots or man-made	4						
	Only on curves and at constrictions	3						
	Frequent along all parts of stream	2	2.5	2	2	2	2	2
	Severe; bank collapses common	1						
	Total bank collapse	0						
7	Channel form							
	Deep; width:depth ratio less than 8:1	4	4	4	4	4	4	4
	Medium; width:depth ratio 8:1 to 15:1	3						
	Shallow; width:depth ratio greater than 15:1	2						
	Artificial; concrete or excavated channel< 8:1	1						
	Artificial; concrete or excavated channel > 8:1	0						
8	Riffle/pool sequence							
	Frequent alternation of riffles and pools	4	4	4	4	4	4	4
	Long pools with infrequent short riffles	3						
	Natural channel without riffle/pool sequence	2						
	Artificial channel; some riffle/pool sequence	1						
	Artificial channel; no riffle/pool sequence	0						
9	Retention devices in stream							
	Many large boulders and/or debris dams	4	4	4	4	4	4	4
	Rocks/logs present; limited damming effect	3						
	Rocks/logs present but unstable; no damming	2						
	Stream or channel with few or no rocks/logs	1						
	Artificial channel; no retention devices	0						
10	Channel sediment accumulations							
	Little or no accumulation of loose sediments	4						
	Some gravel bars but little sand or silt	3	3	3	3		3	3.5
	Bars of sand and silt common	2				2		
	Braiding by loose sediment	1						
	Complete in-filled muddy channel	0						
11	Stream bottom							
	Mainly clean stones with obvious interstices	4						
	Mainly stones with some cover of algae/silt	3		3	3.5	3.5	3	3
	Bottom heavily silted but stable	2	2.5					
	Bottom mainly loose and mobile sandy sedimen	1						
	Bottom mainly loose and mobile muddy sedimer	0						
12	Stream detritus							
	Mainly unsilted wood, bark, leaves	4	4					4
	Some wood, leaves, etc. with much fine detritus	3		3.5	3.5	3.5	3.5	
	Mainly fine detritus mixed with sediment	2						
	Little or no organic detritus, mainly sandy	1						
	No organic detritus, mainly mud	0						
13	Aquatic vegetation							
	Little or no macrophyte or algal growth	4	4	4			4	4
	Substantial algal growth; few macrophytes	3			3.5	3.5		
	Substantial macrophyte growth; little algal grow	2						
	Substantial macrophyte and algal growth	1						
	Total cover of macrophytes plus algae	0						
	RCE Score		47.5	47.5	47.5	46.5	47.5	48.5
	RCE %age		91.3	91.3	91.3	89.4	91.3	93.3

Appendix Table A-4 Clarence EP 918/920 Aquatic Ecology Monitoring Macroinvertebrate and Fish Results Autumn 2024												Sample Site and Sample Date									
									Life Stage			31/5/24	31/5/24	29/5/24	29/5/24	13/6/24	13/6/24	11/6/24	29/5/24		
Phylum	Class	Sub-Class	Order	Sub-Order	Family	Sub-Family	Genus/spp	Common name	L	N	A	BCUp	BCDn1	BCDn2	BCDn2-R	BCDn3	BCDn3-R	PCUp	PCDn	Occurrence	SIG-2
Arthropoda	Insecta		Coleoptera		Dytiscidae			Diving Beetles	x		x	1	1	1		1				4	2
Arthropoda	Insecta		Coleoptera		Elmidae			Riffle Beetles	x		x				1	1	1			3	7
Arthropoda	Insecta		Coleoptera		Gyrinidae			Whirligig Beetles	x		x	1	1	1		1		1	1	6	4
Arthropoda	Insecta		Coleoptera		Scirtidae			Marsh Beetles	x			1	1	1	1	1	1	1	1	8	6
Arthropoda	Insecta		Diptera		Ceratopogonidae			Biting Midges	x			1	1	1	1	1		1	1	7	4
Arthropoda	Insecta		Diptera		Chironomidae	Chironominae		Bloodworms	x			1	1	1		1		1	1	6	3
Arthropoda	Insecta		Diptera		Chironomidae	Orthocladiinae		Bloodworms	x			1	1	1			1	1	1	6	4
Arthropoda	Insecta		Diptera		Chironomidae	Tanypodinae		Bloodworms	x			1	1	1		1		1	1	6	4
Arthropoda	Insecta		Diptera		Simuliidae			Black Flies	x			1	1		1		1	1	1	6	5
Arthropoda	Insecta		Diptera		Tipulidae			Crane Flies	x					1	1	1	1		1	5	5
Arthropoda	Insecta		Ephemeroptera		Baetidae			Mayflies		x					1	1	1			3	5
Arthropoda	Insecta		Ephemeroptera		Coloburiscidae			Mayflies		x					1		1			2	8
Arthropoda	Insecta		Ephemeroptera		Leptophlebiidae			Mayflies		x		1	1	1	1	1	1	1	1	8	8
Arthropoda	Insecta		Ephemeroptera		Oniscigastridae			Mayflies		x			1	1		1			1	4	8
Arthropoda	Insecta		Hemiptera		Corixidae			Lesser Water Boatmen					1							1	2
Arthropoda	Insecta		Hemiptera		Notonectidae			Backswimmers				1								1	1
Arthropoda	Insecta		Hemiptera		Veliidae			Small Water Striders				1								1	3
Arthropoda	Insecta		Megaloptera		Corydalidae			Dobsonflies	x								1			1	7
Arthropoda	Insecta		Neuroptera		Neurorthidae			Lacewings	x						1		1			2	9
Arthropoda	Insecta		Odonata	Epiproctophora	Corduliidae			Dragonflies	x									1		1	5
Arthropoda	Insecta		Odonata	Epiproctophora	Synthemistidae			Dragonflies	x			1	1	1	1	1		1	1	7	2
Arthropoda	Insecta		Odonata	Epiproctophora	Telephlebiidae			Dragonflies	x				1	1	1	1	1		1	6	9
Arthropoda	Insecta		Odonata	Zygoptera	Argiolestidae			Damselflies	x					1		1			1	3	5
Arthropoda	Insecta		Odonata	Zygoptera	Synlestidae			Damselflies	x				1	1		1		1	1	5	7
Arthropoda	Insecta		Plecoptera		Austroperlidae			Stoneflies		x					1					1	10
Arthropoda	Insecta		Plecoptera		Eustheniidae			Stoneflies		x					1		1			2	10
Arthropoda	Insecta		Plecoptera		Gripopterygidae			Stoneflies		x		1	1	1	1	1	1	1	1	8	8
Arthropoda	Insecta		Trichoptera		Conoesucidae			Caddis Flies	x					1	1					2	7
Arthropoda	Insecta		Trichoptera		Ecnomidae			Caddis Flies	x			1				1		1		3	4
Arthropoda	Insecta		Trichoptera		Helicophidae			Caddis Flies	x			1	1	1		1	1	1	1	7	10
Arthropoda	Insecta		Trichoptera		Helicopsychidae			Caddis Flies	x					1	1				1	3	8
Arthropoda	Insecta		Trichoptera		Hydrobiosidae			Caddis Flies	x			1			1		1			3	8
Arthropoda	Insecta		Trichoptera		Hydropsychidae			Caddis Flies	x						1		1			2	6
Arthropoda	Insecta		Trichoptera		Hydroptilidae			Caddis Flies	x			1	1	1	1	1		1	1	7	4
Arthropoda	Insecta		Trichoptera		Leptoceridae			Caddis Flies	x			1	1	1	1	1	1	1	1	8	6
Arthropoda	Insecta		Trichoptera		Philopotamidae			Caddis Flies	x						1					1	8
Arthropoda	Insecta		Trichoptera		Philorheithridae			Caddis Flies	x				1	1	1	1	1	1	1	7	8
Arthropoda	Arachnida		Acarina	Hydracarina				Freshwater Mites				1	1	1				1	1	5	6
Arthropoda	Crustacea	Copepoda	Cyclopoida		Cyclopidae			Copepods					1	1		1		1		4	*
Arthropoda	Crustacea		Amphipoda		Neoniphargidae			Side Swimmers				1								1	4
Arthropoda	Crustacea		Isopoda	Phreatoicidea	Phreatoicidae			Isopods						1						1	4
Annelida	Oligochaeta							Freshwater Worms				1				1	1		1	4	2
Chordata	Osteichthyes				Galaxiidae		*Galaxias olidus*	Mountain Galaxias					1			1		1		3	*
							Total number of invertebrate taxa per site:					21	21	24	22	23	19	19	22	42	
								Site SIGNAL2 Scores:				4.67	5.50	5.74	6.86	5.50	6.89	5.44	5.73		
Notes:	* represents those taxa for which SIGNAL-2 scores are not available							Total number of EPT taxa:				7	7	9	14	9	10	7	8	17	

Plate 1: Looking north across track crossing just upstream of Bungleboori Creek site BCUp in autumn 2024.

Plate 2: Looking downstream from the track crossing.

Plate 3: Looking downstream at Bungleboori Creek upstream site BCUp.

Plate 4: Looking downstream in BCUp.

Plate 5: Looking downstream through large pool at the upstream end of BCDn1.

Plate 6: Looking upstream at BCDn1.

Plate 7:Looking downstream through pool at BCDn1.

Plate 8: Looking downstream through shallow incised channel at BCDn1.

Plate 9: Debris bank up and sediment deposition at BCDn1.

Plate 10: Looking downstream through deeper pool area at BCDn1.

Plate 11: Looking upstream through narrow channel riffle zone at BCDn1.

Plate 12: Looking upstream at the confluence of Bungleboori Creek (right hand side) and Paddys Creek (entering from the left hand side), just upstream from BCDn2.

Plate 13: Looking upstream at BCDn2.

Plate 14: Looking upstream towards gorge at BCDn2.

Plate 15: Algae (*Batrachospermum* sp) on cobbles BCDn2.

Plate 16: Looking upstream through cobble riffle section at BCDn2.


Plate 17: Looking upstream through cobble riffle section at BCDn2


Plate 18: Looking upstream through riffle section at BCDn3.

Plate 19: Looking upstream at erosional point on bend at BCDn3.

Plate 20: Looking upstream through riffle zone at BCDn3.


Plate 21: Looking upstream at BCDn3.


Plate 22: Looking downstream through contained pool area with macrophytes at PCUp.


Plate 23: Looking upstream at deep pool area at PCUp.


Plate 24: Looking upstream PCUp.


Plate 25: Looking upstream through open pool area and bedrock confined run at PCDn.


Plate 26: Looking upstream at PCDn.

Plate 27: Looking downstream at PCDn.

Plate 28: Looking upstream at PCDn.

CENTENNIAL COAL
CLARENCE COLLIERY

BUNGLEBOORI CREEK CATCHMENT
AQUATIC ECOLOGY

SPRING 2023 DATA REPORT

Figure 1. Looking downstream at Bungleboori Creek site BCDn2.

REPORT PREPARED FOR
CLARENCE COLLIERY PTY LTD

MARINE POLLUTION RESEARCH PTY LTD
MARCH 2024

FIGURES

TABLES

APPENDIX

A FIELD NOTES, SITE PHOTOGRAPHS AND SAMPLING DATA

1 INTRODUCTION

Clarence Colliery Pty Ltd owns and operates the existing Clarence Colliery underground coal mine near the village of Clarence in NSW, and is preparing an Extraction Plan (EP) to enable the partial extraction of two panels known as the 918 and 920 Panels. Each panel has two sub-panels providing for four sub-extraction areas.

The EP 918/920 area is located within the upper Bungleboori Creek catchment, one of the major tributaries to the Wollangambe River. The study area catchments are contained within the Gardens of Stone State Conservation Area (SCA), with catchment areas upstream and downstream of the proposed mine footprint comprising mixed undeveloped native forest and former state forest pine plantation, Blue Mountains National Park and Hansons' Sand Quarry. The Bungleboori and Paddys Creek catchment drainage lines overlying and downstream from the proposed extraction area contain Newnes Plateau Shrub and Hanging Swamp endangered ecological communities (EECs).

As part of the Environmental assessment process, Clarence Colliery commissioned Marine Pollution Research Pty Ltd (MPR) to review existing aquatic ecological information and initiate a baseline aquatic ecology monitoring program to describe the existing aquatic environment of the EP 918/920 proposal footprint. The aims of the baseline aquatic ecology (streamhealth) monitoring program are as follows:

- To develop an understanding of the aquatic ecological attributes of the Newnes Plateau Shrub Swamps which overly the areas of proposed mining in order to enable impact assessment and provide suitable mitigation and offset measures where necessary or desirable.
- To provide additional aquatic site base-line data that can be utilised to monitor potential impacts of partial extraction mining activities.

This data report provides the results for the fifth consecutive seasonal aquatic ecology baseline monitoring survey for Clarence EP 918/920 undertaken in spring 2023, and follows on from baseline monitoring survey reports for spring 2021 (MPR 2022a), autumn and spring 2022 (MPR 2022b, MPR 2023a) and autumn 2023 (MPR 2023b).

1.1 Description of Locality and Existing Information

The two panels are located in the upper Bungleboori Creek catchment including a tributary of Paddys Creek (**Figure 2**). Several sub-catchments support Newnes Plateau Shrub Swamp (NPSS) habitats dominated by shrubs and sedges that occur on sites with impeded drainage in low slope headwater valleys on the Newnes Plateau in the upper Blue Mountains (Web Reference 1).

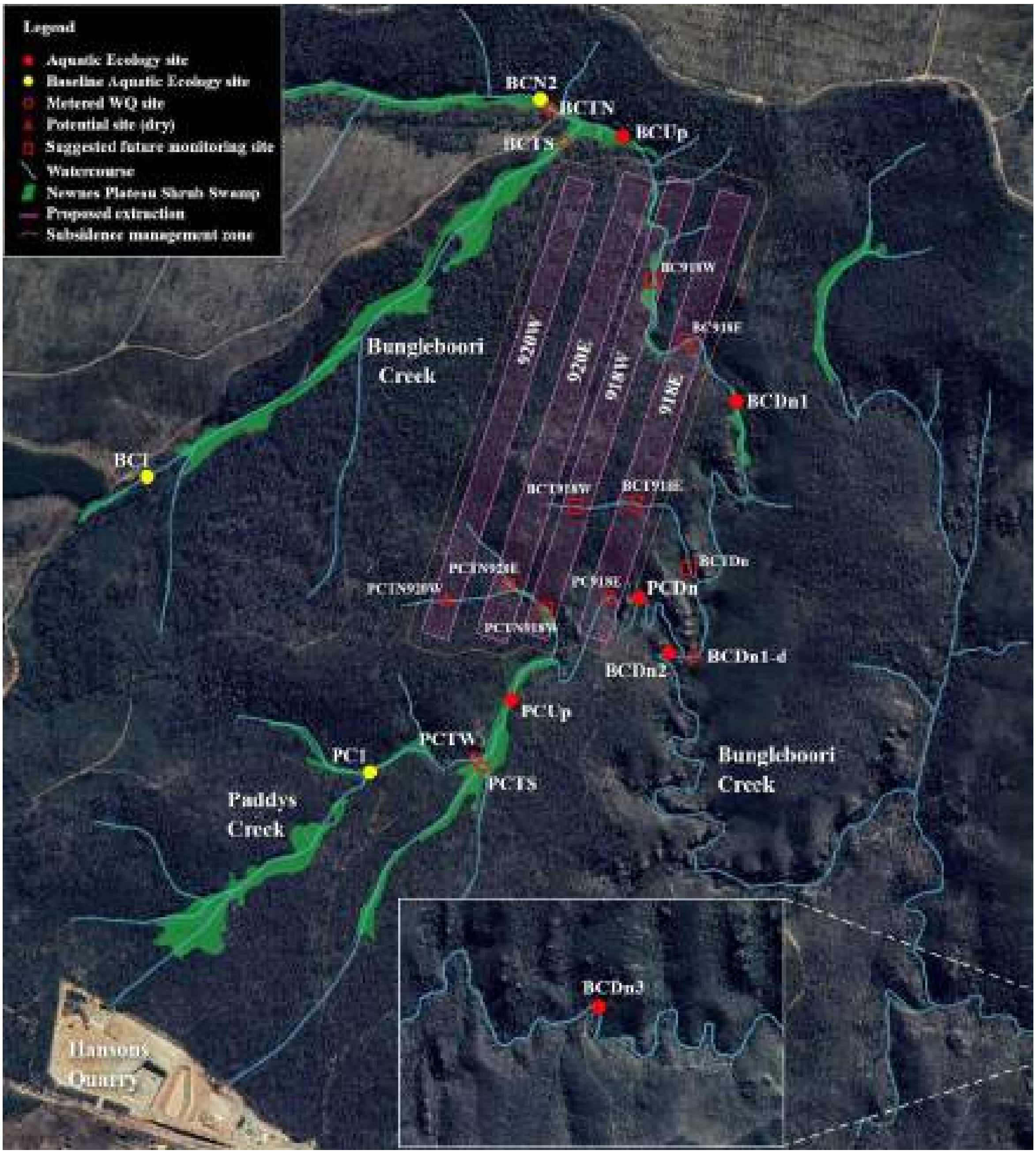


Figure 2: Clarence EP 918/920 aquatic ecology survey sites.

The NPSSs are listed as Endangered Ecological Communities (EECs) under the NSW *Biodiversity Conservation Act 2016* (BCA) and are also listed as part of the Temperate Highland Peat Swamps on Sandstone (TPHSS) under the federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Bungleboori Creek originates on the Newnes Plateau in the Blue Mountains Range at elevations reaching 1170m Australian Height Datum (AHD) and has an average annual rainfall of 1092mm. From the headwaters the creek flows in a north easterly direction for 3km where it meets Waratah Ridgeline, turns to the south for 4km flowing through narrow escarpment ridgelines, whereby it changes direction to flow in a general easterly direction before discharging into the Colo River.

The Bungleboori Creek study area is situated in the Gardens of Stone SCA, around 11km upstream from the western boundary of the Blue Mountains National Park. The upper headwaters to the south of Waratah Ridge are divided into two separate drainages of equal size, of which approximately half of the catchment area was historically (pre-May 2022) occupied by plantation pine forest, and the remainder comprises native bushland. The ridgelines bounding the drainages and bordering the adjacent creek catchment boundaries contain a complex network of access tracks, and both sub-catchment drainage channels contain NPSS's. The gradient of the entire southern drainage where the NPSS prevails consists of gentle slopes, with a 40m change in relief over the 2.6km length of the drainage line. Downstream of each NPSS in the study area sub-catchments, the channel valleys become more incised and bordered by steep sandstone escarpments, which increase in depth and frequency with increasing distance downstream.

The proposed EP 918/920 mining footprint underlies Bungleboori Creek for a distance of around 860m (**Figure 2**), which contains intermittently occurring shrub swamps and incised creek drainage channel throughout the length. There is one small 1st order unnamed sub-catchment tributary to Bungleboori Creek which overlies the mining footprint (BCT in **Figure 2**) and flows from the west to join Bungleboori Creek just above its confluence with Paddys Creek.

Paddys Creek originates on the Newnes Plateau in the Blue Mountains Range near State Mine Gully at elevations reaching 1190m AHD. The headwaters of Paddys Creek catchment border the upper Bungleboori Creek catchment to the south, and flow in a north easterly direction for a distance of around 4.1km before merging with Bungleboori Creek.

Whilst there were no pine plantation compartments within the Paddys Creek catchment area, the two main sub-catchment branches accommodate Hansons' Sand Quarry in their upper limits (**Figure 2**). The longer northern sub-catchment supports a NPSS upstream of the site that extends for approximately 1300m in length, and the smaller southern sub-catchment contains a NPSS that is around 660m in length, which continues further downstream from the confluence of the sub-catchments for a distance of 520m, after which the stream channel becomes incised and meandering through bedrock escarpment and gullies in its lower limits. A small tributary to Paddys Creek overlies the proposed underground footprint (PCTN in **Figure 2**) which merges with Paddys Creek at the downstream limits of the NPSS distribution in the main channel.

In terms of existing aquatic ecological sampling information for the study area, a previous Environmental Assessment for the adjoining Springvale Colliery mining lease area included a baseline aquatic ecology monitoring program that ran from 2010 to 2016. This study included three sites in the upper Bungleboori Creek and Paddys Creek catchments, and Springvale Colliery provided permission to incorporate these results as long-term streamhealth indices for this project which were provided in the first Clarence EP 918/920 monitoring report (MPR 2022a).

1.2 Newnes Plateau Site Threatened Species Considerations

The NPSS provide habitat for several water related terrestrial species; the giant dragonfly (*Petalura gigantea*) and the Blue Mountains water skink (*Eulamprus leuraensis*) and possible habitat for one aquatic species, the Adams emerald dragonfly (*Archaeophya adamsi*). The giant dragonfly and water skink are listed as Endangered under the BCA with the latter also being listed as Endangered under the EPBC Act. The emerald dragonfly is listed as Endangered under the NSW *Fisheries Management Act 1994* (FMA).

The giant dragonfly is semi-aquatic, living in burrows in swamps and along stream edges. The larvae emerge from the terrestrial entrances at night and in wet weather in search of insects and other arthropods to eat, and larvae are not known to swim and avoid open water (Web Reference 2). Given their crepuscular habits of the larvae it is unlikely that specimens would occur in routine macroinvertebrate sampling. Adults emerge between October and January and therefore targeted searches were undertaken for both exuviae (the larval skins shed in the process of metamorphosis into an adult) and adults in suitable swamp locations during sampling for the spring 2023 survey.

There is little information available on the ecology and biology of Blue Mountains water skink. The Blue Mountains water skink is restricted to sedge and shrub swamps that have boggy soils and appear to be permanently wet, and is semi-aquatic being active on warm, sunny days from September until late April (Web Reference 3). Although it is known from the Carne Creek swamps, no individuals were observed during this survey.

The Adams emerald dragonfly have been collected in small numbers from only a few localities in NSW, including six creeks in the broader Blues Mountains and Wollemi National Park areas (Theischinger et al 2011). Specimens of *A. adamsi* are extremely rare, and prior to 1998 only 5 adult specimens were known, indicating that this species has extremely low local population sizes. Habitats where larvae have been found include small creeks with gravel or sandy bottoms, in narrow shaded riffle zones with moss and rich riparian vegetation (Web Reference 4). Considering these observations and owing to the generally poor level of knowledge of this species state-wide, the presence of *A. adamsi* in the Newnes Plateau study area (Bungleboori Creek and Paddys Creek) cannot be discounted entirely.

2 AQUATIC STUDY DESIGN

2.1 Aims and Objectives

In terms of study aims, the Aquatic Ecology Sampling Program endeavours to answer the following questions:

- Where are the aquatic habitat resources in the study area?
- What are the ecological and riparian attributes of the study area aquatic habitats?
- Do the creeks provide suitable fish passage?
- Do the aquatic resources provide suitable and sustained aquatic habitat for fish and other aquatic biota?
- Are there any protected or threatened aquatic species or communities residing within the study area, or any mammals such as platypus and Australian water rat that may utilise the aquatic resources of the study area?

To achieve these objectives the sampling program includes following features:

- Sampling the aquatic macroinvertebrate fauna twice a year (in spring and autumn) using the AusRivAS sampling, sorting and identification protocols (see Section 2.2 below). Note that for AusRivAS standardised sampling purposes the ‘autumn’ sample season is defined as March 15 to June 15 and ‘Spring’ is defined as September 15 to December 15.
- Estimation of fish occurrence by a combination of overnight and spot bait-trapping, dip netting and observation, with all captured fish identified in-situ and immediately released.
- Depth profiles of basic water quality parameters: Temperature, Electrical Conductivity (salinity), water acidity (pH), Dissolved Oxygen and Turbidity, at each site during each sampling run.
- Descriptions of creek riparian condition and aquatic plant communities within the study area.

The adopted study design to achieve the objectives outlined above incorporated aquatic ecology sampling in spring 2023 at six in-stream sampling sites located up and down-stream of the proposed extraction area in creek drainage channels and NPSS, with water quality metering was undertaken at a further three locations.

Table 1 below presents the site descriptions and coordinates for all sites visited between spring 2021 and spring 2023, and **Figure 2** (above) shows sampling site locations in relation to the proposed underground mine. Note that there were three sites shown as suggested possible future mining impact assessment sites that were not visited for this survey. If access to these sites is possible and the sites are viable aquatic ecology monitoring locations, they could be sampled prior to under-mining and post mining to assess potential mine impacts.

Table 1 Clarence EP 918/920 Seasonal Aquatic Ecology Sample Site Information

Catchment	Site	Site Coordinates		Sp21	Au22	Sp22	Au23	Sp23
		E	N					
Bungleboori Ck	BCTS*	241974	6301203	X	X	X	X	X
	BCTN*	241934	6301300	X	X	X	X	X
	BCUp	242186	6301187	X	X	X	X	X
	BC918W	242302	6300754					
	BC918E*	242405	6300547		X			
	BCDn1	242563	6300328	X	X	X	X	X
	BCDn1-d*	242464	6299495	X	X	X	X	X
	BCDn2	242333	6299501	X	X	X	X	X
	BCDn3	244522	6298422	X	X	X	X	X
	BCT918W	242014	6299966		X			
	BCT918E	242249	6299983		X			
	BCTDn	242422	6299775					
Paddys Creek	PCTW*	241675	6299121	X	X			
	PCTS*	241769	6299127	X	X			
	PCUp	241848	6299318	X	X	X	X	X
	PC918E*	242154	6299684	X				
	PCDn	242255	6299651	X	X	X	X	X
	PCTN920W	241630	6299674	X				
	PCTN920E	241835	6299709	X				
Note:	*Represents metered water quality sites only. Sites shaded grey were visited (not sampled) and are considered not suitable as long-term Aquatic Ecology monitoring sites.							

2.2 Macroinvertebrate Sampling Methods

The aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (the AusRivAS method (Turak et al 2004, Chessman 2003b).

The AusRivAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site.

Sampling has conformed to these definitions:

- A site is "a stream reach with a length of 100 m or 10 times the stream width, whichever is the greater".
- A riffle habitat is "an area of broken water with rapid current that has some cobble or boulder substratum", and riffle samples collected from broken waters with only pebble, gravel, sand or bedrock substratum may not produce reliable results.
- Edge habitat is "an area along the creek with little or no current".

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation.

While many of the upper catchment tributary creek and swamp sites are readily accessible, site selection for sampling aquatic biota from some of the incised catchment sites is constrained by access from the road network through the SCA to the drainages where the creek flows through deeply incised canyons bordered by escarpment.

2.2.1 Field methods for macroinvertebrate sampling

Macroinvertebrate assemblages were sampled using a 250 µm mesh dip net over as many aquatic 'edge' habitat types as could be located within each of the pools along the defined stream reaches. Net samples were then placed into white sorting trays for in situ live sorting for up to 1 person-hour (with a minimum of 40 minutes), as per the AusRivAS protocol. Following cessation of live picking, further observations were made of the pool edge sample areas for surface aquatic macroinvertebrate taxa (e.g., water skaters and spiders) and any other taxa (such as freshwater crayfish) not collected by the dip netting process. Where possible (or necessary) representatives of these organisms were collected and added to the dip net samples.

Rarer specimens for which positive identification could be made in the field (e.g., water scorpions), were generally released. That is, for protection of the pool macroinvertebrate integrity we adopted a 'sampling with replacement' method.
Notwithstanding this procedure, for all taxa that could be positively identified in the field, at least one of each of the field-identified taxa are retained as a representative of that taxa for that sampling event.

For all other macroinvertebrate taxa where field identifications were not definitive, specimens were retained for later detailed taxonomic analysis in the laboratory. Notes are also kept of the presence of burrows and holes that are present in the site aquatic habitats (i.e., as indications of yabbies or burrowing dragonflies). All retained specimens are placed in sample jars and preserved in 70% ethanol for subsequent laboratory identification. Each sample jar is labelled and paper laundry tags are inserted into the jars noting the sample site, sample date and sample collector/picker initials. Any giant dragonfly exuviae or exuviae of other threatened species are kept for confirmation purposes. Any larval threatened species specimens (*Archaeophya adamsi, Petalura gigantea* or *Austrocordulia leonardi*) retained during the macroinvertebrate sampling process are identified and counted, photographed and released.

Searches are also undertaken for threatened dragonflies (adults and exuviae; shells cast larval in the process of emergence) among suitable creek habitats (including Newnes Plateau Shrub swamp and along ridgelines) during the spring surveys.

2.2.2 Laboratory methods for macroinvertebrate samples

In the laboratory, taxonomic identifications are generally facilitated using Maggy lights or binocular dissecting microscopes and taxonomic guides such as; CSIRO, Land and Water Resources & Environment Australia (1999), Hawking & Smith (1997), Hawking & Theischinger (1999), Theischinger (2009) and Williams (1980).

Organisms are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols. These are as follows; family level for all insect taxa except Chironomids which are taken to sub-family). Collembola arthropods (Springtails) are classified as a single class and the arachnid arthropods (spiders and mites) are classified as two orders. For the mites (Order Acarina) we have taken them to sub-order classification level where possible. Crustaceans were taken to Family level where suitable keys are available. Ostracoda were left at Class level. The worm-like taxa are shown at Phylum or Class level. For all taxa, where suitable keys were available, taxa were identified to lower levels of taxonomy.

The sorted specimens are then transferred to individual glass vials (one per family/sub-family) and paper laundry tags inserted into each glass vial with the sample site, sample date and initials of taxonomist noted on the tags. Glass vials are then topped up with 70 % alcohol, sealed with plastic lids and placed back into the original field sample jars.

Where there are any individual specimens where the collected material is too indistinct or fragmented to assign a definitive identification, the samples are dispatched to relevant Australian Museum specialists or other specialists, as recommended by EPA. For all samples the following taxonomic QA/QC procedure is followed:

> At least ten percent of the samples/sites are selected at random and the individual retained taxa are identified without reference to the original identifications. A table is then made of the original identifications verses the second identifications, indicating where there were any anomalies in identification (if any). If there are no anomalies, the QA/QC sample protocol is accepted and no further QA/QC checking is undertaken. If there are differences in identifications, all the samples containing the related taxa are re-examined to clear up the anomalies.

Following this procedure, and if there have been anomalies, an additional 10 percent of the remaining samples are chosen and the QA/QC procedure re-applied. This process continues until there are no differences between original identifications and QA/QC identifications.

2.2.3 Site SIGNAL index & EPT Index calculations

The aquatic invertebrate assemblage for each sample site is described in terms of the site taxa diversity (number of individual AusRivAS taxa) and in terms of a site SIGNAL score. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates. The indices are derived by correlation analysis of macroinvertebrate occurrence against water chemical analysis (Chessman 1995). The water chemistry attributes generally used are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus (Chessman 2003a).

SIGNAL indices may be regionally specific (e.g. SIGNAL HU-97 developed for the Hunter Valley Catchment (Chessman 1997), or applicable Australia wide (e.g. SIGNAL-2, Chessman 2003a). Each macroinvertebrate Family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant). For the present study SIGNAL-2 scores are applied. Taxa with no published SIGNAL score are excluded from the site SIGNAL analysis.

Once taxa SIGNAL indices have been applied individual site SIGNAL indices are calculated (as the mean) from all site taxa with SIGNAL scores. Creek SIGNAL scores are calculated as the mean of all taxa SIGNAL value occurrences recorded within each creek system for a survey. Site and creek SIGNAL scores are then summarised and compared across each survey and between surveys.

As a general guide site SIGNAL Indices are graded into the following categories (Chessman *et al.* 1997):

- SIGNAL Index > 6 = Healthy Unimpaired
- SIGNAL Index 5-6 = Mildly Impaired
- SIGNAL Index 4-5 = Moderately Impaired
- SIGNAL Index < 4 = Severely Impaired.

However, as the intent of this study is to assess site condition relative to other sites over time, the site scores are used for these comparison purposes rather than as overall study area condition indices. That is, the overall changes in site indices over time are of greater interest than the basic and generalised ‘health’ scores (as per Chessman et al 1997).

The combined number of Ephemoptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site (the EPT index) is used to supplement the taxa richness (diversity) and SIGNAL index as an indicator of stream health.

2.3 Field Sampling Methods for Fish and Other Vertebrates

At each macroinvertebrate sampling site, four fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream either overnight, or for the duration of the combined macroinvertebrate sampling and live picking survey (minimum 1.5 hours) and then retrieved. Captured fish are identified i*n situ* using Allen *et. al*., (2002) and McDowall (1996) and immediately released. Fish caught or observed as part of the macroinvertebrate dip net sampling are also identified, noted and released.

Dead fish specimens and any fish that cannot be positively identified in the field are taken to the Australian Museum for confirmation of species identification.
These specimens with capture details are then incorporated into the Australian Museum collection as appropriate.

Following completion of the fish and macroinvertebrate sampling, any further observations of fish during the pool condition survey are also noted with fish species-name only noted if positively identified. For each survey, tadpoles (which are not macroinvertebrates but chordates) are noted in the results. Specimens are not kept or identified. The presence of birds, reptiles and turtles that utilise the aquatic habitats are noted, and notes are made of the potential for the study area habitats to support platypus or Australian water rats where appropriate.

2.4 Field Water Quality Sampling

A calibrated submersible Yeo-Kal 618 water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. At some sites, depth profiles of water quality may also be made to test for layering/mixing. Physical observations are also taken in the field to highlight any aquatic habitat variations (e.g. recent rain, subsequent infilling, detritus in water column or on benthos, scum or flocculates in or on water body etc.) and the presence of fresh yabbie holes are also noted.

2.5 Aquatic Habitat Condition (RCE Index)

A standardised description of site aquatic habitat condition is used to compile a stream site condition index, based on a modified version of the River-Creek-Environment (RCE) method developed by Petersen (1992), as reported by Chessman *et al* (1997) for the greater Hunter River catchment. The index is compiled by giving each of the 13 RCE descriptors a score between 0 and 4, then summing the scores, to reach a maximum possible score of 52. Scores are then expressed as a percentage.

3 CLARENCE EP 918/920 AQUATIC ECOLOGY SURVEY RESULTS

Full field sampling notes for the spring 2023 aquatic ecology sampling are provided in **Appendix Table A2**. Sampling was undertaken over the 17th and 20th October 2023. Note that for sampling purposes the AusRivAS 'spring' season is defined as September 15th to December 15th.

3.1 Sampling Conditions Leading into Spring 2023

Rainfall measurements are recorded at Clarence Mine Meteorological Station, with long-term mean monthly totals acquired from Bureau of Meteorology (BOM) Lithgow (Cooerwull) Gauge 63226 (recorded from 1878 to current). **Appendix Tables A-1** provides the daily rainfall records for 2023 (January to December) and are shown graphically in **Figure 3** below. The period between the autumn (April) and spring 2023 surveys saw diminishing rainfall on a month-to-month basis, and while there were isolated shower events in the lead up to the spring survey in October, the overall conditions were generally dry:

- May was very dry with only 3mm recorded over six rainfall days, and the combined three-month total for May to July of 50mm (spread over 24 rainfall days) is only 27% of the combined mean monthly total.
- August saw more regular precipitation, albeit less than average with 50mm recorded over 13 rainfall days, however dry conditions continued into September where 22mm was recorded, mostly over two days of light showers on the 8th and 9th (totalling 17mm).

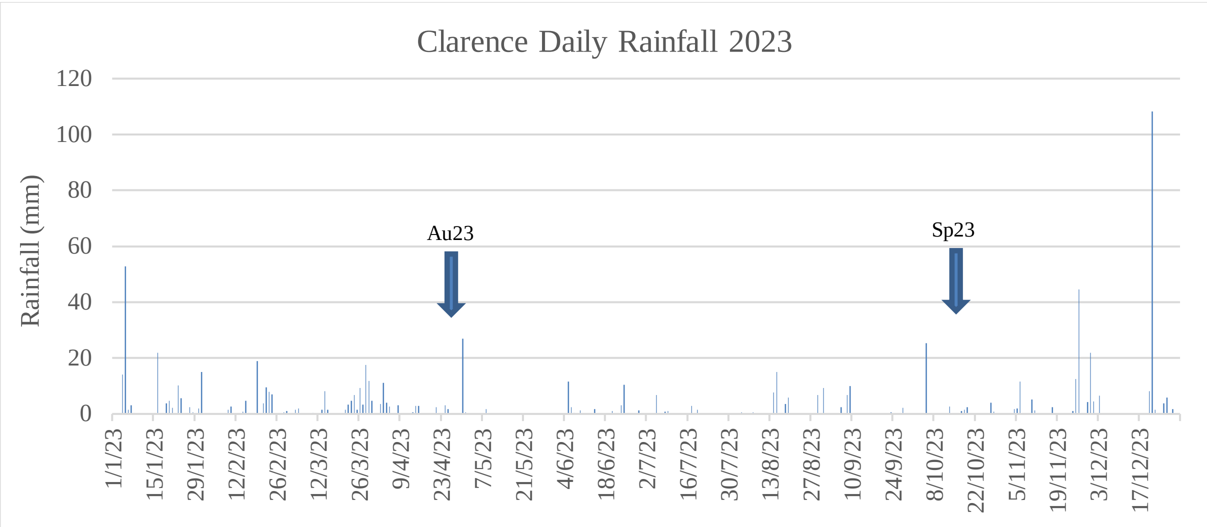


Figure 3 Clarence mine site daily rainfall January to December 2023.

- A single wet day on October 5th produced 25mm which would have re-charged swamp aquifers and creek flows, and for the most part, the remainder of the lead up to the spring 2023 survey were mostly dry however there was some light rain activity over the course of sampling for the spring 2023 survey, totalling 5mm over three days.

3.2 Spring 2023 Aquatic Ecology Survey Results

The Clarence EP 918/920 spring 2023 aquatic ecology monitoring survey was undertaken between the 17th and 20th October 2023 following the sampling outline shown in **Table 1** and **Figure 2** above and using the methodology outlined in **Section 2**. Site photos are also provided **Appendix A**. Summary tables for the spring 2023 Appendix A data are provided in the following sections and include the results from previous baseline surveys (spring 2021, autumn and spring 2022, autumn 2023).

3.3 Spring 2023 Metered Water Quality Results

A calibrated water quality meter is used at all aquatic ecology sampling sites plus at selected intermediary sites to record surface water quality - and where applicable, depth profiles of water temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity to detect potential layering. **Table 2** provides the results of metered water quality sampling for the spring 2023 aquatic ecology field survey.

Table 2 EP 918/920 Extraction Area Water Quality Results Spring 2023

Site	Date	Time	Depth	Temp	Cond	DO	DO	pH	Turb
			m	°C	µS/cm	% sat	mg/L	Units	ntu
BCTN	17/10/23	16:19	0.1	11.41	6	83.7	9.16	5.13	2.2
BCTS	17/10/23	16:33	0.1	9.75	17	67.1	7.63	4.87	6.6
BCUp	17/10/23	15:01	0.1	10.44	15	79.3	8.87	5.11	4.1
BCUp	17/10/23	15:01	0.2	10.44	15	79.0	8.84	5.07	3.8
BCUp	17/10/23	15:01	0.3	10.44	16	78.9	8.82	5.06	3.6
BCUp	17/10/23	15:01	0.5	10.44	16	78.5	8.78	5.02	5.9
BCDn1	17/10/23	13:49	0.1	11.57	4	89.2	9.73	5.58	1.5
BCDn1	17/10/23	13:50	0.3	11.58	4	88.9	9.68	5.42	1.1
BCDn1	17/10/23	13:50	0.4	11.58	4	88.9	9.68	5.41	1.1
BCDn1	17/10/23	13:52	0.7	11.58	5	88.9	9.68	5.31	1.2
BCDn1-d	18/10/23	10:54	0.1	10.61	5	86.6	9.65	5.43	2.0
BCDn1-d	18/10/23	10:54	0.3	10.60	5	86.7	9.66	5.36	1.8
BCDn1-d	18/10/23	10:54	0.4	10.62	6	86.5	9.63	5.34	1.9
BCDn2	18/10/23	11:06	0.1	10.49	5	86.3	9.64	5.41	3.9
BCDn2	18/10/23	11:07	0.3	10.49	5	86.0	9.61	5.35	3.8
BCDn3	20/10/23	08:28	0.1	11.47	8	94.4	10.31	5.09	2.5
BCDn3	20/10/23	08:28	0.2	11.48	8	93.3	10.18	5.08	2.5
PCUp	18/10/23	08:25	0.1	10.03	9	78.1	8.82	4.69	7.5
PCUp	18/10/23	08:25	0.2	10.01	9	77.6	8.77	4.64	12.3
PCDn	18/10/23	13:44	0.1	12.35	10	89.1	9.54	4.66	7.3

3.4 Aquatic & Riparian Habitat Condition

The field notes (**Appendix Table A-2**) provide details of stream reach flows, pool and channel dimensions and available aquatic habitats for the present survey. The overall Aquatic and Riparian Habitat condition - as estimated using the RCE Index - are provided in **Appendix Table A-3** with summary provided below in **Table 3**, and **Table 4** provides the results of aquatic macrophyte occurrences for the spring 2023 aquatic ecology sampling sites.

Table 3 Summary of RCE Results Spring 2023

Category	BCUp	BCDn1	BCDn2	BCDn3	PCUp	PCDn
Land-use pattern beyond immediate riparian zone	3.5	4	4	4	4	4
Width of riparian strip-of woody vegetation	4	4	4	4	4	4
Completeness of riparian strip of woody vegetation	4	4	4	4	4	4
Vegetation of riparian zone within 10 m of channel	4	4	4	4	4	4
Stream bank structure	4	4	4	4	4	4
Bank undercutting	2.5	2	2	2	2	2
Channel form	4	4	4	4	4	4
Riffle/pool sequence	3	4	4	4	4	4
Retention devices in stream	3	4	4	4	4	4
Channel sediment accumulations	3	2.5	3	2.5	3	3
Stream bottom	3	3	3.5	3.5	3	3
Stream detritus	4	4	4	4	4	4
Aquatic vegetation	4	4	3.5	3.5	4	4
Spring 2023 Site RCE Score (%)	88.5	91.3	92.3	91.3	92.3	92.3
Autumn 2023 Site RCE Score (%)	88.5	92.3	94.2	93.3	92.3	92.3
Spring 2022 Site RCE Score (%)	89.4	93.3	94.2	93.3	94.2	93.3
Autumn 2022 Site RCE Score (%)	89.4	94.2	94.2	93.3	92.3	94.2
Spring 2021 Site RCE Score (%)	90.4	94.2	94.2	94.2	92.3	94.2

Table 4 Macrophyte Occurrence Spring 2023

Site	Rush *Baumea rubiginosa*	Grass *Carex gaudichaundiana*	Jointed Rush *Juncus articulatus*	Bulbous Rush *Juncus bulbosus*	Rush *Juncus sp*	Tufted Algae *Batrochospermum sp*	Charophytes
BCUp		1		1		1	1
BCDn1	1	1		1		1	1
BCDn2						1	1
BCDn3						1	1
PCUp	1		1	1	1	1	1
PCDn			1	1		1	1

3.5 Aquatic Macroinvertebrate and Fish Survey Results

Appendix Table A-4 provides the results of aquatic macroinvertebrate taxonomic identifications to the levels required by AusRivAS, plus occurrence data for all aquatic macroinvertebrates and fish. The table also provides site SIGNAL and EPT scores (see **Section 2.2.3** for explanation of SIGNAL and EPT). The spring 2023 Clarence EP 918/920 aquatic ecology monitoring site Diversity (taxa richness), SIGNAL and EPT diversity results are provided in **Figures 4** to **6** below, and include the mean (± standard deviation SD) site summary statistics calculated from four previous surveys (spring 2021, autumn and spring 2022 and autumn 2023).

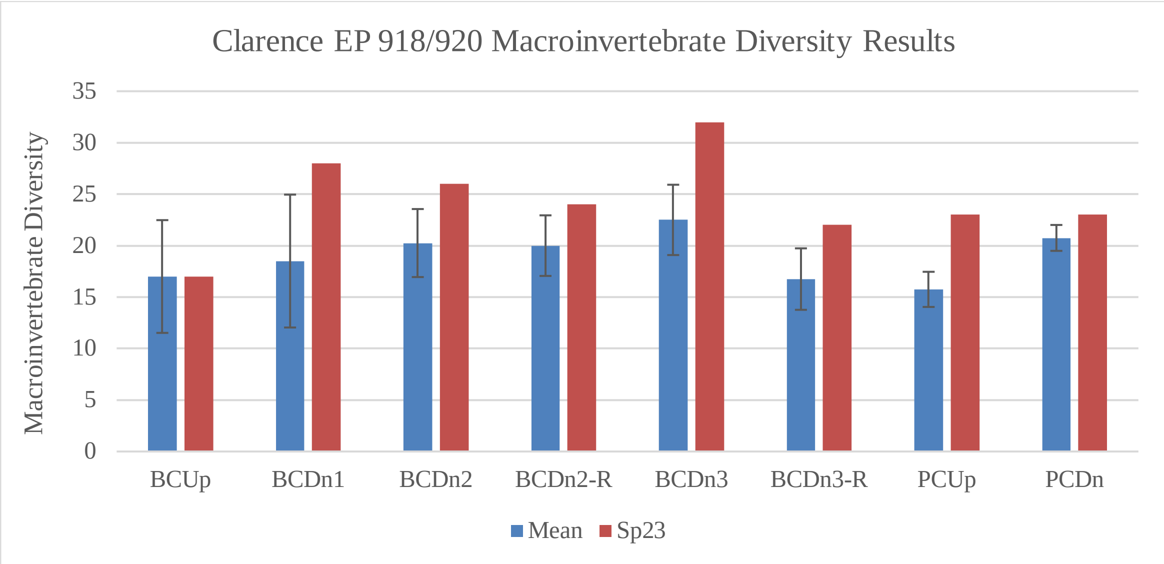


Figure 4 Clarence EP 918/920 survey macroinvertebrate taxa diversity results.

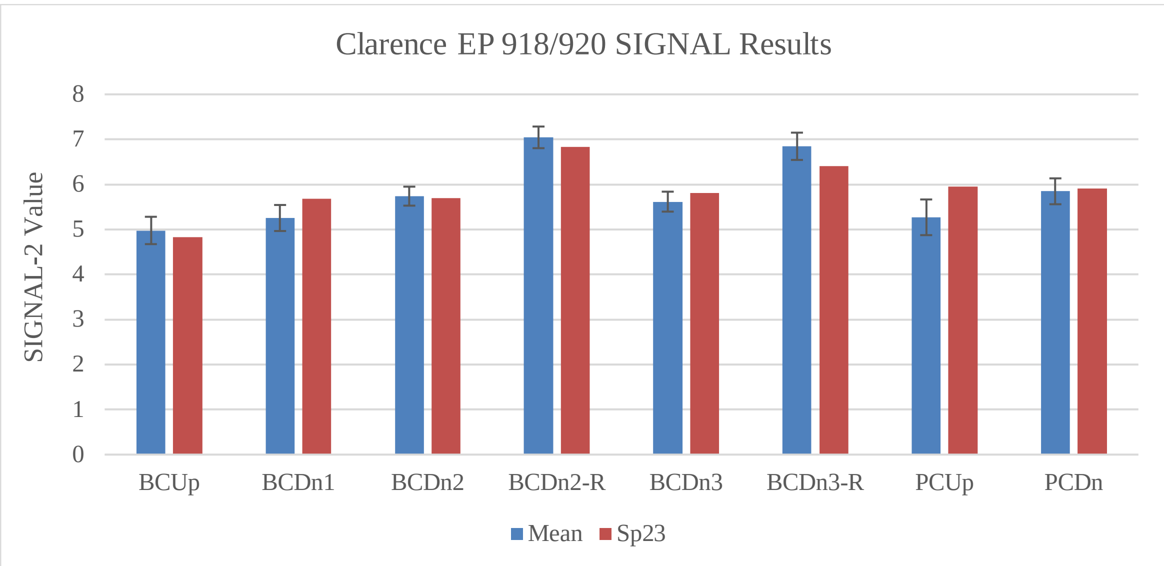


Figure 5 Clarence EP 918/920 survey SIGNAL-2 scores.

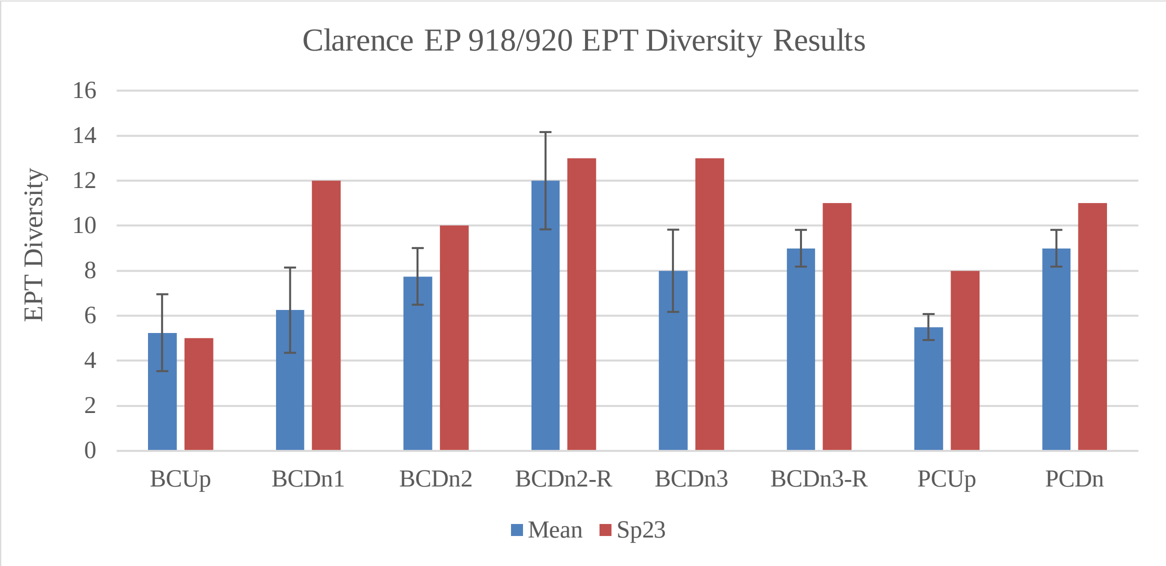


Figure 6 Clarence EP 918/920 survey EPT taxa diversity.

Native mountain galaxias (*Galaxias olidus*) fish were recorded from all sites in spring 2023. There were no threatened or protected invertebrate or vertebrate aquatic species (as listed under the BCA, FMA or EPBC) caught or observed during the spring 2023 Clarence EP 918/920 aquatic ecology monitoring survey, nor were there individuals observed, or any indications of platypus or Australian water rat usage within the study area.

4 REFERENCES

Allen, G.R., Midgley, S.H. and Allen, M. (2002)
Field Guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, WA.

ANZECC/ARMCANZ (2000)
Australian and New Zealand Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Chessman, B. C (1995)
Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology* 20, pp. 122-129.

Chessman, B. C., Growns, J. E. and Kotlash, A. R. (1997)
Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. *Marine & Freshwater Research* 48, pp. 159-172.

Chessman, B. C., (2003a)
New Sensitivity grades for Australian river macroinvertebrates. *Marine & Freshwater Research* 54, pp. 95 - 103.

Chessman, B. C., (2003b)
SIGNAL 2 – A Scoring System for Macro-invertebrate (‘Water Bugs’) in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra

CSIRO, Land and Water Resources & Environment Australia (1999)
Interactive Guide to Australian Aquatic Invertebrates. CSIRO Australia.

Hawking, J. & Smith, F. J. (1997)
Colour Guide to Invertebrates of Australian Inland Waters. Co-operative Centre for Freshwater Ecology, Albury.

Hawking, J. & Theischinger, G. (1999)
Dragonfly Larvae (Odonata). A Guide to the Identification of Larvae of Australian Families and to the Identification and Ecology of Larvae from New South Wales. Co-operative Centre for Freshwater Ecology, Albury, and Australian Water Technologies Pty Ltd, West Ryde. CRCFE Identification Guide No. 24.

McDowall, R. (1996)
Freshwater Fishes of South Eastern Australia. Reed Books, Sydney, NSW.

MPR (2022a)

Bungleboori Creek Catchment Aquatic Ecology- Spring 2021 Data Report. Report prepared for Clarence Colliery, February 2022.

MPR (2022b)

Bungleboori Creek Catchment Aquatic Ecology- Autumn 2022 Data Report. Report prepared for Clarence Colliery, September 2022.

MPR (2023a)

Bungleboori Creek Catchment Aquatic Ecology- Spring 2022 Data Report. Report prepared for Clarence Colliery, March 2022.

MPR (2023b)

Bungleboori Creek Catchment Aquatic Ecology- Autumn 2023 Data Report. Report prepared for Clarence Colliery, August 2023.

Peterson (1992)

The RCE: a Riparian Channel and Environmental Inventory for small streams in the agricultural landscape. Freshwater Biology 27: 295 – 306.

Theischinger, G. & Jacobs, S., & Krogh, M. (2011)

Archaeophya adamsi Fraser (Odonata, Gomphomacromiidae): not in Queensland, but safe in New South Wales? *Agrion* 15 (2): 64 - 68.

Turak, E, Waddell, N, Johnstone, G. (2004)

New South Wales Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual. Department of Environment and Conservation, Sydney.

Web Reference 1:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10974: NSW Threatened Species Website.

Web Reference 2:

http://www.environment.nsw.gov.au/determinations/GiantDragonflyEndSpListing.htm: NSW Dept Environment, Climate Change &Water.

Web Reference 3:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=1022: NSW Threatened Species Website.

Web Reference 4:

http://pas.dpi.nsw.gov.au/Species/Species_Profile.aspx?SpeciesListingID=10: NSW Primary Industries.

Williams, W.D. (1980)

Australian Freshwater Life. The Invertebrates of Australia Inland Waters. The MacMillan Co. of Australia Pty Ltd, Sydney.

APPENDIX A

FIELD NOTES,

SITE PHOTOGRAPHS

AND

SAMPLING DATA

SPRING 2023

Appendix Table A-1 Clarence Mine Meteorological Station Daily Rainfall (mm) for 2023												
Date	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	0.2	0.2	1	0	0.6	0	0	0	0	0	0	4.4
2nd	0	0	0	3.6	0	0	0	0	0	0	0	0
3rd	0.2	0	0	11.2	0	0	0	0.6	0	0	0	6.6
4th	14	0	1.4	4	0	0	0	0	0	0	1.8	0
5th	52.8	0	2	2.6	0	11.6	6.8	0	0	25.4	2	0.2
6th	1.6	0	0	0.2	0	2.4	0	0.2	2.4	0.2	11.6	0
7th	3.2	0	0	0	0	0.4	0	0.6	0	0.2	0.2	0
8th	0.4	0	0	3.2	1.8	0	0.8	0.2	6.8	0	0	0
9th	0.2	1.4	0	0	0	1.2	1	0	10	0	0	0
10th	0	2.6	0.4	0	0	0	0	0	0	0	5.2	0
11th	0	0.2	0	0	0	0	0	0	0	0	1.2	0
12th	0	0	0	0	0	0	0	0	0	0	0	0
13th	0	0	1.4	0.6	0	0	0	0	0	2.6	0	0
14th	0	0.8	8.2	2.8	0.2	1.8	0	7.6	0	0	0	0.2
15th	0	4.6	1.6	2.8	0	0	0	15	0	0	0	0.2
16th	21.8	0.4	0.2	0.2	0	0	0	0.2	0	0	0	0
17th	0	0	0	0	0.2	0	2.8	0	0	1	2.4	0
18th	0	0	0	0	0.2	0	0.2	3.6	0	1.4	0.2	0
19th	3.8	19	0	0	0.2	0	1.4	5.8	0	2.4	0	0
20th	4.6	0.2	0	0	0	1	0	0.2	0	0	0	8.2
21st	2.2	3.8	1.4	2.4	0	0	0	0	0	0	0	108.2
22nd	0.2	9.6	3.4	0	0	0	0	0	0	0	0	1.4
23rd	10.2	8	4.6	0	0	3.2	0	0	0.6	0	0	0.2
24th	5.6	7	6.8	3.2	0	10.4	0	0.2	0	0	1	0
25th	0.2	0.2	1.6	1.8	0	0	0.2	0	0	0	12.4	3.8
26th	0	0	9.4	0	0	0	0.2	0	0	0	44.6	5.8
27th	2.4	0	3.4	0	0	0	0	0	2.2	4	0.2	0.2
28th	0.6	0.6	17.6	0	0	0	0	0	0	0.8	0	1.8
29th	0.2		11.8	0	0	1.2	0	6.8	0	0	4.2	0
30th	2		4.8	27	0	0.2	0	0	0	0	21.8	0
31st	15		0.2		0		0	9.4		0		0.8
Total	141.4	58.6	81.2	65.6	3.2	33.4	13.4	50.4	22	38	108.8	142
Monthly Average*	85.7	81	77.7	57.2	50.7	71.3	61.2	57.9	55.9	62.3	65.8	79.7
Note: Days sampled are highlighted in yellow. *Monthly average is the long-term average from BOM Lithgow station 63226.												

Appendix Table A-2 Field Comments – Spring 2023 Aquatic Ecology Monitoring Sites		
Site	Date	Comments
BCUp	17/10/23	Water was very clear and flowing throughout the site length. Slightly lower flow compared to the former survey. Maximum width was to 1.5m with and average width of 0.6-0.7m. Maximum depth was 0.8m with an average depth of 0.25m. There were less macrophytes and charophytes than BCdn1. Site conditions were similar to the former survey where habitats sampled included undercut banks, trailing bank vegetation, macrophytes and detritus. Submerged surface were covered in a layer of silt. Substrates were made up of mostly sands, gravels and bedrock with lesser amounts of boulders cobbles and pebbles. Filamentous green alga was absent.
BCDn1	17/10/23	Site conditions and channel dimensions consistent with the previous survey. Water very clear and flowing through site length. Maximum pool width to 7.5m, maximum depth 1.3m and average depth 0.4m. The edge habitat availability was continuous throughout the site length, with charophyte beds having increased over consecutive surveys, nice trailing bank vegetation and detrital reservoirs available to sample. Quite a bit of silt on submerged surfaces, particularly so in backwaters and areas of lower flow rates, and overall, the composition and extent of silts and detritus suggest that conditions have been stable for a period. The edge habitats sampled consisted of trailing bank vegetation, undercut bank, detritus and aquatic vegetation (charophytes), and the channel substrates generally equal amounts of bedrock, gravelly sands and cobbles. Filamentous green alga present in small amounts.
BCDn2	18/10/23	Water very clear and flowing through site length, flow probably lower than the autumn 2023 survey. Maximum width around 8 and average width 2m, maximum depth around 1.8m and average depth around 0.4m. Overall stream condition consistent with the previous survey (available edge habitats, dominant substrate types), however there was an increase in the abundance of algae (*Batrachospermum sp*) on submerged cobbles and boulders and slightly more sand in open pool areas, and there was a slight increase in the density of riparian vegetation since autumn 2023 (mostly wattle trees and ferns). The silt levels and accumulation of finer particulate detritus suggest that flow rates had been stable for a period prior to sampling. The edge habitats sampled consisted of trailing bank vegetation, undercut banks and detritus, and the channel substrates were dominated by cobbles and gravelly sands with some boulders. No filamentous green alga observed.

BCDn3	20/10/23	Water very clear and flowing through site length, flow rate and water levels slightly lower than autumn 2023. Maximum width 8m and average width 4m, maximum depth 1.4m and average depth 0.4m. There was an increase in the abundance of algae (*Batrachospermum sp*) on submerged cobbles and boulders since the previous survey, and (possibly) more sand accumulated in open pool areas. The composition of aquatic edge habitats was unchanged, comprising mostly of undercut banks with sections of trailing bank vegetation and detrital accumulations. Silt had accumulated on submerged surfaces throughout the site except for the riffle zones. The site substrates were comprised of mostly of cobble and gravel banks with sections of mobile sandy deposits. Filamentous green alga present in moderate to abundant amounts.
PCUp	18/10/23	Water clear and flowing through site length. Maximum width to 2.5m and average width around 0.8m, maximum pool depth to 1.2m and average depth 0.4m (around half of the site averaging 0.1m and half site averaging 0.6m). General site conditions and available habitats similar to former survey, slight increase in localised charophyte beds and aquatic macrophytes. Layer of silt present on submerged surfaces and variety of detritus (fine and coarse particulate) accumulated in deeper pools and isolated edge areas. The aquatic habitat availability comprised mostly undercut banks and trailing bank vegetation, detrital reservoirs and aquatic vegetation (charophytes and macrophytes), and the channel substrates were dominated by cobbles or gravelly sand accumulations in the upstream end and bedrock benches and cascades in the downstream half of the site. No filamentous green alga observed.
PCDn	18/10/23	Water clear and flowing through site length. Maximum width around 4.5m and average width ~1.0m, maximum depth 0.6m and average depth 0.2m. There was a slight increase in the density of riparian vegetation since autumn 2023 (mostly wattle trees and ferns). The edge habitats sampled included undercut banks, trailing bank vegetation and detritus with a layer of silt on most submerged surfaces in open pool areas and protected backwaters. The channel substrates were dominated by bedrock, with small quantities of gravelly sands. Filamentous green alga present in small to moderate amounts.

Appendix Table A-3

Modified Riparian, Channel and Environment (RCE) Inventory (after Chessman et al 1997).

Descriptor	Category	Value	Sp23 BCUp	Sp23 BCDn1	Sp23 BCDn2	Sp23 BCDn3	Sp23 PCUp	Sp23 PCDn
1	Land-use pattern beyond immediate riparian zone							
	Undisturbed native vegetation	4		4	4	4	4	4
	Mixed native vegetation and pasture/exotics	3	3.5					
	Mainly pasture, crops or pine plantation	2						
	Urban, some vegetation	1						
	Industrial, little vegetation	0						
2	Width of riparian strip-of woody vegetation							
	More than 30 m	4	4	4	4	4	4	4
	Between 5 and 30 m	3						
	Less than 5 m	2						
	No woody vegetation	1						
	No Vegetation	0						
3	Completeness of riparian strip of woody vegetation							
	Riparian strip without breaks in vegetation	4	4	4	4	4	4	4
	Breaks at intervals of more than 50 m	3						
	Breaks at intervals of 10-50 m	2						
	Breaks at intervals of less than 10 m	1						
	No riparian strip at all	0						
4	Vegetation of riparian zone within 10 m of channel							
	Native tree and shrub species	4	4	4	4	4	4	4
	Mixed native and exotic trees and shrubs	3						
	Exotic trees and shrubs	2						
	Exotic grasses/weeds	1						
	No vegetation at all	0						
5	Stream bank structure							
	Banks fully stabilized by trees, shrubs, concrete	4	4	4	4	4	4	4
	Banks firm but held mainly by grass and herbs	3						
	Banks loose, partly held by sparse grass, rubble	2						
	Banks unstable, mainly loose sand or soil	1						
	Banks actively eroding	0						
6	Bank undercutting							
	None, or restricted by tree roots or man-made	4						
	Only on curves and at constrictions	3						
	Frequent along all parts of stream	2	2.5	2	2	2	2	2
	Severe; bank collapses common	1						
	Total bank collapse	0						
7	Channel form							
	Deep; width:depth ratio less than 8:1	4	4	4	4	4	4	4
	Medium; width:depth ratio 8:1 to 15:1	3						
	Shallow; width:depth ratio greater than 15:1	2						
	Artificial; concrete or excavated channel< 8:1	1						
	Artificial; concrete or excavated channel > 8:1	0						
8	Riffle/pool sequence							
	Frequent alternation of riffles and pools	4		4	4	4	4	4
	Long pools with infrequent short riffles	3	3					
	Natural channel without riffle/pool sequence	2						
	Artificial channel; some riffle/pool sequence	1						
	Artificial channel; no riffle/pool sequence	0						
9	Retention devices in stream							
	Many large boulders and/or debris dams	4		4	4	4	4	4
	Rocks/logs present; limited damming effect	3	3					
	Rocks/logs present but unstable; no damming	2						
	Stream or channel with few or no rocks/logs	1						
	Artificial channel; no retention devices	0						
10	Channel sediment accumulations							
	Little or no accumulation of loose sediments	4						
	Some gravel bars but little sand or silt	3	3		3		3	3
	Bars of sand and silt common	2		2.5		2.5		
	Braiding by loose sediment	1						
	Complete in-filled muddy channel	0						
11	Stream bottom							
	Mainly clean stones with obvious interstices	4						
	Mainly stones with some cover of algae/silt	3	3	3	3.5	3.5	3	3
	Bottom heavily silted but stable	2						
	Bottom mainly loose and mobile sandy sedimen	1						
	Bottom mainly loose and mobile muddy sedimer	0						
12	Stream detritus							
	Mainly unsilted wood, bark, leaves	4	4	4	4	4	4	4
	Some wood, leaves, etc. with much fine detritus	3						
	Mainly fine detritus mixed with sediment	2						
	Little or no organic detritus, mainly sandy	1						
	No organic detritus, mainly mud	0						
13	Aquatic vegetation							
	Little or no macrophyte or algal growth	4	4	4			4	4
	Substantial algal growth; few macrophytes	3			3.5	3.5		
	Substantial macrophyte growth; little algal grow	2						
	Substantial macrophyte and algal growth	1						
	Total cover of macrophytes plus algae	0						
	RCE Score		46.0	47.5	48.0	47.5	48.0	48.0
	RCE %age		88.5	91.3	92.3	91.3	92.3	92.3

Appendix Table A-4 Clarence EP 918/920 Aquatic Ecology Monitoring Macroinvertebrate and Fish Results Spring 2023

												Sample Date and Sample Site									
									Life Stage			17/10/23	17/10/23	18/10/23	18/10/23	20/10/23	20/10/23	18/10/23	18/10/23		
Phylum	Class	Sub-Class	Order	Sub-Order	Family	Sub-Family	Genus/spp	Common name	L	N	A	BCUp	BCDn1	BCDn2	BCDn2-R	BCDn3	BCDn3-R	PCUp	PCDn	Occurrence	SIG-2
Arthropoda	Insecta		Coleoptera		Dytiscidae			Diving Beetles	x		x	1	1	1		1				4	2
Arthropoda	Insecta		Coleoptera		Elmidae			Riffle Beetles	x		x		1	1	1	1	1	1	1	7	7
Arthropoda	Insecta		Coleoptera		Gyrinidae			Whirligig Beetles	x		x	1	1	1		1	1		1	6	4
Arthropoda	Insecta		Coleoptera		Hydrophilidae			Scavenger Water Beetles	x		x					1		1		2	2
Arthropoda	Insecta		Coleoptera		Scirtidae			Marsh Beetles	x			1	1	1	1	1		1	1	7	6
Arthropoda	Insecta		Diptera		Athericidae			Flies	x							1				1	8
Arthropoda	Insecta		Diptera		Ceratopogonidae			Biting Midges	x			1	1	1		1	1	1	1	7	4
Arthropoda	Insecta		Diptera		Chironomidae	Chironominae		Bloodworms	x			1	1	1		1	1	1	1	7	3
Arthropoda	Insecta		Diptera		Chironomidae	Orthocladiinae		Bloodworms	x			1	1	1	1		1	1	1	7	4
Arthropoda	Insecta		Diptera		Chironomidae	Podonominae		Bloodworms	x						1					1	6
Arthropoda	Insecta		Diptera		Chironomidae	Tanypodinae		Bloodworms	x			1	1	1	1	1		1	1	7	4
Arthropoda	Insecta		Diptera		Dixidae			Mensicus Midges	x					1						1	7
Arthropoda	Insecta		Diptera		Simuliidae			Black Flies	x			1	1	1	1	1	1			6	5
Arthropoda	Insecta		Diptera		Thaumaleidae			Trickle Midges	x							1				1	7
Arthropoda	Insecta		Diptera		Tipulidae			Crane Flies	x			1			1		1	1		4	5
Arthropoda	Insecta		Ephemeroptera		Baetidae			Mayflies		x				1	1	1	1		1	5	5
Arthropoda	Insecta		Ephemeroptera		Coloburiscidae			Mayflies		x			1		1		1			3	8
Arthropoda	Insecta		Ephemeroptera		Leptophlebiidae			Mayflies		x		1	1	1	1	1	1	1	1	8	8
Arthropoda	Insecta		Ephemeroptera		Oniscigastridae			Mayflies		x			1	1		1		1	1	5	8
Arthropoda	Insecta		Hemiptera		Notonectidae			Backswimmers					1							1	1
Arthropoda	Insecta		Mecoptera		Nannochoristidae			Scorpionflies	x			1	1					1		3	9
Arthropoda	Insecta		Megaloptera		Corydalidae			Dobsonflies	x						1			1		2	7
Arthropoda	Insecta		Neuroptera		Neurorthidae			Lacewings	x						1		1			2	9
Arthropoda	Insecta		Odonata	Epiproctophora	Gomphidae			Dragonflies	x							1				1	5
Arthropoda	Insecta		Odonata	Epiproctophora	Synthemistidae			Dragonflies	x			1	1	1		1	1	1	1	7	2
Arthropoda	Insecta		Odonata	Epiproctophora	Telephlebiidae			Dragonflies	x				1	1	1	1	1	1	1	7	9
Arthropoda	Insecta		Odonata	Zygoptera	Argiolestidae			Damselflies	x							1				1	5
Arthropoda	Insecta		Odonata	Zygoptera	Synlestidae			Damselflies	x				1	1		1		1	1	5	7
Arthropoda	Insecta		Plecoptera		Austroperlidae			Stoneflies		x					1					1	10
Arthropoda	Insecta		Plecoptera		Eustheniidae			Stoneflies		x							1			1	10
Arthropoda	Insecta		Plecoptera		Gripopterygidae			Stoneflies		x		1	1	1	1	1	1	1	1	8	8
Arthropoda	Insecta		Trichoptera		Atriplectididae			Caddis Flies	x				1			1				2	7
Arthropoda	Insecta		Trichoptera		Calocidae			Caddis Flies	x								1			1	9
Arthropoda	Insecta		Trichoptera		Conoesucidae			Caddis Flies	x				1	1		1	1		1	5	7
Arthropoda	Insecta		Trichoptera		Ecnomidae			Caddis Flies	x			1	1			1		1	1	5	4
Arthropoda	Insecta		Trichoptera		Helicophidae			Caddis Flies	x				1	1	1	1		1	1	6	10
Arthropoda	Insecta		Trichoptera		Helicopsychidae			Caddis Flies	x					1						1	8
Arthropoda	Insecta		Trichoptera		Hydrobiosidae			Caddis Flies	x						1	1	1		1	4	8
Arthropoda	Insecta		Trichoptera		Hydropsychidae			Caddis Flies	x				1		1		1			3	6
Arthropoda	Insecta		Trichoptera		Hydroptilidae			Caddis Flies	x			1	1	1	1	1		1	1	7	4
Arthropoda	Insecta		Trichoptera		Leptoceridae			Caddis Flies	x			1	1	1	1	1	1	1	1	8	6
Arthropoda	Insecta		Trichoptera		Odontoceridae			Caddis Flies	x						1	1				2	7
Arthropoda	Insecta		Trichoptera		Philopotamidae			Caddis Flies	x						1					1	8
Arthropoda	Insecta		Trichoptera		Philorheithridae			Caddis Flies	x				1	1	1	1	1	1	1	7	8
Arthropoda	Arachnida		Acarina	Hydracarina				Freshwater Mites					1	1	1	1	1	1	1	7	6
Arthropoda	Crustacea	Copepoda	Cyclopoida		Cyclopidae			Copepods								1		1		2	*
Arthropoda	Crustacea		Decapoda		Parastacidae			Freshwater Crayfish						1		1			1	3	4
Arthropoda	Crustacea		Isopoda	Phreatoicidea	Phreatoicidae			Isopods				1								1	4
Annelida	Oligochaeta							Freshwater Worms					1	1						2	2
Chordata	Osteichthyes				Galaxiidae		*Galaxias olidus*	Mountain Galaxias				1	1	1	1	1		1	1	7	*
								Total number of invertebrate taxa per site:				17	28	26	24	32	22	23	23	49	
								Site SIGNAL2 Scores:				4.82	5.68	5.69	6.83	5.81	6.41	5.95	5.91		
Notes:	* represents those taxa for which SIGNAL-2 scores are not available							Total number of EPT taxa:				5	12	10	13	13	11	8	11	20	

Plate 1: Looking north across track crossing just upstream of Bungleboori Creek site BCUp in spring 2023.

Plate 2: Looking downstream from the track crossing.


Plate 3: Looking downstream at Bungleboori Creek upstream site BCUp.


Plate 4: Looking downstream in BCUp.

Plate 5: Looking downstream through large pool at the upstream end of BCDn1.

Plate 6: Looking upstream at BCDn1.

Plate 7:Looking downstream through pool at BCDn1.

Plate 8: Looking downstream through shallow incised channel at BCDn1.


Plate 9: Debris bank up and sediment deposition at BCDn1.


Plate 10: Looking downstream through deeper pool area at BCDn1.


Plate 11: Mountain galaxias (*Galaxias olidus*) from BCDn1.


Plate 12: Looking upstream at the confluence of Bungleboori Creek (right hand side) and Paddys Creek (left hand side).


Plate 13: Looking upstream at BCDn2.


Plate 14: Looking upstream towards gorge at BCDn2.

Plate 15: Algae (*Batrachospermum* sp) on cobbles BCDn2.

Plate 16: Looking upstream through cobble riffle section at BCDn2.


Plate 17: Looking upstream through cobble riffle section at BCDn2


Plate 18: Looking upstream through riffle section at BCDn3.


Plate 19: Looking upstream at erosional point on bend at BCDn3.


Plate 20: Looking upstream through riffle zone at BCDn3.


Plate 21: Looking upstream at BCDn3.


Plate 22: Looking upstream through contained pool area with macrophytes at PCUp.

Plate 23: Looking downstream through narrow bedrock confined cascade at PCUp.

Plate 24: Looking upstream PCUp.

Plate 25: Looking upstream through incised box-shaped channel at the upstream end of PCDn.

Plate 26: Looking upstream through bedrock run at PCDn.

Plate 27: Looking upstream at PCDn.

Plate 28: Looking downstream at PCDn.

Plate 29: Mountain galaxias (*Galaxias olidus*) from PCDn. This specimen was immediately released.

CENTENNIAL COAL
CLARENCE COLLIERY

DINGO CREEK CATCHMENT
AQUATIC ECOLOGY

AUTUMN 2024 DATA REPORT

Figure 1. Looking upstream in Dingo Creek site DECDn.

REPORT PREPARED FOR
CLARENCE COLLIERY PTY LTD

MARINE POLLUTION RESEARCH PTY LTD

OCTOBER 2024

FIGURES

TABLES

APPENDIX

A FIELD NOTES, SITE PHOTOGRAPHS AND SAMPLING DATA

1 INTRODUCTION

Clarence Colliery Pty Ltd owns and operates the existing Clarence Colliery underground coal mine near the village of Clarence in NSW. Clarence Colliery is seeking to modify state significant development (SSD) consent DA 174-93 to synchronise operational and approval procedures of its existing mining operation in the northern extent of its mining lease area (Mod 8). The Mod 8 study area catchments are contained within the Gardens of Stone State Conservation Area (SCA) and landuse within the proposed mine footprint comprises mixed undeveloped native forest and former state forest pine plantations. Undeveloped native forests downstream of the proposed mine footprint are located in the Blue Mountains National Park. Each of the drainage lines overlying and downstream from the proposed Mod 8 extraction area contain *Newnes Plateau Shrub and Hanging Swamp* endangered ecological communities (EECs).

As part of the environmental assessment process associated with Mod 8, Clarence Colliery commissioned Marine Pollution Research Pty Ltd (MPR) to review existing aquatic ecological information and initiate a baseline aquatic ecology monitoring program to describe the existing aquatic environment of the Mod 8 proposal footprint. The aims of the baseline aquatic ecology (streamhealth) monitoring program are as follows:

- To develop an understanding of the aquatic ecological attributes of the Newnes Plateau Shrub Swamps and associated creeks which overly the areas of proposed mining in order to enable impact assessment and provide suitable mitigation and offset measures where necessary or desirable.
- To provide additional aquatic site base-line data that can be utilised to monitor potential impacts of mining activities.

This data report provides the results for the sixth consecutive aquatic ecology baseline monitoring survey undertaken for Mod 8 in autumn 2024, and follows on from former baseline monitoring reports for survey work undertaken in spring 2021 (MPR 2022a), autumn and spring 2022 (MPR 2022b and MPR 2023a), autumn and spring 2023 (MPR 2023b, MPR 2024).

1.1 Description of Locality

The proposed mining area is concentrated in the upper Carne and Dingo Creek catchments with a small portion situated in the upper limits of Bungleboori Creek in the southern limits of the Mod 8 boundary (**Figure 2**).

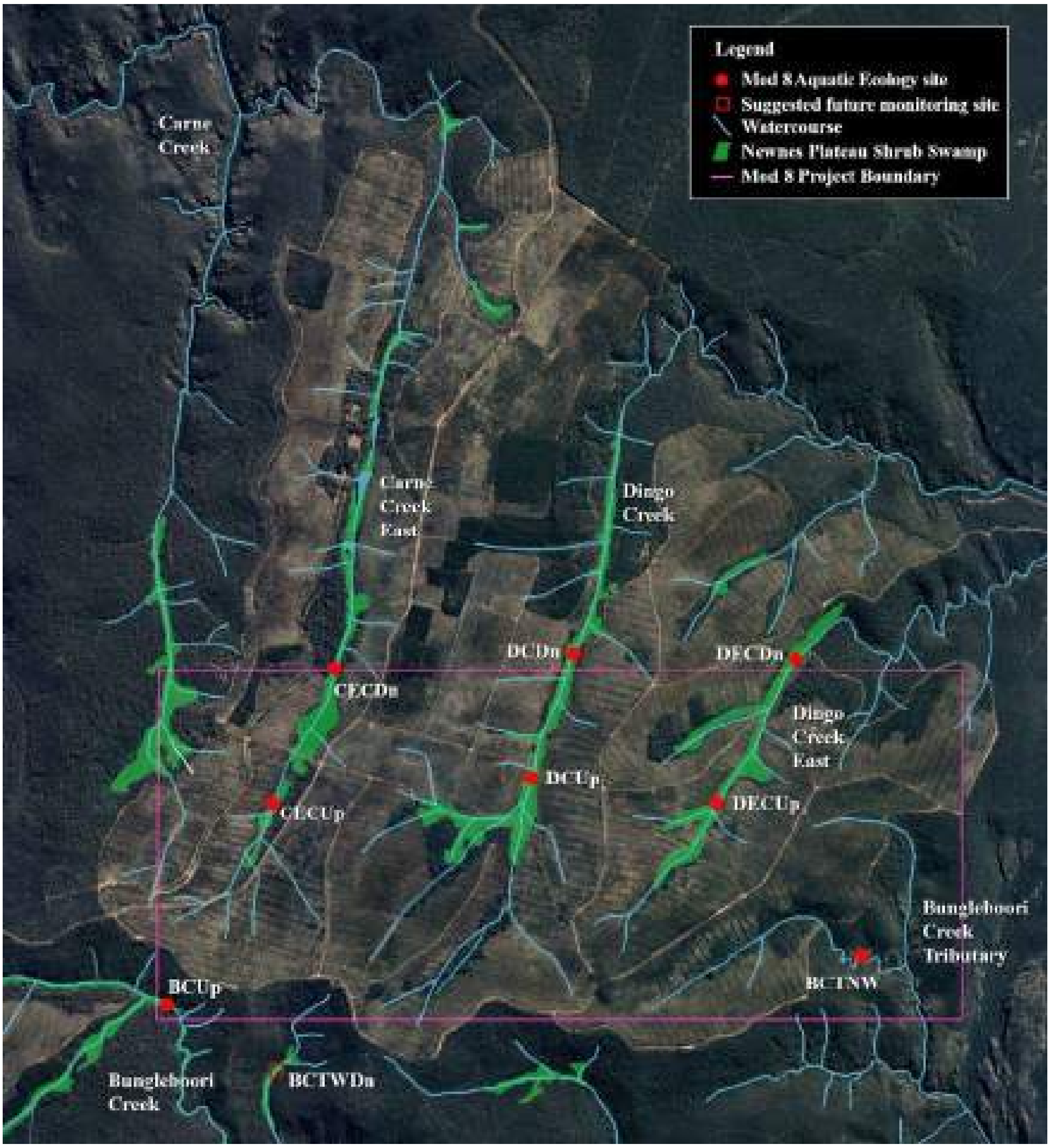


Figure 2 Clarence Mod 8 aquatic ecology survey sites.

Several of the drainage lines support Newnes Plateau Shrub Swamp (NPSS) habitats. These unique habitats are dominated by shrubs and sedges that occur on sites with impeded drainage in low slope headwater valleys on the Newnes Plateau in the upper Blue Mountains (Web Reference 1), however the majority of the sub-catchments surrounding NPSS have been cleared for former pine plantations (**Figure 2**).

The NPSSs are listed as Endangered Ecological Communities (EECs) under the NSW *Biodiversity Conservation Act 2016* (BCA) and are also listed as part of the Temperate Highland Peat Swamps on Sandstone (TPHSS) under the federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Carne Creek originates on Newnes Plateau at elevations reaching 1180m Australian Height Datum (AHD) and has an average annual rainfall of 1073mm. Carne Creek is considered pristine and from its headwaters, Carne Creek flows in a northerly direction for around 21km prior to joining the Wolgan River, a tributary of the Hawkesbury River. The headwaters of Carne Creek consist of at least six separate sub-catchments, with the two eastern most upper sub-catchments overlying the western extent of the Mod 8 boundary in areas of former pine plantation (**Figure 2**). Whereas both sub-catchments support NPSS's along the low-profile main drainage arms, the channel valleys become more incised, bordered by steep sandstone escarpments downstream from the study area.

Dingo Creek lies to the east of Carne Creek on Newnes Plateau reaching altitudes of 1140m in its upper headwaters, and is bounded by Waratah Ridge Rd to the south. The headwaters of Dingo Creek are situated in the Gardens of Stone SCA, and are contained within two main branches which overlie the middle and eastern portion of the Mod 8 boundary. Dingo Creek flows in a northerly direction for around 5km before turning east for a further 16.5km to merge with Bungleboori Creek. The Blue Mountains National Park border lies 550m to the east of the eastern Mod 8 boundary. Whilst most of the Dingo Creek catchment area within the Mod 8 footprint has been cleared for pine plantation, the drainage lines accommodate considerable NPSS communities along the main creeks and lateral feeder tributaries (**Figure 2**). Former pine plantations continue further north (downstream) from Mod 8, before the creek lines become heavily incised into the sandstone escarpment, which is generally continuous downstream to Bungleboori Creek.

In terms of existing aquatic ecological sampling information for the study area, a previous Environmental Assessment for an adjoining Springvale Colliery mining lease area included a baseline aquatic ecology monitoring program that ran from 2010 to 2016. This study included two sites in the eastern Carne Creek catchment (**Figure 2**), and Springvale Colliery provided permission to incorporate these results as long-term streamhealth indices for this project which were provided in the first Mod 8 monitoring report (MPR 2022a).

1.2 Newnes Plateau Site Threatened Species Considerations

The NPSS provide habitat for several water related terrestrial species; the giant dragonfly (*Petalura gigantea*) and the Blue Mountains water skink (*Eulamprus leuraensis*) and possible habitat for one aquatic species, the Adams emerald dragonfly (*Archaeophya adamsi*). The giant dragonfly and water skink are listed as Endangered under the BCA with the latter also being listed as Endangered under the EPBC Act. The emerald dragonfly is listed as Endangered under the NSW *Fisheries Management Act 1994* (FMA).

The giant dragonfly is semi-aquatic, living in burrows in swamps and along stream edges. The larvae emerge from the terrestrial entrances at night and in wet weather in search of insects and other arthropods to eat, and larvae are not known to swim and avoid open water (Web Reference 2). Given their crepuscular habits of the larvae it is highly unlikely that specimens would be collected during routine macroinvertebrate sampling. Adults emerge between October and January and therefore targeted searches are undertaken for both exuviae (the larval skins shed in the process of metamorphosis into an adult) and adults in suitable swamp locations during sampling for the bi-annual spring surveys.

There is little information available on the ecology and biology of Blue Mountains water skink. The Blue Mountains water skink is restricted to sedge and shrub swamps that have boggy soils and appear to be permanently wet, and is semi-aquatic being active on warm, sunny days from September until late April (Web Reference 3). Although it is known from the Carne Creek swamps, no individuals were observed during this survey.

The Adams emerald dragonfly have been collected in small numbers from only a few localities in NSW, including six creeks in the broader Blues Mountains and Wollemi National Park areas (Theischinger et al 2011). Specimens of *A. adamsi* are extremely rare, and prior to 1998 only 5 adult specimens were known, indicating that this species has extremely low local population sizes. Habitats where larvae have been found include small creeks with gravel or sandy bottoms, in narrow shaded riffle zones with moss and rich riparian vegetation (Web Reference 4). Considering these observations and owing to the generally poor level of knowledge of this species state-wide, the presence of *A. adamsi* in the Newnes Plateau study area (Carne Creek, Dingo Creek and Bungleboori Creek) cannot be discounted entirely.

2 AQUATIC STUDY DESIGN

2.1 Aims and Objectives

In terms of study aims, the Aquatic Ecology Sampling Program endeavours to answer the following questions:

- Where are the aquatic habitat resources in the study area?
- What are the ecological and riparian attributes of the study area aquatic habitats?
- Do the creeks provide suitable fish passage?
- Do the aquatic resources provide suitable and sustained aquatic habitat for fish and other aquatic biota?
- Are there any protected or threatened aquatic species or communities residing within the study area, or any mammals such as platypus and Australian water rat that may utilise the aquatic resources of the study area?

To achieve these objectives the sampling program includes following features:

- Sampling the aquatic macroinvertebrate fauna twice a year (in spring and autumn) using the AusRivAS sampling, sorting and identification protocols (see Section 2.2 below). Note that for AusRivAS standardised sampling purposes the ‘autumn’ sample season is defined as March 15 to June 15 and ‘Spring’ is defined as September 15 to December 15.
- Estimation of fish occurrence by a combination of overnight and spot bait-trapping, dip netting and observation, with all captured fish identified in-situ and immediately released.
- Depth profiles of metered water quality parameters: Temperature, Electrical Conductivity (salinity), water acidity (pH), Dissolved Oxygen and Turbidity, at each site during each sampling run.
- Descriptions of creek riparian condition and aquatic plant communities within the study area.

The adopted study design to achieve the objectives outlined above incorporated aquatic ecology sampling at eight in-stream sampling sites in autumn 2024, located overlying and down-stream of the proposed extraction area in creek drainage channels and NPSS.

Table 1 below presents the site descriptions and coordinates for all sites visited for the Mod 8 baseline aquatic ecology monitoring program surveys undertaken between spring 2021 and autumn 2024, and **Figure 2** (above) shows the autumn 2024 sampling site locations in relation to the proposed underground mining footprint. The upper Carne Creek stie CECUp was unable to be sampled in spring 2023 as the site was completely dry. An additional monitoring site was sampled for the second time for this survey, in an upper Bungleboori Creek northern tributary location (BCTNW) which drains land previously utilised for pine plantation (**Figure 2**).

Table 1 Clarence Mod 8 Aquatic Ecology Seasonal Sample Program Site Information

Catchment	Site	Site Coordinates		Sp21	Au22	Sp21	Au23	Sp23	Au24
		E	N						
Carne Creek	CCUp	242025	6302991	X					
	CCDn	242028	6304172	X					
	CECUp	242852	6302574	X	X	X	X	Dry	X
	CECDn	243244	6303488	X	X	X	X	X	X
Dingo Creek	DCUp	244522	6302755	X	X	X	X	X	X
	DCDn	244801	6303631	X	X	X	X	X	X
	DCDn2	245688	6305553	X					
	DECUp	245774	6302620	X	X	X	X	X	X
	DECDn	246264	6303597	X	X	X	X	X	X
Bungleboori Ck	BCUp	242186	6301187	X	X	X	X	X	X
	BCTNW	246751	6301656					X	X
Note:	Site coordinates are in MGA 56								

2.2 Macroinvertebrate Sampling Methods

The aquatic macroinvertebrate assemblages are determined using the standardised National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (the AusRivAS method (Turak et al 2004, Chessman 2003b). The AusRivAS protocol provides a number of definitions of sites and habitats within sites for selection of sampling locations and recommends that, wherever possible, two habitats (riffles and edges) be sampled at each site.

Sampling has conformed to these definitions:

- A site is "a stream reach with a length of 100 m or 10 times the stream width, whichever is the greater".
- A riffle habitat is "an area of broken water with rapid current that has some cobble or boulder substratum", and riffle samples collected from broken waters

with only pebble, gravel, sand or bedrock substratum may not produce reliable results.

- Edge habitat is "an area along the creek with little or no current".

Ideally, a particular reach within each of the sample locations is selected on the basis of it being (i) a reach with high drought resistance (generally based on pool size, depth and riparian cover) and (ii) a reach with high aquatic habitat diversity; ideally deep pools connected by gentle riffles, abundance of stream bed litter, presence of snags, presence of aquatic vegetation and good extent of cover of overhanging riparian vegetation.

While many of the upper catchment tributary creek and swamp sites are readily accessible, site selection for sampling aquatic biota from some of the incised catchment sites is constrained by access from the road network through the forest to the drainages where the creek flows through deeply incised canyons bordered by escarpment.

2.2.1 Field methods for macroinvertebrate sampling

Macroinvertebrate assemblages were sampled using a 250 µm mesh dip net over as many aquatic 'edge' habitat types as could be located within each of the pools along the defined stream reaches. Net samples were then placed into white sorting trays for in situ live sorting for up to 1 person-hour (with a minimum of 40 minutes), as per the AusRivAS protocol. Following cessation of live picking, further observations were made of the pool edge sample areas for surface aquatic macroinvertebrate taxa (e.g., water skaters and spiders) and any other taxa (such as freshwater crayfish) not collected by the dip netting process. Where possible (or necessary) representatives of these organisms were collected and added to the dip net samples.

Rarer specimens for which positive identification could be made in the field (e.g., water scorpions), were generally released. That is, for protection of the pool macroinvertebrate integrity we adopted a 'sampling with replacement' method. Notwithstanding this procedure, for all taxa that could be positively identified in the field, at least one of each of the field-identified taxa are retained as a representative of that taxa for that sampling event. For all other macroinvertebrate taxa where field identifications were not definitive, specimens were retained for later detailed taxonomic analysis in the laboratory. Notes are also kept of the presence of burrows and holes that are present in the site aquatic habitats (i.e., as indications of yabbies or burrowing dragonflies).

All retained specimens are placed in sample jars and preserved in 70% ethanol for subsequent laboratory identification. Each sample jar is labelled and paper laundry tags are inserted into the jars noting the sample site, sample date and sample collector/picker initials. Any giant dragonfly exuviae or exuviae of other threatened species are kept for confirmation purposes. Any larval threatened species specimens (*Archaeophya adamsi, Petalura gigantea* or *Austrocordulia leonardi*) retained during the macroinvertebrate sampling process are identified and counted, photographed and released.

Searches are also undertaken for threatened dragonflies (adults and exuviae; shells cast larval in the process of emergence) among suitable creek habitats (including Newnes Plateau Shrub swamp and along ridgelines) during the spring surveys.

2.2.2 Laboratory methods for macroinvertebrate samples

In the laboratory, taxonomic identifications are generally facilitated using Maggy lights or binocular dissecting microscopes and taxonomic guides such as; CSIRO, Land and Water Resources & Environment Australia (1999), Hawking & Smith (1997), Hawking & Theischinger (1999), Theischinger (2009) and Williams (1980).

Organisms are identified (as a minimum) to the appropriate taxa level as per AusRivAS protocols. These are as follows; family level for all insect taxa except Chironomids which are taken to sub-family). Collembola arthropods (Springtails) are classified as a single class and the arachnid arthropods (spiders and mites) are classified as two orders. For the mites (Order Acarina) we have taken them to sub-order classification level where possible. Crustaceans were taken to Family level where suitable keys are available. Ostracoda were left at Class level. The worm-like taxa are shown at Phylum or Class level. For all taxa, where suitable keys were available, taxa were identified to lower levels of taxonomy.

The sorted specimens are then transferred to individual glass vials (one per family/sub-family) and paper laundry tags inserted into each glass vial with the sample site, sample date and initials of taxonomist noted on the tags. Glass vials are then topped up with 70 % alcohol, sealed with plastic lids and placed back into the original field sample jars.

Where there are any individual specimens where the collected material is too indistinct or fragmented to assign a definitive identification, the samples are dispatched to relevant Australian Museum specialists or other specialists, as recommended by EPA.

For all samples the following taxonomic QA/QC procedure is followed:

> At least ten percent of the samples/sites are selected at random and the individual retained taxa are identified without reference to the original identifications. A table is then made of the original identifications verses the second identifications, indicating where there were any anomalies in identification (if any). If there are no anomalies, the QA/QC sample protocol is accepted and no further QA/QC checking is undertaken. If there are differences in identifications, all the samples containing the related taxa are re-examined to clear up the anomalies.

Following this procedure, and if there have been anomalies, an additional 10 percent of the remaining samples are chosen and the QA/QC procedure re-applied. This process continues until there are no differences between original identifications and QA/QC identifications.

2.2.3 Site SIGNAL index & EPT Index calculations

The aquatic invertebrate assemblage for each sample site is described in terms of the site taxa diversity (number of individual AusRivAS taxa) and in terms of a site SIGNAL score. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates. The indices are derived by correlation analysis of macroinvertebrate occurrence against water chemical analysis (Chessman 1995). The water chemistry attributes generally used are temperature, turbidity, conductivity, alkalinity, pH, dissolved oxygen, total nitrogen and total phosphorus (Chessman 2003a).

SIGNAL indices may be regionally specific (e.g. SIGNAL HU-97 developed for the Hunter Valley Catchment (Chessman 1997), or applicable Australia wide (e.g. SIGNAL-2, Chessman 2003a). Each macroinvertebrate Family has been assigned a SIGNAL score ranging from 10 (very pollution intolerant) to 1 (very pollution tolerant).

For the present study SIGNAL-2 scores are applied. Taxa with no published SIGNAL score are excluded from the site SIGNAL analysis. Once taxa SIGNAL indices have been applied individual site SIGNAL indices are calculated (as the mean) from all site taxa with SIGNAL scores. Creek SIGNAL scores are calculated as the mean of all taxa SIGNAL value occurrences recorded within each creek system for a survey.

Site and creek SIGNAL scores are then summarised and compared across each survey and between surveys. As a general guide site SIGNAL Indices are graded into the following categories (Chessman *et al.* 1997):

- SIGNAL Index > 6 = Healthy Unimpaired
- SIGNAL Index 5-6 = Mildly Impaired
- SIGNAL Index 4-5 = Moderately Impaired
- SIGNAL Index < 4 = Severely Impaired.

However, as the intent of this study is to assess site condition relative to other sites over time, the site scores are used for these comparison purposes rather than as overall study area condition indices. That is, the overall changes in site indices over time are of greater interest than the basic and generalised 'health' scores (as per Chessman et al 1997).

The combined number of Ephemoptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddis-fly) families present per site (the EPT index) is used to supplement the taxa richness (diversity) and SIGNAL index as an indicator of stream health, as members of these groups are known to be sensitive to pollution.

2.3 Field Sampling Methods for Fish and Other Vertebrates

At each macroinvertebrate sampling site, four fish bait traps (dimensions 250 mm by 250 mm by 400 mm, 4 - 5 mm mesh size and 50 mm diameter entrance) are set at suitable locations. These are left in the stream either overnight, or for the duration of the combined macroinvertebrate sampling and live picking survey (minimum 1.5 hours) and then retrieved. Captured fish are identified i*n situ* using Allen *et. al*., (2002) and McDowall (1996) and immediately released. Fish caught or observed as part of the macroinvertebrate dip net sampling are also identified, noted and released.

Dead fish specimens and any fish that cannot be positively identified in the field are taken to the Australian Museum for confirmation of species identification. These specimens with capture details are then incorporated into the Australian Museum collection as appropriate.

Following completion of the fish and macroinvertebrate sampling, any further observations of fish during the pool condition survey are also noted with fish species-name only noted if positively identified. For each survey, tadpoles (which are not macroinvertebrates but chordates) are noted in the results. Specimens are not kept or identified.

The presence of birds, reptiles and turtles that utilise the aquatic habitats are noted, and notes are made of the potential for the study area habitats to support platypus or Australian water rats where appropriate.

2.4 Field Water Quality Sampling

A calibrated submersible Yeo-Kal 618 water quality data logger is used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity at all aquatic ecology sampling sites. At some sites, depth profiles of water quality may also be made to test for layering/mixing. Physical observations are also taken in the field to highlight any aquatic habitat variations (e.g. recent rain, subsequent infilling, detritus in water column or on benthos, scum or flocculates in or on water body etc.) and the presence of fresh yabbie holes are also noted.

2.5 Aquatic Habitat Condition (RCE Index)

A standardised description of site aquatic habitat condition is used to compile a stream site condition index, based on a modified version of the Riparian, Channel and Environmental (RCE) Inventory developed by Petersen (1992), as reported by Chessman *et al* (1997) for the greater Hunter River catchment. The index is compiled by giving each of the 13 RCE descriptors a score between 0 and 4, then summing the scores, to reach a maximum possible score of 52. Scores are then expressed as a percentage.

3 CLARENCE MOD 8 AQUATIC ECOLOGY SURVEY RESULTS

Full field sampling notes for the autumn 2024 aquatic ecology sampling are provided in **Appendix Table A2**. Sampling for the full autumn 2024 survey was undertaken between the 30th May and 11th June 2024. Note that for sampling purposes the AusRivAS 'autumn' season is defined as March 15th to June 15th.

3.1 Sampling Conditions Leading into Autumn 2024

Rainfall measurements are recorded at Clarence Mine Meteorological Station, with long-term mean monthly totals acquired from Bureau of Meteorology (BOM) Lithgow (Cooerwull) Gauge 63226 (recorded from 1878 to current). **Appendix Table A-1** provides the daily rainfall records for 2023 and 2024 (July 2023 to June 2024) and **Figure 3** shows the rainfall data for the period since the most recent survey (spring 2023). While the previous spring (October) 2023 survey was undertaken following a dry winter period, rainfall patterns over summer and autumn were characterised by frequent wet weather events:

- November 2023 to January 2024 saw regular rainfall with 377mm recorded over 50 rainfall days, much higher than the combined three-monthly mean total of 232mm. This included one significant event on December 21 where 109mm fell over a single day (**Figure 3**).
- While February recorded regular rain of 82mm over 22 rainfall days, March was relatively dry with only 30mm.
-

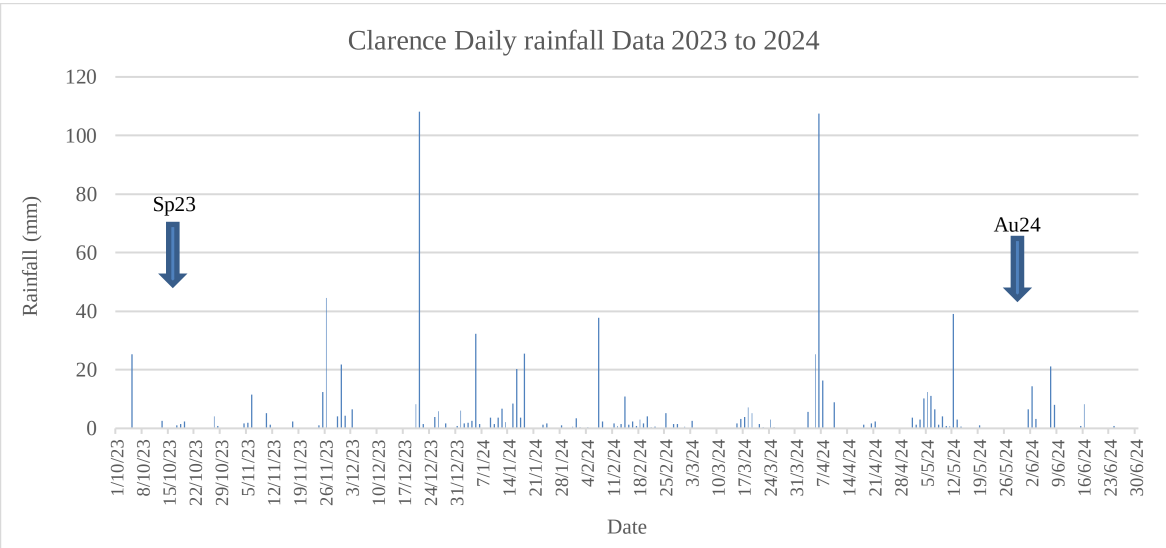


Figure 3 Clarence mine site daily rainfall July 2023 to June 2024.

- Another heavy storm event in early April produced 149mm over a three-day period (including 107mm on April 6th), and the overall April total (169mm) was almost three times its monthly mean.
- The period leading into the autumn 2024 survey saw sustained light showers with 99mm recorded over 18 rainfall days (including one 39mm rain event on May 12th), and only 1.6mm was recorded over the two weeks prior to the commencement of sampling on May 29th.
- Following the initial sample dates in late May, sampling was postponed until the 11th June due to wet weather where 53mm was recorded in early June.

3.2 Autumn 2024 Aquatic Ecology Survey Results

The Clarence Mod 8 autumn 2024 aquatic ecology survey was undertaken between the 30th May and 11th June 2024 following the sampling schedule shown in **Table 1** and **Figure 2** above and using the methodology outlined in **Section 2**. Site photos are also provided **Appendix A**. Summary tables for the autumn 2024 Appendix A data are provided in the following sections and include the results from five previous baseline surveys (spring 2021, autumn and spring 2022, autumn and spring 2023).

3.3 Autumn 2024 Metered Water Quality Results

A calibrated water quality meter is used at all aquatic ecology sampling sites plus at selected intermediary sites to record surface water quality - and where applicable, depth profiles of water temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity. **Table 2** provides the results of metered water quality sampling for the Clarence Mod 8 autumn 2024 aquatic ecology field sampling program.

Table 2 Mod 8 Water Quality Results Autumn 2024

Site	Date	Time	Depth	Temp	Cond	DO	DO	pH	Turb
			m	°C	µS/cm	%sat	mg/L	Units	ntu
CECUp	30/5/24	14:26	0.1	14.68	12	135.2	13.74	4.98	0.1
CECDn	30/5/24	14:55	0.1	6.80	5	92.9	11.36	5.29	1.3
CECDn	30/5/24	14:55	0.2	6.80	5	92.1	11.27	5.34	0.7
DCUp	11/6/24	12:33	0.1	5.81	1	88.2	11.06	4.94	0.5
DCDn	11/6/24	12:03	0.2	5.68	2	88.4	11.12	5.20	15.5
DECUp	30/5/24	10:53	0.1	7.24	5	91.1	11.02	5.43	0.2
DECUp	30/5/24	10:53	0.2	7.25	5	91.0	11.00	5.45	0.2
DECDn	30/5/24	12:46	0.1	7.93	10	98.9	11.76	5.28	0.3
BCUp	31/5/24	9:39	0.1	7.09	5	85.5	10.37	5.28	0.2
BCUp	31/5/24	9:39	0.2	7.09	5	86.1	10.45	5.30	0.5
BCTNW	30/5/24	8:20	0.1	7.07	7	101.8	12.36	5.67	0.2
BCTNW	30/5/24	8:20	0.2	7.07	6	101.1	12.28	5.69	0.2

3.4 Aquatic & Riparian Habitat Condition

The field notes (**Appendix Table A-2**) provide details of stream reach flows, pool and channel dimensions and available aquatic habitats for the present survey. The overall Aquatic and Riparian Habitat condition - as estimated using the RCE Index - are provided in **Appendix Table A-3** with summary provided below in **Table 3**, and **Table 4** provides the results of aquatic macrophyte occurrences for the autumn 2024 aquatic ecology sampling sites.

Table 3 Summary of RCE Results Autumn 2024

Category	CECUp	CECDn	DCUp	DCDn	DECUp	DECDn	BCUp	BCTNW
Land-use pattern beyond immediate riparian zone	2	2	2	2	2	2	3.5	4
Width of riparian strip-of woody vegetation	3.5	3	3	2.5	2.5	3	4	4
Completeness of riparian strip of woody vegetation	3	3	2	2	2	2	4	4
Vegetation of riparian zone within 10 m of channel	3.5	3.5	3.5	3.5	3.5	3.5	4	4
Stream bank structure	3	3	3	3	3	3	4	4
Bank undercutting	3	3	4	4	4	3	2.5	3
Channel form	3	3	2	2	2	4	4	4
Riffle/pool sequence	2	2	2	2	2	4	4	4
Retention devices in stream	2	2	2	2	3	4	4	3.5
Channel sediment accumulations	3	2	2	2	2	2.5	3	3
Stream bottom	4	2	2	2	2	2	2.5	3
Stream detritus	3	3	3	3	3	3	4	3
Aquatic vegetation	3.5	3.5	3.5	3.5	3.5	3.5	4	4
Autumn 2024 Site RCE Score (%)	74.0	67.3	65.4	64.4	66.3	76.0	91.3	91.3
Spring 2023 Site RCE Score (%)	Dry	66.3	65.4	63.5	65.4	75.0	89.4	91.3
Autumn 2023 Site RCE Score (%)	68.3	68.3	65.4	63.5	66.3	75.0	88.5	-
Spring 2022 Site RCE Score (%)	68.3	67.3	65.4	64.4	67.3	76.0	89.4	-
Autumn 2022 Site RCE Score (%)	69.2	68.3	66.3	65.4	67.3	76.9	89.4	-
Spring 2021 Site RCE Score (%)	-	68.3	65.4	64.4	66.3	76.9	90.4	-

Table 4 Macrophyte Occurrence Autumn 2024

Site	Rush *Baumea rubiginosa*	Grass *Carex gaudichaundiana*	Jointed Rush *Juncus articulatus*	Bulbous Rush *Juncus bulbosus*	Rush *Juncus sp*	Water Milfoil *Myriophyllum sp?*	Tufted Algae *Batrochospermum sp*	Charophytes
CECDn			1	1	1	1		
DCUp	1		1	1	1			1
DCDn	1		1	1	1			1
DECUp	1		1	1				1
DECDn	1		1	1	1	1		
BCUp	1		1	1		1	1	
BCTNW		1		1			1	1

3.5 Aquatic Macroinvertebrate and Fish Survey Results

Appendix Table A-4 provides the results of aquatic macroinvertebrate taxonomic identifications to the levels required by AusRivAS, plus occurrence data for all aquatic macroinvertebrates and fish. The table also provides site SIGNAL and EPT scores (see **Section 2.2.3** for explanation of SIGNAL and EPT).

The autumn 2024 Clarence Mod 8 aquatic ecology monitoring site Diversity (taxa richness), SIGNAL and EPT diversity results are provided in **Figures 4** to **6** below, and include the mean (± standard deviation SD) site summary statistics calculated from five previous surveys (spring 2021, autumn and spring 2022, autumn and spring 2023) with the following exceptions:

- CECUp mean values are calculated from three surveys only (autumn and spring 2022, autumn 2023) as the site was not sampled in spring 2021, and there is no data for the spring 2023 survey as the site was dry.
- BCTNW has only been sampled previously on one occasion in spring 2023, and the spring 2023 survey values are shown as by grey bars in Figures 4 to 6.

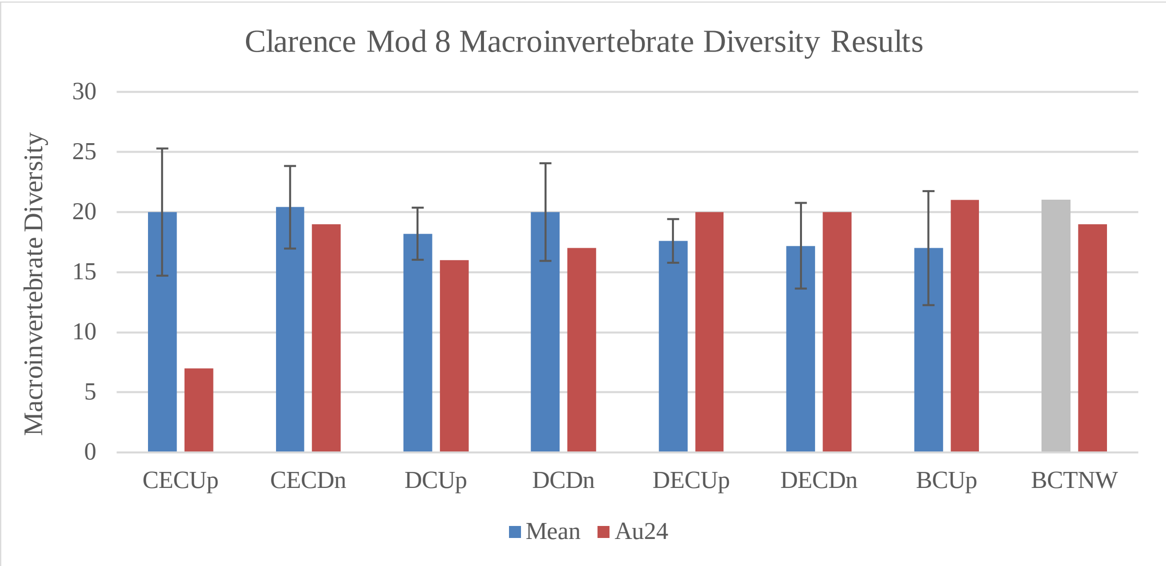


Figure 4 Mod 8 autumn 2024 survey macroinvertebrate taxa diversity results.

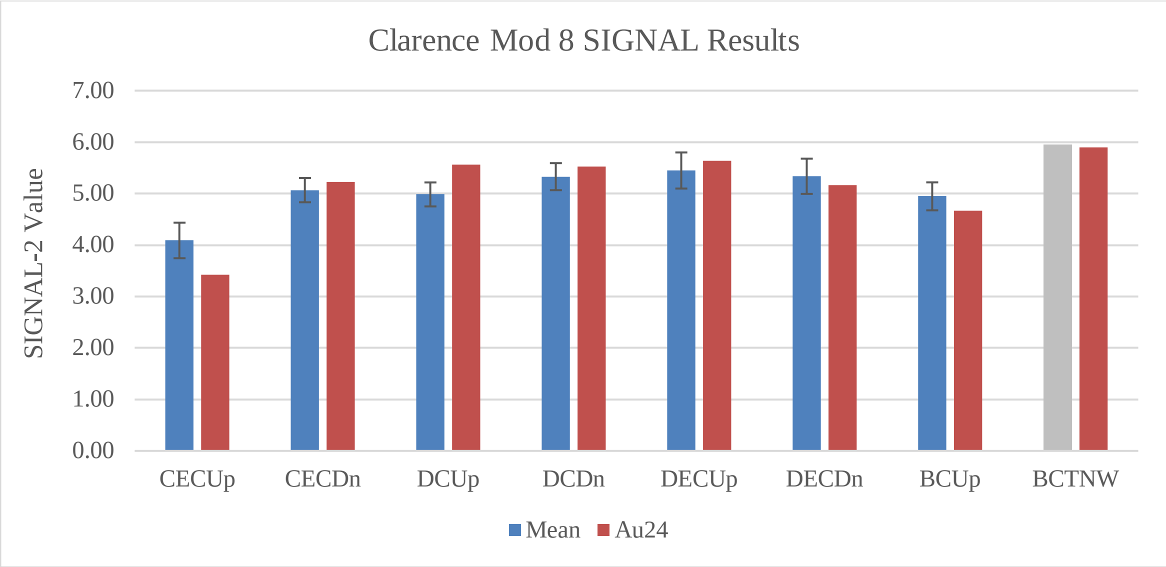


Figure 5 Mod 8 autumn 2024 survey SIGNAL-2 scores.

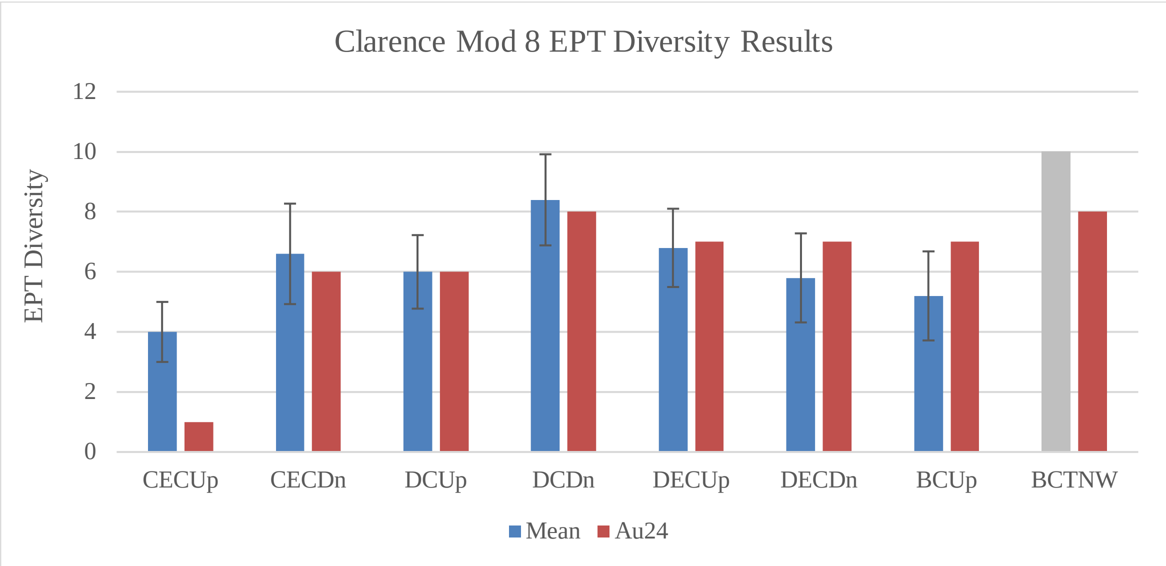


Figure 6 Mod 8 autumn 2024 survey EPT taxa diversity.

Tadpoles were recorded from Carne Creek site CECUp, and mountain galaxias (*Galaxias olidus*) fish were only recorded from Bungleboori Creek site BCTNW in autumn 2024. There were no threatened or protected invertebrate or vertebrate aquatic species (as listed under the BCA, FMA or EPBC) caught or observed during the autumn 2024 Clarence Mod 8 aquatic ecology monitoring survey, nor were there individuals observed, or any indications of platypus or Australian water rat usage within the study area.

4 REFERENCES

Allen, G.R., Midgley, S.H. and Allen, M. (2002)
Field Guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, WA.

ANZECC/ARMCANZ (2000)
Australian and New Zealand Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Chessman, B. C (1995)
Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology* 20, pp. 122-129.

Chessman, B. C., Growns, J. E. and Kotlash, A. R. (1997)
Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. *Marine & Freshwater Research* 48, pp. 159-172.

Chessman, B. C., (2003a)
New Sensitivity grades for Australian river macroinvertebrates. *Marine & Freshwater Research* 54, pp. 95 - 103.

Chessman, B. C., (2003b)
SIGNAL 2 – A Scoring System for Macro-invertebrate (‘Water Bugs’) in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra

CSIRO, Land and Water Resources & Environment Australia (1999)
Interactive Guide to Australian Aquatic Invertebrates. CSIRO Australia.

Hawking, J. & Smith, F. J. (1997)
Colour Guide to Invertebrates of Australian Inland Waters. Co-operative Centre for Freshwater Ecology, Albury.

Hawking, J. & Theischinger, G. (1999)
Dragonfly Larvae (Odonata). A Guide to the Identification of Larvae of Australian Families and to the Identification and Ecology of Larvae from New South Wales. Co-operative Centre for Freshwater Ecology, Albury, and Australian Water Technologies Pty Ltd, West Ryde. CRCFE Identification Guide No. 24.

McDowall, R. (1996)
Freshwater Fishes of South Eastern Australia. Reed Books, Sydney, NSW.

MPR (2022a)

Dingo Creek Catchment Aquatic Ecology- Spring 2021 Data Report. Report prepared for Clarence Colliery, February 2022.

MPR (2022b)

Dingo Creek Catchment Aquatic Ecology- Autumn 2022 Data Report. Report prepared for Clarence Colliery, August 2022.

MPR (2023a)

Dingo Creek Catchment Aquatic Ecology- Spring 2022 Data Report. Report prepared for Clarence Colliery, March 2023.

MPR (2023b)

Dingo Creek Catchment Aquatic Ecology- Autumn 2023 Data Report. Report prepared for Clarence Colliery, August 2023.

MPR (2024)

Dingo Creek Catchment Aquatic Ecology- Spring 2023 Data Report. Report prepared for Clarence Colliery, March 2024.

Peterson (1992)

The RCE: a Riparian Channel and Environmental Inventory for small streams in the agricultural landscape. Freshwater Biology 27: 295 - 306.

Theischinger, G. & Jacobs, S., & Krogh, M. (2011)

Archaeophya adamsi Fraser (Odonata, Gomphomacromiidae): not in Queensland, but safe in New South Wales? *Agrion* 15 (2): 64 - 68.

Turak, E., Waddell, N. & Johnstone, G. (2004)

New South Wales Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual. Department of Environment and Conservation, Sydney.

Web Reference 1:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10974: NSW Threatened Species Website.

Web Reference 2:

http://www.environment.nsw.gov.au/determinations/GiantDragonflyEndSpListing.htm: NSW Dept Environment, Climate Change &Water.

Web Reference 3:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=1022: NSW Threatened Species Website.

Web Reference 4:

http://pas.dpi.nsw.gov.au/Species/Species_Profile.aspx?SpeciesListingID=10: NSW Primary Industries.

Williams, W.D. (1980)
Australian Freshwater Life. The Invertebrates of Australia Inland Waters. The MacMillan Co. of Australia Pty Ltd, Sydney.